LIGO

CALIFORNIA INSTITUTE OF TECHNOLOGY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

DOCUMENT CHANGE NOTICE (DCN)

DCN No. E970126-00-D

SHEET 1 **OF** 1

DOCUMENT No. (DOC-REV-GP. ID)	**TITLE**	**NEW REV.**
D960785-A-D	RECYCLING MIRROR SUBSTRATE	B
E960092-A-D	SUBSTRATE, RECYCLING MIRROR	B

CHANGE DESCRIPTION (FROM/TO):

Specification Changes which will be incorporated in E960092-B-D
The registration mark will be inscribed within 5 mm of the mark drawn on the mirror blank.

Polish from a 5 micrometer grit.

Delete “Data shall be taken from side 1......side 2" from page 4

Side 1 Radius of Curvature 14,900 meters -150m, +750
Astigmatism < 10 nm (surface peak to valley)

Inspection method for scratches and point defects:
1. The surface is examined visually by two observers independently. The examination is done against a dark background using a three-bundle fiberoptic illumination system of 200 W total power. A 100% inspection of the surface is carried out. Pits and scratches down to 2 micrometers in width can be detected using this method of inspection. Any scratches that are detected will be measured using a calibrated eyepiece.

REASON FOR CHANGE: Update documentation to incorporate definition of wedges, change of radius of curvature and other details negotiated with the Polisher.

ACTION: ☐ **Incorporate change** ☐ **Attach DCN to drawing(s)** ☐ **Other action (specify):**

DISPOSITION OF HARDWARE (IDENTIFY SERIAL NUMBERS)

☐ **No hardware affected (record change only)**
☐ **List S/Ns which comply already:**
☐ **List S/Ns to be reworked or scrapped:**
☒ **List S/Ns to be built with this change:** All
☐ **List S/Ns to be retested per this change:**
☐
☐
☐
☐

DCN DISTRIBUTION

Althouse	Barish	Coles
Coyne	Lazzarini	Lindquist
	Sanders	Shoemaker
Stapfer	Tyler	Vogt
Weiss	Whitcomb	

Billingsley Petrac
Kells

SAFETY, COST, SCHEDULE, REQUIREMENTS IMPACT? ☐ **No** ☐ **Yes (If yes, enter CR (CCB) or TCP (TRB) no.** **)**

APPROVALS:		**DATE**	**OTHER APPROVALS (specify)**	**DATE**
ORIGINATOR:	Billingsley G. Billingsley	8-4-97		
TASK LEADER:	Camp J. Camp	8/11/97		
GROUP LEADER:	Whitcomb SE Whitcomb	8/11/97		
DCC RELEASE:	L Turner	8/12/97		

LIGO Form DCN-01 (3/96)

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DOCUMENT CHANGE NOTICE

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SHEET 2 **OF** 2

CHANGE DESCRIPTION (FROM/TO): CONTINUED

2. Further inspection will be done with a 6X eyeglass using the same illumination conditions, again with two observers. Sleeks down to 0.5 micrometers wide can be detected using this method. The surface will be scanned along one or two chords from centre to edge, then at ten positions around the edge, and ten to fifteen positions near the centre.
3. An inspection is then carried out with a dark field microscope with a similar sampling frequency as described in section 2.

Drawing changes which are incorporated in D960785-B-D

Wedge angle changed to 2 degrees 24 minutes

Tolerance of +- 30 minutes on location of registration mark WRT minimum thickness

Etch changed to “etch OR GRIND” in 3 places

Maximum thickness is changed to 97.5 +0, -0.5mm

REV	DATE	DRAWN BY	CHECKED	DCC	DCN/DESCRIPTION
A	9-3-96	C. CONLEY	D. COYNE		E960113/INITIAL RELEASE
B	8-11-97	C. CONLEY			E970126-00-D

