RELATIVE EVALUATION OF STORAGE CAVERN VOLUME MEASUREMENTS

Darrell E. Munson* and Robert E. Myers**
*Sandia National Laboratories, Albuquerque, NM 87185#
**Department of Energy/Strategic Petroleum Reserve, New Orleans, LA 70123

ABSTRACT

Over the course of the construction and operation of the Strategic Petroleum Reserve (SPR) crude oil storage caverns, three types of measurements of the cavern volumes have been maintained: calculated solution volumes based on dissolution of salt by raw water, calculated sonar volumes based on the sonar surveys of the cavern dimensions, and cavern volumes occupied by metered oil inventories. Because these are frequently made almost concurrently, the measures are of the same, but unknown, cavern volume and it is possible to make a comparative evaluation of the volumes. In this way it may be possible to understand and determine the uncertainties involved in these measures. A very simple theory shows that any measure can contain a bias produced by a systematic error and a scatter produced by a random error. By equating volumes determined by different measurement types it is possible to distinguish biases from random scatter. As a result, a comparative evaluation of solution volumes against sonar volumes suggests that a bias of a few percent exists, and this bias seems to depend upon the specific survey company. Because the bias can be removed from the raw results, the remaining random uncertainty data can be analyzed statistically. The random scatter, which is a sum of the scatter of the sonic survey and the solutioning process is very nearly a normal distribution and has a standard deviation of 5.78%, which appears to be reasonable. This statistical uncertainty suggests a +/-2% uncertainty in the sonar measurements and a +/3% uncertainty in the solutioning data. These two values are less than the +/-5% that is customarily associated with these two measures by the survey companies and construction contractors. Evaluation of the equivalent sonar volumes when compared to the oil inventories also show bias and scatter. When analyzed statistically, the random uncertainty in the equivalent sonar volumes compared to the oil inventory also gives essentially a normal distribution with a standard deviation of 1.69%. These results suggest that the deduced +/2% scatter in the sonar survey dominates the uncertainty, with the very small oil inventory uncertainty governed by the highly accurate oil custody transfer meter.

INTRODUCTION

In addition to addressing cavern stability safety issues, salt cavern storage operations normally require some measure of the cavern volume, be it for inventory, operation, or regulatory purposes. In fact, some volume measures, to different degrees, are probably maintained in all storage caverns in salt. Certainly, this is the case for the Strategic Petroleum Reserve (SPR) caverns storing crude oil in facilities located in the Gulf Coast salt domes. In these caverns, historically

#Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the U.S. Department of Energy under Contract DE=AC04-94AL85000