

APOLLO LUNAR SURFACE EXPERIMENTS PACKAGE

ALSEP SYSTEM MASS PROPERTIES

10 August 1971



Prepared for

NASA/Manned Spacecraft Center



by
**Aerospace
Systems Division**



Aerospace
Systems Division

ALSEP Weight Report	NO. ATM 268	REV. NO. AG
	PAGE <u>i</u>	OF _____
	DATE 10 August 1971	

CONTENTS

	<u>Page No.</u>
FOREWORD	1
SECTION 1.0 WEIGHT	2
1.1 ARRAY A-2	3
1.2 FLIGHT 5	4
1.3 ARRAY E	7
SECTION 2.0 CENTER OF GRAVITY LOCATION REQUIRE- MENT	10
SECTION 3.0 REQUIREMENTS	10
SECTION 4.0 COORDINATE RELATIONSHIP	10
TABLE 1 ALSEP WEIGHT STATUS SUMMARY	2
TABLE 1-1 ALSEP FLIGHT 5 WEIGHT ESTIMATE	5
TABLE 1-2 ALSEP FLIGHT 5 C/S ESTIMATED WEIGHT BREAKDOWN	6
TABLE 1-3 ALSEP ARRAY E WEIGHT ESTIMATE	8
TABLE 1-4 ALSEP ARRY E C/S ESTIMATED WEIGHT BREAKDOWN	9
TABLE 2 CENTER OF GRAVITY LOCATIONS	11
TABLE 3 LM SEQ BAY MASS PROPERTY CONSTRAINTS	12



**Aerospace
Systems Division**

ALSEP Weight Report	NO. ATM 268	REV. NO. AG
	PAGE <u>ii</u> OF _____	
	DATE <u>10 August 1971</u>	

CONTENTS (CONTINUED)

		<u>Page No.</u>
FIGURE 1	ALSEP AXIS DEFINITION	13
FIGURE 2	C.G. SPEC LOCATION IN ALSEP COORDINATES	14
FIGURE 3	C.G. SPEC LOCATION IN ALSEP COORDINATES	15
FIGURE 4	LM AXIS DEFINITION	16
FIGURE 5	ALSEP Y & Z C.G. DIMENSIONS	17



**Aerospace
Systems Division**

ALSEP Weight Report	NO.	REV. NO.
	ATM 268	AG
	PAGE <u>1</u> OF <u>17</u>	
DATE 10 August 1971		

FOREWORD

This Revision supersedes the revision issued 25 February 1971.

This report covers mass property information on all ALSEP Flight hardware. It includes, for the first time, actual mass property test results for both subpacks of Flight 5.

Prepared by *R. Foster*
R. Foster

Approved by *J. McNaughton*
J. McNaughton



**Aerospace
Systems Division**

ALSEP Weight Report

NO.	REV. NO.
ATM-268	AG
PAGE 2	OF 17
DATE 10 August 1971	

1.0 WEIGHT

The weight of the ALSEP Flight Systems are summarized in Table 1. The Array A-2 weight is based on actual measured weight data. The Flight 5 weight is based on approximately 75% actual weight data with the remainder estimated. The Array E weight is 100% estimated based on the preceding ALSEP systems. Since there are presently two possible experiment combinations which could be included in Array E, the prime and alternate system weights are reported.

TABLE 1 ALSEP WEIGHT STATUS SUMMARY

	FLIGHT 1	FLIGHT 3	FLIGHT 4	ARRAY A-2	FLIGHT 5	ARRAY E ¹
SUBPACKAGE#1	122.60	124.45	125.43	125.11	140.96	135.5
SUBPACKAGE#2	<u>95.82</u>	<u>91.45</u>	<u>98.17</u>	<u>104.77</u>	<u>85.20</u>	<u>94.95</u>
SUBTOTAL	218.42	215.90	223.60	229.88	226.16	230.45
ACA	<u>59.18</u>	<u>58.67</u>	<u>59.46</u>	<u>58.72</u>	<u>59.40</u>	<u>54.28</u>
TOTAL	277.60	274.57	283.06	288.60	285.56	284.73

NOTATION: All weights are in earth pounds.

¹ Estimate of minimum weight configuration (primary array) consisting of the following experiments: LSP, LMS, LSG, HFE, and LEAM. The alternate array totals 284.68 lbs (reference pages 7 & 8).



Space
Systems Division

ALSEP Weight Report

NO.	REV. NO.
ATM 268	AG
PAGE 3	OF 17
DATE 10 August 1971	

1.1 ALSEP ARRAY A-2

The Array A-2 weights reported below are based on actual mass properties test results adjusted to reflect subsequent changes.

Subpackage #1

The PSE and experiment cable strain relief modifications performed subsequent to mass properties testing resulted in a weight increase of 1.41 lbs from 123.70 lbs to the present weight of 125.11 lbs.

Subpackage #2

Modifications to the SIDE experiment performed at Rice University as well as a change in the PSE Stool resulted in a weight increase of .58 lbs from 104.19 lbs to the present weight of 104.77 lbs.

ACA

The ALSEP Cask Assembly (ACA) remains at 58.72 lbs.



