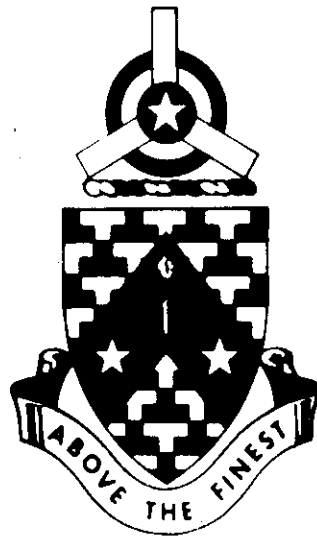


PROGRAMED TEXT

WEIGHT AND BALANCE

AM-84



MARCH 1968

UNITED STATES ARMY
PRIMARY HELICOPTER SCHOOL
FORT WOLTERS, TEXAS

PROGRAMED TEXT

PROGRAM TEXT

FILE NO:

AM-84

PROGRAM TITLE

WEIGHT AND BALANCE

POI SCOPE: Explanation of weight and balance publications. Discussion of basic terms and fundamentals of weight and balance, Proper loading of aircraft. Demonstration on computing weight and balance. Practical exercise on weight and balance.

INSTRUCTOR REFERENCES:

AR 95-16

TM 55-405-9, para 1 thru 42

TM 55-1520-206-10, para 6-60 thru 6-63, para 7-12 thru 7-29, Chapt. 12

PREPARED BY:

CW2 James H. Alexander
Maint/Metro Br.

DATE:

1 March 1968

REVISED BY:

DATE:

APPROVED BY:

Daniel H. Heuer
for MARTIN HEUER, LTC MAJ. TC
Dir, OCD

DATE:

August 1968

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WEIGHT AND BALANCE

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PREFACE

"Weight and Balance" of a helicopter refers to the proper loading of items on the helicopter, and arranging the load items so that the helicopter will be balanced. Proper weight and balance computations will assure safe flight, and an adequate margin of cyclic control will be available at all times.

Start with frame 1 and work each frame in succession. Each frame will usually ask you a question. The correct answer is printed on the top of the next frame. If you were incorrect, turn back and restudy the information before continuing on to the next frame. When you have finished the text, complete the self evaluation exercise. Now begin by studying the performance objectives on page 1.

PERFORMANCE OBJECTIVES

Upon completion of this programed text, you will be able to:

1. Select the publications and regulations pertaining to weight and balance.
2. Extract from the operator's manual the necessary forms and data to accurately complete the weight and balance clearance form "P".

FRAME 1

If an aircraft is loaded "out of balance", which of the following will result?

- A. ☐ High engine RPM.
- B. ☒ Insufficient cyclic stick movement.
- C. ☐ Tail boom oscillation.

Place an "X" in the proper box and turn the page and check your answer.

TURN TO FRAME 2 PAGE 4

TURN TO FRAME 2 PAGE 4

FRAME 20

Now that you have completed the "Limitations" block, and from reference 11 the total aircraft weight and moment is known, these figures are entered in Reference 13 of the 365F, as shown below.

13	TAKEOFF CONDITION (<i>Uncorrected</i>)	2	2	7	6	1	9	0	8	2
14	CORRECTIONS (<i>If required</i>)									
15	TAKEOFF CONDITION (<i>Corrected</i>)	2	2	7	6	1	9	0	8	2
16	TAKEOFF C. G. IN % M. A. C. OR IN.									
17	LESS FUEL									
18	LESS AIR SUPPLY LOAD DROPPED									
19	MISC. VARIABLES									
20	ESTIMATED LANDING CONDITION									
21	ESTIMATED LANDING C. G. IN % M. A. C. OR IN.									
COMPUTED BY										
		SIGNATURE								
WEIGHT AND BALANCE AUTHORITY										
		SIGNATURE								
PILOT										
		SIGNATURE								

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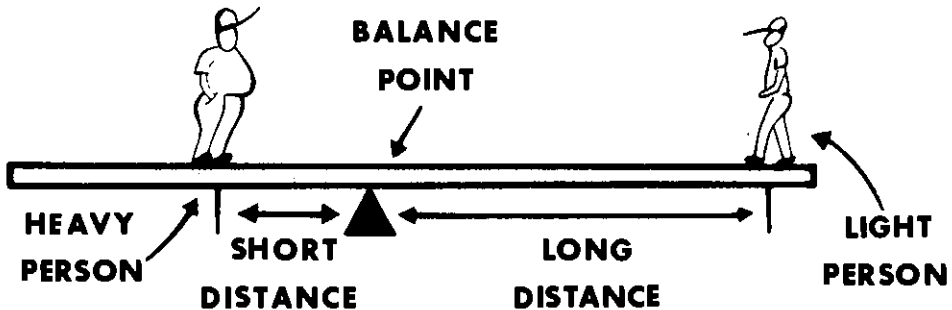
TURN TO FRAME 21 PAGE 5

CONFIRMATION: B. X Insufficient cyclic stick movement.

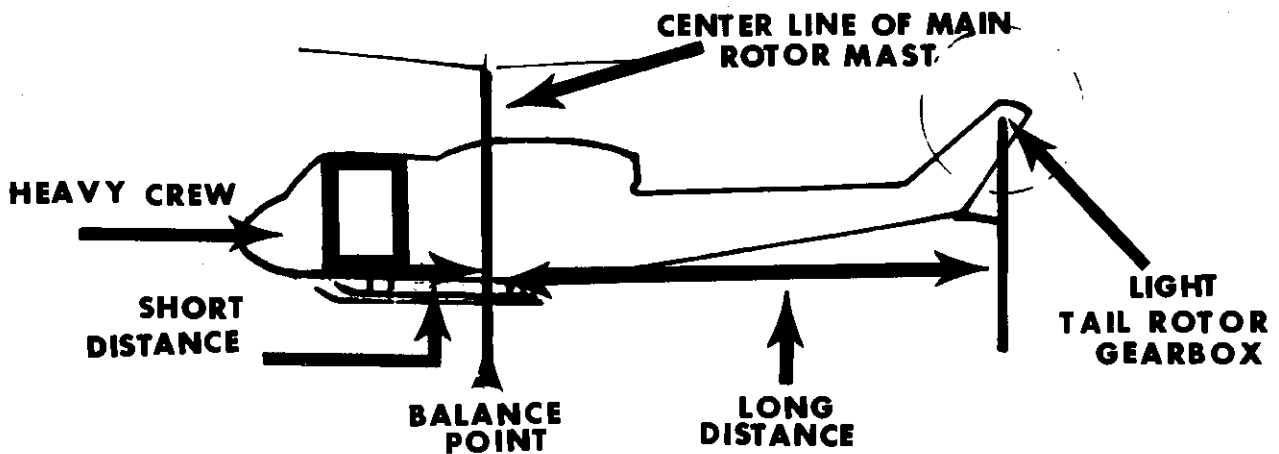
FRAME 2

Principles of loading a helicopter are illustrated in the pictures below.

SEE-SAW - BALANCED



HELICOPTER - BALANCED



TURN TO FRAME 3 PAGE 6

Given the information below, enter it on the form "F".

TOTAL AIRCRAFT WEIGHT - 2557

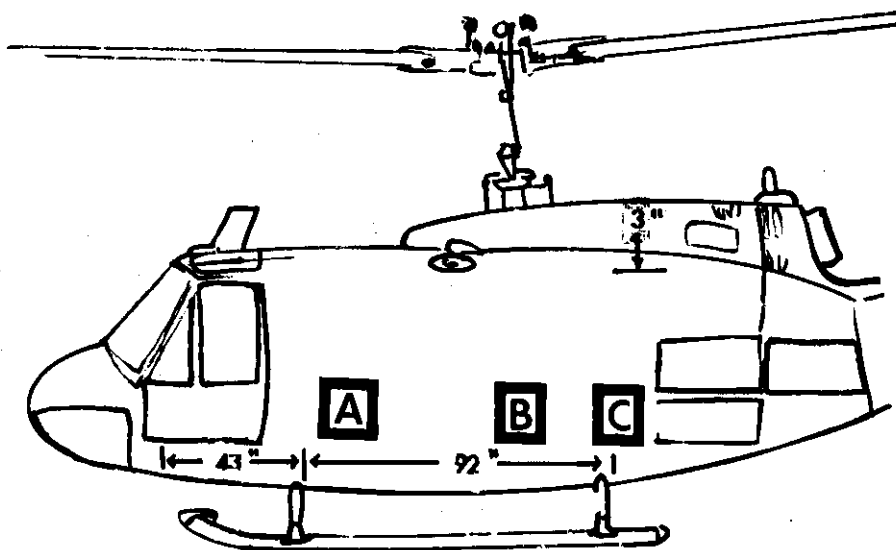
$$\frac{\text{MOMENT}}{100} = 2094.8$$

13	TAKEOFF CONDITION (<i>Uncorrected</i>)	2557	2094.8
14	CORRECTIONS (<i>If required</i>)		
15	TAKEOFF CONDITION (<i>Corrected</i>)	2557	2094.8
16	TAKEOFF C. G. IN % M. A. C. OR IN.		
17	LESS FUEL		
18	LESS AIR SUPPLY LOAD DROPPED		
19	MISC. VARIABLES		
20	ESTIMATED LANDING CONDITION		
21	ESTIMATED LANDING C. G. IN % M. A. C. OR IN.		
COMPUTED BY			
SIGNATURE			
WEIGHT AND BALANCE AUTHORITY			
SIGNATURE			
PILOT			
SIGNATURE			

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FRAME 3

In the diagram below, indicate the position for cargo to be placed, so that the helicopter will be balanced.



