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COVER STORY:

Air blast chamber readied for explosive pressure pulse simulation testing

(details, see page 5)

On the cover:

Explosive pressure pulse simulation testing using an air blast chamber

A customer recently approached Aero Nav Laboratories and inquired whether we could perform simulation tests to determine the survivability of a piece of equipment when subjected to explosive pressure pulse blasts. The equipment was designed to be robust and was expected to survive moderate levels of pulse blasts such as would be experienced in the survivability zone of an explosion. This zone is defined as that where the explosive effects are less severe than would be seen at the point of inception of the blast. After a review of the vendor equipment and discussions of various ways of simulating an explosion in the laboratory, it was decided to proceed with the project.

When an explosion occurs there is a rapid increase in gaseous volume and a release of energy in an extreme manner. The explosive creates a high-pressure pulse which propagates away from the source of the explosion.

The laboratory is not equipped to perform testing using actual explosives on-site, and furthermore is limited by municipal regulations. Another means of achieving the test objectives was required.

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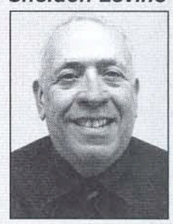
Construction of a blast tube

Accordingly, it was decided to construct a blast tube consisting of a heavy walled steel pipe open at one end and equipped with a pressurized air chamber at the other end. A means was provided to rapidly release the entrapped pressure within the chamber. The equipment under test was fixtured to simulate its actual mounting and installed in the pipe.

The open end of the pipe was set up with a converging section to maintain the air pressure and velocity, as it traversed the length of the pipe. The blast tube is shown in Figure 1.

Air blast event phenomena

At this point in the presentation a discussion of the phenomena associated with air



Sheldon Levine *is a vice president at Aero Nav Laboratories, College Point, Queens, New York, where is responsible for the lab's marketing and business development. His experience includes 36 years at EDO Corporation where he was a senior staff engineer and consultant, and part of the team that designed, developed, and tested helicopter-towed gas turbine-powered hydrofoil boats for the U.S. Navy. Prior to coming to Aero Nav he performed forensic engineering investigations. Levine, who holds a BSME degree from the City University of New York and a masters degree in heat transfer and fluid mechanics, is a member of the American Society of Mechanical Engineers, the Institute of Environmental Sciences and Technology, and the American Society for Quality.*

blast effects is in order. When an air blast event occurs there will exist two effects: peak pressure in the wave front, and drag loading. The peak pressure is the maximum pressure in the wave front as it passes the test item. The drag loading represents the effect of the bulk of the air mass moving past the test item. The drag loading is the same as that encountered by an object moving in a fluid stream. In a ground-level explosive event in an open field, the explosive effects radiate outward in a semi-hemispheric manner. However, when constrained within a long, relatively small-diameter pipe, the effects are directed axially outward towards the open end. The object under test in the tube therefore experiences the full effect of the sudden release of pressure and the rapid movement of the air past the unit.

This manner of testing the unit was considered for this device to be a sufficient simulation of the actual explosive event.

The pressure buildup and subsequent decay in the blast tube was measured by a pressure transducer placed on the upstream side of the device under test. Figure 2 presents a typical pressure trace showing the pressure versus time. The pressures which are usually shown as psig are presented as percentages of peak pressure since the actual values are considered to be proprietary. Rapid buildup of pressure in an almost linear manner is followed by a slower, more gradual, drop-off of pressure. The entire event is seen to take place in slightly more than 400 milliseconds. The rise of pressure to its peak level occurs within 100 milliseconds.

Multiple test runs were performed at various peak pressures. The equipment under test was found to have survived the effects of the air blasts with no physical damage or functional degradation.

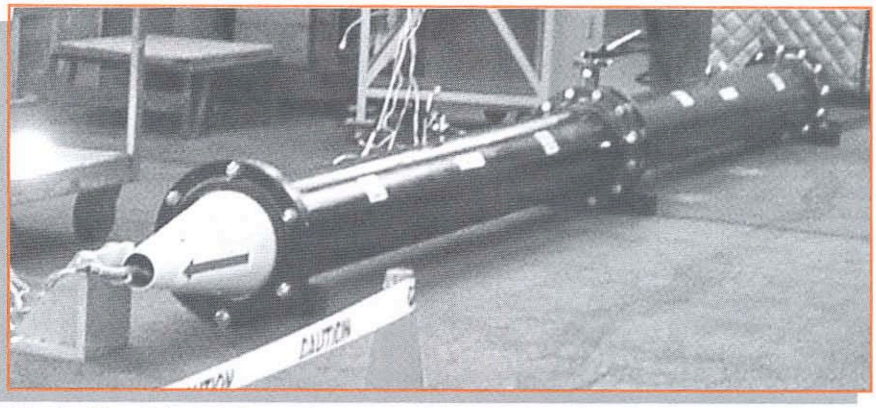


FIG. 1—The blast tube, a heavy-walled steel pipe, open at one end, and equipped with a pressurized air chamber at the other end.

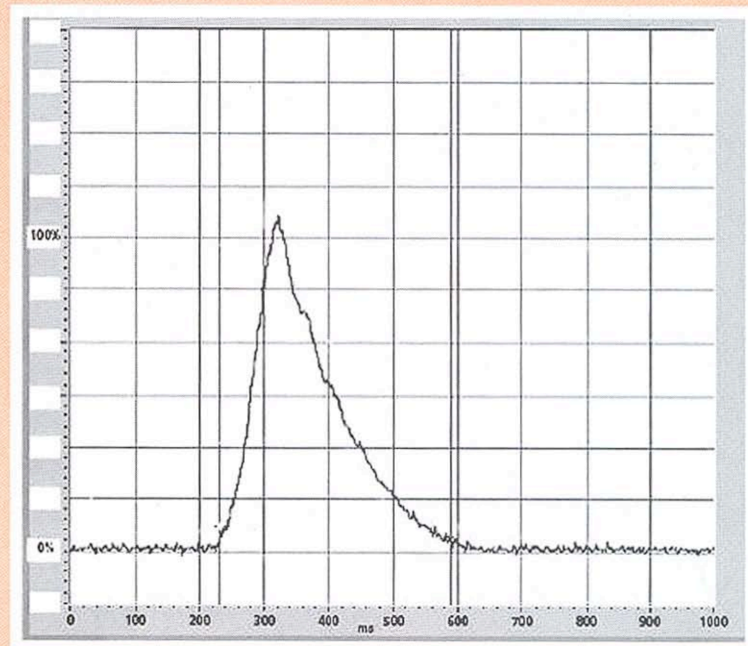


FIG. 2—Simulated air blast, pressure versus time.

References

The U.S. Department of Defense, and the Energy Research and Development Administration, have prepared an excellent reference entitled "The Effects of Nuclear Weapons," third edition, 1977, by S. Glasstone and P. J. Dolan. It includes a section entitled "Air Blast Loading" and provides a detailed discussion of the interaction of blast waves with structures.

For more information about Aero Nav Laboratories' testing services, CIRCLE #163 or go to **www.testmagazine.biz/info.php/8jj163**