CR 151211

SAIL PAYLOAD ACCOMMODATIONS STUDY

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SPACE SHUTTLE ENGINEERING AND OPERATIONS SUPPORT

AVIONICS SYSTEM ENGINEERING

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1.0 SUMMARY

The results of the evaluation of six methods of accommodating payloads in SAIL showed four to be difficult to implement and limited in their ability to accommodate payloads. Two methods, much easier to implement, were found which, together, would handle all known payload requirements.

It was concluded that a special SAIL payload pallet be used as the standard method to verify avionics systems and experiments.

Recommendations included a continuing and more detailed study of the special SAIL payload pallet method for verifying payload and experiment avionics. Also, it was recommended that the baselined North door entrance method be retained as a method for accommodation of flight-type payloads in SAIL.

2.0 INTRODUCTION

This Design Note has been prepared to present in organized form various options (methods) for installing known payload configurations in the SAIL. Additionally, its purpose is to evaluate a matrix of these options vs. applicable installation criteria and develop a conclusion regarding the optimum method of payload accommodation.

In an evaluation of this type, options could become quite numerous. The options selected for evaluation below are those that: (1) have been discussed with NASA and MDTSCO personnel and (2) are made physically apparent by observation of the SAIL facility.

The options which arise when substantial additions to Building 16 are considered become numerous. Several configurations have been proposed. The lack of firm plans at this time disqualifies these options from consideration in this paper.

3.0 DISCUSSION

Simply stated, the problem is to evaluate several methods of bringing payloads into the SAIL and in some cases handling them after they are in the building. Several basic questions which must be answered become apparent when the problem statement is logically expanded. They are: (1) how is the payload handled outside the building, (2) how is the payload brought into the building, (3) how is the payload handled (lifted, moved, placed) inside the building, (4) what size payloads may be accommodated, and (5) are there approaches other than introducing payloads into the SAIL, to accomplish payload to Orbiter avionics verification?

A few basic conditions (ground rules) are assumed prior to performing the individual evaluations of each payload installation option. They are: (1) the assumption that proper payload support rails have been installed in the SAIL, and (2) "staging" or preliminary operational verification of the payload has been performed outside the SAIL area. These facilities and activities, at present, are not part of a firm implementation plan. However, the assumptions are made to set up standard conditions for the process of evaluating each payload installation option.

The left-hand column of Table I gives the "Significant Accommodation Criteria" against which all installation options are measured. Each optional method of bringing a payload into the SAIL is given as a column heading on Table 1. The matrix is developed by measuring each installation area against each significant accommodation criteria. The result of each comparison is given in the appropriate box in the matrix. The sources of information given in the results are drawings of the SAIL physical layout,measurements of components of the SAIL installation, and physical observation of the SAIL facility. Figure (3.0) illustrates the areas of payload entrance under discussion.