- A. ☐
- B. ☒
- C. ☐

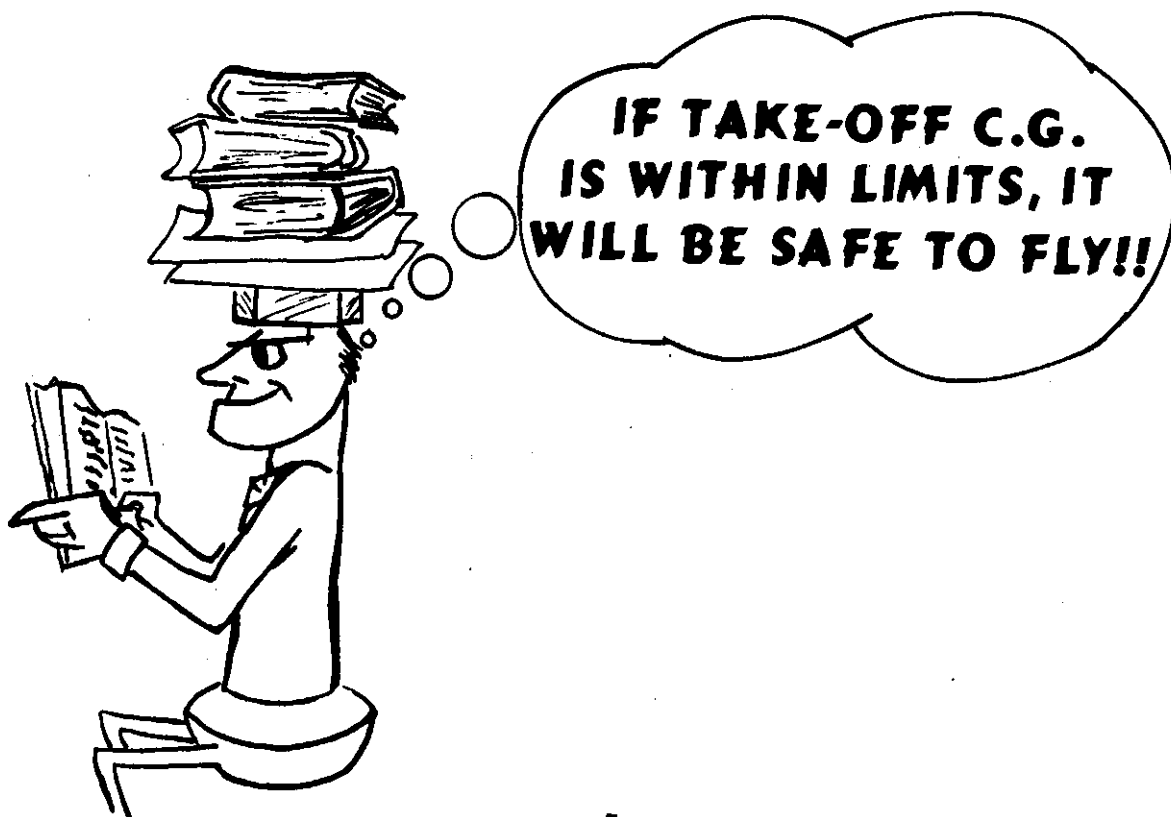
Place an "X" in the proper box and turn the page and check your answer.

13	TAKEOFF CONDITION (<i>Uncorrected</i>)	2557	2094.8
14	CORRECTIONS (<i>If required</i>)		
15	TAKEOFF CONDITION (<i>Corrected</i>)	2557	2094.8
16	TAKEOFF C. G. IN % M. A. C. OR IN.		
17	LESS FUEL		
18	LESS AIR SUPPLY LOAD DROPPED		
19	MISC. VARIABLES		
20	ESTIMATED LANDING CONDITION		
21	ESTIMATED LANDING C. G. IN % M. A. C. OR IN.		
COMPUTED BY			
SIGNATURE			
WEIGHT AND BALANCE AUTHORITY			
SIGNATURE			
PILOT			
SIGNATURE			

16-07010-4 U.S. GOVERNMENT PRINTING OFFICE

FRAME 22

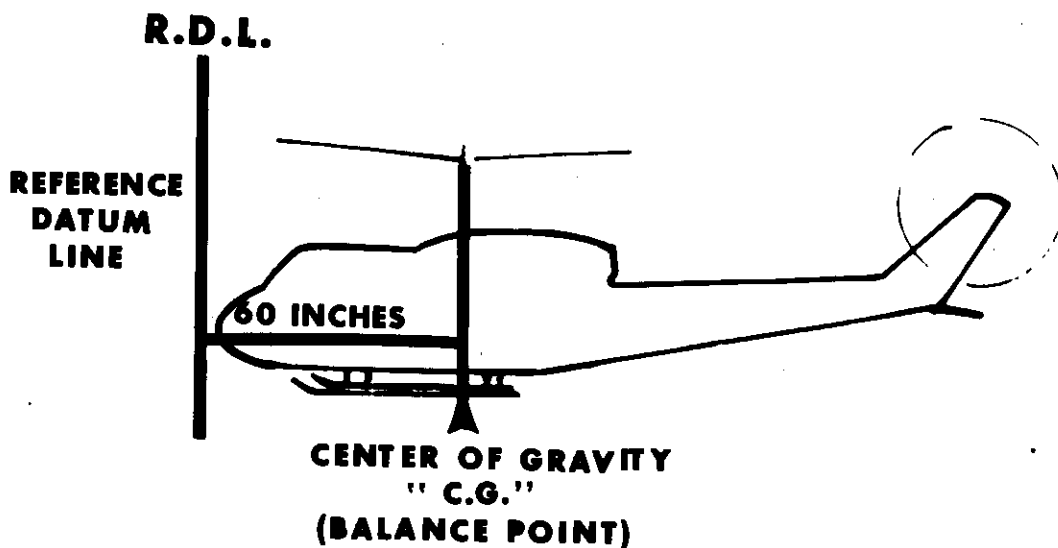
The center of gravity for take-off can now be computed.



CONFIRMATION: B. X

FRAME 4

The point at which a helicopter will balance is called the "center of gravity" (CG) and is measured from an imaginary line called the Reference Datum Line. (RDL) This measurement is in inches.



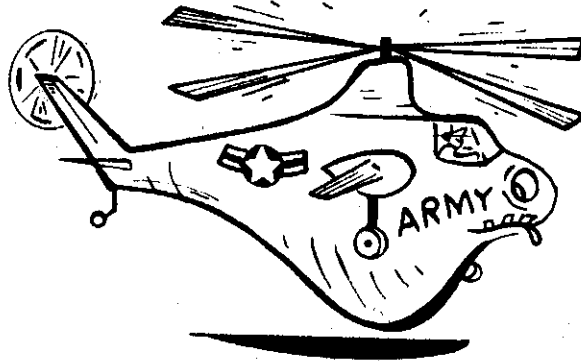
The center-of-gravity or "balance point" of the aircraft is determined by dividing the total aircraft moment by the total weight. Expressed as a formula:

$$\text{C.G.} = \frac{\text{TOTAL MOMENT}}{\text{TOTAL WEIGHT}}$$

***TOTAL
MOMENT***



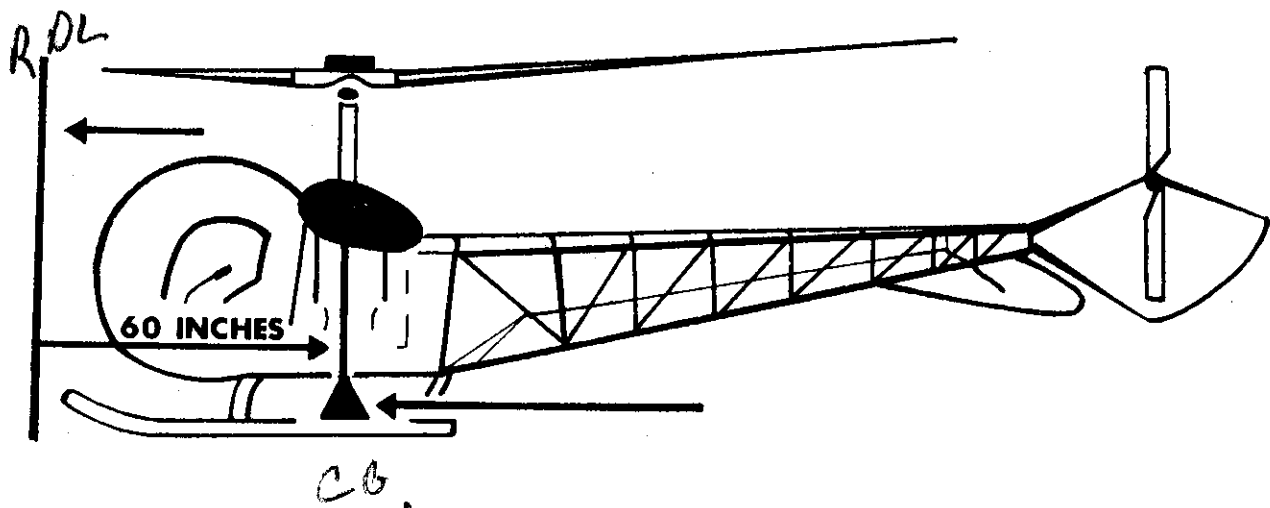
C.G. =



***TOTAL
WEIGHT***

FRAME 5

On the diagram below, label the Reference Datum Line and the Center of Gravity.



