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PHASE I ARCHITECTURAL SURVEY OF THE NASA PLUM BROOK STATION, ERIE COUNTY, OHIO

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ABSTRACT

In 2002 Gray & Pape, Inc., of Cincinnati, Ohio, was retained by SAIC of Dublin, Ohio., to conduct a Phase I architecture survey at the Plum Brook Station in Erie County, Ohio. The project was conducted on behalf NASA as part of their ongoing Section 110 and Section 106 compliance efforts. The Area of Potential Effect (APE) for the project included all NASA owned structure located within and adjacent to the Station.

The Phase I architecture survey for the project was conducted in April 2002. A total of XXX buildings was mapped, photographed, and documented on Ohio Historic Inventory forms.

Several facilities at the Station have been documented previously. Specifically the Space Power Facility is a National Historic Landmark while the Reactor Facility has been determined not eligible for listing in the National Register of Historic Places, but is in the process of being documented by NASA. Of the remaining facilities, Gray & Pape recommends…..

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CHAPTER I. INTRODUCTION

This report presents the results of work conducted at NASA's Plum Brook Station, located in Erie County, Ohio.

CHAPTER II. PROJECT METHODS

CHAPTER III. HISTORIC CONTEXT

An Introduction to the Plum Brook Ordnance Works

The Plum Brook Ordnance Works (PBOW) is today known as Plum Brook Station (PBS) and is part of NASA's Glenn Research Center. Located approximately seven-miles from Sandusky, Ohio, in Erie County, PBOW was one of five government-owned, contractor-operated (GOCO) facilities constructed by the Department of Defense (DOD) Ordnance Department in Ohio. The other GOCO plants were the Ravenna Ordnance Plant in Portage County in the northeastern portion of the state; the Scioto Ordnance Plant in Marion, north of Columbus in the center of the state; Kings Mill Ordnance Plant, Warren County, north of Cincinnati, in the southwest portion of the state; and the Buckeye Ordnance Works at South Point, in south-central Ohio, just north of Huntington, West Virginia.

A Brief History of Government-Owned Contractor-Operated Plants

GOCO plants were established to allow the federal Ordnance Department to place into operation new trinitrotoluene (TNT) and smokeless powder plants operated by established explosive manufacturers, chiefly the DuPont, Atlas, Hercules, and Trojan companies (Thomson & Mayo 1960:112). This arrangement allowed companies with previous experience in handling explosives and other related chemicals to oversee the daily operations and provide trained personal. The confused and wasteful experience of the mobilization effort during World War I taught the military that planning, particularly for priorities and balanced production, was key to a successful procurement program. Although the country was intensely isolationist after World War I, planning efforts were begun in a small way soon after that war. These efforts grew with the increasing military tensions in the 1930s and the increased military budgets that corresponded to those tensions. For a more detailed history of the events and policies that shaped the planning effort and the resultant GOCO Ordnance Plant/Ordnance Works System, see the national historic context, *Historic Context for the World War II Ordnance Department's Government-Owned Contractor-Operated Industrial Facilities, 1939-1989* (Kane 1994).

The planning effort for procurement began just after World War I. The ill planned experience during that war convinced military planners that planning was essential for well-organized and rapid preparations for war in the future. One of the first measures was Congressional approval of the National Defense Act of 1920, which among other purposes, delineated responsibility for procurement planning through the Assistant Secretary of War. In 1922, 13 Ordnance Districts were established throughout the country and played a key role in procurement planning and the GOCO industrial facilities program during the war. The government's six arsenals were also extremely important in the planning efforts because of their individual specializations in the manufacturing of a

particular kind of materiel and the fact that these arsenals were the storehouses for detailed information on these processes.

The arsenals developed plans and layouts for implementation of the manufacturing processes by private industry, which were later used as the preferred models for the GOCO industrial plants. Working with private industry, Ordnance personnel planned for future production of explosives, propellants, and associated chemicals in the development of plans and specifications for "typical plants" based on technical developments at Picatinny and Frankford arsenals (Kane 1944:26).

The Start of World War II and Planning for the Plum Brook Ordnance Works

Just before France fell to the Germans on May 27, 1940, President Roosevelt declared a state of limited national emergency. From this time until December 1941, Congress voted to fund the Ordnance Department's budget many times over the 1920 appropriation. This period became the crucial 18 months that military planners theorized was the minimum time needed to prepare for war. The first National Defense Appropriation Act was passed in June 1940. In that same month Congress passed supplemental acts that included funds for the construction of GOCO facilities.

The original site for the PBOW was acquired by the Department of Defense (DOD) in 1938 and consisted of 9,009.32 acres inland and an additional 1.35 acres for a pump station along Lake Erie. The locations of the GOCO plants were determined by several primary factors that were mainly related to the geographical and industrial characteristics of the vicinity being studied for a particular site. The stated factors included existing railroad lines near the plant location for shipping purposes, level but relatively inexpensive land, an inland location more than 200 miles inland to minimize the possibility of enemy attack by air, a large available labor and materials pool, remoteness from large population centers due to the potentially hazardous character of the operations, and the proximity of other war materiel production plants. An additional, though unstated, factor that motivated the choice of a particular location involved the degree of political influence.

The operating contractor for PBOW was the Trojan Powder Company of New York with an office in Allentown, Pennsylvania. The PBOW mission during World War II was to produce 2.4.6-trinitrotoluene (TNT), dinitrotoluiene (DNT), and pentolite. Between 1941 and 1945, it has been noted that more than one billion pounds of ordnance was manufactured at PBOW (www.lrh.usace.army.mil/PM/PBOW/history.htm). The plant operated three shifts a day with 896 workers on the first shift, 2215 workers on the second shift, and 989 third shift workers (Corp of Engineers 1944:2).

TNT was first produced in the 1860s and is a highly flammable nitrated derivative of toluene. TNT is used as a powerful explosive for shells and bombs, and was the main high explosive used in World War II. More GOCO facilities manufactured TNT than any other explosive. GOCO facilities that made TNT included Alabama, Chickasaw, Kankakee, Kentucky, Keystone, Lake Ontario, Longhorn, Oklahoma, Pennsylvania,

Plum Brook, Radford, Virginia, Volunteer, Weldon Springs, and West Virginia Ordnance Works (Voight 1945). DNT was manufactured at a number of GOCO industrial facilities, including Alabama, Chickasaw, Kankakee, Plum Brook, and Weldon Springs Ordnance Works (Voight 1945). DNT manufacturing began, like TNT production with the nitration of toluene for explosives. Pentolite what is it?

One of the chief components of TNT was oleum **[which is what?];** therefore, the first plants to produce TNT were located near the heavy acid industries located in Chicago, St. Louis, and Cleveland (Fine & Remington XXXX:137 should double ck reference-is it McGreen, Thomson & Roots?). Also the qualities that made for good industrial tracts also were the most profitable farms. In many cases, the tracts that best met the criteria for an ideal location for an ordnance works were the in use and highly profitable as farms. As a result, many of the chosen plant locations received a negative response from local citizens and farmers, since they resulted in the taking of highly prized cultivated lands rather than waste land. These disputes delayed several ordnance projects, including PBOW (Fine & Remington XXXX:311 should double ck reference—is it McGreen, Thomson, & Roots?).

Despite this controversy, PBOW was one of three explosives plants constructed during the first wave of plants in the early 1940s. These plants took 21 months to complete and within this short-time span the former farmlands were transformed into small self-contained "cities".

Plum Brook Ordnance Works

The firm of E.B. Badger & Sons Co., (Badger & Sons) of Boston, Massachusetts, was selected to prepare the architectural-engineering drawings and provide construction services at PBOW (Stone & Webster Engineering Corporation, another firms often selected on DOD contracts, purchased Badger & Sons in 1950). Badger & Sons was not only responsible for the design of the plant buildings, but also the development of its domestic water system, sewage treatment plants, electrical distribution system, roads and railroad spurs, surface draining, fences, and more. As a result, the landscape and infrastructure layout at NASA/Plum Brook Station (PBS) is still visible today. Therefore, the primary layout, streets, and underlying utilities used at PBS are a result of the Badger & Sons design.

As originally designed, the plant was divided into 10 areas (Plate X). The administration area was located in the northeastern portion of the plant and near the present-day entrance to PBS on Columbus Road. Staff residences were located north of the administration area and along Columbus Road. It originally consisted of several building but only a handful remain including the sewage pump station, hospital and administration building, fire department, and personnel building (ADD OHI #). Most of these building are currently owned by (XX) (GSA). The buildings in the administration area were designed with limited architectural details. The details are reflective of the Colonial Revival style but are restrained in their interpretation.