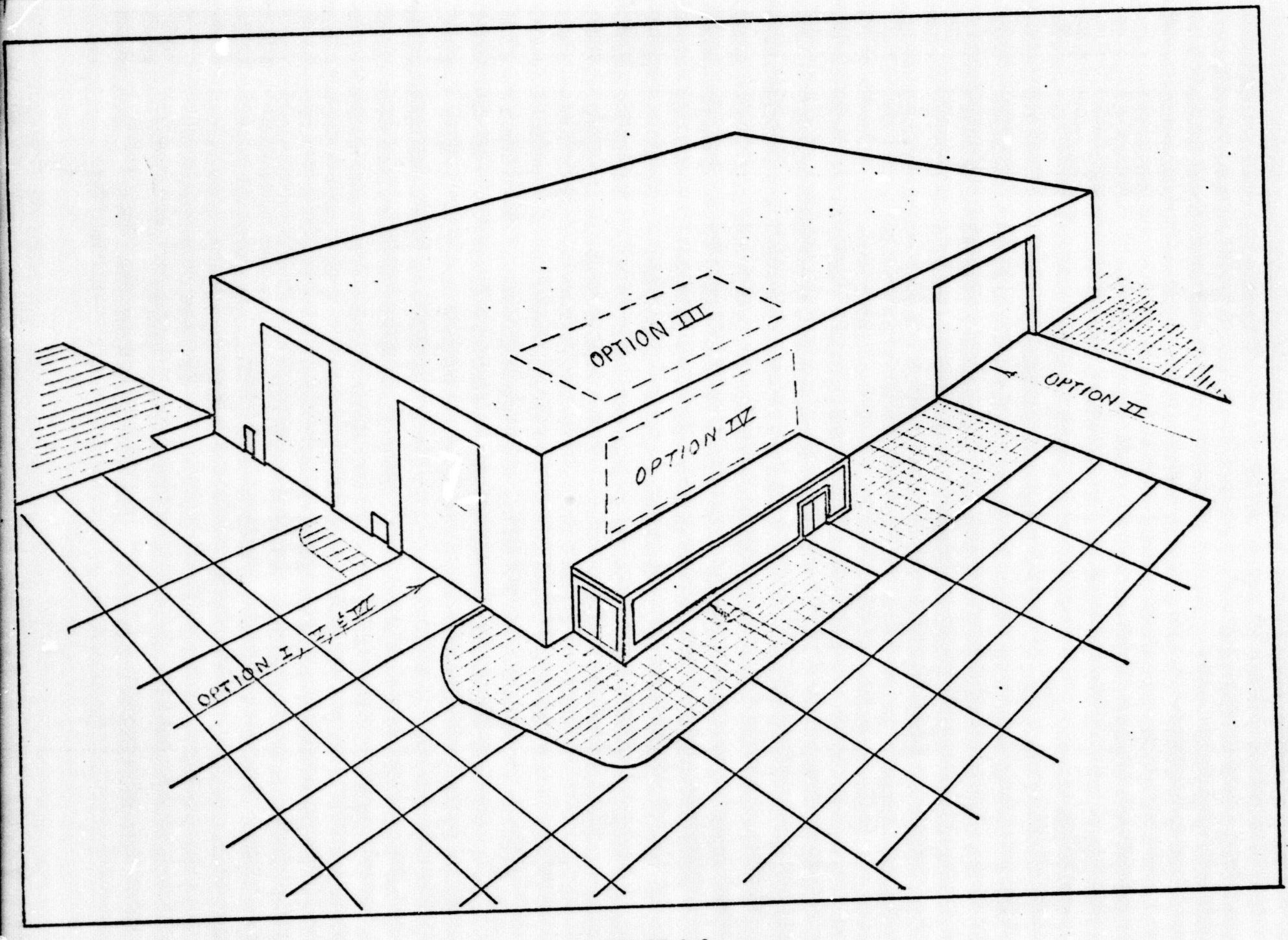

FIGURE 3.0

SAIL PAYLOAD ACCOMMODATION OPTION AREAS

SIGNIFICANT ACCOMMODATION CRITERIA	OPTION I ENTRANCE THROUGH NORTH DOOR (AFT AVIONICS ROOM REMOVED)	OPTION II ENTRANCE THROUGH WEST DOOR	OPTION III ENTRANCE THROUGH ROOF OVER PAYLOAD BAY AREA	OPTION IV ENTRANCE THROUGH WEST WALL OF BUILDING	OPTION V ENTRANCE THROUGH NORTH DOOR (AFT AVIONICS ROOM RAISED)	OPTION VI ENTRANCE THROUGH NORTH DOOR WITH SAIL UNIQUE PALLETS
1. WHAT ACCOMMODATION CONSTRAINTS EXIST INTERNAL TO SAIL?	LENGTH OF PAYLOAD IS RESTRICTED TO APPROXIMATELY 20 FEET - IMPOSED BY DOOR TO SUPPORT RAIL DISTANCE LIMITATION	DISTANCE BETWEEN CRANE HOOK AND RAISED FLOOR IN MMES AREA IS APPROXIMATELY ONLY 8 FEET. PAYLOAD DEPTH THUS RESTRICTED.	NONE	NONE	CONCEPT IS TOTALLY IMPRACTICAL DUE TO MECHANICAL INTERFERENCES WITH BUILDING INTERNAL STRUCTURE AND PAYLOAD SUPPORT RAILS - PRECLUDES ANY DISCUSSION OF INTERNAL CONSTRAINTS.	NOT APPLICABLE
2. IS ALTERATION OF BUILDING 16 STRUCTURE REQUIRED?	NO	NO	YES. AREA OF ROOF OVER PAYLOAD BAY REQUIRES EXTENSIVE ALTERATION - BOTH TO BUILDING STRUCTURE AND INTERIOR. ROOF CRANE AND TRANSFER AREA ON ROOF REQUIRED.	YES. WALL OVER HYDRAULICS ROOM MUST BE CUT OPEN. INTERIOR SAIL CRANE TRACK MUST BE CUT OR REMOVED.	NO	NO
3. IS TRANSPORTATION DEVICE REQUIRED TO MOVE PAYLOAD INTO BUILDING?	YES	YES	NO	NO	YES. SEE CRITERIA 1 FOR CONSTRAINT COMMENTS.	YES
4. IS PORTABLE CRANE REQUIRED FOR LIFTING PAYLOAD ONTO TRANSPORTER?	YES	YES	NO	NO	YES. SEE CRITERIA 1 FOR CONSTRAINT COMMENTS.	YES
5. MAY EXISTING SAIL CRANE BE USED TO PLACE PAYLOAD ON SUPPORT RAILS?	YES	NO	NO	NO	YES.. SEE CRITERIA 1 FOR CONSTRAINT COMMENTS.	YES
6. IS REMOVAL OF AFT AVIONICS ROOM REQUIRED?	YES	NO	NO	NO	NO	NO
7. WHICH OF THE FOLLOWING PAYLOAD CATEGORIES MAY ENTER SAIL AREA? CAT. A:S/L PALLET (15'W x 60'L x 7'H) CAT.B:S/L SHORT CORE MODULE (15'D x 14'L) CAT. C:S/L LONG CORE MODULE (15'D x 23'L) CAT. D:IUS (ENGINES + P/L) (10'D x 15'L + P/L) CAT. E:SAIL UNIQUE PALLET (15'W x 6'L x 5'4)	ALL PAYLOAD CATEGORIES MAY ENTER SAIL AREA. PAYLOAD CATEGORIES A, B, D, AND E MAY BE INSTALLED IN PAYLOAD BAY. SEE CRITERIA 1 FOR CONSTRAINT COMMENTS.	ALL PAYLOAD CATEGORIES MAY ENTER SAIL AREA. ONLY PAYLOAD CATEGORY E MAY BE INSATLLED IN PAYLOAD BAY.	PAYLOAD CATEGORIES A, B, C, DISASSEMBLED D AND E MAY ENTER SAIL AREA AND BE INSTALLED IN PAYLOAD BAY	PERMISSABLE HEIGHT OF WALL OPENING RESTRICTS ENTRY OF PAYLOADS TO CATEGORIES A AND E. THEY MAY BE INSTALLED IN PAYLOAD BAY.	PAYLOAD CATEGORIES NOT APPLICABLE DUE TO IMPRACTICAL CONCEPT.	CATEGORIZATION OF PAYLOADS NOT APPLICABLE. CONCEPT OF OPTION VI NOT RELATED TO DIMENSIONS IN GIVEN CATEGORIES.

TABLE 1

4.0 RESULTS

The results of the study of entrance options vs. significant installation criteria given in Table 1 are summarized below. Each option has favorable and unfavorable characteristics. In addition some characteristics are considered to be in neither category. They are usually related to the handling of payloads outside the building; something which must be done in one manner or another, regardless of the option under discussion.

4.1 OPTION I: ENTRANCE THROUGH NORTH DOOR (AFT AVIONICS ROOM REMOVED).

The high bay door will admit all payload size categories. Figure (4.1) shows, however, that a limitation on payload length exists when the SAIL crane is used for the internal transport medium. Alteration of the structure of Building 16 is not required.

The aft avionics room will have to be disconnected and removed from the entrance area each time a payload is installed or removed. This requirement is considered unfavorable for Option I.

Other characteristics of Option I are: a transporter (or some carrying method) is required to move the payload into the building; provision is required for lifting the payload on the transporter outside the building; and Category C and D payloads, if longer than about 20 feet, may be accommodated if a special transporter is used in lieu of the SAIL crane.

