CULTURAL RESOURCES REPORT COVER SHEET

Author: DAVID HARVEY

Title of Report: Washington State University Modified TRIGA Nuclear Research Reactor Building

Date of Report: September 21, 2010

County(ies): Whitman Section: 33 Township: 15 Range: 45 E

Quad: Pullman Acres: 20,000 sq. ft.

PDF of report submitted (REQUIRED) ☒ Yes

Historic Property Export Files submitted? ☒ Yes ☐ No

Archaeological Site(s)/Isolate(s) Found or Amended? ☐ Yes ☒ No

TCP(s) found? ☐ Yes ☒ No

Replace a draft? ☐ Yes ☒ No

Satisfy a DAHP Archaeological Excavation Permit requirement? ☐ Yes # ☒ No

DAHP Archaeological Site #:

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- Please submit paper copies of reports ***unbound.***
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Washington State University Modified TRIGA Nuclear Research Reactor Building

Section 106 Technical Report

SEPTEMBER 21, 2010

PREPARED BY:

ENTRIX
Down to Earth. Down to Business.™

ENTRIX, Inc.
1835 Terminal Dr.
Ste. 130B
Richland, Washington 99354

PREPARED FOR:

Pacific Northwest
NATIONAL LABORATORY

Battelle Memorial Institute,
Pacific Northwest National Laboratory
902 Battelle Boulevard
Richland, Washington 99352

Table of Contents

Figures

SECTION 1 INTRODUCTION

ENTRIX, Inc. (ENTRIX) prepared this Cultural Resources Section 106 Technical Report for the Pacific Northwest National Laboratory (PNNL) as part of an agreement to provide cultural resources technical support to PNNL. This report documents and evaluates the Washington State University (WSU) Modified one-megawatt (1 MW) Training, Research, Isotopes, General Atomics (TRIGA) Nuclear Research Reactor Building (Figure 1), located in Pullman, Washington (Figure 2) for eligibility for listing in the National Register of Historic Places (NRHP), and includes a historic context, historic property inventory documentation, project effects, and mitigation measures.

1.1 Project Purpose and Description

The WSU submitted an application to the Nuclear Regulatory Commission (NRC) for the renewal of its Facility Operating License No. R-76 for the Nuclear Research Reactor (Figure 3). Issuance of a renewed license would authorize operation of the reactor for an additional 20 years. In accordance with the National Environmental Policy Act (NEPA), NRC is completing an Environmental Assessment for the licensing action. As part of requirements under Section 106 of the National Historic Preservation Act (NHPA), the Washington Department of Archaeology and Historic Preservation (DAHP) requested that the NRC perform and submit a cultural resource survey along with a historic property inventory (HPI) report. NRC requested that the PNNL provide technical services to assist the NRC in conducting portions of the environmental review for the license renewal of the Nuclear Research Reactor, and specifically, to perform a cultural resource survey and historic property inventory documentation as part of NRC's obligation under Section 106 of the NHPA. PNNL contracted with ENTRIX to conduct a cultural resources assessment of the reactor, prepare a Section 106 technical report, and prepare a HPI for the reactor. The technical report also includes a determination of NRHP eligibility and an assessment of the impacts of license renewal upon the nuclear research reactor. The format and content of the report and the HPI follow the Washington State Standards for Cultural Resource Report as established by the DAHP.

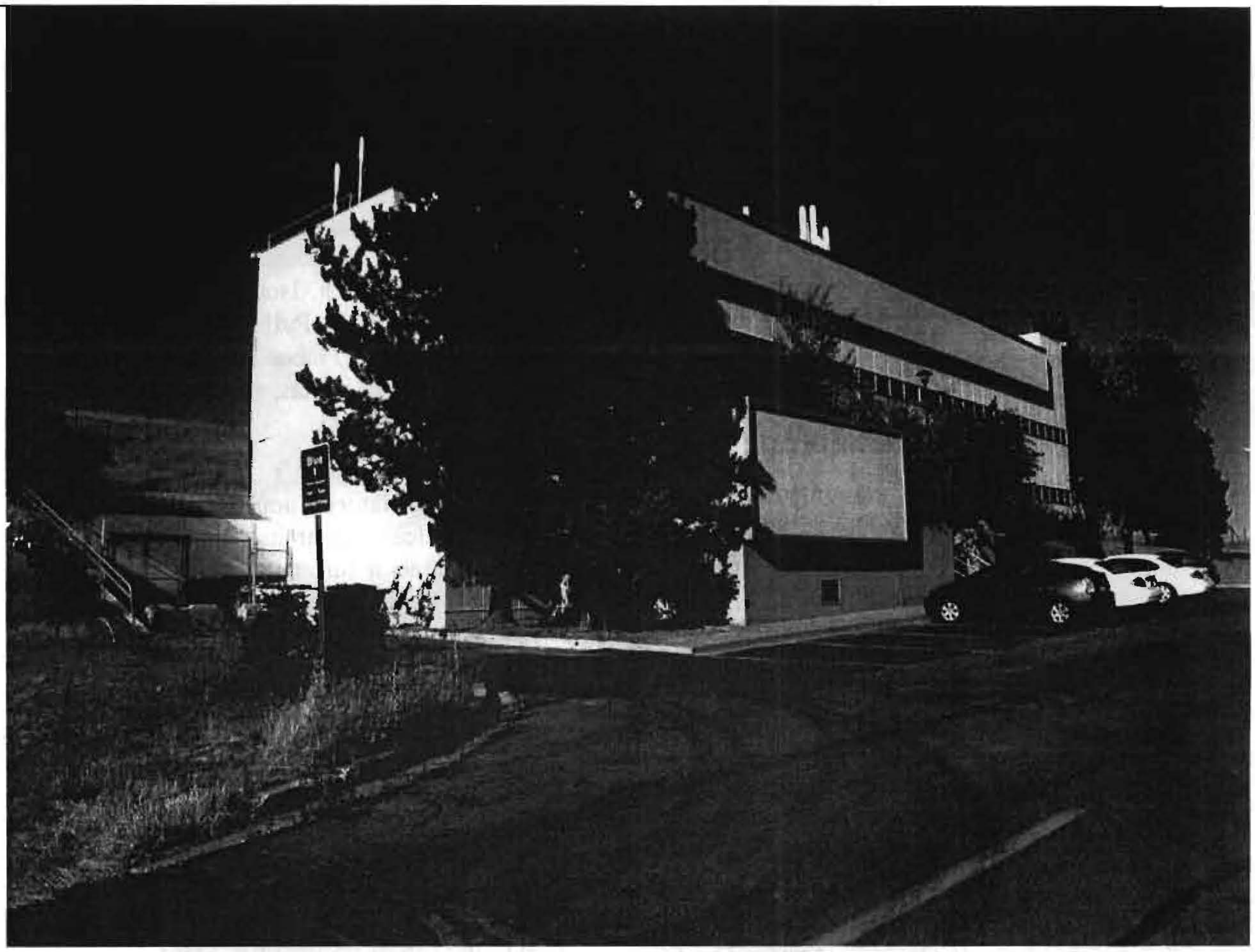

Figure 1. WSU TRIGA Nuclear Research Reactor Building (Radiation Center), West and South (Front) Elevation (ENTRIX 2010)

