Also

$$E_n = E_p(X_n) + \frac{3R}{M} T_n \left[1 + \frac{1}{20} \frac{\theta_n^2}{T_n^2}\right]$$

from the equation of state (Sec. III.B). Hence E_n can be elimi-
nated between the equations and the equation for T_n becomes

$$T_n^2 - \frac{M}{3R}\left[E_{n-1} + \frac{1}{2} V_o(P_n + P_{n-1})(X_{n-1} - X_n) - E_p(X_n)\right]T_n + \frac{1}{20} \theta_n^2 = 0.$$

Now all (P_n, V_n, T_n) reverberation states can be calculated if
u_p and T_o are given.

Using resistivity theory results (Sec. III.A.4), the
resistivity change due to temperature rise is also calculated.
Computations show that at 100 kbar the thermal resistivity change
is 4% lower than for a single shock. The graph of shock iso-
thermal resistivity versus pressure is not strongly affected by
the correction, but the amount of resistivity change attributed
to defects generated by the shock is about 20% higher on the
MRC curve and 4.5% higher on the W3N curve after the multiple
shock calculation for the data points.

2. Temperature Rise Due to Plastic Deformation

Plastic deformation is an irreversible process. The
entropy rise increases the thermal energy, which influences the
temperature rise due to the shock wave.

Although the shock transition is achieved by irrevers-
ible processes, initial and final thermodynamic states are con-
sidered to be equilibrium states on the equation of state
surface of the shocked substance. If entropy production can be

expressed as a function of volume, then temperature can be found from an integration of

$$T\, dS = C_V dT + \frac{\gamma}{V} T\, dV \tag{8}$$

along an equilibrium path (the Hugoniot curve) between initial and final states.

According to the theory of irreversible thermodynamics, define a local entropy $S(X_0, X_1, \ldots)$ with functional dependence on local extensive parameters $X_0, X_1, \ldots$ identical to its dependence in equilibrium thermodynamics (Callen, 1960). Then

$$dS = \sum_k F_k\, dX_k$$

where the F_k are local intensive parameters (entropy representation) having the same functional dependence on local extensive parameters as intensive parameters in equilibrium thermodynamics do.

In the shock transition there is entropy production due to plastic deformation and due to the hydrodynamic shock process itself (viscous dissipation) $dS = dS_1 + dS_2$ where

$$d S_1 = \frac{V}{T} \sum_j s_j de_j^p = \frac{V}{T} \left(\frac{4}{3}\,\tau\right)\left(d\epsilon_x - \frac{d\tau}{\mu}\right)$$

as in Eq. (5) and (6). An expression for dS_2 can be found using the Rankine-Hugoniot relation

$$dE = \frac{1}{2} dP_x(V_1 - V) - \frac{1}{2}(P_x + P_x^1)\, dV$$

where V_1 and P_x^1 are values at the Hugoniot elastic limit. Locally, for the hydrodynamic process

$$dS_2 = \frac{1}{T}\, dE + \frac{P_x}{T}\, dV$$