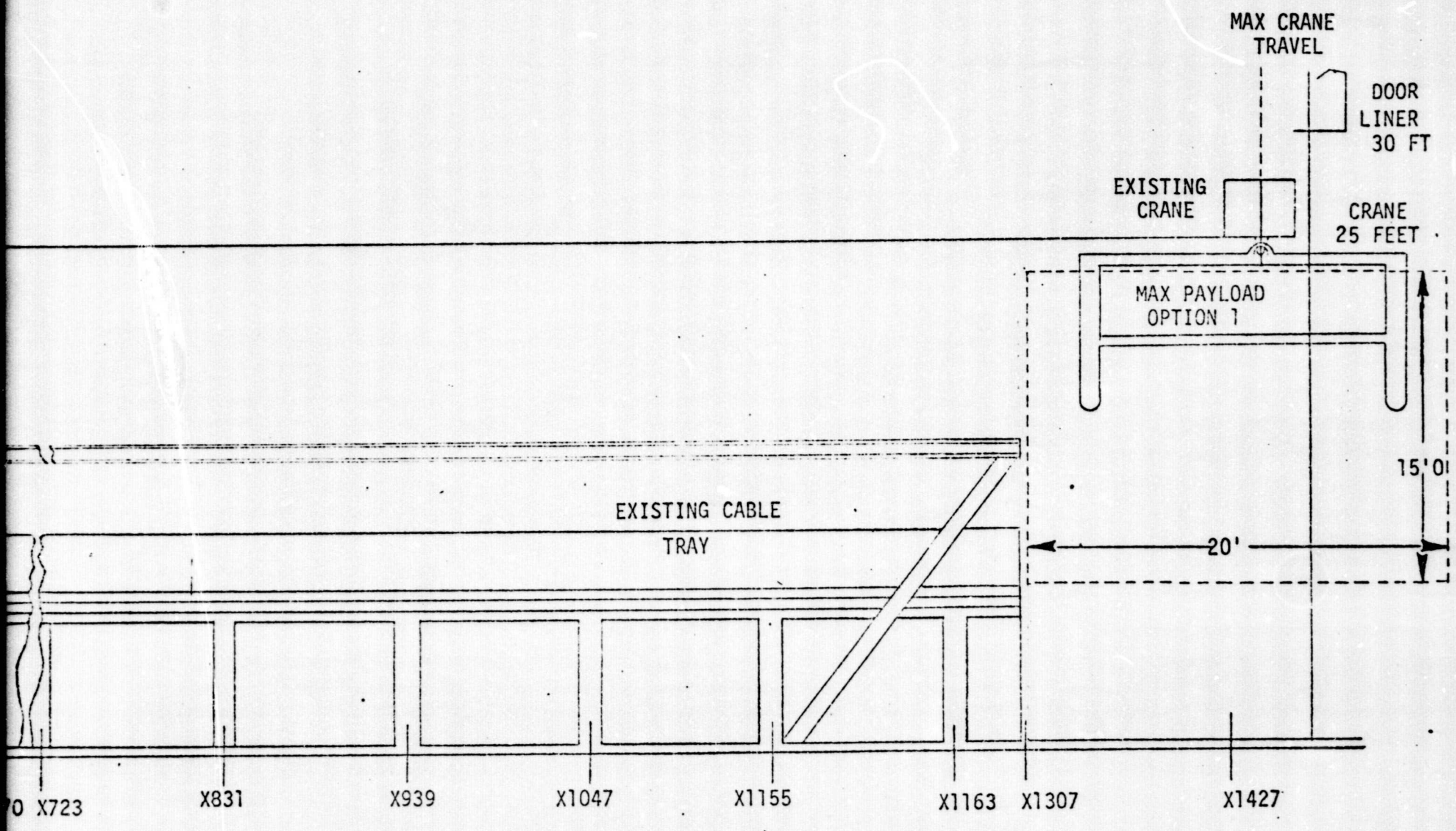

FIGURE 4.1

OPTION I: NORTH DOOR ENTRY

(SIDE VIEW OF SAIL PAYLOAD BAY)

4.2 OPTION II: ENTRANCE THROUGH WEST DOOR.

The high bay door will admit all payload size categories; there is no limit on length. Additionally, the aft avionics room does not have to be moved.

However, there are some serious unfavorable characteristics associated with Option II. They are: the existing SAIL crane travel prevents its use as a payload lift and transport device; equipment on the upper deck must be removed; and the maximum allowable payload height is about 8' (between any crane hook and the raised floor on the upper deck). These constraints preclude installation of all payload size categories. See Figure (4.2).

Other characteristics are a transporter requirement and an additional crane for internal building handling. Also, outside building handling is identical to Option I.

