REPORT NUMBER 131

OCTOBER 1963

LANDING GEAR CRITERIA
GROUND LOADS AND REACTIONS

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LANDING GEAR CRITERIA
GROUND LOADS AND REACTIONS

U.S. ARMY XV-5A LIFT FAN
FLIGHT RESEARCH AIRCRAFT PROGRAM

CONTRACT NUMBER DA44-177-TC715

REPORT NO. 131

OCTOBER 1963

ADVANCED ENGINE AND TECHNOLOGY DEPARTMENT
GENERAL ELECTRIC COMPANY
CINCINNATI, OHIO
45215

CONTENTS

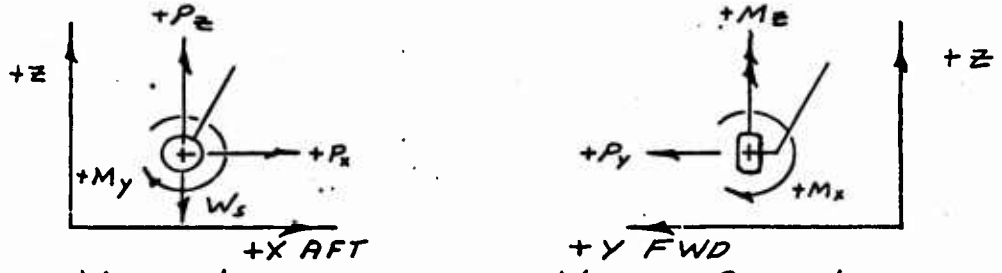
INTRODUCTION

The development of landing gear ground and internal loads for the U. S. Army XV-5A Lift Fan Research Aircraft is presented in this report.

The main landing gear is provided with a two-position feature: the position forward for conventional landing, and the position aft for vertical landing. Criteria was generated for both conventional and vertical landing. Calculations of ground loads were based on methods in MIL-A-8862. A computer program was developed which provides fuselage reactions and internal member loads for all landing and taxiing conditions.

LANDING GEAR CRITERIA

SIGN CONVENTION



VIEW INB'D VIEW OUTB'D

ALL LOADS IN ACCORDANCE WITH MIL-A-8862

THE LANDING GEAR LOAD CRITERIA IS SUMMARIZED IN THE FOLLOWING TABLE.

TABLE	LANDING COND.	WEIGHT	LANDING V	SINK V	C.G.	GEAR POSIT	
1	CONVEN. LANDING	9200	172 FT/SEC	10 FT/SEC	240	FWD	
1	CONVEN. LANDING	9200	172 FT/SEC	10 FT/SEC	246	FWD	
1	CONVEN. LANDING	12.500	200 FT/SEC	6 FT/SEC	240	FWD	*
1	CONVEN. LANDING	12500	200 FT/SEC	6 FT/SEC	246	FWD	*
2	EMERGENCY LANDING	9200	172 FT/SEC	6 FT/SEC	240	AFT	
2	EMERGENCY LANDING	9200	172 FT/SEC	6 FT/SEC	246	AFT	
2	VTOL LANDING	9200	0	10 FT/SEC	240	AFT	
2	VTOL LANDING	9200	0	10 FT/SEC	246	AFT	
3	TAXIING	12500	-	-	240	FWD	*
3	TAXIING	12500	-	-	246	FWD	*
3	TAXIING	9200	-	-	240	AFT	
3	TAXIING	9200	-	-	246	AFT	

* WHEN THE AIRCRAFT IS AT THE 12500* FERRY WEIGHT, THE LANDING GEAR SHALL BE IN THE FORWARD POSITION ONLY, FOR ALL LANDING AND TAXIING CONDITIONS.

GENERAL

METHODS:

ALL LOADS ARE IN COMPLIANCE WITH MIL-A-8862.

A/C WEIGHTS

CONVEN. LANDING MODE GEAR FWD.
LANDING DESIGN GROSS WEIGHT = 9200#
MAX. DESIGN GROSS WEIGHT = 12500#

VTOL & EMERGENCY LANDING MODE GEAR AFT
A/C WEIGHT = 9200#

WHEEL & TIRE DATA

MAIN.

TIRE 20X4.4 TYPE VII 12 P.R.
180 PSI INFLATION PRESSURE
ROLLING RADIUS = 8.9 IN W'T = 12#

NOSE

TIRE 18X4.4 TYPE VII 10 PR
185 PSI INFLATION PRESSURE
ROLLING RADIUS = 7.9 IN W'T = 10.3#

MAIN WHEEL ROTATING W'T = 14.1#
NOSE WHEEL ROTATING W'T = 8.05#

LANDING V

9200# V_{SL} = 84.6 KTS
12500# V_{SL} = 98.6 KTS

GENERAL

LIST OF SYMBOLS

d_v = TOTAL DEFLECTION (FT.) AT TIME t_v.

$F_{D_{SU}}$ = MAX. SPIN-UP DRAG LOAD, PARALLEL TO GROUND, BEFORE CORRECTION FOR DYNAMIC MAGNIFICATION, LBS.

$F_{V_{MAX}}$ = MAX. VERTICAL LOAD, LBS.

$F_{V_{SU}}$ = MAX. VERTICAL LOAD AT TIME t_{SU}.

I_W = POLAR MASS MOMENT OF INERTIA OF ROTATING WHEEL ASSEMBLY, SLUG-FT^2.

K_{SB} = SPRING BACK DYNAMIC RESPONSE FACTOR.

K_{SU} = SPIN UP DYNAMIC RESPONSE FACTOR.

n_s = SIDE LOAD FACTOR AT THE C.G.

n_z = GROUND REACTION FACTOR.

r = TIRE ROLLING RADIUS, FT.

t_{SU} = TIME REQUIRED FOR WHEEL CIRCUMFERENTIAL VELOCITY TO REACH GROUND VELOCITY, SEC.

t_v = TIME REQUIRED TO DEVELOP MAX. VERTICAL REACTION AFTER INITIAL INSTANT OF CONTACT, SEC.

V_L = LANDING SPEED

V_V = A/C VERTICAL SPEED (SINK SPEED) FT/SEC.

Θ = ANGLE BETWEEN OLEO CENTERLINE AND THE VERTICAL, DEG. POSITIVE FOR OLEO INCLINED FWD. FROM FUS.

TABLE 1

SUMMARY LOADS (GEAR FWD.)

GEAR	WEIGHT	SPIN UP V	SPIN UP D	SPRING BACK V	SPRING BACK D	MAX. VERT. REA. Fv	MAX. VERT. REA. FD	SIDE DRIFT Fv	SIDE DRIFT FD	SIDE DRIFT Fs	
NOSE C.G. 240	9200	5827	3600	6205	-4441	6230	1558	0	0	0	
	12500	3238	2001	3192	-2438	3205	801	0	0	0	
MAIN C.G. 246 3 P'T	9200	8283	4640	9474	-6670	9550	2388	0	0	0	
	12500	4727	2647	4876	-3725	4915	1229	0	0	0	
MAIN 2PT LEVEL	9200	9815	4613	11950	-8640	12144	3036	6072	0	4858	IN
										3643	OUT
	12500	5693	2674	6150	-4836	6250	1562	31.25	0	2500	IN
										1875	OUT
2P'T TAIL DOWN (MAIN)	9200	10095	3207	11670	-9876	12144	3036	0	0	0	
	12500	5856	1861	6006	-5455	6250	1562	0	0	0	

SPIN UP & SPRING BACK LOADS NORMAL & PARALLEL TO OLEO.

MAXIMUM VERTICAL REACTION & SIDE DRIFT LOADS ARE IN THE PLANE OF THE GROUND.

SUBJECT: L/G LOADS
SECTION: C
ENGINEER: UPDEGRAFF
CHECKER:

MODEL: XV-5A
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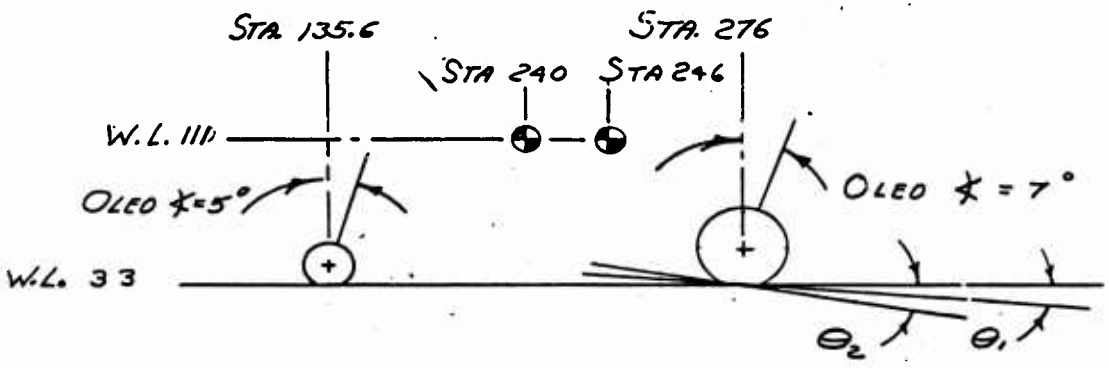
SUBJECT: L/G Loads SECTION: L C ENGINEER: UPDEGRAFF CHECKER:		MODEL: XV-5A PAGE: 6 REPORT: DATE: 10/4/62

STATIC WHEEL POSITION CONVEN. LANDING MODE



MAIN GEAR AXEL ℄ W.L. = 41.9

NOSE GEAR AXE ℄ W.L. = 40.9

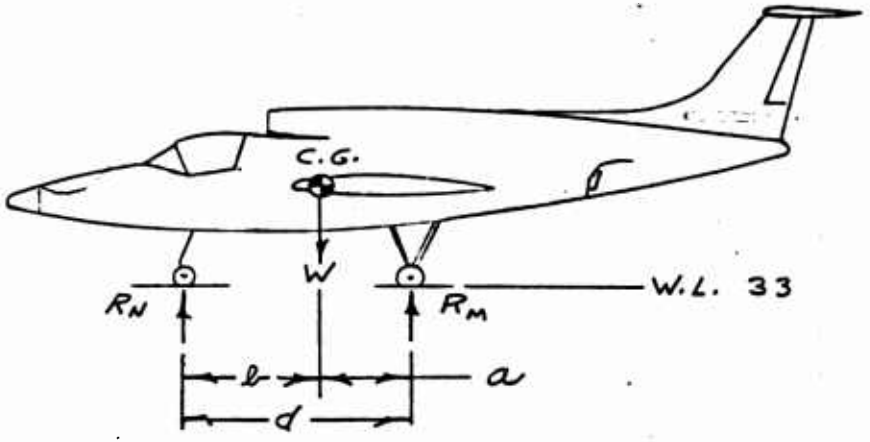
WHEEL BASE = 140.4 IN

θ_1 = W.L. ∡ LEVEL 2 P'T

$$\theta_1 = \frac{\text{NOSE OLEO STROKE}}{\text{WHEEL BASE}} = \frac{8}{140.4} = .05698 = 3^\circ 16'$$

θ_2 = TAIL DOWN ∡ = 9°

STATIC GROUND REACTIONS
CONVENTIONAL LANDING MODE



R_N = NOSE GEAR REACTION

R_M = MAIN GEAR REACTION

W = 9200# LANDING DESIGN GROSS WEIGHT

W = 12500# MAX. DESIGN GROSS WEIGHT

C.G. 240

$a = 36.0$
$b = 104.4$
$d = 140.4$

$$R_N = \frac{W a}{d}$$

$$R_M = \frac{W b}{2d}$$

C.G. 246

$a = 30.0$
$b = 110.4$
$d = 140.4$

SUBJECT: L/G LOADS SECTION: C ENGINEER: UPDEGRAFF CHECKER:		MODEL: XV-5A PAGE: 8 REPORT: DATE: 10/4/62

STATIC GROUND REACTIONS
CONVENTIONAL LANDING MODE

C.G. 240

9200#

3 P'T

$R_N = \frac{(9200)(36.0)}{140.4} = 2359^{\#}$ ←

$R_M = \frac{(9200)(104.4)}{(2)(140.4)} = 3420^{\#}$ ←

2 P'T

$R_N = 0$ ←

$R_M = 4600^{\#}$ ←

C.G. 246

9200#

3 P'T

$R_N = \frac{(9200)(30)}{140.4} = 1966^{\#}$ ←

$R_M = \frac{(9200)(110.4)}{(2)(140.4)} = 3617^{\#}$ ←

2 P'T

$R_N = 0$ ←

$R_M = 4600^{\#}$ ←

SUBJECT: L/G LOADS SECTION: C ENGINEER: UDDEGRAFF CHECKER:		MODEL: XV-5A PAGE: 9 REPORT: DATE: 10/4/62

STATIC GROUND REACTIONS
CONVENTIONAL LANDING MODE

C. G. 240

12500 #

3 P'T

$R_N = \frac{(12500 \times 36)}{140.4} = 3205$ # ←

$R_M = \frac{(12500 \times 104.4)}{(2)(140.4)} = 4648$ # ←

2 P'T

$R_N = 0$ ←

$R_M = 6250$ # ←

C. G. 246

12500 #

3 P'T

$R_N = \frac{(12500 \times 30)}{140.4} = 2671$ # ←

$R_M = \frac{(12500 \times 110.4)}{(2 \times 140.4)} = 4915$ # ←

2 P'T

$R_N = 0$ ←

$R_M = 6250$ # ←

SUBJECT: L/G LOADS SECTION: C ENGINEER: UPDEGRAFF CHECKER:		MODEL: XV-5A PAGE: 10 REPORT: DATE: 4/12/62

GROUND REACTION FACTOR (n_z)

THE GROUND REACTION FACTOR WILL BE DETEMINED BY THE ENERGY ABSORBED BY THE TIRE & OLEO STRUT TAKING INTO ACCOUNT 1g WING LIFT

TOTAL ENERGY = K. E. + P. E.

P.E. = 0 WHEN CONSIDERING 1g WING LIFT

$\therefore E = K.E. = \frac{WV^2}{2g}$

n_z FOR LANDING DESIGN GROSS WEIGHT (9200#)

OLEO STROKE = 9.00 IN

EFFECTIVE STROKE ASSUMED = 8.5 IN = .708 FT

DESIGN SINK SPEED = 10 FT/SEC.

TIRE SIZE = 20 x 4.4 TYPE VII

INFLATION PRESSURE = 180 PSI

LOAD/TIRE = $9200^{\#}/2 \times n_z = 4600 \times 2.635 = 12{,}121^{\#}$

E_{TIRE} = .4 (DYNAMIC LOAD x TIRE DEFLECTION)

TIRE DEFLECTION = .145 FT *

$E_{TIRE} = (.4)(12{,}121)(.145) = 703$ FT-LBS

$E_{OLEO} = \frac{WV^2}{2g} = \frac{(4600)(10)^2}{64.4} = 7143$ FT-LBS

$E_{TOTAL} = E_{OLEO} - E_{TIRE} = 7143 - 703 = 6440$ FT-LBS

n_o = OLEO EFFICIENCY = 75%

$V = \frac{E_{TOTAL}}{n_o \times STROKE} = \frac{6440}{(.75)(.708)} = 12128^{\#}$

* B. F. GOODRICH LOAD DEFLECTION CHARACTERISTIC CURVES

GROUND REACTION FACTOR

n_z FOR 9200# A/C (CONT.)

$V = 12128^{\#}$

$n_z = \frac{12128}{4600} = \underline{2.636}$ ←

n_z FOR 12500# MAX. DESIGN GROSS WEIGHT

DESIGN SINK SPEED = 6 FT/SEC

LOAD/TIRE = (6250)(.98) = 6125#

TIRE DEFLECTION = .100 FT

$E_{TIRE} = (.4)(.1)(6125) = 245$ FT-LBS

$E_{OLEO} = \frac{(6250)(6)^2}{64.4} = 3494$ FT-LBS

$E_{TOTAL} = 3494 - 245 = 3249$ FT-LBS

$V = \frac{3249}{(.75)(.708)} = 6120^{\#}$

$n_z = \frac{6120}{6250} = .98$ USE $\underline{1.00}$ ←

n_z FOR 9200# A/C EMERGENCY LANDING

DESIGN SINK SPEED = 6 FT/SEC

LOAD/TIRE = 4600#

TIRE DEFLECTION = .08 FT

$E_{TIRE} = (.4)(.08)(4600) = 147$ FT-LBS

$E_{OLEO} = \frac{(4600)(6)^2}{64.4} = 2571$ FT-LBS

$E_{TOTAL} = 2571 - 147 = 2424$ FT-LBS

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GROUND REACTION FACTOR

$$V = \frac{2424}{(.75)(.708)} = 4600\ \#$$

$$n_z = \frac{4600}{4600} = \underline{1.00} \longleftarrow$$

CALCULATION OF t_v

MAIN GEAR A/C W'T = 9200# $n_z = 2.636$

$V_v = 10$ FT/SEC TIRE SIZE = 20X4.4 INFLATION = 180psi

TYPE VIII $d_v = x_t + .5\,x_o$ $x_t = 1.336$ IN Av.

$x_o = 9.0$ IN $d_v = 1.336 + .5(9.0) = 5.836$ IN $= .486$ FT

$$t_v = \frac{V_v - [V_v^2 - 29.8\,d_v\,n_z]^{1/2}}{14.9\,n_z} = \frac{10 - [10^2 - (29.8)(.486)(2.64)]^{1/2}}{14.9(2.64)}$$

$$t = \frac{10 - [100 - 37.66]^{1/2}}{39.74} = \frac{10 - 7.90}{39.74} = \underline{.054\ \text{SEC}} \longleftarrow$$

9200# A/C $V_v = 6$ FT/SEC $n_z = 1.00$

$$t_v = \frac{6 - [(6)^2 - (29.8)(.486)(1.00)]^{1/2}}{(14.9)(1.00)} = \frac{6 - [36 - 14.48]^{1/2}}{14.9}$$

$$t_v = \frac{6 - 4.64}{14.9} = \underline{.091\ \text{SEC}} \longleftarrow$$

CALCULATION OF t_v (CONT)

$W_T = 12500^{\#}$ $n_z = 1.00$ $V_v = 6$ FT/SEC

$d_v = .486$ FT

$$t_v = \frac{V_v - [V_v^2 - 29.8 d_v n_z]^{1/2}}{14.9 n_z} = \frac{6 - [36 - 29.8(.486)(1.00)]^{1/2}}{14.9(1.00)}$$

$$t_v = \frac{6 - [21.52]^{1/2}}{14.9} = \frac{6 - 4.64}{14.9} = .091 \text{ SEC}$$

NOSE WHEEL

$W_T = 9200^{\#}$ $n_z = 2.6$ $V_v = 10$ FT/SEC

$X_b = 1.25$ IN AVERAGE TIRE SIZE = 18x4.4 PR 35 PSI Type VII

$X_o = 8.0$ IN

$d_v = 1.25 + .5(8.0) = 5.25$ IN $\sim .438$ FT

$$t = \frac{10 - [100 - 29.8(.438)(2.6)]^{1/2}}{14.9(2.6)} = \frac{10 - [100 - 33.94]^{1/2}}{38.74}$$

$$t_v = \frac{10 - [66.06]^{1/2}}{38.74} = \frac{10 - 8.13}{38.74} = .048 \text{ SEC}$$

W_T 9200$^{\#}$ $n_z = 1.00$ $V_v = 6$ FT/SEC $d_v = .438$ FT

$$t = \frac{6 - [36 - (29.8)(.438)(1.00)]^{1/2}}{(14.9)(1.00)} = \frac{6 - [36 - 13.05]^{1/2}}{14.9} = \frac{6 - [22.95]^{1/2}}{14.9}$$

$$t = \frac{6 - 4.79}{14.9} = .081 \text{ SEC}$$

$W_T = 12500$ $n_z = 1.00$ $d_v = .438$ FT $V_v = 6$ FT/SEC

$$t_v = \frac{6 - [36 - 29.8(.438)(1.00)]^{1/2}}{14.9(1.00)} = \frac{6 - [36 - 13.05]^{1/2}}{14.9} = \frac{6 - [22.95]^{1/2}}{14.9}$$

$$t_v = \frac{6 - 4.79}{14.9} = .081 \text{ SEC}$$

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MAXIMUM VERTICAL LOAD

9200# A/C

NOSE GEAR C.G. 240

$F_{V_{MAX}} = n_z R_N = 2.64(2359) = \underline{6230}^{\#}$ ←

MAIN GEAR C.G. 246

3 P'T

$F_{V_{MAX}} = n_z \cdot R_M = 2.64(3617) = \underline{9550}^{\#}$ ←

2 P'T

$F_{V_{MAX}} = n_z R_M = 2.64(4600) = \underline{12144}^{\#}$ ←

12500# A/C

NOSE GEAR C.G. 240

$F_{V_{MAX}} = (1.00)(3205) = \underline{3205}^{\#}$ ←

MAIN GEAR C.G. 246

3 P'T

$F_{V_{MAX}} = (1.00)(4915) = \underline{4915}^{\#}$ ←

2 P'T

$F_{V_{MAX}} = (1.00 \times 6250) = \underline{6250}^{\#}$ ←

SUBJECT: L/G LOADS
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POLAR MASS MOMENT INERTIA (I_w)

MAIN WHEEL

$$I_w = \frac{W_t}{g} K_t^2 + \frac{W_w}{g} K_w^2$$

W_t = WEIGHT OF TIRE = 12.0 #

W_w = WEIGHT OF WHEEL ASSEM. = 14.1 #

$K_t = \frac{OD_{MIN} + OD_{MAX}}{4K}$ $\quad K = 1.26$ FOR TYPE VII TIRE

$K_w = .4D$ $\quad D$ = RIM LEDGE DIA. = 13.624 IN

TIRE 20 X 4.4 - 12 PR. 180 PSI INFLATION P.

MAX. O.D. = 20 IN MIN O.D. = 19.55 IN

$$K_t = \frac{19.55 + 20}{4(1.26)(12)} = .6539 \text{ FT}$$

$$K_w = .4(13.624)/12 = .45413 \text{ FT}$$

$$I_w = \frac{12}{32.2}(.6539)^2 + \frac{14.1}{32.2}(.4513)^2 = .1594 + .0892 =$$

$I_w = .249$ SLUG-FT^2 ←

NOSE WHEEL

TIRE 18 X 4.4 10 PR. 185 PSI INFLATION P.

