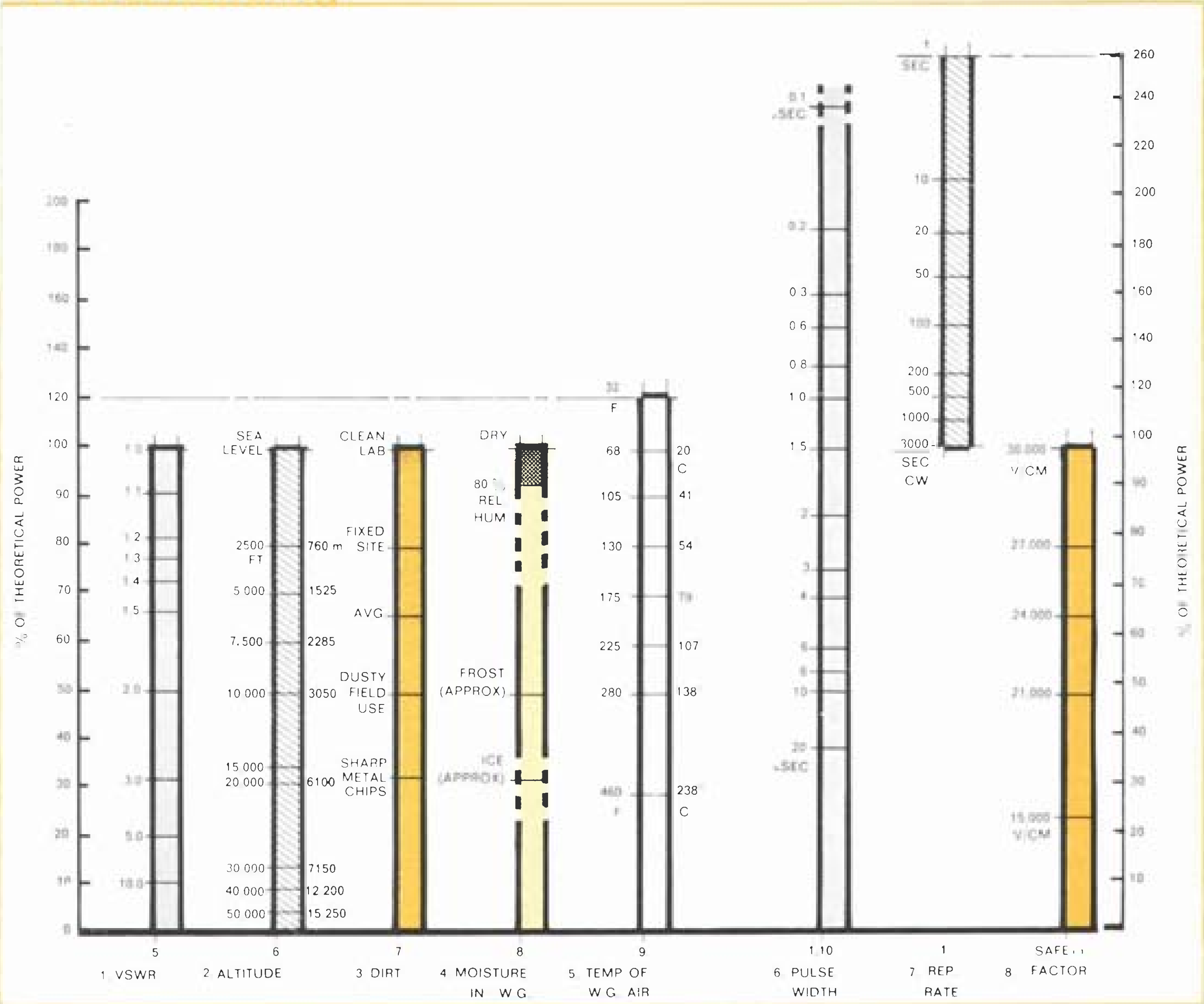
Power handling



1. System parameters affecting waveguide power handling capacity are derived by aligning each parameter horizontally with the vertical scales.

How to use the charts

Consider a ground-based radar set used from sea level to 10,000 feet which operates with a peak output power of 4 MW at 3.9 GHz. The duty cycle is 6 μsec at 300 pulses per second, and the VSWR at the transmitter output is 1.4 using WR 284 waveguide. System components most directly affecting the power capability include straight waveguide and bends, side wall couplers and a rotary joint with a type of door knob transition. The temperature at 10,000 feet, the extreme case, is approximated at 90° due to ambient plus 20° temperature rise due to signal attenuation in the waveguide, a total of 110°F.