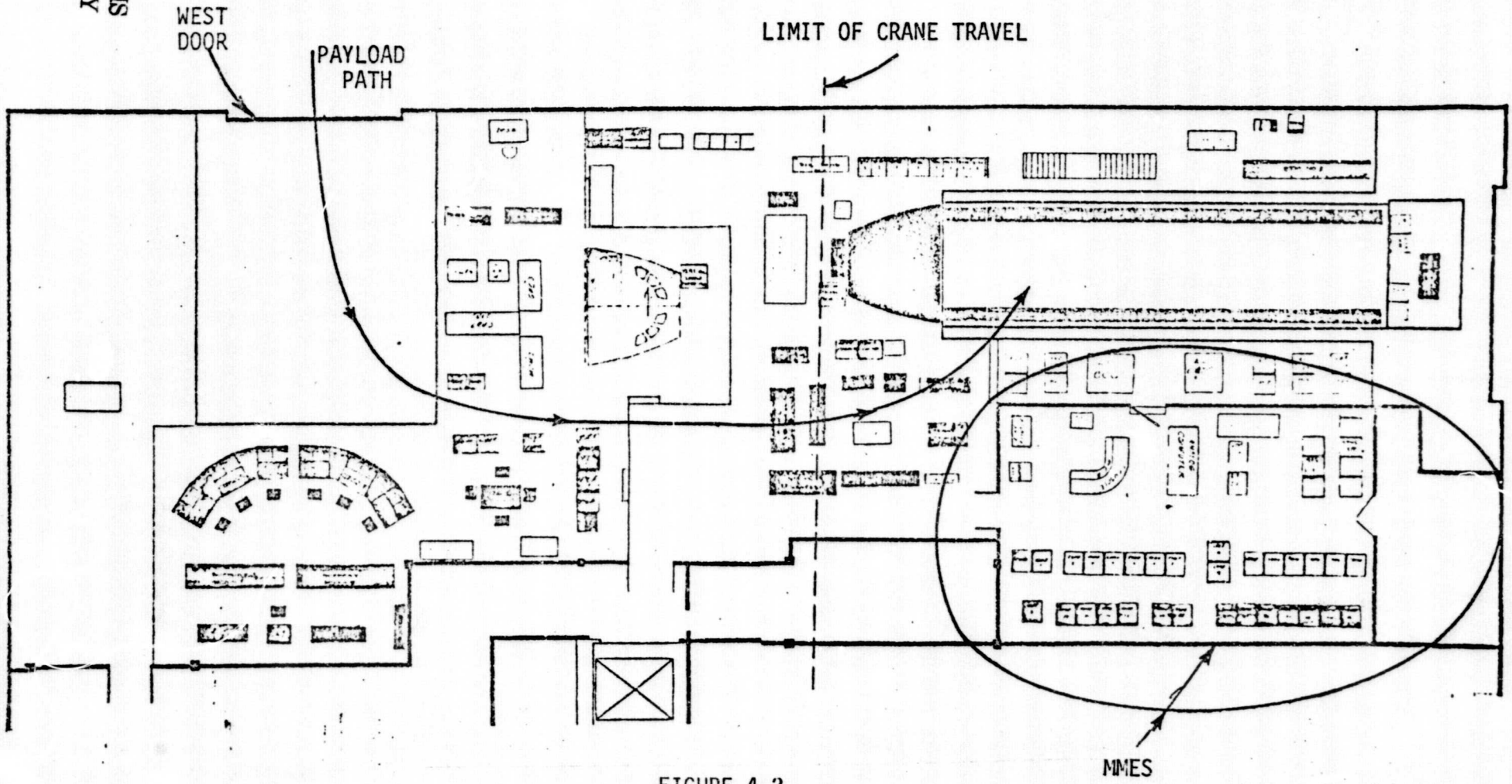

FIGURE 4.2

OPTION II: WEST DOOR ENTRY

(VIEW LOOKING DOWN)

4.3 OPTION III: ENTRANCE THROUGH ROOF OVER PAYLOAD BAY AREA.

Installation of all payload categories is possible with the condition that Category D payloads must be disassembled. Removal of the aft avionics room is not required.

This option also has some substantial unfavorable characteristics. They are: alteration of the basic exterior and interior building structure is required; substantial economic impact (not priced) is apparent; and, as given above, an assembled Category D size payload entrance is precluded by the dimensions of the roof opening.

Other characteristics include a payload changeover area on the roof to switch from an external crane to a roof-mounted crane. See Figure (4.3) for a sketch of these conditions.

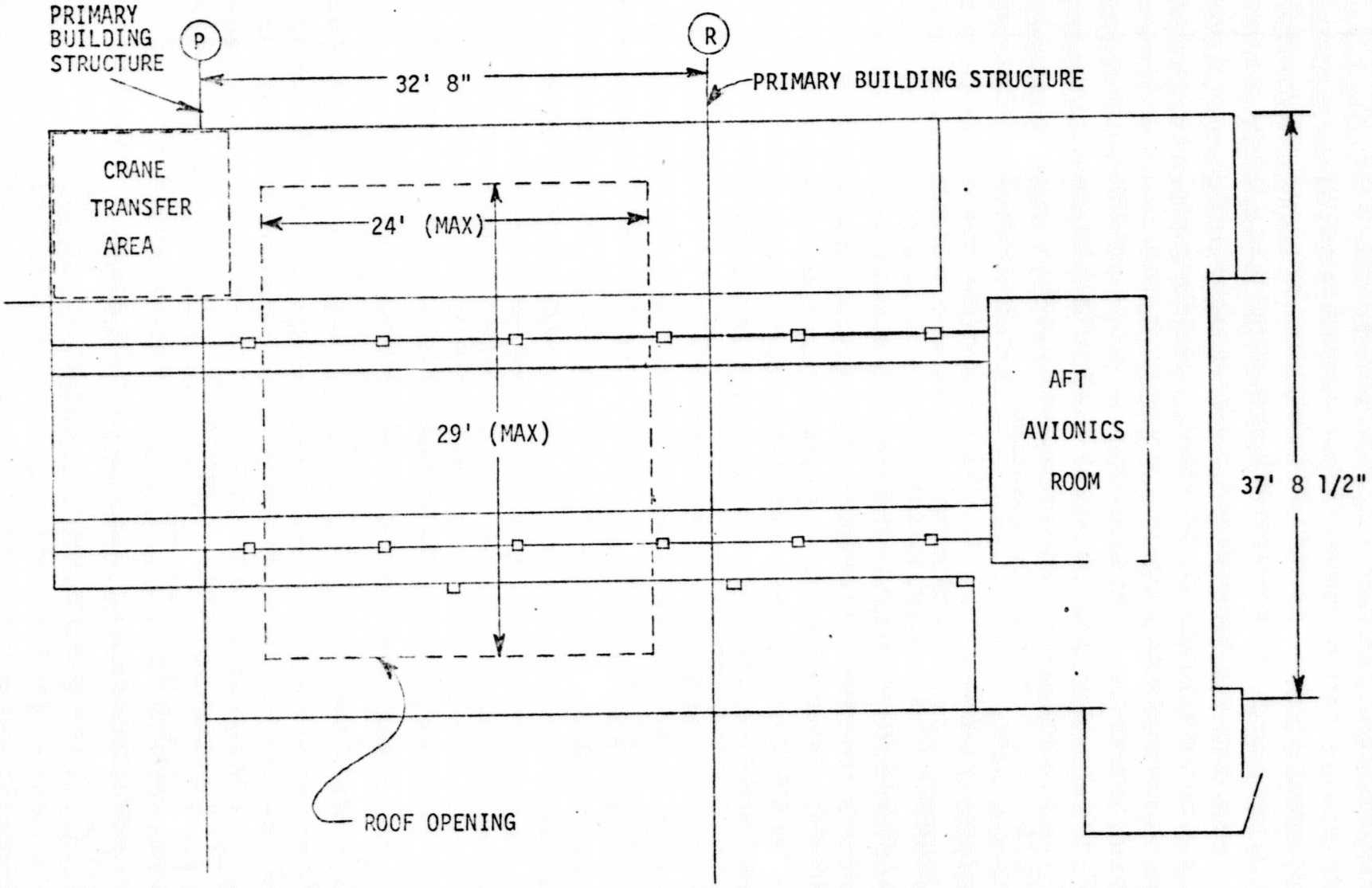

FIGURE 4.3

OPTION III: SAIL ROOF ENTRY

(VIEW LOOKING DOWN)

4.4 OPTION IV: ENTRANCE THROUGH WEST WALL OF BUILDING.

This option will permit installation of Category A and E payloads only. See Figure (4.4) a transporter is not required nor is the removal of the aft avionics room.