$O.D._{MAX} = 18.00$ IN $\quad O.D._{MIN} = 17.50$ IN

$W_t = 10.30$ #

$W_w = 8.05$ #

$$K_t = \frac{18.00 + 17.50}{4(1.26)(12)} = \frac{35.5}{60.48} = .5870 \text{ FT}$$

$$K_w = .4(11.62)/12 = .3873 \text{ FT}$$

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POLAR MASS MOMENT INERTIA (I_W)

NOSE WHEEL (CONT.)

$$I_W = \frac{10.3}{32.2}(.5870)^2 + \frac{8.05}{32.2}(.3873)^2 = .1102 + .0375$$

$$I_W = .148 \text{ SLUG-FT}^2$$

SUBJECT: L/G LOADS
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SPIN UP TIME (t_{SU})

$$t_{SU} = \frac{V_L I_W}{.55 Y^2 F_{VMAX}} + .363\, t_V \quad \text{FOR } t_{SU} > t_V$$

$$t_{SU} = \frac{2 t_V}{\pi} \cos^{-1}\left[1 - \frac{V_L I_W \pi}{1.1 t_V Y^2 F_{VMAX}}\right] \quad \text{FOR } t_{SU} < t_V$$

t_{SU} FOR 9200# A/C

$V_L = 1.2\, V_{SL} = (1.2 \times 84.6) = 101.5$ KTS
$V_L = 101.5 \times 1.69 = 172$ FT/SEC

t_{SU} NOSE GEAR

C.G. 240 CRITICAL
$Y^2 = .433$ FT^2 REF. PAGE 3
$I_W = .148$ SLUG-FT^2 REF. PAGE 16
$F_{VMAX} = n_z R_N^* = (2.64)(2359) = 6230$#
$t_V = .048$ SEC REF. PAGE 13

LANDING CONDITION 3P'T

$$t_{SU} = \frac{(2)(.048)}{\pi} \cos^{-1}\left[1 - \frac{(172)(.148)\pi}{1.1(.048)(.433)(6230)}\right] = .0306 \cos^{-1} .43878$$

$t_{SU} = (.0306)(1.115) = \underline{.034 \text{ SEC}}$ ←

*REF. PAGE 14

SPIN UP TIME (t_{SU})

t_{SU} MAIN GEAR

C.G. 246 CRITICAL

$Y^2 = .550\ FT^2$ REF PAGE 3

$I_W = .249\ FT^2$ REF PAGE 15

$t_V = .054$ SEC REF PAGE 12

LANDING CONDITION 3 PT

$FV_{MAX} = n_z\ R_M = (2.64)(3617) = 9550^{\#}$

$$t_{SU} = \frac{(2)(.054)}{\pi}\ \cos^{-1}\left[1 - \frac{(172)(.249)(\pi)}{(1.1)(.054)(.550)(9550)}\right] = .0344\cos^{-1}.56898$$

$t_{SU} = (.0344)(.966) = \underline{.033\ \text{SEC.}}$ ←

LANDING CONDITION 2 PT

$FV_{MAX} = n_z\ R_M = (2.64)(4600) = 12144^{\#}$

$$t_{SU} = .0344\cos^{-1}\left[1 - \frac{(172)(.249)(\pi)}{(1.1)(.054)(.550)(12144)}\right] = .0344\cos^{-1}.86104$$

$t_{SU} = (.0344)(.847) = \underline{.029\ \text{SEC}}$ ←

SPIN UP TIME (t_{SU})

t_{SU} FOR 12500#

$V_L = 1.2\ V_{SL} = (1.2 \times 167) = 200$ FT/SEC REF. PAGE

t_{SU} NOSE GEAR C.G. 240 CRITICAL

$t_V = .081$ SEC REF. PAGE 13
$I_W = .148$ SLUG FT^2 REF. PAGE 16
$\gamma^2 = .433$ FT^2 REF. PAGE 3
$F_{V_{MAX}} = n_z R_N = (1.00)(3205) = 3205$# REF PAGE 14

LANDING CONDITION 3 P'T

$$t_{SU} = \frac{2(.081)}{\pi} \cos^{-1}\left[1 - \frac{(200 \times .148)\pi}{(1.1)(.081 \times .433 \times 3205)}\right] = .0516 \cos^{-1} .248$$

$t_{SU} = (.0516 \times 1.321) = \underline{.068 \text{ SEC}}$ ←

t_{SU} MAIN GEAR C.G. 246 CRITICAL

$t_V = .091$ SEC REF. PAGE 13
$I_W = .249$ SLUG-FT^2 REF. PAGE 15
$\gamma^2 = .550$ FT^2 REF. PAGE 3
$F_{V_{MAX}} = n_z R_M = (1.00 \times 4915) = 4915$# REF. PAGE 14

LANDING CONDITION 3 P'T

$$t_{SU} = \frac{(2 \times .091)}{\pi} \cos^{-1}\left[1 - \frac{(200)(.249 \times \pi)}{(1.1)(.091)(.55 \times 4915)}\right] = .0580 \cos^{-1} .42195$$

$t_{SU} = (.058 \times 1.135) = \underline{.066 \text{ SEC}}$ ←

SPIN UP TIME (t_{SU})

t_{SU} MAIN GEAR C.G. 246 CRITICAL

LANDING CONDITION 2 P'T

$FV_{MAX} = n_z R_M = (1.00)(6250) = 6250^{\#}$ REF. PAGE 14

$$t_{SU} = .058 \cos^{-1}\left[1 - \frac{(200)(.249)(\pi)}{(1.1)(.091)(.55)(6250)}\right] = .058 \cos^{-1} .54552$$

$t_{SU} = (.058)(.993) = .058$ SEC ◄

SUMMARY SPIN UP TIMES

9200

NOSE GEAR C.G. 240

$t_{SU} = .034$ SEC

MAIN GEAR C.G. 246

$t_{SU} = .033$ SEC 3 P'T

$t_{SU} = .029$ SEC 2 P'T

12500

NOSE GEAR C.G. 240

$t_{SU} = .068$ SEC.

MAIN GEAR C.G. 246

$t_{SU} = .066$ SEC. 3 P'T

$t_{SU} = .058$ SEC 2 P'T

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$F_{VSU} = F_{V_{MAX}} \sin\left(\frac{\pi}{2t_V} \cdot t_{SU}\right)$ $F_{DSU} = .55\, F_{V_{MAX}} \sin\left(\frac{\pi}{2t_V} \cdot t_{SU}\right)$ For t_{SU} =

$D = K_{SU}(F_{DSU}\cos\theta - F_{VSU}\sin\theta)$ $V = F_{VSU}\cos\theta + F_{DSU}\sin\theta$

RM R2A REV 9-60

LANDING COND.	C.G.	1 W-LBS	2 $F_{V_{MAX}}$-LBS	3 t_V-SEC	4 t_{SU}-SEC	5 $\frac{\pi}{2} \times \frac{④}{③}$	6 SIN ⑤
3 POINT	240	9200	6230	.048	.034	1.11203	.896
NOSE GEAR	240	12500	3205	.091	.068	1.31864	.968
3 POINT	246	9200	9550	.054	.033	.95944	.819
MAIN GEAR	246	12500	4915	.091	.066	1.13926	.904
2 POINT	246	9200	12149	.054	.029	.84353	.747
LEVEL	240	12500	6250	.091	.054	1.00117	.842
2 POINT	246	9200	12149	.054	.029	.84353	.747
TAIL DOWN	240	12500	6250	.091	.054	1.00117	.842

A

Up Normal Landing Mode

SUBJECT: L/G LOADS
SECTION: C
ENGINEER: UDEGRAFF
CHECKER:

RYA

8 F_{DSU} .55 x ⑦	9 θ °OLEO	10 SIN θ	11 COS θ	12 K_{SU}	13 ⑧ x ⑪	14 ⑦ x ⑩	15 ⑦ x ⑪	16 ⑧
3070	5° 00'	.087	.996	1.40	3058	486	5560	2
1706	5° 00'	.087	.996		1699	270	3090	1
4302	7° 00'	.122	.992		4268	954	7758	5
2455	7° 00'	.122	.992		2435	544	4427	3
4990	10° 16'	.178	.984		4910	1615	8927	8
2894	10° 16'	.178	.984		2848	937	5178	5
4990	16° 00'	.276	.961		4795	2504	8718	13
2894	16° 00'	.276	.961	1.40	2781	1452	5057	7

D = NORMAL TO OLEO
V = PARALLEL TO OLEO

SPIN UP

MODE

SUBJECT: L/G LOADS
SECTION: C
ENGINEER: UDEGRAFF
CHECKER:

RYAN

MODEL: XV-5A
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11 Cos θ	12 Ksu	13 ⑧ x ⑪	14 ⑦ x ⑩	15 ⑦ x ⑪	16 ⑧ x ⑩	17 D-Lbs ⑫ x [⑬ - ⑭]	18 V-Lbs ⑮ + ⑯
.996	1.40	3058	486	5560	267	3600	5927
.996		1699	270	3090	148	2001	3238
.992		4268	954	7758	525	4640	8283
.992		2435	544	4427	300	2641	4727
.994		4910	1615	8927	888	4613	9815
.984		2848	937	5178	515	2674	5693
.961		4795	2504	8719	1377	3207	10095
.961	1.40	2781	1452	5057	799	1861	5856

OLEO
TO OLEO

SPIN UP

C

$$D = K_{SB}(F_{DSU}\cos\theta - F_{VSU}\sin\theta) + F_{VSU}\left(.9 + \frac{F_{VMAX}}{F_{VSU}}\right)$$

$$V = F_{VMAX}\cos\theta$$

FORM R2A REV 9-60

LANDING COND.	C.G.	1 W LBS	2 F_{VMAX}-LBS	3 F_{DSU}-LBS	4 F_{VSU}-LBS	5 θ° C
3 POINT NOSE GEAR	240	9200	6280	3070	5582	5° C
	240	12500	3205	1637	3086	5° C
3 POINT MAIN GEAR	246	9200	9550	4302	7921	7°
	246	12500	4915	2455	4463	7° C
2 POINT LEVEL	246	9200	12144	4990	9072	10° L
	246	12500	6250	2494	5262	10° L
2 POINT TAIL DOWN	246	9200	12144	4990	9072	16° C
	246	12500	6250	2494	5262	16° C

A

$\frac{\text{MAX}}{\text{SU}}$) SIN θ

DYNAMIC SPRING BACK NORMAL LANDING

SUBJEC
SECTIC
ENGIN
CHECK

θ° OLEO	COS θ	SIN θ	K_{SB}	③×⑥−④×⑦	.9 + ②/⑦	④×⑩×⑦	⑧×[⑨+⑪]	⑫×(
5° 00'	.996	.087	1.25	2572	2.02	941	-4441	62
5° 05'	.996	.087		1429	1.93	521	-2438	31
7° 00'	.994	.122		3313	2.12	2023	-6670	947
7° 00'	.994	.122		1891	2.00	1039	-3725	48
10° 16'	.984	.178		3295	2.24	3617	-8640	1192
10° 16'	.984	.178		1911	2.09	1958	-4836	61
16° 00'	.961	.276		2292	2.24	5609	-9876	116
16° 00'	.961	.276	1.25	1329	2.09	3035	-5455	60

B

AL LANDING

SUBJECT: L/G LOAD
SECTION: C
ENGINEER: UPDEGRAFF
CHECKER:

RYAN

MODEL: XV-5A
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11 ④ × ⑩ × ⑦	12 ⑧ × [⑨ + ⑪]	13 ② × ⑤					
941	-4441	6205					
521	-2438	3192					
2023	-6670	9474					
1089	-3725	4876					
3617	-8640	11950					
1958	-4836	6150					
5609	-9876	11670					
3035	-5455	6006					

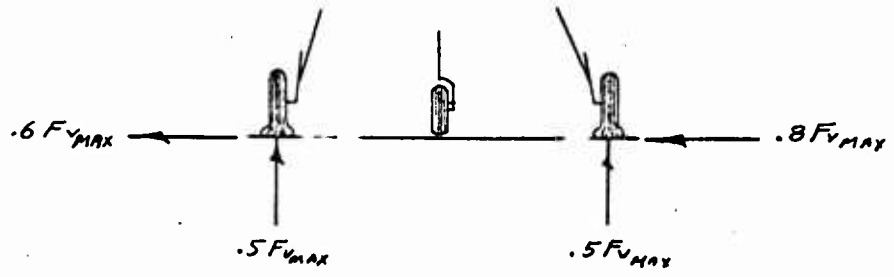
DYNAMIC SPRING BACK

C

MAX. VERTICAL REACTION & DRIFT LANDING (REF: MIL-A-8862)

MAX. VERT. LOAD ($F_{V_{MAX}}$) IN COMBINATION WITH THE DRAG LOAD (F_D) OCCURING AT INSTANT OF MAXIMUM VERT. LOAD WHICH DRAG LOAD SHALL NOT BE LESS THAN .25 OF $F_{V_{MAX}}$

DRIFT LANDING THE VERTICAL REACTION ON EACH MAIN GEAR SHALL BE .5 OF MAX. VERICAL REACTION OF SYMMETRICAL 2PT LANDING. THE SIDE LOAD ON ONE MAIN GEAR SHALL CONSIST OF AN INWARD ACTING LOAD OF .8 TIMES THE VERTICAL REACTION, THE SIDE LOAD ON THE OTHER SHALL CONSIST OF AN OUTWARD ACTING LOAD OF .6 TIMES THE VERTICAL LOAD. BOTH SIDE LOADS WILL ACT SIMULTANEOUSLY AT THE GROUND. DRAG LOADS WILL BE ZERO. AIRCAFT SHALL BE IN LEVEL 2 PT ATTITUDE



SUBJECT: L/G LOADS SECTION: C ENGINEER: UDDEGRAFF CHECKER:		MODEL: XV-5A PAGE: 24 REPORT: DATE: 10/6/62

MAXIMUM VERTICAL REACTION

9200# A/C

NOSE GEAR C.G. 240 CRITICAL

$F_{V_{MAX}}$ = 6230# ←

F_D = .25 $F_{V_{MAX}}$ = 1558# ←

MAIN GEAR C.G. 246 CRITICAL

3 P'T LANDING

$F_{V_{MAX}}$ = 9550# ←

F_D = (.25)(9550) = 2388# ←

2 P'T LANDING

$F_{V_{MAX}}$ = 12144# ←

F_D = (.25)(12144) = 3036# ←

12500# A/C

NOSE GEAR C.G. 240 CRITICAL

$F_{V_{MAX}}$ = 3205# ←

F_D = (.25)(3205) = 801# ←

MAIN GEAR C.G. 246 CRITICAL

3 P'T LANDING

$F_{V_{MAX}}$ = 4915# ←

F_D = (.25)(4915) = 1229# ←

SUBJECT: L/G LOADS SECTION: C ENGINEER: UPDEGRAFF CHECKER:		MODEL: XV-5A PAGE: 25 REPORT: DATE: 10/6/62

MAXIMUM VERTICAL REACTION

12500# A/C

MAIN GEAR C.G. 246 CRITICAL

2 PT LANDING

$F_{V_{MAX}}$ = 6250# ←

F_D = (.25)(6250) = 1562# ←

DRIFT LANDING

9200# A/C

$F_V = .5\ F_{V_{MAX}} = .5(12144) =$ 6072# ←

$F_{S(IN)} = .8\ F_V = (.8)(6072) =$ 4858# ←

$F_{S(OUT)} = .6\ F_V = (.6)(6072) =$ 3643# ←

12500# A/C

$F_V = .5\ F_{V_{MAX}} = (.5)(6250) =$ 3125# ←

$F_{S(IN)} = (.8)(F_V) = (.8)(3125) =$ 2500# ←

$F_{S(OUT)} = (.6)(F_V) = (.6)(3125) =$ 1875# ←

THE FOLLOWING LOADS FOR MAIN GEAR C.G. 240 AND NOSE GEAR C.G. 246 ARE NOT CRITICAL FOR LANDING GEAR, BUT ARE REQUIRED TO SATISFY FUSELAGE INERTIA LOAD DATA.

MAIN GEAR LOADS C.G. 240

A/C WEIGHT 9200#

$F_{V_{MAX}} = (2.64 \times 3420) = 9029^{\#}$

$$t_{SU} = \frac{2(.059)}{\pi} \cos^{-1}\left[1 - \frac{(172 \times .249 \times \pi)}{(1.1 \times .059 \times .55 \times 9029)}\right] = .0344 \cos^{-1} 1 - \frac{134.48}{694.98}$$

$t_{SU} = .0344 \cos^{-1} 1 - .45589 = .0344 \cos^{-1} .54411 = \underline{.034 \text{ SEC}}$

SPIN UP

$$F_{V_{SU}} = F_{V_{MAX}} \sin\left(\frac{\pi \cdot t_{SU}}{2 t_Y}\right) = 9029 \sin\left(\frac{\pi (.034)}{2 (.059}\right) = 9029 \sin .98851$$

$F_{V_{SU}} = (9029 \times .835) = \underline{7539^{\#}}$

$F_{D_{SU}} = .55 (F_{V_{SU}}) = \underline{4146^{\#}}$

$\theta = 7^{\circ} \quad \cos\theta = .992 \quad \sin\theta = .122$

$V = F_{V_{SU}} \cos\theta + F_{D_{SU}} \sin\theta = 7539^{\#}(.992) + 4146(.122)$

$V = \underline{7984^{\#}}$

$D = K_{SU}(F_{D_{SU}} \cos\theta - F_{V_{SU}} \sin\theta) = 1.4[4146(.992) - 7539(.122)]$

$D = \underline{4470^{\#}}$

SPRING BACK

$V = F_{V_{MAX}} \cos\theta = 9029(.992) = \underline{8957^{\#}}$

$$D = K_{SB}(F_{D_{SU}} \cos\theta - F_{V_{SU}} \sin\theta) + F_{V_{SU}}\left(.9 + \frac{F_{V_{MAX}}}{F_{V_{SU}}}\right) \sin\theta$$

$D = 1.25(3192.8) + 7539(.9 + 1.198)(.122) = \underline{-5920^{\#}}$

NOSE GEAR C.G. 246

A/C WEIGHT 9200#

$F_{V_{MAX}} = (2.64)(1966) = 5190^{\#}$

$t_V = .048$

$$t_{SU} = .0306 \cos^{-1}\left[1 - \frac{(172)(.148)(\pi)}{(1.1)(.048)(.433)(5190)}\right] = .0306 \cos^{-1} 1 - \frac{79.93}{118.64}$$

$t_{SU} = .0306 \cos^{-1} 1 - .67371 = .0306 \cos^{-1} .32629 = .0306 (1.237)$

$t_{SU} = \underline{.038 \text{ SEC}}$

SPIN UP

$$F_{V_{SU}} = F_{V_{MAX}} \sin\left(\frac{\pi \cdot t_{SU}}{2 t_V}\right) = 5190 \sin 1.24291 = 5190 (.947)$$

$F_{V_{SU}} = \underline{4915}^{\#}$

$F_{D_{SU}} = .55 F_{V_{SU}} = \underline{2703}^{\#}$

$V = (4915)(.996) + (2703)(.087) = \underline{5130}^{\#}$

$D = 1.4[(2703)(.996) - (4915)(.047)] = \underline{3170}^{\#}$

(2264)

SPRING BACK

$V = 5190 (.996) = \underline{5169}^{\#}$

$D = 1.25 (2264) + 4915 \left(.9 + \frac{5190}{4915}\right) .087 -$

$D = \underline{-3668}^{\#}$

RESOLVED LOADS MAIN

SPIN UP

$P_Z = V\cos\theta - D\sin\theta$

$P_X = D\cos\theta + V\sin\theta$

$\theta = 7^\circ$

$\cos\theta = .992$

$\sin\theta = .122$

3 POINT

C.G. = 240

$V = 7984$

$D = 4470$

$P_Z = 7984(.992) - 4470(.122) = \underline{7375^{\#}}$

$P_X = 4470(.992) + 7984(.122) = \underline{5408^{\#}}$

C.G. = 246

$V = 8283$

$D = 4640$

$P_Z = 8283(.992) - 4640(.122) = \underline{7651^{\#}}$

$P_X = 4640(.992) + 8283(.122) = \underline{5613^{\#}}$

RESOLVED LOADS MAIN

SPIN UP 2 PT LEVEL

$V = 9815^{\#}$

$D = 4613^{\#}$

$P_Z = 9815(.992) - 4613(.122) = \underline{9174}^{\#}$

$P_X = 4613(.992) + 9815(.122) = \underline{5774}^{\#}$

2 PT TAIL DOWN

$V = 10095^{\#}$

$D = 3226^{\#}$

$P_Z = 10095(.992) - 3226(.122) = \underline{9621}^{\#}$

$P_X = 3226(.992) + 10095(.122) = \underline{4432}^{\#}$

SPRING BACK

$P_Z = V\cos\theta + D\sin\theta$

$P_X = V\sin\theta - D\cos\theta$

C. G. 240

3 PT

$V = 8957^{\#}$

$D = -5920^{\#}$

RESOLED LOADS MAIN

$P_Z = (8957)(.992) + 5920\ (.122) = 9608^{\#}$

$P_X = (9957)(.122) - 5920\ (.992) = -4780^{\#}$

C.G. 246 3 PT

$V = 9474^{\#}$

$D = -6670^{\#}$

$P_Z = (9474)(.992) + (6670)(.122) = 10212^{\#}$

$P_X = -(6670)(.992) + (9474)(.122) = -5461^{\#}$

2 PT LEVEL

$V = 11950^{\#}$

$D = -8640^{\#}$

$P_Z = 11950(.992) + (8640)(.122) = 12908^{\#}$

$P_X = -(8640)(.992) + (11950)(.122) = -7113^{\#}$

2 PT TAIL DOWN

$V = 11670^{\#}$

$D = -9876^{\#}$

$P_Z = 11670(.992) + 9876(.122) = 12781^{\#}$

$P_X = -9876(.992) + 11670(.122) = -8373^{\#}$

RESOLVED LOADS MAIN

MAX. VERT. REACTION

C.G. 240

3 PT

$P_Z = .264(3420) = \underline{9029}^{\#}$

$P_X = (.25)(9029) = \underline{2257}^{\#}$

C.G. 246

3 PT

$P_Z = \underline{9550}^{\#}$

$P_X = 2388^{\#}$

2 PT LEVEL

$\Theta = 3^{\circ}16'$

$P_Z = F_V \cos\Theta + F_D \sin\Theta$ $\quad \cos\Theta = .998$

$P_X = F_D \cos\Theta - F_V \sin\Theta$ $\quad \sin\Theta = .057$

$F_V = 12144^{\#}$

$F_D = 3036^{\#}$

$P_Z = 12144(.998) + 3036(.057) = \underline{12293}^{\#}$

$P_X = 3036(.998) - 12144(.057) = \underline{2338}^{\#}$

RESOLVED LOADS MAIN

2 PT TAIL DOWN

$F_V = 12144^{\#}$

$F_D = 3036^{\#}$

$\theta = 9^\circ$

$\cos\theta = .988$

$\sin\theta = .156$

$P_Z = 12144(.988) + 3036(.156) = \underline{12472}^{\#}$

$P_X = 3036(.988) - 12144(.156) = \underline{1105}^{\#}$

SIDE DRIFT

$F_V = 6072^{\#}$

$F_{S_{IN}} = 4858^{\#}$

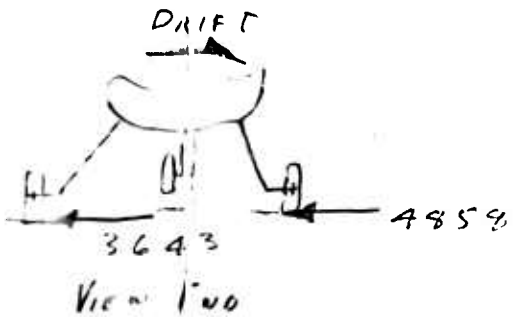
$F_{S_{OUT}} = 3643^{\#}$

$P_Z = 6072(.998) = \underline{6060}^{\#}$

$P_X = 6072(.057) = -\underline{346}^{\#}$

$P_{Y_{IN}} = -\underline{4858}^{\#}$ For IBM + 4858

$P_{Y_{OUT}} = 3643^{\#}$



View Two

MAIN GEAR LOADS C.G. 240

UPDEGRAFF
10/23/62
34

A/C $W = 12500^{\#}$ 3 PT

$F_{V_{MAX}} = 4648^{\#}$ $\quad t_V = .091$

$$t_{SU} = .0580\ \cos^{-1}\left[1 - \frac{(200)(.249)(\pi)}{(1.1)(.031)(.55)(4644)}\right] = .058\cos^{-1}\left(1 - \frac{156.4}{255.9}\right)$$

