THE AFWL HULL CODE
CODES FOR LARGE PROBLEMS
FLUID DYNAMICS

Daniel A. Matuska, Charles E. Needham, Richard E. Durrett
Air Force Weapons Laboratory
Kirtland Air Force Base, New Mexico

The Air Force Weapons Laboratory (AFWL) has maintained a strong interest in large scale fluid dynamics problems since its establishment some ten years ago. Typically, these problems have a spatial extent which changes by several orders of magnitude between the initial conditions and the solution of interest. Time variations of orders of magnitude are also possible. In any case the large scale fluid dynamics problems solved by AFWL may be defined as those in which the smallest lineal resolution desired is less than one percent of the total dimension of interest. A large number of problems fit into this category in two and three dimensions. The AFWL has developed a system of solution for such problems which is easy to use, adaptable to many different problems and computers, and, most importantly, extremely accurate. This system is represented by the HULL code. The basic part of the code is a second order accurate, multi-dimensional Eulerian hydrodynamic code. The differencing method was developed by Capt D. Matuska at AFWL and is itself unique.

The advantages of HULL over many previous and existing radiation hydrodynamic codes include

1. Flexibility and adaptability
    a. Equations of state for over 50 materials
    b. Seven rezone choices
    c. A variety of atmospheres
    d. A high explosive burn routine
    e. Radiation diffusion
    f. A variety of possible input sources (options include input from other 1 and 2-D codes)
    g. Possible time dependent boundary conditions
    h. Written in standard Fortran as much as possible
    i. The code is running on several different machines
2. Ease of use
    a. Input is free format English
    b. Input determines the code to be used
    c. All options are internally exercised
3. Applicable to large problems
    a. Data is blocked for convenient buffering
    b. Code is designed for large array processing
    c. Only minimal code is generated for each individual problem
    d. Minimal array storage is automatically allocated for each individual problem

The inclusion of the above options is made possible by a higher level language, developed by Durrett and Matuska, known as SAIL. SAIL is a preprocessor which produces Fortran code based on input parameters. Some problems which have been

recently calculated using HULL include

1. A 1 megaton burst detonated at 3KM to calculate pressures at ground level to less than 1 PSI (2-D)

2. A 2 material problem using over 10^5 zones (2-D)

3. A multiple burst calculation requiring 3 dimensions

4. Flow from a nozzle

5. Very low pressure (50 torr) gas flow

6. Detonation of 120 tons of explosive in a hemispherically capped cylinder with the air blast followed to less than 8 PSI overpressure.

Comparisons of HULL calculations with a large variety of experimental data substantiate its high accuracy. Figures 1 and 2 are comparisons of calculational results with experimental waveforms measured during project pre-Dice Throw.

