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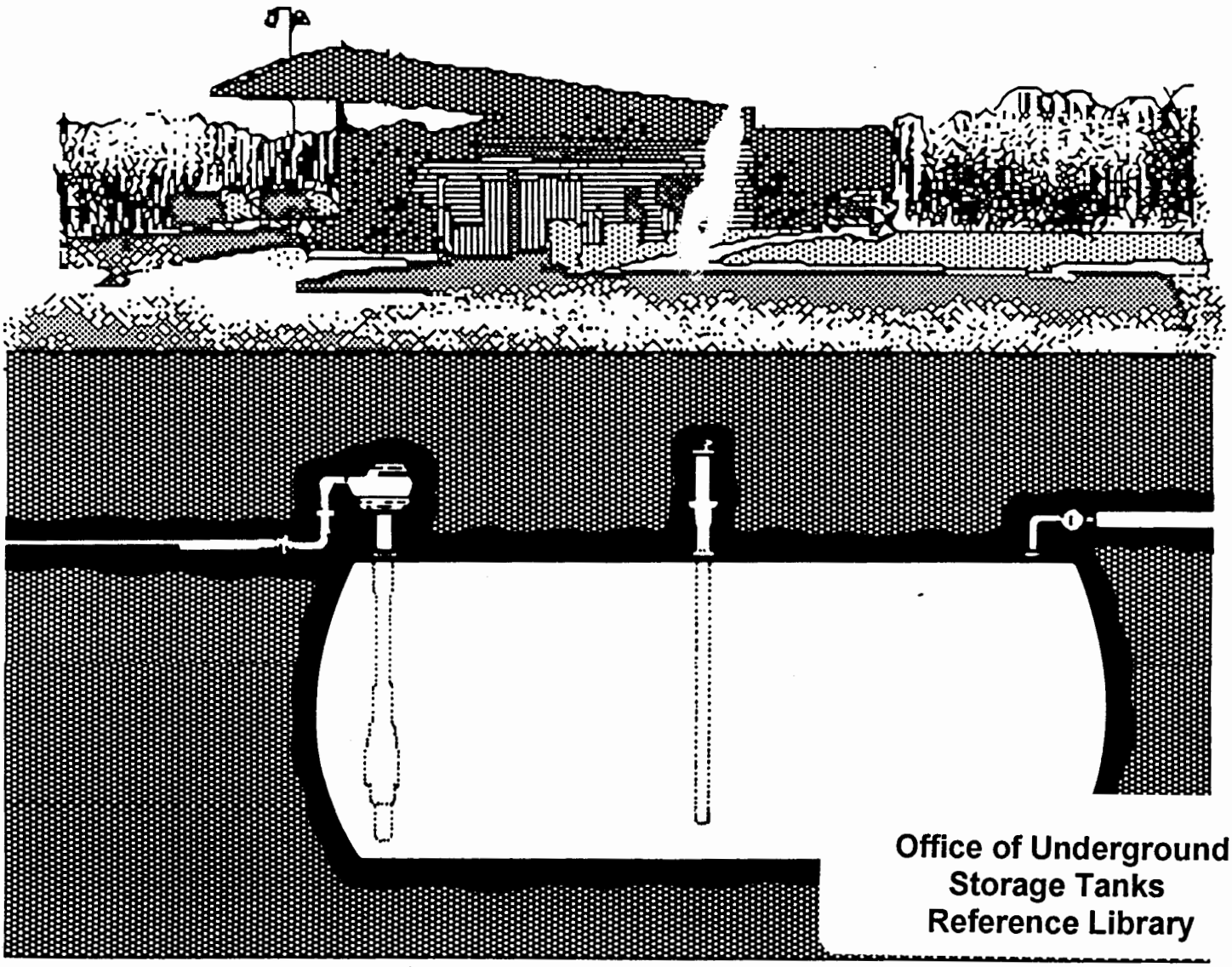

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16. Abstract (Limit: 200 words)