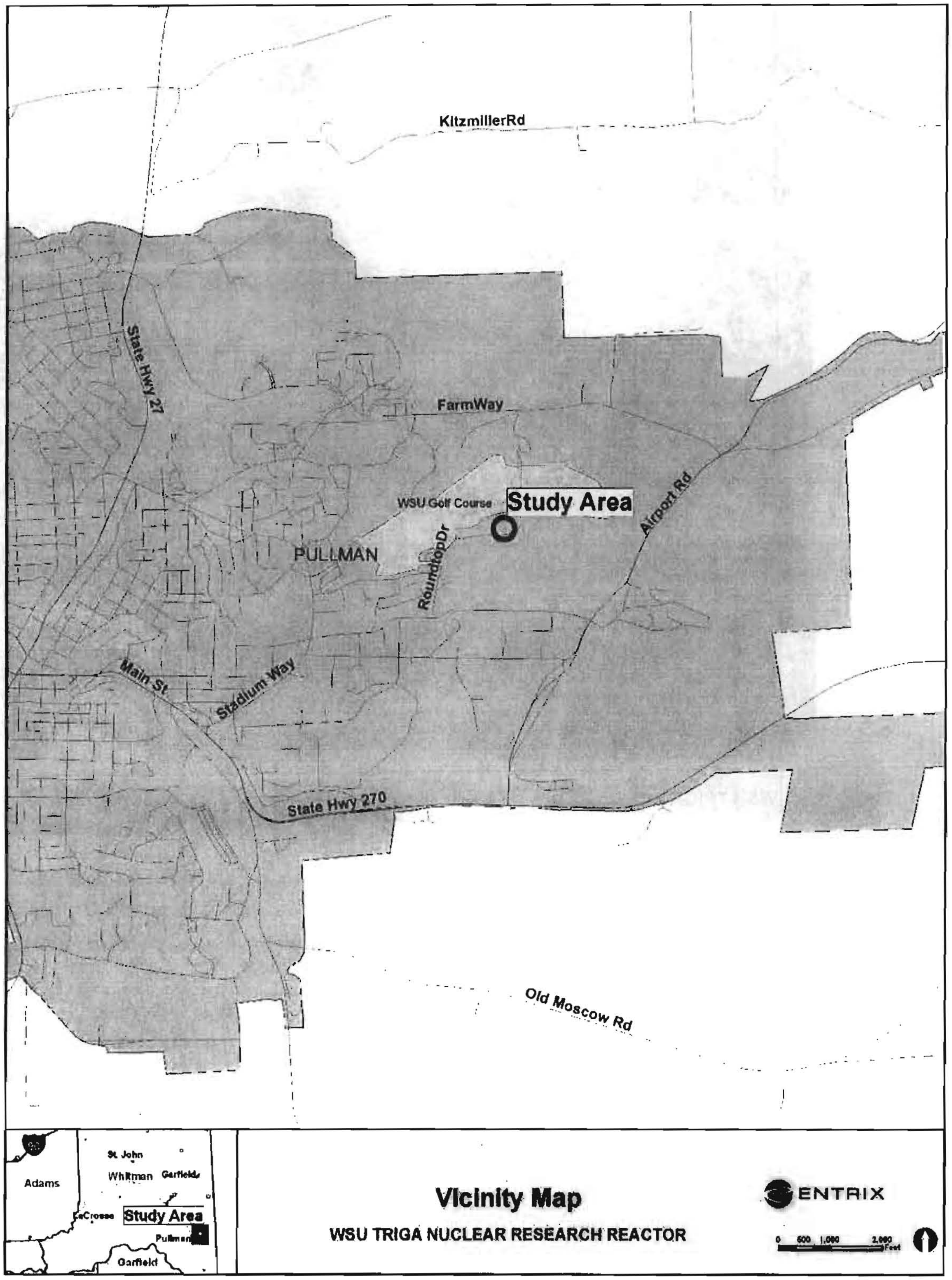

Figure 2. Vicinity Map

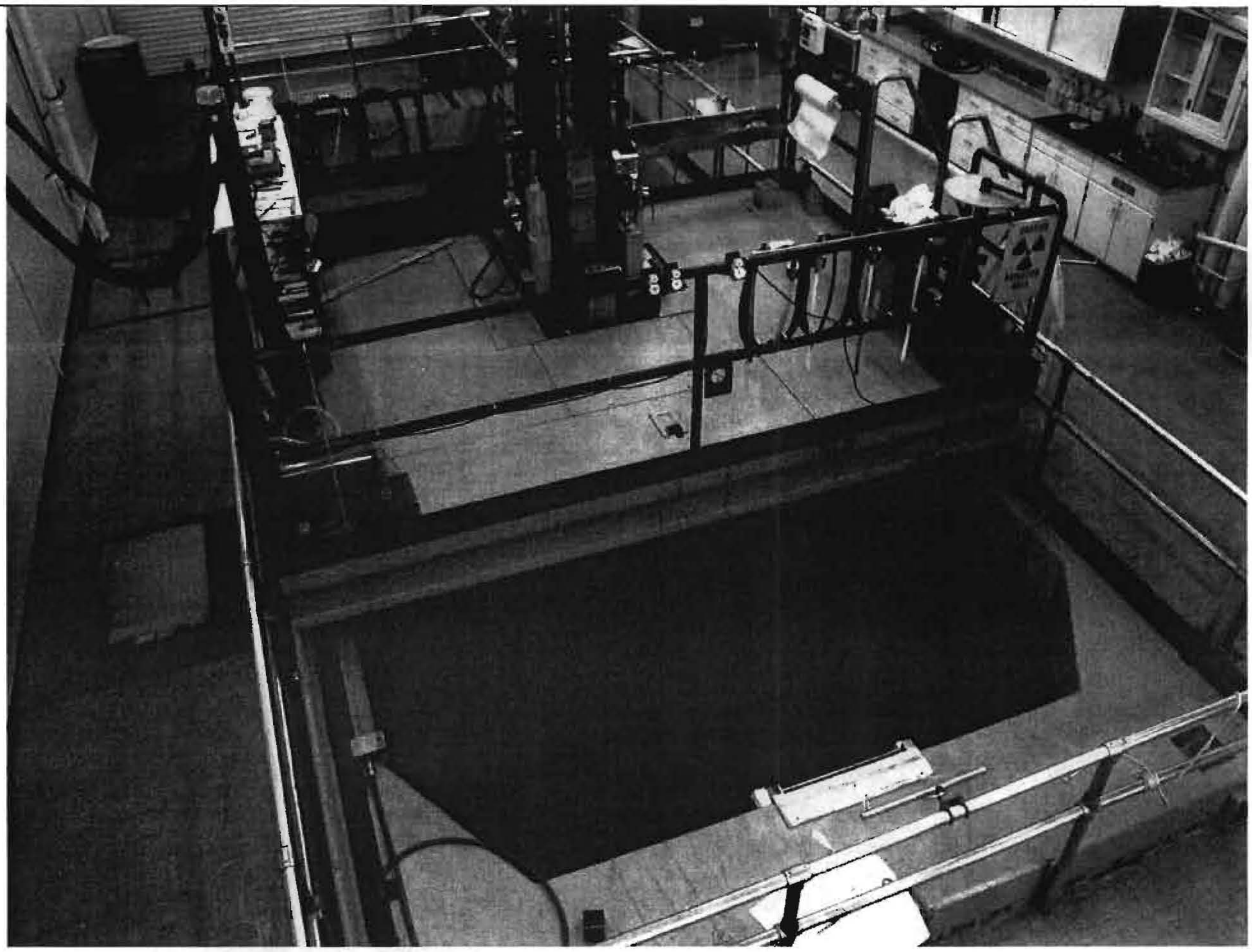

Figure 3. WSU TRIGA Nuclear Research Reactor, Pool, and Bridge (ENTRIX 2010)

SECTION 2 CULTURAL RESOURCES REGULATIONS AND AGENCY COORDINATION

The Project is being conducted in compliance with Section 106 of NHPA, the NEPA, and the Washington State Environmental Policy Act (SEPA).

The following discussion briefly describes the federal and state environmental laws and regulations that govern the cultural resources review process for this Project.

2.1 Federal and State Regulations

Under NEPA, federal agencies must evaluate impacts to cultural resources which includes prehistoric and historical resources before a project is approved. Section 106 of the NHPA of 1966, as amended, requires that any federal or federally-assisted project, or any project requiring federal licensing or permitting, take into account the effect of the undertaking on historic properties defined as cultural resources that are eligible for, or listed in, the NRHP. The regulations that govern the implementation of the NHPA (36 CFR Part 800.8) allow for combining NEPA and Section 106 studies in an effort to streamline the environmental compliance process. The NRC is the lead Federal Agency for this project under NEPA and NHPA.

The NRHP, created under the NHPA, is the federal list of historic, archaeological, and cultural resources worthy of preservation. Resources listed in the NRHP include districts, sites, buildings, structures, and objects that are significant in American history, prehistory, architecture, archaeology, engineering, and culture. The NRHP is maintained and expanded by the National Park Service on behalf of the Secretary of the Interior. The DAHP in Olympia, Washington administers the local NRHP program under the direction of the State Historic Preservation Officer (SHPO). To guide the selection of properties included in the NRHP, the National Park Service has developed the NRHP Criteria for Evaluation (36 CFR Part 60.4). The criteria are standards by which every property that is nominated to the NRHP is judged. The quality of significance in American history, architecture, archaeology, and culture is possible in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, material, workmanship, feeling, and association, and meet one of the following criteria:

Criterion A: Are associated with events that have made a significant contribution to the broad patterns of our history; or

Criterion B: Are associated with the lives of persons significant in our past; or

Criterion C: Embody the distinctive characteristics of a type, period, or method of construction or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components make lack individual distinction; or

Criterion D: Has yielded, or may be likely to yield, information important in prehistory or history.

Archaeological sites are primarily assessed under Criterion D. Buildings less than 50 years old do not meet the NRHP criteria unless they are of exceptional importance under Criterion Consideration G, as described in the National Park Service Bulletin No. 22, "How to Evaluate and Nominate Potential National Register Properties That Have Achieved Significance Within the Last 50 Years."

The Washington SEPA (RCW 43.21C) and implementing rules contained in the Washington Administrative Code (WAC 197-11) also apply to this Project. These rules require the identification of historic, archaeological, and cultural resources listed on or eligible for the national, state, or local registers. Measures must be considered to reduce or control impacts to identified historic properties affected by a proposed project.

2.2 Determination of the Area of Potential Effect

In compliance with NHPA, this study evaluates the NRHP eligibility of cultural resources that are at least 50 years of age and are located within the Area of Potential Effect (APE) or the "geographic area or areas within which (the) undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist" (36 CFR 800.16(d)). This study identifies issues relating to the Project's potential effects on historic properties in the APE.

For this cultural resources study, the Project APE is confined to location of the WSU Modified TRIGA Nuclear Research Reactor Building (also known as the Nuclear Radiation Center), as depicted in Figure 4. The reactor building is located on Round Top Drive east of the center of the WSU campus and approximately one and one-half miles from the center of Pullman, Whitman County, Washington.

