



		IDENTIFICATION			
		FABSEQ			
TITLE	BEAM TUBE CAN SECTION FABRICATION SEQUENCE	REFERENCE NO.		SHT 1 OF 17	
		930212			
PRODUCT	LIGO BEAM TUBE MODULES CALIFORNIA INSTITUTE OF TECHNOLOGY	OFFICE		REVISION	
		PCR		2	
		MADE BY	CHKD BY	MADE BY	CHKD BY
		GLW	KHF	WLR	SWP
		DATE	DATE	DATE	DATE
		2/3/94	4/5/94	5/2/95	5/12/95

1.0 SCOPE

This procedure outlines the fabrication sequences to be followed during the stiffener attachment, expansion bellows installation, pump port installation, testing and cleaning of the beam tube assemblies. Detail or supporting procedures for welding, testing, cleaning, etc. are referenced as required.

The following section headings are included:

- 2.0 Fabrication Sequence
- 3.0 Testing Sequence
- 4.0 Cleaning Sequence
- 5.0 Referenced Procedures
- 6.0 Sequence Diagram and Sketches

2.0 FABRICATION SEQUENCE

- 2.1 Deliver factory tube sections, stiffeners, pump port materials, weld materials, etc. to receiving area. Valves, blind flanges and associated bolting furnished by others will also be received at the storage area and handled in a similar manner.
- 2.2 Visually inspect factory tubes, stiffeners, pump port materials, welding materials, etc. for shipment damage and compare to shipping papers or packing list.

Note

Factory Tubes, Expansion Bellows, Stiffeners,
Pump Port Materials and Valves will have
inspection and factory release papers with shipment.

- 2.3 Complete material receiving reports for all contract materials received at the site will be prepared. The receiving report will have attached any applicable inspection, certification, release, shipping manifests or other related documents.



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2.4 Store beam tube cans or other materials in designated receiving storage area.

Warning

Do not perform any welding
or tacking on beam tubes until proper
backing purge has been established.

Use nylon slings and designated rigging for
handling beam tubes and expansion bellows.

Do not use screw clamps or chains for handling beam tubes.

2.5 Move beam tube to desired stiffener fitting and weld area.

Note:

Clean clothing and shoe covers shall be worn
for all work inside the beam tube.

2.6 Mark beam tube serial number identification on beam tube exterior using CBI approved ball point paint markers or paint stencil with 3" high letters. Markings to be a minimum of three places approximately 120° around on each end of bare beam tube can section.

Mark location of machined support stiffener and all other stiffeners. Indicate beam tube can section final installation direction at each end of beam tube can section and location of expansion bellows and pump port, if applicable. Layout pump port reinforcing ring, if applicable. Verify that pump port reinforcing ring does not cross spiral weld.

Note

For convention, beam tube
direction is outward from apex.



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Note

Pump port layout to be between spiral welds so that reinforcing ring welding does not cross spiral weld. Rotate tube as required to obtain required spacing.

- 2.7 Slide on and rough position near final location all vacuum stiffeners.

Reference

See
Fitting/Purge Procedure for Stiffener
Attachment Welds for LIGO
Doc ID "FPStiffener"

- 2.8 Install machined support stiffener(s) with bolts (no welding). Machined stiffener halves to be placed in final position.
- 2.9 Set beam tube in stiffener fit-up and weld area. Position end turning trunnion and opposite end support.
- 2.10 Purge beam tube interior with nitrogen gas. Purge until oxygen level is less than 1.0% oxygen. End point to be verified with oxygen analyzer. Upon reaching 1.0% oxygen, establish nitrogen flow rate to a minimum flow rate necessary to maintain adequate purge level (light positive flow).
- Purge to be maintained at less than 1.0% oxygen within tube. Check periodically during any tacking and welding operation.
- 2.11 Tack machined support stiffener(s).
- 2.12 Final position, fit and tack balance of stiffeners. Vacuum stiffener splice to be positioned over tube spiral weld. Do not tack within 2" of spiral weld.
- 2.13 Weld machined support and vacuum stiffeners.



