DOE/OR/22686-1--Vol. 1

SNS

SPALLATION NEUTRON SOURCE

SNS

VALUE ENGINEERING

VALUE ENGINEERING STUDY FINAL REPORT ON --

SPALLATION NEUTRON SOURCE, OAK RIDGE, TENNESSEE

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JANUARY 1999

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Spallation Neutron Source
Table of Contents

*Page No.

Table of Contents 1

Project Description and Background 3

Schematic Drawing of SNS Accelerator System and Collaboration Responsibility 4

SNS Level 1 System Diagram 5

SNS Functional Organizational Chart 6

SNS Work Breakdown Structure 7

Executive Summary 8

Value Engineering Total Project Savings by WBS 10

Summary of Accepted SNS Value Engineering Proposals 11

Value Engineering Proposals Summaries and Proposals by WBS:

WBS 1.2 - Project Support 15

WBS 1.3 - Front End 26

WBS 1.4 - Linac and Linac Controls 40

WBS 1.5 - Ring 74

WBS 1.6 - Target 107

WBS 1.7 - Instruments (This WBS was not studied individually, but proposals were realized from within other WBS)

WBS 1.8 - Conventional Facilities 152

WBS 1.9 - Controls 228

WBS 1.10 - Operations 255

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Spallation Neutron Source
Table of Contents

*Page No.

Supporting Documents:

Appendix A: Contact Directory 268

Appendix B: Speculation Lists 272

Appendix C: Cost Models 294

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Spallation Neutron Source
Project Description and Background

The Spallation Neutron Source (SNS) is a next-generation, accelerator-based, pulsed-neutron source being built for the Department of Energy's (DOE) Office of Science (SC) to serve the R&D needs of DOE and the scientific and industrial communities in the United States. The SNS will produce neutron beams by bombarding a flowing mercury target with protons from an accelerator system. The accelerator consists of an ion source, a linear accelerator (Linac), and an accumulator ring that combine to produce intense, 1 GeV, short (1 Fs) pulses of protons delivered to the target at a frequency of 60 Hz. The protons produce neutrons in the mercury target through the spallation nuclear reaction process with each proton producing 20C30 neutrons. The pulsed neutron beams are moderated and guided into 18 beam lines in an experiment hall where they are used for a variety of neutron scattering measurements. The initial design of SNS is for a neutron source with an average beam power of 1 MW. However, since the future needs of the neutron science community are for higher intensities, the SNS is being designed to be upgradeable to significantly higher powers.

A collaborative approach has been chosen for the design and construction of the SNS. It involves five DOE National Laboratories [Argonne National Laboratory (ANL), Brookhaven National Laboratory (BNL), Lawrence Berkeley National Laboratory, Los Alamos National Laboratory (LANL), and Oak Ridge National Laboratory (ORNL)]. This approach has the advantages of assembling the best available expertise in accelerator, target, and instrument design from among the participating laboratories, as well as allowing ORNL to transition to a staff skilled in operating, maintaining, and upgrading the facility for the DOE user community once SNS is completed. Also, by involving DOE laboratories with active neutron user programs (Intense Pulsed Neutron Source at ANL, Los Alamos Neutron Science Center at LANL, High Flux Beam Reactor at BNL, and High Flux Isotope Reactor at ORNL), the SNS gains immediate access to the neutron science community and the most recent information on instrumentation development.

The need and justification for the SNS has been firmly established through the distillation and assessment of numerous studies by the DOE and the national and international scientific communities dating from the early 1970s. The actual performance requirements and instrumentation needs have been similarly established through recent scientific assessments and user meetings involving the scientific and industrial communities. These requirements form the basis of the current reference design and proposed instrument suite for the SNS.

The SNS Project has had numerous DOE/SC reviews to validate the technical baseline, management approach, cost, schedule, and Conceptual Design Report. As a result, in FY 1999 the SNS received $130 million and approval from Congress to initiate Title 1 design and construction activities. Since this funding was less than requested for FY 1999 ($157 million) and validated in previous reviews, and because of improved costing information, the SNS Project team will reassess the cost and schedule baselines in an upcoming DOE review in January 1999. In preparation for this reassessment, the SNS has initiated a value engineering process to improve the design and to recover cost and contingency. Value engineering will continue throughout the life of the project, but the results described in this report are our initial efforts.

SPALLATION NEUTRON SOURCE

ARGONNE NATIONAL LABORATORY
UNIVERSITY OF CHICAGO

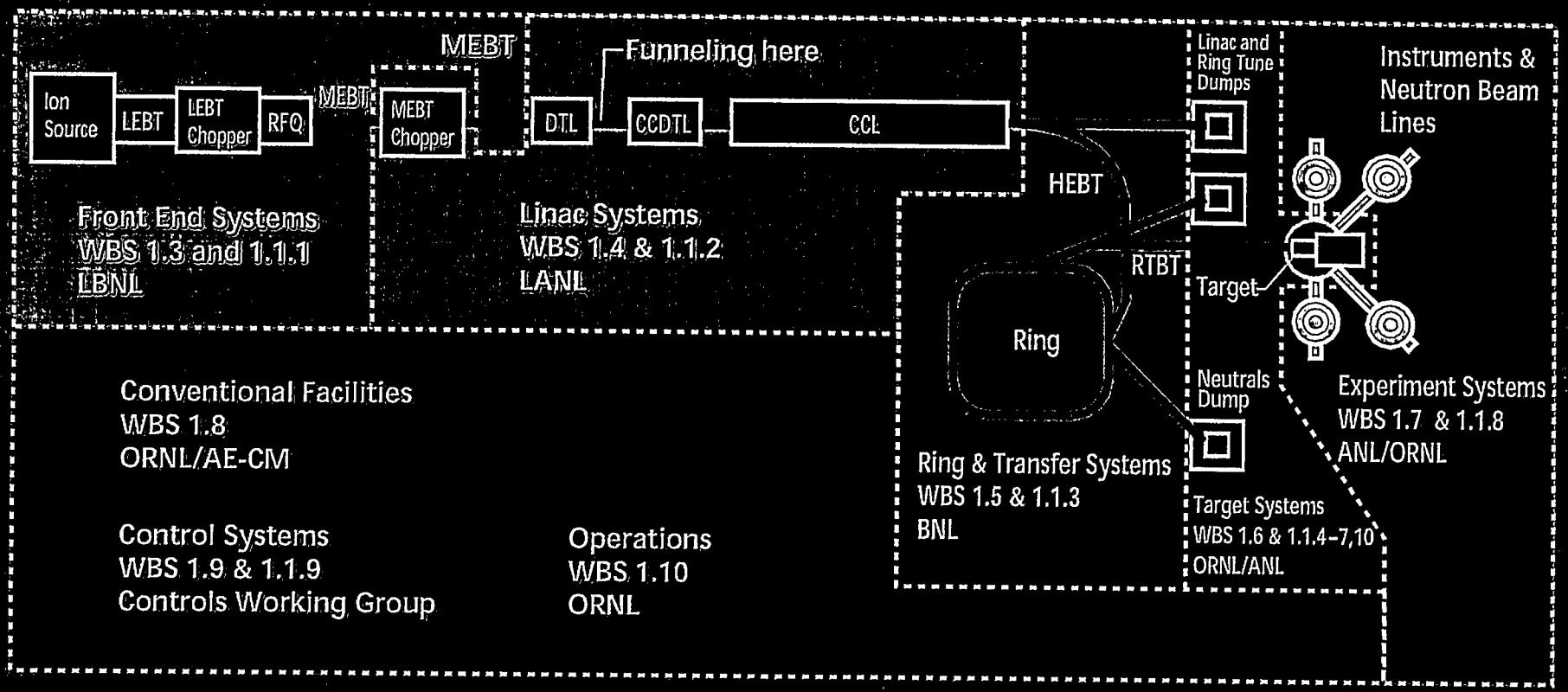
BNL
BROOKHAVEN NATIONAL LABORATORY

BERKELEY LAB

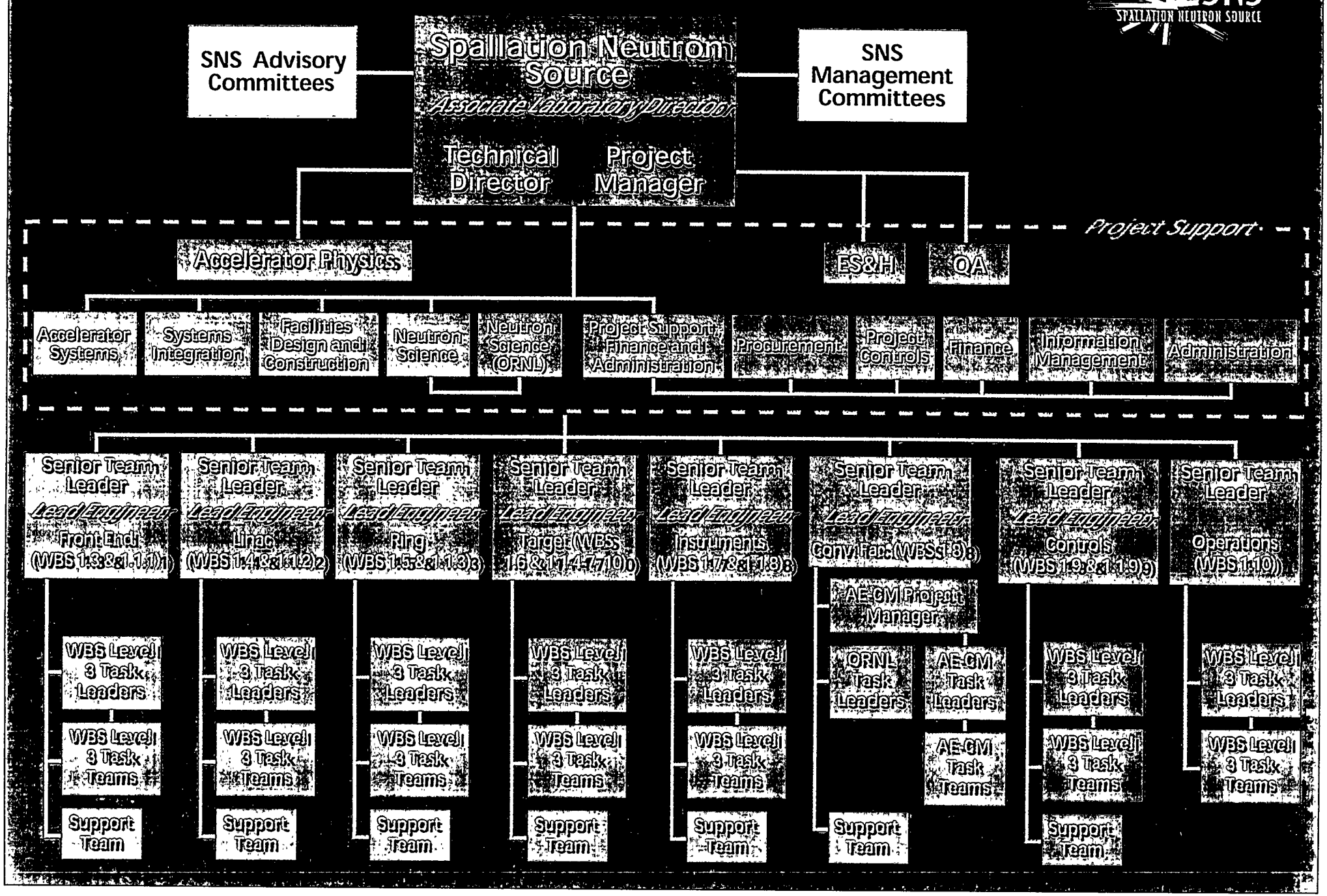
Los Alamos
NATIONAL LABORATORY

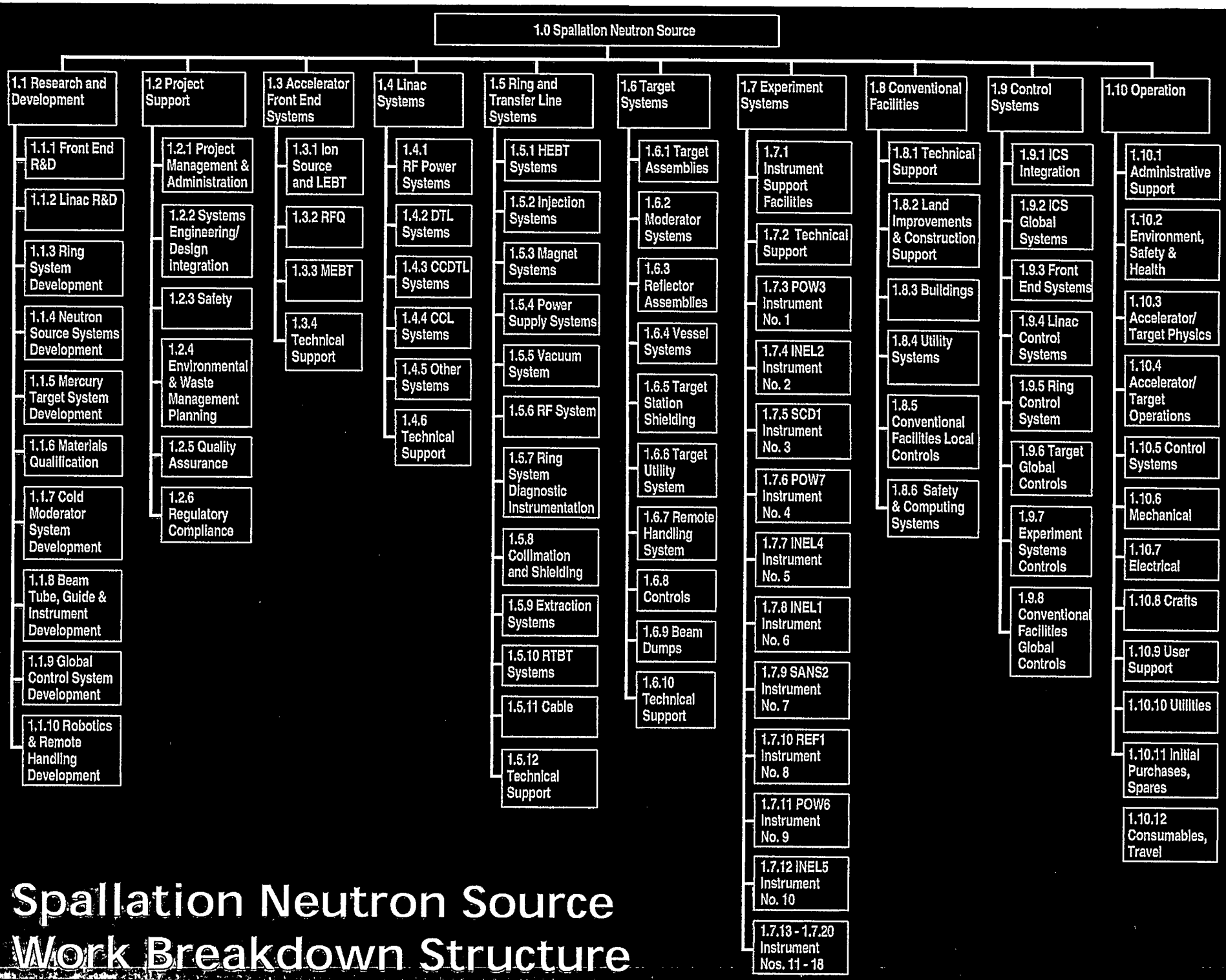
ornl

Spallation Neutron Source (SNS)
Level 1 System Diagram



SNS Organization Chart





Spallation Neutron Source Work Breakdown Structure

Spallation Neutron Source
Executive Summary

The concept of Value Engineering (VE) is something that has been built into the design and R&D philosophy of the SNS collaboration from the beginning. To illustrate this, some of the items identified in the current VE study were actually identified earlier in the project but are just now coming to completion. Consequently, the collaboration views VE as a continuous process.

The present VE study was prompted by cost imbalances that arose at the time of the Department of Energy's June 1998 review, and the recognition that the SNS project would not receive the requested funding for FY 1999 and would thus need further reexamination of the baseline costs. On September 1-3, 1998, the SNS collaboration held two workshops – one for commissioning and pre-ops planning, and one to lay the ground work for a formal VE workshop. This initiation started the participating laboratories thinking about what would be needed when we met again for a full VE workshop. We interviewed a number of firms and selected the Army Corps of Engineers OVEST organization to facilitate the VE process for the SNS.

The Value Engineering study was initiated during the VE working conference conducted in the Oak Ridge National Laboratory, SNS Project Office, during October 20 through 23, 1998. The study was based on the Concept Design and WBS Level 3, Estimate submittal dated October 6, 1998. Participating in the workshop portions of the study were representatives of Argonne National Laboratory, Brookhaven National Laboratory, Department of Energy, Fermi National Accelerator Laboratory, Lawrence Berkeley National Laboratory, Lockheed Martin Energy Systems, Lockheed Martin Energy Research Corp, Los Alamos National Laboratory, Knight/Sverdrup, Oak Ridge National Laboratory, Stanford Linear Accelerator Center, and CoE – Nashville District and OVEST. A site tour was conducted with Conventional Facilities design team members to present site conditions and overview of the design with the Nashville District and OVEST team members.

The project was studied using the Corps of Engineers' standard value engineering (VE) methodology, consisting of five phases:

> Information Phase: Presentations were made by WBS elements with general scope descriptions and relative WBS costs. The team reviewed the descriptions of project work, drawings, figures, and cost models to understand the work to be performed and the functions to be achieved. Cost models were compared to areas of relative high cost to ensure that the team focused on those parts of the project which offered the most potential for cost savings.
>
> Speculation Phase: The team speculated by conducting brainstorming sessions to generate ideas for alternative designs. Each WBS was brainstormed. All team members contributed ideas and critical analysis of the ideas was discouraged.
>
> Analysis Phase: Following the Speculation Phase, the team analyzed these ideas and ranked them by WBS and by priority for development. Ideas which did not survive critical analysis were noted to be deleted.

Spallation Neutron Source
Executive Summary

Development Phase: WBS working groups were formed to fully coordinate and develop the selected priority ideas during an intensive technical development session. Four Categories were defined for all ideas as follows: I – Recommended for January Baseline (typically low risk, implementable, and savings can be identified); II – May follow January Baseline (typically medium risk, possibly implementable after longer deliberation, and savings can be identified); III – Recommended for long term study beyond January Baseline (typically higher risk, not fully known to be implementable, and savings relative to risk may be marginal); and IV – Idea Deleted (with reason for elimination). Coordination was maximized as ideas were defined and developed as many items crossed WBS boundaries.

Presentation Phase: Formal Presentation of the VE study recommendations was made by each WBS working group Team Leader during November 3-4, 1998. Identified savings of $85.6 million were realized to recover project cost contingency and redefine the baseline costs. The summary of the SNS Total Project Savings by WBS is given on the following page.

SPALLATION NEUTRON SOURCE TOTAL PROJECT SAVINGS BY WBS

SUB-PROJECT	WBS	10/6/98 ESTIMATE	11/3/98 ESTIMATE	IDENTIFIED SAVINGS	NEW ESTIMATE
Project Support	1.2	$ 40.6 M	$ 40.6 M	$ 9.5 M	$ 31.1 M
Front End	1.3,1.1.1, 1.9.3	24.1	24.1	1.16	22.9
Linac	1.4, 1.1.2, 1.9.4	317.8	317.8	32.7	285.1
Ring	1.5, 1.1.3, 1.9.5	158.4	158.4	6.2	152.2
Target	1.6, 1.1.4-7, 1.1.10, 1.9.6	99.7	99.7	2.6	97.1
Instruments	1.7, 1.1.8, 1.9.7	64.3	64.3	--	64.3
Conventional Facilities	1.8, 1.9.8	303.7	303.7	30.8	272.9
Controls	1.9.1-2, 1.1.9	25.7	25.7	1.6	24.1
Operations	1.10	69.2	80.8	1.0	79.8
Subtotal Work Package Cost		1,103.5	1,115.1	85.6	1,229.5
Tenn Tax		40.7	40.7		40.7
TOTAL		1,144.2	1,155.8	85.6	1,070.2

SUMMARY OF ACCEPTED SNS VALUE ENGINEERING PROPOSALS

Number	Category		Amount (K$)
		Project Support (WBS 1.2)	
1	I	Apply new special overhead rates from ORNL	1,000
2	I	Transfer project dedicated personnel to Building 104 and SNS Division	5,000
3	I	Transfer or loan project dedicated personnel to SNS Division	3,500
		Total Project Support	**9,500**
		Front End (WBS 1.3)	
1	I	Eliminate RFQ Model. Do not build prototype RFQ model.	620
2	I	Eliminate Tech Support to Pre Ops in FY 2004	540
3	I	Transfer 402.5 MHz Klystron system to WBS 1.4 (2200)	
		Total Front End	**1,160**
		Linac (WBS 1.4)	
1	I	Change to IGBT for DTL, CCDTL and CCL	7,200
2	I	Change overheads, taxes, and PM	24,600
3	I	Change design basis to 52 Klystrons and shorten DTL to CCL length by 28 m	9,600
4	I	Quantity Discounts and Manufacturing Process Change	3,100
7	I	Transfer RFQ Klystron System to LANL (2200)	
8	II	Limit upgrade of LANL brazing facility	1,000
12	II	Procure preshaped copper	8,000
13	II	Use existing equipment for 402.5 MHz Klystrons	300
		Items accounted for in 10/6 total	(21,100)
		Total Linac	**32,700**

SUMMARY OF ACCEPTED SNS VALUE ENGINEERING PROPOSALS

Number	Category		Amount (K$)
		Ring and Transport Systems (WBS 1.5)	
1	I	Reduce the number of HEBT corrector magnets	56
2	I	Reduce the number of HEBT corrector power supplies	266
3	I	Reduce the number of HEBT BPM	490
4	I	Reduce RF cavities from 4 to 3. RF Cavity.	840
5	I	Reduce RF cavities from 4 to 3. Power Amplifier.	560
6	I	Reduce the number of RTBT corrector magnets	56
7	I	Reduce the number of RTBT corrector power supplies	182
8	I	Reduce the number of RTBT BPM	420
9	I	Reduce software support manpower	840
10	II	Remove extraction kicker magnet spares from construction budget (to 1.10, 280)	
11	II	Remove extraction kicker power supply spares from construction budget (to 1.10, 98)	
12	II	Remove extraction lambertson magnet spare (to 1.10, 280)	
13	I	HEBT and RTBT controls cost reduction due to corrector and BPM change (to 1.9, 431)	
14	I	Sample testing of production magnet	700
15	I	Provide 1/2 the number of ion pumps	336
17a	I	Reduce the number of portable shields	840
19	I	Shorten the RTBT line by 20 meters	420
21	I	Shorten the HEBT line by 6 meters	48
23a	I	Use two normal magnets in lieu of a special, long magnet for the Linac dump line	71
37	I	Have all collimator shielding fabricated in Tennessee	114
		Total Ring and Transport Systems	**6,239**

SUMMARY OF ACCEPTED SNS VALUE ENGINEERING PROPOSALS

Number	Category		Amount (K$)
		Target Systems (WBS 1.6)	
2	I	Use Y-12 Hg	30
5	I	No on-line replacement for H2 circulators	60
6	II	Use recycled lead for reflector	100
8	II	Use TTF manipulators for SNS	285
13	II	Power and duty specs for beam dumps	200
15	II	Eliminate high velocity erosion/corrosion test	693
16	I	No design/V7V for ORELA experiment	100
17	I	No neutronic R&D Technical Support	108
18	I	No irradiation with flowing Hg	1,000
		Total Target Systems	**2,576**
		Conventional Facilities (WBS 1.8)	
1	I	Front End Bldg – reduce height from 18' to 12'	210
2	I	Front End Bldg – Control Room changed to Tech Shop	10
3	I	Shorten linac length by 28 m	3,340
6	III	Use precast tunnels	1,110
9	I	Eliminate stubouts for HEBT & RTBT, and reduce length of RTBT by 20 m	5,110
10	I	Replace existing Ring Escape Hatch with horizontal egress	230
12a	I	Defer upgrade capability	550
16	I	Defer Predictive Maintenance System	1,900
17	I	Eliminate HEPA filters in tunnels	1,180
18	I	Review Business Computing System	1,130
24	I	Eliminate Visitor Gallery in Target Bldg.	2,540
27	I	Minimize AC in shops	410
33	I	Reduce target floor loads	1,470
34	I	Use Gantry crane instead of overhead crane in Klystron Shop	300
35	I	Use reinforced earth retaining wall instead of concrete	1,470
39	I	Construct maintenance shops early	1,020

SUMMARY OF ACCEPTED SNS VALUE ENGINEERING PROPOSALS

Number	Category		Amount (K$)
		Conventional Facilities (WBS 1.8)	
44	I	Combine offices & control bldg. Review total offices	110
51a	I	Reconfigure Target Bldg.	3,340
60	I	Front End Bldg. – optimize footprint	260
61	I	Use cryo unit from ANL	2,490
63	I	Reduce the power and duty factor specs. for 3 beam dumps	750
64	I	Shorten HEBT by 6 m	410
68	I	Change to IGBT (DTL to CCL)	1,450
		Total Conventional Facilities	**30,790**
		Controls (WBS 1.9)	
1	I	Software development systems	200
2	I	Defer Interface Predictive Maintenance System	400
		Eliminate Interface to Business Computing System	400
L1	I	Controls savings related 52 Klystron change	175
R1	I	Controls savings related to reduction in ring needs	431
		Total Controls	**1,606**
		Operations (WBS 1.10)	
1	I	Optimize spares	1,000
		Total Operations	**1,000**
		Grand Total	**85,571**

B. R. Appleton
12/1/98

VALUE ENGINEERING PROPOSALS

WBS 1.2 – Project Support

No./ Cat.	WBS Numbers	Proposal Description	Rational/ Advantages	Impact/ Disadvantages	Risk	Savings (000)	Recommended Action	Comments
1/I	1.2.1	Apply new special overhead rates from ORNL	Cost savings	None	L	1.0M	Re-estimate ORNL work. (P. Rader)	DOE approved
2/I	1.2.1	Transfer project dedicated personnel to building 104 (33 people) and SNS Division	Review costs, improves project control	None to project, functional organization will experience an increase in rates	L	5.0M	ALD agreement within Lab	Assume 80% will be realized, TBD
3/I	1.2.1	Transfer or loan project dedicated personnel to SNS Division (7 people)	Improves costs, improves project control	None	L	3.5M	ALD agreement within Lab	For full-time personnel not relocated with project.
4/I	1.2.1	Plan/consolidate meetings to reduce costs	Cost savings, more efficient use of personnel	None	L	TBD (Minimal)	Project meetings schedule. Consolidate advisory groups. Implement site reviews. (Strawbridge / Johnson)	Validate budget
5/I	1.2.1	Perform ORNL staff review to eliminate duplicate functions with project site personnel	Eliminate overlapping functions, improve efficiency.	None	L	TBD (minimal) (may increase)	Strawbridge / Rader / Johnson	Follow-up during site visits
6/I		Support review common use of contract by all sites	Reduction effort in awards, pre-qualify local vendors	None	L	TBD (minimal)	Policy direction. (L. Brown)	Use to capture contingency (goal)
Subtotal I						9.5M		
7/II		Move technical support dollars to line items (review rates)	Consistent approach	Audit acceptance of rationale	L	L/M	Direction to Labs to move PM of R&D (Rader)	
Subtotal II						TBD		
8/III		Review overhead charges/taxes at all Labs for additional reductions	Maximize benefit from lower rates, lower TPC		L	TBD	Analyze during cost scrubs (Rader)	
9/III		Complete negotiations on favorable application of TN tax	Minimize tax liability	Potential application to design not in current estimate	M	5M	Complete negotiation (DOE/HQ assist with DOE Gen. Counsel) (Rader)	
		Move business computing to ORNL (from 1.8) (office PC's)	←		Back to 1.8			
10/III		Identify long-term economic travel strategy (from 1.8)	Reduced cost	None	L	TBD (small)	1) Examine budgets during site visits 2) Formulate plan for lodging, rental cars, etc.(Rader	
Subtotal III						5.0M		

New ORNL Overhead Rates
WBS 1.2 Project Support (1/I)

- **Proposal Description:**
  - Apply new, lower, special overhead rates from ORNL to all ORNL activities.
- **Rationale:**
  - New overhead rates were developed as a result of the implementation of a new cost accounting system at ORNL. The rates are, in general lower.
- **Savings:**
  - TBD (requires in-depth analysis of all areas).
- **Schedule Impact:**
  - None
- **Related Impact (include operations):**
  - All WBS elements involving ORNL staff will need to re-estimate planned work based on the approved new rates. It is expected that certain WBS elements will be favorably impacted while others will he adversely impacted. The overall impact to the project is expected to be.neutral. Impact to the operations budget is expected to be a slight decrease.
- **Benefits/Advantages:**
  - Realignment of the project budget based on the new rates.
- **Risk :**
  - None
- **Action/Person Responsible:**
  - Pat Rader

Transfer of Dedicated Staff to SNS Division (Employees co-located with the SNS Division)
WBS 1.2 – Project Support (2/I)

- **Proposal Description: Transfer-in or arrange a loanee-in agreement for project dedicated personnel who will be co-located with SNS Division personnel (~33 people).**
- **Rationale: These employees will be co-located with the SNS Division and will be supervised and directed by SNS Management.**
- **Savings: $6.2M (to be refined). This is based on escaping organizational burden and space charge costs. The SNS Division pays the office space lease cost directly in lieu of the space charge**
- **Schedule Impact: None**
- **Related Impact (include operations): None**
- **Benefits/Advantages: Cost savings by eliminating excessive burden and space costs.**
- **Risks: Low**
- **Actions/Person Responsible: Agreement with lab/other divisions. (Bill Appleton)**

Transfer of Dedicated Staff to the SNS Division (Employees not co-located with the SNS Division)
WBS 1.2 – Project Support (3/I)

SNS

- **Proposal Description: Transfer-in or arrange a loanee-in agreement for project dedicated personnel who will not be co-located with SNS Division personnel (~7 people).**
- **Rationale: The employees will be dedicated to the SNS Project.**
- **Savings: ~$3.5M (to be refined)**
- **Schedule Impact: None**
- **Related Impact (include operations): None**
- **Benefits/Advantages: Cost savings**
- **Risks: Low**
- **Actions/Person Responsible: Agreement with lab/other divisions. (Bill Appleton)**

Consolidate Meetings / Reduce Travel
WBS 1.2 Project Support (4/I)

- **Proposal Description**
  - Plan / consolidate meetings to reduce cost.
- **Rationale:**
  - Coordinate planning and progress of project execution meetings with other external reviews by customer and advisory committees.
- **Savings:**
  - TBD (may be small due to some meetings not currently budgeted).
- **Schedule Impact:**
  - None
- **Related Impact (include operations):**
  - No impact on operations funding.
- **Benefits/Advantages:**
  - Aligns internal project reviews (including design reviews, collaboration technical and project management meetings) to support external reviews and optimize travel costs and reduce demands on site management. Consolidate advisory committees and coordinate recommendations for more effective implementation
- **Risks:**
  - None.
- **Actions/Person Responsible**
  - Assess current budgets for meetings (ORNL – Johnson)
  - Develop plan to consolidate advisory groups and adjust budget (ORNL – Strawbridge)
  - Eliminate rental hall budget for external reviews ($700k) (ORNL – Rader)
  - Implement project site reviews (ORNL – Strawbridge)
  - Promulgate annual (FY) project meeting schedule (ORNL -Strawbridge/Johnson)

Eliminate Overlapping Functions
WBS 1.2 – Project Support (5/I)

- **Proposal Description: Perform staff review to eliminate dual or overlapping functions.**
- **Rationale: Ensure the Project Office is properly aligned with other lab project support activities. This will increase the efficiency and effectiveness of all SNS project support activities**
- **Savings: TBD**
- **Schedule Impact: None**
- **Related Impact (include operations): None**
- **Benefits/Advantages: Establish clear lines of responsibility and minimize organizational problems and potential conflicts.**
- **Risks: None**
- **Actions/Person Responsible: Staff review of project office support to ORNL-base functions. (Strawbridge, Rader, Johnson)**

Procurement
Investigate the Common-Use of Subcontracts by All Sites
WBS 1.2 – Project Support (6/I)

- **Action/Concern/Issue**
  - **Investigate the common-use of subcontracts by all sites in the Collaboration**

- **Rationale:**
  - **Reduces effort in award of subcontracts; prequalification of local vendors; economies of scale; leverage buying power; aids standardization**

- **Savings:**
  - **Requires further review and and investigation once material/services to be procured is known. To be determined.**

- **Schedule Impact:**
  - **Slight improvement in procurement cycle time expected.**

- **Related Impact:**
  - **None**

- **Benefits/Advantages:**
  - **Reduced procurement cycle time; achieve economies of scale; leveraged buying power.**

- **Risks:**
  - **Low**

- **Actions/Person Responsible:**
  - **Establish a project policy on the use of subcontracts at other labs (Strawbridge, Lisa Brown)**
  - **Establish a dialog with procurement staffs at the labs to determine subcontract areas and provide the information to all laboratories. (Lisa Brown)**

Move Technical Support to Line Item
WBS 1.2 Project Support (7/II)

- **Proposal Description**
  - Move technical support costs from R&D to Line Item in some subproject areas
- **Rationale:**
  - Improved cost, uniformity across the collaboration.
- **Savings:**
  - TBD
- **Schedule Impact:**
  - None
- **Related Impact (include operations):**
  - None
- **Benefits/Advantages:**
  - Could lead to improved management and coordination of both the R&D and Line Item activities.
- **Risks:**
  - None.
- **Actions/Person Responsible**
  - Senior Team Leaders of areas where this applies take action to conduct the review.
  - Pat Rader to coordinate.

Reduce Overhead and Indirect Rates
WBS 1.2 – Project Support (8/III)

- **Proposal Description: Review overhead charges/taxes at all Labs for additional reductions.**
- **Rationale: To ensure the SNS Project is benefiting from favorable overhead and indirect rates. Where favorable rates are not available, determine if a lower causal-beneficial can be negotiated.**
- **Savings: TBD**
- **Schedule Impact: None**
- **Related Impact (include operations): None**
- **Benefits/Advantages: Lower overhead and indirect rates will lower the TPC**
- **Risks: Low**
- **Actions/Person Responsible: Analyze lab SNS cost estimate documents during project site reviews/cost scrub (Rader)**

Tennessee Sales/Use Tax
WBS 1.2 – Project Support (9/III)

SNS

- **Proposal Description: Complete negotiations on favorable application of Tennessee sales/use tax.**
- **Rationale: As a general rule, Tennessee applies a Sales/Use tax on project materials that come into the state of Tennessee. The project has engaged legal counsel to help determine if contracts or business practices can be legally "crafted" in such a way to minimize the Project's tax liability. In addition, the cost estimate needs to be reviewed in detail to determine if taxes have been properly estimated.**
- **Savings: TBD - Goal $5M**
- **Schedule Impact: None**
- **Related Impact (include operations): None**
- **Benefits/Advantages: Cost savings**
- **Risks: Medium**
- **Actions/Person Responsible: Rader**
  Assist from DOE-ORO (Watkins) if involvement of DOE-HQ General Counsel is needed.

Identify Long-Term Economic Travel Strategy
WBS 1.2 – Project Support (10/III)

- **Action/Concern/Issue**
  - Investigate possible travel and long-term housing arrangements.

- **Rationale:**
  - Large numbers of laboratory and vendor staff will be required to be on the SNS site during construction, in particular during testing, turnover, and commissioning activities. Prior arrangements could lead to savings due to the numbers of personnel involved.

- **Savings:**
  - Requires further review when the schedule for these activities is better known. To be determined.

- **Schedule Impact:**
  - None

- **Related Impact:**
  - None

- **Benefits/Advantages:**
  - Could lead to better coordination of these activities if housing results in co-location of staff.

- **Risks:**
  - Low

- **Actions/Person Responsible:**
  - Investigate possible travel, rental car, and housing arrangements. (Rader)

VALUE ENGINEERING PROPOSALS

WBS 1.3 - Front End Systems

No.	Cat.	WBS Numbers	Proposal Description	Rationale/ Advantages	Impact/ Disadvantages	Risk	Savings (000)	Recommended Action	Comments
1	I	1.1.1.4	Do not build prototype RFQ.	Can successfully design & build production unit based on cold model and alpha module testing	Does not produce as much testing demonstration as a full scale prototype would provide.	Low	620	Accept CCB3 required	*ACCEPTED*
2	I	1.3.4	Eliminate technical support to Pre Ops in FY2004	Front End commissioning and acceptance complete in FY03. Only minimal level pre ops support likely to be needed in FY04.	Reduces flexibility in insuring staff availability in support of pre-ops after commissioning and acceptance completed	Low	540	Accept CCB3 required	*ACCEPTED* Additional pre ops support can still be provided in FY04 and beyond by separate "service-contract" type arrangement if needed.
3	I	1.3.2	Transfer 402.5 MHz klystron system to WBS 1.4.xx	LANL has tech responsibility to design/provide system finances and schedule action should also be within their work packages.	Removes direct LBNL mgmt control and oversight from this system	Low	2,200* *transfer to 1.4.x	Transfer cost	*ACCEPTED* Potential savings to be determined by LANL in updating WBS 1.4
4	II	various	Standardize Vacuum Systems and components project-wide	Should result in cost savings project wide	No disadvantage	Low	Small (FE only)	Recommend	Incremental savings for Front End Systems only is quite small. Potentially significant savings to SNS overall.
5	II	various	Standardize 19-inch electronics racks and components project-wide	Should result in cost savings project wide	No disadvantage	Low	Small (FE only)	Recommend	Incremental savings for Front End Systems only is quite small. Potentially significant savings to SNS overall.
6	II	various	Look at standardized diagnostics for front end and LINAC	Should result in cost savings project wide	No disadvantage	Low	Small (FE only)	Recommend	Incremental savings for Front End Systems only is quite small.
7	II	1.8.x	Front End Building requirements simplification	Likely can make Front End Bldg footprint smaller and move location of roll-up door to reduce construction cost	Reduces overall floor space and possible future flexibility.	Low	NA	Recommend; track savings through WBS 1.8	Space and staging support needs for LINAC installation might be compromised if other LINAC access not available for installation phase.
8	III	1.3.3	Raise voltage on MEBT chopper.	Potential benefit long term	Presently high risk; technical uncertainty, and minimal savings overall	Hi	–	Reject	Could still provide benefit when implemented later if design and equipment conditions would allow.
9	III	1.3.3	Revisit question of Chopper and Anti-Chopper (i.e. is Anti-Chopper essential)	Eliminating anti-chopper would simplify MEBT system overall, allow installation of more diagnostics	Presently high risk; requires extensive analysis, and only minimal savings might be achieved.	Hi	–	Reject	

VALUE ENGINEERING PROPOSALS

WBS 1.3 - Front End Systems

No.	Cat.	WBS Numbers	Proposal Description	Rationale/ Advantages	Impact/ Disadvantages	Risk	Savings (000)	Recommended Action	Comments
10	IV	1.3.3	Eliminate MEBT; extend LEBT and provide all chopping in LEBT	Potential of simplifying total system	Hi risk; LEBT chopping may take considerable R&D to develop, if it is realizable at all. Potential savings marginal overall	Hi		Reject	High uncertainty of tech. feasibility.
11	IV	1.3.1	Provide additional (4th) ion source	Would increase redundancy	Already have total of 3 sources.	Low	Cost increase	Reject	Already have 3 sources; consider additional source unnecessary at present time.
12	IV	1.3.1	Accept starting with 14 day continuous operation of ion source instead of 21 days.	Allows greater startup flexibility		Low		Accept flexibility; but don't change baseline	No cost savings foreseen in present estimate.

Eliminate Prototype RFQ

No: 1; Category: I

WBS 1.3

- **Proposal Description**
  - Do not build prototype RFQ for Front End System.
- **Rationale**
  - Reduce overall cost and time required to provide production RFQ unit for Front End Systems. Based on now having characterized RFQ design with cold model and hot model analysis and tests, and based on building and testing a full power "alpha module" planned for this year's R&D work package, we now feel confident that a full length "prototype" RFQ assembly should not be required. Another cold model should, however, be fabricated to ensure adequate characterization of "long cavity" mode stabilization properties.
- **Savings**
  - Would save $620K overall including integrated testing program.
- **Schedule Impact**
  - Could speed up production and delivery of final RFQ assembly. Will enable all commissioning to take place with production RFQ instead of utilizing prototype unit for initial commissioning phases as in baseline plan.
- **Technical Impact**
  - This change should have no negative impact on project. Only risk would occur if resulting RFQ unit exhibits some unanticipated operational shortcoming that limits performance and does not meet requirements. If such an unforeseen condition occurs, then RFQ might need to be repaired/reworked, or in most severe case would need to be rebuilt and require contingency funds to be allocated. Even this latter extreme scenario could still be fabricated and delivered before the overall project completion date.
- **Other Impacts**
  - No other impacts foreseen.
- **Risk and R&D**
  - Low Risk. Less overall R&D required, but will require additional cold model for "long cavity" testing.
- **Action**
  - Recommend. Suggest ORNL CCB3 approval.

