

Facilities Status

Mark Coles

March 31, 1998
G980046-00-F

Mark Coles



Topics Presented

- Status of facilities construction, installation, and commissioning at each site
- Remaining work to be accomplished
- Cost evolution summaries for civil construction, beam tube, and vacuum equipment

Overview

- Facilities scope:
 - Buildings and site infrastructure
 - Beam tubes, enclosures, support slabs
 - Vacuum chambers, pumps, valves, purge air system
 - Work is primarily done through a few major subcontractors (beam tube, vacuum vessels) and many smaller ones (surveying, baffle fabrication, etc.)
- Work is 88% complete
- Work scope and budget have remained stable (<5% cost growth) through design, fabrication, installation, and test phases.
- Remaining work is primarily for installation and acceptance at Livingston site.

Civil Construction - Hanford

- Now have beneficial occupancy for all buildings, but have not yet accepted all of the subsystems. Need to complete HVAC vibration testing.
- LIGO staff occupancy since September 97
- Punch list established
 - 38 of about 1000 items remain
 - 96% complete
 - (all remaining items are fit and finish, mostly waiting on replacement parts)
- Site infrastructure status
 - Roads, parking lots, landscaping installed

Hanford remaining items

- Water system needs to be completed
 - re-engineer potable water system to integrate pumps and holding tanks with keep full control
 - obtain state operating permits for potable water and sewage system
- Complete HVAC remote control on mid and end stations (underground cable installation)

Hanford- remaining work ctd

- Submit as-built documentation
- Training for HVAC system
 - Expect these items complete by June 1
- Clean storage and staging building
 - Complete design and construct
 - Design complete mid April
 - Start construction June
 - Finish construction before 3/99
- Sub-system acceptance
 - Specification require verification of ambient acoustic and structural vibration levels

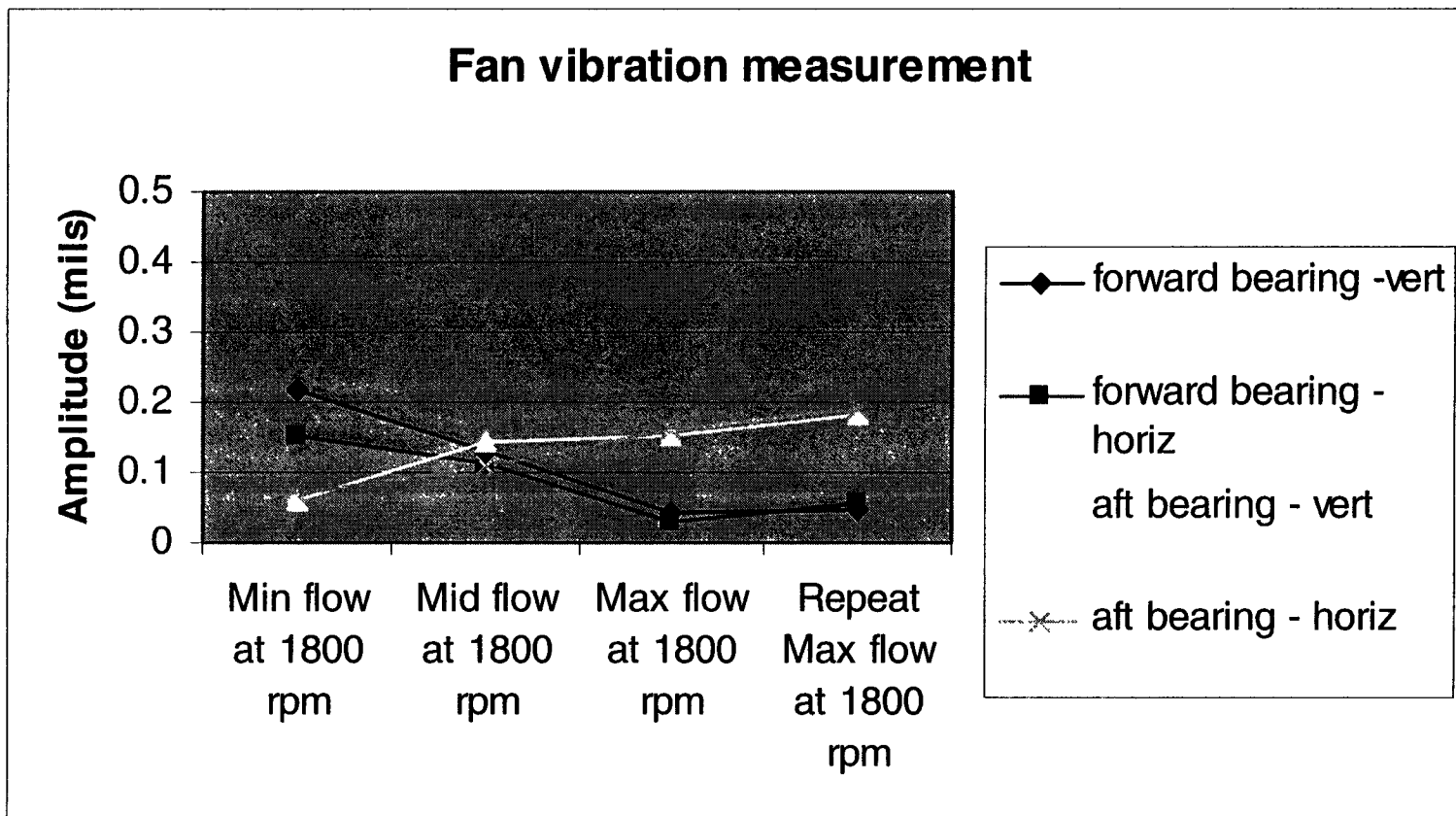
LIGO Verification Testing, and Operational Demonstration Matrix

