CONF-830528--11

CONF-830528--11

DE83 012653

A DROP TEST FACILITY AVAILABLE TO PRIVATE INDUSTRY*

L. B. Shappert and W. D. Box

Chemical Technology Division
Oak Ridge National Laboratory
Oak Ridge, Tennessee, U.S.A.

MASTER

For presentation at the 7th International Symposium on Packaging and Transportation of Radioactive Materials (PATRAM '83), New Orleans, Louisiana, May 15-20, 1983; to be published in the Proceedings.

*Research sponsored by the Office of Nuclear Waste Management, U.S. Department of Energy, under contract W-7405-eng-26 with Union Carbide Corporation.

EDB

A DROP TEST FACILITY AVAILABLE TO PRIVATE INDUSTRY*

L. B. Shappert and W. D. Box
Oak Ridge National Laboratory, Oak Ridge, Tennessee, U.S.A.

FOREWORD

In 1978, a virtually unyielding drop test impact pad was constructed at Oak Ridge National Laboratory's (ORNL's) Tower Shielding Facility (TSF) for the testing of heavy shipping containers designed for transporting radioactive materials. Because of the facility's unique capability for drop-testing large, massive shipping packages, it has been identified as a facility which can be made available for non-DOE users.

INTRODUCTION

The safe transport of radioactive materials to and from nuclear facilities is of paramount importance. Such material must be packaged carefully to prevent any release to the environment during shipment.

Many of the impact tests undertaken to demonstrate the integrity of these packages have taken place at the Drop Test Facility (DTF) which has the capability to lift and drop tremendous weights from heights substantially above those required in the regulations.

Although physical testing of a reduced-scale model frequently has been shown to portray damage to a full-scale package accurately, some specific features are not easily modeled. In such cases, it may be necessary to test the actual package. However, some of the larger radioactive material shipping packages (e.g., spent fuel casks) can weigh up to 100 tons or more. Few facilities exist in the world which are capable of drop testing such packages from the 9-m drop height required in the regulations.

In 1978, a virtually unyielding impact pad, consisting of reinforced concrete with an armor-plate surface, was added to the TSF. With this addition, the facility has become a center for drop testing of large, full-scale packages.

Because the Drop Test Facility, with the impact pad and associated facilities, is unique in its capabilities to test, instrument, and analyze massive full- or reduced-scale packages in a variety of ways, it has been identified as a facility which can be made available for use by private industry for impact testing.

CAPABILITIES OF THE DTF

The Drop Test Facility is located about five miles southeast of the main ORNL area on a ridge adjacent to the Melton Hill Dam and is part of this Tower Shielding Facility (TSF) complex. The facility consists of four towers - each 96 m (315 ft) high - set in a rectangular array, 30 m (100 ft) by 60 m (200 ft) on a side. Each of the towers is guyed with two pairs of 5-cm-diam cables. The hoisting of heavy test pieces is accomplished with a cabling system connected to the top of each tower (Fig. 1).

*Research sponsored by the Office of Nuclear Waste Management, U.S. Department of Energy, under contract W-7405-eng-26 with Union Carbide Corporation.