**Aerospace
Systems Division**

ALSEP Weight Report

NO.	REV. NO.
ATM 268	AG
PAGE 4	OF 17
DATE 10 August 1971	

1.2 ALSEP FLIGHT 5

Much additional actual weight data has been obtained since the last report. Approximately 25% of the weight remains estimated. Detailed weight breakdowns are presented in Tables 1-1 and 1-2.

Subpackage #1

The new weight estimate is 140.96 lbs. based on mass property data, and including cable strain relief and ASE modification weight estimates.

Subpackage #2

The new weight estimate is 85.20 lbs, based on mass property data, and including the ASE modification weight estimate.

ACA

The ACA weight remains at 59.4 lbs as previously reported.

ALSEP FLIGHT 5 WEIGHT ESTIMATE

SUBPACKAGE #1

C/S, PSE and ASE Elect	46.43*
Primary Structure	9.57*
Sunshield Assembly	11.22*
PSE	22.41*
ASE/Cables	22.76*
LSM	20.00
Thermal Control Curtains	2.00
Fasteners (Boyd-bolt)	0.80
PDM	0.75
Sunshield Extenders	0.95
Boom Assy	0.90
Antenna & Cable	<u>1.25*</u>
S/P #1 Total (Estimate)	139.04
	<u>138.66**</u>
Cable Strain Relief	0.25
ASE Modification	<u>2.05</u>
	<u>140.96 lb</u>

SUBPACKAGE #2

Pallet Assembly	13.48*
Structure Carrier	4.75*
Shield Assembly/RTG Cable	1.70
RTG and Cable	28.30
Shorting Plug	1.00
HFE Probes & Electronics	11.70
HFE Subpallet	6.40*
Forward Tool Support	0.60
ALSEP Deployment Tools	5.05*
Boom Release Assy	0.10
Fasteners (Boyd-bolt)	0.60
Antenna Aiming Mech & Box	3.32*
Miscellaneous	0.81
PSE Stool	<u>0.44*</u>
S/P #2 Total	78.35**
	<u>6.85 ASE Modification</u>
	<u>85.20 lb</u>
Total SEQ Bay	226.16
ACA	<u>59.40</u>
ALSEP Total Weight	285.56 lb

ACA

Fuel Capsule	14.5
Fuel Cask	25.5
GAC Structure	5.0
Thermal Shield	2.6
Structure Assembly	5.5
Band Assembly	4.3
Astronaut Protection	<u>2.0</u>
ACA Total	59.4 lb

*Actual Weight Data
**Mass Properties Test Data



Space
Systems Division

NO.	REV. NO.
ATM 268	AG
PAGE 6	OF 17
DATE 10 August 1971	

ALSEP Weight Report

ALSEP FLIGHT 5
CENTRAL STATION ASSEMBLY
DETAILED WEIGHT BREAKDOWN (ESTIMATE)

PDU	2.3
Multiplexer	2.3
Data Processor	3.2
CMD Receiver	2.5
Diplexer Filter	1.0
Diplexer Switch	1.3
Transmitters (2)	3.9
CMD Decoder	2.7
PCU	4.5
Thermal Plate & Hardware	9.0
Harness Assy	3.3
Thermal Bag	2.0
PSE Elect.	4.1
ASE Elect.	3.7
Timer	.5
Miscellaneous	0.13
Total	<u>46.43 lb</u>

TABLE 1-2



**Aerospace
Systems Division**

ALSEP Weight Report

NO. ATM 268	REV. NO. AG
PAGE <u>7</u>	OF <u>17</u>
DATE 10 August 1971	

1.3 ALSEP ARRAY E

The new estimates of Array E system weight for the two experiment configurations under consideration are presented below:

	ARRAY	
	PRIME LSP, LMS, LSG, HFE, & LEAM	ALTERNATE LSP, LMS, PSE, HFE, & LEAM
Subpack #1	135.5	134.0
Subpack #2	<u>94.95</u>	<u>96.40</u>
Total SEQ Bay	230.45	230.40
ACA	<u>54.28</u>	<u>54.28</u>
Array E Total	284.73	284.68

Weight breakdowns are shown in Tables 1-3 and 1-4.

