STRUCTURAL TECHNOLOGY, INC.

77 North Washington Street • Boston, Massachusetts 02114 • (617) 523-2691

December 26, 1989

Society for the Preservation of New England Antiquities
185 Lyman Street
Waltham, MA 02154

Attention: Andrea Gilmore

Re: Harvard College Observatory - Structural Report

Dear Ms. Gilmore:

On December 13, 1989 the author conducted a brief structural inspection of the structure designated as the Harvard College Observatory located in Cambridge, Massachusetts.

The information contained in this report represents the results of a visual inspection only; only minor destructive examinations were undertaken and these are noted in the report.

Appendix No. 1 contains Photograph Nos. 1 to 14 which are referred to throughout the report. In several of the photographs a rule device is used for dimensional reference; it is marked in increments of one inch, six inches and one foot with a total height of five feet.

Our report is divided into the following areas of analysis:

A. First Level Floor System Assessment

B. Observatory Room Interior Conditions

1. Results of Dome Investigation

2. Second Level Floor Examination

C. Exterior Conditions Observed

Our statements of opinion concerning this structure are as follows:

A. FIRST LEVEL FLOOR SYSTEM ASSESSMENT

The wood dome and two floor levels of the structure are supported by brick exterior walls which lie above a granite foundation. The telescope was placed on top of a centrally located truncated cone of what appears to be solid granite masonry extending from the basement foundation to the observatory floor. Each floor level is similarly constructed and was originally intended to be completely free of the telescope support masonry.

Elements of the first level floor system are illustrated by Photograph No. 1. Our comments concerning this level are as follows:

1. The radially located floor joists extend from the exterior wall to the interior granite telescope foundation. They were intended to be cantilevered from the braces shown in Photograph No. 1 in effect forming a bracket. The floor joist connection at the exterior wall is shown in Photograph No. 2. Since a tension tie does not exist at this location, the floor boards act somewhat as a series of compression rings to resist the inward movement of the cantilevered bracket.

2. Two conditions have altered the loads which the floor must now carry. As shown in Photograph No. 3. extensive piping and ductwork materials are supported directly from the floor joists and/or brackets. More importantly the first level has undergone a change of use and has become, in our opinion, a main egress corridor. The present Code would in effect require that this floor be capable of resisting 100 pounds per square foot of load in addition to the work hung from it below.

3. Evidence exists that the floor has sagged and that it is not functioning as originally intended. Such sag would have occurred as the wood members underwent shrinkage or as loads were increased over the original quantities. Photograph No. 4 indicates that many of the floor joists are now in fact supported by the telescope support masonry. Furthermore, a cementitous levelling slab was placed on the floor surface, presumably to correct problems caused by deflection.

A number of loose conditions were observed at the exterior brace supports such as that shown in Photograph No. 5. This would occur if the interior portion of the floor joist was supported by the telescope masonry rather than being free of it. Many braces have been wedged and several are missing as

shown in Photograph No. 6.

4. A far more rigorous structural investigation and analysis is required to ascertain whether the present system can be utilized to support the Code stipulated loads but based upon present information, we feel that reinforcement is required. Two approaches or combination thereof are suggested.

A series of segment beams supported on columns could be added to support the interior end of the floor joist. Alternatively, the existing system could be reinforced to carry the additional loads. We favor this latter approach since it follows the original design intent; however, the brackets support beams located at the corners of the structure will most certainly require replacement or modification.

5. We also observed minor mortar washout at localized areas of the exterior granite foundation.

The repair costs required in this section are estimated between $15,000 and $20,000.

B. Observatory Room Interior Conditions

B1. Results of Dome Investigation

Four openings were made into the interior of the dome to ascertain the conditions within. The following items were noted:

1. The dome had obviously experienced leakage and/or condensation problems in the past; however, at all locations, including that at the aperture doors, present moisture content reading of the wood were less than 7%. No evidence of present leakage through the dome was observed.

2. Very slight surface rot was observed at the vicinity of the aperture door at the location designated by Photograph Nos. 7 and 8. No rot was observed at other locations.

3. Moderate nail rust was observed near the base of the dome; loose boarding does exist but we do not believe that repair is mandatory at this time. If the exterior copper sheathing is ever replaced, however, such reattachment as may be required should be undertaken.