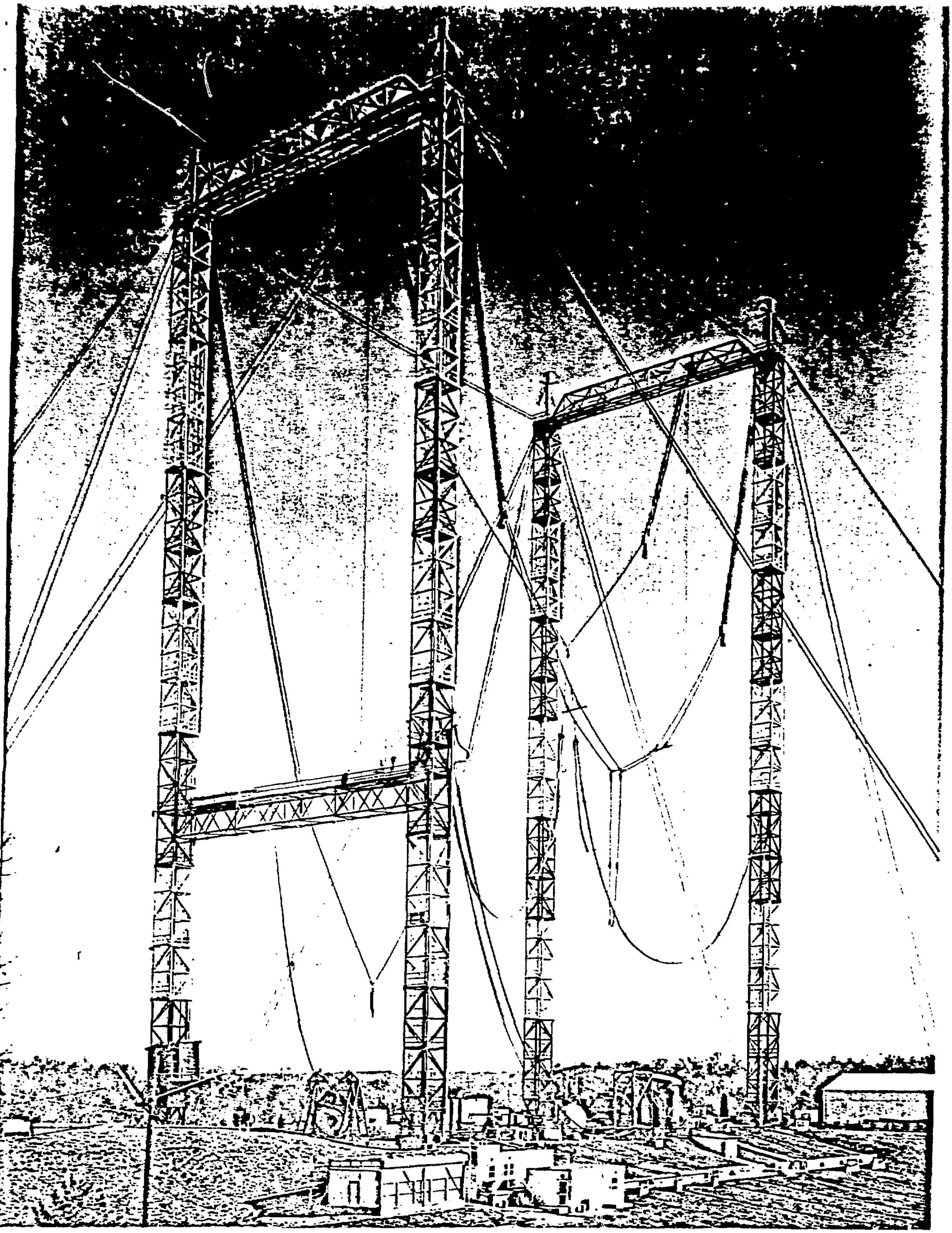

Fig. 1. The Drop Test Facility.

The assessment of the lifting capabilities of the facility is based on an evaluation of the load-carrying capacity of each of the tower components: inclined guy cables (stay-type cables between the top of each tower and the ground), horizontal tie cables (cables connecting the top of the towers), structural components of the tower legs, dynamic loading associated with the cable snap-back occurring at the time of cask release, soil-bearing capacity at the footings of each of the tower legs, and loads in the supporting sheaves. In addition, the tower capabilities were analyzed on the basis of the system kinematics (Fig. 2).

The safety factors assumed for the lifting system of the facility exceed a factor of six; safety factors for other components of the facility where applicable, are comparable. The assessment resulted in a curve of lift height as a function of weight.

MEASUREMENT CAPABILITIES

Drop tests are recorded by high- and normal-speed motion picture cameras. While capabilities exist at the Oak Ridge National Laboratory to film drops at extremely high film speeds, frequently 500 frames per second are used. Detailed measurements of the test pieces are taken following each impact. This information, along with knowledge of the package design, permit an evaluation of the response of the package to the physical insults required by the regulations.

Other measurement and data acquisition capabilities include signal conditioning and high-speed recording equipment for a variety of sensors such as accelerometers and strain gages. The capability also exists for on-line spectral analysis and plotting of any selected sensor data. Resources are available for off-line digitization of FM tapes, and computer analysis of test results can be made if desired (Fig. 3).

THE IMPACT PAD

The impact surface and pad design are important factors in the drop testing of shipping packages. The regulations require that the impact target be a "solid, unyielding surface" to ensure that all kinetic energy of the package, at the time of impact, is absorbed in the package and none in the target. While it is impossible in an actual test not to have some energy absorbed in the impact pad, the fraction of energy lost to the target structure can be minimized by making the pad a massive, monolithic structure with a very large bottom surface area that can distribute the impact loads over a wide area.

The design approach for the impact pad at the Drop Test Facility was to set thick pieces of hardened steel (armor plate) in the impact surface of a large mass of reinforced concrete. The pad, weighing 670 metric tons, was conservatively designed using the working stress method of the American Concrete Institute for conventional rectangular footings.

The shape of the pad is a stepped-pyramid arrangement with a large impact surface, a larger base, and sufficient reinforcing steel to permit the entire mass to react as a unit to the impact.