$t_{SU} = .058\cos^{-1}(1 - .61117) = .058\cos^{-1}(.38883) = .058(1.17)$

$t_{SU} = .068$

SPIN UP

$$F_{V_{SU}} = 4648\ \sin\left(\frac{\pi \cdot 058}{.162}\right) = 4648\ \sin 1.17318$$

$F_{V_{SU}} = 4644(.922) = 4285^{\#}$ $\quad \theta = 7^{\circ}$

$\cos\theta = .992$

$F_{D_{SU}} = .55(4285) = 2357^{\#}$ $\quad \sin\theta = .122$

$V = 4285(.992) + 2357(.122) = 4538^{\#}$

$D = 1.4[2357(.992) - 4285(.122)] = 1.4(1815)$

$D = 2542^{\#}$

SPRING BACK

$V = 4648(.992) = 4611^{\#}$

$$D = 1.25(1815) + 4648\left(.9 + \frac{4644}{4285}\right)(.122)$$

$D = -3392^{\#}$

NOSE GEAR

UPDEGRAFF
10/23/62

C.G. 246 A/C W=12500

3 Pt $F_{UMAX} = 2671^{\#}$ $t_v = .081_{SEC}$

$t_{SU} = .0516 \cos^{-1} |-.90189 = .0516 \cos^{-1} .09811$

$t_{SO} = .0516(1.47) = .076$ SEC

SPIN UP

$F_{VSU} = 2671 \sin \frac{\pi .076}{.162} = 2671 . \sin 1.47308$

$F_{USU} = 2671(.995) = 2658^{\#}$

$F_{DSU} = .55(2658) = 1462^{\#}$

$\theta = 5^{0}$
$\cos\theta = .996$
$\sin\theta = .087$

$V = 2658(.996) + 1462(.087)$
$V = \underline{2774}^{\#}$

$D = 1.4[1462(.996) - 2658(.087)] = 1.4(1225)$
$D = 1715^{\#}$

SPRING BACK

$V = 2671(.996) = 2660^{\#}$

$D = 1.25(1225) + 2658\left(.9 + \frac{2671}{2658}\right).087$
$D = -1971^{\#}$

UPDEGRAFF
10/23/62

NORMAL LANDING

A/C WEIGHT = 12500 # MAIN GEAR

LOADS RESOLVED INTO A/C AXIS

$P_Z = V\cos\theta - D\sin\theta$
$P_X = D\cos\theta + V\sin\theta$ } SPIN UP

3 PT

$\theta = 7^0$ $\cos\theta = .992$ $\sin\theta = .122$

SPIN UP

C. G. 240

$V = 4538$ # $D = 2542$ #

$P_X = 2542(.992) + 4538(.122) = 3075$ #

$P_Z = 4538(.992) - 2542(.122) = 4192$ #

C. G. 246

$V = 4727$ # $D = 2647$ #

$P_X = 2647(.992) + 4727(.122) = 3207$ #

$P_Z = 4727(.992) - 2647(.122) = 4366$ #

UPDEGRAFF
10/23/62

SPIN UP

2 PT LEVEL

$V = 5693^{\#}$ $D = 2674^{\#}$

$P_X = 2674(.992) + 5693(.122) = 3347^{\#}$

$P_Z = 5693(.992) - 2674(.122) = 5321^{\#}$

2 PT' TAIL DOWN

$V = 5856^{\#}$ $D = 1861^{\#}$

$P_X = 1861(.992) + 5856(.122) = 2560^{\#}$

$P_Z = 5856(.992) - 1861(.122) = 5582^{\#}$

SPRING BACK

$P_X = V\sin\theta - D\cos\theta$

$P_Z = V\cos\theta + D\sin\theta$

3 P'T C.G. 240

$V = 4611^{\#}$ $D = -3392^{\#}$

$P_X = 4611(.122) - 3392(.992) = -2802^{\#}$

$P_Z = 4611(.992) + 3392(.122) = 4988^{\#}$

3 P'T C.G. 246

$V = 4876^{\#}$ $D = -3725^{\#}$

$P_X = 4876(.122) - 3725(.992) = -3100^{\#}$

$P_Z = 4876(.992) + 3725(.122) = 5291^{\#}$

UPDEGRAFF
10/23/62

2 P'T LEVEL

$V = 6150^{\#}$ $D = -4836^{\#}$

$P_x = 6150(.122) - 4836(.992) = -4047^{\#}$

$P_z = 6150(.992) + 4836(.122) = 6691^{\#}$

2 P'T TAIL DOWN

$V = 6006^{\#}$ $D = -5455^{\#}$

$P_x = 6006(.122) - 5455(.992) = -4679^{\#}$

$P_z = 6006(.992) + 5455(.122) = 6623^{\#}$

MAX VERT REACT.

3 P'T C.G. 240

$P_x = .25(4648) = 1162^{\#}$

$P_z = 4648^{\#}$

3 P'T C.G. 246

$P_x = 1229^{\#}$

$P_z = 4915^{\#}$

UPDEGRAFF
10/23/62

2 PT LEVEL

$F_V = 6250^{\#}$
$F_D = 1562^{\#}$

$\theta = 3^\circ 16'$
$\cos\theta = .998$
$\sin\theta = .057$

$P_X = 1562(.998) - 6250(.057) = 1203^{\#}$

$P_Z = 6250(.998) + 1562(.057) = 6326^{\#}$

2 PT TAIL DOWN

$F_V = 6250^{\#}$
$F_D = 1562^{\#}$

$\theta = 9^\circ$
$\cos\theta = .988$
$\sin\theta = .156$

$P_X = 1562(.988) - 6250(.156) = 568^{\#}$

$P_Z = 6250(.988) + 1562(.156) = 6419^{\#}$

SIDE DRIFT

$P_X = 3125(.057) = -178$

$P_Y = .2500^{\#}$ IN

$P_Y = 1875^{\#}$ OUT

$P_Z = 3125(.998) = 3119^{\#}$

SUMMARY LOADS (GEAR AFT) TABLE 2

EMERGENCY LANDING		SPIN UP		SPRING BACK		MAX. VERT. REA.		SIDE DRIFT			
GEAR	WEIGHT	V	D	V	D	F_V	F_D	F_V	F_D	F_S	
NOSE C.G. 240	9200	3132	1935	3199	-2242	3212	803	0	0	0	
MAIN C.G. 246 3P'T	9200	2583	3352	3071	-2231	3166	792.	0	0	0	
2P'T LEVEL	9200	3581	4138	4517	-2839	4600	1150	2300	0	1840	IN
										1380	OUT
2P'T TAIL DOWN	9200	3860	3618	4582	-2830	4600	1150	0	0	0	
				WEIGHT 9200	NOSE C.G. 240	8480	0	0	0	0	
					MAIN C.G. 246 3P'T	8358	0	0	.0	0	
					2P'T	12144	0	6072	0	4858	IN
										3643	OUT

'VTOL

F_V & F_D IN PLANE OF GROUND

V & D NORMAL & PARALLEL TO OLEO.

SUBJECT L/G LOADS
SECTION D
ENGINEER LANDEGRAFF
CHECKER

MODEL XV-5A
PAGE 40
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SUBJECT: L/G LOADS
SECTION: 2.0
ENGINEER: UPDEGRAFF
CHECKER:

MODEL: XV-5A
PAGE: 41
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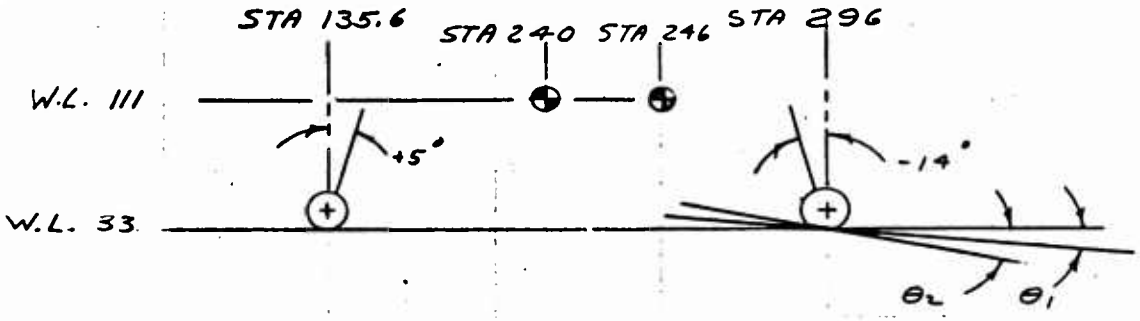
STATIC WHEEL POSITION VTOL MODE



WHEEL BASE = 160.4

MAIN GEAR AXEL ℄ WL = 41.9

NOSE GEAR AXEL ℄ WL = 40.9

$\theta_1 = 3°16'$

$\theta_2 = 9°$

SUBJECT: L/G LOADS
SECTION: D
ENGINEER: UPDEGRAFF
CHECKER:

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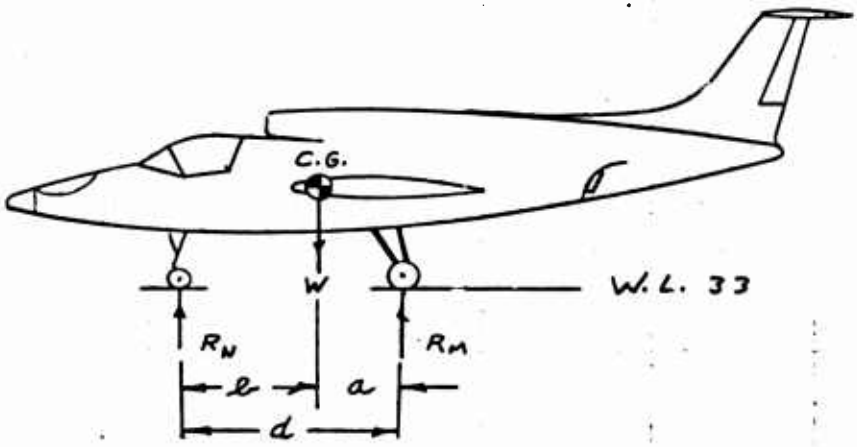
STATIC GROUND REACTION
VTOL MODE



R_N = NOSE GEAR REACTION
R_M = MAIN GEAR REACTION
W = 9200 #

C.G. 240

a = 56
ℓ = 104.4
d = 160.4

C.G. 246

a = 50
ℓ = 110.4
d = 160.4

$$R_N = \frac{W a}{d}$$

$$R_M = \frac{W \ell}{2 d}$$

SUBJECT: L/G LOADS
SECTION: D
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STATIC GROUND REACTIONS
VTOL MODE (GEAR AFT)

C.G. 240

3P'T

$R_N = \frac{(9200)(56)}{160.4} = 3212^{\#}$ ←

$R_M = \frac{(9200 \times 104.4)}{2(160.4)} = 2994^{\#}$ ←

C.G. 246

3P'T

$R_N = \frac{(9200 \times 50)}{160.4} = 2868^{\#}$ ←

$R_M = \frac{(9200)(110.4)}{2(160.4)} = 3166^{\#}$ ←

2PT

$R_N = 0^{\#}$ ←

$R_M = 4600^{\#}$ ←

SUBJECT: L/G LOADS		MODEL: XV5A
SECTION: D		PAGE: 44
ENGINEER: UPDEGRAFF		REPORT:
CHECKER:		DATE: 4/19/63

GROUND REACTION FACTOR

EMERGENCY LANDING $n_z = 1.00$ REF. PAGE 11

V.T.O.L. LANDING $n_z = 2.64$ REF. PAGE 11

t_v

EMERGECY LANDING - MAIN WHEEL $t_v = .091$ SEC.
NOSE WHEEL $t_v = .091$ SEC.

V.T.O.L. LANDING $t_v = 0$

REF. PAGES 12, 13

POLAR MASS MOMENT OF INERTIA

$I_{W_{MAIN}} = .249$ SLUG-FT^2 REF. PAGE 15

$I_{W_{NOSE}} = .148$ SLUG-FT^2 REF. PAGE 16

SUBJECT: L/G LOADS SECTION: D ENGINEER: VDDEGRAFF CHECKER:		MODEL: XV-5A PAGE: 45 REPORT: DATE: 10/9/62

MAXIMUM VERTICAL LOAD

n_z GROUND REACTION FACTOR = 1.00 ○○

$F_{V_{MAX}}$ = STATIC GROUND REACTIONS

REF. PAGE 43

SPIN UP TIME (t_{SU})

COND. EMERGENCY LANDING GEAR AFT

WEIGHT = 9200 #

LANDING. V = 172 FT/SEC REF PAGE 2

t_{SU} NOSE GEAR C.G. 240 CRITICAL

$\gamma^2 = .433\ FT^2$ REF PAGE 3

$I_W = .148\ SLUG\text{-}FT^2$ REF PAGE 16

$F_{V_{MAX}} = n_z\ R_N = (1.00)(3212) = 3212$ #

$t_V = .081$ SEC.

LANDING COND. 3P'T

$$t_{SU} = \frac{2t_V}{\pi} \cos^{-1}\left[1 - \frac{V_L I_W \pi}{1.1\, t_V \gamma^2 F_{V_{MAX}}}\right] \quad \text{FOR } t_{SU} < t_V$$

$$t_{SU} = \frac{2(.081)}{\pi} \cos^{-1}\left[1 - \frac{(172)(.148)(\pi)}{(1.1)(.081)(.433)(3212)}\right] = .0516 \cos^{-1}(.35499)$$

$t_{SU} = (.0516)(1.21) = \underline{.062\ SEC}$ ←

t_{SU} MAIN GEAR C.G. 246 CRITICAL

$\gamma^2 = .55\ FT^2$ REF PAGE 3

$I_W = .249\ SLUG\text{-}FT^2$ REF PAGE 15

$t_V = .091$ SEC REF PAGE 12

LANDING COND. 3 PT

$F_{V_{MAX}} = n_z\ R_M = (1.00)(3166) = 3166$ #

$$t_{SU} = \frac{2(.091)}{\pi} \cos^{-1}\left[1 - \frac{(172)(.249)(\pi)}{(1.1)(.091)(.55)(3166)}\right] = .058 \cos^{-1}(.22841)$$

SPIN UP TIME (t_{SU})

LANDING COND. 3 Pt (CONT.)

$t_{SU} = (.058)(1.34) = .078$ SEC

LANDING COND. 2 Pt

$F_{V_{MAX}} = n_z R_M = (1.00)(4600) = 4600^{\#}$ REF. PAGE 43

$$t_{SU} = .058 \cos^{-1}\left[1 - \frac{(172)(.249)(\pi)}{(1.1)(.091)(.55)(4600)}\right] = .058 \cos^{-1}(.46895)$$

$t_{SU} = (.058)(1.083) = .063$ SEC

EMERGENCY LANDING

SPIN UP LOADS

NOSE GEAR C.G. 240

$F_{V_{MAX}} = 3212^{\#}$

$t_V = .081$ Sec

$t_{SU} = .062$ Sec.

$F_{V_{SU}} = F_{V_{MAX}} \sin\left(\frac{\pi}{2t_V} t_{SU}\right) = 3219 \sin\left(\frac{\pi}{2(.081)} .062\right)$

$F_{V_{SU}} = 3212 \sin 1.20172 = (3212 \times .934) = \underline{3000^{\#}}$ ←

$F_{D_{SU}} = .55 F_{V_{MAX}} \sin\left(\frac{\pi}{2t_V} t_{SU}\right) = .55(3000)$

$F_{D_{SU}} = \underline{1650^{\#}}$ ←

$V = F_{V_{SU}} \cos\theta + F_{D_{SU}} \sin\theta \qquad \theta = 5°$

$\cos\theta = .996 \qquad \sin\theta = .087$ REF PAGE 41

$V = (3000)(.996) + (1650)(.087) = \underline{3132^{\#}}$ ←

$D = K_{SU}(F_{D_{SU}} \cos\theta - F_{V_{SU}} \sin\theta)$

$K_{SU} = 1.4$

$D = 1.4[1650(.996) - 3000(.087)] = \underline{1935^{\#}}$ ←

SUBJECT: L/G LOADS
SECTION: D
ENGINEER: UPDEGRAFF
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EMEGENCY LANDING

SPIN UP LOADS

MAIN GEAR C.G. 246

3 P'T

$F_{V_{MAX}} = 3166^{\#}$ $t_V = .091$ sec $t_{SU} = .078$ Sec

$F_{V_{SU}} = 3166 \sin\left(\frac{\pi}{2(.091)} .078\right) = 3166 \sin 1.34571$

$F_{V_{SU}} = (3166 \times .975) = \underline{3087}^{\#}$ ←

$F_{D_{SU}} = .55 F_{V_{MAX}} \sin\left(\frac{\pi}{2t_V} t_{SU}\right) = .55(3087) = \underline{1698}^{\#}$ ←

$V = F_{V_{SU}} \cos\theta + F_{D_{SU}} \sin\theta$ $\theta = -14°$

$\cos\theta = .970$ $\sin\theta = -.242$

$V = 3087(.970) + 1698(-.242) = \underline{2583}^{\#}$ ←

$D = K_{SU}\left[F_{D_{SU}} \cos\theta - F_{V_{SU}} \sin\theta\right]$

$D = 1.9\left[1698(.970) - 3087(-.242)\right] = \underline{3352}^{\#}$ ←

2P'T LEVEL

$F_{V_{MAX}} = 4600^{\#}$ $t_V = .091$ Sec $t_{SU} = .063$ Sec

$\theta = -10°44'$ $\cos\theta = .982$ $\sin\theta = -.186$

$F_{V_{SU}} = 4600 \sin\left(\frac{\pi}{2(.091)} .063\right) = 4600 \sin 1.08692$

$F_{V_{SU}} = (4600)(.885) = \underline{4071}^{\#}$ ←

$F_{D_{SU}} = .55(4071) = \underline{2239}^{\#}$ ←

SUBJECT: L/G LOADS
SECTION: D
ENGINEER: UPDEGRAEF
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EMERGENCY LANDING

SPIN UP LOADS

MAIN GEAR C.G. 346

2P'T LEVEL CONT.

$V = 4071(.982) + 2239(-.186) = 3781^{\#}$ ←

$D = 1.4[2239(.982) - 4071(-.186)] = 4138^{\#}$ ←

2P'T TAIL DOWN

$\theta = -5^{\circ}$ $\cos\theta = .996$ $\sin\theta = -.087$

$FY_{SU} = 4071^{\#}$ REF PAGE. 49

$FD_{SU} = 2239^{\#}$ REF PAGE. 49

$V = 4071(.996) + 2239(-.087) = 3860^{\#}$ ←

$D = 1.4[2239(.996) - 4071(-.087)] = 3618^{\#}$ ←

EMERGENCY LANDING

DYNAMIC SPRING BACK

$V = F_{V_{MAX}} \cos\theta$

$D = X_{SL}\left(F_{D_{SU}}\cos\theta - F_{V_{SU}}\sin\theta\right) + F_{V_{SU}}\left(.9^{*} + \frac{F_{V_{MAX}}}{F_{V_{SU}}}\right)\sin\theta$

* FOR MINUS OLEO ∴ .9 TAKEN AS 0

NOSE GEAR C.G. 240

$\theta = 5^{\circ}$ $\cos\theta = .996$ $\sin\theta = .087$

$F_{V_{MAX}} = 3212^{\#}$ $F_{D_{SU}} = 1650^{\#}$ $F_{V_{SU}} = 3000^{\#}$

$X_{SL} = 1.25$

$V = 3212(.996) = \underline{3199}^{\#}$ ←

$D = 1.25\left[1650(.996) - 3000(.087)\right] + 3000\left(.9 + \frac{3212}{3000}\right).087$

$D = 1728 + 514 = \underline{2242}^{\#}$ ←

MAIN GEAR C.G. 246

3 PT

$\theta = -14^{\circ}$ $\cos\theta = .970$ $\sin\theta = -.242$

$F_{V_{MAX}} = 3166^{\#}$ $F_{D_{SU}} = 1698^{\#}$ $F_{V_{SU}} = 3087^{\#}$

$V = 3166(.970) = \underline{3071}^{\#}$ ←

$D = 1.25\left[1698(.97) - 3087(-.242)\right] + 3087\left(\frac{3166}{3087}\right)(-.242)$

$D = 2993 - 762 = \underline{2231}^{\#}$ ←

EMERGENCY LANDING

DYNAMIC SPRING BACK (CONT.)

