D 1018

United States Department of the Interior
BUREAU OF MINES
WESTERN FIELD OPERATIONS CENTER
EAST 360 3RD AVENUE
SPOKANE, WASHINGTON 99202

November 24, 1987

Memorandum

To: Charlotte Abrams, Project Officer, Geotechnical Branch, Division of Waste Management, U.S. Nuclear Regulatory Commission, Washington, DC

From: Chief, Branch of Engineering and Economic Analysis

Subject: Letter report pertaining to the AIME Columbia Section Meeting November 17, 1987, Spokane, Washington (Interagency Agreement NRC-02-85-004)

FIN D1018

In response to your request, Russell G. Raney of the Bureau's Western Field Operations Center attended the subject meeting. Enclosed are six copies of Mr. Raney's letter report.

Gary B. Branch [signature]
for Robert D. Weldin

Enclosure

attachment in pocket #2

W Ltr Ltd 11/24/87
To: Charlotte Abrams
Fm: Robert D. Wellin

D 1018

LETTER REPORT

SUBJECT: AIME Columbia Section and Northwest Mining Association monthly meeting, November 17, 1987

BY: Russell G. Raney, Physical Scientist
Western Field Operations Center
Bureau of Mines
Spokane, Washington

Mr. R.W. Leanna and Mr. Alan D. Krug, both of Westinghouse Hanford, were featured speakers at the November, 1987 combined meeting of the Columbia Section of the AIME and the Northwest Mining Association. Mr. Leanna, who is Westinghouse's Manager of Maintenance Training, addressed safety issues pertaining to the operation of the plutonium-producing N Reactor and Mr. Krug, Staff Engineer for Repository Design and Development, discussed DOE's Basalt Waste Isolation Program on the Hanford Reservation. Synopses of the presentations are included.

The synopses were prepared from the speakers' presentations and handout material.

Preface
by
Russell G. Raney

The N reactor, on the Hanford Nuclear Reservation, has been the center of controversy in the Pacific northwest for a number of years. The controversy has intensified recently as the result of the Chernobyl reactor accident and discovery of anomalously high uranium and traces of radioactive iodine in domestic water wells. Further, the Department of Energy has recently released over 10,000 pages of material in which it was admitted that on a number of occasions over the past 40 years, radioactive material has been released to the atmosphere and the Columbia River. Battle lines have been drawn between those who feel that N reactor presents a real and present threat to the health and welfare of people living in the vicinity or down-wind of the reactor, and those who feel the reactor presents no such danger. The latter faction is composed largely of those whose livlihood is directly or indirectly tied to the continued operation of the reactor.

Westinghouse Hanford has recently mounted a public relations campaign in an effort to answer some of the criticisms regarding operation of N reactor and to address public concern pertaining to the possible siting of a nuclear waste repository on the Hanford reservation; Mssrs. Leanna and Krug are a part of that effort.

You Be The Judge of the N Reactor

R. W. Leanna

BACKGROUND

On December 2, 1942, a team of scientists led by Enrico Fermi conducted the first controlled nuclear chain reaction. In the ensuing months, the race to develop nuclear weapons during World War II changed the land in and around Hanford from a quiet desert to a storm of engineering activity.

Hanford was selected as the site for the top secret Manhattan Project in January 1943 as it was remote yet near railroads, had an abundance of water available for reactor cooling, and plentiful electricity from regional hydroelectric plants. Hanford's mission was to produce plutonium for a new weapon that could bring about a swift conclusion of World War II.

Beginning in January 1943 the small farming communities of Hanford and White Bluff were transformed into a construction camp of more than 51,000 scientists, engineers, and workers. The world's first three plutonium-production reactors soon took shape along the Columbia River about 35 miles from Richland.

Two years and three months from the start of construction, plutonium produced at Hanford provided the explosive charge for the world's first nuclear detonation. The test detonation at Alamogordo, New Mexico, was shortly followed by by the use of nuclear weapons on the Japanese cities of Hiroshima and Nagasaki.

By 1964, nine plutonium production reactors, including N reactor which was constructed between 1958 and 1963, were in operation at Hanford. The complex also housed facilities for the entire nuclear cycle, including fuel fabrication, chemical processing, waste management, and research.

Operational diversification at Hanford began in 1965. Between 1964 and 1971, eight of the nine reactors were decomissioned. Hanford gradually changed from a top secret military facility and began to place emphasis on peaceful uses of nuclear power. In 1967, Hanford was selected as the site for the Fast Flux Test Facility advanced reactor.

The last of the single purpose reactors was decomissioned in 1971 leaving only N reactor with its dual purpose of plutonium and electricity production.

By 1975, energy research had become the major thrust at Hanford in which energy sources such as nuclear, geothermal, solar, fossil, wind, and organic waste were investigated.

Hanford's role changed again in 1980 to re-emphasize defense production. Currently about 60 percent of site funding is expended for national defense and 40 percent for energy research and related programs.

N REACTOR

On April 26, 1986, a devastating accident occurred at Chernobyl, in the Soviet Union, that cast a cloud of radioactive material into the atmosphere over northern Europe. The accident also cast a cloud of suspicion over operations of N reactor at Hanford. This cloud of suspicion and doubt acted to diminish public confidence in N reactor operations and impeded production of materials needed for national defense.

N reactor is a light-water cooled reactor that began operations in December 1963. At the time, N reactor was the largest reactor in the world. It is classified as a dual-purpose reactor in that it produces electricity for use within the State and plutonium for nuclear weapons. In times of drought, N reactor has been pressed into service to augment hydroelectric plant production. To date, the reactor has produced over 65 million kilowatts of electricity.

While some limited similarities exist between N reactor and the Chernobyl plant (e. g., both use graphite as a moderator), there are vast differences in design and operation. The major differences are summarized below:

1. The Chernobyl reactor has a slow scram time (emergency shut-down time) that requires as much as 20 seconds for the insertion of control rods. Scram time for N reactor is 1.5 seconds.

2. The Chernobyl reactor is a boiling water reactor that produces steam within its core. Due to a (designed) positive void coefficient, power output increases upon loss of coolant. This, in turn, increases the boiling rate and results in further loss of coolant; power "automatically" increases in an upward spiral. This is essentially what occurred in 1986. Chernobyl's power output went from about 200 megawatts thermal to about 350,000 megawatts thermal in a matter of 6-10 seconds; a power rate 111 times the reactor's design capacity. N reactor, on the other hand, decreases power levels and starts to cool down immediately on loss of coolant, a design feature known as "negative void coefficient". Further, N reactor's core is pressurized; the coolant does not boil.

3. The Soviet reactor is very unstable at low power levels; N reactor is stable at all power levels as it is equipped with a number of control systems to maintain stability.

REACTOR CONTROL

N reactor is equipped with 1,003 process tubes each containing 16 fuel elements for a total of 16,048 elements. The control system consists of 84 boron control rods that are inserted horizontally using hydraulic power. The Soviet reactor uses a system in which control rods are inserted vertically from the top using gravity. This accounts for the large time difference in scram time; 1.5 seconds for N reactor and 20 seconds for the Russian reactor.

A backup control system in N reactor consists of 107 hoppers containing a number of boron balls mounted above access channels on top of the core. In the event a control rod fails to complete its insertion within the allotted 1.5 seconds, the balls are automatically released into the core effecting an immediate cecession of the fission process.

Since the Chernobyl accident, N reactor has been the focus of investigations, inquiries, reviews, and technical studies by more than 50 agencies and institutions. These include the State of Oregon, the General Accounting Office, the Roddis Commission of six independent consultants, the National Academy of Science, Energy Department internal reviews, and others. A majority of the reviewers concluded that N reactor was operationally safe; all reviewers stated that an accident such as that at Chernobyl cannot happen at N reactor.

The recently released report of the National Academy of Science pertaining to N reactor was positive; it did not point out any reasons why the reactor should be considered unsafe. Several points pertaining to "enhanced safety procedures" were, however, recommended. One was the need for a DOE safety committee to review operational and safety procedures; this is currently being emplaced.

One hundred fifty seven of the 228 recommendations of the many reviews and studies have been implemented at N reactor. A number of these were incorporated into an enhanced safety program. "Enhanced" safety does not mean that the reactor or operating procedures in the past have been less than safe. The speaker likened the program to the installation of a fire alarm system in a newly-built house; the house is inherently safe (provided it met all building and safety codes) but the alarm system acts to enhance that safety.

The reactor has been shut down since January to effect changes and recommendations promulgated by the various reviewing agencies; start-up is slated for March, 1988. An Environmental Impact Statement pertaining to safety and the scheduled start-up is in the process of preparation and will be released <u>in about a year, minimum</u> (emphasis added).

A number of features and facilities have been installed or are in the process of implementation or construction. These include:

o A liquid effluent retention facility to contain reactor fluids in the event it is necessary to use the emergency core cooling system. The retention facility consists primarily of a large excavation that is lined and covered to prevent percolation of contaminated water into the subsurface and to prevent escape of radionuclides into the atmosphere.

o A hydrogen monitoring system has been installed in the reactor and containment structures.

o A hydrogen mitigation system is being installed. This acts in conjunction with the monitoring system to inject non-reactive nitrogen into the containment to dilute any build-up of potentially explosive hydrogen.

o Integrity tests of the confinement system. N reactor has a confinement system designed to confine to the immediate area any contaminants that may be released from the reactor in the event of an accident. The Chernobyl reactor, however, used a containment system around various components of the reactor. The system was designed to limit the spread of contaminants to those areas so protected. The reactor itself was not a part of the containment system, it was surrounded by a steel shell that failed during the course of the accident and allowed the escape of radioactive material.

o A supplementary emergency core cooling system has been added and a procedure emplaced to inspect the emergency cooling dump tanks.

N REACTOR ECONOMICS

Were N reactor shut down today, over 3,000 jobs would be lost; another 3,000 jobs, mostly those within the reservation that support N reactor activities, would be lost 90 days hence. A ripple effect throughout Washington state would account for another 16,000 lost jobs; these include suppliers, subcontractors and so forth. An estimated tax revenue loss of $47 million would be expected.

Personal Observations

The author did not address documented releases of radionuclides to the atmosphere nor did he address the current flap pertaining to the presence of radioactive iodine in local groundwater. The presentation may have acted to instill confidence in the audience that N reactor would not go berserk as did Chernobyl but did nothing to allay fears of the long-term effects of radionuclides released by the facility. Throughout the presentation, the author underscored the dire economic results of a permanent shut-down of the reactor. He seemed to pose the question, "Would you rather take your chances on our ability to run a tight ship or face the horror of unemployment, welfare, and greatly increased taxes?"

Basalt Waste Isolation Program
by
Alan D. Krug

The Basalt Waste Isolation Program (BWIP) is operated for the Department of Energy (DOE) by Westinghouse Hanford. Design activities for the project have been conducted by a consortium of several engineering firms.

The project itself is rather large with an operating budget of over $100 million and a staff of more than 800 people. The largest staff component is in the geotechnical disciplines of geology, geophysics, geochemistry, hydrology, and mining engineering. This is probably the largest collection of geotechnical people in the northwest.

The prime concern of BWIP is the final disposal of nuclear waste. This problem, essentially, began in Chicago in 1942 with the first reactor beneath the University of Chicago football stadium. Since that time, the problem of waste disposal has been with us; it hasn't been resolved.

Currently, more than 100 nuclear reactors are producing waste. By the turn of the century, more than 50,000 metric tons of waste will require disposal. This is a problem, waste currently being generated and that generated in the past must be stored at the reactor site. At most reactor sites, waste is stored in water. Further, most sites have limited storage capacity. As time goes by, the need for a permanent disposal site becomes more critical. The ultimate concern is to develop a safe system for disposal of the waste.

