Status of the LIGO Livingston Observatory

Mark Coles

October 27, 1998
~~L980470-00-L~~
G980156-00-L

LIGO

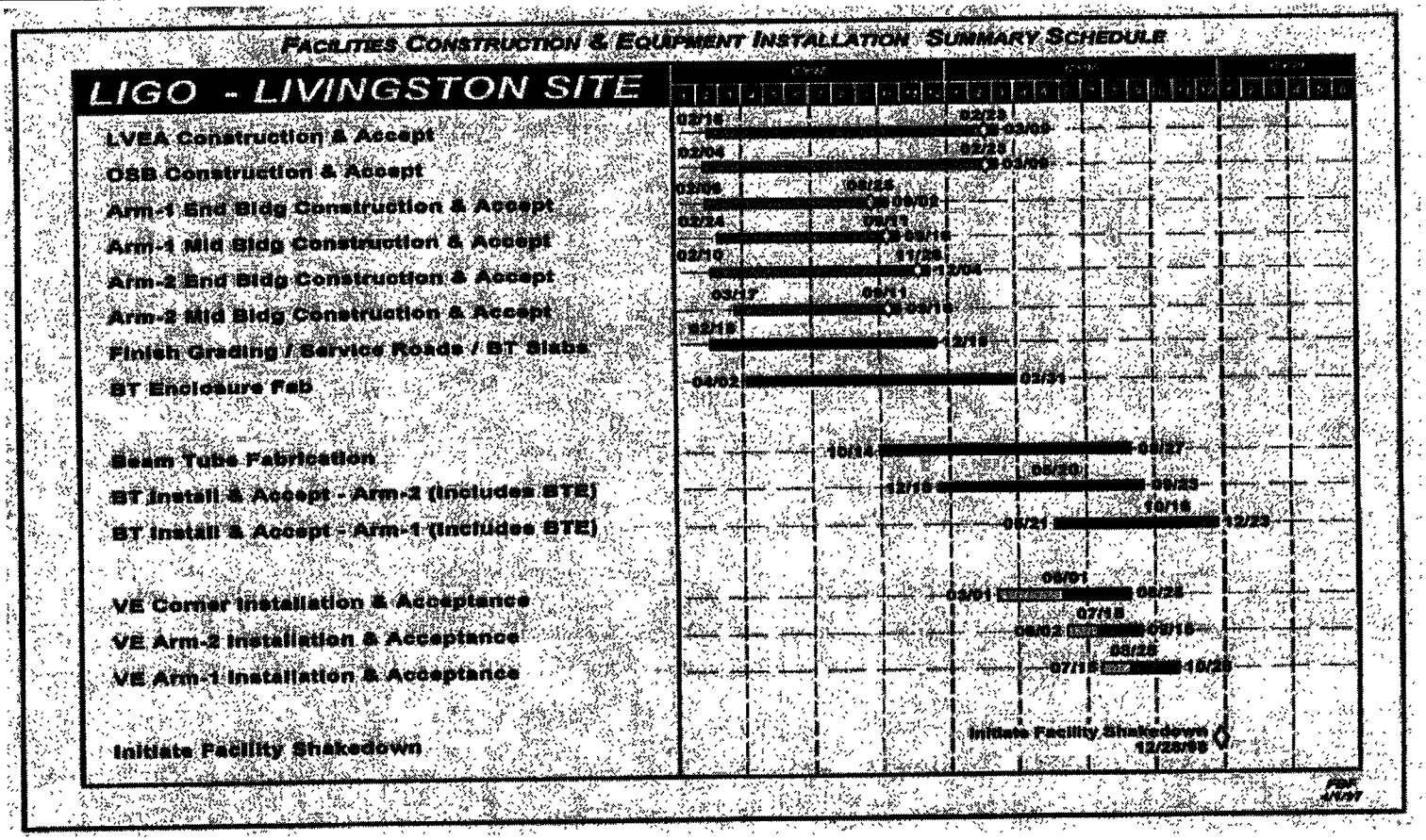
Topics Presented

- Status of facilities construction, installation, and commissioning
- Remaining work to be accomplished
- Staffing
- Plans and preparation for detector installation
- Educational outreach

Introduction

- **The LIGO Livingston Observatory (LLO) is just completing major facility construction and acceptance.**
- **Civil construction, beam tube work, and vacuum equipment should all be completed by year end or shortly after.**
- **Part of our effort is now directed toward preparation for detector installation.**
- **We are also expanding relationships with institutions in Louisiana to increase the scope of scientific collaboration and to develop educational outreach opportunities.**

Construction Schedule - Livingston



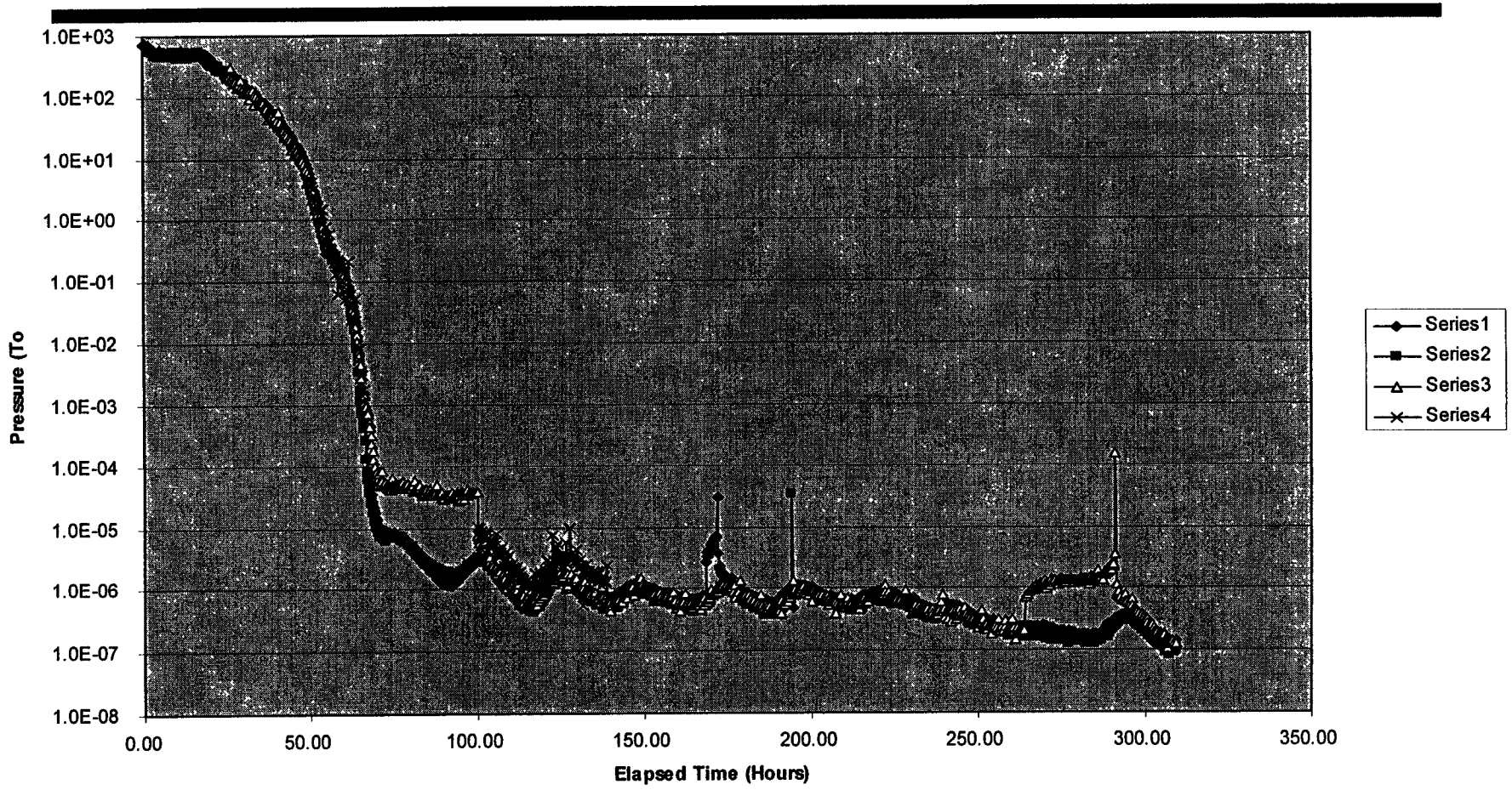
Beam Tube

- **Accomplishments since last review:**
  - **Completion of all beam tube fabrication**
  - **Completion of Y arm installation**
  - **Alignment of X and Y arm**
  - **Installation of all beam tube enclosures**
  - **Pump down and acceptance of X arm**
  - **Pump down of Y arm - acceptance in progress**
  - **Vent of X arm using purge air system.**

