REPORT MDC K0388
REVISION “E”
ISSUED: AUGUST 1998

MD-11
AIRPLANE CHARACTERISTICS FOR AIRPORT PLANNING

OCTOBER 1990

To Whom It May Concern:

This document is intended for airport planning purposes.
Specific aircraft performance and operational requirements are established by the airline that will use the airport under consideration.

Questions concerning the use of this document should be addressed to:

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MCDONNELL DOUGLAS
DOUGLAS AIRCRAFT COMPANY

REVISIONS
MD-11 AIRPLANE CHARACTERISTICS FOR AIRPORT PLANNING

REV. A NOV. 12, 1990 PAGE	REV. B FEB. 2, 1991 PAGE	REV. C MAY 22, 1991 PAGE	REV. D NOV. 30, 1993 PAGE	REV. E AUG. 31, 1998 PAGE
2–2	2–2	5–7	2–2	i to ii
2–3	2–3	7–7	2–3	1-2
2–14	2–5	4–3	2–4	2-2 to 2-5
2–15	2–25		2–5	2-10
3–1	2–27		2–16	2-12-2-15
3–2	4–4		2–18	2-17 to 2-19
3–3	4–5		2–23	2-24
3–4	4–8		2–24	2-28
3–5	5–12		2–25	3-1
3–6	7–4		2–27	4-2 to 4-3
3–7	7–5		Section 3	4-8 to 4-9
3–8	7–7		4–3	5-3
3–9	7–9		4–7	5-7
3–10	7–11		5–3	5-12
3–11	7–13		5–12	6-9
3–12	7–15		6–9	7-4 to 7-7
3–13	7–21		7–2	7-9
3–14	7–22		7–4	7-11
3–15	7–23		7–5	7-13
3–16	7–24		7–6	7-15
3–17			7–7	7-21 to 7-24
			7–9	8-1
			7–11	
			7–13	
			7–15	
			7–21	
			7–22	
			7–23	
			7–24	

REVISIONS (CONTINUED)
MD-11 AIRPLANE CHARACTERISTICS FOR AIRPORT PLANNING

REV. F JUNE 2010 PAGE
7-1
7-18
7-21

CONTENTS

CONTENTS (CONTINUED)

1.0 SCOPE

1.1 Purpose

1.2 Introduction

1.0 SCOPE

1.1 Purpose

This document provides, in a standardized format, airplane characteristics data for general airport planning. Since operational practices vary among airlines, specific data should be coordinated with the using airlines prior to facility design. Douglas Aircraft Company should be contacted for any additional information required.

Content of this document reflects the results of a coordinated effort by representatives of the following organizations:

- Aerospace Industries Association
- Airports Council International
- Air Transport Association of America
- International Air Transport Association

The airport planner may also want to consider the information presented ine the “CTOL Transport Aircraft: Characteristics, Trends, and Growth Projections,” available from the US AIA, 1250 Eye St., Washington DC 20005, for long range planning needs. This document is updated periodically and represents the coordinated efforts of the folllowing organizations regarding future aircraft growth trends:

- International Coordinating Council of Aerospace Industries Association
- Airports Council International
- Air Transport Association of America
- International Air Transport Association

1.2 Introduction

This document conforms to NAS 3601. It provides Model MD-11 characteristics for airport operators, airlines, and engineering consultant organizations. Since airplane changes and available options may alter the information, the data presented herein must be regarded as subject to change. Similarly, for airplanes not yet certified, changes can be expected to occur.

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2.0 AIRPLANE DESCRIPTION

2.0 AIRPLANE DESCRIPTION

2.1 General Airplane Characteristics — MD-11

Maximum Design Taxi Weight (MTW). Maximum weight for ground maneuvering as limited by aircraft strength (MTOW plus taxi fuel).

Maximum Design Landing Weight (MLW). Maximum weight for landing as limited by aircraft strength and airworthiness requirements.

Maximum Design Takeoff Weight (MTOW). Maximum weight for takeoff as limited by aircraft strength and airworthiness requirements. (This is the maximum weight at the start of the takeoff run.)

Operating Empty Weight (OEW). Weight of structure, power plant, furnishing, systems, unusable fuel and other unusable propulsion agents, and other items of equipment that are considered part of a particular airplane configuration. OEW also includes certain standard items, personnel, equipment, and supplies necessary for full operations, excluding usable fuel and payload.

Maximum Design Zero Fuel Weight (MZFW). Maximum weight allowed before usable fuel and other specified usable agents must be loaded in defined sections of the aircraft as limited by strength and airworthiness requirements.

Maximum Payload. Maximum design zero fuel weight minus operational empty weight.

Maximum Seating Capacity. The maximum number of passengers certified or anticipated for certification.

Maximum Cargo Volume. The maximum space available for cargo.

Usable Fuel. Fuel available for aircraft propulsion.

MODEL		PASSENGER	PASSENGER 'ER'	COMBI (6 PALLET)	FREIGHTER	CONVERTIBLE FREIGHTER
ENGINE		CF6-80C2	CF6-80C2	CF6-80C2	CF6-80C2	CF6-80C2
MAXIMUM DESIGN TAXI WEIGHT*	LB kg	605,500 274,655	633,000 287,122	605,500 274,655	605,500 274,655	605,500 274,655
MAXIMUM DESIGN TAKEOFF WEIGHT	LB kg	602,500 273,294	630,500 285,988	602,500 273,294	602,500 273,294	602,500 273,294
MAXIMUM DESIGN LANDING WEIGHT	LB kg	430,000 195,048	430,000 195,048	458,000 207,749	471,500 213,872	471,500 213,872
OPERATING EMPTY WEIGHT	LB kg	283,975 128,808	291,120 132,049	283,975 128,808	248,567 112,748	288,296 130,768
MAXIMUM DESIGN ZERO FUEL WEIGHT	LB kg	400,000 181,440	400,000 181,440	430,000 195,048	451,300 204,710	451,300 204,710
MAXIMUM PAYLOAD (WEIGHT-LIMITED)	LB kg	116,025 52,632	108,880 49,391	146,707 66,549	202,733 91,962	163,004 73,942
MAXIMUM SEATING CAPACITY	STD MAX	323 410	323 410	214 290	0 0	298 410
MAXIMUM CARGO VOLUME	FT^3 m^3	5,566 157.6	5,288 149.7	9,152 259.2	21,530 609.7	21,288 602.3
MAXIMUM USABLE FUEL	U.S. GAL liters LB kg	38,615 146,173 258,721 117,356	41,615 157,529 278,821 126,470	38,615 146,173 258,721 117,356	38,615 146,173 258,721 117,356	38,615 146,173 258,721 117,356

* OPTIONAL MTW: 608,500 LB (276,016 kg)
613,000 LB (278,057 kg)
621,000 LB (281,686 kg)
628,000 LB (284,861 kg)
633,000 LB (287,122 kg)

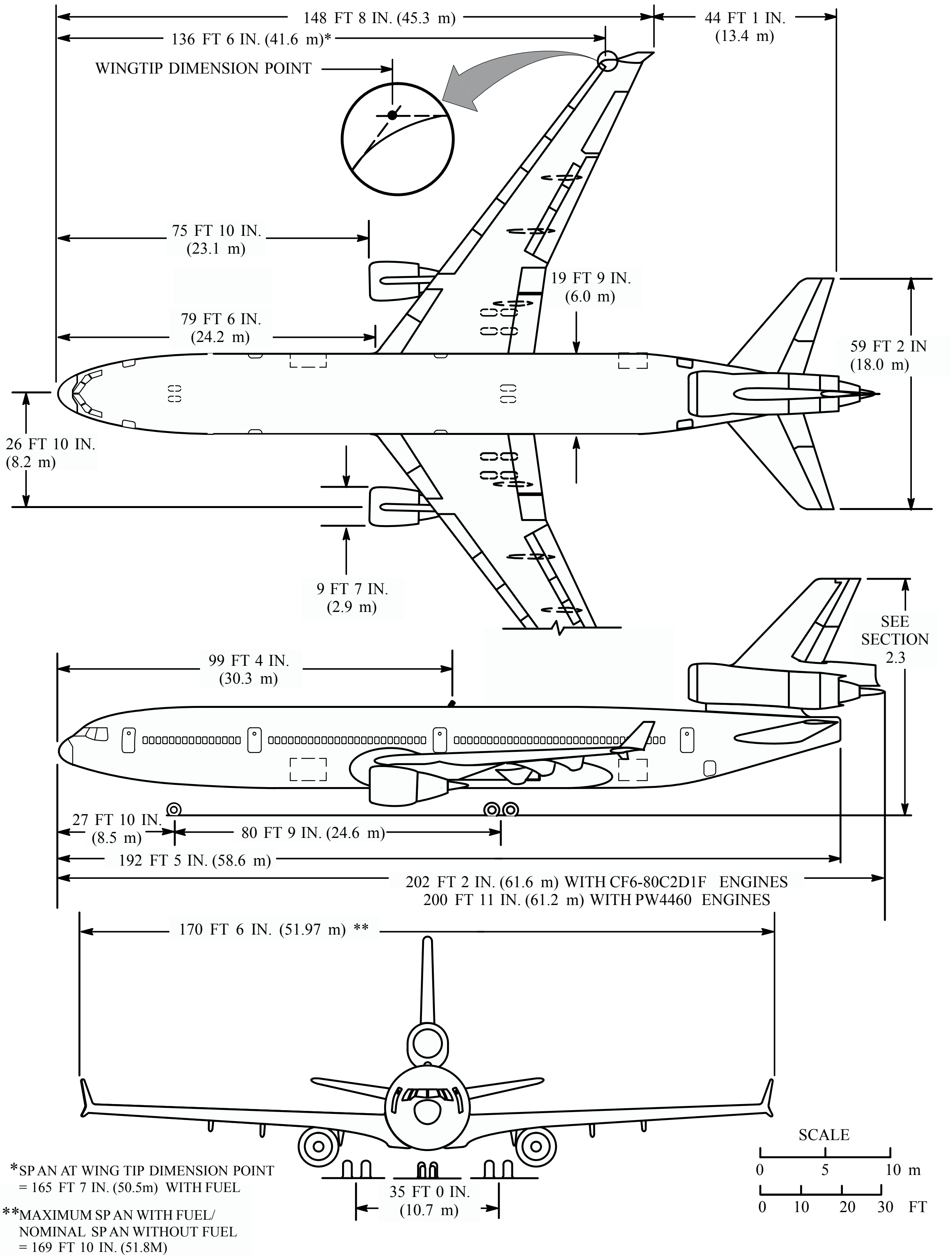
** OPTIONAL MLW (FREIGHTER ONLY): 491,500 LB (222,944 kg)

2.0 AIRPLANE DESCRIPTION
2.1 GENERAL AIRPLANE CHARACTERISTICS
MODEL MD-11 GE ENGINE

MODEL		PASSENGER	PASSENGER 'ER'	COMBI (6 PALLET)	FREIGHTER	CONVERTIBLE FREIGHTER
ENGINE		4460	4460	4460	4460	4460
MAXIMUM DESIGN TAXI WEIGHT*	LB kg	605,500 274,655	633,000 287,122	605,500 274,655	605,500 274,655	605,500 274,655
MAXIMUM DESIGN TAKEOFF WEIGHT	LB kg	602,500 273,294	630,500 285,988	602,500 273,294	602,500 273,294	602,500 273,294
MAXIMUM DESIGN LANDING WEIGHT	LB kg	430,000 195,048	430,000 195,048	458,000 207,749	471,500 213,872	471,500 213,872
OPERATING EMPTY WEIGHT	LB kg	283,975 128,808	291,120 132,049	283,975 128,808	248,567 112,748	288,296 130,768
MAXIMUM DESIGN ZERO FUEL WEIGHT	LB kg	400,000 181,440	400,000 181,440	430,000 195,048	451,300 204,710	451,300 204,710
MAXIMUM PAYLOAD (WEIGHT-LIMITED)	LB kg	116,025 52,632	108,880 49,391	146,707 66,549	202,733 91,962	163,004 73,942
MAXIMUM SEATING CAPACITY	STD MAX	323 410	323 410	214 290	0 0	298 410
MAXIMUM CARGO VOLUME	FT^3 m^3	5,566 157.6	5,288 149.7	9,152 259.2	21,530 609.7	21,288 602.3
MAXIMUM USABLE FUEL	U.S. GAL liters LB kg	38,615 146,173 258,721 117,356	41,615 157,529 278,821 126,470	38,615 146,173 258,721 117,356	38,615 146,173 258,721 117,356	38,615 146,173 258,721 117,356

* OPTIONAL MTW: 608,500 LB (276,016 kg)
613,000 LB (278,057 kg)
621,000 LB (281,686 kg)
628,000 LB (284,861 kg)
633,000 LB (287,122 kg)

2.0 AIRPLANE DESCRIPTION
2.1 GENERAL AIRPLANE CHARACTERISTICS
MODEL MD-11 P&W ENGINE



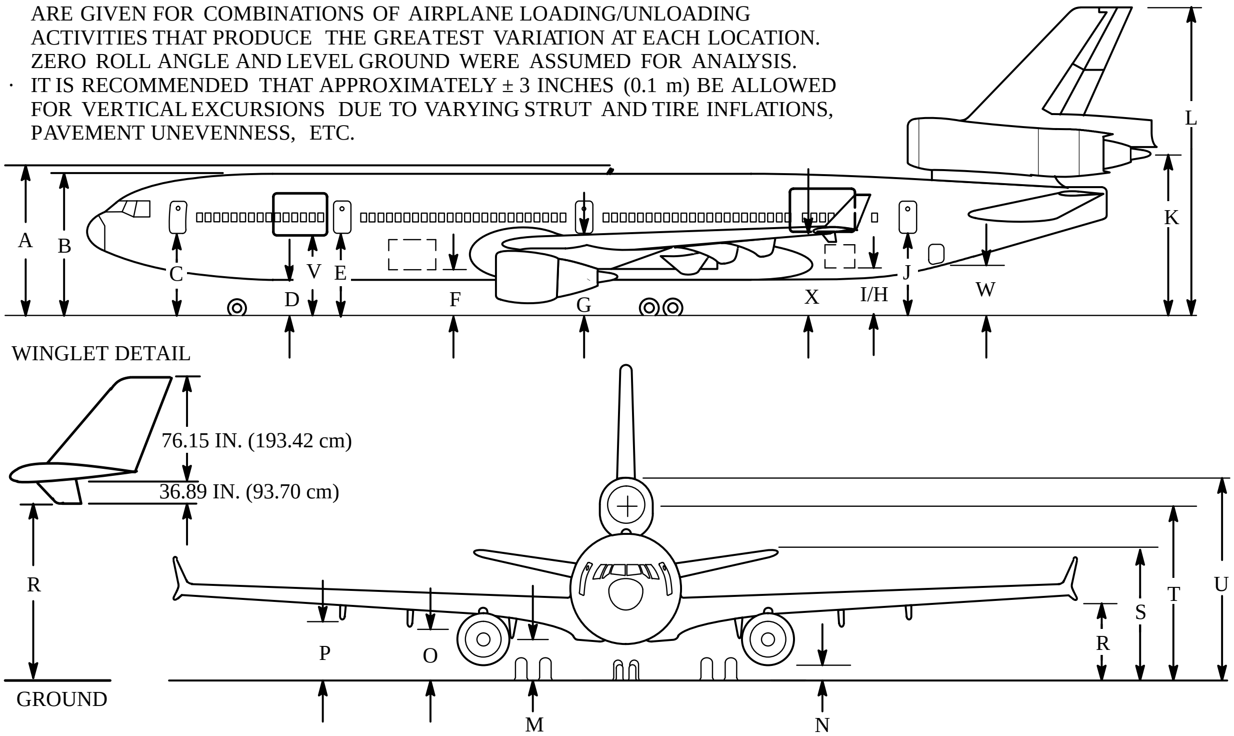
*SP AN AT WING TIP DIMENSION POINT
= 165 FT 7 IN. (50.5m) WITH FUEL

**MAXIMUM SP AN WITH FUEL/
NOMINAL SP AN WITHOUT FUEL
= 169 FT 10 IN. (51.8M)

2.2 GENERAL AIRPLANE DIMENSIONS
MODEL MD-11

REV E

- MAXIMUMAND MINIMUMCLEARANCES OF INDIVIDUALLOCATIONS ARE GIVEN FOR COMBINATIONS OF AIRPLANE LOADING/UNLOADING ACTIVITIES THAT PRODUCE THE GREATEST VARIATION AT EACH LOCATION. ZERO ROLL ANGLE AND LEVEL GROUND WERE ASSUMED FOR ANALYSIS.
- IT IS RECOMMENDED THAT APPROXIMATELY ± 3 INCHES (0.1 m) BE ALLOWED FOR VERTICAL EXCURSIONS DUE TO VARYING STRUT AND TIRE INFLATIONS, PAVEMENT UNEVENNESS, ETC.

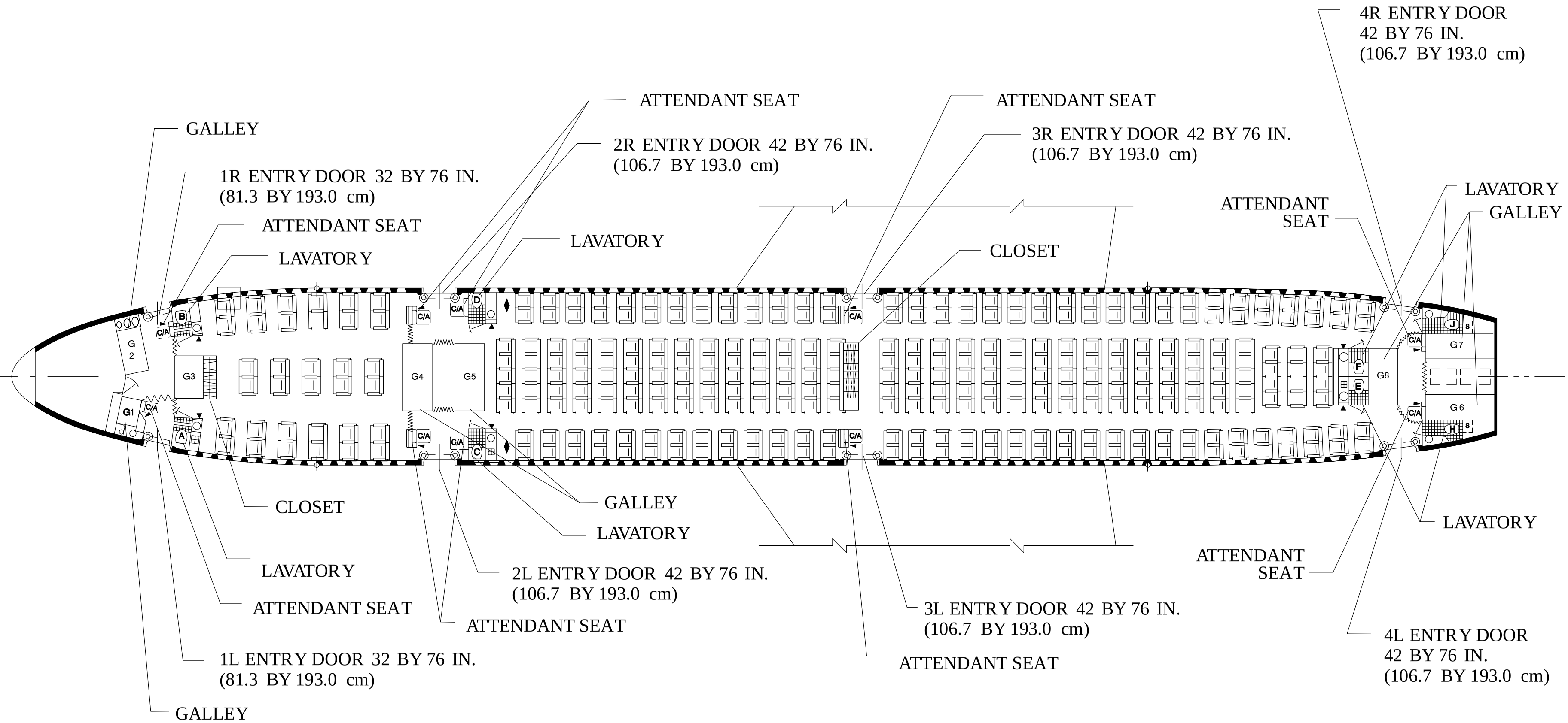


VERTICAL CLEARANCE				
	MIN CLEARANCE CRITICAL WT AND CG		MAX CLEARANCE CRITICAL WT AND CG	
	FT – IN.	METERS	FT – IN.	METERS
A	28 – 7	8.71	29 – 2	8.89
B	27 – 1	8.27	28 – 6	8.69
C	15 – 9	4.81	17 – 5	5.31
D	7 – 4	2.23	8 – 9	2.67
E	15 – 8	4.78	16 –11	5.16
F	9 – 2	2.80	10 – 3	3.12
G	15 – 7	4.75	16 – 3	4.95
H	8 – 10	2.69	9 – 9	2.97
I	8 – 10	2.69	9 – 9	2.97
J	15 – 4	4.67	16 – 3	4.95
K	29 – 5	8.97	30 – 9	9.37
L	57 – 6	17.53	58 – 10	17.93
M	7 – 10	2.38	8 – 5	2.57
N *	3 – 2	0.96	4 – 5	1.35
O	9 – 8	2.93	10 – 5	3.17
P	10 – 8	3.25	11 – 7	3.53
R	12 – 4	3.77	13 – 4	4.06
S	23 – 4	7.11	25 – 7	7.80
T	32 – 7	9.93	33 – 6	10.21
U	37 – 3	11.35	38 – 2	11.63
V	15 – 8	4.80	17 – 1	5.21
W	10 – 3	3.12	11 – 4	3.45
X	15 – 5	4.70	16 – 3	4.95

* = GE CF6–80C2 D1F
H = STANDARD CENTER CARGO DOOR
I = COMBI CENTER CARGO DOOR
V = FREIGHTER
X = COMBI MAINDECK DOOR

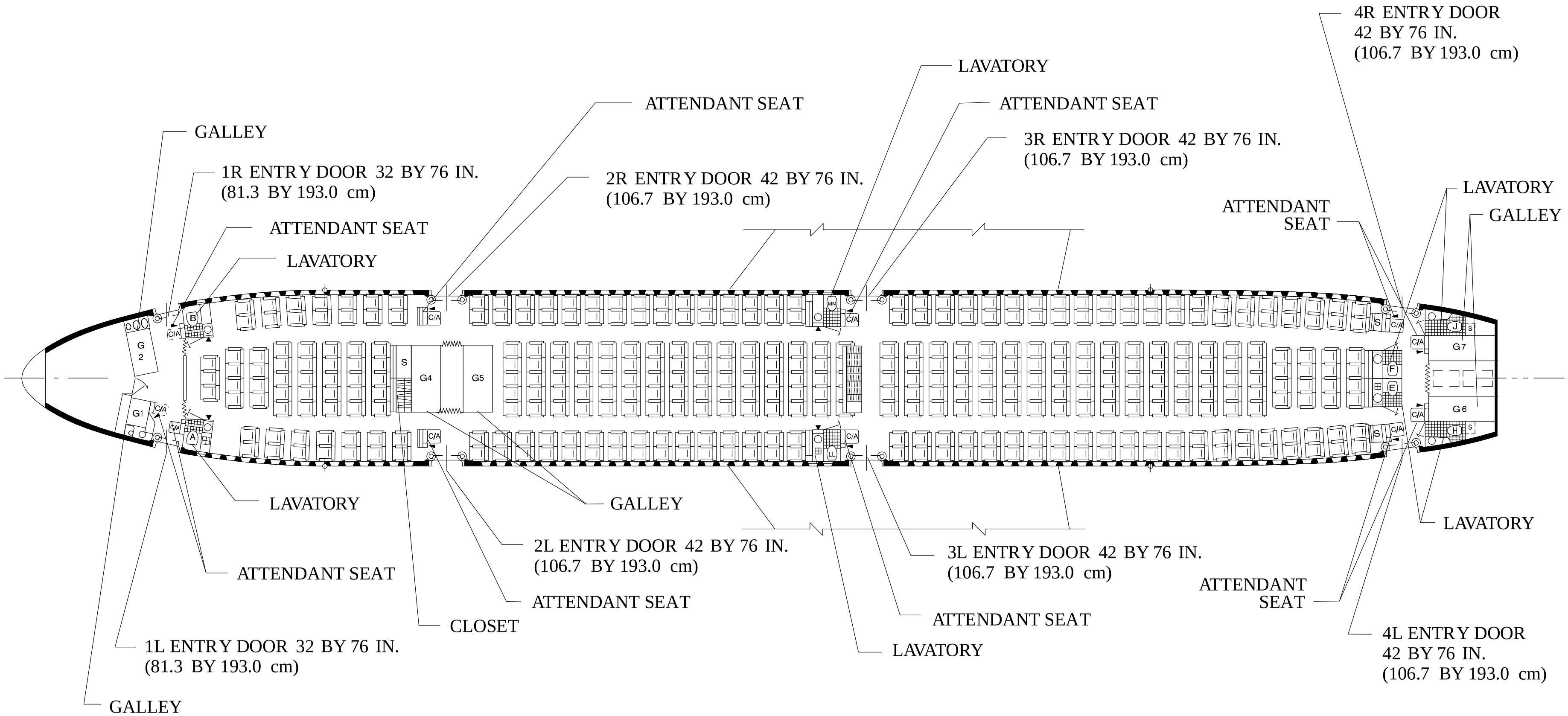
2.3 GROUND CLEARANCES
MODEL MD-11

323 SEATS, 34 FIRST CLASS — 6 ABREAST, 289 COACH — 9 ABREAST



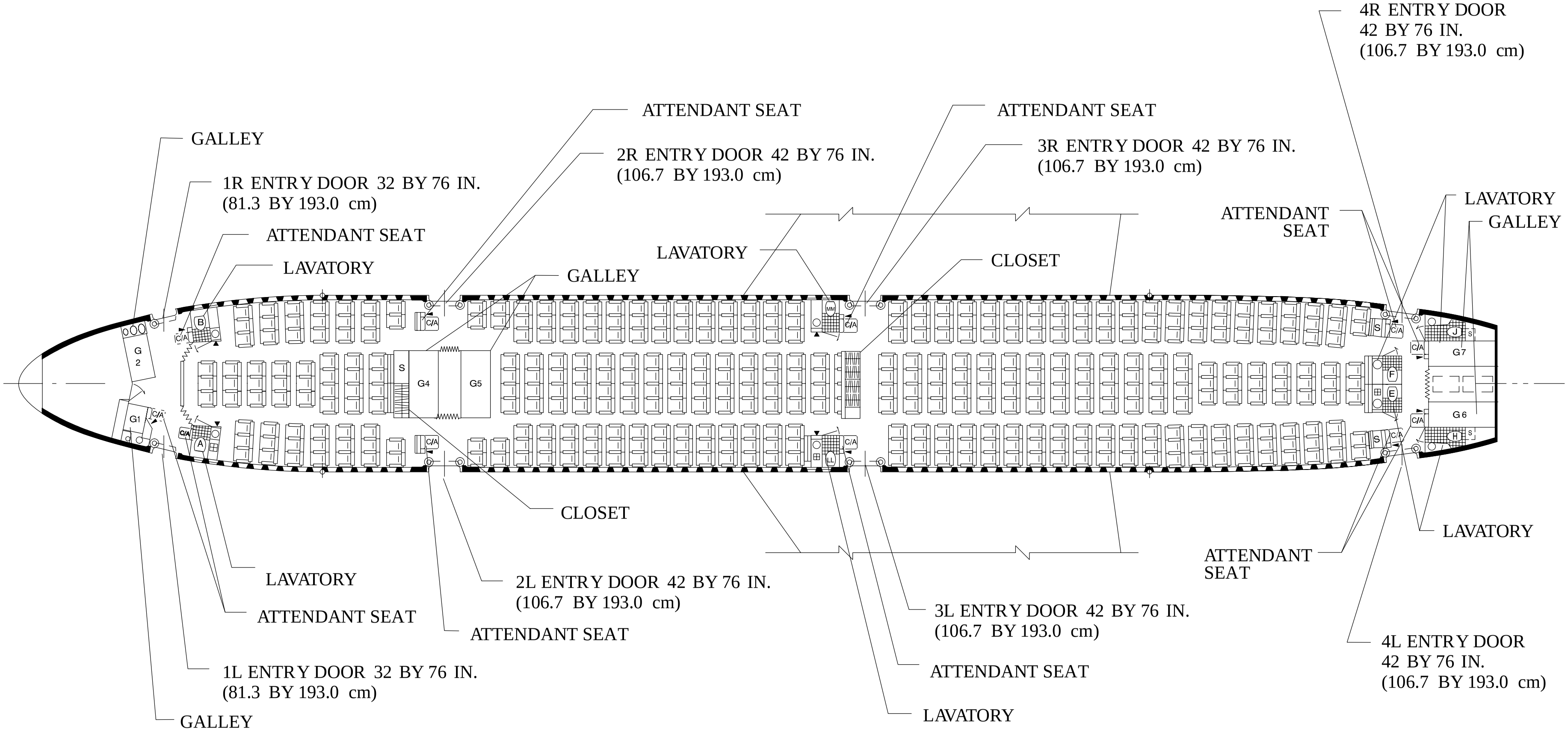
2.4 INTERIOR ARRANGEMENTS
2.4.1 PASSENGERS – MIXED-CLASS SEATING
MODEL MD-11

379 SEATS — 9 ABREAST



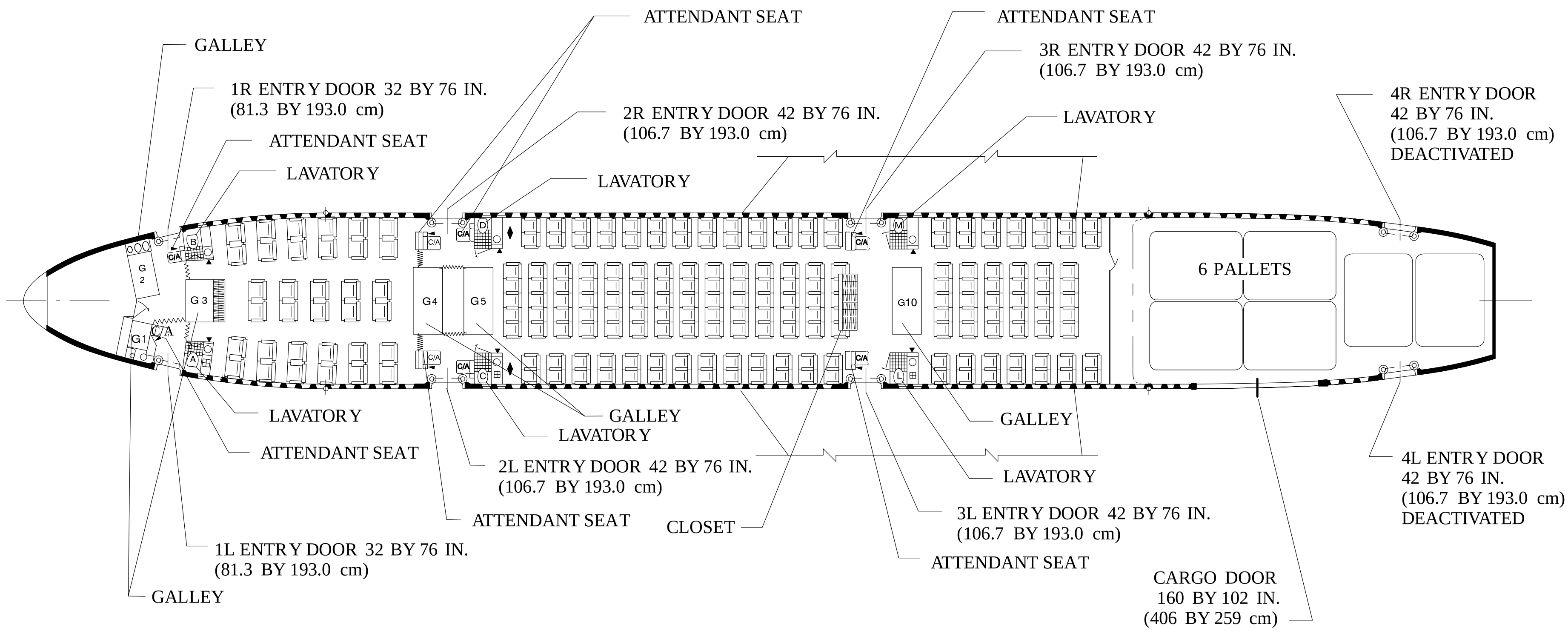
2.4.2 PASSENGERS – ECONOMY SEATING MODEL MD-11

410 SEATS — 10 ABREAST



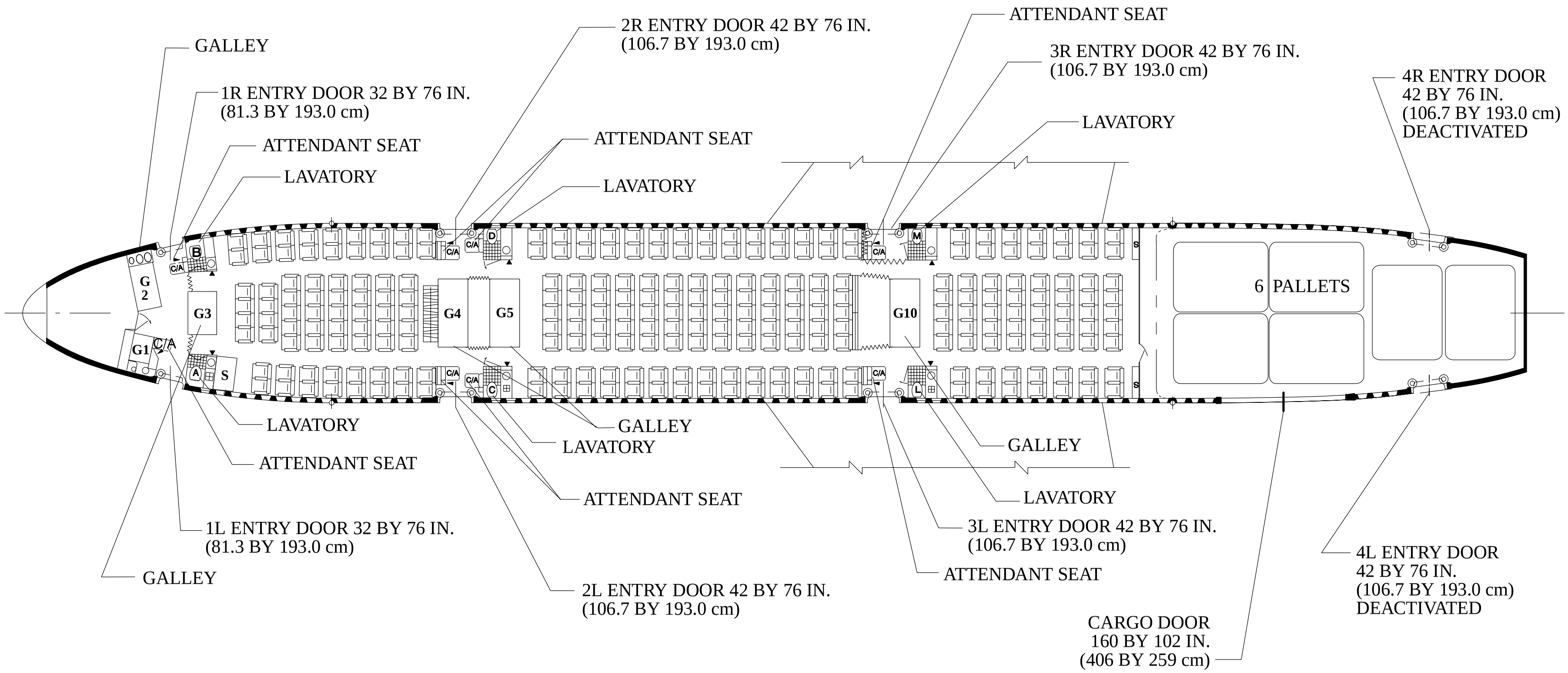
2.4.3 PASSENGERS – HIGH-DENSITY SEATING
MODEL MD-11

214 SEATS, 34 FIRST CLASS — 6 ABREAST, 180 COACH — 9 ABREAST



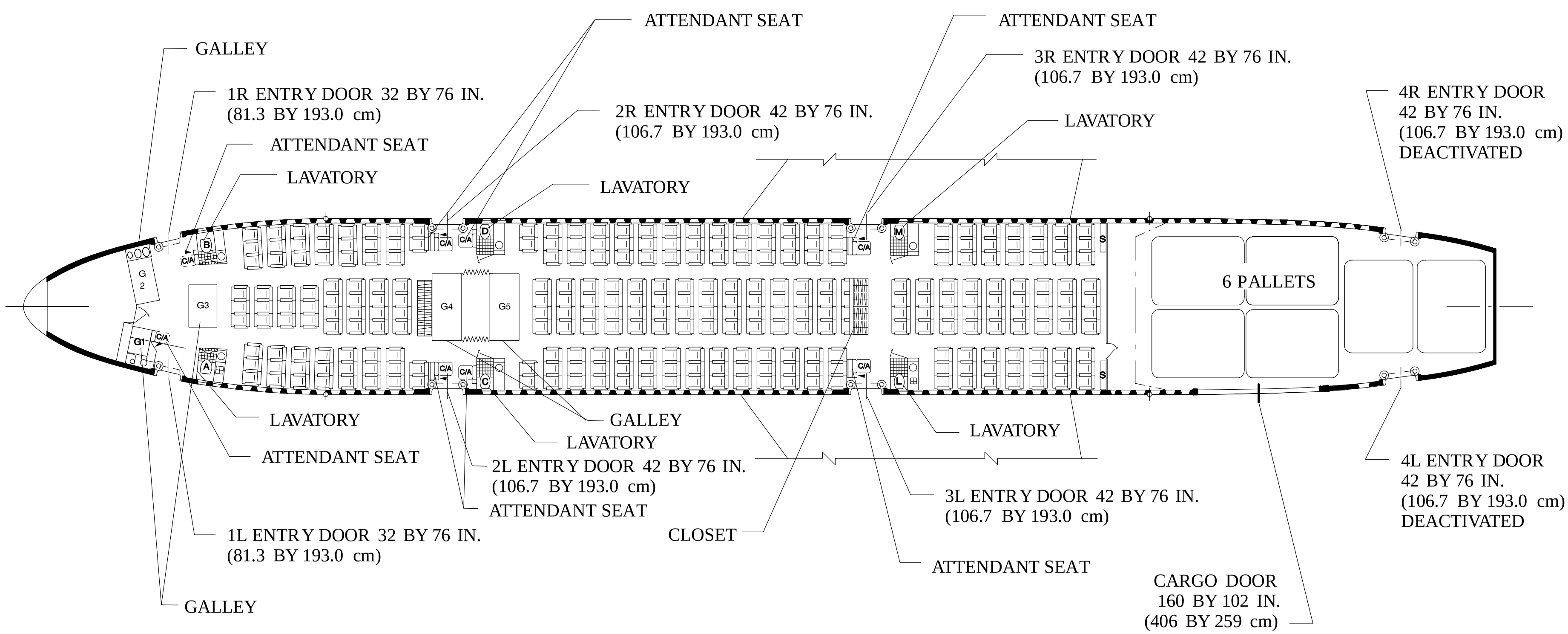
2.4.4 PASSENGERS – MIXED-CLASS SEATING
MODEL MD-11 COMBI

261 SEATS - 9 ABREAST

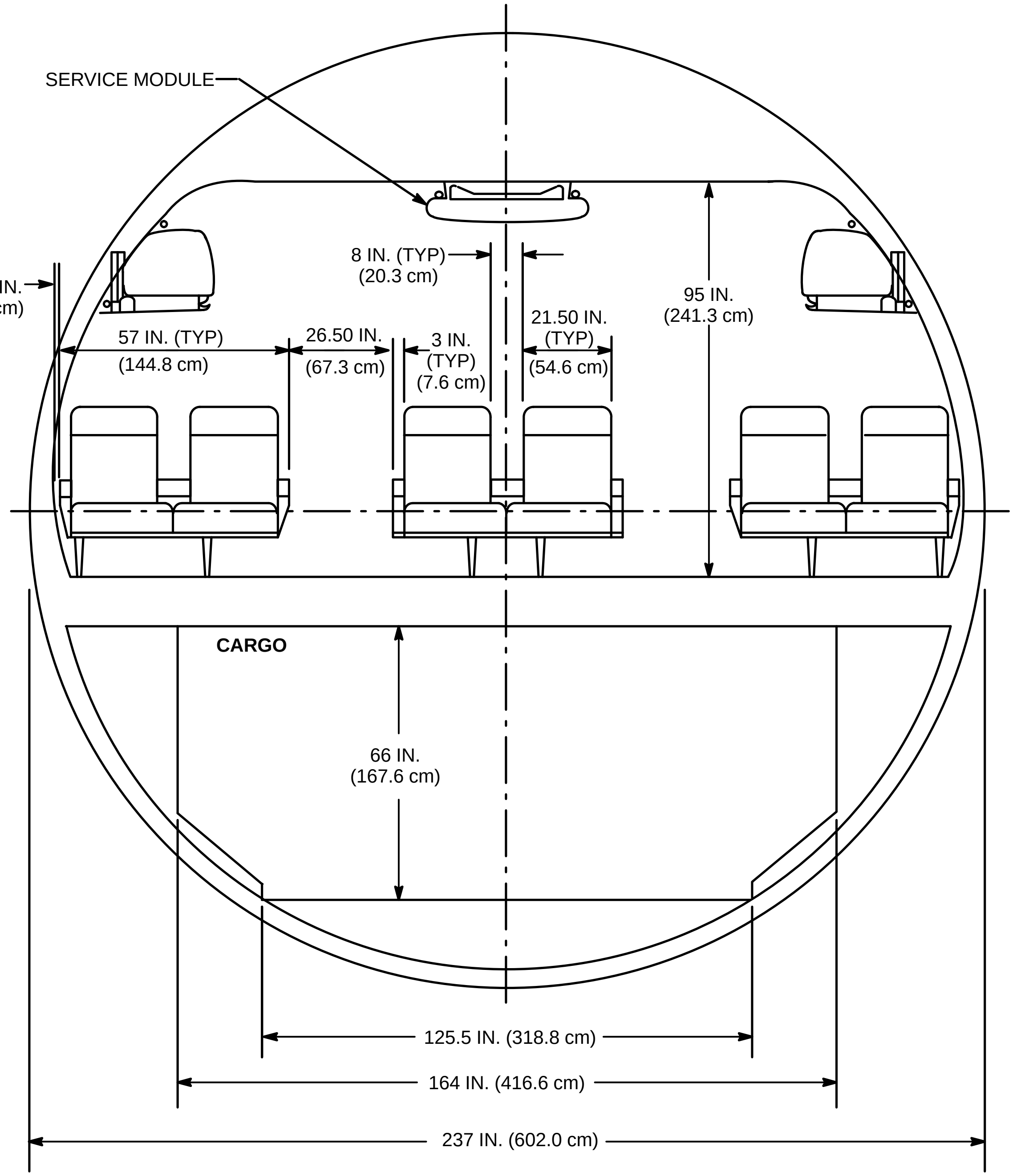


2.4.5 PASSENGERS - ECONOMY SEATING
MODEL MD-11 COMBI

290 SEATS — 10 ABREAST

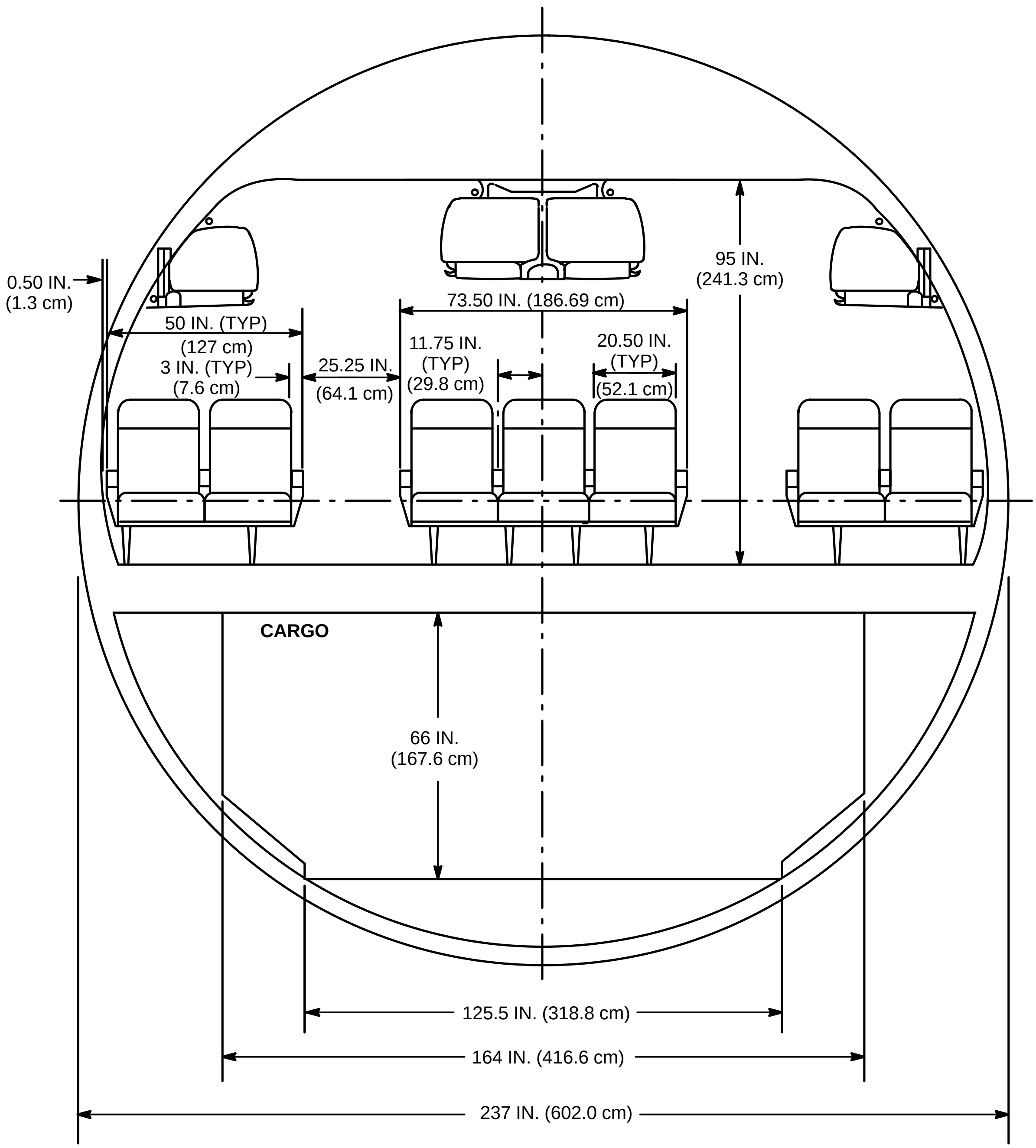


2.4.6 PASSENGERS – HIGH-DENSITY SEATING MODEL MD-11 COMBI



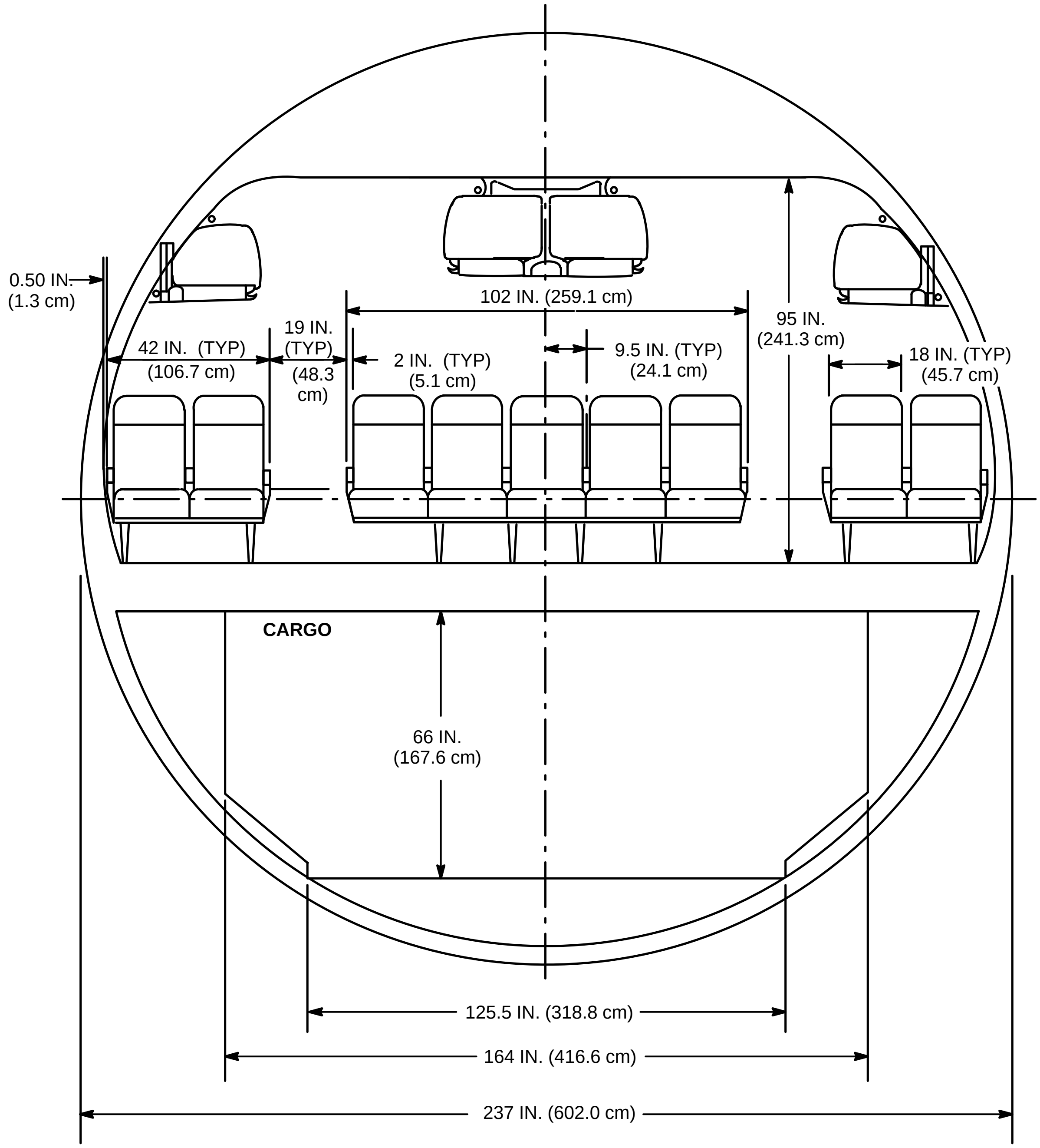
2.5 CABIN CROSS SECTION
2.5.1 FIRST CLASS
MODEL MD-11