A nationally representative sample of 2,812 establishments were interviewed to determine the presence of underground motor fuel storage tanks. This sample represented establishments in fuel-related industries (1,612), large establishments in all other industries (600), and farms (600). A total of 890 of these establishments were found to have a total of 2,445 underground motor fuel storage tanks. Only 19 farms with 34 tanks were found. The following national estimates were made: there are 796,000 underground motor fuel storage tanks at 326,000 establishments in the Unisted States -- 158,000 of these are on 79,000 farms. A subsample of 218 establishments was selected for tank tightness testing, using a modification of a commercially available test. The method over-filled the tank system into a standpipe, and thus detected leakage anywhere in the system of tank vessel, pipes, lines, joints, and fittings. Among the non-farm establishments tested, the following estimates were made: 35 percent (189,000) of tank systems were judged to be leaking under test conditions; the average leak rate of those systems with quantifiable leak rate, adjusted for test pressure, was 0.32 gallons per hour; half the leaks among all systems judged to be leaking were 0.25 gallons per hour or less.

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AUTHORS AND CONTRIBUTORS

The research on underground storage tanks contained in this report represents the joint efforts of several organizations and many individuals. The project team met separately to refine the study design, analyses, and approach to data interpretation. The names of the principal authors and the contributions of the various organizations are summarized below.

Westat, Inc. -- Designed and selected the national sample of establishments with tanks; conducted on-site data collection from establishment managers; designed and conducted fuel inventory survey; conducted statistical analysis of all tightness test and questionnaire data; provided national estimates of leaking tanks and leak rate; produced tabulations, multi-variate models and interpretive analysis; wrote sections of the final report and; provided overall coordination and editing. Key Westat staff included:

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Midwest Research Institute -- Designed and conducted an evaluation of available tank system test methods; selected the field tightness test equipment and developed a test protocol; directed tank tightness tests; selected on-site tank and establishment data; provided data reduction of tank leak data; conducted test/retests for quality control; contributed to statistical and interpretive data analysis; and wrote sections of the final report on tightness testing. Key Midwest Research Institute staff included:

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Washington Consulting Group -- Provided design and analysis of inventory reconciliation analysis; analyzed inventory data; provided statistical assessment of reliability and consistency of various inventory analysis methods to determine leak status; and wrote the section on inventory analysis of the final report. Washington Consulting Group's senior analyst and author was:

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O.H. Materials; Double Check Company, Inc.; and Protanic, Inc. -- Provided test crews and equipment to conduct the field testing. The principal personnel representing each of the firms were:

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Vista Research, Inc. -- Assisted in the development of the test method; analyzed initial field data to determine performance characteristics; developed techniques for ambient noise analysis; and assisted in the preparation of technical documents. The key Vista Research contributor was:

Joseph W. Maresca, Jr.

EPA, OTS, Exposure Evaluation Division -- EPA staff played an active role in guiding this study, from the conceptual design through the test and analysis methods and quality control checks on data accuracy. Principal EPA contributors included:

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EXECUTIVE SUMMARY

Background and Objectives - The U.S. Environmental Protection Agency's Office of Toxic Substances (OTS) conducted a national survey of underground motor fuel storage tank systems. This study was conducted in support of the EPA's Office of Underground Storage Tanks, which has responsibility for implementing the requirements of the 1984 Amendments to the Solid Waste Disposal Act. The results of the survey are presented in this report.

The primary objectives of the national survey were to provide estimates of: (1) the total number of underground motor fuel storage tanks; (2) the number of establishments with underground motor fuel storage tanks; (3) the number of tanks that leak; and (4) characteristics of tanks and tank establishments. These tank and establishment characteristics were analyzed in a search for possible correlations with leak status (i.e., whether or not a tank system leaks) and leak rate. In addition, OTS conducted an evaluation of the use of inventory reconciliation analysis as an indirect method of detecting and measuring leaks.