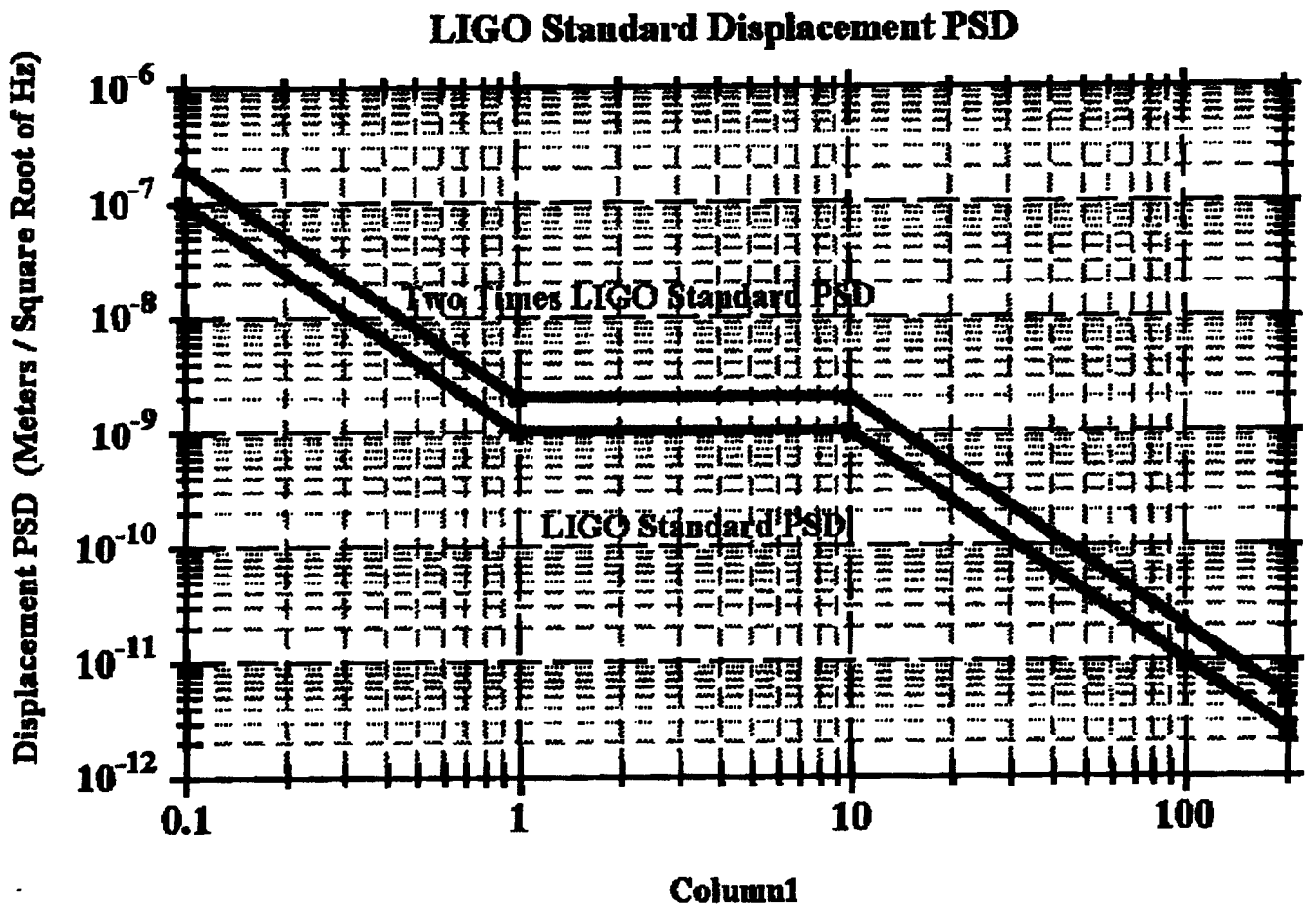
Item	Furnished By	Installed By	Hydro-Test	Shop Certification	Site Performance Test	Site Operational Demonstration	Vibration Test	Acoustics Test	RFI Emissions	Air or Hydro Balance Certification	Rotational Check	Electrical Continuity Check	Electrical Isolation Check	Electric Ground Check
Bridge Cranes	Construction Contractor	Construction Contractor		Yes	Yes	Yes					Yes	Yes		Yes
Mono Rails	Construction Contractor	Construction Contractor		Yes	Yes	Yes						Yes		Yes
Supply Fans	Construction Contractor	Construction Contractor		Yes	Yes	Yes	Yes	Yes		Yes	Yes			Yes
Cooling Coils	Construction Contractor	Construction Contractor	Shop	Yes		Yes				Yes				
Chiller Units	Construction Contractor	Construction Contractor	Shop	Yes		Yes	Yes			Yes	Yes	Yes		Yes
Humidifiers	Construction Contractor	Construction Contractor		Yes	Yes	Yes						Yes		Yes
Electric Heater	Construction Contractor	Construction Contractor		Yes	Yes	Yes						Yes		Yes
HVAC Air Distribution	Construction Contractor	Construction Contractor				Yes		Yes		Yes				
Chilled Water Piping	Construction Contractor	Construction Contractor	Site			Yes	Yes			Yes				
Domestic Water Piping	Construction Contractor	Construction Contractor	site			Yes						Yes		
Chilled water Pumps	Construction Contractor	Construction Contractor		Yes	Yes	Yes	Yes			Yes	Yes	Yes		Yes
Fire Pumps	Construction Contractor	Construction Contractor	Shop	Yes	Yes	Yes	Yes				Yes	Yes		Yes
Domestic Water Pump	Construction Contractor	Construction Contractor	Shop	Yes	Yes	Yes	Yes				Yes	Yes		Yes
FMCS	Construction Contractor	Construction Contractor			Yes	Yes						Yes	Yes	Yes
Medium Voltage Distribution	Construction Contractor	Construction Contractor			Yes				Yes		Yes	Yes		Yes
Medium Voltage Trans. & S.G.	Construction Contractor	Construction Contractor		Yes	Yes						Yes	Yes		Yes
480V Power Distribution	Construction Contractor	Construction Contractor			Yes						Yes	Yes	Yes	Yes
Motor Control Centers	Construction Contractor	Construction Contractor		Yes	Yes						Yes	Yes	Yes	Yes
Lighting Transformers	Construction Contractor	Construction Contractor		Yes	Yes				Yes			Yes	Yes	Yes
120V Power Distribution	Construction Contractor	Construction Contractor			Yes							Yes	Yes	Yes
UPS (Filtered Power)	Construction Contractor	Construction Contractor		As Needed	Yes							Yes	Yes	Yes
Telephone System	Construction Contractor	Construction Contractor		As Needed	Yes	Yes							Yes	Yes

Fan Vibration

- Structural vibration calculations predict maximum budget for sources due rotating equipment
 - example: 0.5 mil max amplitude on vane axial fans
- Develop spec for max vibration amplitude (0.3 mil p-p on fans)

Hanford Fan Vibration Measurements





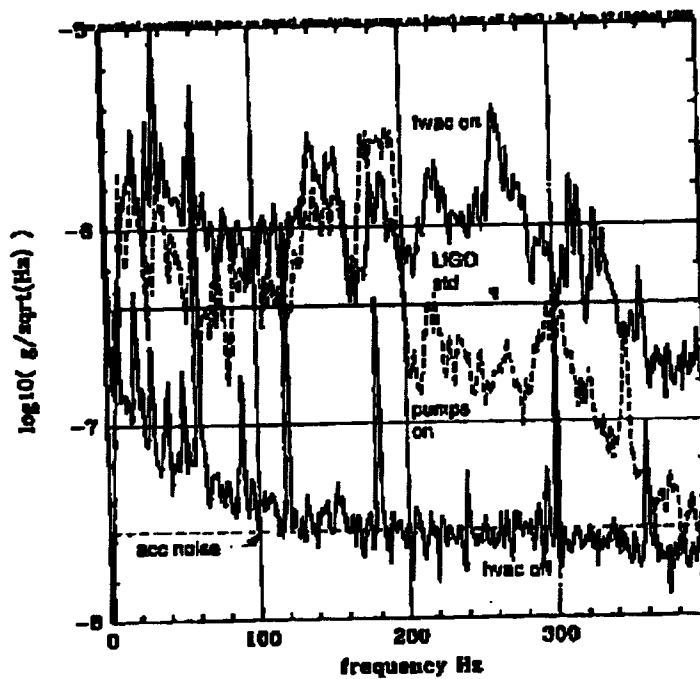


Figure 3a: Vertical acceleration measurements in the LVEA; HVAC off, only circulating pumps on, and HVAC on. The acceleration noise is determined by the input noise of the charge amplifier. The LIGO standard spectrum is given in acceleration units.