REV E



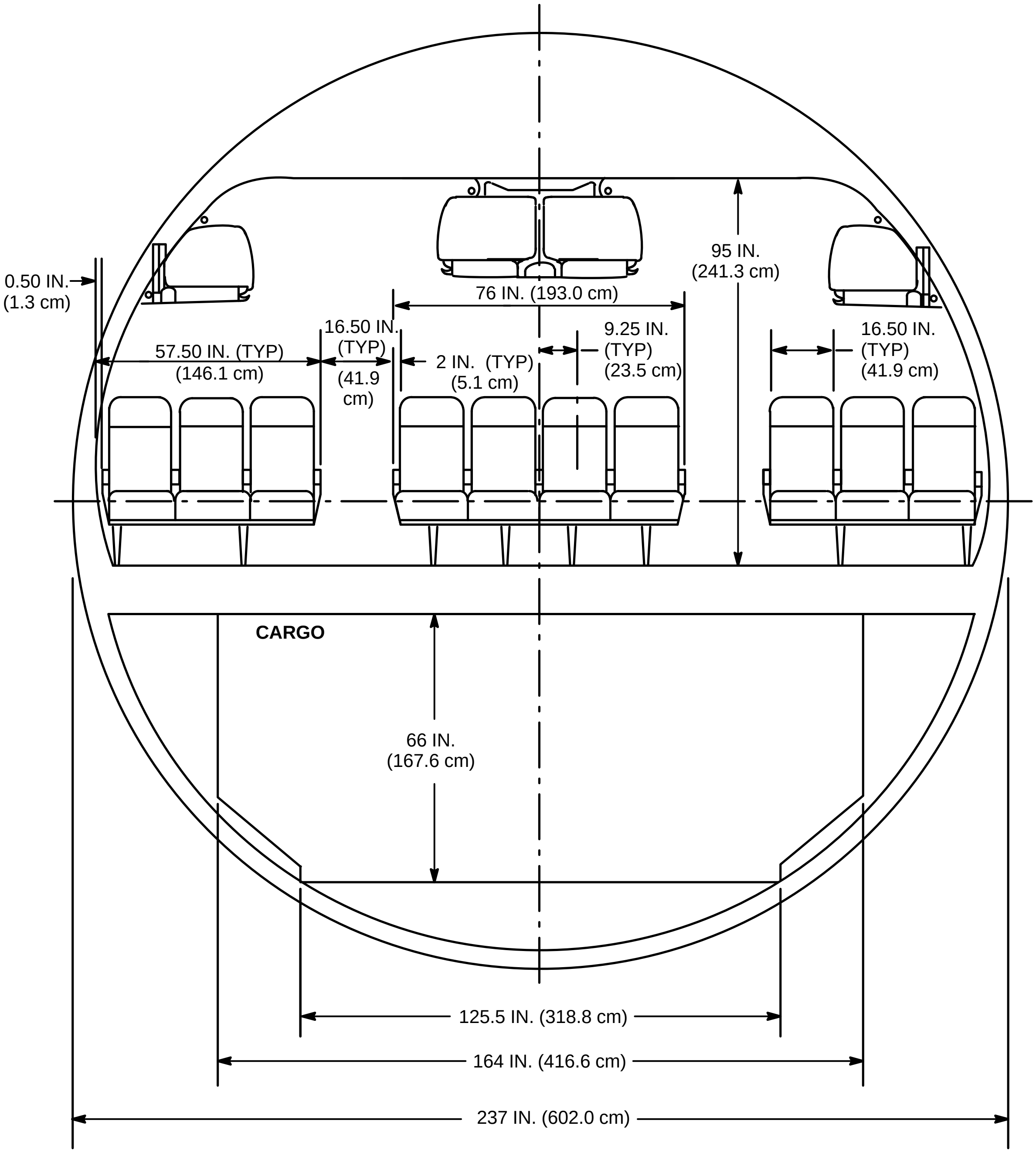
2.5.2 BUSINESS CLASS
MODEL MD-11

REV E



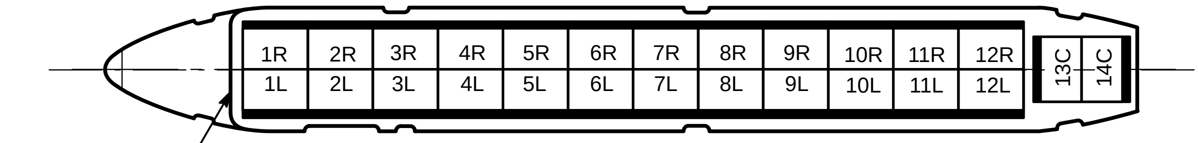
2.5.3 ECONOMY
MODEL MD-11

REV E

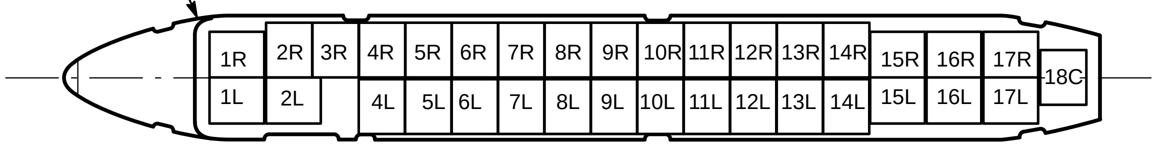


2.5.4 HIGH-DENSITY
MODEL MD-11

REV E



FREIGHTER (26) 88- BY 125-IN. PALLETS = 14,542 FT^3 (411.8 m^3)
(26) 96- BY 125-IN. PALLETS = 15,514 FT^3 (439.3 m^3)
CF (26) 88- BY 125-IN. PALLETS = 13,521 FT^3 (382.9 m^3)
(26) 96- BY 125-IN. PALLETS = 14,508 FT^3 (410.8 m^3)

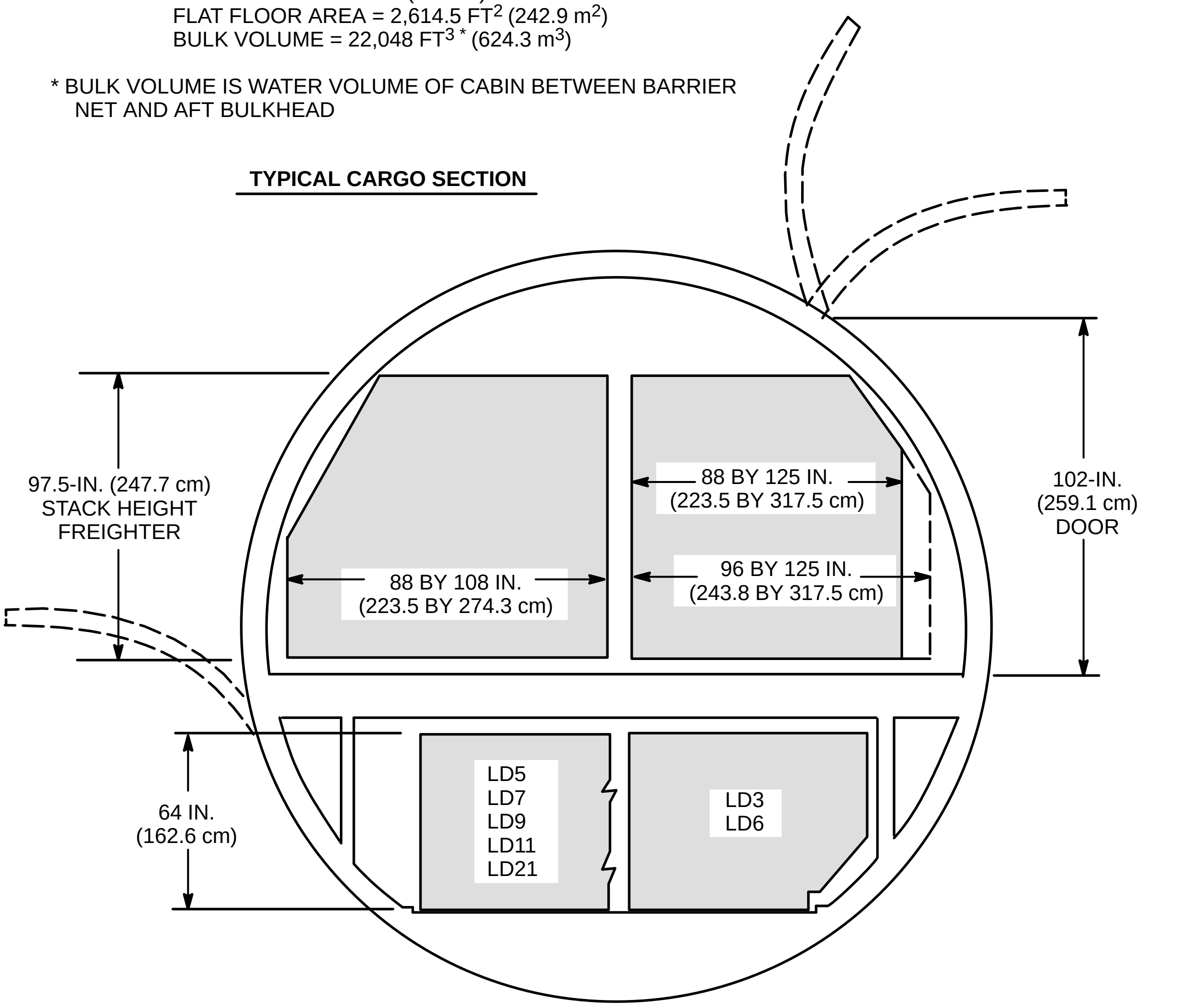


FREIGHTER (34) 88- BY 108-INCH PALLETS = 15,537 FT^3 (440.0 m^3)

MAIN CARGO LOADED COMPARTMENT
LENGTH = 144 FT 4 IN. (44.0 m)
FLAT FLOOR AREA = 2,614.5 FT^2 (242.9 m^2)
BULK VOLUME = 22,048 FT^3 * (624.3 m^3)

* BULK VOLUME IS WATER VOLUME OF CABIN BETWEEN BARRIER NET AND AFT BULKHEAD

TYPICAL CARGO SECTION



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2.5.5 CROSS SECTION – CARGO
MODEL MD-11F/CF

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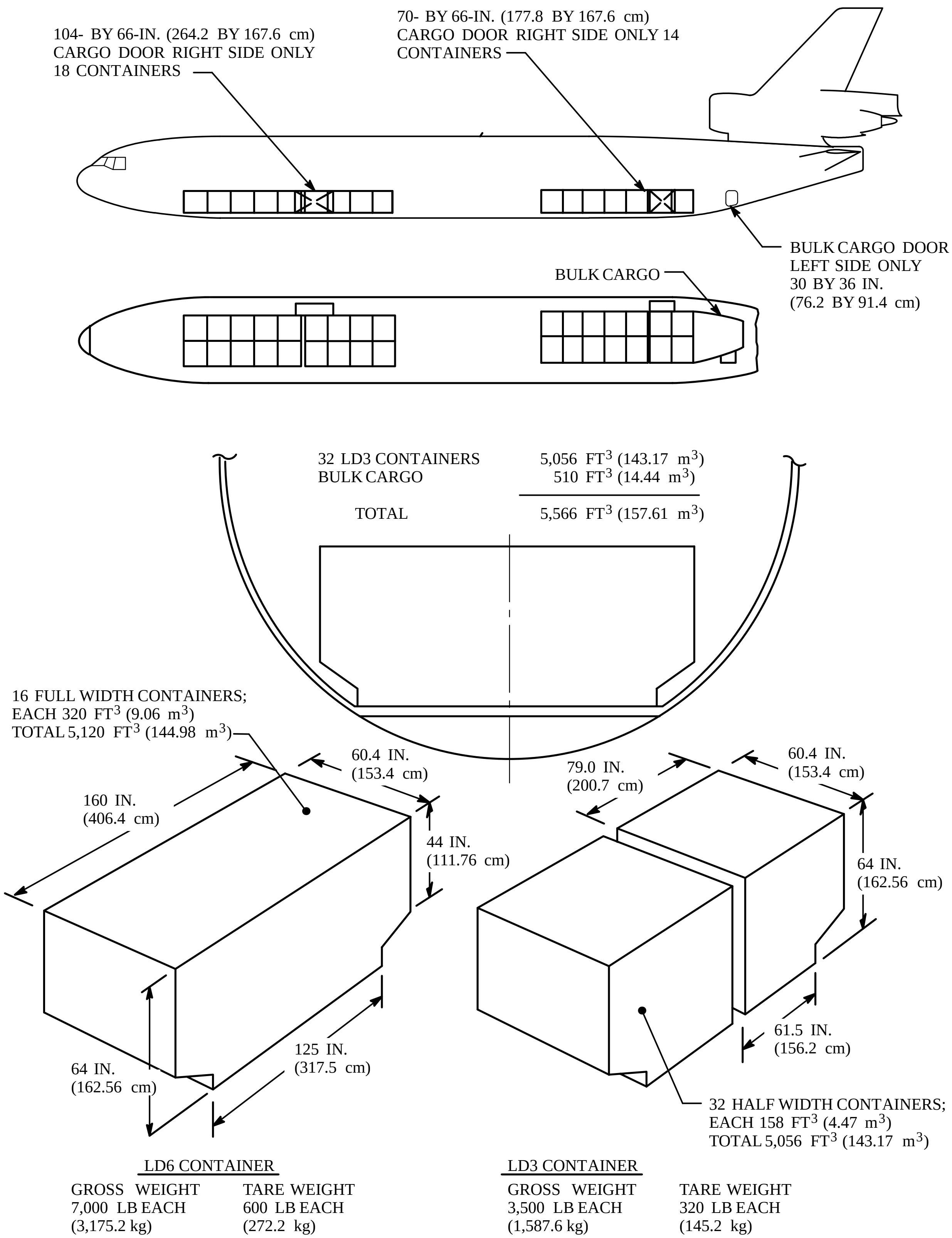
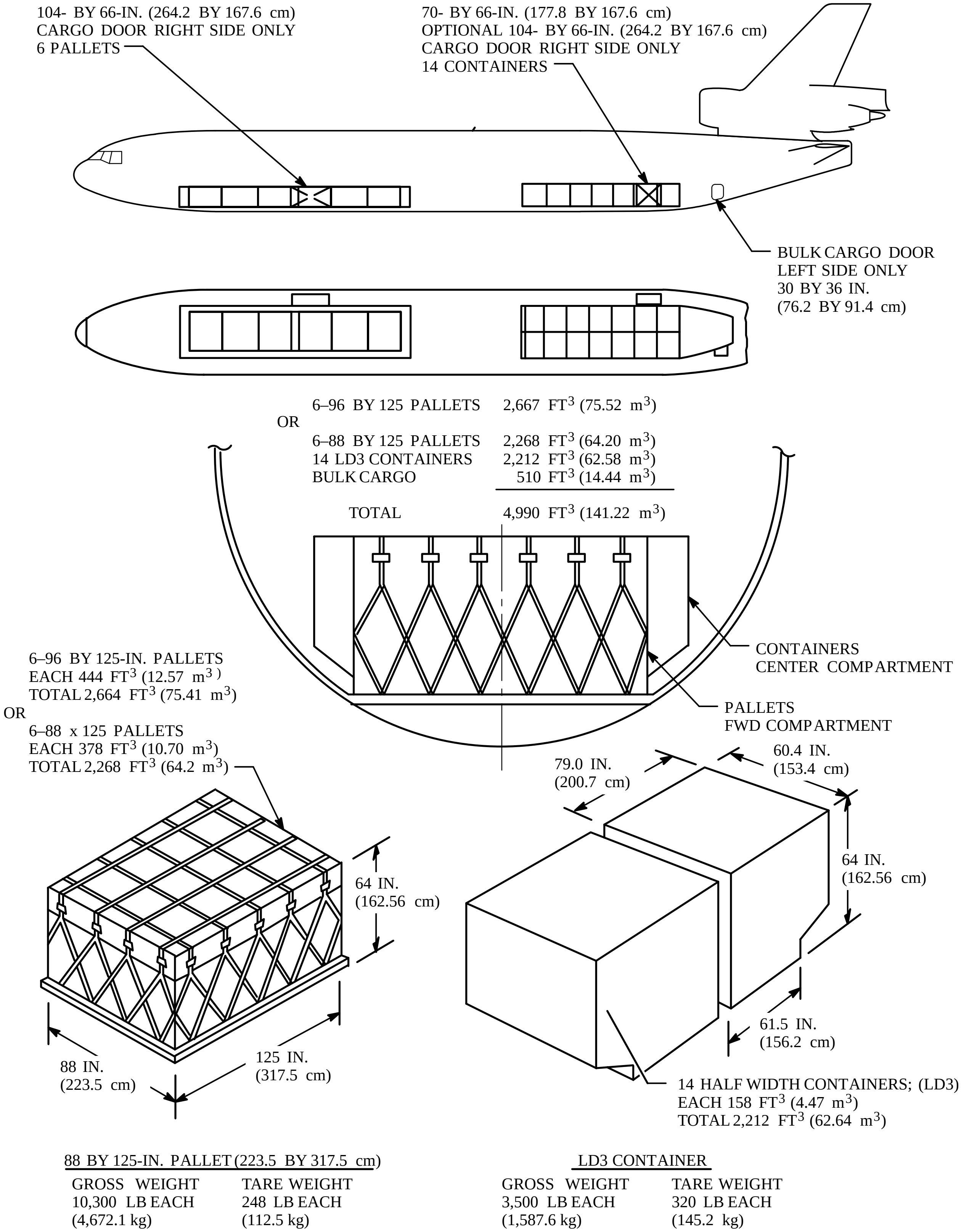
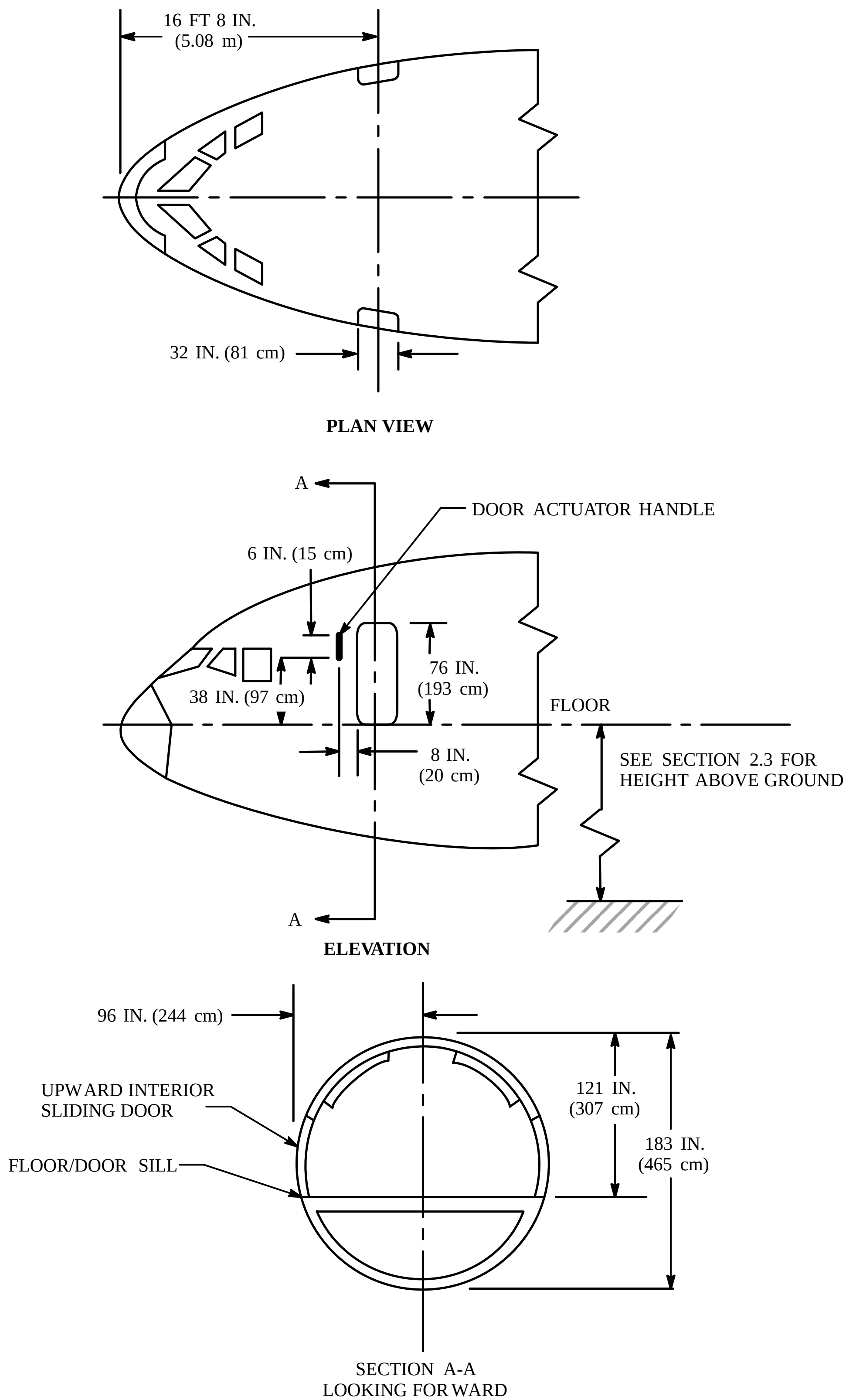


2.6 LOWER COMPARTMENT
2.6.1 CARGO COMPARTMENTS – CONTAINERS
MODEL MD-11

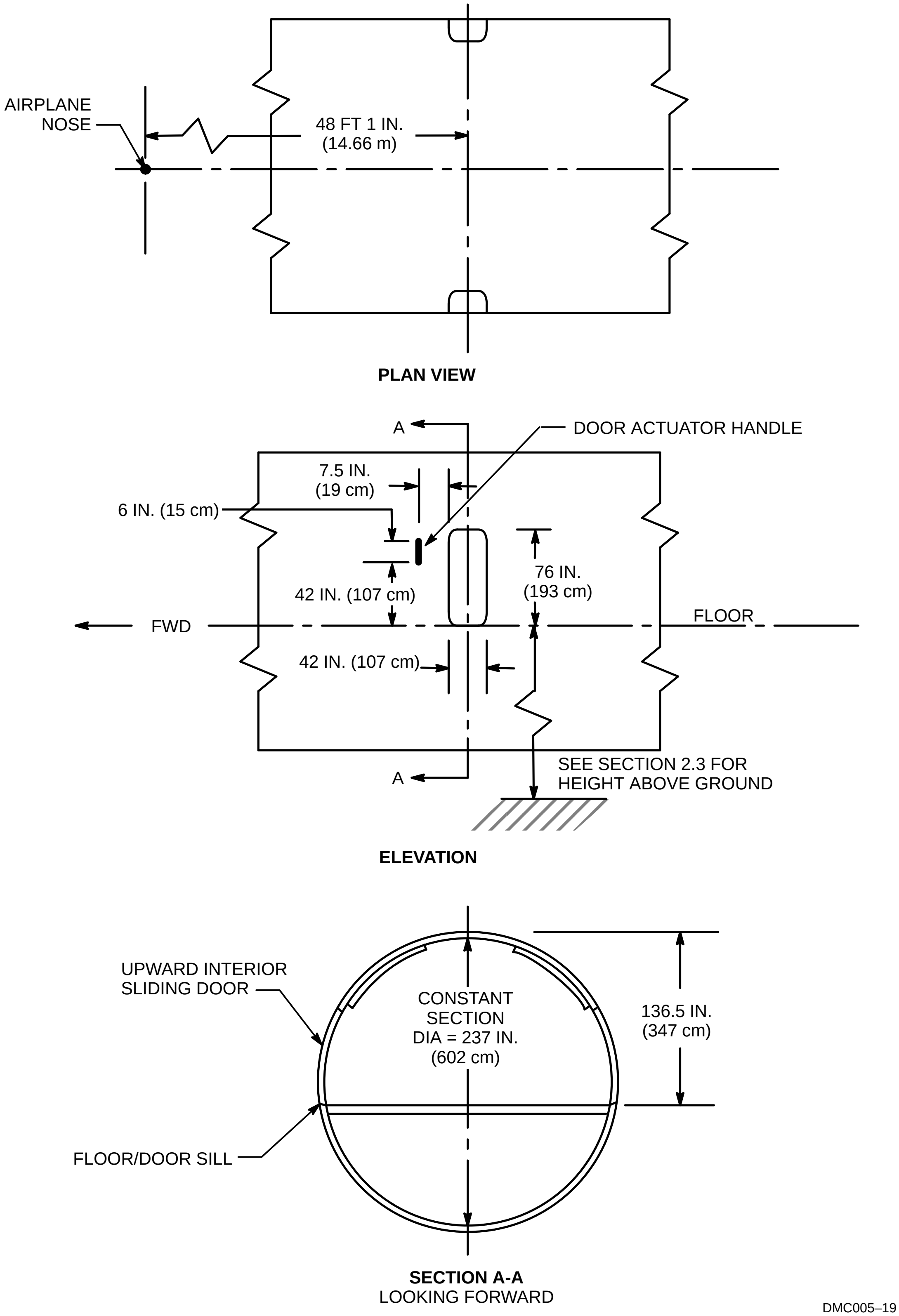
REV E



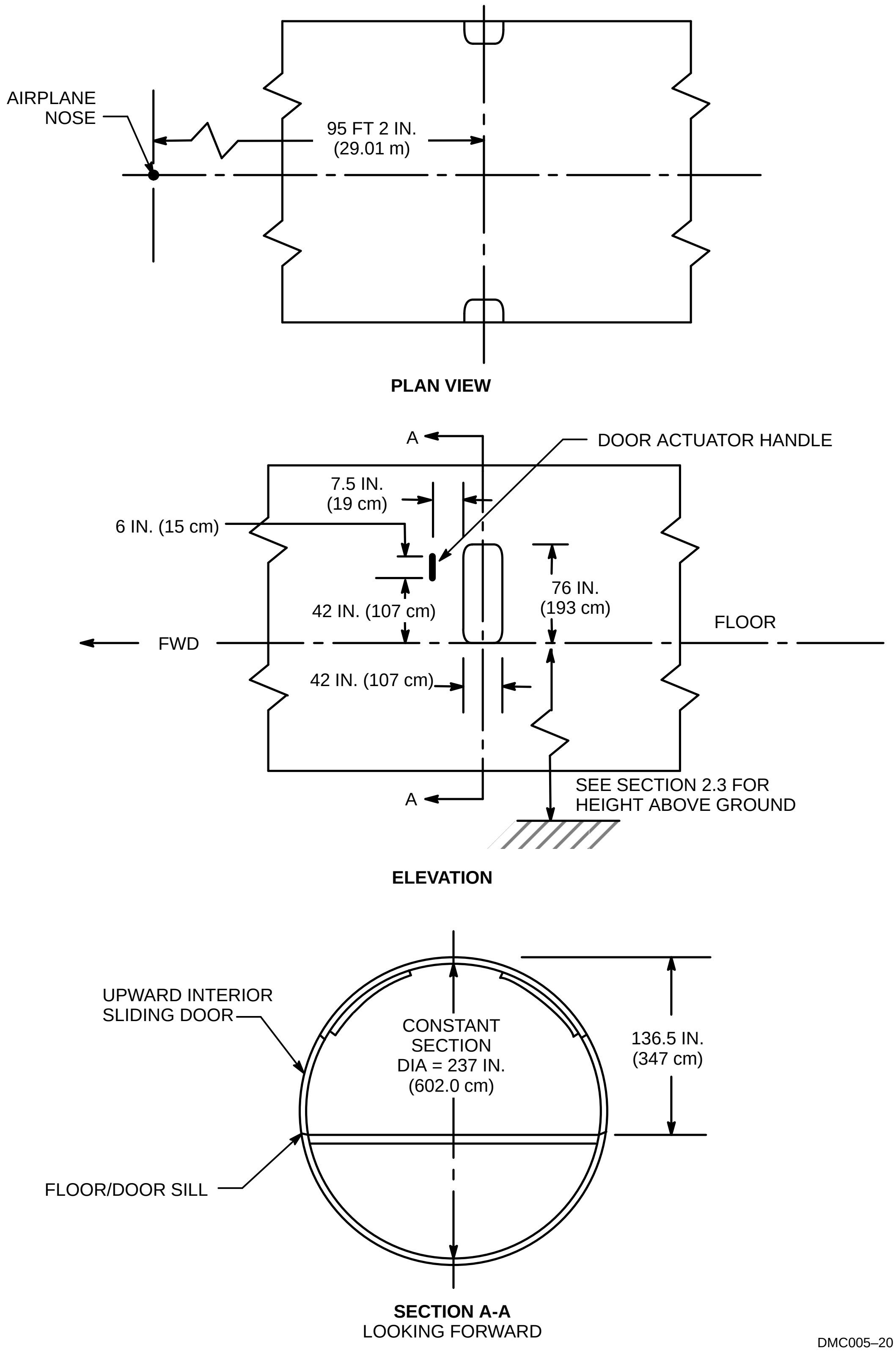
2.6.2 CARGO COMPARTMENTS – CONTAINERS/PALLETS MODEL MD-11



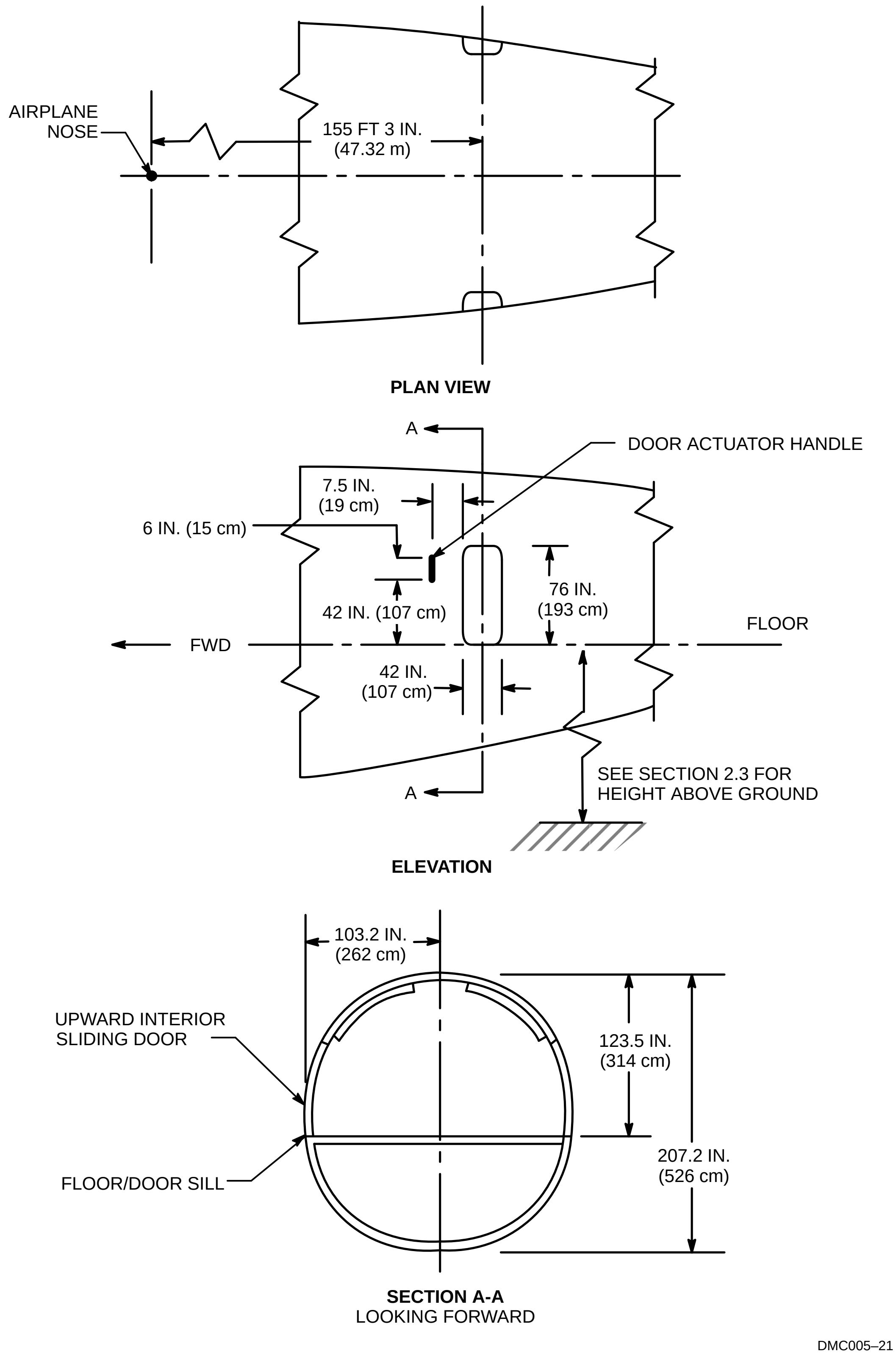
2.7 DOOR CLEARANCES
2.7.1 CLEARANCES, PASSENGER LOADING DOORS, DOOR NO. 1
MODEL MD-11



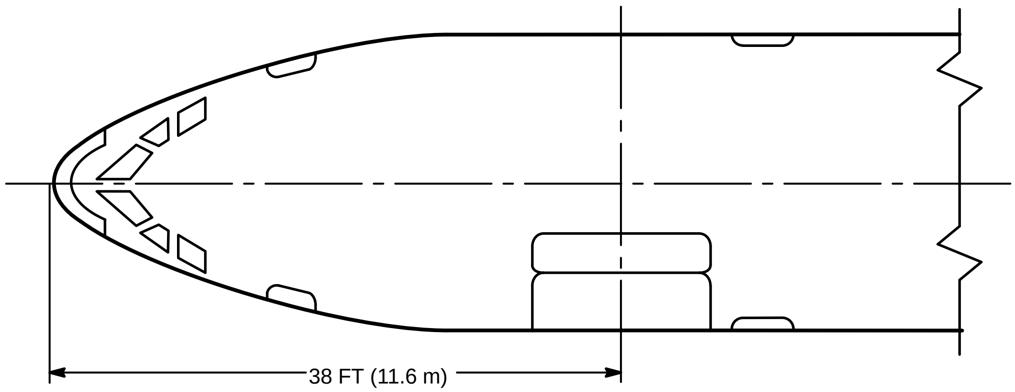
2.7.1 CLEARANCES, PASSENGER LOADING DOORS, DOOR NO. 2
MODEL MD-11



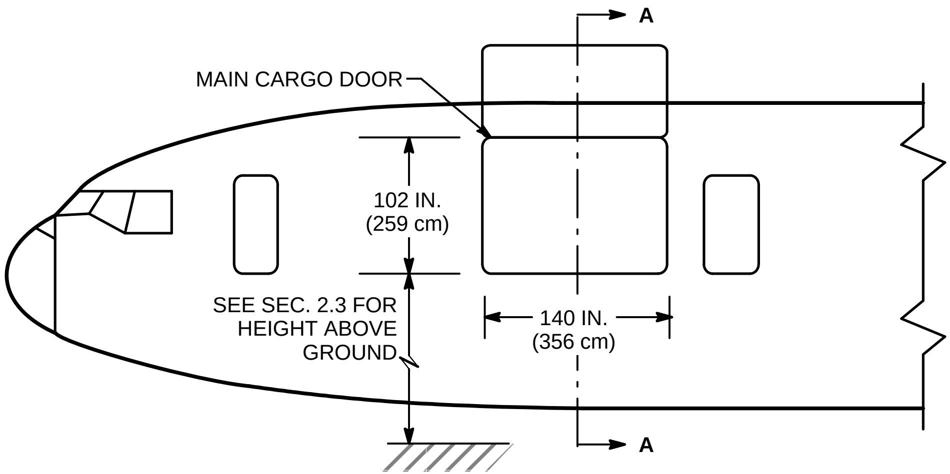
2.7.1 CLEARANCES, PASSENGER LOADING DOORS, DOOR NO. 3 MODEL MD-11



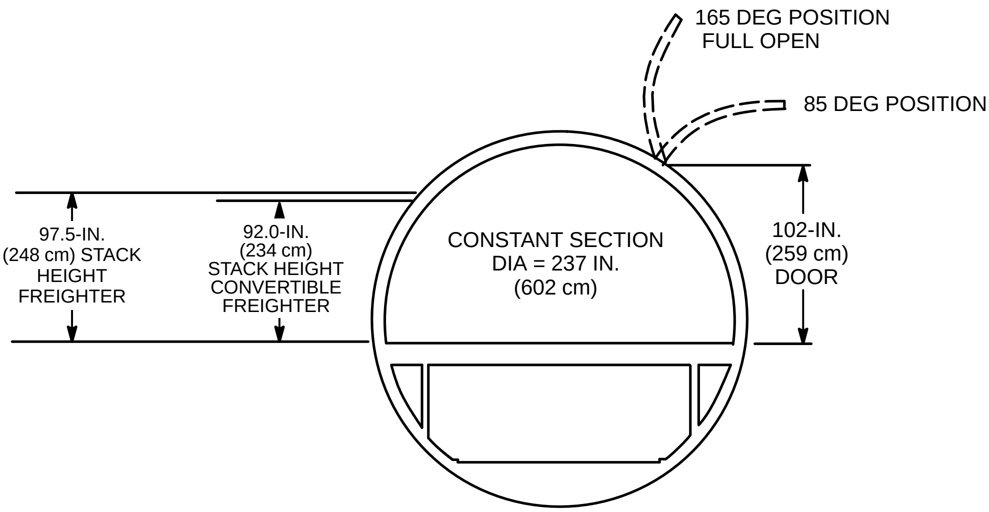
2.7.1 CLEARANCES, PASSENGER LOADING DOORS, DOOR NO. 4
MODEL MD-11



PLAN VIEW



ELEVATION



SECTION A-A
LOOKING AFT

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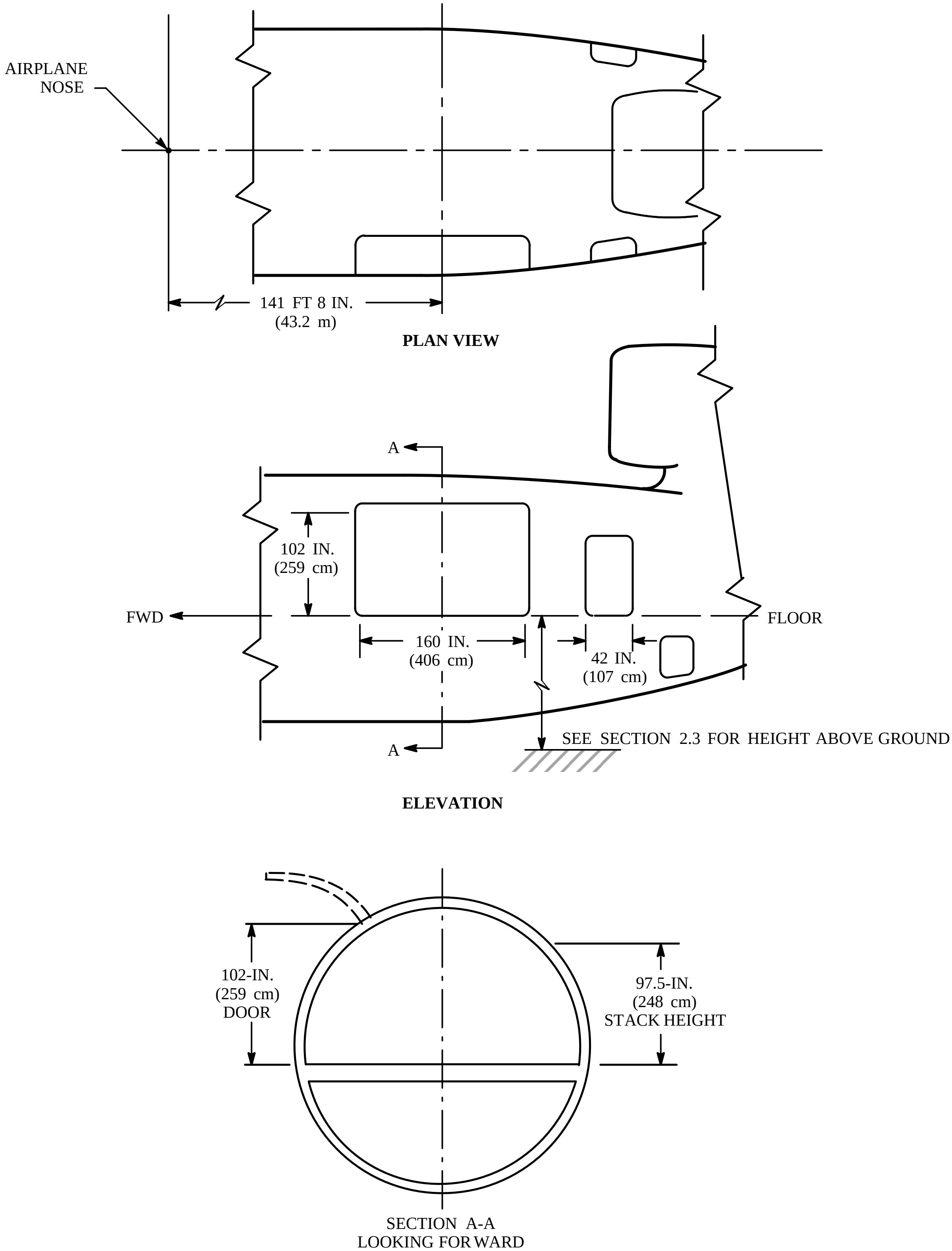
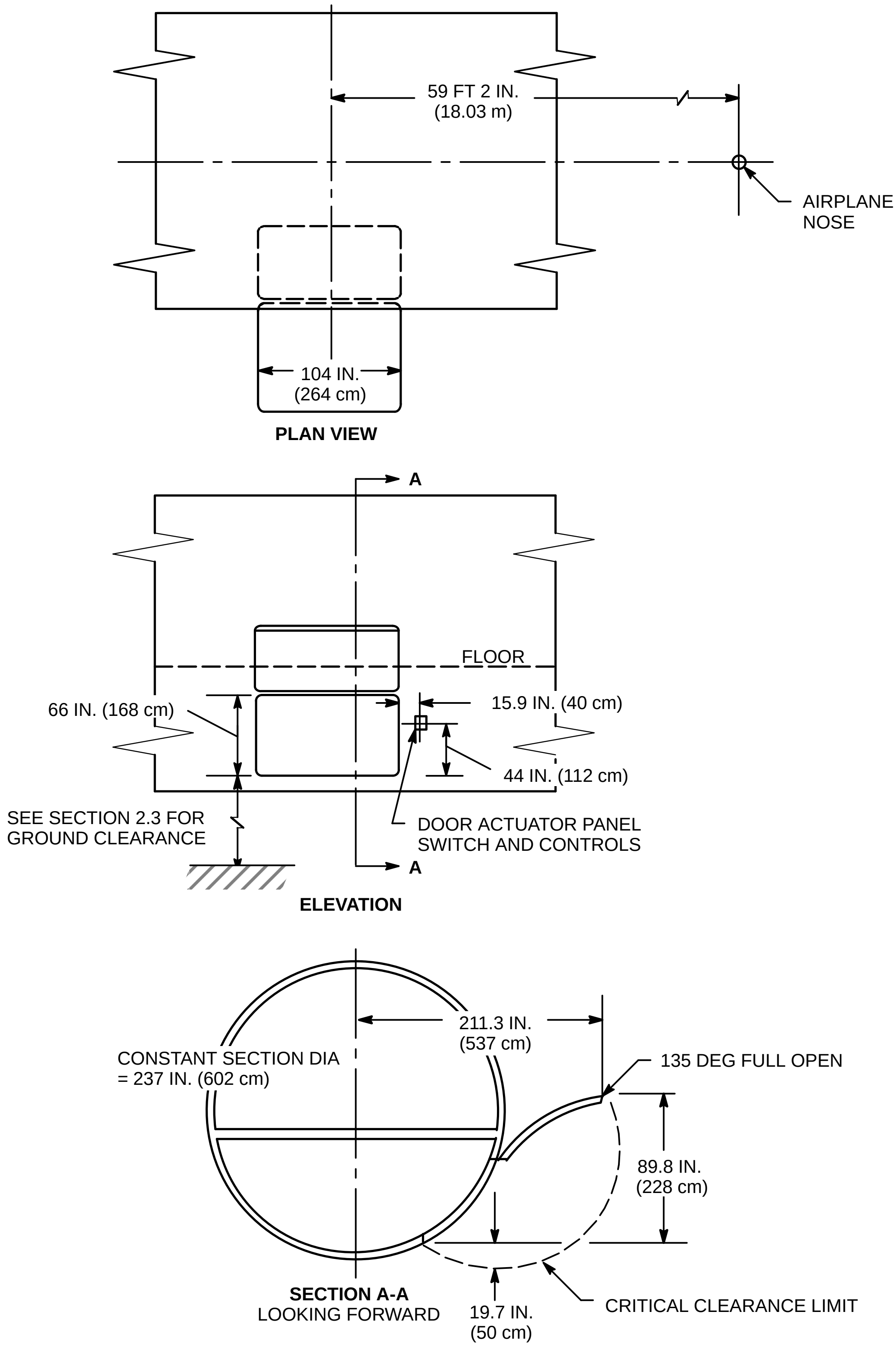
2.7.2 CARGO LOADING DOORS – MAIN DECK
MODEL MD-11F/CF

