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# REVIEW OF PROPOSED CONTROL AND INSTRUMENT ROOM FOR BUILDING 4776, MARSHALL SPACE FLIGHT CENTER HUNTSVILLE, ALABAMA

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## FOREWORD

This memorandum was originally issued as an informal note RCP 65-11, November, 1965, and hand carried to the appropriate personnel responsible for the design of the instrument room. This final version is submitted for the record.

## 1.0 INTRODUCTION

This room is to house the controls and instruments for the thermo-simulation facility, and the cold flow facility. These facilities comprise supersonic gas jets, which will produce high sound pressure levels in the immediate vicinity of the jet flows. The room is required to reduce the noise to a level suitable for the facility personnel to tolerate.

## 2.0 EXPECTED SOUND PRESSURE LEVELS

Sound pressure levels as high as 150 dB, re: 0.0002 dyne/cm$^2$, have been estimated for the region near the jet flows, (Reference 1). This level occurs when the cold jet operates set back inside the building. The spectrum of this noise is calculated to peak at 2500 cps.

## 3.0 PROPOSED CONSTRUCTION

The following description is taken from a sketch provided by R-AERO-AFG, (Reference 2). The proposed room would be constructed with staggered 2 x 4 inch studs with 1/2 inch plywood attached to both sides, to produce a double wall construction. See Figure 1a. The inner and outer walls are attached at the top and bottom to a 2 x 6 inch board. A double ceiling is provided, and the construction uses wood and glue. A double window facing the jets is included to allow the facility controller to view the gas flows and instrument rakes etc.

It should be noted that this construction is not to the required standard as asked for by M.J. Fisher IITRI in his letter of August 20 to K. Johnson R-AERO-AM. Therefore, the acoustic levels inside the instrument room will not be as low as desired.

## 4.0 ESTIMATED NOISE REDUCTION OF CONSTRUCTION TECHNIQUE

The noise reduction was estimated for two sections. First, for the double wall staggered stud construction, the sound reduction is estimated as 25 dB. This is on the basis of the figures given in Reference 3 , and the experience of expert acousticians at Wyle Laboratories.

The second region concerns the large double glazed windows. The type of construction is particularly important here, but an estimated sound reduction of no greater than 20 dB can be estimated. This is assuming that the construction has been altered to remove the direct connection between the two walls around the window, as explained in the next section.

These figures are estimated for high frequency air-borne noise. On the basis of the levels estimated in Reference 1, and the figures given here, the levels inside the building would be of the order of 125 to 130 dB, depending on the transmission through the window.

## 0 CRITICISM OF THE PROPOSED CONSTRUCTION TECHNIQUE

The immediate criticism of the instrument room, must be that the sound absorption features of the proposed construction are not sufficient. The proposed construction contains numerous examples where the double wall technique is jeopardized by direct connection between the inner and outer walls. This will remove the full advantages of this form of sound insulation. It should also be noted that a double floor is not provided.

The double windows, as designed, include 2 x 6 inch members connecting the inner and outer walls. These were included to seal the space between the glass panes to allow control of window misting. However, this does provide a direct path between the two walls. Therefore, it is recommended that the two windows be constructed separately. If any sealing is necessary it could be accomplished using flexible polyethelene sheet.

The proposed ceiling construction also connects the inner and outer room, as does the construction of the door frames. Both of these techniques should be eliminated. The two rooms should be completely separate, except through the connection at the floor. Double doors are not specified, but these are necessary if the full advantages of the double wall construction are to be realized.

The proposed observation window is a particularly weak point. This window is large and it will allow a fair amount of sound to be transmitted, unless the glass is very heavy and the edges properly sealed. In view of this, it is felt that the requirements for this window should be reconsidered, and, if at all possible, it should be eliminated.

The estimated levels for the sound pressures inside the room are still too high for comfortable working, and also these levels could cause quite severe problems with delicate measuring and recording instrumentation. Therefore, it is recommended that a better design, causing lower sound levels, should be substituted for the proposed construction. It must be remembered that even at levels of 100 dB, personnel will generally require ear protection for sustained exposure. The recommended design changes, based on a similar construction technique, are outlined in the next section.

## 6.0 RECOMMENDATIONS

a) The double room construction should be modified so that there is absolutely no connection between the inner and outer rooms. This includes the ceiling of both rooms, and the construction of double doors.

b) The proposed facility does not call for a double floor. It is recommended that such a false floor be included, and a suggested design would have the floor suspended from the inner wall, and supported at intervals by vibration isolators, or isomode pads. The space under the floor could also contain an absorptive blanket. This construction should eliminate the possibility of vibration from the facilities being transmitted into the instrument room through the concrete base of the building.

c) The observation window should be eliminated. If it is necessary to have direct observation of the nozzles, then the double window should be as small as possible, say 6 inches by 6 inches. The window should be glazed with heavy glass and the edges set in rubber seals.

d) The use of plasterboard rather than plywood will produce a better sound reduction, because of its greater mass. However, it must be firmly mounted and sealed at the joints. It should prove advantageous to add an extra layer to the outer wall by tacking on plasterboard over the plywood.