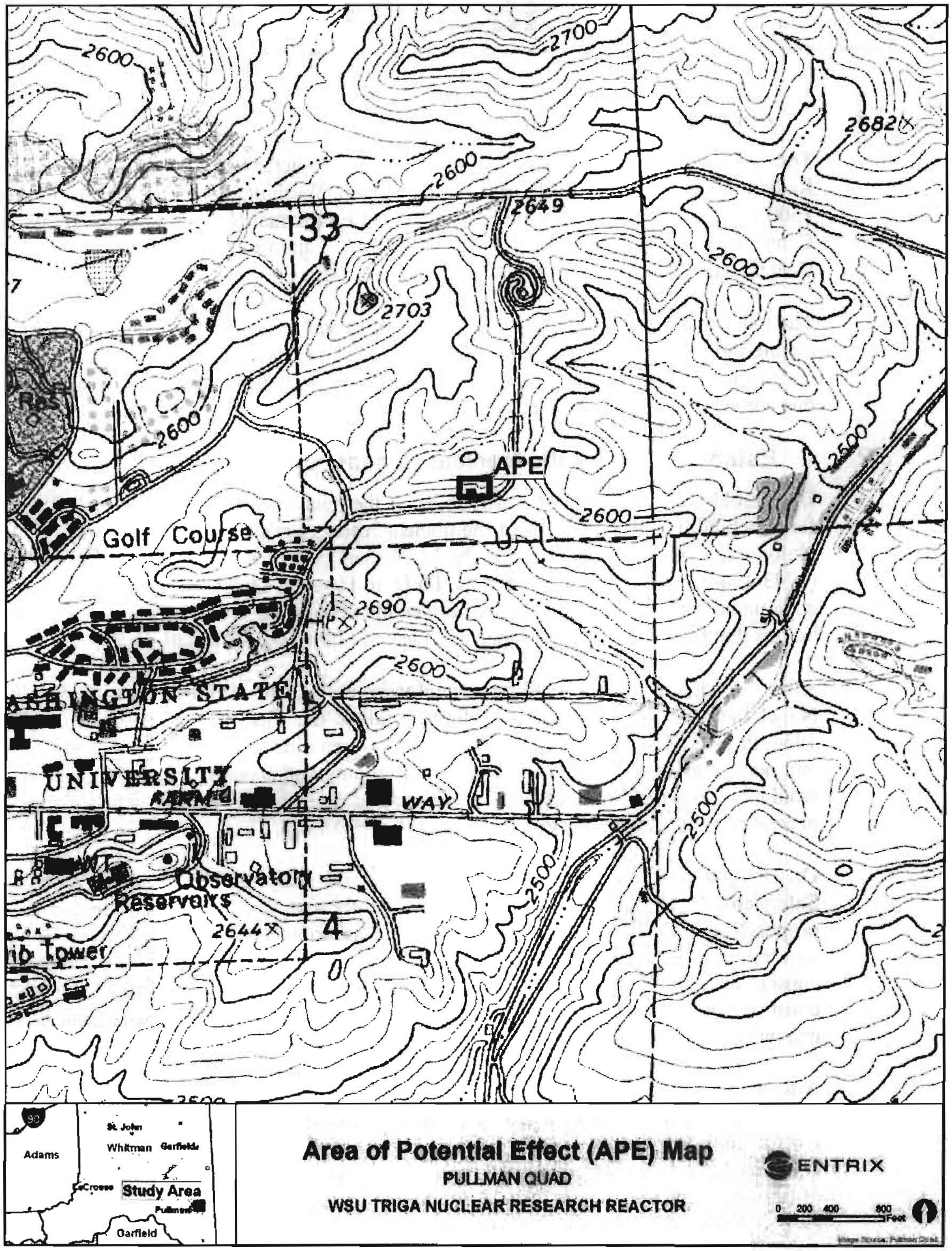

Figure 4. Area of Potential Effect Map

SECTION 3 HISTORY

3.1 Location and Setting

The WSU Modified TRIGA Nuclear Research Reactor is housed in the university's Nuclear Radiation Center on the WSU campus in Pullman, Washington. The Radiation Center also houses a 1500 Curie Cobalt-60 Irradiation Facility and an Epithermal Neutron Capture Treatment Facility. The Center is a specialized research facility under the authority of the WSU Office of Research. The Center is also home to the WSU Radiation Safety Office (Wall 2010).

The Palouse region surrounding the WSU campus and the town of Pullman is a rural agricultural area devoted to dry land farming. The reactor, adjacent to cultivated wheat fields and the Palouse Ridge Golf Course, is located on Round Top Drive east of the center of the WSU campus and approximately one and one-half miles from the center of Pullman.

3.2 Establishment of the Nuclear Research Reactor

Dr. Harold Dodgren, chemist and founder of the nuclear reactor program at WSU, was the primary force behind the establishment of the nuclear research reactor at the university. Dodgren assisted in plutonium production research for the Manhattan Project at the University of California, Berkeley (1943-1946), where he later earned his Ph.D. in Physical Chemistry. The Manhattan Project was the code name for the United States program conducted during World War II to develop the first atomic bombs that led to the defeat of Japan and the end of the Second World War.

After the war, Dodgren worked for several years at the Institute for Nuclear Studies in Chicago under Nobel Laureate Dr. W. F. Libby before he joined the Chemistry Department at WSU in 1948. In 1954, the WSU Board of Regents appointed Dodgren director of the nuclear reactor program at WSU, and he was assigned the task of designing, building and securing funds for the reactor facility. "He would be responsible for obtaining engineering design specifications and working out the details necessary to construct a nuclear reactor" (Croteau 2000, p. 2).

Dr. Dodgren and the General Electric Company, the contractor for the project, prepared a classified Safeguards Report for the Atomic Energy Commission (AEC) that contained a description of the proposed reactor facility and the calculation of hazards to the surrounding area in case of a nuclear accident at the facility (Croteau 2000). Dodgren and WSU proposed a swimming pool type reactor, chosen for its inherent safety features, adaptability to extensive nuclear research, and cost of construction (Croteau 2000). As a safety precaution, the reactor was located away from the center of campus and the town of Pullman.

After the submission of the Safeguards Report to the AEC, WSU filed an Application for Facilities License in 1955. Once the AEC approved the application and issued the license, construction of the reactor commenced in 1957. Dodgren oversaw the design and building of the reactor, which was completed two years later. In 1961, the AEC approved the fuel request of 4.0 kilograms (nine pounds) of fully-enriched U-235 to power the reactor, and issued the reactor operating license to the university (WSU 1998). The highly enriched Uranium 235 was encased in 30 aluminum alloy jackets approximately 40 inches long (WSU 1998). When the reactor was activated, the jackets or fuel assembly were plugged into a grid plate located at the bottom of a 70,000 gallon capacity pool of demineralized water.

When the reactor became operational in 1961, it joined the Massachusetts Institute of Technology, the University of Michigan, Pennsylvania State University and North Carolina State University as the five college campuses to house research reactors with a maximum capacity of one MW.

3.3 Atoms for Peace

The establishment of the nuclear research reactor at WSU had its origins in the Eisenhower administration's "Atoms for Peace" program. President Eisenhower's speech to the United Nations in 1953 stressed the need to apply atomic energy to the needs of agriculture, medicine and other non-military activities. The "Atoms for Peace" program led to initiatives across the country to establish nuclear research reactors on college campuses. Most of the research reactors were built with the assistance of federal funds during the 1950s and 1960s to pursue the peaceful uses of nuclear power (Rabinowitz 2005). The WSU reactor was constructed using funding from the AEC and a National Science Foundation (NSF) grant supported by the Atoms for Peace program.

The Atoms for Peace initiative permitted the use of uranium outside of government laboratories but only after strict design, structural, environmental, maintenance, personnel, and safety guidelines were met and documented. WSU prepared extensive studies, inspections, reports, applications for funding, and variety of building and operating studies prior to being issued the permit to operate its research reactor (Croteau 2000).

Directed by the Atoms for Peace program, the AEC pursued the development of practical applications for nuclear energy that included the establishment of nuclear research reactors and nuclear engineering programs on college campuses. The proximity of WSU and the University of Washington (UW) to the Hanford Nuclear Site and the exchange of staff between Hanford and the two universities enhanced the ability of the two state institutions to obtain federal grants for the construction of research reactors on both campuses (Martin 2008).

Research reactors on university campuses became common place by the late 1950s. The early 1960s was a boom time for nuclear engineering programs at the college level. By 1968, over 75 nuclear reactors were in operation at universities in the U. S. (Martin 2008). North Carolina State became the setting for the first university-based reactor in the world in 1953, followed by Pennsylvania State University in 1955.

Between 1960 and 1965, nine college-campus reactors came on-line in the U. S., including WSU and UW in 1961, preceded by Idaho State (1967), Oregon State (1967), and Reed College (1968) (Martin 2008).

3.4 Reactor Construction and Design

The Atomic Power Equipment Division of the General Electric Company designed and built the WSU nuclear research reactor and fabricated the fuel elements. General Electric had designed and fabricated three other similar reactors in Spain, Venezuela and Taiwan. The company provided consultation and supervised the installation, pre-critical testing, start-up and post-start-up testing of the WSU reactor (State College of Washington 1958). WSU architect Phillip Keane designed the three-story; reinforced concrete Nuclear Radiation Center that houses the reactor. The Center also houses the reactor control room, offices, storage rooms, multiple laboratories and the 27-foot deep pool where the reactor core is immersed. The pool of demineralized water is 30 feet long and 12 feet wide into which the uranium fuel elements are suspended from a bridge at the top of the pool. The bridge spans the width of the pool and is on wheels by which it may be moved to relocate the uranium fuel in the pool. The fuel inserts are placed between the rows of the reflector elements at the bottom of the pool. The reacting "core" is suspended below the surface of the water near the bottom. When looking into the pool, one can see the glowing core (radiation) of the reactor (Balch 1961) (Figure 5).

Nuclear radiation from the reactor core is channeled into laboratories for experimental use through beam tubes and beam ports located below the pool (Spokesman-Review 1959). The reactor provides large quantities of neutron and other radiation through the ports and thermal column openings for research use.

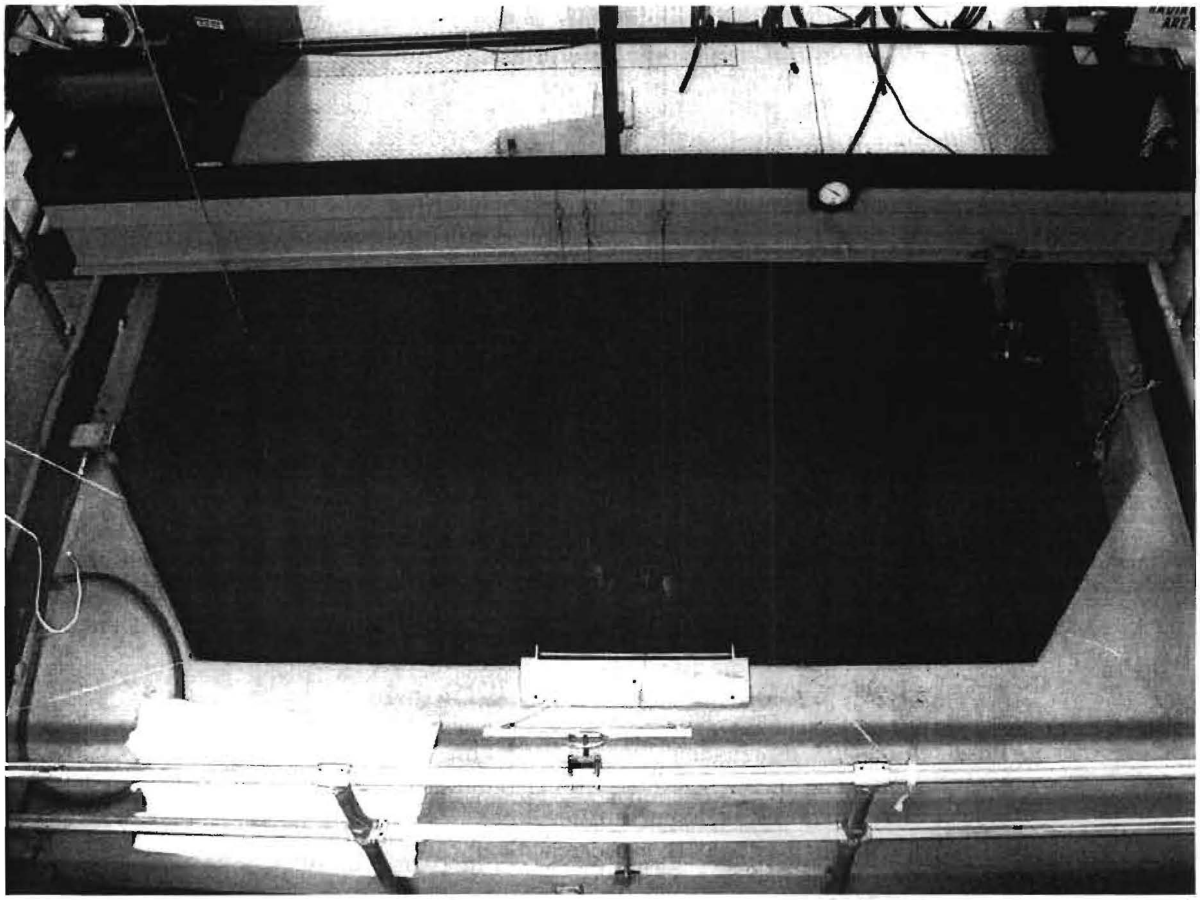

Figure 5. Reactor Pool and "Glowing" Core (ENTRIX 2010)

The reactor pool functions as a protective shield against harmful levels of radiation. The five-foot concrete walls of the pool also act as a shield against the neutrons and gamma rays emitted from the core (Balch 1961).

