MINING:
THE BEGINNING - THE COMPLETION
OF THE NUCLEAR CYCLE

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Mining is one of the world's oldest industries with a rich history that has evolved into modern times. A new chapter in that history is currently being written in Southeastern New Mexico at the Waste Isolation Pilot Plant (WIPP).

It might seem odd to think that the age old institution of mining would be linked as it is to the problem of nuclear waste disposal. In fact, the nuclear industry would not be in existence without mining. Uranium ore is mined either from underground or surface mines as the initial process in harnessing the magnificent resource of nuclear power and energy.

FIRST REACTOR

¹The dawning of the nuclear age began in 1789, when uranium was discovered in pitchblende ore from a mine in Germany. Radioactivity, however, was not discovered until 1896. Radium, a daughter of uranium decay, was discovered by the Curies and Bemont in 1898 from pitchblende ore that was taken from a Joachimov, Czechoslovakia mine.

In the early 1900's, radium became very important in medical therapy and this led to a search for uranium ore as a source for the radium. The first important sources of radium outside of Czechoslovakia were the uranium vanadium sandstone deposits found in Western Colorado and Eastern Utah.

In 1923, the United States deposits were supplanted as a source of radium by the large and rich chinkolovwe vein deposits in the Belgian Congo. In 1933, the production began from another vein deposit in the northwest territories of Canada. From that time on, the entire market was shared by Canada and the Belgian Congo with only a minor amount of the domestic uranium sandstone ore mined between the years of 1924 and 1935.

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¹United States Mineral Resources; Donald A. Brobet and Walden P. Pratt. Geological Survey Professional Paper 820, 1973.

MASTER

FIRST REACTOR

²On December 2, 1942, man first initiated a controlled self-sustaining nuclear chain reaction. ³This event launched the modern nuclear age and with the first atomic bomb test occurring on July 16, 1945, established the use of atomic power as a weapon. The first energy as electrical power was generated on December 20, 1951, from the Experimental Breeder Reactor 1 in Arco, Idaho.

FIRST ELECTRIC POWER BRR-1

Vast expansion of nuclear power for generating electricity, the space program, fuel for nuclear submarines, and many other areas is a matter of record. The WIPP may well be the final chapter in closing out the nuclear cycle by the disposal of nuclear waste 2150 feet in an underground repository.

WIPP AERIAL

The WIPP is a United States Department of Energy project located 30 miles southeast of Carlsbad, New Mexico, where the nation's first underground engineered nuclear repository is being constructed. The WIPP site was selected because of its location amidst a 2000 foot thick salt bed which provides a remarkably stable rock formation for the permanent storage of nuclear waste.

The underground facility is located 2150 feet below the earth's surface in the Salado formation which comprises two-hundred-million year old halides with minor amounts of clay and anhydrides.

WIPP PLAN

When completed, the WIPP underground facility will consist of two components: approximately 20 acres of experimental area and approximately 100 acres of repository. The repository area consists of eight storage panels with seven rooms each. Each room will have a nominal size of 13 feet high, 33 feet wide, and 300 feet long.

At the WIPP, traditional procedures for underground mining activities have been significantly altered in order to assure underground safety and project adherence to numerous regulatory requirements. Innovative techniques have been developed for the WIPP underground procedures, mining equipment, and operating environments. The mining emphasis is upon quality of the excavation, not, as in conventional mines, in the production of ore.

PANEL ROOM

In the early 1940s, the United States began generating radioactive waste through the nation's defense programs, as a by-product of the production of nuclear weapons and the operations of military nuclear reactors. The nuclear industry has grown since that time with the expansion of the United States Defense Programs and the introduction of nuclear power into the commercial world. Yet, for well over forty years the United States has generated nuclear waste without

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²The First Reactor; U.S. Department of Energy, December 1982.

³The History of Nuclear Energy; U.S. Department of Energy, August 1985.

any solution for its permanent and safe disposal. The solution for the defense program is being developed at the WIPP through a unique blending of conventional and innovative mining technologies.

Mining at the WIPP engineered repository is quite different from mining in conventional potash mines like those found in the Carlsbad area. The personnel and the basic equipment are virtually the same as those found in conventional mines. At the WIPP, however, traditional methods of mining are applied with a level of skill which results in a mining finish unlike any other underground facility today. For example, at an engineered repository like the WIPP, mining activities have extremely rigid and deliberate requirements. In a conventional mine, the production and cost factors are paramount, with a primary concern for minimizing the dilution of ore. At the WIPP, the "rock in the box" theory has been replaced with an emphasis on safety as our number ONE priority and a commitment to quality as our product.

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The WIPP has taken an industry that is steeped in the tradition of mining hard rock with brute force to yield the highest quantity and has married it to a concept that demands superior safety and a conservative approach to produce the highest quality. The process is refined and has produced cultural shock in the local attitude toward mining.

The result is that WIPP has achieved one million man-hours without a lost time accident four times. The last two-million man-hours have been contiguous and as of September 1, 1991, 2.3 million man-hours without a lost time accident was achieved and is ongoing as of this printing.

WIPP has won the Operator of the Year Award from the State of New Mexico four consecutive years for the best safety record in our class.

The WIPP Silver and Blue Mine Rescue Teams have, from the excellence of competitive performance against the other teams of the mining industry in the nation, developed a reputation of being the team to beat. During the National Competition in Las Vegas, Nevada in July 1990, the WIPP Silver Mine Rescue Team won 1st place in the nation and the WIPP Blue Mine Rescue Team won 6th place in the nation making these teams undoubtedly the two best teams in the nation that are in one operation.

WIPP's safety record is attributed to its people and their adoption of safety as their number one priority as a commitment, not just a slogan, and to its training program that constantly develops a culture of safety in the minds of the miners who work at WIPP.