e) The addition of a fiberglass blanket, of some other sound absorption material, between the two walls will be necessary to provide any reasonable reduction in the noise level. This fiberglass blanket would be tacked on to one wall only, so as not to constrain the movement of the two walls. A sketch shows this addition and the extra plasterboard layer in Figure 1b. Such a construction would be expecially advantageous on the wall facing the nozzles.

f) The rooms should be mounted on rubber isolation isomode mats, to reduce the floor borne transmission to a minimum, as also should be all equipment mounted from the floor inside the room. Such pads are obtainable from MB Electronics.

g) The gap between the outer wall of the instrument room and the building wall will allow a reverberation to be set up in the narrow space. This gap should be at least 6 inches, and possibly tapered by setting the instrument room at a slight angle, to reduce this effect to a minimum. The addition of fibreglass in this gap will also help reduce this possible path of sound transmission.

h) Care should be taken in installing services, instrumentation wires, and other items into the room. They should be fitted so there is no rigid connection between the inner and outer walls, and the holes where they pass through the walls should be carefully sealed.

i) Care should be taken in fixing items to the walls of the instrument room, such as electricity sockets, etc. These are best fixed to the wall panels, rather than to the 2 x 4 studs, since they then give the wall additional mass.

j) The present plans call for an acoustic baffle to be constructed behind the nozzles and extending from the wall at the cold jet end of the building to the corner of the instrument room. This wall serves the double purpose of reducing the noise in the main part of the building, and controlling the air conditions in the building when the roll up doors are opened for the jets to run. It is recommended that this wall should not be directly connected to the instrument room, to eliminate transmission of vibration from the facilities to the instrument room.

## 7.0 ESTIMATED LEVELS IN REDESIGNED ROOM

The elimination of the windows and the addition of a fibreglass blanket and plasterboard to the walls should reduce the acoustic levels inside the room considerably below the levels for the presently proposed construction. The addition of the false floor should also eliminate the possibility of major vibration effects being transmitted from the facilities into the instrument room.

The addition of the plasterboard and the acoustic blanket should double the mass of the wall, from about 3.0 pound/ft.$^2$ to 7.0 pound/ft.$^2$. The values given in References 3 and 4 suggest that a transmission loss of 45 dB can be expected for this type of construction, and the addition of another plasterboard layer on the inside wall will increase the transmission loss to near 50 dB. Therefore, for the expected noise levels of the jets, the sound level inside the modified room would calculate as 100 dB, re: 0.0002 dyne/cm$^2$.

REFERENCES

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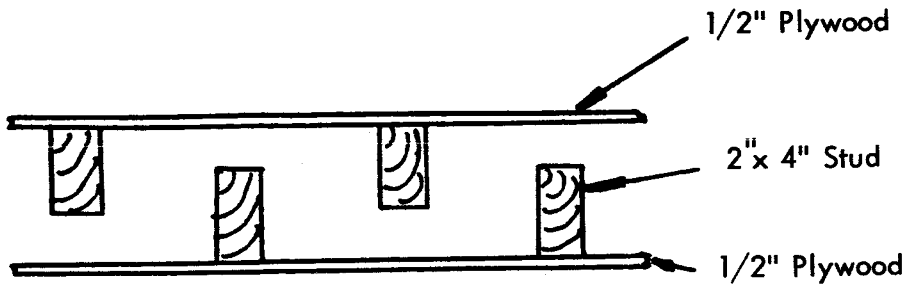


Figure 1a. Proposed Construction

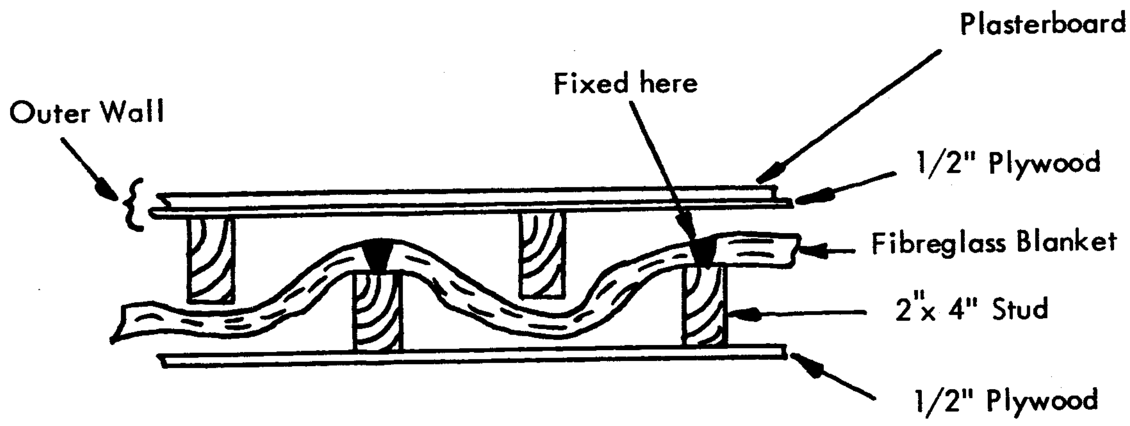


Figure 1b. Recommended Construction