Required Area for a crew person in a space vehicle
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Reference used:
The Effects of Confinement as a Factor in Manned Space Flight
By T.M. Fraser
Prepared under Contract No. NASr-115 by Lovelace Foundation for Medical Education and Research
NASA CR-511
circa 1966

This 176 page report was written in circa 1966 to examine the effects of confinement during space flight. One of the topics covered was the required size of a space vehicle for extended missions. Analysis was done using size of crew and length of time in a confined space. The report was based on all information available at that time. The data collected and analyzed included both NASA and (when possible) Russian missions flown to date, analogs (such as submarines), and ground studies.

Both psychological and physiological responses to confinement were examined. Factors evaluated in estimating the degree of impairment included the level of performance of intellectual, perceptual, manual and co-ordinated tasks, response to psychological testing, subjective comments of the participants, nature and extent of physiological change, and the nature and extent of behavioral change and the nature and extent of somatic complaints. Information was not included from studies where elements of perceptual isolation were more than mildly incidental - water immersion studies, studies in darkened and acoustically insulated rooms, studies with distorted environmental inputs - unpatterned light and white noise.

Using the graph from the document, the upper line provides a threshold of minimum acceptable volume - all points above the line may be considered acceptable. The lower line provides a threshold of unacceptable volume - all points below the line are unacceptable. The area in between the two lines is the area of doubtful acceptability where impairment tends to increase with reduction in volume and increased duration of exposure. Reference is made of the Gemini VII, 14-day duration mission which had detectable impairment with a combination of 40 cubic feet per man for 14 days. In line with all other data this point should be in the 'marked impairment' zone. It is assumed that the state of fitness, dedication and experience influenced this outcome. Copy of the figure from the document is attached.

Conclusion:

10 day mission	Threshold of acceptable volume 135 cubic feet per person
	Threshold of unacceptable volume 50 cubic feet per person

STS Volume Question

Volumes of habitable area

AirLock	123.8
A/L Tunnel	39.8
MidDeck	402.6
Flight Deck	123.00

We do not have validated dimensions for the interior of the airlock (A/L) and the airlock tunnel. Therefore, the actual volume is less than those given above for the A/L and A/L tunnel, which are for the outside dimensions.

The middeck volume takes into account 7 stowage bags, 4.5 airlock-out large bags, and 2 EMUs. Those items that are documented and have specific dimensions. Equipment, such as computers, loose cables, etc. as seen in the attached photograph have not been counted.

Usable volume for STS-91 is :

with 6 crew up -	123.2 cubic feet per person
with 7 crew down -	105.6 cubic feet per person

The volume for a ten-day mission has a threshold of acceptable volume of 135 cubic feet per person
The volume for a ten-day mission has a threshold of unacceptable volume of 50 cubic feet per person.
Both the up and down volumes fall into the area of doubtful acceptability where impairment tends to increase with reduction in volume and increased duration of exposure.

