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October 25, 1999

Professor G.E. Otto Widera
Marquette University
Department of Mechanical Engineering
1515 W. Wisconsin Avenue
Milwaukee, Wisconsin 53233

Reference: 9th International Conference on Pressure Vessel Technology

Subject : LIGO Beam Tube Module Design, Fabrication, and Installation

LIGO Project and Chicago Bridge and Iron Company

Dear Professor Otto Widera,

You should have received two copies of the LIGO paper on October 22 along with separate discettes containing the text and pictures. I did not enclose a copy of the cover page and synopsis with the submittal. An updated cover sheet and synopsis are attached. The cover page has been revised to show my current E-mail address and the synopsis has been revised to replace "CBI" with "Chicago Bridge and Iron Company".

I hope that the submittal meets your needs. Please call me if you have any questions or need any additional information. Thank you.

Regards,

Marty Tellalian

M. L. Tellalian
Plainfield Engineering

Title of Paper: LIGO Beam Tube Module Design, Fabrication & Installation
LIGO Project Document Number LIGO-P990007-00-B

Authors: Lance Buboltz, CB&I
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Topic: B. Materials and Manufacturing of Components
4. Factory and on-site manufacturing techniques

Date of Posting: October 21, 1999

Institution: Chicago Bridge and Iron Company and the LIGO Project. The LIGO Project is a scientific collaboration of the California Institute of Technology (Caltech) and the Massachusetts Institute of Technology (MIT) and is funded by the National Science Foundation.

Country of Origin: United States of America

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Synopsis
LIGO Beam Tube Module Design, Fabrication, and Installation
LIGO Project Document Number LIGO-P990007-00-B

LIGO (Laser Interferometer Gravitational-wave Observatory) is an instrument for sensing the dynamics of matter in the distant reaches of the cosmos using laser interferometry. LIGO does this by detecting gravitational waves - ripples in the fabric of time and space - created by violent events such as the collisions of stars and the vibrations of black holes. LIGO's interferometers will be the world's largest precision optical instruments. As such, they are housed in two of the world's largest vacuum systems. The observatory is made up of two separate facilities with L shaped vacuum beam tubes which are each composed of (4) 2-kilometer long, 1245 mm diameter beam tube modules. The unprecedented sensitivity of the LIGO detector requires an unobstructed path for the laser between the suspended mirrors. The beam tubes must be essentially leak free, clean, and composed of material with very low outgassing characteristics. Under the direction of the LIGO Project, Chicago Bridge and Iron Company (CB&I) designed, fabricated, erected and tested the beam tube modules at two separate facilities. Important developments were made in the areas of material processing, mobile fabrication, spiral welded tube fabrication, leak detection, field clean room construction, and alignment. This paper describes the developmental and installation process and the resulting configuration, procedures and equipment used by CB&I to successfully build the LIGO beam tube modules.