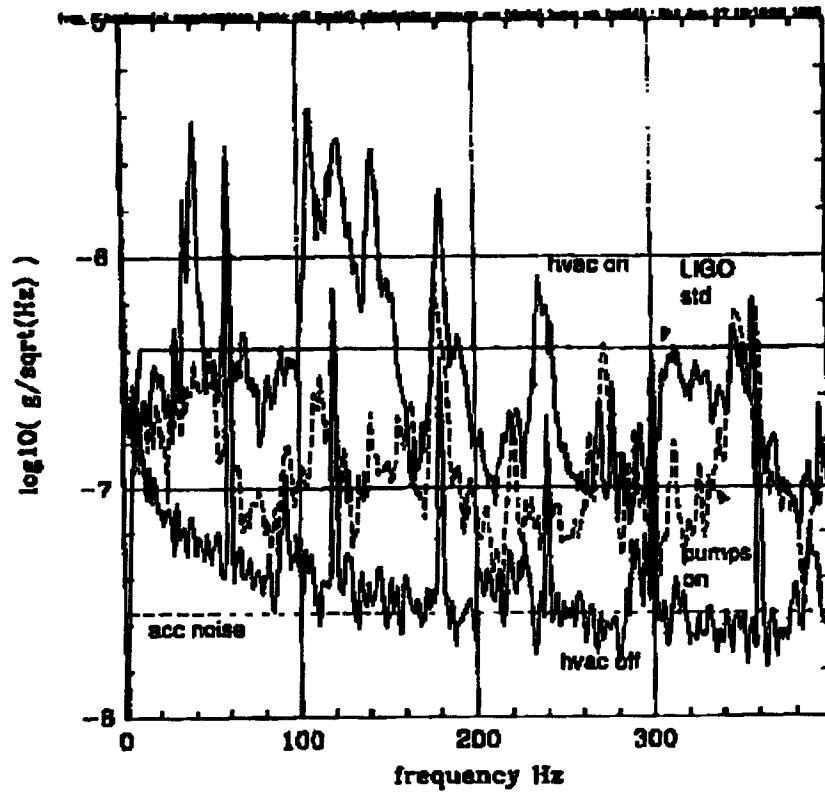


Figure 3b: Horizontal acceleration spectrum along the x direction in the LVEA

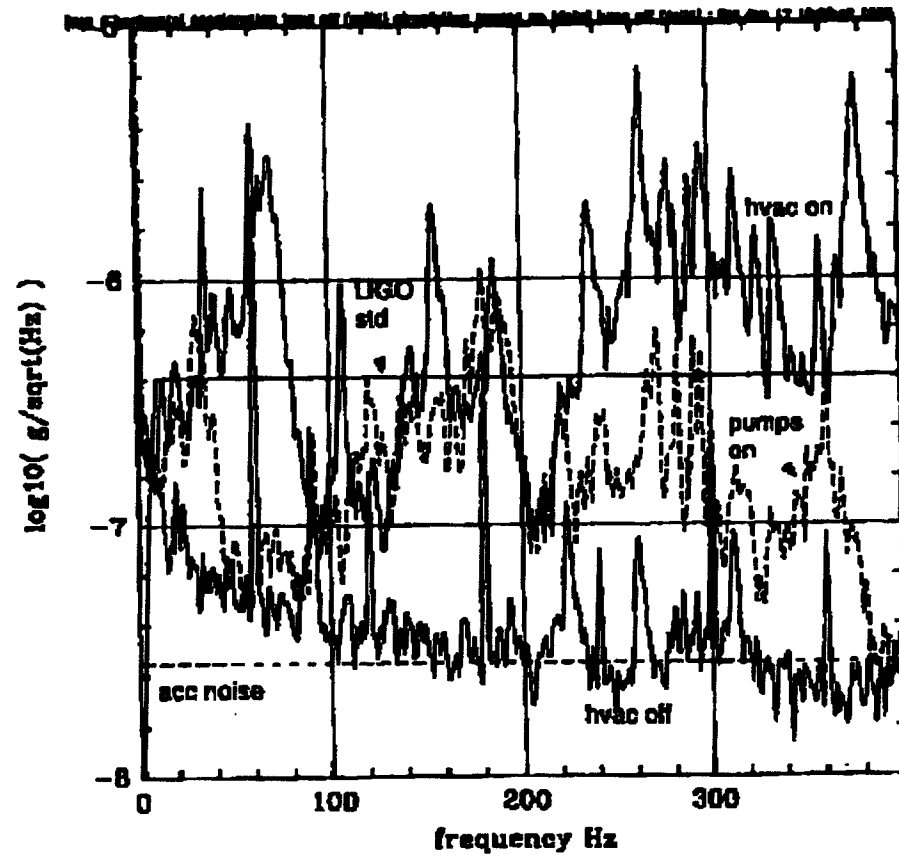


Figure 3c: Horizontal acceleration spectrum in the y direction in the LVEA.

Civil Construction - Livingston

- We are now in joint occupancy for all buildings
- LIGO staff moved in 2/17/98
- Punch list established
 - 1018 items
 - 31% complete
 - examples: electrical labelling, overhead doors, and other workmanship items
- Site infrastructure status
 - Roads, parking lots, erosion control in place
 - Landscaping in progress

Beam Tube Slab, Enclosures, Road

- Beam tube slabs for both arms complete
- 2000 enclosures cast (77%)
- 1300 enclosures installed (right arm complete)
- service road base course complete
- high voltage power distribution along both arms complete

Livingston - remaining work

- Complete staging and storage building
 - Joint occupancy scheduled 4/1/98)
- Complete overpass (before May 1)
- Complete modification of water system
- Close out punch list (estimate June 1)
- Verify as-built documentation
- Training and final acceptance of installed sub-systems (HVAC, etc.)

Livingston - Remaining work ctd

- Complete casting and installation of remaining beam tube enclosures
- Install chip and seal course on all service roads
- Install final asphalt course around corner station

Remaining issues

- Access road (provided by state of Louisiana) needs to be completed.
- Experience indicates this should be upgraded (requires Legislature approval)

Beam Tube and Slab Budget History

WBS 1.1.3 Beam Tube Enclosures and Slab		
Date	Budget	Comment
Apr-95	19687	Initial budget
Sep-96	19384	Transferred budget for surveying and QA to 1.1.4 as part of building contract @ both sites
Jun-97	19943	Cement treatment of berm for soil stabilization in La
Sep-97	19796	Reduced budget for Livingston due totax exemption, increased budget to incentivate slab construction
Total Cost Growth in K\$	109	
Total cost growth of remaining scope in K\$	412	
Total Delta % Cost Growth in remaining scope	2.1	

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Run Date: 25MAR98

COST / SCHEDULE STATUS REPORT (CSSR)

Page 1

CONTRACTOR: Caltech

CONTRACT NUMBER:

CONTRACT BUDGET
BASELINE

REPORTING PERIOD:

PROJECT FILE NAME:
LIGO Master Merged PMB - WBS 1.0











LOCATION: Pasadena, CA

PHY-9210038

292, 100, 000

31JAN98-28FEB98

PERFORMANCE DATA (K\$s)

REPORTING LEVEL	CUMULATIVE TO DATE					AT COMPLETION		
MPR LEVEL	BUDGETED COST		ACTUAL COST	VARIANCE		BUDGET (BAC)	ESTIMATE (EAC)	VARIANCE (6-7)
	WORK SCHEDULED	WORK PERFORMED	WORK PERFORMED	SCHEDULE (2-1)	COST (2-3)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1.1.1 : Vacuum Equipment	35607	36610	33905	1003	2704	42739	43617	(878)
1.1.2 : Beam Tubes	37378	39815	38681	2437	1134	47050	47147	(98)
1.1.3 : Beam Tube Enclosur	16663	17565	15261	902	2304	19796	19244	552
1.1.4 : Facility Design &	48025	48964	48930	939	34	50605	51774	(1169)
1.1.5 : Beam Tube Bake	999	999	779	0	220	3564	3744	(180)
1.2 : Detector	27352	21397	18698	(5955)	2699	54200	53499	701
1.3 : Research & Developme	22211	22144	20351	(67)	1793	23490	23489	1
1.4 : Project Office	23603	23603	24100	0	(497)	27574	28570	(995)
SUBTOTAL	211838	211097	200707	(741)	10391	269019	271085	(2066)
CONTINGENCY						0	21015	(21015)
MANAGEMENT RESERVE						23081	0	23081
TOTAL	211838	211097	200707	(741)	10391	292100	292100	0

Beam Tube Enclosure and Arms - Remaining Cost Estimate

Site	BAC	EAC	Variance	Comments
Wa	9209	8913	295	Planned return to contingency at contract completion
La	9597	9525	72	Disputed taxes of \$322K may add to this

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Buildings and Infrastructure Budget History

Date	Budget K\$	Comments
Apr-95	48078	Original budget
Jan-96	49100	pipeline Xing (520K), add'l budget for clearing (136K), add'l design scope @ RMP (\$265K)
Sep-96	47681	reduced due to Wa bid of \$15651K (3IFO bldg) vs \$17196K budget (6 IFO bldg), plus QA scope Xfer from 1.1.3 (\$126K)
Jan-97	48311	Add storage, staging bldg (\$220K), new proc. For HVAC duct cleaning (\$233), plus Xfer of survey scope from 1.1.3 (\$177K)
Jun-97	48624	Cement treatment of coil @ La corner, end stns
Sep-97	48581	Budget reduced for tax exemption in La
Jan-98	49953	Add storage, staging bldg in La, Wa erosion ctrl, landscaping, OSB mods both sites, add'l constr. oversite
Mar-98	50605	Add clean storage, staging bldg at Wa, extend constr. Oversight.
Total cost growth excluding scope transfers	2224	
Total % cost growth of initial scope	4.6	

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Civil Construction Potential and Planned Contingency