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Note:

Do not weld on or over the beam
tube can section spiral weld.

Reference

See

Weld Procedure Specification for Stiffener Welds
Doc ID "WPS-ER308L/Stiffener"

- 2.14 Fit and weld pump port reinforcing ring, if applicable. Verify prior to welding that pump port reinforcing ring does not cross spiral weld.

Reference

See

Weld Procedure Specification for
GMA Welding for 304L Materials
Doc ID "WPS-ER308L/GMA"

- 2.15 Steps 2.16 thru 2.29 are for installation of expansion bellows. Skip if not applicable to specific beam tube can section.

- 2.16 Move stiffened tube section can section to expansion bellows fit/weld area.

Reference

See

Fitting/Purge Procedure for
Circumferential Butt Welds for LIGO
Doc ID "FPCircumferential"

- 2.17 Start aligning expansion bellows using mechanical alignment jig. The expansion bellows needs to be mechanical rough aligned (no tacking or welding) to allow installation of the inflatable purge ring.



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Warning

**Do not perform any tacking
or welding at this time.**

Note:

**Clean clothing and shoe covers shall be worn
for all work inside the beam tube.**

2.18 Install inflatable purge ring, centered on weld seam, and connect 3/8" diameter stainless steel purge/evacuation lines listed below:

- a) Annular space vent line (weld purge gas).
- b) Ring seal pressure line (nitrogen ring seal gas).
- c) Annular space pressure/purge line (weld purge gas).

See "Weld Joint Purging Arrangement" or sketch on page 12 of 17 of this fabrication sequence.

2.19 Inflate purge ring outer seals by opening valve on nitrogen ring seal gas supply holding inflatable purge ring in position centered on the beam tube/expansion joint weld joint to be welded. Regulator should be set at 5 psig.

2.20 Open evacuation line valve and annular space pressure line valve allowing 100% Argon backing purge gas to purge annular space. Purge until oxygen level is less than 1.0% oxygen. End point to be verified with oxygen analyzer. Upon reaching 1.0% oxygen, establish Argon flow rate to a minimum flow necessary to maintain adequate purge level (light positive flow).

Warning

**Welding or tack welding at weld
joint to be only performed after
completion of the above weld purge.**

2.21 Complete fit up of weld joint. Tack welding is allowed at this step. See visual inspection procedure DOC ID "VI8X" for fit up check.

Reference



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See
**Weld Procedure Specification
 for Circumferential Welds**
 Doc ID "WPS-ER308L/Circumferential"

- 2.22 Set up and position automatic weld equipment and complete welding of beam tube weld joint.
- 2.23 Shut valve on annular space pressure/purge line to 100% Argon weld purge gas.
- 2.24 Valve on annular space evacuation line should be open and remain open.
- 2.25 Shut nitrogen ring seal gas supply.
- 2.26 Open purge ring outer seal vent valve
- 2.27 Close both evacuation valves associated with annular space evacuation line and purge ring outer seals after venting stops and weld joint purge ring has slackened.
- 2.28 Disconnect and remove the three (3) 3/8" diameter stainless steel purge/evacuation lines.
- 2.29 Remove inflatable purge ring.
- 2.30 Steps 2.31 thru 2.41 are for installation of pump port. Skip if not applicable to specific beam tube can section.
- 2.31 Move stiffened tube section to pump port fit and weld area.

Reference

See
**Fitting/Purge Procedure for Pump
 Port Attachment Welds for LIGO**
 Doc ID "FPumpPort"

Note:

Clean clothing and shoe covers shall be worn
 for all work inside the beam tube.