FRAME 24

Using the C. G. formula, determine the take-off C. G. for an aircraft having the following weight and moment.

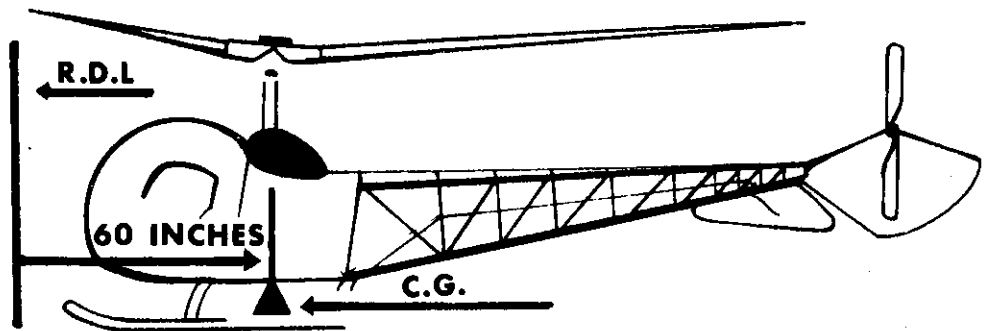
Total weight - 2576 lbs

Total moment = 2090.4
100

Do your calculations here, and turn the page and check your answer.

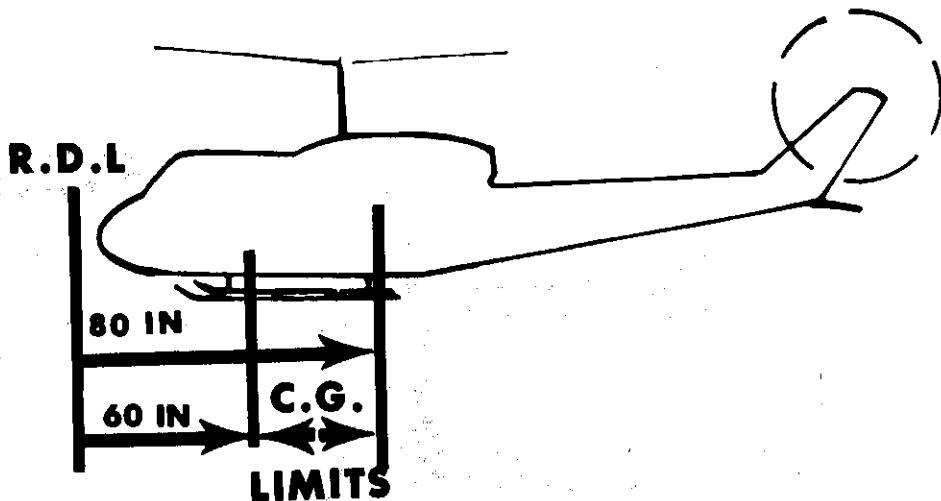
$$\begin{array}{r}
 81.15 \\
 2576 \overline{) 2090.40.0} \\
 \underline{20608} \\
 2960 \\
 \underline{2576} \\
 9840 \\
 \underline{2576} \\
 12640 \\
 \underline{12880} \\
 260
 \end{array}$$

RESPONSE :



FRAME 6

In actual helicopter flying, the manufacturer gives us the range of movement the C. G. can have, and the aircraft will be safe to fly if it balances between these points. This range of movement is called the "C.G. limits".



**HELICOPTER CAN BALANCE ANY WHERE
BETWEEN THESE TWO POINTS, AND
STILL BE SAFE TO FLY.**

CONFIRMATION

$$\begin{array}{r} 81.15 = \text{C.G.} \\ \hline 2576 \quad 2090.40. \end{array}$$

20608

2960

2576

3840

2576

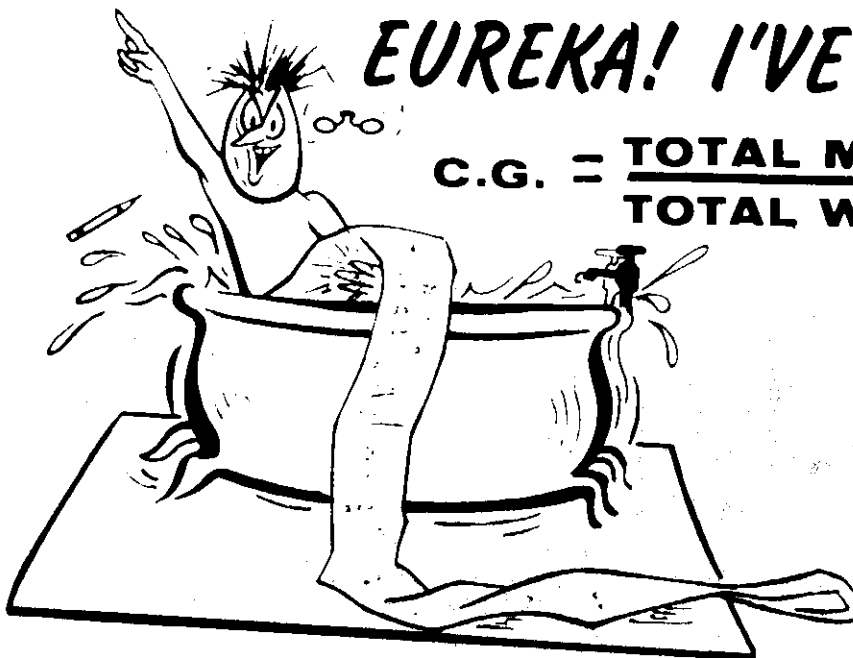
12640

12880

C.G. = 81.15 IN.

SIMPLIFIED MOMENT

REMEMBER TO MOVE
DECIMAL POINT OVER
TWO PLACES.!!



EUREKA! I'VE GOT IT !

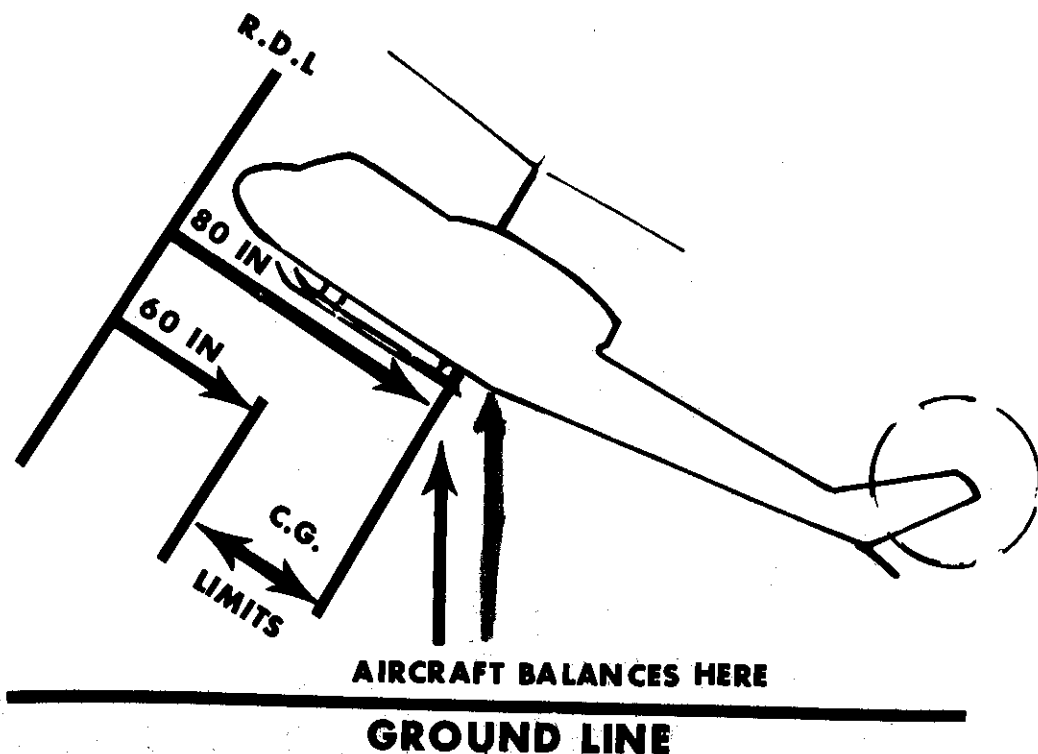
C.G. = $\frac{\text{TOTAL MOMENT}}{\text{TOTAL WEIGHT}}$!!!

FRAME 7

In the diagram below, will the aircraft be safe to fly?