Beam tube acceptance

- **Right arm (X-arm) pumped down and accepted as an entire arm.**
- **Acceptance complicated by initial problems with site electrical power and X mid-station gate valve accident**
  - **Electrical power:**
    - **Initially phase imbalances of up to 10% caused trips of pumps and HVAC**
    - **Situation remedied by placement of substation close to site by utility provider (DEMCO). Now have phase imbalance of less than 0.5%**
  - **Gate valve:**
    - **gate accidentally freewheeled closed while electrical drive was being connected at right mid-station**

LLO Beam Tube Pump Down



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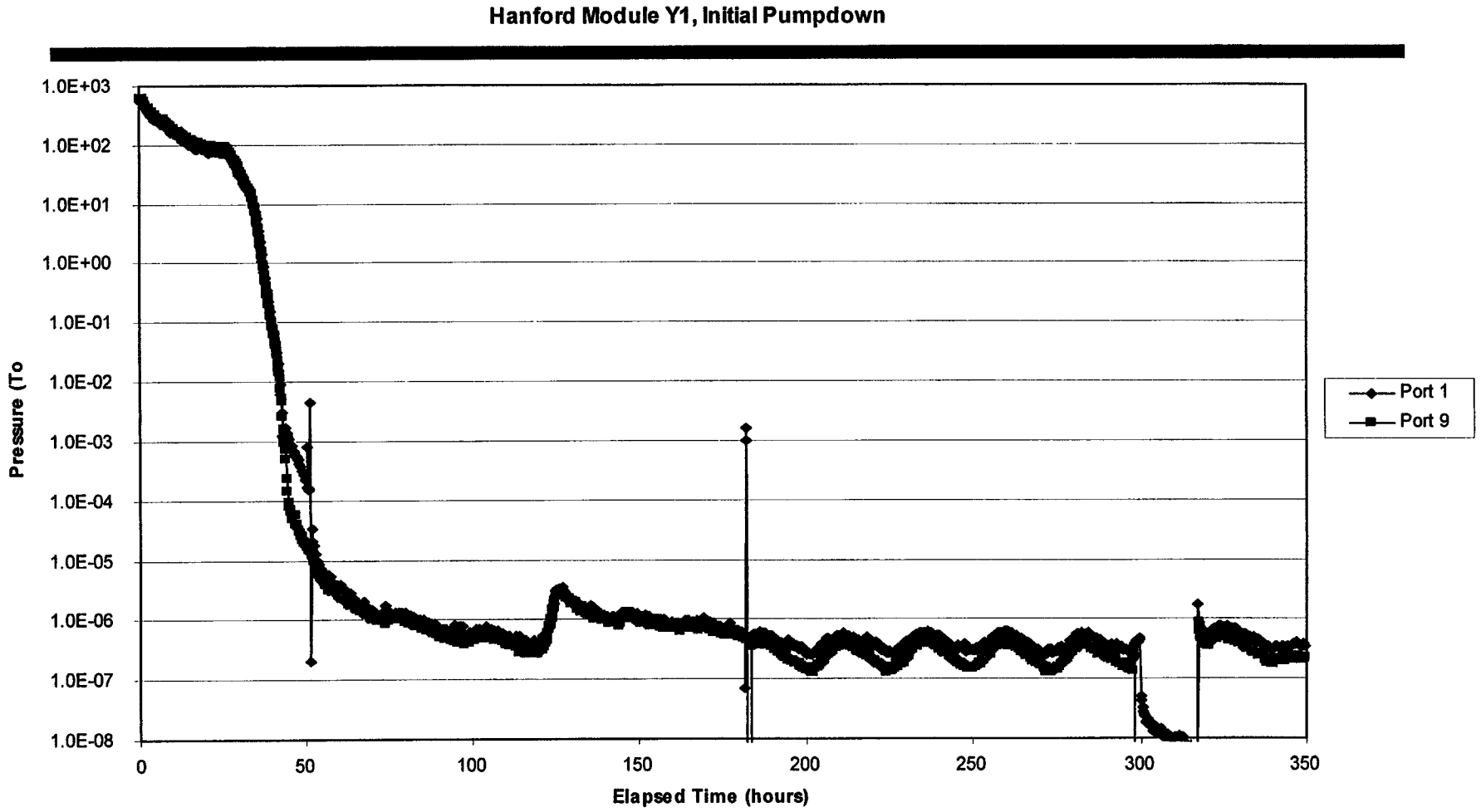
LHO Beam Tube Pump Down



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Livingston X arm vacuum tests

Table 1: Gas model in the 4km volume of the Livingston x arm in 10^{-8} torr liters/sec

Gas	7/15/98	7/23/98	7/28/98	7/30/98
			2.66×10^{-6} air lk in x2	2.66×10^{-6} air lk in x1
H_2	1490±13	1020±3.8	1740±24	1840±35
CH_4	2.08 ±0.13	2.93 ±0.22	15.4 ±0.59	9.3 ±0.69
N_2	25.8±3.4	17.9±1.9	312±6.9	263±9.5
CO	29.9±3.0	15.4±2.4	39.2±7.9	99.0±9.1
O_2	7.9±0.3	1.5±0.2	28.5±0.8	31.7±0.9
A	0.13 ±0.01	0.016±0.007	0.52 ±0.03	0.75 ±0.04
CO_2	261±6.6	87±2.3	360±4.9	594±16
NO	179±3.2	102±1.4	374±9.2	690±12
C_2H_6	0.56 ±0.05	0.31±0.06	0.12 ±0.09	0.37 ±0.19
Temp C	28 (est)	29.1	32.2	34.5

Table 2: Estimated upper limits for air leak in entire arm

from	cracking fraction for air	air lk in 10^{-7} torr liters/sec
N_2	1.0	1.8
O_2	0.096	1.6
A	0.0021	3.4

Table 3: Prebake outgassing rates at 23C

gas	T_0 K	J(296K) torr liters/sec cm^2
H_2	8000	6.0×10^{-14}
CO	10000	8.2×10^{-16}
CH_4	10000	9.1×10^{-17}
CO_2	10000	1.3×10^{-14}

Acceptance criteria

leak rate< 2x10-7

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Substation provided by utility (DEMCO)