3.5 TRIGA Reactors

The WSU TRIGA reactor is a swimming pool-type reactor designed for use by universities for student education/training, private commercial research, public service (tours), non-destructive testing and medical isotope production. TRIGA reactors were designed to be safe in the hands of students. The TRIGA fuel was found to be a much safer fuel for use in campus reactors since it is very difficult to "melt down, even under most dire circumstances" (Croteau 2000, p. 8). The TRIGA reactors are reportedly the most widely-used nuclear research reactors in the world (General Atomics 2010). A total of 35 TRIGA reactors were constructed in the U. S., and another 35 were installed in other countries (General Atomics 2010). TRIGA reactors were originally designed to be fueled with highly enriched uranium. Due to national security concerns, however, the Department of Energy (DOE) launched its Reduced Enrichment for Research Reactors program, which promoted reactor conversion to low-enriched uranium (LEU) TRIGA fuel.

3.6 Reactor Conversions and Building Modifications

The WSU nuclear research reactor was originally powered by Material Test Reactor (MTR) plate-type, highly-enriched uranium fuel. In 1966-67, WSU scientists replaced the MTR fuel elements in the grid plate at the bottom of the reactor core with four-rod clusters of TRIGA fuel consisting of U-235 and zirconium hydride ("Grants Enable Reactor Conversion" 1966). During this conversion the reactor operating system was increased from 100 kilowatts to 1000 kilowatts.

In 1976, the reactor was converted to another type of TRIGA fuel. Known as the Fuel Life Improvement Program (FLIP), this highly enriched uranium fuel was used until 2008 when the reactor was converted to a LEU fuel. This conversion was conducted to comply with a 1986 law that required research reactors to no longer use highly enriched fuel since the fuel could be used in nuclear weapons.

In the late 1960s/early 1970s, the Radiation Center underwent several modifications and additions. In 1964, WSU Architect Phillip Keene designed the Radioactive Waste Storage Shed, located adjacent to the north (rear) elevation (Keene 1964). In 1966, Miller and Fiedler Architects of Spokane, Washington designed the Cooling Tower and Pump Room (Figure 6), which is also located behind the main building (Miller and Fiedler 1966). In 1968, Miller and Fiedler designed the three-story addition onto the east elevation and the one story office/reception addition (Figure 7) onto the south elevation (Miller and Fiedler 1968). The additions and modifications doubled the square footage of the Radiation Center and provided additional laboratories, office space, storage rooms, and experimental space (Figure 8). In 1976, the reactor control room was enlarged and partitioned from the pool room into a separate, climate-controlled unit with a modified reactor console (Wall 2010).

In the early 1970s, the Radiation Center acquired a Van de Graff accelerator from the Stanford Research Institute (Croteau 2000). The accelerator was installed on the first floor in the accelerator bay in the 1970s addition. Scientists operated the accelerator from a console in the accelerator control room. The accelerator was capable of producing high-energy neutrons with minimal radioactive by-products; it could be adapted for use in a broad range of research applications. It complimented the reactor's capability of producing a large number and variety of radioactive nuclei. It also did not require an operating license, but at the same time it was expensive to operate, needed constant repair and maintenance, and did not perform any function that could generate revenue. In contrast, the reactor could produce medical isotopes and radiate samples for clients. The accelerator was decommissioned during the late 1970s.

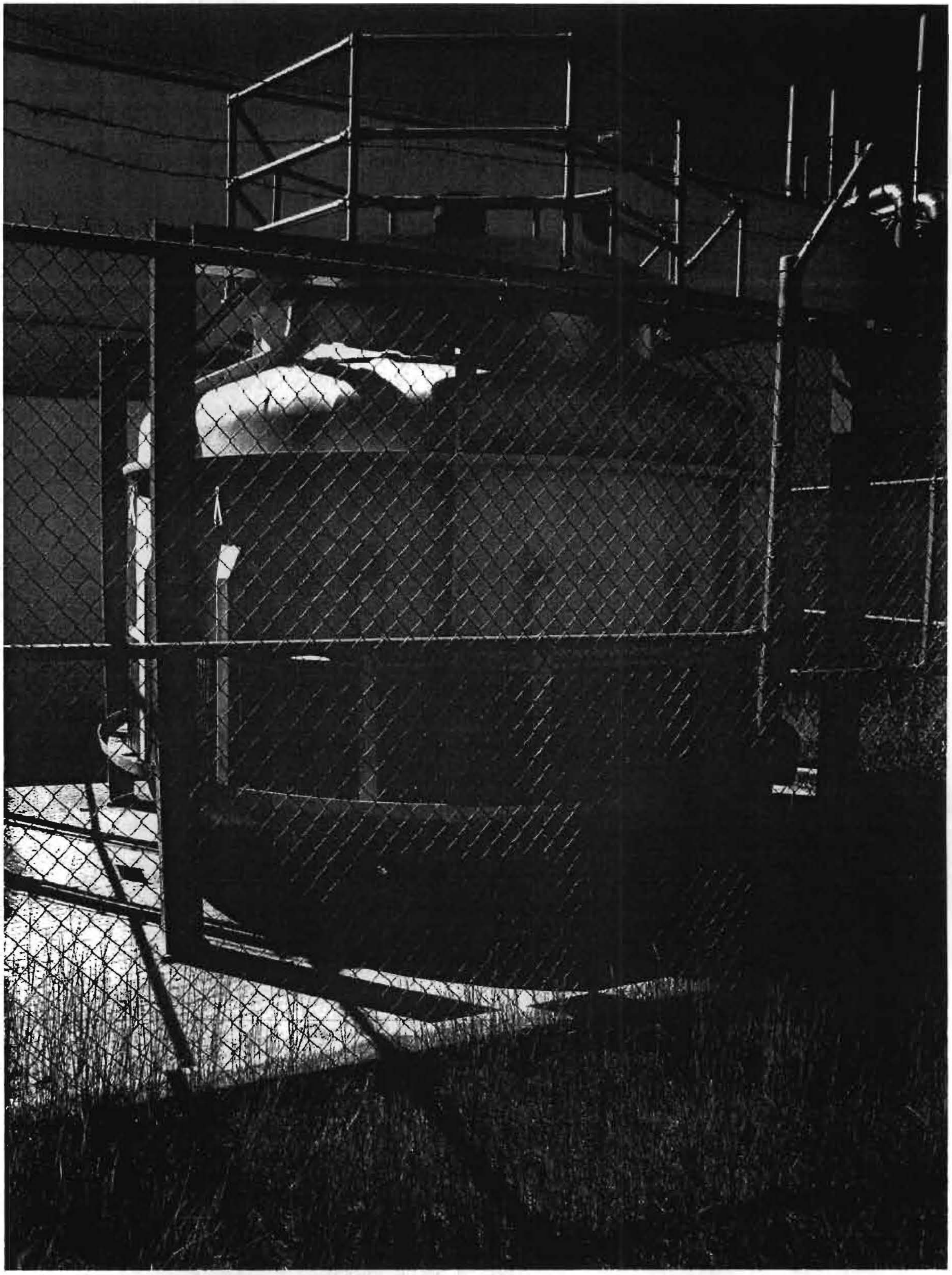

Figure 6. Research Reactor Building Cooling Tower (ENTRIX 2010)

Figure 7. Research Reactor Building and Main Office/Reception Area Addition, South (Front) Elevation (ENTRIX 2010)

