Aeronautical Engineering Design I

Landing Gear Sizing and Placement

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Landing gear configurations

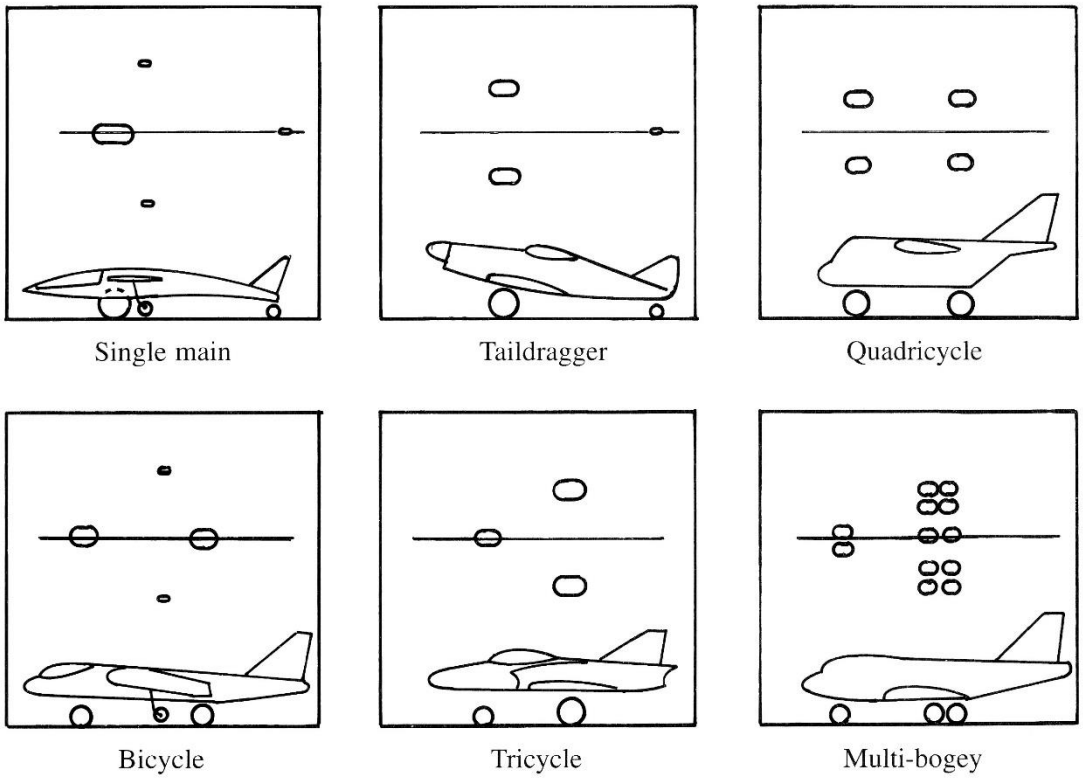


Fig. 11.2 Landing gear arrangements.

Tricycle landing gear

Tricycle landing gear

- Advantages of tricycle landing gear:
  - Cabin floor is horizontal when the airplane is on the ground.
  - Forward visibility is improved for the pilot when the airplane is on the gound.
  - The CG is ahead of the main wheels and this enhances stability during the ground roll.

