TEST CASE DOCUMENTATION
AND TESTING RESULTS

TEST CASE ID CESE-VER-1.1

1-D Shock Tube Problem

Tested with LS-DYNA® v980 Revision Beta

Friday 1st June, 2012

LSTC
Livermore Software
Technology Corp.

Document Information	
Confidentiality	**external use**
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1 Introduction

1.1 Purpose of this Document

This document specifies the test case CESE-VER-1.1. It provides general test case information like name and ID as well as information to the confidentiality, status, and classification of the test case.

A detailed description of the test case is given, the purpose of the test case is defined, and the tested features are named. Results and observations are stated and discussed. Testing results are provided in section 4.1 for the therein mentioned LS-DYNA® version and platforms.

2 Test Case Information

Test Case Summary	
Confidentiality	external use
Test Case Name	1-D Shock Tube Problem
Test Case ID	CESE-VER-1.1
Test Case Status	Under consideration
Test Case Classification	Verification
Metadata	SHOCK WAVES

Table 1: Test Case Summary

3 Test Case Specification

3.1 Test Case Purpose

This is a classic 1-D model, introduced by G.A. Sod [2] and its purpose is to verify the ability of the CESE solver to solve fluid dynamics problems with shock wave behavior.

3.2 Test Case Description

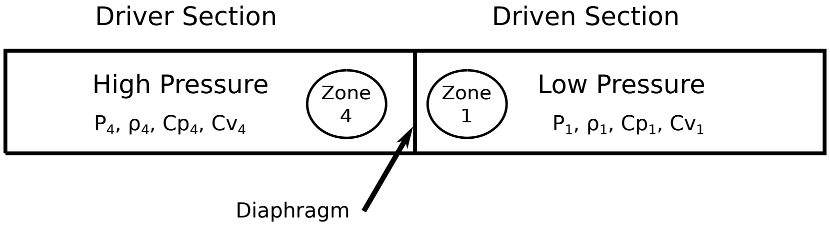

Figure 1: Initial state in the shock tube

Shock tubes have many important applications in the study of high-temperature gases in physics and chemistry [1] and are frequently used in the testing of supersonic bodies and hypersonic entry vehicles. The test case consists of a tube closed at both ends, with a diaphragm separating a region of high-pressure gas on the left from a region of low pressure gas on the right (see Figure (1)). When the diaphragm is removed, an expansion wave travels to the left and a shock wave to the right (see Figure (2)). Analytical solutions exist that permit the description of the behavior of the velocity, pressure and density variables along the horizontal axis at a given time (see Figure (3)) [1].