Reduce Technical Support

No: 2; Category: I

WBS 1.3

- **Proposal Description**
  - Eliminate Front End Systems technical support to Pre-Ops in FY2004 and beyond.
- **Rationale**
  - The Line Item construction category "Technical Support" must include Management, Engineering, and Scientific support to the Front End Systems through the commissioning and acceptance phase. After the Front End system has been fully characterized, commissioned, and accepted (in FY2003) there might be very little need for LBNL to continue to budget and plan dedicated staff and personnel to be available for further pre-operations support to other SNS systems. The Line Item WBS and Work Package categories could reasonably be closed out at the time of the acceptance certification.
- **Savings**
  - Would save $540K in present baseline plan.
- **Schedule Impact**
  - No schedule impact.
- **Technical Impact**
  - This change should have no negative technical impact on project.
- **Other Impacts**
  - Only commissioning and Pre-ops impact results in not having dedicated staff on "stand-by" to provide loosely defined "commissioning" support to other subsystems. If additional LBNL staff are needed beyond FES commissioning completion and acceptance, then a "service-contract" type arrangement can be developed between ORNL/LBNL within a Pre-operations WBS and Work Package to provide dedicated support if/as needed.
- **Risk and R&D**
  - Low Risk. No R&D issues.
- **Action**
  - Recommend acceptance.

Transfer Klystron Cost to WBS 1.4

No: 3; Category: I

WBS 1.3

Proposal Description
- Transfer cost of 402.5 MHz klystron system to WBS 1.4.x

- **Rationale**
  - The 402.5 MHz RF system for the Front End System RFQ is presently included in the cost estimate for LBNL, but is actually planned to be purchased and managed by LANL (along with their DTL RF systems). Potential overall cost savings can be realized by combining LBNL system with LANL work packages now. LANL is presently proposing to reconfigure their WBS elements to more conveniently and realistically address all their RF systems. We propose transferring these costs now and that all value engineering and other adjustments be made for all the relevant combined RF systems in a common WBS structure.

- **Savings**
  - Would reduce Front End System cost by $2,200K, and would increase LINAC system cost by the same amount. Some savings in the LINAC cost should be realized by combining like systems, and also by taking advantage of currently projected savings in IGBT technology etc.

- **Schedule Impact**
  No adverse schedule impact. Transfer to LANL would make it easier for them to manage and schedule all of their RF system work within a common work package.

- **Technical Impact**
  - This change has no technical impact

- **Other Impacts**
  - Simplifies overall budgeting, costing and accounting organization for 402.5 MHz systems.

- **Risk and R&D**
  - Low/no Risk.

- **Action**
  - Recommend. Suggest making cost transfer adjustments now.

Standardize Vacuum Components

No: 4; Category: II

WBS 1.3

- **Proposal Description**
  - Standardize Vacuum System and components project-wide.
- **Rationale**
  - Potential savings can be realized by early definition and standardization of as many similar systems as possible. Many vacuum components (valves, pumps, controllers, instrumentation) will be required throughout the facility and as much standardization as reasonable and possible will not only reduce initial costs but will also reduce maintenance and spares requirements during operation.
- **Savings**
  - No significant cost savings for Front End Systems alone, but potentially large savings overall throughout entire project might be realized.
- **Schedule Impact**
  - No schedule impact
- **Technical Impact**
  - Should have no technical impact as long as overall requirements are recognized and met.
- **Other Impacts**
  - Potential savings in reliability, maintenance and spares costs should be realized during operations.
- **Risk and R&D**
  - Low Risk.
- **Action**
  - Support and Recommend. No direct action by Front End Systems group required.

Standardize 19-inch racks

No: 5; Category: II

WBS 1.3

- **Proposal Description**
  - Standardize 19-inch electronics racks and components project-wide.
- **Rationale**
  - Potential savings can be realized by early definition and standardization of as many similar systems as possible. Many electronics components will be required throughout the facility and as much standardization as reasonable and possible will not only reduce initial costs but will also reduce maintenance and spares requirements during operation. Possible "group-buys" might be contracted for standardized 19-inch electronics racks resulting in overall savings project-wide.
- **Savings**
  - No significant cost savings for Front End Systems alone, but potentially large savings overall throughout entire project might be realized.
- **Schedule Impact**
  No schedule impact
- **Technical Impact**
  - Should have no technical impact as long as overall requirements are recognized and met.
- **Other Impacts**
  - Potential gains in reliability and savings in maintenance and spares costs should be realized during operations.
- **Risk and R&D**
  - Low Risk.
- **Action**
  - Support and Recommend. No direct action by Front End Systems group required.

Standardize Front-End and Linac Diagnostics

No: 6; Category: II

WBS 1.3

- **Proposal Description**
  - Look at possibilities for standardized diagnostics for Front End and LINAC.
- **Rationale**
  - Potential savings can be realized by early definition and standardization of as many similar systems as possible. Some common diagnostics requirements exist between the Front End System and LINAC and as much standardization as reasonable and possible will not only reduce initial costs but will also reduce maintenance and spares requirements during operation. Early definition and characterization of MEBT and LINAC diagnostics requirements should be encouraged.
- **Savings**
  - Potential cost savings for Front End Systems and LINAC both might be realized; amount of savings potential not easily determined at this time.
- **Schedule Impact**
  Could have favorable schedule impact if identification of potential is done early enough.
- **Technical Impact**
  - Should have no technical impact as long as overall requirements are recognized and met.
- **Other Impacts**
  - Potential gains in reliability and savings in maintenance and spares costs should be realized during operations.
- **Risk and R&D**
  - Low Risk.
- **Action**
  - Support and Recommend. Front End group and LINAC group should work together to identify potential areas of savings.

Reexamine Front-End Building

No: 7; Category: II

WBS 1.3

- **Proposal Description**
  - Reexamine requirements for Front End Building footprint, layout, and other specific features to try to simplify requirements and make cost-effective tradeoffs.
- **Rationale**
  - Reduce overall size of building, if possible, with particular attention to meeting 1 MW initial requirements (e.g. possibly defer incremental space addition required for funneling or other upgrade arrangements). Any reduction in size, particularly to reduce the need to dig into the hillside on north and west end, might be very cost effective. Also, the height of the building should be reduced now since there is no longer a requirement to have a bridge crane installed. Finally, possible relocation of the roll-up door from the west side to the south side would again simplify the excavation and retaining wall requirements.
- **Savings**
  - Could save considerable cost in the WBS 1.8.3 category; potential savings will be determined by conventional facilities team.
- **Schedule Impact**
  - Could speed up building fabrication by simplifying the overall excavation and retaining wall requirements.
- **Technical Impact**
  - This change should have no negative impact on project as long as the overall space requirements for the Front End Systems and all ancillary equipment are met.
- **Other Impacts**
  - Initial LINAC component staging and installation is currently planned to be done in/through the Front End Building. Additional LINAC access points along the tunnel have been requested by LINAC group and if provided would also reduce the need for staging area space in the Front End Building.
- **Risk and R&D**
  - Low Risk. Additional space could be added in future as needed for upgrade increments.
- **Action**
  - Recommend. Suggest ORNL conventional facilities group examine potential savings.

Raise MEBT-Chopper Voltage

No: 8; Category: III

WBS 1.3

- **Proposal Description**
  - Raise voltage on MEBT chopper.
- **Rationale**
  - Higher voltage on MEBT chopper electrodes would lead to more efficient current suppression between mini pulses and consequently reduce radiation spill in the ring, leading to improved accessibility of ring components or relaxing the scraper requirements. It might also be possible to reshape the MEBT beam envelope and reduce the power density on the chopper target, simplifying its design.
- **Savings**
  - No cost savings for the chopper structure; rather cost increase for the electronics, but possible savings for the chopper target and maybe for ring components or during the operations phase.
- **Schedule Impact**

  Schedule impact presently uncertain. Strong probability that technical implementation would delay completion of chopper electronics or other MEBT components.
- **Technical Impact**
  - Potential technical benefits for ring operation/service or the design of ring scrapers. Higher requirements for chopper electronics and voltage hold-off of chopper structure.
- **Other Impacts**
  - Needs recalculation of MEBT beam dynamics in any case, especially if simplification of the chopper-target design is intended. Benefits for the ring systems would have to be addressed.
- **Risk and R&D**
  - Hi Risk.
- **Action**
  - Reject

Revisit Need for Anti-Chopper

No: 9; Category: III

WBS 1.3

- **Proposal Description**
  - Revisit question of whether both a Chopper and Anti-Chopper pair are needed (i.e. is Anti-Chopper essential?).
- **Rationale**
  - Eliminating the Anti-Chopper would lead to a cost reduction for this one structure, in exchange for a spool piece. The emptied space could be utilized for MEBT diagnostics.
- **Savings**
  - Unknown. The power-rating of the common power supply does not change when one chopper structure is eliminated.
- **Schedule Impact**
  Potential delay in completion of MEBT hardware, caused by necessity of new beam-tracking studies for MEBT and linac.
- **Technical Impact**
  - Elimination of the Anti-Chopper will in all probability lead to a larger effective beam envelope in the linac due to beam oscillations caused by power supply ringing, and in consequence to higher radiation spill in the linac. It could also result in an unacceptable increase in the chopper rise-time.
  -
- **Other Impacts**
  - No other impacts foreseen.
- **Risk and R&D**
  - Hi Risk. Also, considerable additional R&D and analysis would be required.
- **Action**
  - Reject

Eliminate MEBT

No: 10; Category: IV

WBS 1.3

- **Proposal Description**
  - Consider eliminating MEBT completely; extend LEBT and do all chopping in LEBT.
- **Rationale**
  - Eliminating the MEBT would certainly lead to substantial cost savings for the development, fabrication, and testing of this one subsystem.
- **Savings**
  - Overall savings unknown.
- **Schedule Impact**
  Substantial delay for the Front-End completion date, due to need for entirely new set of beam dynamics calculations for front end and DTL, as well as a totally new LEBT design.
- **Technical Impact**
  - Without a MEBT, the LEBT would have to provide for chopping of the beam into mini pulses at substantially lower beam energy and therefore higher space-charge density. The lower beam velocity would require an enormous increase in LEBT chopper voltage if a viable technical concept could be found at all. The LEBT would have to be much longer than presently planned; this would lead to unacceptable, varying degrees of space-charge neutralization during pulses. Only a rudimentary set of beam-diagnostics elements could be installed, and there would be no beam diagnostics at all between RFQ and DTL. The issue of matching the beam from the RFQ into the DTL would have to be revisited.
- **Other Impacts**
  - No other impacts foreseen.
- **Risk and R&D**
  - Hi Risk. Hi uncertainty of technical possibility.
- **Action**
  - Reject.

Provide Additional Ion Source

No: 11; Category: IV

WBS 1.3

- **Proposal Description**
  - Provide additional (4th) Ion Source for Project.
- **Rationale**
  - An additional ion source would increase redundancy and presumably increase reliability of the facility operations. At the present time, however, it is anticipated that a total of three sources, (one in service, one in standby for immediate replacement, and one in overhaul) are all that are presently justified.
  -
- **Savings**
  - Would increase present cost estimate by approximately $100K.
- **Schedule Impact**
  No schedule impact.
- **Technical Impact**
  - No technical impact.
  -
- **Other Impacts**
  - Potentially would improve redundancy and reliability.
- **Risk and R&D**
  - Low Risk.
- **Action**
  - Reject at present time.

Reduce Required Operation Time for Ion Source

No: 12; Category: IV

WBS 1.3

- **Proposal Description**
  - Instead of requiring the Ion Source to operate continuously for 21 days, accept initial operation of 14 days or less.
- **Rationale**
  - If the 21-day requirement is driving critical design decisions the relaxation of this requirement might lead to a simpler and less expensive Ion Source design. In this particular case, nothing is identified that would be saved or changed in the current design if the requirement were lessened. However, it might be prudent anyway to expect that the initial operation level might easily accommodate this flexibility in uninterrupted running requirements during the early commissioning and pre-operations phase.
- **Savings**
  - No savings identified.
- **Schedule Impact**
  No construction schedule effect identified.
- **Technical Impact**
  - No technical impact.
- **Other Impacts**
  - Potential operations impact and maintenance issues would result.
- **Risk and R&D**
  - Low Risk to overall project operations.
- **Action**
  - Accept flexibility suggested, but don't change baseline requirements.

Value Engineering Spreadsheet for Linac and Linac Controls (WBS 1.4 and 1.9.4)

VALUE ENGINEERING PROPOSALS

WBS 1.4, 1.9.4 - Linac, Linac Controls

No.	WBS Numbers	Proposal Description	Rational/ Advantages	Impact/ Disadvantages	Risk*	Savings ($k)	Recommended Action	Comments
1#	1.4.1	Change to IGBT for DTL, CCDTL, CCL.	•Improved reliability; •Saves money; •Saves space; •Reduced complexity; •Less noise on line; •No "cap bank" room.	•None known.	I	$ 7,200	•Bill Reass; •Accept; •CCB3-4 ASAP.	Folds into WBS 1.8 with smaller footprint that should be costed. Savings in WBS 1.4 covered previously.
2#	1.4	Change overheads, taxes and PM.	•Proper way to conduct business; •Saves money; •Lab contributes to project.	•None known.	I	$ 24,600	•Stan Schriber; •Accept; •CCB4 ASAP.	LANL deserves a "gold" star for this one. Some savings in WBS 1.4 covered previously.
3#	1.4.1-.4, 1.9.4	Change design basis to 52 klystrons and shorten DTL to CCL length by 28m.	•Design changes improve modularity; •Easier upgrade to 4MW; •Improves rf efficiency; •Lowers power requirements; •Saves money.	•Smaller bore size; •Slightly higher gradient; •Reliability about same.	I	$ 9,600	•Mike Lynch; •John Erickson; •Accept; •CCB3 ASAP.	Folding into WBS 1.8 saves $4M costs from shorter length facilities and operation/commissioning costs from 2MW less AC power requirement. 1.4.1-$5.8M, 1.4.3-.4-$3.8M.
4#	1.4.2-.4	Quantity discounts and manufacturing processes.	•Saves money.	•May affect cash flow negatively.	I	$ 3,100	•John Erickson; •Further study.	Further assessment may show larger savings.
5	1.4	Reduce tunnel width.	•To be determined by WBS 1.8. We will provide specifications and implications.	•Impacts installation and maintenance; •Increases MTTR; •Adds to ALARA; •Increases safety concerns.	I	???	•John Erickson; •Specs to WBS 1.8 to decide; •Reject.	Specifications and impacts to be provided to WBS 1.8, to assist in assessment of this item.
6#	1.4	Competitive procurement of stands.	•Saves money and schedule.	•None known.	I	$ -	•John Erickson; •Accept.	Already included in item 4 as best business practices.

40

Value Engineering Spreadsheet for Linac and Linac Controls (WBS 1.4 and 1.9.4)

7#	1.4.1	Transfer RFQ klystron driver to LANL.	•Saves money and adds uniformity; •Will be IGBT; •Reduces spares.	•None known.	I	$ -	•Paul Tallerico; •Accept and CCB3 ASAP.	Transfer $2.2M from LBNL WBS 1.3.3.2 to LANL for possible cost savings and uniformity. Appropriate way to conduct business.
-1#	1.4	Items accounted in 10/6/98 "Total Project Cost..." Sheet from Cleaves.	•Not new savings.	•None	I	$ (21,100)	•Stan Schriber; •Accounted in process -- confirmation completed.	Savings accounted within LANL Step 6 process. This is $8.1M (higher by $0.9M than expected now) from item 1 above and $4M + $4M + $3.2M of item 2 above plus a further $1.8M of initial fixes. Includes R&D and manpower level changes which increased costs.
	#		**Risk "I" Subtotal**			**$ 23,400**		#
8#	1.4.3-.4	Limit upgrade of LANL brazing facility.	•Saves money.	•Possible impact on schedule; •More impact on shipping, QA and travel.	II	$ 1,000	•John Erickson; •Decide best path; •CCB4 if done.	Choose between 3 options for brazing. #
9	1.4.5	Eliminate miscellaneous diagnostics.	•Saves money.	•Loss of critical information for operations and problem solving; •Impacts commissioning, schedule, operations negatively.	II	$ 800	•Andy Jason; •Reject.	FBM - $200k; A-C - $100k; CRT - $500k; Not a good idea.
10	1.4.5	Use LEDA beam dump.	•Saves money.	•Impacts commissioning.	II	$ 200	•Andy Jason; •Reject.	Not a good idea. Using LEDA beam stop may lead to transportation problems from activated system and it may not be available when needed.
11#	1.4.3-.4	Review manufacturing techniques.	•Saves money; •Already incorporated within plan (see above item 4).	•None known.	II	???	•John Erickson; •Accept.	Combined with item 4 and will not be reported on in future. #

Value Engineering Spreadsheet for Linac and Linac Controls (WBS 1.4 and 1.9.4)

12#	1.4.3-.4	Procure pre-shaped copper.	•Saves money; •Already incorporated within plan (see above item 4).	•None known.	II	$ 8,000	•John Erickson; •Accept.	Good idea -- vendor checks needed ASAP. Some vendor interactions confirm our estimate. Combined with item 4 for plan, but will be reported out as a separate item here. #
13#	1.4.1	Use existing equipment for 402MHz klystrons.	•Saves money.	•Increased manpower; •Replacement concerns.	II	$ 300	•Paul Tallerico; •Accept.	Does one gain value from this action? #
14	1.4	Reduce beam height in tunnel from 5 to 4 ft.	•Saves money; •Makes beam access better.	•Impacts installation and maintenance negatively.	II	$ 150	•John Erickson; •Reject after study confirmation.	Specifications and impacts to be provided to WBS 1.8, to assist in assessment of this item.
15#	1.4.2-.4	Revisit number of vacuum pumps.	•Saves money.	•Could affect commissioning schedule.	II	???	•John Erickson; •Further study.	Further assessment may show savings. #
16#	SNS	Combine all vacuum design, implementation and oversight.	•Uniformity; •Easier maintenance; •Lower procurement costs; •Fewer spares.	•None known other than needed coordination.	II	???	•John Erickson; •Overall SNS issue for ORNL.	Coordinate with WBS 1.10. #
17#	1.4	Revisit startup to meet requirements for being off 1 hour, 1 day, 1 week and >1 month.	•Understand system limitations.	•None known.	II	???	•Andy Jason; •Further study.	Coordinate with WBS 1.10. #
18#	1.4.1	Optimize waveguide runs and level of rf gallery.	•Saves money; •Improves performance; •Less earth movement; •Improves installation and upgrades.	•None known.	II	???	•Paul Tallerico; •Further study with WBS 1.8.	Important to coordinate with WBS 1.8. Possible significant benefits from the 45° suggestion. #
19#	1.4.1	Optimize AC for klystron gallery.	•Improves reliability; •Prevent equipment failures.	•None known.	II	???	•Paul Tallerico; •Accept.	Important to coordinate with WBS 1.8 and to look at humidity levels. #
			Risk "II" Subtotal			**$ 10,450**		

Value Engineering Spreadsheet for Linac and Linac Controls (WBS 1.4 and 1.9.4)

20	1.4.5	Eliminate "beam-in-gap" diagnostic.	•Saves money.	•Severe loss of critical information for operating ring to achieve low losses and no instabilities.	IV	$ 1,000	•Andy Jason; •Reject.	Severe impact on operations. No a good idea.
21	1.4.5	Eliminate "bunch rotator".	•Saves money.	•Difficulty in tuning chopper and anti-chopper.	IV	$ 3,400	•Andy Jason; •Reject.	Severe impact on operations. No a good idea.
22	1.4	Reduce output energy in discrete steps (e.g., 975 MeV).	•Saves money on linac. Costs increase everywhere else.	•Users unhappy; •Impacts ring and target severely; •Impacts ring design and impacts schedule.	IV	$ 4,400	•Stan Schriber; •Reject.	Not recommended. Next step would be 934 MeV for an overall savings of $9700k for the shorter linac.
23	1.4.4	Reduce bore radius another 1 mm.	•Improves structure efficiency; •Saves life cycle costs.	•Bore decreased already by as much as considered reasonable; • No construction $$ savings.	IV	$ -	•Andy Jason; •Reject.	Gain marginal at best. Loss of some safety margin.
24	1.4.2-.4	Consider alternatives for ion pumps (NEG).	•Saves money.	•Severe impact on availability.	IV	???	•John Erickson; •Reject.	Not recommended.
25	1.4.2-.4	Consider bidding vacuum system design.	•Saves money.	•Was considered and rejected earlier. •Design underway.	IV	???	•John Erickson; •Reject.	Doesn't add value at this time. No advantage.
26	1.4.4	Change CCL to superconducting.	•Saves capital and operations money.	•Inadequate information on pulsing S/C cavities.	IV	$ -	•Andy Jason; •Reject.	Not recommended.
27	1.4.3-.4	Change to permanent magnets.	•Saves money; •Saves operations costs.	•Severe impact on schedule; •Decreased tuning capability.	IV	$ 800	•Andy Jason; •Reject.	Possible non-optimal operation.
8			**Risk "IV" Subtotal**			**$ 9,600**		

Value Engineering Spreadsheet for Linac and Linac Controls (WBS 1.4 and 1.9.4)

28	To 1.8	Review conventional facilities for linac.	•To be determined by WBS 1.8.	???	???	???	•Transfer to WBS 1.8.	Item transferred to WBS 1.8.
29	To 1.8	Optimize linac berm shielding.	•To be determined by WBS 1.8.	???	???	???	•Transfer to WBS 1.8.	Item transferred to WBS 1.8.
30	To 1.8	Revisit number of escape hatches for shorter tunnel.	•To be determined by WBS 1.8.	???	???	???	•Transfer to WBS 1.8.	Item transferred to WBS 1.8.
31	To 1.8	Consider precast construction for tunnel.	•To be determined by WBS 1.8.	???	???	???	•Transfer to WBS 1.8.	Item transferred to WBS 1.8.
32	To 1.10	Reduce requirements for linac dump.	•To be determined by WBS 1.10.	???	???	???	•Transfer to WBS 1.10; •Andy Jason to coordinate.	Item transferred to WBS 1.10.
5			**Transfers Subtotal**			**$ -**		
13			**Sum Total for Acceptance**			**$ 32,700**		

- In the "Comment" row. Indicates an item to be considered for the Sum Total of the last column.

"Risk" row:

I - Low risk, $ savings, put in budget now, no-brainer or big gain possible, hustle to get in January baseline.

II - Medium risk, longer deliberation, good potential savings may/may not be doable for January.

III - High risk, long study needed, marginal savings.

IV - Reasons for "x"'s, for documentation.

44

Item #1, IGBT in WP 1.4.1

- **Proposal Description:**
  - Replace all high power rf tube drivers with IGBT based systems. See notes for details.
- **Rationale:**
  - Saves overall costs. Leads to improved performance and expected RAMI improvements.
- **Savings:**
  - Saves $7.2M in construction costs and should lead to $14M 40 year operation costs savings.
- **Schedule Impact:**
  - Minimal negative impact on schedule. Installation savings associated with less space and elimination of large "cap bank" areas.
  - Related Impact (Including Operations):
  - Better rf system with improved performance and better RAMI expectations. Less number of components, simpler voltage systems, less high voltage systems should lead to safety enhancement. Eliminates need for dual track approach. Still need conventional modulators (from mostly spare components) to test rf tubes.
- **Benefits/Advantages:**
  - Conventional facilities need to provide less space. Improved AC distribution and computer networking. No need for "cap bank" areas. No impacts on upstream and downstream components. Less noise on lines.
  - Risks:
  - Low risk on the basis of existing systems and modernization efforts at other facilities. Needed R&D underway and no change.
- **Actions//Person Responsible:**
  - ORNL CCB3 approval following LANL CCB4 approval ASAP. // William A. Reass

Item #2, Change overheads, taxes and PM - all

- Proposal Description:
  - LANL construction project overhead fixed at FY98 reduced rate for project duration. Move PO to DO. Reduce group overhead. Fix escalation rates. Fix schedule logic. Fix LANSCE-8 rates in 1.9.4.
  - Rationale:
  - Appropriate manner to conduct business. New rate established for FY98. Proper location for project of this size.
- Savings:
  - Respectively saves $4.0M + $6.2M + $5.4M + $4.0M + $3.2M + $1.8M = $24.6M.
- Schedule Impact:
  - N/A.
- Related Impact (Including Operations):
  - N/A.
- Benefits/Advantages:
  - Significant $$$ savings and streamlined management.
- Risks:
  - LANL decides to change agreements. Very very low risk of happening.
- Actions//Person Responsible:
  - LANL CCB4 approval ASAP. // Stan Schriber and Bob Hardekopf

Item #3, Shorter 52 Klystron Design in WP 1.4.1, 1.4.3-.4

- **Proposal Description:**
  - Improve linac design using 52 klystron drivers, down from 56 of CDR design. Reduces linac length by 28 m and improves upgrade path to 2- and 4- MW.
- **Rationale:**
  - Reduce linac costs and unnecessary extra rf of previous design. At same time improve design.
- **Savings:**
  - Save $5.8M from reduction of 4 drivers. Save $3.8M from reduction of linac length by 28m (6%). Any savings in controls reported in controls input.
- **Schedule Impact:**
  - Minimal negative impact. Improvements because of common systems and less construction.
- **Related Impact (Include Operations):**
  - Leads to improved design and simpler process to upgrade to 2 and to 4 MW in future. Improved layout for quads, diagnostics and hardware assembly. Possible RAMI improvements. Improved mechanical systems.
- **Benefits/Advantages:**
  - No impacts on upstream and downstream components. Reduce length of conventional facilities and reduce AC, cooling and HVAC requirements. Less control system interfaces and less operations issues. Should lead to $12M (for the rf) and $8M (for the structure) 40 year operation costs savings.
- **Risks:**
  - Low on basis of basically same design. Smaller bore and higher gradient still within acceptable operational space for pulsed beam format. No extra R&D.
- **Actions//Person Responsible:**
  - ORNL CCB3 approval ASAP. // John Erickson and Mike Lynch

Item #4, Quantity Discounts and Manufacturing Process Changes in WP 1.4.2-.4

- Proposal Description:
  - Engineering design, procurement and construction cost improvements by process similarities.
- Rationale:
  - Save costs, time and assembly steps by forcing more similarities using quantity purchases and manufacturing process changes.
- Savings:
  - Save $3.1M.
- Schedule Impact:
  - Might improve schedule for fabrication, installation and commissioning. Also might realize some operation and maintenance improvements.
  - Related Impact (Including Operations):
  - Could have significant impact on design, installation and commissioning. Similar components and connections could lead to overall system improvements.
- Benefits/Advantages:
  - Might have an impact on later maintenance and operations. Could assist some of the conventional systems issues by similar requirements for some of the interfaces. No impact on downstream or upstream components, unless there is a need to make similarities in these areas.
- Risks:
  - Moderate risk for the systems, however this cannot become a major work activity otherwise it will be difficult to force decisions in a timely manner.
- Actions//Person Responsible:
  - Need to complete an early assessment and then proceed through LANL CCB4 and ORNL CCB3 processes as necessary. // John Erickson

Item #5, Tunnel Width in WP 1.4

- **Proposal Description:**
  - Reduce width of linac tunnel to 12 feet.
- **Rationale:**
  - Reduces construction cost of linac tunnel.
- **Savings:**
  - Savings to be evaluated in WBS 1.8.
- **Schedule Impact:**
  - Minimal impact on construction schedule of tunnel. Installation schedule of linac could be significantly extended because of increased interference between installation crews and increased damage to components during installation.
- **Related Impact (Including Operations):**
  - Besides increasing the installation schedule of the linac, a smaller tunnel will have a significant negative impact on the operation of the linac. Maintenance and repairs will take longer because of the limited working space and possible interference between maintenance crews. This negatively affects linac availability through increased MTTR. Difficult working conditions also leads to increased risk of damage to linac components during installation or replacement.
- **Benefits/Advantages:**
  - The increased time required for repairs will lead to increased radiation doses for maintenance personnel -- not consistent with ALARA commitment. Difficult working conditions will also lead to increased risk of injury to maintenance personnel through mechanical or electrical accidents.
- **Risks:**
  - No risk to tunnel construction, but significant risk for the installation and operation of the linac.
- **Actions//Person Responsible:**
  - Not recommended because of adverse affects on linac installation and operation. // John Erickson

Item #6, Competitive Stand Procurement in WP 1.4

- Proposal Description:
  - Procure support stands through competitive bid.
- Rationale:
  - Potential cost saving.
- Savings:
  - None. Included in normal best practices and optimized in Item #4.
- Schedule Impact:
  - N/A.
- Related Impact (Including Operations):
  - N/A.
- Benefits/Advantages:
  - N/A.
- Risks:
  - N/A.
- Actions//Person Responsible
  - None. Already included. // John Erickson

Item #7, Transfer RFQ Klystron System to LANL in WP 1.4.1

- **Proposal Description:**
  - Transfer 402.5 MHz RFQ klystron system into WBS 1.4.1 from 1.3.3.2. See notes.
- **Rationale:**
  - Not wise to have different systems. Issue is allocating funds to LBNL to LANL, or directly to LANL.
- **Savings:**
  - Transfer of $2.2M might be done for $2.2M.
- **Schedule Impact:**
  - Slightly improve commissioning schedule.
- **Related Impact (Including Operations):**
  - Reduce spares requirements. Maybe make a three "holer". Operations improvements.
- **Benefits/Advantages:**
  - Primary benefits in commissioning and operations.
- **Risks:**
  - Need to study three versus two "holer".
- **Actions//Person Responsible:**
  - LBNL CCB4, LANL CCB4 and ORNL CCB3 approval ASAP. // Paul Tallerico

Item #8, Minimal brazing facility additions in WP 1.4.2-.4

- **Proposal Description:**
  - Reduce brazing facility improvements from $2M to only $1M.
- **Rationale:**
  - Try to save costs for the project construction phase.
- **Savings:**
  - Assumed saving $1M.
- **Schedule Impact:**
  - Could have an impact by not being able to produce linac components as required because of inadequate facilities to meet delivery needs. Need further study and a determination of available capabilities (facilities and skill base for copper) within industrial complex.
  - Related Impact (Including Operations):
  - Could affect delivery schedule and ability to make repairs on braze failures or small vacuum leaks.
- **Benefits/Advantages:**
  - If installation and commissioning of the linac is delayed this can have a serious effect on testing the ring and the target with beam. Can impact installation team scheduling at ORNL.
- **Risks:**
  - Significant risk for the schedule. No R&D other than a study of capabilities within US. QA processes will be increased to cover liaison at satellite brazing shops.
- **Actions//Person Responsible:**
  - CCL fabrication plan development is FY '99 activity. Consider options and impacts. Decide best course of action. Might require ORNL CCB3 decision. // John Erickson

Item #9, Eliminate Miscellaneous Diagnostics in WP 1.4.5

- **Proposal Description:**
  - Eliminate fourier bunch monitor (FBM) for bunch length data during commissioning and in the zero-degree HEBT line during operation. Eliminate anti-chopper (A-C) that returns partially chopped beam to axis in MEBT. Eliminate MEBT chopper rise-time development (CRT) of fast FET for 2.5 -ns chopper rise time.
- **Rationale:**
  - Cost and simplicity. Criticality to commissioning and operations needs to be considered.; CRT - Beam dynamics showed that partially chopped beam was transmitted with no apparent detrimental effect. Fast rise time may not be necessary for 1-MW facility - additional beam loss may be OK.
- **Savings:**
  - FBM - Saves $200k.; A-C - Saves $100k in chopper construction. Possible savings in decrease of MEBT length TBD.; CRT - Saves $500k.
- **Schedule Impact:**
  - FBM - Negative impact. Saves on interfaces but slows down commissioning.; A-C - Minimal. Chopper could be ready earlier. CRT - Minimal. Liaison time with vendor reduced.
- **Related Impact (Including Operations):**
  - FBM - Reduces number of control channels during operations and simplifies commissioning equipment.; A-C - Requires suppression of chopper pulse ringing. Likely requires additional collimation in MEBT. Possible additional beam loss detrimental to operations availability and maintainability. CRT - Partially chopped pulses will pass through linac involving 1% of beam. Possible particle loss with negative impact on operations availability and maintainability.
- **Benefits/Advantages:**
  - FBM - Minimally simplifies the diagnostics efforts required.; A-C - Possibility of shortening MEBT not investigated - requires extensive beam dynamics work.; CRT - Possible greater ease in maintaining electronics.
- **Risks:**
  - FBM - Low. Impacts the commissioning and operations linac tuning negatively. Decreases availability and beam quality.; A-C - Possibly high - requires additional study. Beam loss due to chopper ringing. Partially chopped pulses will not be returned to axis -- likely beam loss. Possible mismatch to ring and subsequent activation. ; CRT - Possibly high -- requires further study. Emittance growth of beam. Halo growth. Appreciable particle loss.
- **Actions//Person Responsible:**
  - Reject proposal. // Andrew Jason

Item #10, Use LEDA Beam Dump in WP 1.4.5

- **Proposal Description:**
  - **A high-current beam dump and associated instrumentation will be constructed and used for LEDA at LANL as part of the APT program. Consider using this dump for commissioning SNS at ORNL.**
  - Rationale:
  - **Cost.**
- **Savings:**
  - **$200k.**
- **Schedule Impact:**
  - **Minimal. SNS commissioning beam dump does not have to be constructed. However, adaptation to SNS may increase effort required.**
  - Related Impact (Including Operations):
  - **None.**
- **Benefits/Advantages:**
  - **Cost.**
- **Risks:**
  - **Moderate. Savings may be illusory since beam stop will be radioactive and suitable for inapplicable energy range.**
- **Actions//Person Responsible:**
  - **Reject. // Andrew Jason**

Item #11, Review Manufacturing Techniques in WP 1.4.3 -.4

- **Proposal Description:**
  - Evaluate technical performance versus cost/schedule risk for less expensive fabrication techniques.
- **Rationale:**
  - Try to save costs for the project construction phase.
- **Savings:**
  - None. Potential savings included in Item #4.
- **Schedule Impact:**
  - No impact.
- **Related Impact (Including Operations):**
  - No major impact.
- **Benefits/Advantages:**
  - None.
- **Risks:**
  - Moderate risk. Could be significant risk. Depends on cost/benefit analysis.
- **Actions//Person Responsible:**
  - None. Activity is already planned for FY '99. Potential savings included in item #4. // John Erickson

Item #12, Procure Pre-Shaped Copper in WP 1.4.3 -.4

- **Proposal Description:**
  - Save on rough machining costs by procuring forged shapes or shapes already roughed out by material vendor.
- **Rationale:**
  - Try to save costs for the project construction phase.
- **Savings:**
  - Potential Savings of about $8 M.
- **Schedule Impact:**
  - Could improve schedule pressure.
- **Related Impact (Including Operations):**
  - No impact.
- **Benefits/Advantages:**
  - As above.
- **Risks:**
  - No risk.
- **Actions/Person Responsible:**
  - Include in FY '99 fabrication study. Vendor checks underway. // John Erickson

Item #13, Use existing 402.5 MHz Klystrons in WP 1.4.1

- **Proposal Description:**
  - Use the GTA 425 MHz, 1.25 MW peak, 75 kW average power klystrons to drive the DTL and RFQ.
- **Rationale:**
  - The 10 GTA klystrons have been operated for a few hundred hours only , and then stored under vacuum for 10 years. It is likely that at least four will still meet their original specifications. All have good vacuum, and pass a perveance test at low voltage.
- **Savings:**
  - Present schedule has $823 k for two new 402.5 MHz klystrons. Costs of testing 10 existing klystrons and tuning four good ones to 402.5 MHz is estimated at $500 k, so net savings is $300 k.
- **Schedule Impact:**
  - Minimal, but in the" improve it" direction, since the klystrons are already available.
- **Related Impact (Including Operations):**
  - Will reduce operational spares requirements; at least one spare will be available at very low cost. Further klystrons (for operations) may be repaired by vendor at lower cost than new klystrons, yielding operational savings.
- **Benefits/Advantages:**
  - Cost savings, both in initial and operational stages. The remaining GTA klystrons can be rebuilt under operating budgets, and provide future savings to the program.
- **Risks:**
  - These klystrons have not been run in 10 years, and there is a possibility that all will have to be rebuilt, which would wipe out most of the initial savings.
  - Actions//Person Responsible:
  - Accept. No action in the RF area is required in this fiscal year. The RF team of the linac, will test the klystrons in FY '00. // Bill Reass and Paul Tallerico

Item #14, Reduce Beam Height from 5 ft to 4 ft in WP 1.4

- **Proposal Description:**
  - Lower stands might lower costs, provide better access to beam line.
- **Rationale:**
  - Try to save costs for the project construction phase.
- **Savings:**
  - Saves $150k in tunnel costs.
- **Schedule Impact:**
  - Negative impact on installation.
- **Related Impact (Including Operations):**
  - Negative impact on installation and maintenance.
- **Benefits/Advantages:**
  - May have a negative impact on overall possible operations during commissioning and/or operations of the facility. Vacuum systems would be negatively affected.
- **Risks:**
  - Schedule risk.
- **Actions//Person Responsible:**
  - Reject after study confirmation. // John Erickson

Item #15, Revisit Number of Vacuum Pumps in WP 1.4

- **Proposal Description:**
  - Reduce assumed number of turbo pumps.
- **Rationale:**
  - Try to save costs for the project construction phase.
- **Savings:**
  - Saves $???M in vacuum pump costs.
- **Schedule Impact:**
  - Negative impact on initial pump-down and conditioning.
- **Related Impact (Including Operations):**
  - Negative impact on RAMI due to insufficient turbo pumps .
- **Benefits/Advantages:**
  - May have a negative impact on overall possible operations during commissioning and/or operations of the facility. Vacuum system efficiency would be negatively affected.
- **Risks:**
  - Schedule risk. Technical risk.
- **Action**
  - Will require further study including RAMI to determine sensitivity of system performance to vacuum system reliability/maintainability. // John Erickson with SNS coordinator

Item #16, Combine Vacuum System Responsibilities in Overall SNS

- **Proposal Description:**
  - Combine all vacuum system responsibilities at a single Lab or company.
- **Rationale:**
  - Try to save costs for the project construction phase. Uniformity and easier maintenance.
- **Savings:**
  - Saves $??? in vacuum equipment design, procurement and installation costs.
- **Schedule Impact:**
  - Should be positive impact.
- **Related Impact (Including Operations):**
  - Should be positive impact.
- **Benefits/Advantages:**
  - Should be positive impact. Fewer spares.
- **Risks:**
  - Should be positive impact.
- **Actions//Person Responsible:**
  - Will require further study and negotiations. // John Erickson

Item #17, Determine Startup Requirements after Shutdown in WP 1.4

- **Proposal Description:**
  - Determine start up requirements after linac shut down for 1 hr, 1 day, 1 week, and more than 1 month.
- **Rationale:**
  - Determine operations logistics and availability.
- **Savings:**
  - Not estimated -- study needed. Savings in enhanced operations planning.
- **Schedule Impact:**
  - Knowledge enhances operations schedule.
- **Related Impact (Including Operations):**
  - Enhanced operations availability and better-known schedule.
- **Benefits/Advantages:**
  - Enhanced operations.
- **Risks:**
  - None known.
- **Actions//Person Responsible:**
  - Further study. // Andrew Jason

Item #18, Optimize Waveguide Runs and Klystron Gallery Level in WP 1.4

- **Proposal Description:**
  - Consider using waveguide tunnels that are not perpendicular to linac axis, and make the klystron gallery height as low as possible. With the waveguide tunnels rotated, the construction of the gallery and tunnel may be able to proceed in parallel, rather than in series.
- **Rationale:**
  - The klystron galley height is 20 feet at LAMPF. For SNS, the klystrons are two feet taller, and require 14.5 feet clearance to be moved. Some cut and fill earth moving may be eliminated by rotating the waveguide tunnels.
- **Savings:**
  - It will be enough of a challenge to put the taller klystrons into a building with a 20 foot ceiling and a 14.5 foot clearance to all klystron locations. The parallel construction of the gallery and the linac tunnel should reduce costs.
- **Schedule Impact:**
  - Might improve building schedule, or add flexibility in tunnel versus klystron gallery construction.
- **Related Impact (Including Operations):**
  - The klystron output waveguide is horizontal and 9 feet above the floor, but must bend up immediately for x-ray protection. Thus, the final waveguide elevation is 12 feet above floor. Water cooling, and fire protection lines must be above 14.5 feet in most of gallery, from klystron locations to roll-up doors. Construction savings must be evaluated versus the increased installation costs due to the non-vertical and non-horizontal waveguide tunnels. A platform and personnel access is still required at the 90 degree bend in the waveguide tunnels, and trolleys will be required to move material in the sloped tunnels. Water and electrical systems also use these waveguide tunnels.
- **Benefits/Advantages:**
  - Some cost savings if we can reduce waveguide length or lower galley roof. Construction time and costs may be reduced.
- **Risks:**
  - Must remain within radiation safety guidelines and allow for movement of klystrons, as well as addition of circulators for upgrade.
- **Actions//Person Responsible:**
  - Further study. Careful layout of klystron galley and waveguide runs must be made this year. Responsibility split between balance of plant and linac RF section. // Paul Tallerico

Item #19, Optimize AC for Klystron Gallery in WP 1.4.1

- **Proposal Description:**
  - AC outlets directly into equipment making heat. Don't cool the gallery too much.
- **Rationale:**
  - Most RF system heat load to air occurs in equipment racks and in the converter/modulator. Cooled air should be pumped into these places, and the warmed air then may cool the gallery. This is usual practice. Total power estimate, per klystron is 6.4 kW for RF racks, 4.1 kW from waveguide, and 11.3 kW from the modulator converter, plus 4 kW from linac magnets and diagnostics, and controls, or a total of 26 kW per klystron from each RF station (all controls, diagnostics and linac components) into the gallery air. Humidity must be controlled in the klystron gallery - we cannot have water condensing on electrical systems. Save on AC installation and operation costs.
- **Savings:**
  - Must be integrated with WBS 1.8.
- **Schedule Impact:**
  - Minimal.
- **Related Impact (Including Operations):**
  - Must use a flexible hose when connecting the converter/modulator. How to add AC when system is upgraded? Overall gallery temperature must be below 80 degrees F for maintenance crews.
  - Benefits/Advantages:
  - Cost savings, in initial and operational stages, compared to cooling equipment from ambient air.
- **Risks:**
  - All electronics must be kept cool and dry for long life and availability.
- **Actions//Person Responsible:**
  - Must balance electronic and personnel requirements with desire for low AC costs. This is a joint effort between the linac and conventional construction teams. // Paul Tallerico

Item #20, Eliminate Beam-in-Gap Diagnostic in WP 1.4.5

- **Proposal Description:**
  - Do not develop nor implement laser diagnostic that measures amount of beam in chopper gap.
- **Rationale:**
  - Consider performing measurements in ring with existing equipment.
- **Savings:**
  - Saves $1.0M.
- **Schedule Impact:**
  - Interfaces, installation, and manpower reduced.
- **Related Impact (Including Operations):**
  - Operations negatively impacted. Tune up time will be increased. Substantial beam loss likely.
- **Benefits/Advantages:**
  - Cost.
- **Risks:**
  - High. Study shows no acceptable alternative. Tuners will have no diagnostic to adjust several MEBT and chopper parameters. Substantial beam loss in ring and likely septum damage.
  - Actions//Person Responsible:
  - Reject. // Andrew Jason

64

Item #21, Eliminate Bunch Rotator in WP 1.4.5

- **Proposal Description:**
  - Do not implement bunch rotator in HEBT that provides for longitudinal matching to ring.
- **Rationale:**
  - Consider restricting the degrees of longitudinal-matching freedom by eliminating bunch rotator to save costs. Use linac ramping for longitudinal painting in ring.
- **Savings:**
  - Saves $3.4M.
- **Schedule Impact:**
  - Decreases interfaces and fabrication and installation efforts.
- **Related Impact (Including Operations):**
  - Likely increases beam loss with subsequent loss of availability and maintainability.
- **Benefits/Advantages:**
  - Cost and effort.
- **Risks:**
  - Possibly high. Requires extensive study. If linac energy ramping cannot perform painting then a larger ring tune shift and/or a larger ring beam is expected with attendant additional beam loss. More rf power may be needed in the ring.
- **Actions//Person Responsible:**
  - Reject. // Andrew Jason

Item #22, Reduce Output Energy in WP 1.4 - all

- **Proposal Description:**
  - Reduce output energy in discrete steps.
- **Rationale:**
  - Try to save costs.
- **Savings:**
  - Saves money on linac. Costs increase everywhere else.