Tricycle landing gear

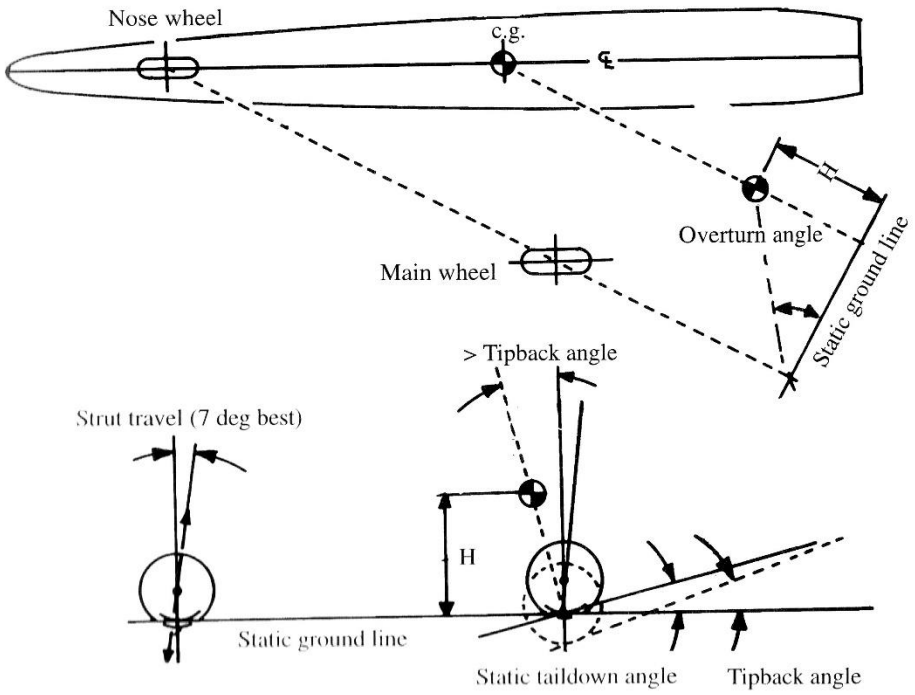


Fig. 11.5 Tricycle landing gear geometry.

Tricycle landing gear

- The length of the landing gear must be set so that the tail doesn't hit the ground during landing.
- This is measured from the wheel in the static position assuming an angle of attack for landing that gives 90% of maximum lift, usually 10^o-15^o.
- The tipback angle is the maximum aircraft nose-up attitude when the tail is touching the ground and the landing gear strut is fully extended.
- To prevent the aircraft from tipping back on its tail, the angle of the vertical from the main wheel position to the cg should be greater than the tipback angle or 15^o, whichever is greater.

Tricycle landing gear

- Tipback angle should not be greater than 25^{o}, otherwise porpoising will occur and a high elevator deflection will be required for rotation during takeoff.
- This means that more than 20% of aircraft weight is carried by the nose wheel.
- The optimum range for the percentage of aircraft weight that is carried by the nose wheel is 8-15% for the most aft and most forward CG positions.
- If it is less than 5% there won't be enough traction to steer.

Tricycle landing gear

- Overturn angle is a measure of the aircraft's tendency to overturn when turned around a sharp corner.
- This is the angle between the CG and the main wheel seen from the rear. This angle should not be greater than 63^{o}.
- The landing gear should be long enough for a propeller clearance of at least 9".