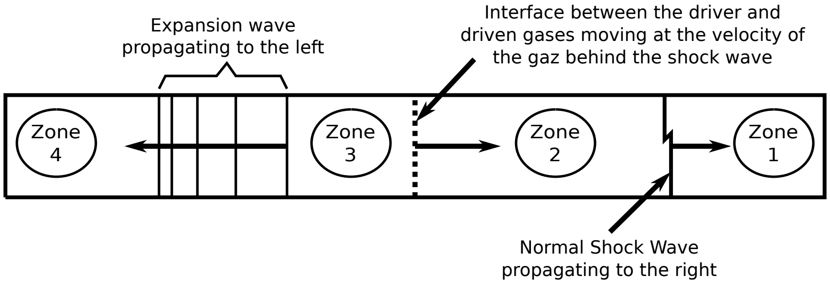

Figure 2: Flow in a shock tube after the diaphragm is broken

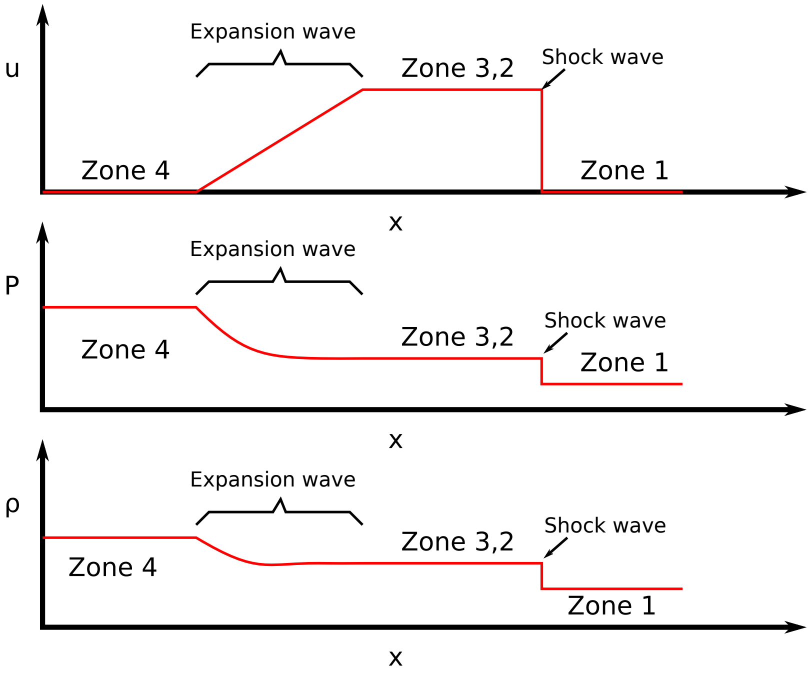

Figure 3: Variation of physical properties after the diaphragm is broken

3.3 Model Description

The computational domain is [0,1] in the x direction, and 200 uniform elements are used for the mesh. Table (2) gives the physical parameters that will be used for the driver and driven gazes. In this test case, the flow will be considered inviscid.

Model physical parameters (dimensionless)		
	Zone 4	Zone 1
Initial Velodicty	0	0
Initial Fluid Density	1	0.125
Initial Pressure	1	0.1
Specific heat at constant volume	717.5	717.5
Specific heat at constant pressure	1004.5	1004.5

Table 2: Test Case Parameters

4 Test Case Results

4.1 Test Case observations

Figure (4) shows the good agreement between numerical results and analytical solutions for pressure, density and velocity at t=0.2.

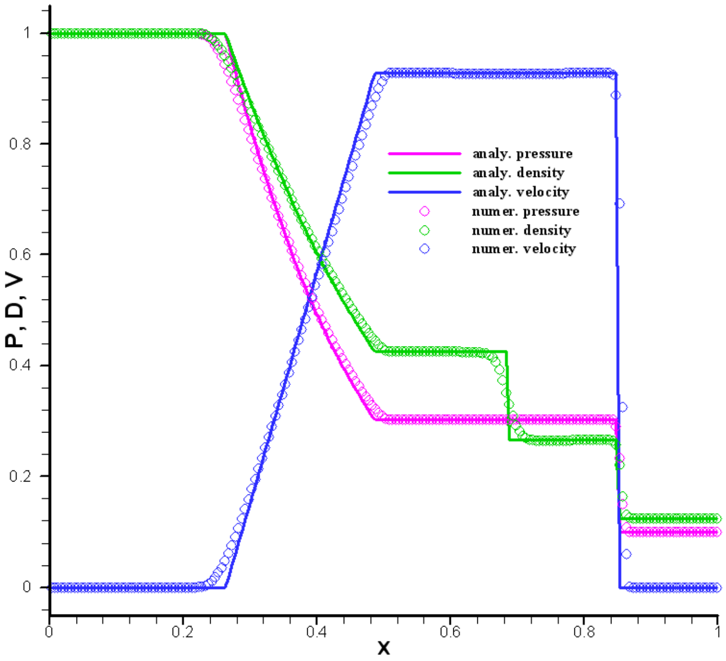

Figure 4: Test Case Velocity profile

References

[1] J. D. Anderson, *Modern Compressible Flow with historical perspective*, Mc Graw Hill, 2003.

[2] G. Sod, *A survey of several finite difference methods for systems of nonlinear hyperbolic conservation laws*, J. Comput. Phys., (1978).