REV D



2.7.2 CARGO LOADING DOORS – MAINDECK
MODEL MD-11 COMBI

REV E



2.7.3 CARGO LOADING DOORS, LOWER DECK FORWARD DOOR MODEL MD-11

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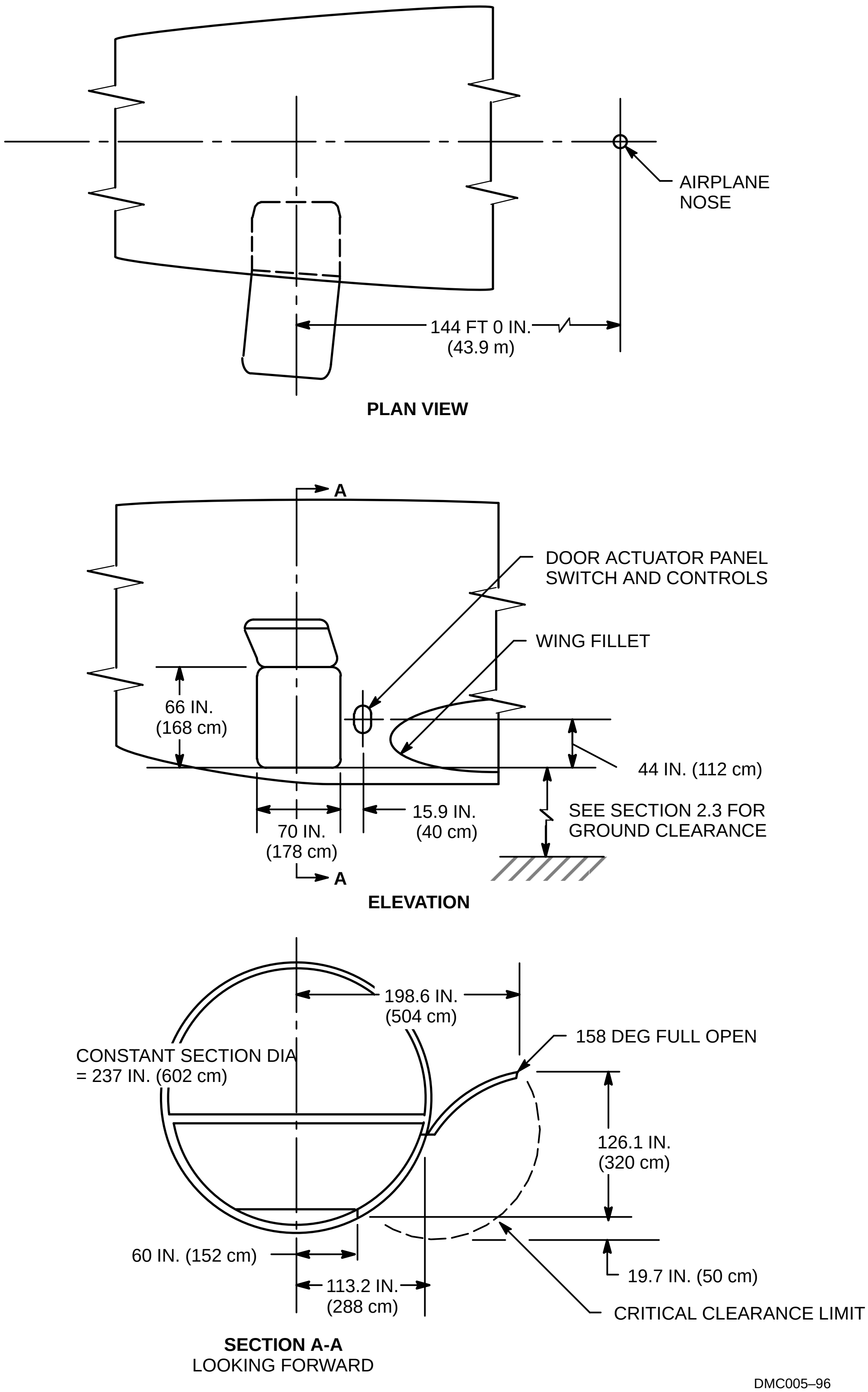
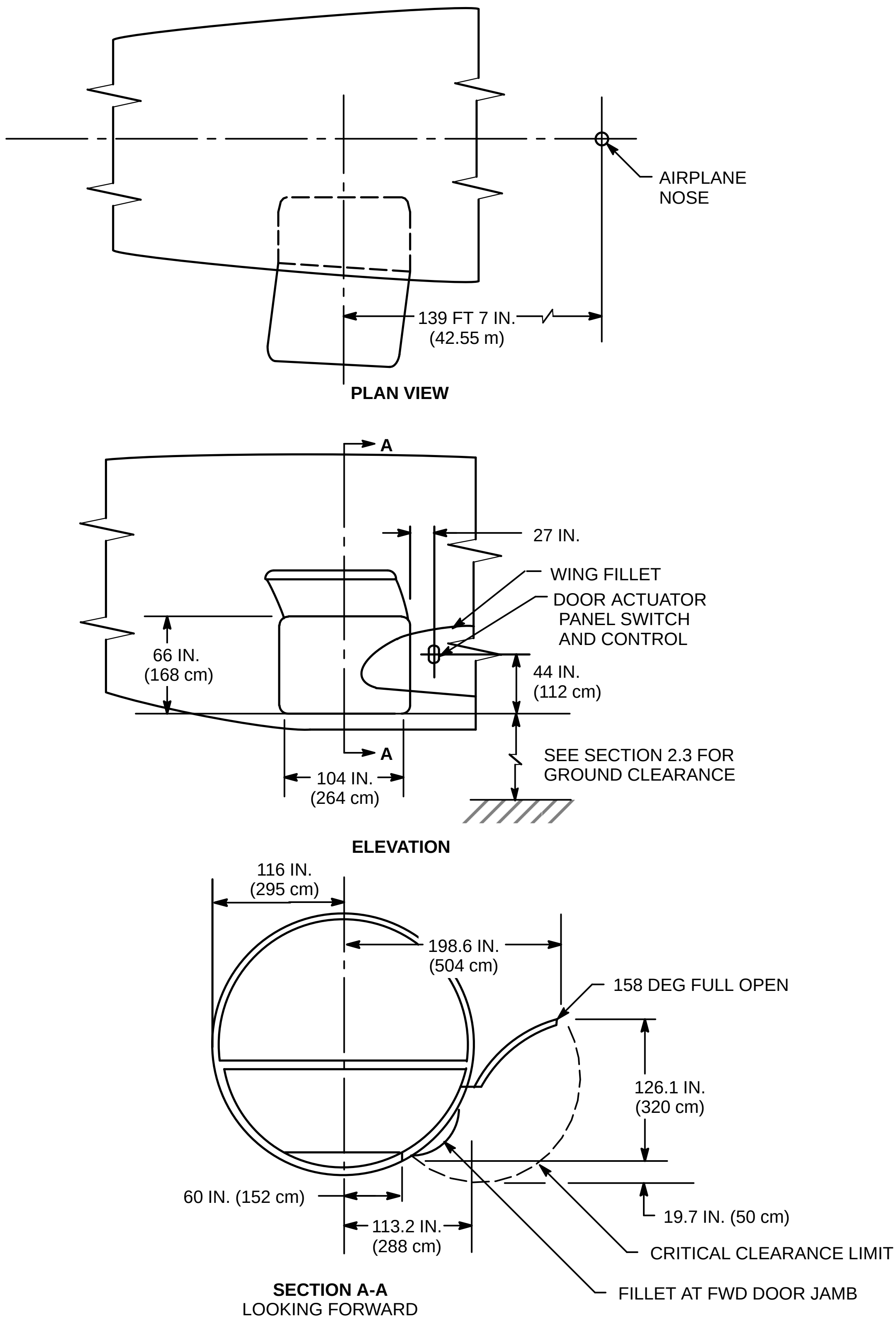


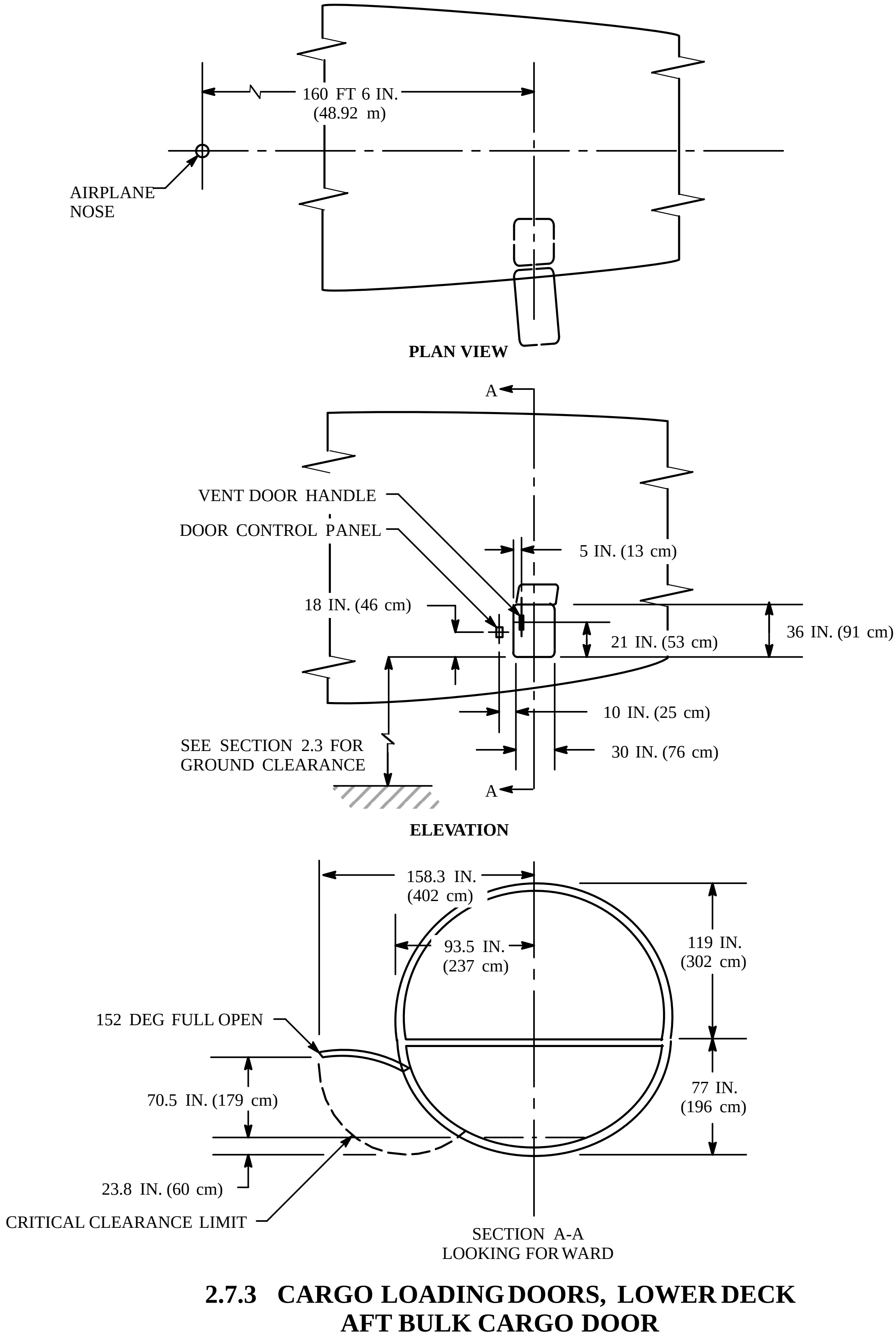
2.7.3 CARGO LOADING DOORS, LOWER DECK
CENTER CARGO DOOR
MODEL MD-11



Chap2–Text

2.7.3 CARGO LOADING DOORS, LOWER DECK
CENTER CARGO DOOR (OPTIONAL FOR OTHER MODELS)
MODEL MD-11 COMBI

REV D



2.7.3 CARGO LOADING DOORS, LOWER DECK AFT BULK CARGO DOOR MODEL MD-11

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3.0 AIRPLANE PERFORMANCE

3.0 AIRPLANE PERFORMANCE

3.1 General Information

Figures 3.2.1 through 3.2.8 present payload-range information for a specific Mach number cruise at the fuel reserve condition shown.

Figures 3.3.1 through 3.4.2 represent FAR takeoff and landing field length requirements for FAA certification.

Standard day temperatures for the altitudes shown are tabulated below:

ELEVATION		STANDARD DAY TEMPERATURE	
FEET	METERS	F	C
0	0	59	15
2,000	610	51.9	11.1
4,000	1,219	44.7	7.1
6,000	1,829	37.6	3.1
8,000	2,438	30.5	–0.8

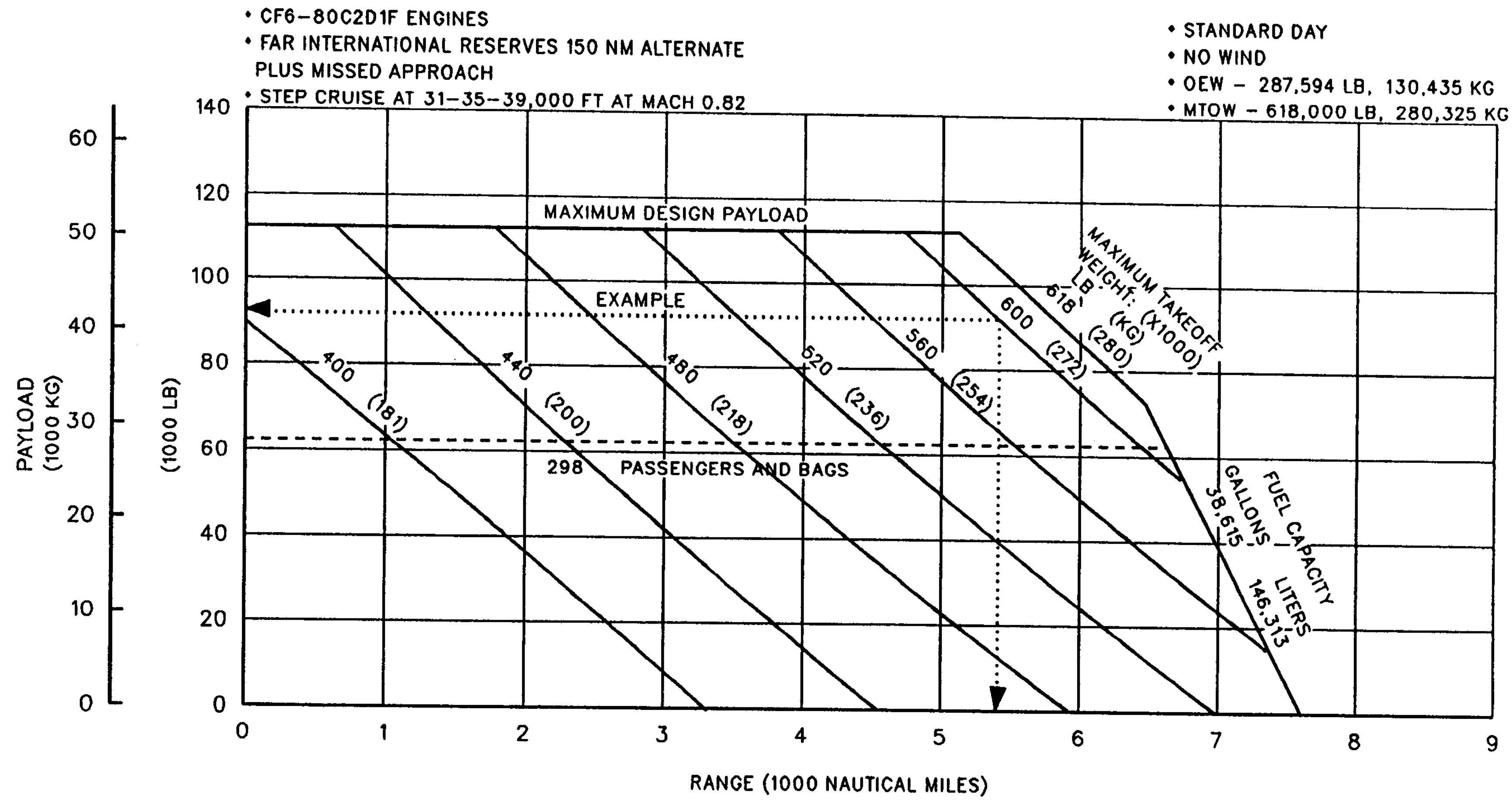
Note: These data are provided for information only and are not to be used for flight planning purposes.

For specific performance data/analysis, contact the using airline or the Airport Technology Group at (425) 237-0126 or:

Boeing Commercial Airplane Group
P.O. Box 3707
Seattle, Washington 98124-2207
USA

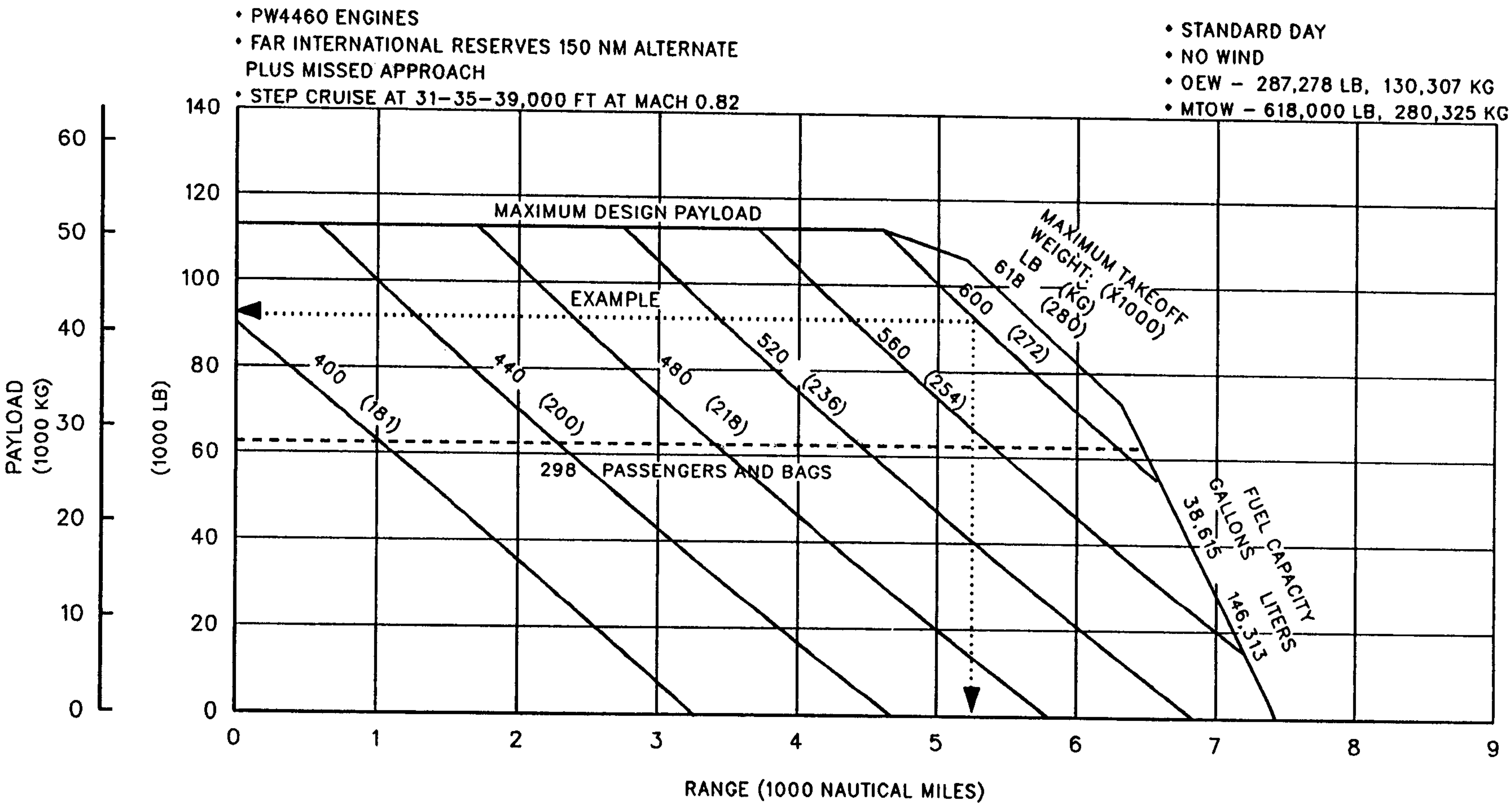
Attn: Manager, Airport Technology
Mail Code 67-KR

NOT TO BE USED FOR
FLIGHT PLANNING PURPOSES



3.2 PAYLOAD-RANGE
3.2.1 GE ENGINE
MODEL MD-11 PASSENGER

NOT TO BE USED FOR
FLIGHT PLANNING PURPOSES

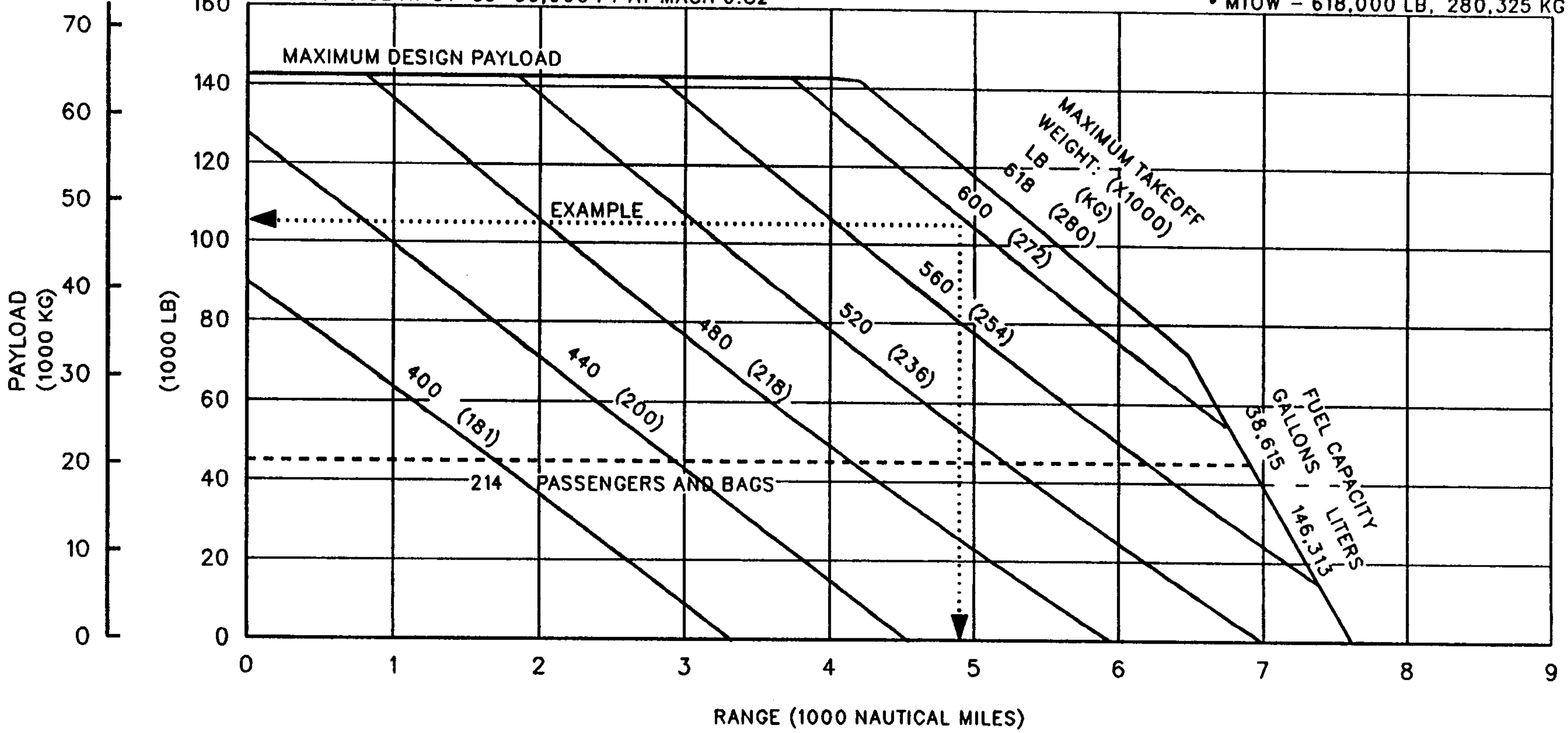


3.2 PAYLOAD-RANGE
3.2.2 PW ENGINE
MODEL MD-11 PASSENGER

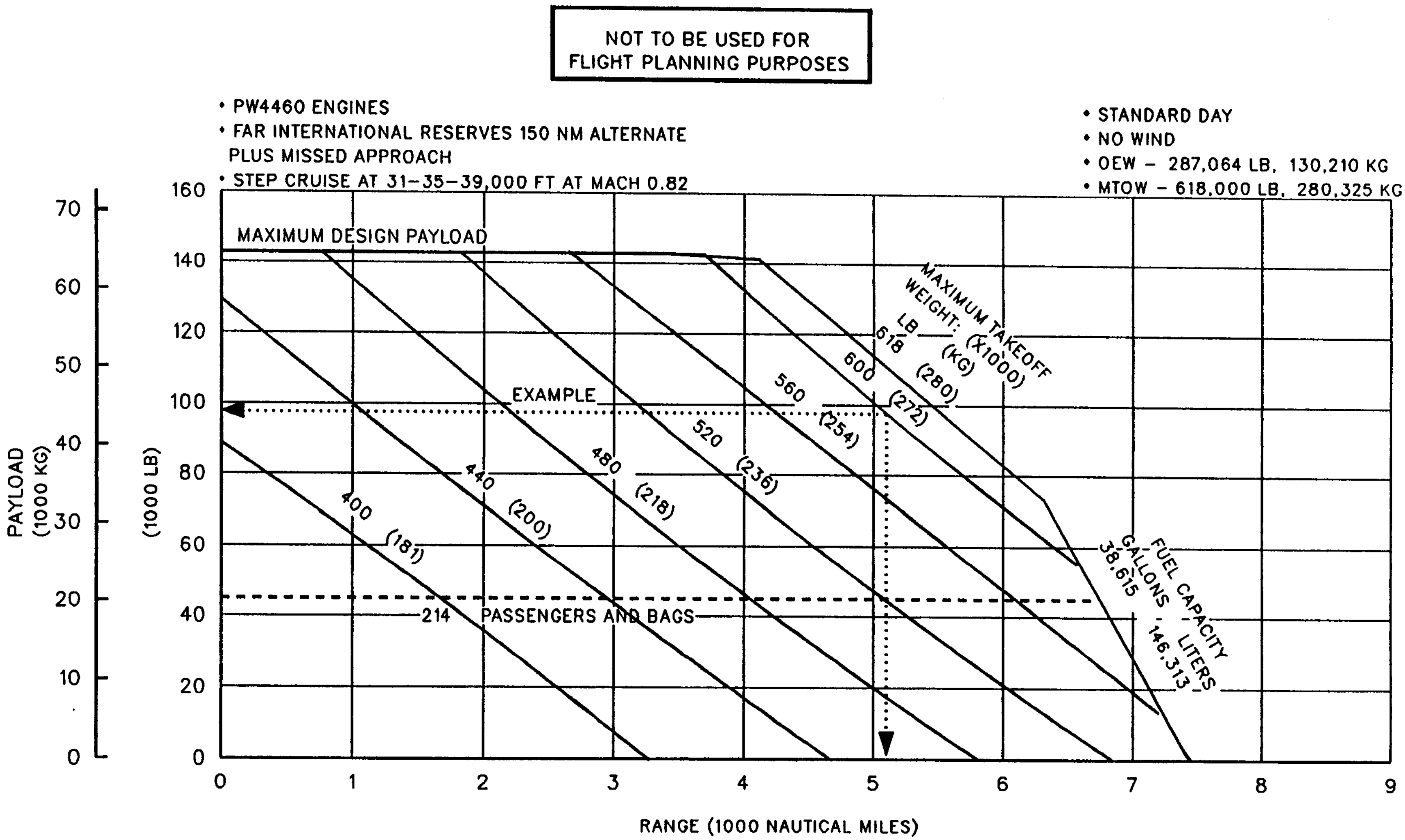
NOT TO BE USED FOR FLIGHT PLANNING PURPOSES

- CF6-80C2D1F ENGINES
- FAR INTERNATIONAL RESERVES 150 NM ALTERNATE PLUS MISSED APPROACH
- STEP CRUISE AT 31-35-39,000 FT AT MACH 0.82

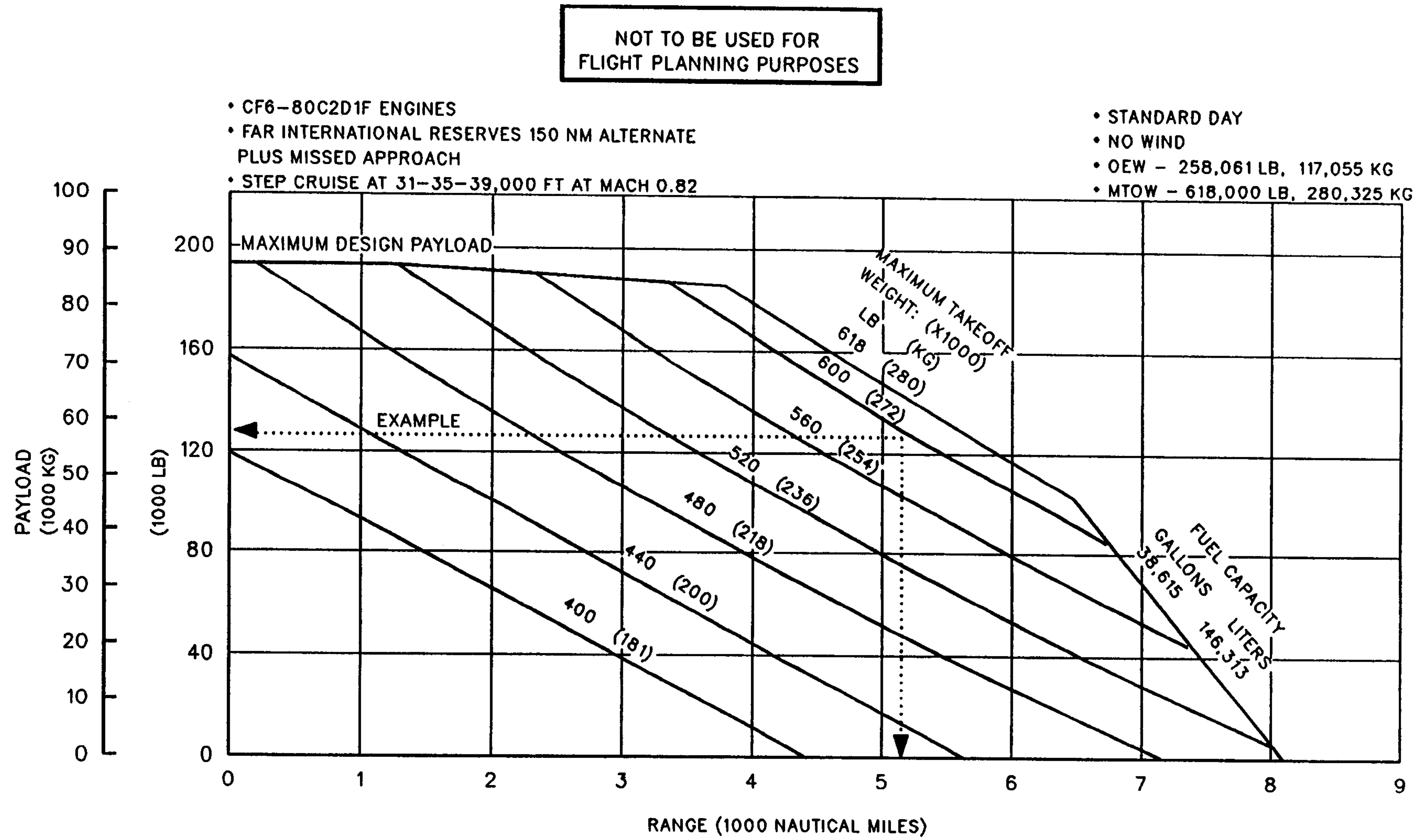
- STANDARD DAY
- NO WIND
- OEW - 287,380 LB, 130,354 KG
- MTOW - 618,000 LB, 280,325 KG



3.2 PAYLOAD-RANGE
3.2.3 GE ENGINE
MODEL MD-11 COMBI

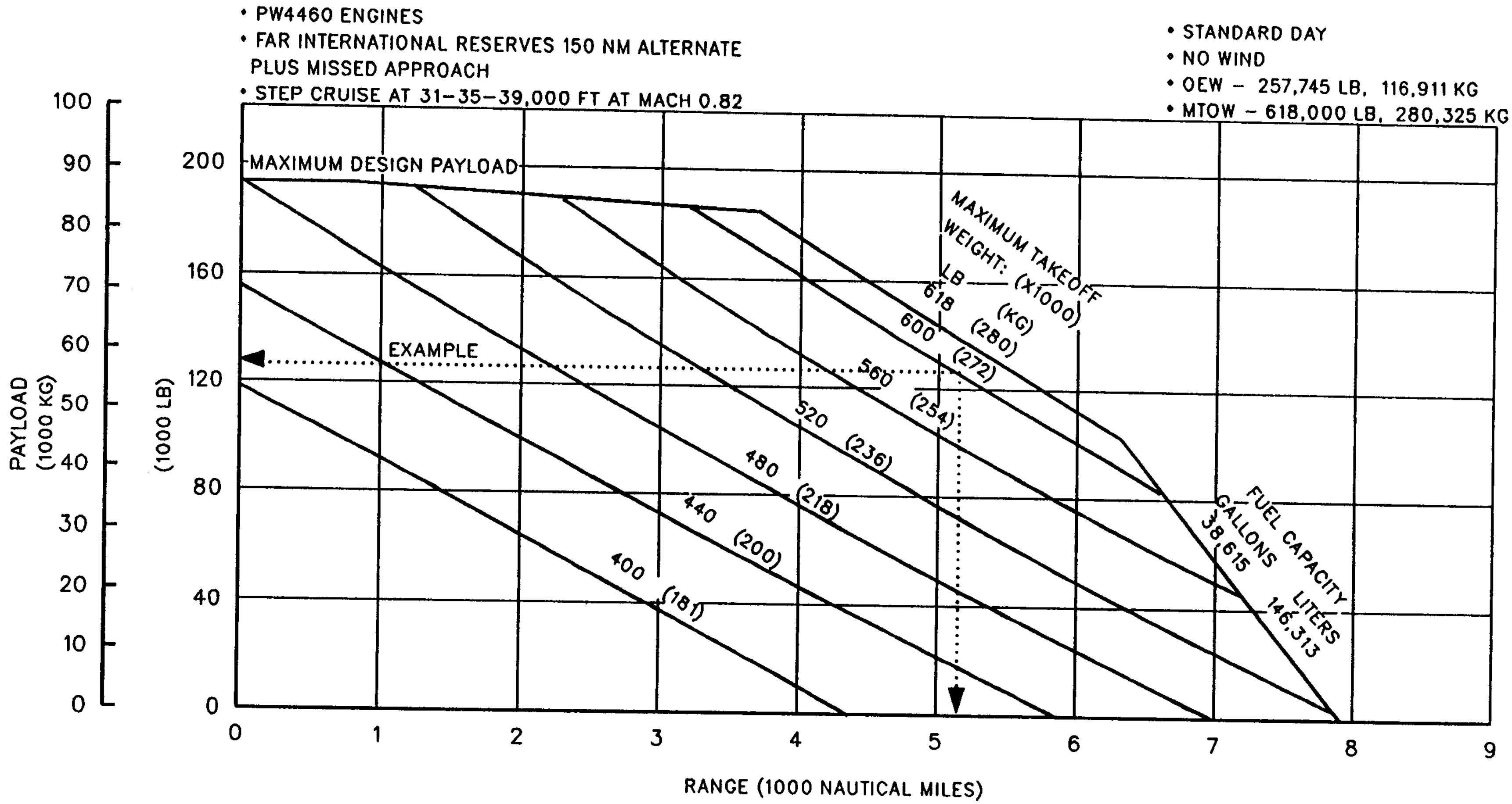


3.2 PAYLOAD-RANGE
3.2.4 PW ENGINE
MODEL MD-11 COMBI



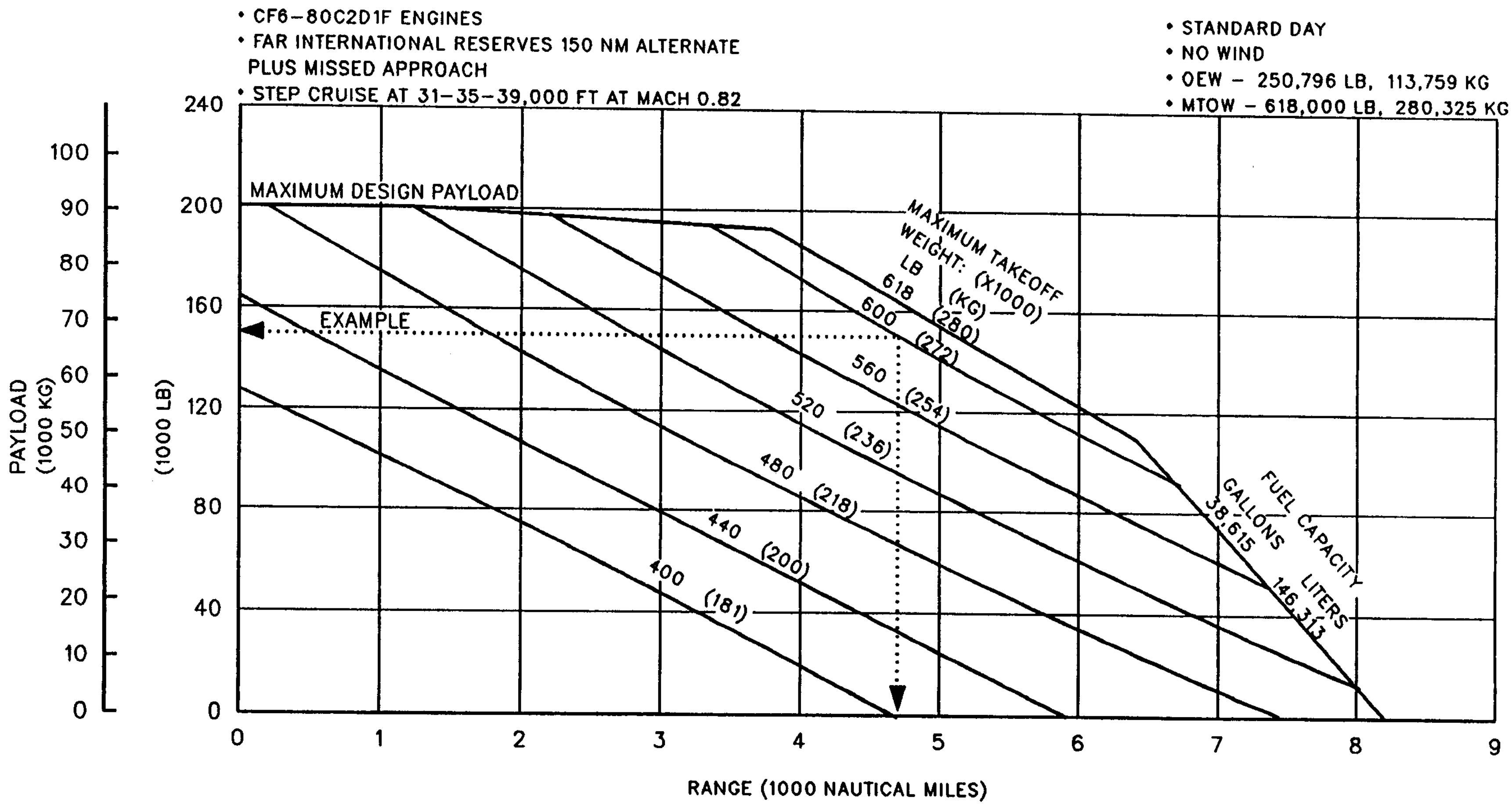
3.2 PAYLOAD-RANGE
3.2.5 GE ENGINE
MODEL MD-11 CONVERTIBLE FREIGHTER

NOT TO BE USED FOR
FLIGHT PLANNING PURPOSES



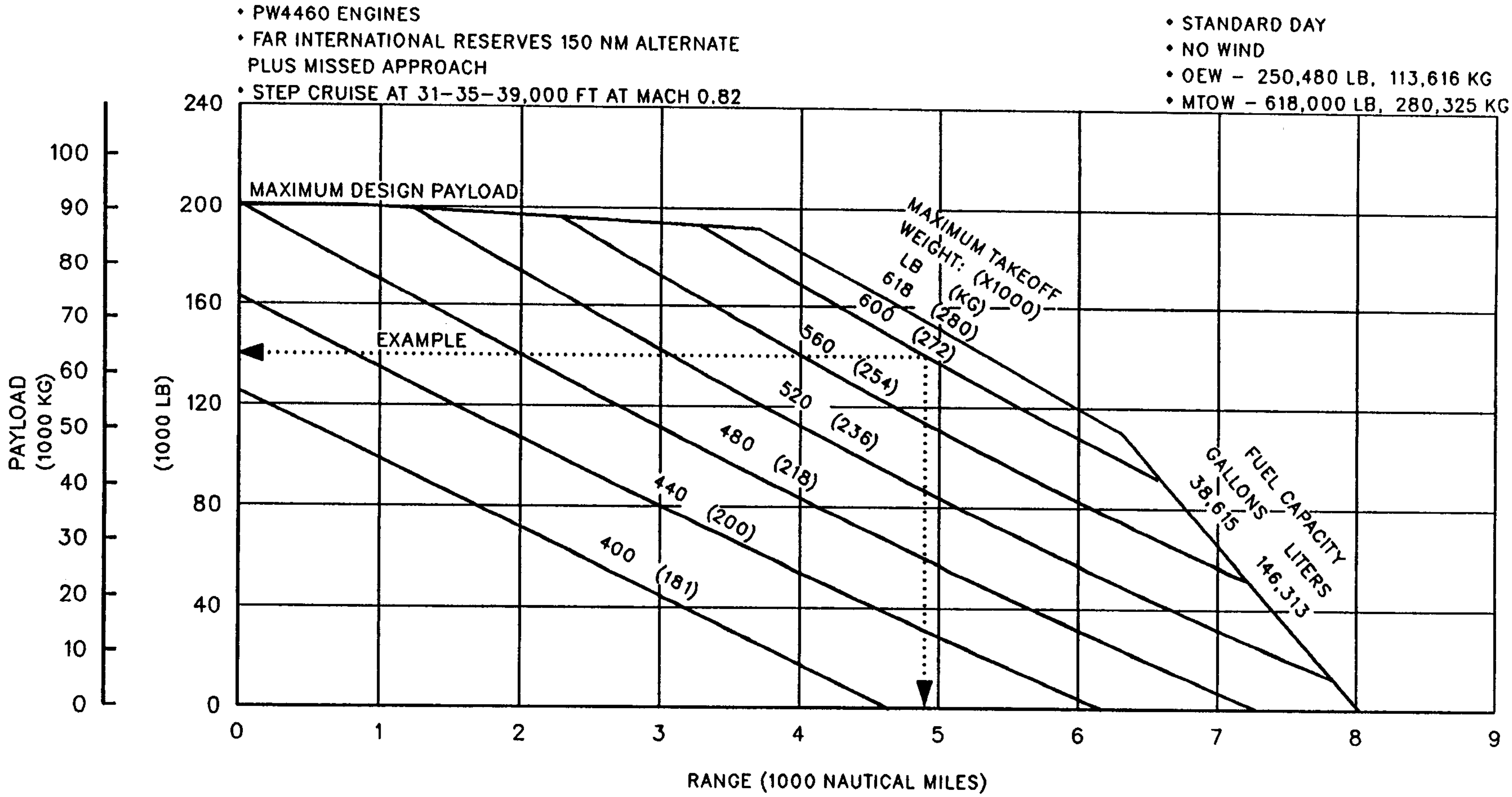
3.2 PAYLOAD-RANGE
3.2.6 PW ENGINE
MODEL MD-11 CONVERTIBLE FREIGHTER