ALSEP ARRAY E WEIGHT ESTIMATE

<u>SUBPACKAGE #1</u>	Configuration		<u>SUBPACKAGE #2</u>		<u>ACA</u>	
	Prime	Alternate				
C/S and LSP/CSE	43.2	N/A	Pallet Assy	13.5	Fuel Capsule	15.25
C/S and LSP & PSE CSE	N/A	47.4	Structure Carrier	5.1	Fuel Cask	25.07
Primary Structure	9.3	9.3	Shield Assy/RTG Cable	1.7	Thermal Shield	} 13.96
Sunshield Assy/Sub/Fast	10.1	11.3	RTG & Cable	28.15*	Structure Assy	
Support Structure, LSG	1.6	N/A	Shorting Plug	1.5	Band Assy	
T/C Curtains	2.0	2.0	ALSEP Tools	3.4	Astronaut Protect.	
Boom	0.9	0.9	Aiming Mechanism	1.9		
PDM	1.0	1.0	Aim. Mech. Box	2.0		
Sunshield Extenders	0.9	0.9	Fasteners	0.7	ACA Total	54.28
Antenna & Cable	1.3	1.3	Carry Bar	2.1		
Antenna Mast	1.0	1.0	HFE Subpallet	6.4		
Fasteners	1.0	1.0	HFE Probes & Electronics	12.2		
LSG/Cable	27.7	N/A	LEAM/Cable & Spool	15.3		
LSP/Geo/Ant/Cable*	14.0	14.0	PSE Stool & Support Brkt.	1.45 (Alternate Only)		
LMS/Cable	20.0	20.0	Miscellaneous	<u>1.0</u>		
PSE	N/A	22.4				
Miscellaneous	<u>1.5</u>	<u>1.5</u>				
S/P #1 Total	135.5	134.0	S/P #2 Total (Primary)	94.95		
S/P #2 Total	<u>94.95</u>	<u>96.40</u>	S/P #2 Total (Alternate)	96.40		
SEQ Bay Total	230.45	230.40				
ACA Total	<u>54.28</u>	<u>54.28</u>				
ARRAY E TOTAL	284.73	284.68				

*The present weight estimate of the Explosive Package Transport Module (stowed in SEQ #3) is 38.8 lbs.

*actual weight.

TABLE 1-3



**Aerospace
Systems Division**

ALSEP Weight Report

NO. ATM 268	REV. NO. AG
PAGE <u>9</u> OF <u>17</u>	
DATE 10 August 1971	

ALSEP ARRAY E
CENTRAL STATION ASSEMBLY
DETAILED WEIGHT BREAKDOWN (ESTIMATE)

	<u>Prime</u>	<u>Alternate</u>
Data Process/Multiplexer	4.2	4.2
CMD Receiver	2.5	2.5
Diplexer Filter	1.0	1.0
Diplexer Switch	1.3	1.3
Transmitters (2)	3.0	3.0
CMD Decoder	3.6	3.6
PCU/PDU	8.8	8.8
Thermal Plate & Hardware	9.0	9.0
Harness Assy	2.1	2.1
Thermal Bag	2.0	2.0
PSE Elect.	---	4.2
LSP Elect.	3.7	3.7
Miscellaneous	<u>2.0</u>	<u>2.0</u>
	43.2 lb	47.4 lb

TABLE 1-4

ALSEP Weight Report

NO.	REV. NO.
ATM 268	AG
PAGE 10	OF 17
DATE 10 August 1971	

2.0 CENTER OF GRAVITY (c. g.) LOCATION

Table 2 contains the c. g. locations measured on the subpackages during the mass properties tests. Also presented are estimates of the ARRAY E centers of gravity.

3.0 REQUIREMENTS

The LM SEQ Bay mass property constraints on ALSEP are shown in Table 3.

Table 3A shows the variation in weight limitations with the different ALSEP Models.

The reference c. g. locations are shown in Table 3B and the c. g. envelope requirements are defined in Table 3C.

4.0 COORDINATE RELATIONSHIP

Figures 1 through 5 define the orientation of the ALSEP axes and the LM axes, the origin of the ALSEP axes in terms of LM coordinates, and the specified c. g. reference location for point A in both ALSEP and LM coordinates.

CENTER OF GRAVITY LOCATIONS (IN ALSEP COORDINATES)

		Subpackage #1		Subpackage #2		
		C. G. Inches	Delta (Δ) Inches	C. G. Inches	Delta (Δ) Inches	
Flight 1 (Measured)	X	8.46	(A) -2.53 (B) +0.48	9.20	(A) -1.79 (B) +1.22	
	Y	-12.61	-0.16	12.97	+0.52	
	Z	10.57	-1.48	11.94	-0.10	
Flight 3 Measured 6-69 S/P #2 Revised 2-23-70 S/P #1 Revised 3-17-70	X	7.92	(A) -3.07 (B) -0.07	8.48	(A) -2.50 (B) +0.50	
	Y	-14.10	-1.98	13.17	+0.73	
	Z	9.97	-2.17	12.42	-0.38	
Flight 4 S/P #2 Measured 6-16-70 S/P #1 Measured 6-18-70	X	7.58	(A) -3.41 (B) -0.41	9.18	(A) -1.81 (B) +1.20	
	Y	-13.18	-1.37	12.55	+0.11	
	Z	10.42	-1.63	12.51	+0.47	
Array A-2 S/P #1 Measured 11-6-70 S/P #2 Measured 1-12-71	X	8.36	(A) -2.63 (B) +.37	9.61	(A) -1.38 (B) +1.62	
	Y	-12.86	-.42	13.19	+0.74	
	Z	10.91	-1.14	11.97	-0.08	
Array D S/P #1 Measured 6-11-71 S/P #2 Measured 4-22-71	X	8.46	(A) -2.53 (B) +.47	9.60	(A) -1.39 (B) +1.61	
	Y	-13.44	-1.00	15.94	+3.49	
	Z	10.65	-1.40	10.65	-1.40	
Array E-Primary Array (E-1) Estimated	X	8.5	(A) -2.49 (B) +.52	9.7	(A) -1.29 (B) +1.72	
	Y	-13.2	-.78	14.8	+2.36	
	Z	11.6	+.45	11.5	+0.55	
Array E-Alternate Array (E-2) Estimated	X	7.6	(A) -3.39 (B) -.39	9.7	(A) -1.29 (B) +1.72	
	Y	-12.5	-.07	14.8	+2.36	
	Z	11.6	+.45	11.5	+0.55	
Offset RMS Δ = $\sqrt{\Delta X^2 + \Delta Y^2 + \Delta Z^2}$			Offset-Inches		Offset-Inches	
	Flight 1		1.57		1.33	
	Flight 3	(A) 4.25	(B) 2.90	(A) 2.63	(B) 0.96	
	Flight 4	(A) 4.02	(B) 2.15	(A) 1.87	(B) 1.29	
	Array A-2	(A) 2.89	(B) 1.26	(A) 1.57	(B) 1.79	
	Array D	(A) 3.06	(B) 1.79	(A) 4.01	(B) 4.09	
	Array E-1	(A) 2.64	(B) 1.03	(A) 2.74	(B) 2.96	
	Array E-2	(A) 3.27	(B) .60	(A) 2.74	(B) 2.96	