2 P'T LEVEL

$\theta = -10°44'$ $\quad \cos\theta = .982 \quad \sin\theta = -.186$

$F_{V_{MAX}} = 4600^{\#} \quad F_{V_{SU}} = 4071^{\#} \quad F_{a_{SU}} = 2239^{\#}$

$V = (4600 \times .982) = \underline{4517}^{\#}$ ←

$D = 1.25\left[2239(.982) - 4071(-.186)\right] + 4071\left(\frac{4600}{4071}\right) - .186$

$D = 3695 - 856 = \underline{2839}^{\#}$ ←

2 P'T TAIL DOWN

$\theta = -5° \quad \cos\theta = .996 \quad \sin\theta = -.087$

$F_{V_{MAX}} = 4600 \quad F_{V_{SU}} = 4071^{\#} \quad F_{D_{SU}} = 2239^{\#}$

$V = 4600\,(.996) = \underline{4582}^{\#}$ ←

$D = 1.25\left[2239(.996) - 4071(-.087)\right] + 4071\left(\frac{4600}{4071}\right)(.087)$

$D = 3230 - 400 = \underline{2830}^{\#}$ ←

SUBJECT: L/G LOADS SECTION: D ENGINEER: VDDEGRAFF CHECKER:		MODEL: XV-5A PAGE: 53 REPORT: DATE: 10/8/62

EMERGENCY LANDING

MAX. VERTICAL REACTION

SINK V = 6 FT/SEC

$n_z = 1.00$

3 P'T

NOSE GEAR C.G. 240

$F_{V_{MAX}} = 3212^{\#}$

$F_D = .25(3212) = 803^{\#}$

MAIN GEAR C.G. 246

3P'T

$F_{V_{MAX}} = 3166^{\#}$

$F_D = .25(3166) = 792^{\#}$

2P'T

$F_{V_{MAX}} = 4600^{\#}$

$F_D = .25(4600) = 1150^{\#}$

SIDE DRIFT

$F_V = .5(4600) = 2300^{\#}$

$F_{V_{IN}} = .8(2300) = 1840^{\#}$

$F_{V_{OUT}} = .6(2300) = 1380^{\#}$

SUBJECT: L/G LOADS SECTION: D ENGINEER: UDDEGRAFF CHECKER:		MODEL: XV-5A PAGE: 54 REPORT: DATE: 10/8/62

VTOL LANDING

SINK V = 10 FT/SEC WEIGHT = 9200#

$n_z = 2.64$

$V_L = 0$

NOSE GEAR C.G. 240

$F_V = (2.64)(3212) = 8480^{\#}$

MAIN GEAR C.G. 246

3P'T

$F_V = (2.64 \times 3166) = 8358^{\#}$

2P'T

$F_V = 2.64(4600) = 12144^{\#}$

SIDE DRIFT

$F_V = (.5 \times 12144) = 6072^{\#}$

$F_{V_{IN}} = (.8 \times 6072) = 4858^{\#}$

$F_{V_{OUT}} = (.6 \times 6072) = 3643^{\#}$

EMERGENCY LANDING
REF. PAGE 43-45

UPDEGRAFF
10/15/62

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MAIN GEAR LOADS C.G. 240

A/C WEIGHT 9200# GEAR AFT

$F_{V_{MAX}} = 2994$

$t_V = .091$

$t_{SU} = .058 \cos^{-1}\left(1 - \frac{139.98}{164.82}\right) = .058 \cos^{-1}(1 - .81592)$

$t_{SU} = .058 \cos^{-1} .18408 = .058(1.385) = .080$ SEC

SPIN UP

$F_{V_{SU}} = F_{V_{MAX}} \sin \frac{\pi}{2t_U} t_{SU} = 2994 \sin \frac{\pi .080}{.182} = 2994 \sin 1.38$

$F_{V_{SU}} = 2994 (.98218) = 2941$#

$F_{D_{SU}} = .55\ F_{V_{SU}} = 1617$#

$\theta = -14°$
$\cos\theta = .970$
$\sin\theta = -.242$

$V = 2941 (.970) + 1617(-.242) = \underline{2461}$#

$D = 1.4 [1617 (.970) - 2941 (-.242)] = \underline{3192}$#

S. B.

$V = 2994 (.970) = \underline{2904}$#

$D = 1.25 (2280) + 2941 \left(\frac{2994}{2941}\right) - .242 =$

$D = 2850 - 724 = \underline{-2126}$#

EMERGENCY LANDING

NOSE GEAR C.G. 246

$F_{V_{MAX}} = 2868^{\#}$

$t_V = .081$ Sec

$\theta = 5^\circ$
$\cos\theta = .996$
$\sin\theta = .087$

$$t_{SU} = .0516 \cos^{-1}\left[1 - \frac{172(.148)\pi}{(1.1)(.081)(.433)(2868)}\right] = .0516 \cos^{-1} 1 - \frac{79.5}{110.6}$$

$$t_{SU} = .0516 \cos^{-1} 1 - .72236 = .0516 \cos^{-1} .27764$$

$t_{SU} = .0516 (1.29) = .066$ SEC

SPIN UP

$$F_{V_{SU}} = 2868 \sin \frac{\pi .066}{.162} = 2868 \sin 1.27925$$

$F_{V_{SU}} = 2868 (.958) = 2748^{\#}$

$F_{O_{SU}} = .55(2748) = 1511^{\#}$

$V = 2748(.996) + 1511(.087) = 2868^{\#}$

$D = 1.4[(1511)(.996) - (2748)(.087)] = 1772^{\#}$

S.B

$V = 2868(.996) = 2856^{\#}$

$D = 1.25(1266) + 2748\left(.9 + \frac{2868}{2748}\right).087 = 1582 + .465$

$D = -2047^{\#}$

E. L EMERGENCY LANDING UPDECRAFT 10/16/62

5

RESOLVED LOADS . MAIN

EMER. GEAR AFT

$\theta = -14^\circ$
$\cos\theta = .970$
$\sin\theta = -.242$

SPIN UP

3 PT LANDING

$P_Z = V\cos\theta - D\sin\theta$

$P_X = D\cos\theta + V\sin\theta$

C.G. 240

$V = 2461^{\#}$
$D = 3192^{\#}$

$P_Z = 2461(.970) - 3192(-.242) = 3160^{\#}$

$P_X = 3192(.970) + 2461(-.242) = 2501^{\#}$

C. G. 246

$V = 2583^{\#}$
$D = 3352^{\#}$

$P_Z = 2583(.970) - 3352(-.242) = 3317^{\#}$

$P_X = 3352(.970) + 2583(-.242) = 2626^{\#}$

SPRING BACK

C.G. 240

$V = 2904^{\#}$
$D = -2126^{\#}$

$P_Z = 2904(.970) - (-2126)(-.242) = 2302^{\#}$

$P_X = -2126(.970) + 2904(-.242) = -2765^{\#}$

SPRING BACK

C.G. 246

$V = 3071^{\#}$
$D = -2231^{\#}$

$P_Z = 3071(.970) - (-2231)(-.242) = 2439^{\#}$

$P_X = -2231(.970) + 3071(-.242) = -2907^{\#}$

MAX. VERT. REAC.

C.G. 240

$P_Z = 2994^{\#}$

$P_X = .25(2994) = 748^{\#}$

C.G. 246

$P_Z = 3166^{\#}$

$P_X = .25(3166) = 792^{\#}$

SPIN UP

2 PT LEVEL

$V = 3581$
$D = 4138$

$P_z = 3581(.970) - 4138(-.242) = 4475^{\#}$

$P_x = 4138(.970) + 3581(-.242) = 3147^{\#}$

2 PT TAIL DOWN

$V = 3860$

$D = -3618$

$P_z = 3860(.970) - 3618(-.242) = 4620^{\#}$

$P_x = 3618(.970) + 3860(-.242) = 2575^{\#}$

SPRING BACK

2 PT LEVEL

$V = 4517^{\#}$
$D = -2839^{\#}$

$P_z = 4517(.970) - (-2839)(.242) = 3694^{\#}$

$P_x = -2839(.970) + 4517(-.242) = -3847^{\#}$

E.L.

VPOEGRAFF
10/17/62

SPRING BACK

2 PT TAIL DOWN

$V = 4582^{\#}$
$D = -2830^{\#}$

$P_Z = 4582(.970) - (-2830)(-.242) = 3760^{\#}$

$P_X = -2830(.970) + 4582(-.242) = -3854^{\#}$

MAXIMUM VERTICAL REAC.

3 PT C.G. 240

$P_Z = 2994^{\#}$

$P_X = .25(2994) = 748^{\#}$

C.G. 246

$P_Z = 3166^{\#}$

$P_X = 792^{\#}$

2 PT LEVEL

$\theta = 3°, 16'$

$V = 4600^{\#}$
$D = 1150$

$\cos\theta = .998$
$\sin\theta = .05.$

$P_Z = V\cos\theta + D\sin\theta$

$P_Z = 4600(.998) + 1150(.057) = 4656^{\#}$

$P_X = D\cos\theta - V\sin\theta$

$P_X = 1150(.998) - 4600(.057) = 886^{\#}$

E. L.

UPDEGRAFF
10/17/62

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MAXIMUM VERTICAL REACTION

2 PT TAIL DOWN

$\theta = 9^0$
$\cos\theta = .988$
$\sin\theta = .156$

$V = 4600^{\#}$
$D = 1150^{\#}$

$P_z = 4600(.988) + 1150(.156) = 4724^{\#}$

$P_x = 1150(.988) - 4600(.156) = 419^{\#}$

SIDE DRIFT

$\theta = 3^0 16'$
$\cos\theta = .998$
$\sin\theta = .057$

INB'D WHEEL

$P_z = 2300(.998) = 2295^{\#}$

$P_x = 2300(.057) = -131$

$P_y = 1840^{\#}$

OUTB'D WHEEL

$P_z = 2295^{\#}$

$P_x = -131^{\#}$

$P_y = 1380^{\#}$

V.T.O.L.

UPDEGRAFF
10/18/62

62

MAIN

3 PT C.G. 240

$P_Z = 2994(2.64) = 7904^{\#}$

C.G. 246

$P_Z = 8358^{\#}$

2 PT LEVEL $\theta = 3°16'$

$P_Z = 12144(.998) = 12120^{\#}$

$P_X = 12144(.057) = -693$

2 PT. TAIL DOWN $\theta = 9°$

$P_Z = 12144(.968) = 11998^{\#}$

$P_X = 12144(.156) = -1894^{\#}$

2 PT DRIFT $\theta = 3°16'$

INB'D $P_Z = 6072(.998) = 6060^{\#}$

$P_X = 6072(.057) = 346^{\#}$

$P_Y = 4958$

OUTB'D WHEEL

$P_Z = 6060^{\#}$

$P_X = 346^{\#}$

$P_Y = 3643$

NOSE GEAR

UPDEGRAFF
10/24/62

EMERGENCY LANDING

SPIN UP

C.G. 240

$\theta = 5^0$
$\cos\theta = .996$
$\sin\theta = .087$

$V = 3132^{\#}$ $D = 1935^{\#}$

$P_x = 1935(.996) + 3132(.087) = 2200^{\#}$
$P_y = 0$
$P_z = 3132(.996) - 1935(.087) = 2951^{\#}$

C.G. 246

$V = 2868^{\#}$ $D = 1772^{\#}$

$P_x = 1772(.996) + 2868(.087) = 2014^{\#}$
$P_y = 0$
$P_z = 2868(.996) - 1772(.087) = 2702^{\#}$

SPRING BACK

C.G. 240

$V = 3199^{\#}$ $D = -2242^{\#}$

$P_x = -2242(.996) + 3199(.087) = -1955^{\#}$
$P_y = 0$
$P_z = 3199(.996) + 2242(.087) = 3381^{\#}$

C.G 246

$V = 2856^{\#}$ $D = -2047^{\#}$

$P_x = -2042(.996) + 2856(.087) = -1785^{\#}$
$P_y = 0$
$P_z = 2856(.996) + 2042(.087) = 3022^{\#}$

NOSE GEAR

E. L.

MAX. VERT. REACT.

C. G. 240

$P_x = 803$ #
$P_y = 0$
$P_z = 3212$ #

C. G. 246

$P_x = 717$ #
$P_y = 0$
$P_z = 2868$ #

NOSE GEAR

VTOL

MAX. VERT. REACT.

C. G. 240

$P_x = 0$
$P_y = 0$
$P_z = 8480$ #

C. G. 246

$P_x = 0$
$P_y = 0$
$P_z = 7572$ #

SUBJECT: L/G LOADS
SECTION: E
ENGINEER: WDEGRAFF
CHECKER:

SUMMARY TAXI LOADS TABLE 3

12500* A/C GEAR FWD

	3P'T BRAKED ROLL		2P'T BRAKED ROLL		UNSYMMETRICAL BRAKING			TURNING			
GEAR	F_V	F_D	F_V	F_D	F_V	F_D	F_S	F_V	F_D	F_S	
NOSE C.G. 240	3205	0	0	0	4895	0	1105	3205	0	1602	
MAIN C.G. 246	4915	3932	6250	5000	4021	3217	582	9693	0	4846	1
					4021	0	582	2430	0	632	2
	9200* A/C GEAR AFT.										
NOSE C.G. 240	3850	0	0	0	4187	0	637	3210	0	1380	
MAIN C.G. 246	3800	3040	5520	4420	2650	2170	337	6330	0	2850	1
					2650	0	337	1590	0	360	2

F_V, F_D & F_S IN PLANE OF GROUND

MODEL: XV-5A
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DATE: 10/10/62

SUBJECT: L/G LOADS
SECTION: E
ENGINEER: UPDEGRAFF
CHECKER:

Ryan

MODEL: XV-5A
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DATE: 12/7/61

TAXIING LOADS (REF: MIL-A-8862)

BRAKING FOR BRAKING THE GEAR & TIRES WILL BE IN THE STATIC POSITION.

CONDITIONS:

TWO-PT BRAKED ROLL VERTICAL LOAD FACTOR (n_z) ACTING AT THE C.G. SHALL BE 1.2 AT THE LANDING DESIGN GROSS WEIGHT (9200#) & 1.00 AT MAX. DESIGN GROSS WEIGHT (12500#). DRAG REACTION AT WHEELS WITH BRAKES ASSUMED ACTING AT GROUND EQUAL TO .8 OF THE VERTICAL REACTION.

3-PT BRAKED ROLL n_z ACTIN AT C.G. WILL BE 1.2 AT (9200#) & 1.00 AT 12500#. DRAG AT WHEELS WITH BRAKES EQUAL .8 OF VERTICAL REACTION.

UNSYMMETRICAL BRAKING n_z WILL BE 1.00 AT C.G. AT 9200# & 12500# DRAG WILL BE ASSUMED TO BE .8 OF VERTICAL REACTION ACTING AT ONE WHEEL. SIDE LOADS AT MAIN & NOSE GEAR REACTING YAWING MOMENT. VERTICAL LOADS AT MAIN & NOSE GEAR REACTING PITCHING MOMENT. FORWARD ACTING LOAD AT C.G. WILL BE .8 OF VERTICAL REACTION OF BRAKED WHEEL. SIDE LOAD AT C.G. = 0. SIDE LOAD AT THE NOSE SHALL BE ACTING AT THE GROUND, AND SHALL NOT EXCEED THE VERTICAL REACTION X .8. NOSE GEAR SHALL BE ALIGNED FOR & AFT.

REVERSE BRAKING. LOADS SAME AS 2 PT BRAKED ROLL.

TURNING n_z SHALL BE 1.00 ACTING AT C.G. AT THE GROUND SIDE LOADS SHALL BE APPLIED SUCH THAT THE RESULTANT OF SIDE & VERTICAL LOADS PASSES THRU C.G.. THE SUM OF SIDE ~~THE SIDE~~ LOADS SHALL BE .5W THIS SUM WILL NOT EXCEED A VALUE WHICH WOULD RESULT IN OVERTURNING.

SUBJECT: L/G LOADS
SECTION: E
ENGINEER: UPDEGRAFF
CHECKER:

MODEL: XV-5A
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REPORT:
DATE: 10/9/62

TAXIING LOADS

TAXI WEIGHT = 12500 #

GEAR POSITION = FWD.

3 P'T BRAKED ROLL

NOSE GEAR C.G. 240

F_V = 3205

MAIN GEAR C.G. 246

F_V = 4915 #

F_D = .8 (4915) = 3932 #

2 P'T BRAKED ROLL

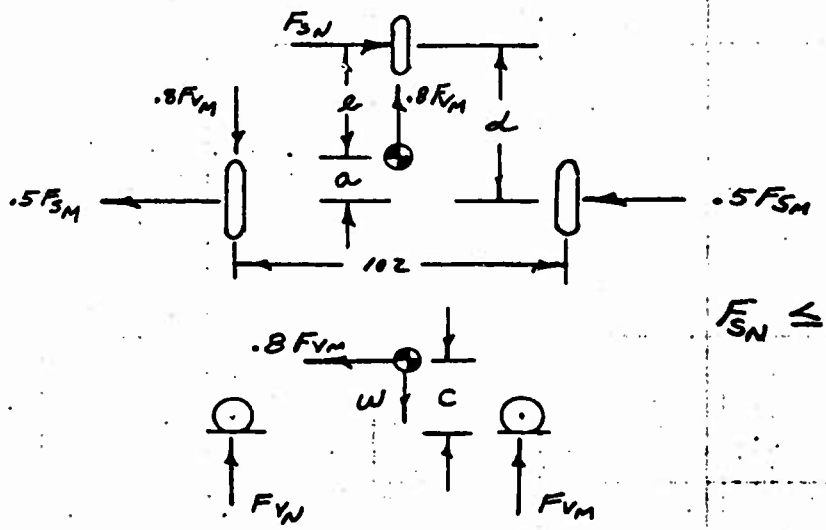
F_V = 6250 #

F_D = .8(6250) = 5000 #

SUBJECT: L/G LOADS SECTION: E ENGINEER: UPDEGRAFF CHECKER:		MODEL: XV-5A PAGE: 68 REPORT: DATE: 10/2/62

TAXIING LOADS

UNSYMMETRICAL BRAKING



$F_{SN} \leq .8\, F_{VM}$

$$F_{V_N} = W \frac{a + .4c}{d + .4c}$$

$$F_{V_M} = .5 (W - F_{V_N})$$

$$F_{S_N} = \frac{.8\, F_{V_M}\ 51}{d}$$

SUBJECT: L/G LOADS
SECTION: E
ENGINEER: UDREGRAFF
CHECKER:

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REPORT:
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TAXIING LOADS

UNSYMMETRICAL BRAKING

$W = 12500$ #

NOSE GEAR C.G. 240

$a = 36$
$b = 104.4$
$d = 140.4$
$c = 78$

$F_{V_N} = 12500 \frac{36 + 31.2}{140.4 + 31.2} = \underline{4895}$ #

$F_{V_M} = .5(12500 - 4895) = 3802$ #

$F_{S_N} = \frac{(.8 \times 3802)(51)}{140.4} = \underline{1105}$ #

MAIN GEAR C.G. 246

$a = 30$
$b = 110.4$
$c = 78$
$d = 140.4$

$F_{V_N} = 12500 \frac{30 + 31.2}{140.4 + 31.2} = 4458$ #

$F_{V_M} = .5(12500 - 4458) = \underline{4021}$ #

$F_D = .8(4021) = \underline{3217}$ # BRAKED WHEEL

$F_{S_M}^{*} = \frac{.8(4021)(51)}{(2)140.4} = \underline{582}$ #

* HALF SIDE LOAD REACTED AT EACH MAIN GEAR

TAXIING LOADS

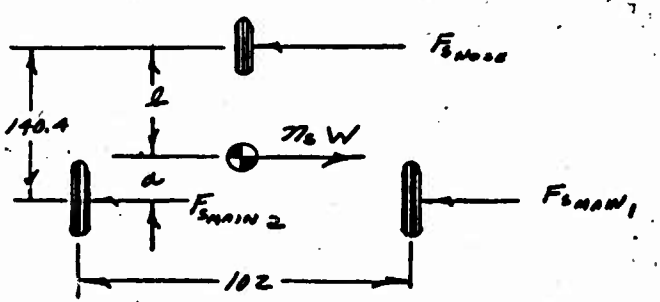
TURNING

NORMAL LANDING CONFIG.

OUTSIDE GEAR

$F_{V_{M_1}} = .5\frac{Wb}{140.4} + n_s\frac{W78}{102}$ WHERE $n_s = .5\frac{b\,102}{(140.4)(78)}$ BUT NOT $> .5$

$F_{SM_1} = n_s F_{V_{M_1}}$



C.G. STA. 240
a = 36
b = 104.4

C.G. STA. 246
a = 30
b = 110.4

W = 12 500 #

C.G. STA 240

$n_{s_{OUT}} = .5\frac{(104.4)(102)}{(140.4)(78)} = .49$

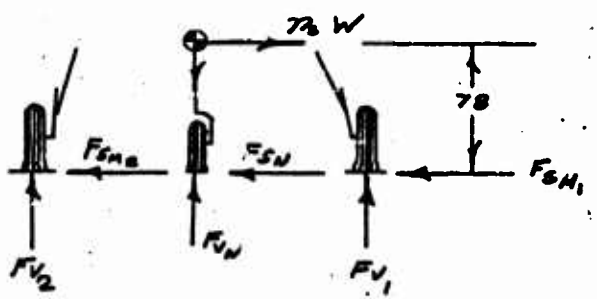
$n_{s_{IN}} = .25(3.972) = .24$

C.G. STA 246

$n_{s_{OUT}} = .5\frac{110.4(102)}{10351} = .51$

USE $n_{s_{OUT}} = .50$

$n_s = .25(1.029) = .26$



NOSE GEAR

$F_{V_N} = W\,a/140.4$ $\quad F_{S_N} = n_s F_{V_N}$

INSIDE GEAR

$F_{V_{M_2}} = .5\frac{Wb}{140.4} - n_s\frac{W78}{102}$ WHERE $n_s = .25\frac{b\,102}{(140.4)(78)}$ BUT NOT $> .5$

$F_{S_{M_2}} = n_s F_{V_{M_2}}$

SUBJECT: L/G LOADS
SECTION: E
ENGINEER: UPDEGRAFF
CHECKER:

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TAXIING LOADS

TURNING

NOSE GEAR C.G. 240

$F_{V_N} = \frac{(12500)(36)}{140.4} = \underline{3205}^{\#}$ ←

$F_{S_N} = (.50)(3205) = \underline{1602}^{\#}$ ←

MAIN GEAR C.G. 246

OUTSIDE GEAR

$F_{V_{M_1}} = .5\frac{(12500)(110.4)}{140.4} + .5\frac{(12500)(78)}{102} = \underline{9693}^{\#}$ ←

$F_{S_{M_1}} = .5(9693) = \underline{4846}^{\#}$ ←

INSIDE GEAR

$F_{V_{M_2}} = .5\frac{(12500)(110.4)}{140.4} - .26\frac{(12500)(78)}{102} = \underline{2430}^{\#}$ ←

$F_{S_{M_2}} = .26(2430) = \underline{632}^{\#}$ ←

240 C.G.

OUTD - $F_V = 9426^{\#}$ $F_S = 4713^{\#}$

INBD - $F_V = 2353^{\#}$ $F_S = 565^{\#}$

SUBJECT: L/G Loads SECTION: E ENGINEER: UPDEGRAFF CHECKER:		MODEL: XV-5A PAGE: 72 REPORT: DATE: 5/8/62

TAXIING LOADS VTOL

$W_T = 9200^{\#}$

LANDING GEAR POSITIONED AFT OLEO ANGLE = -14°

DESIGN $W_T = 9200 \times n_z = 9200 \times 1.2 = 11040^{\#}$

LOAD WILL BE DETERMINED FOR TWO C.G. POSITIONS
C.G. = STA 240 - 246.