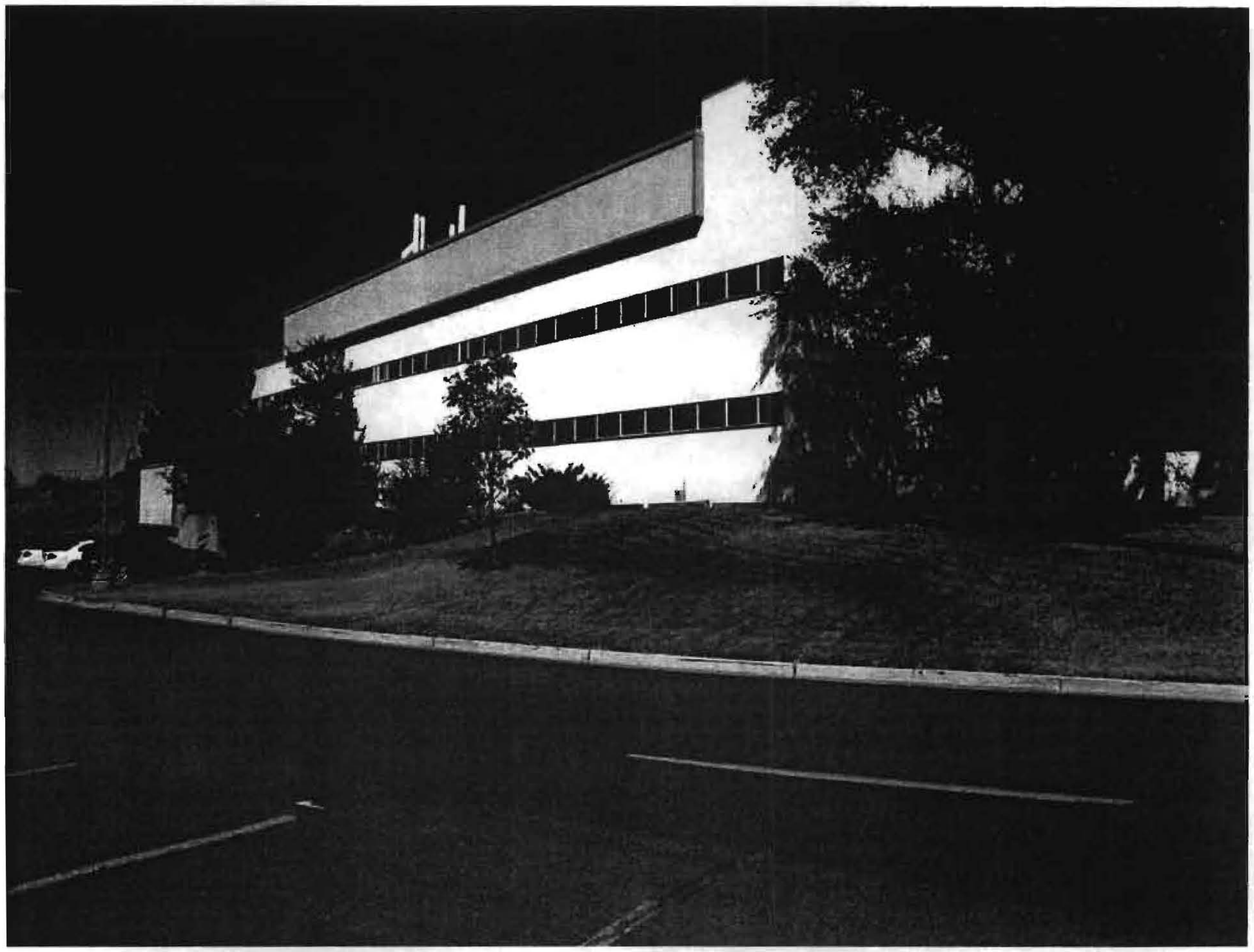

Figure 8. Nuclear Research Reactor Building, South (Front) Elevation (ENTRIX 2010)

3.7 Nuclear Radiation Center

The Nuclear Radiation Center, which houses the TRIGA research reactor, serves as an all-University resource unit, supporting research and graduate education related to nuclear sciences, physics, radiochemistry, elemental analysis, irradiation, medical isotope production, neutron radiography, gamma irradiation, fission track analysis, and neutron activation analysis (NAA). The Center provides facilities for graduate and undergraduate courses in nuclear science for faculty and the student body, including classes in nuclear chemistry, biological research, industrial research, radiation effects on materials, and training of students to be nuclear engineers and reactor operators. Neutron/gamma irradiation services are provided to the university and to other educational institutions throughout the Pacific Northwest, supported by Department of Energy (DOE) funding (Status Report 1998).

On-going projects include research of boron neutron capture therapy for treating brain tumors (Ruddy 1995); air, and soil pollution tracking, isotope generation, trace element analysis, and nondestructive testing. The reactor staff specifically focuses on research, teaching and public service. The Center offers classes in reactor operations, nuclear engineering, and chemistry and physics. There is training in the use of radioactive materials, and the staff arranges for open houses during the fall and spring to educate the public on nuclear science and reactor operations. The staff is also available to conduct outreach programs and presentations to area public schools.

3.8 Previous Studies

On August 31, 2010, ENTRIX staff conducted a cultural resource records search for the project area and vicinity through the Washington Information System for Architectural and Archaeological Records Data (WISAARD) online portal to DAHP in Olympia. No NRHP listed or determined eligible sites were identified within one-quarter mile vicinity of the Project APE. In 1996, there was a cultural resources survey conducted of the proposed Plant Growth Research Center on the WSU campus (Washington State University, Department of Anthropology 1996). The proposed project area was 3.2 acres in area. The survey did not identify any significant cultural resources or traditional cultural properties within the project area.

SECTION 4 METHODS

4.1 Research Methods

As described in Section 3.8, ENTRIX staff conducted a background records search in the DAHP database. Site forms for all previously recorded cultural resources in the Project APE were downloaded electronically. Reports for all previous cultural resources surveys in the Project's immediate vicinity were also downloaded electronically. Researchers also obtained historical data, descriptions of reactor processes, and photographs from the WSU Nuclear Radiation Center's records and files located in the reactor control room. ENTRIX staff also collected copies of building and reactor construction drawings and site plans from the WSU Facilities Development Department. A review of the WSU Nuclear Radiation Center web site provided additional reactor histories and building construction data. Dr. Donald Wall, Director of the Nuclear Radiation Center, also provided historical information and data concerning construction and development of the reactor and the Nuclear Radiation Center.

4.2 Architectural History Field Methods

ENTRIX architectural historians conducted a pedestrian survey of the WSU Nuclear Research Reactor Building on August 31st, 2010. ENTRIX staff took photographs, collected historical data, recorded physical descriptions/architectural features, and prepared a statement of significance on a historic property inventory form for inclusion in the DAHP historic property database. ENTRIX researchers accompanied Dr. Wall on a tour of the building where he provided ENTRIX additional information concerning the uses and historical development of the reactor and the facility.

4.3 Archaeological Resources Field Methods

The WSU Nuclear Research Reactor Building is located in an area that has been previously disturbed by construction of the building, golf course, and cultivated wheat fields. There is, thus, no potential for buried archaeological resources to be located within the Project APE. For these reasons, there was no research or field studies conducted of archaeological resources.

SECTION 5 CULTURAL RESOURCE INVENTORY RESULTS

This section provides a summary of the architectural history survey results. The Nuclear Research Reactor Building is the only architectural history resource located within the APE. An HPI Report documenting the NRHP recommendations for eligibility is attached in Appendix A.

5.1 Historic Property Inventory

WSU TRIGA Nuclear Research Reactor Building

PHYSICAL DESCRIPTION

Exterior:

The construction of the Nuclear Research Reactor and the Radiation Center began in 1957, and was completed in 1959. The reactor became operational in 1961. The Atomic Power Equipment Department of the General Electric Company designed and constructed the nuclear research reactor, which included the fabrication of the fuel elements and the reactor "core, control rods, rod-drive units, bridge and control instrumentation" (State College of Washington 1958, p. 3). Phillip Keene, the College architect, designed the Radiation Center in 1957 and Sceva Construction Company was the general contractor (State College of Washington 1958; Keene 1957).

The modified, L-shape, three-story, flat roof Radiation Center is approximately 20,700 square feet in area. In 1970, the Center doubled in size to its current dimensions when an addition of nearly identical proportions and materials was built onto the east elevation (Miller and Fiedler 1968). The entire building is constructed of reinforced monolithic concrete. The cladding consists of marblecrete stucco and mixed aggregate concrete with aluminum coping along the roofline. The building's symmetrical proportions are indicative of the International style, with its unadorned geometric forms, box-like features, and strong horizontal lines. Other typical features include the building's stress on functionalism with its taut concrete and glass surfaces devoid of ornamentation and repetitive window treatment. On the south (front) elevation the symmetrical arrangement of steel frame, ribbon windows with fixed sashes is broken up by metal grilles or louvers.

The main front office/reception area is a low, one story projecting addition to the south (front) elevation (Miller and Fiedler 1968). It is a reinforced concrete structure with marblecrete stucco cladding, and similar architectural proportions as the rest of the building. It is devoid of surface ornamentation with no windows (except for a small window on the addition's east elevation next to the front entrance). An extended roofline provides cover/shelter over the entrance. The entire building is elevated slightly above the front parking lot and street as the building was constructed into the north (rear) elevation embankment. Access to the front entrance is by a set of mixed aggregate concrete stairs from the front parking lot. Adjacent to the front and east elevations are stands of conifers and mixed deciduous growth and a grass lawn.

The east elevation (Figure 9) consists of a small loading dock on the first floor with an access door and stairs. The second story includes an exterior landing/balcony, access door and exterior stairs that lead to the rear of the building.

The west elevation has reinforced concrete cladding and no windows (Figure 10).

The north (rear) elevation is the main loading/delivery area and storage yard. Most of the area is surrounded by a metal security fence. The Radioactive Waste Storage Shed (Keene 1964) is located in the storage yard. It is a plain one story, corrugated metal structure without windows. It has a flat roof and a corrugated metal, roll-up door. The Cooling Tower and Pump Room are also located in the storage yard (Miller and Fiedler 1966).

HVAC equipment and air vents/stacks dominate the built-up roof surface. Four metal ducts extend along the surface of the north (rear) elevation from the ground floor to the roof.

Figure 9. Research Reactor Building, East and South (Front) Elevation (ENTRIX 2010)