A. Yes ☐

B. No ☒



In the diagram above, the aviator will

A. ☐ not be affected.

B. ☐ exit the aircraft.

C. ☒ experience a shortage of forward cyclic control.

FRAME 25

The center of gravity table in the -10 Operator's Manual will show the C.G. for various gross weight and moment combinations.

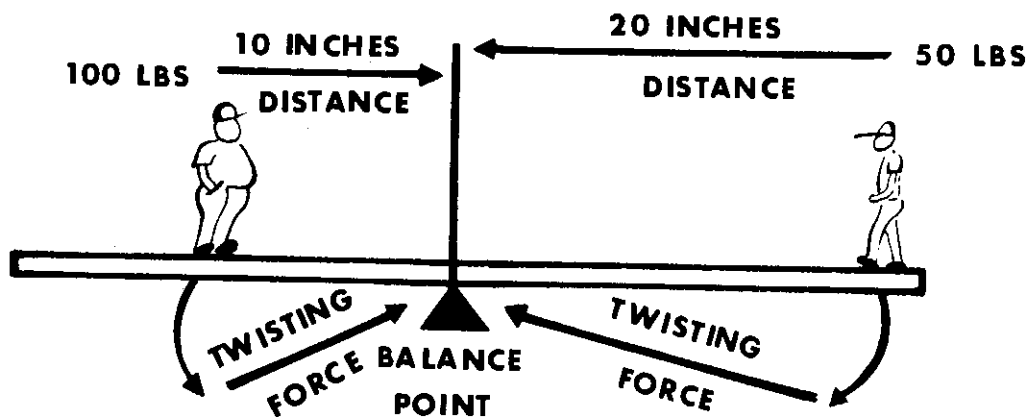
CENTER OF GRAVITY TABLE													
GROSS WEIGHT	MOMENT/100						GROSS WEIGHT	MOMENT/100					
	79.5	80.0	81.0	82.0	83.0	84.8		79.5	80.0	81.0	82.0	83.0	84.8
1900	1511	1520	1539	1558	1577	1611	2330	1852	1864	1887	1911	1934	1976
1910	1518	1528	1547	1566	1585	1620	2340	1860	1872	1895	1919	1942	1984
1920	1526	1536	1555	1574	1594	1628	2350	1868	1880	1904	1927	1951	1993
1930	1534	1544	1563	1583	1602	1637	2360	1876	1888	1912	1935	1959	2001
1940	1542	1552	1571	1591	1610	1645	2370	1884	1896	1920	1943	1967	2010
1950	1550	1560	1580	1599	1619	1654	2380	1892	1904	1928	1952	1975	2018
1960	1558	1568	1588	1607	1627	1662	2390	1900	1912	1936	1960	1984	2027
1970	1566	1576	1596	1615	1635	1671	2400	1908	1920	1944	1968	1992	2035
1980	1574	1584	1604	1624	1643	1679	2410	1916	1928	1952	1976	2000	2044
1990	1582	1592	1612	1632	1652	1688	2420	1924	1936	1960	1984	2009	2052
2000	1590	1600	1620	1640	1660	1696	2430	1932	1944	1968	1993	2017	2061
2010	1598	1608	1628	1648	1668	1704	2440	1940	1952	1976	2001	2025	2069
2020	1606	1616	1636	1656	1677	1713	2450	1948	1960	1985	2009	2034	2078
2030	1614	1624	1644	1665	1685	1721	2460	1956	1968	1993	2017	2042	2086
2040	1622	1632	1652	1673	1693	1730	2470	1964	1976	2001	2025	2050	2095
2050	1630	1640	1661	1681	1702	1738	2480	1972	1984	2009	2034	2058	2103
2060	1638	1638	1669	1689	1710	1747	2490	1980	1992	2017	2042	2067	2112
2070	1646	1656	1677	1697	1716	1755	2500	1988	2000	2025	2050	2075	2120
2080	1654	1664	1685	1706	1726	1764	2510	1996	2008	2033	2058	2083	2129
2090	1662	1672	1693	1714	1735	1772	2520	2003	2016	2041	2066	2092	2137
2100	1670	1680	1701	1722	1743	1781	2530	2011	2024	2049	2075	2100	2146
2110	1678	1688	1709	1730	1751	1789	2540	2019	2032	2057	2083	2108	2154
2120	1686	1696	1717	1738	1760	1798	2550	2027	2040	2066	2091	2117	2162
2130	1694	1704	1725	1747	1768	1806	2560	2035	2048	2074	2099	2125	2171
2140	1702	1712	1733	1755	1776	1815	2570	2043	2056	2082	2107	2133	2179
2150	1709	1720	1742	1763	1785	1823	2580	2051	2064	2090	2116	2141	2188
2160	1717	1728	1750	1771	1793	1832	2590	2059	2072	2098	2124	2150	2196
2170	1725	1736	1758	1779	1801	1840	2600	2067	2080	2106	2132	2158	2205
2180	1733	1744	1766	1788	1809	1849	2610	2075	2088	2114	2140	2166	2213
2190	1741	1752	1774	1796	1818	1857	2620	2083	2096	2122	2148	2175	2222
2200	1749	1760	1782	1804	1826	1866	2630	2091	2104	2130	2156	2183	2230
2210	1757	1768	1790	1812	1834	1874	2640	2099	2112	2138	2164	2191	2239
2220	1765	1776	1798	1820	1843	1883	2650	2107	2120	2146	2173	2200	2247
2230	1773	1784	1806	1829	1851	1891	2660	2115	2128	2154	2181	2208	2256
2240	1781	1792	1814	1837	1859	1900	2670	2123	2136	2162	2189	2216	2264
2250	1789	1800	1823	1845	1868	1908	2680	2131	2144	2170	2197	2224	2273
2260	1797	1808	1831	1853	1876	1916	2690	2139	2152	2178	2206	2233	2281
2270	1805	1816	1839	1861	1884	1925	2700	2147	2160	2187	2214	2241	2290
2280	1813	1824	1847	1869	1892	1933	2710	2154	2168	2195	2222	2249	2298
2290	1821	1832	1855	1877	1900	1942	2720	2162	2176	2203	2230	2258	2307
2300	1829	1840	1863	1886	1909	1950	2730	2170	2184	2211	2239	2266	2315
2310	1836	1848	1871	1894	1917	1959	2740	2178	2192	2219	2247	2274	2324
2320	1844	1856	1879	1902	1926	1967	2750	2186	2200	2228	2255	2283	2332
							2800	2226	2240	2268	2296	2324	2374

CONFIRMATION: B. /X/ NO! - Aircraft is "outside" C. G. limits.

C. /X/ shortage of forward cyclic control.

FRAME 8

In order for an aircraft to be balanced, the moments on each side of the C.G. must equal each other. A moment is a twisting force about a point, and it is measured in inch-pounds. A weight multiplied by a distance is a moment, and the balancing of moments about a point (C.G.) is shown below.



$$100 \text{ lbs} \times 10 \text{ in} = 1000 \text{ in/lbs (moment)}$$

$$50 \text{ lbs} \times 20 \text{ in} = 1000 \text{ in/lbs (moment)}$$

Moments equal - see-saw balanced

The C. G. table

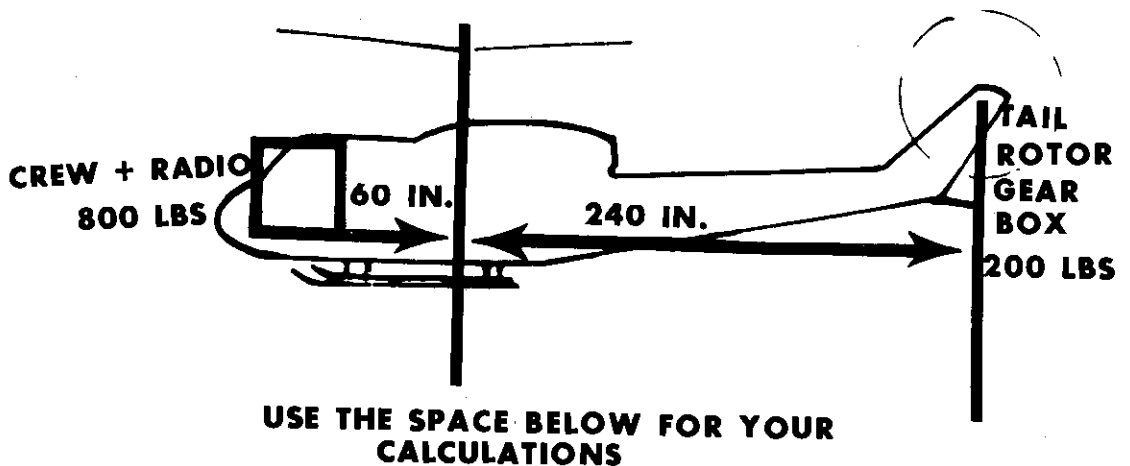
- A. ☐ allows safe aircraft operation.
- B. ☐ contains loading diagram.
- C. ☒ is located in the -10 Operator's Manual.

FRAME 9

Are the moments balanced on the aircraft below?