Energy (MeV)	Δ l (m)	Δ rf $ ($M)	Δ m $ ($M)	Total $ ($M)
975	10	2.9	1.5	4.4
934	27	5.8	3.9	9.7

- **Schedule Impact:**
  - No significant impact.
- **Related Impact (Including Operations):**
  - Changes baseline.
- **Benefits/Advantages:**
  - Significant concerns for ring and target.
  - Impacts users.
  - Could be offset 2.5% (or 6.6%) by beam current increase; therefore affects downstream and upstream.
- **Risks:**
  - Significant risk for system design and operations.
- **Actions//Person Responsible:**
  - Not recommended by previous reviews. Reject. // Stan Schriber

Item #23, Reduce Linac Bore Radius in WP 1.4.4

- **Proposal Description:**
  - Further reduce linac bore radius. Consider 1 mm reduction.
- **Rationale:**
  - Bore reduction increases linac shunt impedance with subsequent decrease in linac power.
- **Savings:**
  - Undetermined. No construction savings expected; cost savings will be in operating power.
- **Schedule Impact:**
  - None.
- **Related Impact (Including Operations):**
  - Operations power costs will decrease by an estimated few percent.
- **Benefits/Advantages:**
  - Anticipated decreased life-cycle costs.
- **Risks:**
  - Moderate. Further study required. Beam loss in linac will increase; bore size has been reduced as much as considered reasonable. Power gain will be small.
- **Actions//Person Responsible:**
  - Reject. // Andrew Jason

Item #24, Consider Alternatives to Ion Pumps in WP 1.4.2-.4

- **Proposal Description:**
  - Consider alternative pumps such as NEGs.
- **Rationale:**
  - Try to save costs for the project construction phase.
- **Savings:**
  - Saves $??? in vacuum equipment design, procurement and installation costs.
- **Schedule Impact:**
  - Unknown.
- **Related Impact (Including Operations):**
  - Should be no impact. Might impact availability.
- **Benefits/Advantages:**
  - Not sure.
- **Risks:**
  - May have negative impact on technical risk.
- **Actions//Person Responsible:**
  - Reject. // John Erickson

Item #25, Consider Bidding Vacuum System Design in WP 1.4.2-.4

- **Proposal Description:**
  - Consider bidding Vacuum System Design.
- **Rationale:**
  - Try to save costs for the project construction phase.
- **Savings:**
  - No savings. Already planned for FY '99 activity as separate parcels.
- **Schedule Impact:**
  - None.
- **Related Impact (Including Operations):**
  - Should be no impact.
- **Benefits/Advantages:**
  - Unknown. Was considered earlier for entire system to be delivered as a purchase and was rejected for numerous reasons.
- **Risks:**
  - None.
- **Actions//Person Responsible:**
  - Reject. Idea already incorporated in standard best practices and in Item #4. // John Erickson

Item #26, Change CCL to Superconducting Structure in WP 1.4.4

- **Proposal Description:**
  - Use superconducting technology for linac structure above 100 MeV.
- **Rationale:**
  - Decreases operating power.
- **Savings:**
  - Save $3M per year in estimated operating costs. Construction costs are estimated to be similar to normal structure costs.
- **Schedule Impact:**
  - If decision is made now, the optimistic scenario (successful R&D program) indicates no effect on schedule. Failure of R&D would set schedule back by up to two years.
  - Related Impact (Including Operations):
  - Operations would cost less. Ease of operations would not likely change.
- **Benefits/Advantages:**
  - Substantial decrease in life-cycle cost.
- **Risks:**
  - Extremely high. $13M in R&D and possible two year schedule delay. Need information on pulsing superconducting cavities.
- **Actions//Person Responsible:**
  - Reject. // Andrew Jason

Item #27, Use Permanent Magnets in Linac in WP 1.4.3-.4

- **Proposal Description:**
  - Use permanent magnets for focusing quads in linac.
- **Rationale:**
  - Eliminate magnet power supplies.
- **Savings:**
  - Estimated $800k.
- **Schedule Impact:**
  - Minimal. Present design efforts would have to be restarted. Fabrication would take longer.
- **Related Impact (Including Operations):**
  - Operations simpler. Reduces operating power by approximately 1 MW. Decreases controls interfaces. Installation simpler.
- **Benefits/Advantages:**
  - Eases space restrictions in linac lattice. Reduced operating costs.
- **Risks:**
  - High. Reduces tuning capabilities; cannot optimize halo beam loss. Focusing strength is temperature dependent.
- **Actions//Person Responsible:**
  - Reject . // Andrew Jason

Items # 28 to 32, Transferred Items

- **Proposal Description:**
  - **Item #28**

    Review conventional facilities for linac.
  - **Item #29**

    Optimize linac berm shielding.
  - **Item #30**

    Revisit number of escape hatches for shorter tunnel.
  - **Item #31**

    Consider precast construction for tunnel.
  - **Item #32**

    Reduce requirements for linac dump.
- **Actions//Person Responsible:**
  - **Need to ensure that items are addressed. // ORNL management; Appropriate leaders of WP 1.8 and 1.10.**

Status after VE Input
98/10/31 Revised 98/11/30

All Numbers for Linac plus Linac Controls						
Item	Step	1.4, 1.9.4 $M	1.1.2 R&D $M	Total $M	1.4, 1.9.4 Contingency relative to $334.4 (339.5)- $10.5M	1.4, 1.9.4 Total $M relative to 25% contingency
TPC fixed and LANL baseline 98/06 DOE review	0	$ 273.8	$ 18.8	$ 292.6	18%	$ 353.5
Incorporate Group rates	1	$ 269.8	$ 18.8	$ 288.6	20%	$ 348.5
"Bottoms-Up" estimate by LANL team	2	$ 308.2	$ 18.8	$ 327.0	5%	$ 396.4
IGBT technology adopted for rf systems	3	$ 300.1	$ 18.8	$ 318.9	8%	$ 386.3
Schedule logic and FY98 escalation rates	4	$ 296.9	$ 18.8	$ 315.7	9%	$ 382.3
Change between R&D and Construction (1.9.4 plus-up $4.7M)		$ 304.1	$ 13.7	$ 317.8	8%	$ 391.4
Fix L-8 rates, Const G&A, Change PO/TOs, Fix staff levels *	5	$ 304.1	$ 13.7	$ 317.8	8%	$ 391.4
Fix schedule logic, Miscellaneous fixes *	6	$ 304.0	$ 13.7	$ 317.7	8%	$ 391.2
Initial cost accounting changes **	A	$ 292.4	$ 13.7	$ 306.1	13%	$ 376.7
Initial value engineering actions ***	B	$ 280.8	$ 13.7	$ 294.5	17%	$ 362.2
Further value engineering actions ****	C	$ 274.2	$ 13.7	$ 287.9	20%	$ 354.0
VE actions not accepted 98/10/21 *****	E	$ 279.6	$ 13.7	$ 293.3	18%	$ 360.7
Add risk II items - preshaped Cu(8) and 425-402(0.3)	W	$ 271.3	$ 13.7	$ 285.0	21%	$ 350.4
Add 2 rf test stands **(in spares for $2.4M)**	X	$ 271.3	$ 13.7	$ 285.0	21%	$ 350.4
Add 6 complete rf stations **(in operations $8.7M)**	Y	$ 271.3	$ 13.7	$ 285.0	21%	$ 350.4
SAVINGS re Step W to 6		**$ 32.7**				
* =Agrees with John Cleaves table dated 10/6/98 listed as "Total Project Cost by WBS Level 3"						
** =Div. infrastructure(5.4), PO to DO(6.2) = $11.6M						
*** =52 klystrons(5.8), 28m less(3.8), brazing(1) , beam-in-gap(1) = $11.6M						
**** =Quantity discounts(3.1), Misc.(1), Bunch rotator(3.4), **Oct. Increase IGBT(0.9)** = $6.6M						
*****= **Beam-in-gap(1), Misc.(1), Bunch rotator(3.4)** = $5.4M						

VALUE ENGINEERING PROPOSALS

WBS 1.5 RING AND TRANSPORT SYSTEMS

No.	Cat.	WBS No.	Proposal Description	Rational/Description	Impact/ Disadvantages	Risk	Ring Savings	Savings Others	Recommended Action	Comments
1	I	1.5.1.1	Reduce the number of HEBT corrector magnets	Reduced quantity will provide necessary steering	Some steering control is lost	low	$ 56		CCB III approval	magnets can be added later but at a higher cost
2	I	1.5.1.2	Reduce the number of HEBT corrector power supplies.	Reduced quantity will provide necessary steering	Some steering control is lost	low	$ 266		CCB III approval	
3	I	1.5.1.4	Reduce the number of HEBT BPM	Reduced quantity will provide necessary instrumentation	Some beam position information is not available	low	$ 490		CCB III approval	Adding BPM later would be very expensive
4	I	1.5.6.1	Reduce RF cavities from 4 to 3. RF Cavity	fourth system is required for 2MW upgrade	Higher cost to fabricate and install in the future	low	$ 840		CCB III approval	
5	I	1.5.6.2	Reduce RF cavities from 4 to 3. Power Amplifier.	fourth system is required for 2MW upgrade	Higher cost to fabricate and install in the future	low	$ 560		CCB III approval	
6	I	1.5.10.1	Reduce the number of RTBT corrector magnets	Reduced quantity will provide necessary steering	Some steering control is lost	low	$ 56		CCB III approval	magnets can be added later but at a higher cost
7	I	1.5.10.2	Reduce the number of RTBT corrector power supplies	Reduced quantity will provide necessary steering	Some steering control is lost	low	$ 182		CCB III approval	
8	I	1.5.10.4	Reduce the number of RTBT BPM	Reduced quantity will provide necessary instrumentation	Some beam position information is not available	low	$ 420		CCB III approval	Adding BPM later would be very expensive
9	I	1.5.12.3 and 1.10	Reduce software support manpower	The pre-ops group will do the final application codes after commissioning.		low	$ 840		CCB III approval	
10	II	1.10	Remove extraction kicker magnet spares from construction budget.	Cost becomes part of the pre-ops spares cost.	This is a critical device if a spare is not available a long shutdown could result.	medium	$ 280		approve	Pre-ops must form a spares requirement study group.
11	II	1.10	Remove extraction kicker power supply spares from construction budget.	Cost becomes part of the pre-ops spares cost.	This is a critical device if a spare is not available a long shutdown could result.	medium	$ 98		approve	Pre-ops must form a spares requirement study group.
11A	IV	1.5.9.1	Build identical kicker magnets.	Identical kickers would reduce spares requirements.	Kicker dimensions were optimized for lower voltage and larger apertures.	high	$ 210		reject	Kickers are packaged in a single module to improve RAMI
12	II	1.10	Remove extraction lambertson magnet spare from the construction budget.	Cost savings from reduced quantities.	This is a critical device if a spare is not available a long shutdown could result.	medium	$ 280		approve	Pre-ops must form a spares requirement study group.
13	I	1.9.5	HEBT and RTBT controls cost reduction due to corrector and BPM change.	Items 1, 2, 3, 6, 7, 8 no longer require controls support.	none	low	$ 431		approve	
14	I	1.5.3.5	Sample testing of production magnet.	Sample tests should provide ample warning of persistent QA production problems.	Individual mistakes may not get caught.	low	$ 700		approve	
15	I	1.5.5.2	Provide 1/2 the number of ion pumps.	Pressure will increase by 3x.	Pressure is adequate for operations. Pumps can be added later if needed.	low	$ 336		CCB III approval	Cables will be installed now to expedite installation of ion pumps in the future.
16	IV	1.8 Item (7)	Eliminate HEBT and RTBT cranes.	Components can be installed with transporter and forklifts.	Installation manpower costs and transporter costs will increase. Future maintenance, repairs, and upgrades will take longer.	medium	$ (420)	$ 100	reject	Major driver will be future operations and maintenance of the ring systems and ALARA for ring maintenance crew.

VALUE ENGINEERING PROPOSALS

WBS 1.5 RING AND TRANSPORT SYSTEMS

17	III	1.8 Item (8)	Reduce width of ring tunnel from 18 ft. to 16 ft.	Reduce the tunnel construction costs.	Space is adequate for moving equipment around the ring with the crane. It will restrict the space available for portable shielding, RF cavity power amplifiers, and future upgrades.	low	$ -	$ 130	transferred	Major driver will be future operations and maintenance of the ring systems and ALARA for ring maintenance crew. Savings are in conventional facilities.
17a	I	1.5.8	Reduce the number of portable shields	Cost savings from reduced quantities.	Additional shields may be required to protect operating equipment from radiation damage during operations.	low	$ 840		approve	Additional shields can be fabricated as required in the future to meet operation needs.
18	IV	1.5.3	Commercial competitive bids for magnet assembly.	Commercial vendors can assemble magnets at a lower cost.	Increased cost for detailed production specifications, QA inspections, and travel.	low	$ -		reject	Magnet components will be purchased via commercial competitive bids (per WBS estimate).
19	I	1.5.10 and 1.8	Shorten the RTBT line by 20 meters.	Reduced cost for both beam line components and conventional facilities.	Added length was originally required to provide space for instrumentation and future cross-over lines.	low	$ 420	C.F.	CCB III approval	Additional savings in conventional facilities.
20	X	1.5.1	Eliminate HEBT line.	Savings from reduced component requirements and conventional facilities equipment.	There is no margin for error in the Linac beam structure. All beam loss will occur in the ring injection area and the first bend.	high	$ 12,000		rejected	This change would set the project back for a year.
21	I	1.5.1 and 1.8	Shorten the HEBT line by 6 meters	Reduced cost for both beam line components and conventional facilities.	Added length was provided for other possible users of the Linac beam. Alternate methods could be found for extraction.	low	$ 48	$ 360	CCB III approval	Input and funding needed from any group that wants to extract before the achromat.
22	III	1.5.1	Reduce the aperture of the HEBT magnets and beam pipes	Material cost savings in the magnet size is offset by a cost increase in the vacuum system.	Aperture matches reduction in Linac aperture.	low	$ -		study	Further study of the lattice and the beam size is required.
23	IV	1.5.1	Purchase Magnets by functional specifications.	Commercial vendors can assemble magnets at a lower cost.	Increased cost for details production specifications, QA inspections, and travel.	low	$ -		reject	Magnet component costs are based on commercial costs from previous orders. See item 18.
23a	I	1.5.1	Use two normal magnets in lieu of a special long magnet for the Linac dump line.	Reduced development costs and special fixtures requirements.	Must meet lattice requirements.	low	$ 71		CCB III approval	Further study of the lattice is required.
24	X	1.5	Build RCS.	Significantly reduce Linac cost.	Increased ring cost and significant technical risk.	high	NA	C.F.	rejected	This change would set the project back for years.
25	I	1.8	Don't stub out the HEBT and RTBT tunnels now for future upgrades.	Reduced conventional construction cost no effect on ring systems.	Increased cost for construction in the future.	low	$ -	$ 4,520	transferred	C.F./Operations issue to be studied. Will not affect ring systems.
26	I	1.8 item (10)	Revise escape hatch design to provide ramps to grade level.	Reduced conventional construction cost and added ring access for rolling diagnostic tools.	Shielding and cost must be studied.	low	$ -	$ 200	transferred	
27	III	1.5	Consider design changes suggested by ASAC	ASAC requires additional R&D and additional accelerator components.	Added cost.	high	NA		study	

VALUE ENGINEERING PROPOSALS

WBS 1.5 RING AND TRANSPORT SYSTEMS

28	I	1.5.3	Have all stands fabricated in Tennessee.	Reduced shipping costs.	Stands costs were based on commercial competitive bids FOB ORNL. ORNL should provide and maintain an approved local vendors list for inclusion in the bid process.	low	$ -		no change	Cost savings may be offset by increased costs for vendor visits by engineers.
29	IV	1.5.3	Consider fully value engineering magnet measurement needs.	Covered under item 14 above			NA		Item 14	
30	X	1.5.3	Consider rectangular end dipoles.	Small cost savings in machining.	Magnet end field effect are significant for short magnets.	high	$ -		rejected	Insignificant savings do not justify the poor end field shape.
31	IV	1.5.7	Defer Damper system RF drive.	Cost savings during construction but it will have to be added as intensity increases.	The damper will be required for 1 MW operation.	high	$ 213		reject	
32	I	1.8	Optimize ring berm shielding.	Reduced construction cost.	No effect on machine operations as long as shielding meets specifications.	low	$ -		transferred	
33	X	1.5.1	Use permanent magnets in HEBT or other areas.	Reduced power consumption during operations. Construction costs are equal.	Reduced flexibility in accelerator system operations will result in increased downtime.	high	NA		rejected	RAMI implications.
34	III	1.5.5	Reconsider the need for a clean room for assembly at BNL.	Cost savings in laboratory equipment at BNL.	Clean assembly and bakeout required to meet 10-9 Torr operation w/o bakeout.	medium	$ 71		reject	Without the clean room there is a greater need for cleaning and recleaning components during assembly.
35	III	1.5.7	Unify some diagnostics.	ORNL instrumentation group is developed during construction to handle common systems.	There is additional cost due to the start-up of a new group in a green field.	high	$ -		transferred	Alternative would be for ORNL pre-ops group to higher an instrumentation specialist who would work with the laboratories during equipment design and development.
36	X	1.5	Consider removing beam-in-gap monitor from ring.	Cost reduction by eliminating diagnostic equipment.	Beam in the extraction gap can activate equipment.	high	$ 284		reject	A beam-in-gap monitor is being studied.
37	I	1.5.8	Have all collimator shielding fabricated in Tennessee.	Reduced shipping costs.	Stands costs were based on commercial competitive bids FOB ORNL. ORNL should provide and maintain an approved local vendors list for inclusion in the bid process.	low	$ 114		approve	Cost savings may be offset by increased costs for vendor visits by engineers.
38	IV	1.5.10	Fabricate RTBT entirely from ring components.	Reduced development costs and special fixtures requirements.	Commonality has been established with quadrupoles and correctors. Other components cannot meet RTBT specifications.	high	$ -		reject	
39	III	1.5 and 1.8	Lower beam height from 5 foot to 4 foot.	Reduce the height of the tunnel. No advantage for ring systems.	Room under the stands may be necessary if the cranes are removed to facilitate the use of a transporter.	low	$ -	C.F.	reject	Rejected by the Linac. A step in the floor between Linac and ring is not cost effective.
40	X	1.5	Lower ring elevation relative to the Linac	Reduced conventional facility cost.	Significant added cost to ring systems and added operation problems.	high	NA		rejected	
41	II	1.5 and 1.8 and 1.10	Coordinate survey and alignment between systems and move responsibility to ORNL.	ORNL will do the survey at installation.	This has no cost savings.	low	$ -		transferred	Check to make sure that equipment costs are not double counted.

VALUE ENGINEERING PROPOSALS

WBS 1.5 RING AND TRANSPORT SYSTEMS

42	I	1.8 and 1.10	Add radiation barriers in HEBT	This will help the commissioning schedule and future maintenance.	Added cost.	low	$ -	C.F.	transferred	Driven by Linac commission and operations.
43	IV	1.5.5	Revisit the vacuum gate valves.	Original estimate called for bakeable gate valves.	Already identified in $1,000K for vacuum system.	medium	$ 355		rejected	All metal gate valves are provided for radiation resistance.
44	IV	1.5 and 1.8 item (11) and 1.10	Take out the ring crane.	Components can be installed with transporter and forklifts.	Installation manpower costs and transporter costs will increase. Future maintenance, repairs, and upgrades will take longer.	medium	$ (426)	$ 100	rejected	Major driver will be future operations and maintenance of the ring systems and ALARA for ring maintenance crew.
45	I	1.2 and 1.10	Revisit overhead charge/tax at labs.	transferred 1.2 and 1.10					transferred	
46	I	1.2 and 1.10	Move tech. Support/PM to line items.	transferred 1.2 and 1.10					transferred	
47	I	1.2 and 1.10	Negotiate Tennessee Tax Savings	transferred 1.2 and 1.10					transferred	
48	I	1.2 and 1.10	Revisit staff overlaps between ORNL and Labs.	transferred 1.2 and 1.10					transferred	
49	III	1.5.2 and 1.6	Add 2 strong dynamic steering systems in the injection dump line.	Will reduce the construction and operating cost of the WBS 1.6 beam dump system.	Cost increase for the ring systems. Magnet and power supply will increase.	low	$ (114)	T.S.	study	Target systems must study cost savings. Item 13 on their list. Alternate lattice may change beam intensity w/o cost increase.
50	III	1.5.10	Study diagnostics in front of RTBT/Target vacuum window.	Infra-red detector system may be more reliable.	Reliability of the Harp may be better.	high	$ -		reject	Design baseline change not a VE change.

Total from category I items: $ 6,670 VE Savings

Total from category II items: $ 658 Transfer to 1.10

Total from category III items: $ (43)
Total from category IV items: $ (68)
Total from category X items: $ 12,284

77

Reduce HEBT and RTBT corrector magnets and beam position monitors

Ring 1, 2, 3, 6, 7, 8, 13 **WBS 1.5**

Proposal description: Reduce the number of corrector magnets and their associated beam position monitors in both transfer lines.

Rational: With the reduced quantity there will still be sufficient beam steering ability and instrumentation to meet the SNS specifications.

Savings: $1,901K - Reduced quantities of purchased parts, installation costs, and costs for controls system.

Schedule Impact: No impact.

Related Impact: none

Benefits/Advantages: Cost Savings for construction.

Risks: Low risk. Some steering control is lost and some beam position information will not be available. Magnets can be added later but at a much higher costs. Installing additional beam position monitors would require significant additional cost and down time.

Actions/Person Responsible: Ring personnel must evaluate the cost savings and update the estimates.

Eliminate fourth RF Cavity

Ring 4, 5 **WBS 1.5.6**

Proposal description: Reduce the number of first harmonic rf systems from 3 to 2.

Rational: Beam loading at 2 MW probably requires three rf systems only 2 systems will suffice at 1 MW.

Savings: $1,400K Reduced quantities of purchased parts, and installation costs.

Schedule Impact: none.

Related Impact: A third RF system will be needed for 2 MW operation. It will be more expensive to buy it later. The operating voltage with two RF systems is 10 kV. With three systems the voltage can be 6.5 kV. The system is more reliable operating at the lower voltage.

Benefits/Advantages: Cost Savings.

Risks: None for 1MW operations. Greater cost for fabrication and installation of a single cavity for 2MW operations.

Actions/Person Responsible: Ring personnel must evaluate the impact on the design and installation cost.

79

Reduce software support manpower

Proposal description: Reduce the manpower for applications software development.

Rational: During commissioning and the first year of operation, only the application software for linear measurements, such as: orbit, tune, chromaticity, beta function, etc. will be needed.

Savings: $ 1,400K - Reduced BNL manpower requirements.

Schedule Impact: none

Related Impact: none

Benefits/Advantages: Cost Savings during construction. Software development during and after commissioning may be better directed based on operations experience.

Risks: Low risk.

Actions/Person Responsible: CCB-4 and CCB-3 approval.

Remove spare components from the construction budget.

Ring 10, 11, 12 Operations **WBS 1.5, 1.10**

Proposal description: The present ring systems construction budget includes critical spare components for operations. These spares should be in the operations spares budget.

Rational: A spares philosophy must be adopted project wide.

Savings: $ 658K - The operations group will have to study the proposed spares for the entire accelerator systems determine which critical spares are needed on day one. These will then be included in the operations spare budget.

Schedule Impact: None; but, the decisions on spares must be made during the equipment fabrication phase in years 2000, 2001, and 2002. If custom components are purchased at a later date the cost will be significantly higher.

Related Impact: These components have long lead times for fabrication and assembly and they would be difficult to repair if they were damaged during operation.

Benefits/Advantages: Cost savings by having a common criteria for spares needs and optimizing the spares budget project wide.

Risks: Low risk for installation. Medium/high risk for operations if adequate spares are not purchased during construction.

Actions/Person Responsible: Ring personnel must evaluate the impact on the construction cost. The operations group must determine their spare needs and provide the budget.

Design extraction kickers with identical apertures.

Proposal description: The apertures and lengths of the kickers are matched to the size of the beam in the lattice. This is done to prevent a limiting aperture in the kicker straight sections. The lengths are inversely proportional to the aperture so that the inductance will be the same. The proposal is to build all of the kickers with the same large aperture to reduce spare requirements.

Rational: If all of the kicker cores are the same than only one spare core will be required.

Savings: $ 210K - The savings are all in spares requirements. Only one spare kicker core of the common size will be required at a savings of $150K. But the present design has the eight cores split between two large vacuum vessels. With the present design only one large diameter (45 cm) seal, flange, and clamp assembly is required per chamber. To put each kicker core in a separate chamber with a separate seal, flange, and clamp assembly will increase the vacuum chamber costs by $40K and the vacuum bake-out blanket cost by $10K.

Schedule Impact: none

Related Impact: The large aperture kickers will have to operate at a higher voltage. This could affect manufacturing cost for both the power supply and the kicker. Large aperture flange assemblies are less reliable than small aperture flanges. This change will increase the number the large aperture baked flanges from 2 to 10.

Benefits/Advantages: Cost Savings.

Risks: High risk for operations: greater likelihood of vacuum leaks, high voltage arcs, greater time to change magnets.

Actions/Person Responsible: Conventional Facility personnel must estimate cost savings. Ring personnel must evaluate the impact on the design and installation cost for all components that are installed in the tunnels.

Value Engineer the Magnet Measurements Program.

Ring 14, 29 **WBS 1.5.3.5**

Proposal description: Sample testing of production magnets/value engineer magnet measurement needs.

Rationale: Full field mapping of each of the production magnets is not required. Sample testing should reveal any recurring problems in the production magnets. Basic magnet measurements of all the magnets will provide the necessary Quality Assurance.

Savings: $ 700K – The savings is all in manpower during production testing.

Schedule Impact: none

Related Impact: none

Benefits/Advantages: Cost savings.

Risks: Low. An error in production or a single mistake on a magnet may be missed.

Actions/Person Responsible: Ring systems personnel must define a plan for sample testing. Also basic tests must be defined that will assure the quality of each production magnet.

Provide ½ the number of ring vacuum ion pumps

Ring 15

WBS 1.5.5

Proposal description: Reduce construction cost by reducing the number of sputter ion pumps in the accumulator ring vacuum system.

Rational: The design vacuum of $1x10^{-9}$ Torr was to be achieved by positioning one 200 l/s ion pump at every arc half-cell and two 200 l/s ion pumps in every straight section half-cell. These commercially available ion pumps can be added later so long as the pumping ports are installed in the vacuum chambers during construction. For ALARA reasons it is also recommended that the power cables for the missing pumps be pulled into to the tunnel during construction. The cables can always be used as spares later.

Savings: $ 336K - The savings are all in Ring vacuum system. Reduced quantities of purchased sputter ion pumps, ion pump power supplies and the installation cost.

Schedule Impact: None.

Related Impact: None.

Benefits/Advantages: Cost Savings.

Risks: Low. Due to the high conductance of the ring chambers, the average pressure will only increase by a factor of three. These ion pumps and power supplies can be installed during maintenance periods.

Actions/Person Responsible: Ring personnel will estimate the cost saving as well ensure that pumping ports and cables are installed for future implementation.

Eliminate cranes in HEBT, RING, and RTBT

Ring 16, 44 Conventional Facility 7, 11 **WBS 1.5, 1.8**

Proposal description: Reduce construction cost by eliminating cranes in all ring system tunnels.

Rational: The tunnel walls do not have to be reinforced to carry the crane rails and their associated load. The electrical distribution system for the cranes does not have to be installed. The cranes do not have to be purchased.

Savings: -$ 846 – (a cost increase for ring systems.) The savings are all in conventional facilities. They are balanced by the cost to reinforce the floor for the rolling load of the transporter and/or to provide a guide rail if air pallets are used. The ring systems cost will increase due to the need for a transporter with a component "parking" system. Installation time and costs will increase. Some component design modifications may be required to facilitate transporter installation.

Schedule Impact: By increasing the manpower in the rigging crew there should be no schedule impact.

Related Impact: The time to remove damaged components during operations will be increased from 1 to 2 hours to 6 to 10 hours. This affects both the operating schedule and ALARA. Removing a defective collimator assembly with its 38 tons (US) of shielding will require through the roof access. A significant redesign of the RF cavity/power amplifier assembly in the ring would be required since the power amplifier extends into the aisle.

Benefits/Advantages: Cost Savings.

Risks: High risk for operations: longer maintenance periods, longer radiation cool down periods to reduce personnel dose, higher installation labor costs, more complicated rigging equipment required, difficulty moving portable shielding, higher cost during future upgrades.

Actions/Person Responsible: Conventional Facility personnel must estimate cost savings. Ring personnel must evaluate the impact on the design and installation cost for all components that are installed in the tunnels.

Reduce the width of the RING by 2 feet.

Ring 17 Conventional Facility

WBS 1.5, 1.8

Proposal description: The present width of the ring tunnel is 18 ft.

Rational: The smaller width will not affect installation or the performance of the ring components.

Savings: $0 - No net savings for ring systems. The savings are all in conventional facilities.

Schedule Impact: None.

Related Impact: If the cranes are removed in the ring tunnel this change will limit the space available for moving equipment around the ring with the transporter. This is especially true in the arcs because of the size of the dipole magnets and at the RF cavities. The power amplifier will have to be removed when the transporter is moved around the ring.

Benefits/Advantages: Cost Savings.

Risks: Low risk for installation. High risk for operations if the ring crane is removed.

Actions/Person Responsible: Conventional Facility personnel must estimate cost savings. Ring personnel must evaluate the impact on the design and the installation schedule.

Reduce the number of portable shields

Ring 17a **WBS 1.5**

Proposal description: Cost savings from purchasing a smaller number of shields.

Rational: With a reduced number of movable shields there will still be sufficient flexibility to accommodate all operational and maintenance requirements during the early years of operation.

Savings: $ 840K - Reduced quantities of purchased parts and transportation costs.

Schedule Impact: None.

Related Impact: If the additional shields should be necessary for a maintenance operation there will be an impact on the time required to carry out the operation as the smaller number of shields are moved around. There will also be an ALARA impact from the additional time required. The shields can also be used for equipment protection during operations.

Benefits/Advantages: Cost Savings.

Risks: Low risk for construction. Higher risk for maintenance (ALARA), higher cost for subsequent individual movable shield purchases as opposed to bulk purchase at start of project, and reduced quantities available for equipment protection.

Actions/Person Responsible: Ring personnel must evaluate the cost impact.

87

Purchase Magnets from commercial vendor via functional specifications.

Ring 18, 23 **WBS 1.5**

Proposal description: The magnets will be designed by BNL. Magnet components will be purchased from commercial vendors by competitive bids based on design drawings and specifications. The components will be assembled and tested at BNL with the vacuum chambers and beam position monitors then shipped to ORNL for installation. With these proposals the magnets are designed, developed, and assembled by commercial vendors or foreign National Laboratories based on functional specifications.

Rational: Commercial vendors or foreign laboratories can provide the assemblies at lower costs.

Savings: $0 Base costs were based on commercial procurements. The savings are in lower labor costs especially from foreign vendors which are difficult to estimate.

Schedule Impact: Potentially large. The magnet installation schedule will be in the hands of the major contractor. Functional specifications will have to be developed, the design will have to be analyzed, and reviewed, the first articles will have to be tested before production can proceed.

Related Impact: Coordination of vendor production and component testing.

Benefits/Advantages: Cost savings.

Risks: High risk for meaningful savings. Extra engineering and travel will be required to verify the performance of the vendors. To meet the schedule the magnets will have to be shipped directly to ORNL where a green field facility will have to be set up for acceptance testing. Vacuum chambers with the Beam Position Monitor will have to be shipped to the assembly vendor. The vendors have to make a profit.

Actions/Person Responsible: Remove.

Shorten the RTBT line by 20 meters

Ring 19 Conventional Facilities 64 **WBS 1.5, 1.8**

Proposal description: Reduce construction cost by shortening the RTBT line by 20 meters.

Rational: Reduced cost for the both beam line components and conventional facilities.

Savings: $ 420K - Reduced tunnel cost (in conventional facility VE report), vacuum cost, instrumentation cost, quadrupole magnet cost, corrector magnet cost, controls cost, power supply cost and installation cost.

Schedule Impact: No impact.

Related Impact: Extraction dump may have to be moved to allow space for crossover lines to second target.

Benefits/Advantages: Cost Savings.

Risks: Low risk for 1 and 2 MW operation. Added length was originally required by the target and instrumentation groups to provide 100 meters distance between target and ring dump. Extraction beam dump will be nearer to future cross over lines.

Actions/Person Responsible: Ring personnel and conventional facility personnel must estimate cost saving.

Eliminate HEBT line

Ring 20

WBS 1.5, 1.8

Proposal description: Eliminate the 90-degree bend from the HEBT

Rational: Cost saving

Savings: ~$12,000K - Saving from reduced component requirements and conventional facilities. More study will be required to provide an accurate change in the HEBT design and a new cost estimate.

Schedule Impact: Major redesign of the HEBT and the site footprint changes will result in a one year to two year delay.

Related Impact: There is no margin for error in the linac beam structure. All beam loss will occur in the ring injection and first bend. This change will require a change in the injection area and the inclusion of collimator sections in the first 90° achromat in the ring.

Benefits/Advantages: Cost saving.

Risks: High for both schedule and design. Also the activation of components in the injection area and the first ring bend will be significantly higher.

Actions/Person Responsible: Remove

90

Shorten the HEBT line by 6 meters

Ring 21 **WBS 1.5, 1.8**

Proposal description: Shorten the HEBT line by 6 meters (1/2 FODO cell).

Rational: Reduced cost for the both beam line components and conventional facilities.

Savings: $ 48K - Reduced tunnel cost (in conventional facility VE report), vacuum cost, instrumentation cost, quadrupole magnet cost, and installation cost .

Schedule Impact: No impact.

Related Impact: No space for future beam extraction to a new user facility (ISOL) before the 90° acrhomat.

Benefits/Advantages: Reduced cost for tunnel construction and beam line components.

Risks: Low. Added length was originally required to provide space for beam extraction for future new user facilities. The polarity of the first quadrupole magnet after the linac will have to be reversed.

Actions/Person Responsible: Ring personnel and conventional facility personnel must estimate cost saving. Linac will have to evaluate the impact of the polarity change.

Reduce the aperture of the HEBT magnets and beam pipe.

Ring 22 **WBS 1.51**

Proposal description: Reduce the aperture of the LAMS and ARMS section of the HEBT line from 12 cm to 8 cm.

Rational: Reduced cost for quadrupole magnets and correctors magnets.

Savings: $0 - See related impact.

Schedule Impact: None.

Related Impact: Small 8 cm aperture magnets can not meet all of the HEBT requirements. 7 larger aperture quadrupoles and 4 larger correctors will be required in the ARMS line. To save development cost the achromat 20 cm quadrupole and corrector magnets will be used. The increased cost for these larger magnets reduces the savings of the 9 cm magnets. Buying odd sized 12 cm magnets to meet the ARMS requirement would increase EDIA costs and spares requirements. There is a vacuum cost increase due to reduced conductance of the beam pipe requiring an increased number of ion pumps. Together with the larger aperture quadrupoles there is no cost savings.

Benefits/Advantages: Reduced power usage during operations.

Risks: Low risk, but some loss of aperture safety margin.

Actions/Person Responsible: Further study of the beam size in the HEBT line is required to determine if a better aperture compromise can be made.

92

Use two normal magnets in lieu of the special long magnet for the Linac dump line.

Ring 23a **WBS 1.5.1**

Proposal description: Use two normal magnets in lieu of the special long magnets for the Linac dump line.

Rational: Reduced development costs and special fixture costs. A higher BL can be obtained by driving the standard length magnets harder and revising the lattice.

Savings: $ 71K - Development cost and fixture costs

Schedule Impact: No impact.

Related Impact: None

Benefits/Advantages: Cost saving.

Risks: Low risk, re-configuration of the magnet lattice.

Actions/Person Responsible: Approve, Ring personnel must revise lattice and estimate cost saving.

93

Use a Rapid Cycling Synchrotron for acceleration.

Ring 24

WBS 1.5.1

Proposal description: Use rapid cycling synchrotron design instead of storage ring.

Rational: The maximum Linac energy can be reduced to 400 MeV. This will reduce the Linac cost and the reduce the tunnel length.

Savings: ?? - The Linac cost savings will be partially offset by the need to redesign the ring components for acceleration. The cost saving could be 5% of the accelerator complex total cost.

Schedule Impact: Redesign of the ring and linac components and revisions to the conventional facilities will add two years to the project schedule.

Related Impact: The ring components will be much less reliable in the synchrotron mode.

Benefits/Advantages: Cost saving. A major re-estimate of the ring and linac components would be required to quantify the savings.

Risks: High risk both for meeting the project schedule and the reliability goals for the accelerator complex

Actions/Person Responsible: This proposal should be dropped.

94

Conventional Facility modifications to the tunnel design.

