# section 8
## ENGINEERING AND TECHNICAL INFORMATION

Whether designing aircraft tires or simply talking about them, standardization of terms is vitally important to ensure a common understanding between user, supplier and manufacturer.

## 8.1 TIRE SIZE SELECTION

**MAIN WHEEL TIRES** In the selection of tires for a newly designed aircraft, allowances should be made to provide an increase in loading capability.

Aircraft growth is generally experienced during the complete life of the aircraft starting from the prototype to the first production units and progressing to heavier weight versions to meet the requirements dictated by the operators of the aircraft. The selection of a tire that permits an increased load rating capability will avoid the costly necessity of a change in tire size or wheel details required to support the heavier version aircraft.

The main wheel tire requirements should be based upon the most aft center of gravity location and the ground operational load-speed-time history considered to be the most severe during normal service operations. Consideration should be given to operations at high elevation airports and also high ambient temperature.

**NOSE WHEEL TIRES** It is important that the selection of a nose wheel tire be reviewed from both a static load requirement and also a dynamic braking condition. Care should be taken during initial selection of the tire to program allowances for loading growth to avoid possible retrofitting in the future.

In the case of the nose wheel tire, the load should be based upon the most forward center of gravity location.

To enable the aircraft tire manufacturer to lend technical assistance in the selection of the main/nose gear tires, the forms on the next page are provided listing the essential requirements for an engineering review to be conducted.

## 8.2 INFLATION UNDER LOAD

The inflation pressures shown are for unloaded tires. When tires are inflated under load, the applicable pressures should be increased four percent. For example:

| | | |
|---|---|---|
| Rated static load and inflation | 38,300 lb at 185 psi | |
| Operating static load | –Case 1 | 38,300 lb |
| | –Case 2 | 37,000 lb |
| For Case 1, inflate tire | –If unloaded | 185 psi |
| | –If loaded | 185 x 1.04 = 192 psi |
| For Case 2, inflate tire | –If unloaded | $\frac{37,000}{38,300}$ x 185 = 179 psi |
| | –If loaded | $\frac{37,000}{38,300}$ x 185 x 1.04 = 186 psi |

## 8.3 TIRE MEASUREMENT PROCEDURE

Before a tire can be measured, it must be mounted on its proper rim, inflated to the pressure given in the applicable table of the Tire Data section, allowed to stand at least 12 hours at ambient room temperature, and the pressure checked. The outside diameter of the tire should be determined by measuring circumferentially:

$$OD = \frac{\text{Circumference}}{3.1416}$$

## 8.4 OPERATING TIRE TEMPERATURES

Aircraft tires shown in this handbook are not recommended for usage where tire surface temperatures exceed 225˚F (107˚C), or where brake heat results in temperatures that exceed 300˚F (149˚C) at wheel surfaces adjacent to the tire and tube. Consult Goodyear for operation outside these limits.

## 8.5 LOAD RATINGS USED FOR HELICOPTERS

Special load ratings have been set up for tires used on helicopters.

When used on helicopters, standard aircraft tires may be rated up to a factor of 1.50 for both load and inflation.

Maximum permissible inflation is usually 1.5 times normal aircraft inflation, but limited cases may be 1.8 times normal aircraft inflation.

These factors are to be applied to ratings shown in the tables for standard aircraft tires.

Maximum allowable dimensions for new tires used on helicopters are 4 percent larger than maximum aircraft tire dimensions. (In calculating maximum outside and shoulder diameters, rim diameters are deducted before applying the 4 percent.)

## 8.6 RADIUS OF GYRATION

**TIRE ASSEMBLIES**

The approximate values for the radius of gyration of tire assemblies are calculated by using the following formula:

