CONF-790975-2

LA-UR-79-2768

TITLE: PROGRESS IN MODELING CARD GAP TESTS

AUTHOR(S): Allen L. Bowman, Los Alamos Scientific Laboratory

SUBMITTED TO: Chemical Propulsion Information Agency
The Johns Hopkins University/AP
Attn: Ms. Debra S. Barnes
Johns Hopkins Road
Laurel, MD 20810

MASTER

DISCLAIMER

LOS ALAMOS SCIENTIFIC LABORATORY
Post Office Box 1663 Los Alamos, New Mexico 87545
An Affirmative Action/Equal Opportunity Employer

Form No. 836 R3
St. No. 2629
12/78

UNITED STATES
DEPARTMENT OF ENERGY
CONTRACT W-7405-ENG. 36

PROGRESS IN MODELING CARD GAP TESTS*

Allen L. Bowman
Los Alamos Scientific Laboratory
Los Alamos, New Mexico

ABSTRACT

The current status of the numerical modeling of card gap tests is described. The LASL standard test has been modeled with good agreement between calculated and experimental values for PBX-9404 and TATB. The NOL standard test has also been modeled but with very poor agreement for VTQ-2.

INTRODUCTION

The relative shock sensitivities of explosive compositions are commonly assessed using card gap tests. In these tests the shock from a standard donor explosive is transmitted to the test explosive through an inert barrier (card gap). The shock sensitivity of the test material is characterized by the gap thickness for which the probability of detonation is 0.5.

Hercules Inc. is using the NOL# card gap test as a means of evaluating the effects of rocket propellant formulation and processing variables on the propellant reaction to shock. A concurrent effort at Los Alamos Scientific Laboratory is that of modeling the card gap test numerically, thereby providing a better understanding of the test.

The Los Alamos Scientific Laboratory has used its own versions of the card gap test for many years, primarily as a measure of the hazards associated with an explosive material.[1] The arrangement used in the current standard, or large-scale, test is shown in Fig. 1. The Dural spacer and relatively long booster are used to obtain greater precision in the tests. The gap length at which detonation of 50% of the samples would be expected to occur is estimated by the up-and-down procedure. A step height of 0.25 mm is used for the final determination of the 50% point.

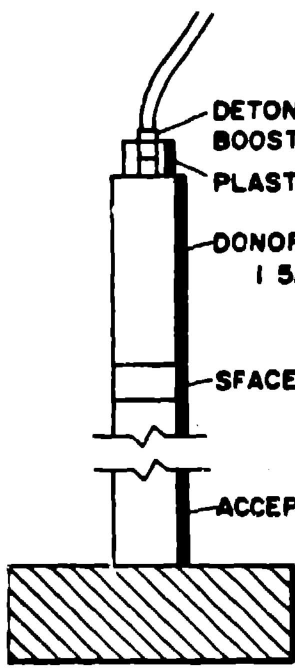

Fig. 1. LASL standard gap-test assembly.

#Naval Ordnance Laboratory, White Oak, now Naval Surface Weapons Center, Silver Spring, MD

*Work Performed Under Contract N0003077 MD 77002 SSPO 13, Amend. 2

MODEL AND RESULTS

The numerical study of the card-gap test was begun with the LASL standard test because of the relative ease of consultation with the people performing the tests and the readily available experimental data. The geometrical model is the arrangement of Fig. 1 turned upside down, with the detonator, booster pellet, and plastic holder replaced by a 1-5/8-inch-diameter hot spot initiation. The exact dimensions of the experiment are used in the model, with a cell dimension of 2.064 mm. The NOL standard gap test is modeled in a similar fashion, with the model geometry shown in Fig. 2. The computations were performed with the two-dimensional Eulerian reactive hydrodynamic code 2DE,[2,4] using the Forest Fire burn rate for the test samples.[3,4]

The progress of a LASL card-gap run is shown by a series of isopycnic contour plots in Fig. 3. The NOL card-gap calculation is shown in the same way in Fig. 4. The initiation and propagation of a detonation in the acceptor is shown by mass fraction contour plots in Figs. 5-7. The mass fraction (W) is defined such that W = 1 for a solid and W = 0 for a gas, with a continuous variation between these limits for a burning propellant. The results for three different explosive materials are summarized in Table I. The shock pressures induced in

TABLE I

STANDARD CARD-GAP TEST
(Gap in mm)

	Go	No-Go	Experimental
LASL			
PBX-9404	52	62	56-58
TATB	14	21	22
NOL			
VTQ 2	46	55	42