ORNL-DWG 81-23240

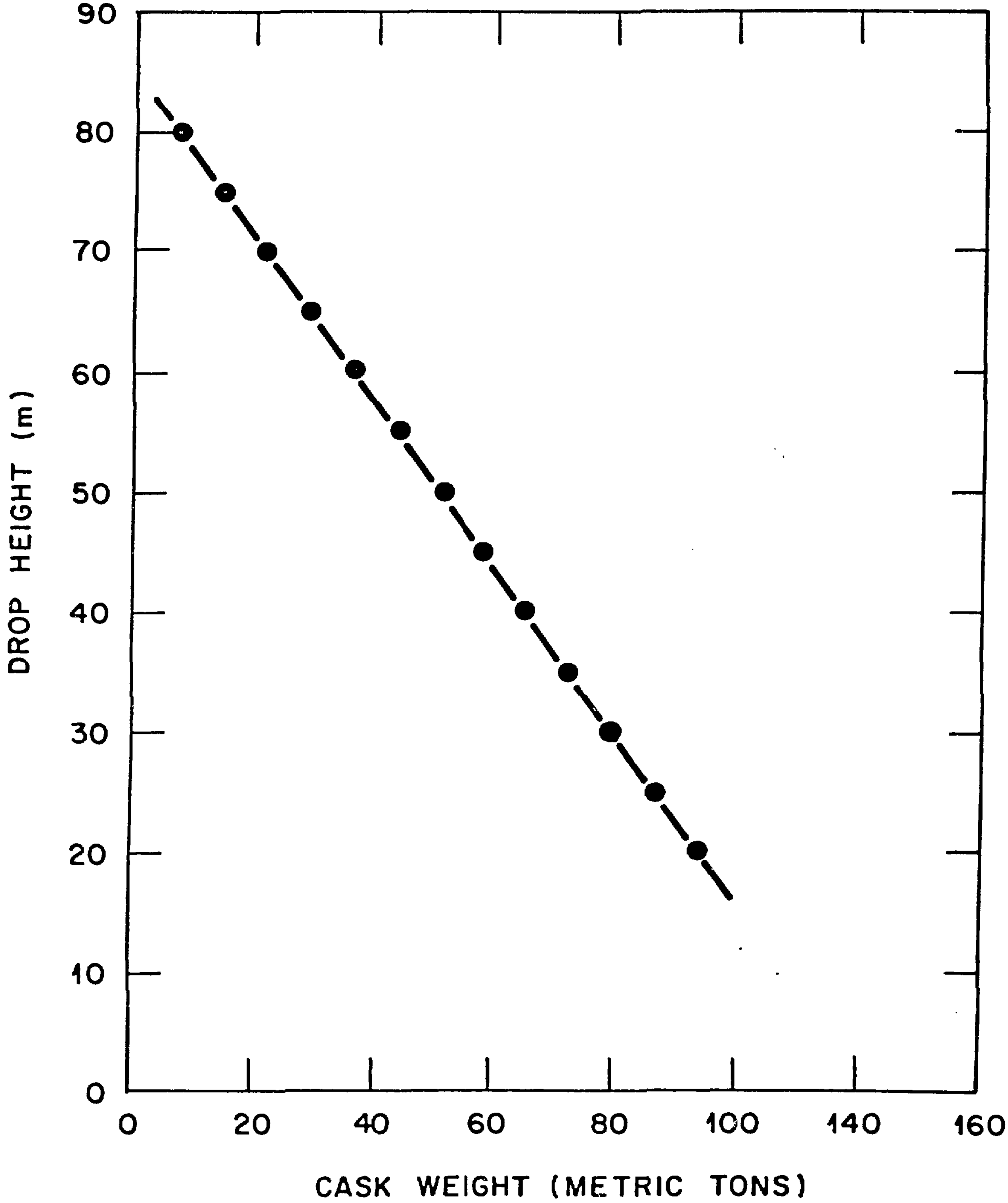

Fig. 2. Tower Lifting Capacity vs Drop Height.