The system now under consideration is one of disposal in a deep geological repository wherein wastes are constrained from reaching the biosphere for a period of 10,000 years. This 10,000 year timespan was selected as it is approximately the amount time required for the spent fuel to reach the radiation level of the original uranium ore (not concentrated uranium oxides) used as fuel. A real problem is to find a certifiable location that would safely confine the waste for the 10,000 year period.

In the 1970's, there were a number of activities underway within the government to select a disposal system. Proposed disposal systems included firing the waste into deep space or into the sun via rocket, dropping it into the deep oceans, and a variety of other systems. For many reasons, these systems were discarded and it was decided to opt for deep burial within a geologic repository.

The search for a geologic burial site began in earnest during the Carter Administration in which several rock types across the Nation were studied for their suitability as a repository. Crystalline and shaley rocks along the east coast from Georgia to New Hampshire and in the Great Lakes area, salt deposits along the Gulf Coast and in the Texas Panhandle and Utah, volcanic tuff deposits in Nevada, and basalt accumulations in Central Washington were studied. Sties selected for possible characterization were narrowed down to those in Deaf Smith County, Texas (salt), Yucca Mountain, Nye County, Nevada (welded tuff), and the nuclear reservation at Hanford (basalt).

The program at Hanford began in 1976. Between that year and 1982, a number of surface and subsurface facilities were installed. In 1982, the program was formalized with the passage of the Nuclear Waste Policy Act. This Act is currently the guiding force behind the disposal program. One of the important aspects of the Act was to place the economic burden of waste storage in the hands of the utilities producing the waste. This precludes the necessity of a general tax increase to support the program

BWIP has two specific objectives: 1) to determine the feasibility of the site for a repository, and 2) to develop the needed engineering technology to be employed should the site be selected.

Of particular interest to BWIP (regarding feasibility) is the Pasco Basin, site of the thickest accumulation of Columbia River Basalt (CRB). Boreholes more than 10,000 (sic) feet deep have been drilled in the Pasco Basin without penetrating the basalt; from most indications, the basalt may persist to 15,000 feet. The proposed repository horizon would be at a depth of about 3,000-3,2000 feet beneath the surface in the Cohassett flow.

The hydrologic aspects of the basalt site are of great interest to BWIP workers. One of their interests and priorities is to accurately determine the age of the water beneath the site. This would aid in selecting a specific area in which the waste will remain in place or, if transported by ground water, take at least 10,000 years for the radionuclides to reach the biosphere. Much of the preliminary information gathered so far indicates a ground water age of about 100,000 years. This indicates that it takes a long time to recharge the area.

Another hydrologic interest concerns ground water chemistry. The chemistry of the ground water must be determined in order to anticipate what reactions may occur between the water, waste, and other engineering components of the repository.

Movement of the ground water beneath the site is also of interest to BWIP personnel. A series of hydrologic test wells have been drilled to moderate depths to determine the direction and rate of ground water flow.

In 1978, a near-surface test facility was constructed at a depth of about 150 feet within the Pomona flow that outcrops on Gable Mountain. The purpose of the facility was to allow geophysical, geochemical, engineering, and other tests to be conducted in basalt. Although conditions in the facility do not reflect those at repository depths, it does provide an opportunity to conduct certain tests that do not require such conditions. Most of the activities at the near-surface test facility have been oriented toward developing the technology, equipment, and procedures needed for deep testing and site characterization.

Presently, BWIP is preparing a site characterization program to identify the types of information they need to collect in order to determine whether the site is feasible for a repository. A site characterization plan, that includes, among other things, the methods that will be employed to collect the needed information, is being prepared. The document will be released to certain reviewing agencies in early 1988 and to the public about a year later.

Post-Presentation Questions

Question: In your estimation, what are the probabilities of hydrocarbon resources existing beneath the Hanford reservation?

Answer: Some natural gas was found in the Rattlesnake Hills in the 1930's but this seems to be an isolated pocket. The reservation is situated above a syncline and most oil or gas that may have been generated probably migrated up dip toward the margins of the basin. That is why the current exploration effort (Shell, AMOCO, Tyrex, etc.) is concentrated there.

Question: If hydrocarbons that may have been generated in sub-basalt sediments have migrated up dip from the central portion of the basin, why would the major oil companies want to conduct exploration programs on the reservation? Why have 145 applications to the DOE to conduct such activities been denied?

The speaker declined to address the questions.

Personal Note

I am not aware of any borehole on the reservation that comes anywhere near the 10,000 foot depth cited by the speaker. In a recent hydrocarbon resource workshop in Richland, WA, Mr. Curtis Canard, a certified petroleum geologist representing the Council of Energy Resource Tribes, stated that DC-1, at about 5,600 feet, was the deepest borehole on the nuclear reservation.

LETTER REPORT

SUBJECT: AIME Columbia Section and Northwest Mining Association monthly meeting, November 17, 1987

BY: Russell G. Raney, Physical Scientist
Western Field Operations Center
Bureau of Mines
Spokane, Washington

Mr. R.W. Leanna and Mr. Alan D. Krug, both of Westinghouse Hanford, were featured speakers at the November, 1987 combined meeting of the Columbia Section of the AIME and the Northwest Mining Association. Mr. Leanna, who is Westinghouse's Manager of Maintenance Training, addressed safety issues pertaining to the operation of the plutonium-producing N Reactor and Mr. Krug, Staff Engineer for Repository Design and Development, discussed DOE's Basalt Waste Isolation Program on the Hanford Reservation. Synopses of the presentations are included.

The synopses were prepared from the speakers' presentations and handout material.

Preface
by
Russell G. Raney

The N reactor, on the Hanford Nuclear Reservation, has been the center of controversy in the Pacific northwest for a number of years. The controversy has intensified recently as the result of the Chernobyl reactor accident and discovery of anomalously high uranium and traces of radioactive iodine in domestic water wells. Further, the Department of Energy has recently released over 10,000 pages of material in which it was admitted that on a number of occasions over the past 40 years, radioactive material has been released to the atmosphere and the Columbia River. Battle lines have been drawn between those who feel that N reactor presents a real and present threat to the health and welfare of people living in the vicinity or down-wind of the reactor, and those who feel the reactor presents no such danger. The latter faction is composed largely of those whose livlihood is directly or indirectly tied to the continued operation of the reactor.

Westinghouse Hanford has recently mounted a public relations campaign in an effort to answer some of the criticisms regarding operation of N reactor and to address public concern pertaining to the possible siting of a nuclear waste repository on the Hanford reservation; Mssrs. Leanna and Krug are a part of that effort.

You Be The Judge of the N Reactor

R. W. Leanna

BACKGROUND

On December 2, 1942, a team of scientists led by Enrico Fermi conducted the first controlled nuclear chain reaction. In the ensuing months, the race to develop nuclear weapons during World War II changed the land in and around Hanford from a quiet desert to a storm of engineering activity.

Hanford was selected as the site for the top secret Manhattan Project in January 1943 as it was remote yet near railroads, had an abundance of water available for reactor cooling, and plentiful electricity from regional hydroelectric plants. Hanford's mission was to produce plutonium for a new weapon that could bring about a swift conclusion of World War II.

Beginning in January 1943 the small farming communities of Hanford and White Bluff were transformed into a construction camp of more than 51,000 scientists, engineers, and workers. The world's first three plutonium-production reactors soon took shape along the Columbia River about 35 miles from Richland.

Two years and three months from the start of construction, plutonium produced at Hanford provided the explosive charge for the world's first nuclear detonation. The test detonation at Alamogordo, New Mexico, was shortly followed by by the use of nuclear weapons on the Japanese cities of Hiroshima and Nagasaki.

By 1964, nine plutonium production reactors, including N reactor which was constructed between 1958 and 1963, were in operation at Hanford. The complex also housed facilities for the entire nuclear cycle, including fuel fabrication, chemical processing, waste management, and research.

Operational diversification at Hanford began in 1965. Between 1964 and 1971, eight of the nine reactors were decomissioned. Hanford gradually changed from a top secret military facility and began to place emphasis on peaceful uses of nuclear power. In 1967, Hanford was selected as the site for the Fast Flux Test Facility advanced reactor.

The last of the single purpose reactors was decomissioned in 1971 leaving only N reactor with its dual purpose of plutonium and electricity production.

By 1975, energy research had become the major thrust at Hanford in which energy sources such as nuclear, geothermal, solar, fossil, wind, and organic waste were investigated.

Hanford's role changed again in 1980 to re-emphasize defense production. Currently about 60 percent of site funding is expended for national defense and 40 percent for energy research and related programs.

N REACTOR

On April 26, 1986, a devastating accident occurred at Chernobyl, in the Soviet Union, that cast a cloud of radioactive material into the atmosphere over northern Europe. The accident also cast a cloud of suspicion over operations of N reactor at Hanford. This cloud of suspicion and doubt acted to diminish public confidence in N reactor operations and impeded production of materials needed for national defense.

N reactor is a light-water cooled reactor that began operations in December 1963. At the time, N reactor was the largest reactor in the world. It is classified as a dual-purpose reactor in that it produces electricity for use within the State and plutonium for nuclear weapons. In times of drought, N reactor has been pressed into service to augment hydroelectric plant production. To date, the reactor has produced over 65 million kilowatts of electricity.

While some limited similarities exist between N reactor and the Chernobyl plant (e. g., both use graphite as a moderator), there are vast differences in design and operation. The major differences are summarized below:

1. The Chernobyl reactor has a slow scram time (emergency shut-down time) that requires as much as 20 seconds for the insertion of control rods. Scram time for N reactor is 1.5 seconds.

2. The Chernobyl reactor is a boiling water reactor that produces steam within its core. Due to a (designed) positive void coefficient, power output increases upon loss of coolant. This, in turn, increases the boiling rate and results in further loss of coolant; power "automatically" increases in an upward spiral. This is essentially what occurred in 1986. Chernobyl's power output went from about 200 megawatts thermal to about 350,000 megawatts thermal in a matter of 6-10 seconds; a power rate 111 times the reactor's design capacity. N reactor, on the other hand, decreases power levels and starts to cool down immediately on loss of coolant, a design feature known as "negative void coefficient". Further, N reactor's core is pressurized; the coolant does not boil.

3. The Soviet reactor is very unstable at low power levels; N reactor is stable at all power levels as it is equipped with a number of control systems to maintain stability.

REACTOR CONTROL

N reactor is equipped with 1,003 process tubes each containing 16 fuel elements for a total of 16,048 elements. The control system consists of 84 boron control rods that are inserted horizontally using hydraulic power. The Soviet reactor uses a system in which control rods are inserted vertically from the top using gravity. This accounts for the large time difference in scram time; 1.5 seconds for N reactor and 20 seconds for the Russian reactor.

A backup control system in N reactor consists of 107 hoppers containing a number of boron balls mounted above access channels on top of the core. In the event a control rod fails to complete its insertion within the allotted 1.5 seconds, the balls are automatically released into the core effecting an immediate cecession of the fission process.

Since the Chernobyl accident, N reactor has been the focus of investigations, inquiries, reviews, and technical studies by more than 50 agencies and institutions. These include the State of Oregon, the General Accounting Office, the Roddis Commission of six independent consultants, the National Academy of Science, Energy Department internal reviews, and others. A majority of the reviewers concluded that N reactor was operationally safe; all reviewers stated that an accident such as that at Chernobyl cannot happen at N reactor.

The recently released report of the National Academy of Science pertaining to N reactor was positive; it did not point out any reasons why the reactor should be considered unsafe. Several points pertaining to "enhanced safety procedures" were, however, recommended. One was the need for a DOE safety committee to review operational and safety procedures; this is currently being emplaced.