4. The dome rests upon a laminated tension ring which is shown in Photograph No. 8. The aperture door was installed in such a manner that a portion of the ring was severed. Although a slight tilt in the ring was observed, the ring is

supported upon and bolted to a cast iron track and the dome is sheathed on two sides with wood boarding. Based upon present information and the fact that the dome loads are low, we do not feel repair of this defect is warranted.

5. The dome ring was vertically drilled through its entire depth to ascertain if an accumulation of water in the cast iron track caused any rot damage. No rot damage was discovered.

6. Concern was expressed regarding the iron aperture door mechanism and its attachment to the dome. This assembly is shown in Photograph No. 9. We observed that a number of original square head lag screws or bolts had been replaced with new hex head through bolts.

As long as the mechanism is used solely for the purpose for which it was designed, we feel, based upon present information, that it can adequately carry the aperture door loads. However, since the mechanism must travel with the dome, its lower portion is not supported horizontally. Significant leverage could be developed to damage the assembly and overstress the bolts if, for example, a number of individuals were allowed to lean against the mechanism.

B2. Second Level Floor Investigation

The second level or observatory room floor utilizes a floor support system very similar to that at the first level which has been previously described in Section A above. Photograph No. 10 illustrates the typical conditions below the floor surface. The floor braces are concealed behind the wood framing for the lower plastered dome. Our comments concerning this area are as follows:

1. Because the telescope is supported on a truncated cone foundation, the floor joists at this level cantilever a far greater distance than those on the first floor. We feel that the observatory room floor should not be treated as a "public assembly area" because this would require that the floor carry 100 pounds per square foot of load. The floor is not capable of sustaining such forces.

Rather, the maximum occupancy should be restricted to approximately 15 people at any one time. This would not, in our opinion, involve a significant change in use.

2. As shown by Photograph No. 11 one area of localized floor joist rot was discovered at the exterior wall. The condition could be corrected by attaching a supplementary support to the face of the brick.

3. In our opinion the plaster dome supports shown in Photograph No. 10 contributed significantly to the strength of the existing floor.

C. Exterior Conditions Observed

The following defects and conditions were observed on the exterior of the structure.

1. Elements of the exterior surface are shown in Photograph No. 12. We observed significant sag at the underside of the overhang. As shown by Photograph No. 13 sections of this area have been shored. This situation has resulted more from nail detachment and flashing failure than from a deterioration of the structural members which support the roof immediately above the overhang. We estimate that repair and relining of the gutter combined with new flashing and support for the underside will cost approximately $20,000.

2. Deterioration of the exposed wood casing of the aperture door was observed. If the aperture door is to remain sealed and no further repairs are to be made to it, epoxy consolidation of the wood will be required. If the door is to remain permanently closed, we recommend that the area be flashed.

If you have any questions or comments regarding the items discussed, please call us at your earliest convenience.

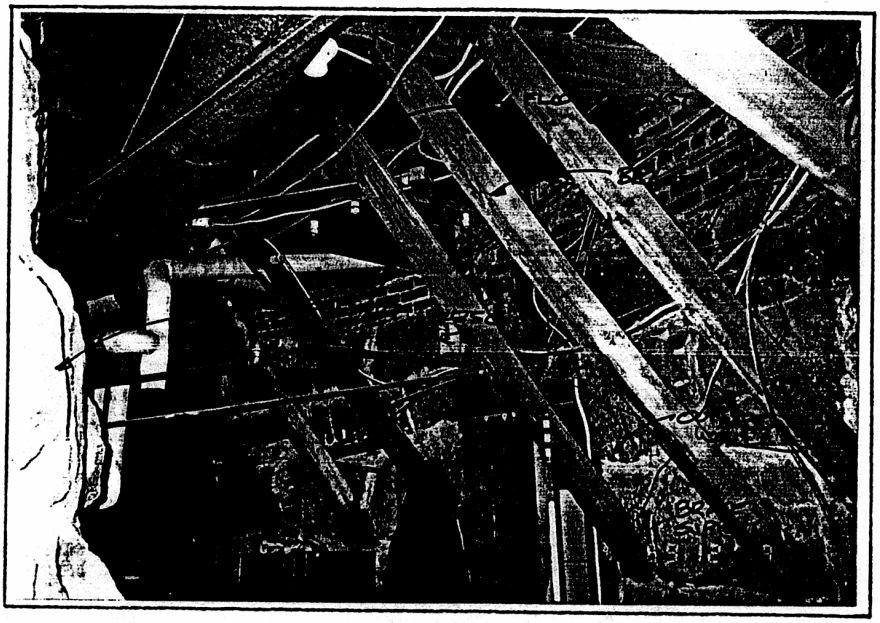
Very truly yours,

Conor M. Power, Pres.
STRUCTURAL TECHNOLOGY INC.