$$\text{Radius of gyration} = \frac{\text{Max O.D.} + \text{Min O.D.}}{5.12}$$

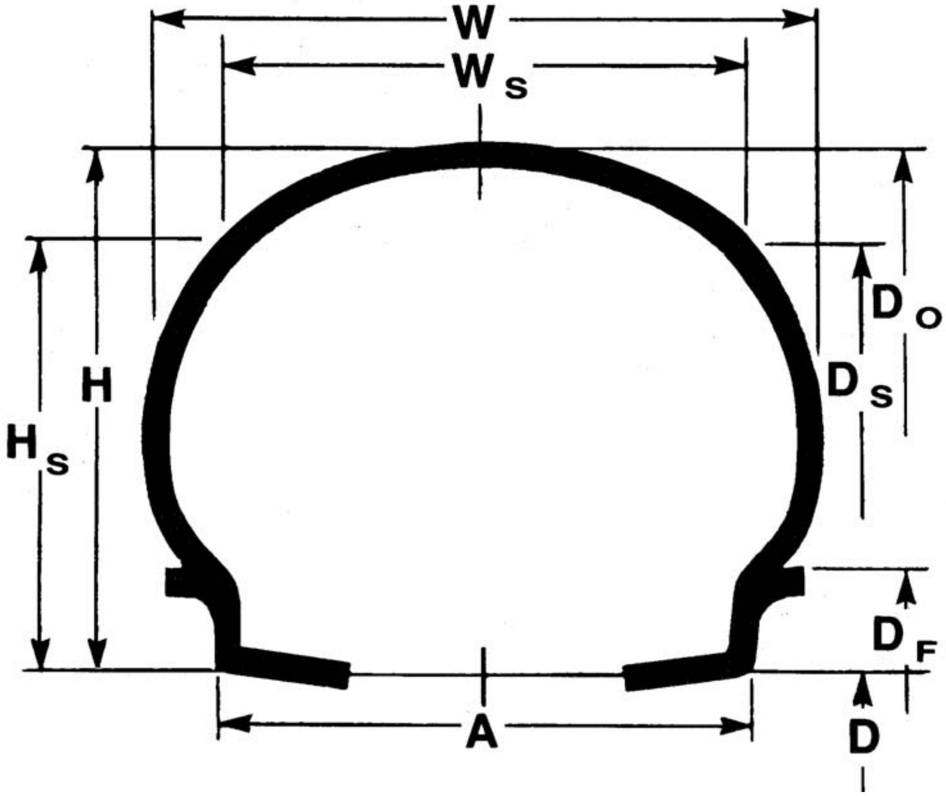
**WHEEL ASSEMBLIES**

Approximate values for radii of gyration of wheel assemblies are calculated by using the following formula:

**(Including rotating brake parts)**

Radius of gyration = 0.40 x “D” (“D” = rim ledge diameter). (The above formula is accurate to ± 20 percent.)

# 8.7 AIRCRAFT TIRE DIMENSIONS AND DEFLECTION




$D$ = Rim Ledge Diameter

$D_F$ = Rim Flange Outer Diameter

•$D_o$ = Outside Diameter

•$D_S$ = Shoulder Diameter

•$W$ = Cross Section Width

•$W_S$ = Shoulder Width

•$H$ = Section Height

•$H_S$ = Shoulder Section Width

$W_S$ (max) = .90 W (max)

$D_S$ (max) = 2 (.90 H (max)) + D

$$H = \frac{D_o - D}{2}$$

$$H_S = \frac{D_S - D}{2}$$

•Maximum dimensions of new, unused inflated tires (after 12 hours stretch minimum).

