Therefore along the Hugoniot

$$C^2(\rho, S) = C^2(\rho, S_o) + 0\left[(\rho - \rho_o)^2\right] .$$

Hence

$$\int_{\rho_o}^{\rho} C^2\left[\rho, S_H(\rho)\right] = \int_{\rho_o}^{\rho} C^2(\rho, S_o)d\rho + \int_{\rho_o}^{\rho} 0\left[(\rho - \rho_o)^2\right]d\rho$$

$$I(\rho) = P(\rho, S_o) + 0\left[(\rho - \rho_o)^3\right] .$$

Near $\rho = \rho_o$, $S = S_o$, the difference between the isentrope passing through ρ_o and $I(\rho)$ is fourth order in $\rho - \rho_o$. Since $I(\rho)$ and $P(\rho, S_o)$ have a third order contact at ρ_o and $P(\rho, S_o)$ and the Hugoniot have a second order contact at ρ_o, $I(\sigma)$ and the Hugoniot also have a second order contact at ρ_o.