ROCKY MOUNTAIN OILFIELD TESTING CENTER

PROJECT TEST RESULTS

NOVERFLO (SMART CABLE)
LIQUID LEAK DETECTION SYSTEM

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RMOTC TEST REPORT

NOVERFLO
LIQUID LEAK DETECTION SYSTEM (SMART CABLE)

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Summary

As part of RMOTC's continuing mission to support and strengthen the domestic oil and gas industry by allowing testing by individual inventors and commercial companies to evaluate their products and technology, RMOTC has completed a series of tests of Noverflo's liquid leak detection system (Smart Cable). The cable system is designed to test the presence of several different liquids using sensors and a fiber optic cable. The system is anticipated to be used to detect pipeline leaks, storage tanks leaks, and other vessel or piping leaks.

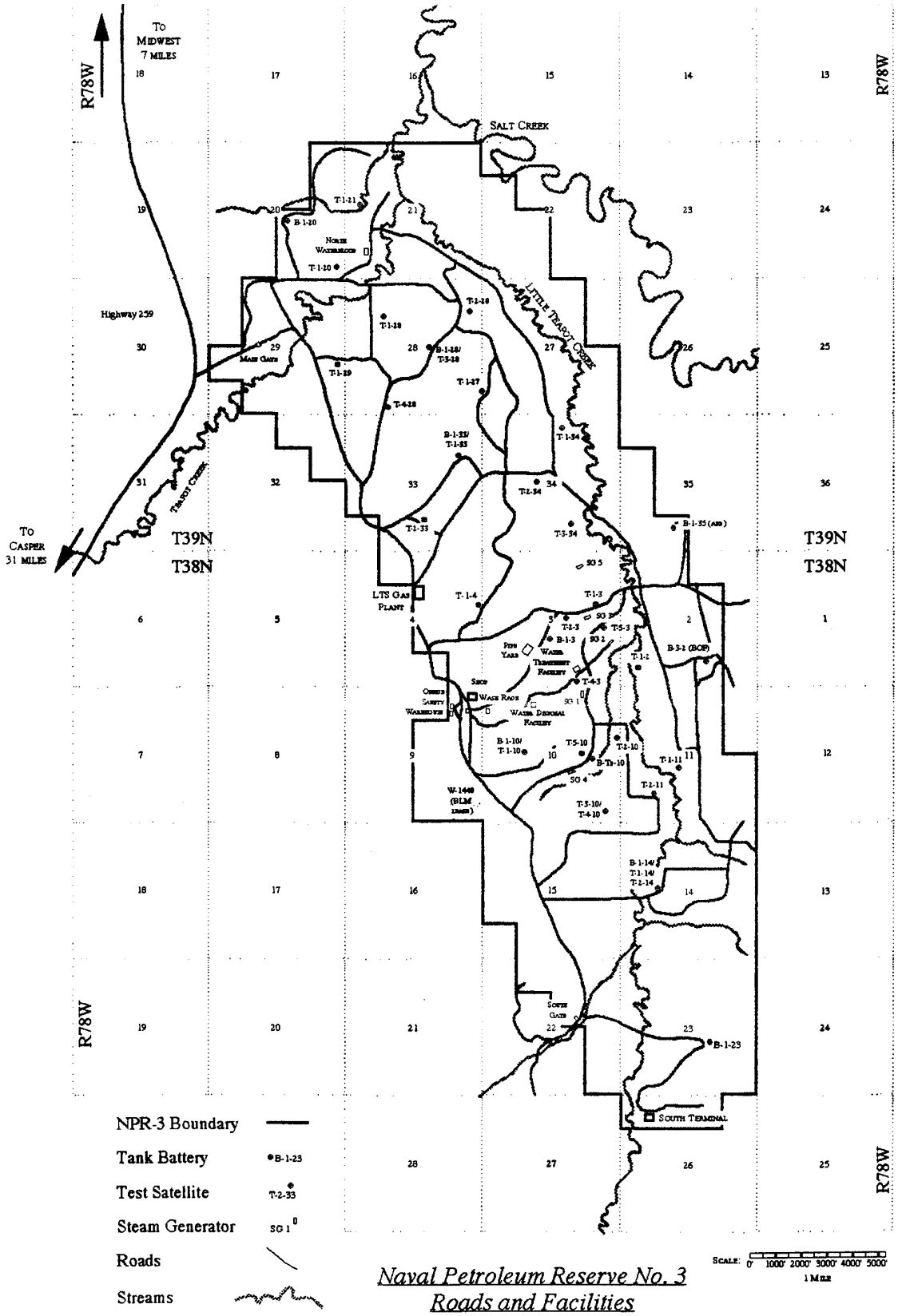
INTRODUCTION

This article describes some recent work performed at the Naval Petroleum Reserve No. 3 (NPR-3), comprising the federally owned Teapot Dome oilfield and located 35 miles north of Casper, Wyoming by the Rocky Mountain Oilfield Testing Center (RMOTC) and an industry partner, Noverflo, Inc., of Rockville, Maryland. RMOTC is operated by Fluor Daniel, the management and operating contractor for the Department of Energy's Naval Petroleum Oil Shale Reserves in Colorado, Utah, and Wyoming.

