Assumptions:

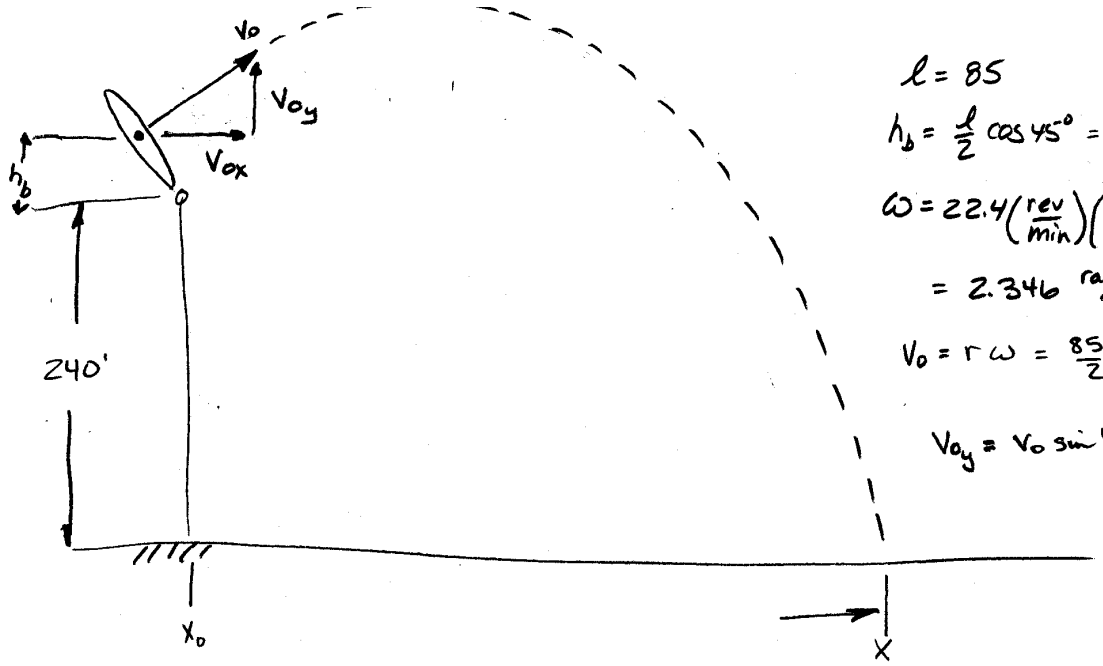
1. Blade or ice loss occurs such that projectile is thrown at a 45 degree inclined angle (see sketch following page).

2. Air resistance is neglected, which is very dependent upon the nature of the fracture and how the blade is liberated whether it goes end over end rapidly, slowly, or flies like an arrow.

3. Blade loss assumes fracture at root, blade velocity at centroid (as opposed to center of gravity).

Reference:

Engineering Mechanics: Dynamics, Bela I. Sandor, Prentice-Hall, Inc., 1983, page 537.



$\ell = 85$

$h_b = \frac{\ell}{2}\cos 45^\circ = 30$ ft

$\omega = 22.4\left(\frac{\text{rev}}{\text{min}}\right)\left(\frac{2\pi}{\text{rev}}\right)\left(\frac{1\text{ min}}{60\text{ s}}\right)$

$= 2.346$ rad/s

$V_0 = r\omega = \frac{85}{2}(2.346) = 99.7$ ft/s

$V_{oy} = V_0 \sin 45^\circ = 70.5$ ft/s

$y - y_0 = v_{oy} t + \frac{1}{2} a_y t^2$

$0 - 270 = 70.5t + \frac{1}{2}(-32.2)t^2$

$0 = 16.1 t^2 - 70.5t - 270$

roots $= \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ so $t = \frac{70.5 \pm 149.5}{2 \cdot 16.1}$

$t = 6.83$ s

$x - x_0 = v_{ox} t + \frac{1}{2} a_x t^2$ (w/ $V_{0x} = V_0 \cos 45^\circ = 70.5$ ft/s)

$x - 0 = 70.5 t + \frac{1}{2}(0) t^2$

$= 70.5 (6.83)$

$\boxed{X = 482'}$ WHOLE FAN BLADE.

Ice @ Blade Tip, Same Trajectory:

$h_b = \ell \cos 45° = 60.1$ ft

$V_o = r\omega = 85'(2.346\ r/s) = 199.4$ ft/s

$V_{oy} = V_o \sin 45° = 141$ ft/s

$$y - y_o = V_{oy} t + \frac{1}{2} a_y t^2$$

$$0 - 300 = 141\,t - 16.1\,t^2$$

$$0 = 16.1\,t^2 - 141\,t - 300$$

$$t = \frac{141 \pm 198}{32.2}$$

$= 10.53$ s (time of flight)

$$x - x_o = V_{ox} t + \frac{1}{2} a_x t^2$$

$$x - 0 = 141\,t + 0$$

$$= 141(10.53\text{ s})$$

$$\boxed{x = 1{,}484 \text{ ft}}$$

Distance traveled by ice chunk thrown from blade tip (neglecting air resistance, which would require ice to be cubic in form as opposed to a thin sheet)

This would also apply to a piece of blade tip, again neglecting air resistance.