Taildragger landing gear

Taildragger landing gear

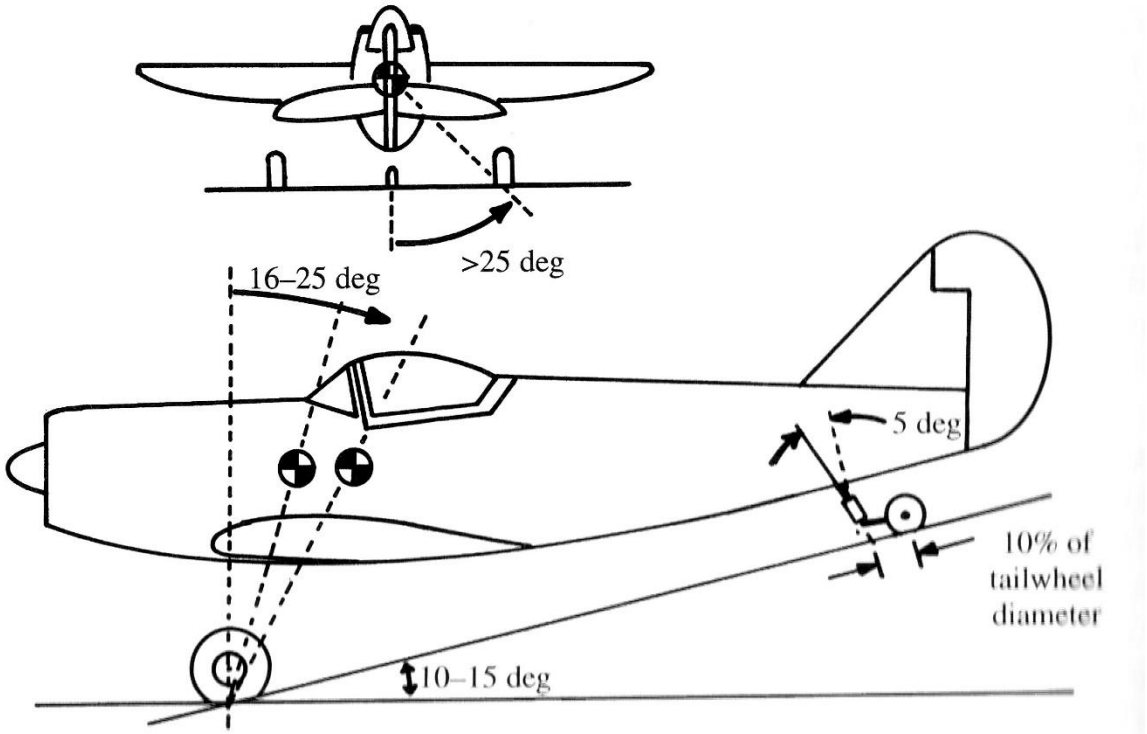


Fig. 11.4 Taildragger landing gear.