**METHOD OF CALCULATION**

$$SLR = \frac{D_M}{2} - d\left[\frac{(D_M - D_F)}{2}\right]$$

SLR = Static Load Radius

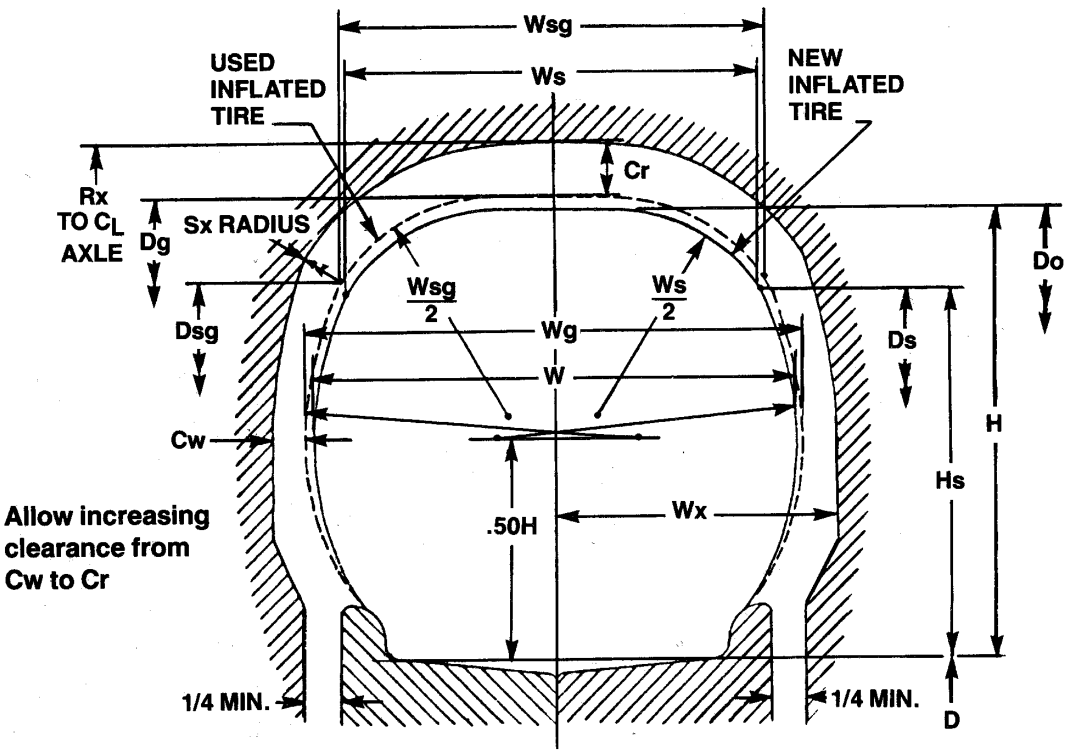
$D_M$ = Mean Overall Tire Diameter @ C/L

$D_F$ = Rim Flange Outer Diameter

$d$ = Percent Tire Deflection (in Decimal Form)

# 8.8 GROWTH AND MINIMUM CLEARANCE ALLOWANCE

A. An allowance on the maximum tire dimensions shown in the tables must be made to compensate for the growth or stretch of the tire fabric during service. It is important that the following rules be observed by anyone using aircraft tire dimensions.



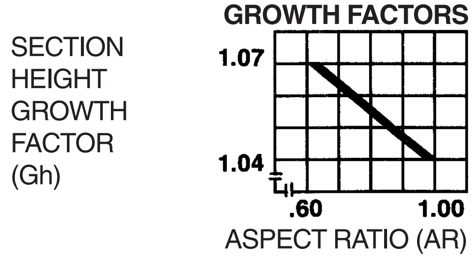

Note: Radii Ws/2 and Wsg/2 are drawn through their respective shoulder points tangent to Do and Dg respectively. Radii below the shoulder points pass through the shoulder points and are tangent to W and Wg respectively.

| | | | | | |
|---|---|---|---|---|---|
| D | = | Rim Ledge Diameter | *Ws | = | Maximum Shoulder Width |
| *Do | = | Maximum Outside Diameter | Wg | = | Maximum Growth Section Width |
| *H | = | Maximum Section Height | Dg | = | Maximum Growth Outside Diameter |
| *W | = | Maximum Cross Section Width | Wsg | = | Maximum Growth Shoulder Width |
| *Ds | = | Maximum Shoulder Diameter | Dsg | = | Maximum Growth Shoulder Diameter |
| *Hs | = | Maximum Shoulder Height | * Dimensions of new, unused inflated tire. | | |

Obtain new tire dimensions Do, Ds, W and Ws shown in the tire tables as maximum.
Note: Dimensions “W” and “Wg” include all protective side ribs, lettering, bars and decorations.
Determine “grown” dimensions as follows: (use appropriate growth factor from graph)

Wg = Gw (W)
Dg = D + 2 (Gh) (H)
Wsg = Gw (Ws)
Dsg = D + 2(Gh)(Hs)
H = (Do - D)/2
Hs = (Ds - D)/2

GROWTH FACTORS




Section Width Growth Factor Gw = 1.04
Section Height Growth Factor Gh = 1.115 - (.075 x AR)