Ring 25, 26, 32 Conventional Facility **WBS 1.5, 1.8**

Proposal description: Don't stub out the HEBT and RTBT tunnels now for future upgrades. Revise escape hatch design to provide ramps to grade level. Optimize ring berm shielding.

Rational: None of these changes will affect the installation, operation, or maintenance of tunnel components.

Savings: No cost change for ring systems. The savings are all in conventional facilities.

Schedule Impact: None for ring components.

Related Impact: The ramps for the escape hatches will make access to the tunnels for maintenance easier. Tool carts, leak detectors, scopes, etc. can be easily rolled down the ramps for direct access to various locations in the tunnels.

Benefits/Advantages: Cost Savings for conventional facilities and ease of maintenance.

Risks: None for the ring systems.

Actions/Person Responsible: Conventional Facility personnel must estimate cost savings.

95

Consider changes suggested by the ASAC review.

Ring 27

WBS 1.5.1

Proposal description: Evaluate the ASAC recommendation of triplet lattice ring. Other recommendations can be incorporated with a small schedule and cost impact.

Rational: May result in a ring with a larger aperture and the flexibility to incorporate laser stripping at injection.

Savings: ?? - These changes may add cost to the ring systems construction. The scope of these changes can not be estimated at this time.

Schedule Impact: Redesign of the ring magnet lattice and revisions to the conventional facilities to cover a new tunnel footprint will be required. This will add 6 months to 1 year to the finalization of the ring design parameters. Impact on the ring completion date is uncertain at this time.

Related Impact: The redesign of the ring components and conventional facilities requirements.

Benefits/Advantages: Unknown at this time further study is needed.

Risks: Medium risk for meeting the project schedule. These changes may result in greater halo generation due to a mismatch of the lattice function.

Actions/Person Responsible: This proposal will be studied and a decision will be made whether to adopt these proposals on or before March 1999.

96

Have large components fabricated in Tennessee and shipped directly to ORNL.

Ring 28, 37

WBS 1.5, 1.8

Proposal description: Components such as magnet stands and collimator shielding which do not require further assembly or testing at BNL should be purchased from local ORNL vendors and shipped directly to ORNL.

Rational: Shipping costs may be reduced for local vendors.

Savings: $ 114 K - The costs for those components were based on competitive bids from commercial vendors. Some savings from the shipping cost estimates may be realized. Some extra travel to visit the vendors will be incurred.

Schedule Impact: None for ring components.

Related Impact: ORNL will have to provide and maintain a list of local vendors who will be included in the bid process for large components. The purchase orders will request prices FOB ORNL.

Benefits/Advantages: Cost Savings.

Risks: ORNL must have the storage facilities in place to accept these shipments.

Actions/Person Responsible: The shipping cost estimates must be revised.

97

Consider Rectangular Ends for the Dipole Magnets

Ring 30

WBS 1.5.3.1

Proposal description: Reduce magnet production costs by having rectangular magnet ends.

Rationale: Rectangular ends will be easier to machine.

Savings: ~$ 40K – Added cost for additional material to form machined ends for a machining fixture to provide the 68 ends required for the ring dipole magnets. The additional cost to redesign the magnet and to check the effect of this change on the lattice is not considered.

Schedule Impact: There is a risk to the schedule of 6 months. Redesign of the magnet will be required and a study of the effect on the ring lattice will be required.

Related Impact: Each ring high field dipole provides an 11.25° bend over a short 1.4 meter magnetic length. The end fields of these magnets will have a significant affect on the quality of the magnet. The horizontal size of the beam is large so variations in the BL of the magnet across its width will affect the beam quality.

Benefits/Advantages: Cost savings during core fabrication.

Risks: Poor performance.

Actions/Person Responsible: Rejected

98

Defer the ring damper system.

Ring 31 **WBS 1.5.7**

Proposal description: Defer the Beam Damper System in the Ring.

Rationale: Studies have not shown serious instabilities, but Damper may be needed to reach higher intensities.

Savings: $ 213K - High power RF amplifiers and associated manpower costs.

Schedule Impact: None

Related Impact: The tune measurement system requires the kicker, beam pickups, and the low level electronics that are part of the Damper system. The tune measurement system can not be removed for the ring instrumentation system.

Benefits/Advantages: Cost Savings.

Risks: High. If an instability develops during commissioning the excessive losses will keep the intensity well below the design value. The lead time required to produce and install the Damper high power RF amplifiers would be over one year.

Actions/Person Responsible: Study cost savings accrued from deferring the high power RF amplifiers.

99

Use permanent magnets in the HEBT or other areas

Ring 33

WBS 1.5

Proposal description: Use permanent magnet dipoles in the HEBT or other areas.

Rational: Reduced power consumption during operations. Construction cost are equal.

Savings: Reduced operating costs. (~40 kW energy cost saved per year). No savings in construction costs. Increased magnet fabrication cost is offset by savings in power supply and controls costs.

Schedule Impact: Since the magnets would have to be developed, there would probably be slippage in the schedule.

Related Impact: HEBT achromat can only take beam at the fixed design energy. The magnets are always "on" which has safety implications during installation and maintenance. Disassembly of permanent magnets is difficult.

Benefits/Advantages: Reduced operating cost.

Risks: High. Reduced flexibility in accelerator system operations.

Actions/Person Responsible: Remove

100

Reconsider the need of a clean room for assembly at BNL

Ring 34

WBS 1.5.5

Proposal description: Reduce cost by eliminating a clean room for assembly and testing of vacuum components at BNL.

Rational: Cost savings.

Savings: $ 71K - The savings are in not refurbishing an existing building to meet the minimum clean environment typically required for vacuum assembly. The cost saving will be offset by the need to chemically clean components and assemblies repetitively after exposure to ordinary mechanical shop environment

Schedule Impact: It will increase the required assembly and testing period.

Related Impact: The out-gassing of the contaminated surface can be a few orders of magnitude higher than a clean surface. The pressure will increase proportionally. The secondary electron yield of a contaminated surface is also much higher than that of a clean surface.

Benefits/Advantages: Cost savings for construction.

Risks: High. May not be able to achieve the design vacuum. This may impact the schedule due to the need to re-clean the components and assemblies after assembly or installation at ORNL.

Actions/Person Responsible: This proposal should be rejected.

101

Unify some diagnostics

Ring 35

WBS 1.5.7

Proposal description: Develop an ORNL Instrumentation group to handle common systems.

Rationale: Some systems may benefit from a common approach.

Savings: ?? - Cost increases related to the start-up of an instrumentation group (physicist, engineers, and technicians) that must design and develop new equipment designs.

Schedule Impact: 1 to 2 years for group start up.

Related Impact: System design for data acquisition integrates all systems and a "stand-alone" may require additional Controls hardware and software effort.

Benefits/Advantages: Will help train ORNL personnel in the systems they will operate.

Risks: High. The BLM system is the main protector against beam loss that can cause activation and machine damage. It is not advisable to use it for "On-the Job Training" for inexperienced instrumentation designers.

Actions/Person Responsible: Transferred to ORNL operations; not a value engineering item. ORNL Instrumentation specialists should be hired and sent to the various providing laboratories to work with the experienced design groups. There they will learn about the systems as they are designed, fabricated, and tested. The ORNL personnel should attempt to foster common approaches where possible.

Consider removing beam-in-gap monitor from ring

Ring 36

WBS 1.5.7

Proposal description: Consider removing Beam-In-Gap (BIG) monitor from ring

Rationale: Cost reduction by eliminating some systems

Savings: $ 284K - R and D costs and hardware costs. The design of the BIG is still being developed.

Schedule Impact: Would need to be studied.

Related Impact: Without a BIG monitor activation of the ring equipment, particularly in the extraction area, could be prohibitive. This is both an ALARA and machine reliability concern.

Benefits/Advantages: Cost savings.

Risks: High. While the Beam in the extraction gap coming from the Linac may be detected elsewhere, processes in the ring may also lead to this condition. Without a means of observing this in the ring, studies to eliminate the source of beam loss during extraction would be difficult.

Actions/Person Responsible: Further study of the BIG is required by the ring instrumentation group.

Reduce beam height in HEBT, RING, and RTBT by 1 foot.

Ring 39 Conventional Facility 65 Linac 17 **WBS 1.4, 1.5, 1.8**

Proposal description: The present beam height is 5 ft. in the Linac, HEBT and Ring and 6 ft. in the RTBT line (because of vertical extraction).

Rational: The lower height will reduce the construction cost.

Savings: $0 - The savings are all in conventional facilities. There will be a small savings in the steel required for the equipment stands.

Schedule Impact: Small. There will be some redesign required on the layouts for tunnel equipment.

Related Impact: If the cranes are removed in the tunnels this change will limit the space available for the transporter equipment under the transport line and ring components. It will limit the vertical space available for the RF cavity power amplifier that is adjacent to the cavity. The power amplifier can be made wider but it will reduce access to the RF cavity.

Benefits/Advantages: Cost Savings.

Risks: Low risk for installation. Medium risk for operations because of the RF cavity access. High risk for operations if the ring crane is removed because the RF power amplifiers will have to be removed when ever the transporter is used near the cavities.

Actions/Person Responsible: Conventional Facility personnel must estimate cost savings. Ring personnel must evaluate the impact on the design and installation cost for all components that are installed in the tunnels.

Revisit the vacuum gate valves.

Ring 43 **WBS 1.5.5**

Proposal description: Reduce the cost by using non-bakeable vacuum gate valves in the ring.

Rational: Non-bakeable valves may be used since majority of the ring will not be baked.

Savings: $ 355K - The savings are in the purchasing price of non-bakeable valves in comparison with that of the bakeable valves.

Schedule Impact: None.

Related Impact: The all-metal bakeable valves are used in the ring because of their superior radiation resistance. The non-bakeable valves use Viton elastomer O-rings for the valve seal. The viton has a limited life in a high radiation environment. To replace a gate valve seal two vacuum sections must be vented to atmospheric pressure. The out-gassing of the O-ring valves is also higher than that of the all-metal ones. The AGS has seen failures of viton sealed valves after 28 months of high intensity proton operation.

Benefits/Advantages: Cost savings for construction.

Risks: High risk for operation. Failure of the gate valves in a high radiation area near injection, extraction, or the collimators could result in significant dose to personnel. Work near the extraction kicker section will require extra time for the vacuum bake-out of the ferrite kickers, resulting in a two day shutdown.

Actions: Reject.

105

Study diagnostics in front of RTBT/Target vacuum window

Ring 50 **WBS 1.5.10, 1.6**

Proposal description: Study alternate diagnostic approaches for the instrumentation in front of RTBT target vacuum window

Rationale: Infrared detector may be more reliable or less expensive.

Savings: ?? - Cannot estimate since an IR system, which can meet the specifications for this area, has not been conceptualized or proposed yet.

Schedule Impact: Would need to be studied.

Related Impact: The target group would have to provide a shielded labyrinth pathway for the IR system optics.

Benefits/Advantages: Possible small cost savings for construction.

Risks: High. This is an interlock device that helps prevent catastrophic failure of the mercury target system. The HARP system is proven reliability; the IR system is not. A long and multi-element optical system (particularly IR) is not easy to align, maintain, and focus on a curved window surface. Real time video processing at 60 Hz is exotic. Non-uniformity's, such as window deflection and uneven water cooling, must be analyzed, defined, and compensated for before sending beam to the target.

Actions/Person Responsible: The proponent of the IR system should do study and make a specific proposal. The RTBT responsible physicist and the target group will then evaluate it.

106

WBS 1.6 – Target Systems

No.	Cat.	WBS Numbers	Proposal Description	Rationale/ Advantages	Impact/ Disadvantages	Risk	Savings (000)	Recommended Action	Comments
1	IV	1.6.1.2	Size Hg Heat Exchanger for 1 MW	Possible cost savings but small	Must be replaced for higher powers	L	5	Reject	
2	I	1.6.1.2	Use Y-12 Hg	Cost Savings	None	L	30	Baseline now	Baseline
3	IV	1.6.1.1	Use same tank for Hg storage and spill collection	Improvement over CDR		L	0	None	Already Incorporated in current Design Manual. No net savings identified for system
4	IV	1.6.2.2/ 1.1.7.4	Eliminate Variable Speed Hydrogen Circulator	Save Development Cost	Limited control and flexibility- less reliable	L	200	Reject	
5	I	1.6.2.2	Eliminate On-Line replacement capability for hydrogen circulators	Cost savings by simplification of loop - still have redundant pump	System down if both pumps fail	L	60	Accept	Baseline
6	II	1.6.3.1	Use recycled lead for reflector assemblies	Cost savings no charge for recycled material	Effects of contaminants on performance not known	L	100	Verify product contains no unacceptable contaminants	Baseline
7	IV	1.6.7.1	Use TV viewing in lieu of 2 shield windows	Cost savings	Extended maintenance and cell operations time and added operator time for waste processing	H	0	Reject	
8	II	1.6.7.1	Use the TTF Model F manipulators for SNS	Cost savings	TTF arms were to be spares - could impact availability	M	285	Accept	Baseline

SNS

WBS 1.6 – Target Systems

No.	Cat.	WBS Numbers	Proposal Description	Rationale/ Advantages	Impact/ Disadvantages	Risk	Savings (000)	Recommended Action	Comments
9	IV	1.6.8.1	Eliminate the PLC development system	Cost savings	Schedule impact and operations impact	H	70	Reject	Expected delays for installation and operation of the Target Protection System
10	IV	1.6.5.1	Restrict access to the area immediately above target and eliminate or reduce roof shield	Cost savings - continuous occupancy above target not needed	Likely to not meet shielding requirements for instrument area due to skyshine	H	100	Reject	Shielding requirements should be re-examined. A higher allowable dose rate above the target may avoid potential design complexity with the inner plug
11	III	1.6.5.1	Use lower cost cast concrete for shielding with dense recycled metal as aggregate	Cost saving on material and fabrication for iron shielding	Decontamination and Decommissioning cost could increase. Shutter case cost could increase	M	150	Evaluate and design system by Sep 99	Design and analysis needed to evaluate. Has a good potential for cost savings.
12	IV	1.6.9.1	Eliminate the ring extraction dump	Cost savings / assumes target available	Schedule impact on commissioning. BNL still requires dump	H	1000	Reject	
13	II	1.6.9	Identify/reduce the power & duty factor on all three dumps	Using common design may cost more then designing for actual needs	Beam dumps could be undersized if there are unforeseen requirements	L	200	Accept and redesign & reestimate the dumps	Linac dump reduced to 67 kW at 10% duty factor and Extraction dump reduced to 6.7 KW at 1% duty factor. WBS 1.8 will also have savings
14	IV	1.6.9.1	Combine the primary cooling systems for the three dumps	Cost savings from eliminating some pumps and heat exchanges	No net savings due to additional piping and shielding.	H	0	Reject	Increases risk of leakage of tritiated water in transfer tunnels.
15	II	1.1.5.1	Eliminate high velocity erosion/corrosion tests	Cost savings; could also improve schedule	No high velocity Hg data if Japanese do	M	693	Implement now	Confirm that Japanese will conduct tests

VALUE ENGINEERING PROPOSALS

WBS 1.6 – Target Systems

No.	Cat.	WBS Numbers	Proposal Description	Rationale/ Advantages	Impact/ Disadvantages	Risk	Savings (000)	Recommended Action	Comments
					not perform tests				
16	I	1.1.4.3	Eliminate Calor V&V analysis of accelerator experiments	Cost savings	Increases uncertainty in neutronics	M	100	Implement now	Baseline
17	I	1.1.4.4	Eliminate neutronics R&D Technical Support	Cost Savings		L	108	Implement now	Baseline
18	II	1.1.6.2	Eliminate irradiation tests with flowing Hg at ORELA	Cost savings; Experimental conditions not prototypical	Increased uncertainty in target lifetime and reliability	M	1,000	Implement now	Baseline
19	II	1.8.4.3	Use existing cryo refrigerator from CWDD at ANL	Cost savings	Possible non-optimal system design	M	2,000	Further study	**Transferred to WBS 1.8**
20	IV	1.6.5.1	Reduce shielding to that required for 2 MW	Cost savings	Retrofitting will be difficult and costly	H	500	Reject	
21	II	1.6	Revisit Haz Cat 2 vs Cat 3	Need to fix the baseline approach to avoid cost increases later	Potential cost increase if Cat 2	H	0	Implement by Jan '99	Could be additional $525K increase if safety class systems, structures, or components are required
22	IV	1.6.5.1	Use non-concentric shielding configuration for forward scattering	Perceived cost savings	Schedule delay, more complex configuration to construct	L	0	Reject	Could actually be a net cost increase if schedule impacts and rework are included.
23	IV	1.6.1	Look at solid target backup option	Solid target have been used as targets at low power	Uncertain performance at powers of 1 MW or higher	H	0	Keep solid target as fallback option	
24	II	1.6.7.1	Use surplus hot cell	Cost savings	Equipment may need	L	?	Further study	Will continue to try to locate

SNS

WBS 1.6 – Target Systems

No.	Cat.	WBS Numbers	Proposal Description	Rationale/ Advantages	Impact/ Disadvantages	Risk	Savings (000)	Recommended Action	Comments
25	IV	1.6	Revisit moderator installation method – vertical vs. horizontal	Potential cost savings	No cost savings; increased safety hazard in target cell	H	0	Reject	
26	III	1.6	Use model or mockup to check assembly interferences	Increased confidence in installation		L	0	Study later	Full scale-mockups planned for Hg target and loop, inner plug, and proton beam window
27	IV	1.8	Hold purchase of H2 cryogenic system until after FY05	Cost savings	Limits initial performance and requires significant expenditure during operation phase			Reject	**Moved to WBS 1.8**
28	II	1.7	Use LBNL steel for instrument shielding						**Transferred to WBS 1.7**
29	IV	1.6.8.1	Omit PLC operation interface	Cost savings			0	Reject	
30	IV	1.6.2.1	Consider liquid nitrogen for cooling of moderators	Expands capability of SNS	Adds cost		0	Reject	Beyond baseline scope
31	II	1.5	Look at alternate diagnostic in front of proton beam window						**Moved to WBS 1.5**
32	IV	1.5, 1.6	Revisit proton beam profile requirements to reduce cost	Potential cost savings		L	0	Reject	Specification already eliminates any detailed profile requirement. Ring systems requirements currently drive beam uniformity.

TARGET SYSTEMS

Category I

No.	Proposal Description	$K Savings
2	Use Y-12 Hg	30
5	No On-line replacement for H_2 Circulators	60
16	No design/ V&V for ORELA Experiment	100
17	No Neutronic R&D Technical Support	108
18	No irradiation with flowing Hg	1,000
		$1,298

Revised Version 11/13/98

TARGET SYSTEMS

Category II

No.	Proposal Description	$K Savings
6	Use recycled lead for reflector	100
8	Use TTF Manipulators for SNS	285
13	Power and duty specs for beam dumps	200
15	Eliminate high velocity erosion/corrosion test	693
21	Revisit Category 2 versus Category 3	0-
24	Second-hand equipment	?
		$1,278

Revised Version 11/13/98

Category III

No.	Proposal Description	$K Savings
11	Cast concrete shielding with dense material	150
26	Revisit model or mock-up for assemblies	0-
		150

TARGET SYSTEMS

Category IV

No.	Proposal Description	$K Savings
1	**Size Hg heat exchange for 1 MW**	**5**
3	**Use same tank for Hg storage/spill collection**	**0**
4	**Eliminate variable speed hydrogen circulator**	**200**
7	**Use TV in lieu of 2 shield windows**	**0**
9	**Eliminate the PLC development system**	**70**
10	**Restrict access to area above target/roof shield**	**100**
12	**Eliminate ring extraction dump**	**1,000**
14	Combine Primary systems for 3 dumps	0-
20	**Reduce shielding to 2 MW**	**500**
22	**Optimize shielding (non-concentric)**	**0-**
23	**Revisit solid target backup option**	**0-**
25	**Revisit moderator: vertical versus horizontal**	**0-**
29	Omit PLC operation interface	0
30	**Consider liquid nitrogen for cooling of a 100K moderator**	**0-**
32	**Evaluate Ts specifications of proton beam profile**	**0**
		$1,895

Revised Version 11/13/98

TARGET SYSTEMS

Items Moved To Other WBS Elements

No.	Proposal Description	WBS
19	Consider Used Cryogenic System at Argonne National Laboratory	1.8
27	Hold purchase of H_2 Cryogenic unit until after 10/1/2005	1.8
28	Use Lawrence Berkeley National Laboratory steel	1.7
31	Proton Beam Window Diagnostics	1.5

TARGET SYSTEMS

No./Category: 1/IV **WBS# 1.6.1.2**

- **Proposal Description:** Size Hg heat exchanger for 1 MW
- **Rationale:** The current cost is based on initial installation of a heat exchanger capable of handling a beam power upgrade to 2 MW. Cost savings would result if a heat exchanger sized for only the initial power of 1 MW were used.
- **Savings:** Approximately $ 5k.
- **Schedule Impact:** No impact on initial construction schedule. Increases in amount of work during upgrade to 2 MW may impact required down time.
- **Related Impact:** None
- **Benefits/Advantages:** Reduced construction costs
- **Risks/Disadvantages:** The initial savings of $5 k is small compared to the $ 100 k cost to replace the unit with one sized for 2 MW
- **Actions/Person Responsible:** Item should be dropped, no further action is recommended - D. Lousteau

Revised Version 11/13/98

TARGET SYSTEMS

No./Category: 2/I **WBS# 1.6.1.2**

- **Proposal Description:** Use mercury available from Y12 rather than purchase from vendor.
- **Rationale:** Cost savings resulting from the use of government owned supply
- **Savings:** $ 30 k
- **Schedule Impact:** None
- **Related Impact:** None
- **Benefits/Advantages:** Cost savings
- **Risks/Disadvantages:** None
- **Recommended Actions/Person Responsible:** Accept proposal, no further action required - D. Lousteau

Revised Version 11/13/98

No./Category: 3/IV **WBS# 1.6.1.2**

- **Proposal Description:** The elimination of the tank used to store the process mercury during the replacement of the target module is proposed. In the revised scheme the mercury would be stored in the tank used to catch mercury and water in the event of a leak.

This proposal has already been implemented.

TARGET SYSTEMS

No./Category: 4/IV **WBS# 1.6.2.2 & 1.1.7.4**

- **Proposal Description:** Eliminate the infinitely variable cryogenic hydrogen circulators
- **Rationale:** Savings by elimination of development costs
- **Savings:** $200K
- **Schedule Impact:** None
- **Related Impact:** Some negative impact on the hydrogen safety case
- **Benefits/Advantages:** Cost savings
- **Risks/Disadvantages:** The cryogenic loop would be more limited in control and much less flexible. This could force the hydrogen system to be shutdown in situations that could be avoided with the variable flow circulators in place.
- **Recommended Actions/Person Responsible** Reject this proposal – T. Lucas

Revised Version 11/13/98

TARGET SYSTEMS

No./Category: 5/I **WBS# 1.6.2.2**

- **Proposal Description:** Eliminate the ability to replace cryogenic hydrogen circulators during cold source operation
- **Rationale:** Cost savings by simplification of the cryogenic loop and elimination of four cryogenic valves
- **Savings:** $60K
- **Schedule Impact:** None
- **Related Impact:** Favorable impact, hydrogen safety case
- **Benefits/Advantages:** Cost reduction, circuit simplification, and simplified cryogenic hydrogen safety document.
- **Risks/Disadvantages:** Loss of the cold source systems if the operating circulator and its installed spare fails
- **Recommended Actions/Person Responsible:** Accept this proposal – T. Lucas.

Revised Version 11/13/98

No./Category 6/II

WBS # 1.6.3.1

- **Proposal Description:** Use recycled lead in reflector plug assemblies rather than "virgin" material.
- **Rationale:** Forming costs for lead are less than the disposal costs. The company doing the disposal work will provide the material at no cost and do the forming operations for free.
- **Savings:** Material cost: ~125,000 lbs @ $0.40/lb = $50K
  Forming cost: ~125,000 lbs @ $0.40/lb = $50K
  Total savings = $100K
- **Schedule Impact:** None
- **Related Impact:** Contaminants in lead may affect D&D requirements.
- **Benefits/Advantages:** Cost Savings to project. Use of recycled materials
- **Risks:** Lead may contain contaminants that affect neutron beam performance.
- **Recommended Actions/Person Responsible:** Determine whether supplier can verify product contains no unacceptable contaminants. - R. Allen

Revised Version 11/13/98

No./Category: 7/IV

WBS # 1.6.7.1

- **Proposal Description:** Replacement of the Target Cell windows with in-cell viewing cameras is proposed for 2 of the window/manipulator stations currently included in the baseline design.

- **Rationale:** It is thought that camera viewing can be as good or better than shield windows for many types of operations. Specifically, cameras are able to be locally positioned to assist with detailed handling operations; they can provide overall views of large cell areas and can be used outside the viewing area of windows. For this reason, the current Target Cell system includes a limited number of cameras to support through-window operations. The proposed change expands on the use of cameras to eliminate 2 windows, particularly during the early phases of the project when the use of some of the cell bays will be limited.

- **Savings:** The material cost of a, 30 in X 30 in X 40 in thick window is estimated by Hot Cell Services as $200K. An additional cost of $30K was added for miscellaneous supporting equipment. The total engineering for any number of windows is $78K. It is also assumed that the window frames are installed. Some of savings are offset by the cost of a 6 camera set, including additional engineering and installation. The total estimated cost savings is 0.

- **Schedule Impact:** None

No./Category: 7/IV (continued) **WBS # 1.6.7.1**

- **Related Impact:** Camera only operations are less efficient and more time consuming than the proposed window with camera viewing system currently proposed. Quantifying the impact is difficult; however, the judgement of experienced cell operators strongly supports maintaining the current configuration.

- **Benefits/Advantages:** Cost Reduction

- **Risks:** Extended maintenance and cell operations times with additional operator hours required to perform waste processing operations.

- **Recommended Actions/Person Responsible:** Reject proposal. Maintain current baseline configuration and cost - Mark Rennich

TARGET SYSTEMS

No./Category: 8/II

WBS# 1.6.7.1

- **Proposal Description:** The two pairs of CRL Model F arms received by ORNL from Princeton Plasma Physics Laboratory for the Target Test Facility are suitable for use in the SNS Target Cell. Propose using both pairs of manipulators in SNS Target cell.

- **Rationale:** Cost savings resulting from the use of on-hand equipment

- **Savings:** If both pairs are used the total cost savings will be $285K.

- **Schedule Impact:** None

- **Related Impact:** The current baseline design assumed the TTF arms would be used as spares to improve the reliability and shorten the down-time of the cells.

- **Benefits/Advantages:** Cost Reduction

- **Risks:** Increased cell down-time and reduced system reliability

- **Recommended Actions/Person Responsible:** Accept Recommendation – M. J. Rennich

Revised Version 11/13/98

TARGET SYSTEMS

No./Category: 9/ IV **WBS # 1.6.8.1**

- **Proposal Description:** Eliminate the PLC development system for the target.
- **Rationale:** The target PLC development system would be used by designers to develop and modify software for PLCs used in the target—primarily the Target Protection System. Elimination of this equipment would save money.
- **Savings:** $70 K
- **Schedule Impact:** Installation of the production PLC could be delayed while software was being developed.
- **Related Impact:** Operations would be impacted because software maintenance and modification testing would need to be done on production equipment.
- **Benefits/Advantages:** The benefit of not purchasing a development system is the capital cost reduction.
- **Risks:** Testing, checkout, and final approved operation of the Target Protection System could be delayed because of the unavailability of a PLC development system.
- **Recommended Actions/Person Responsible:** Do not accept elimination of the development system because of the expected delays for installation and operation of the Target Protection System – R. Battle

Revised Version 11/13/98

TARGET SYSTEMS

No./Category: 10/IV **WBS# 1.6.5.1**

- **Proposal Description:** Restrict access to area above target and reduce/eliminate roof shield
- **Rationale:** Cost savings resulting from the elimination of the design and fabrication for the roof shield
- **Savings:** Eliminating the roof shield could save about $100K. Making the shield thinner would only slightly reduce the cost since all the resources would have been spent on the design and fabrication.
- **Schedule Impact:** None
- **Related Impact:** This severely reduces the access to the hi-bay floor at the target station reducing access for maintenance. Some concrete shielding is required to reduce the "sky shine" in the experiment hall.
- **Benefits/Advantages:** Cost Reduction
- **Risks/Disadvavantages:** Does not meet shielding requirements for instrument area, reduced system availability.
- **Recommended Actions/Person Responsible:**Eliminate proposal to change roof shielding as a value engineering item but re-examine the shielding requirements and occupancy to avoid potential design complexity with the inner plug. - K. K. Chipley

Revised Version 11/13/98

TARGET SYSTEMS

No./Category: 11/II **WBS# 1.6.5.1**

- **Proposal Description:** Use lower cost cast concrete with dense aggregate (iron or contaminated lead) to replace the steel shielding in the target station shielding.
- **Rationale:** Cost savings resulting from eliminating purchase of virgin steel as well as the fabrication and installation of shielding plates, blocks, or other specified shapes.
- **Savings:** This proposal could save as much as $150K for the initial construction.
- **Schedule Impact:** None
- **Related Impact:** None for line item. There maybe a substantial effect on long term D&D effort.
- **Benefits/Advantages:** Cost reduction could be significant if the long term D&D costs were reasonable.
- **Risks:** The long term D&D costs could be impacted, shutter cases could increase in cost.
- **Recommended Actions/Person Responsible:** This is probably a good suggestion. Evaluate and design system for cost savings by September 1999. - K. K. Chipley

Revised Version 11/13/98

TARGET SYSTEMS

No./Category: 12/IV **WBS: 1.6.9.1**

- **Proposal Description:** Eliminate the ring Extraction dump and use the target as the only available dump when tuning the ring.
- **Rational:** Other facilities (ISIS) have found that this dump is seldom used and that the target is almost always available when the LINAC is available and the ring needs a place to tune beam
- **Savings:** This beam dump will cost about $1M. It has costs also in WBS 1.8.
- **Schedule Impact:** Eliminating this dump will extend the commissioning time by about three months.
- **Related Impact:** None
- **Benefits/Advantages:** Cost Reduction
- **Risks:** The use of a flowing mercury target makes the SNS unique and there may be times that the target is not available when ring tuning is needed. This has substantial effects on availability. The BNL design staff for the Ring feel strongly that this dump is necessary.
- **Recommended Actions/Person Responsible:** Do not eliminate this dump. Reduce the power and duty factor (see 13/I) – K. Chipley

TARGET SYSTEMS

No./Category: 13/II **WBS: 1.6.9.1**

- **Proposal Description:** Identify the specific power and duty factor requirements for each of the three beam dumps.
- **Rationale:** There is not a lot of design effort to be saved by making these dumps a common design. There is a lot of money to be saved if large dump shielding and piping systems can be eliminated.
- **Savings:** Reducing the power and duty factor can reduce costs by at least $200K.
- **Schedule Impact:** None
- **Related Impact:** Conventional Facilities (WBS 1.8) will also have savings
- **Benefits/Advantages:** Cost Reduction
- **Risks:** There is the chance that some unforeseen activity could cause the beam dumps to be insufficiently sized and cause increased unavailability.
- **Recommended Actions/Person Responsible:** Reduce the power and duty factor. The meeting during the VE study (10/20/98) established new power and duty factor requirements (200kW/100%, 67kW/10%, and 6.7kW/1%). This change will be evaluated and costs estimated by January 1999. – K. Chipley

Revised Version 11/13/98

TARGET SYSTEMS

No./Category: 14/IV **WBS: 1.6.9.1**

- **Proposal Description:** Combine primary cooling systems for the three dumps.
- **Rationale:** This would eliminate some heat exchangers and pumps at the expense of additional activated water piping systems.
- **Savings:** It is now estimated that the piping and shielding between beam dumps would cost more than the pumps and heat exchangers that might be eliminated. $0K
- **Schedule Impact:** None
- **Related Impact:** Target Systems Utility Systems (WBS 1.6.6) would have increased costs
- **Benefits/Advantages:** None
- **Risks:** Some environmental risks associated with pipe leakage for long distance piping of activated water
- **Recommended Actions/Person Responsible:** This alternative should not be pursued. K. K. Chipley

Revised Version 11/13/98

TARGET SYSTEMS

No./Category: 15/II

WBS: 1.1.5.1

- **Proposal Description:** Eliminate high velocity erosion/corrosion tests. These long-term (~18 month) tests were intended to confirm that corrosion rates are acceptably low at relevant operating temperatures, temperature differences through the loop, and velocities (~1-2 m/s). It is proposed that these tests be eliminated from the R&D program.

- **Rationale:** Since these tests are confirmatory in nature and the Japanese spallation source team plans to look at this phenomenon earlier that we do, it is felt that we could eliminate this part of the mercury target development program with minimal risk.

- **Savings:** The full cost of this phase of the MTHL program $693K is saved.

- **Schedule Impact:** Elimination of this activity may also have a favorable impact on the Target Systems schedule, but this requires further study to determine. Tests can be added back into R&D program later if needed.

- **Related Impact:** None

- **Benefits/Advantages:** Cost Reduction

- **Risks:** Increased uncertainty in Hg target lifetime. SNS will have no tests examining long-term corrosion effects at relevant velocities. Rely on other (Japanese) to conduct these tests and share results.

Revised Version 11/13/98

No./Category: 15/II (continued) **WBS: 1.1.5.1**

- **Recommended Actions/Person Responsible:** Recommend elimination of this task and discussing information exchange with our Japanese colleagues. – J. Haines

TARGET SYSTEMS

No./Category 16/I **WBS # 1.1.4.3**

- **Proposal Description:** Eliminate CALOR verification and validation analysis of ORELA accelerator experiments.
- **Rationale:** Cost savings resulting from the elimination of manpower costs associated with computational effort.
- **Savings:** $100K can be saved if the analysis of the ORELA accelerator experiment is dropped.
- **Schedule Impact:** None
- **Related Impact:** Dropping the ORELA experiment and thereby the analysis eliminates our in beam test with flowing Hg. (see No. 18)
- **Benefits/Advantages:** Cost reduction.
- **Risks/Disadvantages:** Increased uncertainties associated with the SNS neutronics and shielding design efforts resulting in more conservative designs and possible increased costs associated with shielding, cooling, reflecting, and construction materials. (see No. 18)
- **Recommended Actions/Person Responsible:** Implement now. – J. Johnson

Revised Version 11/13/98

TARGET SYSTEMS

No./Category 17/I **WBS # 1.1.4.4**

- **Proposal Description:** Eliminate SNS project R&D technical support for neutronics analysis.
- **Rationale:** Cost savings resulting from the elimination of manpower costs associated with this effort.
- **Savings:** Cost savings of $108K if eliminated.
- **Schedule Impact:** None
- **Related Impact:** None
- **Benefits/Advantages:** Cost reduction.
- **Risks/Disadvantages:** Depending on how things evolve, funding for this may be needed at a latter date.
- **Recommended Actions/Person Responsible:** Implement now. – Jeffrey O. Johnson

TARGET SYSTEMS

No./Category 18/I **WBS # 1.1.6.2**

- **Proposal Description:** Eliminate irradiation/flowing Hg test at ORELA
- **Rationale:** 1. The primary motivation to eliminate this test is cost savings, and
  2. The experimental conditions are not prototypic of SNS
- **Savings:** $1M
- **Schedule Impact:** None before startup of the SNS..
- **Related Impact:** Possible negative effect on reliability of SNS in early operational period.
- **Benefits/Advantages:** The immediate benefit is cost savings in the FY 1999/2000 R&D program. If no target lifetime problems are encountered this would translate to overall cost savings. If problems are encountered, then the overall cost benefit of eliminating this test could be erased or reversed.

Revised Version 11/13/98

No./Category 18/I (continued) **WBS # 1.1.6.2**

- **Risks:** The SNS target will be the first operational experience with materials subject to long term, charged particle irradiation in contact with flowing mercury. Unexplored interactions could occur, which could cause failure or necessitate early shutdown of the target. Unexpected phenomena historically have often been encountered when exposing materials to irradiation in new environments. However, there are no presently identified reasons to anticipate problems. The ongoing materials R&D program is planned to determine the extent of separate radiation damage and compatibility issues. A low energy/low dose/low cost proton irradiation in static Hg will be carried out to explore very limited radiation effects/compatibility interactions.

- **Recommended Actions/Person Responsible:** Accept - L. K. Mansur

No Category: 19/II **WBS# 1.8.4.3**

- **Proposal Description:** Use of existing cryogenic refrigerator from CWDD at Argonne National Laboratory.

This Item Has Been Moved To WBS 1.8

TARGET SYSTEMS

No./Category: 20/IV **WBS: 1.6.5.1**

- **Proposal Description:** Reduce shielding to that required for 2MW operations.
- **Rationale:** Shielding for 4 MW operation could presumably be added later.
- **Savings:** Unknown, but crudely estimated to be $500K.
- **Schedule Impact:** None
- **Related Impact:** Conventional Facilities (WBS 1.8) might have slight cost savings due to reduced floor loading.
- **Benefits/Advantages:** Cost Reduction
- **Risks:** Retrofitting additional shielding material for the 4 MW operation would be almost impossible within a 6-month shutdown and costly.
- **Recommended Actions/Person Responsible:** This alternative should not be pursued. - K. K. Chipley

TARGET SYSTEMS

No./Category: 21/ II **WBS # 1.6**

- **Proposal Description:** Revisit Hazard Category 2 versus 3. The Hazard Category classification of the target service cells and the bulk shielding area may change from the CDR assumption of Hazard Cat 3 to Cat 2

- **Rationale:** The independent reviews of the "white paper" indicated that for setting the category we should not take any credit for active systems which shut off the beams.

- **Savings:** This change can only increase costs. Assuming the site boundary is at the JINS facility it is likely that there will be no safety class Systems, Structures or Components. For that case no significant cost increase within Target Systems have been identified. To increase to significant or safety class systems could increase cost - $125K to $650K.

- **Schedule Impact:** None

- **Related Impact:** There will be an increase within WBS 1.2 for the SAR documentation Conventional facilities will incur a slight cost increase.

- **Benefits/Advantages:**

- **Risks:** If safety class instrumentation is needed, the estimated increase is 650K$..If facility segmentation does not separate the instrument area, there may be operational impacts.

- **Recommended Actions/Person Responsible:** Accept proposal – T. McManamy

Revised Version 11/13/98

TARGET SYSTEMS

No./Category: 22/IV **WBS: 1.6.5.1**

- **Proposal Description:** Use non-concentric shielding configuration to account for forward scattering.
- **Rationale:** The high-energy neutron scatter in the forward direction might allow for thicker shielding in the downstream direction from the target and thinner shielding toward the front and sides.
- **Savings:** None. Possible savings of $100K in shielding materials offset by increased design and construction costs.
- **Schedule Impact:** Extended design schedule by 6 months.
- **Related Impact:** Conventional Facilities (WBS 1.8) will have additional costs due to more complex interfaces and construction techniques.
- **Benefits/Advantages:** None
- **Risks/Disadvantages:** Schedule delay
- **Recommended Actions/Person Responsible:** The alternative of asymmetric shielding should not be pursued. The team will optimize the shielding by strategic placement of more dense shielding materials in the forward direction while maintaining the cylindrical geometry. - K. K. Chipley

Revised Version 11/13/98

TARGET SYSTEMS

No./Category 23/IV **WBS # 1.6.1**

- **Proposal Description:** Evaluate solid target backup option relative to cost impact.
- **Rationale:** Solid targets have been used in previous short pulse spallation sources, however, not at 1 MW or higher. (ISIS → .180 MW)
- **Savings:** $0, could increase cost if we have to use this option.
- **Schedule Impact:** If the decision is made before March 2000 to use the solid target backup, schedule impact is minimal, after that date schedule impact will occur.
- **Related Impact (include operations):** Target commissioning and facility final commissioning will be delayed if the decision to use the solid target backup is made after March 2000.
- **Benefits/Advantages:** None. Our decision date is sufficient to allow us to produce a solid target backup, which will fit within the volume allocated with the Hg target.
- **Risks:** If we have to switch to the solid target backup, thermal pressure waves will still be a problem. The facility may have to operate at a lower power until the difficulties associated with the Hg target are resolved. There is also no current plan to determine methods for increasing the power load of a solid target up to ~4 MW.
- **Recommended Actions/Person Responsible** No actions needed at this time. - T. Gabriel

Revised Version 11/13/98

No./Category: 24/II **WBS# 1.6.7.1**

- **Proposal Description:** Use surplus equipment from existing facilities. Surplus equipment, such as manipulators, hot cell tools, shielding windows and handling containers may be available from several DOE facilities. Specific equipment has not yet been located so a detailed evaluation has not been performed; however, this proposal should be pursued throughout the life of the project since surplus items can be expected to become available in the future.

- **Rationale:** Cost savings resulting from the use of government owned equipment. In addition, the funding may be provided to remove the equipment from decommissioning sites.