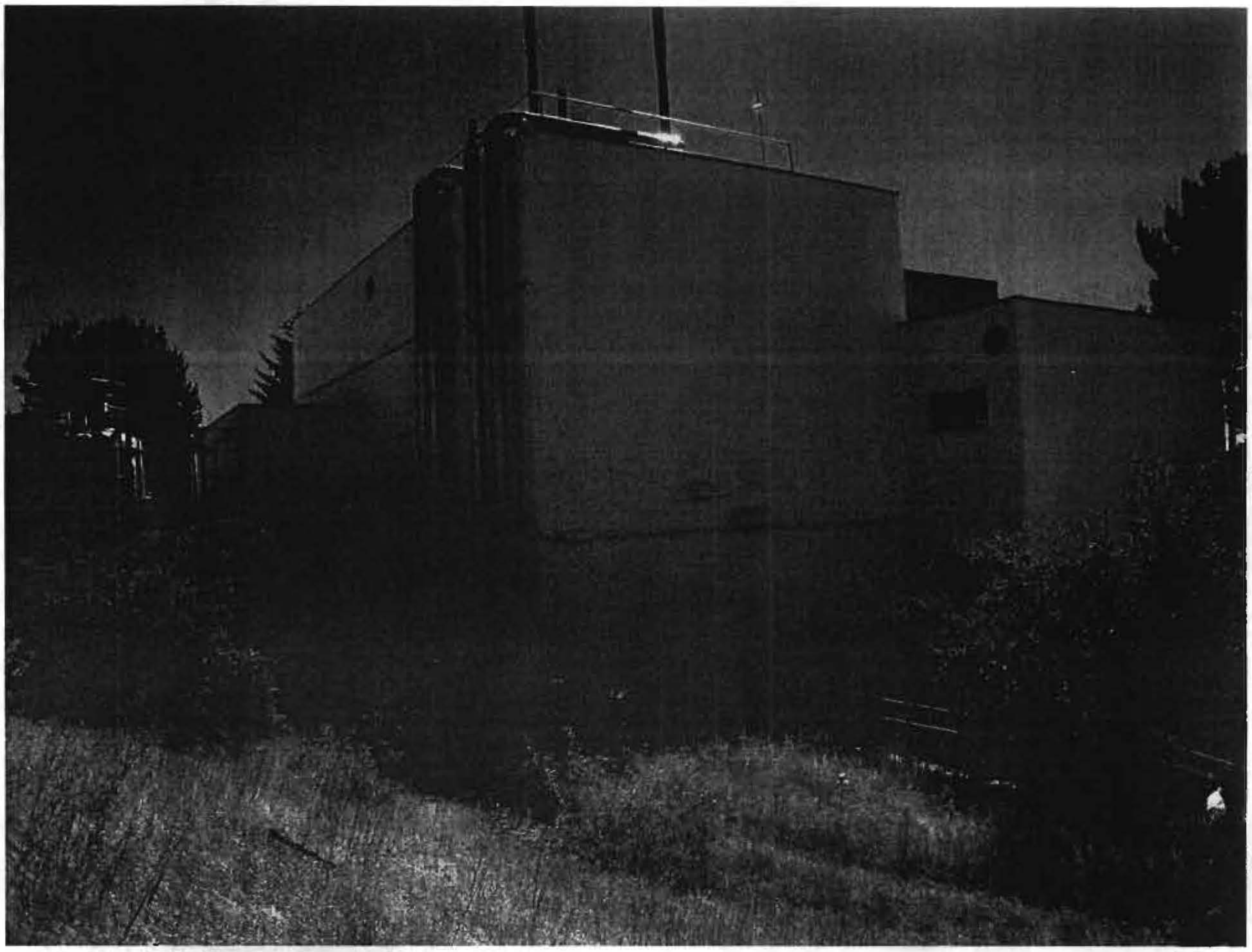

Figure 10. West and North (Rear) Elevation (ENTRIX 2010)

Interior:

The interior of the reactor building consists of numerous offices; radiochemistry, health physics, transuranic, bio-physics, and cold chemical laboratories (with fume hoods); storage and supply rooms, reactor control room, a pool room with a mezzanine storage area and a ceiling crane and hoist, machine room, electronics shop, and a main reception/office area.

Other interior features consists of concrete and plaster/sheet rock walls, concrete floors covered with asphalt or asbestos tiles, exposed ceilings with visible piping or acoustic tiles, and florescent lights.

The research and experimental laboratories consist of utilitarian features such as tile or linoleum floors, florescent lights, exposed ceilings with visible piping, concrete or plaster walls, wooden, metal or glass cabinets, wooden and metal desks, shelves and bookcases, and counter tops, sinks, and storage areas.

The reactor control room is a climate-controlled room located on the top floor adjacent to the pool room. A partition with a large picture window was constructed that separated the control room from the pool room. The reactor operators use the modified reactor console in the control room to monitor and guide the reactor core and the bridge apparatus.

The reactor pool is situated in a high bay with a mezzanine supply/storage area. In the reactor pool, the fuel and graphite rod assemblies are submerged in the reactor grid at the bottom of the 70,000 gallon pool of demineralized water.

STATEMENT OF SIGNIFICANCE

The WSU Modified TRIGA Nuclear Research Reactor and Radiation Center, located on the WSU campus in Pullman, Washington, is recommended eligible for listing in the NRHP under Criterion A for its important association with the development and placement of nuclear research reactors on college campuses. The reactor is the third oldest continuously operational civilian research reactor in the nation behind the research reactors at Pennsylvania State University and Massachusetts Institute for Technology, and the largest university reactor in the western United States.

The Nuclear Radiation Center, which houses the one megawatt research reactor, has and continues to serve as an important teaching and research tool for students in a wide variety of academic disciplines in nuclear science. The reactor has served as a valuable asset for students training to be nuclear engineers and reactor operators. The reactor provides students hands-on experience and challenges to handle the daily complexities of operating a nuclear reactor facility.

The reactor building was constructed when nuclear technology held great promise as a clean, cheap and efficient energy source (Martin 2008). The reactor expresses the important association with the post-World War II optimism in nuclear energy (Martin 2008). The number of research reactors on college campuses, however, has shrunk from a peak of 75 reactors to 27 operational research reactors today. The 1970s and 80s saw the rise of the anti-nuclear movement due to increasing concerns about plant safety, disposal of nuclear wastes, excessive construction costs, and the Three-Mile Island and Chernobyl nuclear accidents (Ruddy 1995; Croteau 2000). Nevertheless, the WSU reactor has retained its historically significant association with nuclear energy research during a period of decline of nuclear engineering on college campuses. The reactor is the only academic nuclear reactor in the State of Washington, and retained its role as an important research and teaching tool in the field of nuclear energy.

The building is also eligible for the NRHP under Criterion B for its association with a person significant in the field of nuclear energy for research and teaching purposes. Dr. Harold Dodgren, chemist and founder of the nuclear reactor program at WSU, was the primary force behind the establishment of the nuclear research reactor at the university. Dodgren assisted in plutonium production research for the important Manhattan Project (1943-1946) and earned his Ph.D. in Physical Chemistry at the University of California, Berkeley. He joined the Chemistry Department at WSU in 1948 after working several years at the Institute for Nuclear Studies in Chicago under Nobel Laureate Dr. W. F. Libby. In 1954, the WSC Board of Regents appointed Dodgren director of the nuclear reactor program at the university, where he successfully completed the task of designing, building and securing the funds for the reactor facility. Dodgren promoted the establishment of research reactors on college campuses to serve as research and education centers for students training to be nuclear engineers and operators of nuclear reactors. He also saw the WSU reactor as a means to educate the public on the benefits of nuclear energy, such as the production of medical isotopes to fight cancer and its important role in providing an infinite supply of relatively clean energy in contrast to the finite amount of fossil fuels.

The WSU research reactor, however, is not eligible for listing in the NRHP under Criterion C. The building is a fine example of the International architectural style that was prevalent during the mid-20th century, used in the design of numerous government, educational, and commercial facilities. The reactor building reflects International style features with its clean, geometric lines, symmetrical horizontal proportions, and concrete, glass and steel materials. The facility, however, has suffered a loss of physical integrity with the construction of an incompatible addition onto the front (south) elevation that houses the main office and reception area. Thus, the property has not retained enough of its physical integrity to convey its historic significance under Criterion C.

The building and research reactor is also eligible under Criterion Consideration G for a property achieving significance within the past fifty years due to its exceptional importance. While the property was completed in 1959 and went operational in 1961, the research reactor building's period of significance under Criterion A and B extends into the period that is less than fifty years.

5.2 Archae ological Resources

The WSU Nuclear Research Reactor Building is located in an area that has been previously disturbed by construction of the building, golf course and wheat fields. There is, thus, no potential for buried archaeological resources to be located within the Project APE (Figure 11). For these reasons, the focus of this inventory report is on the one architectural resource (the Nuclear Research Reactor Building) located within the Project APE.

Figure 11. Aerial View of Area of Potential Effect

SECTION 6 **PROJECT EFFECTS**

6.1 Architectural History Resources

ENTRIX recommends that the WSU Modified TRIGA Nuclear Research Reactor Building within the APE is eligible for listing in the NRHP under Criterion A and B, and Criterion Consideration G (see Appendix A for documentation of building in the HPI Report). The WSU submitted an application to the NRC for the renewal of its Facility Operating License No. R-76 for its nuclear research reactor. Issuance of a renewed license would authorize operation of the reactor for an additional 20 years. ENTRIX believes that the issuance of a renewed license to operate the reactor for an additional 20 years will have no adverse effects on the physical integrity and the NRHP eligible features of the Nuclear Research Reactor Building because the relicensing action will not result in any alterations to the contributing elements that make the building eligible. During the life span of the new license there is always the potential for reactor fuel modifications and technological upgrades to the control room and the reactor's operational apparatus and features. There could also be laboratory upgrades and new missions and experiments in the Radiation Center that could necessitate the introduction of new equipment and technological features. Nevertheless, there is no planned physical expansion of the facility or extensive modifications of the reactor and associated features during the next 20 years that would have an adverse effect on the building's NRHP eligible features.

6.2 Archaeolo gical Resources

There will be no affects to archaeological resources because none are known to be located within the Project APE.

SECTION 7 **MITIGATION MEASURES**

7.1 Architectural History Resources

The issuance of a renewal license to WSU to operate the nuclear research reactor for an additional 20 years is not anticipated to have any adverse effects on the NRHP eligible features of the Modified TRIGA Nuclear Research Reactor. Thus, no mitigation measures are recommended. ENTRIX, however, recommends that WSU prepare a historic properties management plan to identify and incorporate the NRHP features of the reactor and building into future facility additions and modifications, and technological and scientific upgrades. This plan would assist the University in their long-term operation and management of the facility and protection of the property's significant features. As stated, there are no planned extensive facility modifications or upgrades to the reactor as part of the relicensing effort.

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SECTION 9

List of Prepares

9.1 Laboratory Personnel

Battelle Memorial Institute, Pacific Northwest National Laboratory
902 Battelle Boulevard
Richland, Washington 99352
Contracts Specialist..Shannon Malisani

Battelle Memorial Institute, Pacific Northwest National Laboratory
902 Battelle Boulevard
Richland, Washington 99352
Technical Administrator ....Tonya Keller

9.2 Cultural Resources Consultants

ENTRIX, Inc.
1835 Terminal Dr.
Ste. 130B
Richland, WA 99354

MANAGEMENT STAFF

Principal-in-Charge..Kimberly Demuth
Project Manager..David Harvey

KEY STAFF

Cultural Resources..David Harvey
Cultural Resources..Jennifer Flathman
Billing Coordination..Linda Miller
Geographical Information Systems (GIS)..Joel Hancock
Technical Editing..Joseph Rubin

APPENDIX A

Historic Property Inventory Report

Historic Inventory Report

Location

Field Site No. **DAHP No.**

Historic Name: WSU TRIGA Nuclear Research Reactor Building

Common Name: Nuclear Radiation Center

Property Address: Round Top Drive Dr , Pullman, WA WA

Comments:

Tax No./Parcel No.