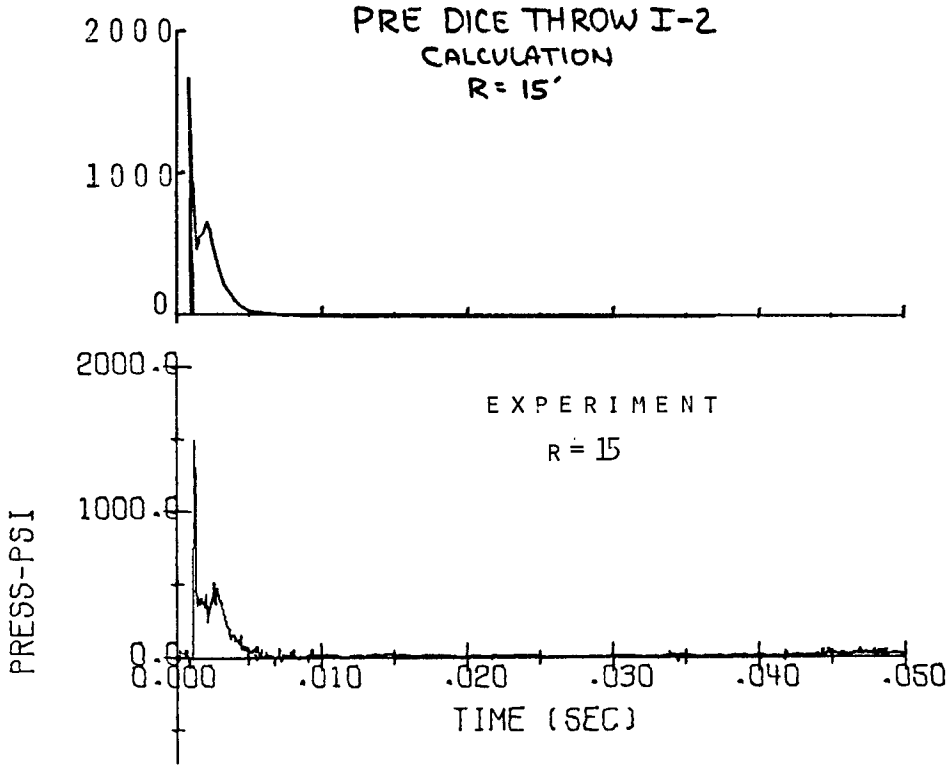

FIGURE 1

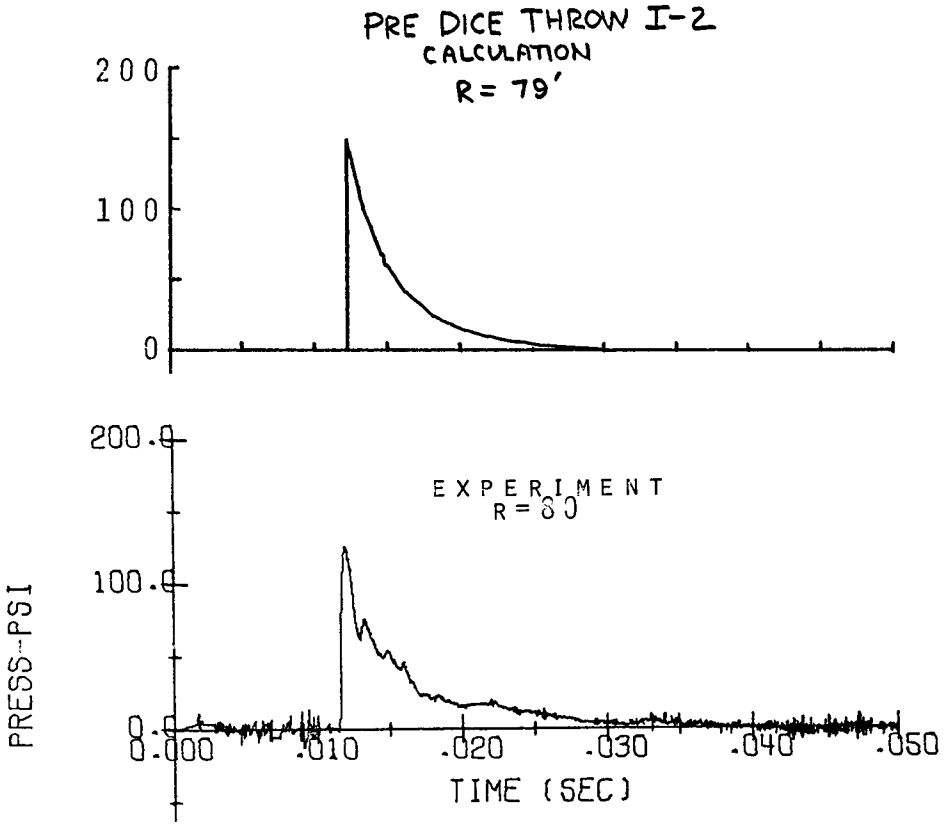
PRE DICE THROW I-2
CALCULATION
R = 79'
200
100
0
EXPERIMENT
R = 80
200.0
100.0
0.0
PRESS--PSI
0.000
.010
.020
.030
.040
.050
TIME (SEC)

FIGURE 2