- **Savings:** The savings resulting from the use of surplus equipment can be computed on a case-by-case basis since the amount of potentially costly renovation and decontamination can be determined only after locating and evaluating each specific piece of equipment.

- **Schedule Impact:** None

- **Related Impact:** None

- **Benefits/Advantages:** Cost reduction could be significant if relatively clean, and otherwise expensive components can be located.

No./Category: 24/II (continued) **WBS# 1.6.7.1**

- **Risks:** Cell commissioning could be complicated if slightly activated or contaminated equipment is installed.

- **Recommended Actions/Person Responsible:** Search for surplus equipment for use in SNS throughout the design and procurement phase of the project - Mark Rennich

TARGET SYSTEMS

No./Category 25/IV **WBS # 1.6**

- **Proposal Description:** Revisit moderator installation method – vertical versus horizontal.
- **Rationale:** Possible Cost savings resulting from the elimination of the vertical cask if the moderators were installed horizontally.
- **Savings:** None.
- **Schedule Impact:** 6 month or more design delay for a major change in configuration for nearly all target components. Possible delay in PSAR to include accidents with hydrogen in target hot cell.
- **Related Impact**: Target replacement would be more complex and may take longer since the moderator connections must be broken. Addition safety analysis needed for PSAR.
- **Benefits/Advantages: Possible** cost reduction
- **Risks/Disadvantages:** Hydrogen in target service cells with activated mercury an increased operational risk. Added cost to make all connections remote for cryogenic lines. Added complexity to target plug. Vertical cask still needed for proton beam window.
- **Recommended Actions/Person Responsible:** Do not implement. - T. McManamy

Revised Version 11/13/98

TARGET SYSTEMS

No./Category: 26/ III **WBS# 1.6**

- **Proposal Description:** Use model or mock-up to check for assembly interferences
- **Rationale:**
- **Savings:**None
- **Schedule Impact:** None
- **Related Impact:** Could benefit Conventional facilities
- **Benefits/Advantages:** Visualization of potential interferences
- **Risks:**
- **Recommended Actions/Person Responsible:** Evaluate later in the design process if a new mock-up or model is needed. At present there is a full-scale mockup planned for the mercury loop, inner plug handling, and proton beam window handling. All target systems will be modeled in 3-D and checked for interferences. The mock-up would have to include assembly tolerances and realistic weights to add significant value.

Revised Version 11/13/98

No./Category 27/IV **WBS # 1.8**

- **Proposal Description:** Hold purchase of H_2 Cryogenic system unit until after 10/15/2005.

Transferred to WBS 1.8

- **Proposal Description:** Use Lawrence Berkeley National Laboratory steel.

MOVED TO WBS 1.7

TARGET SYSTEMS

No./Category: 29/ IV **WBS # 1.6.8.1**

- **Proposal Description:** Omit PLC operation interface.
- **Rational:** Eliminate local controls that would be provided with equipment purchased as a packaged unit from a supplier. There could be some savings realized by not including this equipment, but the conceptual design estimate was based on the PLC equipment not having local displays such as those identified in this proposal.
- **Savings:** $0
- **Schedule Impact:** There is not a schedule impact from this proposal.
- **Related Impact:** None.
- **Benefits/Advantages**: There are no cost savings associated with this proposal.
- **Risks:** Additional funds would be required to provide the interface
- **Actions/Person Responsible**: Do not accept this proposal because it will not result in cost savings.- R. Battle

TARGET SYSTEMS

No./Category: 30/IV **WBS# 1.6.2.1**

- **Proposal Description:** Consider liquid nitrogen for cooling of moderators
- **Rationale:** Operation of a cool moderator (possibly N15, CH_4 or polyethylene) possibly in place of one ambient temperature moderator
- **Savings:** None
- **Schedule Impact:** Additional development time
- **Related Impact:** Changes to target system design
- **Benefits/Advantages:** Moderator spectrum between ambient and cold temperature moderators
- **Risks/Disadvantages:** Development of new techniques
- **Recommended Actions/Person Responsible:** Do not accept proposal. No further action required. - T. McManamy

Revised Version 11/13/98

No./Category 31/II **WBS # 1.5**

- **Proposal Description:** Proton Beam Window Diagnostics

Moved to WBS 1.5

TARGET SYSTEMS

No./Category: 32/ IV **WBS # 1.6**

- **Proposal Description:** Evaluate if the specification on beam profile can be changed to save costs
- **Rationale**: there may be significant cost involved within the ring to meet the target specification
- **Savings:** None
- **Schedule Impact:** None
- **Related Impact:** Ring systems must provide the beam shape specified
- **Benefits/Advantages:**
- **Risks:**
- **Recommended Actions/Person Responsible:** No action. The specification for the beam on the target has already eliminated any detailed profile requirement. The desire for a more uniform profile is common to both the ring and target systems. – T. McManamy

VALUE ENGINEERING PROPOSALS

WBS 1.8 - Conventional Facilities

No./ Cat.	WBS Numbers	Proposal Description	Rational/ Advantages	Impact/ Disadvantages	Risk*	Savings** (000)	Recommended Action	Comments
1/I	1.8.3.1	Front End bldg. - reduce height from 18' to 12'	Saves material	None	L	210	Accepted	Include 36
2/I	1.8.3.1	Front End bldg. -- Control Room changed to Tech. Shop	Clarifies function	None	L	10	Accepted	
3/I	1.8.3.2	Shorten Linac length by 28m	Reduces construction time	None	L	3340	Accepted	Include 32
4/I	1.8.3.2	Reduce Linac width (14' to 12')	Saves material	Tighter work space	L	220	Rejected	
5/I	1.8.3.2	Linac Berm Shielding reduction (30' to 22')	Reduces fill requirements	None	L	0	Accepted	Include 29 & 42
6/III	1.8.3.2 1.8.3.4 1.8.3.5 1.8.3.6	Use precast tunnels	Reduces on-site labor	Unknown issues	L	1110	Accepted	Same as 28
7/I	1.8.3.4 1.8.3.6	Eliminate cranes in HEBT & RTBT	None. One crane will work both tunnels	Introduces operations inefficiencies	M	110	Rejected	
8/I	1.8.3.5	Reduce Ring Tunnel width (18' to 16')	Saves material	Tighter work space	L	150	Rejected	
9/I	1.8.3.4 1.8.3.6	Eliminate stubouts for HEBT & RTBT and reduce length of RTBT by 20m	Locations for future expansion unknown	Will have to be done later	L	5110	Accepted	Include 23; reducing the tunnel length 1240K, eliminating the stubouts 3280K;
10/I	1.8.3.5	Replace existing Ring Escape Hatch with horizontal egress	Improved operating efficiency. Improved construction.	Safety concerns	L	230	Accepted	
11/I	1.8.3.5	Eliminate Ring Crane	Saves material	Need transporter	M	110	Rejected	
12a/I	Multiple	Defer upgrade capability low risk	Not needed at 1 MW capacity	Increased future year cost	L	550	Accepted	Savings in non-intrusive upgrades outside the tunnel complex
12b/II	Multiple	Defer upgrade capability high risk	d.o.	Moderate impact on operations	H	7560	Rejected	Potential savings of $500K for additional moderately-intrusive upgrades outside tunnel structures;

No./ Cat.	WBS Numbers	Proposal Description	Rational/ Advantages	Impact/ Disadvantages	Risk*	Savings** (000)	Recommended Action	Comments
								Additional consideration/study required by user community
13/IV	1.8.3.2 1.8.3.4 1.8.3.5 1.8.3.6	Delete F/P sprinklers in tunnels	NR	NR	H	100	Rejected	
14/IV	1.8.3.7	Delete smoke detectors in Target Building	NR	NR	H	150	Rejected	
15/II	1.8.4.1	Use overhead instead of underground power distribution	Less expensive construction techniques	Increased outages (up to 3x)	H	1920	Deferred	Additional consideration/study required by user community
16/I	1.8.5.6	Defer Predictive Maintenance System	Eliminates a system	Possibly decreases reliability	M	1900	Accepted	
17/I	1.8.3.2 1.8.3.4 1.8.3.5 1.8.3.6	Eliminate HEPA filters in tunnels	Not required for ES&H	None	M	1180	Accepted	
18/I	1.8.6.2	Review Business Computing System	Sharing systems; non-redundant	None	M	1130	Accepted	
19		See 51			-	0	-	
20		See 51			-	0	-	
21/II	1.8.4.1	Contract with TVA for Switchhouse	Potential life cycle cost advantage	Loss of control & uncertainty of future pricing	L	2700	Deferred	Additional consideration/study required by user community
22/II	1.8.4.1	Contract with TVA for Substation	d.o.	d.o.	L	7120	Deferred	Additional consideration/study required by user community
23		See 9			-	0	-	
24/I	1.8.3.7	Eliminate Visitor Gallery in Target Bldg.	Reduces building size & complexity	Less PR	L	2540	Rejected	
25/IV	1.8.3.7	Eliminate additional piping in trenches – Target bldg.	NR	NR	L	30	Rejected	
26		See 51			-	0	-	
27/I	1.8.3.15	Minimize A/C in shops	A/C not required in some shops	Impacts personnel comfort	L	410	Accepted	**Klystron shop needs A/C; original proposed savings reduced to this estimate**
28		See 6			-	0	-	

No./ Cat.	WBS Numbers	Proposal Description	Rational/ Advantages	Impact/ Disadvantages	Risk*	Savings** (000)	Recommended Action	Comments
29		See 5			-	0	-	
30/IV	1.8.2.1	Use north access to site instead of south access	NR	NR	L	230	Rejected	
31/1V	1.8.3.7	Reduce cryogenic loads to moderators in Target bldg.	Matches current requirements & defers upgrade	Will have to be done later at increased cost	L	1,240	Deferred	This is a backup option to utilize the cryogenic equipment from ANL
32		See 3			-	0		
33/I	1.8.3.7	Reduce Target floor loads	Matching reduced requirements	None	L	1470	Accepted	
34/I	1.8.3.15	Use Gantry crane instead of overhead crane in Klystron shop	Matches requirements	None	L	300	Accepted	
35/I	1.8.3.3	Use reinforced earth retaining wall instead of concrete	Matches requirements and lower cost	None	L	1470	Accepted	
36		See 1			-	0	-	
37/III	All	Relocate SNS to Bethel Valley Road near JINS site	NR	NR	M	0	Investigate	
38/IV	All	Relocate SNS to CRBR site	NR	NR	H	0	Rejected	
39/I	1.8.3.15	Construct maintenance shops early	Reduces construction mobilization	Needs to match overall schedule	L	1020	Accepted	
40/III	All	Ask State to rebate taxes			L	0	Deferred	**Additional study required**
41/IV	1.8.3.2 1.8.3.4 1.8.3.5 1.8 3.6	Use geotechnical membrane	NR	NR	L	0	Deferred	The idea will be studied during title I
42		See 5			-	0	-	
43/IV	1.8.3.2	Optimize excavation by canting beamline	NR	NR	L	0	Rejected	
44/I	1.8.3.13 1.8.3.14	Combine offices & control bldg. Review total offices	Efficiency	None	L	110	Accepted	Include 45, 49, & 50;
45		See 44			-	0	-	
46/IV	1.8.3.15	Use existing facilities for maintenance offices	NR	NR	L	0	Rejected	
47/IV	1.8.2.1	Eliminate west access road	NR	NR	L	290	Rejected	
48/IV	1.8.3.7	Eliminate translucent roof panels in	NR	NR	L	0	Rejected	

No./ Cat.	WBS Numbers	Proposal Description	Rational/ Advantages	Impact/ Disadvantages	Risk*	Savings** (000)	Recommended Action	Comments
		Target bldg.						
49		See 44			-	0	-	
50		See 44			-	0	-	
51a/I	1.8.3.7	Reconfigure Target bldg. (low risk)	More efficient operations	Less coverage	L	3340	Accepted	Include 19, 20, & 26; eliminates 1 bay and length of RTBT within bldg.
51b/III	1.8.3.7	Reconfigure Target bldg. (high risk)	Reduces building space	Limits expansion of experimental space	H	1370	Rejected	
52/I	Multiple	Use second hand equipment	Cheap	Reliability	L	TBD	Investigate	No equipment currently identified
53/IV	1.8.2.2	Deliver geotechnical report early	NR	NR	L	0	Accepted	No savings identified
54/IV	1.8.2.1	Review parking spaces	NR	NR	L	0	Accepted	No savings identified
55/II	1.8.3.2 1.8.3.3	Re-examine HVAC requirements	Matches criteria	None	L	TBD	Deferred	**Evaluate during title I**
56/III	1.8.2.1 1.8.4.3	Separate parking lot and cooling tower	Avoid auto damage	Could increase pipe runs	L	TBD	Deferred	**Evaluate during title I**
57/III	1.8.3.2	Provide horizontal access to Linac	Efficiency of installation & operations	Radiation has to be considered	L	TBD	Deferred	**Evaluate during title I**
58/I	1.8.3.7	Review location of user Target Operation bldg.	More appropriate location	None	L	TBD	Deferred	**Evaluate during title I**
59/II	1.8.3.2 1.8.3.4 1.8.3.7	Establish settlement criteria	To meet modified requirements	None	L	TBD	Deferred	**Propose that Linac use BNL criteria**
60/I	1.8.3.1	Front End Bldg. – optimize footprint	To meet modified requirements	Less space for Linac	L	260	Accepted	**Includes building cost as well as excavation required**
61/I	1.8.3.7	Use cryogenic unit from ANL	Cheap	Must match requirements	L	2490	Accepted	Reference item 19, WBS 1.6;
62/I	1.8.3.7	Defer cryogenic unit for Target Bldg. To Operational funds	Matches current requirements & defers upgrade	Funds required from Operations	L	3730	Deferred	**Items 19, 60, and 61 are mutually exclusive**
63/I	1.8.3.7	Reduce the power and duty factor specs. for 3 beam dumps	Matches criteria	Complicates upsizing	L	750	Accepted	
64/III	1.8.3.4	Shorten HEBT by 6 meters	Matches criteria	None	L	410	Rejected	Reference item 21; included in baseline but additional study required
65/I	1.8.3.2 1.8.3.4 1.8.3.5	Lower beam height from 5' to 4' (Linac & Ring)	Improved efficiency	Must verify all clearances. Safety	L	80	Rejected	

No./ Cat.	WBS Numbers	Proposal Description	Rational/ Advantages	Impact/ Disadvantages	Risk*	Savings** (000)	Recommended Action	Comments
	1.8.3.6			considerations				
66/III	1.8.3.4	Add radiation barriers in HEBT	Operational efficiency	New requirement	L	-170	Deferred	Not considered a VE item but will be required (-150)
67/III	Multiple	Optimize UPS requirements	Matches operating requirements	None	L	TBD	Deferred	Reference Item 5, WBS 1.9; evaluate during Title I
68/I	1.8.3.2 1.8.3.3	Change to IGBT (DTL to CCL)	Increased efficiency; less interference	Increases number of power supplies	M	1450	Accepted	Reference Item 1, WBS 1.4
69/III	1.8.3.2 1.8.3.3	Optimize wave guide runs	Increased efficiency		L	TBD	Accepted	Consider with evaluation of the building relationships in item 57
		TOTAL OF ACCEPTED				27,840		

Risk is as evaluated by Conventional Facilities
***** Savings in escalated dollars with overheads and burden***

Item 13: Delete Fire Protection Sprinklers in Tunnels
WP 1.8.3.2, 1.8.3.4, 1.8.3.5, 1.8.3.6

- **Area/Concern/Issue:**
  - **Eliminate automatic sprinkler system fire suppression systems throughout Linac, HEBT, Ring, and RTBT tunnels.**

- **Rationale:**
  - **Reduce cost.**

- **Savings:**
  - **Save $ 250K in sprinkler installation labor and materials (from CDR). Elimination of sprinklers requires additional stair tower at $ 150K. Actual net savings of $ 100K.**

- **Schedule Impact:**
  - **None.**

- **Conventional Facilities Impacts:**
  - **Life Safety Code travel distances to reach an exit can be extended when sprinkler protection is provided. Reduced travel distances without sprinkler protection requires the construction of an additional stair tower at a cost of $ 100K.**

- **Other Impacts:**
  - **None.**

- **Risks:**
  - **High risk of excessive damage and losses due to fire without sprinkler protection. (See attached.)**
  - **High risk of unacceptable programmatic delays due to fire without sprinkler protection.**
  - **Incipient stage fires will likely develop into large fires due to difficult and less than timely manual suppression efforts. A fire may continue unchecked**

Item 1 - Reduce Front End Building Height
WP 1.8.3.1

- **Area/Concern/Issue**
  - Reduce the interior clear height of the Front End Building (FEB) from 18'-0" to 12'-0". The 18' height of the CDR is more than is required for operations within the FEB. The upper level, however, must remain on the same level as the Klystron Building. This area of work also includes relocation of the overhead door access to the south side of the building and reducing the cut required for the west end of the FEB.

- **Rationale**
  - **Reduces construction costs for conventional facilities.**

- **Savings**
  - **Saves $0.210 M in reduced structures and reduced cut-and-haul quantities. HVAC system is minimally affected so no reduction is expected for this system.**

- **Schedule**
  - **No negative impact on schedule for design or construction of the FEB. Reduced site work effort will be offset by additional retaining wall construction required on west end of building.**

- **Conventional Facilities Impact**
  - **Will not affect the design or operation of the facility. Relocating the overhead door access to the south will, however, require more floor area to be devoted to access lane into the linac from this end.**

- **Other Impacts**
  - **No impacts.**

- **Risk and R&D**
  - **Low on basis of no affect on operation of the FEB.**

- **Action/Person Responsible**
  - **Conventional Facilities Team STL**

Item 2: Eliminate Front End Building Control Room
WP 1.8.3.1

- **Area/Concern/Issue**
  - **Eliminate the separate control room area on the main level of the Front End Building (FEB).**
- **Rationale**
  - **Reduces construction costs for conventional facilities.**
- **Savings**
  - **Saves $10K in reduced materials and labor. Cost includes burden and EDIA.**
- **Schedule**
  - **No negative impact on schedule for design or construction of the FEB.**
- **Conventional Facilities Impact**
  - **Will not affect the design or operation of the facility.**
- **Other Impacts**
  - **No impacts.**
- **Risk and R&D**
  - **Low on basis of no affect on operation of the FEB.**
- **Action/Person Responsible**
  - **Conventional Facilities Team STL**

Item 3 & 32: Shorten Linac

WBS 1.8.3.2 – Conventional Facilities

- **Area/Concerns/Issues: Shorten Linac length by 28m. Include equal length reduction in Klystron gallery.**
- **Rationale: Extra length not required**
- **Savings: $3.340 M (material + labor + engineering)**
- **Schedule: Improved due to reduced construction effort**
- **Conventional Facilities Impact: None**
- **Other Impacts: Less construction effort, cost**
- **Risks: Low**
- **Actions/Person Responsible: If approved, incorporate into Design Manual and cost estimate.**
  Person responsible: Jim Lawson

Item 4: Reduce Linac Width

WBS 1.8.3.2 – Conventional Facilities

- **Area/Concern/Issue: Reduce Linac width (14' to 12')**
- **Rationale: Extra width not required**
- **Savings: $0.220 M (material + labor only)**
- **Schedule: Very slight improvement due to reduced construction effort**
- **Conventional Facilities Impact: Tighter work space for installation & maintenance of equipment**
- **Other Impacts: Slightly less construction effort, materials**
- **Risks: Too cramped for operating efficiently. Will be virtually impossible to retrofit (widen) later.**
- **Actions/Person Responsible: Rejected due to installation and operations concerns.**
  Person responsible: Jim Lawson

Item 5: Linac Beam Shielding Reduction (30' to 22') (Low Risk)
WP 1.8.3.2

- **Area/Concern/Issue**
  - **Reduce linac shielding from 30' to 22'.**
- **Rationale**
  - **22' of shielding is based on beam loss accident source term. Reduces fill requirements.**
- **Savings**
  - **Savings for this item have been previously identified by earlier VE studies performed by conventional facilities team.**
- **Schedule**
  - **Positive schedule impact due to reduction of time to backfill tunnel.**
- **Conventional Facilities Impact**
  - **No impact.**
- **Other Impacts**
  - **No other impacts.**
- **Risk**
  - **Low risk based on known accelerator source term.**
- **Action**
  - **ORNL CCB approval required.**

Item 6: Use Precast Tunnels

WBS 1.8.3.2 – Conventional Facilities

-
- **Area/Concern/Issue: Use precast sections for tunnels (Linac, HEBT, ring, RTBT)**
- **Rationale: Meets program (structural) requirements at reduced cost & improved construction efficiency.**
- **Savings: Potentially $1.110 M + (material + labor)**
- **Schedule Impact: Improve construction schedule dramatically. Once base slab is poured, can set 300+ feet of tunnel/day.**
- **Conventional Facilities Impact: Base slab width to increase over CDR design. HEBT, ring, RTBT {Modify crane rail design; precast vendors indicate walls can accommodate crane load. Probable design is to suspend crane from ceiling}**
- **Other Impact: Much less labor intensive than forming and pouring cast-in-place.**
- **Risks: Low**
- **Actions/Person Responsible: Further study required to address crane feasibility and other issues.**
  Person responsible: Jim Lawson

Item 7. Eliminate Cranes in HEBT & RTBT Tunnels in WP 1.8.4.5 & 1.8.3.4 &1.8.3.6

- **Area/Concern/Issue**
  - Eliminate the cost of bridge cranes in the HEBT and RTBT tunnels and depend on portable carts and rigs for installation and replacement of equipment. The recommendation is to retain a single crane and provide cart to switch crane from the different tunnels.

- **Rationale**
  - Reduces conventional facility costs, but will drive up installation and operational costs.

- **Savings**
  - Assuming one bridge crane is retained, the tunnel rails are all the same, and a rigging cart is provided to transfer the crane the savings are $0.110 M.

- **Schedule**
  - Some negative impact on schedule of installation of technical components, i.e., scheduling conflicts. Operational time for replacement of technical components may be increased by 2X.

- **Conventional Facilities Impact**
  - Eliminates crane cost, requires a crane lifting/transport cart, and lengthens installation of components within the tunnels. Operations inefficiencies will be increased.

- **Other Impacts**
  - Ring components will require inherent design to minimize the time the crane is required to install the component and or handling carts.

- **Risk**
  - Installation risk increase due to efficiencies in transporting components into the tunnels. Operations risk in the rigging/handling of crane when transferring from one tunnel to the other. Increased down time when replacing a technical component in the tunnel.

- **Action:** - Rejected due to installation and operation problems.

Item 8: Reduce Ring Tunnel Width

WBS 1.8.3.5 – Conventional Facilities

- **Area/Concern/Issue: Reduce ring tunnel width from 18' to 16'**
- **Rationale: Saves material. Extra width is not required.**
- **Savings: $0.150 M (material + labor only)**
- **Schedule: Very slight improvement due to reduced construction effort**
- **Conventional Facilities Impact (include operations): Tighter work space for installation & maintenance of equipment**
- **Other Impacts: Slightly less construction materials, effort**
- **Risks: See Linac #4**
- **Actions/Person Responsible: Rejected due to installation and operational problems.**
  Person responsible: Jim Lawson

Item 9: a) Eliminate HEBT & RTBT Stubouts & b) Shorten RTBT
WBS 1.8.3.4 and 1.8.3.6 – Conventional Facilities

SNS

Category 1

- **Proposal Description:** A) Eliminate stubouts for HEBT & RTBT
  B) Reduce Length of RTBT by 20m
- **Rationale:** A) Can be deferred till upgrade is definite
  B) Extra length of RTBT not required
- **Savings:** A) $3.280 M
  B) $1.240 M
  $5.110 M (material + labor + engineering)
- **Scheduled Impact:** Improved due to reduced construction scope
- **Related Impact (include operations):** A) Stubouts will have to be added later if upgrade is done
  B) No negative impact from shortening RTBT
- **Benefits/Advantages:** Cost savings with minimal risk and impact
- **Risks:** Low
- **Actions/Person Responsible:** ORNL CCB approval required. Incorporate into Design Manual and cost estimate.
  Person responsible: Jim Lawson

Item 10: Replace Ring Stair Tower with Tunnel

WBS 1.8.3.5 – Conventional Facilities

- **Area/Concern/Issue: Replace existing ring escape hatch with horizontal egress, (such as a precast tunnel similar to Linac)**
- **Rationale: Improve accessibility to ring.**
- **Savings: $0.230 M**
- **Schedule: Improved due to easier construction**
- **Conventional Facilities Impact: Improves accessibility for more efficient operations and maintenance**
- **Other Impacts: Improve operating efficiency**
- **Risks: Low**
- **Actions/Person Responsible: Approved. Incorporate into Design Manual and cost estimate.**
  Person responsible: Jim Lawson

Item 11. Eliminate Cranes in Ring Tunnel in WP 1.8.4.5 & 1.8.3.5

- **Area/Concern/Issue**
  - Eliminate the cost of bridge cranes in the Ring tunnel and depend on portable carts and rigs for installation and replacement of equipment. The recommendation is to retain a single crane and provide cart to switch crane from the different tunnels. This Item is linked to Item 7, Eliminate Cranes in HEBT & RTBT Tunnels.

- **Rationale**
  - **Reduces conventional facility costs, but will drive up installation and operational costs.**

- **Savings**
  - **Assuming one bridge crane is retained from Item 7 and the tunnel rails are all the same the savings are $0.110 M.**

- **Schedule**
  - **Some negative impact on schedule of installation of technical components, ie, scheduling conflicts. Operational time for replacement of technical components may be increased by 2X.**

- **Conventional Facilities Impact**
  - **Eliminates crane cost, requires a crane lifting/transport cart, and lengthens installation of components within the tunnels. Operations inefficiencies will be increased.**

- **Other Impacts**
  - **Ring components will require inherent design to minimize the time the crane is required to install the component and or handling carts.**

- **Risk and R&D**
  - **Installation risk increase due to efficiencies in transporting components into the tunnels. Operations risk in the rigging/handling of crane when transferring from one tunnel to the other. Increased down time when replacing a technical component in the tunnel. Additional cranes could be added at a later date.**

- **Action**
  - **Rejected, none required.**

Item 12a: Defer Upgrade Capabilities (Low Risk) in WP 1.8.4.3

- **Area/Concern/Issue**
  - Defer upgrade capabilities within the design of conventional facilities that are level 1, low risks. These are capabilities that would not effect the schedule outage limit of 6 months, but have cost impacts on the upgrades and life cycle costs.

- **Rationale**
  - Reduces conventional facilities costs for the 1 MW capacity design, but transfers costs to the upgrade.

- **Savings**
  - Saves $0.550 M from decreasing underground pipe sizes for cooling water systems from 4MW to just 1 MW.
  - Will require installation of addition piping for 2 &/or 4 MW upgrade operation at $0.380 at 2 MW and $0.807 at 4 MW.

- **Schedule**
  - No negative impact on schedule for design or installation of 1 MW. Will require installation of additional underground piping during 1 MW operation to obtain the max. 6 month outage requirement.

- **Conventional Facilities Impact**
  - Will not affect the 1 MW design or operation of the facility. Will require site excavation and tie-in's for addition underground piping.

- **Other Impacts**
  - No impacts.

- **Risk and R&D**
  - Low on basis of no affect on 1 MW operation, will require new piping installation to meet upgrade capabilities.

- **Action**
  - ORNL CCB approval required.

Item 12b: Defer Upgrade Capabilities (High Risk) in WP 1.8.4.3

- **Area/Concern/Issue**
  - **Defer upgrade capabilities within the design of conventional facilities that are level III, high risks. These are capabilities that would effect the schedule outage limit of 6 months and have cost impacts on the upgrades and life cycle costs. Item included are: size front-end building and klystron gallery for 1 MW only, cryo-system sized for only 1 MW, eliminate tunnel stubs, and size indoor utilities for only 1 MW demands. The cryo-system and tunnel stubs are not included here since they are Items 31 and 9, respectively.**

- **Rationale**
  - **Reduces conventional facilities costs for the 1 MW capacity design, but transfers costs to the upgrades.**

- **Savings**
  - **Overall savings are $7.650 M.**
  - **Saves $0.950 M from decreasing inside pipe sizes for cooling water systems from 4MW to just 1 MW.**
  - **Save $1.070 M by sizing FE building for 1 MW only.**
  - **Save $5.630 M by sizing Klystron building for 1 MW only.**
  - **Will require installation of addition piping for 2 &/or 4 MW upgrade operation and building additions.**

- **Schedule**
  - **No negative impact on schedule for design and installation of 1 MW. Additional piping and building additions will have a negative impact on schedule for upgrading.**

- **Conventional Facilities Impact**
  - **Will not affect the 1 MW design or operation of the facility. Will require building disruption and tie-in's for building additions, equipment relocation, and additional piping.**

- **Other Impacts**

- **This will effect the front end, linac and target systems. Klystron alignment with linac structures in the tunnel will be difficult and cause long RF guides.**

- **Risk**
  - **High on basis that it will require new piping installation and building additions and/or modifications that could not be done within the 6 month outage requirement. Many of these changes can not be done in parallel with accelerator operation.**

- **Action**
  - **Rejected.**

Item 13: Delete Fire Protection Sprinklers in Tunnels
WP 1.8.3.2, 1.8.3.4, 1.8.3.5, 1.8.3.6

- **Area/Concern/Issue:**
  - Eliminate automatic sprinkler system fire suppression systems throughout Linac, HEBT, Ring, and RTBT tunnels.

- **Rationale:**
  - Reduce cost.

- **Savings:**
  - Save $ 250K in sprinkler installation labor and materials (from CDR). Elimination of sprinklers requires additional stair tower at $ 150K. Actual net savings of $ 100K.

- **Schedule Impact:**
  - None.

- **Conventional Facilities Impacts:**
  - Life Safety Code travel distances to reach an exit can be extended when sprinkler protection is provided. Reduced travel distances without sprinkler protection requires the construction of an additional stair tower at a cost of $ 100K.

- **Other Impacts:**
  - None.

- **Risks:**
  - High risk of excessive damage and losses due to fire without sprinkler protection. (See attached.)
  - High risk of unacceptable programmatic delays due to fire without sprinkler protection.
  - Incipient stage fires will likely develop into large fires due to difficult and less than timely manual suppression efforts. A fire may continue unchecked if manual suppression efforts are deemed a safety hazard to emergency personnel.

- **Actions/Person Responsible:**
  - Rejected, none.

Item 14: Delete Fire Protection Smoke Detectors in Target Building
WP 1.8.3.7

- **Area/Concern/Issue:**
  - **Delete smoke detectors in Target Building.**

- **Rationale:**
  - **Reduce cost.**

- **Savings:**
  - **Total cost of Target Building Fire Alarm System is $ 1.000 M. Cost of fire alarm detection equipment estimated at 15% of total cost. Savings of approximately $ 150K.**

- **Schedule:**
  - **None.**

- **Conventional Facilities Impacts:**
  - **None.**

- **Other Impacts:**
  - **None.**

- **Risks:**
- **High risk of excessive damage and losses due to fire without smoke detection systems. (See attached.)**
- **Property protection mandates redundant fire protection systems, to include smoke detection and automatic sprinkler protection, to limit losses to acceptable levels.**
- **Since sprinkler protection cannot be adequately applied in several locations within the experimental apparatus, smoke detection offers early warning which minimizes the potential for the development of large fires, thereby reducing property losses resulting from fire.**

- **High risk of unacceptable programmatic delays due to fire without smoke detection systems.**
- **Early warning of incipient stage fires, subsequent immediate notification, and rapid response also minimizes the impacts to operations.**

- **Actions/Person Responsible:**
  - **Rejected, none.**

Item 15: Overhead vs. Underground Power Distribution in WP 1.8.3 and 1.8.4

- **Area/Concern/Issue**
  - Use overhead construction (poles and bare conductors) for medium voltage power distribution instead of underground (duct banks and insulated cables).

- **Rationale**
  - Reduce construction costs associated with underground distribution, i.e. excavation, concrete, conduits, manholes, and cables.

- **Savings**
  - Save $1.920 M by reducing construction costs. Savings estimate based on routing 75% of site electrical distribution aerially on poles. Also assumes reduction in underground duct bank requirements for telecommunications/alarm circuits. Assumes no savings in engineering costs.

- **Schedule**
  - Positive impact on schedule. Simpler construction will require less craft coordination.

- **Conventional Facilities Impacts**
  - No associated cost impact to technical systems.

- **Other Impacts**
  - Advantages are reduced costs, simpler construction.

- **Risks**

- **Increases risk of power outages by at least 3 times based on published data from IEEE Std 500. Historical records kept on existing overhead 13.8 kV feeders at ORNL indicate increase in outage risk could be much greater due to area's susceptibility to lightning. Aesthetic concerns for a national user facility.**

- **Action**
  - **Deferred due to risk. Re-evaluate during AE Title I design.**

Item 16: Eliminate Predictive Maintenance System
WBS 1.8.5.6

Area/Concern/Issue: Eliminate the predictive maintenance system from the current project scope.

Rationale: Potential benefits don't justify cost of system. (See attached for more-detailed rationale).

Savings: Current budget for the PdM System is $1.9M (in "Primavera dollars").

Schedule: None

Conventional Facilities Impact: None

Other Impact: Reduction in overall project cost.

Risks: The availability of SNS could be impacted.

Actions/Person Responsible:

CCB-3 approval ASAP, Bill Devan.

Detailed rationale:

The predictive maintenance (PdM) system would monitor equipment for signs of pending failure. (e.g. Monitor vibration as an indicator of bearing wear). In theory this would increase equipment availability by enabling one to fix equipment during scheduled maintenance periods, before it fails.

While it is true that some benefits would likely be seen, they do not seem to warrant the cost at this time:

1. In general, critical equipment will be provided in a redundant configuration. In these cases there is little benefit (from an availability point of view) in PdM monitoring, since if a critical piece of equipment fails you can simply switch to the redundant back-up equipment.

2. It may be a long time before the project sees the benefits of the PdM system, since at the start of operations all equipment will be new. Equipment wear should not be a concern for several years.

3. There is no operational experience at this point to allow us to focus on the real problem areas. This forces us to take a "shot-gun" approach and monitor every critical piece of equipment. By deferring PdM until after operation has begun, resources can be used more efficiently by focusing on the equipment that is the most troublesome.

4. Most equipment that would be monitored cannot be purchased "off-the-shelf" with PdM monitors. The PdM monitors have to be specially installed on equipment. Given this, postponing PdM monitors should have little cost impact should it be decided to install them at a later date.

Item 17: "Eliminate Tunnel Exhaust and Purge System HEPAs" in WPS 1.8.3.2.3.3, 1.8.3.4.3.3, 1.8.3.5.3.3, 1.8.3.6.3.3

SNS

- **Area/Concern/Issue**
  Omit HEPA filtration in exhaust and air purge systems serving the Linac, HEBT, Ring and RTBT tunnels.

- **Rationale**
  Analysis is expected to show that unfiltered emissions are sufficiently low enough to preclude the requirement for filters to protect on and off-site of personnel and the environment. Also, none of the current accelerators employ HEPA filter exhaust.

- **Savings**

The estimated first cost savings to the project are expected to be $ 1.180 M. Additional operational cost savings would accrue over time due to energy conservation associated with the power necessary to overcome the pressure loss of the filters and labor costs associated with periodic change-out of the filters.

- **Schedule**
  Omitting the HEPA filtration systems would not impact project schedule for the current 1MW scheme or for the 2 or 4 MW upgrades.

- **Conventional Facilities Impact**
  No impact on conventional facilities operations except that operational costs would be reduced over the life of the project.

- **Other Impacts**
  Elimination of HEPA filters also eliminates a potentially contaminated waste steam.

- **Risk and R&D**
  Emissions will have to be monitored to assure that the process does not exceed safe levels.

- **Action**
  Change must be approved by CCB, Woods.

Item 18a: Review Business Computing Systems Costs
WBS 1.8.6.2

Proposal Description: Reduce the WBS 1.8.6.2 budget for office automation equipment.

Rationale: The cost of personal computer hardware and software has dropped dramatically since the original CDR estimate. Also, there is some overlap with other WBSs in the procurement of office automation equipment. (See attached for more details)

Savings: $770 K.

Schedule: None

Conventional Facilities Impact: None.

Other Impact: Reduction in overall project cost.

Risks: The quality and quantity of office automation equipment available for operations personnel at the end of the project may be reduced.

Actions/Person Responsible: CCB-3 approval ASAP, Bill Devan.

Detailed rationale:

# Offices =	160				
	Was:		Now:		
	Cost/sys.	Total	Cost/sys.	Delta:	Total delta
	(k$)	(k$)	(k$)	(k$)	(k$)
PC hardware cost	4	640	2	2	320
PC software cost	2	320	1	1	160
Unburdened total					480
Burden factor (from CDR est.)					X 1.2
Total delta due to revised purchase costs					576
Estimated overlap with WBS 1.8, etc. (30 systems)					+ 100
Total delta					676

Item 18b: Review Business Computing Systems Costs
WBS 1.8.6.2

Action/Concern/Issue: Reduce the WBS 1.8.6.2 budget for development of software support systems.

Rationale: Some of the support systems to be provided by WBS 1.8.6.2 will be required during design and construction. It turns out that there is some overlap with WBS 1.8.2, 1.8.3, and 1.8.4 in this area. For example, the AE will be required to develop and maintain equipment databases and document management systems. It is estimated that AE-performed system development and maintenance activities (funded out of WBS 1.8.2, 1.8.3, and 1.8.4) should enable the WBS 1.8.6.2 effort to be reduced by 2 man-years of engineering.

Savings: $360K.

Schedule: None.

Conventional Facilities Impact: None.

Other Impact: Reduction in overall project cost.

Risks: The quality and quantity software support systems available for design, construction, and operations activities may be reduced.

Actions/Person Responsible:

CCB-3 approval ASAP, Bill Devan.

Item 21: Contract w/ TVA for 13.8 kV Switchhouse in WP 1.8.4.1

- **Area/Concern/Issue**
  - Contract with TVA to design, build, and maintain 13.8 kV switchhouse. ORNL would operate this facility.
- **Rationale**
  - Potential to reduce capital construction costs.
- **Savings**
  - Save $2.700 M by eliminating cost of switchhouse from project. Savings estimate assumes no up-front capital commitment from ORNL/DOE.
- **Schedule**
  - No known impact on schedule. Loss of control could lead to negative schedule impact.
- **Conventional Facilities Impact**
  - No associated cost impact to technical systems. Potential for severe operational impacts if ORNL does not operate the facility.
- **Other Impact**
  - Advantages are reduced capital construction costs. Life cycle cost impacts undetermined at this time, could be favorable or unfavorable.
- **Risks**
  - Loss of control, introduces new interface (between CM and TVA). Approach could also hinder ORNL/DOE in taking advantage of future deregulation in the utility industry. Could impact ability to make future modifications to 13.8 kV distribution system in a cost effective, timely manner.

- **Action**
  - **Deferred until life cycle cost impacts are identified via DOE HQ-FM contract.**

Item 22: Contract w/ TVA for 161 kV Substation in WP 1.8.4.1

- **Area/Concern/Issue**
  - **Contract with TVA to design, build, operate, and maintain 161 kV substation.**

- **Rationale**
  - **Potential to reduce capital construction costs.**

- **Savings**
  - **Save $7.12 0M by eliminating cost of substation and incoming 161 kV transmission line from project. Savings estimate assumes no up-front capital commitment from ORNL/DOE.**

- **Schedule**
  - **No known impact on schedule. Loss of control could lead to negative schedule impact.**

- **Conventional Facilities Impacts**
  - **No associated cost impact to technical systems.**

- **Other Impact**
  - **Advantages are reduced capital construction costs, design by entity familiar with Oak Ridge Area electrical infrastructure. Life cycle cost impacts undetermined at this time, could be favorable or unfavorable.**

- **Risks**
  - **Loss of control, introduces new interface (between CM and TVA). Approach could also hinder ORNL/DOE in taking advantage of future deregulation in the utility industry.**

- **Action**
  - **Deferred until life cycle cost impacts are identified via DOE HQ-FM contract.**

Item 24: Eliminate Visitors' Gallery in Target Building
WP 1.8.3.7

- **Area/Concern/Issue**
  - Eliminate the visitors' gallery (observation gallery) on the north and south sides of the target building. This leaves no way for visitors, guests, or public officials to view activities on the instrument floor. A window, which would provide limited viewing of the soutn side/east end of the instrument floor, could be added in the office area.

- **Rationale**
  - Reduces construction costs for conventional facilities by reducing materials and labor and the building complexity.

- **Savings**
  - Saves $2.540 M.

- **Schedule**
  - No negative impact on schedule for design or construction of the Target Building.

- **Conventional Facilities Impact**
  - Will not affect the design or operation of the facility.

- **Other Impacts**
  - No impacts.

- **Risk and R&D**
  - Low on basis of no affect on operation of the Target Building.

- **Action/Person Responsible**
  - Accept, Conventional Facilities Team.