One hundred fifty seven of the 228 recommendations of the many reviews and studies have been implemented at N reactor. A number of these were incorporated into an enhanced safety program. "Enhanced" safety does not mean that the reactor or operating procedures in the past have been less than safe. The speaker likened the program to the installation of a fire alarm system in a newly-built house; the house is inherently safe (provided it met all building and safety codes) but the alarm system acts to enhance that safety.

The reactor has been shut down since January to effect changes and recommendations promulgated by the various reviewing agencies; start-up is slated for March, 1988. An Environmental Impact Statement pertaining to safety and the scheduled start-up is in the process of preparation and will be released <u>in about a year, minimum</u> (emphasis added).

A number of features and facilities have been installed or are in the process of implementation or construction. These include:

- A liquid effluent retention facility to contain reactor fluids in the event it is necessary to use the emergency core cooling system. The retention facility consists primarily of a large excavation that is lined and covered to prevent percolation of contaminated water into the subsurface and to prevent escape of radionuclides into the atmosphere.

- A hydrogen monitoring system has been installed in the reactor and containment structures.

- A hydrogen mitigation system is being installed. This acts in conjunction with the monitoring system to inject non-reactive nitrogen into the containment to dilute any build-up of potentially explosive hydrogen.

- Integrity tests of the confinement system. N reactor has a confinement system designed to confine to the immediate area any contaminants that may be released from the reactor in the event of an accident. The Chernobyl reactor, however, used a containment system around various components of the reactor. The system was designed to limit the spread of contaminants to those areas so protected. The reactor itself was not a part of the containment system, it was surrounded by a steel shell that failed during the course of the accident and allowed the escape of radioactive material.

- A supplementary emergency core cooling system has been added and a procedure emplaced to inspect the emergency cooling dump tanks.

N REACTOR ECONOMICS

Were N reactor shut down today, over 3,000 jobs would be lost; another 3,000 jobs, mostly those within the reservation that support N reactor activities, would be lost 90 days hence. A ripple effect throughout Washington state would account for another 16,000 lost jobs; these include suppliers, subcontractors and so forth. An estimated tax revenue loss of $47 million would be expected.

Personal Observations

The author did not address documented releases of radionuclides to the atmosphere nor did he address the current flap pertaining to the presence of radioactive iodine in local groundwater. The presentation may have acted to instill confidence in the audience that N reactor would not go berserk as did Chernobyl but did nothing to allay fears of the long-term effects of radionuclides released by the facility. Throughout the presentation, the author underscored the dire economic results of a permanent shut-down of the reactor. He seemed to pose the question, "Would you rather take your chances on our ability to run a tight ship or face the horror of unemployment, welfare, and greatly increased taxes?"

Basalt Waste Isolation Program
by
Alan D. Krug

The Basalt Waste Isolation Program (BWIP) is operated for the Department of Energy (DOE) by Westinghouse Hanford. Design activities for the project have been conducted by a consortium of several engineering firms.

The project itself is rather large with an operating budget of over $100 million and a staff of more than 800 people. The largest staff component is in the geotechnical disciplines of geology, geophysics, geochemistry, hydrology, and mining engineering. This is probably the largest collection of geotechnical people in the northwest.

The prime concern of BWIP is the final disposal of nuclear waste. This problem, essentially, began in Chicago in 1942 with the first reactor beneath the University of Chicago football stadium. Since that time, the problem of waste disposal has been with us; it hasn't been resolved.

Currently, more than 100 nuclear reactors are producing waste. By the turn of the century, more than 50,000 metric tons of waste will require disposal. This is a problem, waste currently being generated and that generated in the past must be stored at the reactor site. At most reactor sites, waste is stored in water. Further, most sites have limited storage capacity. As time goes by, the need for a permanent disposal site becomes more critical. The ultimate concern is to develop a safe system for disposal of the waste.

The system now under consideration is one of disposal in a deep geological repository wherein wastes are constrained from reaching the biosphere for a period of 10,000 years. This 10,000 year timespan was selected as it is approximately the amount time required for the spent fuel to reach the radiation level of the original uranium ore (not concentrated uranium oxides) used as fuel. A real problem is to find a certifiable location that would safely confine the waste for the 10,000 year period.

In the 1970's, there were a number of activities underway within the government to select a disposal system. Proposed disposal systems included firing the waste into deep space or into the sun via rocket, dropping it into the deep oceans, and a variety of other systems. For many reasons, these systems were discarded and it was decided to opt for deep burial within a geologic repository.

The search for a geologic burial site began in earnest during the Carter Administration in which several rock types across the Nation were studied for their suitability as a repository. Crystalline and shaley rocks along the east coast from Georgia to New Hampshire and in the Great Lakes area, salt deposits along the Gulf Coast and in the Texas Panhandle and Utah, volcanic tuff deposits in Nevada, and basalt accumulations in Central Washington were studied. Sties selected for possible characterization were narrowed down to those in Deaf Smith County, Texas (salt), Yucca Mountain, Nye County, Nevada (welded tuff), and the nuclear reservation at Hanford (basalt).

The program at Hanford began in 1976. Between that year and 1982, a number of surface and subsurface facilities were installed. In 1982, the program was formalized with the passage of the Nuclear Waste Policy Act. This Act is currently the guiding force behind the disposal program. One of the important aspects of the Act was to place the economic burden of waste storage in the hands of the utilities producing the waste. This precludes the necessity of a general tax increase to support the program

BWIP has two specific objectives: 1) to determine the feasibility of the site for a repository, and 2) to develop the needed engineering technology to be employed should the site be selected.

Of particular interest to BWIP (regarding feasibility) is the Pasco Basin, site of the thickest accumulation of Columbia River Basalt (CRB). Boreholes more than 10,000 (sic) feet deep have been drilled in the Pasco Basin without penetrating the basalt; from most indications, the basalt may persist to 15,000 feet. The proposed repository horizon would be at a depth of about 3,000-3,2000 feet beneath the surface in the Cohassett flow.

The hydrologic aspects of the basalt site are of great interest to BWIP workers. One of their interests and priorities is to accurately determine the age of the water beneath the site. This would aid in selecting a specific area in which the waste will remain in place or, if transported by ground water, take at least 10,000 years for the radionuclides to reach the biosphere. Much of the preliminary information gathered so far indicates a ground water age of about 100,000 years. This indicates that it takes a long time to recharge the area.

Another hydrologic interest concerns ground water chemistry. The chemistry of the ground water must be determined in order to anticipate what reactions may occur between the water, waste, and other engineering components of the repository.

Movement of the ground water beneath the site is also of interest to BWIP personnel. A series of hydrologic test wells have been drilled to moderate depths to determine the direction and rate of ground water flow.

In 1978, a near-surface test facility was constructed at a depth of about 150 feet within the Pomona flow that outcrops on Gable Mountain. The purpose of the facility was to allow geophysical, geochemical, engineering, and other tests to be conducted in basalt. Although conditions in the facility do not reflect those at repository depths, it does provide an opportunity to conduct certain tests that do not require such conditions. Most of the activities at the near-surface test facility have been oriented toward developing the technology, equipment, and procedures needed for deep testing and site characterization.

Presently, BWIP is preparing a site characterization program to identify the types of information they need to collect in order to determine whether the site is feasible for a repository. A site characterization plan, that includes, among other things, the methods that will be employed to collect the needed information, is being prepared. The document will be released to certain reviewing agencies in early 1988 and to the public about a year later.

Post-Presentation Questions

Question: In your estimation, what are the probabilities of hydrocarbon resources existing beneath the Hanford reservation?

Answer: Some natural gas was found in the Rattlesnake Hills in the 1930's but this seems to be an isolated pocket. The reservation is situated above a syncline and most oil or gas that may have been generated probably migrated up dip toward the margins of the basin. That is why the current exploration effort (Shell, AMOCO, Tyrex, etc.) is concentrated there.

Question: If hydrocarbons that may have been generated in sub-basalt sediments have migrated up dip from the central portion of the basin, why would the major oil companies want to conduct exploration programs on the reservation? Why have 145 applications to the DOE to conduct such activities been denied?

The speaker declined to address the questions.

Personal Note

I am not aware of any borehole on the reservation that comes anywhere near the 10,000 foot depth cited by the speaker. In a recent hydrocarbon resource workshop in Richland, WA, Mr. Curtis Canard, a certified petroleum geologist representing the Council of Energy Resource Tribes, stated that DC-1, at about 5,600 feet, was the deepest borehole on the nuclear reservation.

LETTER REPORT

SUBJECT: AIME Columbia Section and Northwest Mining Association monthly meeting, November 17, 1987

BY: Russell G. Raney, Physical Scientist
Western Field Operations Center
Bureau of Mines
Spokane, Washington

Mr. R.W. Leanna and Mr. Alan D. Krug, both of Westinghouse Hanford, were featured speakers at the November, 1987 combined meeting of the Columbia Section of the AIME and the Northwest Mining Association. Mr. Leanna, who is Westinghouse's Manager of Maintenance Training, addressed safety issues pertaining to the operation of the plutonium-producing N Reactor and Mr. Krug, Staff Engineer for Repository Design and Development, discussed DOE's Basalt Waste Isolation Program on the Hanford Reservation. Synopses of the presentations are included.

The synopses were prepared from the speakers' presentations and handout material.

Preface
by
Russell G. Raney

The N reactor, on the Hanford Nuclear Reservation, has been the center of controversy in the Pacific northwest for a number of years. The controversy has intensified recently as the result of the Chernobyl reactor accident and discovery of anomalously high uranium and traces of radioactive iodine in domestic water wells. Further, the Department of Energy has recently released over 10,000 pages of material in which it was admitted that on a number of occasions over the past 40 years, radioactive material has been released to the atmosphere and the Columbia River. Battle lines have been drawn between those who feel that N reactor presents a real and present threat to the health and welfare of people living in the vicinity or down-wind of the reactor, and those who feel the reactor presents no such danger. The latter faction is composed largely of those whose livlihood is directly or indirectly tied to the continued operation of the reactor.

Westinghouse Hanford has recently mounted a public relations campaign in an effort to answer some of the criticisms regarding operation of N reactor and to address public concern pertaining to the possible siting of a nuclear waste repository on the Hanford reservation; Mssrs. Leanna and Krug are a part of that effort.

You Be The Judge of the N Reactor

R. W. Leanna

BACKGROUND

On December 2, 1942, a team of scientists led by Enrico Fermi conducted the first controlled nuclear chain reaction. In the ensuing months, the race to develop nuclear weapons during World War II changed the land in and around Hanford from a quiet desert to a storm of engineering activity.

Hanford was selected as the site for the top secret Manhattan Project in January 1943 as it was remote yet near railroads, had an abundance of water available for reactor cooling, and plentiful electricity from regional hydroelectric plants. Hanford's mission was to produce plutonium for a new weapon that could bring about a swift conclusion of World War II.

Beginning in January 1943 the small farming communities of Hanford and White Bluff were transformed into a construction camp of more than 51,000 scientists, engineers, and workers. The world's first three plutonium-production reactors soon took shape along the Columbia River about 35 miles from Richland.

Two years and three months from the start of construction, plutonium produced at Hanford provided the explosive charge for the world's first nuclear detonation. The test detonation at Alamogordo, New Mexico, was shortly followed by by the use of nuclear weapons on the Japanese cities of Hiroshima and Nagasaki.

By 1964, nine plutonium production reactors, including N reactor which was constructed between 1958 and 1963, were in operation at Hanford. The complex also housed facilities for the entire nuclear cycle, including fuel fabrication, chemical processing, waste management, and research.

Operational diversification at Hanford began in 1965. Between 1964 and 1971, eight of the nine reactors were decomissioned. Hanford gradually changed from a top secret military facility and began to place emphasis on peaceful uses of nuclear power. In 1967, Hanford was selected as the site for the Fast Flux Test Facility advanced reactor.