The TNT lines included Nitration Houses, Fortifying Houses, Wash Houses, Acid and Fume Recovery House, and Nailing Houses. NASA demolished many of these building between 1958 and 1964. TNT Area "A" was sited near the present day Engineering Building. All that remains from this area is a tower tank located near the corner of Fox Road and Columbus Avenue (OHI #). TNT Area "B" was located in the central of the plant between Short Cut and North Magazine roads. NASA officials did not retain any buildings in this area; however, three tanks are still standing. TNT Area "C" was located in the western portion of the plant between Campbell Street and Ransom Road. The only PBOW structures remaining in this area includes two barns (OHI #s) that predate that ordnance works but were utilized by them for storage. The other standing structure built by the PBOW is the Acid & Fume Recovery House (OHI #).

The Acid Areas were comprised of Anhydrous Ammonia Storage, Ammonia Oxidation Plants, Nitric and Sulphuric Acid Concentrators, and tank farms. PBS retained some of the storage and warehouse buildings in these areas but most of the manufacturing buildings were demolished. Acid Areas No. 1's waste disposal and maintenance area was located in the northern half of the plant, just west of its center along Fox Road. Approximately 19 buildings were retained by NASA officials including tower tanks, the reservoir pumping station, a few warehouses, and the locomotive shop and garage (OHI #). The waste disposal and maintenance area for Acid Area No. 2 was located in the western portion of the plant near Pipe Creek. Again, NASA officials demolished most of the structures retaining only a few buildings including the powerhouse, reservoir pumping station, and a shop/warehouse building (OHI #). To the northeast of TNT Area "C" was waste disposal and Acid Area No. 3. NASA officials demolished the majority of these buildings when they took over the property. The remaining PBOW building includes a single warehouse (OHI #).

The magazine area included 99 concrete igloos in the southeastern portion of the plant between North and South Magazine roads. All the igloos are still standing and are used as storage areas by PBS (OHI #). The final section of the plant was the Pentolite Area located in the northwestern section near Patrol Road. NASA officials in the mid-1960s demolished the majority of buildings in this vicinity. I don't think anything is still here, ck IT maps.

PBOW also constructed staff houses and moved some of the farmsteads located within the core plant area to Columbus Road. Several of these buildings are still standing but are outside the scope of this project. The were also substations constructed throughout the plant along with roads, 36.4 miles of railroad spurs, and plant garages and maintenance buildings. PBS continues to use many of the utilitarian resources constructed by Badger & Sons. These include the two pumping stations, Rye Beach and Big Island on Lake Erie, most of the tank towers, warehouses, igloos, process water system, and clarified and domestic water systems. Until 1995, PBS also used the sewage

plant located on Taylor Road; however, in that year the station was closed and the Station was converted to the Perkins County system.

> Architectural style played a very minimal role in the appearance of the buildings at the PBOW. The specific technical functions and accompanying equipment layout in the buildings were the determining factors for the shapes and sizes of the buildings. There are other ordnance plants that have retained many of their original buildings, and when the remaining PBOW buildings are compared to these facilities, it can be seen that the buildings are not unusual structures in the context of GOCO plants.

The Administration Area represented one of the few locations within the complex that have a reference to style in its form and layout (Plate X). The area has a circular drive with a centrally located flagpole (removed by NASA around 1964). The buildings, including the administration building, fire station, and other related structures, feature a simple Colonial Revival style, complemented by porches supported with columns and symmetrical facades (Plate X and X). Although probably not intentional, the flat roofs and stripped-down treatment of the powerhouses provide a very modern appearance (Plate X).

The PBOW manufacturing buildings were based on several typical plans that were used somewhat interchangeably for structures in the different manufacturing areas and GOCO plants. Although most types were confined to one kind of manufacturing area meaning that typically, one building plan was used for TNT and a different one for DNT. The majority of structures were one and two stories tall with gable roofs and rectangular or square footprints. Building types characteristic of the TNT lines are shown in Plates X and X. Representative buildings of the Acid Areas and Pentolite Line are shown on Plates X through X. Safety concerns also influenced the design of these structures, in the form of safety chutes that connected to the exterior wall of the second floor with double-leaf doors, which swung outward (visible in the above Plates).

For economic reasons, the Ordnance Department's issued an order in January 1941, which required that all buildings constructed after that date be built as "temporary, five-year" mobilization structures, rather than the "permanent, 25-year" construction used before this date (Kane 1994:115, S&W 1943a:66). This meant that many buildings were built using frame construction instead of brick, and only those structures not suitable for frame, such as maintenance and service building, used concrete block construction. The storage magazines covered with earth, known as igloos, were constructed entirely of poured concrete in accordance with standard plans of the Quartermaster Corps (Plates X and X). PBS is still utilizing the igloos as storage facilities.

PBOW began producing TNT in December 1941 (McGreen, Thomson, & Roots 1955:340—should double ck reference is it Fine & Remington?). By 1943 there was a drastic reduction in bomb requirements resulting in lessened demand for TNT, ammonium reduction, and other related products (Thomson & Mayo 1960:143). Although there were small increases around 1945, most of the GOCO plants were

operated at levels much lower than their capacity. On December 17, 1945, physical custody of PBOW was transferred from the Trojan Powder Company to the Army Ordnance Department and the plant was renamed Plum Brook Depot, and was used for ammunition storage. (www.lrh.usace.army.mil/PM/PBOW/history.htm). It was also during this time that the first efforts to decontaminate the plant began. In 1946, the property was transferred to the War Assets Administration and between 1946 and 1949 the property was protected and maintained by Matthew-Levis and Sons **[who were they and how did they get involved?]** (www.lrh.usace.army.mil/PM/PBOW/history.htm). In 1949, the property was again transferred, this time to the General Services Administration (GSA) which maintained oversight of the facility and leased portions of the land to NASA's Lewis Research Center starting in 1955.

The Beginning of Plum Brook Station

Starting in 1951, National Advisory Committee for Aeronautics (NACA) began examining the requirements to construct a facility to research and develop nuclear propulsion engines. This research began in the late 1940s at NACA's Lewis Research Center (Lewis), in Cleveland, Ohio. It was concluded in 1948 that the development of nuclear rockets and ramjets "presented nearly insuperable technical problems" but aircraft nuclear propulsion could create a propulsion " 'breakthrough' comparable to the turbojet" (Dawson 1991:184). Lewis acquired a cyclotron for basic research in materials in 1949; however, they still needed a nuclear reactor facility. Abe Silverstein, the director of Lewis, selected some of the Center's Compressor and Turbine Division's most versatile engineers and scientists to attend a "nuclear school" along with other engineers for the Center to learn the principles of nuclear physics (Dawson 1991:156). The first group of engineers totaled 24 and they attended classes for six months and had no other projects. Silverstein believed that nuclear research would be come an important component of future research. Also around 1954, NACA began a survey of 16 locations for a nuclear reactor in both Ohio and Pennsylvania (Dawson 1991:184). The location had to meet a list of criteria including a relatively close proximity to Cleveland, easy accessibility, safety, and cost. In 1955 Congress authorized the construction of a nuclear reactor and Lewis leased 500 acres of land the former Plum Brook Ordnance Works. In September 1956, NACA held a groundbreaking ceremony and work on the Reactor Facility began. Its construction would take a total of six years. Meanwhile, Silverstein created a Nuclear Reactor Division to direct the new research at Plum Brook Station (PBS).

Plum Brook Station

In 1956, Lewis expanded its facilities outside the Cleveland laboratory limits with PBS in Sandusky, Ohio. During the 1950s, NACA allowed its laboratories a sizable amount of autonomy (Dawson 1991:162). NACA engineers began contemplating such daring fields as the possibility of space exploration and even manned explorations. These pursuits were finally received seriously by NACA officials and congressional supporters

in Washington, D.C., when Russia launched Sputnik, the first artificial satellite, on October 4, 1957. Lewis was prepared to meet the challenge of space with research it had already conducted on high-energy rocket engines and fuels, especially the use of liquid hydrogen. This liquid hydrogen propulsion technology paved the way for the United States' successful manned space rocket launch.

With new and improved technology into the outer limits of atmospheric flight, the organization was prepared for the change in mission that occurred when the National Advisory Committee for Aeronautics (NACA) was reconstructed into the National Aeronautics and Space Administration (NASA). In 1958 President Eisenhower dissolved NACA and NASA was created under the National Aeronautics and Space Act of 1958 to be responsible for aeronautical and space activities sponsored by the United States, including non-military space projects such as lunar probes and scientific satellites (Hagerty 1958:1).

With the creation of NASA came a new responsibility for the Lewis including "the advancement of the technologies of propulsion and power, the development and operation of launch vehicles, and supporting research in related areas" (NASA LeRC 1973:1). At the forefront of the NASA agenda was the Project Mercury program, which focused on the development of a multistaged manned rocket. Before a manned space vehicle could be launched, however, much information was needed concerning the performance of such a vehicle in space conditions. PBS placed a significant role in testing vehicles and materials under space conditions. Its first large-scale facility was the Plum Brook Reactor Facility (PBRF).