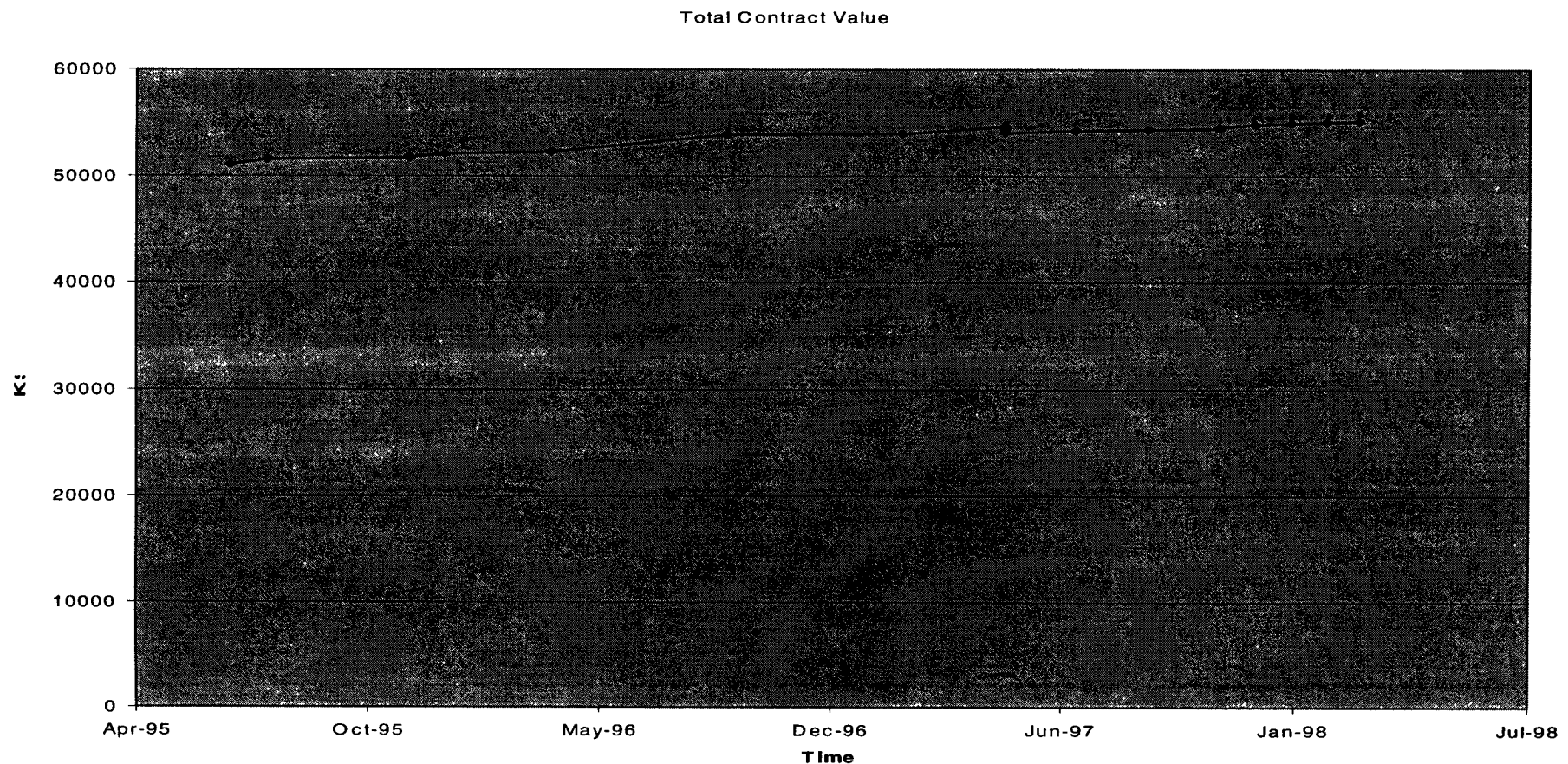
Potential and Remain Actual Contingency Needs for Facilities	
Description	Amount
Bid pkg costs	50000
HVAC cleaning process in La	250000
Corner/end station telephones (both sites)	300000
Extend RMP @ La	54363
In-house labor rate variance	196813
Mod Ha water sys	314363
New well installation	50000
TOTAL	1215539

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Civil Construction Major Subcontract Cost Evolution



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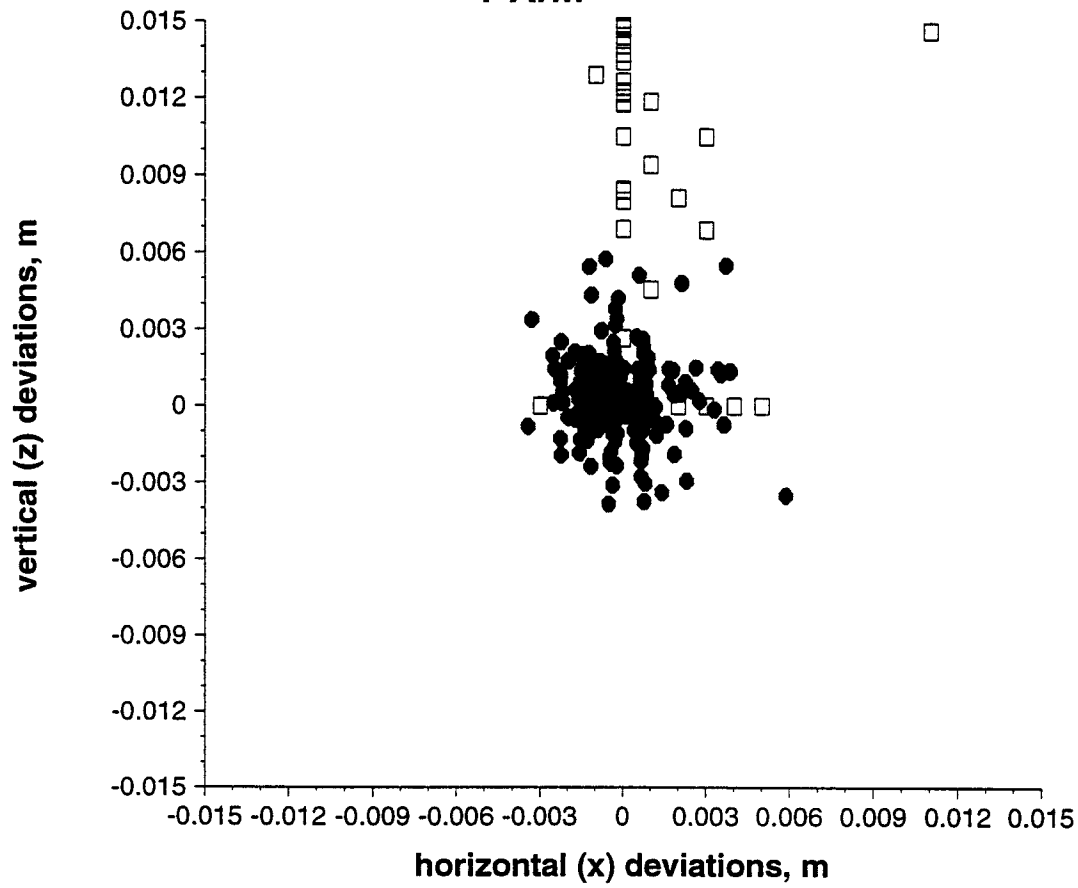
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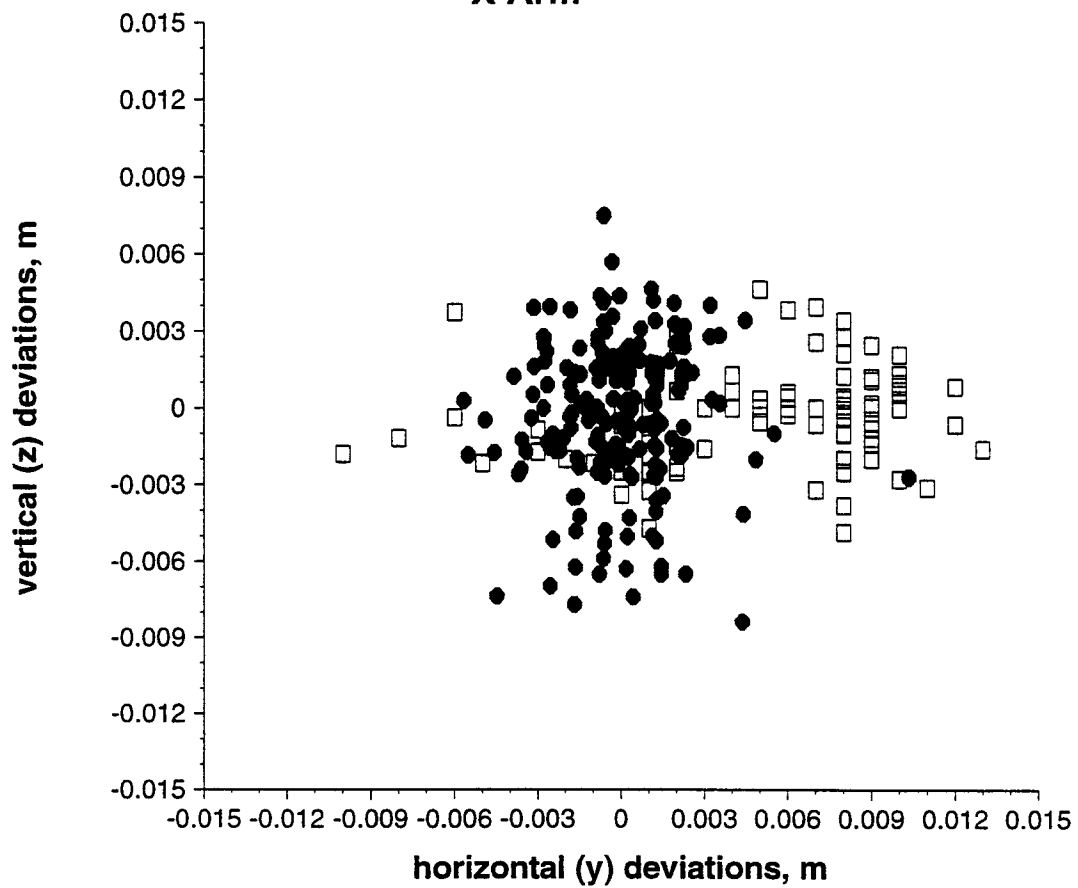
Beam Tube Status