Several serious unfavorable requirements are created by this option. They are: alteration of the basic exterior and interior building structure is required; substantial economic impact (not costed) is apparent; removal of the existing SAIL 20 ton crane is required; and accommodation of Category B, C, and D payloads are precluded by the limited size of the wall opening.

Other characteristics include a special exterior crane which is required to move payloads horizontally. Placement on support rails is virtually a "blind" action for the crane operator.

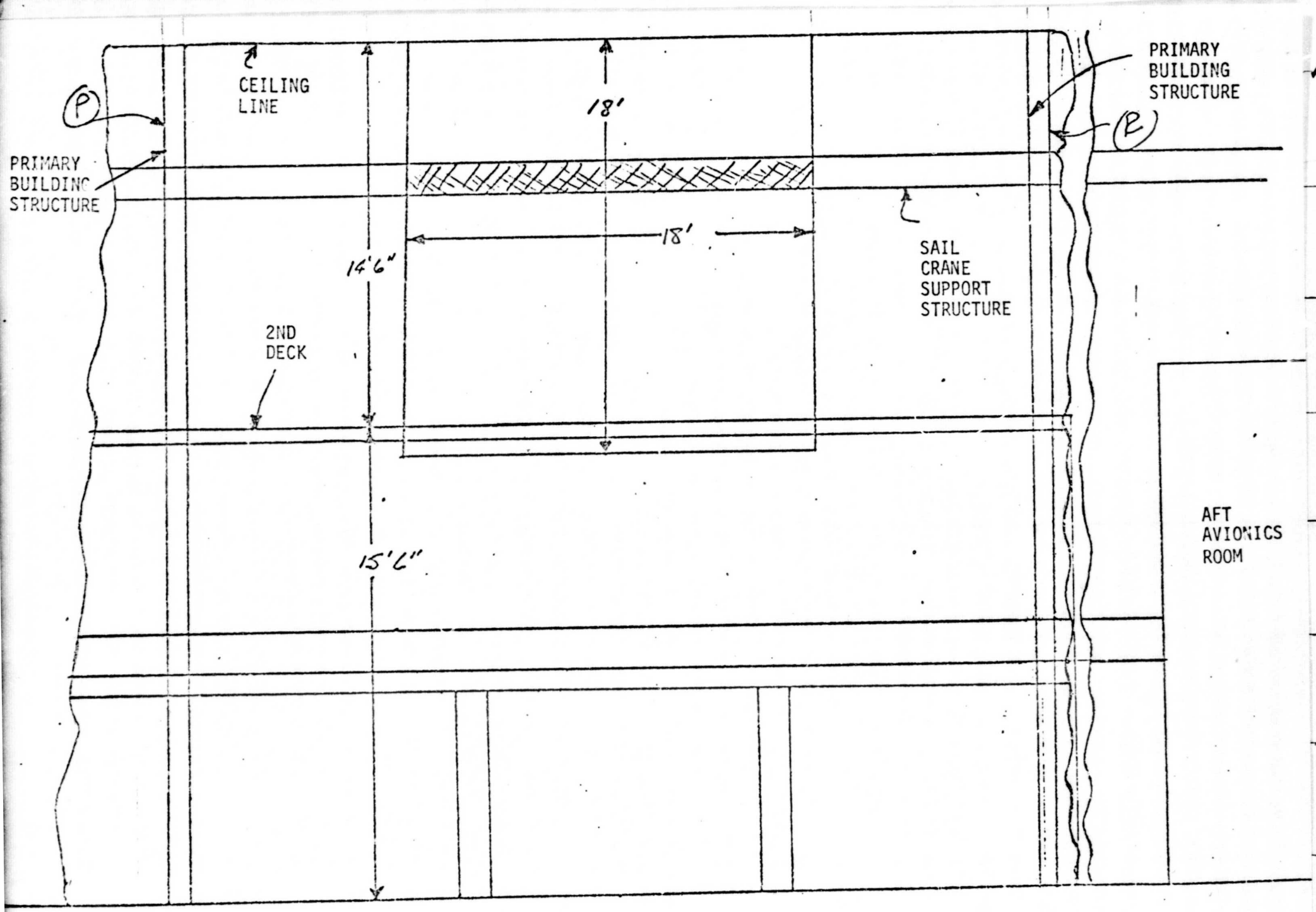

FIGURE 4.4

OPTION IV: WEST WALL ENTRY
(VIEW LOOKING WEST)

4.5 OPTION V: ENTRANCE THROUGH NORTH DOOR (AFT AVIONICS ROOM RAISED)

Please see Figure (4.5.1). This concept is totally unworkable due to mechanical interferences. Raising the aft avionics room requires elevating the cable trays up to it. The advantage of raising the room is to allow payloads to be brought in below it. However, Figure 5B shows that payloads cannot be placed on the support rails because they cannot be brought up between the cable trays. The cable trays cannot be moved outward because they will interfere with the support rails at their mutual crossover point (Figure 4.5.2). If the trays are outside the support rails they will interfere with the deck on each side.

This method has been given considerable study to determine if a way was available to overcome the disadvantages. However, no solution is apparent that would allow this approach to be practically implemented.