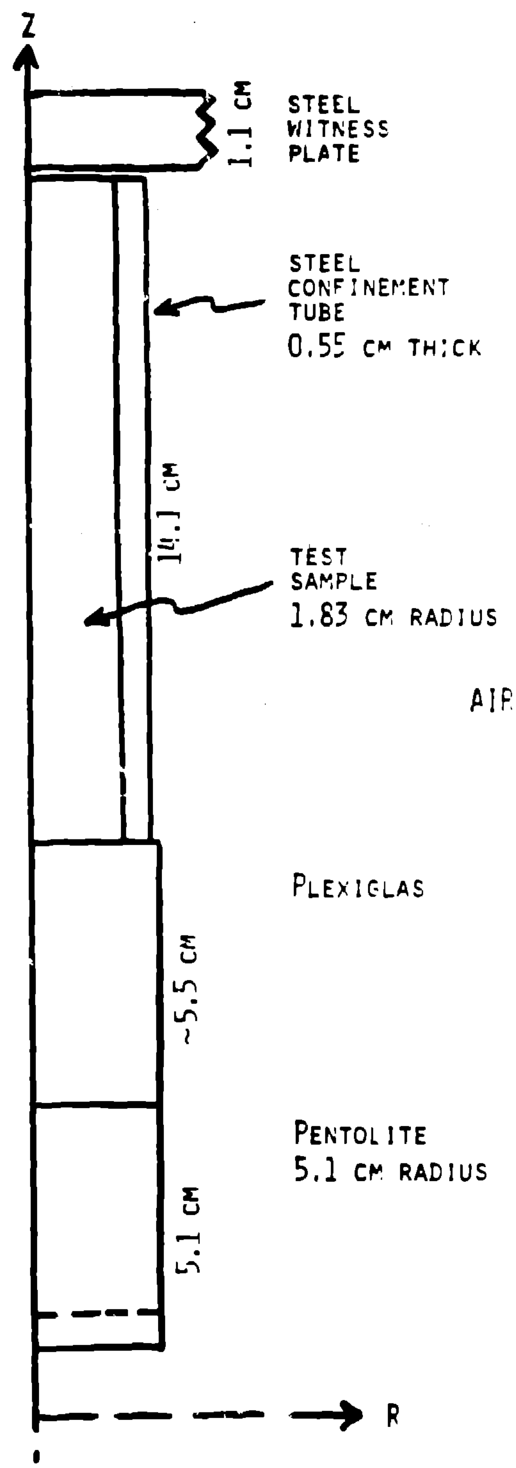

Fig. 2. NOL standard gap-test model.