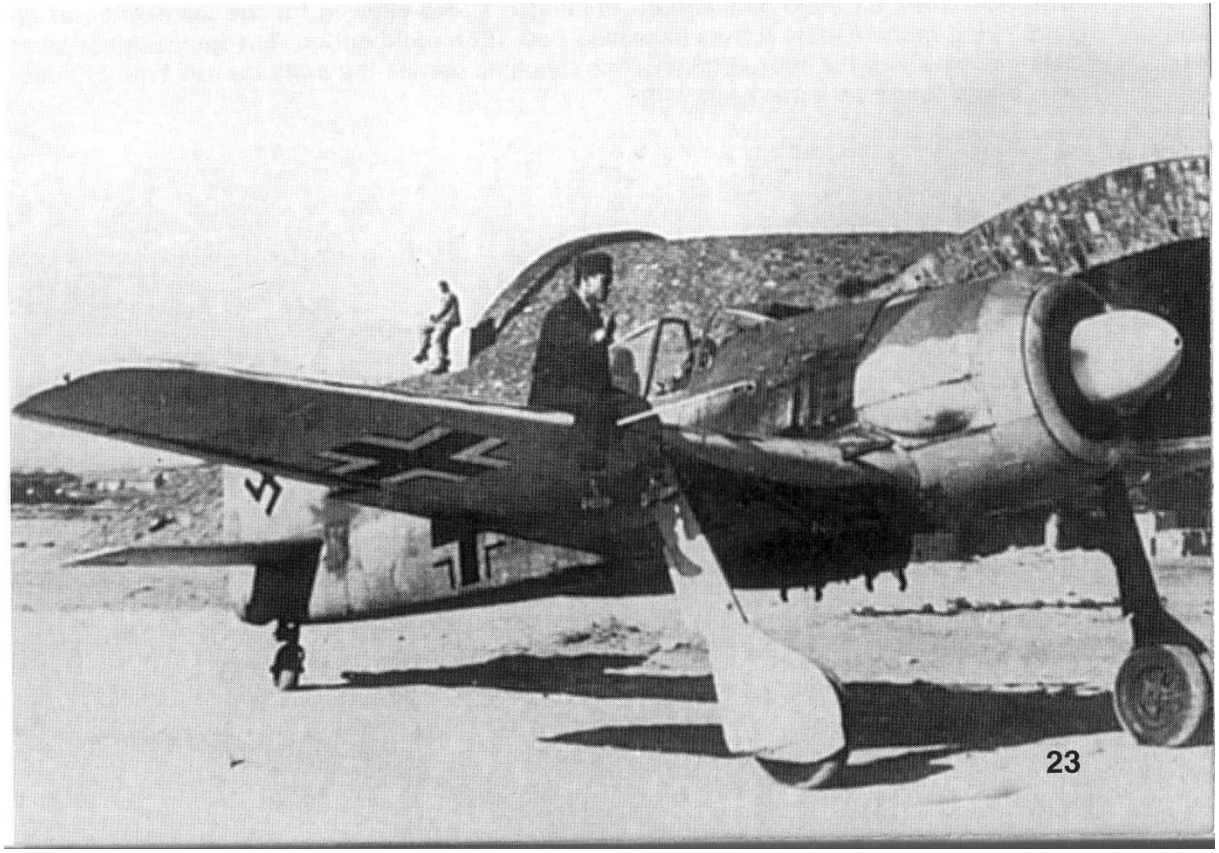
Taildragger landing gear

- Advantages of taildragger landing gear:
  - Propeller clearance is greater.
  - Takeoff distance is shorter because the wing is at a high angle of attack when the airplane is on the ground.
- For this configuration, the main wheels are ahead of the CG, which is an unstable configuration during ground roll.
- Also, forward visibility is poor for the pilot when on ground.
- The bicycle landing gear is useful for high-wing airplanes with long span.