During the 1950s the United States Air Force (USAF) and the Atomic Energy Commission (AEC) initiated a joint series of feasibility studies on the use of nuclear propulsion for aircraft, rockets, and space vehicles. Project Rover, initiated by the AEC in response to a USAF request, concentrated upon the technical feasibility of utilizing nuclear propulsion for rockets (Project Rover was renamed NERVA [Nuclear Engine for Rocket Vehicle Application] in 1961). The proposed nuclear propulsion of rockets substituted a nuclear reactor for the combustion chamber of a chemical rocket. A nuclear rocket would require both nuclear fuel elements for the reactor and liquid rocket fuel. The development of this proposed technology faced three major obstacles. Beginning with the fact that current reactor materials were inadequate at the high operating temperatures required to produce the necessary thrust. There was also the problem that shield weights for current reactor designs were too heavy, greatly diminishing payload weights. The final problem was that materials used in proximity to the reactor were vulnerable to radiation. In 1955 Congress appropriated funds to construct the PBRF. Although the original purpose of the reactor facility was for research associated with aircraft nuclear propulsion, but the time it was completed in 1959, the interest in this research had waned (Dawson 1991:238). Therefore, the $15 million reactor facility supported NASA's nuclear rocket and power supply programs by performing irradiation tests of fueled and unfueled experiments for space program applications.

Construction was complete in March 1961, and a year later an open house was held for the press. It was not until July 1963 that the reactor facility completed its first experiment. Although the PBRF was the first facility constructed by NASA during its six-year construction period, NASA installed other smaller research site and retained 41 of the former ordnance buildings including 99 of its concrete igloos for use primarily as storage. NASA also obtained the infrastructure developed by DOD for the ordnance works including its roads, railroad spurs, water and sewage systems, substations and more.

The land required by NASA for PBS included approximately 8,000 acres, of this; 2,600 acres were used for a buffer zone outside the Station's security fence. Between 1958 and 1960 PBS also saw its greatest amount of construction when six of its small test sites were constructed along with support facilities either constructed or the renovation of former PBOW's buildings.

The six small test sites included the Liquid Hydrogen Pump Site, known as "A" Site; Turbo Pump Site called "C" Site; a Controls and Turbine Test Site now called "D: Site; a Dynamics Stand, known as "E" Site; the Fluorine Pump Site, now called "I" Site and "J" Site an Oxidizer Hydraulics Lab. Two control and data buildings were also constructed known as "B" and "H" Buildings. The nuclear power program supported the majority of research done at the PBS. This included using the Reactor Facility to study the effects of neutron and gamma radiation on materials and spacecraft components. Like many of the test at PBS, these were done in anticipation of a full-scale space nuclear rocket system and space power system.

The small test sites also conducted experiments to support the development of chemical and nuclear engines. Including "D" Site which was designed to test research turbines for use in the development of the drive turbines for rocket propellant pumps in chemical and nuclear engines (OHI #). "A" Site was developed to test liquid hydrogen research pumps of various designs and pump seals (OHI #). This data was then used to help design liquid hydrogen pumps for advanced chemical and nuclear rockets. Other test sites include the Hydraulics Lab ("F" Site) were cryogenic and other fluids are passed through test setups to study various fluid flow conditions (OHI#). This data was also used to support the concept of a nuclear rocket engine. "C" Site was the Turbo Pump Site and research programs here focused on liquid hydrogen turbopumps and pump inducers in order to fine a pump that will operated efficiently in boiling hydrogen (OHI#). This is another instance when the data was needed for the development of an efficient pump for nuclear rocket applications. "I" Site was a Fluorine Pump Test Site and supported research in the chemical rocketry field since fluorine was one of the most active oxidizers known(OHI#).

"J" Site was actually built around 1958 for the purpose of testing high performance oxidizers such as oxygen and fluorine(OHI#). These tests were needed in the development of a rocket since oxidizers can react violently with many materials. The majority of tests performed at the smaller test sites helped to perfect the use of liquid hydrogen as a fuel for the Centaur's RL-10 rocket engines. This same research would

also be the basis for the Space Shuttle Main Engines, which used a combination of liquid hydrogen and liquid oxygen as fuel.

One of the smaller test sites built in 1960, "E" site, the Dynamics Stand, was not necessarily constructed for the nuclear program(OHI#). This 144' stand was equipped with an electro-magnetic shake device, which simulated forces encountered on a spacecraft during launch, and in flight. Research tests performed at "E" Site included the Atlas-Centaur-Surveyor combination. The information helped to insure the success of the Surveyor project that soft-landed the Surveyor instrument packages on the Moon.

In 1961 B-1, the High Energy Rocket Engine Research Facility, "B-1" was constructed (OHI#). Similar to "E" Site, this facility was designed to test propellant systems at altitude conditions. Tests included work on the Centaur Vehicle and the NERVA (Nuclear Engine for Rocket Vehicle Application) propellant feed systems. There was a period of three years before the next facility was constructed. B-3, known as the Rocket Dynamics and Control Facility, was also used for altitude tests (OHI#). B-3 studied various components for large engine that were projected for interplanetary travel. Following its construction was "K" Site in 1965.

The Great Space Push

In May 1961, President John F. Kennedy announced that the United States would land a man on the moon within the decade. This announcement brought both new projects but also an increase in the NASA budget. Lewis and PBS benefited from this budgetary gain, as indicated by an increase of staff and facilities and as an important center for nuclear rocket propulsion. Lewis took a leading role in the nuclear stage since it was seen as the key to providing sufficient power to reach the Moon (Dawson 1991:182). Congress authorized a major three-year $40 million building program for Plum Brook in the fall of 1962 (Dawson 1991:185). Lewis and PBS were also establishing themselves as the NASA center for space propulsion. While researchers at Ames and Langley continued to work on air-breathing engines and aeronautics, Lewis worked also exclusively on space-related projects in the 1960s particularly the Centaur and Agena programs (Dawson 1991:196).

This swelling budget was primarily earmarked for construction and many of those were proposed at PBS. Some of the new buildings proposed at PBS included "K" Site, also known as the Cryogenic Propellant Tank Site (OHI#). "K" Site was brought into service in 1965. This test site was a remodeled steam plant constructed for the PBOW. "K" Site is the first of all the previously mentioned facilities to still be in operation by NASA. "K" Site is used for NASA's deep space experiments and to test the performance of its high-energy propellants which are cyogens and must be stored at very low temperatures which range down to –425 Fahrenheit. The facility tests the super propellant tank insulation systems to determine pressurizing gas requirements during propellant outflow.

In 1966 another research test area was added with the construction of the Hydrogen Heat Transfer Facility. This facility was converted in 1969 to a Hypersonic Tunnel Facility and is commonly called HTF (OHI#). Constructed for $2.4 million, the Hydrogen Heat Transfer Facility provided a test for nuclear rocket nozzles and components. Its heat exchanger was able to supply hot hydrogen gas to simulate the temperatures normally encountered in a nuclear rocket reactor. During this use, the facility had a vertical tunnel to test engines to a velocity of Mach 6. In June 1969, the last test was performed in the vertical tunnel, and the facility was converted to a horizontal hypersonic tunnel (HTF Capabilities Document 1999:6). This transformation allowed the facility to create air velocities and temperatures that simulate flight speeds up to seven times the speed of sound, and altitude conditions up to 120,000 feet. This facility is still utilized at PBS.

The last two facilities were added in 1968 and included B-2, a Spacecraft Propulsion Research Facility (OHI#), and SPF, the Space Power Facility (OHI#). B-2 was listed in the National Register of Historic Places as a National Historic Landmark in 1985 as part of the "Man In Space" thematic study. Both facilities are still used by NASA. B-2 had $15 million appropriated for its construction. The construction was difficult since it required excavating a 73-foot in diameter and 185 foot deep hole. The primary purpose of this facility is to test space vehicles and upper stage rocket engines in a simulated space environment.

SPF, the Space Power Facility required $25.7 million to construct and allowed the testing of space nuclear power generation systems under simulated space environmental conditions. These conditions include high vacuum thermal environment and the nuclear environment inherent in a nuclear system. Thus making this facility essentially a very large vacuum tank for the testing of spacecraft and/or their subsystems and components in a simulated space environment. Advanced propulsion and space power systems, including systems with nuclear heat sources could be subjected to thermal vacuum environment and operated at power levels up to 15 megawatts thermal equivalent. The SPF test chamber was designed to have a low neutron activation and a high resistance to corrosion by fluids such as mercury, cesium, and others.

The Decline of the Space Program

Although Lewis and PBS were extremely well funded in the early and mid 1960s, the space program was about to change. In 1966, the Agena project was phased down and Lewis's research and development budget declined by $73.3 million (Dawson 1991:197). More cutbacks followed including another $87.2 million in 1967 along with staff cuts (Dawson 1991:197). Engineers and scientists at Lewis and PBS took a large amount of pride in the 1969 Apollo 11 mission since they helped to solve some of the problems that paved the way for this mission. However, the nation was changing at its focus was no longer on space exploration but the various social problems that plighted it including Civil Rights, riots in the inner city, and the conflict in Vietnam.