NPR-3 lies along the southeastern portion of the larger Salt Creek anticlinal structure. The field was originally developed in the early part of the century and became well known through the Teapot Dome scandal of the 1920's. After the oil crisis of the 1970s, the field was developed on a large scale basis. During the late 1970s and early 1980s, hundreds of new producing and injection wells were drilled for primary and secondary recovery. In addition, a large scale, light oil steamdrive was developed in the shallow, heterogeneous Shannon formation in the late 1980's to supplement the projected low recovery (-5 % of OOIP).

More recently, the Department of Energy has authorized the oilfield to be used as a testing center for inventors and commercial companies. Access to an active oilfield with complete production, injection and EOR facilities is now possible in accordance with DOE's, "Domestic Natural Gas and Oil Initiative", which allows, "new applications that lead to increased production, lower operating costs, and improved environmental compliance costs to be tested at Naval Petroleum Reserve No. 3,…"

The test of the leak detection system developed by Noverflo is an example of the type of support that RMOTC offers to the individual inventors and commercial businesses. RMOTC has performed four independent, third party tests of, the system utilizing water, water and sand, diesel, and diesel and sand.



Naval Petroleum Reserve No. 3
Roads and Facilities

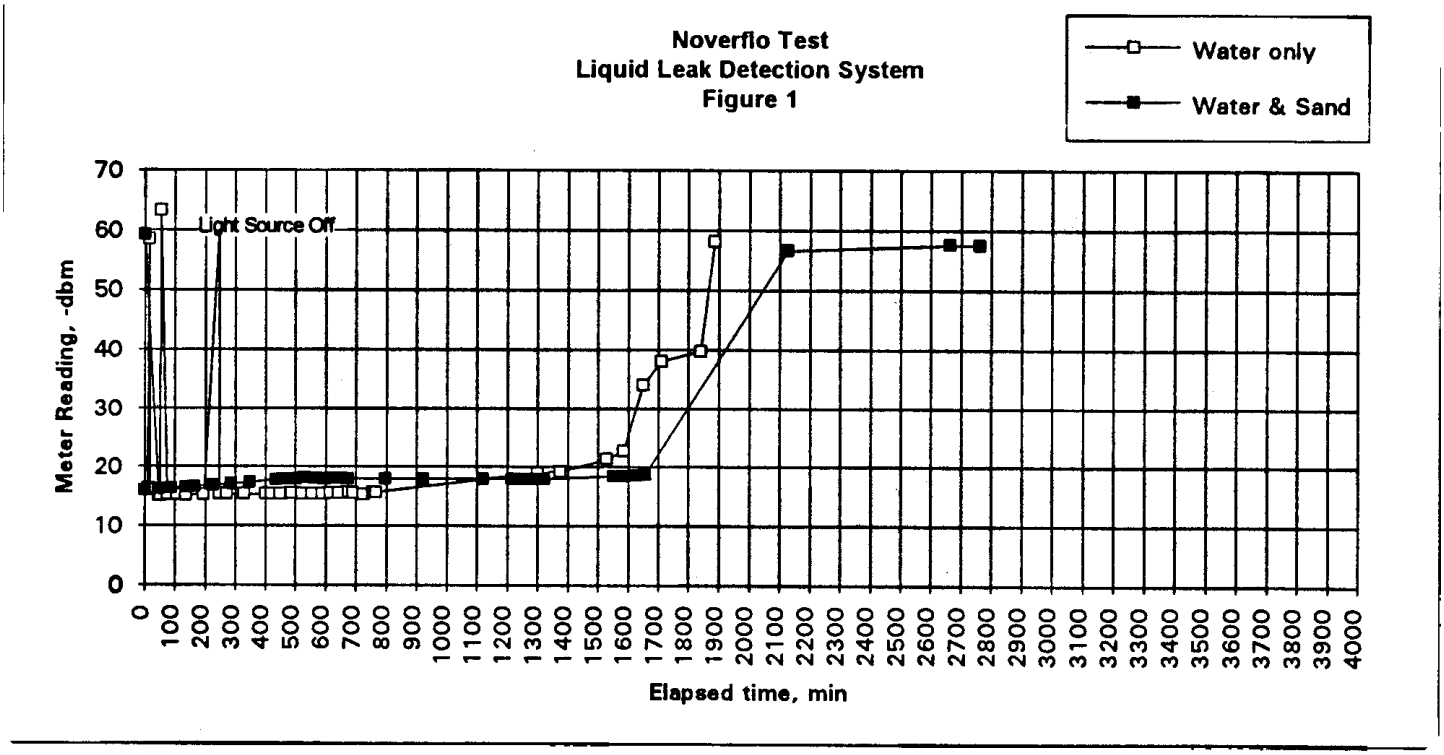
Attachment 3

Rocky Mountain Oilfield Testing Center
Technical Report
Noverflo Liquid Leak Detection System (Smart Cable)