TABLE 2

ALSEP Weight Report

LM SEQ BAY MASS PROPERTY CONSTRAINTS

3A. Specified Weight Limitations - lbs.

	Flts 1 - 4	Array A-2	Array D	Array E
Per Compartment	125.0	155.0	145.0	155.0
Both Compartments	215.0	266.0	226.0	266.0
Total System	-	293.35	280.0	285.0

3B. CENTER OF GRAVITY-REFERENCE LOCATIONS (INCHES)

	COMPARTMENT 1			COMPARTMENT 2		
	X	Y	Z	X	Y	Z
Upper Hemisphere (A)						
ALSEP Coordinates	10.985	-12.445	12.045	10.985	12.445	12.045
M Coordinates	141.7	-62.0	-44.4	141.7	-44.4	-62.0
Lower Hemisphere (B)						
ALSEP Coordinates	7.985	-12.445	12.045	7.985	12.445	12.045
LM Coordinates	138.7	-62.0	-44.4	138.7	-44.4	-62.0

3C. C.G. ENVELOPE

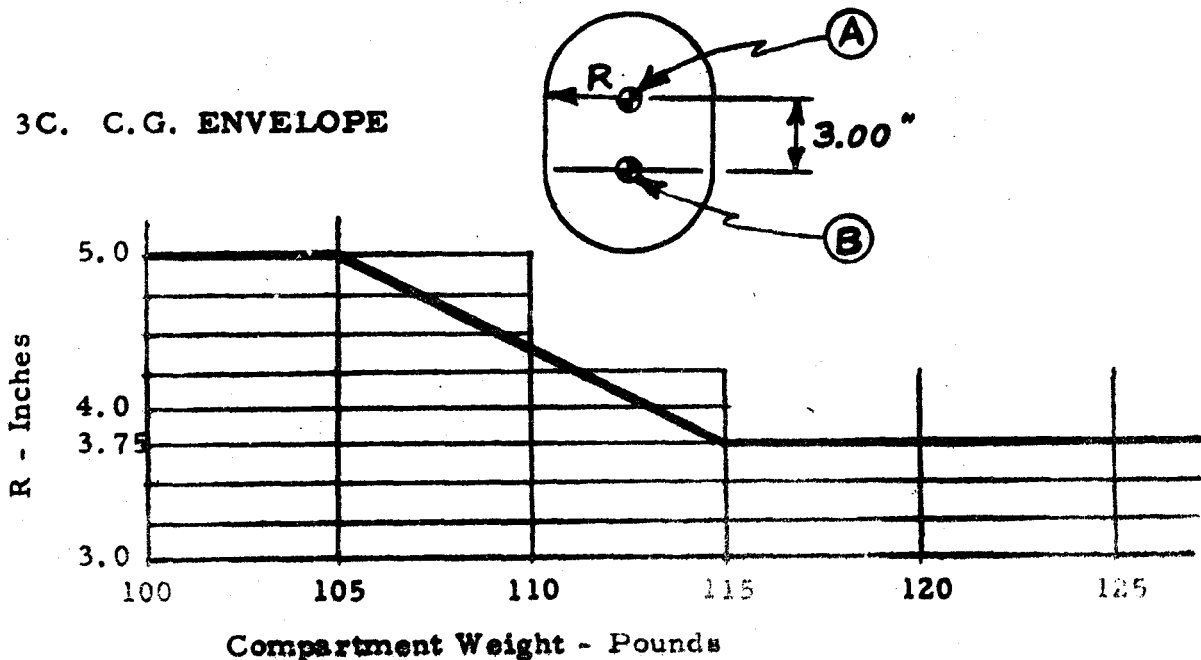


TABLE 3



**Aerospace
Systems Division**

ALSEP Weight Report

NO.	ATM-268	REV. NO.	AG
PAGE	13	OF	17
DATE	10 August 1971		

**ALSEP Plane $X = 0$,
Equivalent to LM Plane
 $X - 130.715$**

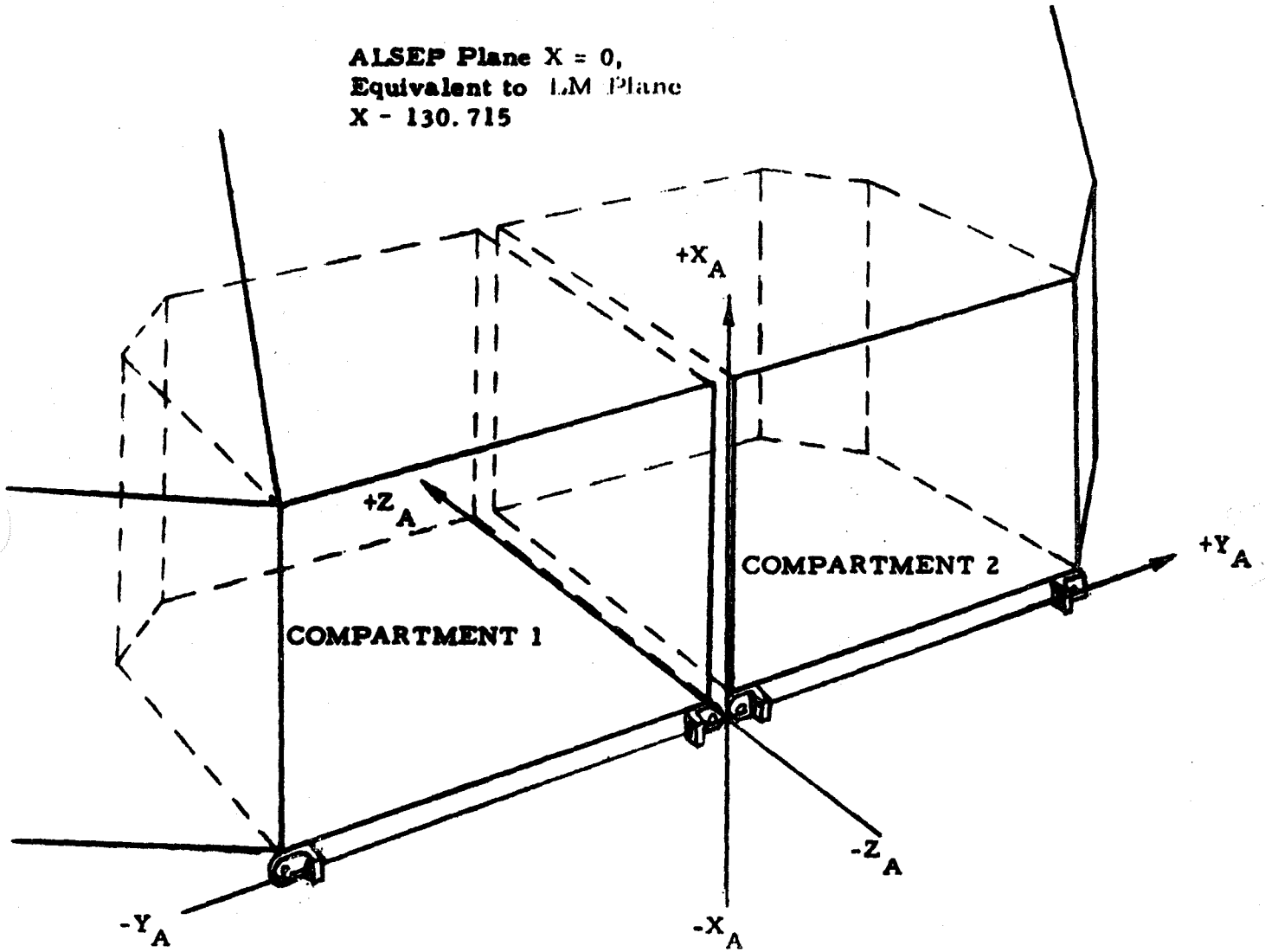


Figure 1 ALSEP Axis Definition



**Aerospace
Systems Division**

ALSEP Weight Report

NO.	ATM-268	SERV. NO.	AG