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- 2.32 Install internal purge diaphragm, set-up and cut nozzle opening for 10" nominal pump port nozzle.
- 2.33 Grind cut edges per fitting procedure.
- 2.34 Install and fit pump port nozzle. Purge with 100% Argon until oxygen level is less than 1.0% oxygen and tack on outside. Perform visual inspection and add clean filler material to areas where gap exceeds .010" using WPS-ER308L/REPAIR.
- 2.35 Weld external of pump port nozzle.

Reference

See

Weld Procedure Specification
for Pump Port Welds
Doc ID "WPS-ER308L/Port"

- 2.36 Install external purge unit and purge with 100% Argon until oxygen level is less than 1.0% oxygen.
- 2.37 Complete welding inside of pump port nozzle.
- 2.38 Complete grinding per drawing.
- 2.39 Visually inspect and repair per procedure any required areas using 100% Argon purge on the appropriate side.
- 2.40 Remove external purge unit and internal purge diaphragm.
- 2.41 Install temporary pump port blind flanges.
- 2.42 Install end caps.
- 2.43 Move beam tube assembly to post fab storage area. The beam tube assembly shall be supported using temporary cribbing or loaded on transfer trailers while in storage to avoid contact with mud or other contamination.

3.0 TESTING SEQUENCE



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- 3.1 Move beam tube assembly to test area and remove end caps.
- 3.2 Perform pretest cleaning and black light testing cleaning procedure.

Reference

See

Cleaning of Completed Tube Can Sections
Doc ID "CLIN"

- 3.3 Perform visual examination noting any suspect areas.
- 3.4 Perform leak test on beam tube can section.

Reference

See

Helium Mass Spectrometer Hood Test
of Beam Tube Can Sections
Doc ID "HMST1N"

- 3.5 Complete test records for beam tube can section.
- 3.6 Steps 3.7 thru 3.11 are for repeat Time of Flight testing and repair of beam tube assemblies that have failed previous test. Skip if not applicable to specific beam tube section.
- 3.7 Perform visual examination noting any suspect areas.
- 3.8 Perform "Time of Flight" test noting any leak or leaks.
- 3.9 Perform weld repair using appropriate purge method depending upon area to be repaired. Repair per specific contract welding procedures.
- 3.10 Perform leak test on beam tube can section per "Helium Mass Spectrometer Hood Test of Beam Tube Can Sections."



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3.11 Complete test records for all repaired beam tube can sections.

3.12 Install end caps.

3.13 Move beam tube can section to post test storage area.

4.0 BEAM TUBE CAN SECTION CLEANING

4.1 Move beam tube assembly to cleaning area and remove end caps.

Note:

Beam tube can sections should be cleaned
as required by installation requirements
with limited storage time between final
cleaning and installation.

4.2 Set-up for beam tube assembly cleaning locating movable end clean enclosures at each end of beam tube assembly. Cleaning rack to be sloped to allow drainage from beam tube assembly. Drainage to be towards opposite end from expansion bellows, if applicable.

Reference

See

Cleaning of Completed Tube Can Sections
Doc ID "CL1N"

4.3 Clean interior of beam tube can section.

4.4 Dry interior of beam tube can section.

4.5 Install cleaned end protection caps and polyethylene bagged double seal. Do not use tape on the beam tube interior or on the beam tube exterior within 6 inches of the end.

4.6 Complete cleaning records for beam tube can section.



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4.7 Move cleaned and sealed beam tube can section to post clean storage area. The beam tube assembly shall be supported using temporary cribbing or loaded on transfer trailers while in storage to avoid contact with mud or other contamination.