DESCRIPTION OF OPERATIONS

1st Test The first test of the leak detection system began on December 7, 1995. The fiber optic cable was placed in a 4 inch PVC tube which was then filled with water at 60OF (15.5°C) to simulate a possible leak for the fiber optic cable system. During the test, a light source was attached to one end of the cable system, and a light power meter was attached to the other end. Power readings, in decibels above 1 milliwatt (dbm), were taken during the length of the test to determine the detection characteristics of the system. An decrease of 10 dbm was considered to be the threshold level for a positive confirmation of liquid detection. Initial readings were negative and became more negative during all the tests.

For the first test, initial readings of the cable system were -15.3 dbm +/-0.3 dbm. See Figure 1. The readings were almost constant for the first 800 minutes (13.3 hrs). After this, the power readings slowly decreased reaching the threshold change of 10 dbm after 1600 minutes (26.7 hours) with a sharp change. The power readings continued to drop quickly to -58 dbm at 1900 minutes (32 hrs) when the test was terminated. The final reading was close to the power readings present when the light source was switched off indicating an almost complete elimination of light passing through the cable system.



2nd Test The second test of the leak detection system began on December 20, 1995. The fiber optic cable was embedded in sand inside the 4 inch PVC tube. The PVC tube, similar to the first test, was then filled with water at 60°F (15.5°C) saturating the sand pack. During the test, a light source was attached to one end of the cable system, and a light power meter was attached to the other end. Initial power readings were slightly lower than the first test, -16.5 dbm +/-0.3 dbm. The readings decreased to -18 dbm and remained fairly flat until a sharp

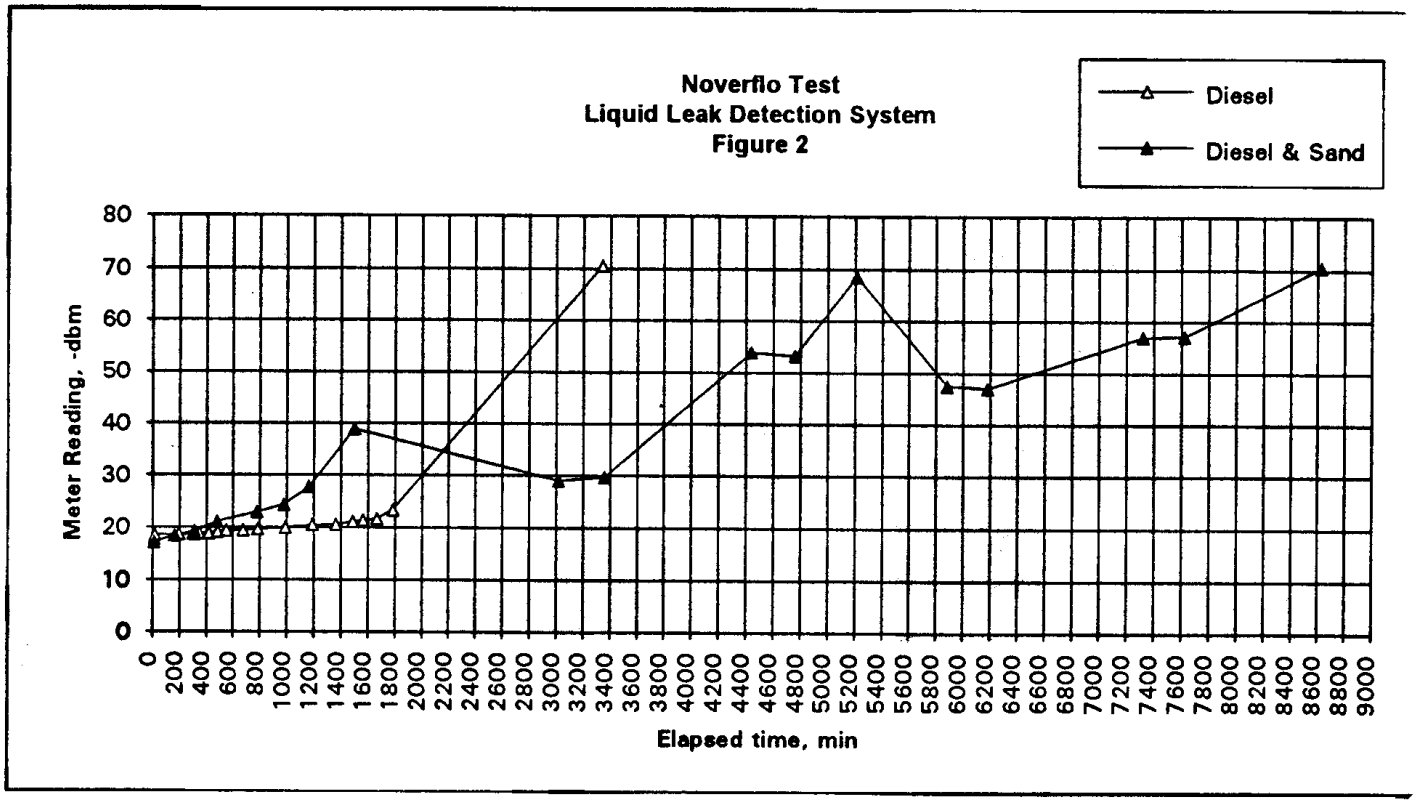
drop is interpolated between two data points. See Figure 1.

