Nevada Test Site

Nuclear Rocket Research

March 2001

President Kennedy departs the Rocket Development Station after viewing a full-scale mock-up of a NERVA (Nuclear Engine for Rocket Vehicle Application) engine on December 8,1962 at the Nevada Test Site.

Introduction

The idea to use atomic energy to propel a rocket for interplanetary travel was born in 1906 when American space pioneer Robert Goddard, a college sophomore, wrote a paper on the use of atomic energy. The concept moved from theory to reality in the mid-1950s when the United States launched a nuclear rocket program called Project Rover. Area 25 in the southwest corner of the Nevada Test Site was chosen as the location for the nuclear reactor and engine tests. The Atomic Energy Commission (AEC) and the National Aeronautics and Space Administration's (NASA) Space Nuclear

Propulsion Office jointly administered the test area, later called the Nuclear Rocket Development Station (NRDS).

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More than $140 million was spent from 1958 to 1971 on facility construction and equipment. NRDS consisted of three test stands: A, C, and ETS-1 (Engine Test Stand-1). The complex also included R-MAD (Reactor Maintenance, Assembly, and Disassembly), E-MAD (Engine Maintenance, Assembly, and Disassembly), a control point/technical operations complex, an administrative area and a radioactive material storage area. The three test cell areas were connected by road and railroad to the R-MAD and E-MAD buildings. Typically a reactor or engine was put together in one of these buildings and then transported to a test cell by the Jackass and Western Railroad (jokingly called the world's shortest and slowest).

Constructed in1965 at a cost of more than $50 million, the E-MAD facility was the largest "hot cell" in the world. The building is 80 feet high with 100,000 square feet of floor space. The hot bay, used to receive and store radioactive materials, is 140 feet long, 66 feet wide, and 76 feet high. The walls are five to six feet thick and contain 17 lead glass shielding windows. The 32-inch-thick concrete roof is designed to reduce the scatter of radiation to exterior work areas.

Project Rover employed a workforce of 1,800 representing government and industry. A total of 13 research reactors and six NERVA (Nuclear Engine for Rocket Vehicle Application) reactors/nuclear engines were assembled, disassembled and tested at the NRDS. The Rover Program proved that a nuclear reactor can be used to heat liquid hydrogen for spacecraft propulsion. Instead of burning hydrogen with oxygen as an energy source for propulsion, as in a space shuttle's chemical rockets, the nuclear rocket used a nuclear reactor to heat hydrogen to extremely high temperatures, resulting in rapid expansion and discharge of exhaust out of the rocket's nozzle. A space craft powered by a nuclear rocket has a greater thrust to weight ratio and approximately twice the engine efficiency of a chemical rocket. The nuclear reactor used in the Rover Program was a hydrogen-cooled, solid-core reactor employing enriched uranium-235 as nuclear fuel.

Research reactors developed to demonstrate the basics of nuclear rocket reactor technology were known as the Kiwi, Phoebus, and Pewee Series. The reactors were designed to study high-temperature fuels and long-life fuel elements. The Rover Program also included NERVA – an effort to discover the characteristics of the NRX and XE reactor engines during start up, full power, and shutdown conditions.

In 1963, the in-flight test program was cancelled. Based on the test results, designs were begun for a nuclear rocket using a high-power, high-thrust NERVA engine and a low-power, low-thrust, small engine. In 1969, however, the Saturn V launch vehicle program considered the primary launch vehicle for a nuclear rocket was cancelled as a result of a decision to abandon human exploration of Mars that had been planned as a follow-on to the Apollo lunar landings. The decision eventually resulted in the termination of the Rover Program in 1973. The Rover Program, however, developed to the point of in-flight engine development and testing without any technical barriers to the successful development of a nuclear rocket. Moreover, much of the Rover Program could be applied today, given the advances in computers and materials technologies.

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