Site Electrical Power

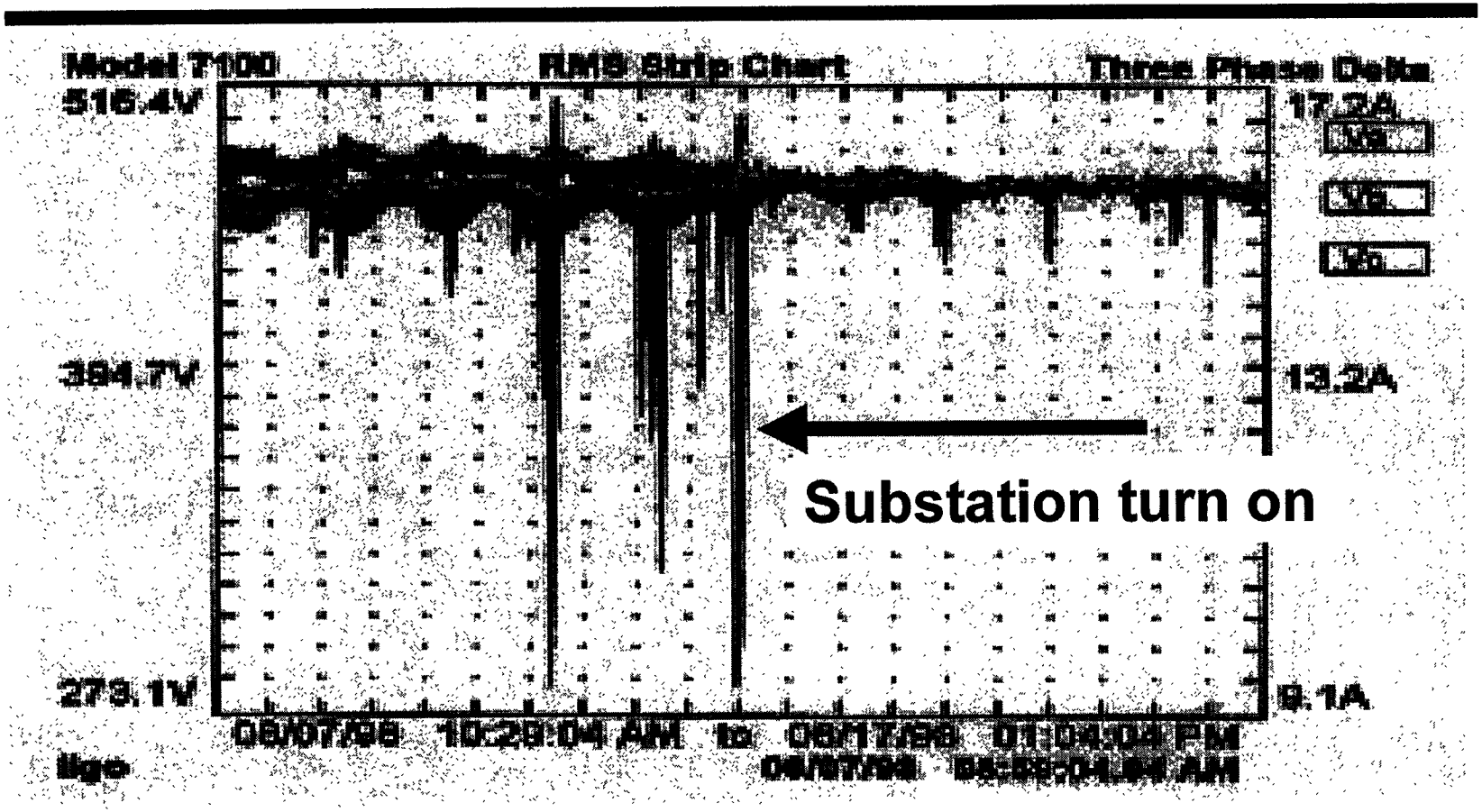

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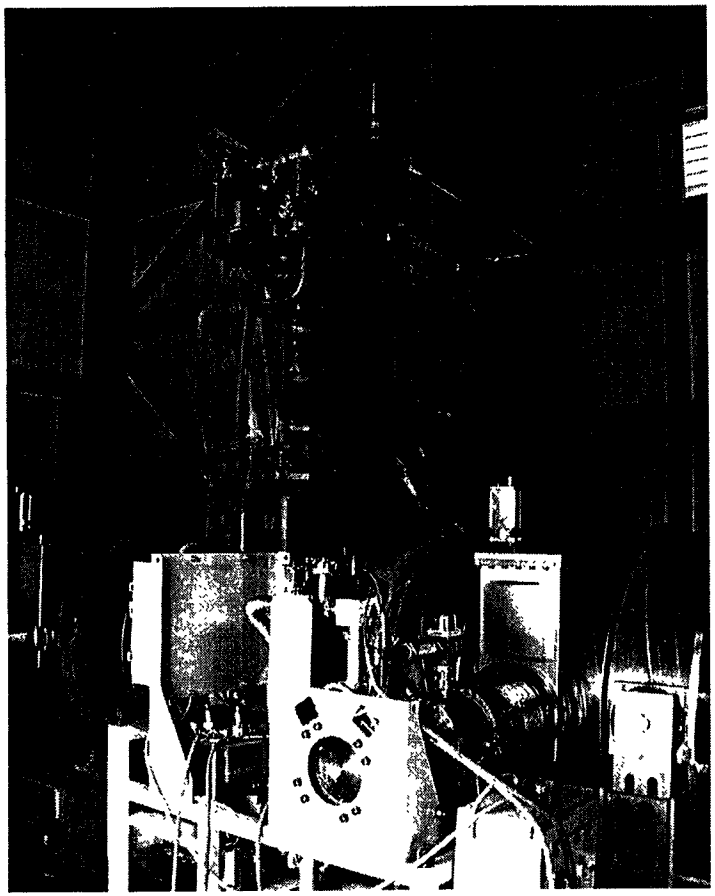
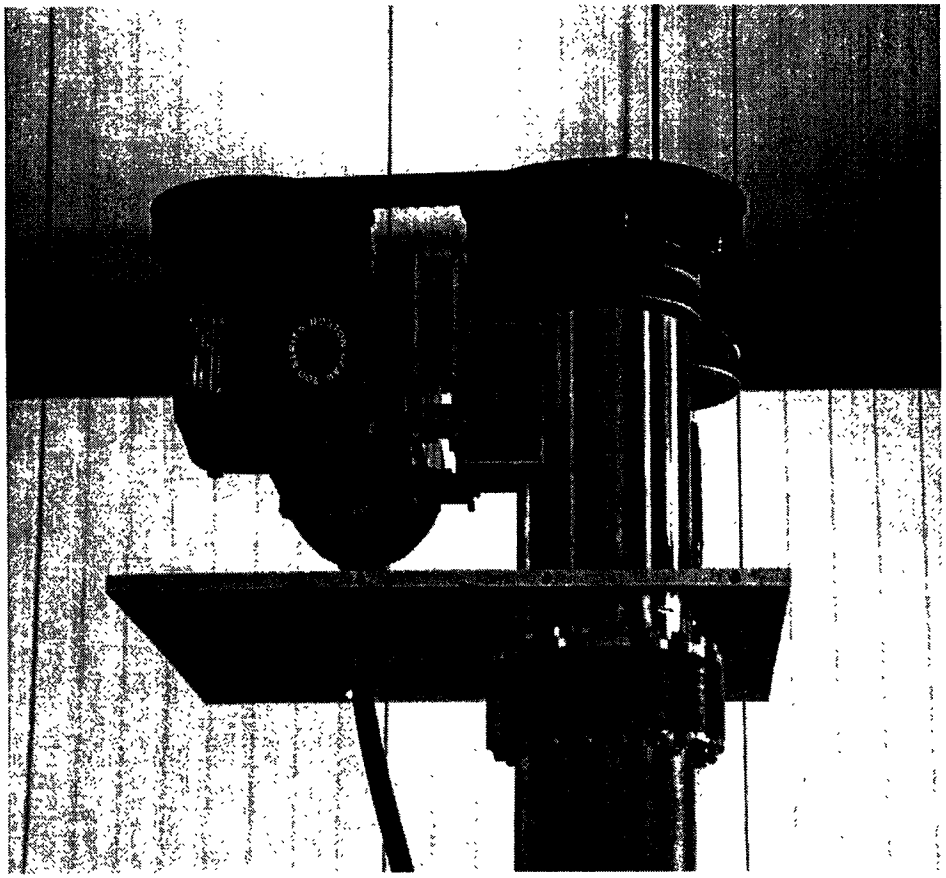
Photo of gate valve