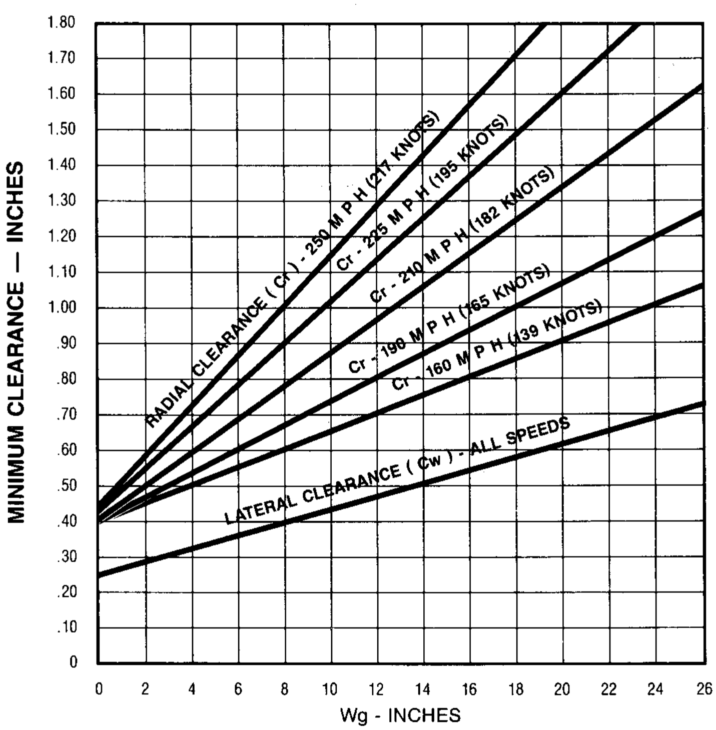
# 8.8 GROWTH AND MINIMUM CLEARANCE ALLOWANCE

B. Clearance allowances between the tire and the adjacent parts of the aircraft must be made by the aircraft manufacturer. These allowances are to be based on the maximum overall tire dimensions shown in the tables, plus growth allowance due to service, plus the increase in diameter due to centrifugal force. Minimum distances to adjacent parts of the aircraft are determined as follows:

1. Determine maximum grown tire envelope as instructed in note 8.8A on page 42. (This is the dotted line labeled “used inflated tire.”)
2. Obtain radial clearance Cr and lateral clearance Cw from the following formulae:

| | |
|---|---|
| Cr = .073 Wg + 0.4 for 250 MPH | Cw = .019 Wg + .23 |
| .060 Wg + 0.4 for 225 MPH | |
| .047 Wg + 0.4 for 210 MPH | |
| .037 Wg + 0.4 for 190 MPH | |
| .029 Wg + 0.4 for 160 MPH | |

The following is a graphic representation of the above formulae:




3. Determine distance to adjacent parts as follows:

Rx (Min.) = Radial distance from axle C/L to adjacent part.
= (Dg/2) + Cr

Wx (Min.) = Lateral distance from the C/L to adjacent part.
= (Wg/2) + Cw

Sx Radius (Min.) = Clearance allowed between tire shoulder area and adjacent part.

$$= \frac{Cw + Cr}{2}$$

## 8.9 AIRCRAFT TIRE OPERATING CHARACTERISTICS

Heavy loads combined with high speeds and high deflections make the operating conditions of aircraft tires extremely severe.

### A. HEAT GENERATION

Heavy loads and high speeds cause the heat generation in aircraft tires to exceed that of all other tires and can have a very detrimental effect. Rubber, the major material used in a tire, is a good insulator and, therefore, dissipates heat slowly. For this reason aircraft tires can only be used intermittently.

The internal heat generation is significantly affected by taxi speed, inflation pressure or deflection, and taxi distance. High taxi speeds and improper inflation pressures will reduce the tire life substantially.

### B. CENTRIFUGAL FORCES

Both heavy load and high speed contribute to the severe centrifugal forces which act on an aircraft tire. High centrifugal forces can cause traction waves to be developed and the onset of traction waves are very dependent on proper inflation pressures, which control deflection. Traction waves can lead to groove cracking, rib undercutting and tread separations.

### C. TENSILE, COMPRESSION AND SHEAR FORCES

An aircraft tire is designed so that the internal tensile forces on each layer of fabric is uniform in an unloaded condition. When a tire is deflected, the tensile forces on the outer plies will be higher than those on the inner plies. Due to this gradient from outer to inner plies, shear forces are developed between the various layers of fabric. Underinflating or overloading a tire will increase these shear forces and rapidly decrease the life of the tire, causing carcass separations in the shoulders and lower sidewalls.

### D. TREADWEAR

Proper inflation pressures give the best treadwear. High operating temperatures, excessive high speed braking, sharp and fast turns, long rollouts and pivoting can adversely affect treadwear significantly due to the high ground contact pressures.

## 8.10 TUBELESS TIRES IN PLACE OF TUBE TYPE TIRES

A Goodyear tubeless tire of the same size can be used in place of a tube type tire if the tubeless tire has an equal or higher speed and ply rating than the tube type tire it is being used to replace.