- **Hanford beam tube completed**
 - beam tube installed
 - aligned
 - All 4 modules vacuum tested individually
 - Accepted - we own it!
 - Completion review held
 - all travelers, manufacturing, installation, and test data transferred to us
- **Schedule variance for complete job ~ 2 weeks.**

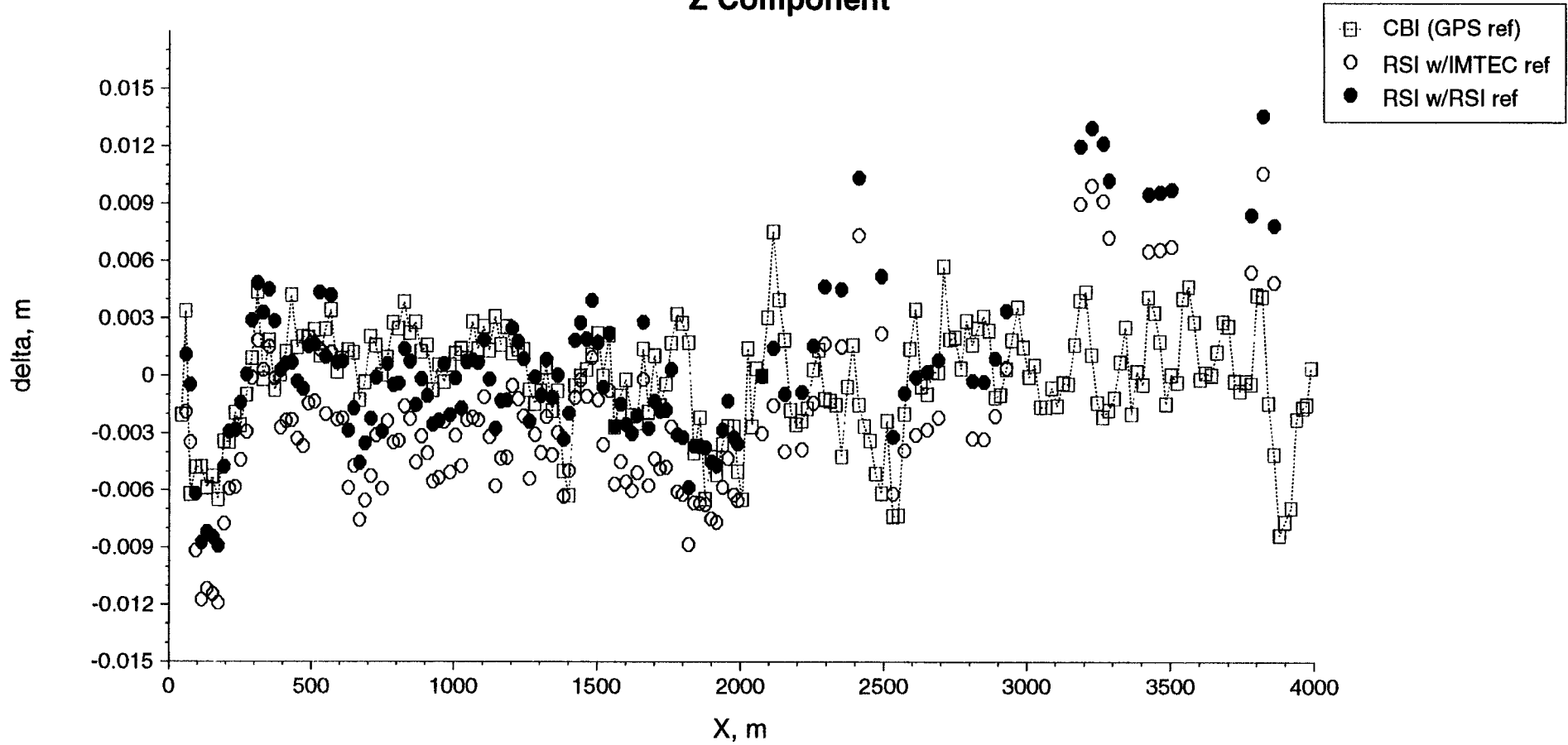
Y Arm



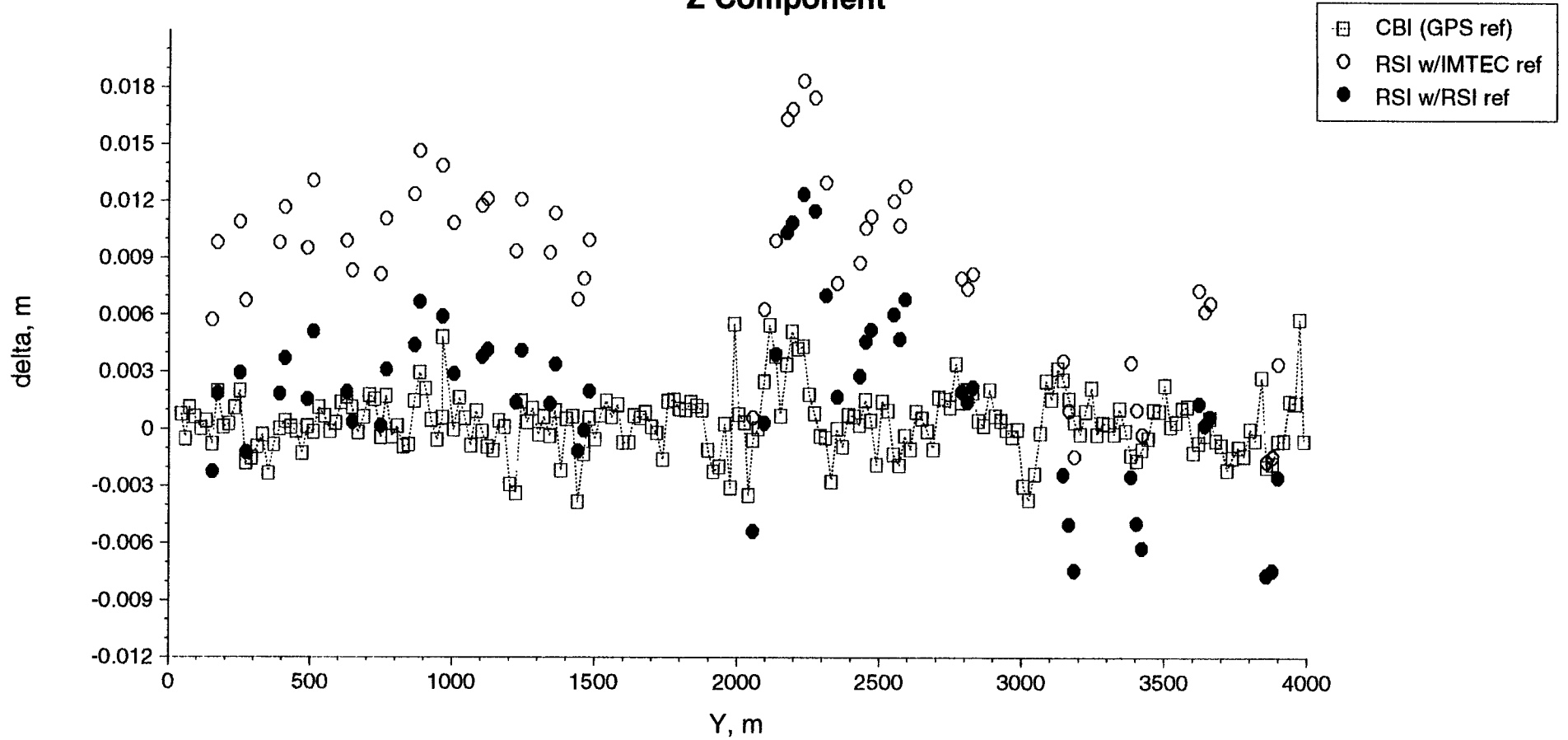
X Arm



Hanford Beam Tube, X arm Vertical Deviations Z Component



Hanford Beam Tube, Y arm Vertical Deviations Z Component



draft wea 2/21/98

Module Leak Test Results

Hanford Beam Tube Acceptance Test Results						
Module	X1	X2	Y1	Y2	spec	Comment
H2 Outgassing - tl/s/cm2	9.50E-14	<7.4e-14	1.20E-14	3.10E-15	1.00E-13	(goal)
Air Signature - tl/s	1.10E-07	1.30E-07	2.30E-08	2.50E-07	4.00E-07	(instrumental limit)
Temperature normalized	Y	Y	N	N		
Temp - C	26	27	0.3	-4.9		

From Rai Weiss

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Hanford Beam Tube Status

- Beam tube at Hanford has now been insulated in preparation for bake out (planned for 6/98)
- Procurement and installation of control and monitoring instrumentation in progress.
- Power supplies, chillers on hand, power distribution cable ordered
- bid out for electrical installation
- Bake out to complete by 4/99 at Hanford

Livingston Beam Tube Status

- Right arm installation complete and beam tubes covered.
- Pump down scheduled week of 3/30
- Left arm installation began early March