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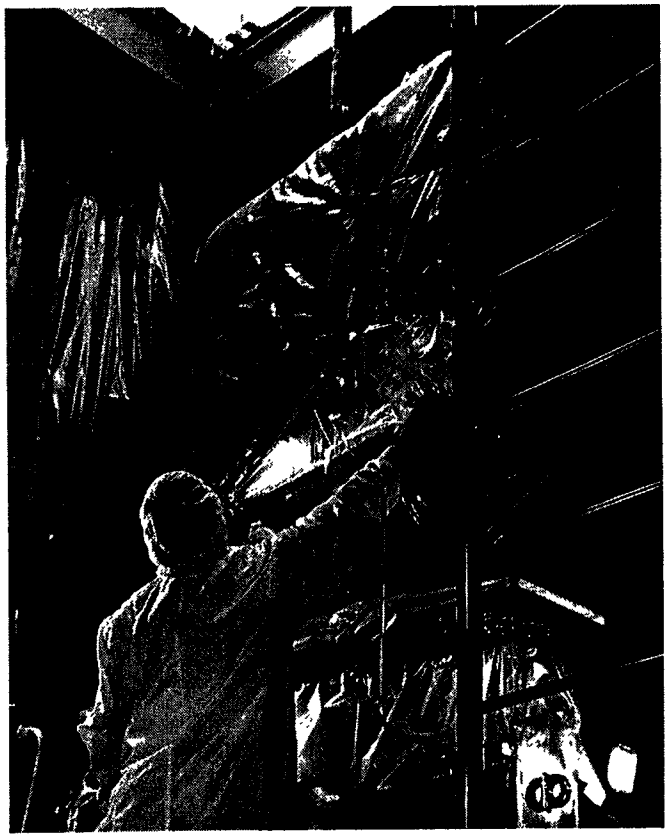
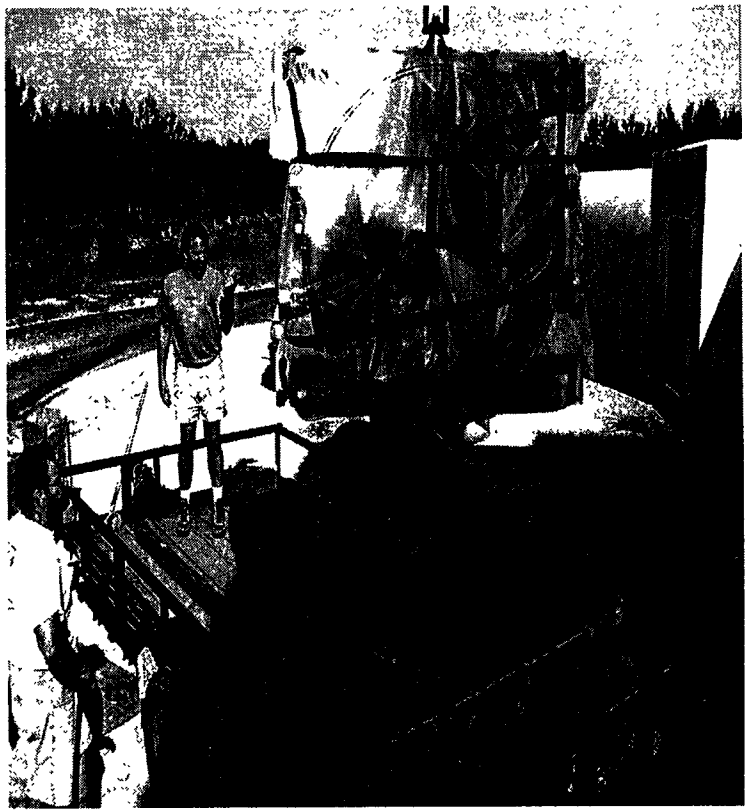
Gate valve removal





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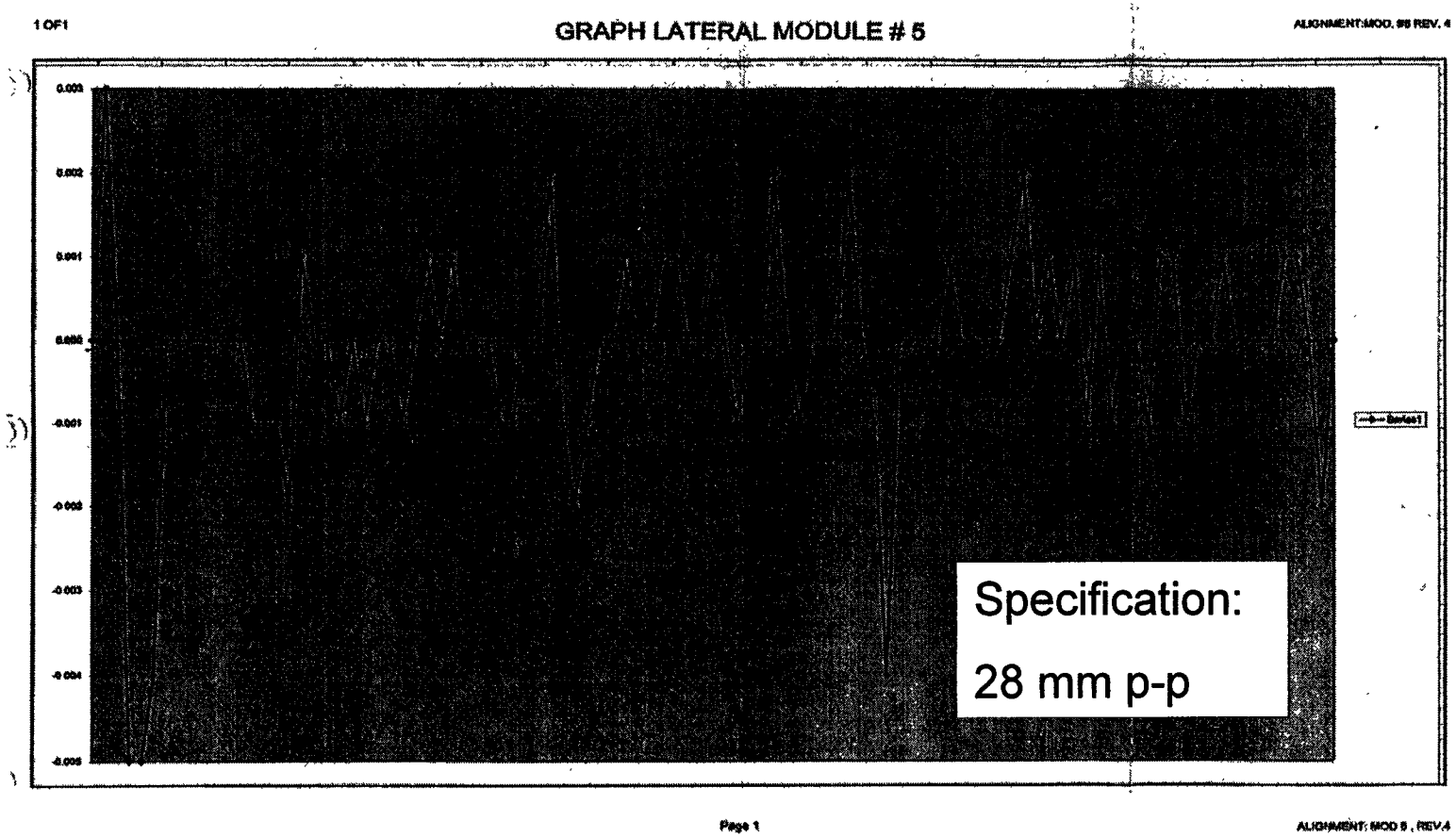
Lessons Learned

- Damaged gate valve (repair as part of planned inspection of all gate valves)
  - repair damaged stops and wheels
  - inspect gate
  - reinstall and adjust gate gap
- Implementation of work permit system:
  - identification of responsible authority
  - submission of procedures
  - use of lock-out tag-out
- regular permit meeting held to authorize all work
  - permits and procedures kept on file