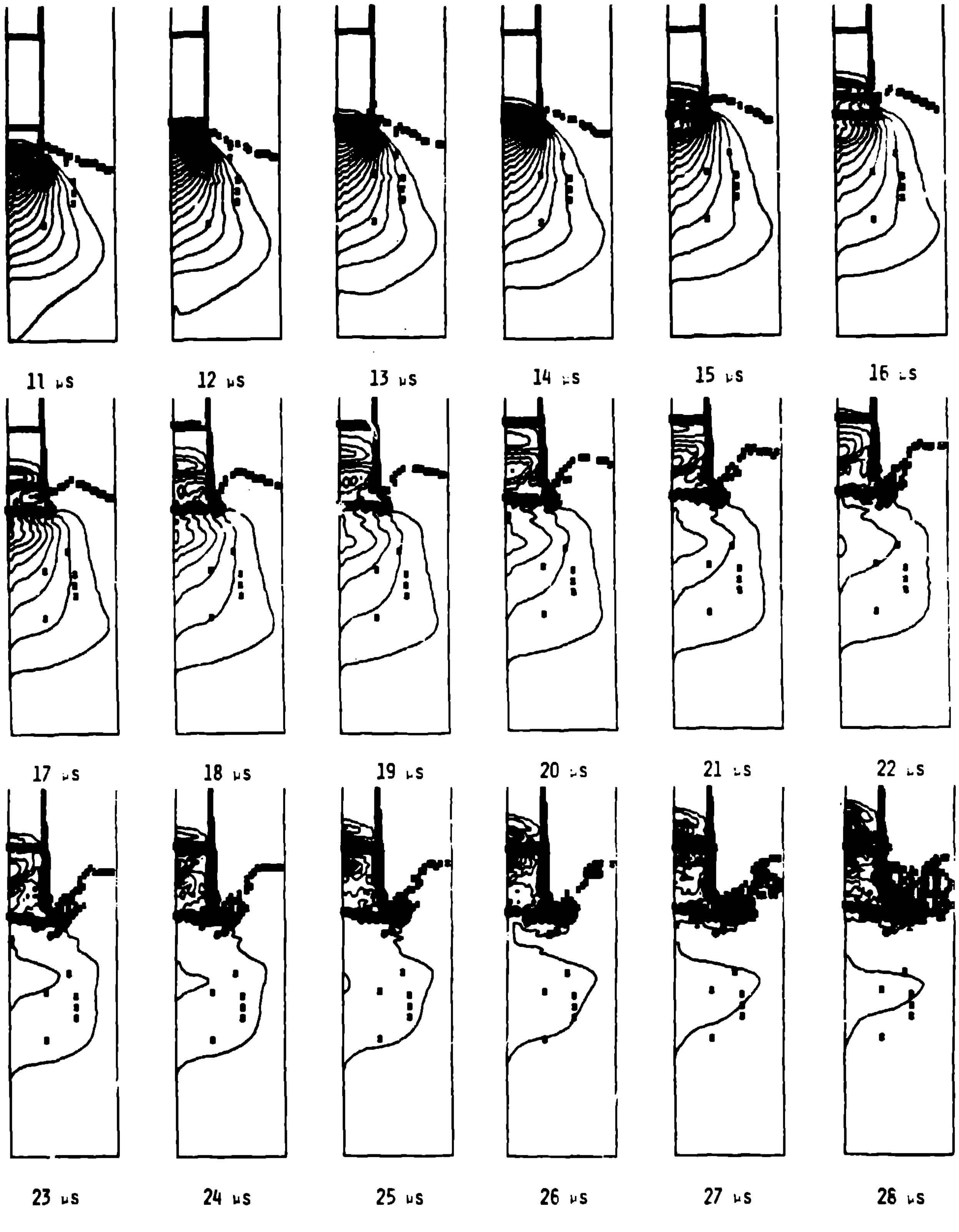

Fig. 3. LASL standard gap-test calculation; isopycnic contour plots (0.1-g/cm^3 interval). PBX-9404 acceptor, 52-mm gap.