4056-82

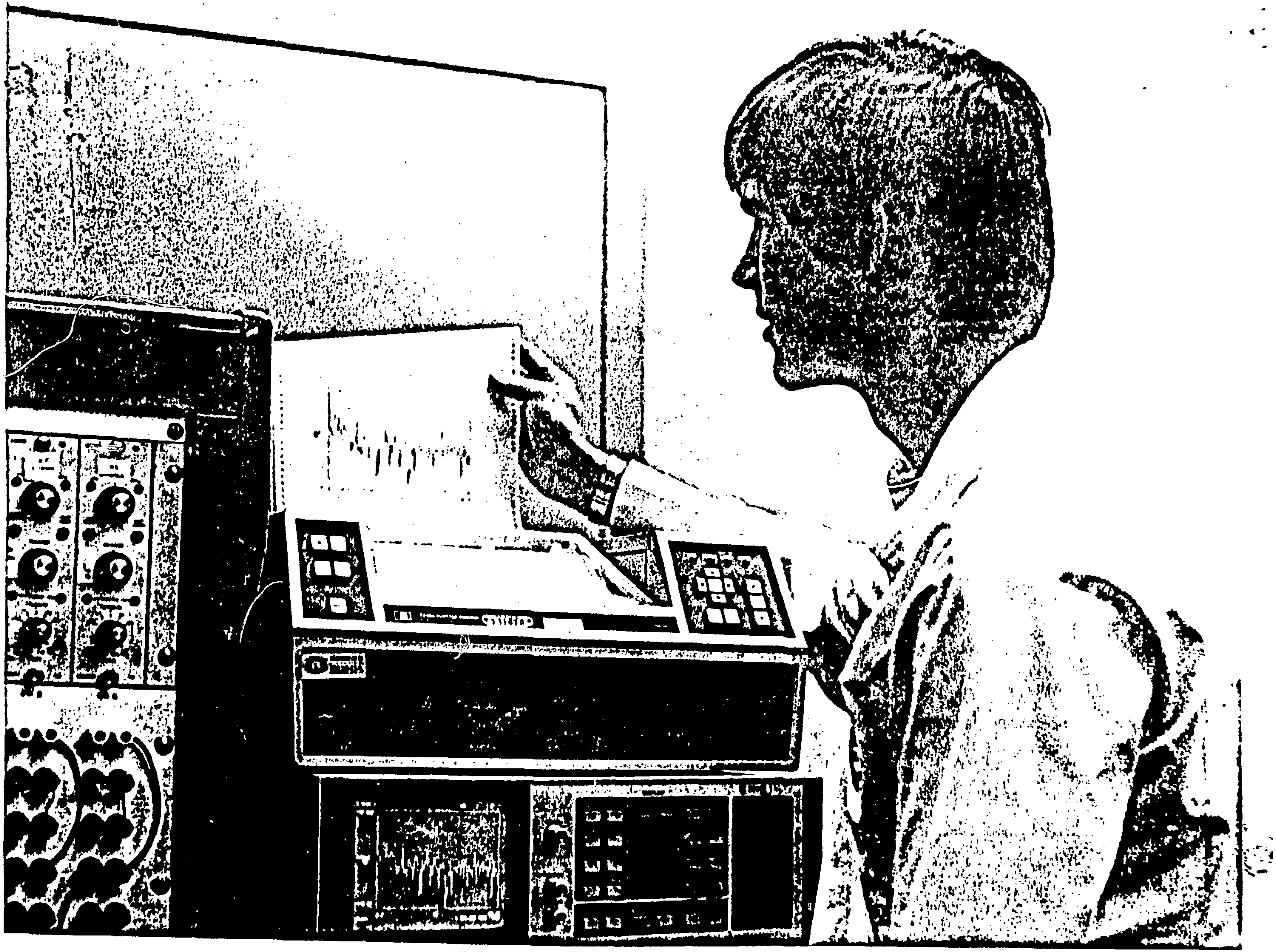

Fig. 3. Analysis of Accelerometer Data.

PREVIOUS TESTS

Many drop tests have been performed at the Drop Test Facility. Often these tests have been carried out on full-scale packages in order to obtain technical information on package behavior under specific conditions. The largest cask tested to date has been a spent fuel cask weighing almost 23,000 kg. The cask was instrumented with both piezoelectric accelerometers and bonded-resistance strain gages. Cask damage was predicted using analytical techniques prior to each drop. Calculated and actual damage agreed within the limits of engineering accuracy.

Recently the facility has been used to test newly designed overpacks for 10- and 14-ton UF_6 cylinders prior to submitting a safety analysis report for packaging (SARP), and newly designed TRU waste packages; scale models of casks also have been tested in order to predict damage to the full-scale packaging.

FUTURE USES OF THE DTF

The Drop Test Facility is quite flexible in its capabilities. Because of its design, it is capable of lifting large weights to great heights; this feature permits the testing of packages under conditions more severe than regulations require. For example, the impact velocity required by the regulations [48 kph (30 mph)] can be doubled by increasing the drop height from 9 m to 36 m. Also, tests can be carried out at temperatures other than ambient.

Scale-model testing can be a valuable tool in safety analyses, but because of the difficulty in scaling welds, bolting for closures, etc., it is often desirable to carry out confirmatory full-scale testing of a package prior to submitting a license application to the regulatory bodies. Both full- and reduced-scale tests of the packages can be carried out at the Drop Test Facility, In addition, packaging components, such as valves, closures, impact limiters, etc., can be tested on a full-scale basis.

Proposals to use the facility will be reviewed by a panel of engineers who can judge the appropriateness of the work and the suitability of the ORNL facilities to accomplish the task.

Inquiries should be addressed to:

L. B. Shappert
Chemical Technology Division
Oak Ridge National Laboratory
P. O. Box X
Oak Ridge, TN 37830
Tel. (615) 576-2066
FTS 626-2066