Scope - The target universe included the following kinds of establishments if they had motor fuel stored in underground tanks: (1) fuel-related establishments, including business, government and military (establishments which store fuel for retail sales or transportation services including gas stations, trucking companies, auto dealers, marinas and other industry groups using or dispensing motor gasolines, diesel fuel, aviation gasoline, and jet fuel); (2) large establishments in non-fuel-related industries (establishments which store fuel for purposes such as company vehicles and private fleets); and (3) farms. The

survey excluded: tanks storing heating oil, used motor oil, chemicals, hazardous wastes and sewage; tanks which are above or partially above ground, abandoned or nonfunctional tanks; private non-business tanks; bulk storage tanks; and tanks which do not dispense fuel to end users.

Data Collected - Survey data collection was conducted with a national probability sample of 890 establishments, with a total of 2,445 tanks. A subsample of 218 establishments was selected for physical tank testing, and at those sites there were 433 tank system tests that yielded conclusive results.

Three different primary data collection efforts were used in this survey. In-person interviews were conducted with tank establishment operators in order to collect a variety of information such as the type of business, type of fuel stored, number of tanks, and tank characteristics (such as capacity, age, material of construction). The second type of data collection involved fuel inventory data which were provided by establishment operators and analyzed to evaluate inventory reconciliation techniques as an indirect method of detecting and measuring leaks. The third data collection effort involved physical tank system tightness tests at a representative subsample of establishments.

Response Rate - A rigorous quality assurance program was implemented at every stage of the survey. Response rate for the interview with tank owner/operators was 99 percent, which is very high. The tank testing phase achieved an excellent cooperation rate of 95 percent; even after allowing for untestable tanks, the tank testing response rate remained at a high level of 85 percent. For the inventory data collection, 78 percent of those contacted provided complete or partially complete data. However, only 41 percent produced data that were sufficiently complete and

accurate to be used in the inventory reconciliation analysis of this study.

Terminology - Several terms are important to the understanding of the survey's results and are thus defined here. The estimates apply to the tank system which includes the underground vessel together with all connecting distribution lines, vent and fill pipes and connections. Manifolded tank systems consist of two or more tank systems which are joined together. Whether or not a tank system passed the tightness test is determined by a statistical decision rule applied to the physical measurement data. This decision rule involves the null hypothesis that the tank system is tight. This test has a 5 percent risk of falsely declaring a test failure, and a 5 percent risk of not detecting a failure at 0.10 gallons per hour. The actual test failures could be due to product loss anywhere in the tank system -- in the vessel, lines, pipes, or bungs.

Major Findings - Following are the major findings of this study. The estimates given are subject to sampling error and nonsampling error. The ranges in parentheses following the estimates represent 95 percent confidence limits for the estimates due to sampling error. These national estimates are for the contiguous United States.

1. There are an estimated 796,000 (503,000-1,090,000) individual motor fuel storage tanks in the United States.

   - 158,000 (35-453,000) of these are on farms.

2. The above tanks are located at an estimated 326,000 (296,000-356,000) establishments.

   - 79,000 (58,000-100,000) of these are farms.
   - The estimated mean of number of tanks per establishment is 2.4 (1.6-3.2), overall, which varies from 1.9 for large establishments that are not in a fuel-related business to 3.5 for gasoline stations.

3. Under test conditions, an estimated 35 percent (30-40%) of the non-farm underground motor fuel storage tank systems, including manifolded systems, did not pass the tightness test. This represents an estimated 189,000 (153,000-226,000) tank systems. Using a different test criterion (i.e., the commonly used NFPA 0.05 gallon per hour cutoff) rather than the statistical significance test used above leads to a very similar estimate (33%) of tanks not passing the tightness test with an estimated 44 percent total classified as "uncertifiable" (i.e., 44% = 33% test failures plus 11% untestable tanks and inconclusive test results which are also counted as uncertifiable in most commercial tests). Of the physical tank system tests attempted, 5 percent were untestable with the method used because of unusual system configurations or large interferences.

