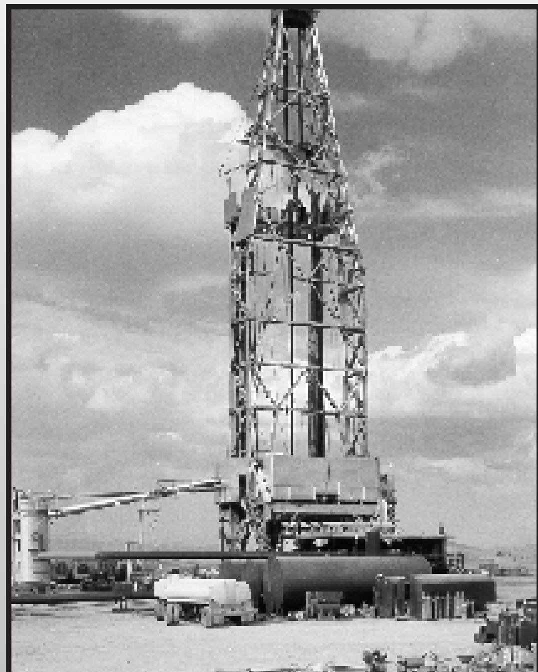
Nevada National Security Site History

Big Hole Drilling

Introduction

On July 26, 1957, a safety experiment called Pascal-A was detonated in an underground hole at the Nevada Test Site (NTS), now known as the Nevada National Security Site (NNSS). The test, although successful, brought the issue of drilling to the forefront.



An Emsco 1500 heavy duty drilling rig is drilling an 64-inch 3,850 foot emplacement hole for the Jorum test which was detonated on September 16, 1969.

The need to drill large-diameter holes at the NTS resulted from the Limited Test Ban Treaty (LTBT), signed by President John F. Kennedy in Moscow on August 5, 1963. The LTBT prohibited testing nuclear weapons in the atmosphere, underwater, and in outer space. As a result, scientists from what was then the U.S. Atomic Energy Commission weapons laboratories had to relocate all test packages underground, which required the creation of deep emplacement holes in a multitude of depths and diameters.

At first, larger diameter holes were drilled with conventional "oil industry" drilling techniques. This method was not very efficient for drilling such large holes in the dry, packed soil and volcanic formations at the NTS. Necessity was the mother of invention. There was a need to construct these large diameter holes faster and more efficiently, thus, NTS contractors worked with the drilling industry to design new equipment and employ different techniques for drilling large diameter holes.

To accomplish this, scientists developed innovative drilling techniques to overcome the problems of a slow penetration rate, porous terrain, the need for straight line-of-sight holes, and the need to have a hole wide enough to accommodate the test package.

Big Hole Drilling Perfected at the NTS

When drilling began at the NTS in 1959, the biggest problem was the length of time it took to drill into the desert floor. A 36-inch diameter hole at a depth of 1,000 feet could take up to 60 days. The initial method utilized successive pass drilling, where one hole was drilled using several bits, each larger than the previous one. This time-consuming process was reduced somewhat when all three bits were mounted together in a tri-stage simultaneous drilling setup. Even with this innovation, the drillers worked 30 days to complete a hole.

Successive modifications stacked the bits closer together. Eventually the tri-stage gave way to the flat bottom bit, with 12 to 24 cutters chewing up the rock as the entire unit rotated. To expedite the process, drillers increased the weight of the bit. The weight of this assembly was about 300,000 pounds. This meant the workers could drill a 1,000-foot hole in 20 days.

Every 100 hours the drill string was completely removed from the hole to enable routine maintenance and to replace the drill bit with a rebuilt bit or a new one, sometimes a difficult task. For instance, to change a bit at a

The EMSCO 3000, one of the largest drill rigs used at the NNSS.

depth of 2,000 feet meant removing at least 45 joints of drill pipe, an operation that could take approximately seven hours to complete before drilling could commence once again -- no mean task, especially in a hostile environment of cold winds, temperatures hovering near zero, and the occasional added discomfort of snow or icy slivers of sleet penetrating the drillers' exposed skin.

For every foot drilled with a 96-inch bit, more than 50 cubic feet of cuttings had to be removed from the hole. Transporting the rubble from the working level to the surface, while the porous ground was absorbing the moisture injected to carry those materials, posed a problem. It was solved by using a dual string-airlift reverse circulation system.

In simple terms, dual string-airlift reverse circulation required a 13-3/8 inch pipe into which a smaller 7-inch pipe had been inserted. Water was then pumped down between the inner and outer pipes, which was then circulated over the cutters to collect the ground-up rubble to be sucked to the surface through the 7-inch pipe using airlift pumping.

A line-of-sight drill hole was essential in preventing the diagnostic package with the test experiments from binding or catching on the sides of the hole. A drilling assembly weight of 250,000 pounds was suspended by the drill pipe to keep the hole straight and plumb.

Conclusion

A variety of holes were drilled on the NTS, ranging from six feet to 12 feet in diameter, and up to thousands of feet in depth. A large hole required the removal of more than 4,280 cubic yards of soil. If the depths of all the 36-inch diameter holes drilled for underground nuclear tests since 1961 were combined, they would total about 280 miles.

Big hole drilling came a long way from its modest beginnings at the NTS in 1959. It was essential to the nation's underground testing program, which ended with the last test, Divider, on September 23, 1992. However, one thing was evident - if it had not been for the highly trained drillers it is questionable whether underground testing would have been possible. Although no drilling currently takes place at the NNSS, the drilling techniques that were developed there continue to be used throughout the world.

For more information, contact:
U.S. Department of Energy
National Nuclear Security Administration
Nevada Field Office
Office of Public Affairs
P.O. Box 98518
Las Vegas, NV 89193-8518
phone: 702-295-3521
fax: 702-295-0154
email: nevada@nnsa.doe.gov
http://www.nv.energy.gov

National Nuclear Security Administration

DOE/NV - - 773
August 2013