From Figure 1 using a straight edge, the percentages of theoretical power realized due to each condition may be read off as follows:

VSWR of 1.4 resuls in 73%.
Altitude of 10,000 feet results in 50%.
Dirt (fixed site) results in 80%.
Temperature (110°F) results in 88%.
Pulse width (6 μsec) results in 60%.
Repetition rate (300) results in 125%.
Safety factor, E (using 30,000 V/cm) results in 100%.
(No safety factor will be considered in this first try).
Components result in 35%.
(The rotary joint is the critical one here).

The cumultative effect of all these parameters is found by multiplying all percentages; (0.73) (0.50) (0.80) (0.88) (0.60) (1.25) (1.00) (0.35) = 0.0675 or 6.75%.

The rapid calculation indicates that under practical operating conditions, the waveguide system can only handle 6.75% of the theoretical power of MW or 675,000 W peak. This figure does not even approach the desired peak power output of the radar of 4 MW, so steps muist be taken to increase the power handling capacity of the system.

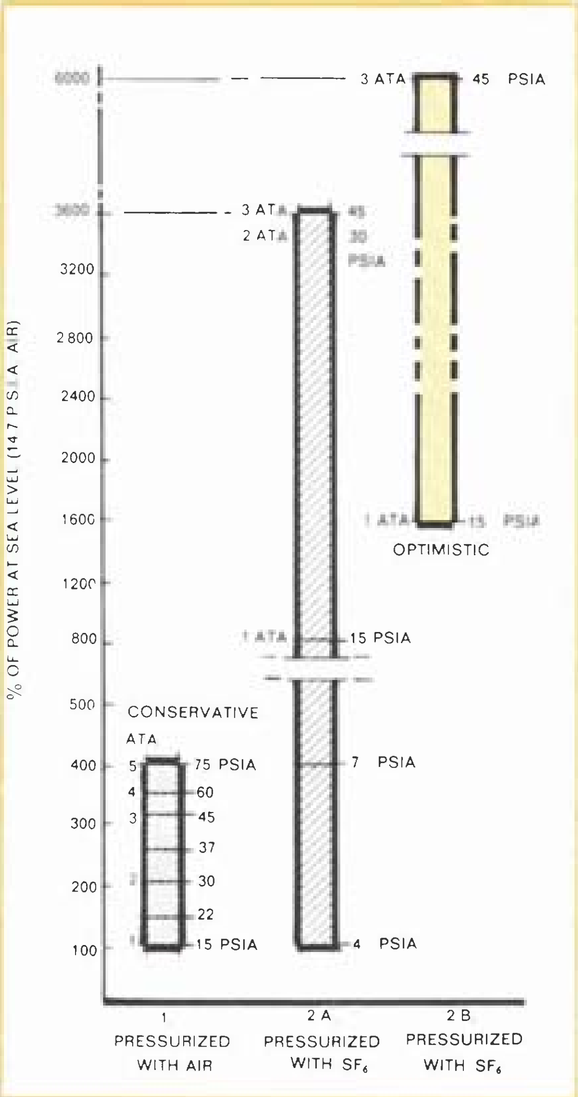


Fig 2. Ways to increase power handling capacity include pressurizing with air or SF, as well as special methods such as cooling, purging air through the guide, or creating special waveguide sizes.

Pressurization

Since Figure 1 is referenced to power handling capacity with 14.7 psia or 1 atmosphere (air) in the waveguide line and in the previous calculations it was assumed an altitude of 10,000 feet existed (resulting in 50% of theoretical power), the next step is to re-evaluate the power capacity at sea level. From Figure 1, 14.7 psia power equals 100% of the theoretical. Therefore, with 14.7 psia (air) in the waveguide, the power capacity is double that at 10,000 feet or 1.35 MW. To further increase the system power capacity, various means described in Figure 1 may be considered. The most commonly used method consists of pressurizing the system (waveguide and related components) with air since this is readily available and equipment for this purpose is available from numerous manufacturers at reasonable prices and delivery. Since the desired power to carry is 4 MW and the power handeled at 15 psia is 13.5 MW, the increase still required = 4.00/1.35 x 100 = 300%. On reading the pressurized with air scale at 300% it is seen that an air pressure of approximately 41 psia is required. By using 45 psia (35 psi gauge at 10,000 feet altitude) a safety factor will be introduced. Since pressurization is required, all components in the line must be designed to withstand this pressure.

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