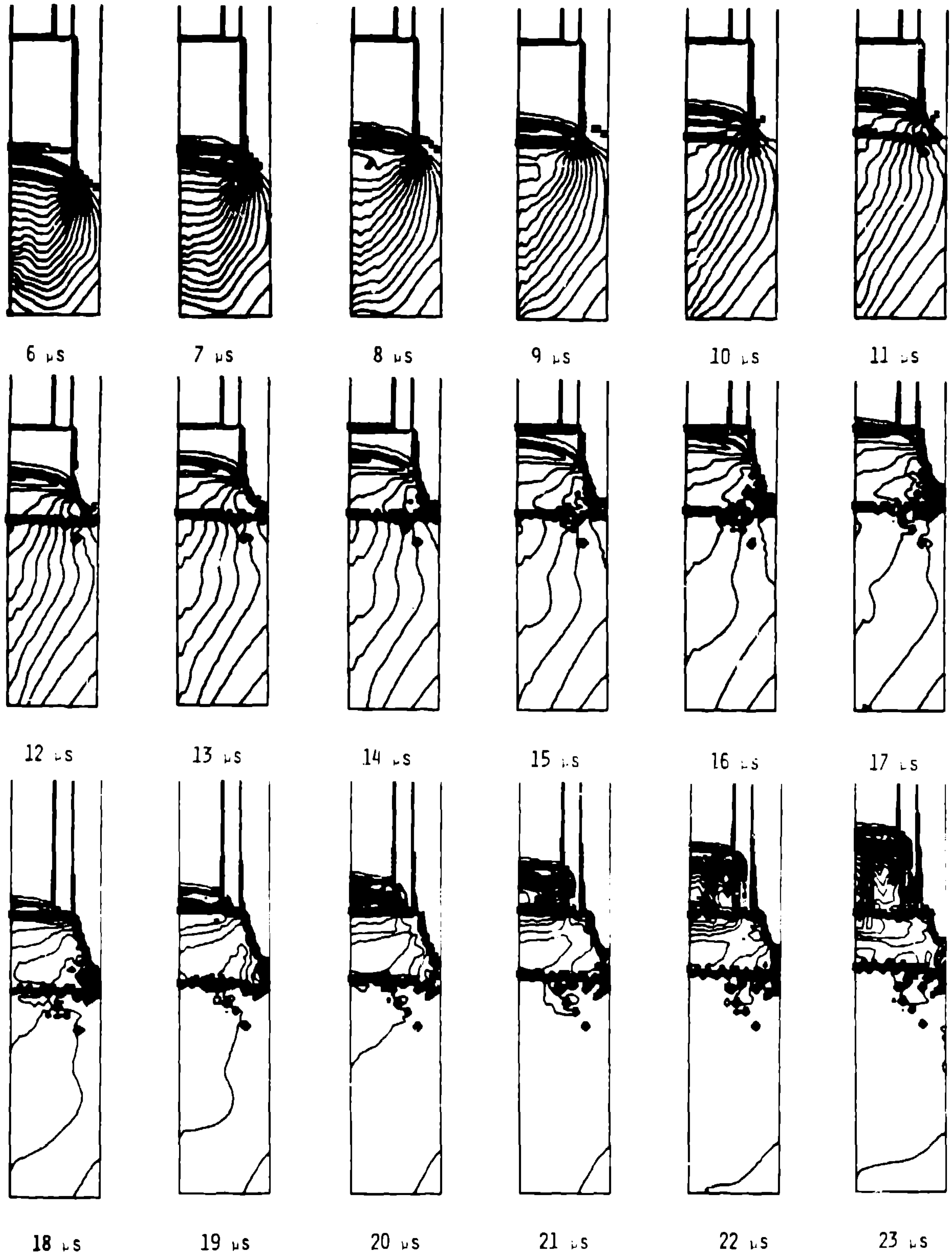

Fig. 4. NOL standard gap-test calculation; isopycnic contour plots (0.1-g/cm^3 interval). VTQ-2 acceptor, 46-mm gap.

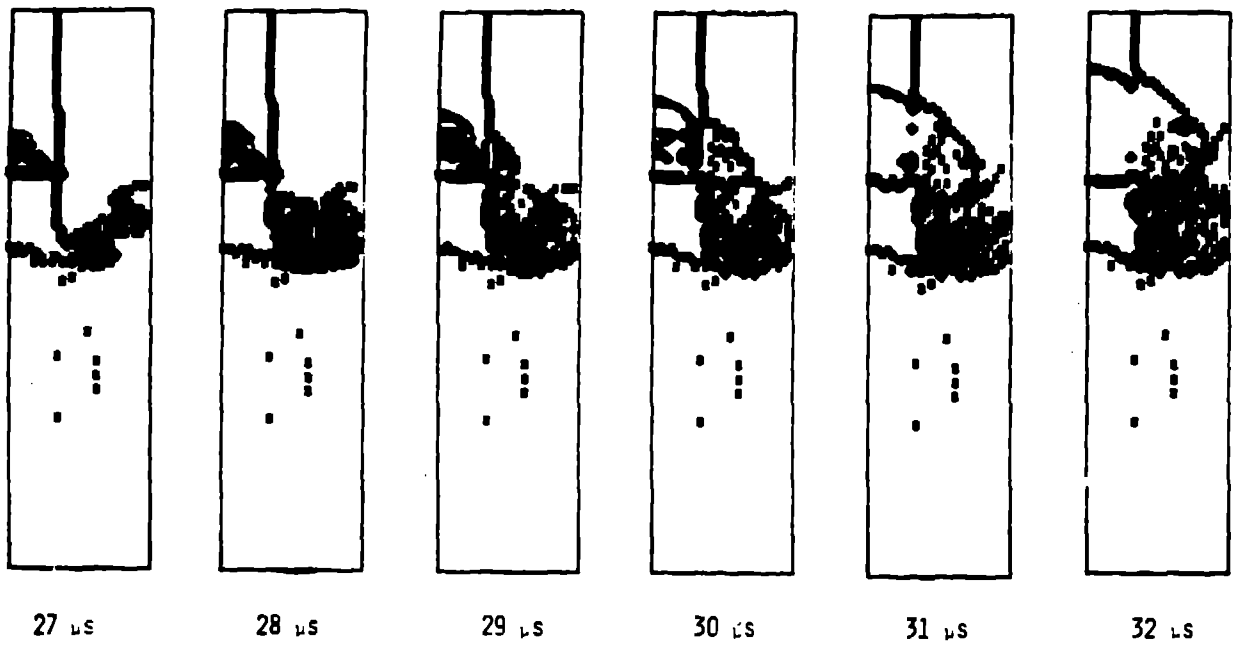

Fig. 5. LASL gap test - detonation of PBX-9404, 52-mm gap.