TWO POINT BRAKED ROLL

OLEO ANGLE $\theta = -10°44'$

$F_{V_{MAX}} = 11040/2 = 5520^{\#}$

$F_D = .8(5520^{\#}) = 4420^{\#}$

3 POINT BRAKED ROLL

C.G. STA 240

MAIN WHEEL

$F_{V_{MAX}} = 2994(1.2) = 3590^{\#}$

$F_D = .8\, F_{V_{MAX}} = 3590(.8) = 2870^{\#}$

NOSE WHEEL

$F_{V_{MAX}} = 3212(1.2) = 3850^{\#}$

$F_D = 0$

C.G. STA. 246

MAIN WHEEL

$F_{V_{MAX}} = (3166)(1.2) = 3800^{\#}$

$F_D = .8(3800) = 3040^{\#}$

NOSE WHEEL

$F_{V_{MAX}} = 2864(1.2) = 3440^{\#}$

$F_D = 0$

SUBJECT: L/G LOADS
SECTION: E
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TAXIING LOADS VTOL

UNSYMMETRICAL BRAKING

$W = 9200$ #

NOSE GEAR C.G. 240

$a = 56$
$b = 104.4$
$c = 78$
$d = 160.4$

$F_{V_N} = W \frac{a + .4c}{d + .4c}$

$F_{V_M} = .5(W - F_{V_N})$ REF PAGE

$F_{S_N} = \frac{.8 F_{V_M} 51}{d}$

$F_{V_N} = 9200 \frac{56 + 31.2}{160.4 + 31.2} = \underline{4187}$ # ←

$F_{V_M} = .5 (9200 - 4187) = 2506$ #

$F_{S_N} = \frac{.8(2506) 51}{160.4} = \underline{637}$ # ←

MAIN GEAR C.G. 246

$a = 50$
$b = 110.4$
$c = 78$
$d = 160.4$

$F_{V_N} = 9200 \frac{81.2}{191.6} = 3899$ #

$F_{V_M} = .5(9200 - 3899) = \underline{2650}$ # ←

$F_D = .8(2650) = \underline{2120}$ # BRAKE WHEEL ←

$F_{S_M}^{*} = \frac{(2120)(51)}{2(160.4)} = \underline{337}$ # ←

* HALF SIDE LOAD REACTED AT EACH MAIN GEAR

SUBJECT: L/G LOADS SECTION: E ENGINEER: UPDEGRAFF CHECKER:		MODEL: XV-5A PAGE: 74 REPORT: DATE: 5/9/62

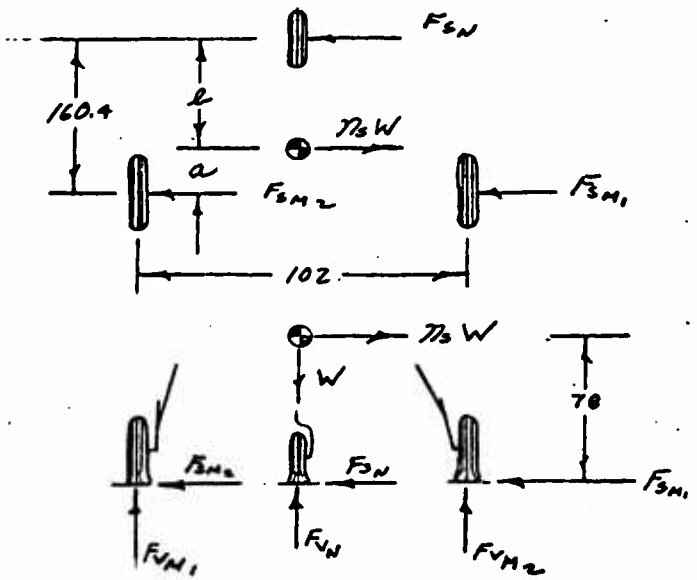
TAXING LOAD VTOL

TURNING

C.G. = 240 | C.G. = 246 | W = 9200 # (GEAR AFT)

a = 56 | a = 50

ℓ = 104.4 | ℓ = 110.4



OUTSIDE GEAR

$F_{VM_1} = .5\frac{W\ell}{160.4} + n_s\frac{W\,78}{102}$ WHERE $n_s = .5\frac{\ell\,102}{(160.4)(78)}$ BUT NOT > .5

$F_{SM_1} = n_s F_{VM_1}$

INSIDE GEAR

$F_{VM_2} = .5\frac{W\ell}{160.4} - n_s\frac{W\,78}{102}$ WHERE $n_s = .25\frac{\ell\,102}{(160.4)78)}$ BUT NOT > .5

$F_{SM_2} = n_s F_{VM_2}$

NOSE GEAR

$F_{VN} = \frac{Wa}{160.4}$ $F_{SN} = n_s F_{VN}$ WHERE $n_s = n_s$ OUTSIDE WHEEL

SUBJECT: L/G LOADS
SECTION: E
ENGINEER: UPDEGRAFF
CHECKER:

MODEL: XV-5A
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TAXIING LOADS VTOL

TURNING (CONT.)

C.G. - STA 240

OUTSIDE GEAR

$F_{V_{M_1}} = .5\,\frac{(9200)(104.4)}{160.4} + .43\,\frac{(9200)(78)}{102} = 6020^{\#}$

$\eta_S = .5\,\frac{(104.4)(102)}{(160.4)(78)} = .43$

$F_{S_{M_1}} = (.43)(6020) = 2590^{\#}$

NOSE GEAR

$F_N = \frac{(9200)56}{160.4} = 3210^{\#}$ $\quad F_{S_N} = .43(3210) = 1380^{\#}$

INSIDE GEAR

$F_{V_{M_2}} = 2994 - .21\,\frac{(9200)(78)}{102} = 1520^{\#}$

$\eta_S = .25\,\frac{(104.4)(102)}{(160.4)(78)} = .21$

$F_{S_{M_2}} = .21(1520) = 320^{\#}$

C.G. STA 246

OUTSIDE GEAR

$\eta_S = .5\,\frac{(110.4)(102)}{(160.4)(78)} = .45$

$F_{V_{M_1}} = .5\,\frac{(9200)(110.4)}{160.4} + .45\,\frac{(9200)(78)}{102} = 6330^{\#}$

$F_{S_{M_1}} = .45(6330) = 2850^{\#}$

NOSE GEAR

$F_{V_N} = \frac{(9200)(50)}{160.4} = 2870^{\#}$ $\quad F_{S_N} = .45(2670) = 1290^{\#}$

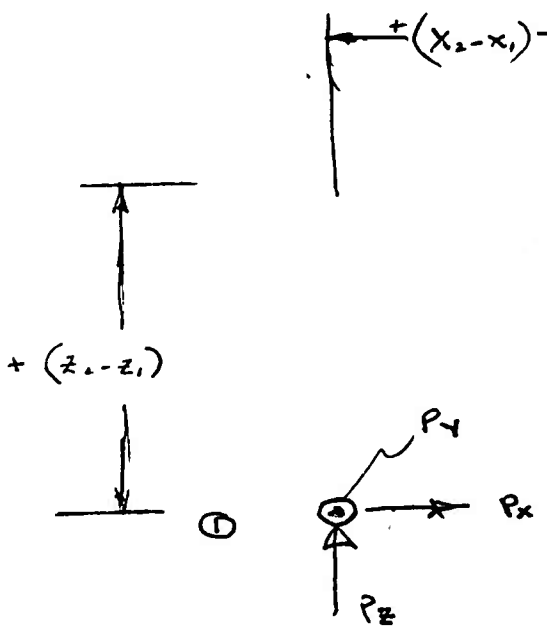
INSIDE GEAR

$N_S = .225$ $\quad F_{V_{M_2}} = 3166 - .225\,\frac{(9200)(78)}{102} = 1590^{\#}$

$F_{S_{M_2}} = .225(1590) = 360^{\#}$

Transfer Loads from Point ① to Point ②

Given:



Also:

$Y_2 > Y_1$

$$M_X = +(Z_2 - Z_1) P_Y - (Y_2 - Y_1) P_Z$$

$$M_Y = -(Z_2 - Z_1) P_X + (X_2 - X_1) P_Z$$

$$M_Z = +(Y_2 - Y_1) P_X - (X_2 - X_1) P_Y$$

$$Y_2 - Y_1 = 50.30 - 51.00 = -.70$$

Points 2

$X_2 = 275.65$
$Y_2 = 51.00$
$Z_2 = 39.00$

Point 1

$X_1 = 276.00$
$Y_1 = 50.30$
$Z_1 = 41.90$

$$Z_2 - Z_1 = 39.00 - 41.90 = -2.9$$

$$Y_2 - Y_1 = 51.00 - 50.30 = +.7$$

$$X_2 - X_1 = 275.65 - 276.00 = -.35$$

$$M_X = -2.9\,P_Y - .7\,P_Z$$

$$M_Y = +2.9\,P_X - .35\,P_Z$$

$$M_Z = +.7\,P_X + .35\,P_Z$$

TURNING — C.G. 240 MAIN

OUTSIDE GEAR

$$F_{V_{M_1}} = .5\frac{(12500)(104.4)}{140.4} + .5\frac{(12500)(78)}{102}$$

$$F_{V_{M_1}} = 4647 + 4779 = 9426\ \#$$

$$F_{S_{M_1}} = .5(9426) = 4713\ \#$$

INSIDE GEAR

$$F_{V_{M_2}} = 4647 - .24\frac{(12500)(78)}{102}$$

$$F_{V_{M_2}} = 4647 - 2294 = 2353\ \#$$

$$F_{S_{M_2}} = .24(2353) = 565\ \#$$

NOSE — C.G. .246

$$F_{V_N} = \frac{(12500)(30)}{140.4} = 2671\ \#$$

$$F_{S_N} = .5(2671) = 1335\ \#$$

12500 RESOLVED LOADS TAXI MAIN GEAR FWD.

3 PT BRAKED ROLL

C.G. 240

$P_Z = F_V = 4648^{\#}$

$P_X = F_D = 3718^{\#}$

C.G. 246

$P_Z = 4915^{\#}$

$P_X = 3932^{\#}$

2 PT BRAKED ROLL

$\theta = 3^\circ 16'$

$P_Z = F_V \cos\theta + F_D \sin\theta$

$P_X = F_D \cos\theta - F_V \sin\theta$

$\cos\theta = .998$

$\sin\theta = .057$

$F_V = 6250^{\#}$

$F_D = 5000^{\#}$

$P_Z = 6250(.998) + 5000(.057) = 6522^{\#}$

$P_X = 5000(.998) - 6250(.057) = 4634^{\#}$

12500 RESOLVED LOADS MAIN

TAXI

UNSYMM. BRAKING.

C.G. 240

P_z = 3802#

P_y = ±1105# BOTH SAME SIGN FOR BROWN

C.G. 246

P_z = 4021#

P_x = 3217# ONE WHEEL

P_y = ±582

TURNING

C.G. 240

OUTSIDE GEAR

P_z = 9331#

P_x = 0

P_y = 4572#

INSIDE GEAR

P_z = 2353#

P_y = 565#

12500# RESOLVED LOADS MAIN

TAXI

TURNING

C. G. 246

OUTSIDE GEAR

P_Z = 9693#

P_Y = 4846#

INSIDE GEAR

P_Z = 2430#

P_Y = 632#

NOSE GEAR 12500# GEAR FWD

STA 135.612

WL. 40.9 — ℄ AXLE ℄ B.L. 00.00

3 PT BRAKED ROLL C.G. 240

$P_x = 0$
$P_y = 0$
$P_z = 3205$#

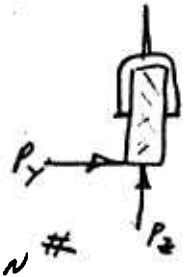
3 PT BRAKE ROLL C.G. 246

$P_x = 0$
$P_y = 0$
$P_z = 2671$#

UNSYMMETRICAL BRAKING

C.G. 240

$P_x = 0$
$P_y = -1105$#
$P_z = 4895$#



$M_x = 7.9(-1105) = -8730$ IN#

C.G. 246

$P_x = 0$
$P_y = -1164$#
$P_z = 4458$#

$M_x = 7.9(-1164) = -9196$ IN#

TURNING A/C W=12500# GEAR FWD

C.G. 240

$P_X = 0$
$P_Y = 1602$ #
$P_Z = 3205$ #

$M_X = 7.9(1602) = 12656$ IN#

C.G. 296

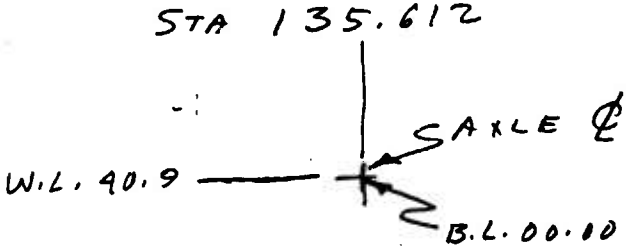
$P_X = 0$
$P_Y = 1335$ #
$P_Z = 2671$ #

$M_X = 7.9(1335) = 10546$ IN#

TAXI

UPDEGRAFF
10/23/62

VTOL NOSE GEAR



3 PT BRAKED ROLL

C.G. 240

$P_X = 0$
$P_Y = 0$
$P_Z = 3850$ #

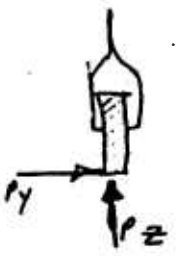
C.G. 246

$P_X = 0$
$P_Y = 0$
$P_Z = 3440$ #

UNSYMMTRICAL BRAKING

C.G. 240

$P_X = 0$
$P_Y = -637$ #
$P_Z = 4187$ #
$M_X = -5032$ IN #



TAXI

UPDEGRAFF
10/23/62

UTOL NOSE GEAR

C.G. 246

$P_X = 0$
$P_Y = -674$ #
$P_Z = 2650$ #

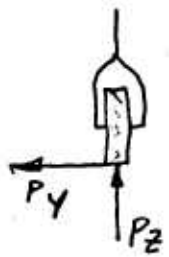
$M_X = -5325$ IN #

TURNING

C.G. 240

$P_X = 0$
$P_Y = 1380$ #
$P_Z = 3210$ #

$M_X = 10902$ IN #

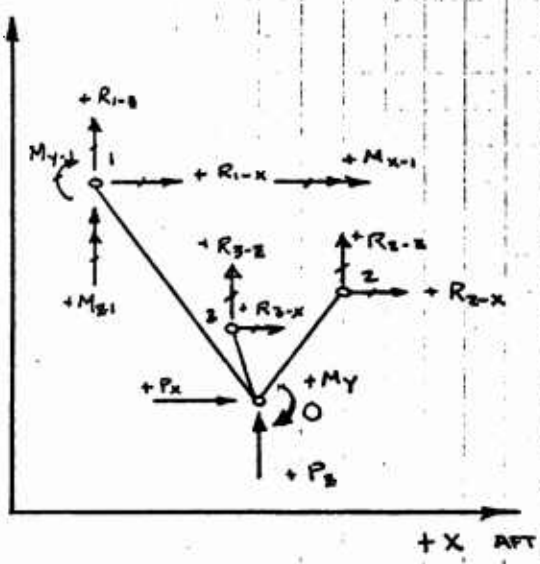


C.G. 246

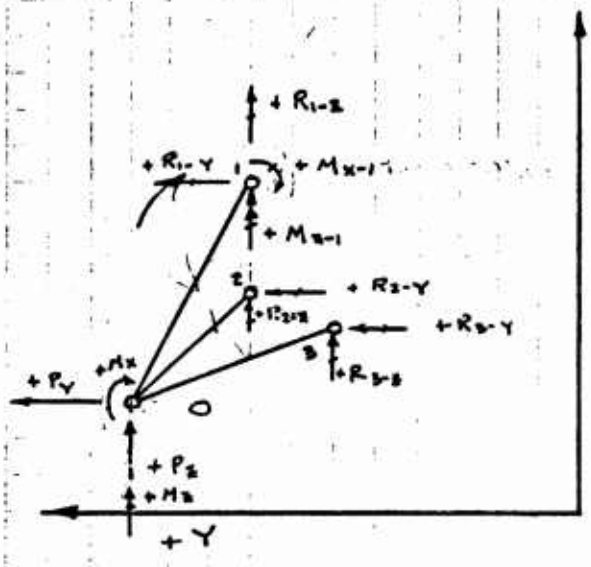
$P_X = 0$
$P_Y = 1290$ #
$P_Z = 2870$ #

$M_X = 10191$ IN #

MODEL 143 MAIN LANDING GEAR INTERNAL LOADS & REACTIONS



VIEW INB'D.



VIEW FWD.

GIVEN

(1) Tri-Pod members 0-1, 0-2, and 0-3.

(2) Coordinates of points 0, 1, 2, and 3.

(3) Forces and moments at Point 0: P_X, P_Y, P_Z, M_X, M_Y, & M_Z.

(4) a. Members 0-2 and 0-3 take axial load only.

b. Member 0-1 takes axial load, a bending load at Point 1, and a concentrated torsion at Point 1. The concentrated torsion reaction vector T_1 is positive pointing (left-hand rule) from 0 to 1 and has the direction cosines of 0-1.

Rozelle
73 Feb '62
87

FIND

(1) Projected lengths of 0-1, 0-2, and 0-3.

For 0-1 : $X_1 - X_0$, $Y_1 - Y_0$, $Z_1 - Z_0$.

For 0-2 : $X_2 - X_0$, $Y_2 - Y_0$, $Z_2 - Z_0$.

For 0-3 : $X_3 - X_0$, $Y_3 - Y_0$, $Z_3 - Z_0$.

(2) True lengths of 0-1, 0-2, and 0-3.

$$L_{0-1} = \left[(X_1 - X_0)^2 + (Y_1 - Y_0)^2 + (Z_1 - Z_0)^2 \right]^{1/2}$$

$$L_{0-2} = \left[(X_2 - X_0)^2 + (Y_2 - Y_0)^2 + (Z_2 - Z_0)^2 \right]^{1/2}$$

$$L_{0-3} = \left[(X_3 - X_0)^2 + (Y_3 - Y_0)^2 + (Z_3 - Z_0)^2 \right]^{1/2}$$

(3) Direction Cosines of 0-1, 0-2, and 0-3 :

$$C_{0-1,X} = \frac{X_1 - X_0}{L_{0-1}} \qquad C_{0-2,X} = \frac{X_2 - X_0}{L_{0-2}} \qquad C_{0-3,X} = \frac{X_3 - X_0}{L_{0-3}}$$

$$C_{0-1,Y} = \frac{Y_1 - Y_0}{L_{0-1}} \qquad C_{0-2,Y} = \frac{Y_2 - Y_0}{L_{0-2}} \qquad C_{0-3,Y} = \frac{Y_3 - Y_0}{L_{0-3}}$$

$$C_{0-1,Z} = \frac{Z_1 - Z_0}{L_{0-1}} \qquad C_{0-2,Z} = \frac{Z_2 - Z_0}{L_{0-2}} \qquad C_{0-3,Z} = \frac{Z_3 - Z_0}{L_{0-3}}$$

<u>check</u> : $(C_{0-1,X})^2 + (C_{0-1,Y})^2 + (C_{0-1,Z})^2 = 1$

$(C_{0-2,X})^2 + (C_{0-2,Y})^2 + (C_{0-2,Z})^2 = 1$

$(C_{0-3,X})^2 + (C_{0-3,Y})^2 + (C_{0-3,Z})^2 = 1$

Find R_{1-x}, R_{1-y}, R_{1-z}, T_1, P_{0-2}, and P_{0-3} as a function of P_x, P_y, P_z, M_x, M_y, and M_z.

	UNKNOWNS							KNOWNS					
	R_{1-x}	R_{1-y}	R_{1-z}	T_1	P_{0-2}	P_{0-3}		P_x	P_y	P_z	M_x	M_y	M_z
1.	1.0	0	0	0	$C_{0-2,x}$	$C_{0-3,x}$	=	-1.0	0	0	0	0	0
2.	0	1.0	0	0	$C_{0-2,y}$	$C_{0-3,y}$	=	0	-1.0	0	0	0	0
3.	0	0	1.0	0	$C_{0-2,z}$	$C_{0-3,z}$	=	0	0	-1.0	0	0	0
4.	0	$-(z_1-z_0)$	(y_1-y_0)	$C_{0-1,x}$	0	0	=	0	0	0	-1.0	0	0
5.	(z_1-z_0)	0	$-(x_1-x_0)$	$C_{0-1,y}$	0	0	=	0	0	0	0	-1.0	0
6.	$-(y_1-y_0)$	(x_1-x_0)	0	$C_{0-1,z}$	0	0	=	0	0	0	0	0	-1.0

$$[A] \begin{Bmatrix} R_{1-x} \\ R_{1-y} \\ R_{1-z} \\ T_1 \\ P_{0-2} \\ P_{0-3} \end{Bmatrix} = \begin{Bmatrix} -P_x \\ -P_y \\ -P_z \\ -M_x \\ -M_y \\ -M_z \end{Bmatrix} \quad \text{or} \quad \begin{Bmatrix} R_{1-x} \\ R_{1-y} \\ R_{1-z} \\ T_1 \\ P_{0-2} \\ P_{0-3} \end{Bmatrix} = [A]^{-1} \begin{Bmatrix} -P_x \\ -P_y \\ -P_z \\ -M_x \\ -M_y \\ -M_z \end{Bmatrix}$$

Rose)k
28 Dec '61
(13 Feb. '62)
(88)

(5) Find Q = Resultant of R_{1-x}, R_{1-Y}, & R_{1-z}

$$Q = \left[R_{1-x}^2 + R_{1-Y}^2 + R_{1-z}^2 \right]^{1/2}$$

(6) Find Direction cosines of Resultant Q :

a. $C_{Q,x}$ = Dir. Cos. of Q in x direction = $\frac{R_{1-x}}{Q}$

b. $C_{Q,Y}$ = Dir. Cos. of Q in Y direction = $\frac{R_{1-Y}}{Q}$

c. $C_{Q,z}$ = Dir. Cos. of Q in z direction = $\frac{R_{1-z}}{Q}$

(7) Find $\cos\beta = C_{Q,x} \cdot C_{o-1x} + C_{Q,Y} \cdot C_{o-1,Y} + C_{Q,z} \cdot C_{o-1,z}$

where β = true angle between Q and P_{o-1} .

(8) Find $P_{o-1} = Q \cos\beta$

(9) Find $N = Q \sin\beta$

(10) Find N_x ; N_Y ; and N_z, the components o

a. $N_x = R_{1-x} - P_{o-1} \cdot C_{o-1,x}$

b. $N_Y = R_{1-Y} - P_{o-1} \cdot C_{o-1,Y}$.

c. $N_z = R_{1-z} - P_{o-1} \cdot C_{o-1,z}$

(17) Find Reaction components at Point 2 :

a. $R_{2-X} = P_{0-2} \cdot C_{0-2,X}$

b. $R_{2-Y} = P_{0-2} \cdot C_{0-2,Y}$

c. $R_{2-Z} = P_{0-2} \cdot C_{0-2,Z}$

(18) Find Reaction Components at Point 3 :

a. $R_{3-X} = P_{0-3} \cdot C_{0-3,X}$

b. $R_{3-Y} = P_{0-3} \cdot C_{0-3,Y}$

c. $R_{3-Z} = P_{0-3} \cdot C_{0-3,Z}$

Check

$$R_{1-X} + R_{2-X} + R_{3-X} + P_X = 0$$
$$R_{1-Y} + R_{2-Y} + R_{3-Y} + P_Y = 0$$
$$R_{1-Z} + R_{2-Z} + R_{3-Z} + P_Z = 0$$

SUBJECT: L/G LOADS
SECTION: F
ENGINEER: UPDEGRAFF
CHECKER:

MODEL: XV-5-A
PAGE: 91
REPORT:
DATE: 4/22/63

LOADS BASED ON 9 IN OLEO STROKE:

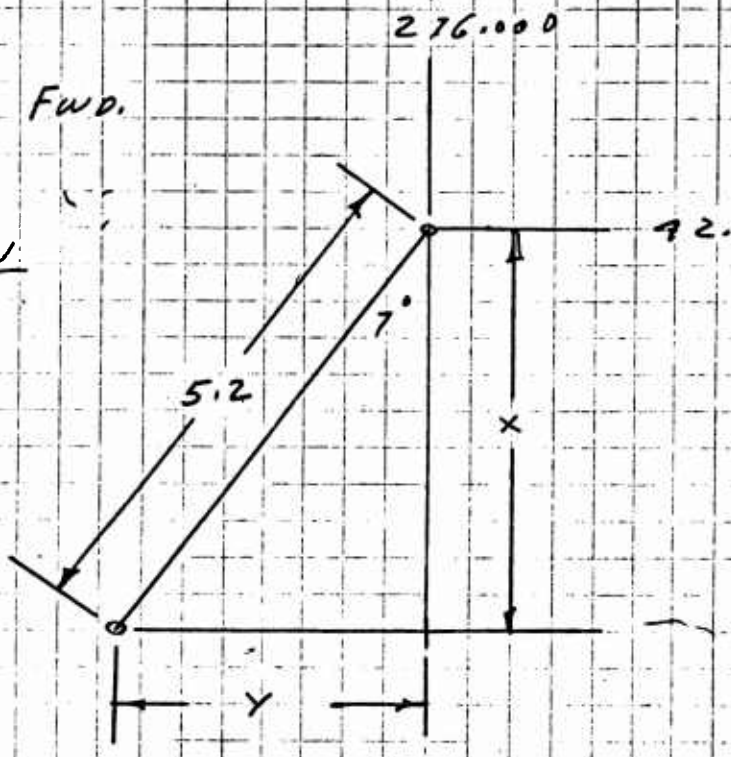
COORDINATES:

POINT	STA.	W.L.	B.L.
GEAR FWD.			
1	285.4739	93.1073	20.350
2	282.6717	77.700	2.340
3	314.7125	54.30368	0.00
0	275.6300	39.00	51.00
20% COMP AXLE ℄	275.3700	36.84	51.18
STATIC AXLE ℄	276.00	42.00	50.321
GEAR AFT			
1	286.5446	93.1107	20.350
2	289.4453	77.721	2.340
3	313.414	104.70325	0.00
0	296.73	39.07	51.00
20% COMP. AXLE ℄	297.26	36.95	51.18
STATIC AXLE ℄	296.00	42.00	50.321

20% COMP. OLEO COORDINATES AXEL ℄

℄ GEAR FWD.