A. Yes ☒

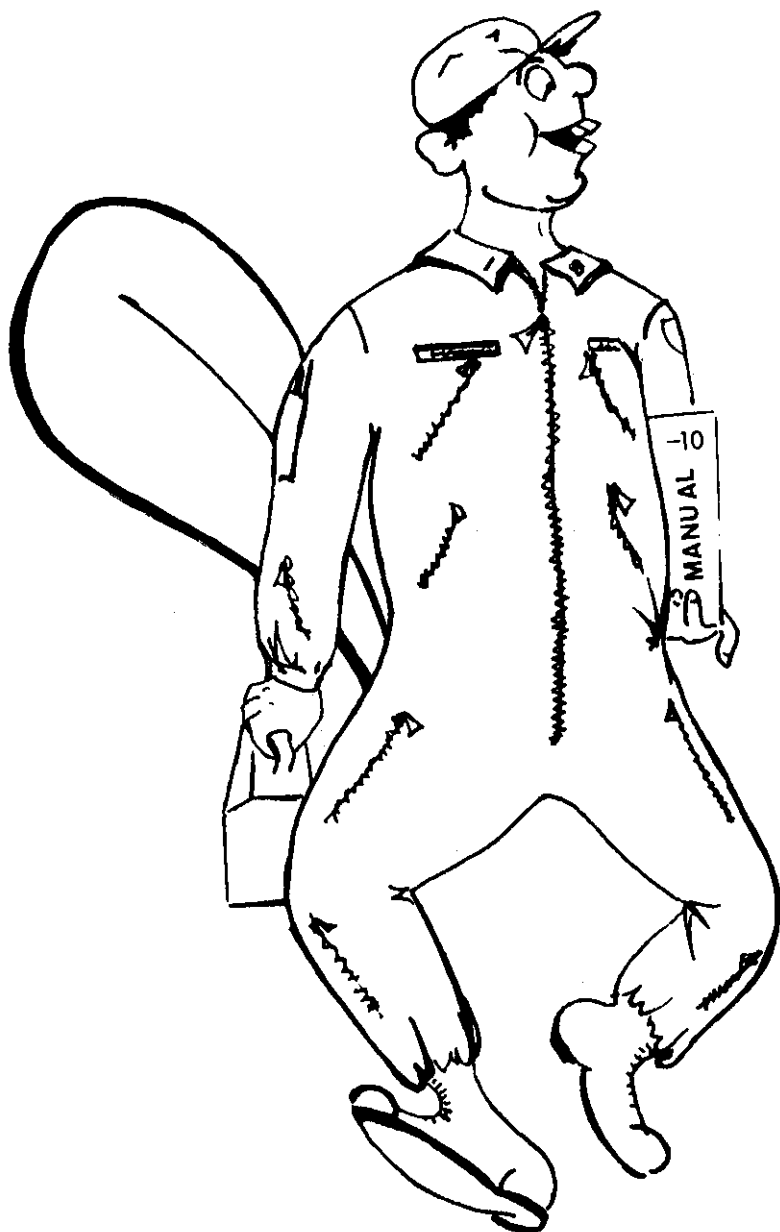
B. No ☐



$$\begin{array}{r} 800 \\ 60 \\ \hline 48000 \end{array}$$

$$\begin{array}{r} 240 \\ 200 \\ \hline 48000 \end{array}$$

CONFIRMATION: C. / X / is located in the -10 Operator's Manual.

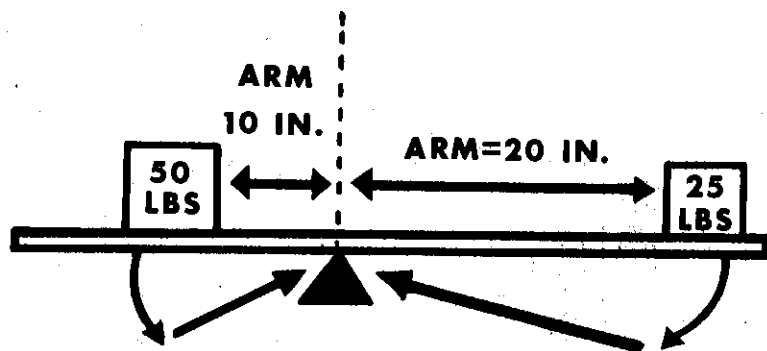


**EAGER BEAVER TYPE
PILOT WITH
-10 OPERATOR'S
MANUAL**

CONFIRMATION: A. $\overline{X}$ Yes - 48000 in/lbs = 48000 in/lbs

FRAME 10

The distance in inches from an item to a reference point is called the arm, and this distance multiplied by the weight of the item will give the moment of the item. In other words, weight x arm = Moment.



$$\text{WT.} \times \text{ARM} = \text{MOMENT}$$
$$50 \text{ LBS.} \times 10 \text{ IN.} = 500 \text{ IN. LBS.}$$

$$\text{WT.} \times \text{ARM} = \text{MOMENT}$$
$$25 \text{ LBS.} \times 20 \text{ IN.} = 500 \text{ IN. LBS.}$$

Study the center-of-gravity table below, and then work the problem on next page.

Sample Problem

GROSS WT: 2190 lbs

TOTAL MOMENT
100 = 1818.0

Find - C.G. = 83.0 inches

① Read
Down:
Locate
Gross Weight

③ Read UP:
Find C.G.

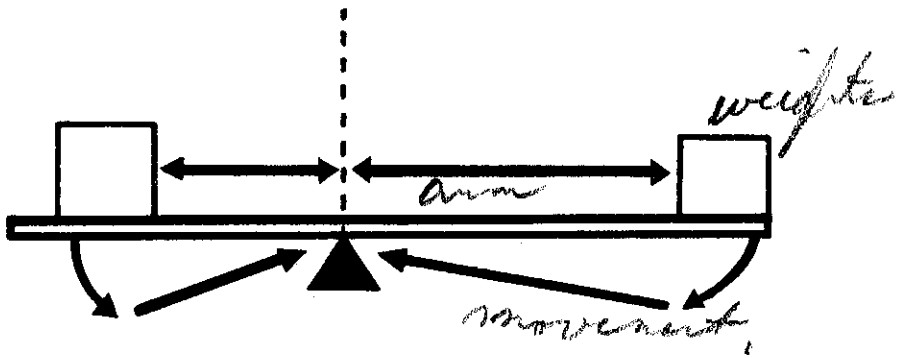
CENTER OF GRAVITY TABLE

GROSS WEIGHT	MOMENT/100						GROSS WEIGHT	MOMENT/100					
	79.5	80.0	81.0	82.0	83.0	84.8		79.5	80.0	81.0	82.0	83.0	84.8
1900	1511	1520	1539	1558	1577	1611	2330	1852	1864	1887	1911	1934	1976
1910	1518	1528	1547	1566	1585	1620	2340	1860	1872	1895	1919	1942	1984
1920	1526	1536	1555	1574	1593	1628	2350	1868	1880	1904	1927	1951	1993
1930	1534	1544	1563	1583	1602	1637	2360	1876	1888	1912	1935	1959	2001
1940	1542	1552	1571	1591	1610	1645	2370	1884	1896	1920	1943	1967	2010
1950	1550	1560	1580	1599	1619	1654	2380	1892	1904	1928	1952	1975	2018
1960	1558	1568	1588	1607	1627	1662	2390	1900	1912	1936	1960	1984	2027
1970	1566	1576	1596	1615	1635	1671	2400	1908	1920	1944	1968	1992	2035
1980	1574	1584	1604	1624	1643	1679	2410	1916	1928	1952	1976	2000	2044
1990	1582	1592	1612	1632	1652	1688	2420	1924	1936	1960	1984	2009	2052
2000	1590	1600	1620	1640	1660	1696	2430	1932	1944	1968	1993	2017	2061
2010	1598	1608	1628	1648	1668	1704	2440	1940	1952	1976	2001	2025	2069
2020	1606	1616	1636	1656	1677	1713	2450	1948	1960	1985	2009	2034	2078
2030	1614	1624	1644	1665	1685	1721	2460	1956	1968	1993	2017	2042	2086
2040	1622	1632	1652	1673	1693	1730	2470	1964	1976	2001	2025	2050	2095
2050	1630	1640	1661	1681	1702	1738	2480	1972	1984	2009	2034	2058	2103
2060	1638	1638	1669	1689	1710	1747	2490	1980	1992	2017	2042	2067	2112
2070	1646	1656	1677	1697	1718	1755	2500	1988	2000	2025	2050	2075	2120
2080	1654	1664	1685	1706	1726	1764	2510	1996	2008	2033	2058	2083	2129
2090	1662	1672	1693	1714	1735	1772	2520	2003	2016	2041	2066	2092	2137
2100	1670	1680	1701	1722	1743	1781	2530	2011	2024	2049	2075	2100	2146
2110	1678	1688	1709	1730	1751	1789	2540	2019	2032	2057	2083	2108	2154
2120	1686	1696	1717	1738	1759	1798	2550	2027	2040	2066	2091	2117	2162
2130	1694	1704	1725	1747	1768	1806	2560	2035	2048	2074	2099	2125	2171
2140	1702	1712	1733	1755	1776	1815	2570	2043	2056	2082	2107	2133	2179
2150	1709	1720	1742	1763	1785	1823	2580	2051	2064	2090	2116	2141	2188
2160	1717	1728	1750	1771	1793	1832	2590	2059	2072	2098	2124	2150	2196
2170	1725	1736	1758	1779	1801	1840	2600	2067	2080	2106	2132	2158	2205
2180	1733	1744	1766	1788	1809	1849	2610	2075	2088	2114	2140	2166	2213
2190	1741	1752	1774	1796	1818	1857	2620	2083	2096	2122	2148	2175	2222
2200	1749	1760	1782	1804	1826	1868	2630	2091	2104	2130	2156	2183	2230
2210	1757	1768	1790	1812	1834	1874	2640	2099	2112	2138	2164	2191	2239
2220	1765	1776	1798	1820	1843	1883	2650	2107	2120	2146	2173	2200	2247
2230	1773	1784	1806	1829	1851	1891	2660	2115	2128	2154	2181	2208	2256
2240	1781	1792	1814	1837	1859	1900	2670	2123	2136	2162	2189	2216	2264
2250	1789	1800	1823	1845	1868	1908	2680	2131	2144	2170	2197	2224	2273
2260	1797	1808	1831	1853	1876	1916	2690	2139	2152	2178	2206	2233	2281
2270	1805	1816	1839	1861	1884	1925	2700	2147	2160	2187	2214	2241	2290
2280	1813	1824	1847	1869	1892	1933	2710	2154	2168	2195	2222	2249	2298
2290	1821	1832	1855	1877	1900	1942	2720	2162	2176	2203	2230	2258	2307
2300	1829	1840	1863	1886	1909	1950	2730	2170	2184	2211	2239	2266	2315
2310	1836	1848	1871	1894	1917	1959	2740	2178	2192	2219	2247	2274	2324
2320	1844	1858	1879	1902	1926	1967	2750	2186	2200	2228	2255	2283	2332
							2800	2226	2240	2268	2296	2324	2374