The 1970s were a time of trouble for the space program as a whole and most importantly for PBS. By 1971, Lewis had cut its civil service positions by 700 and in the following year PBS was slated for closing (Dawson 1991:201). In 1973, 180 employees at the PBRF were released and by the next year another 177 employees were eliminated when all the test sites and facilities (with the exception of SPF) were placed on standby mode. SPF at that time was the world's largest space environment simulation chamber and was being considered by the Air Force and Navy for testing space satellites. In order to operate SPF, a total of 50 positions were retained. It was also determined that 4 NASA Civil Service personnel and 40 support service contractors would be retained to maintain the facilities that had been placed in a standby mode (Kilgore 1974:8).

All the buildings at PBS were evaluated in an "End of Condition Statement" dating from 1974 and placed into one of three readiness categories (Located in individual building folders in the not so vital records room, no date, no author). Readiness Category 1 is "only the utilities and/or plant equipment are on and operating that are necessary to provide a minimum amount of heat and power for prevention of building deterioration and/or because of some projected use during standby mode." Readiness Category 2 is described as "any building so classified shall not have any of the available utilities, equipment, or utilities special on and operating. Everything shall be protected, preserved, and secure. The buildings can be reactivated with a minimum cost. Deterioration is a factor considered." The final category was Readiness Category 3 meaning that "any buildings so classified and are beyond economical repair shall not have deterioration considered." Some of the building in Readiness Categories 1 and 2 had a new listing of use. This listing was always storage/warehouse.

Also during this time parts and equipment from different buildings were removed and used at other NASA facilities. This included removing the vacuum-jacketed line and its support structure from B-1 Test Stand around 1978 for use at Langley Research Center. The 34.5-2.4 kV-transformer in Building 3161 was removed and transferred to Lewis around 1980, and the a/c unit in Building 2211 was removed to Room 225 in the Instrument Research Laboratory, Building 77. Other work orders from this period note that the compressed air heater in Building 2251 was shipped to Lewis for installation in ORL-Cell 11 as well as its heater being removed in 1982.

Many of the "End of Condition Statements" were updated in 1982. At this time several of the buildings that originally assigned as Readiness Category 1 where re-evaluated as Readiness Category 2. There is a note in many of these folders that reads "Prior to 1979, it was determined that some of the research facilities at Plum Brook Station would not be kept in standby at their intended research configuration. The research systems and/or equipment were surveyed for use by Lewis-Cleveland and other agencies. Everything left was incorporated in a salvage contract that would leave the building institutionally intact. In 1981, the salvage work was completed under GSA Sale No. 50PS-80-9, Contract No. GS-05-DP-(S)-01964. The institutional part of the building (such as electrical, water, gas, sewage, etc…) remains fairly intact" (Located in Not So Vital Records Room no date, no author). This is the condition of the test sites excluding

K-Site, HTF, SPF, and B-2, which are all currently active. The remaining sites are either used for storage or are relatively empty.

During the mid-1970s Lewis was in charge of medium-class launch vehicles including Atlas-Centaur and Titan-Centaur. Both were part of the highly visible mission side of NASA. Between 1970 and 1980, Lewis took charge of a total of 39 launches with 18 of these having specific scientific goals (Dawson 1991:202). The space probes launched during this time took photographs of the planets, put communications satellites in orbit, and soft-landed on Mars (Dawson 1991:202). It was also at this time that NASA began its ambitious plan to develop a manned space station using a reusable space transport plane. This mission was known as the Space Shuttle (Dawson 1991:202).

PBS had a limited role in much of the NASA work during the 1970s and 1980s. However, its research in the 1960s had helped lay the technology base for the proposed mission. These tests included proving the liquid hydrogen was no longer an unconventional and dangerous fuel allowing it to be used in the shuttle's main engine. Also the design of many of the main engine components were developed out of the testing at Lewis and PBS. These components included pumps, seals, and bearings, fuel injectors, cooled baffle elements, and heat transfer data (Dawson 1991:202). Although the research at Lewis and PBS had established the groundwork for the Space Shuttle, the two stations played only a minor role in its development.

A New Beginning for Plum Brook Station

During the 1970s the United States was also becoming more aware of its dependence on fossil fuels. Therefore, Lewis staff members began to develop new approaches to energy production (Dawson 1991:206). It was noted by industry professionals that Lewis had the expertise to help develop and examine various power-producing systems.

One of the first new alternative energy sources to be considered was wind. Wind turbine technology had been suggested since 1970. In 197X, the first of three wind turbines were constructed at PBS. The first one was a 100-kilowatt wind turbine with average speeds of 18 miles per hour. This turbine was anticipated to generate 180,000 kilowatt hours per years in the form of 440-volt, 3-phase, 60-cycle alternating current output (Dawson 1991:207). Other experiments followed and in 1974, Lewis received $1.5 million for its wind energy program from the National Science Foundation and the Energy Research and Development Administration (later called the Department of Energy).

EPA AND CAR NOISE TESTING IN THE 1980s I think –any information? NEED TO ASK AMY ABOUT CONTACT PERSON

DOES ANY OF THIS TESTING STUFF MEAN ANYTHING TO YOU? ANY IDEAS WERE TO GO FOR INFORMATION TO MAKE IT "READABLE"

SPF—Brayton Cycle Power System, Skylab Shroud Jettison Test (1987ish), Titan/Centaur Shroud Jettison (1987 ish), Shuttle Base Heating Experiment, Centaur Lox Boost Pump Test, Marshall Flight Center. Also Atlas I Payload Fairing Jettison (General Dynamics in 1989), Spear II High Voltage Power Supply Flight Hardware Test (Defense Nuclear Agency, SDI, 1990), and Titan IV 86-ft long Payload Fairing Jettison (Air Force, Martin Marietta, 1990). Ariane 5 Payload Fairing Jettison (European Space Agency 1993), Photovoltaic Module Test (NASA Space Station Freedom 1994).

B-2 reactivated in October 1987. Spear I Flight Harware Tests (Defense Nuclear Agency, SDI 1987), Exceed III Flight Hardware Tests (Defense Nuclear Agency, SDI 1987), Spear III Mock Up Test (Defense Nuclear Agency, SDI, 1992), Spear III Flight Hardware Test (Defense Nuclear Agency, SDI, 1992).

K Site, reactivated in 1989 to support NASA LH2 Technology Development Programs and LH2 Testing Ongoing, 1992 Slush H2 Fuel Tank Shosh Tests, and Slush H2 Technology Development Testing Ongoing in support of National Aerospace Plane (NASP).

HTF—Reactive 1993 to support NASA Generic Hypersonic Work.

Current Status of Plum Brook Station

Today, PBS is continuing to do research in its four active test sites (SPF, B-2, K Site, and HTF). They also have agreement with several state and federal agencies including the Department of the Interior, USDA, and XX to do testing on the 6, 000 acre facility. This testing involves XXX.

PBS is also undergoing two decontamination projects. These include the United State Army Corps of Engineers (USACE) decontamination of the former PBOW and NASA decommissioning of the PBRF. USACE is XX and anticipates finishing this project in XX.

In 1999, NASA submitted a decommissioning plan to the NRC (stands for?). This plan was revised in March 2001 to meet NRC specifications and the process of removing piping and loose equipment and fixtures was commenced. Over the next seven years, NASA plans to decontaminate everything and demolish the entire structure. It is NASA's intent to restore the area to the condition it was in prior to the construction of PBRF.

NEW FACILITY TO BE BUILT NEAR E STAND.

CHAPTER IV. RESULTS OF SURVEY

Plum Brook Reactor Facility (PBRF)

This facility occupies the northwestern corner of PBS and is bounded by Pentolite and Patrol roads and Ransom Brook. It consists of Buildings 1111, 1112, 1121, 1131, 1132, 1133, 1134, 1135, 1136, 1141, 1142, 1151, 1153, 1154, 1155, 1156, 1157, 1161, 1191, 1192, 1193, 1194, 1195, 1196, and 1197. All of these buildings with the exception of Building 1121, the ATS Building, are scheduled for demolition as part of the current decommissioning of the facility. The ATS Building has been determined as "clean" and will be retained by NASA officials for an undetermined use. This $15 million facility is currently being extensively documented by History Enterprises Inc., as part of a three-year contract with XXX. This documentation includes archiving all the data from PBRF, video documentation of the decommissioning, and the completion of a book about the facility and its importance to NASA. PBRF was also determined not eligible for the National Register of Historic Places by the Ohio Historic Preservation Office (OHPO) in October, 2000 (Epstein 2000:n.p.). In April 2001 Gray & Pape prepared the *Artifact Identification and Assessment Plum Brook Reactor Facility* (O'Bannon 2001).