NOT TO BE USED FOR
FLIGHT PLANNING PURPOSES



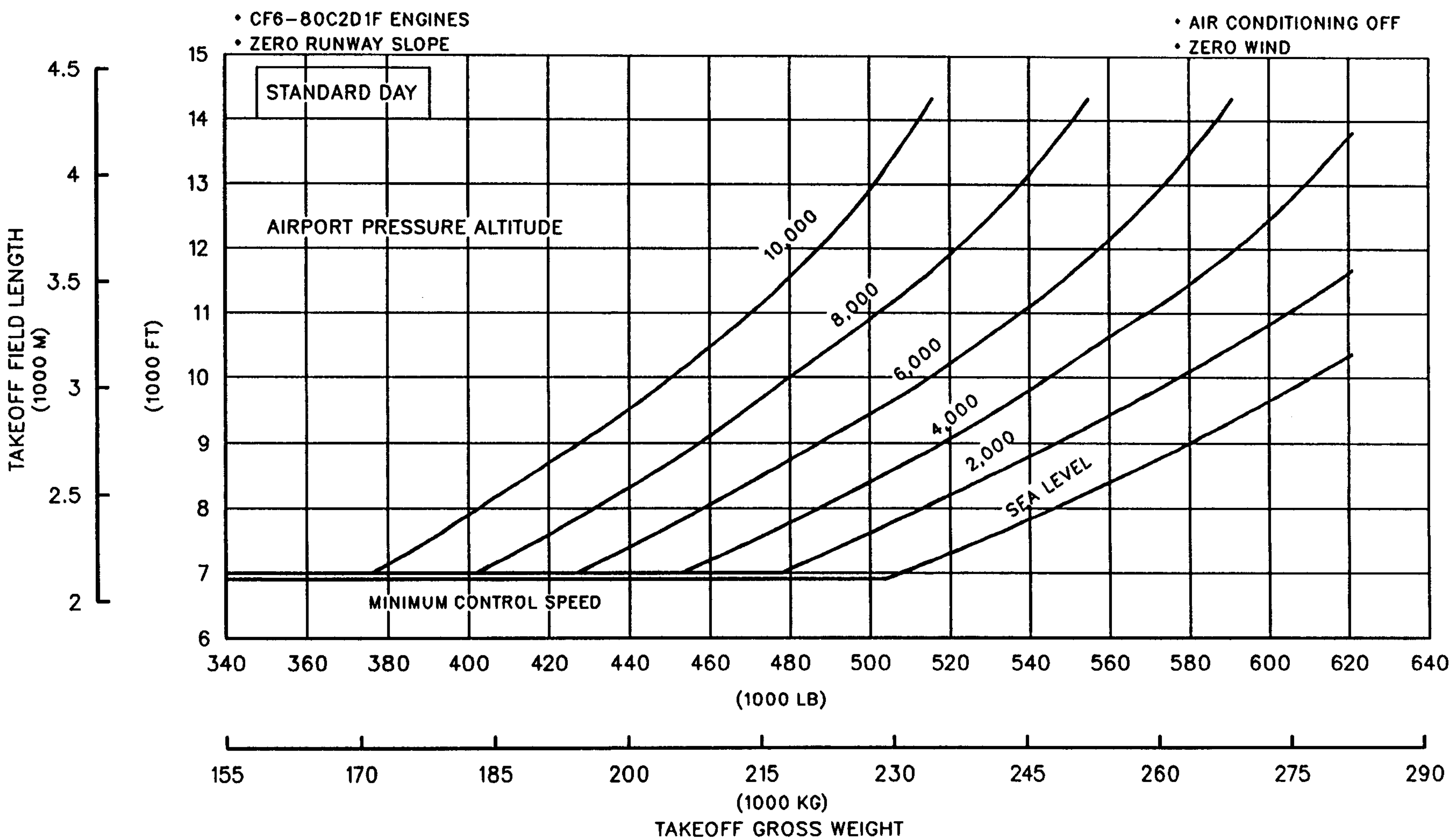
3.2 PAYLOAD-RANGE
3.2.7 GE ENGINE
MODEL MD-11 FREIGHTER

NOT TO BE USED FOR
FLIGHT PLANNING PURPOSES



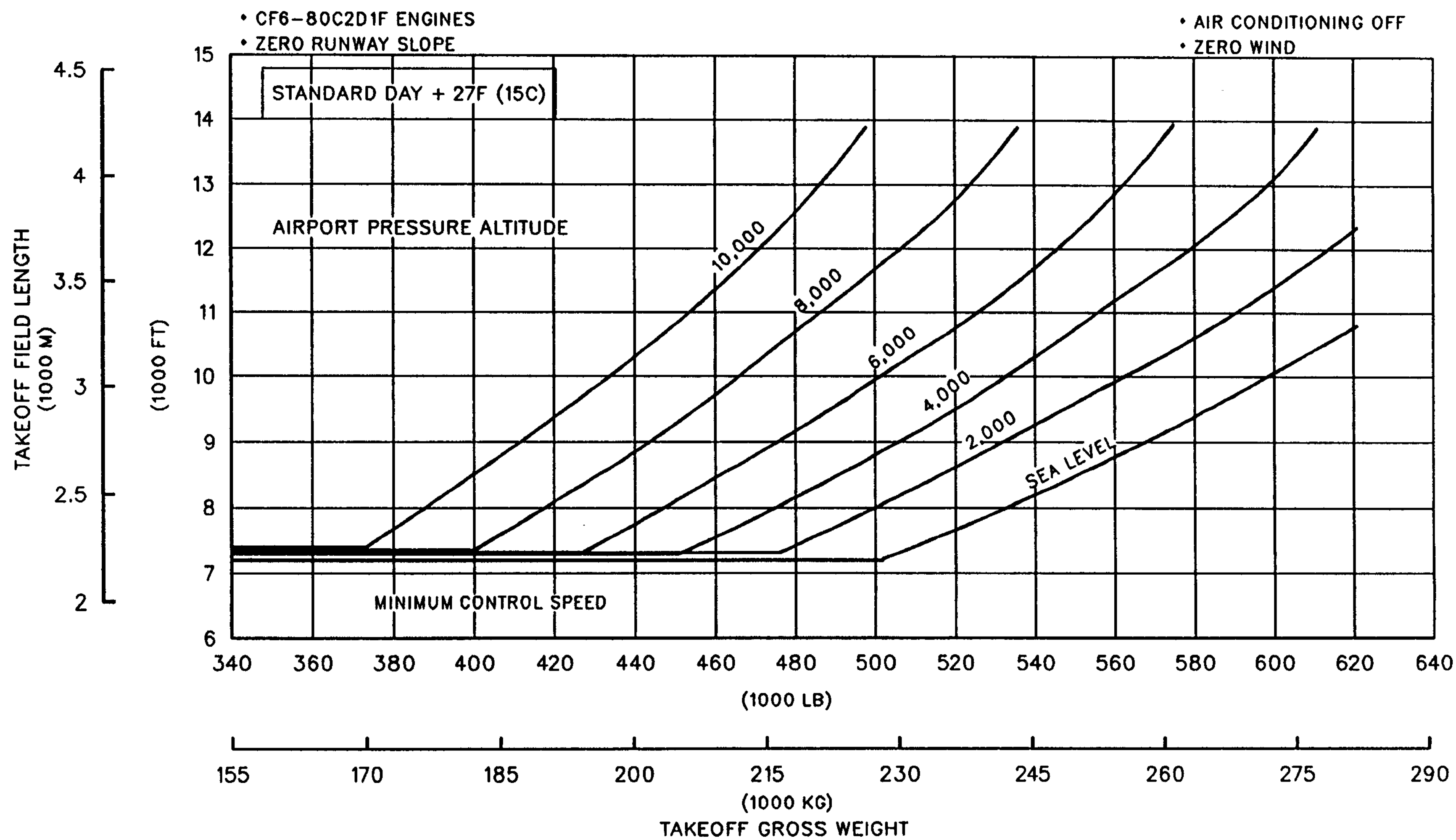
3.2 PAYLOAD-RANGE
3.2.8 PW ENGINE
MODEL MD-11 FREIGHTER

NOT TO BE USED FOR
FLIGHT PLANNING PURPOSES



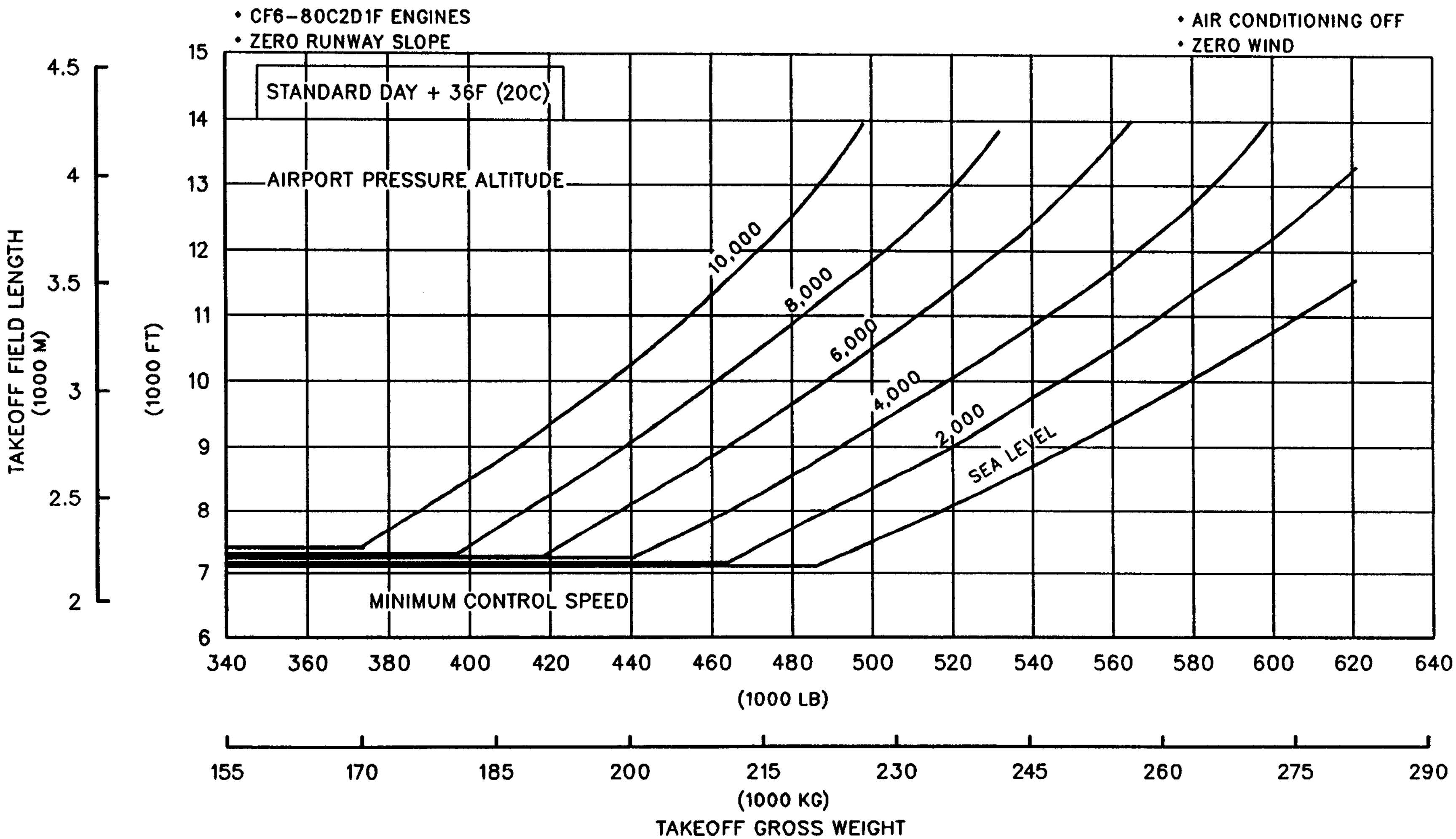
3.3 FAR TAKEOFF FIELD LENGTH REQUIREMENTS
3.3.1 STANDARD DAY
MODEL MD-11 GE ENGINE

NOT TO BE USED FOR
FLIGHT PLANNING PURPOSES



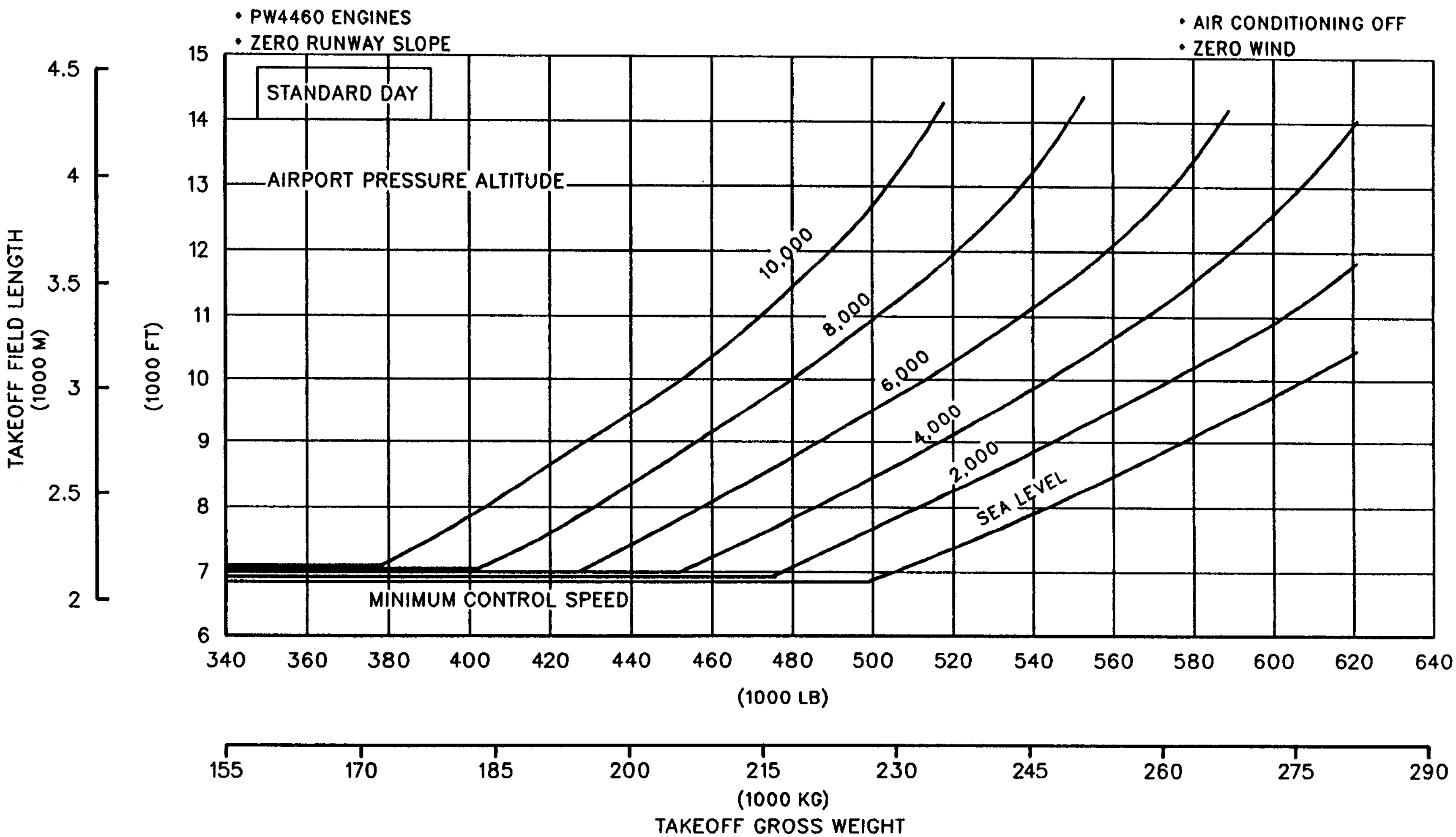
3.3 FAR TAKEOFF FIELD LENGTH REQUIREMENTS
3.3.2 STANDARD DAY + 27F (15C)
MODEL MD-11 GE ENGINE

NOT TO BE USED FOR
FLIGHT PLANNING PURPOSES



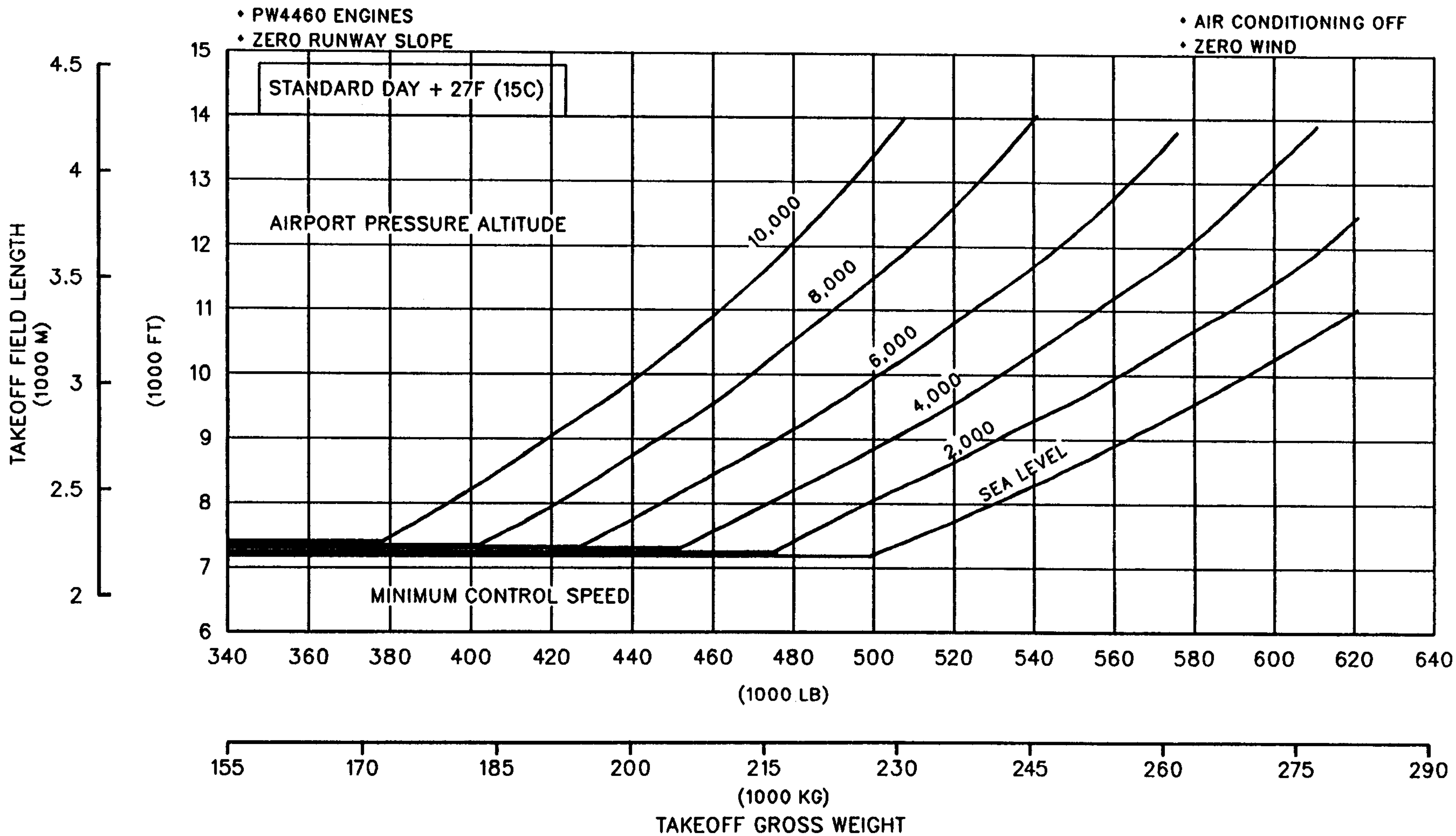
3.3 FAR TAKEOFF FIELD LENGTH REQUIREMENTS
3.3.3 STANDARD DAY + 36F (20C)
MODEL MD-11 GE ENGINE

NOT TO BE USED FOR
FLIGHT PLANNING PURPOSES



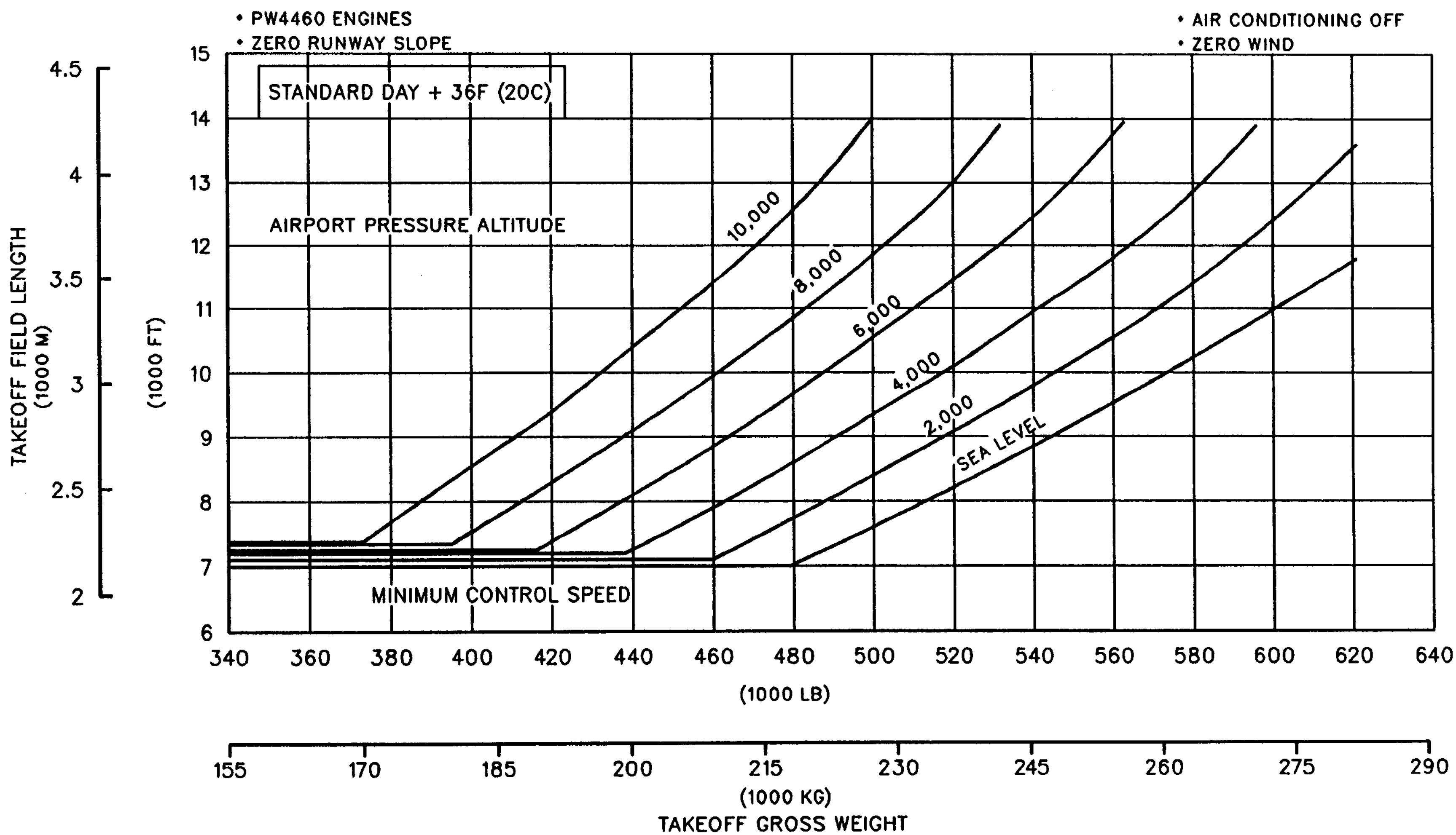
3.3 FAR TAKEOFF FIELD LENGTH REQUIREMENTS
3.3.4 STANDARD DAY
MODEL MD-11 PW ENGINE

NOT TO BE USED FOR
FLIGHT PLANNING PURPOSES

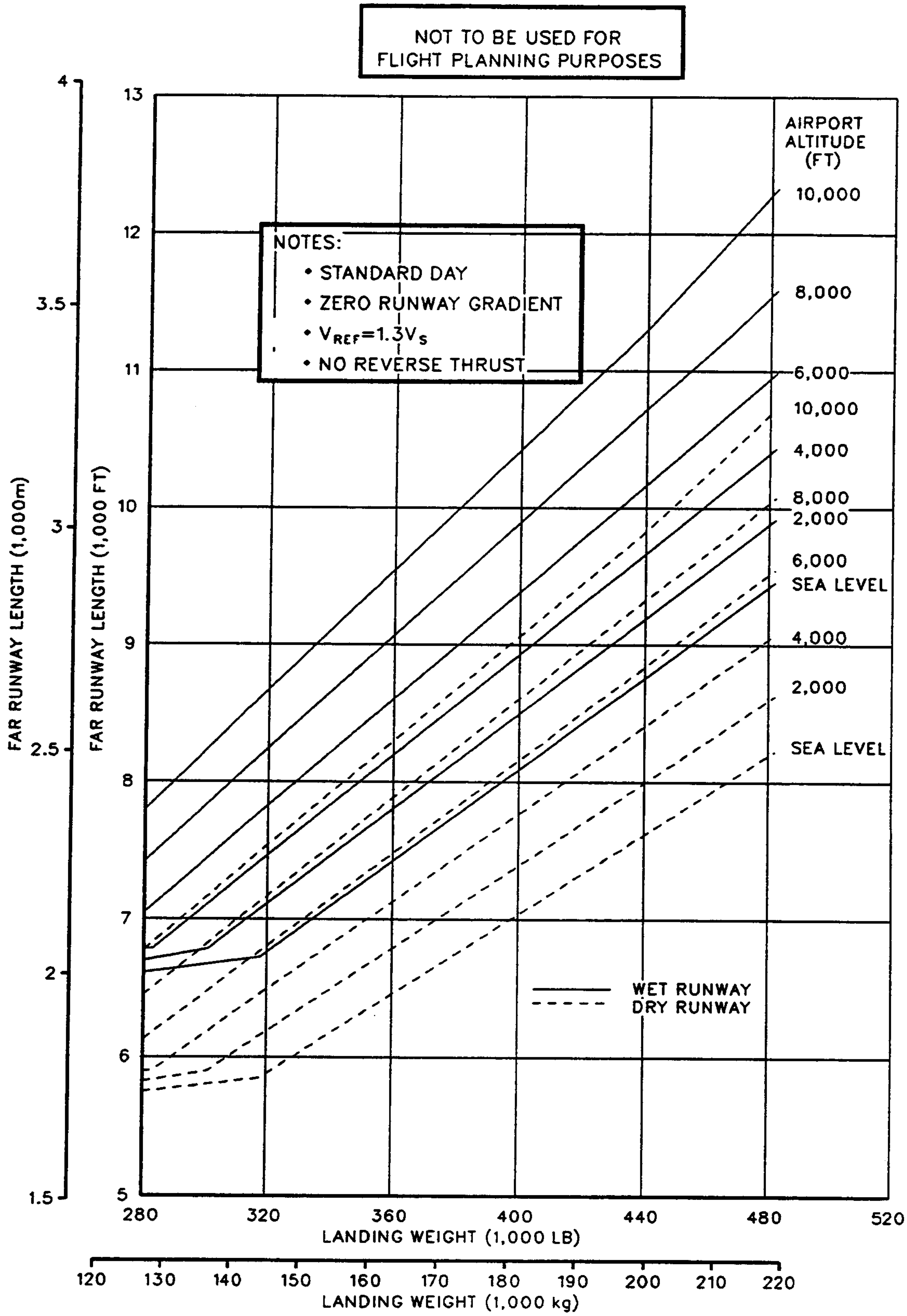


3.3 FAR TAKEOFF FIELD LENGTH REQUIREMENTS
3.3.5 STANDARD DAY + 27F (15C)
MODEL MD-11 PW ENGINE

NOT TO BE USED FOR
FLIGHT PLANNING PURPOSES

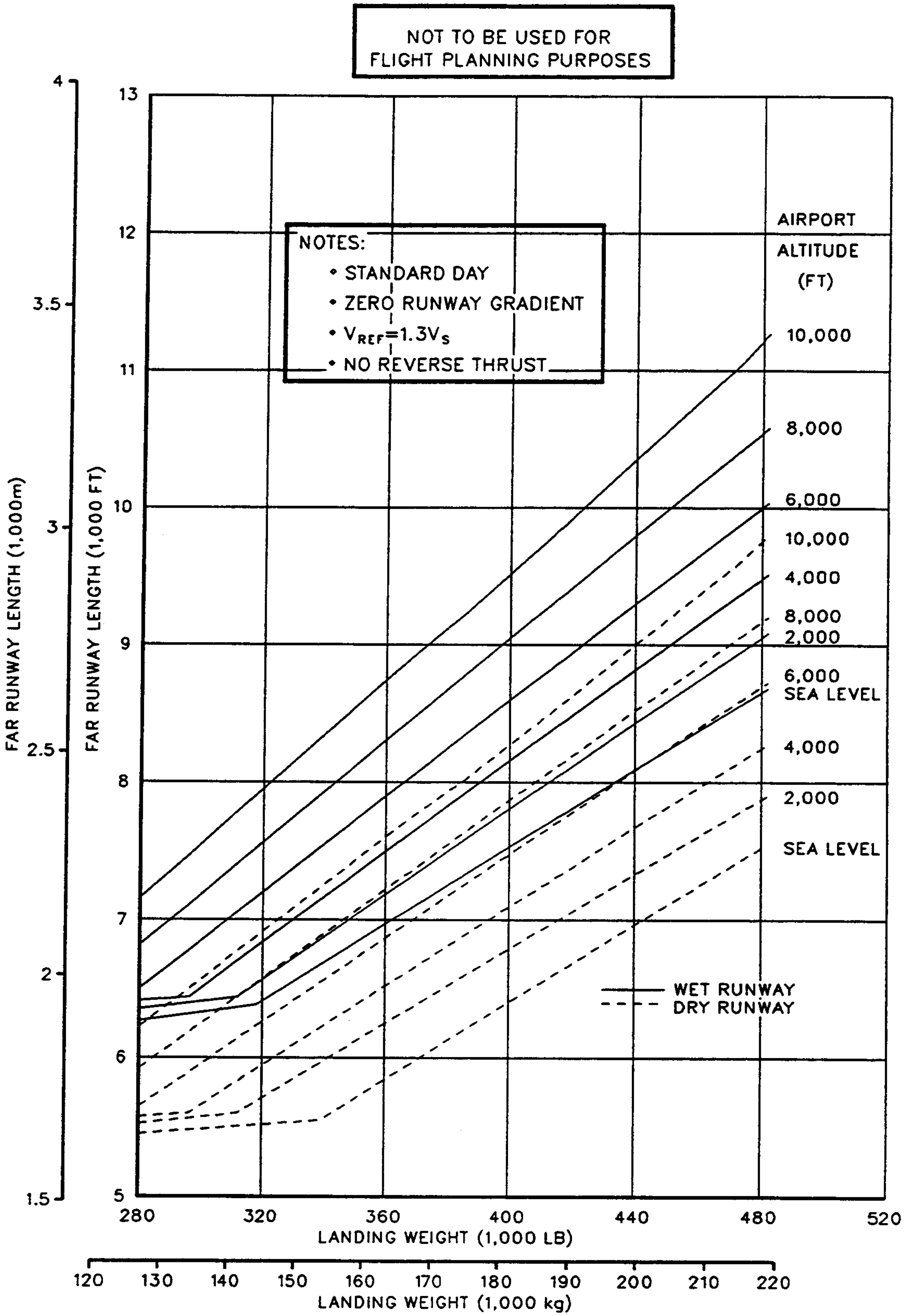


3.3 FAR TAKEOFF FIELD LENGTH REQUIREMENTS
3.3.6 STANDARD DAY + 36F (20C)
MODEL MD-11 PW ENGINE



3.4 FAR LANDING RUNWAY LENGTH REQUIREMENTS
3.4.1 FLAPS 35 DEGREES
MODEL MD-11

REV D



3.4 FAR LANDING RUNWAY LENGTH REQUIREMENTS
3.4.2 FLAPS 50 DEGREES
MODEL MD-11

REV D

4.0 GROUND MANEUVERING

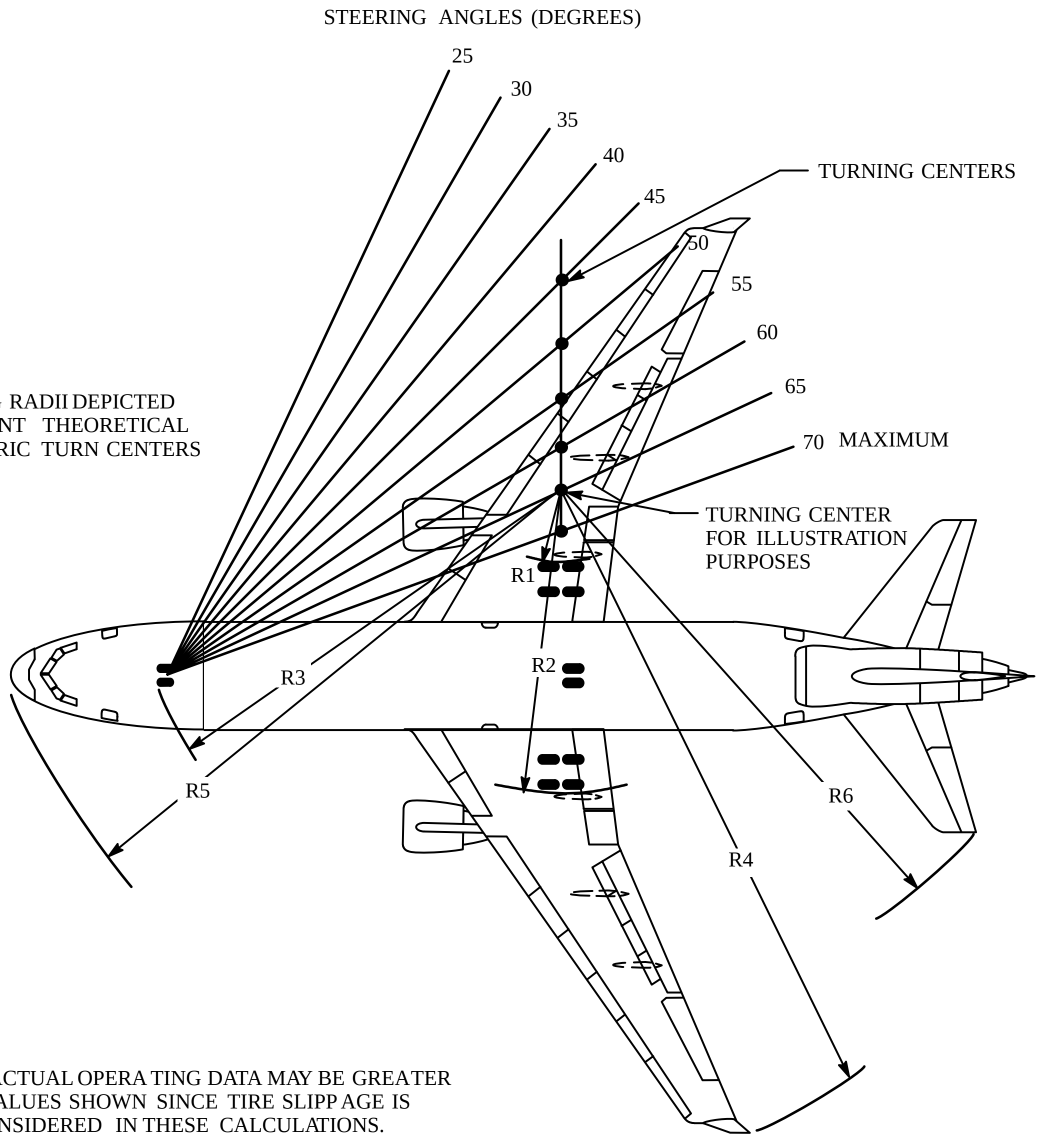
4.0 GROUND MANEUVERING

4.1 General Information

This section provides airplane turning capability and maneuvering characteristics.

For ease of presentation, these data have been determined from the theoretical limits imposed by the geometry of the aircraft, and where noted, provide for a normal allowance for tire slippage. As such, they reflect the turning capability of the aircraft in favorable operating circumstances. The data should only be used as guidelines for determining such parameters and to obtain the maneuvering characteristics of this aircraft type.

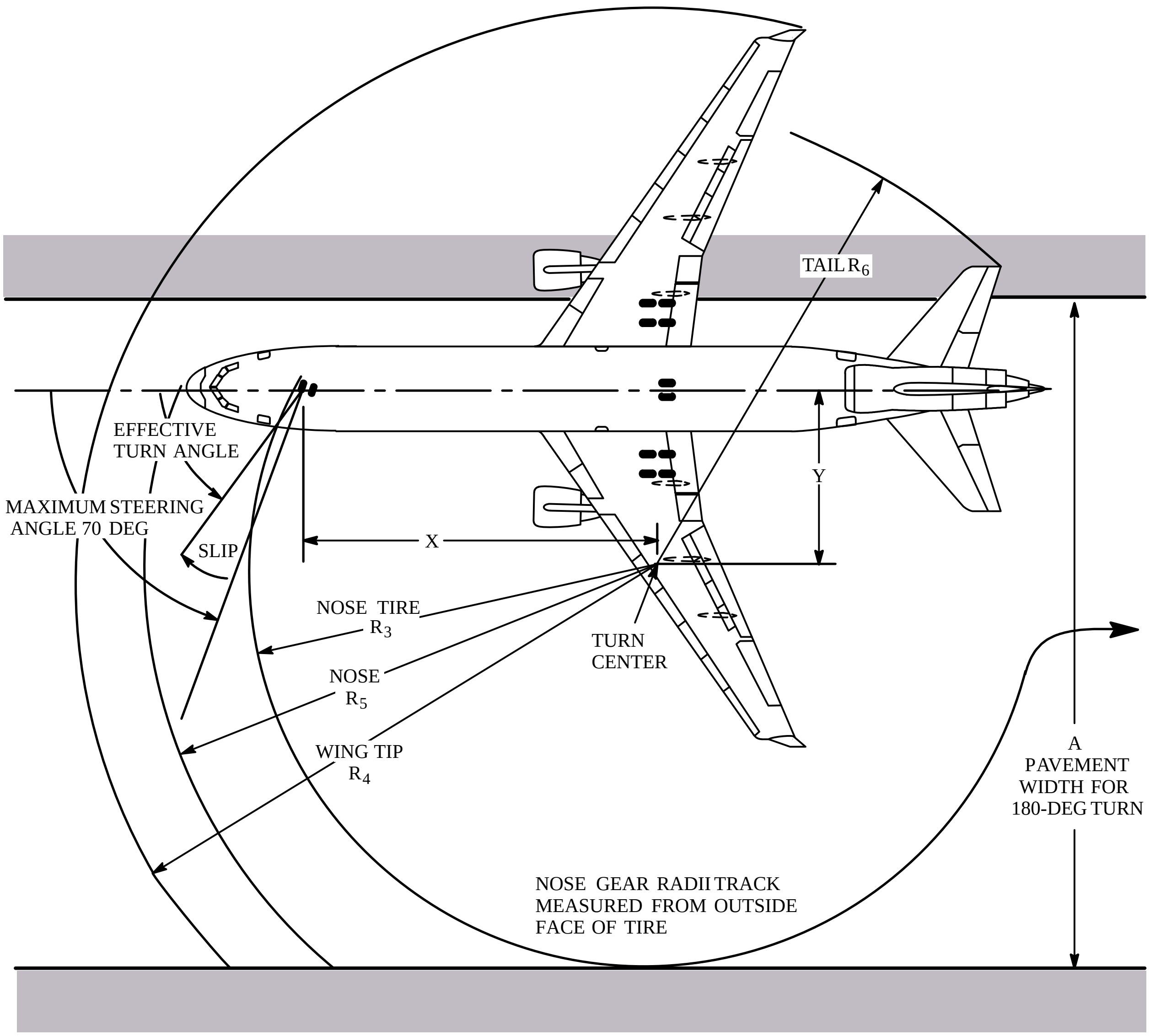
In the ground operating mode, varying airline practices may demand that more conservative turning procedures be adopted. Airline operating techniques will vary in level of performance over a wide range of circumstances throughout the world. Variations from standard aircraft operating patterns may be necessary to satisfy physical constraints within the maneuvering area, such as adverse grades, limited space, or high risk of jet blast damage. For these reasons, ground maneuvering requirements should be coordinated with the using airlines prior to layout planning.



NOTE: ACTUAL OPERATING DATA MAY BE GREATER THAN VALUES SHOWN SINCE TIRE SLIPPAGE IS NOT CONSIDERED IN THESE CALCULATIONS. CONSULT AIRLINE FOR OPERATING PROCEDURES R3 MEASURED FROM OUTSIDE FACE OF TIRE.