Item 25: Eliminate Additional Utilities in Trenches for Future Neutron Instruments
WP 1.8.3.7

- **Proposal Description:**
  - **Eliminate future piping, conduits, and cable trays located in the floor trenches for future neutron instruments.**

- **Rationale:**
  - **Reduce cost.**

- **Savings:**
  - **Save $ 30K in piping and electrical installation labor and materials.**

- **Schedule:**
  - **None.**

- **Conventional Facilities Impact:**
  - **None on conventional facilities. Will require extension of utilities when new instruments are installed.**

- **Other Impact:**
  - **None.**

- **Risks:**
  Low risk, but minimal costs.

- **Actions/Person Responsible:**
  - **Rejected, none.**

Item 27: "Minimize Air-conditioning of Shops" in WBS 1.8.3.12

- **Area/Concern/Issue**
  Eliminate air-conditioning of the shops except for the office spaces and restrooms.

- **Rationale**
  Typically, shop areas are not air-conditioned unless mission requirements dictate the need for air-conditioning or personnel comfort is deemed to be an overriding issue.

- **Savings**

First cost savings to the project are expected to be approximately $410 K. Additional operating cost savings would result from the energy savings associated with only heating and ventilating the shop areas versus providing air-conditioning.

- **Schedule**
  No impact on schedule.

- **Conventional Facilities Impact**
  Will not affect the mission of the project.

- **Other Impacts**
  Future maintenance and operating costs will be reduced.

- **Risk and R&D**
  Low risk. Personnel having to work in unair-conditioned shop areas will not be happy with working conditions.

- **Action**
  Change would have to be approved by configuration control board.

Item 30: Use North Access To Site Instead Of South Access (Low Risk)
WP 1.8.2.1

- **Area/Concern/Issue**
  - Use north access to site instead of south access.
- **Rationale**
  - Reduce roadway costs.
- **Savings**
  - Save $0.230 M. South access will still need to be improved but, to a lesser degree.
- **Schedule**
  - Minimal positive schedule impact. South access road will still be improved to a smaller width.
- **Conventional Facilities Impact**
  - Main entrance to site is further away for ORNL.
- **Other Impacts**
  - Main entrance will not be visible from publicly traveled roadway. Access could be slightly more difficult from main highways. Security issues with Y-12 could impact this access.
- **Risk and R&D**
  - Low risk. No R&D.
- **Action**
  - Rejected, no action required.

Item 31: Reduce Cryogenic Refrigeration Requirements to 1 MW in WP 1.8.3.7

- **Area/Concern/Issue**
  - **Defer upgrade capabilities of the cryogenic refrigerator to the 2 MW upgrade. This will require modifications and/or additions to the cryogenic system to allow for upgrade to 2MW design. The 4MW will require an additional unit not included in the CDR for 1 MW design.**

- **Rationale**
  - **Reduces conventional facilities costs for the 1 MW capacity design, but transfers costs to the upgrade.**

- **Savings**
  - **Saves $1.240 M by purchasing and installing only a 2.2 kW refrigerator vs. a 4.5 kW unit.**

- **Schedule**
  - **No negative impact on schedule for design or installation of 1 MW facility. Will require design and installation of additional equipment and/or modification to the existing 1 MW equipment to upgrade to 2 MW.**

- **Conventional Facilities Impact**
  - **Will not affect the 1 MW design or operation of the facility. Will require system modifications and/or additions to upgrade.**

- **Other Impacts**
  - **WP 1.6.2, Moderator cooling system may be affected.**

- **Risk and R&D**
  - **Low on basis of no affect on 1 MW operation, will require new equipment and piping installation to meet upgrade capabilities.**

- **Action**
  - **Deferred due to acceptance of Item 61.**

Item 33: Reduce Target Floor Loads

WBS 1.8.3.7 Conventional Facilities

- **Proposal Description: Reduce target floor loads**
- **Rationale: Match latest design information**
- **Savings: $1.470 M**
- **Schedule: Improved due to reduced mat thickness to construct**
- **Conventional Facilities Impact: None**
- **Other Impact: Reduce base mate thickness**
- **Risks: Difficult to strengthen base mat if shielding requirements happened to increase significantly later**
- **Actions/Person Responsible: Accepted. Incorporate into Design Manual and cost estimate.**
  Person responsible: Jim Lawson

Item 34: Use Gantry Cranes Instead of Bridge Crane in Klystron Shop in WP 1.8.3.12

- **Area/Concern/Issue**
  - **Eliminate the cost of bridge cranes in the Klystron shop and replace it with a gantry crane.**
- **Rationale**
  - **Reduces conventional facility costs, but will increase operational costs slightly.**
- **Savings**
  - **Replacing the bridge crane with a gantry crane is a savings of $0.300 M.**
- **Schedule**
  - **Actually, a positive impact on schedule since the building structure can be a more standard design and the crane will not need installation.**
- **Conventional Facilities Impact**
  - **Minimal.**
- **Other Impacts**
  - **Klystron removal will require extra operational time, but minimal.**
- **Risk and R&D**
  - **None.**
- **Action**
  - **ORNL CCB approval required.**

Item 35: Reinforced Earth Retaining Wall

WBS 1.2 – Project Support

- **Proposal Description: Use reinforced earth retaining wall instead of concrete for Klystron building**
- **Rationale: Matches requirements and lower costs**
- **Savings: $1.470 M**
- **Schedule: Much improved overcast in place**
- **Conventional Facilities Impact: No negative impacts**
- **Other Impact: Cost savings. Separates earth from Klystron wall which eliminates threat of groundwater leakage**
- **Risks: Little or none**
- **Actions/Person Responsible: Incorporate into Design Manual and cost estimate.**
    - **Person responsible: Jim Lawson**

Item 37: Relocate the SNS to the JINS Site All WPs

Area/Concern/Issue

- Relocate the entire SNS facility down the hill and along the north side of Bethel Valley Road in the area near the current site for the Joint Institute for Neutron Sciences.

- **Rationale**
  - This area is much flatter that the ridge top site and may offer some construction savings by reducing the cost of site work.
  - This area has major utilities nearby.
  - This site would be decidedly closer to the JINS facility and to the HFIR facility.

- **Savings**
  - Undetermined.

- **Schedule Impact**
  - This would delay Title I design until approval of the site.
  - An addendum to the EIS would be required.

- **Conventional Facilities Impact**
  - Loss of credibility of Conventional Facilities team.

- **Other Impact**
  - Additional costs of new or addended EIS.

- **Risk and R&D**
  - High on the basis that this change cannot be completed and analyzed by the January review.
  - Project will be delayed by a change that may not necessarily effect cost savings.

- **Action/Person Responsible:** Deferred and under investigation.

Item 38: Relocate the SNS to the CRBR Site All WPs

- **Area/Concern/Issue**
  - Relocate the entire SNS facility to the west end of the ORR, the Clinch River Breeder Reactor (CRBR). This site is far away from HFIR and the ORNL site and does not currently belong to DOE. This site is also the most prime industrial development property in this area of the state.

- **Rationale**
  - **This area is much flatter that the ridge top site and may offer some construction savings by reducing the cost of site work.**
  - **This area has major utilities nearby.**

- **Savings**
  - **Undetermined.**

- **Schedule**
  - **This would delay Title I design until approval of the site.**
  - **A new EIS would be required.**

- **Conventional Facilities Impact**
  - **Loss of credibility of CF team.**

- **Other Impact**
  - **Additional costs of EIS.**

- **Risk and R&D**
  - **High on the basis that this change cannot be completed and analyzed by the January review.**
  - **Project will be delayed by a change that may not necessarily effect a cost savings.**

- **Action/Person Responsible: Rejected, none.**

Item 39: Construct Maintenance Shops Early
WBS 1.8.3.15

- **Area/Concern/Issue**
  - **Build maintenance shops early and use for construction shops.**

- **Rationale**
  - **Minimize the number of temporary construction structures.**

- **Savings**
  - **25 percent of baseline cost for construction shops ($4.080 M, escalated) equating to ~$1.020 M. The cost baseline number was obtained from Appendix C of the Project Controls Manual. No backup data exists in the cost estimate for this item, so a more detailed estimate could not be done.**

- **Schedule Impact**
  - **Site grading for shop buildings must be completed as early as possible to allow early construction of permanent shops.**

- **Conventional Facilities Impact**
  - **Temporary or short-term construction offices are still required until permanent buildings are usable.**
  - **Some expense may be required to convert buildings from construction shops to operational facilities after construction is complete.**

- **Other Impact**
  - **Reduces expense of temporary facilities during construction.**

- **Risks**
  - **Site may not accommodate early grading of shop area.**

- **Early shop construction may interfere with the construction of more critical facilities.**

- **Actions/Person Responsible**
  - **Conventional Facilities STL must implement through the Knight/Sverdrup contract.**

Item 41: Geosynthetic Drainage Material (Medium Risk)
WP 1.8.3.2, 1.8.3.4, 1.8.3.5, 1.8.3.6

- **Area/Concern/Issue**
  - **Use geosynthetic drainage material (geonet) and geotextile composite as a substitute for the coarse limestone capillary break in the shielding berm.**
- **Rationale**
  - **Reduce cost of capillary break in shielding berm.**
- **Savings**
  - **Potential for good savings. Savings cannot be identified at this point.**
- **Schedule**
  - **Potential for positive impact on schedule due to ease of construction.**
- **Conventional Facilities Impact**
  - **Must assess performance of composite material during Title I to determine impacts on conventional facilities.**
- **Other Impacts**
  - **Must assess performance of composite material during Title I to determine other impacts.**
- **Risk and R&D**
  - **Further study is needed to determine if composite material could handle estimated inflow of ground water and or surface water into shielding berm and can continue to perform efficiently over the life of the facility.**
  -
- **Action**
  - **Defer until Title I.**

Item 43. Optimize Excavation by Canting Linac Tunnel in WP 1.8.3.2

- **Area/Concern/Issue**
  - To optimize the cost of excavation and berm thickness it was proposed that the Linac Tunnel be canted downward based on the shielding berm requirements.
- **Rationale**
  - **Reduces conventional facility costs of excavation and backfill.**
- **Savings**
  - **These costs were not estimated since LANL stated this was not practical.**
- **Schedule**
  - **Negative impact on schedule of installation of technical components due to working on sloped surfaces. Operational time for replacement and alignment of technical components may be increased by 2X.**
- **Conventional Facilities Impact**
  - **Installation and operations inefficiencies will be increased. Safety concerns of handling heavy equipment on sloped surfaces.**
- **Other Impacts**
  - **Linac dynamics and alignment would be adversely affected.**
- **Risk and R&D**
  - **Installation and operation risks increase due to efficiencies in transporting components on a sloped surface. The operation and the design risks of the Linac technical components has been deemed to be to high.**
- **Action**
  - **Rejected, none.**

Item 44: Combine Administration, Central Control, and Target Users' Office Buildings
WPs 1.8.3.7, 1.8.3.13, and 1.8.3.14

- **Area/Concern/Issue**
  - Combine Administrative Offices, Central Control Building, and Target Office Buildings into a single structure, thus optimizing requirements for support spaces, service connections, and sitework.
  - Utilize multi-story construction to optimize services.
  - Relocate Administration Offices and Control Building to Target Building Offices.

- **Rationale**
  - Reduces construction costs for conventional facilities by grouping similar types of construction and by reducing materials and labor through utilizing shared systems (toilets and stairways) and by reducing amount of roof construction. This approach will actually move the Central Control Building closer to offices of personnel managing the control room.

- **Savings**
  - Saves $110 K in reduced area of roofing if a three-story structure is constructed.
  - Allows for a single central utility room and shared toilet and conference room facilities.
  - Could reduce site preparation work by requiring prep for one site only.

- **Schedule**
  - Ties beneficial occupancy of all office facilities to completion of Target Building facility.

- **Conventional Facilities Impact**
  - No negative impact on the design or construction of the facility.

- **Other Impacts**

- May dictate a location for the administrative offices and control room which are not optimum to overall site operation.

- **Risk and R&D**
  - Low on basis that this change is easy to accomplish.

- **Action/Person Responsible**
  - Conventional Facilities Team STL
  - ORNL CCB approval required

Item 46. Use Existing Facilities for Maintenance Offices in WP 1.8.3.12

- **Area/Concern/Issue**
  - To eliminate or reduce the costs of the shops and laboratories it was proposed to use existing shops and laboratories in ORNL.
- **Rationale**
  - Reduces conventional facility costs of buildings and utilities.
- **Savings**
  - These costs were not estimated since LANL, BNL, and LBNL all stated that these shops need to be near the facility.
- **Schedule**
  - Positive impact on schedule of installation since these building would be required to be constructed. Operational time would be increased requiring transportation of personnel and equipment to and from the shops. This area was also the offices for the operational staff of the accelerator systems.
- **Conventional Facilities Impact**
  - Reduce scope and costs of WP 1.8.3.12.
- **Other Impacts**
  - Operations and maintenance would of accelerator components would be effected.
- **Risk and R&D**
  - Time to respond to accelerator outages would be greatly increased.
- **Action**
  - Rejected, none.

Item 47: Eliminate West Access Road (Low Risk)
WP 1.8.2.2

- **Area/Concern/Issue**
  - **Eliminate west access road.**
- **Rationale**
  - **Reduce roadway costs.**
- **Savings**
  - **Savings $0.290 M**
- **Schedule**
  - **Positive impact on schedule due to eliminating access road.**
- **Conventional Facilities Impact**
  - **Eliminates easy access to borrow area if needed. Eliminates easy access to tie-in point on electrical grid. Eliminates easy access to powerline for maintenance and construction activities. Eliminates one site egress point.**
- **Other Impacts**
  - **No other impacts.**
- **Risk and R&D**
  - **Low risk. No R&D.**
- **Action**
  - **Rejected, eliminate this proposal.**

Item 48: Eliminate Translucent Roof Panels over Instrument Floor
WPs 1.8.3.7

- **Area/Concern/Issue**
  - **Translucent roof panels over the Instrument Floor of the Target Building cannot be eliminated because the original CDR estimate did not include these panels, but included metal roofing instead.**

- **Rationale**
  - **The introduction of translucent roof panels would result in an increase in cost.**

- **Savings**
  - **No savings**

- **Schedule**
  - **None.**

- **Conventional Facilities Impact**
  - **None.**

- **Other Impacts**
  - **None.**

- **Risk and R&D**
  - **Low on basis that this change is easy to accomplish.**

- **Action/Person Responsible**
  - **Rejected, none.**

Item 51a: Reconfigure Target Building (Low Risk)
WP 1.8.3.7

- **Area/Concern/Issue**
  - **Eliminate the 20'-0" wide bay, running north and south, on the west end of the Target Building, nearest the RTBT. This also eliminates 20' of the beam tunnel coming into the target building. The basement is not affected, but foundations under the instrument floor will be reduced.**

- **Rationale**
  - **Reduces construction costs for conventional facilities by reducing materials and labor.**

- **Savings**
  - **Saves $3.340 M in reduced materials and labor, HVAC load, electrical fixturing.**

- **Schedule**
  - **No negative impact on schedule for design or construction of the Target Building.**

- **Conventional Facilities Impact**
  - **Will not affect the design or operation of the facility.**

- **Other Impacts**
  - **May crowd instruments in this area of the instrument floor.**
  - **Limits flexibility in arrangement of instruments and equipment on the instrument floor.**
  - **May not allow adequate space for the crossover stairway connecting the north and south instrument halls and/or cryogenics equipment.**
  - **Shortens the entire site and thus the related sitework.**

- **Risk and R&D**
  - **Low on basis of no affect on operation of the Target Building.**

- **Action/Person Responsible**
  - **Conventional Facilities Team STL**
  - **ORNL CCB approval required**

Item 51b: Reconfigure Target Building (High Risk)
WP 1.8.3.7

- **Area/Concern/Issue**
  - Eliminate the 40'-0" wide bay, running east and west, on the south side of the Target Building. The basement is affected.

- **Rationale**
  - Reduces construction costs for conventional facilities by reducing materials and labor.

- **Savings**
  - Saves $1.370 M in reduced materials and labor, HVAC load, electrical fixturing. Cost includes burden and EDIA.

- **Schedule**
  - No negative impact on schedule for design or construction of the Target Building.

- **Conventional Facilities Impact**
  - Will not affect the design or operation of the facility.
  - Will require reconfiguration of equipment in basement.

- **Other Impacts**
  - Requires reconfiguration of instrument package.
  - Limits flexibility in arrangement of instruments and equipment on the instrument floor, particularly long beam instruments.

- **Risk and R&D**

- **High on basis of the limiting flexibility of the instrument floor, the limited effectiveness of the overhead crane, and the complexity of expanding the building later. This plan would be less than optimum and will pose a number of other problems to solve.**

- **Action/Person Responsible**
  - **Conventional Facilities Team STL**
  - **ORNL CCB approval required**

Item 53: Deliver Geotechnical Report Early (Low Risk)
WP 1.8.2.2

- **Area/Concern/Issue**
  - **Deliver geotechnical report early.**

- **Rationale**
  - **Verify foundation assumptions in CDR estimate.**

- **Savings**
  - **No savings potential if CDR assumptions are verified. Considerable negative dollar impacts if assumptions in CDR are in error.**

- **Schedule**
  - **No schedule impact.**

- **Conventional Facilities Impact**
  - **No impact.**

- **Other Impacts**
  - **No other impacts.**

- **Risk and R&D**
  - **Low risk. No R&D.**

- **Action**
  - **Draft geotechnical report has been delivered. Final report to be delivered the second week in November. Eliminate this proposal.**

Item 55: "Relax HVAC Requirements in Linac to match Ring" (Category II) in WBS 1.8.3.2

- **Area/Concern/Issue**
  Consider impact of relaxing the temperature and humidity requirements for the Linac tunnel to match those established for the Ring, HEBT and RTBT tunnel; i.e. temperature requirement = 60 to 80F versus 75 ± 2 1/2F and relative humidity requirement = 60% maximum instead of 55 ± 5%

- **Rationale**

There are no barriers separating the different parts of the tunnel, as a result it will be difficult to maintain separate climate conditions in those different sections. Offers potential for cost savings. Conditions should be similar because needs are similar.

- **Savings**
  Savings = 0. First costs will not be significantly affected because the size of the HVAC equipment will not be influenced by relaxed HVAC conditions due to the fact that HVAC loads are dependant on lights, equipment, etc; however, operating cost would be reduced by savings associated with reduced energy demands.

- **Schedule**
  No Impact

- **Conventional Facilities Impact**
  None

- **Other Impacts**

If implemented, operating costs would be reduced due to energy conservation by letting temperature drift over a wider range. Also eliminates need to institute design measures which would allow temperature and humidity in different sections of the tunnel to be controlled and maintained at different settings.

- **Risk and R&D**
  Need LANL to verify that there are no consequences related to adverse impacts on technical equipment.

- **Action**
  Deferred, evaluate during Title I design.

Item 56: Separate Cooling Tower from Parking Lot in WP 1.8.4.3

- **Area/Concern/Issue**
  - **Relocate the cooling tower away from the proposed parking area. This is to avoid potential problems with damage to automobiles.**
- **Rationale**
  - **This is to avoid potential problems with damage to automobiles.**
- **Savings**
  - **TBD Design optimization has been deferred to Title I.**
- **Schedule**
  - **No negative impact on schedule for design or installation of 1 MW facility.**
- **Conventional Facilities Impact**
  - **Additional underground pipe may be required or parking totally be relocated.**
- **Other Impacts**
  - **None.**
- **Risk and R&D**
  - **Lowers risk of having car damage problems during operation.**
- **Action**
  - **Deferred, until Title I design.**

Item 57: Re-evaluate Linac Tunnel to the South
WP 1.8.3.2

- **Area/Concern/Issue**
  - The current access to the tunnel during construction requires temporary access at several points along the length. Access during operation is from personnel stairways on the north side of the tunnel which lack equipment hatches. Both pose significant construction issues that will likely increase the cost of the structure above what is currently estimated.

- **Rationale**
  - A revised access scenario and reconfiguration of building relationships will ease the construction problems and prevent unnecessary cost growth.

- **Savings**
  - An accurate estimate of savings is currently unavailable and can only be identified after some title I design of the building configuration is started.

- **Schedule**
  - Minimal negative impact on schedule. The expectation is that schedule improvements are possible because of an improvement in the construction process.

- **Conventional Facilities Impact**
  - Leads to an improved design and simpler construction process. The change would likely ease tunnel access for equipment maintenance during operation.

- **Other Impact**
  - The benefits would be a simpler construction process and and shorter schedule. It is likely that a revised configuration would be easier to construct, thus less costly. Access to the tunnel for maintenance and moving even small items of equipment in and out of the tunnel would be easier during operation which would potentially increase availability of the beam.

- **Risks**
  - **There is no risk to the Linac. The functional requirements of the Linac would be fully met with any revised building design. Coordination with the linac is important because of access to the beam from the Klystron building.**

- **Actions/Person Responsible**
  - **Deferred, will be evaluated during Title I.**

Item 58: Review Location of Target Office Building
WPs 1.8.3.7

- **Area/Concern/Issue**
  - Relocate the Target User Offices to the north side of the building to be closer to the upgrade target building.

- **Rationale**
  - This would locate scientists and experimenters closer together and would promote better interaction of ideas and would put users close to both instrument halls. (Note that the future target building would likely have an office area directly attached to its instrument hall.)

- **Savings**
  - No savings because this would involve virtually the same material and labor costs.

- **Schedule Impact**
  - None.

- **Conventional Facilities Impact**
  - None.

- **Other Impacts**
  - This change could interfere with the future implementation of a direct beam target by infringing on the area available for facilities development.

- **Risk and R&D**
  - Low on basis that this change is easy to accomplish.

- **Action/Person Responsible**
  - Deferred until Title I design.

Item 59: Establish Settlement Criteria (High Risk)
WP 1.8.3.2, 1.8.3.4, 1.8.3.7

- **Area/Concern/Issue**
  - Establish reasonable settlement criteria for accelerator buildings.

- **Rationale**
  - Establish reasonable criteria so that geotechnical consultant can recommend appropriate foundations.

- **Savings**
  - No savings potential from CDR estimate. Major dollar impact if reasonable criteria is not established.

- **Schedule**
  - Negative impact to design schedule due to more complex foundations. Negative impact to construction schedule due to more complex foundation construction.

- **Conventional Facilities Impact**
  - Dollar and schedule impact as detailed above.

- **Other Impacts**
  - Reasonable settlement criteria may require more vertical adjustment capabilities of technical equipment.

- **Risk and R&D**
  - Impractical and drastically more costly foundations if reasonable criteria is not established. Less stringent settlement criteria may require more frequent vertical adjustment of technical equipment after installment.

- **Action**
  - Defer to Title I. Given recommendations in geotechnical report, work with appropriate laboratories to establish reasonable settlement criteria.

Item 60: Optimize Footprint of Front End Building WP 1.8.3.7

- **Area/Concern/Issue**
  - Eliminate the 25'-0" wide bay, running east and west, on the north side of the Front End Building (FEB).
  - Also eliminate space on the mezzanine level not required by program, a 30'-0" X 50'-0" area.
  - Moving the overhead door access to the south face does not allow the elimination of the bay on the west end of the building. This bay is now required as an extension of the access path through the FEB to the west end of the linac tunnel.
  -
- **Rationale**
  - Reduces construction costs for conventional facilities by reducing materials and labor. With the refined design of the FEB equipment, the area originally allocated is larger than now required.
- **Savings**
  - Saves $0.260 M in reduced materials and labor, HVAC load, electrical fixturing, and cut-and-haul earth.
  - Cost includes burden and EDIA.
  - This cost assumes that the height of the FEB is at the reduced height of 12'-0". (VE Item 1)
- **Schedule Impact**
  - No negative impact on schedule for design or construction of the Target Building.
  - Reduction of cut-and-haul earth quantities will shorten construction schedule for site work.
- **Conventional Facilities Impact**
  - Will not affect the design or operation of the facility.
- **Other Impacts**
  - No other impacts.
- **Risk and R&D**
  - Low on basis of no affect on operation of the FEB.

- **Action/Person Responsible**
  - Conventional Facilities Team STL

Item 61: Use Existing Cryogenic Refrigerator from ANL in WP 1.8.4.3

- **Area/Concern/Issue**
  - Use an existing 5 kW CCI refrigerator from the Continuous Wave Deuterium Demonstrator (CWDD) facility at ANL.
- **Rationale**
  - Reduces conventional facilities costs for procurement of the refrigerator.
- **Savings**
  - Saves $2.490 M by obtaining, modifying, and installing the existing 5 kW refrigerator from ANL.
- **Schedule**
  - No negative impact on schedule for design or installation of 1 MW facility. Will require some design and fabrication to modify the refrigerator for SNS use. Will not require design and installation of additional equipment to upgrade to 2 MW.
- **Conventional Facilities Impact**
  - Will require further investigation to assure that this refrigerator will meet the needs for the target moderators. Some design and modification of the refrigerator will be required. Operations will be affected since oil flooded screw compressors and expansion turbines are part of this existing refrigerator.
- **Other Impacts**
  - WP 1.6.2, Moderator cooling system may be affected.
- **Risk and R&D**
  - Low risks if the refrigerator is deemed useable. Operational risk will increase since oil removal systems will have to be maintained and turbo-expanders can fail catastrophically.
- **Action**
  - 1) Verify refrigerator meets the requirements for SNS. 2) ORNL CCB approval required.

Item 62: Defer the Cryogenic System until After 2005 in WP 1.8.4.3

- **Area/Concern/Issue**
  - Defer the installation of the cryogenic systems for the cryogenic moderators for the initial startup of the facility.
- **Rationale**
  - Remove the procurement and installation cost of the cryogenic refrigerator system.
- **Savings**
  - Saves $3.730 M by deferring procurement and installation of the refrigerator and the associated structures and utilities.
- **Schedule**
  - No negative impact on schedule for design or installation of 1 MW facility. Will require design, procurement and installation to add to the facility at a later date.
- **Conventional Facilities Impact**
  - Removes design and installation requirements for the cryogenic system. Will require some design to assure that the He refrigerator system can be installed with minimal impact at a later date.
- **Other Impacts**
  - WP 1.6.2, Moderator system will have to be designed for initial no cryogenic operation.
- **Risk and R&D**
  - Low risks if the system is designed for easy installation of the refrigerator at a later date. High risks for political ramifications of not being a cold moderator facility initially.
- **Action**
  - Defer decision until resolution of Item 61 (Argonne Refrigerator).

Item 63: Reduce Power and Duty Factor of the Beam Dumps (3) in WP 1.8.3.10

- **Area/Concern/Issue**
  - All three beam dumps were designed for 200 kW operation based on the worst case load.
- **Rationale**
  - Each dump has a different beam load and duty factor. All three dumps were designed the same based on the worst case scenario dump, Ring Extraction Dump. The other two dumps are to be designed for the reduced loads.
- **Savings**
  - Cost savings of $0.750 M.
- **Schedule**
  - Slight increase in design cost/schedule since each dump will require a separate design.
- **Conventional Facilities Impact**
  - EDIA will increase.
- **Other Impacts**
  - Target systems will determine the loads and then work with conventional facilities for sizing the beam dumps.
- **Risk and R&D**
  - Unknown.
- **Action**
  - Accepted, needs ORNL CCB approval.

Item 64: Shorten HEBT in

WP 1.8.3.4

- **Proposal Description: Shorten HEBT by 6 meters**
- **Rationale: Match criteria. Extra length not required**
- **Savings: $0.410 M (material + labor + engineering)**
- **Schedule Impact: Improved due to reduced construction effort**
- **Convention Facilities Impact: No negative impact**
- **Other Impact: Less construction effort/cost**
- **Risks: Low**
- **Actions/Person Responsible: Approved, incorporate into Design Manual and cost estimate.**
  Person responsible: Jim Lawson

Item 65: Lower Beam Height from 5' to 4' in WP 1.8.3.2, 1.8.3.4, 1.8.3.5, & 1.8.3.6

SNS

- **Area/Concern/Issue**
  - Lower the beam line for ease of maintenance and lowering tunnel height.
- **Rationale**
  - Operational maintenance of the accelerator would be easier since step ladders would be needed as much to maintain equipment on top of the accelerator. This would also allow the lowering of the tunnel by 1 foot.
- **Savings**
  - Cost savings of $0.080 M by lower the tunnel by 1 foot.
- **Schedule**
  - No negative impact on schedule for design or installation of 1 MW facility.
- **Conventional Facilities Impact**
  - None.
- **Other Impacts**
  - Installation of accelerator equipment (vacuum equipment, instrumentation, manifolds, etc.) may be impacted due to lack of room underneath the accelerator.
- **Risk and R&D**
  - May increase risk to operations and maintenance of equipment located below the accelerator.
- **Action:** Rejected, none.

Item 66: Radiation Barriers in HEBT in WP 1.8.3.4

- **Area/Concern/Issue**
  - **Add Radiation Barriers in HEBT to permit personnel access to Ring and/or HEBT during Linac operation**
- **Rationale**
  - **Increase operational efficiency**
- **Savings**
  - **Cost not in present design. Estimated cost adder of one shield wall with personnel labyrinth is $170 K.**
- **Schedule**
  - **Minimal negative impact on schedule.**
- **Conventional Facilities Impact**
  - **Enables personnel to access ring/HEBT when linac is operating, allowing parallel operations, thus increasing efficiency and decreasing operating costs.**
- **Other Impacts**
  - **New requirement.**
- **Risk and R&D**
  - **Low on basis of known design, similar to that used at other sites. No extra R&D required.**
- **Action**
  - **Deferred. Not considered a VE Item, but will be required.**

Item 68: IGBT Change Out in WP1.8.3.3(C/A), 1.8.4.3(Electrical), 1.8.5.3(HVAC) and Fire Protection -Conventional Facility

- **Area/Concern/Issue**
  - Improve linac design by using IGBTs as voltage regulator for powering klystrons.

- **Rationale**
  - Reduce conventional facility cost by eliminating capacitor/crowbar rooms along length of klystron building. At the same time improve design.

- **Savings**
  - Save approximately $1.450 M in construction and engineering cost in the conventional facility costs by changing to the IGBTs.

  Schedule
  - No impact foreseen on the electrical schedule. Some improvements due to overall less construction effort.

- **Conventional Facilities Impact**
  - Changing to the IGBTs scheme has a net negative cost impact. Additional cost incurred in the electrical discipline due to requirements of each primary transformer, which feeds the IGBT, will require individual 13.8 kV switchgear.

- **Other Impacts**
  - Reduced cost due to changing to IGBTs is noted for HVAC, C/A, and Fire Protection area in conventional facility.

- **Risk and R&D**
  - For conventional facility there is not risk or R&D.

- **Action:** ORNL CCB approval ASAP. Accepted 11/5/98.

Value Engineering Proposals

WBS 1.9 – Global Controls

No	WBS	Proposal/Description	Rationale /Advantages	Impact /Disadvantages	Risk	Savings	Action	Comments
Category I – Low Risk and significant savings								
1	1.9.2.6	Reduce hardware costs for software development system by using existing equipment.	Cost savings.	Available Equipment may be obsolete	Cat. I	$200K	Include	
2	1.9.8.6	Defer Interface for Predictive Maintenance System.	Cost savings		Cat. I	$400K	Include	
3	1.9.8.8	Eliminate Interface to "Business Computing System."	Capability exists already in Global CS scope (1.9.2.1)		Cat. I	$400K	Include	Requires external databases to be in appropriate web formats
L1	1.9.4.4	Controls Savings related to Vacuum, Water, Diagnostics and rf for shorter (52 Klystron) Linac	Spin-off from Linac VE proposal	None	Cat.1	$175K	Include	Transferred from Linac VE proposal. (Estimate based upon 6% scaling.)
R1	1.9.5	Controls Savings related to reduction in ring components and support for reduced Application Programming	Spin-off from Ring VE proposal	None	Cat.1	431.2K	Include	Transferred from Ring VE Proposal.
				Total for WBS 1.9:		**$1606.2K**		
Category II – Medium Risk and modest savings - None								
Category III – Requires longer study and/or involves other WBS elements. No change to January Baseline.								

No	WBS	Proposal/Description	Rationale /Advantages	Impact /Disadvantages	Risk	Savings	Action	Comments
4	1.9.4.6	Use PC IOCs for HPRF interfaces	Cost savings	Reliability uncertain. May not be optimal standards choice.	Cat.III	$100K	Title I Study	This could be extended to other systems. Decision should not be made prematurely.
5	1.8	Optimize UPS Requirements	Availability	Possible increase in cost.	Cat.III		Refer to WBS 1.8.	Establish priorities for UPS. Study needed.
6	Many	Look at most economical strategy for long term travel	Cost savings		Cat.III		Refer to WBS 1.2	Consider rented apartments, government vehicles, etc. Longer study needed.
7	1.3-1.8	Optimize cabling strategy	Cost savings. Maintainability		Cat.III			Cable "Tsar" includes signal cabling. Longer study needed.
8	1.3-1.8	Specify digital interfaces where possible	Maintainability, Flexibility		Cat.III			Possibly no net cost savings. May require cost transfer
9	1.9.2.8	Get early application program requirements	Efficiency, good practice		Cat.III			Get list from Bill Weng
Category X – Deleted by consensus – No further consideration								
10	1.9.6	Do not integrate Target System	Cost savings	Lose correlation ability	Cat. X			Cost of separate interface to CR would be comparable
10a)	1.9.8	Do not integrate Conventional Facilities	Cost Savings	Lose correlation ability	Cat. X			Cost of separate interface to CR would be comparable
11	1.9.2.8	Reduce application programming	Cost savings	Would decrease commissioning ability	Cat. X			17% of already low effort has already been removed from 1.5
12	1.1.9	Reduce standard-setting effort	Cost Savings	Standards and universal buy-in are a major cost saver.	Cat. X			ICWG R&D WPs for 'FY99 are primarily for standard-setting.

No	WBS	Proposal/Description	Rationale /Advantages	Impact /Disadvantages	Risk	Savings	Action	Comments
13	1.9.8.7	Remove Personal Protection System Interface	Cost savings	BAD IDEA. Need PPS in control room with common tools	Cat. X			One way interface deemed a critical requirement.
14	1.9.1	Reduce ICWG travel costs	Cost savings		Cat. X			Controls team has special issues. Use phone conference, NetMeeting

1. Software Development System – Category I
WBS # 1.9.2.6

- **Proposal Description:**
  Reduce the new hardware purchased for the Global Software Development System at Oak Ridge

- **Rationale:**
  The present budget includes time and materials for a software development system at Oak Ridge to support continuing developments during commissioning and operation. It is felt that the hardware estimate can be reduced by making use of systems already at the labs during the engineering phases.

- **Savings:**
  $200K

- **Schedule Impact:**
  None

- **Related Impact (include operations):**
  None

- **Benefits/Advantages:**
  Cost Savings

- **Risks:**
  The main risk is that the hardware purchased earlier may be obsolete at the time it is appropriate to move to ORNL.

- **Actions/Person responsible:**
  A Baseline Change and CCB action should be initiated by Dave Gurd.

2. Predictive Maintenance System – Category I

WBS # 1.9.8.6

- **Proposal Description:**
  Defer the interface between the Predictive Maintenance System and the Global Control System. The Predictive Maintenance System is a package system intended to anticipate failures, especially in pumps and other motorized equipment. (This system has been itself targeted for elimination, however the interface could be eliminated even if the system survives.) The interface IOC and the software to prepare the local database would be saved.

- **Rationale:**
  This system is self contained, and does not require constant control room monitoring. Periodic checks of local status would be adequate to fulfil its function.

- **Savings:**
  $400K (The amount in the present baseline.)

- **Schedule Impact:**
  None

- **Related Impact (include operations):**
  Minor. Occasional visits to the local system would be required to monitor status.

- **Benefits/Advantages:**
  Cost Savings

- **Risks:**
  Little risk. Possibly a slightly elevated risk of delaying required pump maintenance beyond a failure.

- **Actions/Person responsible:**
  A Baseline Change and CCB action should be initiated by Bill DeVan.

3. "Business Computing System" Interface – Category I

WBS # 1.9.8.8

- **Proposal Description:**
  Defer the interface between the "Business Computing" System and the Global Control System. The Business Computing System is a series of databases containing project information of many types, only some of which are of immediate relevance to the control system. The baseline assumed a special interface to these systems, and the proposal is to eliminate that interface.

- **Rationale:**
  This capability (access to databases external to the control system network) is already assumed in the control system design, using a gateway computer. (See attached comments from Marty Knott.)

- **Savings:**
  $400K (The amount in the present baseline.)

- **Schedule Impact:**
  None

- **Related Impact (include operations):**
  None. Desired functionality will be available.

- **Benefits/Advantages:**
  Cost Savings

- **Risks:**
  None. Requires external databases ("Business Computers") to be available on the web or control room access will not be available.

- **Actions/Person responsible:**
  A Baseline Change and CCB action should be initiated by Bill DeVan.

- **Additional Comments ("Business Computing System Interface") (Marty Knott)**

  For those business systems which are implemented with web browser operator interfaces, access to these systems in the SNS control room via a browser is a convenient and beneficial tool. Examples are: safety training status of employees, CF and technical drawing files, schematic viewing, procedures (both SNS and ORNL), logbooks (both operational and studies), SNS operating schedules, call-in lists, work schedules, work permits, property databases, cable databases, etc. (All of the previous list and more have been implemented at APS and all new applications are deemed acceptable ONLY if they are web-based.) As long as these "business systems" are accessible by the SNS operating staff on the same display terminals as other SNS system parameters, they can be put to appropriate use. I see no reason to communicate actual business system database parameters into the control system as process variables, but maybe I haven't given it enough thought. In other words, no effort need be made to "interface" these systems to the control system, but rather vigilance to insure that compatible access methodology be used (today, that is the web). By the way, it should be obvious that all of these applications are useful to everyone on the staff and only incidentally by the operators.

L1. Controls Reductions for Shorter Linac – Category I

WBS # 1.9.4

- **Proposal Description:**
  The proposed reduction in the number of klystrons in the Linac, and the associated change in length, results in corresponding savings in the control system for the CCL klystrons, power supplies, vacuum, diagnostics and cooling systems. Each of these scales by a different factor, all approximately 6%.

- **Rationale:**
  This reduction is a natural result of the change in linac configuration.

- **Savings:**
  $175K (This amount is derived from the application of different scaling factors for each affected subsystem, and allowing for the fact that later channels cost less than earlier ones.) *(Important Note: This savings was originally a part of one of the linac VE proposals. The amount assumed there was $500K. This amount ($500K) should have been removed from the linac proposal, and is replaced by this one.)*

- **Schedule Impact:**
  None

- **Related Impact (include operations):**
  None. Required functionality will be available.

- **Benefits/Advantages:**
  Cost Savings

- **Risks:**
  None.

- **Actions/Person responsible:**
  A Baseline Change and CCB action should be initiated by Dave Gurd

R1. Ring System Controls Reductions – Category I

WBS # 1.9.5

- **Proposal Description:**
  The proposed reduction in the number of Ring components results in a corresponding change in the associated control system requirements. Also – the reduced amount of application programming in WBS 1.9.5.12 results in an associated reduction of support (computers, etc) in WBS 1.9.5.

- **Rationale:**
  This reduction is a natural result of the change in ring configuration, and the reduction in application programming for the ring.

- **Savings:**
  $431.2K (This amount is derived from the application of different scaling factors for each affected subsystem, and allowing for the fact that later channels cost less than earlier ones.) *(Important Note: This savings was originally with the ring VE proposals, and is replaced by this one. The number is unchanged)*

- **Schedule Impact:**
  None

- **Related Impact (include operations):**
  None. Reduced application programming could have an adverse impact on ring commissioning.

- **Benefits/Advantages:**
  Cost Savings

- **Risks:**
  None.

- **Actions/Person responsible:**
  A Baseline Change and CCB action should be initiated by John Smith.

4. PC-based IOCs – Category III

WBS # 1.9.4.6

- **Proposal Description:**
  Where possible, use PC-based IOCs in place of the VME or VXI-based IOCs assumed in the current estimate. The immediate proposal is to do this for the linac high power rf systems, although one might consider other possible applications of this approach.
- **Rationale:**
  The PC is a commodity item, and under the right circumstances (limited I/O) a PC-based IOC is cheaper than VME. Software costs would be the same. An experiment with this configuration is underway for LEDA. The high power rf system is a good candidate because each IOC has only one I/O interface – a PLC bus.
- **Savings:**
  $400K (The amount in the present baseline.)
- **Schedule Impact:**
  None
- **Related Impact (include operations):**
  Each new IOC basis will add some operational overhead for maintenance of multiple systems.
- **Benefits/Advantages:**
  Cost Savings
- **Risks:**
  There is no convincing reliability data on these configurations. There is therefore a risk of less reliable performance. There is a risk in making this decision before the ICWG hardware and architecture standardization studies are complete – there is probably more to be gained by standardization than by these potential hardware cost savings.
- **Actions/Person responsible:**
  Report on LEDA experience as data accumulates. Consider the use of PC-IOCs for this and other applications as part of the ongoing standardization studies.