PAGE	14	OF	17
DATE	10 August 1971		

**C. G. Locations
and Dimensions
Typical Both
Compartments**

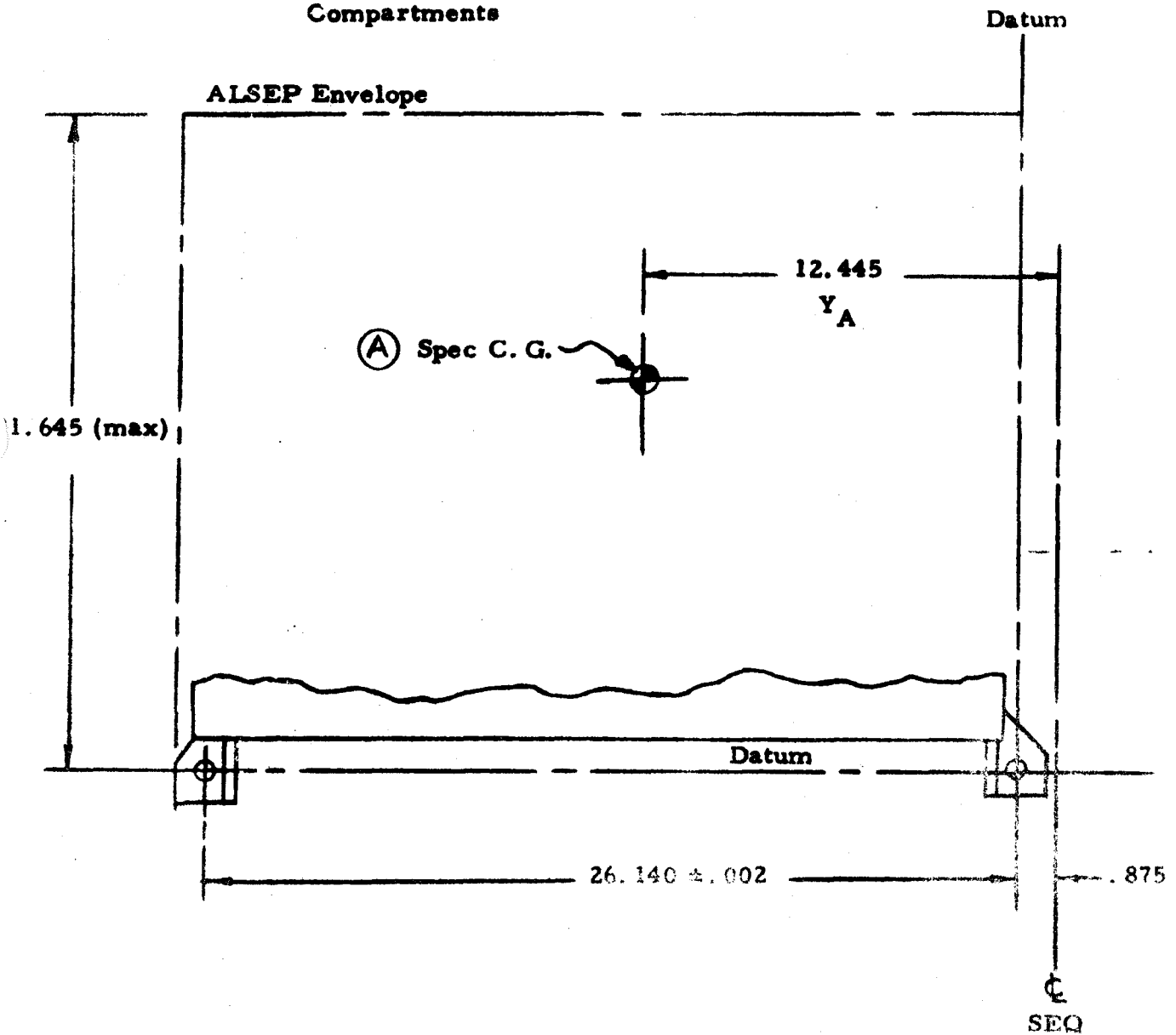


Figure 2 C. G. Spec Location in ALSEP Coordinates

C. G. Locations
 and Dimensions
 Typical Both
 Compartments

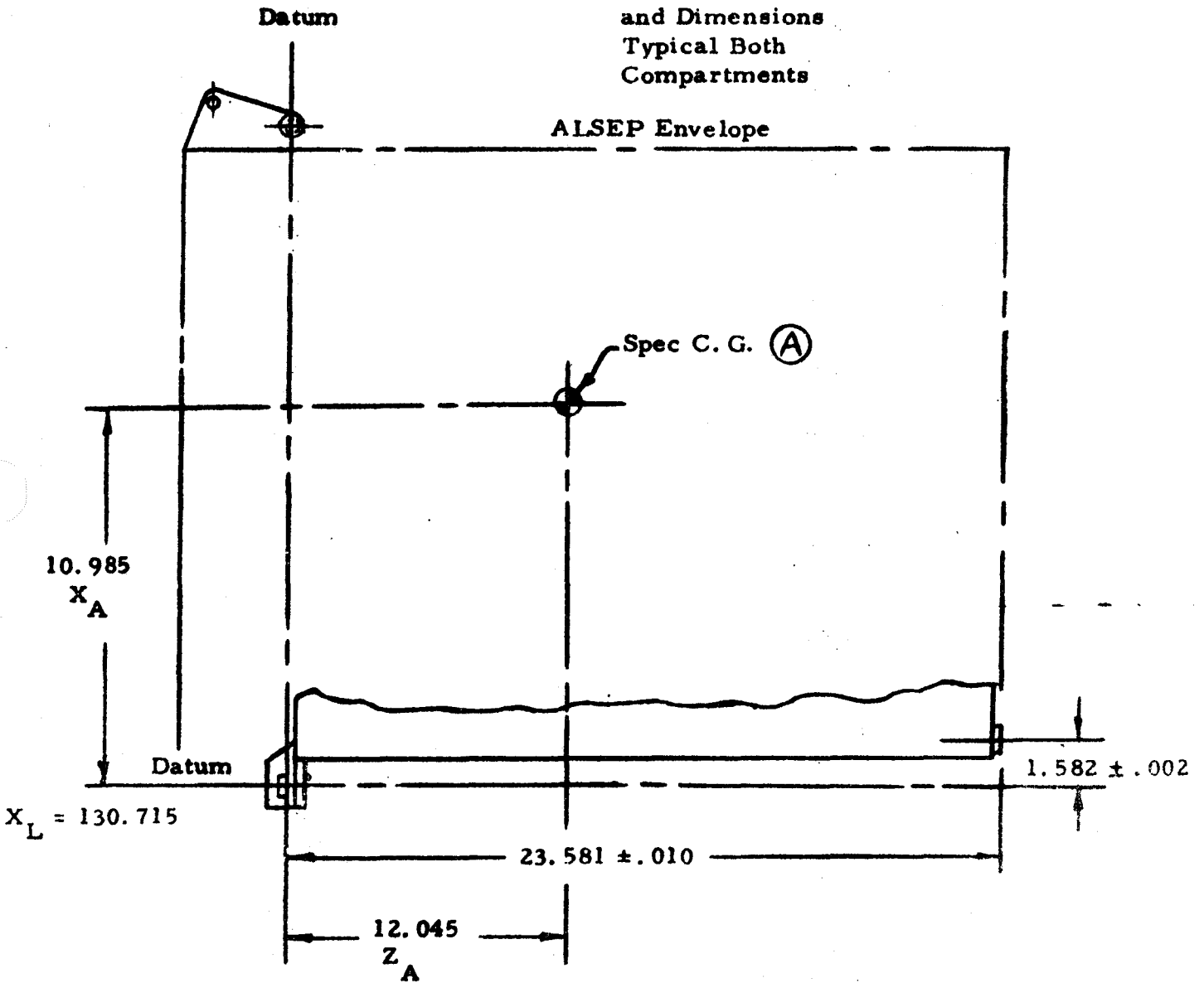


Figure 3 C. G. Spec Location in ALSEP Coordinates



**Aerospace
Systems Division**

ALSEP Weight Report

NO. ATM-268	REV. NO. AG
PAGE 16	OF 17
DATE 10 August 1971	

X - Axis (YAW)
 Y - Axis (PITCH)
 Z - Axis (ROLL)