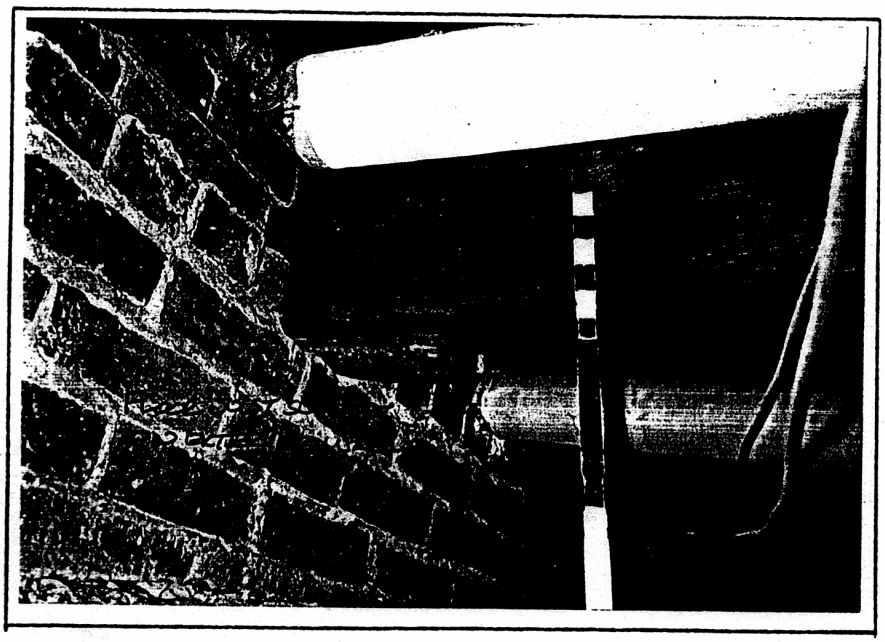
ATTACHMENTS

1. Appendix No. 1 - Photograph Nos. 1 to 14

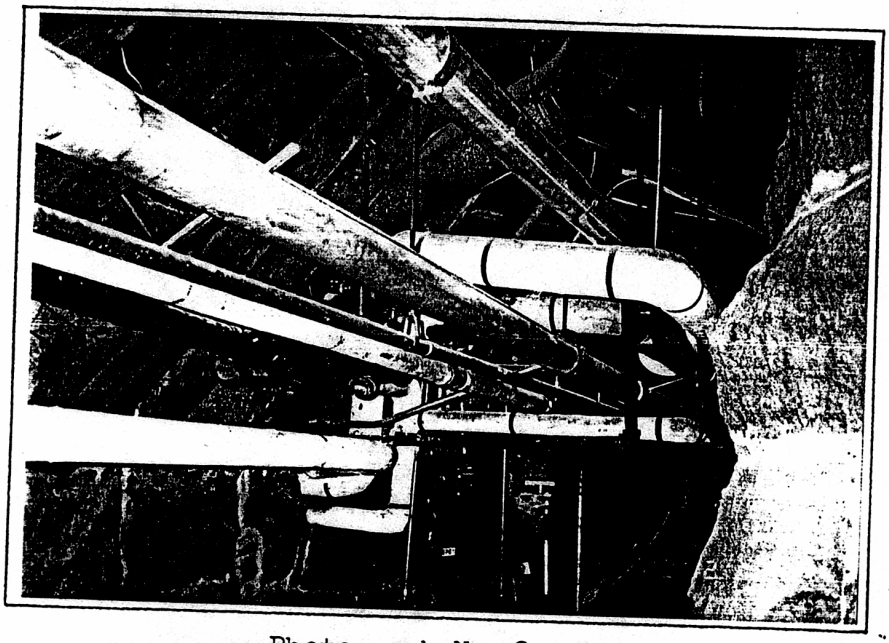
Appendix No. 1 - Photograph Nos. 1 to 14