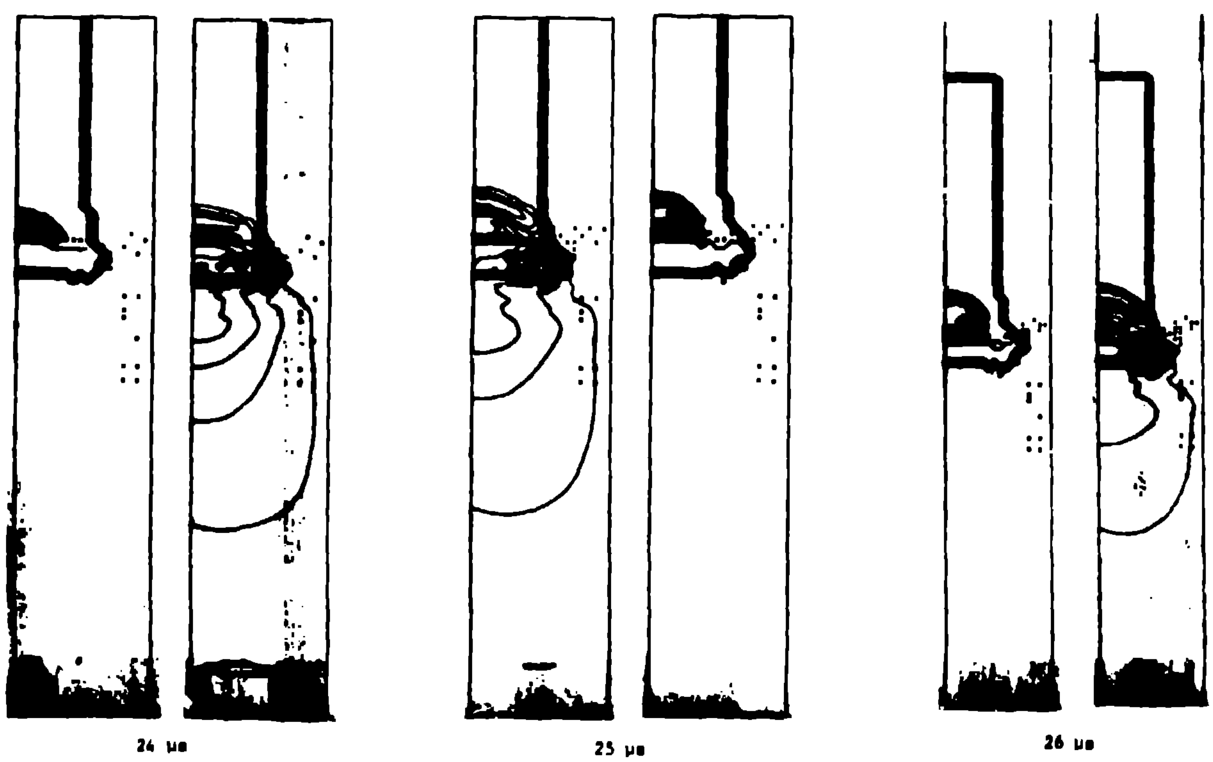

Fig. 6. LASL gap test - detonation of TATB, 14-mm gap.