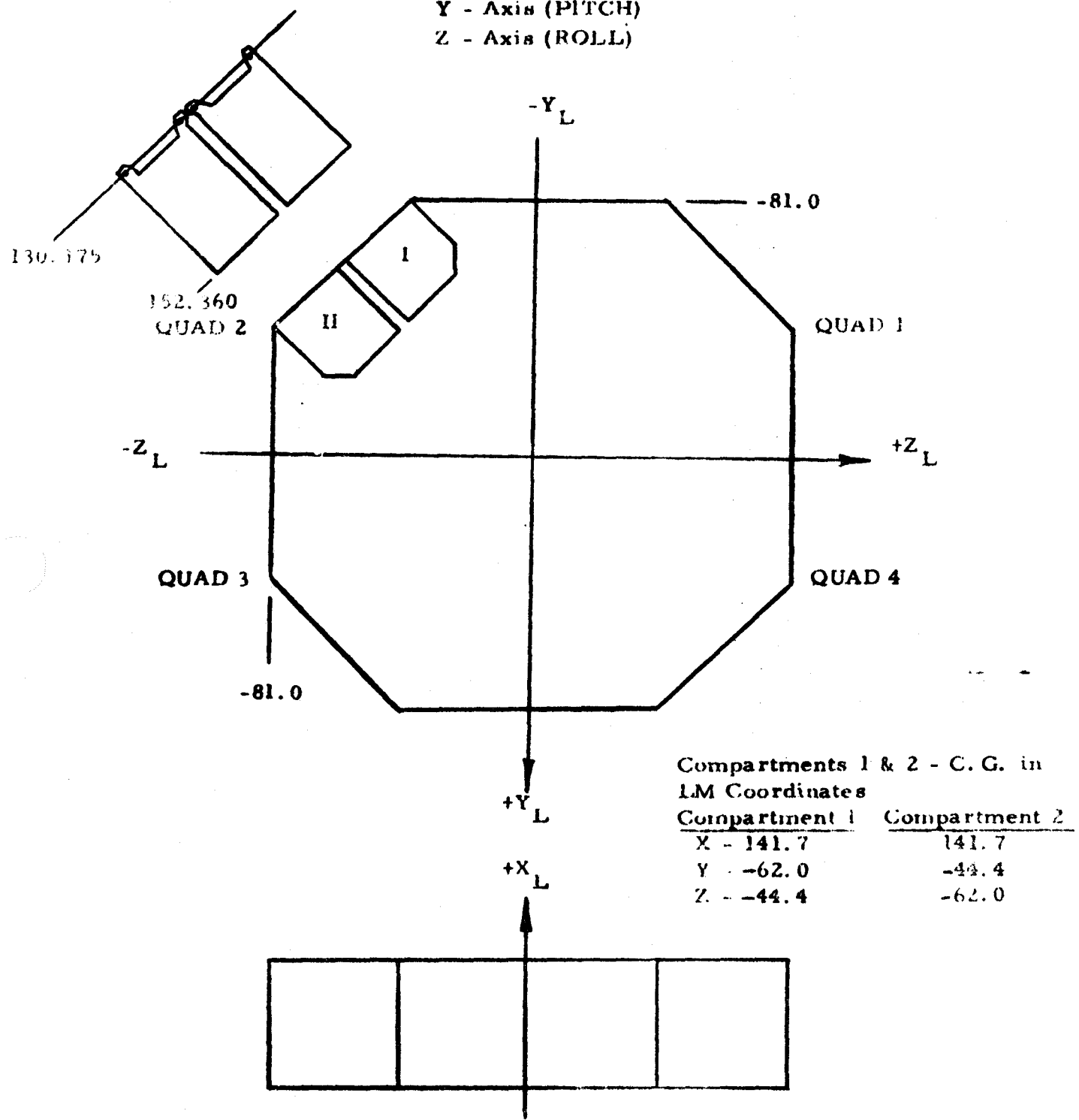


Figure 4 LM Axis Definition

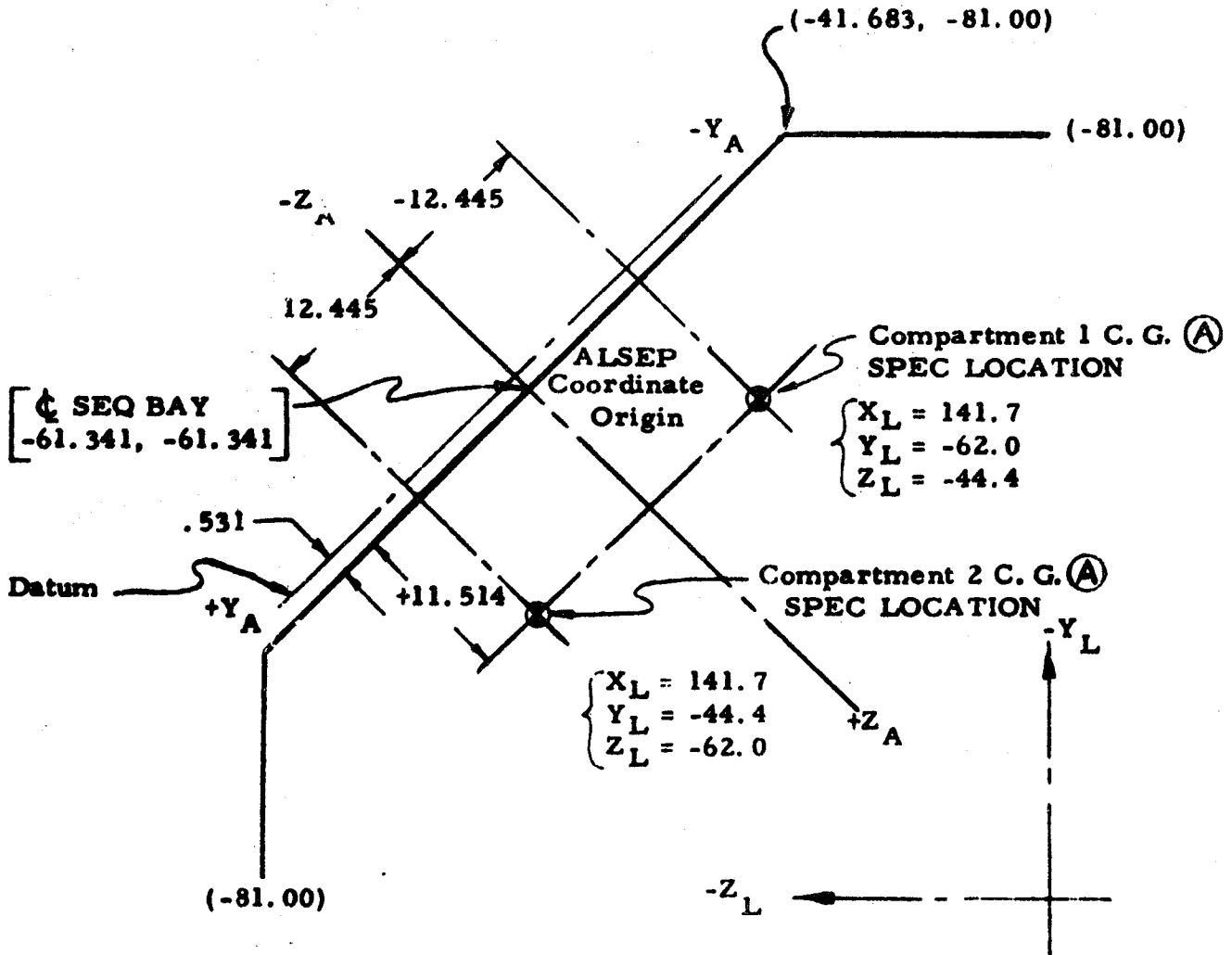


Figure 5 ALSEP Y & Z C. G. Dimensions on $X_L = 141.70$ Plane ($X_A = 10.985$)
(LID 22810 COORDINATES)