Plat/Block/Lot

Acreage

Supplemental Map(s)

Township/Range/EW	Section	1/4 Sec	1/4 1/4 Sec	County	Quadrangle
	04			Whitman	PULLMAN

Coordinate Reference

Easting: 2480354

Northing: 527470

Projection: Washington State Plane South

Datum: HARN (feet)

Identification

Survey Name: WSU TRIGA Nuclear Research Reactor **Date Recorded:** 09/13/2010

Field Recorder: DAVID HARVEY

Owner's Name: Washington State University

Owner Address: French Administration Building

City: Pullman **State:** Washington **Zip:** 99164

Classification: Building

Resource Status: Survey/Inventory **Comments:**

Within a District? No

Contributing? No

National Register:

Local District:

National Register District/Thematic Nomination Name:

Eligibility Status: Not Determined - SHPO

Determination Date: 1/1/0001

Determination Comments:

DEPARTMENT OF ARCHAEOLOGY & HISTORIC PRESERVATION
Protect the Past, Shape the Future

Historic Inventory Report

Description

Historic Use: Education - Research Facility

Current Use: Education - Research Facility

Plan: Irregular **Stories:** Three

Structural System: Concrete - Reinforced Concrete

Changes to Plan: Irregular

Changes to Interior: Concrete - Rein

Changes to Original Cladding: Intact

Changes to Windows: Intact

Changes to Other:

Other (specify):

Style:	Cladding:	Roof Type:	Roof Material:
Modern - International Style	Concrete	Other	Asphalt / Composition - Built Up

Foundation:	Form/Type:
Concrete - Poured	Other

Narrative

Study Unit
Education

Other

Date of Construction: 1961 Built Date

Builder: Sceva Construction Co.

Engineer:

Architect: General Electric Co.; Phillip Keene, WSU architect; Miller & Fiedler Architects

Property appears to meet criteria for the National Register of Historic Places: Yes

Property is located in a potential historic district (National and/or local): No

Property potentially contributes to a historic district (National and/or local): No

Statement of Significance:

HISTORY:

The Washington State University (WSU) Modified TRIGA Nuclear Research Reactor is housed in the University's Nuclear Radiation Center on the WSU campus in Pullman, Washington. The Radiation Center also houses a 1500 Curie Cobalt-60 Irradiation Facility and an Epithermal Neutron Capture Treatment Facility. The Center is a specialized research facility under the authority of the WSU Office of Research. The Center is also home to the WSU Radiation Safety Office (Wall 2010).

Dr. Harold Dodgren, chemist and founder of the nuclear reactor program at WSU, was the primary force behind the establishment of the research reactor at the university. Dodgren assisted in plutonium production research for the Manhattan Project at the University of California, Berkeley (1943-1946), where he later earned his Ph.D. in Physical Chemistry. He joined the Chemistry Department at WSU in 1948 after working several years at the Institute for Nuclear Studies in Chicago under Nobel Laureate Dr. W. F. Libby. In 1954, the WSU Board of Regents appointed Dodgren director of the nuclear reactor program at WSU, and was assigned the task of designing, building and securing funds for the reactor facility.

Dr. Dodgren and the General Electric Company, the contractor for the project, prepared a classified Safeguards Report for the Atomic Energy Commission (AEC) that contained a description of the proposed reactor facility and the calculation of hazards to the surrounding area in case of a nuclear accident at the facility (Croteau 2000). Dodgren and WSU proposed a swimming pool type reactor, chosen for its inherent safety features, adaptability to extensive nuclear research, and cost of construction (Croteau 2000). As a safety precaution, the reactor was located away from the center of campus and the town of Pullman.
The Atomic Energy Commission (AEC) issued WSU a facility's license and construction of the reactor began in 1957. Dodgren oversaw the design and building of the reactor, which was completed two years later.
In 1961, the AEC approved the fuel request of fully-enriched U-235 to power the reactor, and issued the reactor operating license to the university (WSU 1998). The highly enriched Uranium 235 was encased in 30 aluminum alloy jackets approximately 40 inches long (WSU 1998). When the reactor was activated, the jackets or fuel assembly were plugged into a grid plate located at the bottom of a 70,000 gallon capacity pool of demineralized water. When the reactor became operational in 1961, it joined the Massachusetts Institute of Technology, the University of Michigan, Pennsylvania State University and North Carolina State University as the five college campuses to house research reactors with a maximum capacity of one MW.
Atoms for Peace

The establishment of the nuclear research reactor at WSU had its origins in the Eisenhower administration's "Atoms for Peace" program. President Eisenhower's speech to the United Nations in 1953 stressed the need to apply atomic energy to the needs of agriculture, medicine and other non-military activities. The "Atoms for Peace" program led to initiatives across the country to establish nuclear research reactors on college campuses. Most of the research reactors were built with the assistance of federal funds during the 1950s and 1960s to pursue the peaceful uses of nuclear power (Rabinowitz 2005).
Directed by the Atoms for Peace program, the AEC pursued the development of practical applications for nuclear energy that included the establishment of nuclear research reactors and nuclear engineering programs on college campuses. The proximity of WSU and the University of Washington (UW) to the Hanford Nuclear Site and the exchange of staff between Hanford and the two universities enhanced the ability of the two state institutions to obtain federal grants for the construction of research reactors on both campuses (Martin 2008).
Research reactors on university campuses became common place by the late 1950s. The early 1960s was a boon time for nuclear engineering programs at the college level. By 1968, over 75 nuclear reactors were in operation at universities in the U. S. (Martin 2008). North Carolina State became the setting for the first university-based reactor in the world in 1953, followed by Pennsylvania State University in 1955. Between 1960 and 1965, nine college-campus reactors came on-line in the U. S., including WSU and UW in 1961, preceded by Idaho State (1967), Oregon State (1967), and Reed College (1968) (Martin 2008).
Reactor Construction and Design

The Atomic Power Equipment Division of the General Electric Company designed and built the WSU nuclear research reactor and fabricated the fuel elements. WSU architect Phillip Keane designed the three-story; reinforced concrete Nuclear Radiation Center that houses the reactor. The Center also houses the reactor control room, offices, storage rooms, multiple laboratories and the 27-foot deep pool where the reactor core is immersed. The pool of demineralized water is 30 feet long and 12 feet wide into which the uranium fuel elements are suspended from a bridge at the top of the pool. The fuel inserts are placed between the rows of the reflector elements, and the reacting "core" is suspended below the surface of the water near the bottom of the pool (Balch 1961). Nuclear radiation from the reactor core is channeled into laboratories for experimental use through beam tubes and beam ports located below the pool (Spokesman-Review 1959). The reactor provides
large quantities of neutron and other radiation through the ports and thermal column openings for research use. The reactor pool and the five-foot concrete walls of the pool act as a shield against the radiation efects of neutrons and gamma rays emitted from the core (Balch 1961).

TRIGA Reactors

The WSU TRIGA reactor is designed for use by universities for student education/training, private commercial research, public service (tours), non-destructive testing and medical isotope production. TRIGA reactors were designed to be safe in the hands of students. The TRIGA fuel was found to be a safer fuel for use in campus reactors since it is very difficult to "melt down, even under most dire circumstances" (Croteau 2000, p. 8). The TRIGA reactors are reportedly the most widely-used nuclear research reactors in the world (General Atomics 2010). A total of 35 TRIGA reactors were constructed in the U. S., and another 35 were installed in other countries (General Atomics 2010). TRIGA reactors were originally designed to be fueled with highly enriched uranium. Due to national security concerns, however, the Department of Energy (DOE) launched its Reduced Enrichment for Research Reactors program, which promoted reactor conversion to low-enriched uranium fuel (LEU).
Reactor Conversions and Building Modifications

The WSU nuclear research reactor was originally powered by Material Test Reactor (MTR) plate-type, highly-enriched uranium fuel. In 1966-67, WSU scientists replaced the MTR fuel elements in the grid plate at the bottom of the reactor core with four-rod clusters of TRIGA fuel consisting of U-235 and zirconium hydride ("Grants Enable Reactor Conversion" 1966).
In 1976, the reactor was converted to the Fuel Life Improvement Program (FLIP), a highly enriched uranium TRIGA fuel that was used until 2008 when the reactor was converted to a LEU fuel. The latest conversion was conducted to comply with a 1986 law that required research reactors to no longer use highly enriched fuel since the fuel could be used in nuclear weapons.
In the late 1960s/early 1970s, the Radiation Center underwent several modifications and additions. In 1964, WSU Architect Phillip Keene designed the Radioactive Waste Storage Shed, located adjacent to the north (rear) elevation (Keene 1964). In 1966, Miller and Fiedler Architects of Spokane, Washington designed the Cooling Tower and Pump Room, located behind the main building (Miller and Fiedler 1966). In 1968, Miller and Fiedler designed the three-story addition onto the east elevation and the one story office/reception addition onto the front elevation (Miller and Fiedler 1968). The additions and modifications doubled the square footage of the Radiation Center and provided additional laboratories, office space, storage rooms, and experimental space. In 1976, the reactor control room was partitioned and modified into a separate, climate-controlled room with a modified reactor console (Wall 2010).

Nuclear Radiation Center

The Nuclear Radiation Center, which houses the TRIGA research reactor, serves as an all-University resource unit, supporting research and graduate education related to nuclear sciences, physics, radiochemistry, elemental analysis, irradiation, medical isotope production, neutron radiography, gamma irradiation, fission track analysis, and neutron activation analysis (NAA). The Center provides facilities for graduate and undergraduate courses in nuclear science for faculty and the student body, including classes in nuclear chemistry, biological research, industrial research, radiation effects on materials, and training of students to be nuclear engineers and reactor operators. Neutron/gamma irradiation services are provided to the university and to other educational institutions throughout the Pacific Northwest, supported by Department of Energy (DOE) funding (Status Report 1998).
On-going projects include water, air, and soil pollution tracking, isotope generation, trace element analysis, and nondestructive testing. The reactor staff specifically focuses on research, teaching and public service. The Center offers classes in reactor operations, nuclear engineers and chemistry and physics. There is training in the use of radioactive materials, and the staff arranges for open houses during the fall and spring to educate the public on nuclear science and reactor operations.
STATEMENT OF SIGNIFICANCE:

The WSU Modified TRIGA Nuclear Research Reactor Building, located on the WSU campus in Pullman, Washington, is recommended eligible for listing in the NRHP under Criterion A for its important association with the development and placement of nuclear research reactors on college campuses. The reactor is the third oldest continuously operational civilian research reactor in the nation behind the research reactors at Pennsylvania State University and Massachusetts Institute for Technology, and the largest university reactor in the western United States.