② Read
Over:
Locate
Moment

FRAME 11

On the diagram below, label the weights, arms, and moments.



Turn page and check your answer.

FRAME 28

GROSS WT - 2630 lbs

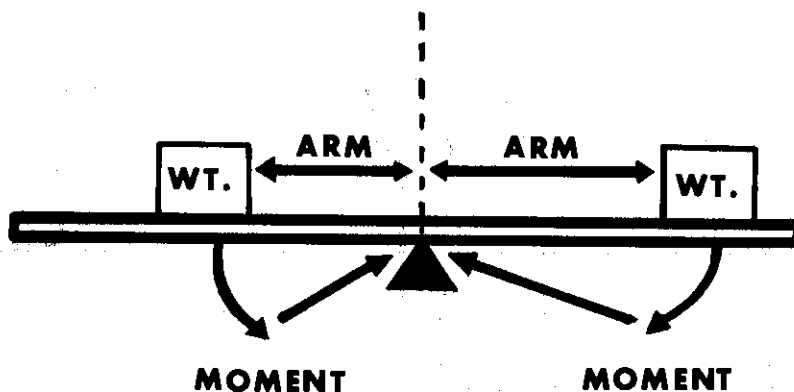
TOTAL MOMENT = 2183.0
100

FIND: C.G. =

83.0

CENTER OF GRAVITY TABLE													
GROSS WEIGHT	MOMENT/100						GROSS WEIGHT	MOMENT/100					
	79.5	80.0	81.0	82.0	83.0	84.8		79.5	80.0	81.0	82.0	83.0	84.8
1900	1511	1520	1539	1558	1577	1611	2330	1852	1864	1887	1911	1934	1976
1910	1518	1528	1547	1568	1585	1620	2340	1860	1872	1895	1919	1942	1984
1920	1526	1536	1555	1574	1594	1628	2350	1868	1880	1904	1927	1951	1993
1930	1534	1544	1563	1583	1602	1637	2360	1878	1888	1912	1935	1959	2001
1940	1542	1552	1571	1591	1610	1645	2370	1884	1896	1920	1943	1967	2010
1950	1550	1560	1580	1599	1619	1654	2380	1892	1904	1928	1952	1975	2018
1960	1558	1568	1588	1607	1627	1662	2390	1900	1912	1936	1960	1984	2027
1970	1566	1576	1596	1615	1635	1671	2400	1908	1920	1944	1968	1992	2035
1980	1574	1584	1604	1624	1643	1679	2410	1916	1928	1952	1976	2000	2044
1990	1582	1592	1612	1632	1652	1688	2420	1924	1936	1960	1984	2009	2052
2000	1590	1600	1620	1640	1660	1696	2430	1932	1944	1968	1993	2017	2061
2010	1598	1608	1628	1648	1668	1704	2440	1940	1952	1976	2001	2025	2069
2020	1606	1616	1636	1656	1677	1713	2450	1948	1960	1985	2009	2034	2078
2030	1614	1624	1644	1665	1685	1721	2460	1956	1968	1993	2017	2042	2086
2040	1622	1632	1652	1673	1693	1730	2470	1964	1976	2001	2025	2050	2095
2050	1630	1640	1661	1681	1702	1738	2480	1972	1984	2009	2034	2058	2103
2060	1638	1638	1669	1689	1710	1747	2490	1980	1992	2017	2042	2067	2112
2070	1646	1656	1677	1697	1718	1755	2500	1988	2000	2025	2050	2075	2120
2080	1654	1664	1685	1706	1726	1764	2510	1996	2008	2033	2058	2083	2129
2090	1662	1672	1693	1714	1735	1772	2520	2003	2016	2041	2066	2092	2137
2100	1670	1680	1701	1722	1743	1781	2530	2011	2024	2049	2075	2100	2146
2110	1678	1688	1709	1730	1751	1789	2540	2019	2032	2057	2083	2108	2154
2120	1686	1696	1717	1738	1760	1798	2550	2027	2040	2066	2091	2117	2162
2130	1694	1704	1725	1747	1768	1806	2560	2035	2048	2074	2099	2125	2171
2140	1702	1712	1733	1755	1776	1815	2570	2043	2056	2082	2107	2133	2179
2150	1709	1720	1742	1763	1785	1823	2580	2051	2064	2090	2116	2141	2186
2160	1717	1728	1750	1771	1793	1832	2590	2059	2072	2098	2124	2150	2196
2170	1725	1736	1758	1779	1801	1840	2600	2067	2080	2106	2132	2158	2205
2180	1733	1744	1766	1788	1809	1849	2610	2075	2088	2114	2140	2166	2213
2190	1741	1752	1774	1796	1818	1857	2620	2083	2096	2122	2148	2175	2222
2200	1749	1760	1782	1804	1826	1866	2630	2091	2104	2130	2156	2183	2230
2210	1757	1768	1790	1812	1834	1874	2640	2099	2112	2138	2164	2191	2239
2220	1765	1776	1798	1820	1843	1883	2650	2107	2120	2146	2173	2200	2247
2230	1773	1784	1806	1829	1851	1891	2660	2115	2128	2154	2181	2208	2256
2240	1781	1792	1814	1837	1859	1900	2670	2123	2136	2162	2189	2216	2264
2250	1789	1800	1823	1845	1868	1908	2680	2131	2144	2170	2197	2224	2273
2260	1797	1808	1831	1853	1876	1916	2690	2139	2152	2178	2206	2233	2281
2270	1805	1816	1839	1861	1884	1925	2700	2147	2160	2187	2214	2241	2290
2280	1813	1824	1847	1869	1892	1933	2710	2154	2168	2195	2222	2249	2298
2290	1821	1832	1855	1877	1900	1942	2720	2162	2176	2203	2230	2258	2307
2300	1829	1840	1863	1886	1909	1950	2730	2170	2184	2211	2239	2266	2315
2310	1836	1848	1871	1894	1917	1959	2740	2178	2192	2219	2247	2274	2324
2320	1844	1856	1879	1902	1926	1967	2750	2186	2200	2228	2255	2283	2332
							2800	2226	2240	2268	2296	2324	2374

RESPONSE:



FRAME 12

When a pilot is actually computing the center of gravity, he can reduce the amount of calculation necessary by using the loading tables in the -10 Operator's Manual.

Study the loading tables on the next page, and notice that the weights, arms, and moments of representative load items are shown. Also note that the moments are all divided by 100, to simplify the calculations. These reduced moments are called simplified moments.

CONFIRMATION: C.G. = 83.0 inches

①

CG =

83.0 in.