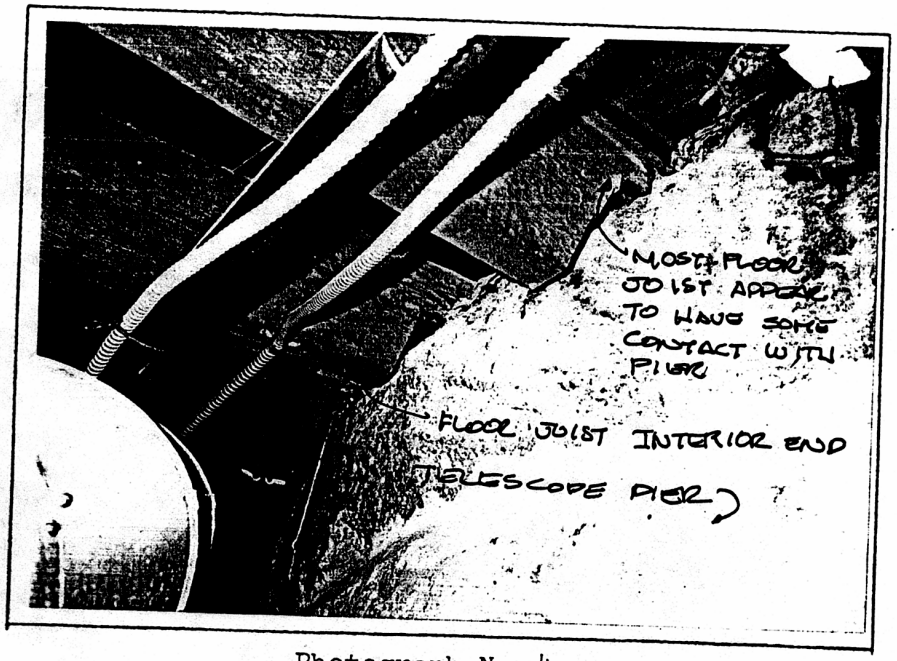
Photograph No. 1



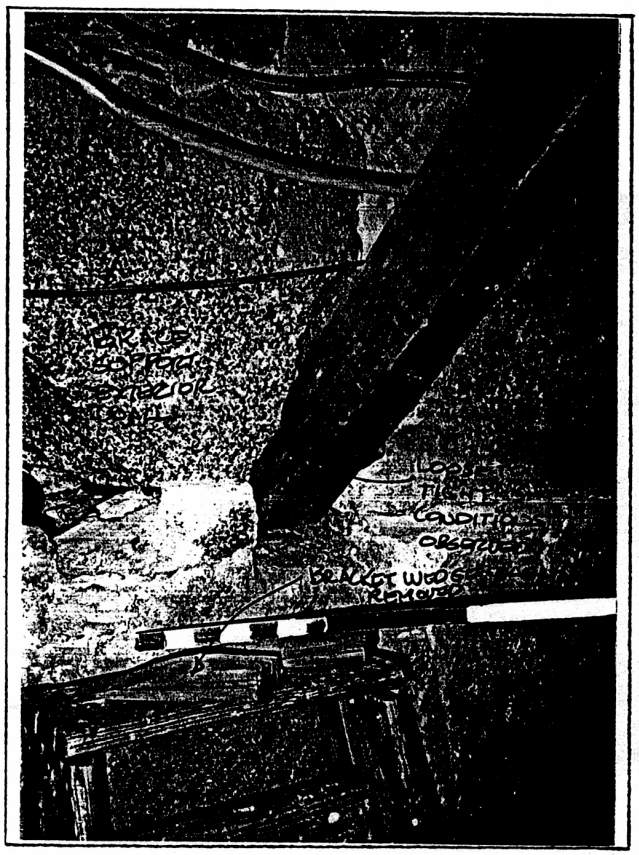
Photograph No. 2



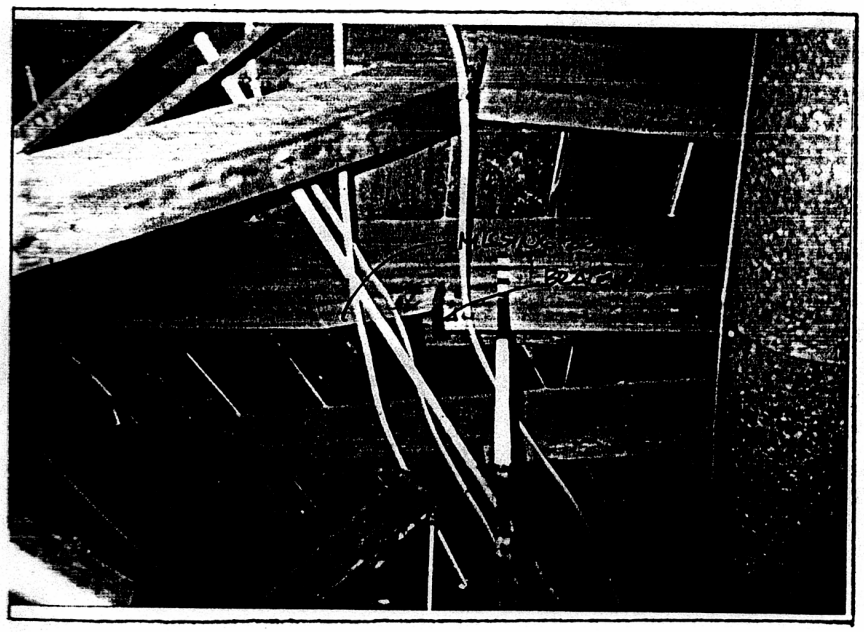
Photograph No. 3



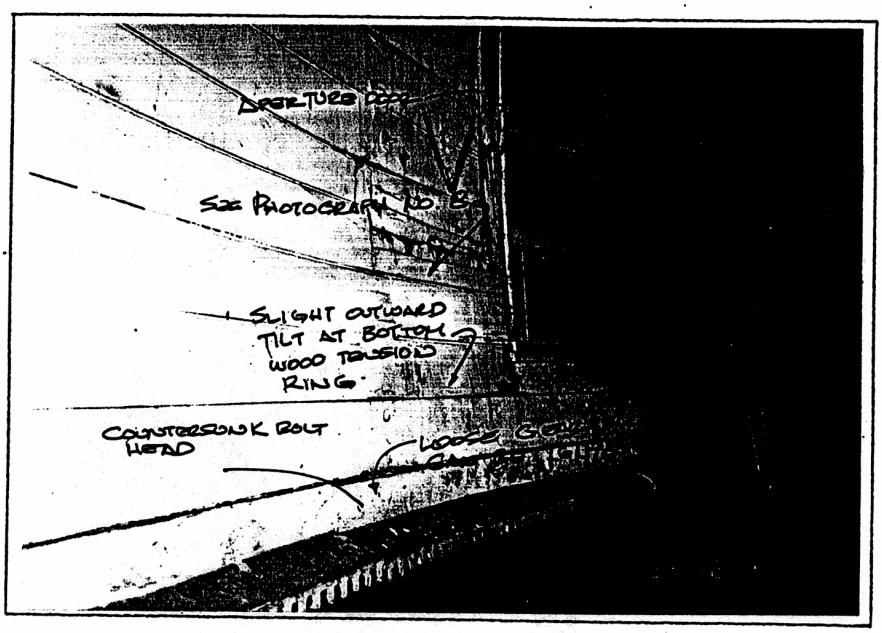