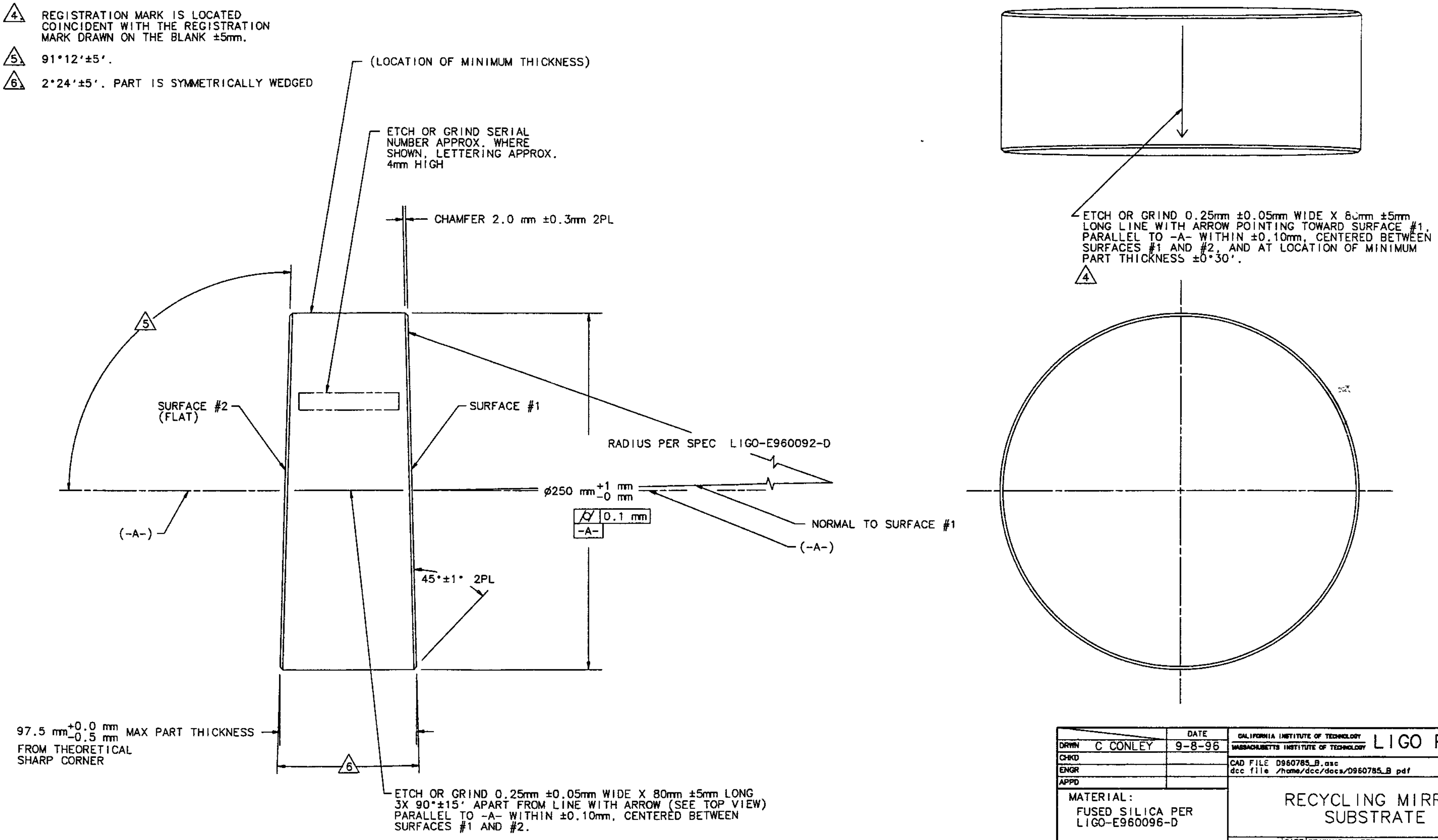
NOTES: (UNLESS OTHERWISE SPECIFIED)

1. ALL DIMENSIONS ARE IN MILLIMETERS AND DEGREES-MINUTES.
2. DRAWING TO BE INTERPRETED PER ANSI Y14.5M-1982.
3. POLISH ALL FACES, EDGES AND CHAMFERS PER SPECIFICATION LIGO-E960092-D.

△4 REGISTRATION MARK IS LOCATED COINCIDENT WITH THE REGISTRATION MARK DRAWN ON THE BLANK ±5mm.

△5 91°12'±5'.

△6 2°24'±5'. PART IS SYMMETRICALLY WEDGED



	DATE
DRWN C CONLEY	9-8-96
CHKD	
ENGR	
APPD	

MATERIAL:
FUSED SILICA PER LIGO-E960096-D

DO NOT SCALE DRAWING

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LIGO PROJECT

CAD FILE D960785_B.asc
dcc file /home/dcc/docs/D960785_B pdf

RECYCLING MIRROR
SUBSTRATE

SCALE NTS
SIZE B
DRAWING NUMBER D960785-B-D
SHEET 1 OF 1

LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY	E960092	- B - D
COMPONENT SPECIFICATION	DRWG NO.	REV. GID
	SHEET 1 OF 4	

TITLE

SUBSTRATE, RECYCLING MIRROR

APPROVALS:		DATE	REV	DCN NO	BY	CHK	DCC	DATE
DRAWN:	G. Billingsley	8/9/97			n/a	n/a	n/a	n/a
CHECKED:	J. Camp	8/11/97						
APPROVED:	Whitcomb	8/11/97						
DCC RELEASE:	Turner	8/12/97						

Applicable Documents

LIGO-D960785-B-D	Recycling mirror Substrate
LIGO-E960096-B-D	Mirror Blank Material, Recycling Mirror
LIGO-D970504-A-D	Recycling Mirror Blank

Requirements

Physical Configuration

According to

LIGO-D960785	Recycling mirror Substrate

Fabricate from

LIGO-E960096	Mirror Blank Material, Recycling Mirror

Serial Number

The Serial number shall be of the format:

RMYY-Z Where

YY	is incremental for each optic starting at 01.
Z	is the current revision letter of this Specification.