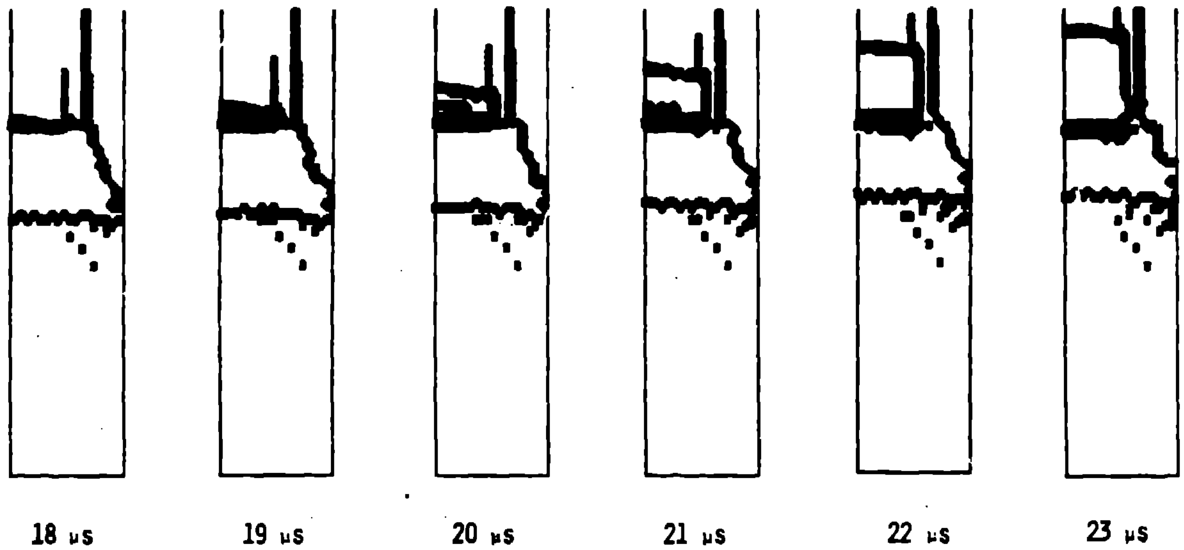

Fig. 7. NOL gap test - detonation of VTQ-2, 46-mm gap

the acceptor were obtained from calculations with inert acceptors, and were found to agree very well with the values obtained from an impedance match with the calculated gap pressures of Fig. 8. The calculated lengths of run to detonation and induced shock pressures correlate very well with the Pop plots for PBX-9404 and TATB.

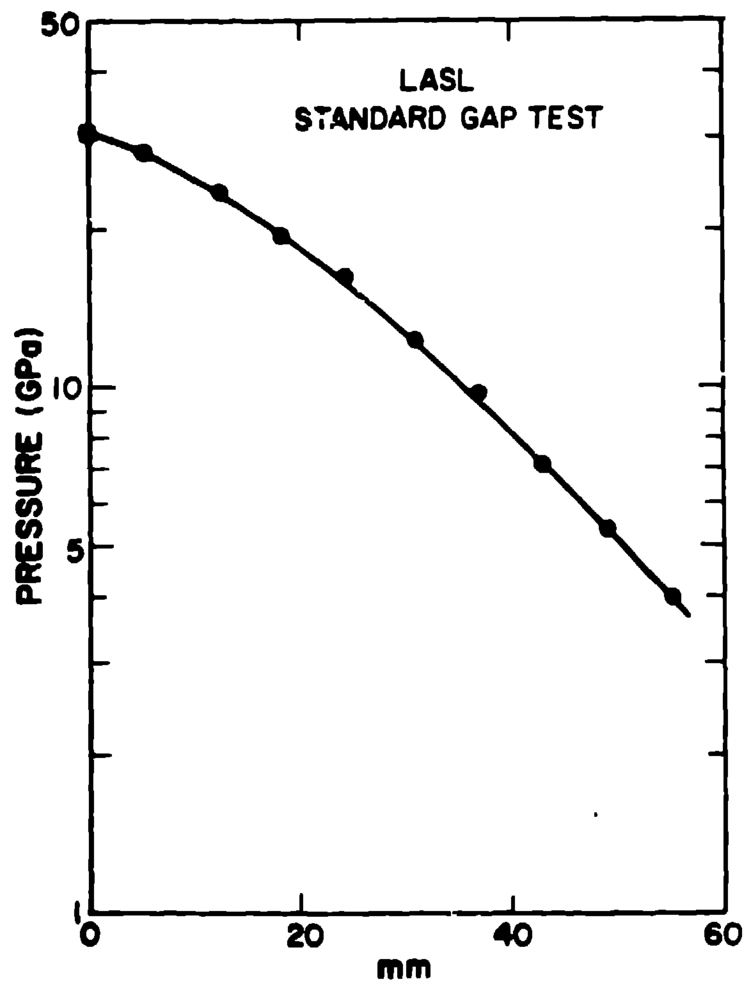

Fig. 8. LASL stardard-gap test. Shock pressures in the Dural gap.

REFERENCES

1. M. J. Urizar, S. W. Peterson, and L. C. Smith, "Detonation sensitivity Tests," Los Alamos Scientific Laboratory report LA-7193-MS (1978).

2. J. D. Kershner and C. L. Mader, "2DE, A Two-Dimensiona Continuous Eulerian Hydrodynamic Code for Computing Multicomponent Reactive Hydrodynamic Problems," Los Alamos Scientific Laboratory report LS-4846 (1972).

3. C. L. Mader and C. A. Forest, "Two-Dimensional Homogeneous and Heterogeneous Detonation Wave Propagations," Los Alamos Scientific Laboratory report LA-6259 (1976).

4. C. L. Mader, Numerical Modeling of Detonations (University of California Press, Berkeley, in press).