4. The percentage of fiberglass and steel tank systems that did not pass the tank tightness test were about the same. Steel tanks, which comprise an estimated 89 percent of all underground motor fuel storage tanks, show little increase in the percentage of tank systems not passing the test as they age except for the oldest tanks (over 20 years), for which the percent increases substantially. There is a much smaller sample of fiberglass tanks, so no comparison by material was possible for the tanks aged 20 or more years, but fiberglass and steel tank systems have no significant difference in percent not passing the test at comparable ages. These findings should not necessarily be interpreted as causal effects of age and tank material. Such statistical associations could be caused by other associated variables.

5. This report presents many descriptive statistics on the characteristics of underground tanks and the facilities or establishments at which they are located. For example, based on the national sample estimates:

   - Thirty-one percent of establishments with underground storage of motor fuels also store waste oil underground;
   - Fourteen percent of establishments have one or more abandoned tanks on site;
   - Seventy-eight percent of establishments used clean sand, pearock, or peagravel to backfill around tanks;
   - Twenty-nine percent of establishments are required to have tank operating licenses;
   - Sixty-nine percent of establishments believe they are insured for non-catastrophic leaks;
   - Eleven percent of underground motor fuel tanks are fiberglass;
   - Twenty-one percent of tanks are installed partially or completely below the water table;
   - Twenty-three percent of tanks are in manifolded systems; and
   - The mean age of tanks is 12 years.

6. The statistical analysis did not identify any single explanatory variable (such as age of tank, type of material, or fuel type) that is strongly correlated with tightness test results. Additional multiple regression and logistic models were developed which suggested the possible influence of a few variables, but their ability to predict the test outcome was weak, as described in the appendices of this report. Soil characteristics were not among the variables analyzed because they were not available in the data base during this study. Soil data more recently developed by EPA and General Software Corporation are described in the appendices of this report.

7. There is only limited agreement between inventory analysis methods and tightness test outcomes on a tank-by-tank basis. It is possible that a longer period than 28 days of inventory data might improve the level of agreement. While each of three inventory methods provided roughly similar overall estimates for the percent of tank systems that might leak, there were substantial disagreements among the inventory methods as to which tank systems leak.

   - o It is very difficult to obtain accurate and usable inventory data. Owners and operators had trouble following even simple inventory data collection procedures. The 78 percent response rate was achieved only after extensive followup efforts. It is not that inventory control does not work, it is just that the successful execution of it is difficult to achieve.

   - o EPA feels that the failure of the inventory analyses as part of the survey was a result of human error and inconsistency and we do not view it as a basic failing of inventory methods.

8. For the tank system tightness tests, EPA initially conducted an extensive evaluation program to test existing methods, then selected one of these, modified it to improve its accuracy, and characterized its field performance. The method used by EPA has stated procedures to identify and correct for potential interference problems which commonly occur in the field and which can otherwise invalidate the test results. These interferences include tank end deflection, temperature effects, water table and vapor pockets. With the modified method, EPA was able to detect a 0.10 gallon/hour leak with 95 percent probability while correctly identifying a tight system with 95 percent probability.

   None of the existing test methods evaluated by EPA could consistently and reliably achieve detection of the 0.05 gallon/hour leak rate specified by the NFPA 329 "Recommended Practices for Underground Leakage of Flammable and Combustible Liquids, 1983." This conclusion is based entirely on the data collected during EPA's evaluation program since supporting data which had been requested from the test companies to document their performance claims were not received.

While some methods can provide reliable results under some specific conditions, most of them do not take definitive steps to deal with the commonly occurring interference problems previously mentioned. EPA believes that in general the field performance of existing test methods could be improved by:

- training field crews to identify interference problems;

- developing stated procedures to deal with interference problems; and

- increasing frequency and duration of data collection.

In any case, it is important that those who must rely on the results from these methods be informed about their performance characteristics. If valid performance data on a method do not exist, they should be generated. If they do exist, they should be made available to those who are potential users.

Simply put, EPA believes that there are problems with existing tank system tightness tests. EPA believes these problems are correctable and for this survey EPA chose a method, modified it to deal with these problems and was able to improve the accuracy over existing methods.