Representative beam tube alignment data



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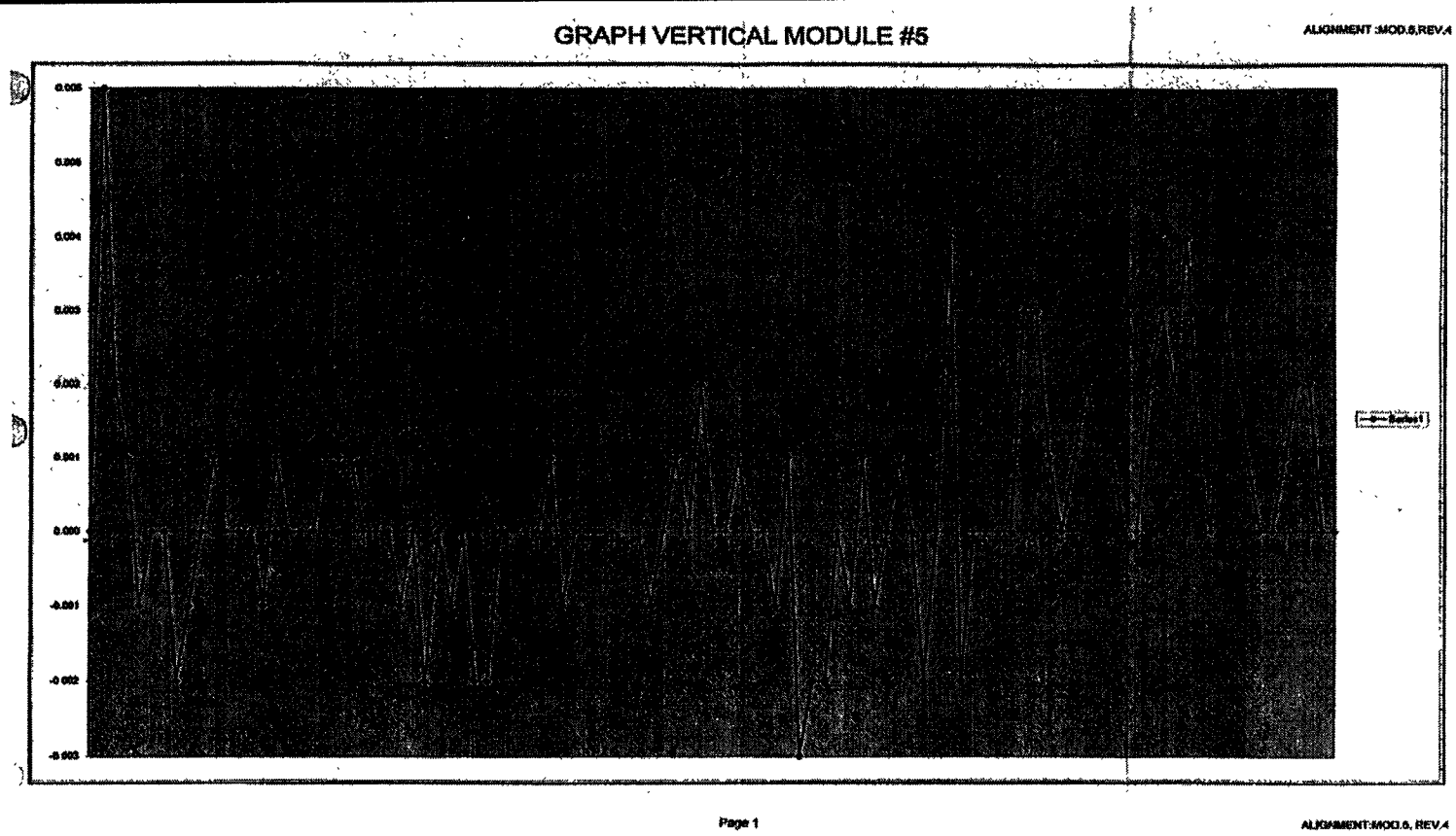
Vertical beam tube alignment data



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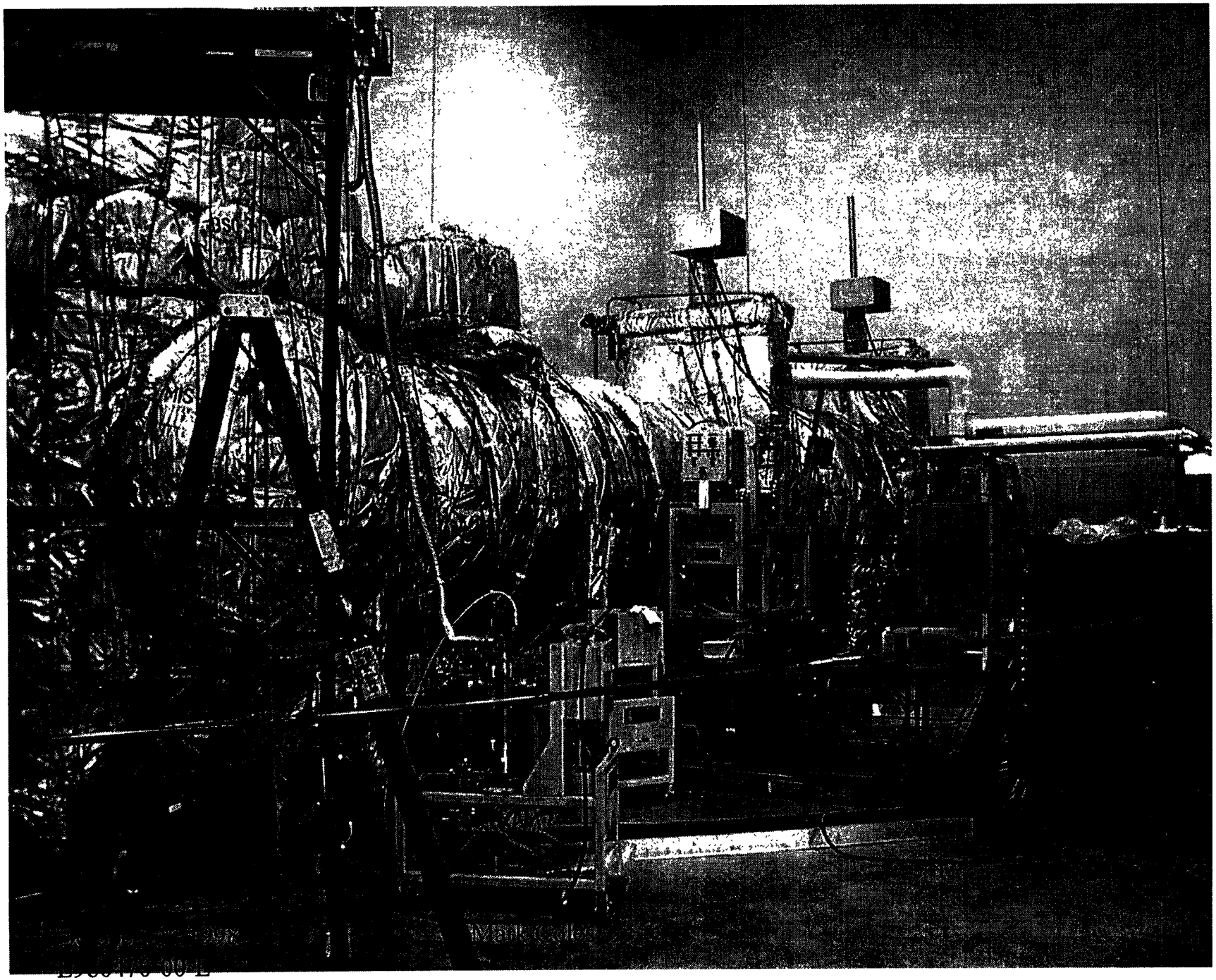
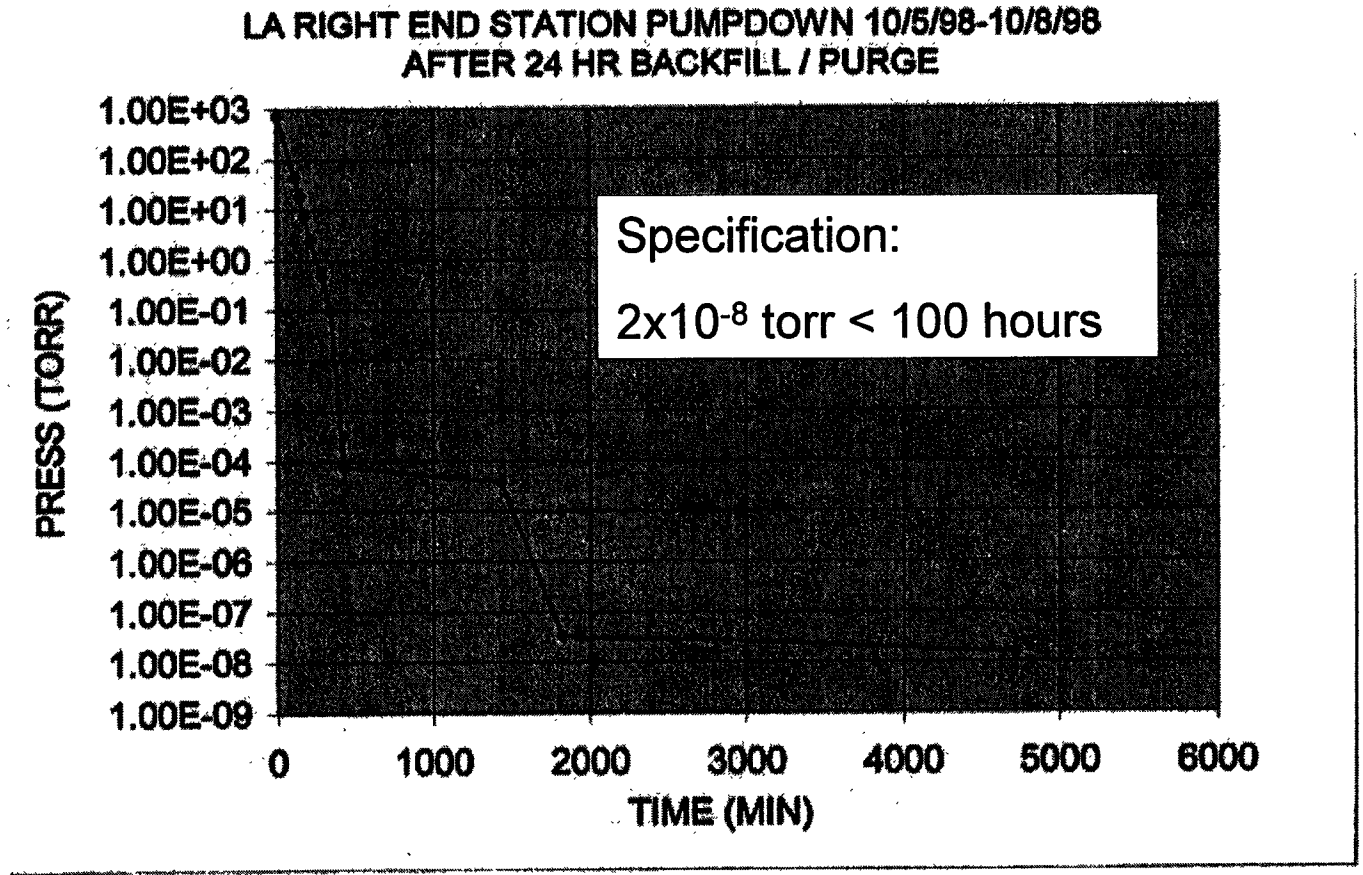
Vacuum Equipment