The was used to study materials and spacecraft components in radition contions similar to those anticipated in a full-scale nuclear rocket system. In the 1970s, the idea of nuclear flight began to fade and the nuclear program ended. The announcement of the end in nuclear powered flight resulted in the closing of PBS. In 1972, PBRF was placed on standby mode and the "mothballing" procedure began. Mothballing included carefully preserving and shutting down the facility since employees initially thought that it would be reopened for future uses. PBRF was enclosed with a fence that remained permanently locked and the lines to the facility were drained, nuclear fuel and waste removed , and the equipment stored. However, it soon became clear that the PBRF would remain permanently closed. This conclusion resulted in many proposals for other uses and finally the decommissioning of the facility. The decommission process is currently in place and anticipated to be completed by 2007.

Building Descriptions

ATS Building (Building 1121)
SAN-XXXX-XX
NEED USE INFO FROM AMY BOWERS/
Building Description

Space Power Facility (SPF)
SAN-XXXX-XX

This facility is located on the south side of South Magazine Road, just west of Columbus Avenue in the southeastern corner of PBS. The facility includes Buildings

1411, 1431, 1432, 1433, 1441, 1451, 1452, 1453, 1454, 1461, and 1491. Originally known as the Space Propulsion Facility in a c. 1962-63 brochure, it was renamed Space Power Facility prior to the c. 1969 publication of the second Station wide tour guide (Anonymous n.d.:n.p.; Johnson n.d.:n.p.).

SPF required $25.7 million to construct. The bid was awarded to Kaiser Engineers, of Oakland, California, in 1962 and construction began in 1965 and was completed in 1969. A NASA document entitled "First Review Committee Report on the Space Propulsion Facility" from 1965 has provided the following information on the people involved in the construction and design of SPF (NASA 1965:16-17). This document lists several people involved in the design/construction phase of SPF including the project manager Harold E. Friedman, the assistant chief of the Facilities Engineering Division. There was also his assistant John W. Macomber he was also responsible for mechanisms and Anthony Colnar oversaw the process systems. Vernon G. Krebs managed the electrical work, while the HVE systems were coordinated with Willis E. Kenyon, and Dennis Trimakas provided the structural analysis. The architecture was the responsibility of Jesse L. Strickland with the design efforts guided by several individuals including G.M. Kaplan, Ira T. Myers, J. Calvin Lovell, of the Space Power Systems Division. Also included in the design process was Robert B. Smith of the Plum Brook Engineering Division and Frank A. Friswold of the Instrument and Computing Division. The above people along with others worked with Kaiser Engineers's subcontractors which include Linde Company, Lockheed Missiles and Space Company, the National Engineering Science Company, and Tenney Engineering Inc. The requirements for the SPF were established by Friedmand and Bernard Lubarsky, Chief of the Space Power Systems Division. There was also a contracting officer, Robert W. Bouman, and construction engineer, Russell L. Koger, who was also the Chief of the Construction Procurement Section.

The facility allowed for the testing of space nuclear power generation systems under simulated space environmental conditions. These conditions include high vacuum thermal environment and the nuclear environment inherent in a nuclear system. Thus making this facility essentially a very large vacuum tank for the testing of spacecraft and/or their subsystems and components in a simulated space environment. The 1969 report entitled "Final Report of the Ad Hoc Safety and Design Review Committee" described the facility as:

> "essentially a very large vacuum tank for the testing of spacecraft and their subsystems and components in a simulated space environment. The facility will provide a vacuum of 10 –7 to 10 –8 torr, space-sink temperature surroundings from –300 degrees F to + 180 degrees F, and a solar flux of 130 watts per square foot highly collimated over a large area, for simulating the space environment. The Test Chamber itself is 100 feet in diameter and 122 feet high, making a high-vacuum volume of 800,000 cubic feet available. The Test Chamber is surrounded by a concrete shell 6 to 7 feet in thickness. Nuclear reactors at power levels up to 15 megawatts can be safely operated in the Test Chamber. The capacity and cold trap capability of the vacuum pumping system are sufficient to allow the

operation of advanced propulsion systems, both electrical and chemical in the chamber. Limited quantities of such corrosive fluids as NaK, cesium, sodium and mercury can also be handled." (NASA/Lewis Research Center 1969:4-6).

This report also discusses the importance the auxiliary builindgs. These include an assembly area and shop, nuclear area, and Test Control and Data Acquisition Center. There is also a disassembly area which includes a hot cell, pits for storage and dismantling of nuclear reactors and isotope materials, as well as an extensive area for radioactive waste disposal (NASA/Lewis Research Center 1969:6). It is also in this area that all test articles decontamination and wash down will occur. In the late 1960s, test articles could have been transported to SPF by either rail or truck to the assembly buildings. Today, the rail lines are no longer active and all materials are shopped by truck. Once in the assembly building the articles are cleaned and prepared according to the test planner's directions on a test support fixture and mounted on special railroad car truck or erected on the Test Chamber floor. (NASA/Lewis Research Center 1969:6).

Once the articles are prepared, they are rolled into the Test Chamber and secured to the floor. Instruments, controls, and services are manually connected to the test articles and final checks are conducted (NASA/Lewis Research Center 1969:7). Following this step, the Test Chamber's shied door are closed and sealed and assess to the chamber is done through an access portal. After the Test Chamber has been cleared, the vacuum conditions are activated. The vacuum conditions include maintaining the annulus at 25 torr and reducing the vacuum to the conditions required for the test. The total pumping time to achieve vacuum levels is one day and the vacuum soak period may last as long as two weeks (NASA/Lewis Research Center 1969:7-8).

SPF will continue to hold the vacuum until the completion of the test. According to the report at that time, "the chamber diffusion pumping system will be shut down and secondary cooling of radiation heat sinks and wrap-around shield for nuclear engines or devices will be maintained as long as necessary. Air will be supplied to return the chamber and enclosures to atmospheric pressure. If the experiment requires an inert gas, nitrogen can be used to pressurize the chamber" (NASA/Lewis Research Center 1969:8).

Building Descriptions

WTG Shop (Building 1921)
SAN-XXXX-XX

This building was originally the shop for the 100 KW Wind Turbine (Building 1911) and Wind Turbine Weather Tower (Building 1913). Both Building 1911 and 1913 were removed around 1985 Once the turbines were dismantled, Building 1921 was renovated as the carpenter shop. Other buildings associated with the wind turbine program included Building 8133. This building was originally one of the pumping stations constructed for the PBOW. With the start of the wind turbine program in 1975?, it was renovated as the control room along with keeping its pumps that operated the

reservoir located to its rear. After the wind turbine program was canceled, the building was renovated as a maintenance shop.

Building Description

A Site
SAN-XXXX-XX

This is the former Liquid Hydrogen Pump Site and consists of Buildings 2111 and 2131. Originally there was a third structure know as Building 2121. In 1982, building 2121 was relocated and renumbered as Building 7233, the plant protection building.

This test site was constructed in 1960 and used for research on liquid hydrogen pumps of various designs. The data from these research programs was used for the design of liquid hydrogen pumps for advanced chemical and nuclear rockets. A Site would test pumps speeds up to 60,000 revolutions per minute. The liquid hydrogen for this research site was supplied by 34,400 gallon railroad dewars. A dewar is a large tank designed to hold gas.

With the shut-down of PBS in 1972, A Site's gaseous nitrogen, gaseous helium, liquid hydrogen and liquid nitrogen systems were left at atmospheric pressure and sealed. The vacuum jackets on cryogenic transfer lines were left in their "as is" condition. The gasoline supply tank to the turbine air heater was drained and filled with a water-glycol mixture (A Site 1974:n.p.). As at its end of condition statement it was noted that the mechanical, electrical, and electronic equipment that was required for operation of the site would be retained and mechanical equipment such as vacuum pump, hydraulic pump and gear boxes would be preserved (A Site 1974:n.p.). It was also determined that only a small amount of research instrumentation components would be left at the site. However when the end of condition statement was revised in 1982, it was noted that several of the research facilities at PBS would not be kept in a standby mode and that all research system and/or equipment would be surveyed for us by other NASA agencies. A Site was one of the research facilities no longer kept at a standby mode. Instead, the building was left institutionally intact with its electrical, water, gas, and sewage capabilities maintained but all its former research equipment was removed. Today, A Site is used for storage.

Building Descriptions

C Site
SAN-XXXX-XX

Built in 1960, C Site was known as the Turbo Pump Site, and was were research programs on liquid hydrogen turbo pumps and pump inducers were performed. The site consisted of Buildings 2211, 2221, and 2231. At this site tests were developed to

investigate if a pump would be operated efficiently in boiling hydrogen. This data was then used to design efficient pumps for nuclear rocket applications.