SIDE VIEW



$x = 5.2 \cos 7^\circ = (5.2)(.99255) = 5.16126$

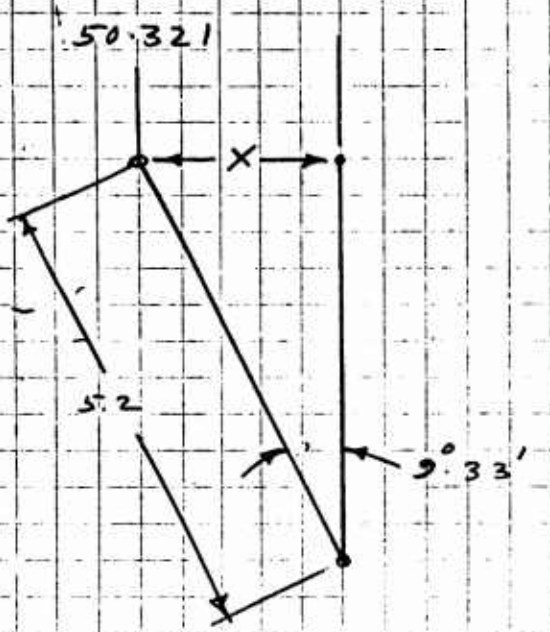
$y = 5.2 \sin 7^\circ = (5.2)(.12187) = .63372$

AXCEL ℄ COORD. STA = 275.366

W.L. = 36.839

LANDING GEAR

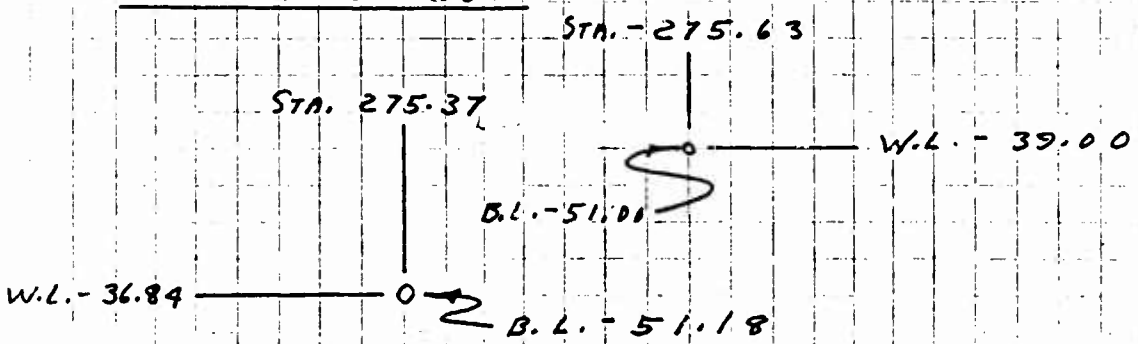
UPDEGRAFF
11/29/62



$X = 5.2 \sin 9°38' = (5.2)(.16591) = .86273$

$W.L._{207.0} = 50.321 + .86273 = 51.184$

GEAR FWD. GEO.



X = .26 Y = .18 Z = 2.16

MOMENTS GEAR FWD

UPDEGRAFF
11/26/62

EQ.

COND N

$M_X = .18 P_Z + 2.16 P_Y$

$M_Y = .26 P_Z - 2.16 P_X$

$M_Z = -.26 P_Y - .18 P_X$

MAIN GEAR - 9200# C.G. 246

SPIN UP 3 P'T

① $P_X = 5613$#
$P_Y = 0$ #
$P_Z = 7651$
$M_X = .18(7651) = 1377$ IN#
$M_Y = .26(7651) - 2.16(5613) = -10135$ IN#
$M_Z = -.18(5613) = -1010$, IN#

2 P'T LEVEL

$P_X = 5774$# $P_Y = 0$ $P_Z = 9174$

② $M_X = .18(9174) = 1651$ IN#
$M_Y = .26(9174) + 2.16(5774) = -10087$ IN#
$M_Z = -.18(5774) = -1039$, IN#

2 P'T TAIL DOWN

③ $M_X = .18(9621) = 1732$, IN#
$M_Y = .26(9621) - 2.16(4432) = -7072$, IN#
$M_Z = -.18(4432) = -798$, IN#

MOMENTS GEAR FWD. UPDEGRAFF
11/26/62

(4) SPRING BACK 3 PT

$M_X = .18(10212) = 1838$

$M_Y = .26(10212) - 2.16(-5461) = 14451, N^{\#}$

$M_Z = -.18(-5461) = 983, N^{\#}$

2 PT LEVEL

(5)

$M_X = .18(12908) = 2323, N^{\#}$

$M_Y = .26(12908) - 2.16(-7113) = 18720, N$

$M_Z = -.16(-7113) = 1280, N^{\#}$

2 PT T.O.

(6)

$M_X = .18(12781) = 2300, N^{\#}$

$M_Y = .26(12781) - 2.16(-8373) = 21409 N$

$M_Z = -.18(-8373) = 1507 IN^{\#}$

MAX. VERT REACTION.

3 PT

(7)

$M_X = .18(9550) = 1719, N^{\#}$

$M_Y = .26(9550) - 2.16(2388) = -2675 IN^{\#}$

$M_Z = -.18(2388) = -430, N^{\#}$

MOMENTS GEARFWD — UPEGRAFF — 12/1/62

MAX. VERT. REAC.

2 PT LEVEL

(8)
$M_X = .18(12293) = 2213, IN^{\#}$

$M_Y = .26(12293) - 2.16(2338) = -1854, IN^{\#}$

$M_Z = -.18(2338) = -421, IN^{\#}$

2 PT T.O.

(9)
$M_X = .18(12472) = 2245, IN^{\#}$

$M_Y = .26(12472) - 2.16(1105) = 856, IN^{\#}$

$M_Z = -.18(1105) = -199, IN^{\#}$

SIDE DRIFT

$M_X = -43236$

(10) INB'D WHEEL

$M_X = -43236 + .18(6060) + 2.16(-4858) = -52638 IN$

$M_Y = .26(6060) - 2.16(-346) = 2323, IN^{\#}$

$M_Z = -.26(-4858) - .18(-346) = 1325, IN^{\#}$

(11) OUTB'D WHEEL $M_X = +32423, IN^{\#}$

$M_X = 32423 + .18(6060) + 2.16(3643) = 41382, IN^{\#}$

$M_Y = .26(6060) - 2.16(-346) = 2323, IN^{\#}$

$M_Z = -.26(3643) - .18(-346) = -985, IN^{\#}$

VIDEGRAFF
11/26/62

MOMENTS GEAR FWD.

12500# A/C C.G. 246

(12) SPIN UP 3 PT

$M_X = .18(4366) = 786\ in\#$

$M_Y = .26(4366) - 2.16(3202) = -6130\ in\#$

$M_Z = -.18(3202) = -576\ in\#$

2 PT LEVEL

(13) $M_X = .18(5321) = 958\ in\#$

$M_Y = .26(5321) - 2.16(3347) = -5846\ in\#$

$M_Z = -.18(3347) = -602\ in\#$

2 PT T.D.

(14) $M_X = .18(5582) = 1005$

$M_Y = .26(5582) - 2.16(2560) = -4078\ in\#$

$M_Z = -.18(2560) = -461\ in\#$

SPRING BACK 3 PT

(15) $M_X = .18(5291) = 952\ in\#$

$M_Y = .26(5291) - 2.16(-3100) = 8072\ in\#$

$M_Z = -.18(-3100) = 558$

MOMENTS GEAR FWD — UDEGRAFF — 12/1/62

SPRING BACK 2 P'T LEVEL

(16) $M_x = .18(6691) = 1204\ IN^{\#}$

$M_y = .26(6691) - 2.16(-4047) = 10.481\ IN^{\#}$

$M_z = -.18(-4047) = 728\ IN^{\#}$

2 P'T T. D.

(17) $M_x = .18(6623) = 1192\ IN^{\#}$

$M_y = .26(6623) - 2.16(-4679) = 11829\ IN^{\#}$

$M_z = -.18(-4679) = 842\ IN^{\#}$

MAX. VERT. REAC. 3 P'T

(18) $M_x = .18(4915) = 885\ IN^{\#}$

$M_y = .26(4915) - 2.16(1229) = -1377\ IN^{\#}$

$M_z = -.18(1229) = -221\ IN^{\#}$

2 P'T LEVEL

(19) $M_x = .18(6326) = 1139\ IN^{\#}$

$M_y = .26(6326) - 2.16(1203) = -954\ IN^{\#}$

$M_z = -.18(1203) = -216\ IN^{\#}$

MOMENTS GEAR FWD — UPDEGRAFF — 12/1/62 —

MAX VERT REACTION 2P'T T. Do

(20)

$M_X = .18(6419) = 1155\ in\#$

$M_Y = .26(6419) - 2.16(568) = 442\ in\#$

$M_Z = -.18(568) = -102\ in\#$

SIDE DRIFT.

INB'D WHEEL

$M_X = -22250\ in\#$

(21)

$M_X = .18(3119) + 2.16(-2500) - 22250 = -27088\ in\#$

$M_Y = .26(3119) - 2.16(-178) = 1195\ in\#$

$M_Z = -.26(-2500) - .18(-178) = 682\ in\#$

OUTB'D WHEEL

$M_X = 16688\ in\#$

(22)

$M_X = 16688\ in\#$

$M_Y = .18(3119) + 2.16(1875) + 16688 = 21299\ in\#$

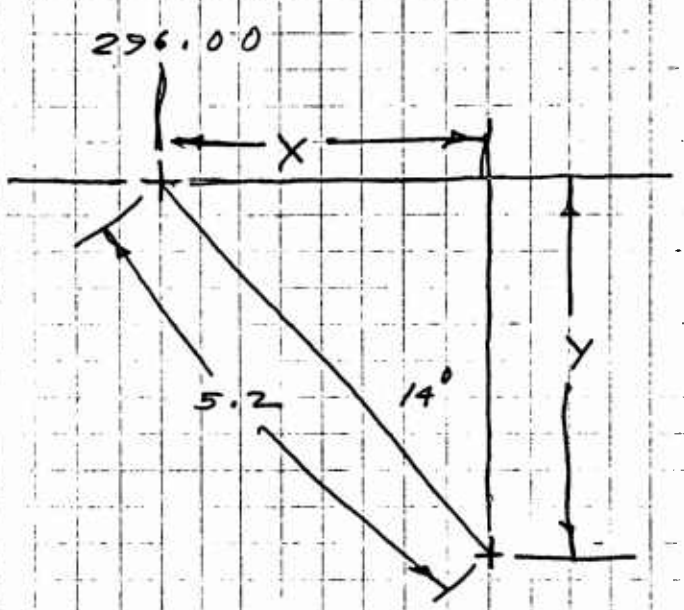
$M_Y = .29(3119) - 2.16(-178) = 1195\ in\#$

$M_Z = -.26(1875) - .18(-178) = -455\ in\#$

GEAR AFT

UPDEGRAFF
12/1/62

100



$Y = 5.2 \cos 14^\circ = 5.2 (.9703) = 5.0456$

$X = 5.2 (.2419.2) = 1.2631$

STA = 296.00 + 1.2631 = 297.26

W.L. = 42 − 5.0456 = 36.95

B.L. = 51.18

GEAR AFT 20% COMP.

STA 296.73

W.L. 39.07 — + — BL. 51.00

X = .53
Y = .18
Z = 2.12

+ — B.L. - 51.18
W.L. 36.95

STA. 297.26

M. GEAR AFT — UPDEGRAFF 12/1/62

$M_x = .18\,P_z + 2.12\,P_y$

$M_y = -2.12\,P_x - .53\,P_z$

$M_z = .53\,P_y - .14\,P_x$

V.T.O.L. LANDING GEAR AFT 9200

C.G. 246

MAX VERT REACT. 3 P'T

(34) $M_x = .18(8358) = 1504\ IN\#$

$M_y = -.53(8358) = -4430\ IN\#$

$M_z = 0$

2 P'T LEVEL

(35) $M_x = .18\,(12120) = 2182\ IN\#$

$M_y = -2.12(-693) - .53(12120) = -4954$

$M_z = -.18\,(-693) = 125\ IN\#$

2 P'T T.D.

(36) $M_x = .18(11998) = 2160\ IN\#$

$M_y = -2.12(-1894) - .53(11998) = -2344\ IN\#$

$M_z = -.18(-1894) = 341\ IN\#$

M. GEAR AFT — UPDEGRAFF

12/1/82

SIDE DRIFT

(37) IN'BD WHEEL $M_X = -43236$ IN#

$M_X = .18(6060) + 2.12(-4858) - 43236 = -52444$ IN#

$M_Y = -2.12(-346) - .53(6030) = -2478$ IN#

$M_Z = .53(4858) - .18(-346) = -2512$ IN#

(38) OUTB'D WHEEL $M_X = 32423$ IN#

$M_X = .18(6060) + 2.12(3643) + 32423 = 41237$ IN#

$M_Y = -2.12(-346) - .53(6060) = -2478$ IN#

$M_Z = .53(3643) - .18(-346) = 1993$ IN#

EMERG. LANDING 9200 # C.G. 246

(23) SPIN UP 3 PT

$M_X = .18(3317) = 597$ IN#

$M_Y = -2.12(2626) - .53(3317) = -7325$ IN#

$M_Z = -.18(2626) = -473$ IN#

(24) 2 PT LEVEL

$M_X = .18(4475) = 806$ IN#

$M_Y = -2.12(3147) - .53(4475) = -9043$ IN#

$M_Z = -.18(3147) = -566$ IN#

MAIN GEAR AFT — UPDEGRAFF 12/3/62

2 PT T. D.

(25)

$M_X = .18(4620) = 832 \text{ IN}^{\#}$

$M_Y = -2.12(2575) - .53(4620) = -7908 \text{ IN}^{\#}$

$M_Z = -.18(2575) = -464 \text{ IN}^{\#}$

SPRING BACK 3 PT

(26)

$M_X = .18(2439) = 439 \text{ IN}^{\#}$

$M_Y = -2.12(-2907) - .53(2439) = 4870 \text{ IN}^{\#}$

$M_Z = -.18(-2907) = 523 \text{ IN}^{\#}$

2 PT LEVEL

(27)

$M_X = .18(3694) = 665 \text{ IN}^{\#}$

$M_Y = -2.12(-3847) - .53(3694) = 6198 \text{ IN}^{\#}$

$M_Z = -.18(-3847) = 692 \text{ IN}^{\#}$

2 PT T. D.

(28)

$M_X = .18(3760) = 677 \text{ IN}^{\#}$

$M_Y = -2.12(-3854) - .53(3760) = 6178 \text{ IN}^{\#}$

$M_Z = -.18(-3454) = 694 \text{ IN}^{\#}$

M. GEAR AFT

UPDEGRAFF
12/3/62

MAX. VERT. REACTION 3 PT

(29) $M_x = .18(3166) = 570, IN^{\#}$

$M_y = -2.12(792) - .53(3166) = -3357, IN^{\#}$

$M_z = -.18(792) = -142, IN^{\#}$

2 PT LEVEL

(30) $M_x = .18(4656) = 838, IN^{\#}$

$M_y = -2.12(886) - .53(4656) = -4346, IN^{\#}$

$M_z = -.18(886) = -159, IN^{\#}$

2 PT T.D.

(31) $M_x = .18(4724) = 850, IN^{\#}$

$M_y = -2.12(419) - .53(4724) = -3392, IN^{\#}$

$M_z = -.18(419) = -75, IN^{\#}$

SIDE DRIFT

(32) IND'D WHEEL $M_x = -16376, IN^{\#}$

$M_x = .18(2295) + 2.12(-1840) - 16376 = -19864, IN^{\#}$

$M_y = -2.12(-131) - .53(2295) = -939, IN^{\#}$

$M_z = .53(-1840) - .18(-131) = -952, IN^{\#}$

M. GEAR AFT — UPDEGRAFF 12/3/62

SIDE DRIFT

(33) OUTB'D WHEEL $M_X = 12282$ IN #

$M_X = .18(2295) + 2.12(1380) + 12282 = 15621$ IN #

$M_Y = -2.12(-131) - .53(2295) = -939$ IN #

$M_Z = .53(1380) - .18(-131) = 755$ IN #

TAXI GEAR FWD.

STA. 276.00

B.L. 50.32 — AXLE ℄ — W.L. 42.00

APEX

B.L. 51.00 — B.L. 32.10

STA. 275.63

$X = .37$

$Y = .68$

$Z = 3.00$

$M_X = -3.00 P_Y - .68 P_Z$

$M_Y = 3.00 P_X - .37 P_Z$

$M_Z = .68 P_X + .37 P_Y$

MVI GEAR FWD. UPDEGRAFF
12500 # 12/3/62

BRAKED ROLL 3 PT

(39) $M_x = -.68(4915) = -3342$ IN #

$M_y = 3.00(3932) - .37(4915) - 34995 = -25018$ IN #

$M_z = .68(3932) = 2674$ IN #

(40) 2 PT

$M_x = -.68(6522) = -4435$ IN #

$M_y = 3.00(4634) - .37(6522) - 41243 = -29754$ IN #

$M_z = .68(4634) = 3151$ IN #

UNSYMMET. BRAKING

(41) BRAKED WHEEL $M_x = 5180$ IN #
$M_y = -28631$ IN #

$M_x = 5180 - 3.00(582) - .68(4021) = 670$ IN #

$M_y = 3.00(3217) - .37(4021) - 28631 = -20468$ IN #

$M_z = .68(3217) + .37(582) = 2403$ IN #

(42) UN. BRAKED WHEEL $M_x = -5180$ IN #

$M_x = -5180 - 3.00(-582) - .68(4021) = -6168$ IN #

$M_y = -.37(4021) = -1488$ IN #

$M_z = .37(-582) = -215$ IN #

TAXI GEAR FWD 12500 # — UPDEGRAFF 12/3/62

TURNING. OUTB'D. WHEEL

(43)

$M_X = -43129$ IN #

$M_X = -43129 - 3.00(-4846) - .68(9693) = -35192$ IN #

$M_Y = -.37(9693) = -3586$ IN #

$M_Z = .37(-4846) = -1793$ IN #

(44)

INB'D WHEEL

$M_X = 5625$ IN #

$M_X = -.68(2430) - 3.00(632) + 5625 = 2077$ IN #

$M_Y = -.37(2430) = -899$ IN #

$M_Z = .37(632) = 234$ IN #

TAXI GEAR AFT 9200 #

X = .73

Y = .68

Z = 2.93

B.L. - 50.32
W.L. - 42.00
STA. 296.00

B.L. - 51.00
W.L. - 39.07
STA 296.73

$M_X = -.68 P_Z - 2.93 P_Y$

$M_Y = .73 P_Z + 2.93 P_X$

$M_Z = -.73 P_Y + .68 P_X$

BRAKED ROLL 3PT

(45)

$M_X = -.68(3800) = -2584\ IN^{\#}$

$M_Y = .73(3800) + 2.93(3040) - 27056 = -15375\ IN^{\#}$

$M_Z = .68(3040) = 2067\ IN^{\#}$

(46) BRAKED ROLL 2 PT

$M_X = -.68(5761) = -3917\ IN^{\#}$

$M_Y = .73(5761) + 2.93(4096) - 36454 = -20247\ IN^{\#}$

$M_Z = .68(4096) = 2785\ IN^{\#}$

UNSYMMET BRAKING

(47) BRAKED WHEEL $M_X = 2999\ IN^{\#}$ $M_Y = -18868\ IN^{\#}$

$M_X = -.68(2650) - 2.93(337) + 2999 = 210\ IN^{\#}$

$M_Y = -18868 + .73(2650) + 2.93(2120) = -10722\ IN^{\#}$

$M_Z = -.73(337) + .68(2120) = 1196\ IN^{\#}$

(48) UNBRAKED WHEEL $M_X = -2999\ IN^{\#}$

$M_X = -.68(2650) - 2.93(-337) - 2999 = -3814\ IN^{\#}$

$M_Y = .73(2650) = 1934\ IN^{\#}$

$M_Z = -.73(-337) = 246\ IN^{\#}$

TAXI GEAR AFT — UPDEGRAFF
9200 # — 12/3/62

TURNING · OUTSIDE GEAR

(49) $M_x = -25365$ #

$M_x = -.68(6330) + 2.93(-2850) - 25365 = -21319$ IN

$M_y = .73(6330) = 4621$ IN #

$M_z = -.73(-2850) = 2080$ IN #

INSIDE WHEEL

(50) $M_x = 3204$ IN #

$M_x = -.68(1590) - 2.93(360) + 3204 = 1068$ IN #

$M_y = .73(1590) = 1161$ IN #

$M_z = -.73(360) = -263$ IN #

XV 5-A
MAIN GEAR LOADS

RYAN

UPDEGRAFF
12/3/62

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9200# A/C C.G. 246 MAIN GEAR FWD
NORMAL LANDING LOADS LIMIT
LOADS AT TRIPOD APEX *

LANDING ATTITUDE	P_x	P_y	P_z		M_x	M_y	M_z	COND
SPIN UP								
3P'T.	5613	0	7651		1377	-10135	-1010	1
2P'T LEVEL	5774	0	9174		1651	-10087	-1039	2
2P'T TAIL DOWN	4432	0	9621		1732	-7072	-798	3
SPRING BACK								
3 P'T	-5761	0	10212		1838	14451	983	4
2 P'T LEVEL	-7113	0	12908		2323	18720	1280	5
2 P'T TAIL DOWN	-8373	0	12781		2300	21909	1507	6
MAX. VERT. REACT.								
3 P'T	2388	0	9550		1719	-2675	-430	7
2 P'T LEVEL	2338	0	12293		2213	-1854	-421	8
2 P'T TAIL DOWN	1105	0	12472		2245	856	-199	9
SIDE DRIFT								
INB'D WHEEL	-346	-4858	6060		-52638	2323	1325	10
OUTB'D WHEEL	-346	3643	6060		41382	2323	-885	11
* APEX								
COORDINATES	STA	W.L.	B.L					
	275.63	39.00	51.00					