STEERING ANGLE (DEG)	R–1		R–2		R–3		R–4		R–5		R–6	
	FT	m	FT	m	FT	m	FT	m	FT	m	FT	m
25	153.7	46.8	194.9	59.4	194.0	59.1	262.6	80.0	205.7	62.7	220.2	67.1
30	120.2	36.6	161.4	49.2	164.3	50.1	229.5	70.0	178.2	54.3	189.5	57.8
35	95.5	29.1	136.7	41.7	143.5	43.7	205.2	62.5	159.4	48.6	167.7	51.1
40	76.3	23.3	117.5	35.8	128.2	39.1	186.4	56.8	145.9	44.5	151.3	46.1
45	60.7	18.5	101.9	31.1	116.6	35.5	171.2	52.2	136.1	41.5	138.5	42.2
50	47.6	14.5	88.8	27.1	107.8	32.9	158.5	48.3	128.7	39.2	128.3	39.1
55	36.3	11.1	77.5	23.6	100.9	30.8	147.6	45.0	123.1	37.5	119.9	36.5
60	26.3	8.0	67.6	20.6	95.6	29.1	138.0	42.1	118.8	36.2	112.9	34.4
65	17.3	5.3	58.5	17.8	91.4	27.9	129.4	39.4	115.6	35.2	107.0	32.6
70 MAXIMUM	9.0	2.7	50.2	15.3	88.2	26.9	121.5	37.0	113.8	34.7	102.0	31.1

4.2 TURNING RADII, NO SLIP ANGLE
MODEL MD-11



NORMAL TURNS

1 SYMMETRICAL THRUST AND NO DIFFERENTIAL BRAKING. SLOW CONTINOUS TURN. AFT CENTER OF GRAVITY AT MAX RAMP WEIGHT

LIGHTLY BRAKED TURN

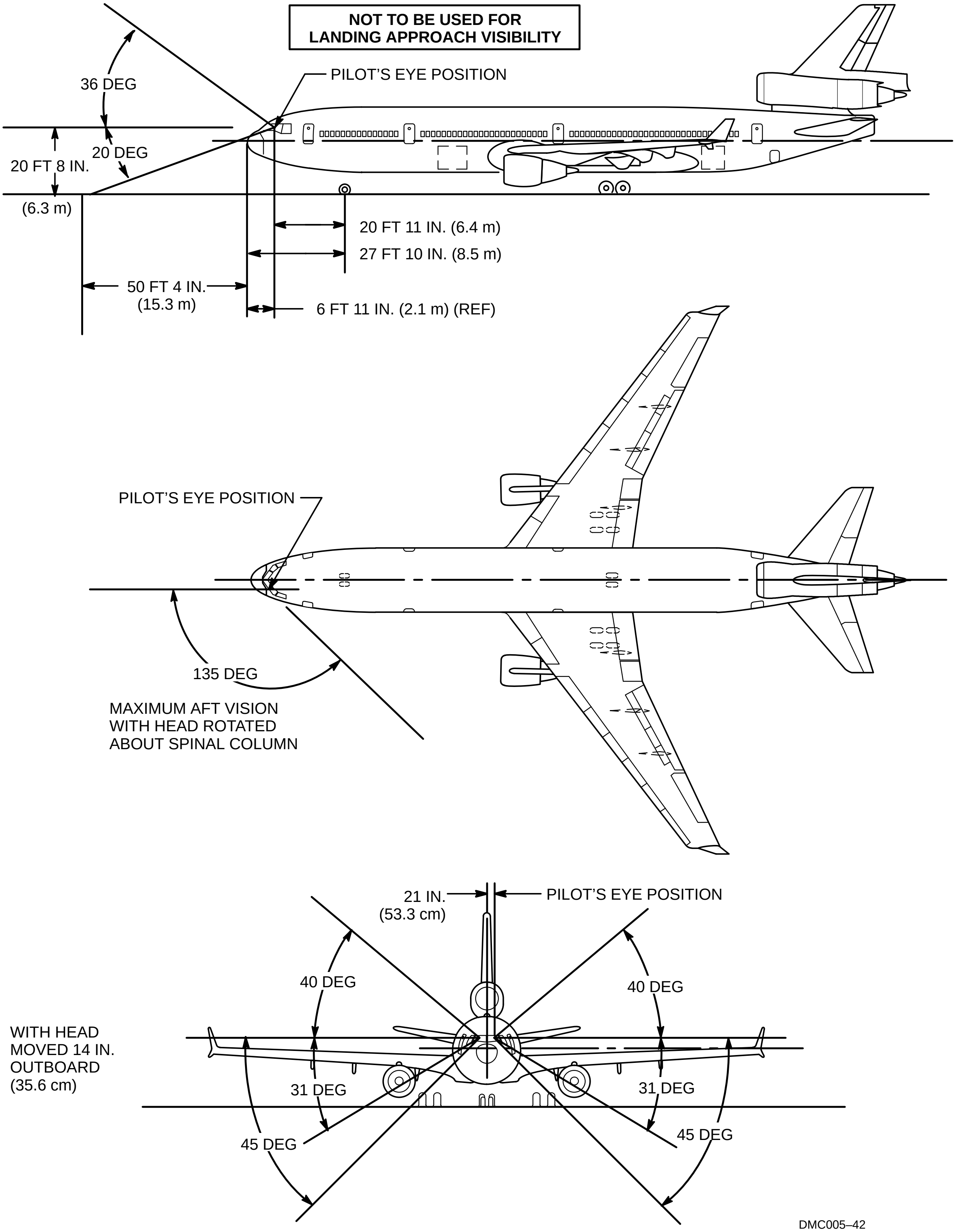
2 UNSYMMETRICAL THRUST AND LIGHT DIFFEREN - TIAL BRAKING. SLOW CONTINUOUS TURN. AFT CENTER OF GRAVITY AT MAX RAMP WEIGHT

3 MINIMUM RECOMMENDED RADIUS TO AVOID EXCESSIVE TIRE WEAR. LIMITED BY 8–DEG MAIN GEAR TIRE SCRUB

TYPE TURN	EFFECTIVE TURN ANGLE	TIRE SLIP ANGLE	X FT/m	Y FT/m	A FT/m	R_3 FT/m	R_4 FT/m	R_5 FT/m	R_6 FT/m
1	60.8 DEG	9.2 DEG	81.2 / 24.7	45.3 / 13.8	160.6 / 49.0	94.7 / 28.9	136.4 / 41.6	118.1 / 36.0	111.9 / 34.1
2	72.0 DEG	–2.0 DEG	81.6 / 24.9	26.5 / 8.1	134.6 / 41.0	87.5 / 26.7	118.5 / 36.1	112.6 / 34.3	100.0 / 30.5
3	–	–	81.2 / 24.7	42.1 / 12.8	155.8 / 47.5	93.1 / 28.4	133.4 / 40.7	116.9 / 35.6	109.8 / 33.5

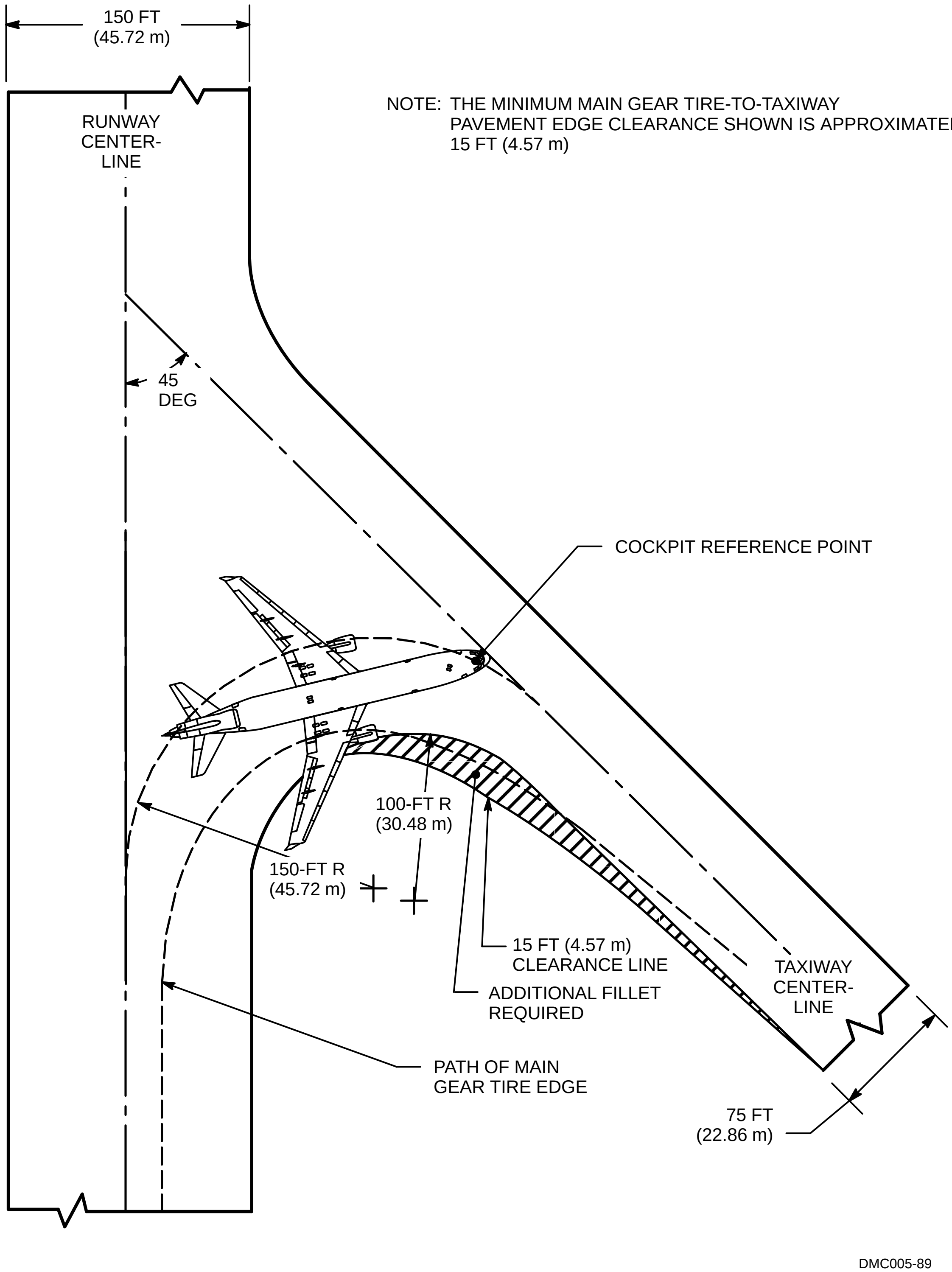
4.3 MINIMUM TURNING RADII
MODEL MD-11

REV E



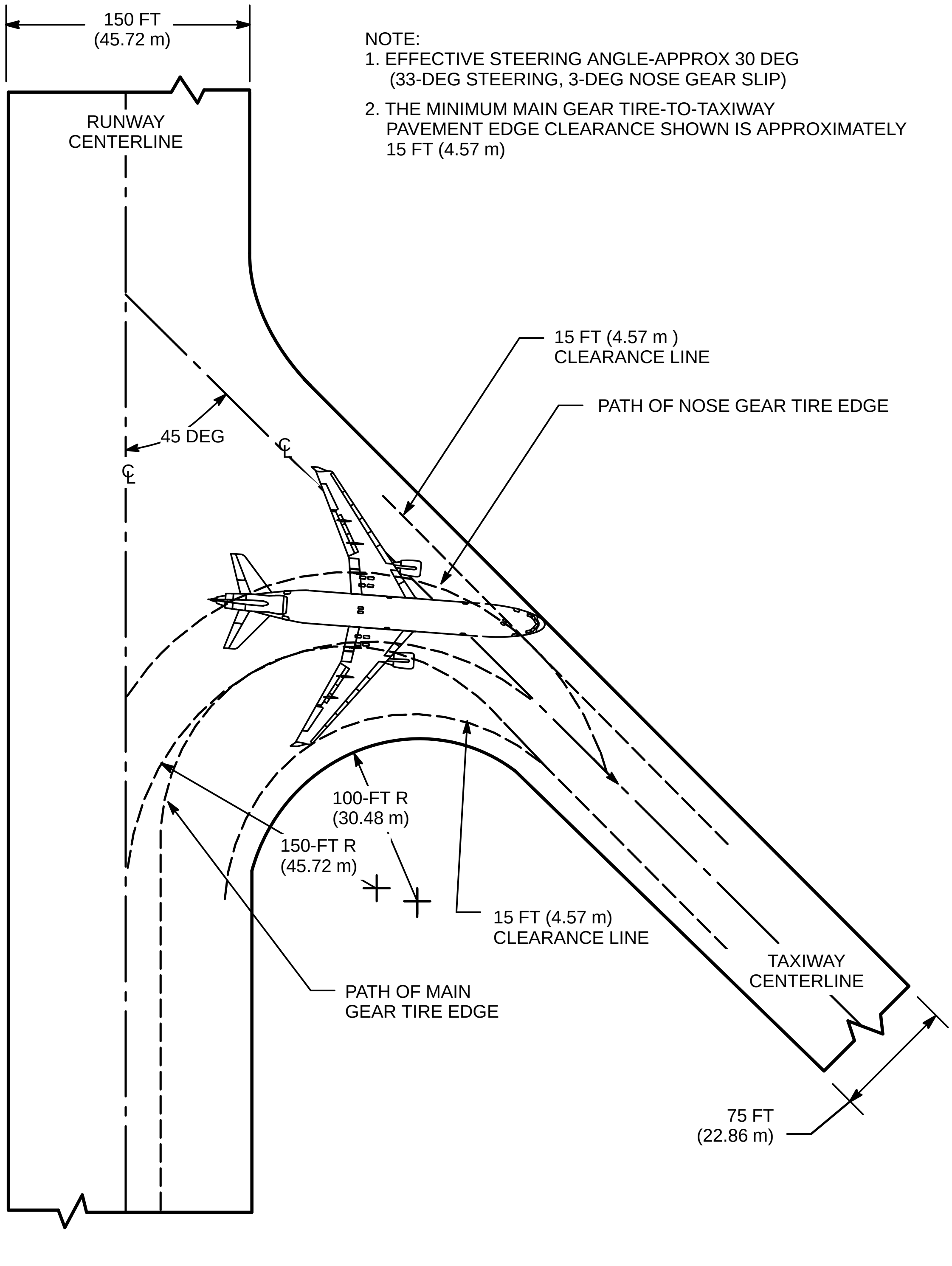
4.4 VISIBILITY FROM COCKPIT IN STATIC POSITION MODEL MD-11

REV B

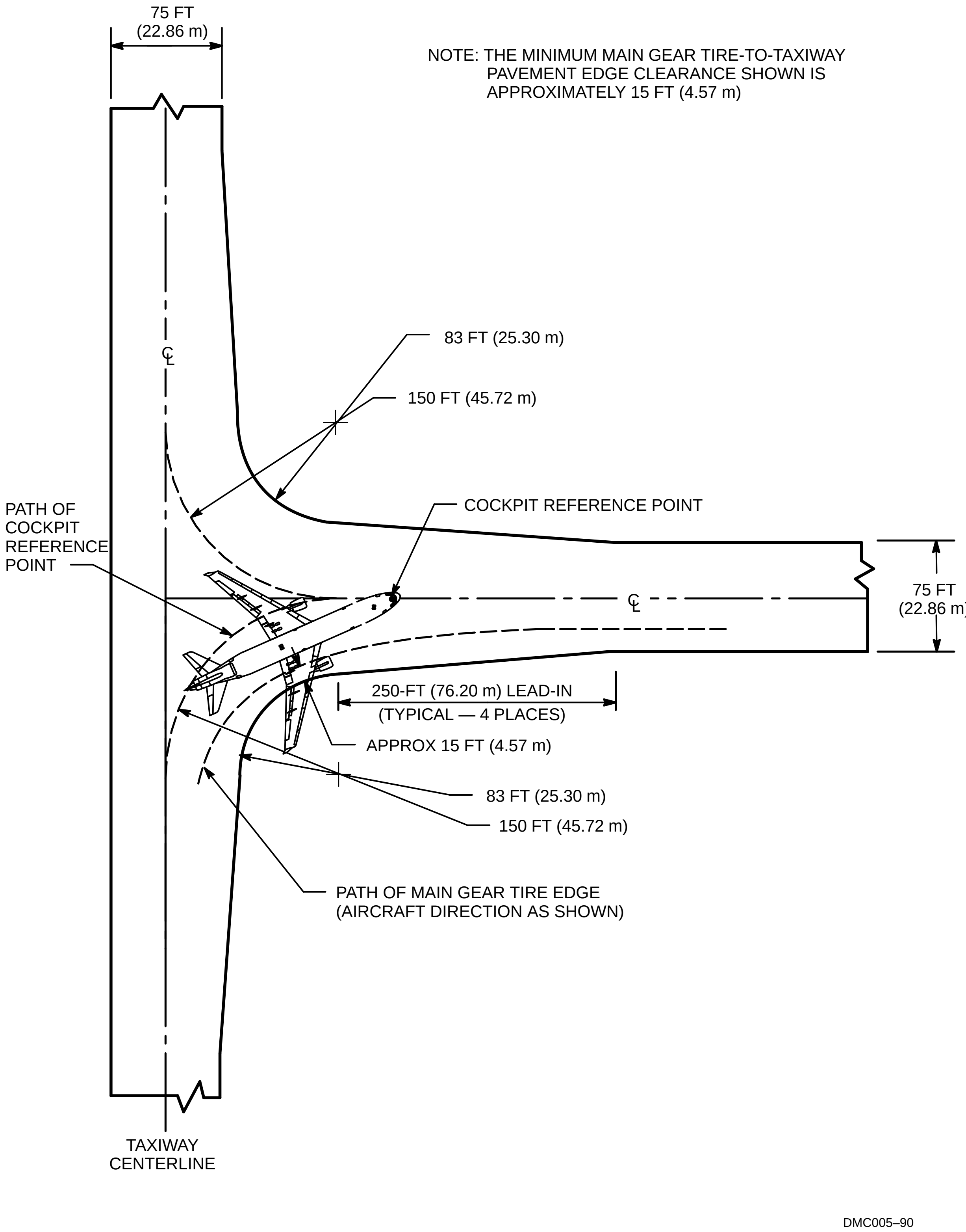


4.5 RUNWAY AND TAXIWAY TURN PATHS
4.5.1 MORE THAN 90-DEG TURN – RUNWAY TO TAXIWAY MANEUVERING METHOD – COCKPIT OVER CENTERLINE MODEL MD–11

REV B

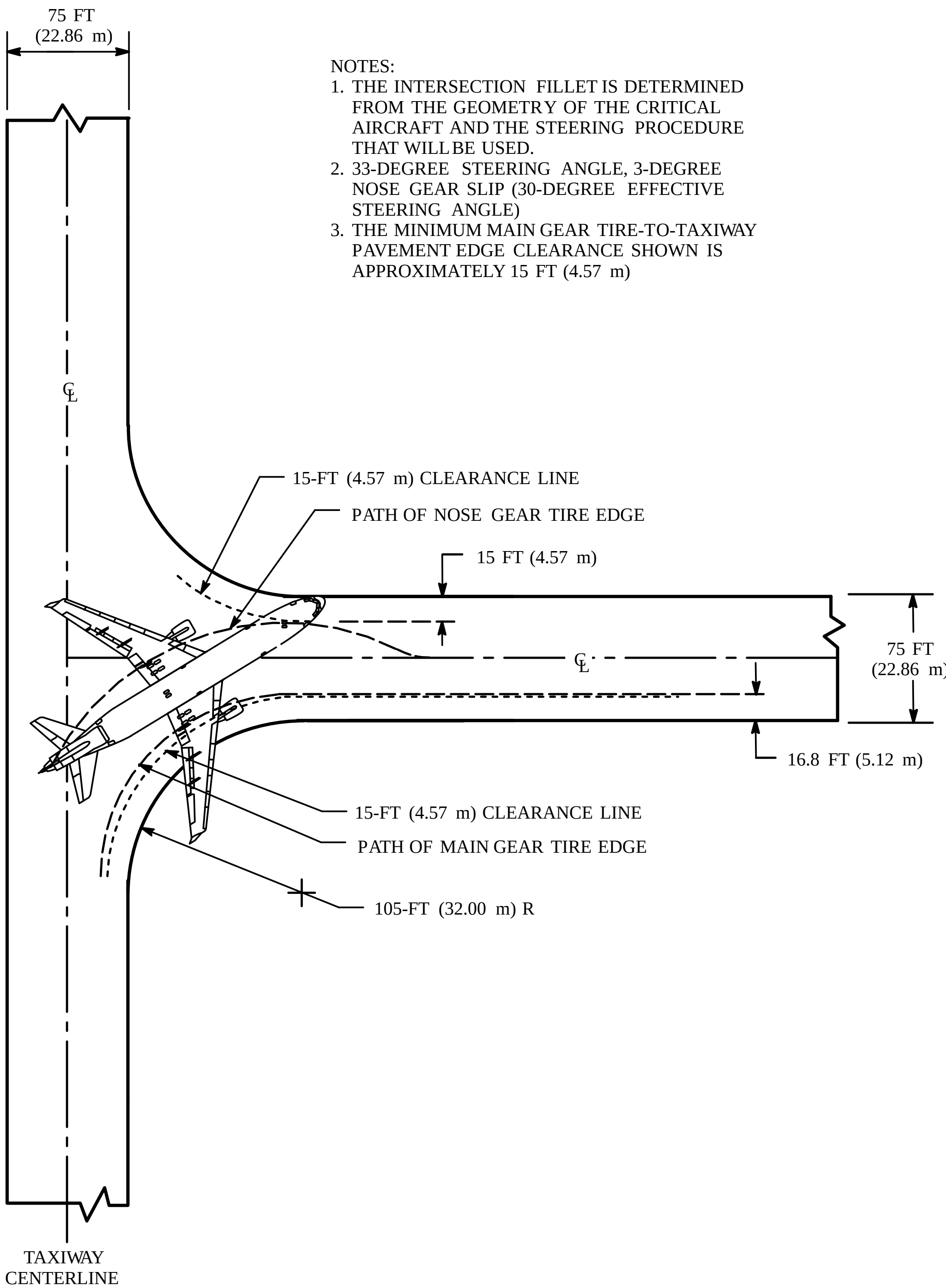


4.5.2 MORE THAN 90-DEGREE TURN – RUNWAY TO TAXIWAY MANEUVERING METHOD — JUDGMENTAL OVERSTEERING MODEL MD–11

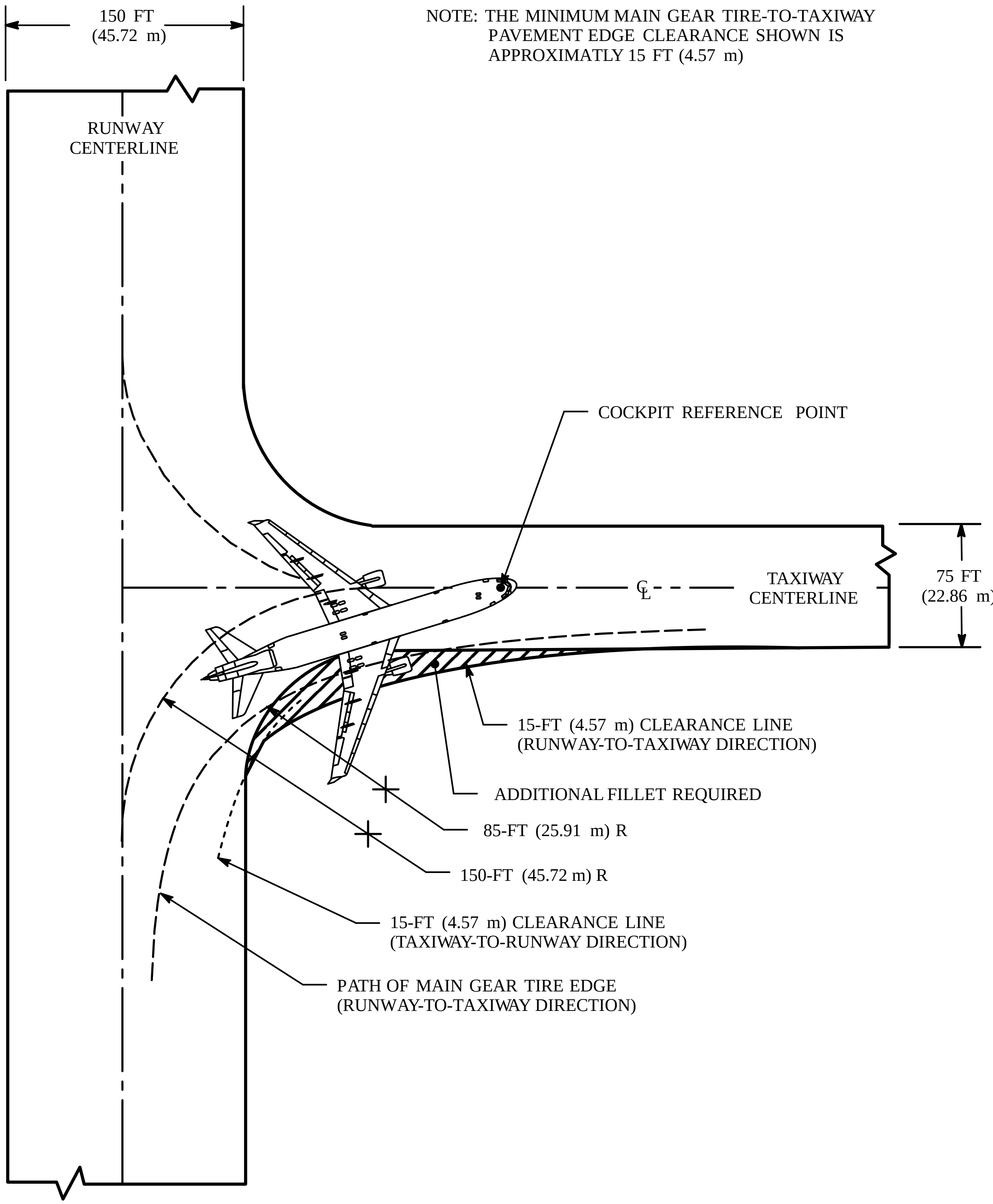


4.5.3 90-DEGREE TURN – TAXIWAY TO TAXIWAY MANEUVERING METHOD — COCKPIT OVER CENTERLINE MODEL MD-11

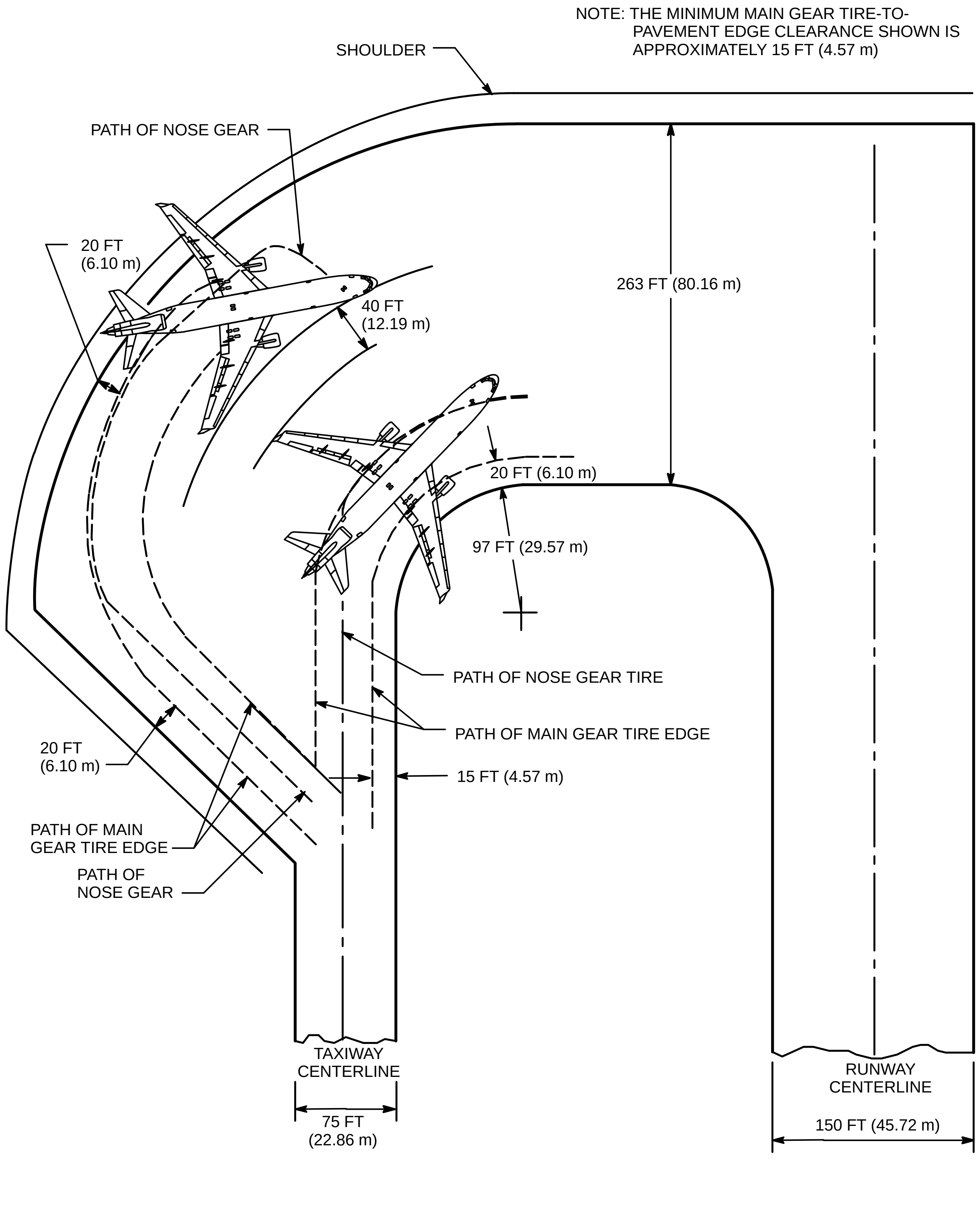
REV D



4.5.4 90-DEGREE TURN – TAXIWAY TO TAXIWAY
MANEUVERING METHOD – JUDGMENTAL OVERSTEERING
MODEL MD-11



4.5.5 90-DEGREE TURN – RUNWAY TO TAXIWAY
MANEUVERING METHOD – COCKPIT OVER CENTERLINE
MODEL MD–11



4.6 RUNWAY HOLDING BAY (APRON)
MODEL MD-11

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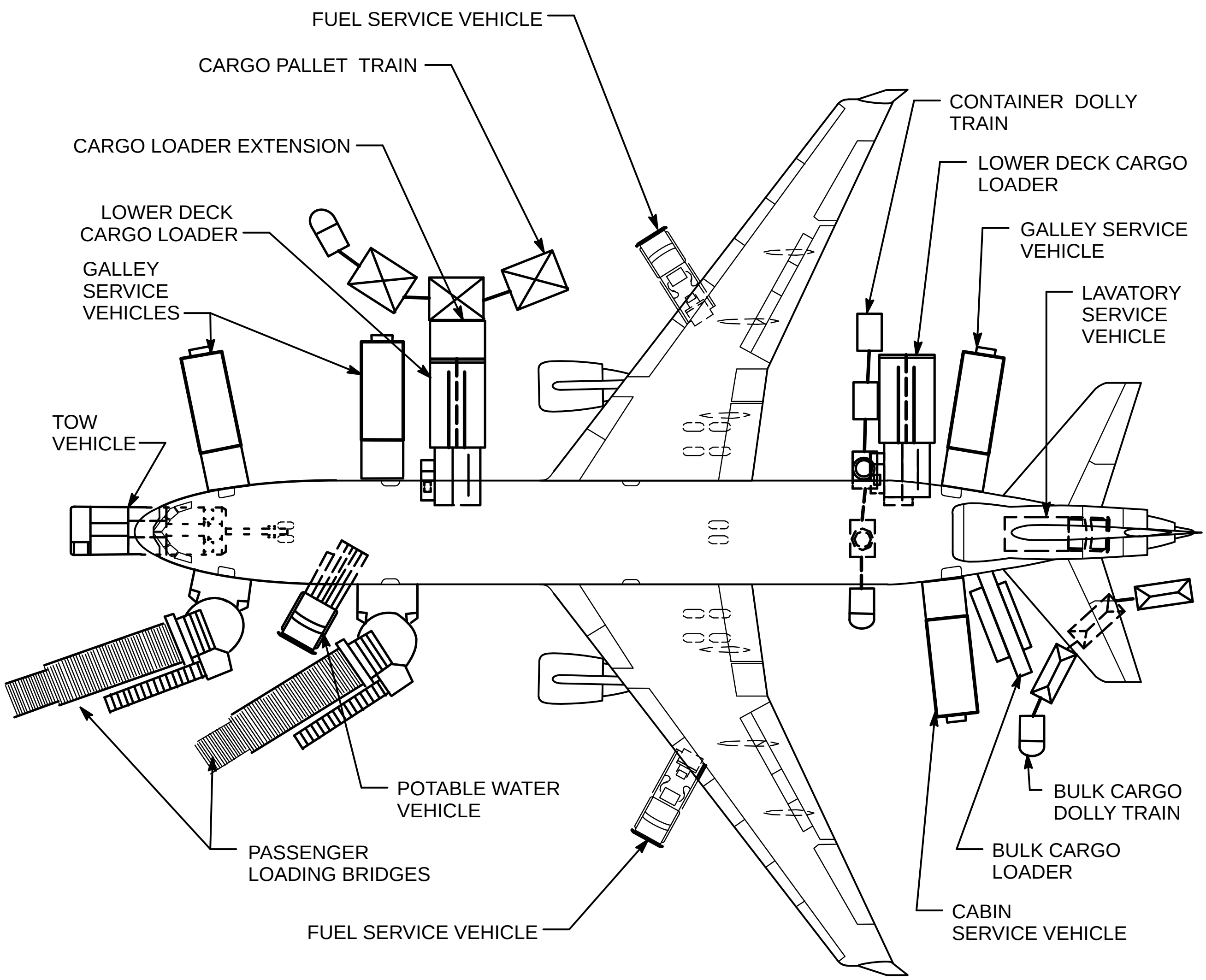
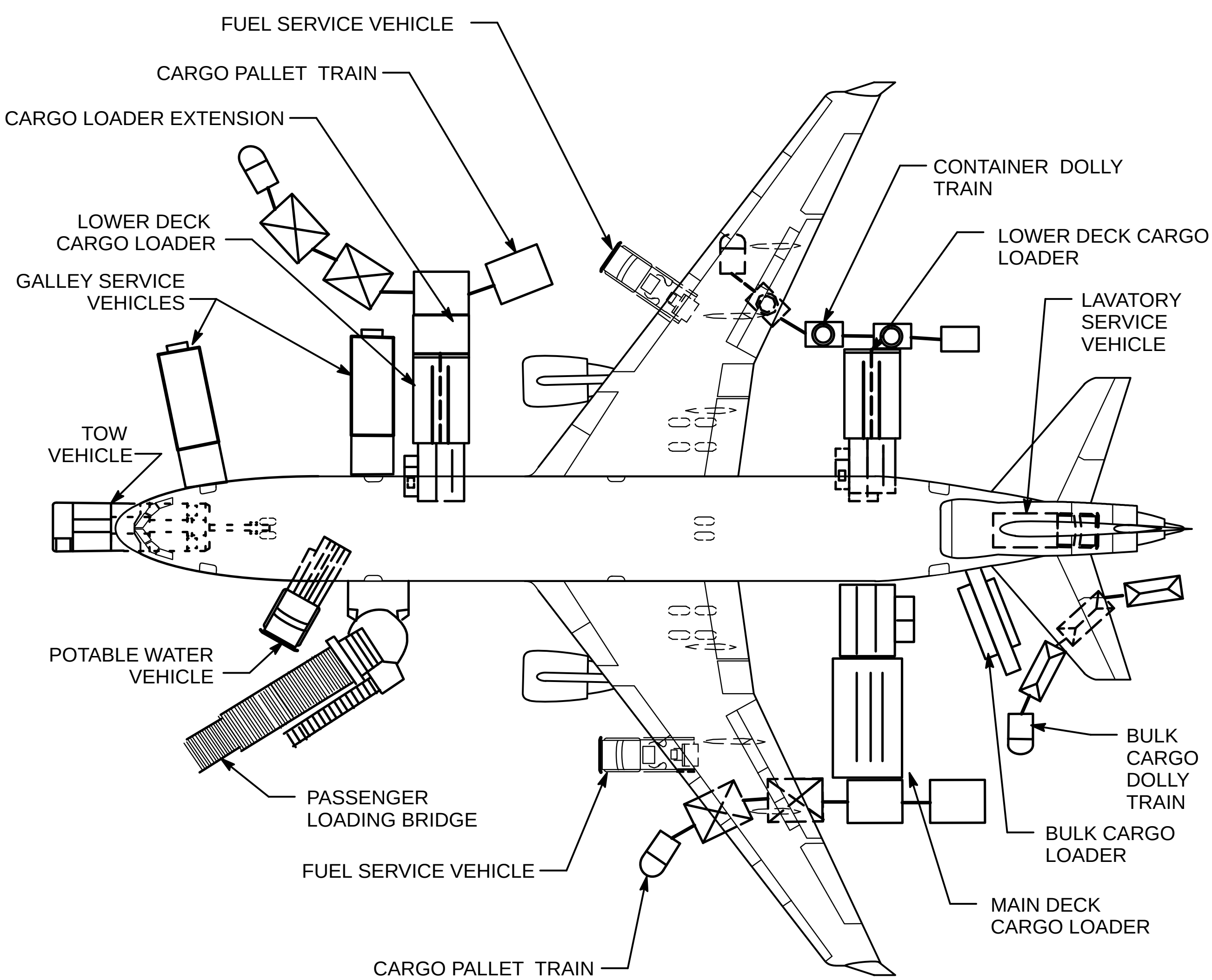
5.0 TERMINAL SERVICING



NOTE: THE AIRCRAFT AUXILIARY POWER UNIT SUPPLIES ELECTRICAL, PNEUMATIC AIR, AND PRECONDITIONED AIR.

DMC005–43

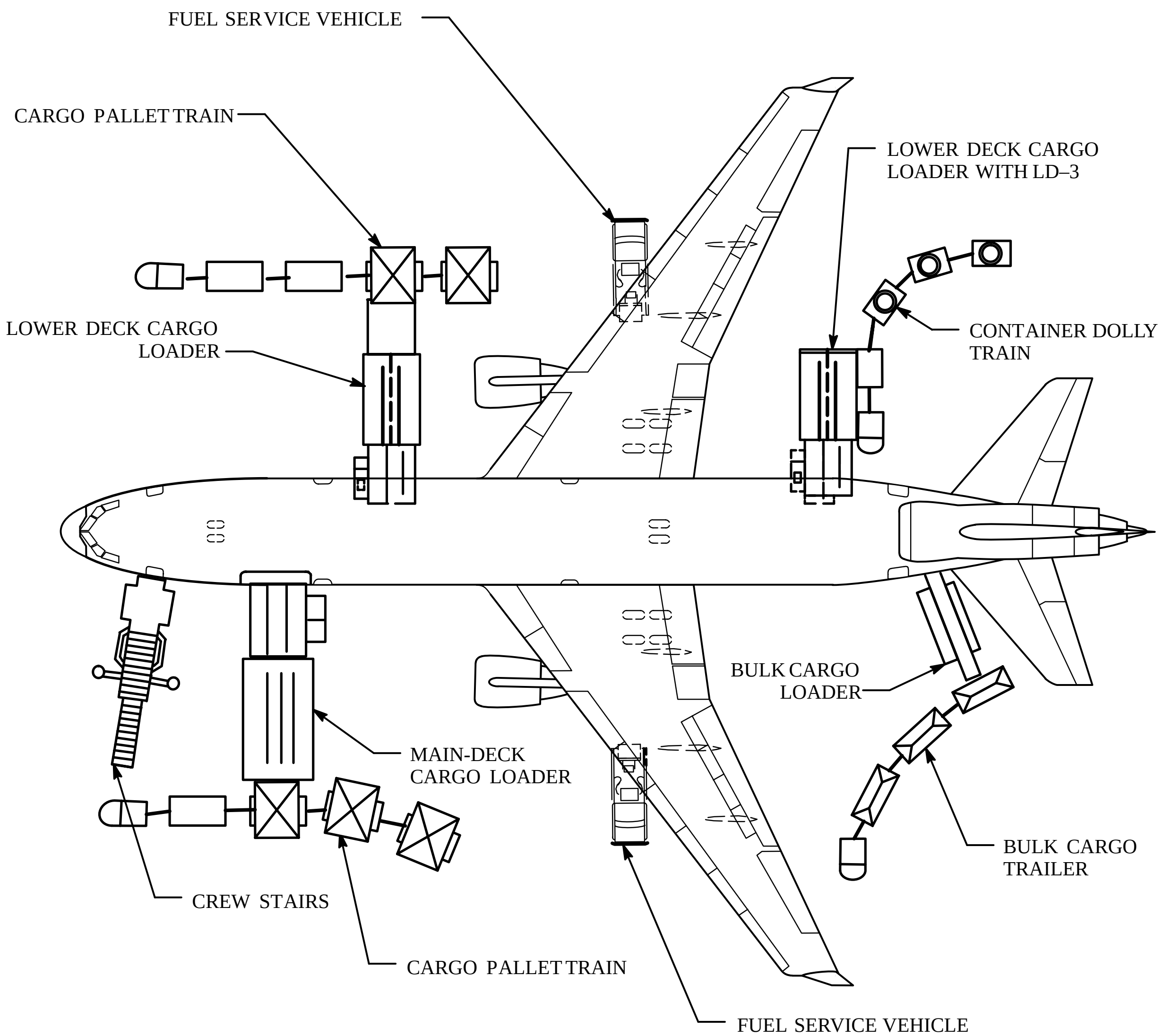
5.0 TERMINAL SERVICING
5.1 AIRPLANE SERVICING ARRANGEMENT (TYPICAL)
5.1.1 AIRPLANE SERVICING ARRANGEMENT — TYPICAL TURNAROUND MODEL MD-11



NOTE: THE AIRCRAFT AUXILIARY POWER UNIT SUPPLIES ELECTRICAL, PNEUMATIC AIR, AND PRECONDITIONED AIR.

DMC005–44

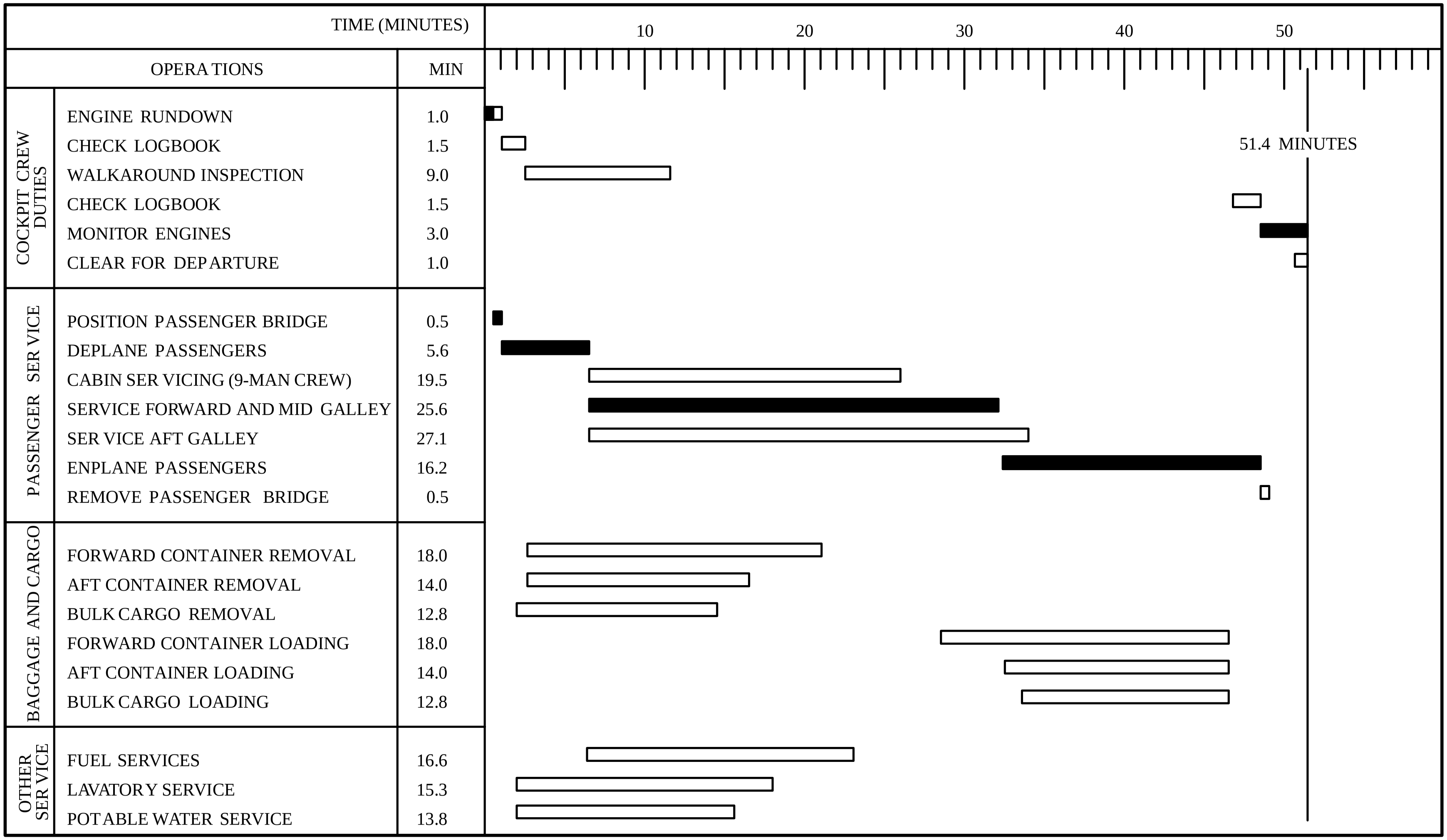
5.0 TERMINAL SERVICING
5.1.2 AIRPLANE SERVICING ARRANGEMENT — TYPICAL TURNAROUND
MODEL MD-11 COMBI



NOTE: THE AIRCRAFT AUXILIARY POWER UNIT SUPPLIES ELECTRICAL, PNEUMATIC, AND PRECONDITIONED AIR

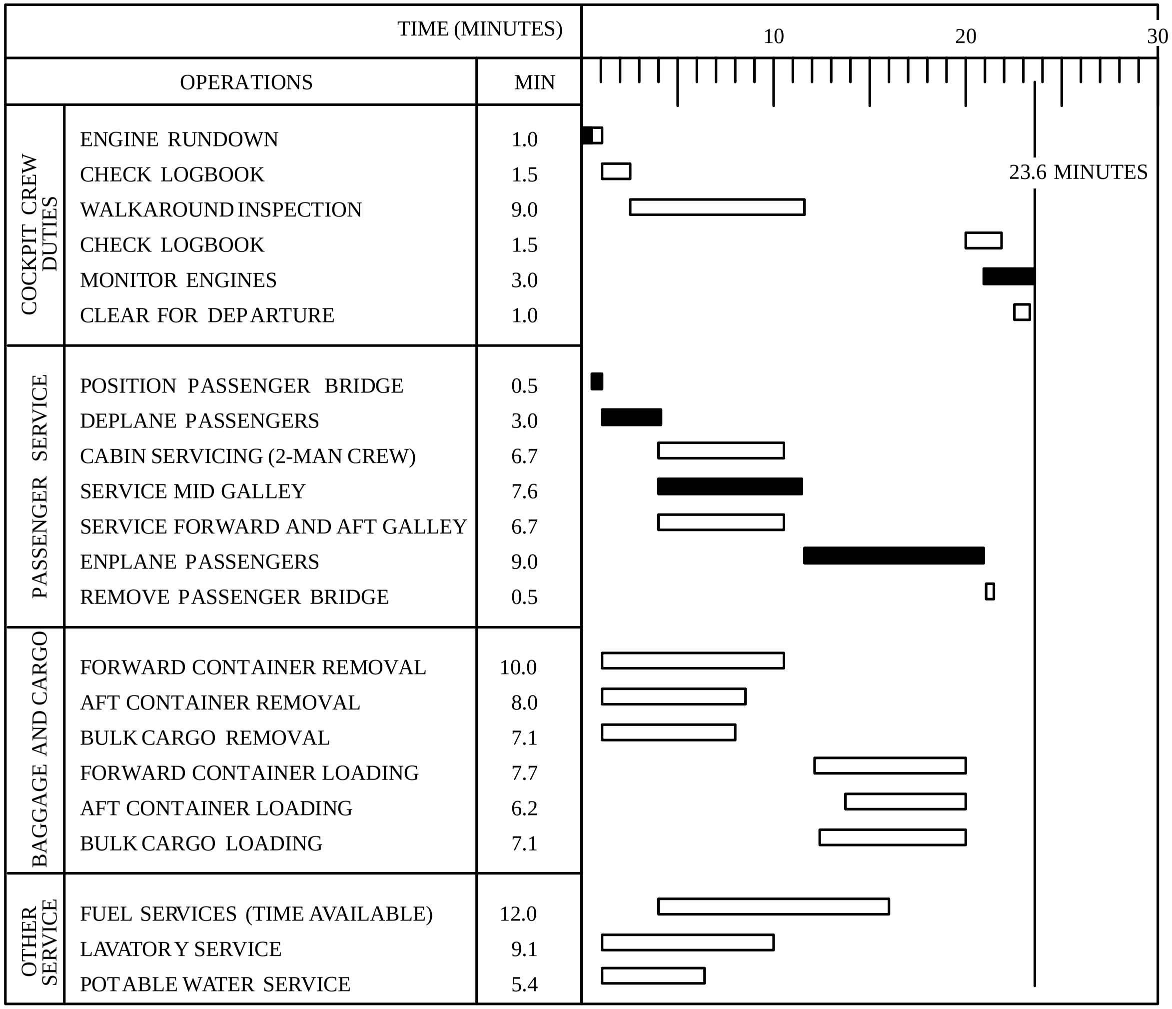
5.0 TERMINAL SERVICING
5.1.3 AIRLINE SERVICING ARRANGEMENT – TYPICAL TURNAROUND
MODEL MD-11F/CF

REV E



NOTES:
1. ■ CRITICAL TIME PATH
2. ESTIMATES BASED ON 34 FIRST CLASS AND 289 COACH
3. DEPLANING AND ENPLANING THROUGH DOORS NO. 1 AND 2
4. 1,562-GPM REFUELING RATE USING TWO HYDRANT VEHICLES
5. UPPER GALLEY CONFIGURATION WITH FWD, MID, AND AFT GALLEYS
6. AFT GALLEY CLOSED OFF DURING PART OF PASSENGER ENPLANEMENT

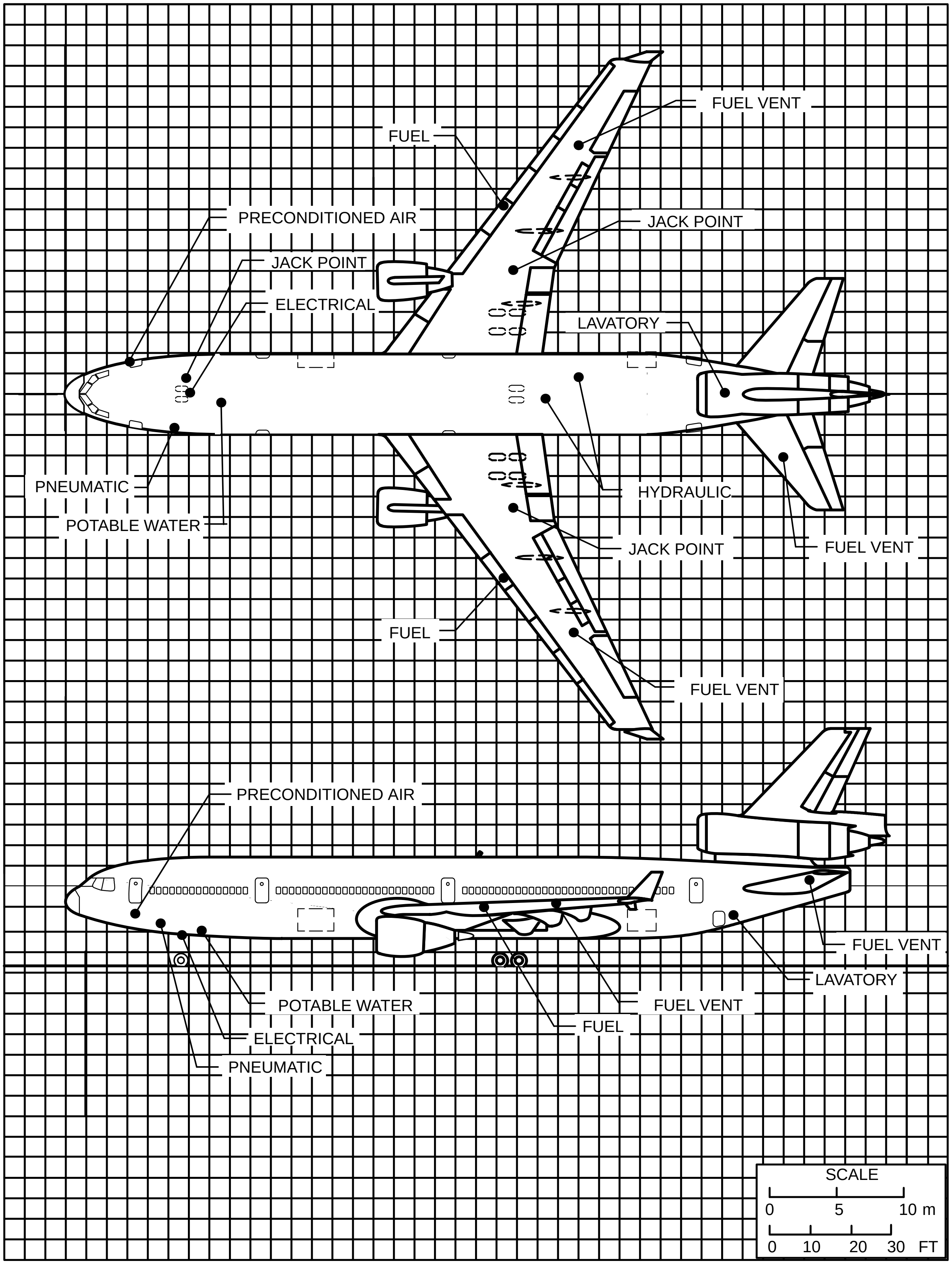
5.2 TERMINAL OPERATIONS, TURNAROUND
5.2.1 TURNAROUND
MODEL MD-11



NOTES:

1. ■ CRITICAL TIME PATH
2. 55-PERCENT LOAD FACTOR; 17 FIRST CLASS AND 160 COACH
3. DEPLANING THROUGH DOORS NO. 1 AND 2
4. ENPLANING FIRST CLASS PSGRS THROUGH NO. 1 DOOR AND COACH PSGRS THROUGH NO. 2 DOOR
5. 962-GPM REFUELING RATE USING TWO TRUCKS
6. UPPER GALLEY CONFIGURATION WITH FWD, MID, AND AFT GALLEYS
7. AFT GALLEY CLOSED OFF DURING PART OF PASSENGER ENPLANEMENT

5.3 TERMINAL OPERATIONS, ENROUTE STATION MODEL MD-11



5.4 GROUND SERVICE CONNECTIONS
MODEL MD–11

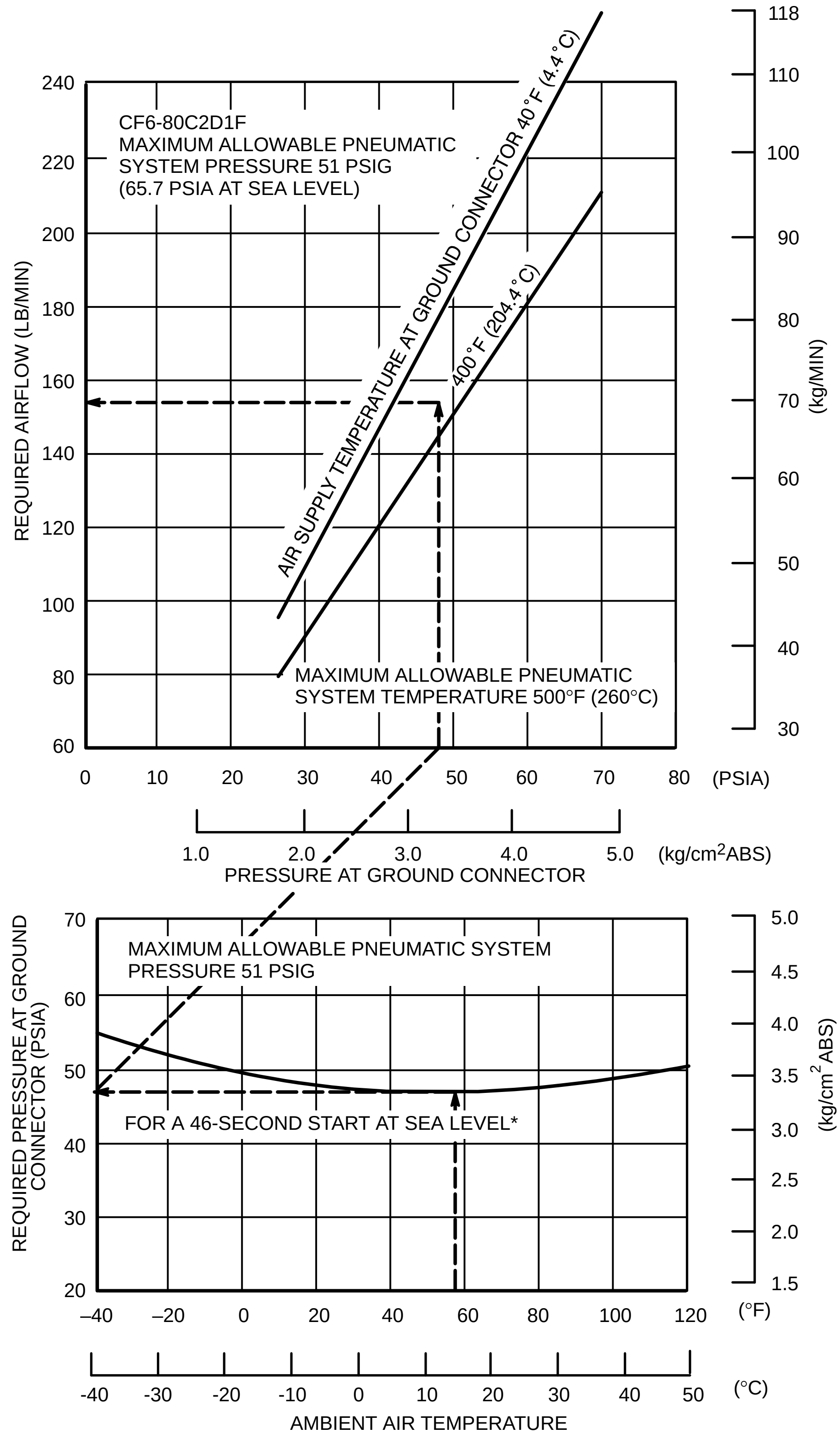
DMC005–48

	DISTANCE AFT OF NOSE		DISTANCE FROM AIRPLANE CENTERLINE				HEIGHTABOVE GROUND			
			RIGHTSIDE		LEFTSIDE		MINUMUM		MAXIMUM	
	FT — IN.	METERS	FT — IN.	METERS	FT — IN.	METERS	FT — IN.	METERS	FT — IN.	METERS
5.4.1 HYDRAULIC SYSTEM TWO SERVICE CONNECTIONS: A. SERVICE PANEL CONTAINING PRESSURE AND TEST STAND CONNECTIONS, 3,000 PSI (21 MPa) AT 50 GPM (189 lPM) MAXIMUM B. RESERVOIR FILL CONNECTIONS, 60 PSI (414 kPA)	126 – 0 118 – 10	38.40 36.22	4 – 2	1.27	3 – 4	1.02	9 – 1 9 – 5	2.77 2.87	9 – 8 10 – 0	2.95 3.05
5.4.2 ELECTRICAL SYSTEM TWO SERVICE CONNECTIONS, 90 KVA, EA. 115 VOLT 400 H_Z ,3 PHASE	30 – 6	9.30			1 – 2	0.36	7 – 4	2.24	8 – 9	2.67
5.4.3 OXYGEN — INDEPENDENTAIRCREW AND PASSENGER SYSTEMS AIRCREW OXYGEN SYSTEM PASSENGER OXYGEN SYSTEM	CYLINDER IN AVIONICS COMPARTMENT, CONNECTED TO MANIFOLD. PORTABLE CYLINDER FOR CREW INFLIGHT COMPARTMENT. CHEMICAL OXYGEN SYSTEM IN MODULES IN OVERHEAD STORAGE RACKS, LAVATORIES, AND ATTENDANT STATIONS, PORTABLE CYLINDERS FOR FIRST AID									
5.4.4 FUEL SYSTEM TWO PRESSURE SERVICE POINTS IN EACH WING LEADING EDGE. 1,250 GPM (4,731 lPM) THROUGH 2 POINTS — 1,600 GPM (6,056 lPM) THROUGH 4 POINTS AT 50 PSIG (345 kPA) TOTAL USABLE CAPACITY 38,652 U.S. GALLONS (146,296 l) 6,075 U.S. GALLONS (22,945 l) EACH WING TANK 1 AND 2 9,767.9 U.S. GALLONS (36,968 l) NUMBER 2 TANK 13,001 U.S. GALLONS (49,208 l) CTR WING AUX TANK UPPER 1,643 U.S. GALLONS (6,217 l) UNDER WING AUX TANK LOWER 2,000 U.S. GALLONS (7,570 l) TAIL AUX TANK										
RIGHT WING SERVICE RECEPTACLES	107 – 10	32.87	42 – 3	12.88			14 – 8	4.47	15 – 5	4.70
LEFT WING SERVICE RECEPTACLES	107 – 10	32.87			42– 3	12.88	14 – 8	4.47	15 – 5	4.70
FUEL VENT WING RIGHT	124 – 3	37.87	58 – 4	17.78			14 – 0	4.27	15 – 1	4.60
FUEL VENT WING LEFT	124 – 3	37.87			58 – 4	17.78	14 – 0	4.27	15 – 1	4.60
TAIL AUX TANK VENT	179 – 9	54.79			15 – 8	4.78	19 – 4	5.89	21 – 3	6.48
5.4.5 PNEUMATIC SYSTEM TWO 3-IN. SERVICE CONNECTIONS FOR ENGINE START AND AIR CONDITIONING	25 – 2	7.67			6 – 7	2.01	10 – 10	3.30	12 – 4	3.76
5.4.6 PRECONDITIONED AIR TWO 8-IN. CONNECTIONS FOR AIR CONDITIONING	15 – 2	4.62	6 – 2	1.88			12 – 3	3.73	13 – 1 1	4.24
5.4.7 POTABLE WATER SYSTEM ONE SERVICE CONNECTION FOUR-TANK SYSTEM 64 U.S. GALLONS EACH (242 l) — TOTAL SYSTEM CAPACITY 256 GAL (969 LITERS)	40 – 6	12.34			3 – 4	1.02	8 – 0	2.44	9 – 1	2.77
5.4.8 LAVATORY SYSTEM NUMBER OF TOILETS — SERVICE LOCATION 1 ([1]) — FORWARD ([2]) UP TO 12 — AFT SERVICE CAPACITIES WASTE HOLDING 260 U.S. GALLONS (984 l)	13 – 10 (2) 163 – 8	4.22 (2) 49.89	℄ ℄	℄ ℄	℄ ℄	℄ ℄	9 – 5 (2) 9 – 9	2.87 (2) 2.97	10 – 8 (2) 11 – 3	3.25 (2) 3.43

([1]) FREIGHTER – 1 TOILET FORWARD LOCATION
([2]) FREIGHTER ONLY

5.4 GROUND SERVICE CONNECTION DATA MODEL MD-11

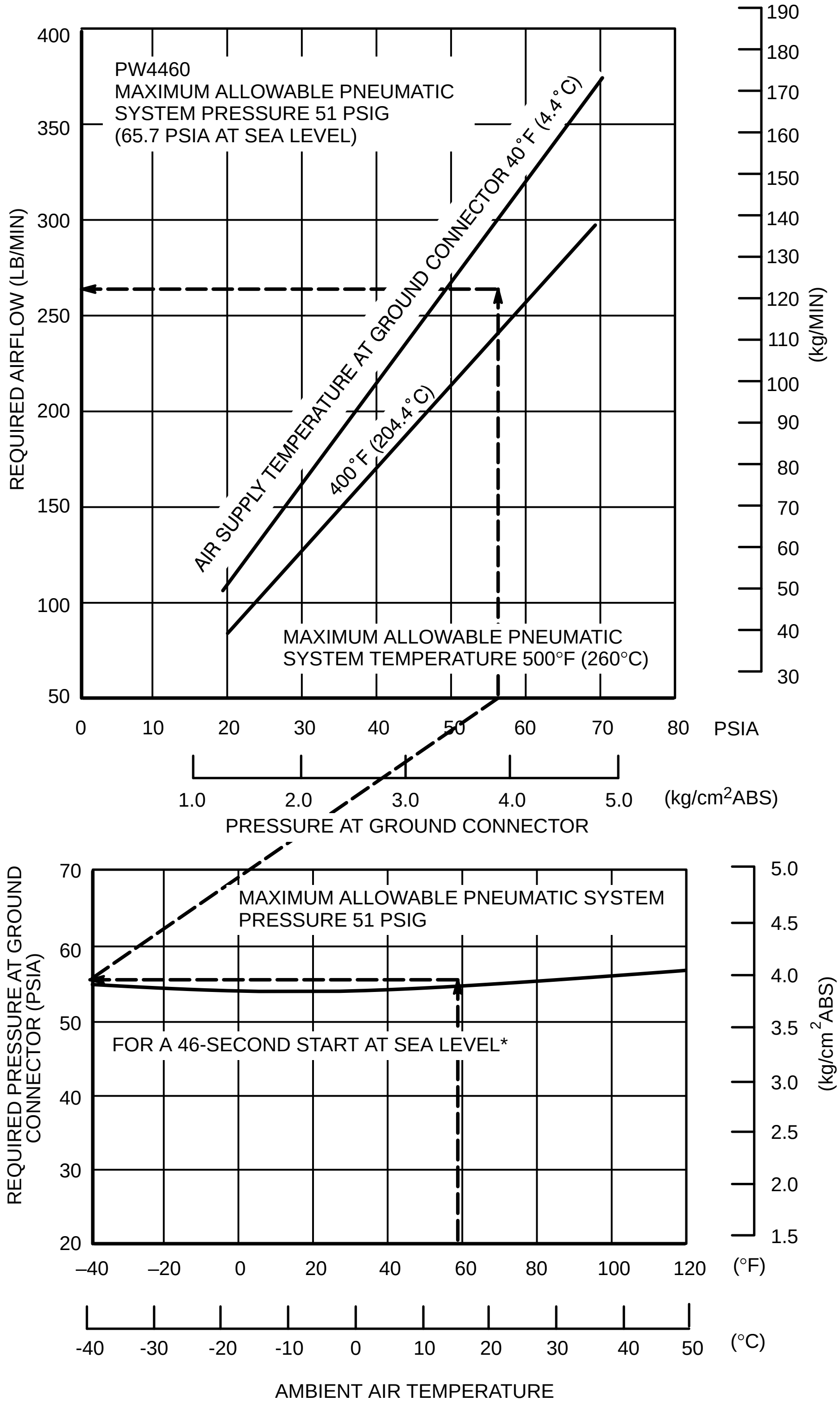
REV E



* THERE IS NO SATISFACTORY DEFINITION FOR “REQUIRED PRESSURE AT GROUND CONNECTOR” SO THAT A SINGLE LINE CAN BE DEPICTED. THE LINE DEPICTED IS FOR A 46-SECOND START TIME, WHICH IS AN ARBITRARY VALUE.

DMC005–49

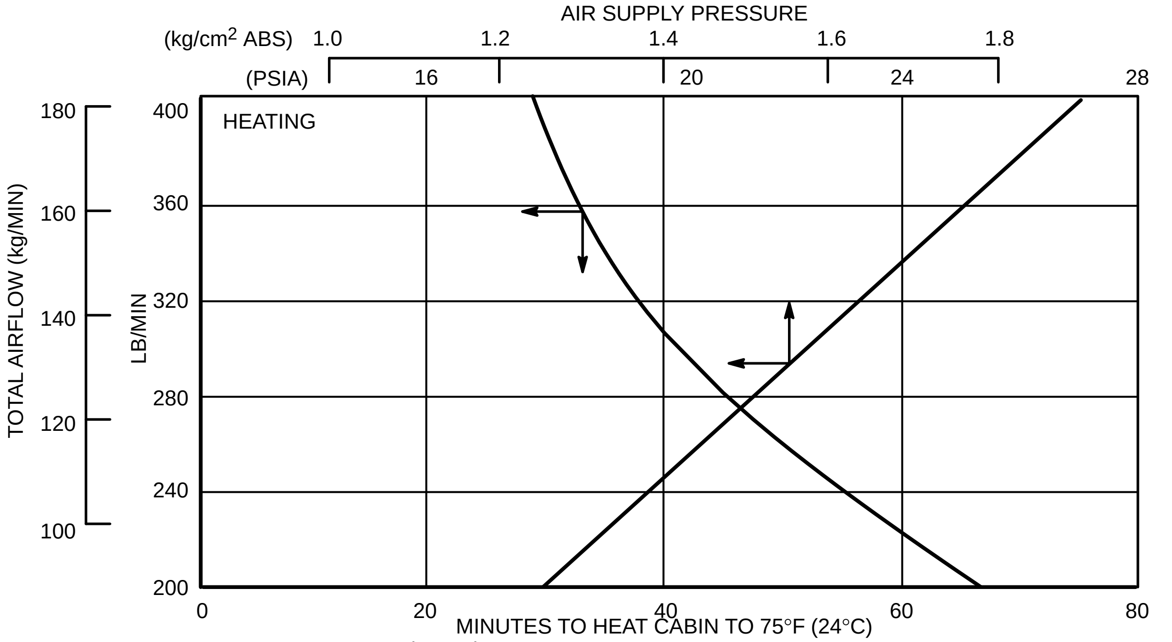
5.5 ENGINE STARTING PNEUMATIC REQUIREMENTS MODEL MD-11 GE ENGINE



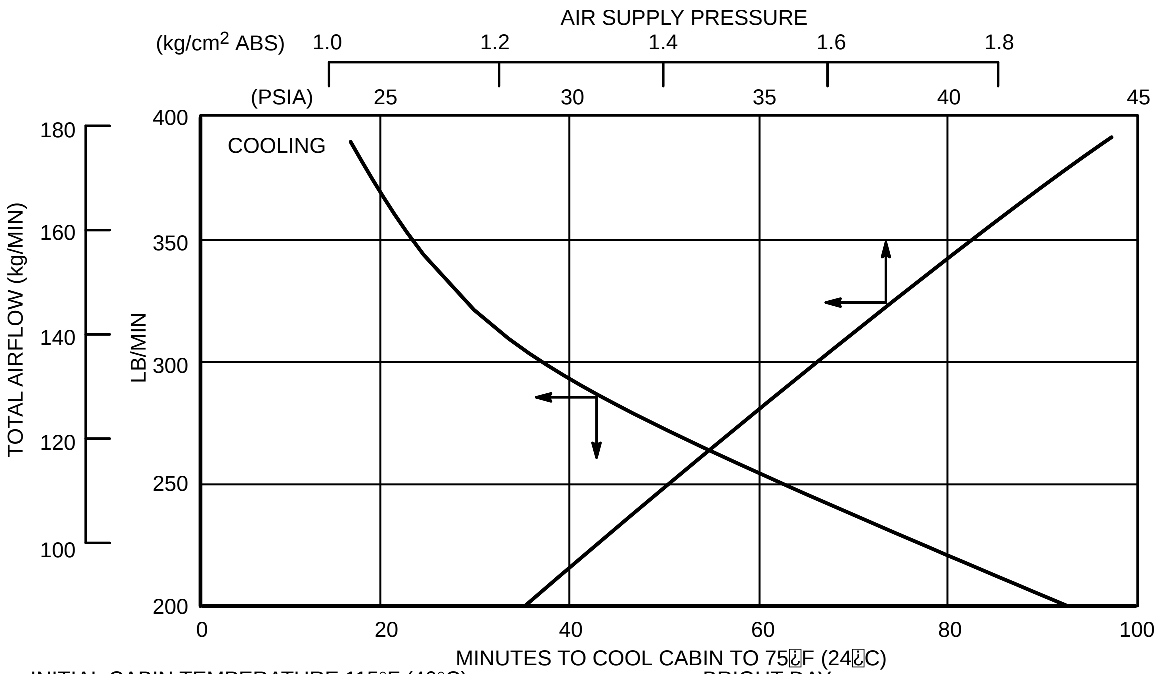
* THERE IS NO SATISFACTORY DEFINITION FOR "REQUIRED PRESSURE AT GROUND CONNECTOR" SO THAT A SINGLE LINE CAN BE DEPICTED. THE LINE DEPICTED IS FOR A 46-SECOND START TIME, WHICH IS AN ARBITRARY VALUE.

DMC005–50

5.5 ENGINE STARTING PNEUMATIC REQUIREMENTS MODEL MD-11 P&W ENGINE



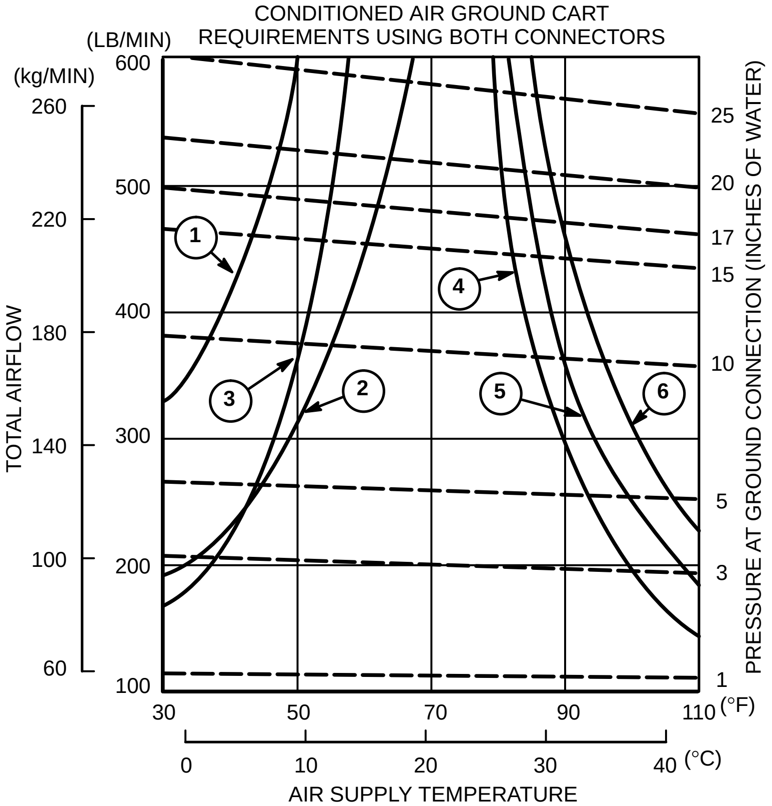
- INITIAL CABIN TEMPERATURE –25°F (–32°C)
- OUTSIDE AIR TEMPERATURE –40°F (–40°C)
- MAX TEMPERATURE AT GROUND CONN 440°F (227°C)
- MIN TEMPERATURE NOT LESS THAN 200°F (93°C) ABOVE O.A.T
- DOORS CLOSED
- DULL DAY
- NO CABIN OCCUPANTS OR ELECTRICAL LOAD
- MAX ALLOWABLE SUPPLY PRESSURE 45 PSIG
- BOTH GROUND CONNECTIONS USED
- THREE-PACK OPERATION



- INITIAL CABIN TEMPERATURE 115°F (46°C)
- OUTSIDE AIR TEMPERATURE 103°F (40°C) REL HUM 42%
- MAX TEMPERATURE AT GROUND CONN 440°F (227°C)
- MIN TEMPERATURE NOT LESS THAN 200°F (93°C) ABOVE O.A.T
- DOORS CLOSED
- BRIGHT DAY
- NO CABIN OCCUPANTS OR ELECTRICAL LOAD
- MAX ALLOWABLE SUPPLY PRESSURE 45 PSIG
- BOTH GROUND CONNECTIONS USED
- THREE-PACK OPERATION

DMC005–51

5.6 GROUND PNEUMATIC POWER REQUIREMENTS
MODEL MD-11



1 CABIN AT 75°F (24°C), 410 OCCUPANTS, BRIGHT DAY (SOLAR IRRADIATION), 103°F (39°C) DAY

2 SAME AS 1 EXCEPT CABIN AT 85°F (29°C)

3 SAME AS 1 EXCEPT CABIN AT 70°F (21°C), NO CABIN OCCUPANTS, FIVE CREW MEMBERS ONLY

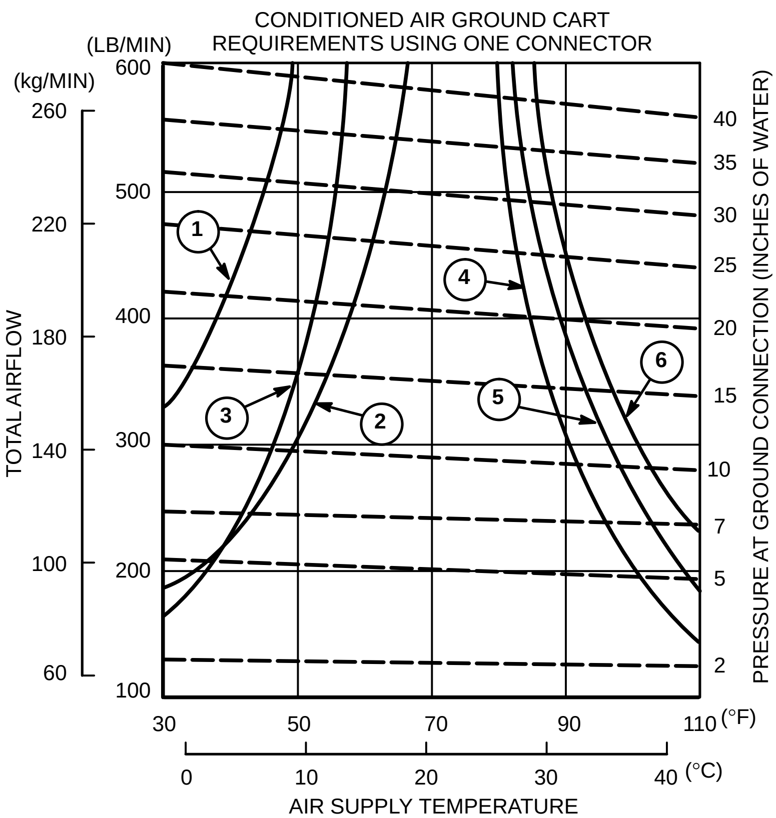
4 CABIN AT 70°F (21°C), 50 CABIN OCCUPANTS, OVERCAST DAY (NO SOLAR IRRADIATION), 0°F (–18°C) DAY

5 SAME AS 4 EXCEPT –20°F (–29°C) DAY

6 SAME AS 4 EXCEPT –40°F (–40°C) DAY

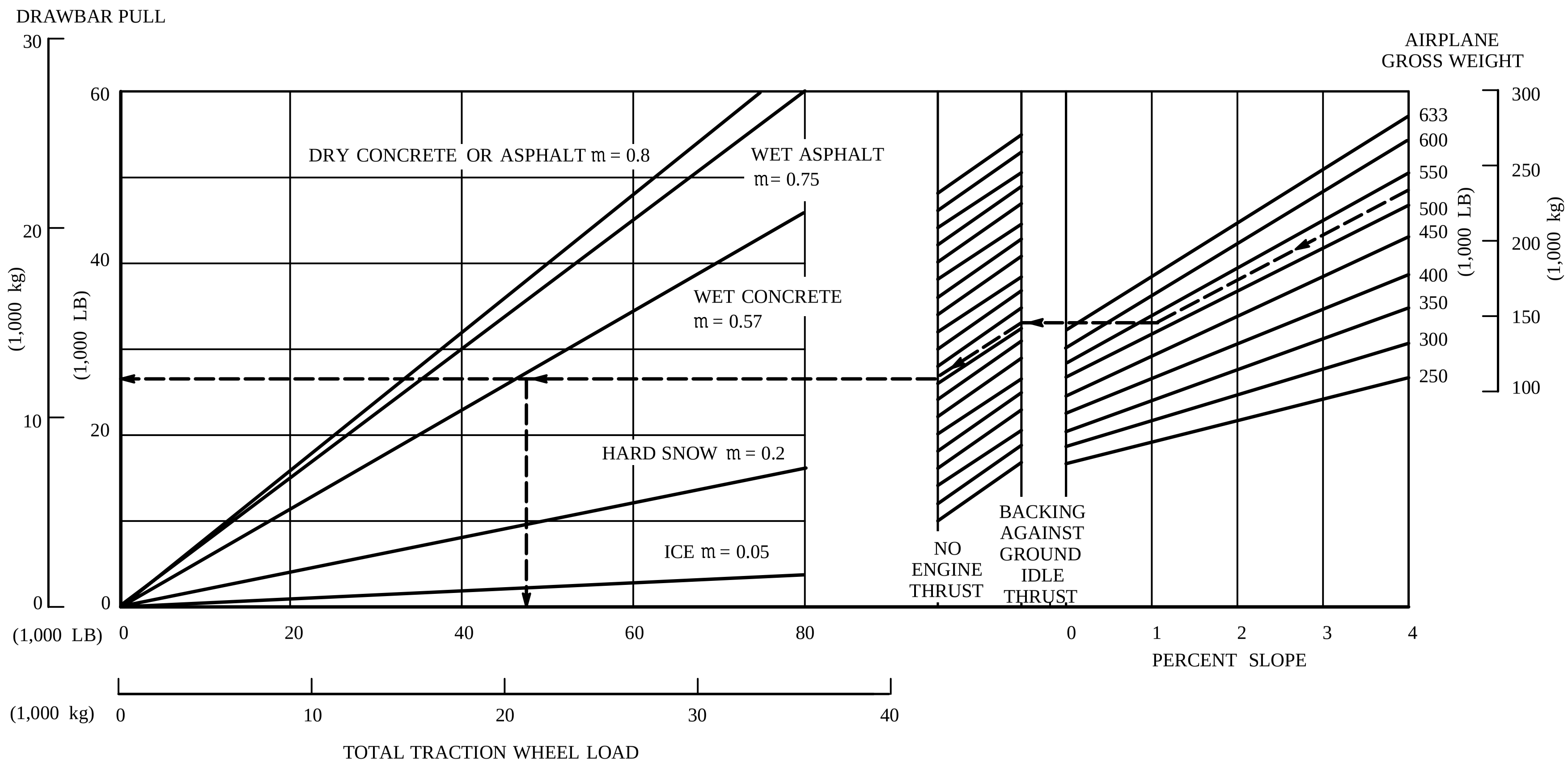
MAXIMUM ALLOWABLE TEMPERATURE 190°F (88°C)

MAXIMUM ALLOWABLE PRESSURE AT GROUND CONNECTION (25 INCHES WATER)



DMC005–53–54

5.7 PRECONDITIONED AIRFLOW REQUIREMENTS MODEL MD-11



- UNUSUAL BREAKAWAY CONDITIONS NOT REFLECTED
- ESTIMATED FOR TOW VEHICLES WITH RUBBER TIRES
- COEFFICIENTS OF FRICTION (m) — APPROXIMATE

5.8 GROUND TOWING REQUIREMENTS MODEL MD-11

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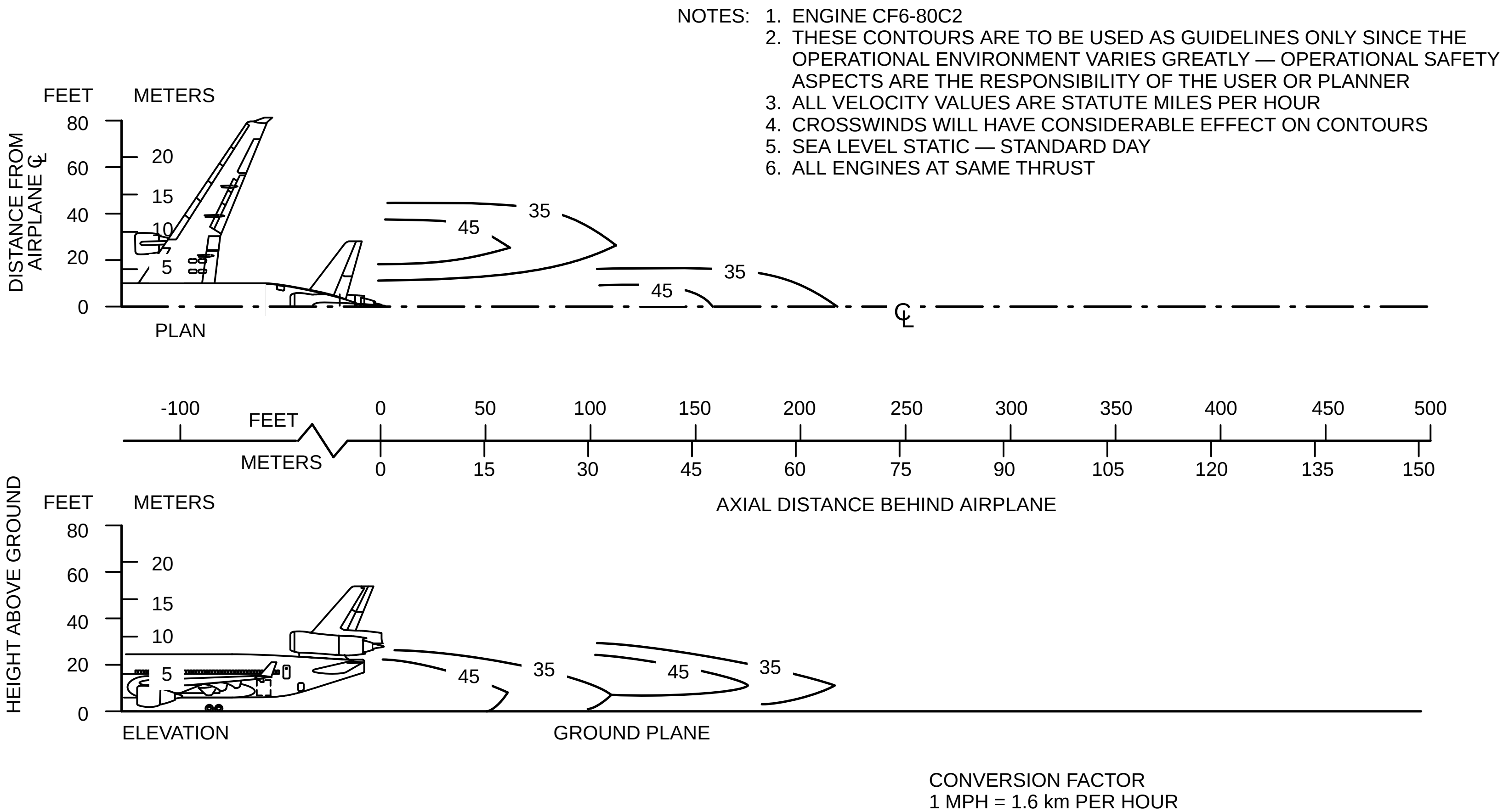
6.0 OPERATING CONDITIONS

6.1 Jet Engine Exhaust Velocities and Temperatures

6.2 Airport and Community Noise



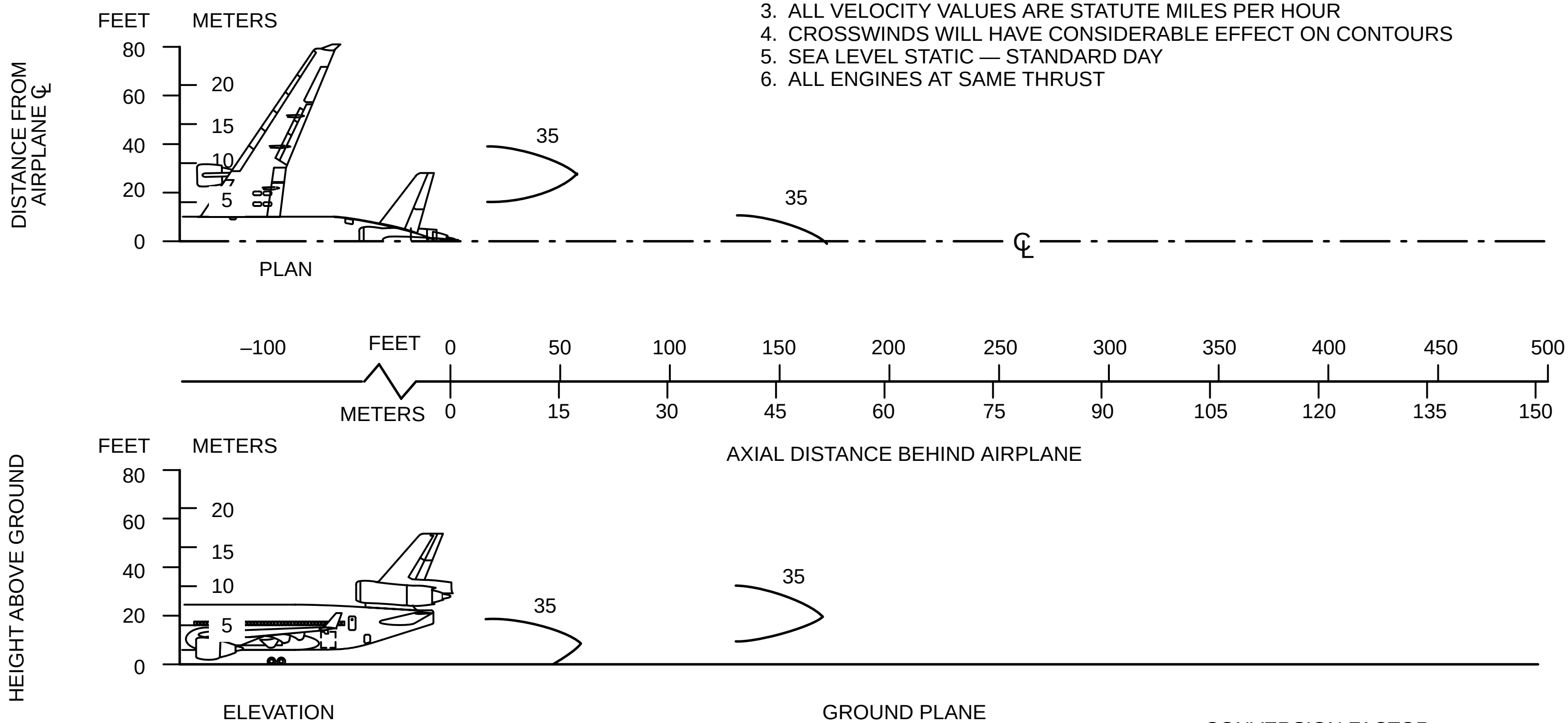
6.0 OPERATING CONDITIONS

6.1 JET ENGINE EXHAUST VELOCITIES AND TEMPERATURES

6.1.1 JET ENGINE EXHAUST VELOCITY CONTOURS, IDLE POWER (ESTIMATED)

MODEL MD-11 GE ENGINE

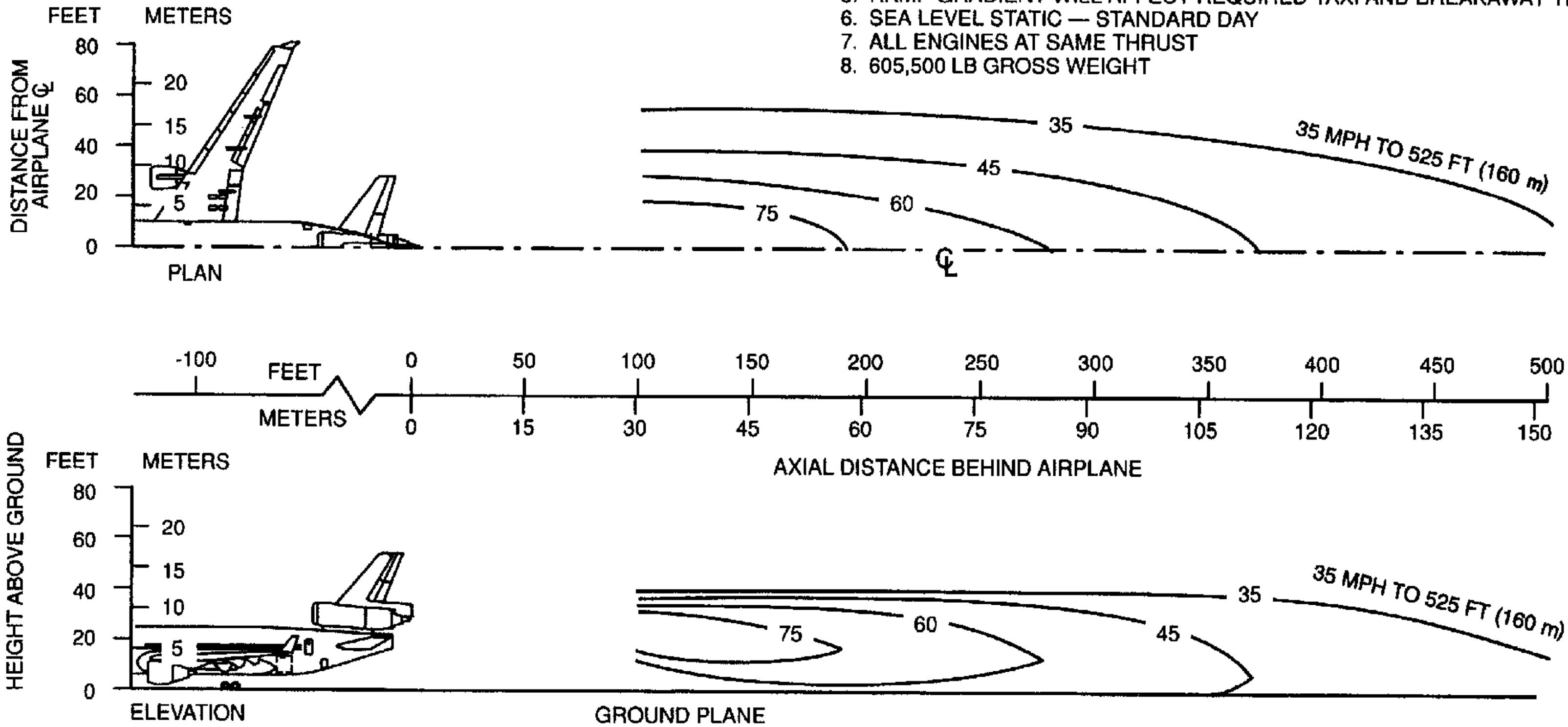
NOTES:
1. ENGINE PW4460
2. THESE CONTOURS ARE TO BE USED AS GUIDELINES ONLY SINCE THE OPERATIONAL ENVIRONMENT VARIES GREATLY — OPERATIONAL SAFETY ASPECTS ARE THE RESPONSIBILITY OF THE USER OR PLANNER
3. ALL VELOCITY VALUES ARE STATUTE MILES PER HOUR
4. CROSSWINDS WILL HAVE CONSIDERABLE EFFECT ON CONTOURS
5. SEA LEVEL STATIC — STANDARD DAY
6. ALL ENGINES AT SAME THRUST



CONVERSION FACTOR
1 MPH = 1.6 km PER HOUR

6.1.1 JET ENGINE EXHAUST VELOCITY CONTOURS, IDLE POWER (ESTIMATED)
MODEL MD-11 P&W ENGINE

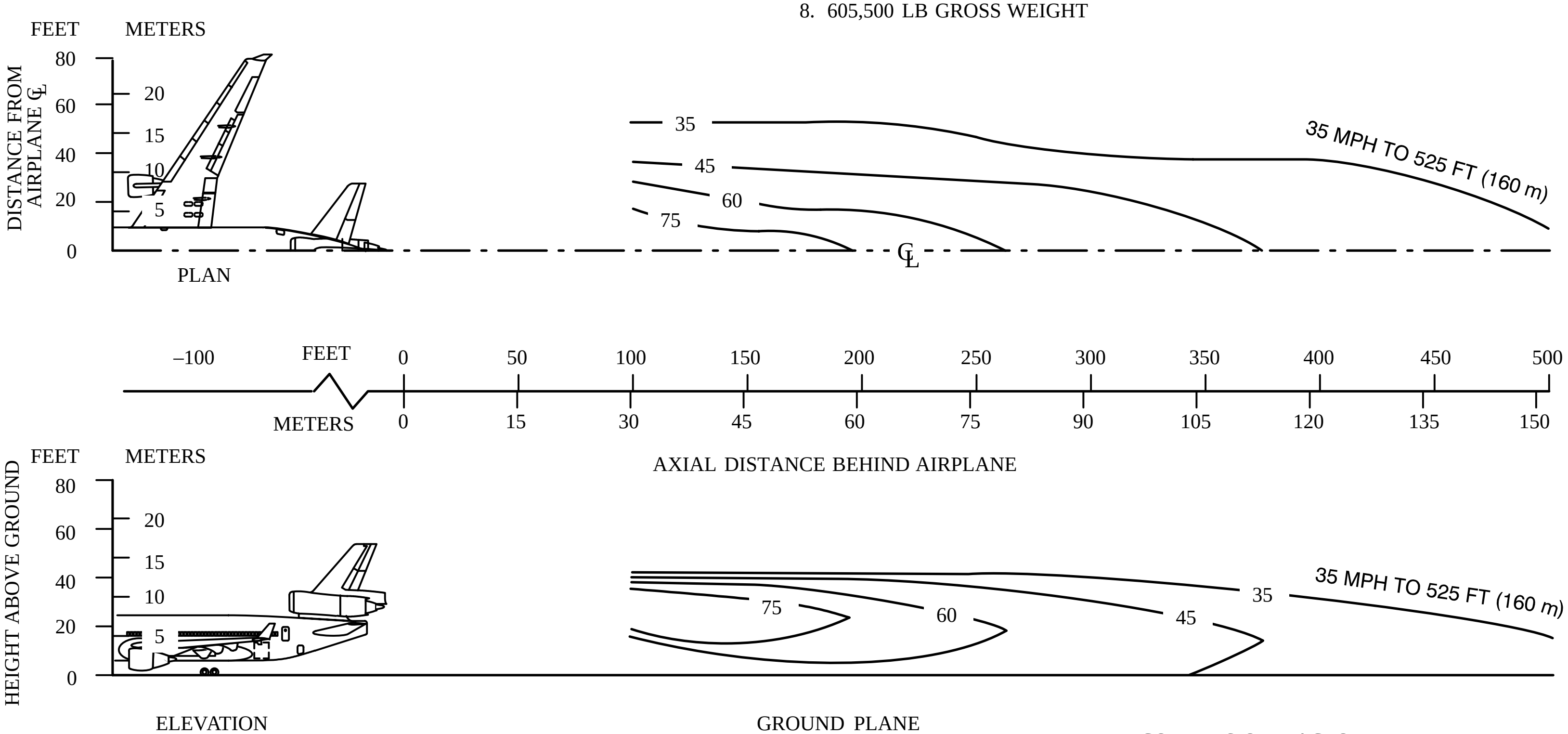
NOTES:
1. ENGINE CF6-80C2DIF
2. THESE CONTOURS ARE TO BE USED AS GUIDELINES ONLY SINCE THE OPERATIONAL ENVIRONMENT VARIES GREATLY — OPERATIONAL SAFETY ASPECTS ARE THE RESPONSIBILITY OF THE USER OR PLANNER
3. ALL VELOCITY VALUES ARE STATUTE MILES PER HOUR
4. CROSSWINDS WILL HAVE CONSIDERABLE EFFECT ON CONTOURS
5. RAMP GRADIENT WILL AFFECT REQUIRED TAXI AND BREAKAWAY THRUST
6. SEA LEVEL STATIC — STANDARD DAY
7. ALL ENGINES AT SAME THRUST
8. 605,500 LB GROSS WEIGHT