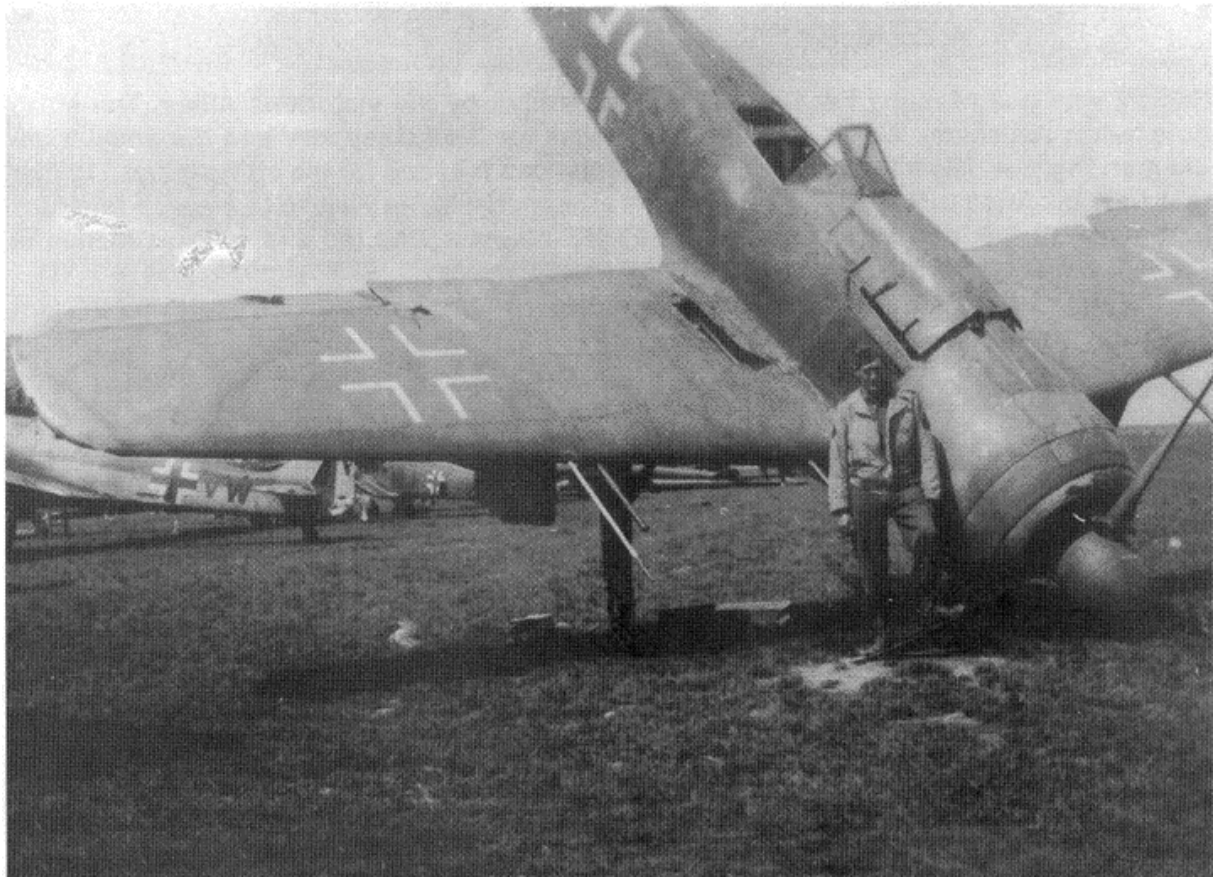
Taildragger landing gear

- The taildown angle ≈ 10^{o}-15^{o}.
- The CG (most aft and forward) should fall between 16^{o}-25^{o} back from the vertical measured from the main wheel location.
- The wheels must be separated beyond 25^{o} of the CG measured from the rear to prevent overturn.