5.0 REFERENCED PROCEDURES

This fabrication sequence is to be used in conjunction with the following procedures:

- 5.1 Planned Approach to Leak Testing for LIGO Project
Doc ID "LIGOTP"
- 5.2 Helium Mass Spectrometer Hood Test of Beam Tube Can Sections
Doc ID "HMST1N"
- 5.3 Cleaning of Completed Tube Can Sections
Doc ID "CL1N"
- 5.4 Fitting/Purge Procedure for Circumferential Butt Welds for LIGO
Doc ID "FPCircumferential"
- 5.5 Welding Procedure Specification for Circumferential Welds
Doc ID "WPS-ER308L/Circumferential"
- 5.6 Welding Procedure Specification for Pump Port Welds
Doc ID "WPS-ER308L/Port"
- 5.7 Welding Procedure Specification for Stiffener Welds
Doc ID "WPS-ER308L/Stiffener"
- 5.8 Welding Procedure Specification for GMA welding of 304L materials
Doc ID "WPS-ER308L/GMA"
- 5.9 Welding Procedure Specification for repair welding of 304L materials
Doc ID "WPS-ER308L/REPAIR"



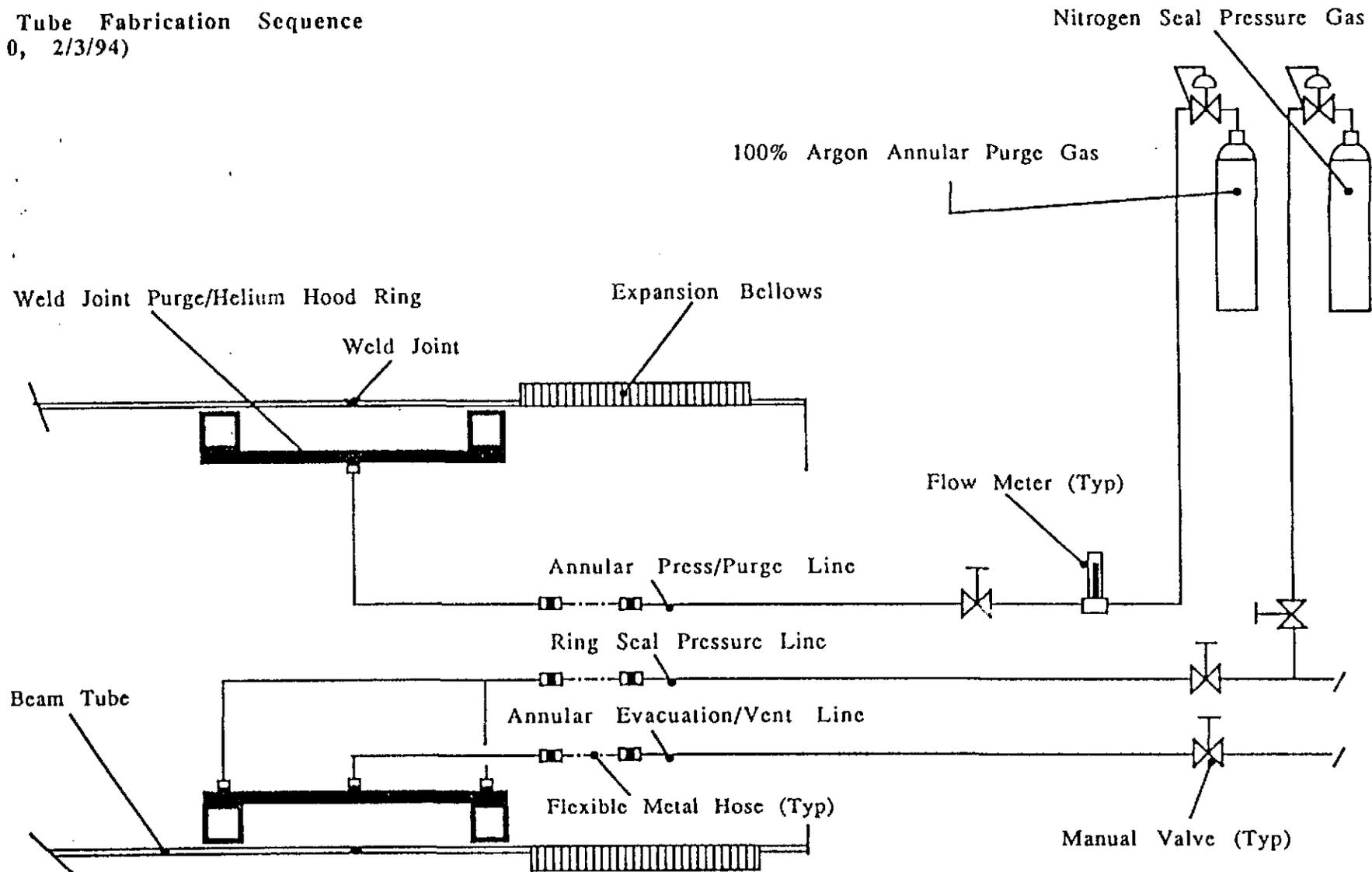
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		FABSEQ			
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6.0 SEQUENCE DIAGRAM AND SKETCHES

