



INSTALLATION SPECIFICATION

TITLE

LBSC4 INSTALLATION (LIVINGSTON X-END STATION BSC)

APPROVALS:		DATE	APPROVALS:		DATE
DRAWN:	Dennis Coyne	2/22/00	CHECKED:	--	--
CHECKED:	Ken Mason	2/22/00	CHECKED:	--	--
CHECKED:	Mike Smith	2/22/00	DCN NO	APPROVED	DATE
CHECKED:	Jonathan Kern	2/22/00	E000104-00-D	Dennis Coyne	2/24/00

Instructions on the use of this document:

- 1) Laminate this procedure (or place it in a plastic sleeve) and have it available at all times during the installation. Check off items as the installation proceeds. (Clean the plastic with isopropyl alcohol and handle it as a class B tool per M990034). Also laminate the LOS installation procedure for BSC chambers (E000062) and have it available during the installation to follow along.
- 2) Use this installation procedure as a check list for preparation and during the installation. Note any discrepancies or deviations and augment with any missing definition. File any significant notes or data from the completed procedure in the electronic logbook (such as any deviations); as a minimum note in the electronic logbook that the installation was completed in accordance with this procedure (cite document number and revision).

1 SCOPE

This installation specification covers the initial installation of the in-vacuum detector components in the BSC chamber at the x-end station (also referred to as the 'right' or 'west' end station) after the seismic isolation system has been installed. It also covers the installation of associated equipment outside of the chamber. The in-chamber equipment installed include the End Test Mass (ETM) Suspension (D960132), the ETM Transmission Telescope (D990053) and the ETM beam dump. The in-vacuum equipment layout is defined in D000056. The equipment installed outside the chamber include the optical lever (D-pending) and the ETM transmission monitor (D980341).

The calibration of the optical levers and the diagonalization of the suspension controller are tasks to be done subsequent to this installation and are not covered in the scope of this document.

2 APPLICABLE DOCUMENTS

Listed below are all of the applicable and referenced documents for this installation procedure. This list gives the latest revisions of the documents; Within the installation steps, only the document number (and not the revision) is quoted.

D960132-B	Large Optic Suspension (LOS) Assembly for End Test Mass
E000033-A	Large Optic Suspension Table (associates the LOS and the appropriate height adapter)
D990053-00	ETM Telescope Note: Drawing not yet filed in the DCC.



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D-pending	ETM Beam Dump Note: The ETM beam dump appears in drawing D000056. A separate beam dump assembly does not currently exist.
D000068-A	Access Cable
D980499-04	ASC Equipment Layout (Louisiana site) Note: This drawing will be revised to: 1) Add a VP800-AR1064 viewport to adapter LA-1E, port P1 for a cavity alignment camera. 2) Delete the VP800-AR1064 viewport designated E1 at location LBSC4-C2G5. Instead a COS viewport is placed at this location for the transmitted beam monitor. (Viewport designations are per D980228, D980229)
D000056-00	LBSC4 In-Vacuum Equipment Layout
D000054-A	LBSC4 Cable and Weight Layout
D-pending	ETM Optical Lever Assembly Note: The ETM optical lever assembly drawing does not currently exist.
D980341-00	ETM Transmission Monitor
D000073-A	COS Viewport
D980228-00	Naming Conventions for Ports on Adapters
D980229-00	BSC Port Designations for Doors
D980227-00	Naming Conventions for BSC Chamber Ports
M990034-B	Contamination Control Plan
M980086-C	Conflat Flange Assembly Procedure
M990202-00	Conflat Leak Testing Procedure
M980133-B	Vent Isolatable Volumes
M980101-B	Procedure for Isolatable Volume Pump Down
M-pending	Spool removal procedure Note: Draft procedure was sent for comment; will be finalized soon.
M980136-A	HAM Chamber Access Door Removal Procedure Note: No procedure currently exists for BSC door removal with the engine hoist; Adapt this procedure in the meantime.
E970154-C	Large Optic Suspension Balancing Specification
E000107-00	ETM Telescope Assembly Procedure



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E000062-C	LOS Installation Procedures for BSC Chambers
T970151-04	Initial Alignment Procedures
M000011-00	Standard Operation Procedure (SOP): COS Infrared Alignment Laser Operation in the LLO VEA
T990088-01	COS IFO Alignment Procedure Note: This document explicitly covers the alignment of 2 km interferometer ETM, but the procedure is identical or the 4km interferometer. Figure 10 in this document shows the alignment layout schematically for chamber WBSC6, but is missing the chamber, optics table, etc.
E000065-04	Chamber Entry/Exit Checklist



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3 PRE-REQUISITES

- 1. The seismic isolation system should be installed and the bellows checked to be leak tight.
- 2. Counterweights and in-vacuum cabling should be in-place in accordance with drawing D000054
- 3. The full payload weight should have been placed on the table for a period of 4 weeks or more.
- 4. A BSC cleanroom must be in place over LBSC4 and operable.
- 5. The vacuum equipment purge air system must be operable before starting the installation.
- 6. The ETMx Suspension assembly and check-out must be completed (per E970154) on a table in the optics lab in a clean room space with class 100 HEPA filtered air.
- 7. The ETMx suspension controller, field wiring and satellite electronics box must be installed.
- 8. The transmission monitor must be in-place on it's pier adjacent to the BSC chamber.
- 9. The ETM transmission telescope assembly and alignment must be completed in advance on an optics table in a clean room space with class 100 HEPA filtered air.