Photograph No. 4



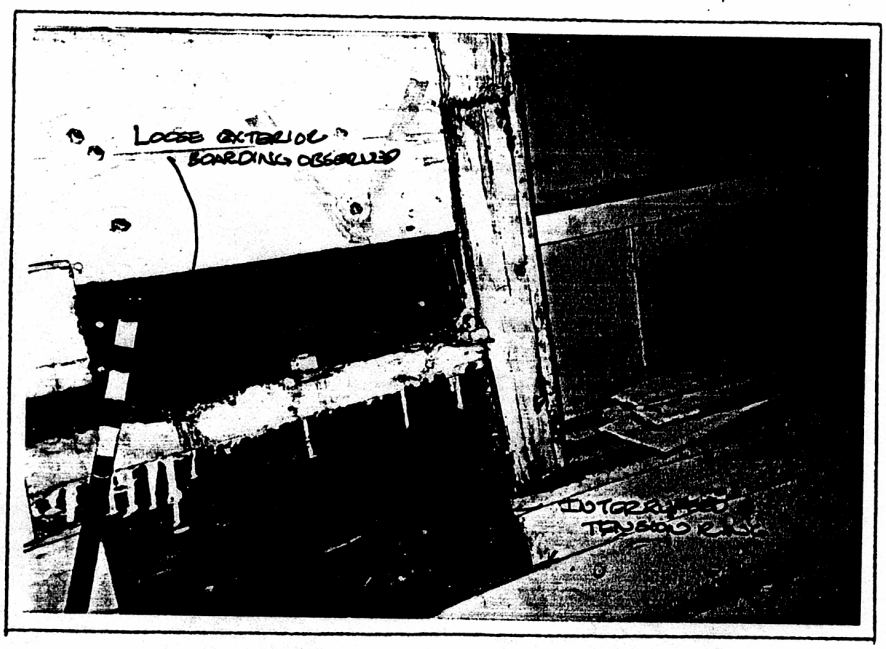
Photograph No. 5



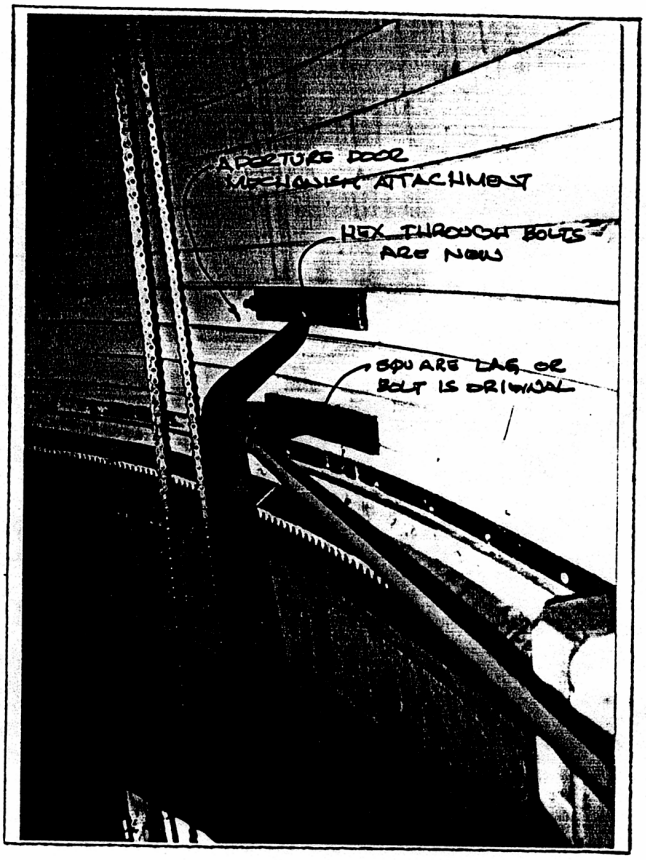
Photograph No. 6



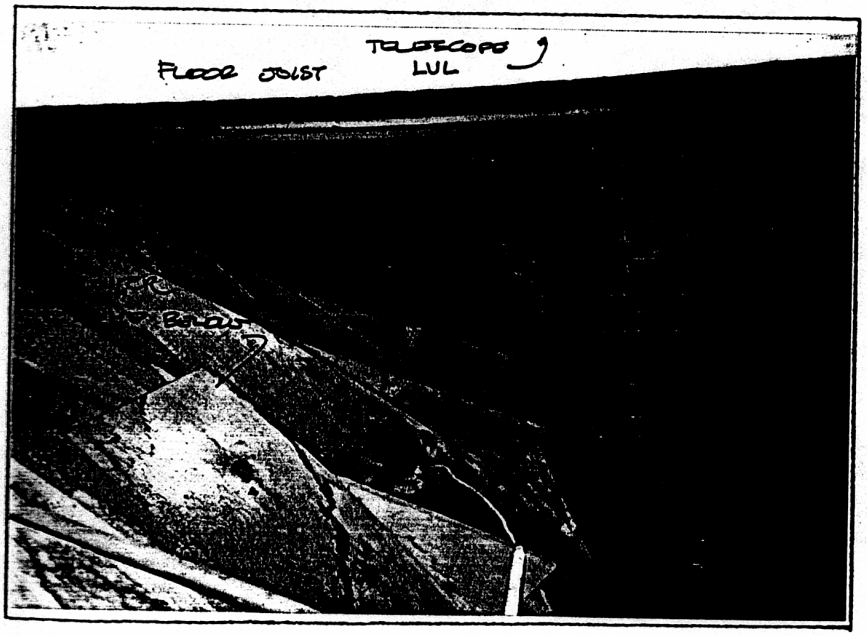
Photograph No. 7