- Expect to complete installation by mid-June
- Beam tube fabrication expected to complete by mid-May
- Plan to have CBI complete all work by year end.
- Bake out planned to follow Hanford in 1999.

Beam Tube Budget History

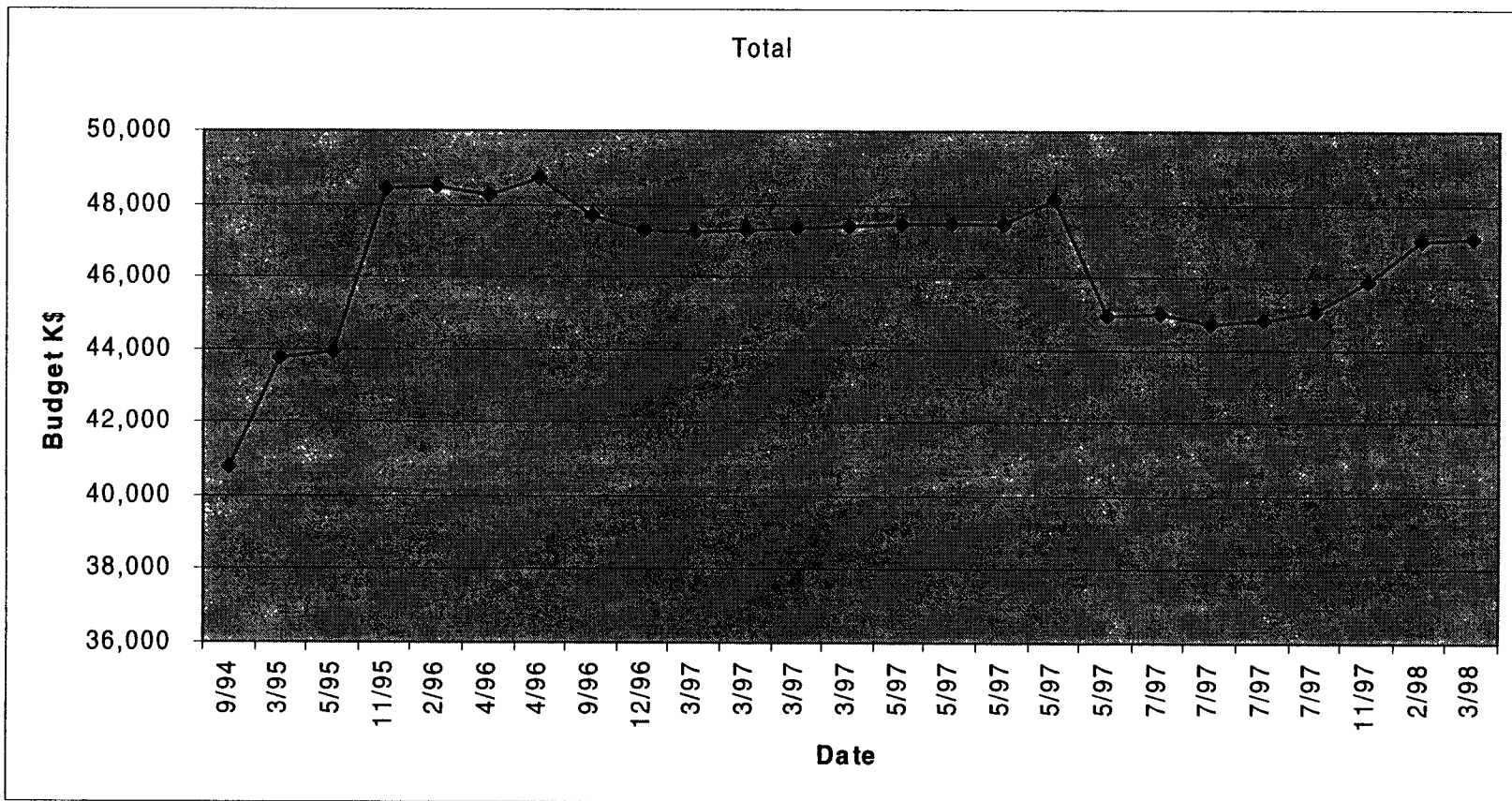
Date	CR No.	Description	Amount, \$K	Total
9/94	N/A	Original Budget		40,780
3/95	N/A	Updated Budget		43,785
5/95	950001	Improve Cleaning	137	43,922
11/95	950024	BT Contract Signing	4,527	48,449
2/96	960006	BT/BTE Model	41	48,490
4/96	960018	BT Support Redesign	(207)	48,283
4/96	960021	Baffle Manuf. & Coat	436	48,719
9/96	960032	Stainless De-escalation	(1,026)	47,693
12/96	960035	Power Cost Transfer	(410)	47,283
3/97	970004	Transformers	(44)	47,239
3/97	970005	Miscellaneous	51	47,290
3/97	970006	BDF Air Monitoring	46	47,336
3/97	970007	Hanford Labor Rates	61	47,397
5/97	970011	Module End Conditions	76	47,473
5/97	970012	Valve Contamination	10	47,483
5/97	970013	X1, X2 Cleaning	8	47,491
5/97	970015	New Baffle Manuf.	666	48,157
5/97	970018	Move Bake Funds	(3,240)	44,917
7/97	970027	Miscellaneous	52	44,969
7/97	970028	Stainless De-escalation	(259)	44,710
7/97	970029	Baffle Retrofit	135	44,845
7/97	970030	Washington Taxes	189	45,034
11/97	970041	Livingston Labor Rates	873	45,907
2/98	970043	In-House & Misc.	1,088	46,995
3/98	N/A	Current Budget		47,050

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Beam Tube Budget History



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Beam Tube Contract Cost Summary