The turbo pump is connected to portable 6000 gallon liquid hydrogen trailers thru a vacuum-jacketed stainless steel piping system. The drive turbine was then powered by high-pressure hydrogen gas. The pump inducer rig was submerged in a 2500 gallon vacuum-jacketed stainless steel liquid hydrogen tank. The inducer is powered by an air turbine which is located on the outside of the tank. A shaft through the bottom of the tank connected the turbine to the inducer. In 1972, PBS was closed and most of the buildings were placed on standby. Prior to 1979, many of the research facilities were determined as no longer necessary. Much of their equipment was stripped and the buildings were used for storage. There are a few work orders and memos pertaining to the removal of equipment for C Site in 1978 and 1979. The items removed included the a/c unit and compressed air heater in Building 2251. It is also noted in the 1982 revised end of condition statement that Buildings 2211 and 2221 are used as warehouse and no longer kept at its intended research configurations.

Building Descriptions

D Site
SAN-XXXX-XX

D Site as it is known is the former Control and Turbine Test Site. Built in 1960, D site includes Buildings 2311, 2321, and 2331. The facility was designed to test research turbines. The data collected helped to design the drive turbines for rocket propellant pumps in both chemical and nuclear engines. D site also tested control systems for application at other PBS test sites. When constructed D site included the electrical, pneumatic, and hydraulic power required to support many different kinds of control systems. It also had a small space simulation chamber to test these systems under a high vacuum and extremely low temperatures. In 1972, Buildings 2311 and 2321 were placed in Readiness Category 1. Building 2331, the boiler house, was disconnected from the test site and a new in-building heating system was installed. Today, D site is used for storage.

Building Description

E Site
SAN-XXXX-XX

Built in 1960, E Site is the Dynamics Stand and includes Buildings 2411 and 2431. Originally, E Site had a third building known as Building 2421. It was a XXX and XXX happened to it. The stand is 144 feet tall and equipped with electro-magnetic shaking devices that simulate forces encountered on a spacecraft during launch and in flight periods. The site was used during PBS's research in the 1960s; however in 1972

when the Station was closed, E Site was also closed and placed in Readiness Category 2 for use as a warehouse. Building 2431 was indicated in Readiness Category 3 in a 1982 document and its boiler was removed leaving the vacant and abandoned. Currently, E Site is used for limited storage and appears to be deteriorating. Some of the tests performed at E Site before it was closed included work with the Atlas-Centaur-Surveyor combination. These tests helped to insure the success of the project including the soft-landing of the Surveyor instrument packages on the Moon.

Building Description

F Site
SAN-XXXX-XX

This is another one of the small research facilities built in 1960. F Site also known as the Hydraulics Lab includes Buildings 2511 and 2531. Tests were conducted here on cryogenic fluids including liquid hydrogen and liquid nitrogen as well as other fluids. The fluids were then passed through various test set-ups to determine the fluid flow conditions. Its primary research purpose was for an experimental water-to-liquid-hydrogen heat exchanger that was to support a new nuclear rocket engine concept.

When PBS was closed in the 1972 and the nuclear program was eliminated. F Site was no longer needed and placed in Readiness Category 2 and used as a warehouse. It continues to be used as a warehouse today.

Building Description

I Site
SAN-XXXX-XX

Buildings 2611 and 2621 currently make up I Site which was a Fluorine Pump Site. Building 2631 was also formerly part of the site but removed prior to 1979. It was at I Site that tests were performed on liquid fluorine pumps since fluorine is the most active oxidizer. The tests included operating the pumps at speeds up to 20,000 revolutions per minute and flow rates of 50 pounds per second. The data was for further exploration in the chemical rocketry field.

Buildings 2611 and 2621 were place in Readiness Category 2 and used as a warehouse after the station closed in 1972. The boiler house, Building 2631, was removed and renumbered as Building 7234, the Plant Protection Boiler House.

Building Description

J Site

SAN-XXXX-XX

Four buildings were part of this 1960 test site including Buildings 2713, 2714, 2721, and 2732. J Site was also known as the Oxidizer Hydraulics Lab. It was the location for testing high performance oxidizers such as oxygen and fluorine to see if they react violently with various other materials. J Site was comprised of a 38 foot diameter containment vessel with a research test loop where materials and components can be evaluated while exposed to liquid fluorine and/or liquid oxygen at pressure up to 1200 pounds per square inch and at a temperature of about –300 degrees Farenheit.

In 1972, PBS was closed and J Site was deactived between 1972 and 1979. This included placing Buildings 2713, 2714 (the tank), and 2732 in Readiness Category 3 and using Building 2721 in Readiness Category 2 and using it as general storage/warehouse. For a time, Building 2713 was used by the US Army Reserve for equipment storage.

Building Descriptions

K Site
SAN-XXXX-XX

The site test building for K Site is known as Building 2811. It was a former Plum Brook Ordnance Works powerhouse known as Building 901/401-3 in the Penolite Area. Prior to NASA's conversion of the property into a test site, it demolished several of its ancilary buildings including its coal conveyor house, large fuel oil pump house and fuel oil storage tanks, and coal elevator tower and building. In 1965, NASA converted the former powerhouse into a Cryogenic Propellant Tank Site. The site was established to test propellants for space vehicles. High energy propellants are cryogens and must be stored at very low temperatures. The propellants are used on space vehicles that are enroute for several days and require super propellant tank insulation systems. K Site was the location for testing these insulation systems and to determine pressurizing gas requirements during propellant outflow.

When NASA converted K Site in 1965, it installed a 25' diameter spherical tank with a 20' diameter access door. The tank serves as a research test chamber where liquid hydrogen rocket fuel tanks up to 18''diameter can be tested. The chamber maintains vacuum conditions and a 10,000 pound hydraulic actuator is used to shake the rocket fuel tanks. Other buildings constructed by NASA to serves Building 2811 included Buildings 2812, 2813, and 2831. Building 2831 is the boiler house that supplies steam to a heat exchanger that is used in the tests. K Site also maintains its own control building (Building 2812). This building is being replaced in 2002 with the construction of Building XXXX was part of the new research facility located XX and known as XXX.

Although K Site was closed during the 1972 shutdown of PBS its status was very different from the other research test sites which were often placed on Readiness Categories 2. Instead, K Site including all three of its buildings were left in Readiness

Category 1. This seems to indicate that the facility was not seen as outmoded like many of the other smaller sites and NASA envisioned future uses for the buildings.

Unlike many of the other research facilities at PBS, K Site was fully reactivated in 1989 to support NASA's liquid hydrogen technology development programs and on-going liquid hydrogen testing. Changes to the site included adding an 800-gallon slush H2 batch production capability in November 1990. In 1992, the shaker system was reactived to support the current shush H2 fuel tank slosh tests. K Site was used in the 1990s for the development of slush H2 technology for the ongoing National Aerospace Plane (NASP). Is this still the work? What is slush H2 technology?

Building Description

B-1
SAN-XXXX-XX

B-1 Test Stand is also known as High Altitude Rocket Test Building. Constructed around 1961 by NASA, the stand was used to test propellant systems of altitude conditions. (Johnson n.d.:n.p.). It was constructed using various contractors including Thermal Products Co., and the Gundlach Sheet Metal Co., who appear to have both manufactured portions of the structure. The Elwin G. Smith Company erected the stand and the Taylor Elevator Service Company Inc. appears to have provided the vertical lift. The seal is one of the more important components of the stand and was supplied by Goodyear Aircraft Corporation. NASA engineer, A.R. Troots, drew the plans for the diaphragm seal specifications. These plans noted that the seal had to be suitable for 10 PSI differential pressure and suitable for use in hydrogen gas atmosphere at –320 degrees F and flexible at this temperature to allow ½" movement in all directions with no strain on the material.

In 1972 PBS along with B-1 Test Stand was closed. B-1 Test Building 3111 in its 1974 end of condition state is listed in Readiness Category 2. With its pump and shop house, Building 3131, in Readiness Category 1. However, this end of condition report was revised in 1982 and Building 3111 was down-graded to Readiness Category 3. There is also a "special job order" form from 1978 that notes the removal of the LH2 Vacuum-Jacketed Transfer Line beginning at the B-3 Line Tee and ending at Building 3111. This vacuum-jacketed line was needed for a hydrogen spill test at Langley Research Center that was being conducted by JPL at the China Lake Naval Facility (Special Job Order 3-1-1978:n.p.). It is recommended in the special job order that the 300 lineal feet of two-inch vacuum-jacketed line be removed along with its support structure. The decrease in real property value for B-1 is estimated at $108,000.00 once the work was completed (Special Job Order 1978:n.p.). There is a second "Special Job Order" also from 1978 that is requesting the removal and transfer of the frieght elevator from Building 3111 and four vacuum systems from Building 2211 (C Site) (Special Job Order 022-00 4-30-1978). These requested removals were to reduce costs for the construction of a facility at Michoud Assembly Facility (Special Job Order 022-00 4-30-

1978). The removal of these items will reduce the real property value of Building 3211 by $123,000.00 and Building 2211 by $18,000.00 (Special Job Order 022-00 4-30-1978). Need to physically check the site for this work.