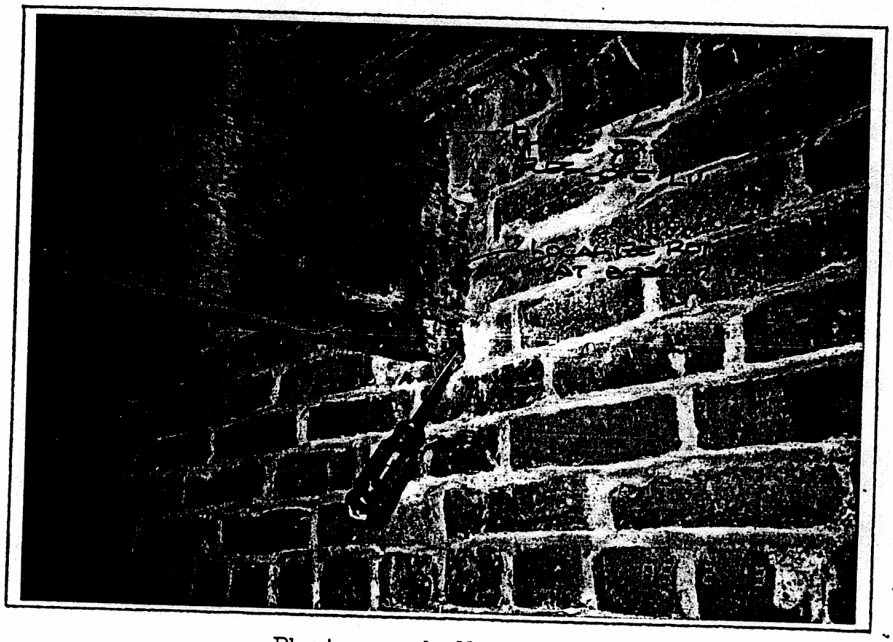
Photograph No. 8



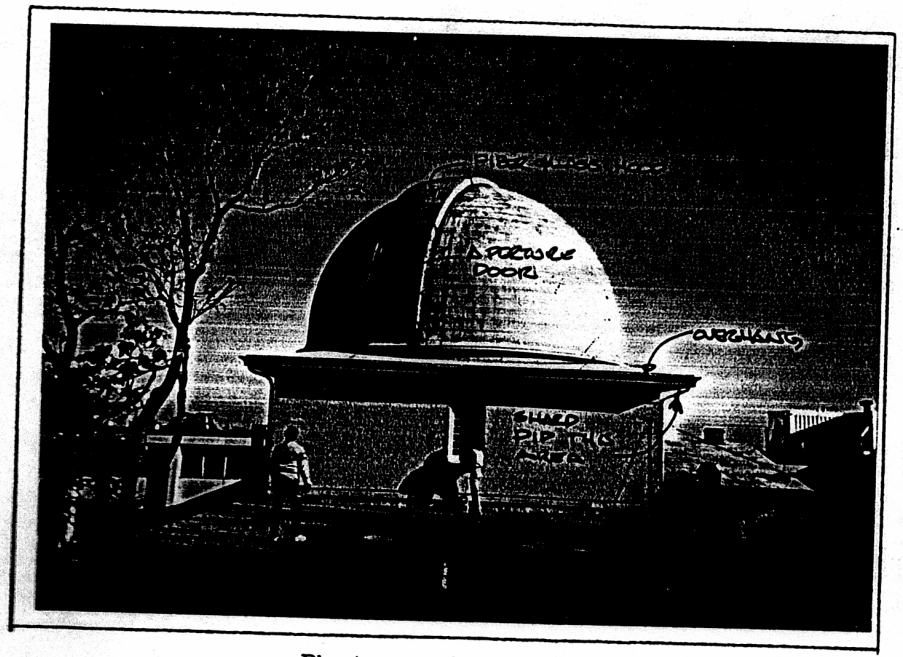
Photograph No. 9



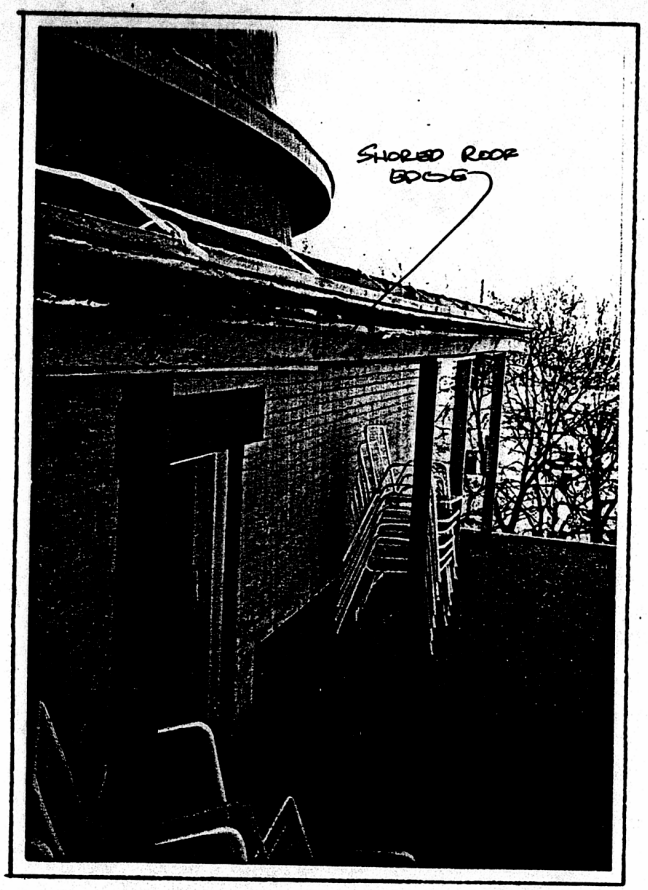
Photograph No. 10



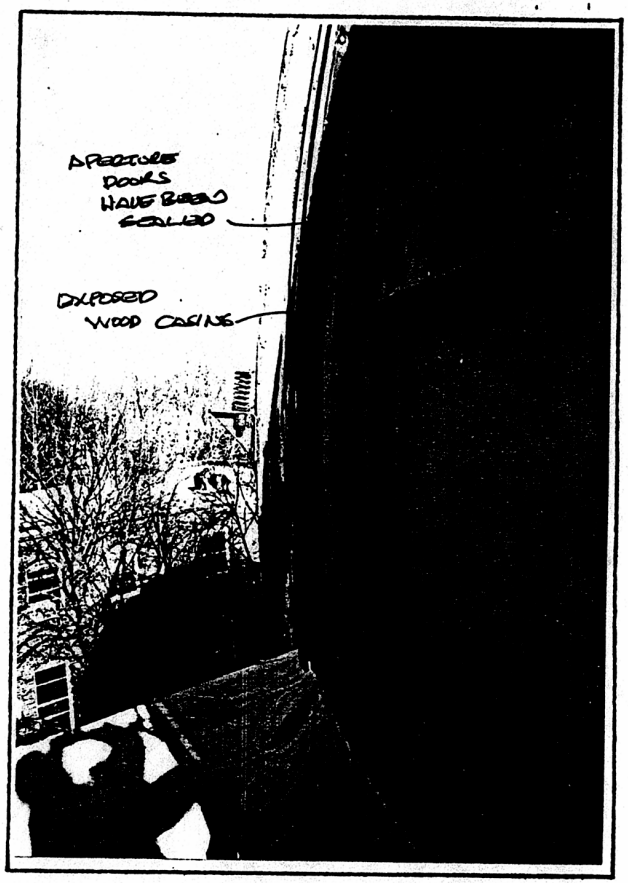
Photograph No. 11



Photograph No. 12



Photograph No. 13



Photograph No. 14

Society
for the Preservation
of New England
Antiquities

Conservation Center
Lyman Estate
185 Lyman Street
Waltham, Massachusetts 02154
617 891-1985

January 10, 1990

Dear Nathan,

Please find enclosed the report for the Harvard College Observatory prepared by Conan Powers. Please review it and call me with your comments.

Sincerely,

Andrea N. Gilmore