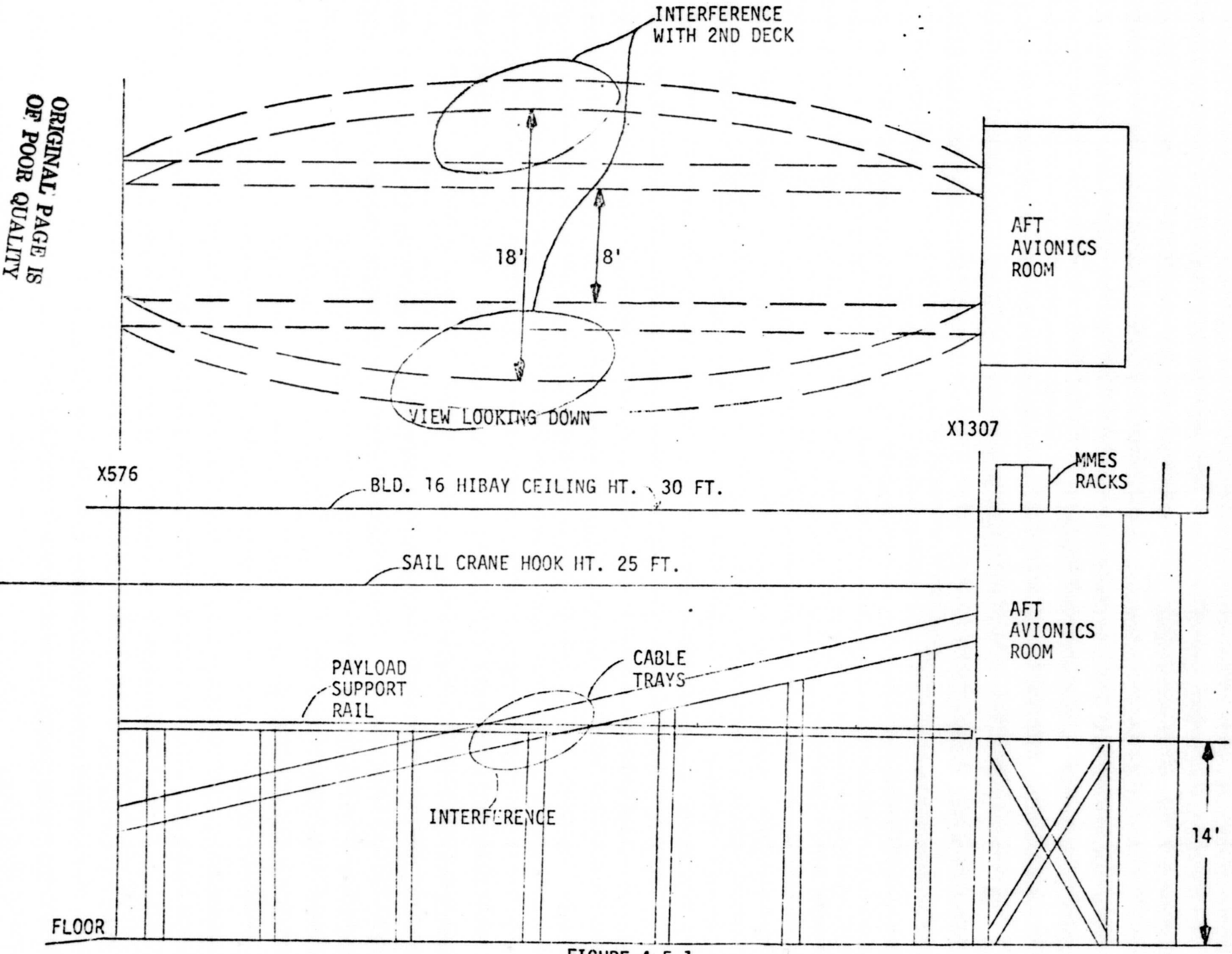

FIGURE 4.5.1
OPTION V: NORTH DOOR ENTRY
(VIEW LOOKING WEST-AFT AVIONICS ROOM RAISED)