The last of the single purpose reactors was decomissioned in 1971 leaving only N reactor with its dual purpose of plutonium and electricity production.

By 1975, energy research had become the major thrust at Hanford in which energy sources such as nuclear, geothermal, solar, fossil, wind, and organic waste were investigated.

Hanford's role changed again in 1980 to re-emphasize defense production. Currently about 60 percent of site funding is expended for national defense and 40 percent for energy research and related programs.

N REACTOR

On April 26, 1986, a devastating accident occurred at Chernobyl, in the Soviet Union, that cast a cloud of radioactive material into the atmosphere over northern Europe. The accident also cast a cloud of suspicion over operations of N reactor at Hanford. This cloud of suspicion and doubt acted to diminish public confidence in N reactor operations and impeded production of materials needed for national defense.

N reactor is a light-water cooled reactor that began operations in December 1963. At the time, N reactor was the largest reactor in the world. It is classified as a dual-purpose reactor in that it produces electricity for use within the State and plutonium for nuclear weapons. In times of drought, N reactor has been pressed into service to augment hydroelectric plant production. To date, the reactor has produced over 65 million kilowatts of electricity.

While some limited similarities exist between N reactor and the Chernobyl plant (e. g., both use graphite as a moderator), there are vast differences in design and operation. The major differences are summarized below:

1. The Chernobyl reactor has a slow scram time (emergency shut-down time) that requires as much as 20 seconds for the insertion of control rods. Scram time for N reactor is 1.5 seconds.

2. The Chernobyl reactor is a boiling water reactor that produces steam within its core. Due to a (designed) positive void coefficient, power output increases upon loss of coolant. This, in turn, increases the boiling rate and results in further loss of coolant; power "automatically" increases in an upward spiral. This is essentially what occurred in 1986. Chernobyl's power output went from about 200 megawatts thermal to about 350,000 megawatts thermal in a matter of 6-10 seconds; a power rate 111 times the reactor's design capacity. N reactor, on the other hand, decreases power levels and starts to cool down immediately on loss of coolant, a design feature known as "negative void coefficient". Further, N reactor's core is pressurized; the coolant does not boil.

3. The Soviet reactor is very unstable at low power levels; N reactor is stable at all power levels as it is equipped with a number of control systems to maintain stability.

REACTOR CONTROL

N reactor is equipped with 1,003 process tubes each containing 16 fuel elements for a total of 16,048 elements. The control system consists of 84 boron control rods that are inserted horizontally using hydraulic power. The Soviet reactor uses a system in which control rods are inserted vertically from the top using gravity. This accounts for the large time difference in scram time; 1.5 seconds for N reactor and 20 seconds for the Russian reactor.

A backup control system in N reactor consists of 107 hoppers containing a number of boron balls mounted above access channels on top of the core. In the event a control rod fails to complete its insertion within the allotted 1.5 seconds, the balls are automatically released into the core effecting an immediate cecession of the fission process.

Since the Chernobyl accident, N reactor has been the focus of investigations, inquiries, reviews, and technical studies by more than 50 agencies and institutions. These include the State of Oregon, the General Accounting Office, the Roddis Commission of six independent consultants, the National Academy of Science, Energy Department internal reviews, and others. A majority of the reviewers concluded that N reactor was operationally safe; all reviewers stated that an accident such as that at Chernobyl cannot happen at N reactor.

The recently released report of the National Academy of Science pertaining to N reactor was positive; it did not point out any reasons why the reactor should be considered unsafe. Several points pertaining to "enhanced safety procedures" were, however, recommended. One was the need for a DOE safety committee to review operational and safety procedures; this is currently being emplaced.

One hundred fifty seven of the 228 recommendations of the many reviews and studies have been implemented at N reactor. A number of these were incorporated into an enhanced safety program. "Enhanced" safety does not mean that the reactor or operating procedures in the past have been less than safe. The speaker likened the program to the installation of a fire alarm system in a newly-built house; the house is inherently safe (provided it met all building and safety codes) but the alarm system acts to enhance that safety.

The reactor has been shut down since January to effect changes and recommendations promulgated by the various reviewing agencies; start-up is slated for March, 1988. An Environmental Impact Statement pertaining to safety and the scheduled start-up is in the process of preparation and will be released <u>in about a year, minimum</u> (emphasis added).

A number of features and facilities have been installed or are in the process of implementation or construction. These include:

o A liquid effluent retention facility to contain reactor fluids in the event it is necessary to use the emergency core cooling system. The retention facility consists primarily of a large excavation that is lined and covered to prevent percolation of contaminated water into the subsurface and to prevent escape of radionuclides into the atmosphere.

o A hydrogen monitoring system has been installed in the reactor and containment structures.

o A hydrogen mitigation system is being installed. This acts in conjunction with the monitoring system to inject non-reactive nitrogen into the containment to dilute any build-up of potentially explosive hydrogen.

o Integrity tests of the confinement system. N reactor has a <u>confinement</u> system designed to confine to the immediate area any contaminants that may be released from the reactor in the event of an accident. The Chernobyl reactor, however, used a <u>containment</u> system around various components of the reactor. The system was designed to limit the spread of contaminants to those areas so protected. The reactor itself was not a part of the containment system, it was surrounded by a steel shell that failed during the course of the accident and allowed the escape of radioactive material.

o A supplementary emergency core cooling system has been added and a procedure emplaced to inspect the emergency cooling dump tanks.

N REACTOR ECONOMICS

Were N reactor shut down today, over 3,000 jobs would be lost; another 3,000 jobs, mostly those within the reservation that support N reactor activities, would be lost 90 days hence. A ripple effect throughout Washington state would account for another 16,000 lost jobs; these include suppliers, subcontractors and so forth. An estimated tax revenue loss of $47 million would be expected.

Personal Observations

The author did not address documented releases of radionuclides to the atmosphere nor did he address the current flap pertaining to the presence of radioactive iodine in local groundwater. The presentation may have acted to instill confidence in the audience that N reactor would not go berserk as did Chernobyl but did nothing to allay fears of the long-term effects of radionuclides released by the facility. Throughout the presentation, the author underscored the dire economic results of a permanent shut-down of the reactor. He seemed to pose the question, "Would you rather take your chances on our ability to run a tight ship or face the horror of unemployment, welfare, and greatly increased taxes?"

Basalt Waste Isolation Program
by
Alan D. Krug

The Basalt Waste Isolation Program (BWIP) is operated for the Department of Energy (DOE) by Westinghouse Hanford. Design activities for the project have been conducted by a consortium of several engineering firms.

The project itself is rather large with an operating budget of over $100 million and a staff of more than 800 people. The largest staff component is in the geotechnical disciplines of geology, geophysics, geochemistry, hydrology, and mining engineering. This is probably the largest collection of geotechnical people in the northwest.

The prime concern of BWIP is the final disposal of nuclear waste. This problem, essentially, began in Chicago in 1942 with the first reactor beneath the University of Chicago football stadium. Since that time, the problem of waste disposal has been with us; it hasn't been resolved.

Currently, more than 100 nuclear reactors are producing waste. By the turn of the century, more than 50,000 metric tons of waste will require disposal. This is a problem, waste currently being generated and that generated in the past must be stored at the reactor site. At most reactor sites, waste is stored in water. Further, most sites have limited storage capacity. As time goes by, the need for a permanent disposal site becomes more critical. The ultimate concern is to develop a safe system for disposal of the waste.

The system now under consideration is one of disposal in a deep geological repository wherein wastes are constrained from reaching the biosphere for a period of 10,000 years. This 10,000 year timespan was selected as it is approximately the amount time required for the spent fuel to reach the radiation level of the original uranium ore (not concentrated uranium oxides) used as fuel. A real problem is to find a certifiable location that would safely confine the waste for the 10,000 year period.

In the 1970's, there were a number of activities underway within the government to select a disposal system. Proposed disposal systems included firing the waste into deep space or into the sun via rocket, dropping it into the deep oceans, and a variety of other systems. For many reasons, these systems were discarded and it was decided to opt for deep burial within a geologic repository.

The search for a geologic burial site began in earnest during the Carter Administration in which several rock types across the Nation were studied for their suitability as a repository. Crystalline and shaley rocks along the east coast from Georgia to New Hampshire and in the Great Lakes area, salt deposits along the Gulf Coast and in the Texas Panhandle and Utah, volcanic tuff deposits in Nevada, and basalt accumulations in Central Washington were studied. Sties selected for possible characterization were narrowed down to those in Deaf Smith County, Texas (salt), Yucca Mountain, Nye County, Nevada (welded tuff), and the nuclear reservation at Hanford (basalt).

The program at Hanford began in 1976. Between that year and 1982, a number of surface and subsurface facilities were installed. In 1982, the program was formalized with the passage of the Nuclear Waste Policy Act. This Act is currently the guiding force behind the disposal program. One of the important aspects of the Act was to place the economic burden of waste storage in the hands of the utilities producing the waste. This precludes the necessity of a general tax increase to support the program

BWIP has two specific objectives: 1) to determine the feasibility of the site for a repository, and 2) to develop the needed engineering technology to be employed should the site be selected.

Of particular interest to BWIP (regarding feasibility) is the Pasco Basin, site of the thickest accumulation of Columbia River Basalt (CRB). Boreholes more than 10,000 (sic) feet deep have been drilled in the Pasco Basin without penetrating the basalt; from most indications, the basalt may persist to 15,000 feet. The proposed repository horizon would be at a depth of about 3,000-3,2000 feet beneath the surface in the Cohassett flow.

The hydrologic aspects of the basalt site are of great interest to BWIP workers. One of their interests and priorities is to accurately determine the age of the water beneath the site. This would aid in selecting a specific area in which the waste will remain in place or, if transported by ground water, take at least 10,000 years for the radionuclides to reach the biosphere. Much of the preliminary information gathered so far indicates a ground water age of about 100,000 years. This indicates that it takes a long time to recharge the area.

Another hydrologic interest concerns ground water chemistry. The chemistry of the ground water must be determined in order to anticipate what reactions may occur between the water, waste, and other engineering components of the repository.

Movement of the ground water beneath the site is also of interest to BWIP personnel. A series of hydrologic test wells have been drilled to moderate depths to determine the direction and rate of ground water flow.

In 1978, a near-surface test facility was constructed at a depth of about 150 feet within the Pomona flow that outcrops on Gable Mountain. The purpose of the facility was to allow geophysical, geochemical, engineering, and other tests to be conducted in basalt. Although conditions in the facility do not reflect those at repository depths, it does provide an opportunity to conduct certain tests that do not require such conditions. Most of the activities at the near-surface test facility have been oriented toward developing the technology, equipment, and procedures needed for deep testing and site characterization.

Presently, BWIP is preparing a site characterization program to identify the types of information they need to collect in order to determine whether the site is feasible for a repository. A site characterization plan, that includes, among other things, the methods that will be employed to collect the needed information, is being prepared. The document will be released to certain reviewing agencies in early 1988 and to the public about a year later.

Post-Presentation Questions

Question: In your estimation, what are the probabilities of hydrocarbon resources existing beneath the Hanford reservation?

Answer: Some natural gas was found in the Rattlesnake Hills in the 1930's but this seems to be an isolated pocket. The reservation is situated above a syncline and most oil or gas that may have been generated probably migrated up dip toward the margins of the basin. That is why the current exploration effort (Shell, AMOCO, Tyrex, etc.) is concentrated there.

Question: If hydrocarbons that may have been generated in sub-basalt sediments have migrated up dip from the central portion of the basin, why would the major oil companies want to conduct exploration programs on the reservation? Why have 145 applications to the DOE to conduct such activities been denied?

The speaker declined to address the questions.