	Amount,	
	\$K	%
Original Contract Cost:	39,545	100.0
Material De-escalation	(1,369)	-3.5
Labor Escalation	1,899	4.8
Baffle Clean & Retrofit	157	0.4
Taxes	343	0.9
All Other Changes	40	0.1
Subtotal	1,070	2.7
Latest Contract Value	40,615	102.7

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Estimate of remaining costs to complete beam tube contract

Estimate does not include contingency items:

<u>Task</u>	<u>Cost, \$K</u>
Fabricate 200 remaining tube sections	3,866
Install 250 remaining tube sections	1,951
Complete acceptance tests, 4 modules	2,056
Hold completion review	<u>201</u>
Total Contract ETC	8,074
Non-Contract* ETC	<u>392</u>
Total Beam Tube ETC	8,466

- *Includes in-house labor, Magnolia Beach electrical, alignment surveying, and in-house travel

Beam Tube - Potential and Planned Contingency

Description	Amount (K\$)
LA add'l FTIR's	5
LA Baffle installation cleaning	20
Module end conditions	23
Mount GNB valves early on Y arm	25
Purchase leftover GPS eqpt	50
Rcv reimburse for LN dewars	-180
Reimburse CBI for Ha leak location te	150
Taxes (WA B&O and sales taxes)	37
TOTAL	130

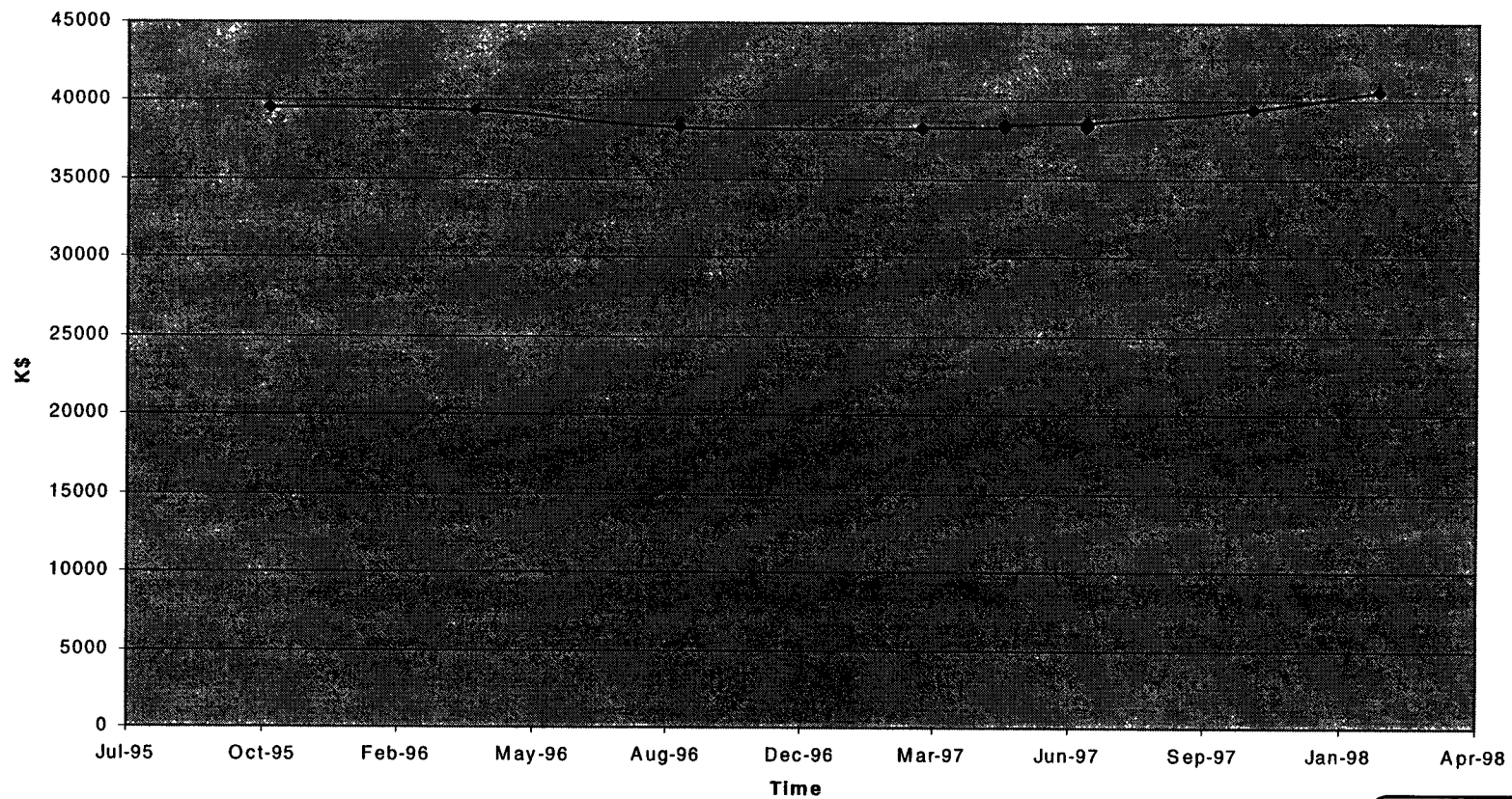
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Stability of Beam Tube Contract Value

Beam Tube Contract Value



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Vacuum Equipment

- PSI Hanford Status
 - All chambers, pumps, valves delivered.
 - All major mechanical equipment (pumps, clean air supplies) installed
 - Bake and vacuum testing complete on Y mid station
 - Bake out underway on Y end station (now in cool down)
 - Staging for X arm in progress
 - Installation status in LVEA
 - electrical work, conduits cable trays, ~80% complete
 - annulus piping ~70% complete
 - Plan to start leak test mid-April