5. Optimize UPS Strategy – Category III

WBS #1.8

- **Proposal Description:**
  Review the current UPS requirements in light of more complete design and better understanding of operational needs.

- **Rationale:**
  Appropriate use of UPS will have a significant impact on operational availability.

- **Savings:**
  Requires study. Actual cost could go up.

- **Schedule Impact:**
  None

- **Related Impact (include operations):**
  Operational availability

- **Benefits/Advantages:**
  Operational availability

- **Risks:**
  None.

- **Actions/Person responsible:**
  Appropriate person from Conventional facilities should review the requirements in consultation with STLs. Jim Lawson.

6. Travel Policy – Category III

WBS #1.2

- **Proposal Description:**
  Look at strategies for more economical long term travel – in particular during the installation phase. Possibilities include using JINS, .renting apartments, leasing government vehicles, etc.

- **Rationale:**
  The collaboration requires a great deal of travel, and long term visits will be required during the installation phase.

- **Savings:**
  Unknown. Requires analysis of current estimates first.

- **Schedule Impact:**
  None

- **Related Impact (include operations):**
  Reasonable travel and living arrangements will make it easier to get needed installers from the collaborating labs.

- **Benefits/Advantages:**
  Cost saving

- **Risks:**
  None.

- **Actions/Person responsible:**
  This should be the responsibility of the Project Office. Carl Strawbridge.

7. Optimize Signal Cabling Strategy – Category III

WBS # 1.3 – 1.8

- **Proposal Description:**
  In the present baseline, responsibility for signal cabling (ie cables running from subsystem transducers and actuators in the tunnel and klystron gallery to the controls racks is the responsibility of the subsystem owners. This activity must be coordinated if it is to be done effectively and at minimum cost. Coordination could be done by the AE/CM with careful specification and monitoring by the concerned groups.
- **Rationale:**
  Costs will be reduced by the imposition of standards and a coordinated signal cabling strategy.
- **Savings:**
  No cost saving can be identified with respect to the baseline, however cost increases should be anticipated if cabling is not coordinated.
- **Schedule Impact:**
  Inefficient cabling strategy could adversely affect the schedule.
- **Related Impact (include operations):**
  Coordination will result in improved cable documentation – essential for operations and maintenance.
- **Benefits/Advantages:**
  Construction Cost Savings. Operational cost savings.
- **Risks:**
  None.
- **Actions/Person responsible:**
  A strategy needs to be developed with the CM. Strawbridge with the STLs (who now own the budgets). (See Marty Knott comment below.)

240

- **Comment from Marty Knott:**
  The benefit for addressing this situation will be in the avoidance of unneeded cost rather than a cost savings. My strong recommendation is that someone in "Systems Engineering" (WBS 1.2or 1.10) should collect rough estimates of cable routing, in a "here to there" description format, preferably with quantities and approximate cable sizes. From this rough information, he should sit with the A/E to lay out the cable tray routes. At this stage, the purpose is to reserve "air corridors" which will eventually contain trays of specific width, number, type, and subdivision. Once these routes are established, drawings are published and sent to all labs so that more detailed information can be provided when it is ready. All trays will have numbers to be used to describe routes. Controls should be careful to reserve exclusive trays (or segments of trays) for fiber usage. PPS may also elect to do this or may elect to provide exclusive-use trays. Other aspects of this are the minimization of cable types and the ideas expressed at the VE workshop seem workable.

8. Digital Interfaces – Category III

WBS #1.9.3 – 1.9.8 and 1.3 – 1.8

Proposal Description:

Use digital interfaces (eg serial, multi-drop buses such as CANbus) wherever appropriate to reduce cable costs. This is particularly appropraite for DC magnet power supplies and vacuum equipment.

- **Rationale:**
  Digital Interfaces can reduce cost, cable complexity and noise problems.

- **Savings:**
  Unknown. Requires analysis of current estimates first.

- **Schedule Impact:**
  None

- **Related Impact (include operations):**
  Reduces noise on signal transmission.

- **Benefits/Advantages:**
  Possible overall cost saving – but more likely a cost transfer from controls to subsystem owners.

- **Risks:**
  Risks associated with new technology. Possible performance degradation due to serial transfers. Subsystem owners may resist new technology.

- **Actions/Person responsible:**
  This strategy is already under study by the ICWG. Committee will be visiting BESSY to evaluate their use of this technology. There will be a report later in the year. Dave Gurd.

9. Application Programming II – Category III

WBS # 1.9.2.8

- **Proposal Description:**
  Get an early start on application programming requirements. Get lists of application programs from existing facility. Select development environment and tools as early as possible. (See also # 11.)

- **Rationale:**
  More efficient use of application programming effort.

- **Savings:**
  Not possible to specify, but early definition of requirements should make better use of resources. No real cost savings, but a better and more complete suite of applications should result.

- **Schedule Impact:**
  Critical applications ready earlier.

- **Related Impact (include operations):**
  Better applications means easier and more efficient operations.

- **Benefits/Advantages:**
  More efficient operations.

- **Risks:**
  None. This should be the normal mode of operating, and was certainly intended in the baseline plan.

- **Actions/Person responsible:**
  Get hopping on understanding the needed applications. This means developing an operation philosophy soon. Consult especially with Bill Weng about the applications he expects. Dave Gurd, John Smith, Jose Alonso.

10. Target System Integration – Category X

WBS # 1.9.6

- **Proposal Description:**
  Do not integrate the stand-alone PLC-based control system with the Global EPICS system. This implies local operation of the target only.

- **Rationale:**
  Non-integration would save the cost of the hardware interfaces, and more significantly of the associated database and software development.

- **Savings:**
  $160K

- **Schedule Impact:**
  None

- **Related Impact (include operations):**
  No operation from the main control room. No ability to correlate target parameters with acceleratot parameters.

- **Benefits/Advantages:**
  Construction Cost Savings

- **Risks:**
  The main risk will be the inability to correlate target with accelerator data for trouble shooting. There would be an increased operational cost for additional operators in the target control room.

- **Actions/Person responsible:**
  Idea was defeated. No further action.

244

- **Comment from Marty Knott:**
  This capability should continue to be included in the SNS control system. If some or all of the target system controls will be implemented with EPICS, those portions will naturally be available to the SNS control system. (Proper protection should be included in the EPICS database to insure the proper isolation of control where needed.) If the target controls are to be implemented with a commercial turn-key systems, the ability to monitor that system's parameters is important, especially if consideration is ever to be given to reducing or eliminating off-shift operators for the target. EPICS's alarm handling capability alone can be vital if used to notify MCR operators of real or potential trouble.

- **Original Suggestion from Bill DeVan:**
  Buy a dedicated "canned" control system for targets. Don't integrate the target control system with EPICS, but standardize on components to minimize the difficulty of integrating later.

  As you can imagine, it is difficult to guess how much this would save. (For reference: Total workpackage dollars for 1.9.6 are about $2.3M). Hardware and software requirements will generally be the same since (a) you still have to execute the required control functions, and (b) you still have to provide some type of operator interface. I think the primary savings is in the design productivity features likely to be available in a canned control system. If you agree with this, then I suggest we calculate the potential savings as follows:

  I used the figure of 4 hours per point to estimate the labor required to configure databases, write sequences, configure graphics, etc.* If we use a "canned" control system, then say the configuration labor drops to 3 hours per point. (The thinking here is that for a simple process control application, a "LabView-like" development environment is likely to yield more design productivity then the EPICS development environment. While we wouldn't use LabView, you can imagine that there are products with a similar development environment).

  Trimming the scope of the graphics provided could also help to trim configuration labor.

  So:

  Say configuratation labor is reduced from 4 hours per point to 3 hours per point.*

There are 4 IOC's for the target.

Say each averages 400 points.

Then the difference in configuration labor is:

(4 hrs/pt - 3 hrs/pt) * $100/hr * 4 IOCs * 400 pts = $160K.

*(Two IOCs had VME I/O; two interfaced with PLC's. I used a figure of 4 hours per point for "VME IOCs". I used a figure of 2 hours per point for "PLC IOCs". However, configuration labor for both the PLC and the IOC combined was still 4 hours per point. With a canned system, "PLCs and IOCs" would get combined into some kind of generic controller, so the labor savings should still be 1 hour per point).

Risk is "medium". (i.e. "Can be retrofitted with cost and operating impacts; has no reliability or safety impacts".)

10a. Conventional Facilities Integration – Category X

WBS # 1.9.8

- **Proposal Description:**
  Do not integrate the Conventional Facilities stand-alone PLC-based control systems with the Global EPICS system. This implies local operation of the various subsystems.

- **Rationale:**
  Non-integration would save the cost of the hardware interfaces, and more significantly of the associated database and software development.

- **Savings:**
  $240K

- **Schedule Impact:**
  None

- **Related Impact (include operations):**
  No operation from the main control room. No ability to correlate conventional facilities parameters with accelerator parameters.

- **Benefits/Advantages:**
  Construction Cost Savings

- **Risks:**
  The main risk will be the inability to correlate conventional facilities with accelerator data for trouble shooting. There could be an increased operational cost for additional operators to monitor the distributed conventional subsystems.

- **Actions/Person responsible:**
  Suggestion was defeated. No further action.

- **Comment from Marty Knott:**
  This capability should continue to be included in the SNS control system. Assuming that a commercial turn-key system is used to control and monitor the plant systems, the availability of many of its parameters can be important to SNS operation. Examples are DI water conductivity, pump pressures and flows, tunnel and building air temperatures, compressed air status, etc. At APS, we are currently striving to add CF building systems monitoring to the control systems database. Correlation of some building parameters with dependent machine parameters can lead to the quick solution of some very tough problems.

  Another aspect of CF building systems is that related to the electrical power distribution system. This is another, even more obvious, area of beneficial communication with the control system. At APS we have Siemans switch gear which provides very sophisticated monitoring tools - voltage, current, KW-hours, and even wave shapes. The ability to diagnose "power bumps" is often important, for example. We have ported this system to the APS control system and have not regretted it.

- **Original Suggestion from Bill DeVan:**
  Buy a dedicated "canned" control system for conventional facilities systems. Don't integrate this control system with EPICS, but standardize on components to minimize the difficulty of integrating later.

  As you can imagine, it is difficult to guess how much this would save. (For reference: Total work package dollars for 1.9.8 are about $2.9M). Hardware and software requirements will generally be the same since (a) you still have to execute the required control functions, and (b) you still have to provide some type of operator interface. I think the primary savings is in the design productivity features likely to be available in a canned control system. If you agree with this, then I suggest we calculate the potential savings as follows:

  I used the figure of 4 hours per point to estimate the labor required to configure databases, write sequences, configure graphics, etc.* If we use a "canned" control system, then say the configuration labor drops to 3 hours per point. (The thinking here is that for a simple process control application, a "LabView-like" development environment is likely to yield more design productivity then the EPICS development environment. While we wouldn't use LabView, you can imagine that there are products with a similar development environment).

  Trimming the scope of the graphics provided could also help to trim configuration labor.

Say configuration labor is reduced from 4 hours per point to 3 hours per point.

There are 6 IOC's for conventional facilities.

Say each averages 400 points.

Then the difference in configuration labor is:

(4 hrs/pt - 3 hrs/pt) * $100/hr * 6 IOCs * 400 pts = $240K.

*(Two IOCs had VME I/O; two interfaced with PLC's. I used a figure of 4 hours per point for "VME IOCs". I used a figure of 2 hours per point for "PLC IOCs". However, configuration labor for both the PLC and the IOC combined was still 4 hours per point. With a canned system, "PLCs and IOCs" would get combined into some kind of generic controller, so the labor savings should still be 1 hour per point).

11. Application Programming – Category X

WBS # 1.9.2.8

- **Proposal Description:**
  In the present baseline, there is application programming in the linac (1.9.4), the ring (1.5.12) and Global Controls (1.9.2.8). Application programming includes all programming that spans more than one IOC – ie across subsystems. Application programming is where the physics is. It is difficult in the early stages to specify the application programs that will be needed. Consequently, application programming appears in the cost estimate simply as a number of FTEs. The proposal was to reduce this number – say by 2-3 FTEs

- **Rationale:**
  Construction costs would be reduced.

- **Savings:**
  Would depend upon the number of FTEs eliminated and when in the schedule they would have been used. The proposal was 2 FTEs, or approximately $400K.

- **Schedule Impact:**
  Inadequate application programming could have an adverse impact on commissioning.

- **Related Impact (include operations):**
  Whatever application programming was not done during construction, would almost certainly be done during operation.

- **Benefits/Advantages:**
  Construction Cost Savings.

- **Risks:**
  The risks are high. Independent reviewers have already suggested that the planned effort in this area is inadequate, and 6 FTEs (17% of the total effort) have already been removed from the ring programming effort (1.5.12).

- **Actions/Person responsible:**
  This suggestion was defeated. No further action required – but see item # 9 ("get an early start on application programming") for advice on efficient use of available funds.

250

12. Reduce Standardization – Category X

WBS # 1.1.9

- **Proposal Description:**
  This year's R&D program is almost entirely directed at establishing a comprehensive set of hardware and software standards to be applied across the project in the controls and interface areas. It might be possible to reduce the associated study, and simply declare a number of standards based upon current knowledge.
- **Rationale:**
  R&D costs could be reduced.
- **Savings:**
  The amount of reduction is somewhat arbitrary. The proposal was to reduce the effort by $250K
- **Schedule Impact:**
  None
- **Related Impact (include operations):**
  None
- **Benefits/Advantages:**
  R&D Cost Savings.
- **Risks:**
  The risks are high. Not only is it essential to develop a set of standards which will be appropriate for the life of the project, but it is particularly important for this collaborative project that there be "buy-in" from all parties to the extent possible. This requires that decisions be made collectively, so that all understand the compromises made and the rationale. Failure to agree on effective standards are likely to cost considerable more than the suggested savings in operations and maintenance.
- **Actions/Person responsible:**
  This suggestion was defeated. No further action required, except to get on with the standardization work ASAP. Dave Gurd and the ICWG.

13. Personnel Safety System Integration – Category X

WBS # 1.9.8.7

- **Proposal Description:**
  Do not integrate the personnel safety system (PPS) with the Global EPICS Control system. (Note: Only a one way – monitoring – interface is planned.)

- **Rationale:**
  Non-integration would save the cost of the hardware interfaces, and more significantly of the associated database and software development.

- **Savings:**
  $160K

- **Schedule Impact:**
  None

- **Related Impact (include operations):**
  Inability to archive safety and operational data together for correlation and reporting.

- **Benefits/Advantages:**
  Construction Cost Savings

- **Risks:**
  Accelerator operators must be constantly aware of the safety issues and conditions during operation. In independent set of control room displays would be needed in any case – probably at comparable cost. Data correlation between systems would be impossible, and this might make necessary reporting (to safety control agencies) more difficult.

- **Actions/Person responsible:**
  Idea was defeated. No further action.

- **Comment from Marty Knott:**
  This capability should continue to be included in the SNS control system. If the PPS is the least bit complex due to the need to allow several different operational modes, the ability to display with EPICS a clear, textual or graphic, explanation of the status and reasons for trips is valuable. In addition, the ability to monitor the PPS status can be used to control EPICS-based scripts so that control is prevented until the PPS status is appropriate.

14. Controls Travel Policy – Category X

WBS #1.9.1

- **Proposal Description:**
  Look at strategies for reducing travel expenses for the ICWG. (See also item #6.)

- **Rationale:**
  The collaborative nature of the controls effort requires many meetings. Can the associated cost be reduced by the use of such tools a phone and video conferences and/or network tools?

- **Savings:**
  Unknown. Requires analysis of current estimates first.

- **Schedule Impact:**
  None

- **Related Impact (include operations):**
  Longer-lasting marriages.

- **Benefits/Advantages:**
  Cost saving

- **Risks:**
  None.

- **Actions/Person responsible:**
  The controls working group already makes effective use of phone conferencing and the free "Netmeeting" software. It is still true that nothing seems as efficient and productive as team meetings. The ICWG will consider combining meetings where possible, but this one will be hard to beat. The special problems of the controls team might be considered in any overall travel strategy developed as a result of item #6 in this list, which was passed to WBS 1.2. Dave Gurd. Carl Strawbridge.

254

Value Engineering Proposals

WBS 1.10 – Pre-Operations

No.	Cat	Proposal Description	Rationale/ Advantage	Impact/ Disadvantage	Risk	Savings (M$)	Recommended action	Comm
1	I	Decrease power on linac dump during commissioning	Smaller dump, cost savings	May limit commissioning flexibility	Low	?	Have 1.4 propose practical linac rep rate, av pwr	Refer t
2	II	Optimize acquis of spares, specialized lab equipment	Could provide some cost savings	Possible insufficient inventory of spares	Med	1<$<5	Prioritize lists from labs	For Jan
3	II	Var. utility/substation contracting options	Lower capital costs	Potential for higher life-cycle costs	High		Explore options, life-cycle effects	Refer t
4	II	Staff plan optimization	Efficient buildup and utilization of staff	Inadequate, poorly-trained staff	High	TBD	Complete commissioning plan	By Jan
5	IV	Reduce power use during commissioning	Save pre-ops power bill	Prolong commiss period, higher failure rate	High	3 M	BAD IDEA	DISMIS
6	IV	"250-year event" recovery strategy	Reduced construction cost		Low	?	Life-safety code reqts more stringent	Refer t

1. Decrease power on linac dump during commissioning (WBS 1.10)

- **Proposal Description:**
  - Reduce size of linac dump can save money, but may limit commissioning flexibility
- **Rationale:**
  - Full-power dump may not be necessary for tuning and commissioning
- **Savings:**
  - TBD, 1.6 should estimate
- **Schedule impact:**
  - None

1. Tune dump size reduction (Cont) ,... WBS 1.10

- **Related impact (including operations):**
  - Will limit flexibility of options for commissioning and tuning. Must evaluate whether tuning at lower rep rate (1 Hz vs 60 Hz), or infrequent burst mode (60 Hz for 1 second every minute) will provide adequate information
- **Benefits/Advantages:**
  - Cost savings
- **Risks:**
  - Loss of flexibility in tuning, commissioning
- **Actions/Person Responsible**
  - REFER TO 1.6
  - 1.4 (Linac) to evaluate risks of lower power commissioning, and assess practical minimum for linac tune dump power rating

2. Optimize Acquisition of Spares, Specialized Lab Equipment (WBS 1.10)

- **Proposal Description:**
  - Careful examination of requested spares inventories, in terms of specific items required, when to acquire and in what quantity.
  - Assigning priorities to each item, and risk to operation of not having sufficient quantities in inventory
- **Rationale:**
  - Optimization process ensures efficient use of project funds
  - Analysis can ensure appropriate stock in inventory to maximize operational up-time
- **Savings:**
  - Preliminary estimate, between 3 to 5 M$ can be saved from TPC.
  - Much will probably just be pushed to Operations.
- **Schedule impact:**
  - TPC savings will NOT affect commissioning, if only low-risk purchases are delayed

2. Spares (Cont) ... WBS 1.10

- **Related impact (including operations):**
  - Delayed purchases will probably have to be made from Operations funds. Except for higher overhead costs, there should be no impact on project completion
- **Benefits/Advantages:**
  - Analysis contributes to optimized spares inventory, reduces inventory of low-risk items
- **Risks:**
  - Graded approach to investment in spares
  - Low-probability failure likely to cause longer recovery time
- **Actions/Person Responsible**
  - STL for Pre-Ops coordinates requests and compiles prioritized lists
  - "Commissioning Team" points of contact at Labs prepare prioritized requests
  - Report ready by January review

3. Various options for Utilities contracting (WBS 1.10)

- **Proposal Description:**
  - TVA to build and lease substation
  - TVA to operate substation
- **Rationale:**
  - Significant capital cost savings possible, though may have deleterious effect on life-cycle costs due to potentially substantially higher operating costs
- **Savings:**
  - Unknown, though probably quite large (>$10M) Figures discussed in 1.8
- **Schedule impact:**
  - Probably none

3. Utilities contracts (Cont) ... WBS 1.10

- **Related impact (including operations):**
  - If electric substation managed by TVA contract, would have impact on staffing and support needs for SNS.
  - Quality of service may be affected, positively or negatively depending on terms of contract and relationships with contractor.
- **Benefits/Advantages:**
  - Savings in capital costs
  - Reduced burden on SNS maintenance staff if substation maintained by TVA
- **Risks:**
  - Locked in to long-term relationship with TVA, would most probably be unable to avail ourselves of cheap power in event deregulation hits TN.
  - Higher power costs owing to need to repay for substation construction
- **Actions/Person Responsible**
  - Refer to 1.8
  - 1.10 RECOMMENDS AGAINST THIS

4. Staffing Plan Optimization (WBS 1.10)

- **Proposal Description:**
  - Revisit Pre-Ops staffing plan to look for possible savings by reducing staff or delaying start-dates for staff
- **Rationale:**
  - Staffing plan has not been revised in over a year, possibility exists that present plan may be optimized to streamline staff needs and start-dates
  - Note: Preliminary look indicates unlikelihood of net savings: areas identified as fat may be trimmed to fill other areas identified as insufficiently staffed.
- **Savings:**
  - TBD, most likely none
- **Schedule impact:**
  - Could be very significant if staff is not available for installation, commissioning in a timely fashion

4. Staff plan optimization (Cont) ... WBS 1.10

- **Related impact (including operations):**
  - Insufficient staff, or staff that has had insufficient time for adequate training could be a serious detriment to efficient operation of the facility.
- **Benefits/Advantages:**
  - Reduced cost
- **Risks:**
  - Very high to efficient operation
- **Actions/Person Responsible**
  - Commissioning plan must be completed (Alonso, Cleaves)
  - Staffing plan will be completed by January review

5. Reduce power use during commissioning (WBS 1.10)

- **Proposal Description:**
  - Operate linac at lower repetition rate to reduce total power consumption
  - Reduce number of shifts used in commissioning (i.e. shut off nights/weekends)
- **Rationale:**
  - Possible reduction in peak power demand could save significant power costs
  - Reduced total GWH consumption also saves on power bill
- **Savings:**
  - Possible savings of $1M to $3M
- **Schedule impact:**
  - Could delay commissioning by unacceptable time period

5. Reduced power use (Cont) ... WBS 1.10

- **Related impact (including operations):**
  - Running at lower repetition rate could mask problems that might occur at full rep rate, causing delays, breakdowns during operations. This would be unacceptable.
  - Shutting down causes loss of thermal stabilization, provides more stress on components due to thermal cycling, leading to increased failures
- **Benefits/Advantages:**
  - Reduces power bill
- **Risks:**
  - Increases failure probabilities
  - Possible extensions in commissioning time, high schedule risk
- **Actions/Person Responsible**
  - Recommend to DISMISS this concept

6. Re-examine "250-year event recovery strategy" (WBS 1.10)

- **Proposal Description:**
  - Review specification in Design Requirements for maximum 2-week recovery from 250-year event.
- **Rationale:**
  - This requirement could be placing excessive demands on structural designs, adding possibly unneeded costs
- **Savings:**
  - Unknown
- **Schedule impact:**
  - Unknown, probably none

6. Re-examine "250-year event recovery strategy" (Cont) ... WBS 1.10

- **Related impact (including operations):**
  - None, unless design changes did cause excessively long recovery times
- **Benefits/Advantages:**
  - Possible reduction in construction costs
- **Risks:**
  - Technical components: low risk – Structure support specifications required by life-safety codes are sufficient to ensure little or no impact from a 250-year event that would affect the SNS located in Oak Ridge.
  - Structural components, buildings: unknown risk, should be evaluated by Conventional Facilities
- **Actions/Person Responsible**
  - Transfer to 1.8

CONTACT DIRECTORY

Spallation Neutron Source
Appendix A - Contact Directory

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Appendix B

Speculation Lists (Annotated through Analysis Phase)

SPECULATION

WBS 1.2 – PROJECT SUPPORT

✓ 1. Apply new special overhead rates from ORNL
✓ 2. Movement of staff from other labs/ organizations into the SNS Division to get lower rates
✓ 3. Reduction in materials and travel costs (fewer planned meetings)
✓ 4. Staffing review to review staff costs
✓ 5. Budget for Advisory Committee
✓ 6. Look at peak demand rate for power during commissioning (i.e. floating 30-day) (WBS 1.10)
✓ 7. Initiate negotiated utility contract **(WBS 1.10)**
✓ 8. Consider connection charge for switchyard go to building (include term) **(WBS 1.10)**
✓ 9. Minimize number of meetings/combine meetings **(Sec. No. 3)**
✓ 10. Procurement strategy – **share contracts**
✓ 11. Look at size of master schedule and work levels to maintain it

WBS 1.2 – PROJECT SUPPORT

✓ 12. Optimize staffing for central PM and each PM

✓ 13. Cap staff – avoid layoffs

SPECULATION

WBS 1.3 – FRONT END

✓ **Develop idea; x = delete**

x 1. Start with 14-day continuous operation – go to 21-day. **Comment evaluation**

✓ 2. Do not build prototype RFQ ($620K) (integrated testing)

✓ 3. Cut tech support to Pre-Ops in (FY04) $540K. **Develop service contract**

✓ 4. Delay building for 4 MW up – grade (Ref. 1.8). Optimize footprint – building shorter

✓ 5. Revisit height of front end building **(Defer to conventional facilities, WBS 1.8)**

✓ 6. Identify savings for transfer of klystron system (1 GBT) (Ref. 1.4)

x 7. Get rid of MEBT – extend LEBT. **Comment with issues, schedule, etc.**

x 8. Revisit question of chopper and anti-chopper. **High risk/low return, $100K**

✓ 9. Standardize vacuum system project-wide

✓ 10. Raise voltage on MEBT chopper

WBS 1.3 – FRONT END

✓ 11. Look at standardization diagnostics for front end and linac

✓ 12. Additional spare ion source on-site (have 2; go to 3). **Benefits – Doesn't have to be a construction item**

✓ 13. Revisit need for front end control room **(WBS 1.8 action item)**

x ~~14. Buy Frankfurt source~~

✓ 15. Buy 19-inch racks project-wide

SPECULATION

WBS 1.4 – LINAC

✓ **Develop idea; x = delete idea**

✓ 1. IGBT - $8.1M
✓ 2. Overheads and taxes - $19.7M (**$14**)
✓ 3. 52 Klystrons - $10.1M (1.8)
✓ 4. Brazing - $1M
✓ 5. Quantity discounts - $3.1M
x 6. Eliminate beam and gap - $
Comment
x 7. Eliminate bunch rotator - $3.4M
✓ 8. Eliminate misc. diagnostics - $1M – **Modify use LEDA - $200,000**
✓ 9. Reduce energy to 975 MeV - $4.4M
Issues
✓ 10. Review FNAL manufacturing techniques – $?

Total $52M

✓ 11. Rough machine copper for free - $16M
✓ 12. Review conventional facilities for linac tunnel **(WBS 1.8)**

WBS 1.4 - LINAC

✓ 13. Reduce tunnel width **(linac controls WBS 1.8 design)**

✓ 14. Consider having stands made in Knoxville area – reduce shipping

✓ 15. Use existing surplus equipment for 402 klystrons/modulators
Comment – low return

✓ 16. Reduce bore by 1 mm

✓ 17. Consider dropping beam height from 5 ft. to 4 ft.

✓ 18. Reduce number of vacuum pumps – (add later **if required**)

x 19. Consider alternatives for ion pumps (NEG)

x 20. Consider bidding vacuum system design outside lab to equipment vendors – **Being considered**

✓ 21. Combine all vacuum design into one activity

✓ 22. Optimize linac berm shielding (Sec. 1.8)

x 23. Change to superconductor
Comments

x 24. Permanent magnets
Comments

✓ 25. Revisit startup time/improvement
Comments

WBS 1.4 - LINAC

x 26. Revisit number of escape hatches for shorter tunnel

✓ 27. Consider precast construction for tunnel **(WBS 1.8)**

✓ 28. Optimize waveguide runs **(Sec. 30 and 31)**

✓ 29. Look to reducing requirements for linac dump **(WBS 1.6)**

✓ 30. Consider changing geometry waveguide to 45° **(Sec. 31)**

✓ 31. Optimize linac tunnel elevation with klystron gallery

✓ 32. **Optimize** AC from klystron gallery **(Examine AC requirements)**

SPECULATION

WBS 1.5 – RING AND TRANSPORT

✓ 1. HEBT Corrector Dipole
✓ 2. HEBT Corrector P.S.
✓ 3. HEBT Beam Position Monitor
✓ 4. RF Cavity
✓ 5. RF Power Amplifier
✓ 6. RTBT Corrector Dipole
✓ 7. RTBT Corrector P.S.
✓ 8. RTBT Beam Position Monitor
✓ 9. Software Support
✓ 10. Extraction Kicker Magnet
✓ 11. Extraction Kicker P.S.
✓ **11a. Make all extraction kicking identical**
✓ 12. Septum Magnet
✓ 13. HEBT & RTBT Control
✓ 14. Sample testing of the production magnets
✓ 15. Provide ½ the number of ion pumps
✓ 16. Eliminate cranes in HEBT and RTBT transfer lines (access ports through roof at collimator locations)
✓ 17. Reduce the width of the ring tunnel – 18 ft. to 16 ft. (keep crane)

WBS 1.5 – RING AND TRANSPORT

✓ **17a. Reduce number of shields (moveable)**
✓ 18. **Consider** fabricate/assemble magnets in ~~Russia/China~~ **other countries**
✓ 19. Shorten RTBT
x 20. Eliminate HEBT – no 90° bend
Comments – schedule
✓ 21. Shorten HEBT by 6 meters
✓ 22. Reduce aperture for HEBT
✓ 23. Consider purchase of HEBT magnets by functional specs.
x 24. Use RCS
✓ 25. Don't stub out in HEBT and RTBT (WBS 1.8)
✓ 26. Revise escape hatch – bring out on grade (WBS 1.8)
✓ 27. Consider design changes suggested by ASAC
✓ 28. Have all stands fabricated in Tennessee
✓ 29. Consider fully Value Engineering magnet measurement needs **(covered under 14)**
x 30. Consider rectangular end dipoles
✓ 31. Defer/eliminate action damper
✓ 32. Optimize ring/berm shielding
x 33. Permanent magnets vs electric
✓ 34. Reconsider need for clean room

WBS 1.5 – RING AND TRANSPORT

✓ 35. Unify some diagnostics
x 36. Consider removing beam and gap from ring (not presently in ring)
✓ 37. Consider fabrication of all shielding/ collimators in Tennessee. **Comments**
✓ 38. Fabricate RTBT entirely from ring components
✓ 39. Lower beam height from 5 ft. to 4 ft.
x 40. Lower ring elevation relative to linac
✓ 41. Coordinate survey and alignment between systems and move responsibility to Oak Ridge
✓ 42. Add radiation barriers in HEBT
x 43. Revisit ring gate valves
✓ 44. Take ring crane out **(WBS 1.8) Transporter required**
✓ 45. Revisit overhead charge/tax at labs
✓ 46. Move tech support/PM to line items
✓ 47. Negotiate Tennessee tax
✓ 48. Revisit staff overlaps between ORNL and labs

SPECULATION

WBS 1.6 – TARGET SYSTEMS

x 1. Size Hg Heat Exchanger for 1 MW
✓ 2. Use Y-12 Hg
✓ 3. Use same tank for Hg storage and spill collection **(Recovery issue)**
✓ 4. Eliminate variable speed hydrogen circulator
x 5. Eliminate on-line replacement capability for hydrogen circulators
✓ 6. Use recycled lead for reflector assemblies
✓ 7. Use TV viewing in lieu of shield windows: however, retain at least one shield window
✓ 8. Use the TTF Model F manipulators for SNS: can allocate one or both pairs to SNS
x 9. Eliminate the PLC development system **(Look into later)**
x 10. Restrict access to the area immediately above target and reduce roof shield
✓ 11. Use lower cost cast concrete for shielding with dense recycled metal as aggregate
x 12. Eliminate the ring extraction dump **(Could extend schedule)**

WBS 1.6 – TARGET SYSTEMS

✓ 13. Reduce the power and duty factor on all three dumps **(Specification – power and duty factor)**

x 14. Combine the secondary cooling systems for the three dumps

✓ 15. Eliminate high velocity erosion/corrosion tests

✓ 16. Eliminate CALOR V&V Analysis of Accelerator Experiments **(partially affected by 18)**

✓ 17. Eliminate Project R&D Technical Support

✓ 18. No irradiation-flowing Mercury

✓ 19. Locate used cryo limit (WBS 1.8)

x 20. Reduce shielding to 2 MW

✓ 21. Revisit Cat. 2 vs Cat. 3

✓ 22. Optimize shielding

✓ 23. Look at solid target option (fall back option) **Comment issues**

✓ 24. Look into secondhand equipment on hot cell

x 25. Revisit moderators vertical vs horizontal **Comments**

✓ 26. Revisit model or mock-up for assemblies

✓ 27. Hold/defer cryo until operating (2005) ($9M).

WBS 1.6 – TARGET SYSTEMS

✓ 28. Use Berkeley steel for instrument shielding **(WBS 1.7)**

x 29. Omit PLC operation interface

✓ 30. Consider liquid nitrogen for cooling of moderator

✓ 31. Look at diagnostic in front of proton beam window (WBS 1.5)

✓ 32. Revisit effects on beam profile

SPECULATION

WBS 1.8 – CONVENTIONAL FACILITIES

✓ 1. Revisit height and footprint of front end building (Front End No. 5)
✓ 2. Revisit need for front end control room (Front End No. 13)
✓ 3. Review conventional facilities for linac tunnel (Linac No. 12)
✓ 4. Reduce tunnel width (Linac No. 13) **(Review construction interface)**
✓ 5. Optimize linac berm shielding (Linac No. 22)
✓ 6. Consider precast construction for tunnel (Linac No. 27)
✓ 7. Eliminate cranes HEBT and RTBT (Ring No. 16)
✓ 8. Reduce width of ring tunnel – 18 ft. to 16 ft. (Ring No. 17)
✓ 9. Don't stub out HEBT and RTBT (Ring 25)
✓ 10. Revise escape hatch – bring out to grade (Ring 26)
✓ 11. Take ring crane out (Ring No. 44)

WBS 1.8 – CONVENTIONAL FACILITIES

✓ 12. Defer upgrade capability **(Exterior/interior)**

x 13. Eliminate F.P. sprinklers in tunnels

x 14. Eliminate smoke detection in the instrument hall

✓ 15. Use above ground vs underground power distribution **(Risk issues)**

✓ 16. Eliminate Predictive Maintenance System **(Defer/risk)**

✓ 17. Eliminate tunnel HEPA filters

✓ 18. Move Business Computing System to ORNL

✓ 19. Optimize equipment location in Target Bldg. to reduce volume

✓ 20. Reduce or simplify east end of experiment hall to minimize the transfer aisle, labs, entrances, exits, etc.

✓ 21. Contract w/TVA to build and operate switch house

✓ 22. Contract w/TVA to build and operate 161kV substation

✓ 23. Reduce length of RTBT tunnel by 20.4 m

✓ 24. Eliminate (reduce) visitor gallery in Target Bldg.

WBS 1.8 – CONVENTIONAL FACILITIES

x 25. Eliminate piping, power, HVAC, etc. for the unused instrument trenches in guide hall

✓ 26. Eliminate the 30 ton x 20 ft transfer crane in Target Bldg.

✓ 27. Minimize AC in Shops

✓ 28. Modify tunnel construction (Precast)

✓ 29. Optimize beam/tunnel elevation

x 30. Provide north side vs south side access to the site

✓ 31. Reduce cryogenic He loads to just the 1 MW demands on 2 moderators

✓ 32. Reduce linac length by 20 m **(28 meters, reduce 1 MW)**

✓ 33. Reduce the target floor loading from 22,000 psf to 15,000 psf

✓ 34. Use gantry crane vs bridge crane in Klystron Shop

✓ 35. Use reinforced earth vs cast-in-place retaining wall behind Klystron Building

✓ 36. **Optimize** access from the west/left Front End Bldg.

x 37. Relocate SNS to JINS site – **Comment**

✓ 38. Relocate to breeder site – **Comment**

WBS 1.8 – CONVENTIONAL FACILITIES

✓ 39. Early construction of shop and maintenance facilities for use by contractors **(Office building area)**

✓ 40. Ask Tennessee to pay for building as partial rebate of taxes

✓ 41. Use geotextiles for ground water control around tunnel

✓ 42. Minimize haul to disposal site

x 43. Optimize excavation by canting beam line

✓ 44. Combine office and control buildings

✓ 45. Combine scientific building with office building

x 46. Use existing facilities for maintenance shops (at ORNL)

x 47. Consider elimination of one access road (west?/power supply)

✓ 48. Eliminate translucent roof panels on Target Bldg.