XV-5-A

MAIN GEAR LOADS

RYAN

UPDEGRAFF 111
12/3/62

12500 # A/C C.G. 246 MAIN GEAR FWD

NORMAL LANDING LOADS LIMIT

LOADS AT TRIPOD APEX *

LANDING ATTITUDE	P_x	P_y	P_z		M_x	M_y	M_z	COND
SPIN UP								
3 P'T	3202	0	4366		786	-6130	-576	12
2P'T LEVEL	3347	0	5321		958	-5846	-602	13
2P'T TAIL DOWN	2560	0	5582		1005	-4078	-461	14
SPRING BACK								
3 P'T	-3100	0	5291		952	8072	558	15
2 P'T LEVEL	-4047	0	6691		1204	10481	728	16
2 P'T TAIL DOWN	-4679	0	6623		1192	11829	842	17
MAX. VERT. REACT.								
3 P'T	1229	0	4915		885	-1377	-221	18
2 P'T LEVEL	1203	0	6326		1139	-954	-216	19
2 P'T TAIL DOWN	569	0	6419		1155	442	-102	20
SIDE DRIFT								
INB'D WHEEL	-178	-2500	3119		-27088	1195	682	21
OUTB'D WHEEL	-178	1875	3119		21299	1195	-455	22
* APEX	STA	W.L.	B.L.					
COORDINATES	275.63	39.00	51.00					

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MAIN GEAR LOADS

RYAN

UPDEGRAFF

12/4/62

9200 # A/C C.G. 246 MAIN GEAR AFT.
EMERGENCY LANDING LOADS LIMIT
LOADS AT TRIPOD APEX*

LANDING ATTITUDE	P_X	P_Y	P_Z		M_X	M_Y	M_Z	COND.
SPIN UP								
3 PT	2626	0	3317		597	-7325	-473	23
2PT LEVEL	3147	0	4475		806	-9043	-566	24
2PT TAIL DOWN	2575	0	4620		932	-7908	-464	25
SPRING BACK								
3 PT	-2907	0	2439		439	4870	523	26
2PT LEVEL	-3847	0	3694		665	6138	692	27
2PT TAIL DOWN	-3654	0	3760		677	6178	694	28
MAX. VERT. REACT.								
3 PT	792	0	3166		570	-3357	-142	29
2PT LEVEL	896	0	4656		838	-4346	-159	30
2PT TAIL DOWN	419	0	4724		850	-3392	-75	31
SIDE DRIFT								
INB'D WHEEL	-131	-1940	2295		-19814	-339	-952	32
OUTB'D WHEEL	-131	1380	2295		15621	-239	755	33
* APEX	STA	W.L.	B.L.					
COORDINATES	296.73	32.07	51.00					

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MAIN GEAR LOADS

RYAN

UPDEGRAFF

12/4/62

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9200 * A/C C.G. 246 MAIN GEAR AFT

V.T.O.L. LANDING LOADS LIMIT

LOADS AT APEX *

LANDING ATTITUDE	P_x	P_y	P_z		M_x	M_y	M_z	COND
MAX. VERT. REACT.								
3 P'T	0	0	8358		1504	-4430	0	34
2 P'T LEVEL	-693	0	12120		2182	-4954	125	35
2 P'T TAIL DOWN	-1894	0	11998		2160	-2349	391	36
SIDE DRIFT								
INB'D WHEEL	-346	-4858	6060		-52444	-2478	-2512	37
OUTB'D WHEEL	-346	3643	6060		41237	-2478	1993	38
* APEX	STA.	W.L.	B.L.					
COORDINATES	296.73	33.07	51.00					

H-786 VELLUM REV. 12-61

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MAIN GEAR LOADS

RYAN

UPDEGRAFF 11A
12/4/62

12500# A/C C.G. 246 MAIN GEAR FWD.
TAXI CONDITION LOADS LIMIT
LOAD AT TRIPOD APEX*

TAXI ATTITUDE	P_x	P_y	P_z		M_x	M_y	M_z	COND.
BRAKED ROLL								
3 PT	3932	0	4915		-3342	-25018	2674	39
2 PT	4634	0	6522		-4935	-29754	3151	40
UNSYMM. BRAKING								
BRAKED WHEEL	3217	582	4021		670	-20468	2403	41
UNBRAKED WHEEL	0	-582	4021		-6168	-1488	-215	42
TURNING								
OUTB'D WHEEL	0	-4846	9693		-35182	-3586	-1793	43
INB'D WHEEL	0	632	2430		2077	-899	234	44
* APEX	STA.	W.L.	B.L.					
COORDINATES	275.63	39.00	51.00					

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MAIN GEAR LOADS

RYAN

UPDEGRAFF 115

12/4/62

9200# A/C C.G. 246 MAIN GEAR AFT.

TAXI CONDITION LOADS LIMIT

LOADS AT TRIPOD APEX*

TAXI ATTITUDE	P_X	P_Y	P_Z		M_X	M_Y	M_Z	COND.
BRAKED ROLL								
3P'T	3040	0	3800		-2584	-15375	2067	45
2P'T	4096	0	5761		-3917	-20247	2785	46
UNSYMM. BRAKING								
BRAKE WHEEL	2120	337	2650		210	-10722	1196	47
UNBRAKE WHEEL	0	-337	2650		-3814	1934	246	48
TURNING								
OUTB'D WHEEL	0	-2850	6330		-21319	4621	2080	49
INB'D WHEEL	0	360	1590		1068	1161	-263	50
*APEX	STA.	W.L.	B.L.					
COORDINATES	296.73	39.07	51.00					

12/06/62

GENERAL TRI-POD SOLUTION FOR LOADS AND MOMENTS APPLIED AT APEX,
ONE MEMBER TAKING BENDING AND TORSION

JOB NO 1064

GEAR FWD

X(N)-X(0)	Y(N)-Y(0)	Z(N)-Z(0)
9.843899	-30.650000	54.107300
7.041702	-48.660000	38.700000
39.082500	-51.000000	55.309699

L(0-1)	L(0-2)	L(0-3)
62.959707	62.570529	84.779741

C(0-N,X)	C(0-N,Y)	C(0-N,Z)
0.156352	-0.486819	0.859396
0.112540	-0.777682	0.618502
0.460989	-0.601559	0.652393

INVERSE OF A MATRIX

-1.6828E-01	2.6332E-01	3.6171E-01	6.3912E-03	1.6845E-02	8.3795E-03
5.2395E-01	-8.1988E-01	-1.1262E 00	-3.3550E-02	-9.9487E-03	4.6814E-04
-9.2494E-01	1.4474E 00	1.9882E 00	2.7397E-02	1.5079E-02	3.5575E-03
-4.7379E-08	7.4140E-08	1.0184E-07	1.5635E-01	-4.8682E-01	8.5940E-01
-1.5861E 00	-2.3402E 00	-1.0371E 00	-3.9963E-02	1.9075E-02	1.8076E-02
2.9215E 00	9.8189E-05	-5.3146E-01	-4.1081E-03	-4.1198E-02	-2.2590E-02

12/06/62

GENERAL TRI-POD SOLUTION FOR LOADS AND MOMENTS APPLIED AT APEX, ONE MEMBER TAKING BENDING AND TORSION

JOB NO 1064

GEAR AFT

X(N)-X(0)	Y(N)-Y(0)	Z(N)-Z(0)
-10.185398	-30.650000	54.040699
-7.284698	-48.660000	38.651000
16.684002	-51.000000	65.633200

L(0-1)	L(0-2)	L(0-3)
62.956826	62.568060	84.776605

C(0-N,X)	C(0-N,Y)	C(0-N,Z)
-0.161784	-0.486842	0.858377
-0.116428	-0.777713	0.617743
0.196800	-0.601581	0.774190

INVERSE OF A MATRIX

2.9659E-01	-2.7245E-01	-2.8710E-01	-5.9347E-03	1.0328E-02	4.7393E-03
8.9251E-01	-8.1984E-01	-8.6393E-01	-3.1493E-02	-9.9488E-03	-1.1578E-02
-1.5736E 00	1.4455E 00	1.5232E 00	2.3755E-02	2.0111E-02	1.5883E-02
0.	0.	0.	-1.6178E-01	-4.8684E-01	8.5838E-01
-1.1094E 00	-2.3400E 00	-1.5363E 00	-4.3784E-02	1.9074E-02	2.5660E-03
2.9179E 00	1.1357E-05	5.4996E-01	4.2529E-03	-4.1197E-02	-2.2564E-02

12/06/62

GENERAL TRI-POD SOLUTION FOR LOADS AND MOMENTS APPLIED AT APEX,
ONE MEMBER TAKING BENDING AND TORSION

JOB NO 1064

S.U. = SPIN UP
S.B. = SPRING BACK
M.V.R. = MAX. VERTICAL REACTION
S.D. = SIDE DRIFT

CONDITION1 9200# GEAR FWD. 3PT S.U.

T(1) = -4281.221497 Q = 11504.959839

C(Q,X)	C(Q,Y)	C(Q,Z)
-0.143636	0.488631	-0.860586

COS BETA = -0.999917 N = 148.410086

N(X)	N(Y)	N(Z)
146.151611	21.304077	-14.521851

P(0-1)	P(0-2)	P(0-3)
-11504.002563	17104.302002	-12766.899292

R(N-X)	R(N-Y)	R(N-Z)
-1652.526321	5621.674438	-9901.011841
1924.922226	-13301.714844	10579.045532
-5885.395874	7680.040649	-8329.034058

CONDITION2 9200# GEAR FWD 2PT LEVEL S.U.

T(1) = -4275.772461 Q = 14866.893433

C(Q,X)	C(Q,Y)	C(Q,Z)
-0.146543	0.488484	-0.860179

COS BETA = -0.999950 N = 148.370821

N(X)	N(Y)	N(Z)
145.720612	25.116211	-12.284058

P(0-1)	P(0-2)	P(0-3)
-14866.152954	18949.705078	-12425.396118

R(N-X)	R(N-Y)	R(N-Z)
-2178.637482	7262.246277	-12788.191528
2132.604309	-14736.852417	11720.431152
-5727.966797	7474.606384	-8106.239807

12/06/62

GENERAL TRI-POD SOLUTION FOR LOADS AND MOMENTS APPLIED AT APEX,
ONE MEMBER TAKING BENDING AND TORSION

JOB NO 1064

CONDITION3 9200# GEAR FWD 2 P'T TAIL DOWN S.U

T(1) = -3027.791321	Q = 17410.863037	
C(Q,X)	C(Q,Y)	C(Q,Z)
-0.150451	0.488282	-0.859619
COS BETA = -0.999982	N = 105.905548	
N(X)	N(Y)	N(Z)
102.702545	25.623413	-4.170532
P(0-1)	P(0-2)	P(0-3)
-17410.540771	17226.059326	-8137.181030
R(N-X)	R(N-Y)	R(N-Z)
0-1 -2619.476562	8501.410522	-14966.713867
0-2 1938.624817	-13396.403320	10654.352661
0-3 -3751.148254	4894.992859	-5308.638855

CONDITION4 9200# GEAR FWD 3 P'T S.B.

T(1) = 5902.862732	Q = 29877.645264	
C(Q,X)	C(Q,Y)	C(Q,Z)
-0.163205	0.487565	-0.857697
COS BETA = -0.999975	N = 212.069885	
N(X)	N(Y)	N(Z)
-204.855896	22.647461	50.099121
P(0-1)	P(0-2)	P(0-3)
-29876.892578	1708.844162	22006.754639
R(N-X)	R(N-Y)	R(N-Z)
-4876.178528	14567.295166	-25625.973145
192.313728	-1328.938049	1056.923584
10144.864502	-13238.356934	14357.049805

12/06/62

GENERAL TRI-POD SOLUTION FOR LOADS AND MOMENTS APPLIED AT APEX,
ONE MEMBER TAKING BENDING AND TORSION

JOB NO 1064

CONDITION5 9200# GEAR FWD. 2pt LEVEL S.U.

T(1) = 7650.022522 Q = 38001.[illegible]797

C(Q,X)	C(Q,Y)	C(Q,Z)
-0.163333	0.487557	-0.857677

COS BETA = -0.999974 N = 274.[illegible]271

N(X)	N(Y)	N(Z)
-265.423950	28.530273	64.450439

P(O-1)	P(O-2)	P(O-3)
-38000.224121	1817.108780	28450.483643

R(N-X)	R(N-Y)	R(N-Z)
-6206.848633	18527.772461	-32592.777832
204.497854	-1413.133545	1123.885468
13115.350586	-17114.638916	18560.892578

CONDITION6 9200# GEAR FWD 2pt TAIL DOWN S.B.

T(1) = 8767.592651 Q = 39118.725586

C(Q,X)	C(Q,Y)	C(Q,Z)
-0.164116	0.487511	-0.857554

COS BETA = -0.999968 N = 313.242313

N(X)	N(Y)	N(Z)
-303.883972	27.652588	70.950195

P(O-1)	P(O-2)	P(O-3)
-39117.471191	-369.444477	32179.901367

R(N-X)	R(N-Y)	R(N-Z)
O-1 -6419.992659	19070.792236	-33546.435059
O-2 -41.577369	287.310471	-228.502161
O-3 14834.569946	-19358.102783	20993.938232

12/06/62

GENERAL TRI-POD SOLUTION FOR LOADS AND MOMENTS APPLIED AT APEX,
ONE MEMBER TAKING BENDING AND TORSION

JOB NO 1064

CONDITION7 9200# GEAR FWD 3 PT M.V.R.

T(1) = -1201.472015 Q = 19537.093018

C(Q,X)	C(Q,Y)	C(Q,Z)
-0.154313	0.488074	-0.859053

COS BETA = -0.999997 N = 47.158325

N(X)	N(Y)	N(Z)
39.838379	24.531982	6.648193

P(0-1)	P(0-2)	P(0-3)
-19537.035889	13819.324463	-2013.947189

R(N-X)	R(N-Y)	R(N-Z)
-3014.823273	9535.537964	-16783.395752
1555.230057	-10747.045532	8547.280273
-928.406830	1211.507660	-1313.884781

CONDITION8 9200# GEAR FWD 2PT LEVEL M.V.R.

T(1) = -886.766281 Q = 25973.661621

C(Q,X)	C(Q,Y)	C(Q,Z)
-0.155252	0.488022	-0.858913

COS BETA = -0.999999 N = 44.047563

N(X)	N(Y)	N(Z)
28.562286	31.252563	12.507080

P(0-1)	P(0-2)	P(0-3)
-25973.624268	16588.654541	-374.013538

R(N-X)	R(N-Y)	R(N-Z)
-4032.475159	12675.713867	-22309.113281
1866.891129	-12900.704834	10260.116577
-172.416002	224.991137	-244.003765

12/06/62

GENERAL TRI-POD SOLUTION FOR LOADS AND MOMENTS APPLIED AT APEX,
ONE MEMBER TAKING BENDING AND TORSION

JOB NO 1064

CONDITION9 9200# GEAR FWD 2PT TAIL DOWN M.V.R.

T(1) = 236.724789 Q = 27772.407471

C(Q,X)	C(Q,Y)	C(Q,Z)
-0.156718	0.487940	-0.858693

COS BETA = -0.999999 N = 38.054748

N(X)	N(Y)	N(Z)
-10.145691	31.138184	19.484375

P(0-1)	P(0-2)	P(0-3)
-27772.381348	14764.162231	3440.129395

R(N-X)	R(N-Y)	R(N-Z)
-4352.423035	13551.269165	-23847.979980
1661.562332	-11481.829346	9131.664307
1585.860672	-2069.440125	2244.315887

CONDITION10 9200# GEAR FWD. 40° WHEEL S.D.

T(1) = 8222.256958 Q = 4193.789246

C(Q,X)	C(Q,Y)	C(Q,Z)
-0.163287	0.305152	-0.938200

COS BETA = -0.980369 N = 826.887703

N(X)	N(Y)	N(Z)
-41.953979	-721.795578	-401.240662

P(0-1)	P(0-2)	P(0-3)
-4111.462585	-7804.648254	4141.376953

R(N-X)	R(N-Y)	R(N-Z)
-684.790855	1279.743729	-3934.613800
-878.336975	6069.537659	-4827.190796
1909.127853	-2491.281769	2701.804779

12/06/62

GENERAL TRI-POD SOLUTION FOR LOADS AND MOMENTS APPLIED AT APEX.
ONE MEMBER TAKING BENDING AND TORSION

JOB NO 1064

CONDITION11 9200# GEAR FWD OUTB'D WHEEL S.D.

T(1) = -4578.727783 Q = 22272.228760

C(Q,X)	C(Q,Y)	C(Q,Z)
-0.157401	0.512069	-0.844399

COS BETA = -0.999568 N = 654.426842

N(X)	N(Y)	N(Z)
-24.865753	567.059082	325.743896

P(0-1)	P(0-2)	P(0-3)
-22262.612061	15886.735962	4476.857544

R(N-X)	R(N-Y)	R(N-Z)
-3505.677673	11404.928101	-18806.648437
1787.897049	-12354.835205	9825.978516
2063.780579	-2693.093048	2920.669922

CONDITION12 12500# GEAR FWD. 3 P'T S.U.

T(1) = -2612.083557 Q = 6559.337891

C(Q,X)	C(Q,Y)	C(Q,Z)
-0.142902	0.488628	-0.860710

COS BETA = -0.999907 N = 89.429670

N(X)	N(Y)	N(Z)
88.127823	12.159241	-9.145630

P(0-1)	P(0-2)	P(0-3)
-6558.728210	9765.457397	-7296.626343

R(N-X)	R(N-Y)	R(N-Z)
-937.344803	3205.074646	-5645.688232
1099.006897	-7594.424500	6039.955261
-3363.662048	4339.349792	-4760.266968

12/06/62

GENERAL TRI-POD SOLUTION FOR LOADS AND MOMENTS APPLIED AT APEX.
ONE MEMBER TAKING BENDING AND TORSION

JOB NO 1064

CONDITION13 12500# GEAR FWD. 2 P'T LEVEL S.U

T(1) = -2478.375305 Q = 8625.159790

C(Q,X)	C(Q,Y)	C(Q,Z)
-0.146553	0.488485	-0.860177

COS BETA = -0.999950 N = 85.988450

N(X)	N(Y)	N(Z)
84.452286	14.571594	-7.110413

P(0-1)	P(0-2)	P(0-3)
-8624.731079	10987.787231	-7200.878540

R(N-X)	R(N-Y)	R(N-Z)
-1264.044769	4213.257080	-7419.166992
1236.568192	-8545.008911	6795.968750
-3319.523407	4331.751831	-4697.801819

CONDITION14 12500# GEAR FWD 2 P'T TAIL DOWN S.U

T(1) = -1746.202209 Q = 10114.385376

C(Q,X)	C(Q,Y)	C(Q,Z)
-0.150494	0.488280	-0.859613

COS BETA = -0.999982 N = 61.100384

N(X)	N(Y)	N(Z)
59.228958	14.862854	-2.356567

P(0-1)	P(0-2)	P(0-3)
-10114.200806	9975.783447	-4686.724426

R(N-X)	R(N-Y)	R(N-Z)
-1522.150192	4938.650940	-8694.456909
1122.677048	-7757.991333	6170.042358
-2160.526855	2819.340332	-3057.585602

12/06/62

GENERAL TRI-POD SOLUTION FOR LOADS AND MOMENTS APPLIED AT APEX, ONE MEMBER TAKING BENDING AND TORSION

JOB NO 1064

CONDITION15 12500# GEAR FWD 3rd S.B.

T(1) = 3301.214417 Q = 15783.481689

C(Q,X)	C(Q,Y)	C(Q,Z)
-0.163602	0.487541	-0.857635

COS BETA = -0.999972 N = 118.283981

N(X)	N(Y)	N(Z)
-114.496796	11.609009	27.406738

P(0-1)	P(0-2)	P(0-3)
-15783.038452	444.175678	12217.706665

R(N-X)	R(N-Y)	R(N-Z)
-2582.212097	7695.096619	-13536.468140
49.987637	-345.427612	274.723560
5632.224304	-7349.669006	7970.744690

CONDITION16 12500# GEAR FWD 2FT LEVEL S.B.

T(1) = 4288.463867 Q = 20101.905273

C(Q,X)	C(Q,Y)	C(Q,Z)
-0.163745	0.487533	-0.857613

COS BETA = -0.999971 N = 153.537037

N(X)	N(Y)	N(Z)
-148.694061	14.626831	35.337646

P(0-1)	P(0-2)	P(0-3)
-20101.318848	355.069038	15832.542969

R(N-X)	R(N-Y)	R(N-Z)
-3291.582672	9800.336548	-17239.648682
39.959554	-276.130947	219.610922
7298.622925	-9524.205566	10329.038086

12/06/62

GENERAL TRI-POD SOLUTION FOR LOADS AND MOMENTS APPLIED AT APEX,
ONE MEMBER TAKING BENDING AND TORSION

JOB NO 1064

CONDITION17 12500# Gear Fwd. 2pt Tail Down S.B.

T(1) = 4848.601318 Q = 20652.461914

C(Q,X)	C(Q,Y)	C(Q,Z)
-0.164480	0.487489	-0.857497

COS BETA = -0.999965 N = 172.926558

N(X)	N(Y)	N(Z)
-167.975616	14.179932	38.592285

P(O-1)	P(O-2)	P(O-3)
-20651.737793	-746.142609	17700.856934

R(N-X)	R(N-Y)	R(N-Z)
-3396.923553	10067.844238	-17709.421631
-83.971066	580.261986	-461.490719
8159.894470	-10648.106323	11547.912842

CONDITION18 12500# Gear Fwd 3pt M.V.R.

T(1) = -618.795998 Q = 10054.969849

C(Q,X)	C(Q,Y)	C(Q,Z)
-0.154313	0.488074	-0.859053

COS BETA = -0.999997 N = 24.332521

N(X)	N(Y)	N(Z)
20.504761	12.629028	3.423218

P(O-1)	P(O-2)	P(O-3)
-10054.940308	7112.249451	-1036.479660

R(N-X)	R(N-Y)	R(N-Z)
-1551.608871	4907.567932	-8637.748901
800.414246	-5531.071289	4398.940735
-477.805378	623.503464	-676.191940

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GENERAL TRI-POD SOLUTION FOR LOADS AND MOMENTS APPLIED AT APEX.
ONE MEMBER TAKING BENDING AND TORSION

JOB NO 1064

CONDITION19 12500# GEAR FWD. 2PT LEVEL M.V.R.

T(1) = -456.882057 Q = 13366.254517

C(Q,X)	C(Q,Y)	C(Q,Z)
-0.155253	0.488022	-0.858913

COS BETA = -0.999999 N = 22.667229

N(X)	N(Y)	N(Z)
14.692169	16.083618	6.437622

P(0-1)	P(0-2)	P(0-3)
-13366.235229	8536.325317	-192.043570

R(N-X)	R(N-Y)	R(N-Z)
-2075.150238	6523.024780	-11480.447021
960.680084	-6638.550049	3279.734558
-88.529909	115.525499	-125.287855

CONDITION20 12500# GEAR FWD 2PT TAIL DOWN M.V.R.