- **Summary of achievements since last review**
  - Delivery of all vacuum chambers, tanks, and pumps
  - Installation and grouting of chambers and tanks
  - Delivery and integration of CDS cryo control system
  - Bake out and acceptance of right end station
  - (Bake out of left end station in preparation)



End station pump down



First Test Results:
Right End Station Bake Out

- Interim report from PSI for each isolatable volume
- Final reports submitted at job closeout.
- Tests witnessed by cognizant LIGO engineer.

Partial Pressure Calculation
Acceptance of the Bakeout with respect to Air Signature and Partial Pressures

Date:9/23/98
Test ID:LA RIGHT END STATION
PSI Engineer:S.MOTEW

AMU	$F_{(amu)}$ transmission efficiency wrt N2	$E_{(amu)}$ ionization efficiency wrt N2	$S_{(E,amu)}$ sensitivity (Torr/A)	$I_{(amu)}$ ion current (A)	$PP_{(amu)}$ (Torr)
2	-	-	12.94	4.00E-10	5.18E-09
16	0.57	1.60	17.00	5.00E-12	4.01E-11
18	0.64	1.12	17.00	8.20E-11	9.93E-10
28	-	-	17.00	4.70E-11	7.99E-10
44	1.57	1.42	17.00	1.40E-12	2.10E-11
all others	-	-	17.00	4.36E-11	7.41E-10

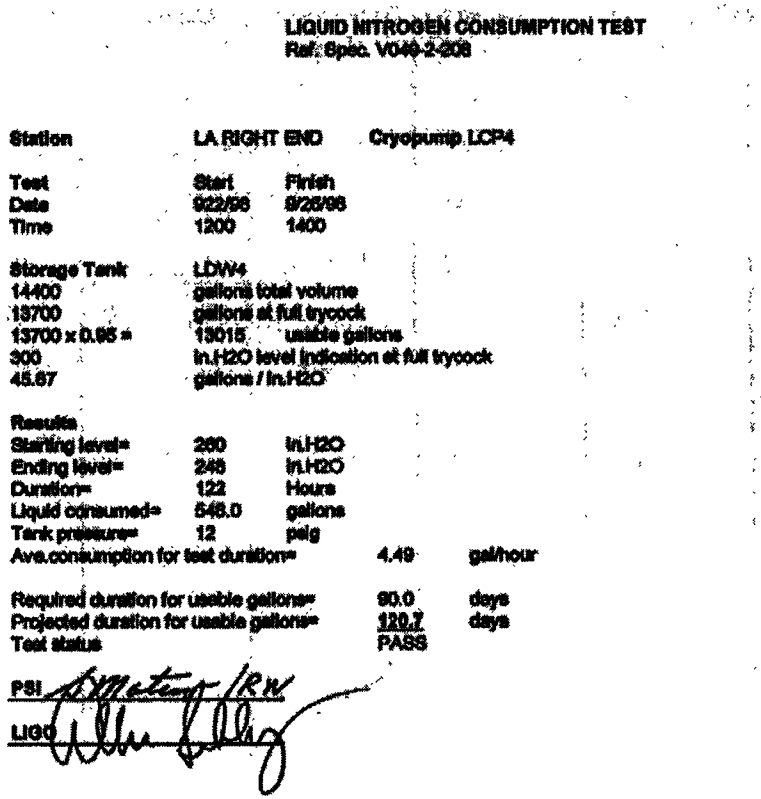
		LIGO Contract Limits	Actual	Pass
Primary Criteria -	Total Pressure:	2.00E-08 Torr	7.77E-09 Torr	Yes
Secondary Criteria -	Others except H2 & H2O:	3.00E-09 Torr	1.60E-09 Torr	N/A

LIGO:

PSI: 9/25/98

Right end station boil off test

- Contract requires > 90 days between fill for each cryopump system. (pump, tank, control system)
- Similar tests to be done for left end station and both corner station systems.
- Tests witnessed by LIGO cognizant engineer



LIQUID NITROGEN CONSUMPTION TEST
Ref. Spec. V049-2-208

Station	LA RIGHT END	Cryopump LCP4		
Test	Start	Finish		
Date	9/22/98	9/26/98		
Time	1200	1400		
Storage Tank	LDW4			
14400	gallons total volume			
13700	gallons at full trycock			
13700 x 0.95 =	13015	usable gallons		
300	In.H2O level indication at full trycock			
45.67	gallons / In.H2O			
Results				
Starting level=	260	In.H2O		
Ending level=	248	In.H2O		
Duration=	122	Hours		
Liquid consumed=	546.0	gallons		
Tank pressure=	12	psig		
Ave.consumption for test duration=			4.49	gal/hour
Required duration for usable gallons=			90.0	days
Projected duration for usable gallons=			120.7	days
Test status			PASS	