Attached find the following related to this fabrication sequence:

- 6.1 Weld Joint Purging Arrangement
(Page 12 of 17)
- 6.2 Beam Tube Fabrication Sequence Logic Diagram
(Page 13 of 17 to Page 17 of 17)

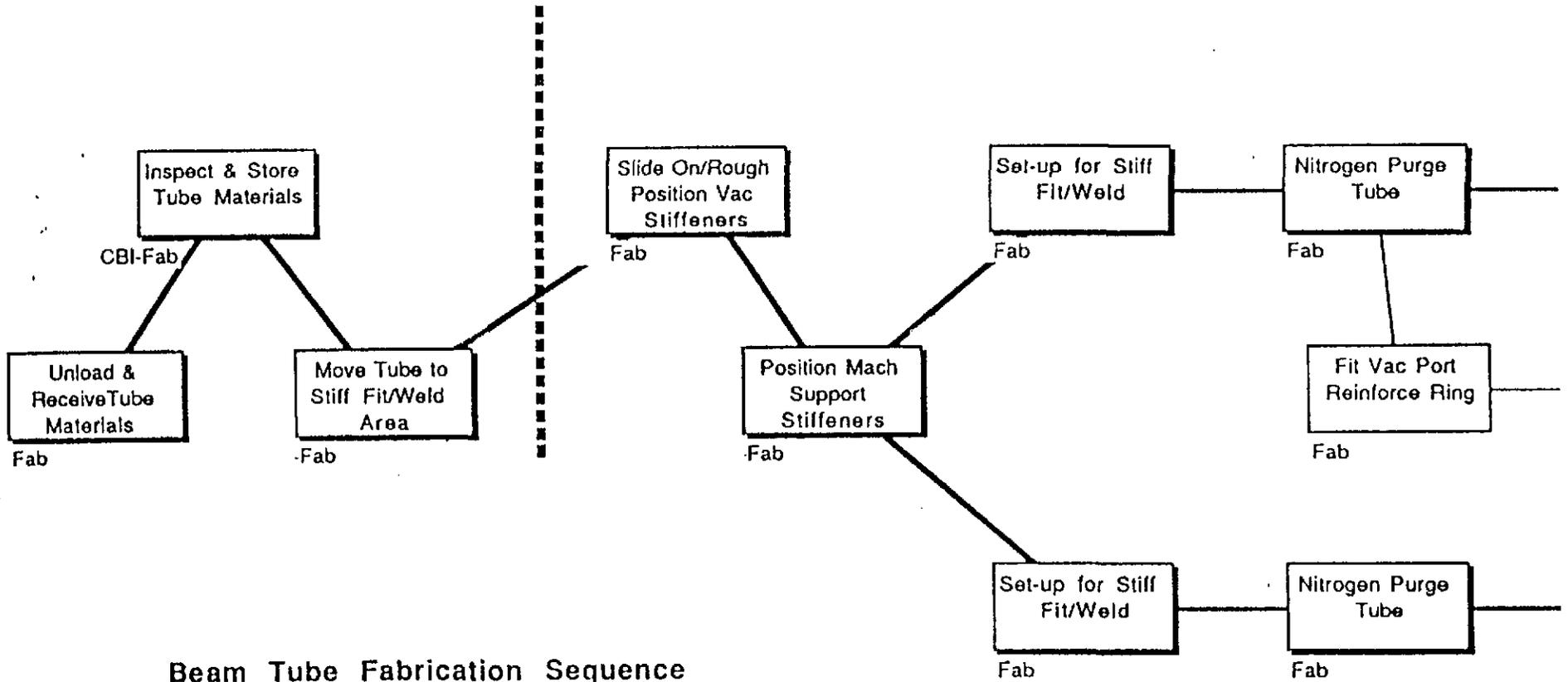
Beam Tube Fabrication Sequence
(Rev 0, 2/3/94)