T(1) = 122.244884 Q = 14294.485840

C(Q,X)	C(Q,Y)	C(Q,Z)
-0.156719	0.487939	-0.858693

COS BETA = -0.999999 N = 19.586817

N(X)	N(Y)	N(Z)
-5.244568	16.018860	10.028198

P(0-1)	P(0-2)	P(0-3)
-14294.472412	7597.529297	1772.692825

R(N-X)	R(N-Y)	R(N-Z)
-2240.219055	6974.843811	-12274.579468
855.027756	-5908.464905	4699.087280
817.191307	-1066.378967	1156.492157

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GENERAL TRI-POD SOLUTION FOR LOADS AND MOMENTS APPLIED AT APEX,
ONE MEMBER TAKING BENDING AND TORSION

JOB NO 1064

CONDITION21 12500# GEAR FWD. INB'D WHEEL S.D.

T(1) = 4230.913757 Q = 2159.111511

C(Q,X)	C(Q,Y)	C(Q,Z)
-0.163283	0.305236	-0.938174

COS BETA = -0.980387 N = 425.524418

N(X)	N(Y)	N(Z)
-21.585060	-371.443001	-206.483200

P(0-1)	P(0-2)	P(0-3)
-2116.764374	-4015.832275	2131.264709

R(N-X)	R(N-Y)	R(N-Z)
-352.546162	659.038734	-2025.621338
-451.942719	3123.042145	-2483.800415
982.488884	-1282.081039	1390.421890

CONDITION22 12500# GEAR FWD OUTB'D WHEEL S.D

T(1) = -2357.375275 Q = 11463.121582

C(Q,X)	C(Q,Y)	C(Q,Z)
-0.157401	0.512070	-0.844399

COS BETA = -0.999568 N = 336.827713

N(X)	N(Y)	N(Z)
-12.793533	291.859802	167.656372

P(0-1)	P(0-2)	P(0-3)
-11458.171875	8176.823303	2303.926666

R(N-X)	R(N-Y)	R(N-Z)
-1804.305740	5869.918884	-9679.446899
920.221642	-6358.971680	5057.381836
1062.084076	-1385.947357	1503.065323

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GENERAL TRI-POD SOLUTION FOR LOADS AND MOMENTS APPLIED AT APEX.
ONE MEMBER TAKING BENDING AND TORSION

JOB NO 1064

CONDITION23 9200# GRAB APT 3PT S.U.

T(1) = -3063.517181	Q = 941.554214	
C(Q,X)	C(Q,Y)	C(Q,Z)
0.270704	0.491079	-0.827986
COS BETA = -0.993597	N = 106.375535	
N(X)	N(Y)	N(Z)
103.529524	6.924213	23.440033
P(0-1)	P(0-2)	P(0-3)
-935.525833	8176.256897	-9801.513672
R(N-X)	R(N-Y)	R(N-Z)
254.882500	462.377079	-779.593933
-951.948410	-6358.782043	5050.827881
-1928.933945	5896.404968	-7588.233826

CONDITION24 9200# GRAB APT 2 PT LEVEL S.U.

T(1) = -3786.269043	Q = 2010.476196	
C(Q,X)	C(Q,Y)	C(Q,Z)
0.224942	0.490544	-0.841884
COS BETA = -0.997863	N = 131.376337	
N(X)	N(Y)	N(Z)
127.672543	9.534821	29.471054
P(0-1)	P(0-2)	P(0-3)
-2006.179153	10575.432739	-12032.337646
R(N-X)	R(N-Y)	R(N-Z)
452.239941	986.226227	-1692.587219
-1231.280579	-8224.652466	6532.902649
-2367.959198	7238.426392	-9315.315430

GENERAL TRI-POD SOLUTION FOR LOADS AND MOMENTS APPLIED AT APEX,
ONE MEMBER TAKING BENDING AND TORSION

JOB NO 1064

CONDITION25 9200# GEAR AFT 2F'T TAIL DOWN S.U.

T(1) = -3317.051971 Q = 3340.141479

C(Q,X) 0.195042 C(Q,Y) 0.489592 C(Q,Z) -0.849858

COS BETA = -0.999407 N = 115.025628

N(X) 111.408775 N(Y) 10.151459 N(Z) 26.755402

P(O-1) -3338.160278 P(O-2) 10142.822632 P(O-3) -10394.109497

R(N-X) 651.469208 R(N-Y) 1635.306641 R(N-Z) -2838.644989

-1180.912491 -7888.205994 6265.660706

-2045.556564 6252.899353 -8047.015625

CONDITION26 9200# GEAR AFT 3F'T S.B.

T(1) = 1993.010300 Q = 9783.067505

C(Q,X) 0.154579 C(Q,Y) 0.487578 C(Q,Z) -0.859286

COS BETA = -0.999973 N = 71.394109

N(X) -70.443695 N(Y) 7.329529 N(Z) -9.120117

P(O-1) -9782.806885 P(O-2) 446.824345 P(O-3) 7351.470703

R(N-X) 1512.256516 R(N-Y) 4770.006592 R(N-Z) -8406.457642

-52.023038 -347.501144 276.022743

1446.766479 -4422.505493 8691.435059

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GENERAL TRI-POD SOLUTION FOR LOADS AND MOMENTS APPLIED AT APEX, ONE MEMBER TAKING BENDING AND TORSION

JOB NO 1064

CONDITION27 9200# GEAR AFT 2 PT LEVEL S.B.

T(1) = 2531.033325 Q = 13772.027588

C(Q,X)	C(Q,Y)	C(Q,Z)
0.155256	0.487618	-0.859141

COS BETA = -0.999978 N = 91.124222

N(X)	N(Y)	N(Z)
-89.857056	10.845093	-10.785034

P(0-1)	P(0-2)	P(0-3)
-13771.726074	1316.106094	9461.635864

R(N-X)	R(N-Y)	R(N-Z)
2138.185883	6715.493835	-11832.119507
-153.232111	-1023.552940	813.015717
1862.046127	-5691.940918	7325.103821

CONDITION28 9200# GEAR AFT 2PT TAILDOWN S.B.

T(1) = 2521.521118 Q = 13902.046143

C(Q,X)	C(Q,Y)	C(Q,Z)
0.155335	0.487623	-0.859124

COS BETA = -0.999979 N = 90.897943

N(X)	N(Y)	N(Z)
-89.599762	11.013977	-10.640869

P(0-1)	P(0-2)	P(0-3)
-13901.748901	1410.635681	9444.934204

R(N-X)	R(N-Y)	R(N-Z)
2159.478760	6778.963196	-11943.583984
-164.238037	-1097.069839	871.410736
1858.759247	-5681.893494	7312.173584

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GENERAL TRI-POD SOLUTION FOR LOADS AND MOMENTS APPLIED AT APEX,
ONE MEMBER TAKING BENDING AND TORSION

JOB NO 1064

CONDITION29 9200# GEAR AFT 3PT M.V.R.

T(1) = -1420.220810 Q = 4116.308044

C(Q,X)	C(Q,Y)	C(Q,Z)
0.173158	0.488606	-0.855149

COS BETA = -0.999929 N = 49.204473

N(X)	N(Y)	N(Z)
46.868698	7.406693	13.034393

P(0-1)	P(0-2)	P(0-3)
-4116.013916	5831.858459	-4196.041931

R(N-X)	R(N-Y)	R(N-Z)
712.773293	2011.253357	-3520.057770
-678.993874	-4535.512695	3602.591461
-825.779366	2524.259338	-3248.533691

CONDITION30 9200# GEAR AFT 2PIT LEVEL M.V.R.

T(1) = -1843.756638 Q = 6577.411804

C(Q,X)	C(Q,Y)	C(Q,Z)
0.170972	0.488494	-0.855653

COS BETA = -0.999953 N = 63.960981

N(X)	N(Y)	N(Z)
60.484543	11.017059	17.648315

P(0-1)	P(0-2)	P(0-3)
-6577.100769	8255.830566	-5332.023804

R(N-X)	R(N-Y)	R(N-Z)
1124.553253	3213.023102	-5627.984497
-961.213043	-6420.667542	5099.983948
-1049.340134	3207.644501	-4127.999512

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GENERAL TRI-POD SOLUTION FOR LOADS AND MOMENTS APPLIED AT APEX.
ONE MEMBER TAKING BENDING AND TORSION

JOB NO 1064

CONDITION31 9200# GEAR AFT 2PT TAIL DOWN M.V.R.

T(1) = -1449.472046 Q = 7575.569580

C(Q,X)	C(Q,Y)	C(Q,Z)
0.167962	0.488335	-0.856340

COS BETA = -0.999978 N = 50.557816

N(X)	N(Y)	N(Z)
46.827789	11.396484	15.289551

P(0-1)	P(0-2)	P(0-3)
-7575.400818	7824.304016	-3965.628937

R(N-X)	R(N-Y)	R(N-Z)
1272.405334	3699.416504	-6487.261169
-910.971100	-6085.063660	4833.411316
-780.434181	2385.647247	-3070.150269

CONDITION32 9200# GEAR AFT IND'D WHEEL S.D

T(1) = -2853.643677 Q = 547.104454

C(Q,X)	C(Q,Y)	C(Q,Z)
0.169556	-0.100182	-0.980415

COS BETA = -0.820225 N = 312.966557

N(X)	N(Y)	N(Z)
20.164442	-273.279686	-151.194187

P(0-1)	P(0-2)	P(0-3)
-448.748501	-1774.580185	-859.571999

R(N-X)	R(N-Y)	R(N-Z)
92.764704	-54.810266	-536.389633
206.611509	1380.114243	-1096.235016
-168.376225	514.695908	-662.375282

12/06/62

GENERAL TRI-POD SOLUTION FOR LOADS AND MOMENTS APPLIED AT APEX.
ONE MEMBER TAKING BENDING AND TORSION

JOB NO 1064

CONDITION33 9200# GEAR AFT OUTB'D WHEEL S.D.

T(1) = 1422.006622 Q = 7208.793518

C(Q,X)	C(Q,Y)	C(Q,Z)
0.162654	0.516368	-0.840778

COS BETA = -0.999409 N = 247.832647

N(X)	N(Y)	N(Z)
6.964355	214.922821	123.209229

P(O-1)	P(O-2)	P(O-3)
-7204.532104	7309.538269	-968.007782

R(N-X)	R(N-Y)	R(N-Z)
1172.541321	3722.388519	-6060.996277
-851.037758	-5684.723633	4515.418274
-190.503542	582.335144	-749.421944

CONDITION34 9200# GEAR AFT 3PT M.V.R

T(1) = -1913.385223 Q = 14796.650757

C(Q,X)	C(Q,Y)	C(Q,Z)
0.165864	0.488222	-0.856813

COS BETA = -0.999990 N = 67.799888

N(X)	N(Y)	N(Z)
60.400360	20.506226	23.014282

P(O-1)	P(O-2)	P(O-3)
-14796.495361	12990.499390	-4785.433716

R(N-X)	R(N-Y)	R(N-Z)
2454.234406	7224.055237	-12577.958740
-1512.462906	-10102.881470	8024.793884
-941.771431	2878.826263	-3704.834930

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GENERAL TRI-POD SOLUTION FOR LOADS AND MOMENTS APPLIED AT APEX, ONE MEMBER TAKING BENDING AND TORSION

JOB NO 1064

CONDITION35 9200# GEAR AFT 2P4 LEVEL M.V.R.

T(1) = -2166.097870	Q = 22759.498047	
C(Q,X)	C(Q,Y)	C(Q,Z)
0.164708	0.488160	-0.857071
COS BETA = -0.999994	N = 78.777239	
N(X)	N(Y)	N(Z)
66.578186	30.071655	29.603760
P(0-1)	P(0-2)	P(0-3)
-22759.361572	18040.470703	-4853.935120
R(N-X)	R(N-Y)	R(N-Z)
3748.675446	11110.274902	-19506.511475
-2100.422913	-14030.310303	11144.379761
-955.252480	2920.035431	-3757.868011

CONDITION36 9200# GEAR AFT 2P4 TAIL DOWN M.V.R.

T(1) = -1084.410095	Q = 24801.199951	
C(Q,X)	C(Q,Y)	C(Q,Z)
0.162966	0.488063	-0.857459
COS BETA = -0.999998	N = 47.772990	
N(X)	N(Y)	N(Z)
29.322052	30.326538	22.726562
P(0-1)	P(0-2)	P(0-3)
-24801.153809	16469.312988	-1169.985886
R(N-X)	R(N-Y)	R(N-Z)
4041.748322	12104.559204	-21266.016357
-1917.495560	-12808.400391	10173.807617
230.252752	703.841347	-905.791367

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GENERAL TRI-POD SOLUTION FOR LOADS AND MOMENTS APPLIED AT APEX;
ONE MEMBER TAKING BENDING AND TORSION

JOB NO 1064

CONDITION37 9200# GEAR AFT INB'D WHEEL S.D.

T(1) = -7534.742432 Q = 1445.760223

C(Q,X)	C(Q,Y)	C(Q,Z)
0.169563	-0.099545	-0.980479

COS BETA = -0.820590 N = 826.276138

N(X)	N(Y)	N(Z)
53.211157	-721.496536	-399.178635

P(O-1)	P(O-2)	P(O-3)
-1186.376984	-4684.316528	-2258.821808

R(N-X)	R(N-Y)	R(N-Z)
245.147799	-143.918907	-1417.537491
545.387421	3643.054291	-2893.705139
-444.535225	1358.864410	-1748.757248

CONDITION38 9200# GEAR AFT OUTB'D WHEEL S.D.

T(1) = 3754.341766 Q = 19033.224854

C(Q,X)	C(Q,Y)	C(Q,Z)
0.162654	0.516363	-0.840781

COS BETA = -0.999409 N = 654.235909

N(X)	N(Y)	N(Z)
18.374298	567.362549	325.250977

P(O-1)	P(O-2)	P(O-3)
-19021.977295	19298.254395	-2555.688232

R(N-X)	R(N-Y)	R(N-Z)
3095.823120	9828.051758	-16002.779053
-2246.864655	-15008.505127	11921.367310
-502.958416	1537.453629	-1978.588272

12/14/62

GENERAL TRI-POD SOLUTION FOR LOADS AND MOMENTS APPLIED AT APEX,
ONE MEMBER TAKING BENDING AND TORSION

JOB NO 1064

B.R. = BRAKED ROLL
U.B. = UNSYMMETRICAL BRAKING

CONDITION39 12500# GEAR FWD 3PT B.R.

T(1) = 13954.739624 Q = 6510.564148

C(Q,X)	C(Q,Y)	C(Q,Z)
-0.106867	0.478141	-0.871757

COS BETA = -0.998662 N = 336.740047

N(X)	N(Y)	N(Z)
320.817978	-52.258545	-87.970154

P(O-1)	P(O-2)	P(O-3)
-6501.849854	11629.274536	-9859.242187

R(N-X)	R(N-Y)	R(N-Z)
-695.761589	3112.967377	5675.631775
1308.761322	-9043.882202	7192.729919
-4544.999573	5930.914795	-6432.097961

CONDITION40 12500# GEAR FWD 2PT B.R.

T(1) = 16499.354492 Q = 9333.206299

C(Q,X)	C(Q,Y)	C(Q,Z)
-0.115302	0.479041	-0.870187

COS BETA = -0.999069 N = 402.652901

N(X)	N(Y)	N(Z)
381.775772	-68.362427	-108.182739

P(O-1)	P(O-2)	P(O-3)
-9324.516602	14447.371460	-11244.908569

R(N-X)	R(N-Y)	R(N-Z)
-1076.134399	4470.992126	-8121.631958
1625.910629	-11235.466675	8935.728638
-5183.776184	6764.474731	-7336.096680

12/06/62

GENERAL TRI-POD SOLUTION FOR LOADS AND MOMENTS APPLIED AT APEX
ONE MEMBER TAKING BENDING AND TORSION

JOB NO 1064

CONDITION41 12500# GEAR FWD BRAKED WHEEL U.B

T(1) = 12134.101196 Q = 6444.648315

C(Q,X)	C(Q,Y)	C(Q,Z)
-0.115752	0.486901	-0.865753

COS BETA = -0.999156 N = 264.791538

N(X)	N(Y)	N(Z)
260.806198	3.177887	-45.649170

P(0-1)	P(0-2)	P(0-3)
-6439.206238	11008.474609	-8047.741089

R(N-X)	R(N-Y)	R(N-Z)
-745.978889	3137.907715	-5579.475159
1238.896347	-8561.097046	6808.763916
-3709.917450	4841.189453	-5250.288879

CONDITION42 12500# GEAR FWD UNBRAKED WHEEL U.B.

T(1) = 424.763939 Q = 8039.362549

C(Q,X)	C(Q,Y)	C(Q,Z)
-0.153607	0.476375	-0.865720

COS BETA = -0.999922 N = 100.612905

N(X)	N(Y)	N(Z)
21.973480	-83.658875	-51.387817

P(0-1)	P(0-2)	P(0-3)
-8038.732910	2593.887665	2045.570007

R(N-X)	R(N-Y)	R(N-Z)
-1234.901367	3829.751373	-6959.840088
291.916733	-2017.220825	1604.324799
942.984596	-1230.530640	1334.515289

12/06/62

GENERAL TRI-POD SOLUTION FOR LOADS AND MOMENTS APPLIED AT APEX.
ONE MEMBER TAKING BENDING AND TORSION

JOB NO 1064

CONDITION43 12510# GEAR FWD. OUTB'D WHEEL TURNING

T(1) = 5295.950500	Q = 12756.017578	
C(Q,X)	C(Q,Y)	C(Q,Z)
-0.151280	0.449058	-0.880603
COS BETA = -0.999049	N = 556.093117	
N(X)	N(Y)	N(Z)
62.812500	-475.779236	-280.941040
P(0-1)	P(0-2)	P(0-3)
-12743.890503	-2593.376099	4819.172607
R(N-X)	R(N-Y)	R(N-Z)
-1929.724838	5728.192505	-11232.985352
-291.859161	2016.822983	-1604.008392
2221.583954	-2899.015686	3143.993835

CONDITION44 12510# GEAR FWD INB'D WHEEL TURNING

T(1) = -963.493256	Q = 6753.626770	
C(Q,X)	C(Q,Y)	C(Q,Z)
-0.154801	0.490925	-0.857338
COS BETA = -0.999988	N = 32.749193	
N(X)	N(Y)	N(Z)
10.461929	27.769836	13.827209
P(0-1)	P(0-2)	P(0-3)
-6753.547363	4095.047150	1268.173386
R(N-X)	R(N-Y)	R(N-Z)
-1045.471130	3315.526978	-5790.142151
460.857582	-3184.646149	2532.794983
584.613556	-762.880859	827.347275

12/14/62

GENERAL TRI-POD SOLUTION FOR LOADS AND MOMENTS APPLIED AT APEX.
ONE MEMBER TAKING BENDING AND TORSION

JOB NO 1064

CONDITION45 9200# GEAR APT 3 P'T B. R.

T(1) = -8857.203125 Q = 5112.104065

C(Q,X)	C(Q,Y)	C(Q,Z)
-0.118298	0.478519	-0.870072

COS BETA = -0.999184 N = 206.415928

N(X)	N(Y)	N(Z)
193.885147	-40.404510	-58.162048

P(0-1)	P(0-2)	P(0-3)
-5107.934998	8915.417236	-7459.164001

R(N-X)	R(N-Y)	R(N-Z)
-604.752541	2446.236786	-4447.899292
1003.343178	-6933.363159	5514.203674
-3438.590576	4487.126404	-4866.304382

CONDITION46 9200# GEAR APT 2 P'T B.R.

T(1) = 11637.615234 Q = 8361.458496

C(Q,X)	C(Q,Y)	C(Q,Z)
-0.125791	0.479336	-0.868570

COS BETA = -0.999463 N = 274.004250

N(X)	N(Y)	N(Z)
254.835876	-60.382843	-80.568115

P(0-1)	P(0-2)	P(0-3)
-8356.967651	12650.780151	-9692.050293

R(N-X)	R(N-Y)	R(N-Z)
-1051.795731	4007.950226	-7262.509949
1423.721802	-9838.289185	7824.533264
-4467.926025	9830.339050	-6323.023193

12/06/62

GENERAL TRI-POD SOLUTION FOR LOADS AND MOMENTS APPLIED AT APEX,
ONE MEMBER TAKING BENDING AND TORSION

JOB NO 1064

CONDITION47 9200# GEAR AFT BRAKED WHEEL U.B.

T(1) = -6212.559692 Q = 1202.497025

C(Q,X)	C(Q,Y)	C(Q,Z)
0.274561	0.488461	-0.828265

COS BETA = -0.993186 N = 140.138668

N(X)	N(Y)	N(Z)
136.939226	5.936646	29.176857

P(0-1)	P(0-2)	P(0-3)
-1194.303238	7422.339905	-8058.893738

R(N-X)	R(N-Y)	R(N-Z)
330.158207	587.373108	-995.985710
-864.171066	-5772.450928	4585.100708
-1585.987045	4848.077820	-6239.114929

CONDITION48 9200# GEAR AFT UNBRAKED WHEEL U.B.

T(1) = 113.347204 Q = 4039.836853

C(Q,X)	C(Q,Y)	C(Q,Z)
0.154763	0.474057	-0.866786

COS BETA = -0.999856 N = 68.012784

N(X)	N(Y)	N(Z)
-28.271164	-51.369354	-34.463379

P(0-1)	P(0-2)	P(0-3)
-4039.264282	3078.021271	-1355.935303

R(N-X)	R(N-Y)	R(N-Z)
625.216583	1915.112411	-3501.675415
-358.369053	-2393.817444	1901.427002
-266.847523	815.704994	-1049.751541

12/06/62

GENERAL TRI-POD SOLUTION FOR LOADS AND MOMENTS APPLIED AT APEX, ONE MEMBER TAKING BENDING AND TORSION

JOB NO 1064

CONDITION49 9200# GEAR AFT OUT'D WHEEL TURNING

T(1) = -2984.799469 Q = 5794.751099

C(Q,X)	C(Q,Y)	C(Q,Z)
0.147849	0.436740	-0.887355

COS BETA = -0.998228 N = 344.819138

N(X)	N(Y)	N(Z)
-79.088921	-285.326202	-176.733521

P(O-1)	P(O-2)	P(O-3)
-5784.482666	2028.664734	-3153.221863

R(N-X)	R(N-Y)	R(N-Z)
856.746986	2530.800415	-5142.001099
-236.194164	-1577.719131	1253.194031
-620.552795	1896.918549	-2441.192810

CONDITION50 9200# GEAR AFT IN'D WHEEL TURNING

T(1) = 963.761375 Q = 3485.903198

C(Q,X)	C(Q,Y)	C(Q,Z)
0.157824	0.490817	-0.856849

COS BETA = -0.999983 N = 20.273947

N(X)	N(Y)	N(Z)
-13.795731	13.885681	5.275269

P(O-1)	P(O-2)	P(O-3)
-3485.844238	3310.362427	-837.082024

R(N-X)	R(N-Y)	R(N-Z)
550.157585	1710.939560	-2986.893646
-385.420158	-2574.512207	2044.954193
-164.737406	503.572689	-648.060532