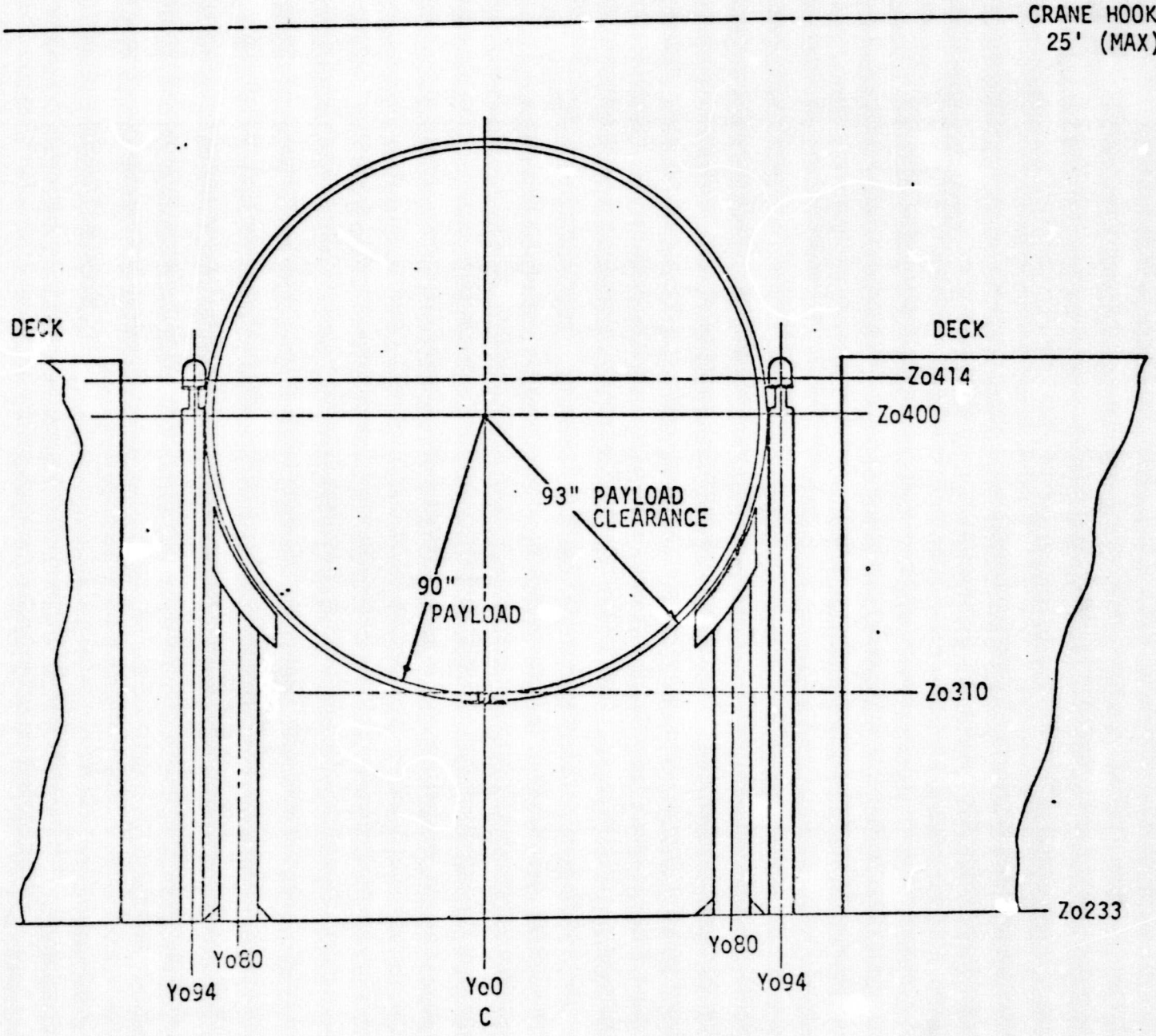

FIGURE 4.5.2
OPTION V: SAIL PAYLOAD SUPPORT ARRANGEMENT

4.6 OPTION VI: ENTRANCE THROUGH NORTH DOOR WITH SPECIAL SAIL PALLETS.

The term "payload" as it relates to the SAIL has been used in the past without thought as to what is really meant when this word is expressed. The constraints of cost, schedule, and availability preclude, for the most part, the arrival in SAIL of an actual flight qualified or engineering model payload. That is to say, a payload which bears a strong physical resemblance to an actual flight-qualified payload. The term "payload article" has been coined to avoid confusing the physical payload, as described above, with any other form of flight-qualifiable avionics which would serve the purpose of payload-to-Orbiter system verification.

The special SAIL pallet or SAIL unique pallet is a concept to provide a solution to verify payload avionics in the SAIL - without encountering the substantial physical problems described in Options I through V. Please see Figure (4.6.1). The SAIL unique pallet is smaller than the Spacelab pallet. It may be brought into SAIL around the aft avionics room. See Figure (4.6.2). It provides space for payload avionics in any state of development; it may be brought up between the cable trays and mounted on the support rails; and it provides floor space for test personnel which enhances the scarce real estate in SAIL.

The use of a special SAIL pallet has the following favorable characteristics: removal of the aft avionics room is not required; alteration of Building 16 structure is not necessary; the existing SAIL crane may be used; the pallet mounts in the same way as a flight payload; and the avionics mounted on the pallet may be arranged to approximate most payload configurations.

There is a likelihood that fidelity in some of the flight wire harnesses lengths will require a compromise; considered to be an unfavorable characteristic.

Another characteristic of this concept is that the special SAIL pallets must be designed and fabricated.