CONVERSION FACTOR
1 MPH = 1.6 km PER HOUR

6.1.2 JET ENGINE EXHAUST VELOCITY CONTOURS, BREAKAWAY POWER (ESTIMATED) MODEL MD-11 GE ENGINE

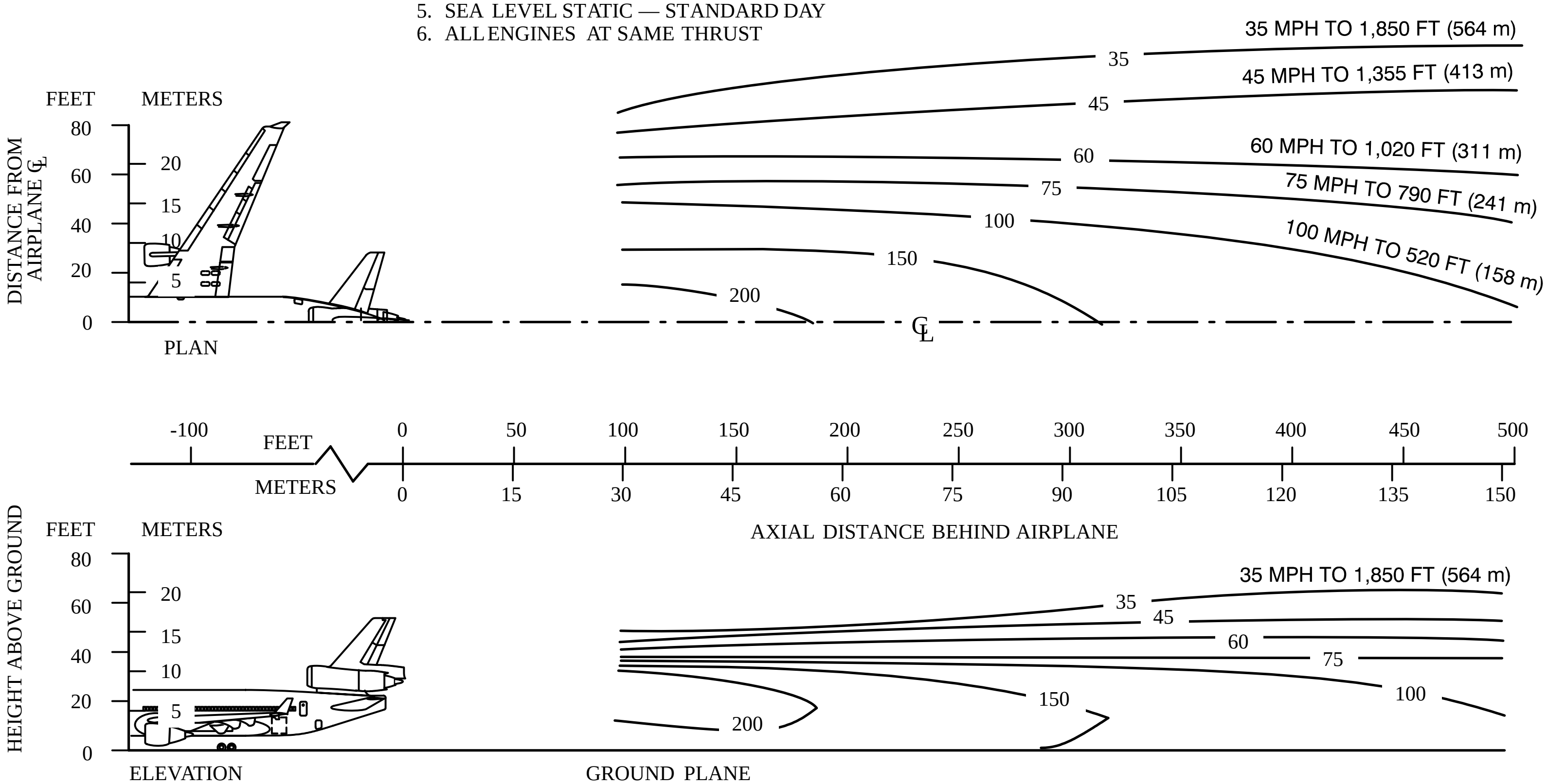
NOTES:
1. ENGINE PW4000
2. THESE CONTOURS ARE TO BE USED AS GUIDELINES ONLY SINCE THE OPERATIONAL ENVIRONMENT VARIES GREATLY — OPERATIONAL SAFETY ASPECTS ARE THE RESPONSIBILITY OF THE USER OR PLANNER
3. ALL VELOCITY VALUES ARE STATUTE MILES PER HOUR
4. CROSSWINDS WILL HAVE CONSIDERABLE EFFECT ON CONTOURS
5. RAMP GRADIENT WILL AFFECT REQUIRED TAXI AND BREAKAWAY THRUST
6. SEA LEVEL STATIC — STANDARD DAY
7. ALL ENGINES AT SAME THRUST
8. 605,500 LB GROSS WEIGHT



CONVERSION FACTOR
1 MPH = 1.6 km PER HOUR

6.1.2 JET ENGINE EXHAUST VELOCITY CONTOURS, BREAKAWAY POWER (ESTIMATED) MODEL MD-11 P&W ENGINE

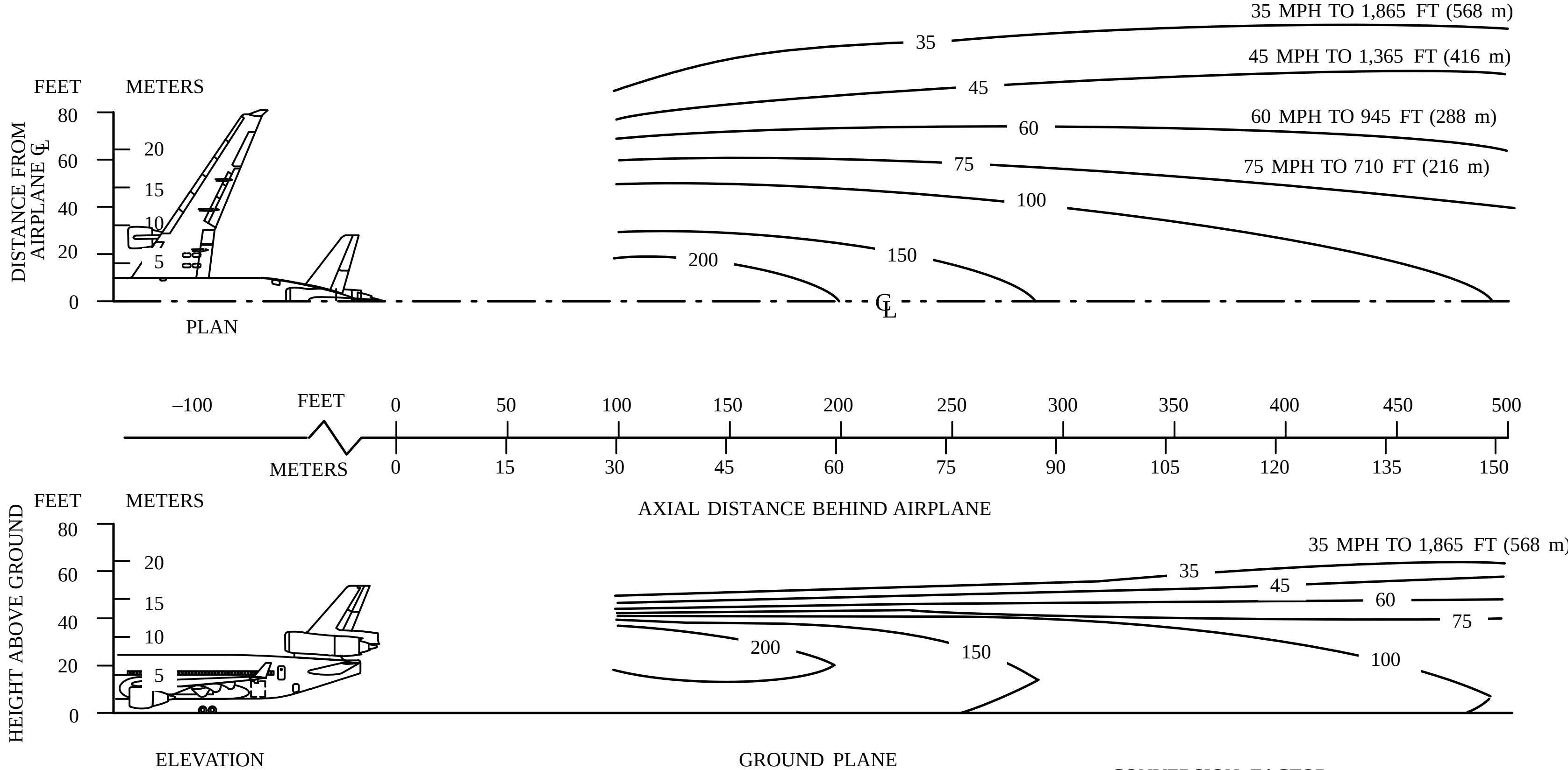
NOTES:
1. ENGINE CF6-80C2D1F
2. THESE CONTOURS ARE TO BE USED AS GUIDELINES ONLY SINCE THE OPERATIONAL ENVIRONMENT VARIES GREATLY — OPERATIONAL SAFETY ASPECTS ARE THE RESPONSIBILITY OF THE USER OR PLANNER.
3. ALL VELOCITY VALUES ARE STATUTE MILES PER HOUR.
4. CROSSWINDS WILL HAVE CONSIDERABLE EFFECT ON CONTOURS
5. SEA LEVEL STATIC — STANDARD DAY
6. ALL ENGINES AT SAME THRUST



CONVERSION FACTOR
1 MPH = 1.6 km PER HOUR

6.1.3 JET ENGINE EXHAUST VELOCITY CONTOURS, TAKEOFF POWER (ESTIMATED)
MODEL MD-11 GE ENGINE

NOTES:
1. ENGINE PW4460
2. THESE CONTOURS ARE TO BE USED AS GUIDELINES ONLY SINCE THE OPERATIONAL ENVIRONMENT VARIES GREATLY — OPERATIONAL SAFETY ASPECTS ARE THE RESPONSIBILITY OF THE USER OR PLANNER
3. ALL VELOCITY VALUES ARE STATUTE MILES PER HOUR
4. CROSSWINDS WILL HAVE CONSIDERABLE EFFECT ON CONTOURS
5. SEA LEVEL STATIC — STANDARD DAY
6. ALL ENGINES AT SAME THRUST



CONVERSION FACTOR
1 MPH = 1.6 km PER HOUR

6.1.3 JET ENGINE EXHAUST VELOCITY CONTOURS, TAKEOFF POWER (ESTIMATED) MODEL MD-11 P&W ENGINE

6.1.4 Jet Engine Exhaust Temperature (MD-11, All Engine Models)

Jet engine exhaust temperature contour lines have not been presented because the adverse effects of exhaust temperature at any given position behind the aircraft fitted with these high-bypass engines are considerably less than the effects of exhaust velocity.

6.2 Airport and Community Noise

Airport noise is of major concern to the airport and community planner. The airport is a major element of the community's transportation system and, as such, is vital to its growth. However, the airport must also be a good neighbor, and this can be accomplished only with proper planning. Since aircraft noise extends beyond the boundaries of the airport, it is vital to consider the impact on surrounding communities. Many means have been devised to provide the planner with a tool to estimate the impact of airport operations. Too often they oversimplify noise to the point where the results become erroneous. Noise is not a simple subject; therefore, there are no simple answers.

The cumulative noise contour is an effective tool. However, care must be exercised to ensure that the contours, used correctly, estimate the noise resulting from aircraft operations conducted at an airport.

The size and shape of the single-event contours, which are inputs into the cumulative noise contours, are dependent upon numerous factors. They include:

1. Operational Factors

   (a) Aircraft Weight — Aircraft weight is dependent on distance to be traveled, en route winds, payload, and anticipated aircraft delay upon reaching the destination.

   (b) Engine Power Settings — The rates of ascent and descent and the noise levels emitted at the source are influenced by the power setting used.

   (c) Airport Altitude — Higher airport altitude will affect engine performance and thus can influence noise.

2. Atmospheric Conditions — Sound Propagation

   (a) Wind — With stronger headwinds, the aircraft can take off and climb more rapidly relative to the ground. Also, winds can influence the distribution of noise in surrounding communities.

   (b) Temperature and Relative Humidity — The absorption of noise in the atmosphere along the transmission path between the aircraft and the ground observer varies with both temperature and relative humidity.

3. Surface Condition — Shielding, Extra Ground Attenuation (EGA)

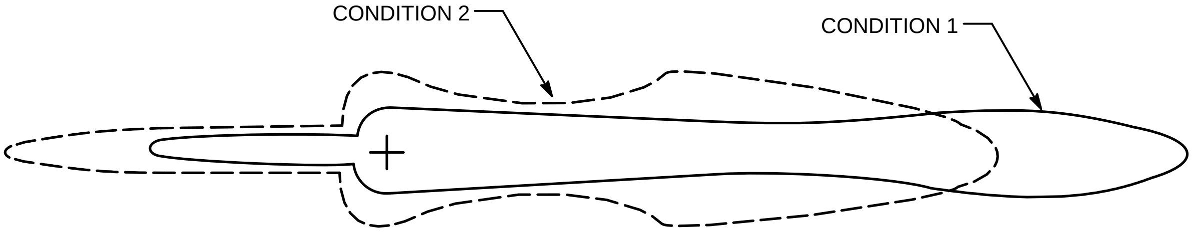
   Terrain — If the ground slopes down after takeoff or up before landing, noise will be reduced since the aircraft will be at a higher altitude above the ground. Additionally, hills, shrubs, trees, and large buildings can act as sound buffers.

All of these factors can alter the shape and size of the contours appreciably. To demonstrate the effect of some of these factors, estimated noise level contours for two different operating conditions are shown below. These contours reflect a given noise level upon a ground level plane at runway elevation.

CONDITION 1

LANDING:
MAXIMUM DESIGN LANDING WEIGHT
10-KNOT HEADWIND
3-DEG APPROACH
84°F
HUMIDITY 15%

TAKEOFF:
MAXIMUM DESIGN TAKEOFF WEIGHT
ZERO WIND
84°F
HUMIDITY 15%



CONDITION 2

LANDING:
85% OF MAXIMUM DESIGN LANDING WEIGHT
10-KNOT HEADWIND
3-DEG APPROACH
59°F
HUMIDITY 70%

TAKEOFF:
80% OF MAXIMUM DESIGN TAKEOFF WEIGHT
10-KNOT HEADWIND
59°F
HUMIDITY 70%

As indicated by these data, the contour size varies substantially with operating and atmospheric conditions. Most aircraft operations are, of course, conducted at less than maximum gross weights because average flight distances are much shorter than maximum aircraft range capability and average load factors are less than 100 percent. Therefore, in developing cumulative contours for planning purposes, it is recommended that the airlines serving a particular city be contacted to provide operational information.

In addition, there are no universally accepted methods for developing aircraft noise contours or for relating the acceptability of specific noise zones to specific land uses. It is therefore expected that noise contour data for particular aircraft and the impact assessment methodology will be changing. To ensure that currently available information of this type is used in any planning study, it is recommended that it be obtained directly from the Office of Environmental Quality in the Federal Aviation Administration in Washington, D.C.

It should be noted that the contours are shown here only to illustrate the impact of operating and atmospheric conditions and do not represent the single-event contour of the family of aircraft described in this document. It is expected that the cumulative contours will be developed as required by planners using the data and methodology applicable to their specific study.

7.0 PAVEMENT DATA

7.0 PAVEMENT DATA

7.1 General Information

A brief description of the pavement charts that follow will help in their use for airport planning. Each airplane configuration is shown with a minimum range of four loads imposed on the main landing gear to aid in interpolation between the discrete values shown. All curves are plotted at constant specified tire pressure at the highest certified weight for each model.

Section 7.2 presents basic data on the landing gear footprint configuration, maximum design taxi loads, and tire sizes and pressures.

Maximum pavement loads for certain critical conditions at the tire-to-ground interface are shown in Section 7.3, with the tires having equal loads on the struts.

Pavement requirements for commercial airplanes are customarily derived from the static analysis of loads imposed on the main landing gear struts. The chart in Section 7.4 is provided in order to determine these loads throughout the stability limits of the airplane at rest on the pavement. These main landing gear loads are used as the point of entry to the pavement design charts, interpolating load values where necessary.

The flexible pavement design curves (Section 7.5) are based on procedures set forth in Instruction Report No. S-77-1, "Procedures for Development of CBR Design Curves," dated June 1977, and as modified according to the methods described in ICAO Aerodrome Design Manual, Part 3, Pavements, 2nd Edition, 1983, Section 1.1 (The ACN-PCN Method), and utilizing the alpha factors approved by ICAO in October 2007. Instruction Report No. S-77-1 was prepared by the U.S. Army Corps of Engineers Waterways Experiment Station, Soils and Pavements Laboratory, Vicksburg, Mississippi.

The following procedure is used to develop the curves, such as shown in Section 7.5:

1. Having established the scale for pavement depth at the bottom and the scale for CBR at the top, an arbitrary line is drawn representing 6,000 annual departures.

2. Values of the aircraft gross weight are then plotted.

3. Additional annual departure lines are drawn based on the load lines of the aircraft gross weights already established.

4. an additional line representing 10,000 coverages (used to calculate the flexible-pavement Aircraft Classification Number) is also placed.

Subsection 7.6 provides LCN conversion curves for flexible pavements. These curves have been plotted using procedures and curves in the International Civil Aviation Organization (ICAO) Aerodrome Design Manual, Part 3 – Pavements, Document 9157-AN/901, 1977.

Subsection 7.7 provides rigid pavement design curves prepared with the use of the Westergaard equations in general accord with the relationships outlined in the 1955 edition of Design of Concrete Airport Pavement, published by the Portland Cement Association, 33 W. Grand Ave., Chicago, Illinois, but modified to the new format described in the 1968 Portland Cement Association publication, Computer Program for Airport Pavement Design by Robert G. Packard. The following procedure is used to develop the rigid pavement design curves.

1. Having established the scale for pavement thickness to the left and the scale for allowable working stress to the right, an arbitrary load line is drawn representing the main landing gear maximum weight to be shown.

2. All values of the subgrade modulus (K-values) are then plotted using the maximum load line, as shown.

3. Additional load lines for the incremental value of weight on the main landing gear are then established on the basis of the curve for K = 300 lb/in.^{3} already established.

Subsection 7.8 presents LCN conversion curves for rigid pavements. These curves have been plotted using procedures and curves in the ICAO Aerodrome Design Manual, Part 3 — Pavements, Document 9157-AN/901, 1977. The same charts include plots of equivalent single-wheel load versus radius of relative stiffness. The LCN requirements are based on the condition of center-of-slab loading. Radii of relative stiffness values are obtained from Subsection 7.8.1.

Subsection 7.9 provides ACN data prepared according to the ACN-PCN system described in Aerodromes, Annex 14 to the Convention on International Civil Aviation. ACN is the Aircraft Classification Number and PCN is the corresponding Pavement Classification Number.

ACN-PCN provides a standardized international airplane/pavement rating system replacing the various S, T, TT, LCN, AUW, ISWL, etc., rating systems used throughout the world. An aircraft having an ACN equal to or less than the PCN can operate without restriction on the pavement. Numerically, the ACN is two times the derived single-wheel load expressed in thousands of kilograms, where the load is on a single tire inflated to 1.25 MPa (181 psi) that would have the same pavement requirements as the aircraft. Computationally, the ACN-PCN system uses PCA program PDILB for rigid pavements and S-77-1 for flexible pavements to calculate ACN values. The method of pavement evaluation is the responsibility of the airport, with the results of its evaluation presented as follows:

REPORT EXAMPLE: PCN 80/R/B/W/T

PCN	PAVEMENT CLASSIFICATION NUMBER
(s)	(BEARING STRENGTH FOR UNRESTRICTED OPERATIONS)

CODE	PAVEMENT TYPE
R	RIGID
F	FLEXIBLE

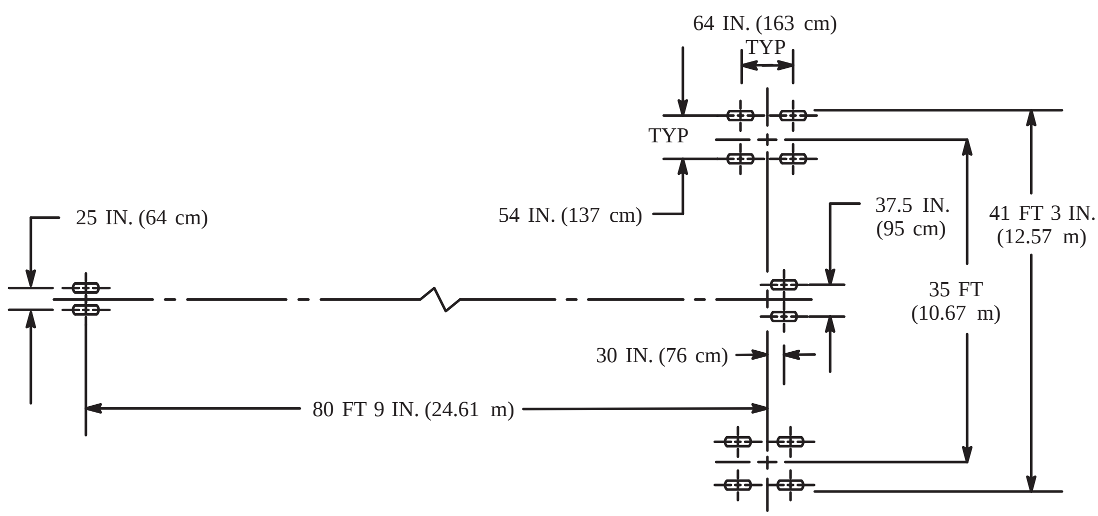
CODE	SUBGRADE CATEGORY
A	HIGH (K = 150 MN/M^3) (OR CBR = 15%)
B	MEDIUM (K = 80 MN/M^3) (OR CBR = 10%)
C	LOW (K = 40 MN/M^3) (OR CBR = 6%)
D	ULTRA LOW (K = 20 MN/M^3) (OR CBR = 3%)

CODE	TIRE PRESSURE CATEGORY
W	HIGH (NO LIMIT)
X	MEDIUM (LIMITED TO 1.5 MPa)
Y	LOW (LIMITED TO 1.0 MPa)
Z	VERY LOW (LIMITED TO 0.5 MPa)

CODE	EVALUATION METHOD
T	TECHNICAL
U	USING AIRCRAFT

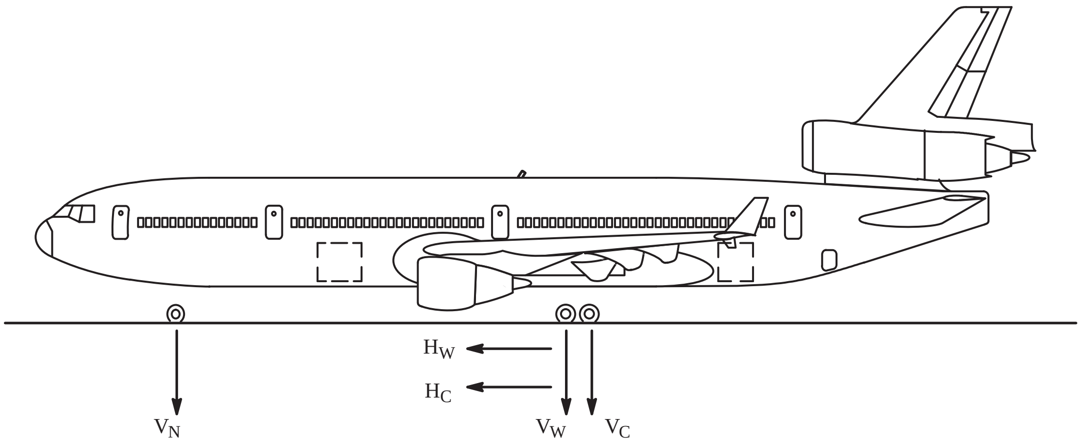
Chap7–Text64

MAXIMUMRAMP WEIGHT	633,000 LB (287,129 kg)
PERCENT OF WEIGHT ON MAIN GEAR	SEE SECTION 7.4
NOSE TIRE SIZE	40 x 15.5 — 16
NOSE TIRE PRESSURE	180 PSI (12.7 kg/cm^2)
WING AND CENTER GEAR TIRE SIZE	H54 x 21.0 — 24
WING GEAR TIRE PRESSURE	206 PSI (14.4 kg/cm^2)
CENTER GEAR TIRE PRESSURE	180 PSI (12.7 kg/cm^2)



7.2 FOOTPRINT
MODEL MD-11

REV E



PAVEMENT LOADS FOR CRITICAL COMBINATIONS OF WEIGHT AND CG POSITIONS
V_N = VERTICAL NOSE GEAR GROUND LOAD PER STRUT
V_W = VERTICAL WING GEAR GROUND LOAD PER STRUT
V_C = VERTICAL CENTER GEAR GROUND LOAD PER STRUT
H_W = HORIZONTAL WING GEAR GROUND LOAD PER STRUT FROM BRAKING
H_C = HORIZONTAL CENTER GEAR GROUND LOAD PER STRUT FROM BRAKING

		NOSE GEAR (1) FORWARD CG		**WING GEAR (2) AFT CG**			**CENTER GEAR (1) AFT CG**		
		V_N	V_N	V_W	H_W		V_C	H_C	
MODEL MD-11	**RAMP WEIGHT**	**STATIC**	**STEADY BRAKING***	**STATIC**	**STEADY BRAKING***	**INST BRAKING****	**STATIC**	**STEADY BRAKING***	**INST BRAKING****
LB	633,000	54,900	93,000	245,400	80,800	170,000	106,300	35,000	73,600
kg	287,129	24,903	42,184	111,313	36,651	77,112	48,218	15,876	33,385

* AIRCRAFT DECELERATION = 10 FT/SEC ^{2}. H_W AND H_C ASSUME DECELERATION FROM BRAKING ONLY
** INSTANTANEOUS BRAKING; COEFFICIENT OF FRICTION = 0.8

7.3 MAXIMUM PAVEMENT LOADS
MODEL MD-11

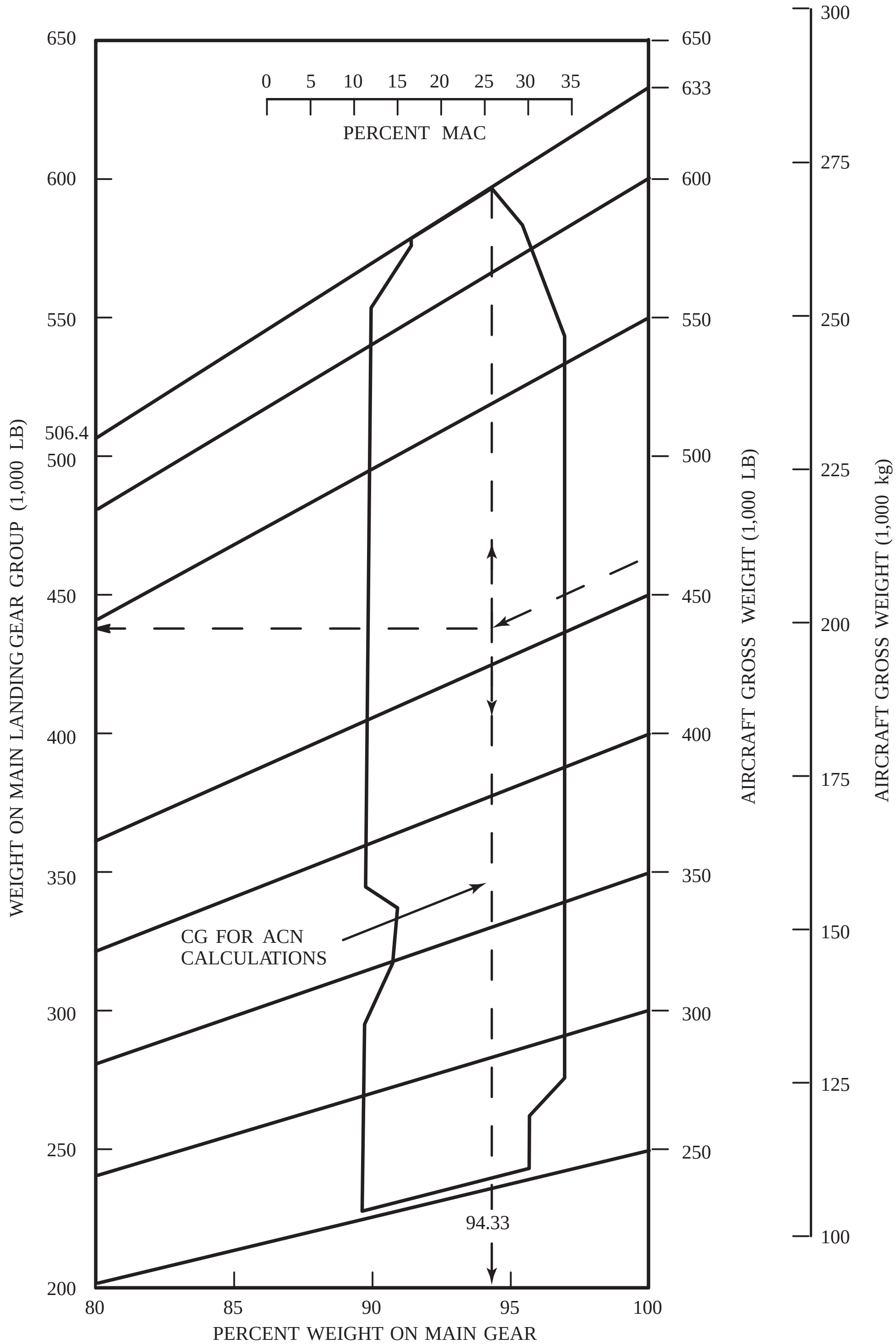
REV E

7.4 Landing Gear Loading on Pavement

7.4.1 Loads on the Main Landing Gear Group

For the MD-11, the main gear group consists of two wing gears plus one center gear.

In the example for the MD-11, the gross weight is 470,000 pounds, the percent of weight on the main gears is 94.33 percent, and the total weight on the three main gears is 443,351 pounds.



7.4 LANDING GEAR LOADING ON PAVEMENT
MODEL MD-11

REV E

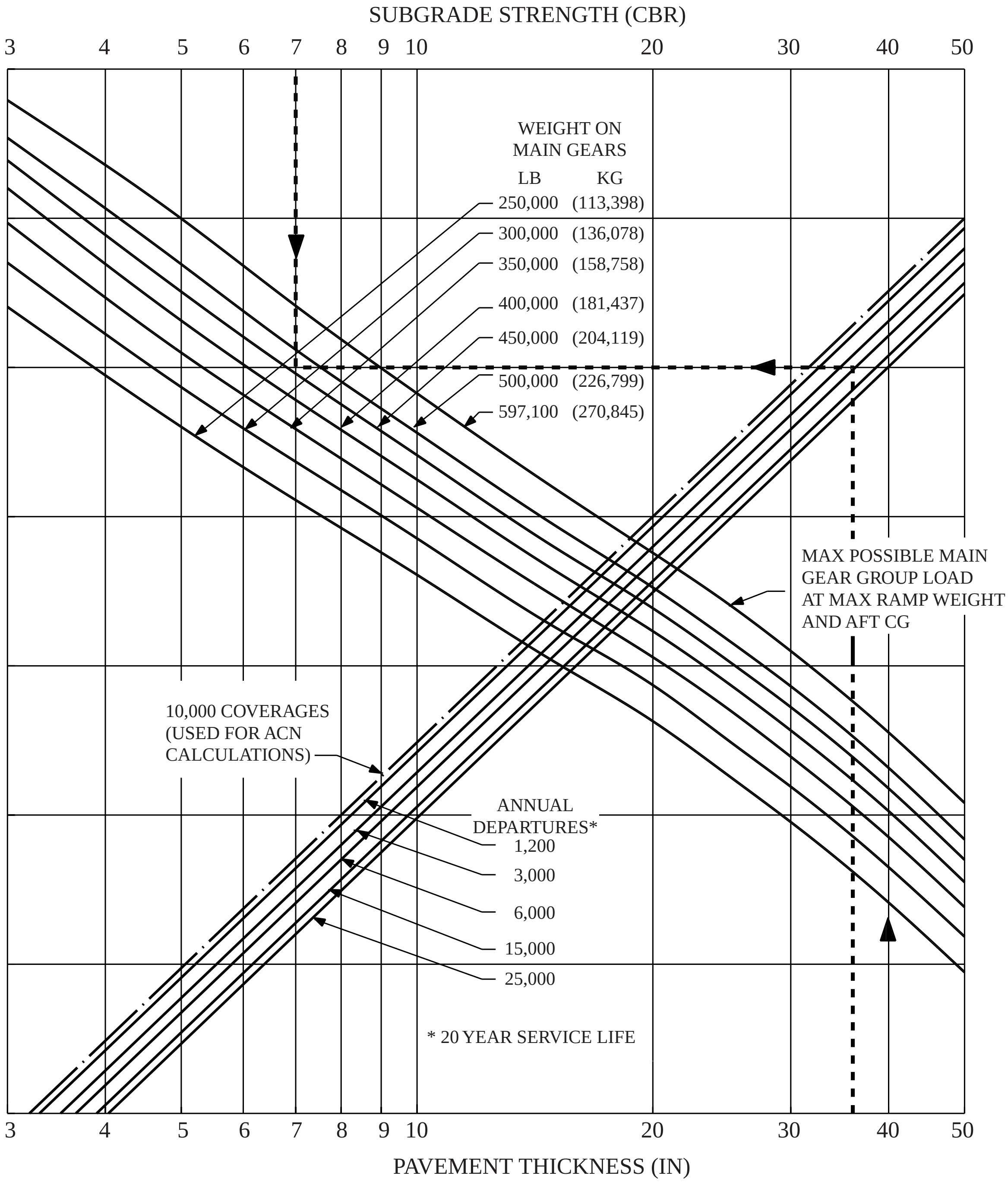
7.5 Flexible Pavement Requirements — U.S. Army Corps of Engineers Method (S-77-1)

To determine the airplane weight that can be accommodated on a particular flexible pavement, the thickness of the pavement, the subgrade CBR, and the annual departure level must be known.

In the example shown for the MD-11, for a CBR of 7.0, an annual departure level of 6,000, and a flexible pavement thickness of 36 inches, the main gear group loading is 450,000 pounds.

The line showing 10,000 coverages is used for ACN calculations, which are shown in another subsection.

NOTE: H54 x 21.0-24 TIRES; TIRE PRESSURE CONSTANT AT 206 PSI (14.5 kg/cm^2)



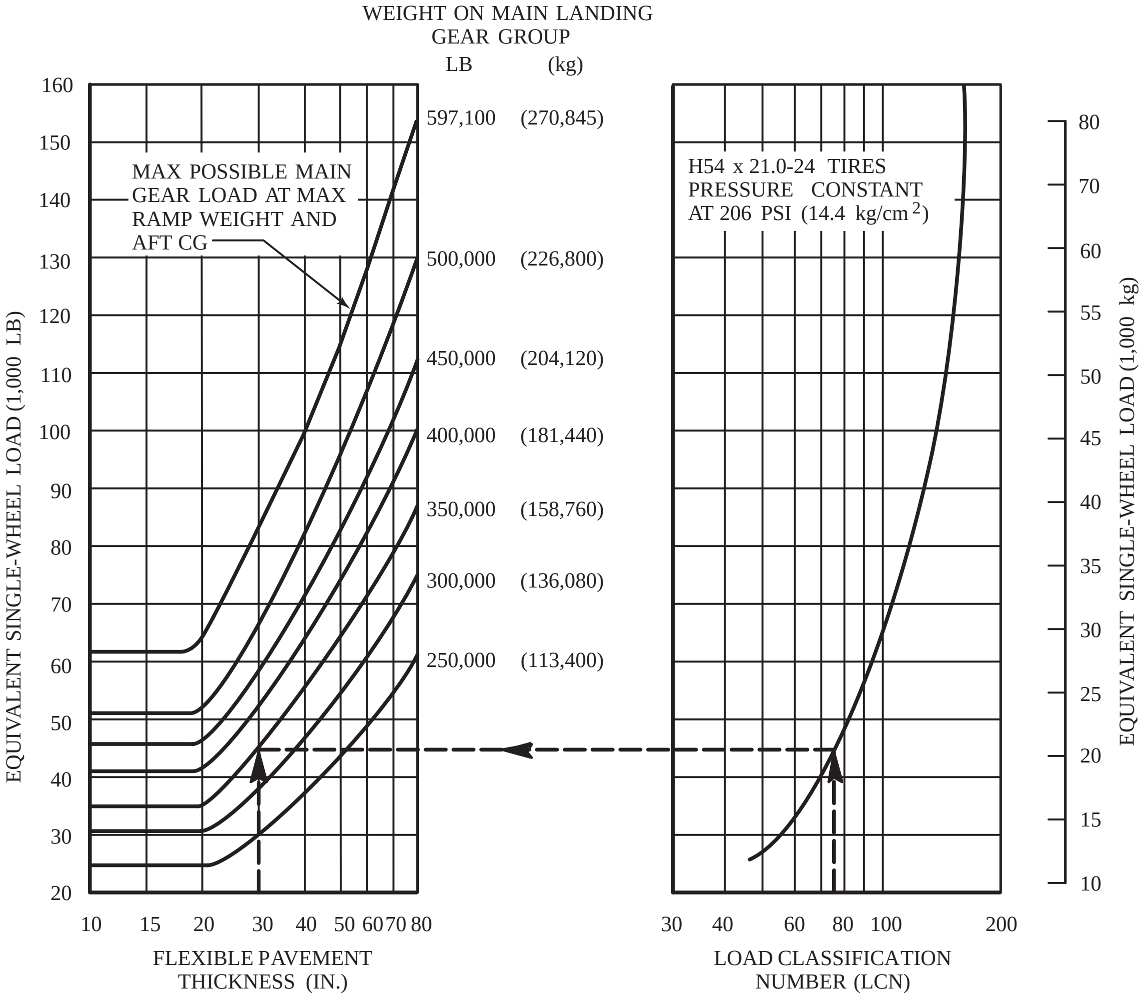
7.5 FLEXIBLE PAVEMENT REQUIREMENTS
U.S. ARMY CORPS OF ENGINEERS/FAA DESIGN METHOD
MODEL MD-11

REV E

7.6 Flexible Pavement Requirements, LCN Conversion

To determine the airplane weight that can be accommodated on a particular flexible airport pavement, both the LCN of the pavement and the thickness (h) of the pavement must be known.

In the example for the MD-11, the flexible pavement thickness is 30 inches, the LCN is 76, and the main landing gear group weight is 350,000 pounds.



NOTE: EQUIVALENT SINGLE-WHEEL LOADS ARE DERIVED BY METHODS SHOWN IN ICAO AERODROME MANUAL, PART 2, PAR. 4.1.3

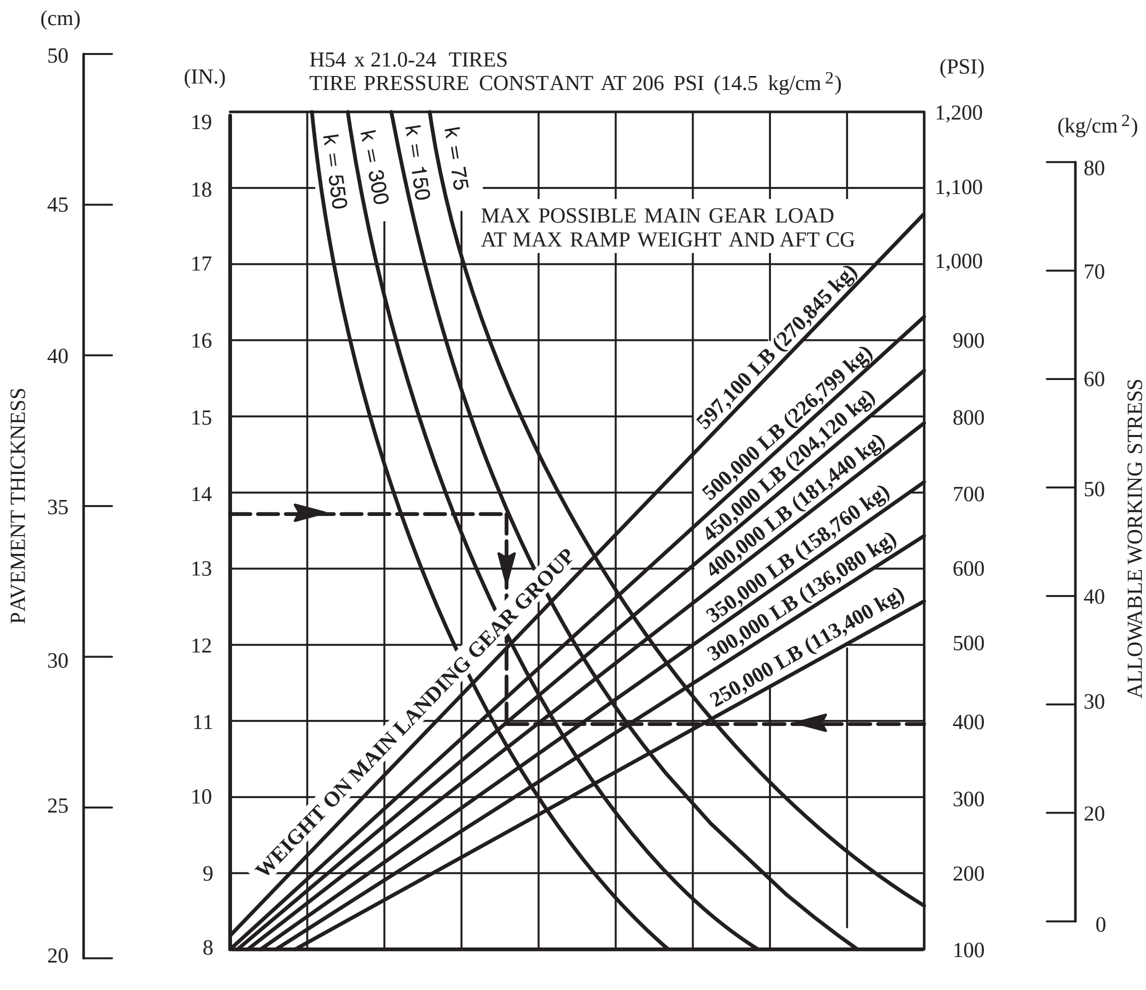
7.6 FLEXIBLE PAVEMENT REQUIREMENTS – LCN CONVERSION MODEL MD-11

REV E

7.7 Rigid Pavement Requirements, Portland Cement Association Design Method

To determine the airplane weight that can be accommodated on a particular rigid pavement, the thickness of the pavement, the subgrade modulus (k), and the allowable working stress must be known.

In the example for the MD-11, the rigid pavement thickness is 13.7 inches, the subgrade modulus is 150, and the allowable working stress is 400 psi. For these conditions, the weight on the landing gear group is 450,000 pounds.



NOTE: THE VALUES OBTAINED BY USING THE MAX LOAD REFERENCE LINE AND ANY VALUES OF K ARE EXACT. FOR LOADS LESS THAN MAX, THE CURVES ARE EXACT FOR K = 300, BUT DEVIATE SLIGHTLY FOR OTHER VALUES OF K.

REF: DESIGN OF CONCRETE AIRPORT PAVEMENT, 1968 PORTLAND CEMENT ASSOCIATION COMPUTER PROGRAM

7.7 RIGID PAVEMENT REQUIREMENTS,
PORTLAND CEMENT ASSOCIATION DESIGN METHOD
MODEL MD-11

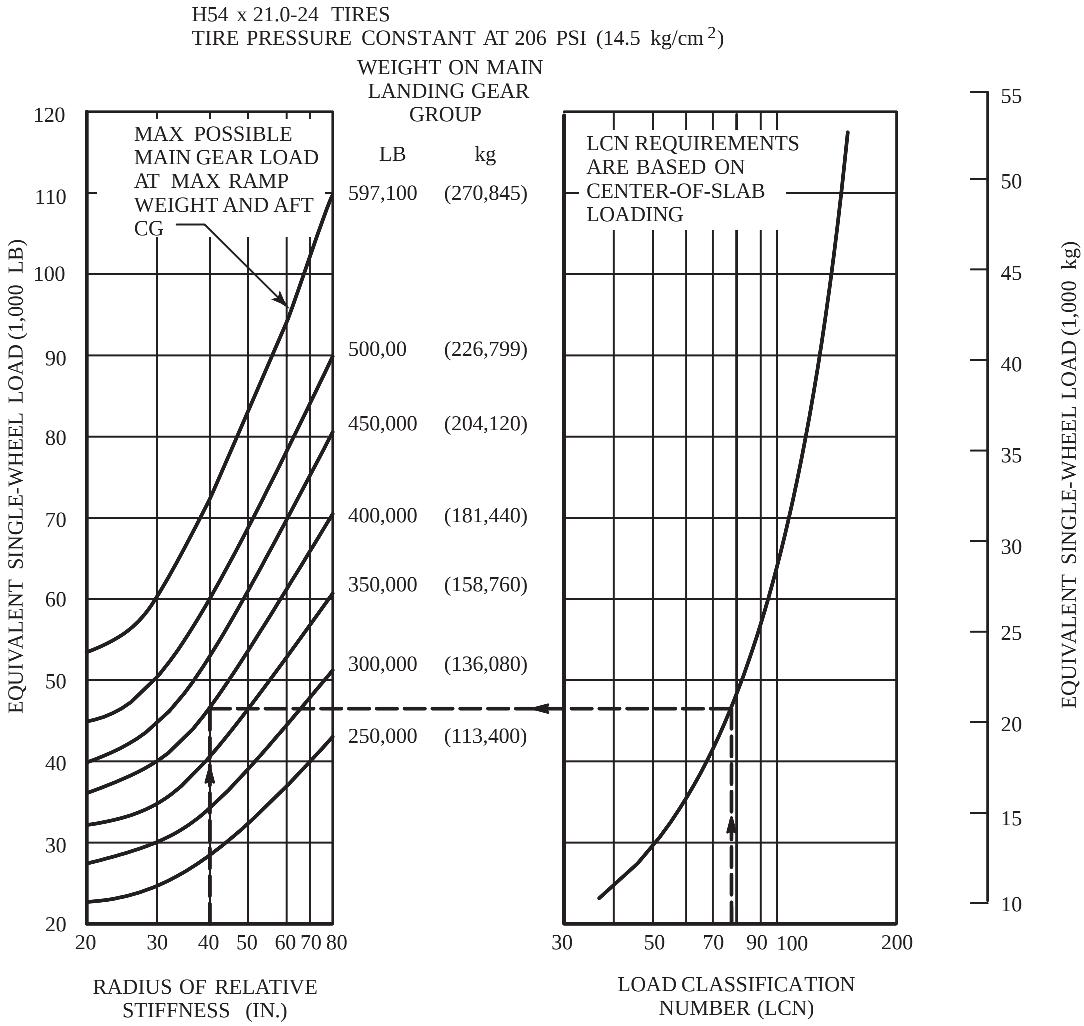
7.8 Rigid Pavement Requirements, LCN Conversion

To determine the airplane weight that can be accommodated on a particular rigid airport pavement, both the LCN of the pavement and the radius of relative stiffness must be known.

In the example for the MD-11, the rigid pavement radius of relative stiffness is 40 inches and the LCN is 78. For these conditions, the weight on the main landing gear group is 400,000 pounds.