Before it was closed, B-1 used for research and development projects including the Centaur Vehicle and the NERVA (Nuclear Engine for Rocket Vehicle Application) (Johnson n.d.:n.p.). These investigations included turbopump tests, fluid instabilities in the engine flow passages, and equipment performance evaluations (Johnson n.d.:n.p.).

The ancilarily structures a pump and shop building and substation D. The control facility for B-1 Test Stand is located at B Control and Data Building. The pipe structure adjacent to the facility is a steam ejector which is used to obtain the necessary altitude test conditions (Johnson n.d.:n.p.). The B3 boiler house (Building 3331) provided the required steam.

Building Description

B-2
SAN-XXXX-XX

Built in 1968, B-2 is also known as the Spacecraft Propulsion Research Facility and was listed in the National Register of Historic Places as a National Historic Landmark in 1985 as part of the Man in Space Thematic Study (Butowsky 1984). The facility was designed for hot firings of full-size space vehicles in an environment simulating conditions including vacuum, cryogenic temperatures, and thermal simulations at an orbital altitude of 100 miles. The facility is comprised of eight buildings. These eight buildings are a test building (Building 3211), an equipment building (Building), a three stage exhaust system (Building), a waste treatment rentention pond (3253), a propellant oxidizer and fuel storage area (3233), an electrical substation (Building 3261), a refrigeration system (Building 3231), and a service building (Building 3252). B-2 also shares its control center (Building 5411) with the other sites in B complex. At Building 5411, the instrumentation signals are sent via landlines to the "H" Building (Building 5412) for recording and processing. B-2's steam generating plant (Building XX) and accumulator (Building XX) are located at B-1 and shared by this facility. The design studies for B-2 were prepared by Bechtel Corporation, a engineering and "constructors" firm from San Francisco, California. The facility design criteria was based on conceptual designs and preliminary vehicle performance data supplied by Lewis Research Center. The earliest documents refer to the complex as the Lunar Propulsion Research Facility (Vertical files n.d.:n.p.).

Like most of the facilities at PBS, B-2 was closed for a time between 1974 and 1987. During this time, the facility was placed on standby and the ramp floor and mezzanine of Building 3211 were used for storage. In 1987 the vacuum chamber was reactivated. Several test programs followed the reactivation including the Spear I Flight Hardware Test (1987), Exceed III Flight Hardware Tests (1987), Spear III Mock Up

Tests (1992), and Spear III Flight Hardware Tests (1992). Today, B-2 is used XXX. However, the significance rests in its association with the development of the Centaur Rocket (YR) and its unique technical capabilities.

B-2 is the only facility owned and operated by NASA that can hot fire a large rocket while simulating the vacuum, cryogenic temperatures, and thermal radiation of space. New vehicles must be thoroughly tested on the ground before they are launched, to reduce the risk of failure during actual flight. These tests were critical to the development of the Centaur Rocket. The Centaur Rocket was designed to fire from Earth Orbit and send vehicles to explore other planets and solar systems including launching the Pioneer, Viking, and Voyager Spacecraft.

Building Descriptions

B-3
SAN-XXXX-XX

B-3 Test Stand was constructed in 1963-1964. Called Nuclear Rocket and Dynamics Controls Facility, it was used for altitude tests on various components for large rocket engines (Johnson n.d.:n.p.). There are only two buildings associated with the complex including Building 3311, the test stand, and Building 3331, the boiler house. The test stand is a 200-foot metal test stand that has not been used since the late 1960s. NASA's 1963 document entitled "Specifications for the Construction of the B-3 Test Stand for the Nuclear Rocket and Dynamics Control Facility at Plum Brook Station" describes the structure as approximately 50 feet by 50 feet square. The stand was 200 feet in height with several supporting structures at grade level associated to the tower. These support structures included a large dewar parking area. Dewars are large tanks designed to hold gas. Other structures that were built to support the test stand included access roads, drainage systems and necessary power and utility extensions.

The stand, itself is partially enclosed with metal siding and has large roll doors, a large crane system, a freight elevator, and heating plant. The stand also uses substation D (Building 3161) and the shop (Building 3131). In 1963 a contract was let for the enclosing of the stand and associated structures along with extending electric power and utilities to the site and constructing the heating plant and a substation (B-3 vertical files). The contract also included equipping of the stand with heat, light, power, ventilation, a/c, plumbing and special services as well as installing the elevator, shop crane, and completing the facility (B-3 vertical files).

B-3 Test Stand like many NASA buildings at Plum Brook was designed by in-house engineers and constructed by various contractors. These contractors included the T.O. Murphy Co., Thermal Products Co., Osborn Engineering Co., Aurora Pump Division of the New York Air Brake Company, Weil Pump Company, the Trane Company, Industrial Engineering and Equipment Company, the Harman Equipment Company, and others.

A memo located in the vertical files from 1965 indicates that a 200,000 gallon liquid hydrogen sphere at B-3 Test Stand was constructed by the Chicago Bridge & Iron Company under contract NAS3-5621-PB (Janett 1965:n.p.). The memo is from Karl S. Janett, Contracting Officer's Representative. The application for bids indicates that the foundation will be furnished by NASA. The actual contract for the construction of the 200,000 gallon hydrogen sphere dates from 1963 (B-3 Contract:1963:n.p.). Contract dates from 10/16/63. The hydrogen sphere is located approximately 450 feet northeast of the test stand.

B-3 was used to testing the structural integrity of the Centaur-Viking vehicle and its protective shroud (Johnson n.d.:n.p.). The Centaur-Viking vehicle XX. In 1974 Buildings 3311 and 3331 were placed in Readiness Category 2. Building 3311 was down-graded to Readiness Category 3 in 1982 and it is noted that the shop area is used as a warehouse and aircraft warning lights will remain active (Vertical Files Building 3311 1982:28). Today, B-3 is used for storage.

Building Descriptions

Hypersonic Tunnel Facility (HTF)
SAN-XXXX-XX

Originally built and designed as a Hydrogen Heat Transfer Facility in 1966, it was converted into a horizontal hypersonic tunnel in 1969 and renamed HTF. The facility includes three buildings: a test building (Building 3411), the boiler and electrical switchgear house (Building 3431), and substation F (Building 3461). ANY ONE ELSE SHARED? DOES DATA GO TO B OR H CONTROL? As a Hydrogen Heat Transfer Facility, it tested nuclear propelled rocket engines as a vertical tunnel. The site was constructed for $2.4 million. Its heat exchanger was capable of supplying hot hydrogen gas that would simulate the temperatures normally encountered in a nuclear rocket reactor. WHY RECONFIGURED? WAS THIS TYPE OF TESTING NO LONGER NEEDED? The site was reconfigured to create air velocities and temperatures that simulate flight speeds up to seven times the speed of sound and altitude conditions up to 120,000 feet. The heat exchanger was left and used for heating up to 128 pounds of nitrogen gas per second to 4000 degrees Fahrenheit. HTF was placed on standby condition in 1974 along with other facilities at PBS. In 1985, a study was performed to address the requirements to rehabilitate HTF. The rehabilitation work began in 1990 including rebuilding the heater, minor oxygen system design changes, and refurbishment of oxygen, nitrogen, and water system valves, pumps, and tanks. In 1993, this work was completed and HTF was reactivated to support NASA's generic hypersonic work. In 1996, the testing of Rocket Based Combined Cycle Engine (RBCC) began. Following this test, over 40 others were conducted at Mach Numbers of 6 and simulated Mach 7 enthalpies with the Mach 6 nozzle. ARE THESE IMPORTANT TESTS? WHY? WHAT OTHER TESTS ARE CONDUCTED AT HTF? IMPORTANCE? ETC..

Building Descriptions

Air Compressor Building (Building 5131)
SAN-XXXX-XX

Built for the PBOW, Building 5131 was originally called Building 302, the Ammonia Oxidation Plant in Area A. In 1958, NASA converted the building into its present use with 9,174 square feet that included over half of it for storage. The building served many of the smaller research facilities including Buildings 2111, 3232, and 3211. XCORRECT? X Can we name anymore? It supplied air for research testing, shop uses, pneumatic control systems, room pressurization, equipment purging, and for powering equipment such as air turbines to operate test rigs (Anonymous/PBS/Lewis Research Center Information Report 1973:4). The compressor system provide either 125 PSIG or 200 PSIG service that was further converted at the individual sites in their pressure-reducing stations (Anonymous/PBS/LeRC Information Report 1973:4). In 1972 when PBS was closed, Building 5131 was placed in Readiness Category 1 and 2 and used as a warehouse. It has remained a warehouse. WAS EQUIPMENT REMOVED, INCLUDED 6 compressors.

Building Description

Shop Building (Building 5221)
SAN-XXXX-XX

Built around 1961, Building 5221 served as the shop building for all of "B" Complex including B-1, B-2, and B-3. The building was placed in Readiness Category 2 and has been used as storage since 1974. It is currently storing pipe components.