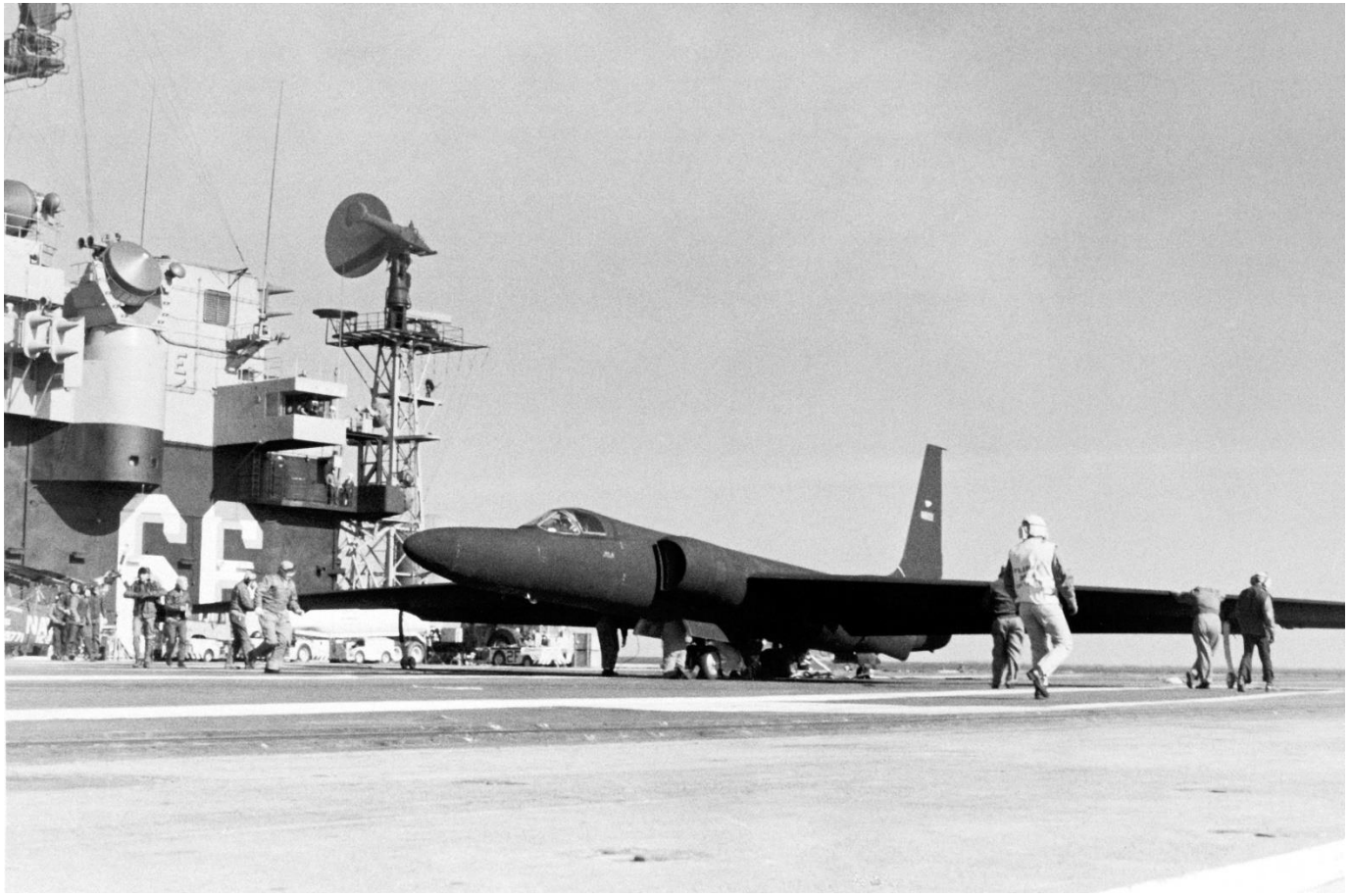
Taildragger landing gear



Taildragger landing gear



Bicycle landing gear



Tyre sizing

- Tyre size depends on the load carried by each tyre.

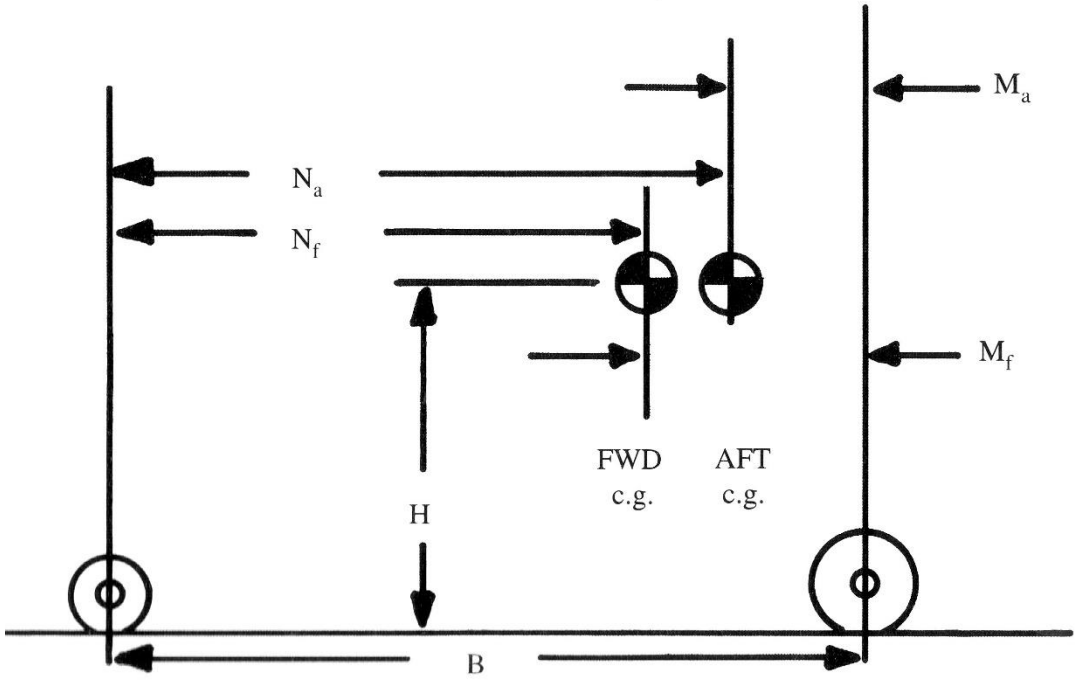


Fig. 11.6 Wheel load geometry.