The elapsed time between the two data points was approximately seven hours and was due to night operation. The threshold change of 10 dbm, interpolated between the data points, is 1750 minutes (29.2 hrs) or 2.5 hrs longer than the first test. The longer response time may be an effect of the fiber optic cable system being embedded in the sand or may be due to a variation in the cable sensors.

The remaining data points - (-58 dbm) indicated no further significant change, and the test was terminated at 2775 minutes (46 hrs).

3rd Test

The third test of the leak detection system began on January 9, 1996. The fiber optic cable was placed in a 4 inch PVC tube which was then filled with diesel to simulate a possible leak for the fiber optic cable system. The test was conducted at one of the oil treating facilities. During the test, a light source was attached to one end of the cable system, and a light power meter was attached to the other end. Initial power readings, -17.8 dbm were slightly lower than the first two tests. See Figure 2. The readings decreased slowly to -23 dbm (1800 minutes or 30 hrs) when the meter malfunctioned. The next data point at 3350 minutes (56 hrs) was in excess of -70 dbm, and the test was terminated at this point.



The elapsed time between the data points was 26 hours and was due to the malfunctioning meter. The threshold change of 10 dbm, interpolated between the data points, is 1975 minutes (32.9 hrs) or 3.7 hrs longer than the second test. The exact threshold time is somewhat questionable due to the meter operation; however, the last

data point prior to the meter malfunction indicated a rapid change in the power readings which would support the estimated threshold time.

4th Test

The fourth test of the leak detection system began on January 16, 1996. The fiber optic cable was embedded in sand inside the 4 inch PVC tube. which was then filled with diesel to simulate a possible leak for the fiber optic cable system. The test was conducted at one of the oil treating facilities. The initial power reading, -17.2 dbm was very close to the previous diesel only test. See Figure 2. The meter readings dropped more rapidly than the first diesel test reaching the threshold level of 10 dbm change at 1200 minutes (20 hrs). One additional data point (-38.8 dbm) was taken before severe winter weather hampered data collection for over 24 hours.

The next two data points increased to -29 dbm at 3000+ minutes (50+ hrs) but were still above the threshold change of 10 dbm. Additional data points taken over the next several days indicated a continued decrease in power readings to -50 to -70 dbm with some unexplained daily fluctuations. The readings did not appear to be related directly to the ambient air temperature which was often near 0° F (-18°C) for parts of the test.

Concluding Remarks

RMOTC has completed the testing of Noverflo's leak detection system. The cable system responded with significant changes in power readings (-dbm) typically between 1600 minutes (26.7 hrs) and 2000 minutes (33.3 hrs) had elapsed. The final readings were similar to the readings present when the light source had been turned off suggesting almost complete elimination of the light passing through the fiber optic cable and sensors. The final test, conducted outdoors, had some long term variations in readings not fully explained.

The performance of the leak detection system under different field conditions may be different from RMOTC's observed performance.

RMOTC offers the opportunity for field testing of petroleum and environmental processes in an active oilfield with workover and drilling rigs, hundreds of producing and injection wells, and technical expertise onsite. A third party field test of Noverflo's leak detection cable system has been completed. RMOTC is continuing the testing of other devices, including two additional Noverflo devices, and drilling techniques to aid the domestic oil and gas industry.

Acknowledgments

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The goal of RMOTC is to partner with the petroleum industry to improve productivity through field testing of new technology, evaluate new equipment and techniques, disseminate information to the industry, and conduct training for universities, native Americans, and private industry. To receive an information packet, or discuss a testing project or new proposal, please contact RMOTC at, 907 Poplar, Suite 100, Casper, Wyoming 82601, phone (307)-261-5000, ext. 5060.