Personal Note

I am not aware of any borehole on the reservation that comes anywhere near the 10,000 foot depth cited by the speaker. In a recent hydrocarbon resource workshop in Richland, WA, Mr. Curtis Canard, a certified petroleum geologist representing the Council of Energy Resource Tribes, stated that DC-1, at about 5,600 feet, was the deepest borehole on the nuclear reservation.

LETTER REPORT

SUBJECT: AIME Columbia Section and Northwest Mining Association monthly meeting, November 17, 1987

BY: Russell G. Raney, Physical Scientist
Western Field Operations Center
Bureau of Mines
Spokane, Washington

Mr. R.W. Leanna and Mr. Alan D. Krug, both of Westinghouse Hanford, were featured speakers at the November, 1987 combined meeting of the Columbia Section of the AIME and the Northwest Mining Association. Mr. Leanna, who is Westinghouse's Manager of Maintenance Training, addressed safety issues pertaining to the operation of the plutonium-producing N Reactor and Mr. Krug, Staff Engineer for Repository Design and Development, discussed DOE's Basalt Waste Isolation Program on the Hanford Reservation. Synopses of the presentations are included.

The synopses were prepared from the speakers' presentations and handout material.

Preface
by
Russell G. Raney

The N reactor, on the Hanford Nuclear Reservation, has been the center of controversy in the Pacific northwest for a number of years. The controversy has intensified recently as the result of the Chernobyl reactor accident and discovery of anomalously high uranium and traces of radioactive iodine in domestic water wells. Further, the Department of Energy has recently released over 10,000 pages of material in which it was admitted that on a number of occasions over the past 40 years, radioactive material has been released to the atmosphere and the Columbia River. Battle lines have been drawn between those who feel that N reactor presents a real and present threat to the health and welfare of people living in the vicinity or down-wind of the reactor, and those who feel the reactor presents no such danger. The latter faction is composed largely of those whose livlihood is directly or indirectly tied to the continued operation of the reactor.

Westinghouse Hanford has recently mounted a public relations campaign in an effort to answer some of the criticisms regarding operation of N reactor and to address public concern pertaining to the possible siting of a nuclear waste repository on the Hanford reservation; Mssrs. Leanna and Krug are a part of that effort.

You Be The Judge of the N Reactor

R. W. Leanna

BACKGROUND

On December 2, 1942, a team of scientists led by Enrico Fermi conducted the first controlled nuclear chain reaction. In the ensuing months, the race to develop nuclear weapons during World War II changed the land in and around Hanford from a quiet desert to a storm of engineering activity.

Hanford was selected as the site for the top secret Manhattan Project in January 1943 as it was remote yet near railroads, had an abundance of water available for reactor cooling, and plentiful electricity from regional hydroelectric plants. Hanford's mission was to produce plutonium for a new weapon that could bring about a swift conclusion of World War II.

Beginning in January 1943 the small farming communities of Hanford and White Bluff were transformed into a construction camp of more than 51,000 scientists, engineers, and workers. The world's first three plutonium-production reactors soon took shape along the Columbia River about 35 miles from Richland.

Two years and three months from the start of construction, plutonium produced at Hanford provided the explosive charge for the world's first nuclear detonation. The test detonation at Alamogordo, New Mexico, was shortly followed by by the use of nuclear weapons on the Japanese cities of Hiroshima and Nagasaki.

By 1964, nine plutonium production reactors, including N reactor which was constructed between 1958 and 1963, were in operation at Hanford. The complex also housed facilities for the entire nuclear cycle, including fuel fabrication, chemical processing, waste management, and research.

Operational diversification at Hanford began in 1965. Between 1964 and 1971, eight of the nine reactors were decomissioned. Hanford gradually changed from a top secret military facility and began to place emphasis on peaceful uses of nuclear power. In 1967, Hanford was selected as the site for the Fast Flux Test Facility advanced reactor.

The last of the single purpose reactors was decomissioned in 1971 leaving only N reactor with its dual purpose of plutonium and electricity production.

By 1975, energy research had become the major thrust at Hanford in which energy sources such as nuclear, geothermal, solar, fossil, wind, and organic waste were investigated.

Hanford's role changed again in 1980 to re-emphasize defense production. Currently about 60 percent of site funding is expended for national defense and 40 percent for energy research and related programs.

N REACTOR

On April 26, 1986, a devastating accident occurred at Chernobyl, in the Soviet Union, that cast a cloud of radioactive material into the atmosphere over northern Europe. The accident also cast a cloud of suspicion over operations of N reactor at Hanford. This cloud of suspicion and doubt acted to diminish public confidence in N reactor operations and impeded production of materials needed for national defense.

N reactor is a light-water cooled reactor that began operations in December 1963. At the time, N reactor was the largest reactor in the world. It is classified as a dual-purpose reactor in that it produces electricity for use within the State and plutonium for nuclear weapons. In times of drought, N reactor has been pressed into service to augment hydroelectric plant production. To date, the reactor has produced over 65 million kilowatts of electricity.

While some limited similarities exist between N reactor and the Chernobyl plant (e. g., both use graphite as a moderator), there are vast differences in design and operation. The major differences are summarized below:

1. The Chernobyl reactor has a slow scram time (emergency shut-down time) that requires as much as 20 seconds for the insertion of control rods. Scram time for N reactor is 1.5 seconds.

2. The Chernobyl reactor is a boiling water reactor that produces steam within its core. Due to a (designed) positive void coefficient, power output increases upon loss of coolant. This, in turn, increases the boiling rate and results in further loss of coolant; power "automatically" increases in an upward spiral. This is essentially what occurred in 1986. Chernobyl's power output went from about 200 megawatts thermal to about 350,000 megawatts thermal in a matter of 6-10 seconds; a power rate 111 times the reactor's design capacity. N reactor, on the other hand, decreases power levels and starts to cool down immediately on loss of coolant, a design feature known as "negative void coefficient". Further, N reactor's core is pressurized; the coolant does not boil.

3. The Soviet reactor is very unstable at low power levels; N reactor is stable at all power levels as it is equipped with a number of control systems to maintain stability.

REACTOR CONTROL

N reactor is equipped with 1,003 process tubes each containing 16 fuel elements for a total of 16,048 elements. The control system consists of 84 boron control rods that are inserted horizontally using hydraulic power. The Soviet reactor uses a system in which control rods are inserted vertically from the top using gravity. This accounts for the large time difference in scram time; 1.5 seconds for N reactor and 20 seconds for the Russian reactor.

A backup control system in N reactor consists of 107 hoppers containing a number of boron balls mounted above access channels on top of the core. In the event a control rod fails to complete its insertion within the allotted 1.5 seconds, the balls are automatically released into the core effecting an immediate cecession of the fission process.

Since the Chernobyl accident, N reactor has been the focus of investigations, inquiries, reviews, and technical studies by more than 50 agencies and institutions. These include the State of Oregon, the General Accounting Office, the Roddis Commission of six independent consultants, the National Academy of Science, Energy Department internal reviews, and others. A majority of the reviewers concluded that N reactor was operationally safe; all reviewers stated that an accident such as that at Chernobyl cannot happen at N reactor.

The recently released report of the National Academy of Science pertaining to N reactor was positive; it did not point out any reasons why the reactor should be considered unsafe. Several points pertaining to "enhanced safety procedures" were, however, recommended. One was the need for a DOE safety committee to review operational and safety procedures; this is currently being emplaced.

One hundred fifty seven of the 228 recommendations of the many reviews and studies have been implemented at N reactor. A number of these were incorporated into an enhanced safety program. "Enhanced" safety does not mean that the reactor or operating procedures in the past have been less than safe. The speaker likened the program to the installation of a fire alarm system in a newly-built house; the house is inherently safe (provided it met all building and safety codes) but the alarm system acts to enhance that safety.

The reactor has been shut down since January to effect changes and recommendations promulgated by the various reviewing agencies; start-up is slated for March, 1988. An Environmental Impact Statement pertaining to safety and the scheduled start-up is in the process of preparation and will be released <u>in about a year, minimum</u> (emphasis added).

A number of features and facilities have been installed or are in the process of implementation or construction. These include:

o A liquid effluent retention facility to contain reactor fluids in the event it is necessary to use the emergency core cooling system. The retention facility consists primarily of a large excavation that is lined and covered to prevent percolation of contaminated water into the subsurface and to prevent escape of radionuclides into the atmosphere.

o A hydrogen monitoring system has been installed in the reactor and containment structures.

o A hydrogen mitigation system is being installed. This acts in conjunction with the monitoring system to inject non-reactive nitrogen into the containment to dilute any build-up of potentially explosive hydrogen.

o Integrity tests of the confinement system. N reactor has a confinement system designed to confine to the immediate area any contaminants that may be released from the reactor in the event of an accident. The Chernobyl reactor, however, used a containment system around various components of the reactor. The system was designed to limit the spread of contaminants to those areas so protected. The reactor itself was not a part of the containment system, it was surrounded by a steel shell that failed during the course of the accident and allowed the escape of radioactive material.

o A supplementary emergency core cooling system has been added and a procedure emplaced to inspect the emergency cooling dump tanks.

N REACTOR ECONOMICS

Were N reactor shut down today, over 3,000 jobs would be lost; another 3,000 jobs, mostly those within the reservation that support N reactor activities, would be lost 90 days hence. A ripple effect throughout Washington state would account for another 16,000 lost jobs; these include suppliers, subcontractors and so forth. An estimated tax revenue loss of $47 million would be expected.

Personal Observations

The author did not address documented releases of radionuclides to the atmosphere nor did he address the current flap pertaining to the presence of radioactive iodine in local groundwater. The presentation may have acted to instill confidence in the audience that N reactor would not go berserk as did Chernobyl but did nothing to allay fears of the long-term effects of radionuclides released by the facility. Throughout the presentation, the author underscored the dire economic results of a permanent shut-down of the reactor. He seemed to pose the question, "Would you rather take your chances on our ability to run a tight ship or face the horror of unemployment, welfare, and greatly increased taxes?"

Basalt Waste Isolation Program
by
Alan D. Krug

The Basalt Waste Isolation Program (BWIP) is operated for the Department of Energy (DOE) by Westinghouse Hanford. Design activities for the project have been conducted by a consortium of several engineering firms.

The project itself is rather large with an operating budget of over $100 million and a staff of more than 800 people. The largest staff component is in the geotechnical disciplines of geology, geophysics, geochemistry, hydrology, and mining engineering. This is probably the largest collection of geotechnical people in the northwest.

The prime concern of BWIP is the final disposal of nuclear waste. This problem, essentially, began in Chicago in 1942 with the first reactor beneath the University of Chicago football stadium. Since that time, the problem of waste disposal has been with us; it hasn't been resolved.

Currently, more than 100 nuclear reactors are producing waste. By the turn of the century, more than 50,000 metric tons of waste will require disposal. This is a problem, waste currently being generated and that generated in the past must be stored at the reactor site. At most reactor sites, waste is stored in water. Further, most sites have limited storage capacity. As time goes by, the need for a permanent disposal site becomes more critical. The ultimate concern is to develop a safe system for disposal of the waste.

The system now under consideration is one of disposal in a deep geological repository wherein wastes are constrained from reaching the biosphere for a period of 10,000 years. This 10,000 year timespan was selected as it is approximately the amount time required for the spent fuel to reach the radiation level of the original uranium ore (not concentrated uranium oxides) used as fuel. A real problem is to find a certifiable location that would safely confine the waste for the 10,000 year period.

In the 1970's, there were a number of activities underway within the government to select a disposal system. Proposed disposal systems included firing the waste into deep space or into the sun via rocket, dropping it into the deep oceans, and a variety of other systems. For many reasons, these systems were discarded and it was decided to opt for deep burial within a geologic repository.