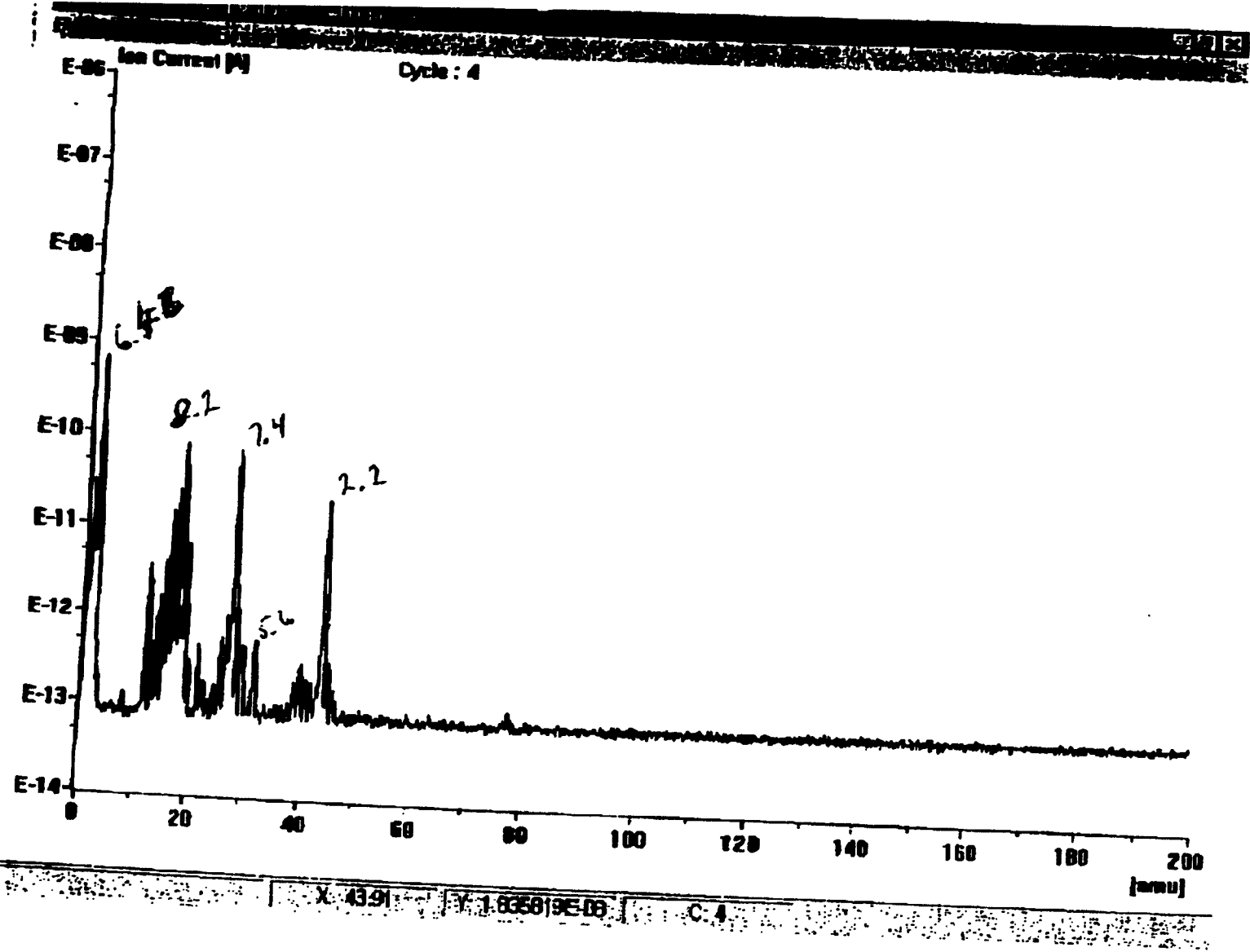
Vacuum Equipment Schedule

- WA schedule
 - installation (including bake out and testing) should complete in July
 - approx. 2 months late with respect to original schedule
 - due to late bldg weather delays,
 - floor height fit up discrepancy in LVEA
- LA schedule
 - expected to complete 11/28/98 as originally planned

RGA data

AMU	Species	Measured partial pressure	Goal
2	H2	6.23E-09	5.00E-09
16	O2	1.04E-10	
18	H2O	5.24E-10	5.00E-09
28	N2+CO	9.70E-10	1.00E-09
44	CO2	2.60E-10	2.00E-10
	TOTAL H2+H2O	6.75E-09	1.00E-08
	Total Others	1.90E-09	1.40E-09

Fax: 818-577-0424 Mar 25 '98 16:06 P.03



RGA baseline for LMID. RGA open to BSC
 5s dwell!

LIGO PROJECT

Vacuum Equipment - La

- First PSI staff arrives 3/30
- PSI will bring in a field crew from their New Iberia facility for off loading. Millwrights from WA will do precision alignment and setting at the LA site.
- Beam tubes pumps delivered and being staged for BT pump down
- Chambers begin shipping in April
- All BSC's, HAM's, 80K pumps, spool pieces, LN tanks, ready for shipment to LA
- Expect VE complete acceptance by 12/98 - as contracted and one month later than original contract date.

Vacuum Equipment Budget History

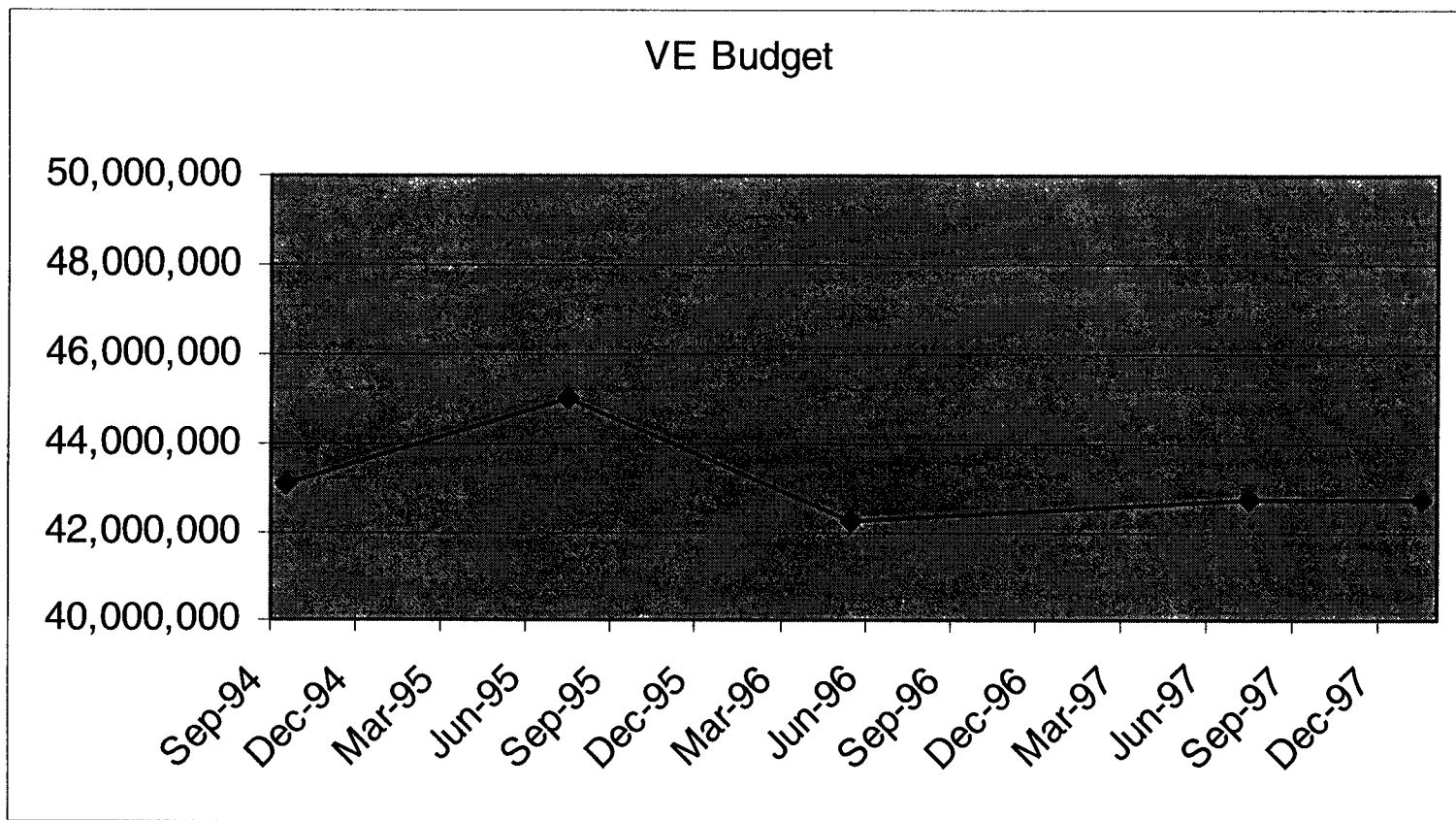
May-95	Delete getter pumps	-1685
Aug-95	Delete TMC chambers	-1677
Sep-95	Adjust to negotiated price	1003
Jan-96	Remove WA beam manifold	-201
Jan-96	Add LVEA pipe bridge	50
Jan-96	Add fail safe valve on roughing pumps	16
Jan-96	Add Aux ports on main ion pumps	10
Feb-96	Mod gate valve weld stub mat'l	18
Mar-96	Add BSC removable spool pcs	110
Mar-96	Mod BSC floors, fewer @ incr. Load	12
Mar-96	Add pump cart chillers	62
Mar-96	Misc reduced costs	-700
Mar-96	Pump cart mods	40
Mar-96	Change annulus conductance spec	-41
Mar-96	Delete 30" flange from mode cInr	-35
Feb-97	Metal seal test	21
Feb-97	Add'l pump carts	650

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Vacuum Equipment Budget History



Remaining Expenses to Complete Vacuum Equipment Contract

Remaining Costs	Remaining budget	total cum costs	Total costs plus commitments	BAC	EAC
Wa eqpt & installation	4762	10965	14459	15727	14935
Wa installation - in house labor & eqpt	30	522	620	553	650
La eqpt & installation	4593	5004	11616	9597	10956
La installation - in house labor and eqpt	311	346	474	657	657
Total - all items	9532	33207	46286	42739	43569

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Vacuum Equipment - Potential and Planned Contingency Items

Additional QA/Safety	164
Chamber floor elevation change	200
Labor rate escalation	200
Light duty cranes/hoists	45
RGA Calib/Outgas meas sys	50
Shop tools	50
Site forklift (La)	50
Stiles/scaffolding	50
Total	809

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Summary

- We are nearing the end of facilities work
- We are carrying out an orderly completion of this work through acceptance testing
- We expect costs to remain within our estimate envelope as the work is closed out.