✓ 49. Review office space requirements

✓ 50. Combine any other techs in office building

✓ 51. Revisit all ideas addressing the Target Building

✓ 52. Look into secondhand equipment items

WBS 1.8 – CONVENTIONAL FACILITIES

✓ 53. Obtain early preliminary foundation report of all buildings/tunnel
✓ 54. Review parking spaces
✓ 55. Reexamine real needs for HVAC/humidity control in each IDD
✓ 56. Look at relocation of parking and cooling towers
✓ 57. Provide horizontal personnel and equipment access to linac tunnel from south
✓ 58. Review location of User Target Operation Building
✓ 59. Reevaluate settlement criteria

SPECULATION

WBS 1.9 – CONTROLS

x 1. Do not integrate **x(1.a.)** target or **x(1.b.)** conventional facilities

x 2. Reduce application programming

✓ 3. PC-based IOC's

✓ 4. **Revisit/optimize** UPS requirements **(WBS 1.8)**

x 5. Reduce standard setting effort (R&D)

✓ 6. **Reduce cost** software development system – **Use existing**

✓ 7. Build JINS early enough to accommodate cost during installation

✓ 8. Cabling strategy - **$ savings**

✓ 9. Predictive Maintenance System Interface (WBS 1.9.8.6)

x 10. Personnel Protection System Interface (WBS 1.9.8.7)

✓ 11. Business Computing System Interface (WBS 1.9.8.8)

✓ 12. Specify digital interface for power supply, pumps, ion pump controller

x 13. Travel issues or problems **(Refer to WBS 1.2 strategy item)**

WBS 1.9 – CONTROLS

✓ 14. Do early interface with application programs

SPECULATION

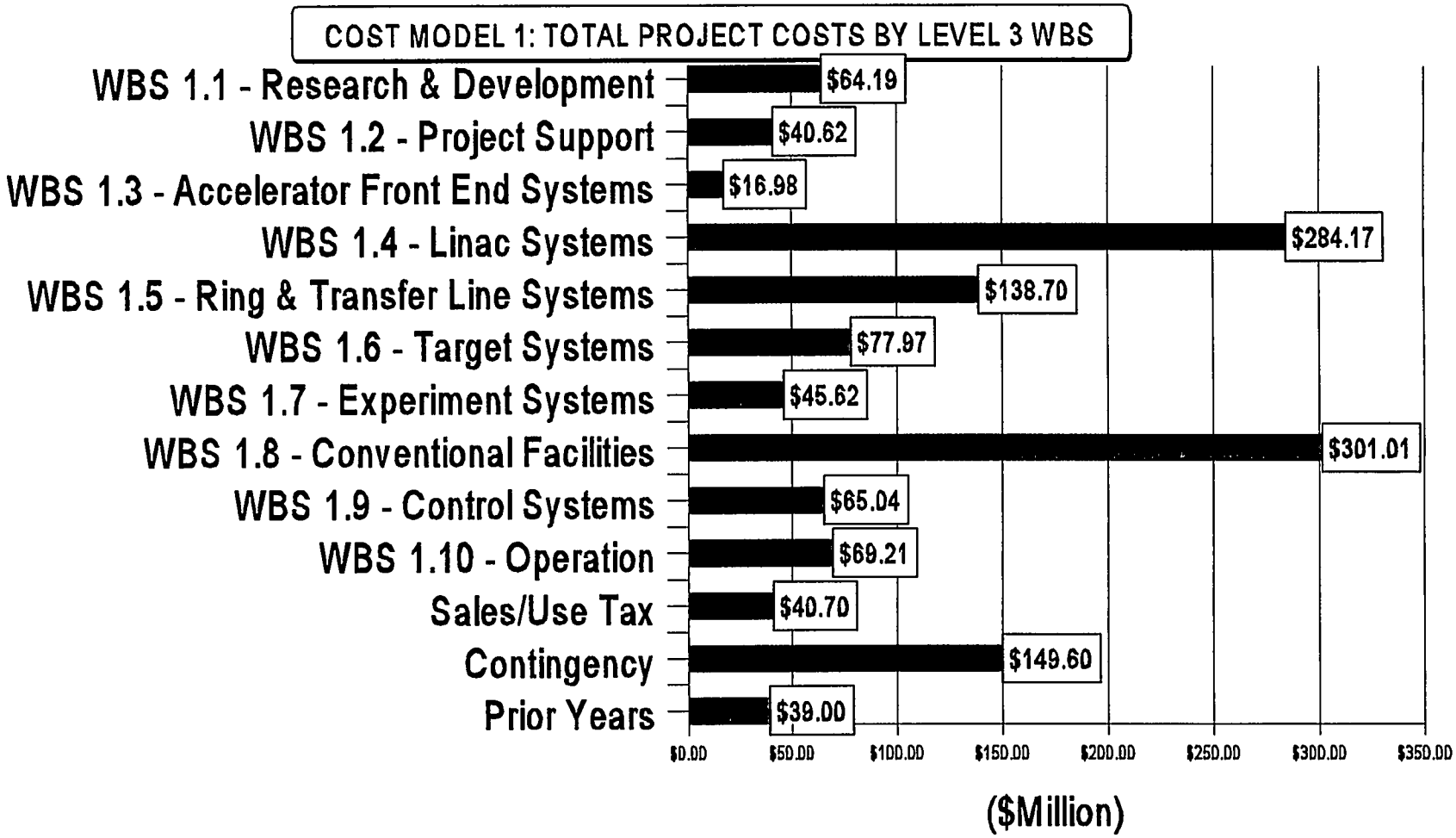
WBS 1.10 – OPERATIONS (Pre-Ops)

✓ 1. Spares – **Prioitize look to reliability and costs**
✓ 2. Specialized lab space – **duplications**
x 3. Utilities
✓ 4. Staffing – **Optimize – See 5, 6, 7**
✓ 5. Reduce duplication in each lab Pre-Ops staff
✓ 6. Hire operators early – participate in assembly (maintenance personnel also)
✓ 7. Coordinated early hiring for (Phys/Engrs) labs/ORNL to carry over into SNS
✓ 8. What is the cost for **2-week** recovery for 250-year event? **(Coordinate period project wide)**
✓ 9. Privatize operation

Spallation Neutron Source
Appendix C

Cost Models

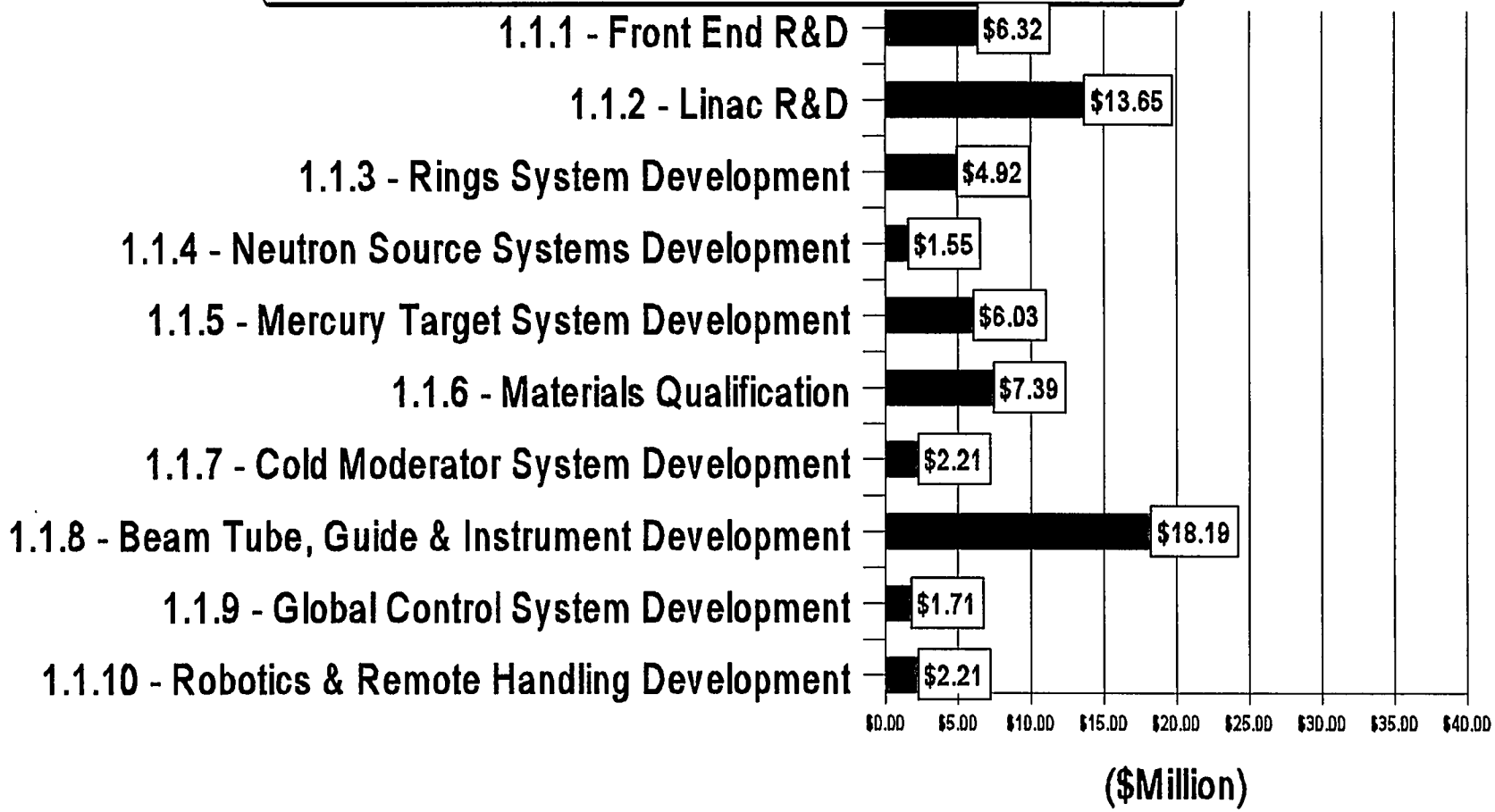
SPALLATION NEUTRON SOURCE



TOTAL COSTS -- $1.332 BILLION

SPALLATION NEUTRON SOURCE

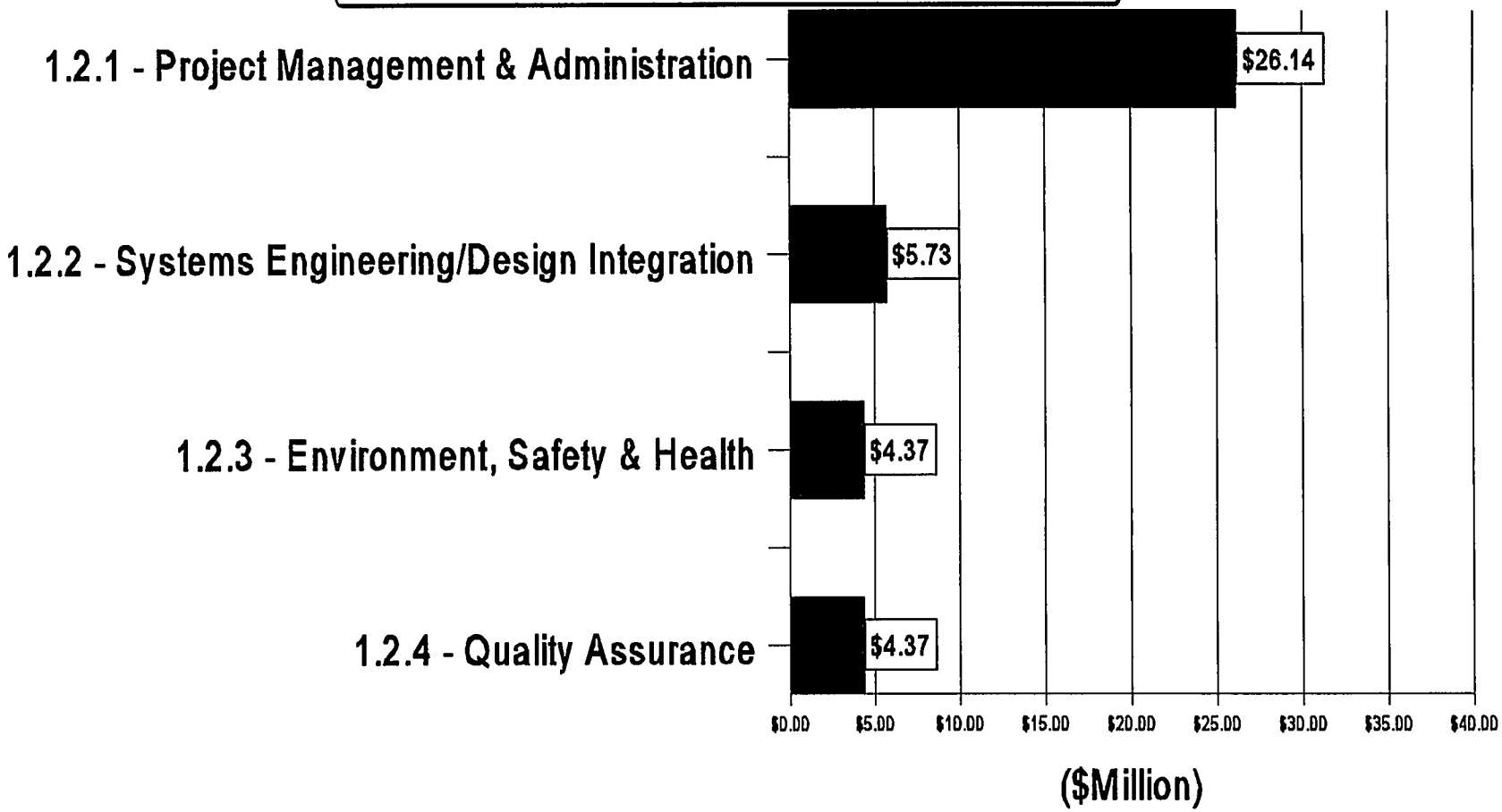
COST MODEL WBS 1.1: RESEARCH & DEVELOPMENT LEVEL 3



SUBTOTAL COSTS - $64.19 Million

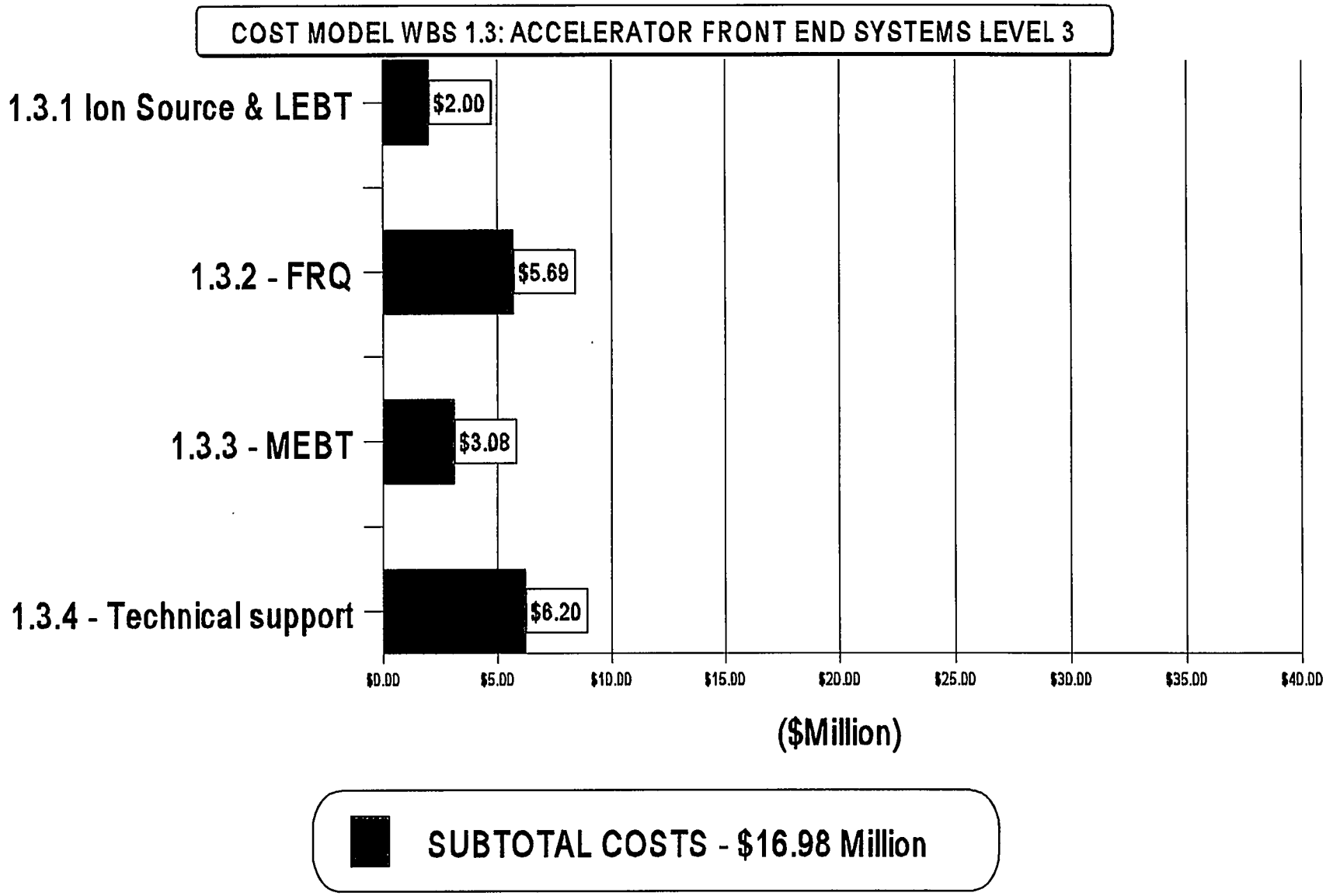
SPALLATION NEUTRON SOURCE

COST MODEL WBS 1.2: PROJECT SUPPORT LEVEL 3

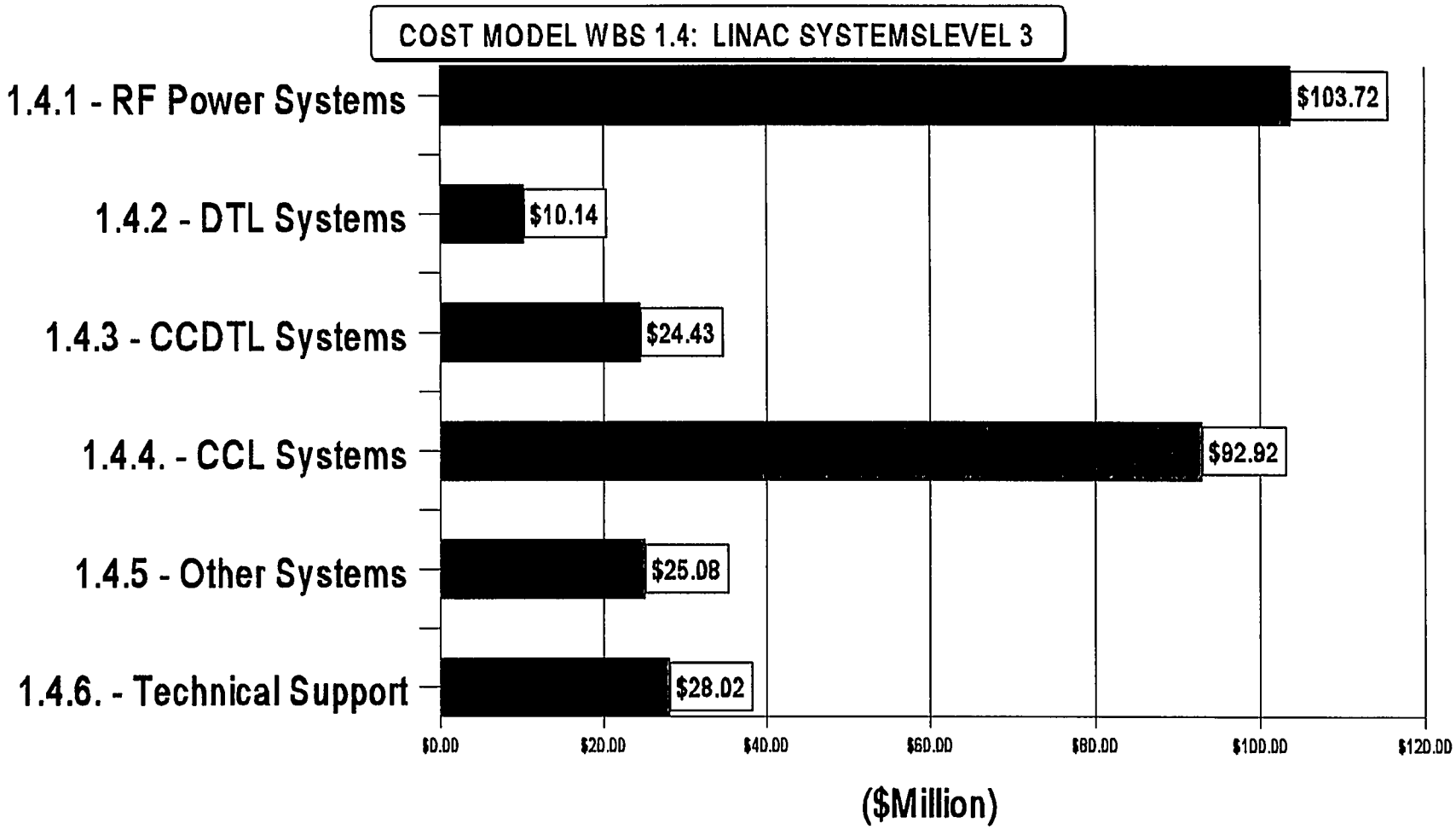


SUBTOTAL COSTS - $40.62 Million

SPALLATION NEUTRON SOURCE

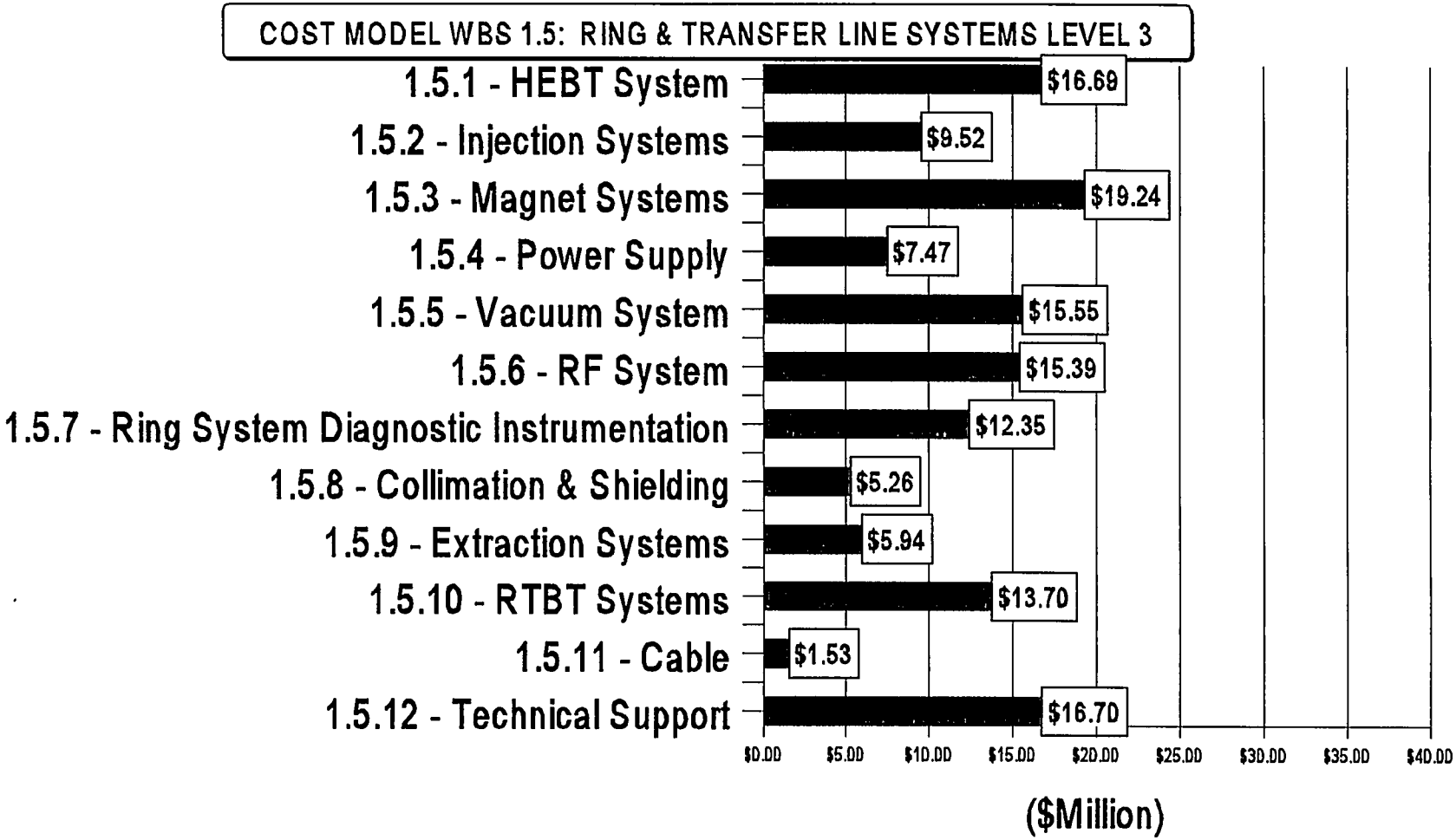


SPALLATION NEUTRON SOURCE



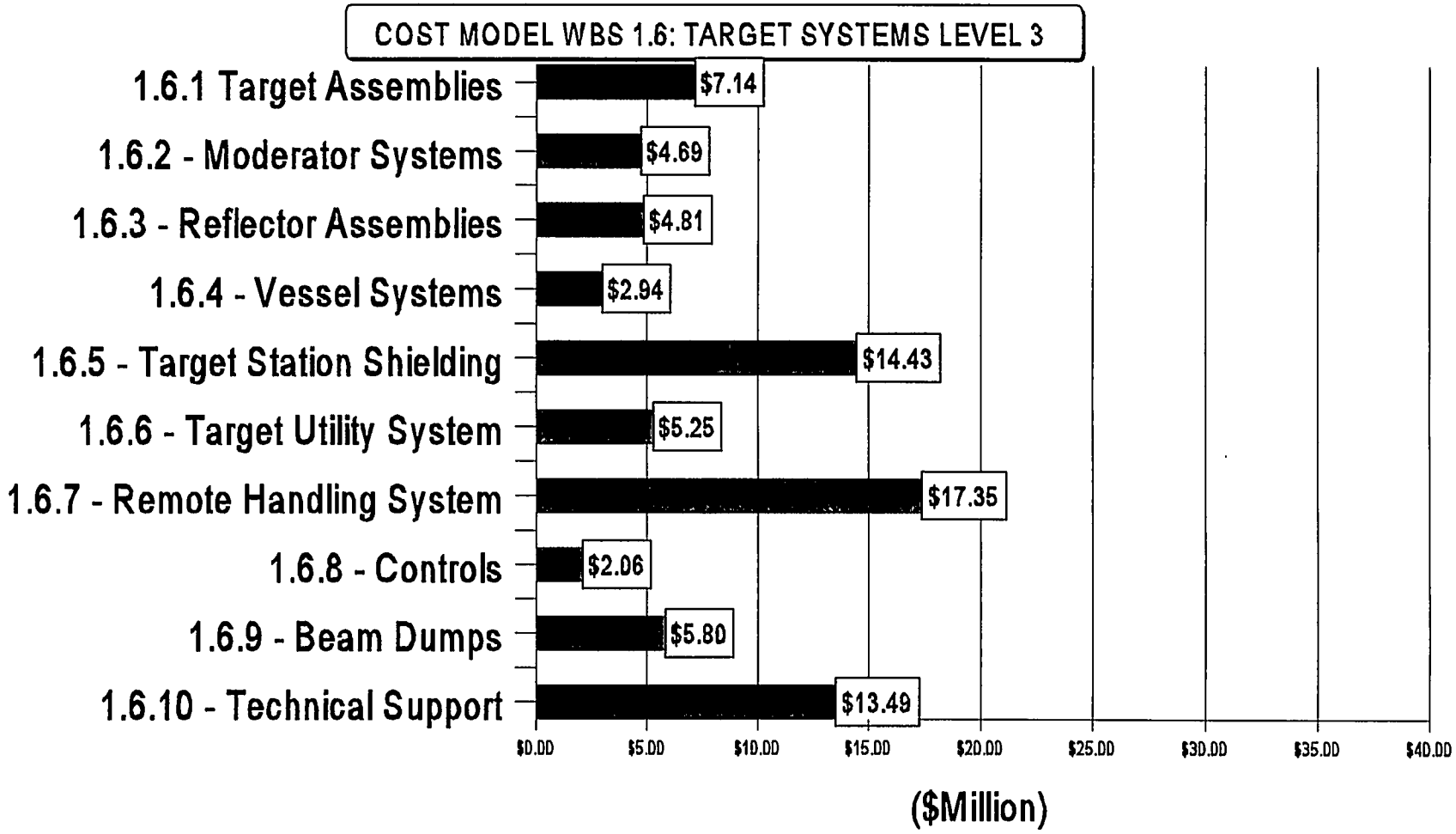
SUBTOTAL COSTS - $284.17 Million

SPALLATION NEUTRON SOURCE



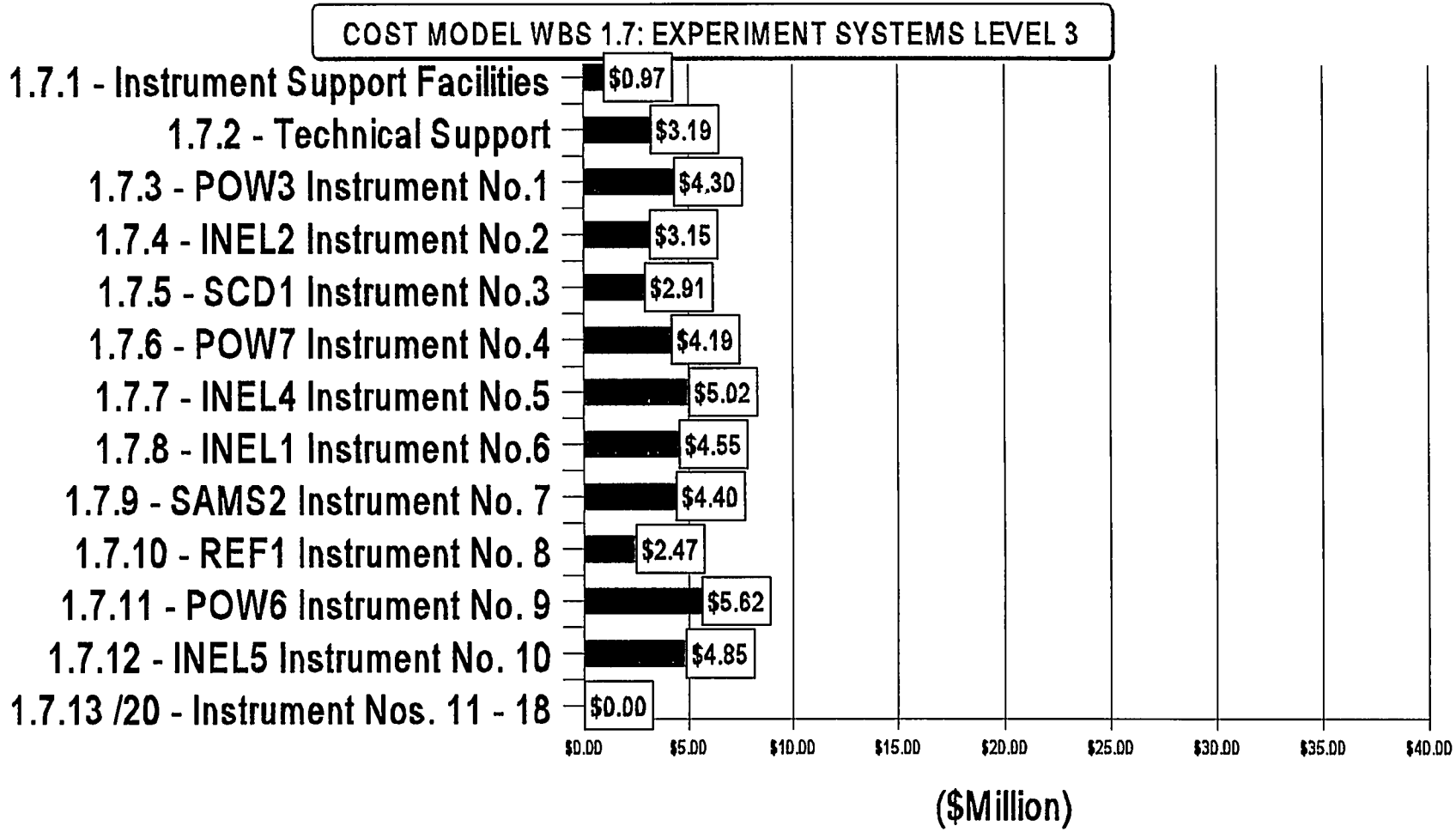
SUBTOTAL COSTS - $138.7 Million

SPALLATION NEUTRON SOURCE



SUBTOTAL COSTS - $77.97 Million

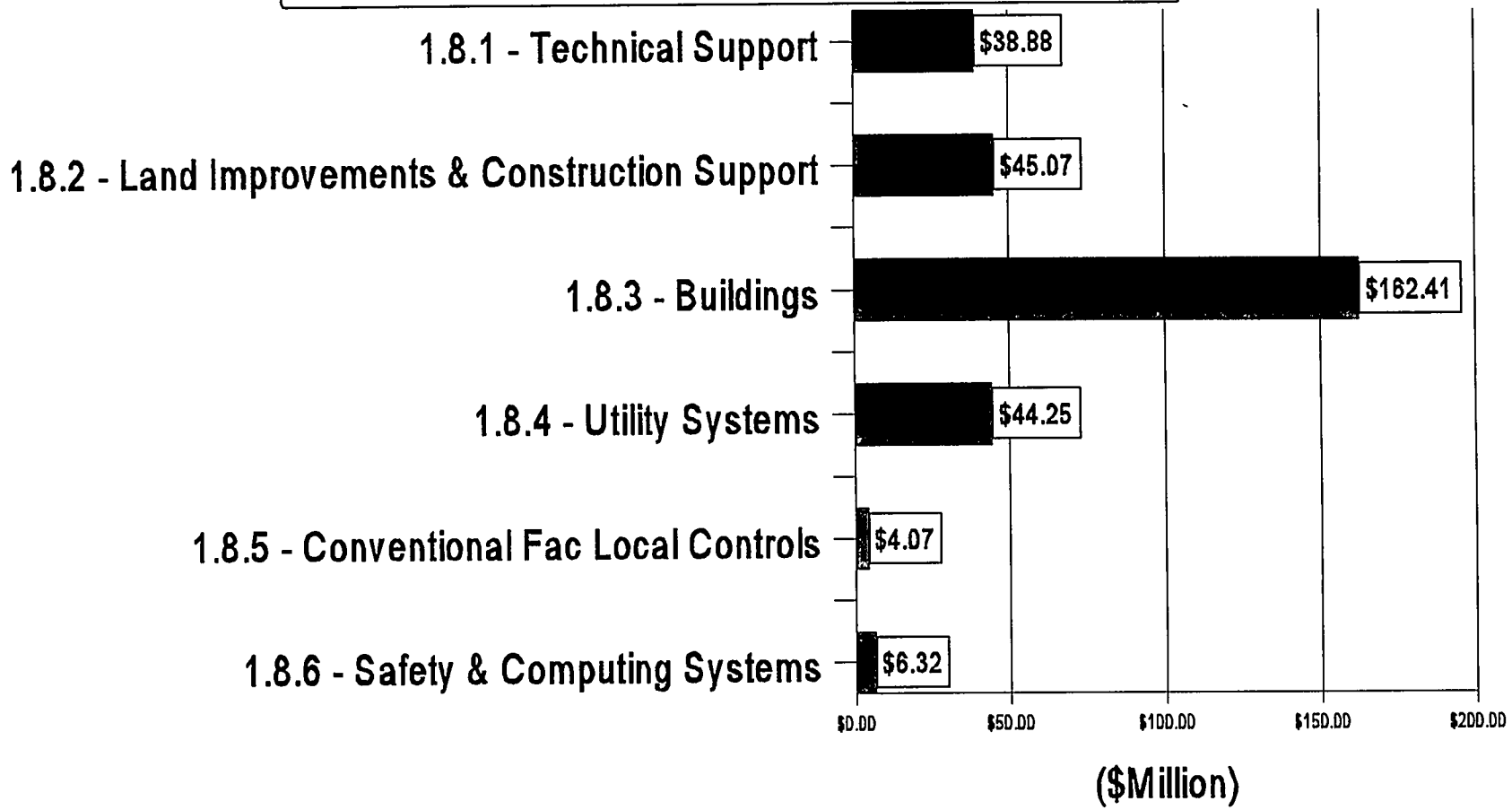
SPALLATION NEUTRON SOURCE



SUBTOTAL COSTS - $45.62 Million

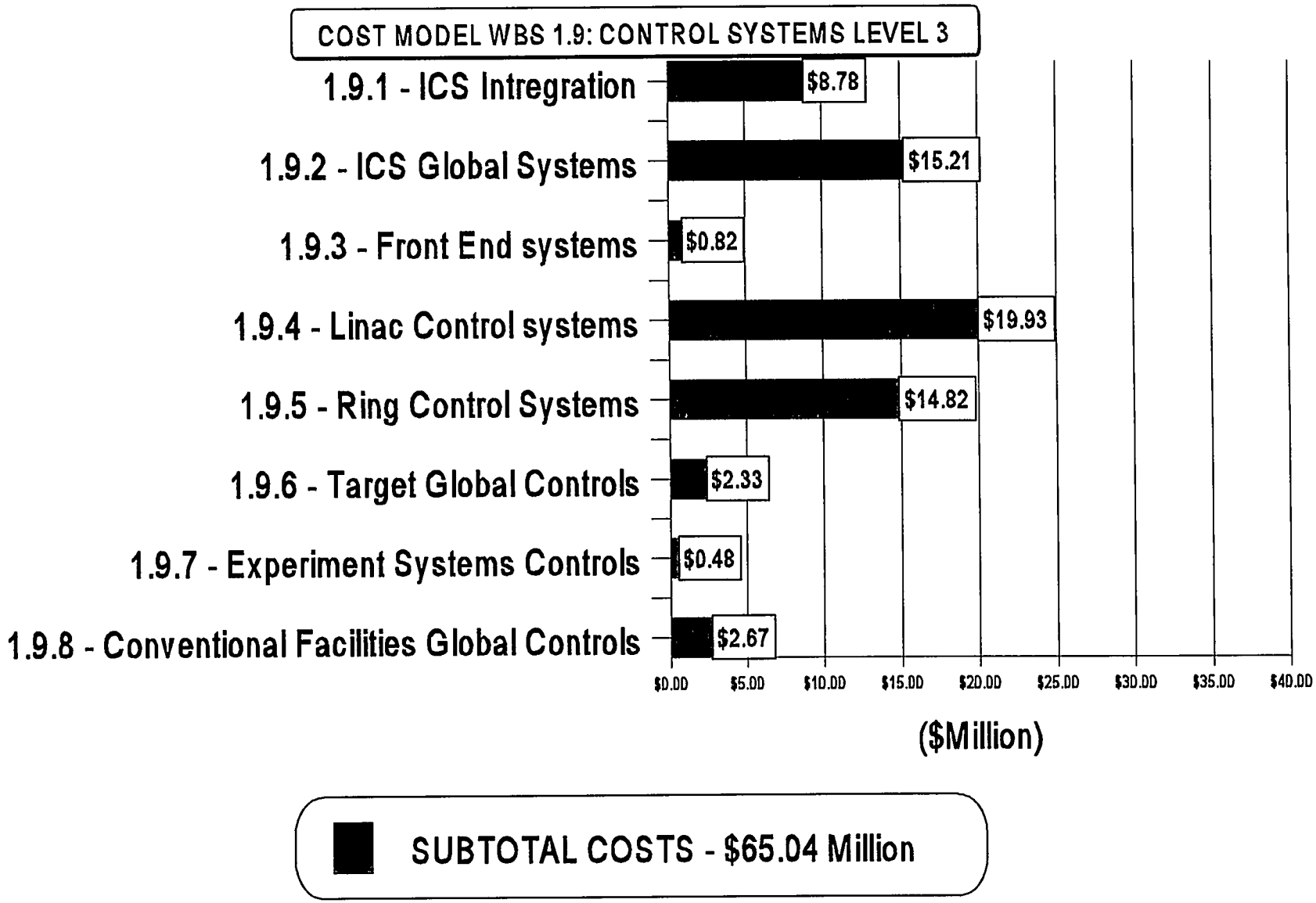
SPALLATION NEUTRON SOURCE

COST MODEL WBS 1.8: CONVENTIONAL FACILITIES LEVEL 3

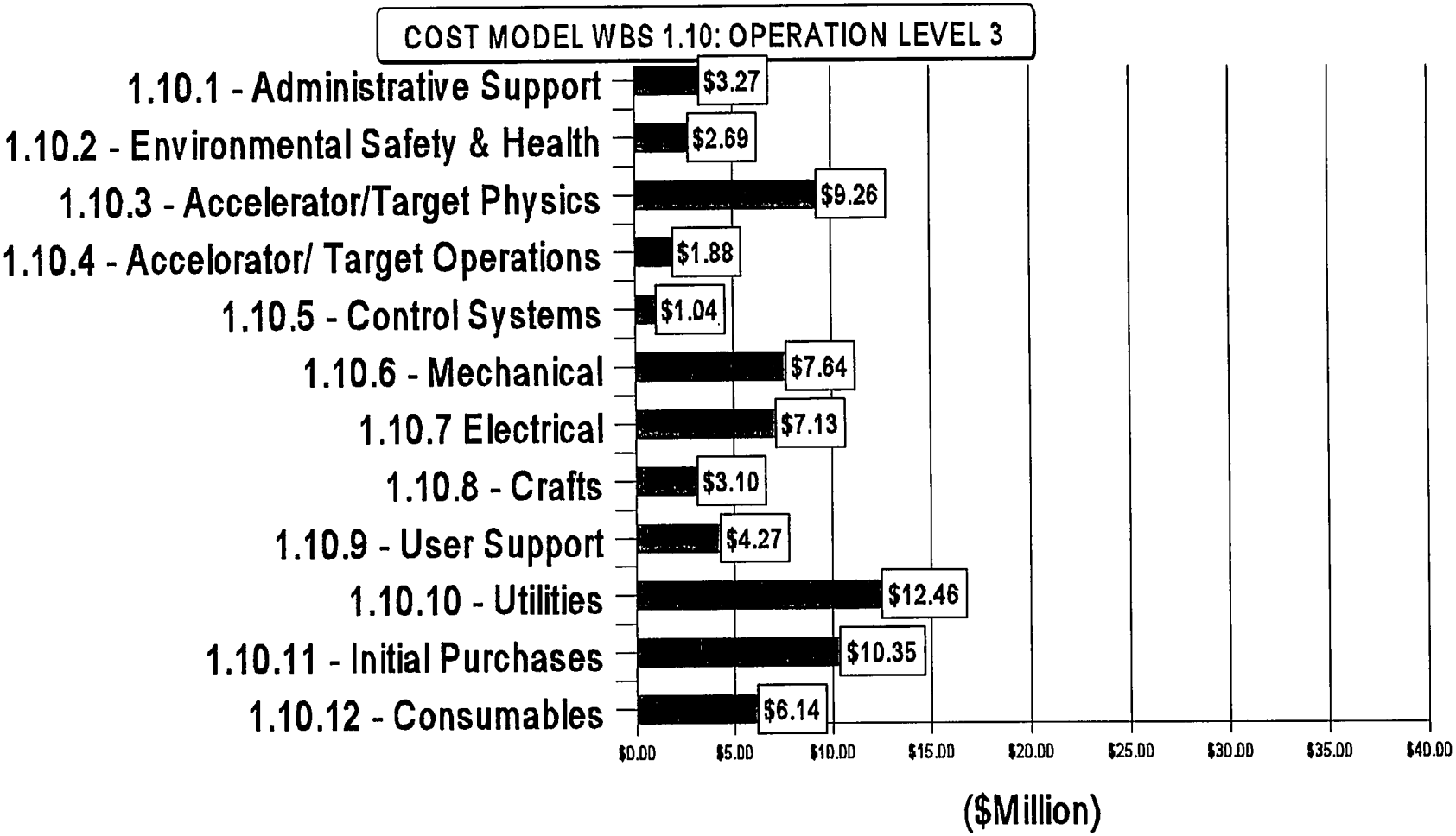


SUBTOTAL COSTS - $301.01 Million

SPALLATION NEUTRON SOURCE



SPALLATION NEUTRON SOURCE



SUBTOTAL COSTS - $69.21 Million