The search for a geologic burial site began in earnest during the Carter Administration in which several rock types across the Nation were studied for their suitability as a repository. Crystalline and shaley rocks along the east coast from Georgia to New Hampshire and in the Great Lakes area, salt deposits along the Gulf Coast and in the Texas Panhandle and Utah, volcanic tuff deposits in Nevada, and basalt accumulations in Central Washington were studied. Sties selected for possible characterization were narrowed down to those in Deaf Smith County, Texas (salt), Yucca Mountain, Nye County, Nevada (welded tuff), and the nuclear reservation at Hanford (basalt).

The program at Hanford began in 1976. Between that year and 1982, a number of surface and subsurface facilities were installed. In 1982, the program was formalized with the passage of the Nuclear Waste Policy Act. This Act is currently the guiding force behind the disposal program. One of the important aspects of the Act was to place the economic burden of waste storage in the hands of the utilities producing the waste. This precludes the necessity of a general tax increase to support the program

BWIP has two specific objectives: 1) to determine the feasibility of the site for a repository, and 2) to develop the needed engineering technology to be employed should the site be selected.

Of particular interest to BWIP (regarding feasibility) is the Pasco Basin, site of the thickest accumulation of Columbia River Basalt (CRB). Boreholes more than 10,000 (sic) feet deep have been drilled in the Pasco Basin without penetrating the basalt; from most indications, the basalt may persist to 15,000 feet. The proposed repository horizon would be at a depth of about 3,000-3,2000 feet beneath the surface in the Cohassett flow.

The hydrologic aspects of the basalt site are of great interest to BWIP workers. One of their interests and priorities is to accurately determine the age of the water beneath the site. This would aid in selecting a specific area in which the waste will remain in place or, if transported by ground water, take at least 10,000 years for the radionuclides to reach the biosphere. Much of the preliminary information gathered so far indicates a ground water age of about 100,000 years. This indicates that it takes a long time to recharge the area.

Another hydrologic interest concerns ground water chemistry. The chemistry of the ground water must be determined in order to anticipate what reactions may occur between the water, waste, and other engineering components of the repository.

Movement of the ground water beneath the site is also of interest to BWIP personnel. A series of hydrologic test wells have been drilled to moderate depths to determine the direction and rate of ground water flow.

In 1978, a near-surface test facility was constructed at a depth of about 150 feet within the Pomona flow that outcrops on Gable Mountain. The purpose of the facility was to allow geophysical, geochemical, engineering, and other tests to be conducted in basalt. Although conditions in the facility do not reflect those at repository depths, it does provide an opportunity to conduct certain tests that do not require such conditions. Most of the activities at the near-surface test facility have been oriented toward developing the technology, equipment, and procedures needed for deep testing and site characterization.

Presently, BWIP is preparing a site characterization program to identify the types of information they need to collect in order to determine whether the site is feasible for a repository. A site characterization plan, that includes, among other things, the methods that will be employed to collect the needed information, is being prepared. The document will be released to certain reviewing agencies in early 1988 and to the public about a year later.

Post-Presentation Questions

Question: In your estimation, what are the probabilities of hydrocarbon resources existing beneath the Hanford reservation?

Answer: Some natural gas was found in the Rattlesnake Hills in the 1930's but this seems to be an isolated pocket. The reservation is situated above a syncline and most oil or gas that may have been generated probably migrated up dip toward the margins of the basin. That is why the current exploration effort (Shell, AMOCO, Tyrex, etc.) is concentrated there.

Question: If hydrocarbons that may have been generated in sub-basalt sediments have migrated up dip from the central portion of the basin, why would the major oil companies want to conduct exploration programs on the reservation? Why have 145 applications to the DOE to conduct such activities been denied?

The speaker declined to address the questions.

Personal Note

I am not aware of any borehole on the reservation that comes anywhere near the 10,000 foot depth cited by the speaker. In a recent hydrocarbon resource workshop in Richland, WA, Mr. Curtis Canard, a certified petroleum geologist representing the Council of Energy Resource Tribes, stated that DC-1, at about 5,600 feet, was the deepest borehole on the nuclear reservation.

LETTER REPORT

SUBJECT: AIME Columbia Section and Northwest Mining Association monthly meeting, November 17, 1987

BY: Russell G. Raney, Physical Scientist
Western Field Operations Center
Bureau of Mines
Spokane, Washington

Mr. R.W. Leanna and Mr. Alan D. Krug, both of Westinghouse Hanford, were featured speakers at the November, 1987 combined meeting of the Columbia Section of the AIME and the Northwest Mining Association. Mr. Leanna, who is Westinghouse's Manager of Maintenance Training, addressed safety issues pertaining to the operation of the plutonium-producing N Reactor and Mr. Krug, Staff Engineer for Repository Design and Development, discussed DOE's Basalt Waste Isolation Program on the Hanford Reservation. Synopses of the presentations are included.

The synopses were prepared from the speakers' presentations and handout material.

Preface
by
Russell G. Raney

The N reactor, on the Hanford Nuclear Reservation, has been the center of controversy in the Pacific northwest for a number of years. The controversy has intensified recently as the result of the Chernobyl reactor accident and discovery of anomalously high uranium and traces of radioactive iodine in domestic water wells. Further, the Department of Energy has recently released over 10,000 pages of material in which it was admitted that on a number of occasions over the past 40 years, radioactive material has been released to the atmosphere and the Columbia River. Battle lines have been drawn between those who feel that N reactor presents a real and present threat to the health and welfare of people living in the vicinity or down-wind of the reactor, and those who feel the reactor presents no such danger. The latter faction is composed largely of those whose livlihood is directly or indirectly tied to the continued operation of the reactor.

Westinghouse Hanford has recently mounted a public relations campaign in an effort to answer some of the criticisms regarding operation of N reactor and to address public concern pertaining to the possible siting of a nuclear waste repository on the Hanford reservation; Mssrs. Leanna and Krug are a part of that effort.

You Be The Judge of the N Reactor

R. W. Leanna

BACKGROUND

On December 2, 1942, a team of scientists led by Enrico Fermi conducted the first controlled nuclear chain reaction. In the ensuing months, the race to develop nuclear weapons during World War II changed the land in and around Hanford from a quiet desert to a storm of engineering activity.

Hanford was selected as the site for the top secret Manhattan Project in January 1943 as it was remote yet near railroads, had an abundance of water available for reactor cooling, and plentiful electricity from regional hydroelectric plants. Hanford's mission was to produce plutonium for a new weapon that could bring about a swift conclusion of World War II.

Beginning in January 1943 the small farming communities of Hanford and White Bluff were transformed into a construction camp of more than 51,000 scientists, engineers, and workers. The world's first three plutonium-production reactors soon took shape along the Columbia River about 35 miles from Richland.

Two years and three months from the start of construction, plutonium produced at Hanford provided the explosive charge for the world's first nuclear detonation. The test detonation at Alamogordo, New Mexico, was shortly followed by by the use of nuclear weapons on the Japanese cities of Hiroshima and Nagasaki.

By 1964, nine plutonium production reactors, including N reactor which was constructed between 1958 and 1963, were in operation at Hanford. The complex also housed facilities for the entire nuclear cycle, including fuel fabrication, chemical processing, waste management, and research.

Operational diversification at Hanford began in 1965. Between 1964 and 1971, eight of the nine reactors were decomissioned. Hanford gradually changed from a top secret military facility and began to place emphasis on peaceful uses of nuclear power. In 1967, Hanford was selected as the site for the Fast Flux Test Facility advanced reactor.

The last of the single purpose reactors was decomissioned in 1971 leaving only N reactor with its dual purpose of plutonium and electricity production.

By 1975, energy research had become the major thrust at Hanford in which energy sources such as nuclear, geothermal, solar, fossil, wind, and organic waste were investigated.

Hanford's role changed again in 1980 to re-emphasize defense production. Currently about 60 percent of site funding is expended for national defense and 40 percent for energy research and related programs.

N REACTOR

On April 26, 1986, a devastating accident occurred at Chernobyl, in the Soviet Union, that cast a cloud of radioactive material into the atmosphere over northern Europe. The accident also cast a cloud of suspicion over operations of N reactor at Hanford. This cloud of suspicion and doubt acted to diminish public confidence in N reactor operations and impeded production of materials needed for national defense.

N reactor is a light-water cooled reactor that began operations in December 1963. At the time, N reactor was the largest reactor in the world. It is classified as a dual-purpose reactor in that it produces electricity for use within the State and plutonium for nuclear weapons. In times of drought, N reactor has been pressed into service to augment hydroelectric plant production. To date, the reactor has produced over 65 million kilowatts of electricity.

While some limited similarities exist between N reactor and the Chernobyl plant (e. g., both use graphite as a moderator), there are vast differences in design and operation. The major differences are summarized below:

1. The Chernobyl reactor has a slow scram time (emergency shut-down time) that requires as much as 20 seconds for the insertion of control rods. Scram time for N reactor is 1.5 seconds.

2. The Chernobyl reactor is a boiling water reactor that produces steam within its core. Due to a (designed) positive void coefficient, power output increases upon loss of coolant. This, in turn, increases the boiling rate and results in further loss of coolant; power "automatically" increases in an upward spiral. This is essentially what occurred in 1986. Chernobyl's power output went from about 200 megawatts thermal to about 350,000 megawatts thermal in a matter of 6-10 seconds; a power rate 111 times the reactor's design capacity. N reactor, on the other hand, decreases power levels and starts to cool down immediately on loss of coolant, a design feature known as "negative void coefficient". Further, N reactor's core is pressurized; the coolant does not boil.

3. The Soviet reactor is very unstable at low power levels; N reactor is stable at all power levels as it is equipped with a number of control systems to maintain stability.

REACTOR CONTROL

N reactor is equipped with 1,003 process tubes each containing 16 fuel elements for a total of 16,048 elements. The control system consists of 84 boron control rods that are inserted horizontally using hydraulic power. The Soviet reactor uses a system in which control rods are inserted vertically from the top using gravity. This accounts for the large time difference in scram time; 1.5 seconds for N reactor and 20 seconds for the Russian reactor.

A backup control system in N reactor consists of 107 hoppers containing a number of boron balls mounted above access channels on top of the core. In the event a control rod fails to complete its insertion within the allotted 1.5 seconds, the balls are automatically released into the core effecting an immediate cecession of the fission process.

Since the Chernobyl accident, N reactor has been the focus of investigations, inquiries, reviews, and technical studies by more than 50 agencies and institutions. These include the State of Oregon, the General Accounting Office, the Roddis Commission of six independent consultants, the National Academy of Science, Energy Department internal reviews, and others. A majority of the reviewers concluded that N reactor was operationally safe; all reviewers stated that an accident such as that at Chernobyl cannot happen at N reactor.

The recently released report of the National Academy of Science pertaining to N reactor was positive; it did not point out any reasons why the reactor should be considered unsafe. Several points pertaining to "enhanced safety procedures" were, however, recommended. One was the need for a DOE safety committee to review operational and safety procedures; this is currently being emplaced.

One hundred fifty seven of the 228 recommendations of the many reviews and studies have been implemented at N reactor. A number of these were incorporated into an enhanced safety program. "Enhanced" safety does not mean that the reactor or operating procedures in the past have been less than safe. The speaker likened the program to the installation of a fire alarm system in a newly-built house; the house is inherently safe (provided it met all building and safety codes) but the alarm system acts to enhance that safety.

The reactor has been shut down since January to effect changes and recommendations promulgated by the various reviewing agencies; start-up is slated for March, 1988. An Environmental Impact Statement pertaining to safety and the scheduled start-up is in the process of preparation and will be released <u>in about a year, minimum</u> (emphasis added).