Tyre sizing

- Maximum static load (main) $= W \frac{N_a}{B}$
- Maximum static load (nose) $= W \frac{M_f}{B}$
- Minimum static load (nose) $= W \frac{M_a}{B}$

Tyre sizing

- Tyre size depends on the load carried by each tyre.

Table 11.1 Statistical tire sizing

	Diameter		Width	
	A	B	A	B
British: Main wheels diameter or width (in.) $= A\ W_W^B$				
General aviation	1.51	0.349	0.7150	0.312
Business twin	2.69	0.251	1.170	0.216
Transport/bomber	1.63	0.315	0.1043	0.480
Jet fighter/trainer	1.59	0.302	0.0980	0.467
Metric: Main wheels diameter or width (cm) $= A\ W_W^B$				
General aviation	5.1	0.349	2.3	0.312
Business twin	8.3	0.251	3.5	0.216
Transport/bomber	5.3	0.315	0.39	0.480
Jet fighter/trainer	5.1	0.302	0.36	0.467

W_W = Weight on wheel.

Tyre sizing

- Nose tyres are 60-100% the size of the main tyres.
- Choose off-the-shelf tyres that closely match the size given by the formula.

Tyre sizing

Table 11.2 Tire data

Size	Speed, mph	Max load. lb	Infi, psi	Max width, in.	Max diam, in.	Rolling radius	Wheel diam	Number of plies
				Type III				
5.00-4	120	1,200	55	5.05	13.25	5.2	4.0	6
5.00-4	120	2,200	95	5.05	13.25	5.2	4.0	12
7.00-8	120	2,400	46	7.30	20.85	8.3	8.0	6
8.50-10	120	3,250	41	9.05	26.30	10.4	10.0	6
8.50-10	120	4,400	55	8.70	25.65	10.2	10.0	8
9.50-16	160	9,250	90	9.70	33.35	13.9	16.0	10
12.50-16	160	12,800	75	12.75	38.45	15.6	16.0	12
20.00-20	174kt	46,500	125	20.10	56.00	22.1	20.0	26
				Type VII				
16 × 4.4	210	1,100	55	4.45	16.00	6.9	8.0	4
18 × 4.4	174kt	2,100	100	4.45	17.90	7.9	10.0	6
18 × 4.4	217kt	4,350	225	4.45	17.90	7.9	10.0	12
24 × 5.5	174kt	11,500	355	5.75	24.15	10.6	14.0	16
30 × 7.7	230	16,500	270	7.85	29.40	12.7	16.0	18
36 × 11	217kt	26,000	235	11.50	35.10	14.7	16.0	24
40 × 14	174kt	33,500	200	14.00	39.80	16.5	16.0	28
46 × 16	225	48,000	245	16.00	45.25	19.0	20.0	32
50 × 18	225	41,770	155	17.50	49.50	20.4	20.0	26
				Three Part Name				
18 × 4.25-10	210	2,300	100	4.70	18.25	7.9	10.0	6
21 × 7.25-10	210	5,150	135	7.20	21.25	9.0	10.0	10
28 × 9.00-12	156kt	16,650	235	8.85	27.60	11.6	12.0	22
37 × 14.0-14	225	25,000	160	14.0	37.0	15.1	14.0	24
47 × 18-18	195kt	43,700	175	17.9	46.9	19.2	18.0	30
52 × 20.5-23	235	63,700	195	20.5	52.0	21.3	23.0	30