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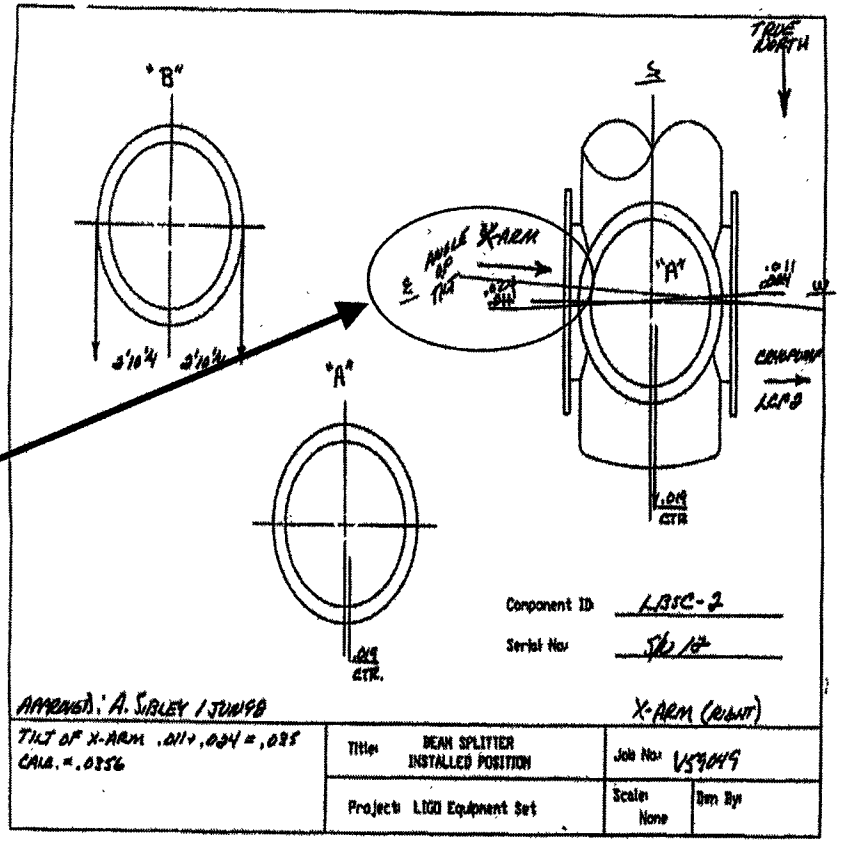
Chamber Alignment Data

- all chambers have been positioned by PSI and alignments have been checked.
- alignment documents are submitted for each chamber.
- spec = 0.080”



Remaining VE Activities

- Bakeout of Y end station (anticipate complete < 10/31)
- Bakeout of corner station
- Boil off tests
- Inspection/repair of all gate valves
- Formal submission and review of acceptance data

Building and site infrastructure

- **Beneficial occupancy since last review. Building Contractor (Hensel Phelps) is now offsite.**
- **Acceptance procedures - QA**
  - status
    - initiated a QA program prior to acceptance of the building to study:
      - Electrical,
      - mechanical,
      - building control,
      - power consumption and optimization of power factors

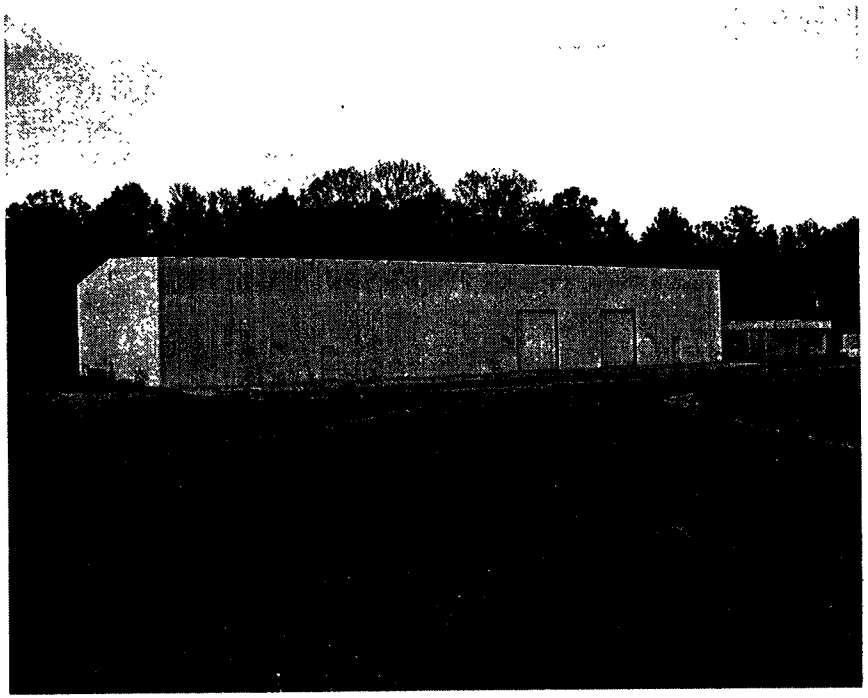
(Note that there are no building inspectors in Livingston parish, so QA needed to insure code requirements .)

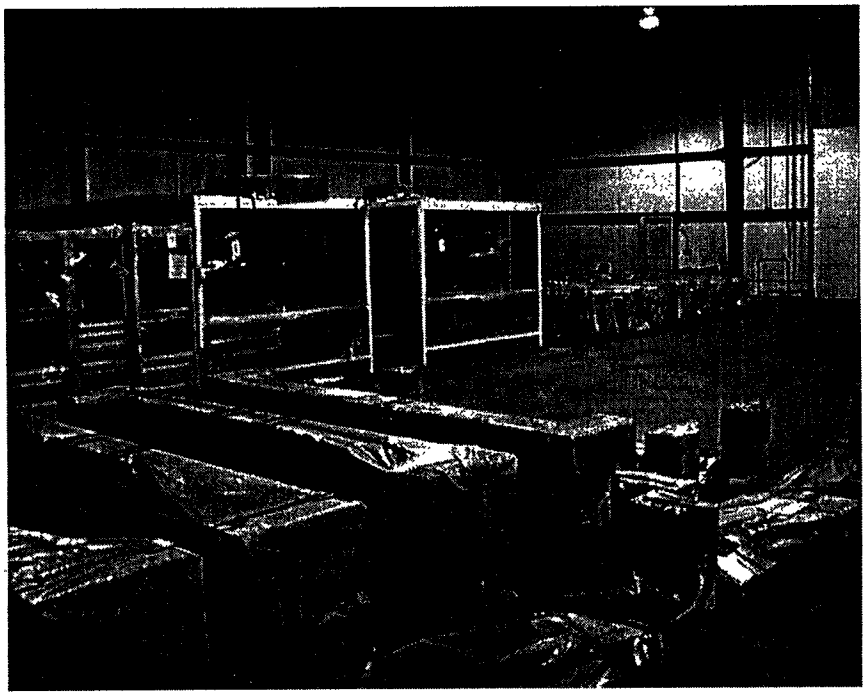
  - Preliminary indications are that we have some deficiencies in the electrical work that need to be remedied.
  - Other outstanding issues on which we are working
    - Maintenance contract - bids received, expect to have in place < Dec. 1
    - panel blistering
    - vault leaks
    - Access road
    - Erosion control and landscaping

Preparations for detector installation

- Staffing Plan
  - Two scientists now resident (Coles, Rizzi)
  - Offer extended to one additional scientist
  - 50% of Site Manager (Gerry Stapfer) and 50% of Site Administrator (Bonnie Wascom) this FY
- 5 other resident staff now fulfilling construction related activities that will transition to detector installation and site sustaining activities.
- We plan two add 2 additional engineering staff in FY99
  - electrical engineer
  - software engineer
- We plan to add two scientific staff as joint appointments with the Univ. of Florida in FY99.

Staging building





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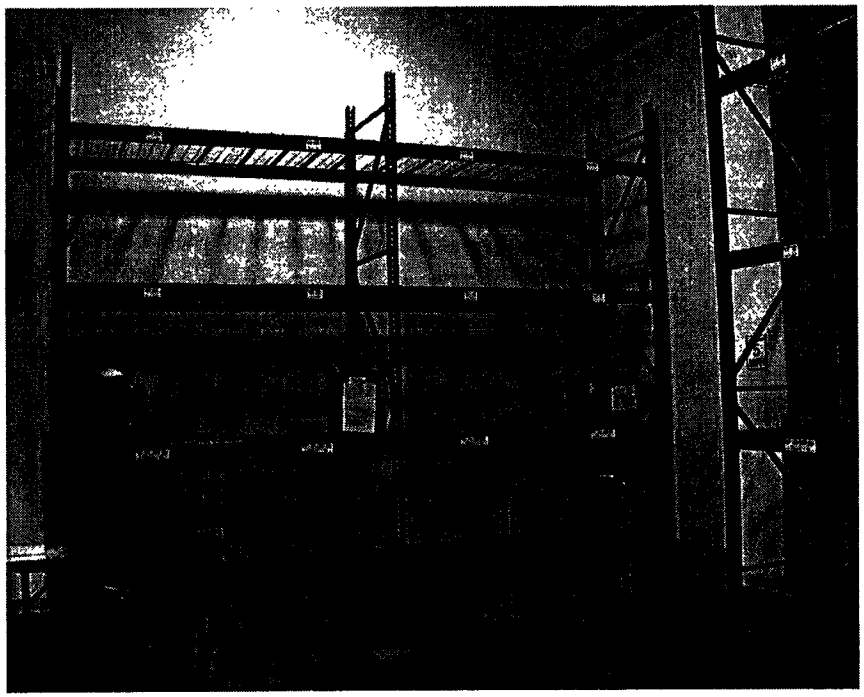
Material handling