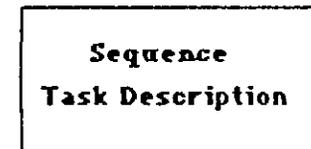
Weld Joint Purging Arrangement

**** Pre Fab Storage ****

..... Fabrication Tasks



Beam Tube Fabrication Sequence
LIGO

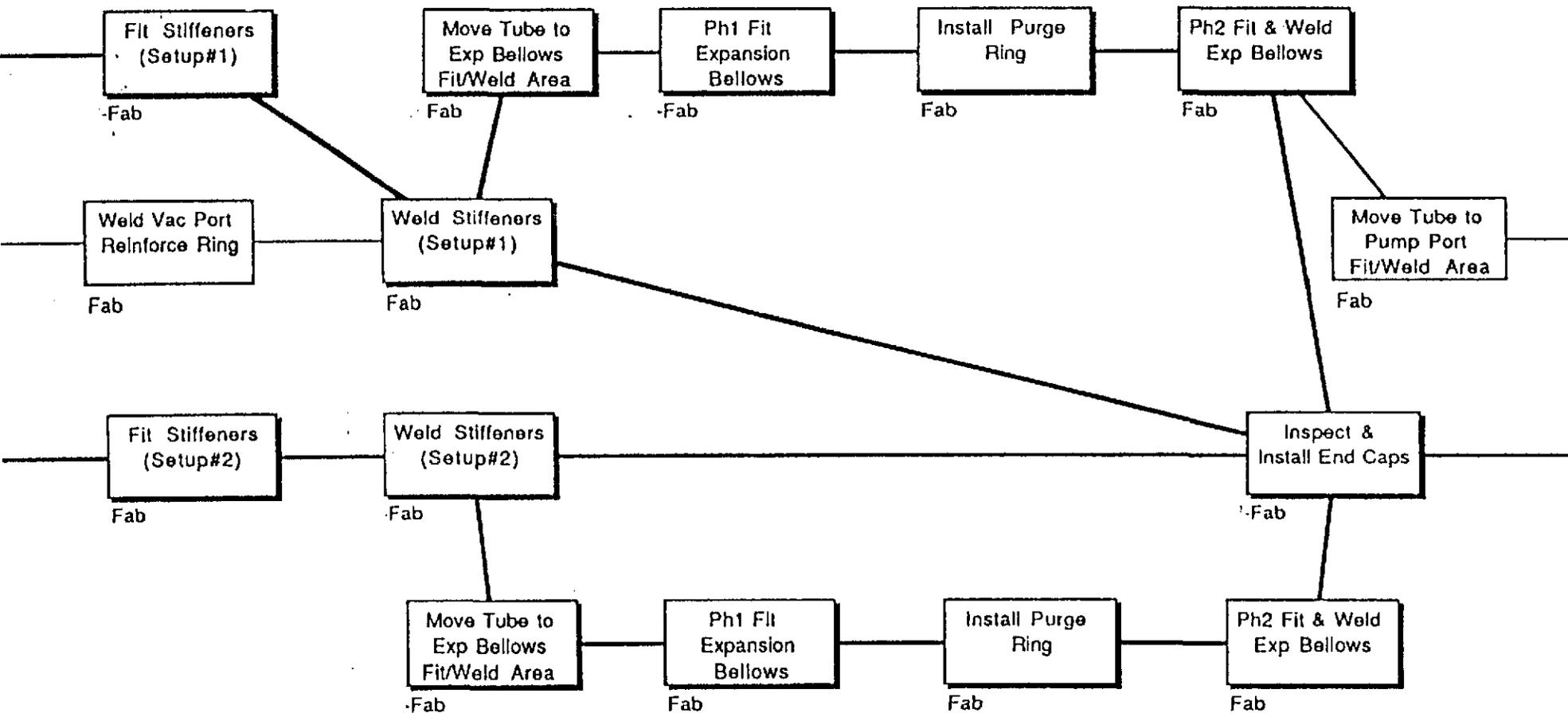


Resource

Fabrication Sequence
Legend

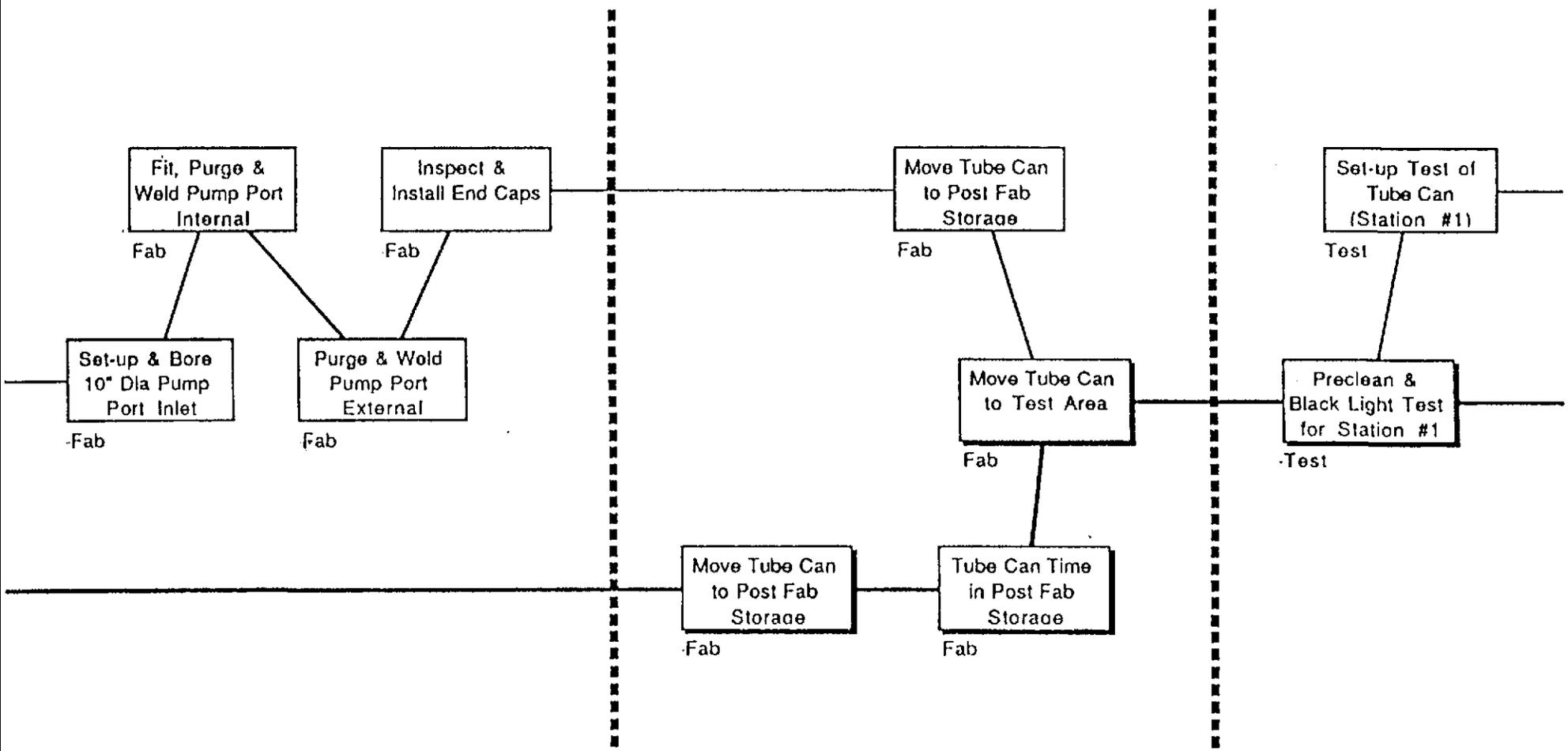
Hanford, WA & Livingston, LA
Rev 0, Jan 20, 1994