CENTER OF GRAVITY TABLE													
GROSS WEIGHT							MOMENT/100						
	79.5	80.0	81.0	82.0	83.0	84.8		79.5	80.0	81.0	82.0	83.0	84.8
1900	1511	1520	1539	1558	1577	1611	2330	1852	1864	1887	1911	1934	1976
1910	1518	1528	1547	1566	1585	1620	2340	1860	1872	1895	1919	1942	1984
1920	1526	1536	1555	1574	1594	1628	2350	1868	1880	1904	1927	1951	1993
1930	1534	1544	1563	1583	1602	1637	2360	1876	1888	1912	1935	1959	2001
1940	1542	1552	1571	1591	1610	1645	2370	1884	1896	1920	1943	1967	2010
1950	1550	1560	1580	1599	1619	1654	2380	1892	1904	1928	1952	1975	2018
1960	1558	1568	1588	1607	1627	1662	2390	1900	1912	1936	1960	1984	2027
1970	1566	1576	1596	1615	1635	1671	2400	1908	1920	1944	1968	1992	2035
1980	1574	1584	1604	1624	1643	1679	2410	1916	1928	1952	1976	2000	2044
1990	1582	1592	1612	1632	1652	1688	2420	1924	1936	1960	1984	2009	2052
2000	1590	1600	1620	1640	1660	1696	2430	1932	1944	1968	1993	2017	2061
2010	1598	1608	1628	1648	1668	1704	2440	1940	1952	1976	2001	2025	2069
2020	1606	1616	1636	1656	1677	1713	2450	1948	1960	1985	2009	2034	2078
2030	1614	1624	1644	1665	1685	1721	2460	1956	1968	1993	2017	2042	2086
2040	1622	1632	1652	1673	1693	1730	2470	1964	1976	2001	2025	2050	2095
2050	1630	1640	1661	1681	1702	1738	2480	1972	1984	2009	2034	2059	2103
2060	1638	1638	1669	1689	1710	1747	2490	1980	1992	2017	2042	2067	2112
2070	1646	1656	1677	1697	1718	1755	2500	1988	2000	2025	2050	2075	2120
2080	1654	1664	1685	1706	1726	1764	2510	1996	2008	2033	2058	2083	2129
2090	1662	1672	1693	1714	1735	1772	2520	2003	2016	2041	2066	2092	2137
2100	1670	1680	1701	1722	1743	1781	2530	2011	2024	2049	2075	2100	2146
2110	1678	1688	1709	1730	1751	1789	2540	2019	2032	2057	2083	2108	2154
2120	1686	1696	1717	1738	1760	1798	2550	2027	2040	2066	2091	2117	2162
2130	1694	1704	1725	1747	1768	1808	2560	2035	2048	2074	2099	2125	2171
2140	1702	1712	1733	1755	1776	1815	2570	2043	2056	2082	2107	2133	2179
2150	1709	1720	1742	1763	1785	1823	2580	2051	2064	2090	2116	2141	2188
2160	1717	1728	1750	1771	1793	1832	2590	2059	2072	2098	2124	2150	2196
2170	1725	1736	1758	1779	1801	1840	2600	2067	2080	2106	2132	2158	2205
2180	1733	1744	1766	1788	1809	1849	2610	2075	2088	2114	2140	2166	2213
2190	1741	1752	1774	1796	1818	1857	2620	2083	2096	2122	2148	2175	2222
2200	1749	1760	1782	1804	1826	1866	2630	2091	2104	2130	2156	2183	2230
2210	1757	1768	1790	1812	1834	1874	2640	2099	2112	2138	2164	2191	2239
2220	1765	1776	1798	1820	1843	1883	2650	2107	2120	2146	2173	2200	2247
2230	1773	1784	1806	1829	1851	1891	2660	2115	2128	2154	2181	2208	2256
2240	1781	1792	1814	1837	1859	1900	2670	2123	2136	2162	2189	2216	2264
2250	1789	1800	1823	1845	1868	1908	2680	2131	2144	2170	2197	2224	2273
2260	1797	1808	1831	1853	1876	1916	2690	2139	2152	2178	2206	2233	2281
2270	1805	1816	1839	1861	1884	1925	2700	2147	2160	2187	2214	2241	2290
2280	1813	1824	1847	1869	1892	1933	2710	2154	2168	2195	2222	2249	2298
2290	1821	1832	1855	1877	1900	1942	2720	2162	2176	2203	2230	2258	2307
2300	1829	1840	1863	1886	1909	1950	2730	2170	2184	2211	2239	2266	2315
2310	1836	1848	1871	1894	1917	1959	2740	2178	2192	2219	2247	2274	2324
2320	1844	1856	1879	1902	1926	1967	2750	2186	2200	2228	2255	2283	2332
							2800	2226	2240	2268	2296	2324	2374

FRAME 13

Using the loading table on the following page, find the simplified moment for the following items.

- A. pilot - 170 lbs, moment = 90
- B. fuel - 230 lbs, moment = 190
- C. ballast - 9 lbs, (cabin) moment = 3.8
- D. oil - 12 1/2 quarts, moment = 22

Use this table
for PILOT, too.

CREW TABLE			
Weight (lb)	Moment 100	Weight (lb)	Moment 100
100	53	360	191
110	58	370	196
120	64	380	201
130	69	390	207
140	74	400	212
150	80	410	217
160	85	420	223
170	90	430	228
180	95	440	233
190	101	450	239
200	106	460	244
210	111	470	249
220	117	480	254
230	122	490	260
240	127	500	265
250	133	510	270
260	138	520	276
270	143	530	281
280	148	540	286
290	154	550	292
300	159	560	297
310	164	570	302
320	170	580	307
330	175	590	313
340	180	600	318
350	186		

Crew Arm - 53 in. Use actual weight.
Allow 20 lb for parachute if used.

Normal Location
for ballast is in
Cockpit.

Cockpit -
Tail Section-

STANDARD BALLAST		
Weight (lb)	Arm	Moment 100
9	42	3.8
9	318	28.6

FUEL TABLE	
Weight (lb)	Moment 100
	48 Gal. Arm Varies
10	7
20	15
30	23
40	31
50	39
60	48
70	56
80	65
90	73
100	81
110	90
120	98
130	106
140	115
150	123
160	132
170	140
180	148
190	157
200	165
210	173
220	182
230	190
240	198
250	207
260	215
270	224
280	232
288	239

AUXILIARY FUEL

Weight (lb)	Moment 100
244	209

Simplified
moment,

Normal oil
load is
12 1/2 qts

OIL TABLE		
QUANTITY (qts)	WEIGHT (lbs)	MOMENT 100 ARM - 94 in.
10	19	18
11	21	19
12	22.5	21
12 1/2 (Normal load)	23	22
13	25	23
14	27	25

CREW TABLE			
Weight (lb)	Moment 100	Weight (lb)	Moment 100
100	53	360	191
110	58	370	198
120	64	380	201
130	69	390	207
140	74	400	212
150	80	410	217
160	85	420	223
170	90	430	228
180	95	440	233
190	101	450	239
200	106	460	244
210	111	470	249
220	117	480	254
230	122	490	260
240	127	500	265
250	133	510	270
260	138	520	276
270	143	530	281
280	148	540	286
290	154	550	292
300	159	560	297
310	164	570	302
320	170	580	307
330	175	590	313
340	180	600	318
350	186		

Crew Arm - 53 in. Use actual weight.
Allow 20 lb for parachute if used.

FUEL TABLE	
Weight (lb)	Moment 100
	48 Gal. Arm Varies
10	7
20	15
30	23
40	31
50	39
60	48
70	56
80	65
90	73
100	81
110	90
120	98
130	106
140	115
150	123
160	132
170	140
180	148
190	157
200	165
210	173
220	182
230	190
240	198
250	207
260	215
270	224
280	232
288	239

AUXILIARY FUEL	
Weight (lb)	Moment 100
244	209

STANDARD BALLAST		
Weight (lb)	Arm	Moment 100
9	42	3.8
9	318	28.6

cockpit
tail

OIL TABLE		
QUANTITY (qts)	WEIGHT (lbs)	MOMENT 100 ARM - 94 in.
10	19	18
11	21	19
12	22.5	21
12½	23	22
13	25	23
14	27	25

FRAME 29

If the exact gross weight and moment are not listed on the C.G. table, the formula; $C.G. = \frac{\text{TOTAL MOMENT}}{\text{TOTAL WEIGHT}}$ must be used to find the exact C.G. location. For example, the problem below must be worked out using the formula.

THESE FIGURES ARE NOT LISTED
IN THE C.G. TABLE, SO THE
FORMULA MUST BE USED.

TAKE OFF WEIGHT	2417 LBS
TAKE OFF <u>MOMENT</u>	1932.0 IN/LBS
100	

$$C.G. = \frac{\text{TOTAL MOMENT}}{\text{TOTAL WEIGHT}} = \frac{193200}{2417}$$

		79.92
2417	1932.00.	←
	1691 9	
	2401 0	
	217 53	
	2257 0	
	21753	
		8170

SIMPLIFIED MOMENT
Don't forget to move
the decimal point.

C.G. = 79.92 IN.

CONFIRMATION: A. / 90 /

B. / 190 /

C. / 3.8 /

D. / 22 /

FRAME 14

When a pilot computes the C.G. of an aircraft to determine if it is safe to fly, his calculations are further simplified by using a Weight and Balance Clearance Form, DD Form 365F. This form is used in conjunction with the loading tables in the -10 Operator's Manual, and other flight planning data.

Study the following DD Form 365F and notice the steps involved.

In the problem below, what procedure would you use?

