APPENDIX A

PRESSURE PULSE ERROR

The charge developed by a piezoelectric gage is stored on a standard capacitor. Since the gage circuit has resistance, a certain portion of the charge will leak off. This discharge through essentially an RC circuit results in an exponential decay of the signal voltage, such as

$$E_R = E\, e^{-\frac{t}{\Theta_2}} \qquad (A.1)$$

where the nomenclature is

E_R . . . . recorded voltage, volts
E . . . . true voltage (a function of time), volts
Θ_2 . . . . time constant of gage circuit, msec
t . . . . event time, msec

If the fractional error E_1 that occurs in recording the true voltage is defined as

$$E_1 = 1 - \frac{E_R}{E} \qquad (A.2)$$

then from equation (A.1)

$$E_1 = 1 - e^{-\frac{t}{\Theta_2}} \qquad (A.3)$$

If the exponential term is expanded into a series, the fractional error can be written

$$E_1 = \frac{t}{\Theta_2} - \frac{t^2}{2!\Theta_2^{\,2}} + \frac{t^3}{3!\Theta_2^{\,3}} - \frac{t^4}{4!\Theta_2^{\,4}} + \ldots \qquad (A.4)$$

In general, instrumentation for piezoelectric gage recording is designed so that $\Theta_2 > t$, thus the bound of equation (A.4) becomes

$$E_1 \leq \frac{t}{\Theta_2} \qquad (A.5)$$

This equation is limited to the range

$$\frac{1}{4F} \leq t \leq \Theta_2 \qquad (A.6)$$

where F is the frequency response of the gage circuit. For the particular instrumentation used in this report, F exceeds 50,000 cycles/second. Thus equation (A.6) can be expressed

$$0.005 \leq t \leq \Theta_2 \text{ (msec)} \qquad (A.7)$$

The particular event time of prime importance here is the total time required to release the pressure in the compression chamber. If this total release time is denoted as T_R, then equation (A.5) becomes

$$E_1 \leq \frac{T_R}{\Theta_2} \qquad (A.8)$$