The number of extensive mining procedures employed at the WIPP is vastly different than those in conventional mining. Procedures in conventional mining industries are generally written in the form of letters or memos from the mine superintendent and passed on either by word of mouth or by informal memos. They are very easy to follow and much is left for interpretation. In a nuclear facility, procedures emerge as very formal controlled documents with several levels of administrative and field verification reviews before implementation. Nothing is assumed in such procedures, nor are any points left open for interpretation. Similarly, training is extensive. Before operators can operate any mining machine or haulage truck, they must take formal training classes and pass written

and practical exams regardless of how many years experience they have in previous mines.

ROAD-HEADER

The maintenance program at the WIPP focuses primarily on preventive maintenance. This type of program extends the life of the equipment and causes less down time due to failures. An elaborate tracking system for each piece of equipment which provides information on the number of operating hours and determines the prescribed maintenance to be done on a scheduled basis is implemented throughout the entire project. Each package consists of step-by-step procedures for repairs or changes to equipment in order to ensure consistency in the program and data used to evaluate its integrity.

Decisions on any item, be it maintenance, safety, or operations, are not left to chance. If there is a shadow of a doubt concerning safety, such as the suitability of a piece of equipment or how to proceed with an assignment, no decisions can be made until all responsible parties meet and concur on the appropriate plan of action. This planning can include several hours of discussion with as many as four different departments. A decision making process such as this could shut down a production mine. But, at the WIPP, product is the quality of the opening not the production of ore. Because the production at the WIPP is an excavated opening, a conventional drum miner is outfitted with a laser guidance system to mine a tolerance in the mine openings unprecedented in the world today.

ROADHAUL MILLING MACHINE

The handling of nuclear waste in the underground requires that haulage roads have extremely tight tolerances to ensure the safe transportation of the waste along these roads. The Haul Road Milling Machine which is a first-of-its-kind used in the underground anywhere in the world is used to provide these extremely smooth surfaces. This machine is equipped with a cutting drum mounted at the rear of the machine. The drum is controlled by a rotating laser beam through two receivers mounted on the mast connected to the milling assembly. The cutter mills the road surface to a very smooth even grade and this enhances the safety of personnel, increases equipment efficiency, and reduces maintenance.

During the excavation process at the WIPP, several standard pieces of mining equipment were purchased and some were modified to meet specific requirements. When WIPP first began the excavation of the first storage panel, Panel 1, it became evident that the Road Header being used for excavation would not remove the amount of salt in the prescribed time to keep within schedule.

MARIETTA MINER

A Marietta 3612 Drum Miner was purchased to improve the excavation schedule. This machine is capable of mining two hundred tons per cutter head hour. At first it appeared that the drum miner would not be able to mine the quality of the opening necessary to meet the prescribed tolerances at the WIPP. However, by installing a laser system on the drum miner, the floor and back could be mined to a tolerance of less than two inches in twenty feet, well beyond the capability that the manufacturer believed possible and well within the tolerances necessary to meet the specifications at the WIPP.

The WIPP also possesses several other unique pieces of equipment and exercises other unique applications of traditional equipment. The Load Haul Dump (LHD) truck can haul up to 4 tons of excavated salt from the continuous miner to the Salt Handling Shaft where the salt is loaded and hauled to the surface. The LHD is also used as support equipment for the installation of electrical and compressed air utilities throughout the underground facility.

A storage or experimental room must be mined within these tolerances to support the accurate data gathering activities that are necessary to demonstrate the scientific theories involved with the project.

The experimental program at the Waste Isolation Pilot Plant (WIPP) began prior to the first opening underground. Sandia National Laboratories, the scientific advisor for WIPP, performed the first underground experiments in a local potash mine several years prior to the first available rooms underground at WIPP.

The experimental programs at WIPP consist of over 4,000 installed instruments which record 15,000 to 20,000 pieces of information every four hours. These instruments provide information on rock mechanics, brine migration, earth pressure, ground water pressure, convergence, rock bolt loading and temperature.

Over 100,000,000 pieces of data have been recorded to date making WIPP one of the most studied and best characterized underground openings in the world.

This intense data gathering is necessary because WIPP is a first-of-a-kind, State-of-the-Art underground repository for nuclear waste. The mission of WIPP has the attention of the entire world mandating that it be done with excellency and the highest quality.

The mining industry may well be the recipients of very valuable technology advancements as a result of all the study. Deliberate roof falls in highly instrumented experimental rooms provides needed data which gives accurate predications of roof destabilization and failure. The potential benefit of this type of technology transfer to the mining industry is obvious.

There are many more differences and technological advances being made in the mining activities at the WIPP, but the main differences between conventional mining techniques and those in the nuclear world lie in the drastic changes that are occurring in terms of the mining culture that is established at the WIPP.

WIPP BACKGROUND

The WIPP is well on the road to achieving a metamorphosis as more machines are modified, attitudes changed, and tighter tolerances are set. Modifying a machine is fairly simple. Changing age-old attitudes in the mining industry is, however, a more difficult journey. Asking the miners to change their basic philosophies and strongly held beliefs about the way to do things is a long and ongoing transition. At the WIPP, we have come to learn that what you take out is much less important than what is left behind; the excavation. Commitments to safety and quality are prerequisites for establishing one of the finest underground repositories in the world.

It is ironic and altogether fitting that the industry that launched the nuclear age be the industry that completes that nuclear cycle by providing a final

resting place for the waste generated from an energy source that has benefitted mankind.

LIST OF REFERENCES

United States Mineral Resources; Donald A. Brobet and Walden P. Pratt. Geological Survey Professional Paper 820, 1973.

The First Reactor; U.S. Department of Energy, December 1982.

The History of Nuclear Energy; U.S. Department of Energy, August 1985.

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