- ☐ Locate approximate figures on chart and then guess.
- ☐ Ask your crew chief for help.
- ☒ Calculate C.G. using formula $C.G. = \frac{\text{TOTAL MOMENT}}{\text{TOTAL WEIGHT}}$

13	TAKEOFF CONDITION (<i>Uncorrected</i>)	2	3	9	2	1	9	7	1	0
14	CORRECTIONS (<i>If required</i>)									
15	TAKEOFF CONDITION (<i>Corrected</i>)	2	3	9	2	1	9	7	1	0
16	TAKEOFF C. G. IN % M. A. C. OR IN.									
17	LESS FUEL									
18	LESS AIR SUPPLY LOAD DROPPED									
19	MISC. VARIABLES									
20	ESTIMATED LANDING CONDITION									
21	ESTIMATED LANDING C. G. IN % M. A. C. OR IN.									
COMPUTED BY										
		SIGNATURE								
WEIGHT AND BALANCE AUTHORITY										
		SIGNATURE								
PILOT										
		SIGNATURE								

10-67910-4 U.S. GOVERNMENT PRINTING OFFICE

NOTE—THIS TRANSPORT CLEARANCE FORM HAS RESULTED FROM TRIPARTITE AGREEMENT AND NO FURTHER CHANGES MAY BE MADE TO IT WITHOUT PRIOR CONSIDERATION BY TRIPARTITE AUTHORITIES.

WEIGHT AND BALANCE CLEARANCE FORM F TRANSPORT (USE REVERSE FOR TACTICAL MISSIONS)						Cross Reference RAF Form 2870 RCAF Form F. 115 C SOM 5-51 (5797)		FORM F T.O. 1-11-1 AN 1-11-1 TM 1-11-1	
DATE ① FILL OUT HEADING		AIRCRAFT TYPE		HOME STATION					
MISSION/FLIGHT NO.		SERIAL NO.		TO		PILOT			
LIMITATIONS				ITEM		WEIGHT		INDEX OR MOM.	
CONDITION	TAKEOFF	LANDING	TURNING WING FUEL						
1 ALLOWABLE GROSS WEIGHT				1 BASIC AIRCRAFT (From Chart C)					
2 TOTAL AIRCRAFT WEIGHT (Ref. 11)				2 OIL () Gal.					
3 OPERATING WEIGHT PLUS ESTIMATED LANDING FUEL WEIGHT				3 CREW (No.)					
4 OPERATING WEIGHT (Ref. 3)				4 CREW'S BAGGAGE					
5 ALLOWABLE LOAD (Ref. 11) Use SMALLEST figure				5 STEWARD'S EQUIPMENT					
6 PERMISSIBLE C.G. TAKEOFF				6 EMERGENCY EQUIPMENT					
7 PERMISSIBLE C.G. LANDING				7 EXTRA EQUIPMENT					
8 LANDING FUEL WEIGHT				8 OPERATING WEIGHT					
				9 TAKEOFF FUEL () Gal.					
				10 WATER IN FUEL () Gal.					
				11 TOTAL AIRCRAFT WEIGHT					
12 DISTRIBUTION OF ALLOWABLE LOAD - PAYLOAD									
UPPER COMPARTMENTS				LOWER COMPARTMENTS					
COMPT PASSENGERS CARGO				COMPT PASSENGERS CARGO					
NO. WEIGHT				NO. WEIGHT					
A				B					
C				D					
E				F					
G				H					
I				J					
K				L					
M				N					
O				P					
FWD BELLY				AFT BELLY					
REMARKS									
3 ENTER "LIMITATIONS"				2 ENTER WEIGHT & MOMENT OF EACH LOAD ITEM					
4 COMPUTE TAKE OFF C.G.									
5 COMPUTE LANDING C.G.									
CORRECTIONS (Ref. 14)									
CHANGES + or -									
COMPT ITEM WEIGHT INDEX OR MOM.									
13 TAKEOFF CONDITION (Uncorrected)									
14 CORRECTIONS (If required)									
15 TAKEOFF CONDITION (Corrected)									
16 TAKEOFF C.G. IN									
17 LESS FUEL									
18 LESS AIR SUPPLY LOAD DROPPED									
19 MISC. VARIABLES									
20 ESTIMATED LANDING CONDITION									
21 ESTIMATED LANDING C.G. IN									
COMPUTED BY									
TOTAL WEIGHT REMOVED				SIGNATURE					
TOTAL WEIGHT ADDED				WEIGHT AND BALANCE AUTHORITY					
NET DIFFERENCE (Ref. 14)				SIGNATURE					
				PILOT					
				SIGNATURE					

WEIGHT AND LOADING LIMITATIONS

CENTER OF GRAVITY LIMITATIONS

TAKEOFF AND LANDING

FORWARD

AFT

LIMIT

LIMIT

79.5 in.

84.8 in.

WEIGHT LIMITATIONS

TAKEOFF AND LANDING

2750 POUNDS

CENTER OF GRAVITY TABLE

GROSS WEIGHT	MOMENT/100						GROSS WEIGHT	MOMENT/100					
	79.5	80.0	81.0	82.0	83.0	84.8		79.5	80.0	81.0	82.0	83.0	84.8
1900	1511	1520	1539	1558	1577	1611	2330	1852	1864	1887	1911	1934	1978
1910	1518	1528	1547	1568	1585	1620	2340	1860	1872	1895	1919	1942	1984
1920	1528	1538	1555	1574	1594	1628	2350	1868	1880	1904	1927	1951	1993
1930	1534	1544	1563	1583	1602	1637	2360	1876	1888	1912	1935	1959	2001
1940	1542	1552	1571	1591	1610	1645	2370	1884	1896	1920	1943	1967	2010
1950	1550	1560	1580	1599	1619	1654	2380	1892	1904	1928	1952	1975	2018
1960	1558	1568	1588	1607	1627	1662	2390	1900	1912	1936	1960	1984	2027
1970	1566	1576	1596	1615	1635	1671	2400	1908	1920	1944	1968	1992	2035
1980	1574	1584	1604	1624	1643	1679	2410	1916	1928	1952	1976	2000	2044
1990	1582	1592	1612	1632	1652	1688	2420	1924	1936	1960	1984	2009	2052
2000	1590	1600	1620	1640	1660	1696	2430	1932	1944	1968	1993	2017	2061
2010	1598	1608	1628	1648	1668	1704	2440	1940	1952	1976	2001	2025	2069
2020	1606	1616	1636	1656	1677	1713	2450	1948	1960	1985	2009	2034	2078
2030	1614	1624	1644	1665	1685	1721	2460	1956	1968	1993	2017	2042	2086
2040	1622	1632	1652	1673	1693	1730	2470	1964	1976	2001	2025	2050	2095
2050	1630	1640	1661	1681	1702	1738	2480	1972	1984	2009	2034	2058	2103
2060	1638	1638	1669	1689	1710	1747	2490	1980	1992	2017	2042	2067	2112
2070	1646	1656	1677	1697	1718	1755	2500	1988	2000	2025	2050	2075	2120
2080	1654	1664	1685	1706	1726	1764	2510	1998	2008	2033	2058	2083	2129
2090	1662	1672	1693	1714	1735	1772	2520	2003	2016	2041	2066	2092	2137
2100	1670	1680	1701	1722	1743	1781	2530	2011	2024	2049	2075	2100	2146
2110	1678	1688	1709	1730	1751	1789	2540	2019	2032	2057	2083	2108	2154
2120	1686	1696	1717	1738	1760	1798	2550	2027	2040	2066	2091	2117	2182
2130	1694	1704	1725	1747	1768	1806	2560	2035	2048	2074	2099	2125	2171
2140	1702	1712	1733	1755	1778	1815	2570	2043	2056	2082	2107	2133	2179
2150	1709	1720	1742	1763	1785	1823	2580	2051	2064	2090	2118	2141	2188
2160	1717	1728	1750	1771	1793	1832	2590	2059	2072	2098	2124	2150	2196
2170	1725	1736	1758	1779	1801	1840	2600	2067	2080	2106	2132	2158	2205
2180	1733	1744	1766	1788	1809	1849	2610	2075	2088	2114	2140	2166	2213
2190	1741	1752	1774	1798	1818	1857	2620	2083	2096	2122	2148	2175	2222
2200	1749	1760	1782	1804	1826	1866	2630	2091	2104	2130	2156	2183	2230
2210	1757	1768	1790	1812	1834	1874	2640	2099	2112	2138	2164	2191	2239
2220	1765	1778	1798	1820	1843	1883	2650	2107	2120	2146	2173	2200	2247
2230	1773	1784	1806	1829	1851	1891	2660	2115	2128	2154	2181	2208	2256
2240	1781	1792	1814	1837	1859	1900	2670	2123	2136	2162	2189	2218	2264
2250	1789	1800	1823	1845	1868	1908	2680	2131	2144	2170	2197	2224	2273
2260	1797	1808	1831	1853	1876	1916	2690	2139	2152	2178	2206	2233	2281
2270	1805	1818	1839	1861	1884	1925	2700	2147	2160	2187	2214	2241	2290
2280	1813	1824	1847	1869	1892	1933	2710	2154	2168	2195	2222	2249	2298
2290	1821	1832	1855	1877	1900	1942	2720	2162	2176	2203	2230	2258	2307
2300	1829	1840	1863	1886	1909	1950	2730	2170	2184	2211	2239	2266	2315
2310	1836	1848	1871	1894	1917	1959	2740	2178	2192	2219	2247	2274	2324
2320	1844	1856	1879	1902	1926	1967	2750	2186	2200	2228	2255	2283	2332
							2800	2226	2240	2268	2296	2324	2374