Registration Mark

Registration mark shall be etched, ground or sandblasted coincident with the registration mark drawn on the Blank within 5 mm. The arrow orientation used on the Blank will be preserved if possible or changes reported in detail. Reference LIGO-D960794, Core Optic Blank.

Side and Bevel Polish

Sides and Bevels shall be polished from a five micrometer grit finish. These surfaces shall appear transparent with no grey, scuffs or scratches visible to the naked eye when viewed in normal room light against a black background.

TITLE

SUBSTRATE, RECYCLING MIRROR

Scratches and Point defects

Scratches

The total area of scratches within the central 80 mm diameter shall not exceed 75 X 10^3 square micrometers (width times length.)

The total area of scratches outside the central 80 mm diameter shall not exceed 750 X 10^3 square micrometers.

Point Defects

There shall be no more than 30 point defects within the central 80 mm diameter

There shall be no more than 100 point defects on the entire surface

Point defects of radius greater than 25 micrometers are treated like scratches for the purpose of this specification. Point defects of radius less than 2.5 micrometers are disregarded.

Inspection Method

1. The surface is examined visually by two observers independently. The examination is done against a dark background using a three-bundle fiberoptic illumination system of 200 W total power. A 100% inspection of the surface is carried out. Pits and scratches down to 2 micrometers in width can be detected using this method of inspection. Any scratches that are detected will be measured using a calibrated eyepiece.
2. Further inspection will be done with a 6X eyeglass using the same illumination conditions, again with two observers. Sleeks down to 0.5 micrometers wide can be detected using this method. The surface will be scanned along one or two chords from centre to edge, then at ten positions around the edge, and ten to fifteen positions near the centre.
3. An inspection is then carried out with a dark field microscope with a similar sampling frequency as described in section 2.

Surface Figure, measured over the central 200 mm diameter

All specified quantities refer to the physical surface of the optic.

Surface 1: Spherical, concave
Radius of curvature: 14,900 meters +750 meters, -150 meters
Astigmatism: < 10 nanometers (surface peak to valley)

Surface 2: Flat
Radius of curvature > 160 kilometers
Astigmatism: < 32 nanometers (surface peak to valley)

Surface Errors, Surface 1 and Surface 2

All specified quantities refer to the physical surface of the optic.
The following root mean square standard deviation (σ_{rms}) values are calculated from the phase maps which are to be provided with each optic. σ_{rms} is defined as the square root of the mean of the square of each pixel value. Known bad pixels are excluded from this calculation.

Low Spatial Frequency Band: $\leq$ 4.3 cm $^{-1}$
With piston, tip, tilt, power (best fit spherical surface) and astigmatism removed over the central 200 mm diameter aperture:
$\sigma_{rms} < 3.2$ nanometers

With piston, tip, tilt, power (best fit spherical surface) and astigmatism removed over the central 80 mm diameter aperture:
$\sigma_{rms} < 1.6$ nanometers

High Spatial Frequency Band: 4.3 - 7,500 cm $^{-1}$
$\sigma_{rms} < 0.4$ nanometers
Measured at the following locations:
1. The center of the mirror substrate.
2. Four positions equally spaced along the circumference of a centered, 80 mm diameter circle.
3. Three positions equally spaced along the circumference of a centered, 200 mm diameter circle.

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COMPONENT SPECIFICATION

E960092 - B - D	
DRWG NO.	REV. GID
SHEET 4 OF 4	
CONTINUATION SHEET	

TITLE

SUBSTRATE, RECYCLING MIRROR

Specification	Test Method	Frequency of Inspection	Data Delivered
Physical Dimensions	Visual Inspection	100%	Diameter, Thickness, Bevel dimension, Wedge angle.
Side and Bevel Polish	Visual Inspection	100%	Inspection Report included with Certification
Scratches and Point defects	Visual Inspection	100%	Hand sketch including scratch/ pit dimensions
Registration Mark Location/Orientation	Visual Inspection	100%	Inspection Report included with Certification
Registration Mark Dimensions	Visual Inspection	100%	Inspection Report included with Certification
Identification Location	Visual Inspection	100%	Inspection Report included with Certification
Identification Serial number	Visual Inspection	100%	Inspection Report included with Certification
Surface Figure	Interferometry	100%	Surface Map
Surface Errors - Low Spatial Frequency	Interferometry	100%	Surface Map
Surface Errors - High Spatial Frequency	High resolution Surface Map	100%	Surface maps for 3 central locations. Numerical values included with Certification

Data:
Orientation: For the purpose of all data collection the Registration mark shall be at the top center of the optic.

Format: All Data shall be delivered according to Table 1. In addition to the hard copy the Surface Data shall be delivered on IBM PC compatible disk or via electronic file transfer in ASCII format. Phase difference data shall be in units of nanometers.