A number of features and facilities have been installed or are in the process of implementation or construction. These include:

o A liquid effluent retention facility to contain reactor fluids in the event it is necessary to use the emergency core cooling system. The retention facility consists primarily of a large excavation that is lined and covered to prevent percolation of contaminated water into the subsurface and to prevent escape of radionuclides into the atmosphere.

o A hydrogen monitoring system has been installed in the reactor and containment structures.

o A hydrogen mitigation system is being installed. This acts in conjunction with the monitoring system to inject non-reactive nitrogen into the containment to dilute any build-up of potentially explosive hydrogen.

o Integrity tests of the confinement system. N reactor has a confinement system designed to confine to the immediate area any contaminants that may be released from the reactor in the event of an accident. The Chernobyl reactor, however, used a containment system around various components of the reactor. The system was designed to limit the spread of contaminants to those areas so protected. The reactor itself was not a part of the containment system, it was surrounded by a steel shell that failed during the course of the accident and allowed the escape of radioactive material.

o A supplementary emergency core cooling system has been added and a procedure emplaced to inspect the emergency cooling dump tanks.

N REACTOR ECONOMICS

Were N reactor shut down today, over 3,000 jobs would be lost; another 3,000 jobs, mostly those within the reservation that support N reactor activities, would be lost 90 days hence. A ripple effect throughout Washington state would account for another 16,000 lost jobs; these include suppliers, subcontractors and so forth. An estimated tax revenue loss of $47 million would be expected.

Personal Observations

The author did not address documented releases of radionuclides to the atmosphere nor did he address the current flap pertaining to the presence of radioactive iodine in local groundwater. The presentation may have acted to instill confidence in the audience that N reactor would not go berserk as did Chernobyl but did nothing to allay fears of the long-term effects of radionuclides released by the facility. Throughout the presentation, the author underscored the dire economic results of a permanent shut-down of the reactor. He seemed to pose the question, "Would you rather take your chances on our ability to run a tight ship or face the horror of unemployment, welfare, and greatly increased taxes?"

Basalt Waste Isolation Program
by
Alan D. Krug

The Basalt Waste Isolation Program (BWIP) is operated for the Department of Energy (DOE) by Westinghouse Hanford. Design activities for the project have been conducted by a consortium of several engineering firms.

The project itself is rather large with an operating budget of over $100 million and a staff of more than 800 people. The largest staff component is in the geotechnical disciplines of geology, geophysics, geochemistry, hydrology, and mining engineering. This is probably the largest collection of geotechnical people in the northwest.

The prime concern of BWIP is the final disposal of nuclear waste. This problem, essentially, began in Chicago in 1942 with the first reactor beneath the University of Chicago football stadium. Since that time, the problem of waste disposal has been with us; it hasn't been resolved.

Currently, more than 100 nuclear reactors are producing waste. By the turn of the century, more than 50,000 metric tons of waste will require disposal. This is a problem, waste currently being generated and that generated in the past must be stored at the reactor site. At most reactor sites, waste is stored in water. Further, most sites have limited storage capacity. As time goes by, the need for a permanent disposal site becomes more critical. The ultimate concern is to develop a safe system for disposal of the waste.

The system now under consideration is one of disposal in a deep geological repository wherein wastes are constrained from reaching the biosphere for a period of 10,000 years. This 10,000 year timespan was selected as it is approximately the amount time required for the spent fuel to reach the radiation level of the original uranium ore (not concentrated uranium oxides) used as fuel. A real problem is to find a certifiable location that would safely confine the waste for the 10,000 year period.

In the 1970's, there were a number of activities underway within the government to select a disposal system. Proposed disposal systems included firing the waste into deep space or into the sun via rocket, dropping it into the deep oceans, and a variety of other systems. For many reasons, these systems were discarded and it was decided to opt for deep burial within a geologic repository.

The search for a geologic burial site began in earnest during the Carter Administration in which several rock types across the Nation were studied for their suitability as a repository. Crystalline and shaley rocks along the east coast from Georgia to New Hampshire and in the Great Lakes area, salt deposits along the Gulf Coast and in the Texas Panhandle and Utah, volcanic tuff deposits in Nevada, and basalt accumulations in Central Washington were studied. Sties selected for possible characterization were narrowed down to those in Deaf Smith County, Texas (salt), Yucca Mountain, Nye County, Nevada (welded tuff), and the nuclear reservation at Hanford (basalt).

The program at Hanford began in 1976. Between that year and 1982, a number of surface and subsurface facilities were installed. In 1982, the program was formalized with the passage of the Nuclear Waste Policy Act. This Act is currently the guiding force behind the disposal program. One of the important aspects of the Act was to place the economic burden of waste storage in the hands of the utilities producing the waste. This precludes the necessity of a general tax increase to support the program

BWIP has two specific objectives: 1) to determine the feasibility of the site for a repository, and 2) to develop the needed engineering technology to be employed should the site be selected.

Of particular interest to BWIP (regarding feasibility) is the Pasco Basin, site of the thickest accumulation of Columbia River Basalt (CRB). Boreholes more than 10,000 (sic) feet deep have been drilled in the Pasco Basin without penetrating the basalt; from most indications, the basalt may persist to 15,000 feet. The proposed repository horizon would be at a depth of about 3,000-3,2000 feet beneath the surface in the Cohassett flow.

The hydrologic aspects of the basalt site are of great interest to BWIP workers. One of their interests and priorities is to accurately determine the age of the water beneath the site. This would aid in selecting a specific area in which the waste will remain in place or, if transported by ground water, take at least 10,000 years for the radionuclides to reach the biosphere. Much of the preliminary information gathered so far indicates a ground water age of about 100,000 years. This indicates that it takes a long time to recharge the area.

Another hydrologic interest concerns ground water chemistry. The chemistry of the ground water must be determined in order to anticipate what reactions may occur between the water, waste, and other engineering components of the repository.

Movement of the ground water beneath the site is also of interest to BWIP personnel. A series of hydrologic test wells have been drilled to moderate depths to determine the direction and rate of ground water flow.

In 1978, a near-surface test facility was constructed at a depth of about 150 feet within the Pomona flow that outcrops on Gable Mountain. The purpose of the facility was to allow geophysical, geochemical, engineering, and other tests to be conducted in basalt. Although conditions in the facility do not reflect those at repository depths, it does provide an opportunity to conduct certain tests that do not require such conditions. Most of the activities at the near-surface test facility have been oriented toward developing the technology, equipment, and procedures needed for deep testing and site characterization.

Presently, BWIP is preparing a site characterization program to identify the types of information they need to collect in order to determine whether the site is feasible for a repository. A site characterization plan, that includes, among other things, the methods that will be employed to collect the needed information, is being prepared. The document will be released to certain reviewing agencies in early 1988 and to the public about a year later.

Post-Presentation Questions

Question: In your estimation, what are the probabilities of hydrocarbon resources existing beneath the Hanford reservation?

Answer: Some natural gas was found in the Rattlesnake Hills in the 1930's but this seems to be an isolated pocket. The reservation is situated above a syncline and most oil or gas that may have been generated probably migrated up dip toward the margins of the basin. That is why the current exploration effort (Shell, AMOCO, Tyrex, etc.) is concentrated there.

Question: If hydrocarbons that may have been generated in sub-basalt sediments have migrated up dip from the central portion of the basin, why would the major oil companies want to conduct exploration programs on the reservation? Why have 145 applications to the DOE to conduct such activities been denied?

The speaker declined to address the questions.

Personal Note

I am not aware of any borehole on the reservation that comes anywhere near the 10,000 foot depth cited by the speaker. In a recent hydrocarbon resource workshop in Richland, WA, Mr. Curtis Canard, a certified petroleum geologist representing the Council of Energy Resource Tribes, stated that DC-1, at about 5,600 feet, was the deepest borehole on the nuclear reservation.

LETTER REPORT

SUBJECT: AIME Columbia Section and Northwest Mining Association monthly meeting, November 17, 1987

BY: Russell G. Raney, Physical Scientist
Western Field Operations Center
Bureau of Mines
Spokane, Washington

Mr. R.W. Leanna and Mr. Alan D. Krug, both of Westinghouse Hanford, were featured speakers at the November, 1987 combined meeting of the Columbia Section of the AIME and the Northwest Mining Association. Mr. Leanna, who is Westinghouse's Manager of Maintenance Training, addressed safety issues pertaining to the operation of the plutonium-producing N Reactor and Mr. Krug, Staff Engineer for Repository Design and Development, discussed DOE's Basalt Waste Isolation Program on the Hanford Reservation. Synopses of the presentations are included.

The synopses were prepared from the speakers' presentations and handout material.

Preface
by
Russell G. Raney

The N reactor, on the Hanford Nuclear Reservation, has been the center of controversy in the Pacific northwest for a number of years. The controversy has intensified recently as the result of the Chernobyl reactor accident and discovery of anomalously high uranium and traces of radioactive iodine in domestic water wells. Further, the Department of Energy has recently released over 10,000 pages of material in which it was admitted that on a number of occasions over the past 40 years, radioactive material has been released to the atmosphere and the Columbia River. Battle lines have been drawn between those who feel that N reactor presents a real and present threat to the health and welfare of people living in the vicinity or down-wind of the reactor, and those who feel the reactor presents no such danger. The latter faction is composed largely of those whose livlihood is directly or indirectly tied to the continued operation of the reactor.

Westinghouse Hanford has recently mounted a public relations campaign in an effort to answer some of the criticisms regarding operation of N reactor and to address public concern pertaining to the possible siting of a nuclear waste repository on the Hanford reservation; Mssrs. Leanna and Krug are a part of that effort.

You Be The Judge of the N Reactor

R. W. Leanna

BACKGROUND

On December 2, 1942, a team of scientists led by Enrico Fermi conducted the first controlled nuclear chain reaction. In the ensuing months, the race to develop nuclear weapons during World War II changed the land in and around Hanford from a quiet desert to a storm of engineering activity.

Hanford was selected as the site for the top secret Manhattan Project in January 1943 as it was remote yet near railroads, had an abundance of water available for reactor cooling, and plentiful electricity from regional hydroelectric plants. Hanford's mission was to produce plutonium for a new weapon that could bring about a swift conclusion of World War II.

Beginning in January 1943 the small farming communities of Hanford and White Bluff were transformed into a construction camp of more than 51,000 scientists, engineers, and workers. The world's first three plutonium-production reactors soon took shape along the Columbia River about 35 miles from Richland.

Two years and three months from the start of construction, plutonium produced at Hanford provided the explosive charge for the world's first nuclear detonation. The test detonation at Alamogordo, New Mexico, was shortly followed by by the use of nuclear weapons on the Japanese cities of Hiroshima and Nagasaki.

By 1964, nine plutonium production reactors, including N reactor which was constructed between 1958 and 1963, were in operation at Hanford. The complex also housed facilities for the entire nuclear cycle, including fuel fabrication, chemical processing, waste management, and research.

Operational diversification at Hanford began in 1965. Between 1964 and 1971, eight of the nine reactors were decomissioned. Hanford gradually changed from a top secret military facility and began to place emphasis on peaceful uses of nuclear power. In 1967, Hanford was selected as the site for the Fast Flux Test Facility advanced reactor.

The last of the single purpose reactors was decomissioned in 1971 leaving only N reactor with its dual purpose of plutonium and electricity production.

By 1975, energy research had become the major thrust at Hanford in which energy sources such as nuclear, geothermal, solar, fossil, wind, and organic waste were investigated.

Hanford's role changed again in 1980 to re-emphasize defense production. Currently about 60 percent of site funding is expended for national defense and 40 percent for energy research and related programs.

N REACTOR

On April 26, 1986, a devastating accident occurred at Chernobyl, in the Soviet Union, that cast a cloud of radioactive material into the atmosphere over northern Europe. The accident also cast a cloud of suspicion over operations of N reactor at Hanford. This cloud of suspicion and doubt acted to diminish public confidence in N reactor operations and impeded production of materials needed for national defense.