The Nuclear Radiation Center, which houses the one megawatt research reactor, has and continues to serve as an important teaching and research tool for students in a wide variety of academic disciplines in nuclear science. The reactor has served as a valuable asset for students training to be nuclear engineers and reactor operators. The reactor provides students hands-on experience and challenges to handle the daily complexities of operating a nuclear reactor facility.

The building was constructed when nuclear technology held great promise as a clean, cheap and efficient energy source (Martin 2008). The reactor expresses the important association with the post-World War II optimism in nuclear energy (Martin 2008). The number of research reactors on college campuses today, however, has shrunk from a total of 75 reactors to only 27 operational research reactors nationwide. The 1970s and 80s saw the rise of the anti-nuclear movement due to increasing concerns about plant safety, disposal of nuclear wastes, excessive construction costs, and the Three-Mile Island and Chernobyl nuclear accidents (Ruddy 1995; Croteau 2000).

Nevertheless, the WSU reactor has retained its historically significant association with nuclear energy research during a period of decline of nuclear engineering on college campuses. The reactor is the only academic nuclear reactor in the State of Washington, and retained its role has an important research and teaching tool in the field of nuclear energy. The building is also eligible for the NRHP under Criterion B for its association with a person significant in the field of nuclear energy for research and teaching purposes. Dr. Harold Dodgren, chemist and founder of the nuclear reactor program at WSU, was the primary force behind the establishment of the nuclear research reactor at the university. Dodgren assisted in plutonium production research for the important Manhattan Project (1943-1946) and earned his Ph.D. in Physical Chemistry at the University of California, Berkeley. He joined the Chemistry Department at WSU in 1948 after working several years at the Institute for Nuclear Studies in Chicago under Nobel Laureate Dr. W. F. Libby. In 1954, the WSC Board of Regents appointed Dodgren director of the nuclear reactor program at the university, where he successfully completed the task of designing, building and securing the funds for the reactor facility. Dodgren promoted the establishment of research reactors on college campuses to serve as research and education centers for students training to be nuclear engineers and operators of nuclear reactors. He also saw the WSU reactor as a means to educate the public on the benefits of nuclear energy, such as the production of medical isotopes to fight cancer and its important role in providing an infinite supply of relatively clean energy in contrast to the finite amount of fossil fuels.

The WSU research reactor, however, is not eligible for listing in the NRHP under Criterion C. The building is a fine example of the International architectural style that was prevalent during the mid-20th century, used in the design of numerous government, educational, and commercial facilities. The reactor building reflects International style features with its clean, geometric lines, symmetrical horizontal proportions, and concrete, glass and steel materials. The facility, however, has suffered a loss of physical integrity with the construction of an incompatible addition onto the front (south) elevation that houses the main office and reception area. Thus, the property has not retained enough of its physical integrity to convey its historic significance under Criterion C.

Description of Physical Appearance:

Exterior:

The construction of the Nuclear Research Reactor Building began in 1957, and was completed in 1959. The reactor became operational in 1961. The Atomic Power Equipment Department of the General Electric Company designed and constructed the nuclear research reactor, which included the fabrication of the fuel elements and the reactor core (State College of Washington 1958). Phillip Keene, the College architect, designed the Radiation Center in 1957 and Sceva Construction Company was the general contractor (State College of Washington 1958; Keene 1957).

The modified, L-shape, three-story, flat roof Radiation Center is approximately 20,700 square feet in area. In 1970, the Center doubled in size to its current dimensions when an addition of nearly identical proportions and materials was built onto the east elevation (Miller and Fiedler 1968). The entire building is constructed of reinforced monolithic concrete. The cladding consists of marblecrete stucco and mixed aggregate concrete with aluminum coping along the roofline. The building's symmetrical proportions are indicative of the International style, with its unadorned geometric forms, box-like features, and strong horizontal lines. Other typical features include the building's stress on functionalism with its taut concrete and glass surfaces devoid of ornamentation and repetitive window treatment. On the south (front) elevation the symmetrical arrangement of steel frame, ribbon windows with fixed sashes is broken up by metal grilles or louvers.

The main front office/reception area is a low, one story projecting addition to the south (front) elevation (Miller and Fiedler 1968). It is a reinforced concrete structure with marblecrete stucco cladding, and similar architectural proportions as the rest of the building. It is devoid of surface ornamentation with no windows (except for a small window on the addition's east elevation). An extended roofline provides cover/shelter over the entrance. The entire building is elevated slightly above the front parking lot and street as the building was constructed into the north (rear) elevation embankment. Access to the front entrance is by a set of mixed aggregate concrete stairs from the front parking lot. Adjacent to the front and east (side) elevations are stands of conifers and mixed deciduous growth and a grass lawn.

The east elevation consists of a small loading dock on the first floor with an access door and stairs. The second story includes an exterior landing/balcony, access door and exterior stairs that lead to the rear of the building.

The west elevation has reinforced concrete cladding and no windows.

The north (rear) elevation is the main loading/delivery area and storage yard. Most of the area is surrounded by a metal security fence. The Radioactive Waste Storage Shed (Keene 1964) is located in the storage yard. It is a plain one story, corrugated metal structure without windows. It has a flat roof and a corrugated metal, roll-up door. The Cooling Tower and Pump Room are also located in the storage yard (Miller and Fiedler 1966).

HVAC equipment and air vents/stacks dominate the built-up roof surface. Four metal ducts extend along the surface of the north (rear) elevation from the ground floor to the roof.

Interior:

The interior of the reactor building consists of numerous offices; radiochemistry, health physics, transuranic, bio-physics, and cold chemical laboratories (with fume hoods); storage and supply rooms, reactor control room, a pool room with a mezzanine storage area and a ceiling crane and hoist, machine room, electronics shop, and a main reception/office area.

Other interior features consists of concrete and plaster/sheet rock walls, concrete floors covered with asphalt or asbestos tiles, exposed ceilings with visible piping or acoustic tiles, and florescent lights.

The research and experimental laboratories consist of typical utilitarian features such as tile or linoleum floors, florescent lights, exposed ceilings with visible piping, concrete or plaster walls, wooden, metal or glass cabinets, wooden and metal desks, shelves and bookcases, and counter tops, sinks, storage areas, chairs, and wood doors.

The reactor control room is a climate-controlled room located on the top floor adjacent to the pool room. A partition that inlcudes a large picture window separates the pool room and the control room. The reactor operators use the modified reactor console to monitor and guide the reactor and he bridge apparatus. The reactor pool is situated in a high bay with a mezzanine supply/storage area. In the reactor pool, the fuel and graphite rod assemblies are submerged in the reactor grid at the bottom of the 70,000 gallon pool of demineralized water.

Balch, J. 1961. "WSU Atom Reactor Soon Runs." Building for Tomorrow. Moscow, Idaho, February 8, 1961.

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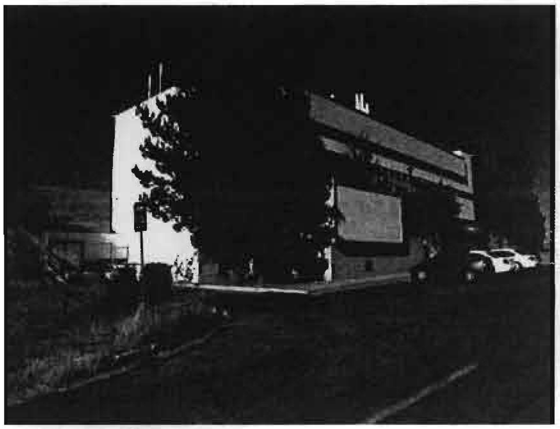
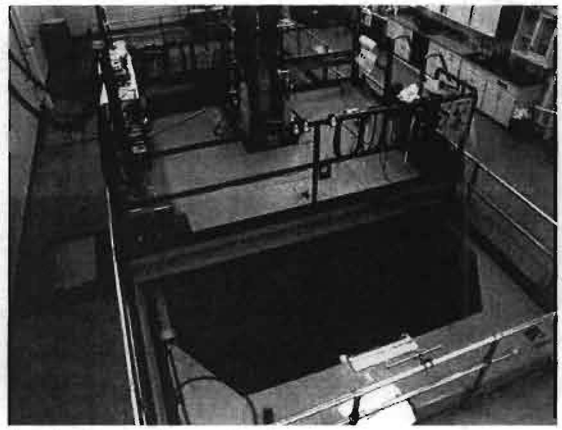
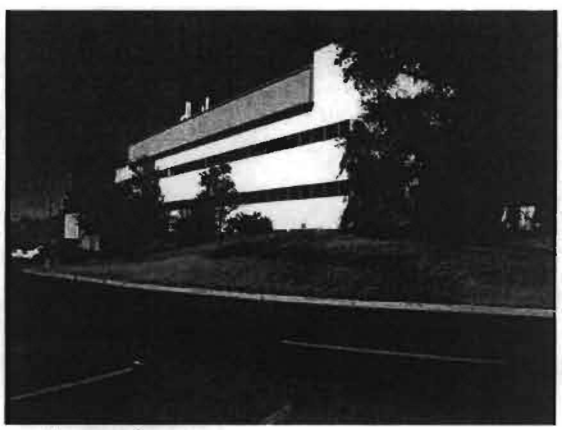
Photos



Looking northeast
West and South (Front) Elevation of Nuclear Research Reactor Building (ENTRIX 2010)
2010



Located in pool room high bay
TRIGA Nuclear Research Reactor Bridge, Pool, and Core (ENTRIX 2010)
2010



Looking northwest
South (Front) Elevation of Nuclear Research Reactor Building (ENTRIX 2010)
2010