The complex radial ***specific*** acoustic impedance and energy flow velocity are (unchanged):

$$\frac{\tilde{z}_{a_r}(r,\omega)}{z_o} = \frac{1}{[1 - i/kr]} = \frac{[1 + i/kr]}{\left[1 + (1/kr)^2\right]} = \frac{\tilde{c}_{a_r}(r,\omega)}{c}$$

The ***frequency-domain*** complex radial acoustic intensity (for $r > a$) is:

$$\tilde{I}_{a_r}(r,\omega) \equiv \frac{1}{2}\tilde{p}(r,\omega)\tilde{u}_r^*(r,\omega) = \frac{1}{2}\frac{1}{z_o}\frac{|\tilde{B}|^2}{r^2}\left[1 + \frac{i}{kr}\right] = \frac{\rho_o \omega^2}{32\pi^2 c}\frac{|\tilde{Q}_a|^2}{r^2}\left[1 + \frac{i}{kr}\right]$$

Note that $\tilde{I}_{a_r}(r,\omega) \propto f^2$ - *i.e.* an acoustic monopole sound source is ***not*** efficient at very low frequencies in terms of generating sound….

The ***frequency-domain*** complex acoustic power associated with the physical monopole sound source (for $r > a$) is:

$$\tilde{P}_a(r,\omega) = \int_S \tilde{I}_{a_r}(r,\omega)\hat{r}\bullet d\vec{S} = 2\pi\frac{|\tilde{B}|^2}{z_o}\left[1 + \frac{i}{kr}\right] = \rho_o\omega^2\frac{|\tilde{Q}_a|^2}{8\pi c}\left[1 + \frac{i}{kr}\right]$$

The ***frequency-domain*** potential, kinetic and total energy densities associated with the physical monopole sound source (for $r > a$) are:

$$w_a^{potl}(r,\omega) \equiv \frac{1}{4}\frac{|\tilde{p}(r,\omega)|^2}{\rho_o c^2} = \frac{\rho_o\omega^2}{64\pi^2 c^2}\frac{|\tilde{Q}_a|^2}{r^2} \quad (Joules/m^3)$$

$$w_a^{kin}(r,\omega) \equiv \frac{1}{4}\rho_o\left(\tilde{u}_r(r,\omega)\cdot\tilde{u}_r^*(r,\omega)\right) = \frac{1}{4}\rho_o|\tilde{u}_r(r,\omega)|^2 = \frac{\rho_o\omega^2}{64\pi^2 c^2}\frac{|\tilde{Q}_a|^2}{r^2}\left[1 + \left(\frac{1}{kr}\right)^2\right] \quad (Joules/m^3)$$

$$w_a^{tot}(r,\omega) \equiv w_a^{potl}(r,\omega) + w_a^{kin}(r,\omega) = \frac{\rho_o\omega^2}{64\pi^2 c^2}\frac{|\tilde{Q}_a|^2}{r^2}\left[2 + \left(\frac{1}{kr}\right)^2\right] \quad (Joules/m^3)$$