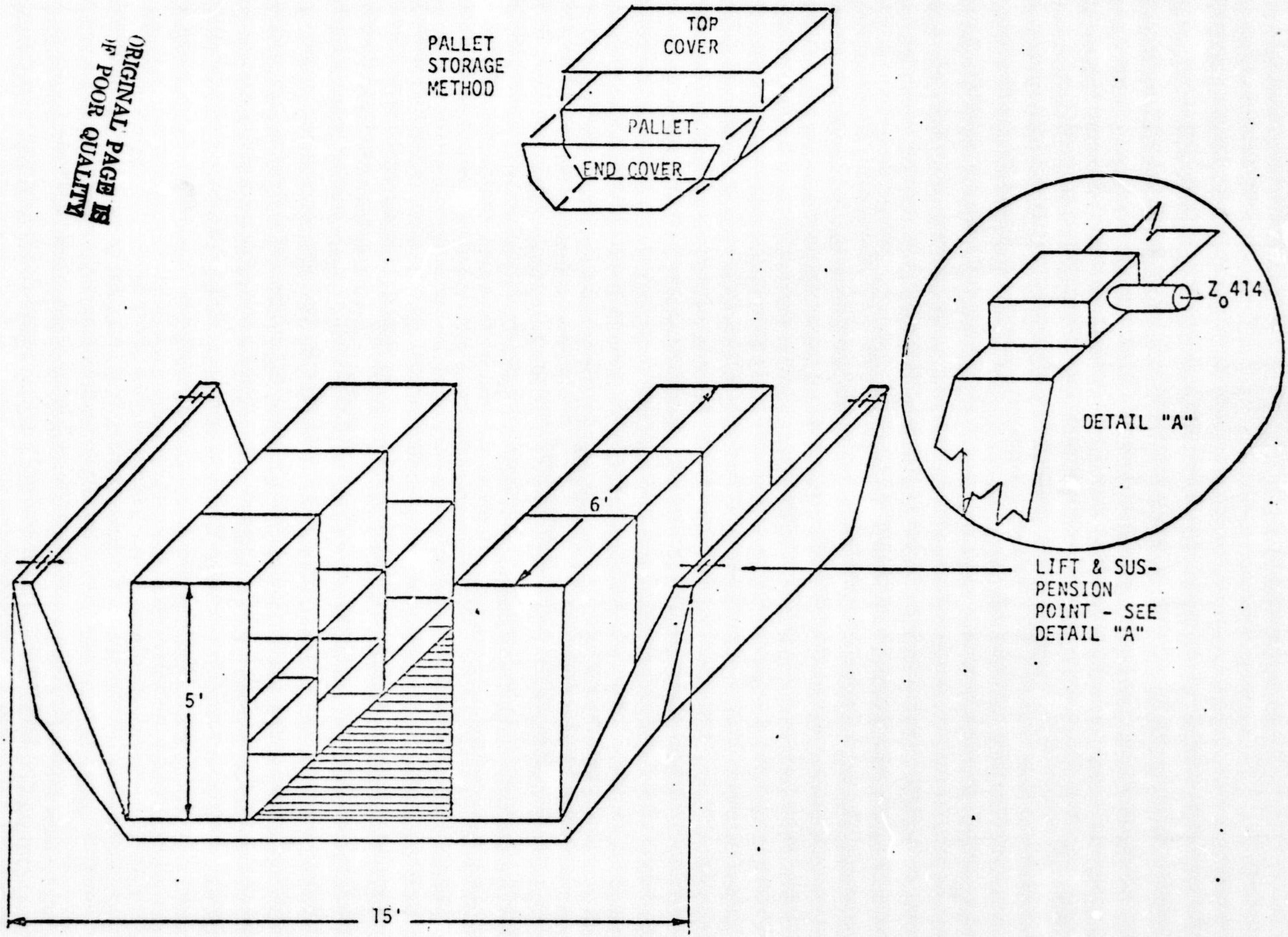

FIGURE 4.6.1

OPTION VI: SAIL UNIQUE PAYLOAD PALLET

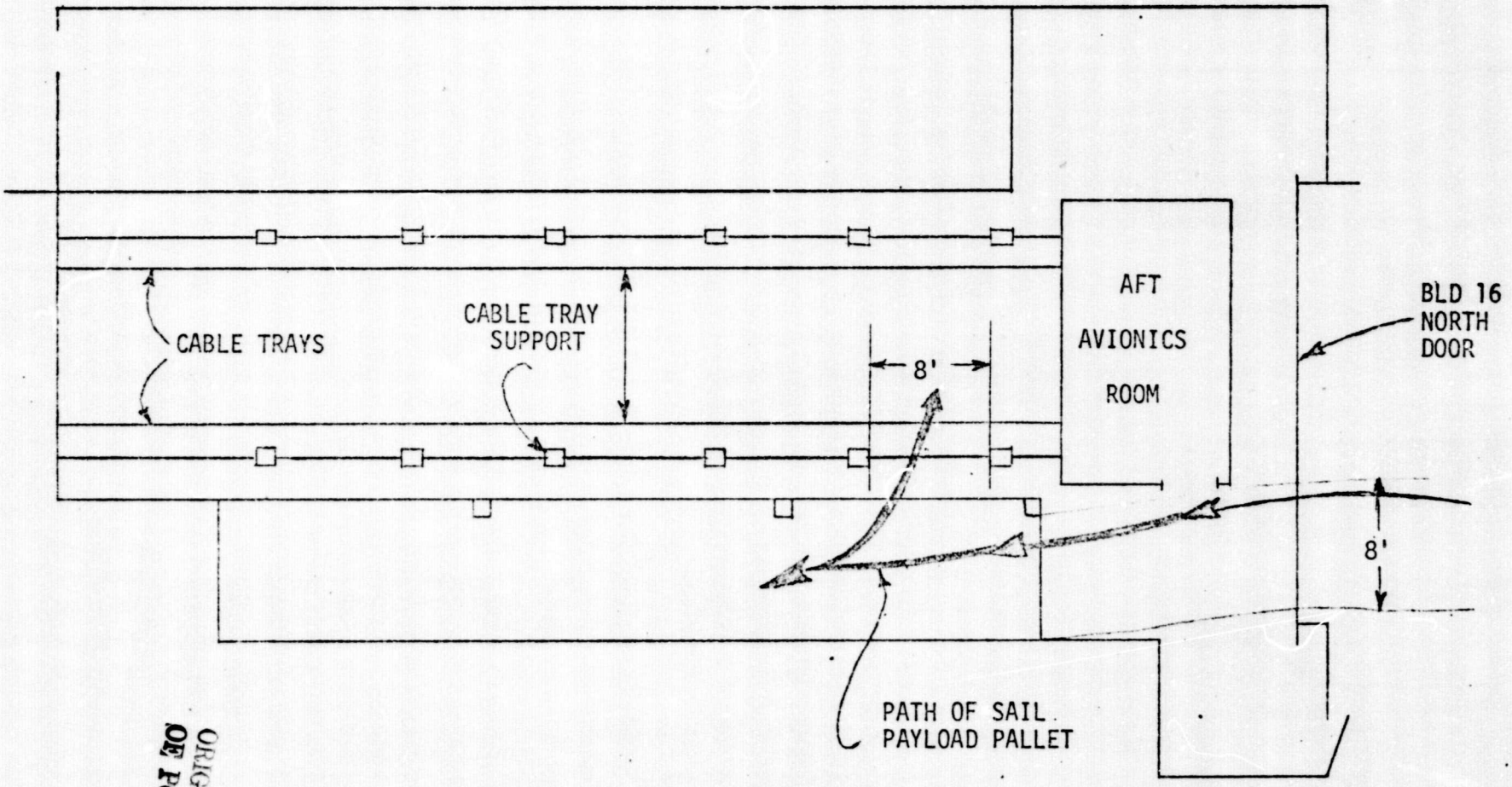

FIGURE 4.6.2

OPTION VI: NORTH DOOR ENTRY

(PATH OF SAIL UNIQUE PALLET)

5.0 CONCLUSION

Option VI is judged to be the preferred method for verifying payload avionics because: with proper planning the aft avionics room need not be moved; alteration of Building 16 structure is not required; fidelity of flight-type payload to Orbiter interface cabling can be preserved; the existing SAIL crane may be utilized as is; scarce SAIL floor space is augmented; and means are provided for off-line checkout and storage.

It is recommended that Option VI, the SAIL unique pallet be established as the standard method of verifying payload avionics in SAIL. Following this a detailed definition of the SAIL unique pallet should be started. An input to the SAIL physical layout baseline should be implemented to insure that an entrance path is available or easily arranged for the installation of the SAIL unique pallets.

The existing baseline requirement for movability of the aft avionics room (Option I) should be maintained. The rationale for this recommendation is that program cost restrictions may preclude the availability of breadboard on prototype payload systems and experiments. In that case, prototype or flight-type payloads will be included as a SAIL payload accommodation if the need arises.

Flight-type payload handling is constrained by mechanical stress limitations. It is also recommended that, when considered appropriate and necessary, a study be initiated to find solutions to the handling problems of these payloads.

6.0 REFERENCES

The information in Table I has been derived from sketches and layout presentations of the SAIL facility. In addition, practical knowledge was acquired through physical inspection of the SAIL and conversations with knowledgeable SAIL facility personnel. Also, JSC's 07700, Vol. IV Payload Accommodations and ESA's Payload Handbook were used as source documents.