Fabrication Tasks (Continued)

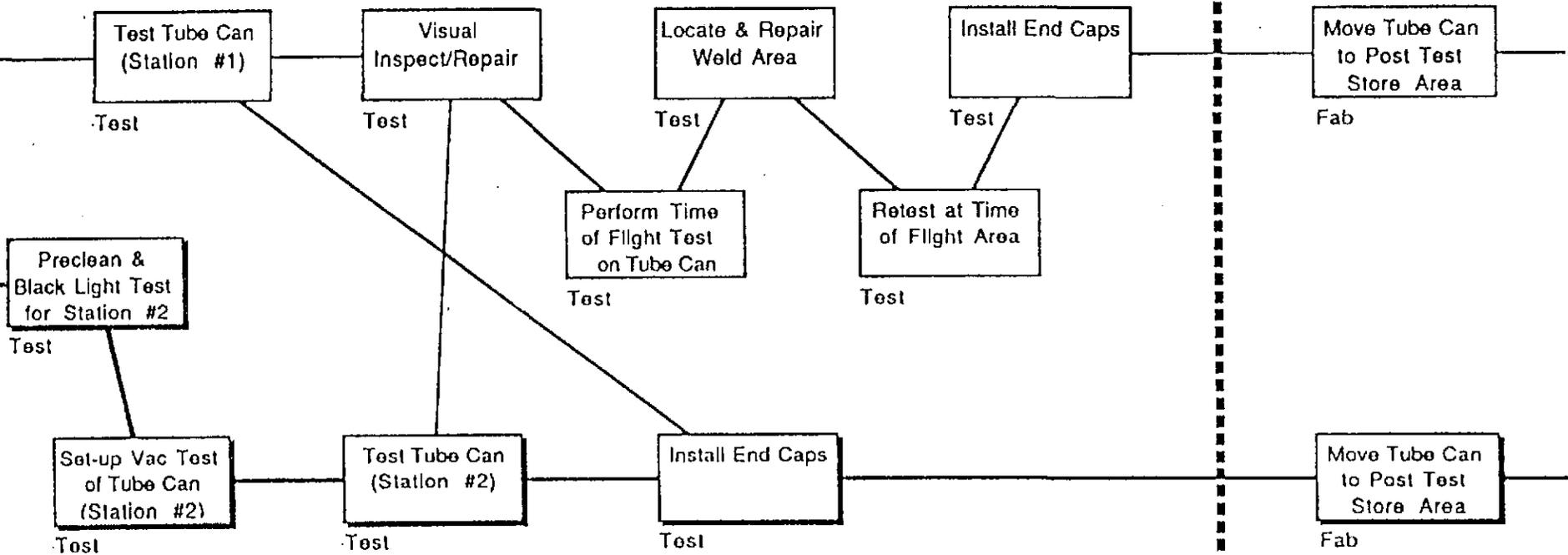


**** Fabrication Tasks (Cont)*****

***** Post Fab Storage *****



Testing Tasks



Post Test Storage

..... Cleaning Tasks

** Post Clean Storage **