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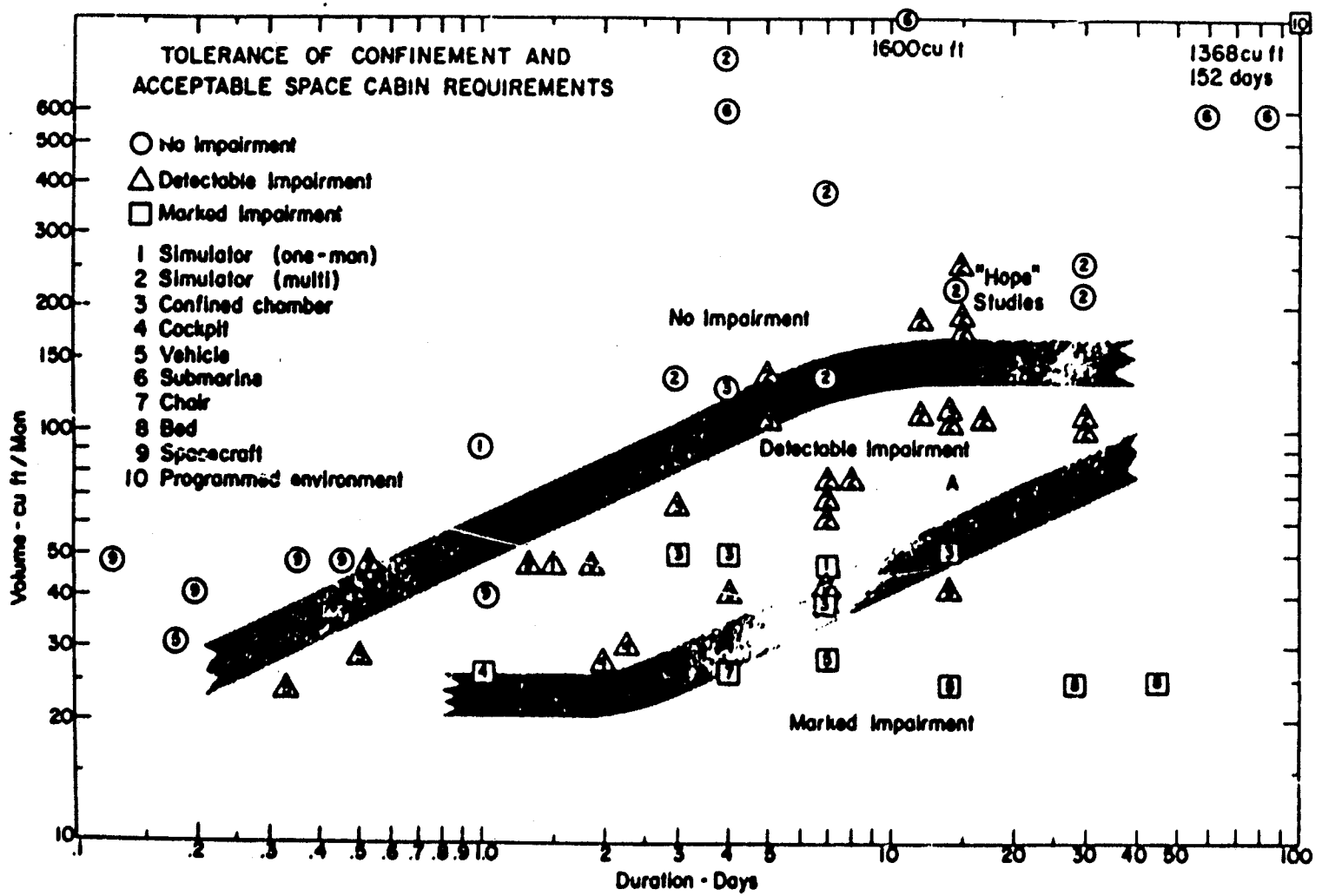
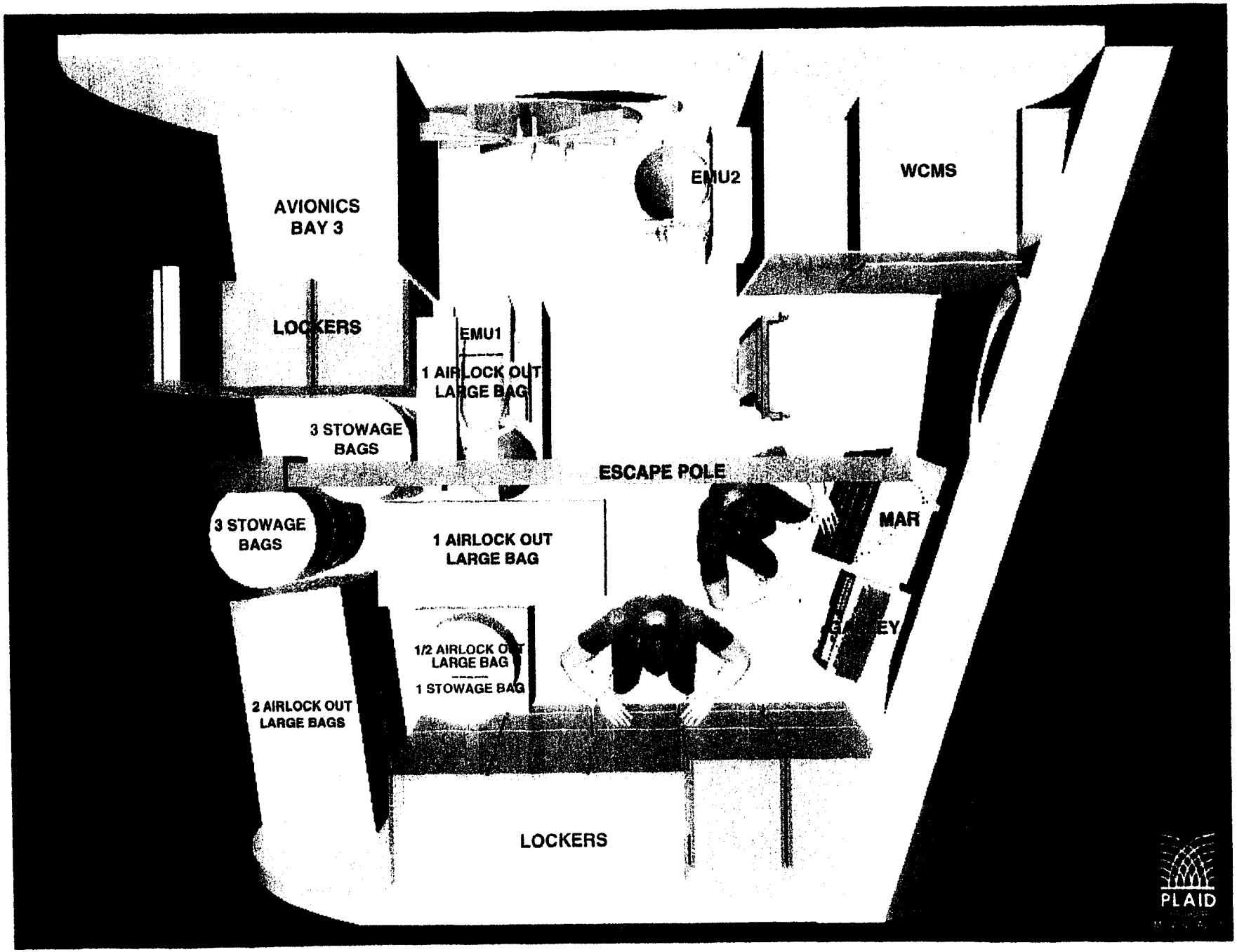


Figure 8. Tolerance of Confinement and Acceptable Space Cabin Requirements.

(no sleep stations)

AVAILABLE VOLUME = 405 ft³



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