N reactor is a light-water cooled reactor that began operations in December 1963. At the time, N reactor was the largest reactor in the world. It is classified as a dual-purpose reactor in that it produces electricity for use within the State and plutonium for nuclear weapons. In times of drought, N reactor has been pressed into service to augment hydroelectric plant production. To date, the reactor has produced over 65 million kilowatts of electricity.

While some limited similarities exist between N reactor and the Chernobyl plant (e. g., both use graphite as a moderator), there are vast differences in design and operation. The major differences are summarized below:

1. The Chernobyl reactor has a slow scram time (emergency shut-down time) that requires as much as 20 seconds for the insertion of control rods. Scram time for N reactor is 1.5 seconds.

2. The Chernobyl reactor is a boiling water reactor that produces steam within its core. Due to a (designed) positive void coefficient, power output increases upon loss of coolant. This, in turn, increases the boiling rate and results in further loss of coolant; power "automatically" increases in an upward spiral. This is essentially what occurred in 1986. Chernobyl's power output went from about 200 megawatts thermal to about 350,000 megawatts thermal in a matter of 6-10 seconds; a power rate 111 times the reactor's design capacity. N reactor, on the other hand, decreases power levels and starts to cool down immediately on loss of coolant, a design feature known as "negative void coefficient". Further, N reactor's core is pressurized; the coolant does not boil.

3. The Soviet reactor is very unstable at low power levels; N reactor is stable at all power levels as it is equipped with a number of control systems to maintain stability.

REACTOR CONTROL

N reactor is equipped with 1,003 process tubes each containing 16 fuel elements for a total of 16,048 elements. The control system consists of 84 boron control rods that are inserted horizontally using hydraulic power. The Soviet reactor uses a system in which control rods are inserted vertically from the top using gravity. This accounts for the large time difference in scram time; 1.5 seconds for N reactor and 20 seconds for the Russian reactor.

A backup control system in N reactor consists of 107 hoppers containing a number of boron balls mounted above access channels on top of the core. In the event a control rod fails to complete its insertion within the allotted 1.5 seconds, the balls are automatically released into the core effecting an immediate cecession of the fission process.

Since the Chernobyl accident, N reactor has been the focus of investigations, inquiries, reviews, and technical studies by more than 50 agencies and institutions. These include the State of Oregon, the General Accounting Office, the Roddis Commission of six independent consultants, the National Academy of Science, Energy Department internal reviews, and others. A majority of the reviewers concluded that N reactor was operationally safe; all reviewers stated that an accident such as that at Chernobyl cannot happen at N reactor.

The recently released report of the National Academy of Science pertaining to N reactor was positive; it did not point out any reasons why the reactor should be considered unsafe. Several points pertaining to "enhanced safety procedures" were, however, recommended. One was the need for a DOE safety committee to review operational and safety procedures; this is currently being emplaced.

One hundred fifty seven of the 228 recommendations of the many reviews and studies have been implemented at N reactor. A number of these were incorporated into an enhanced safety program. "Enhanced" safety does not mean that the reactor or operating procedures in the past have been less than safe. The speaker likened the program to the installation of a fire alarm system in a newly-built house; the house is inherently safe (provided it met all building and safety codes) but the alarm system acts to enhance that safety.

The reactor has been shut down since January to effect changes and recommendations promulgated by the various reviewing agencies; start-up is slated for March, 1988. An Environmental Impact Statement pertaining to safety and the scheduled start-up is in the process of preparation and will be released in about a year, minimum (emphasis added).

A number of features and facilities have been installed or are in the process of implementation or construction. These include:

o A liquid effluent retention facility to contain reactor fluids in the event it is necessary to use the emergency core cooling system. The retention facility consists primarily of a large excavation that is lined and covered to prevent percolation of contaminated water into the subsurface and to prevent escape of radionuclides into the atmosphere.

o A hydrogen monitoring system has been installed in the reactor and containment structures.

o A hydrogen mitigation system is being installed. This acts in conjunction with the monitoring system to inject non-reactive nitrogen into the containment to dilute any build-up of potentially explosive hydrogen.

o Integrity tests of the confinement system. N reactor has a <u>confinement</u> system designed to confine to the immediate area any contaminants that may be released from the reactor in the event of an accident. The Chernobyl reactor, however, used a <u>containment</u> system around various components of the reactor. The system was designed to limit the spread of contaminants to those areas so protected. The reactor itself was not a part of the containment system, it was surrounded by a steel shell that failed during the course of the accident and allowed the escape of radioactive material.

o A supplementary emergency core cooling system has been added and a procedure emplaced to inspect the emergency cooling dump tanks.

N REACTOR ECONOMICS

Were N reactor shut down today, over 3,000 jobs would be lost; another 3,000 jobs, mostly those within the reservation that support N reactor activities, would be lost 90 days hence. A ripple effect throughout Washington state would account for another 16,000 lost jobs; these include suppliers, subcontractors and so forth. An estimated tax revenue loss of $47 million would be expected.

Personal Observations

The author did not address documented releases of radionuclides to the atmosphere nor did he address the current flap pertaining to the presence of radioactive iodine in local groundwater. The presentation may have acted to instill confidence in the audience that N reactor would not go berserk as did Chernobyl but did nothing to allay fears of the long-term effects of radionuclides released by the facility. Throughout the presentation, the author underscored the dire economic results of a permanent shut-down of the reactor. He seemed to pose the question, "Would you rather take your chances on our ability to run a tight ship or face the horror of unemployment, welfare, and greatly increased taxes?"

Basalt Waste Isolation Program
by
Alan D. Krug

The Basalt Waste Isolation Program (BWIP) is operated for the Department of Energy (DOE) by Westinghouse Hanford. Design activities for the project have been conducted by a consortium of several engineering firms.

The project itself is rather large with an operating budget of over $100 million and a staff of more than 800 people. The largest staff component is in the geotechnical disciplines of geology, geophysics, geochemistry, hydrology, and mining engineering. This is probably the largest collection of geotechnical people in the northwest.

The prime concern of BWIP is the final disposal of nuclear waste. This problem, essentially, began in Chicago in 1942 with the first reactor beneath the University of Chicago football stadium. Since that time, the problem of waste disposal has been with us; it hasn't been resolved.

Currently, more than 100 nuclear reactors are producing waste. By the turn of the century, more than 50,000 metric tons of waste will require disposal. This is a problem, waste currently being generated and that generated in the past must be stored at the reactor site. At most reactor sites, waste is stored in water. Further, most sites have limited storage capacity. As time goes by, the need for a permanent disposal site becomes more critical. The ultimate concern is to develop a safe system for disposal of the waste.

The system now under consideration is one of disposal in a deep geological repository wherein wastes are constrained from reaching the biosphere for a period of 10,000 years. This 10,000 year timespan was selected as it is approximately the amount time required for the spent fuel to reach the radiation level of the original uranium ore (not concentrated uranium oxides) used as fuel. A real problem is to find a certifiable location that would safely confine the waste for the 10,000 year period.

In the 1970's, there were a number of activities underway within the government to select a disposal system. Proposed disposal systems included firing the waste into deep space or into the sun via rocket, dropping it into the deep oceans, and a variety of other systems. For many reasons, these systems were discarded and it was decided to opt for deep burial within a geologic repository.

The search for a geologic burial site began in earnest during the Carter Administration in which several rock types across the Nation were studied for their suitability as a repository. Crystalline and shaley rocks along the east coast from Georgia to New Hampshire and in the Great Lakes area, salt deposits along the Gulf Coast and in the Texas Panhandle and Utah, volcanic tuff deposits in Nevada, and basalt accumulations in Central Washington were studied. Sties selected for possible characterization were narrowed down to those in Deaf Smith County, Texas (salt), Yucca Mountain, Nye County, Nevada (welded tuff), and the nuclear reservation at Hanford (basalt).

The program at Hanford began in 1976. Between that year and 1982, a number of surface and subsurface facilities were installed. In 1982, the program was formalized with the passage of the Nuclear Waste Policy Act. This Act is currently the guiding force behind the disposal program. One of the important aspects of the Act was to place the economic burden of waste storage in the hands of the utilities producing the waste. This precludes the necessity of a general tax increase to support the program

BWIP has two specific objectives: 1) to determine the feasibility of the site for a repository, and 2) to develop the needed engineering technology to be employed should the site be selected.

Of particular interest to BWIP (regarding feasibility) is the Pasco Basin, site of the thickest accumulation of Columbia River Basalt (CRB). Boreholes more than 10,000 (sic) feet deep have been drilled in the Pasco Basin without penetrating the basalt; from most indications, the basalt may persist to 15,000 feet. The proposed repository horizon would be at a depth of about 3,000-3,2000 feet beneath the surface in the Cohassett flow.

The hydrologic aspects of the basalt site are of great interest to BWIP workers. One of their interests and priorities is to accurately determine the age of the water beneath the site. This would aid in selecting a specific area in which the waste will remain in place or, if transported by ground water, take at least 10,000 years for the radionuclides to reach the biosphere. Much of the preliminary information gathered so far indicates a ground water age of about 100,000 years. This indicates that it takes a long time to recharge the area.

Another hydrologic interest concerns ground water chemistry. The chemistry of the ground water must be determined in order to anticipate what reactions may occur between the water, waste, and other engineering components of the repository.

Movement of the ground water beneath the site is also of interest to BWIP personnel. A series of hydrologic test wells have been drilled to moderate depths to determine the direction and rate of ground water flow.

In 1978, a near-surface test facility was constructed at a depth of about 150 feet within the Pomona flow that outcrops on Gable Mountain. The purpose of the facility was to allow geophysical, geochemical, engineering, and other tests to be conducted in basalt. Although conditions in the facility do not reflect those at repository depths, it does provide an opportunity to conduct certain tests that do not require such conditions. Most of the activities at the near-surface test facility have been oriented toward developing the technology, equipment, and procedures needed for deep testing and site characterization.

Presently, BWIP is preparing a site characterization program to identify the types of information they need to collect in order to determine whether the site is feasible for a repository. A site characterization plan, that includes, among other things, the methods that will be employed to collect the needed information, is being prepared. The document will be released to certain reviewing agencies in early 1988 and to the public about a year later.

Post-Presentation Questions

Question: In your estimation, what are the probabilities of hydrocarbon resources existing beneath the Hanford reservation?

Answer: Some natural gas was found in the Rattlesnake Hills in the 1930's but this seems to be an isolated pocket. The reservation is situated above a syncline and most oil or gas that may have been generated probably migrated up dip toward the margins of the basin. That is why the current exploration effort (Shell, AMOCO, Tyrex, etc.) is concentrated there.

Question: If hydrocarbons that may have been generated in sub-basalt sediments have migrated up dip from the central portion of the basin, why would the major oil companies want to conduct exploration programs on the reservation? Why have 145 applications to the DOE to conduct such activities been denied?

The speaker declined to address the questions.

Personal Note

I am not aware of any borehole on the reservation that comes anywhere near the 10,000 foot depth cited by the speaker. In a recent hydrocarbon resource workshop in Richland, WA, Mr. Curtis Canard, a certified petroleum geologist representing the Council of Energy Resource Tribes, stated that DC-1, at about 5,600 feet, was the deepest borehole on the nuclear reservation.

PDR-1
LPDR WM-10(2)
WM-11(2)
WM-16(2)

WM DOCKET CONTROL
CENTER

'87 NOV 30 A10:13

WM-RES
WM Record File
D1018
BOM

WM Project 10,11,16
Docket No. ____
PDR ✓
x LPDR ✓ (B,N,S)

Distribution:
CAbrams

(Return to WM, 623-SS)