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Multipurpose room

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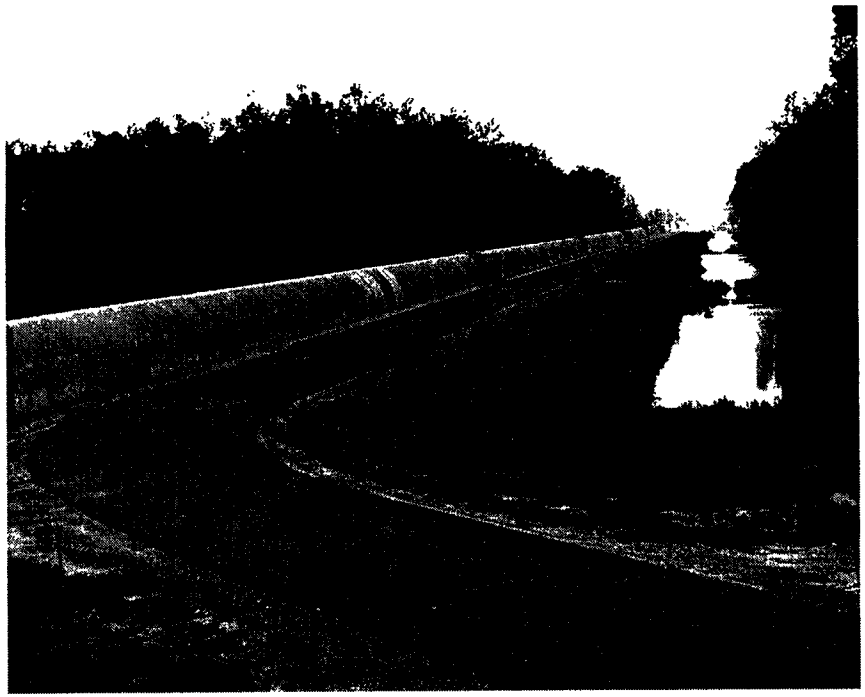
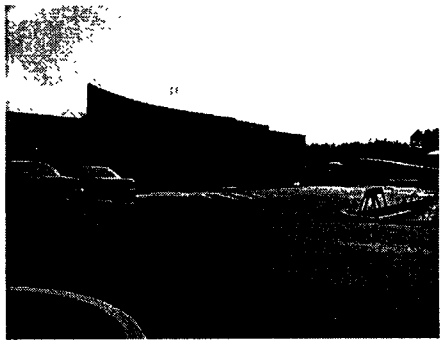
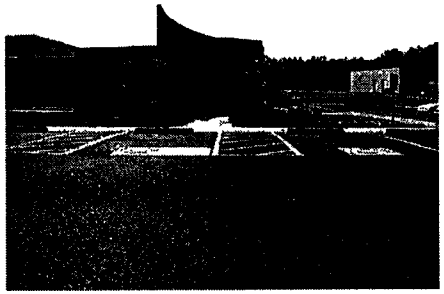
Asphalt roads along arms







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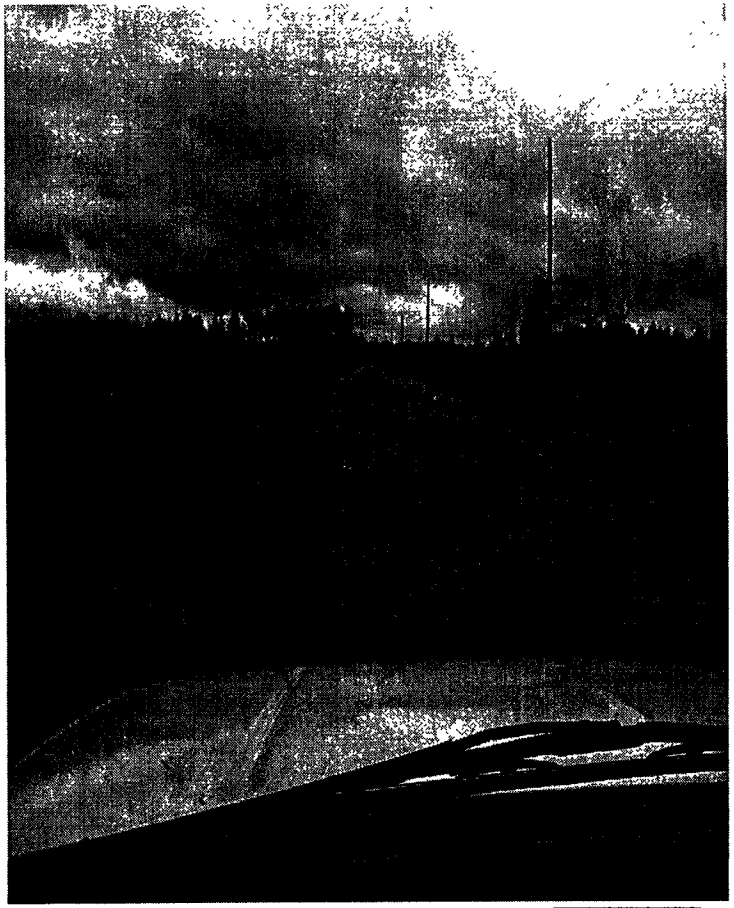
Lab set up

Electrical lab

Mechanical lab

State provided access road -

We are working with LSU and the La DOT to make sure that we get an all weather road.



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FY 99 LLO Staffing Detail

Operations Staff	Name	FTE
Observatory Head	Coles	1
Senior Scientist	Offer extended	0.5
Staff Scientist	Rizzi	1
Staff Scientist	Shu (U of FL joint appt)	0.25
Staff Scientist	Yoshida (U of FL joint appt)	0.25
Observatory Manager	Stapfer	1
Administrator	Wascomb	1
Sr. Mechanical Engr.	Sibley	1
Electrical Engr	Open	0.5
Software Engr.	Open	0.5
Optics Specialist	Kern	0.67
Operations Specialist	Riesen	1
Operations Specialist	Svoboda	1
	TOTAL	*9.67*
Bakeout Staff	**Name**	**FTE**
Vacuum Specialist	Franklin	1
Operations Specialist	Stiff	1
Long term visitors		
Tom Evans	MIT	

Detector Installation Preparation Activities

- **Vacuum preparation and optics labs:**
  - **Clean areas**
  - **Install cabinets, optics tables, low conductivity water system, laser curtains, vacuum bake out oven, etc.**
- **Procure and set up electrical lab, mechanical lab**
  - **Install benches, test equipment, tools, parts, cables, consumable items, etc.**
- **Set up material handling, tracking, inventory systems**
  - **shelves, pallets, lifting eqpt, forklift, clean room handling eqpt and supplies, etc.**
- **Set up control room**
- **Set up open office areas for visiting staff**
- **We are learning from Hanford's experience so that when we do things in Livingston we benefit from that prior experience.**

Educational Outreach

- **Pursuing opportunities to provide educational outreach resources to the local community.**
  - Louisiana State University
  - Southeastern Louisiana University
  - Louisiana Tech University
  - Loyola University
  - East Baton Rouge, Livingston, and St. Tammany Parish schools
  - Louisiana School for Math and Science
  - LaSIP (Louisiana Systemic Initiative)
  - Louisiana Board of Regents
- **Plan to have on-site REU opportunities summer FY99**
- **Some student hiring during school year**

Summary of Activities Underway

- Completion of major subcontracts and remedy of remaining construction problems
- Preparation for detector installation scheduled to begin in January
- Development of educational outreach partnerships with the local community