4 PREPARATION

All preparation must be in accordance with the Contamination Control Plan (M990034).

- 1. Clean the VEA, particularly the floor; Particulates and dust should be removed by mopping with clean water.
Clean the BSC chamber (wipe or mop with clean water) from the stiffening ring above the door down, as well as the floor in the vicinity of the chamber well in advance of the opening of the vacuum system.
- 2. Insure that there are no large openings to the exterior or the beam tube enclosure where insects or dust can get into the VEA.
- 3. Transport a small (~6' x 10') portable clean room with class 100 HEPA panels to the x-end station.
- 4. Transport the ETM Transmission telescope and alignment equipment to the X-end station.
- 5. Stage the required viewports and protective covers at the x-end station:
 - two VP800-AR635 viewports
 - two VP800-AR1064 viewports
 - one VP800/450009 viewport
 - one COS viewport, D00073 (CVI coated optic, not the REO coated optic)
 - one camera housing
 - one illuminator housing



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- 6. Measure the axial distance between the front surface of the ETM optic and the effective reflecting surface of the IAS prism when mounted on the installation fixture. Make this measurement to within 1 mm and in the optics laboratory.
- 7. Transport the LOS suspension installation fixtures for a BSC chamber installation (defined in E000062-C) to the x-end station in advance of the installation.
- 8. Transport the ETMx suspension assembly to the x-end station just prior to needing it for installation, per the detailed steps in E000062.



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5 INSTALLATION STEPS

All installation must be in accordance with the Contamination Control Plan (M990034).

Sequence: The following steps are in a logical and workable sequence. However some of the steps can be done in parallel and some steps can be done at other points in the sequence.

- 1. Survey IAS monuments as defined in T970151
Notes:
 - 1) The height of the installation will be defined by the current height of the SEI optics table (which is set for minimal bellows deflection). The survey should determine the height of the LBSC4 chamber flange centerline scribe marks in global coordinates (or relative to the VE/BT monument height). In the event of a significant discrepancy, the chamber height will be used for setting up the alignment instruments.
 - 2) It is likely that the BSC SEI optics table is ~5 mm high, compared to it's nominal position relative to the chamber center. This is expected and will not be compensated by translation of the table.
- 2. Vent the x-end station volume (per procedure M980133)
- 3. Install a COS viewport (drawing D000073 with a CVI coated optic) on the BSC chamber south door on port G5 (i.e. location LBSC4-C2G5) per D000056 and in accordance with the conflat flange assembly procedure (M980086).
Notes:
 - a) Do not install a VP800-AR1064 viewport as shown in D980499-04, designated item E1, at this location.
 - b) Port location designations are per D980229.

Caution: Put protective covers on the viewports!
- 4. Install a VP800/450009 uncoated viewport for the IAS illuminator (viewport D8 of D980499 at location LBSC4-G8) and place an illuminator housing over the viewport.
Install a VP800-AR1064 viewport for the IR camera (viewport C8 of D980499 at location LBSC4-G5) and place a camera housing over the viewport.
Installation are to be in accordance with the conflat flange assembly procedure (M980086).
Note: Port location designations are per D980228.
Caution: Put protective covers on the viewports if the housings are not available!