The LCN charts use ℓ-values based on Young’s Modulus (E) of 4 million psi and Poisson’s ratio (m) of 0.15. For convenience in finding ℓ-values based on other values of E and m, the curves in chart 7.8.2 are included. For example, to find an ℓ-value based on an E of 3 million psi, the E-factor of 0.931 is multiplied by the ℓ-value found in Chart 7.8.1. The effect of variations in m on the ℓ-value is treated in a similar manner.

Note: If the resulting aircraft LCN is not more than 10 percent above the published pavement LCN, the United Kingdom, which originated the LCN method, considers that the bearing strength of the pavement is sufficient for unlimited use by the airplane. The figure of 10 percent has been chosen as representing the lowest degree of variation in LCN which is significant. (Reference: ICAO Aerodrome Design Manual, Part 3 — Pavements, Document 9157-AN/901, 1977 Edition.)



NOTE: EQUIVALENT SINGLE-WHEEL LOADS ARE DERIVED BY METHODS SHOWN IN ICAO AERODROME MANUAL, PART 2, PAR. 4.1.3

7.8.1 RIGID PAVEMENT REQUIREMENTS, LCN CONVERSION MODEL MD-11

RADIUS OF RELATIVE STIFFNESS (ℓ)
VALUES IN INCHES

$$\ell = \sqrt[4]{\frac{Ed^3}{12(1-\mu^2)k}} = 24.1652 \sqrt[4]{\frac{d^3}{k}}$$

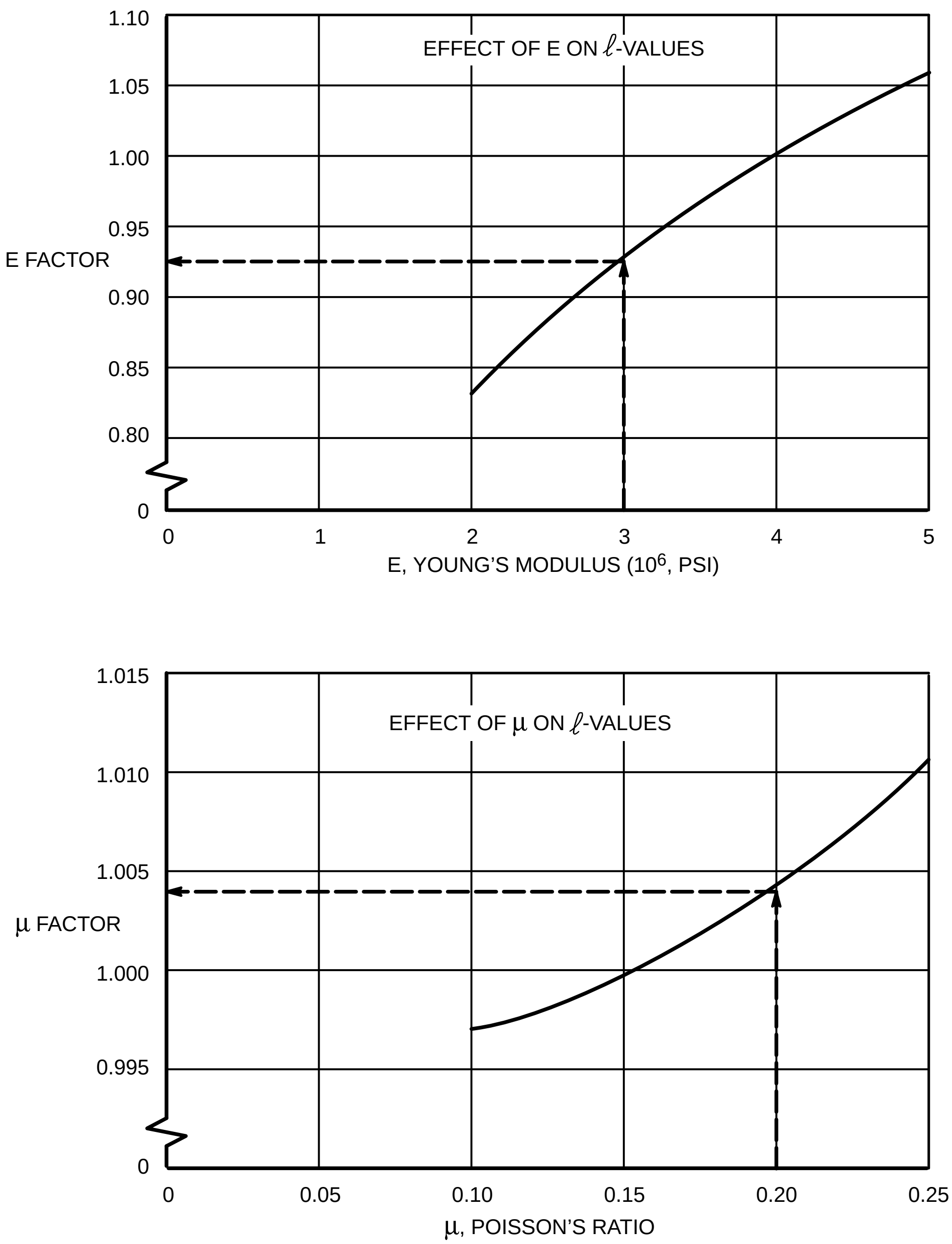
WHERE: E = YOUNG'S MODULUS = 4×10^6 PSI
k = SUBGRADE MODULUS, LB/IN.^{3}
d = RIGID-PAVEMENT THICKNESS, IN.
μ = POISSON'S RATIO = 0.15

d (IN.)	k = 75	k = 100	k = 150	k = 200	k = 250	k = 300	k = 350	k = 400	k = 500	k = 550
6.0	31.48	29.30	26.47	24.63	23.30	22.26	21.42	20.72	19.59	19.13
6.5	33.43	31.11	28.11	26.16	24.74	23.64	22.74	22.00	20.80	20.31
7.0	35.34	32.89	29.72	27.65	26.15	24.99	24.04	23.25	21.99	21.47
7.5	37.22	34.63	31.29	29.12	27.54	26.32	25.32	24.49	23.16	22.61
8.0	39.06	36.35	32.85	30.57	28.91	27.62	26.58	25.70	24.31	23.74
8.5	40.88	38.04	34.37	31.99	30.25	28.91	27.81	26.90	25.44	24.84
9.0	42.67	39.71	35.88	33.39	31.58	30.17	29.03	28.08	26.55	25.93
9.5	44.43	41.35	37.36	34.77	32.89	31.42	30.23	29.24	27.65	27.00
10.0	46.18	42.97	38.83	36.14	34.17	32.65	31.42	30.39	28.74	28.06
10.5	47.90	44.57	40.28	37.48	35.45	33.87	32.59	31.52	29.81	29.11
11.0	49.60	46.16	41.71	38.81	36.71	35.07	33.75	32.64	30.87	30.14
11.5	51.28	47.72	43.12	40.13	37.95	36.26	34.89	33.74	31.91	31.16
12.0	52.94	49.27	44.52	41.43	39.18	37.44	36.02	34.84	32.95	32.17
12.5	54.59	50.80	45.90	42.72	40.40	38.60	37.14	35.92	33.97	33.17
13.0	56.22	52.32	47.27	43.99	41.61	39.75	38.25	36.99	34.99	34.16
13.5	57.83	53.82	48.63	45.26	42.80	40.89	39.35	38.06	35.99	35.14
14.0	59.43	55.31	49.98	46.51	43.98	42.02	40.44	39.11	36.99	36.12
14.5	61.02	56.78	51.31	47.75	45.16	43.15	41.51	40.15	37.97	37.08
15.0	62.59	58.25	52.63	48.98	46.32	44.26	42.58	41.19	38.95	38.03
15.5	64.15	59.70	53.94	50.20	47.47	45.36	43.64	42.21	39.92	38.98
16.0	65.69	61.13	55.24	51.41	48.62	46.45	44.70	43.23	40.88	39.92
16.5	67.23	62.56	56.53	52.61	49.75	47.54	45.74	44.24	41.84	40.85
17.0	68.75	63.98	57.81	53.80	50.88	48.61	46.77	45.24	42.78	41.78
17.5	70.26	65.38	59.48	54.98	52.00	49.68	47.80	46.23	43.72	42.70
18.0	71.76	66.78	60.35	56.16	53.11	50.74	48.82	47.22	44.66	43.61
19.0	74.73	69.54	62.84	58.48	55.31	52.84	50.84	49.17	46.51	45.41
20.0	77.66	72.27	65.30	60.77	57.47	54.92	52.84	51.10	48.33	47.19
21.0	80.55	74.97	67.74	63.04	59.62	56.96	54.81	53.01	50.13	48.95
22.0	83.41	77.63	70.14	65.28	61.73	58.98	56.75	54.89	51.91	50.69
23.0	86.24	80.26	72.52	67.49	63.83	60.98	58.68	56.75	53.67	52.41
24.0	89.04	82.86	74.87	69.68	65.90	62.96	60.58	58.89	55.41	54.11
25.0	91.81	85.44	77.20	71.84	67.95	64.92	62.46	60.41	57.14	55.79

REFERENCE: PORTLAND CEMENT ASSOCIATION

DMC005–71

7.8.2 RADIUS OF RELATIVE STIFFNESS



NOTE: BOTH CURVES ON THIS PAGE ARE USED TO ADJUST THE ℓ-VALUES OF TABLE 7.8.2

DMC005–72

7.8.3 EFFECT OF E AND μ ON ℓ–VALUES

7.9 ACN –PCN REPORTING SYSTEM: FLEXIBLE AND RIGID PAVEMENTS

To determine the ACN of an aircraft on flexible or rigid pavement, both the aircraft gross weight and the subgrade strength category must be known. The examples show that for an aircraft gross weight of 440,000 lb and low subgrade strength, the ACN for flexible pavement is 47.7 and the ACN for rigid pavement for the same gross weight is 50.

Note: An aircraft with an ACN equal to or less than the reported PCN can operate on the pavement subject to any limitations on the tire pressure.

7.9.1 Development of ACN Charts

The ACN charts for flexible and rigid pavements were developed by methods referenced in the ICAO Aerodrome Manual, Part 3 — Pavements, Document 9157-AN/901, 1983 Edition. The procedures used in developing these charts are described below.

The following procedure was used to develop the flexible-pavement ACN charts already shown in this subsection.

1. Determine the percentage of weight on the main gear to be used below in Steps 2, 3, and 4, below. The maximum aft center-of-gravity position yields the critical loading on the critical gear (see Subsection 7.4). This center-of-gravity position is used to determine main gear loads at all gross weights of the model being considered.

2. Establish a flexible-pavement requirements chart using the S-77-1 design method, such as shown on the right side of Figure 7.9.3. Use standard subgrade strengths of CBR 3, 6, 10, and 15 percent and 10,000 coverages. This chart provides the same thickness values as those of Subsection 7.5, but is presented here in a different format.

3. Determine reference thickness values from the pavement requirements chart of Step 2 for each standard subgrade strength and gear loading.

4. Enter the reference thickness values into the ACN flexible-pavement conversion chart shown on the left side of Figure 7.9.3 to determine ACN. This chart was developed using the S-77-1 design method with a single tire inflated to 1.25 MPa (181 psi) pressure and 10,000 coverages. The ACN is two times the derived single-wheel load expressed in thousands of kilograms. These values of ACN were plotted as functions of aircraft gross weight, as already shown.

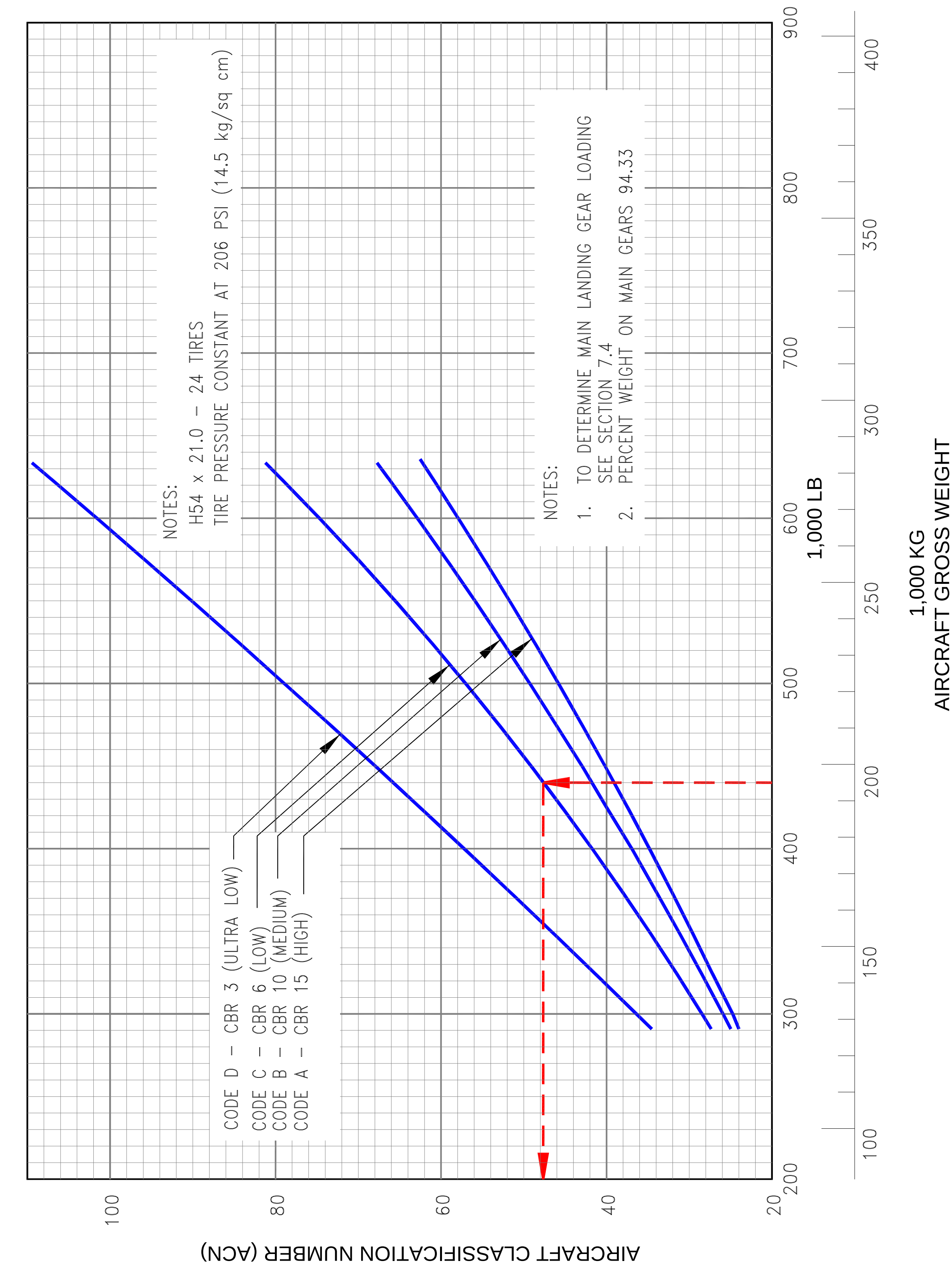
The following procedure was used to develop the rigid-pavement ACN charts already shown in this subsection.

1. Determine the percentage of weight on the main gear to be used in Steps 2, 3, and 4, below. The maximum aft center-of-gravity position yields the critical loading on the critical gear (see Subsection 7.4). This center-of-gravity position is used to determine main gear loads at all gross weights of the model being considered.

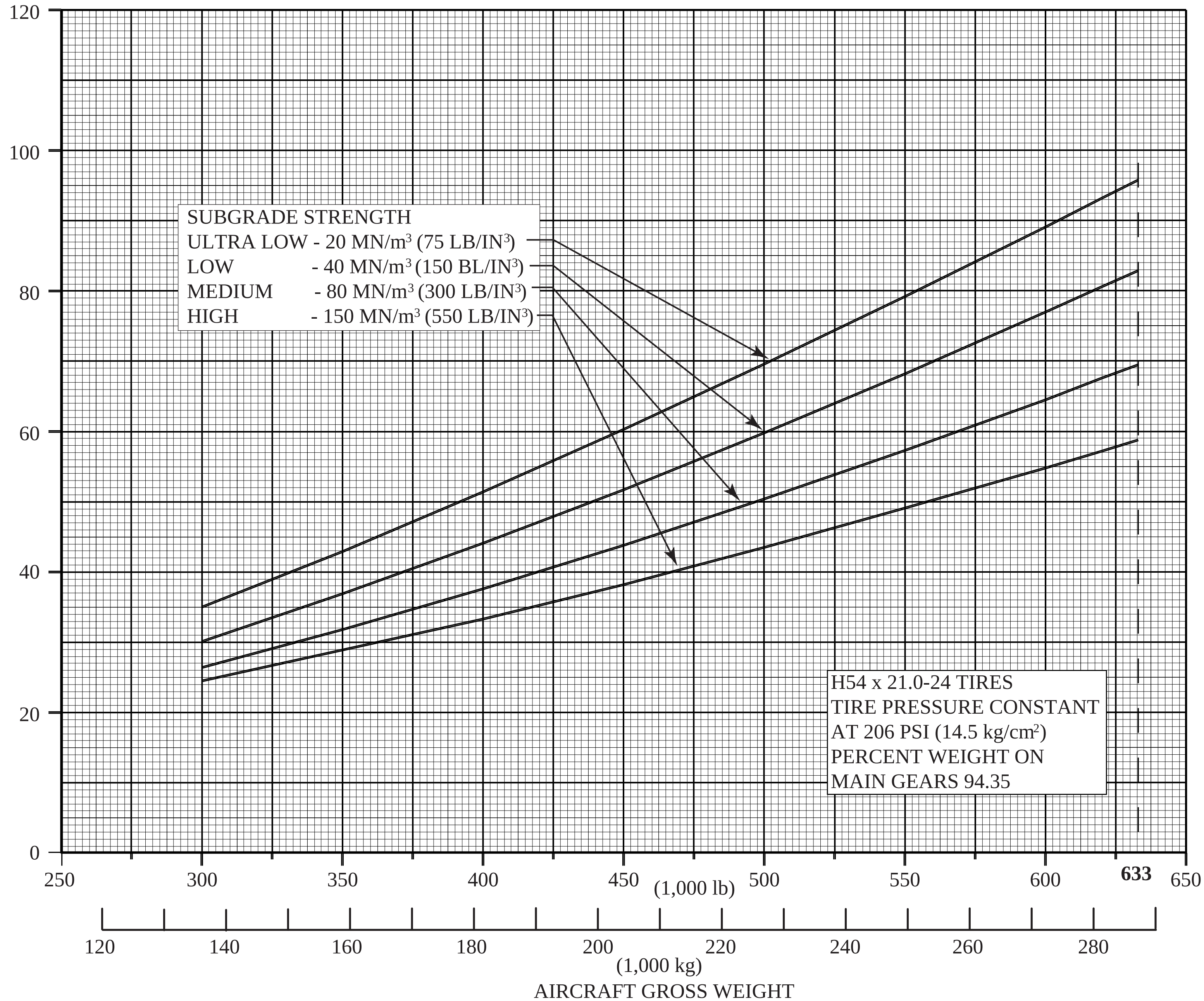
2. Establish a rigid-pavement requirements chart using the PCA computer program PDILB, such as shown on the right side of Figure 7.9.4. Use standard subgrade strengths of k = 75, 150, 300, and 550 lb/in.^{3} (nominal values for k = 20, 40, 80, and 150 MN/m^3). This chart provides the same thickness values as those of Subsection 7.7.

3 Determine reference thickness values from the pavement requirements chart of Step 2 for each standard subgrade strength and gear loading at 400 psi working stress (nominal value for 2.75 MPa working stress).

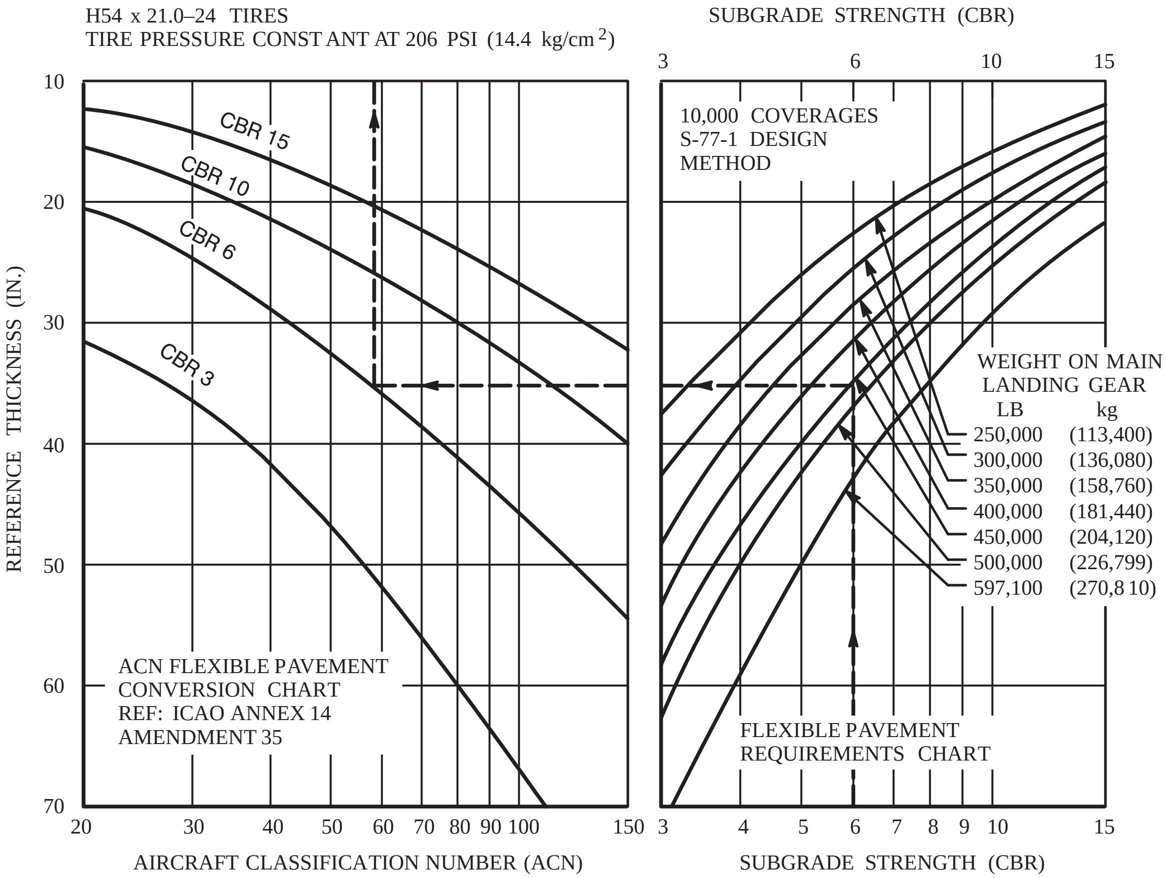
4. Enter the reference thickness values into the ACN rigid-pavement conversion chart shown on the left side of Figure 7.9.4 to determine ACN. This chart was developed using the PCA computer program PDILB with a single tire inflated to 1.25 MPa (181 psi) pressure and a working stress of 2.75 MPa (400 psi.) The ACN is two times the derived single-wheel load expressed in thousands of kilograms. These values of ACN were plotted as functions of aircraft gross weight, as already shown in this subsection.



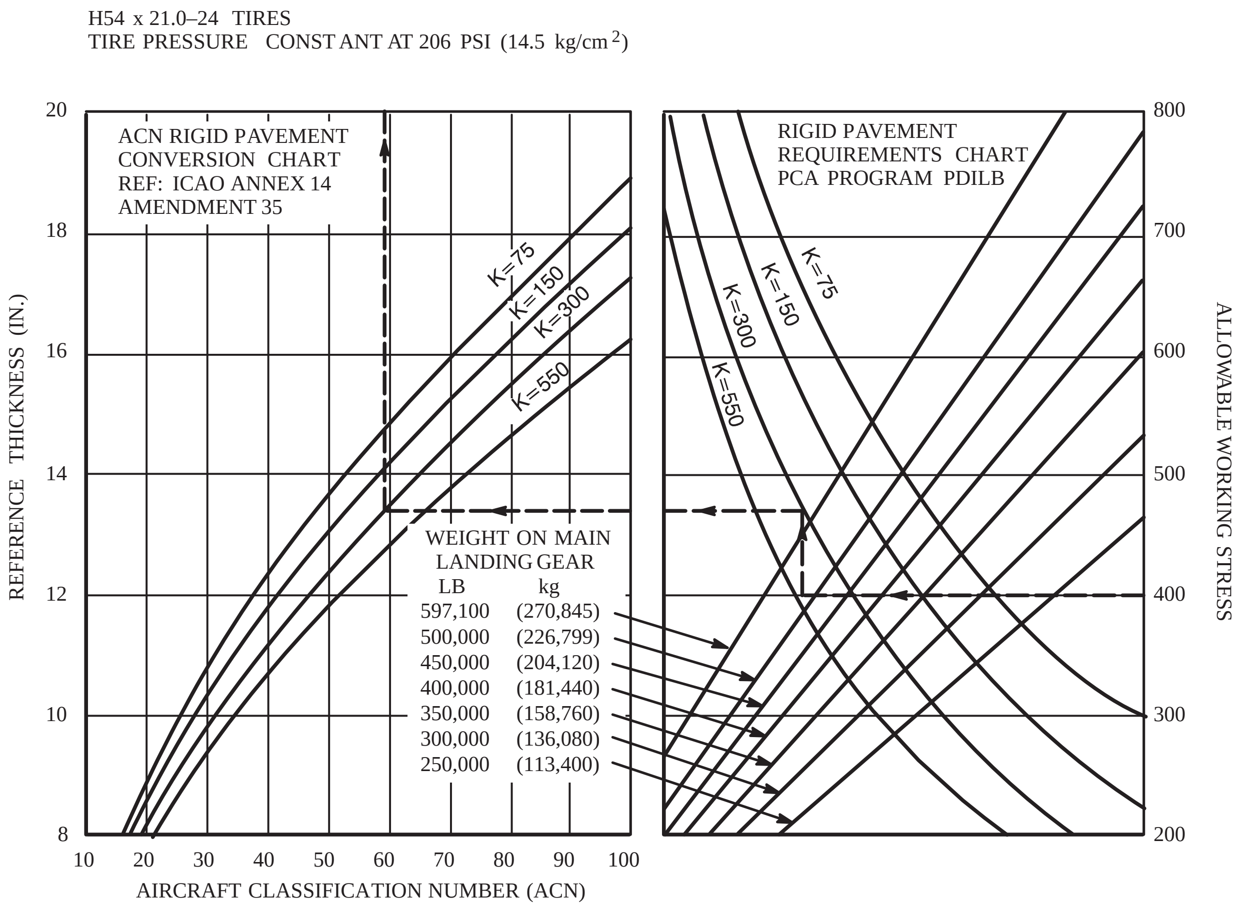
7.9.1 AIRCRAFT CLASSIFICATION NUMBER – FLEXIBLE PAVEMENT
MODEL MD-11



7.9.2 AIRCRAFT CLASSIFICATION NUMBER – RIGID PAVEMENT
MODEL MD-11



7.9.3 DEVELOPMENT OF AIRCRAFT CLASSIFICATION NUMBER (ACN) – FLEXIBLE PAVEMENT MODEL MD-11



7.9.4 DEVELOPMENT OF AIRCRAFT CLASSIFICATION NUMBER (ACN) – RIGID PAVEMENT MODEL MD-11

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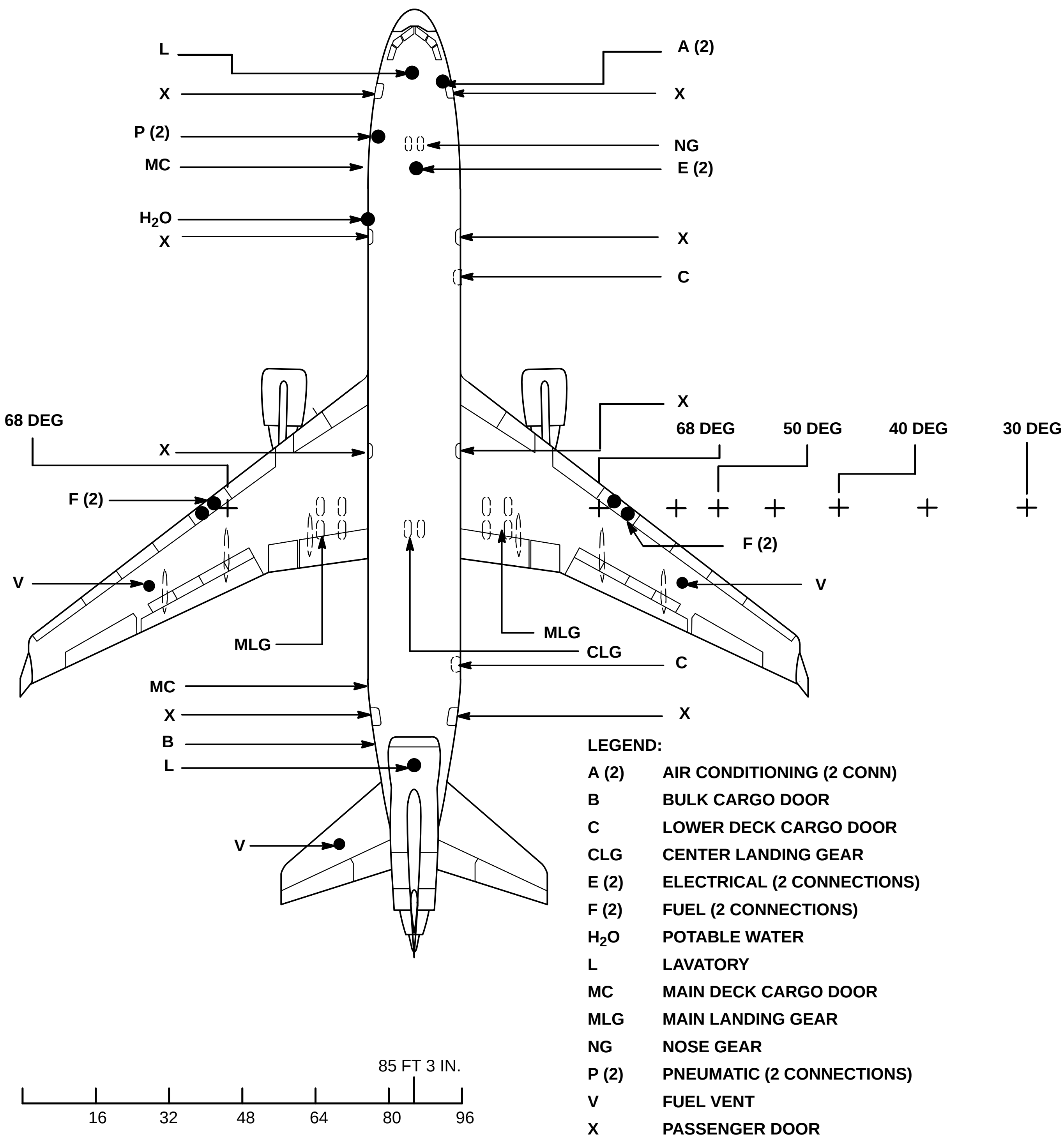
8.0 POSSIBLE MD-11 DERIVATIVE AIRPLANES

8.0 POSSIBLE MD-11 DERIVATIVE AIRPLANES

No additional versions of the MD-11 are currently planned.

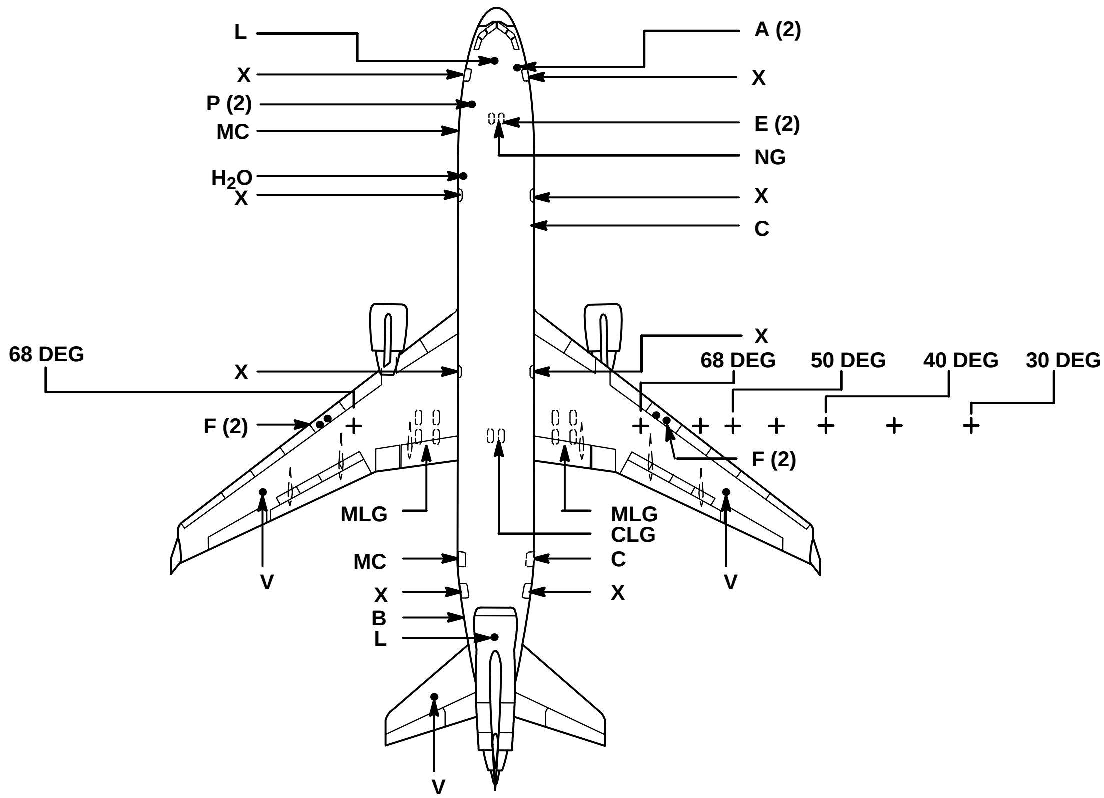
9.0 MD-11 SCALE DRAWINGS



LEGEND:	
A (2)	AIR CONDITIONING (2 CONN)
B	BULK CARGO DOOR
C	LOWER DECK CARGO DOOR
CLG	CENTER LANDING GEAR
E (2)	ELECTRICAL (2 CONNECTIONS)
F (2)	FUEL (2 CONNECTIONS)
H_2O	POTABLE WATER
L	LAVATORY
MC	MAIN DECK CARGO DOOR
MLG	MAIN LANDING GEAR
NG	NOSE GEAR
P (2)	PNEUMATIC (2 CONNECTIONS)
V	FUEL VENT
X	PASSENGER DOOR
+	TURNING RADIUS POINTS: 68 DEG, 60 DEG, 55 DEG, 50 DEG, 45 DEG, 40 DEG, 35 DEG, 30 DEG

9.0 SCALE DRAWINGS
9.1 1 INCH EQUALS 32 FEET
MODEL MD-11

DMC005–81

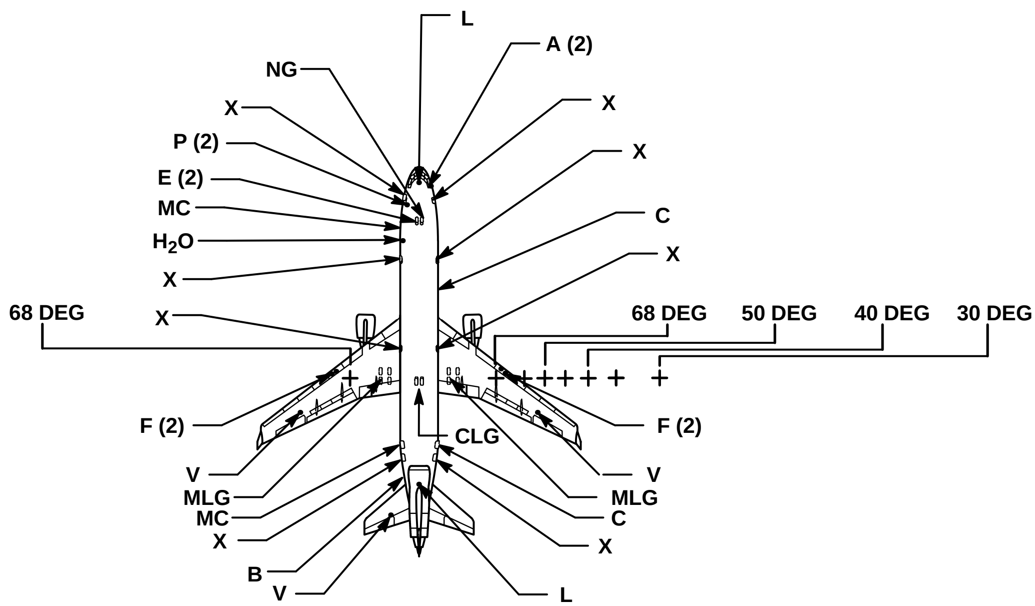


LEGEND:

A (2)	AIR CONDITIONING (2 CONN)	MC	MAIN DECK CARGO DOOR
B	BULK CARGO DOOR	MLG	MAIN LANDING GEAR
C	LOWER DECK CARGO DOOR	NG	NOSE GEAR
CLG	CENTER LANDING GEAR	P (2)	PNEUMATIC (2 CONNECTIONS)
E (2)	ELECTRICAL (2 CONNECTIONS)	V	FUEL VENT
F (2)	FUEL (2 CONNECTIONS)	X	PASSENGER DOOR
H_2O	POTABLE WATER	+	TURNING RADIUS POINTS: 68 DEG, 60 DEG, 55 DEG, 50 DEG, 45 DEG, 40 DEG, 35 DEG, 30 DEG
L	LAVATORY		

DMC005–84

9.0 SCALE DRAWINGS
9.2 1 INCH EQUALS 50 FEET
MODEL MD-11

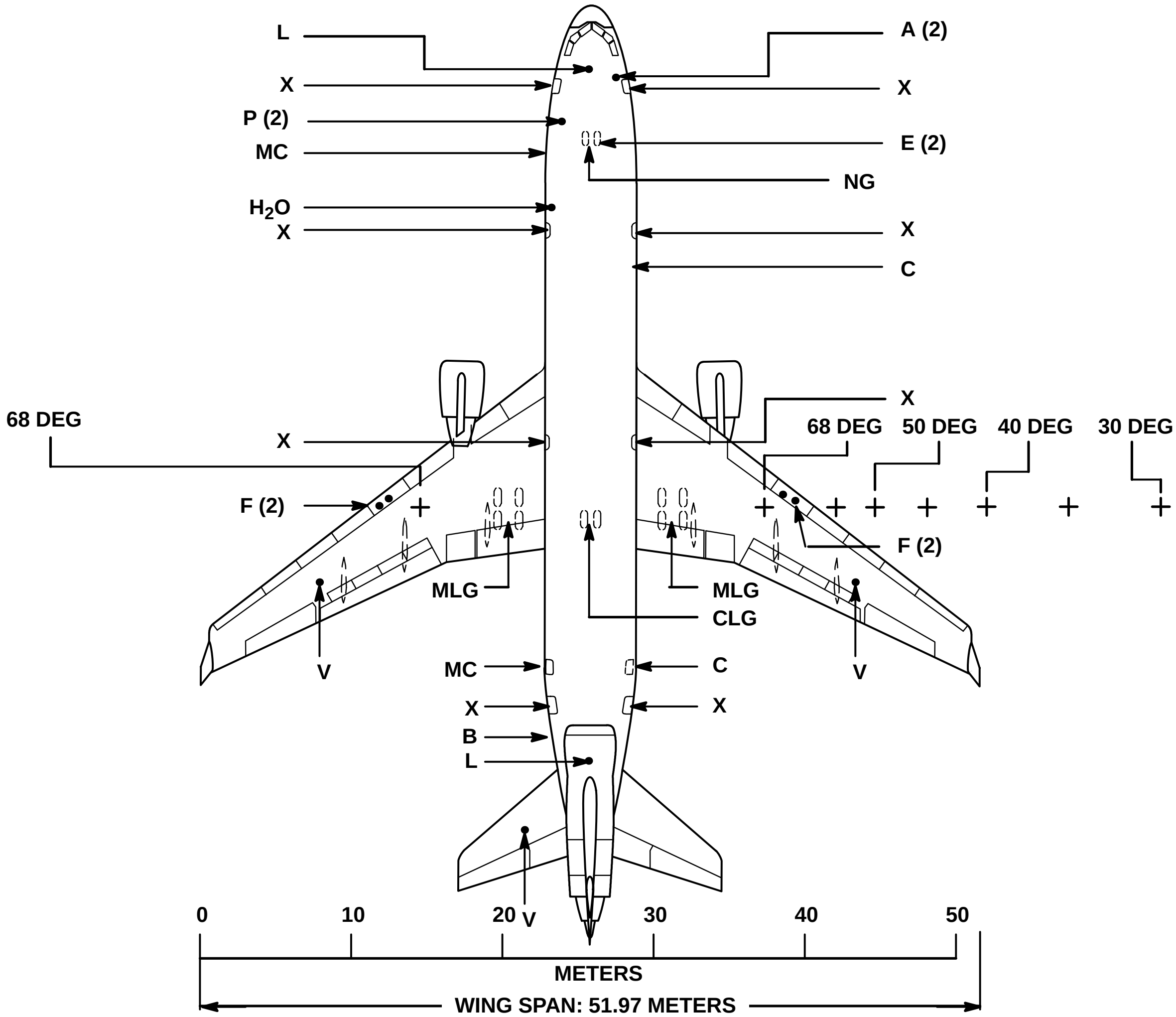


LEGEND:

A (2)	AIR CONDITIONING (2 CONN)	MC	MAIN DECK CARGO DOOR
B	BULK CARGO DOOR	MLG	MAIN LANDING GEAR
C	LOWER DECK CARGO DOOR	NG	NOSE GEAR
CLG	CENTER LANDING GEAR	P (2)	PNEUMATIC (2 CONNECTIONS)
E (2)	ELECTRICAL (2 CONNECTIONS)	V	FUEL VENT
F (2)	FUEL (2 CONNECTIONS)	X	PASSENGER DOOR
H_2O	POTABLE WATER	+	TURNING RADIUS POINTS: 68 DEG, 60 DEG, 55 DEG, 50 DEG, 45 DEG, 40 DEG, 35 DEG, 30 DEG
L	LAVATORY		

DMC005–85

9.0 SCALE DRAWINGS
9.3 1 INCH EQUALS 100 FEET
MODEL MD-11

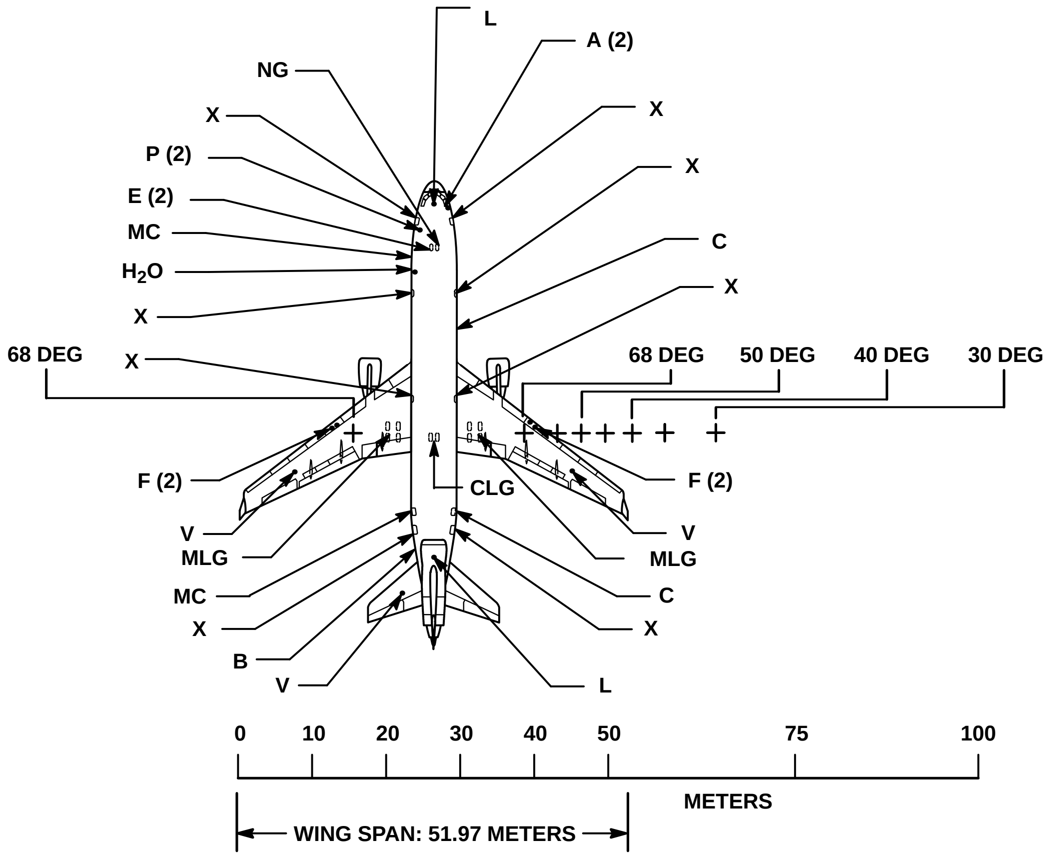


LEGEND:

A (2)	AIR CONDITIONING (2 CONN)	MC	MAIN DECK CARGO DOOR
B	BULK CARGO DOOR	MLG	MAIN LANDING GEAR
C	LOWER DECK CARGO DOOR	NG	NOSE GEAR
CLG	CENTER LANDING GEAR	P (2)	PNEUMATIC (2 CONNECTIONS)
E (2)	ELECTRICAL (2 CONNECTIONS)	V	FUEL VENT
F (2)	FUEL (2 CONNECTIONS)	X	PASSENGER DOOR
H_2O	POTABLE WATER	+	TURNING RADIUS POINTS: 68 DEG, 60 DEG, 55 DEG, 50 DEG, 45 DEG, 40 DEG, 35 DEG, 30 DEG
L	LAVATORY		

DMC005–86

9.0 SCALE DRAWINGS
9.4 1 TO 500
MODEL MD-11



LEGEND:

A (2)	AIR CONDITIONING (2 CONN)	MC	MAIN DECK CARGO DOOR
B	BULK CARGO DOOR	MLG	MAIN LANDING GEAR
C	LOWER DECK CARGO DOOR	NG	NOSE GEAR
CLG	CENTER LANDING GEAR	P (2)	PNEUMATIC (2 CONNECTIONS)
E (2)	ELECTRICAL (2 CONNECTIONS)	V	FUEL VENT
F (2)	FUEL (2 CONNECTIONS)	X	PASSENGER DOOR
H_2O	POTABLE WATER	+	TURNING RADIUS POINTS: 68 DEG, 60 DEG, 55 DEG, 50 DEG, 45 DEG, 40 DEG, 35 DEG, 30 DEG
L	LAVATORY		

DMC005–87

9.0 SCALE DRAWINGS
9.5 1 TO 1,000
MODEL MD-11