NOISE & VIBRATION DESIGN GUIDANCE
PROPELLER TIP CLEARANCE
(Prepared by Noise Control Engineering, Billerica, MA)

The rule-of-thumb for tip clearance is nominally 20% of propeller diameter [1]. Given equal wake fields, the vibration response will decrease for an increase in tip clearance. Other factors having a large influence in the excitation pressures are diameter, rotation rate, depth to shaft line, and ship speed. In terms of the hull response, the exposed hull surface area and hull impedance are design parameters. Thus, achieving the 20% guidance does not ensure a good overall acoustic design; especially if other parameters can be used to compensate for a reduced clearance required due to other design considerations.

Table 1 provides an empirical estimate of the change in the hull pressures due to changes in tip clearance, all other factors being equal. The pressure impulse of blade frequency for a cavitating propeller is proportional to [2]:

$$\Delta p_c \propto \left(\frac{1}{\frac{d}{R}}\right)^{k_c}$$

where:
d = distance from r/R = 0.9 to the hull plating,
R = propeller radius,
$k_c = 1.7 - 0.7\ (d/R)$

For this analysis d = C*2R + 0.1*R, where C is the percent tip clearance. The pressure impulse at blade rate for a non-cavitating propeller is proportional to [2]:

$$p_o \propto \left(\frac{1}{\frac{d}{R}}\right)^{k_o}$$

where $k_o = 1.8 - 0.4\ (d/R)$

The total pressure acting on the hull therefore is:

$$p_z \propto \sqrt{p_c^2 + p_o^2}$$

As shown in Table 1, going from a 20% tip clearance to a 15% tip clearance only increases the hull pressure by 4 dB. This can be compensated for by changes in the hull impedance, improvements in the wake, or good acoustic design of the propeller.

TABLE 1: CHANGE IN HULL PRESSURE VS. TIP CLEARANCE

TIP CLEARANCE, % DIAMETER	INCREASE IN PRESSURE, dB
5	14
10	8
15	4
20	0
25	-3

1. E.F. Noonan & S. Feldman, "State of the Art for Shipboard Vibration and Noise Control," Ship Vibration Symposium, SNAME, NJ, 1978.
2. Vibration Control in Ships, Veritec, Hovik, Norway, 1985.