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- 5. Install three IAS viewports on the LA-1E spool flange per D980499 and in accordance with the conflat flange assembly procedure (M980086):
 - a) a VP800-AR635 viewport, designated item A11 of D980499, at location LA-1E-P3 for the optical lever transmitter
 - b) a VP800-AR635 viewport, designated item A12 of D980499, at location LA-1E-P6 for the optical lever receiver
 - c) a VP800-AR1064 viewport (not shown on D980499-04) at location LA-1E-P1 for a cavity alignment IR camera.Note: Port location designations are per D980228.
Caution: Put protective covers on the viewports!
- 6. Remove the spool (adapter LA-1E) per procedure M-pending. Cover the opening towards the corner station with CpStat or a cleanroom cloth cover. Cover the tube opening towards the chamber with a cloth cover and then with a cleanroom placed so that the spool span is not in the cleanroom.
- 7. Setup the IAS theodolite/autocolimator bench in the open spool.
- 8. Setup for the Initial Alignment of the ETM optic in accordance with the procedure, T970151. The baseline plan is to use the IAS red laser autocolimator (670 nm wavelength) off of the High Reflectance (HR or front) surface of the ETM. As a fallback if the HR surface reflectivity of the ETMx optic is not high enough for the IAS autocolimator (670 nm wavelength), the Anti-Reflectance (AR or rear) surface will be used. The alignment solutions for both approaches are defined in T970151. The basic steps are as follows:
 - a) Setup brunson transit on IAS monument and align.
 - b) Setup total station and autocolimator on the IAS bench over the IAS monument.
 - c) Co-boresight the theodolite and laser autocolimator.
 - d) Set the height and orientation of the theodolite.Note: Refer to the notes on height under the IAS monument survey step above (step number 1)
- 9. Remove the north chamber door (per procedure M980136). Cover openings with cloth covers.
- 10. Execute relevant entry QA checks from E000065
- 11. Remove the stack of counterweights designated as ersatz weights for the ETM telescope in D000054.
Install the ETM telescope on the BSC optics table with the aluminum clamps and 1/4-20 bolts and washers per the layout in D000056



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- 12. Install the ETMx suspension per E000062. There are basically three stages to the installation:
 - a) Transport the suspension from the Optics lab to the x-end station VEA.
 - b) Install the fixtures (support beam, shuttle table, lift table, tilt table, breadboard).
 - c) Install the suspension.
 - d) Align the ETMx optic.Notes:
 - 1) Procedure E000062 is the governing document for this part of the installation and defines the coordination required with initial alignment defined in T970151.
 - 2) Version C of E000062 details how to confirm the functionality of the suspension. This check should be performed at this point in the installation.Complete through step 49 of E000062-C, then **place the suspension on it's chamfer stops!**
- 13. Install the access cable (D000068) from the kapton cable connector to the optics table. This cable is inserted into the J2 connector in the position adjacent to the Side (S) OSEM connector (see the sketch on page 9 of E000062). Record the position of the table connection of this cable as an "as-built" mark-up for drawing revision.
- 14. Align the lateral position of the ETM Telescope: Use the IAS theodolite (placed on the cavity axis) to site targets placed at the entrance and exit of the ETM telescope
- 15. Swap the IAS theodolite/laser autocollimator with the COS laser autocollimator and the appropriate mount to set the COS aperture center to be on the cavity axis.
- 16. Check the levelness of the optics table; Adjust the counterweights if/as required to achieve levelness as defined in E000062.
Back of the ETMx chamfer stops by 1 mm.
- 17. **Transition to a Laser Hazard Condition per the COS Alignment SOP, M000011.**
- 18. Autocollimate off of the HR surface of the ETM optic.
Secure the ETMx optic with the chamfer stops!
Align the ETM Transmission telescope and the transmission monitor per T990088
- 19. Install and position the beam dump to catch the reflected beam from the viewport, using the LBSC4 layout (D000056) as a guide.
Record the position of the beam dump on the layout drawing, as an "as-built" mark-up for drawing revision.
- 20. **Transition to a Laser Safe condition.**
- 21. Remove the COS laser autocollimator and the IAS bench.
- 22. Install the IAS optical lever support structure (except for the receiver column).
- 23. Remove the clean room over the spool section.
Re-install the spool (reverse procedure M-pending)



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- 24. Install the optical lever receiver column, receiver and transmitter per drawing D-pending
Roughly align the transmitter, so that the optical lever laser beam hits the ETM optic.
- 25. Recheck the optics table levelness and release the ETM optic by backing off the chamfer stops approximately 1 mm
- 26. Align the optical lever transmitter and receiver, while the optic is under damping control:
 - a) adjust the transmitter so that the front surface reflection is near the center in the receiver port
 - b) adjust the position of the receiver on it's support column so that the laser beam is near the center of the steering mirror.
 - c) using an opaque or translucent card, adjust the steering mirror until the beam is centered in the opening for the quad detector
 - e) adjust the steering mirror until the x and y quad detector outputs are near zero (as measured with the optical lever breakout box)Install optical lever light path and viewport covers.
(Note: This is step 50 of E000062-C with more detail.)
- 27. Perform steps 51 through 55 of E000062-C. Starting with **securing the optic with the chamfer stops** and ending with cleaning the optic with the CO2 snow gun.
- 28. Execute relevant chamber exit checks per E000065.
Release the chamfer stops.
(Note: This is steps 56 and 57 of E000062-C with more detail.)
- 29. Re-install the chamber doors per M980132.
- 30. Pump down the BSC chamber volume per M980101
- 31. Leak test the conflat flanges which were added to the vacuum volume (five ASC viewports and one COS viewport) per M990202. The COS viewport has a viton o-ring seal against the optic. Leak testing for the COS viewport may require sealing this path with an outer conflat flange to prevent confusion from helium diffusion through the o-ring.