Building Description

Boiler Building (Building 5231)
SAN-XXXX-XX

Building 5231 was constructed in 1961 to serve all of the "B" Complex buildings (B-1, B-2, and B-3) and HTF. It was placed in Readiness Category 2 in 1974 and repaired along with five other boiler facilities in 1975. CURRENT USE

Building Description

Valve House (Building 5232)
SAN-XXXX-XX

Built in 1961 and costing $10,000, Building 5232 did why for what facilities? B.H. Hadley Inc., from California supplied the cryogenic handling valve for the building. In 1972, this building was placed in Readiness Category 2. Today, XX.

Building Description

Gas Handling Facility
SAN-XXXX-XX

This facility includes Buildings 5331, 5332, 5333, and 5334. All four building were constructed in 1960 to take liquid hydrogen or liquid nitrogen and convert it into high purity, high pressure gas. Also originally located in this facility were two permanently installed dewars and vaporizers. This facility was connected to railroad spurs which allowed helium railcars to be unloaded and truck gas trailers pressurized with stationary compressors. The gas was then XX to all XX research sites? Today, NASA has all its gases shopped by trailer truck in movable dewars. The buildings are no longer used to pressurize gas but have limited storage abilities. The parking lot of this facility is used to park the trailer trucks with their movable dewars until they are needed at a specific sites.

Building Descriptions use page 11 for the pass use of each building

LH2 Storage Dewar Control Building & LH2 200K gallon Storage Dewar (Buildings 5335 and 5351)
SAN-XXXX-XX

Built in 1965, So what are Buildings 5335 and 5351? When were they added? Were they built to hold materials before they were shopped on railcars? Does this practice still take place? A memo from 3/10/67 entitled "Gas Handling Facility and Equipment Cost" indicates that NASA added Transfer Lines to LH2 Paul Vaporizer Installation Building at Gas Handling Facility. Is this correct? Also should all these buildings be treated as a facility (station-wide?) or separate?

B Control and Data Building (Building 5411)
SAN-XXXX-XX

Building 5411 was constructed in 1960 as the control room for four research sites (B-1, B-2, B-3, and HTF). The building has 11,508 square feet with 14 rooms including five control rooms, a terminal and instrument room, offic, equipment storage, and utility and observation room. Electrical lines and cables are connected between this building and the individual test sites. Low level and high level instrumentation signals are sent to patchboards and relays via land lines to control rooms in each of the individual test sites. These control rooms hold numerous meters and recording devices. In 1972, this building was closed. The 1982 updated to the End of Condition statement notes that the building was placed in Readiness Category 1. The building was completely reactivied in the late 1980s to support tests at B-2 and HTF.

Building Description

H Control and Data Building (Building 5412)

H Control and Data Building was constructed in 1960 and housed the control rooms for six research sites (A Site, C Site, D Site, F Site, I Site, and K Site). The building has 12,258 square feet of space and is divided into 15 rooms including a data recording and computer room, a data recording and equipment room, control rooms, electronic equipment shop, calibration room, and offices. Several overhead lines connect the individual sites with the patchboards and a switching matrix for routing to analog and digital recording equipment.

In 1972 when PBS was closed Building 5412 maintained in Readiness Category 1 to support K site if it was to reopen. Until the operation of K site began in XXXX, the buildings stored major data acquisition and computer equipment. HOWEVER< K SITE NEVER USED H CONTROL AGAIN DID IT? DID IT JUST REMAIN STORAGE?

Building Description

Guarantee Power Building (Building 5431)
SAN-XXXX-XX

Constructed in 1970, the Guarantee Power Building is located behind B Control and Data Building and provides emergency power if the main power feed was ever lost. Does it still have this function?

Building Description

Maintenance Shop (Building 7121)
SAN-XXXX-XX

Built for the PBOW and located in Area A, Building 7121 was formerly known as Building 274/717 and was the combine shop facility. NASA renovated the building in 1958 but maintained several different shop types including a machine shop, sheet metal shop, pipe, and welding shop, instrument shop, precleaning and disassembly area, clean room, hydraulics room, tool crib area, and nine general shop areas. Several functions took place in this building including fabricating, repairing, testing, and installing tools and related equipment. There were also areas to store high pressure gas bottles, laundry facilities, and other cleaning and dismantling units.

After 1972, much of the equipment in Building 7121 was removed including a 13,000 gallon liquid nitrogen dewar, an miscellaneous equipment and systems that were no longer usable or considered surplus to PBS. Today Building 7121 is XX.

Building Description

Carpenter Shop (Building 7122)
SAN-XXXX-XX

Originally known as Building 278/728 during its use as garage #2/garage and auto repar shop by the PBOW, Building 7122 was renovated into a carpenter shop in 1958 by NASA officials. NASA equipped the building with woodworking tools and machines to do the majority of maintenance work at the Station. Today XX.

Building Description

Locomotive Shop (Building 7123)

Building 7123 Locomotive Shop

- Plans in end of condition folder have 1961 dates indicating NASA renovation of the building. Originally known as Building 279 (also known as Const. Building #718) it was used as the locomotive shop for the PBOW.
- 1982 revised statement has readiness mode 2.

B1 Substation D (Building 3161)

- The 1982 revised end condition statement notes that the substation is in active mode. It also indicates that the 34.5-2.4 kV-transformer was moved to Lewis-Cleveland. The 300-kVa 7200/480-volt transformer will remain active.

Additions to Electric Power Facility (Building 8561)

- The NASA's document "Specifications for Additions to Electric Power Facilities" for the Plum Brook Station Project # C-2242" has no date. The work description includes "construction of a new 138-34.5 kv electrical substation, modifications and additions to an existing substation (later called out as Substation H—does not appear on current map—AT SPF 1461 NEED TO FIGURE OUT 8561 is SUB A was it demolished?) and construction of approximately 2.4 miles of 34.5 kv transmission lines. The work includes foundations, grading, construction of an access roadway (at Pentolite and Ransom Roads to Substation A), a control center building, and related

items of work. DATE appears to be around 1964. Was existing substation from ACE?

- Commonwealth and Associates were awarded the contract.

Building 7233 (Station Plant Protection Building)

- The end of condition folder for Building 2121 was revised in 1982 to indicate that Building 2121 was relocated and is now Building 7233 (Station Plant Protection Building).
- The former Plant Protection building was excessed to the Perkins School District prior to 1982. This building was built for PBOW as Building 6 the safety building and first hospital (Real Property Record Card 1955:Building 6). When PBS was shut down in 1973, Building 7231 was used as Communications Center and housed emergency equipment and as headquarters for security personnel. The ACE pumped water to their fire system from the two pumping stations on Lake Erie. The water was pumped through a 24" steel main and a 34" concrete main. In 1958 ACE sold this system to the city of Sandusky (?) note on real property records.

Building 7234

- This was formerly the boiler house for I-site. Sometime prior to 1982 NEIL CASTER , the building and boiler were relocated to the current position and reclassified as Building 7234. Information from vertical files end of condition statements for building 2631 revised 1982. Original end of condition is from 1974.
- The former boiler house Building 7232 was excessed to Perkins School District prior to 1982.

Buildings 8336 SPF, 2700, 3200 B-2 Facility, 5411 B Control Bldg)

- The 1982 revised end of condition has the following "The SPF Package Plant (8336) shall remain active to serve Garrett personnel. Wastewater quality surveillance (XV) shall be performed weekly for SPF per the State of Work for Plum Brook resident contractor. The B Control Building (5411) Package Plant shall be de-energized at the breaker panel. The B-2 Facility Package Plant (3200) shall be partially dismantled and deenergized at the breaker panel. The motor and blower shall be removed, tagged, and stored in the B-2 test Building 3211. Tags or signs shall be installed at the package plant location, restroom facilities and the breaker panel. Information located in 2713 J-Site end of condition file, a memo by Alan D. Johnson dated 6/10/74. What happened to buildings 3200 and 2700? Not on current map. DEMOLISION J SITE NEVER REACTIVED< ASK B-2 mid-late 1990s have Lallier check NPDES Permit. MODIFY PERMIT, MANHOLE COVER, NOT PULLED> CK KEITH P..

Substation F

- End Condition for Buildg 3461 is active as of 1982.

Building 7131 Garage

- 1963 plans from electrical with power and lighting details from 1963 indicating possible renovations. Built as the garage and auto repair shop for the PBOW, Building 277 continued to be used as a garage by NASA (Real Property).
- In 1982 it was classified as active same as 1974 document.

Building 7132 vehicle service station

- 1982 revised has active mode listed same as 1974.

Building 7141

- Need more information—architect? Date of construction?
- 1982 revised statement has this as active and level 1. "Present plans are to only retain the lower level of the north wing of this building open for occupancy. The entranceways into the building on both the NE corner and w front of this wing will remain open. Partions shall be erected to prevent access to the second story of both wings. The partions shall be so located that they will prevent entrance to the east wing of the building and the e and w second floor of the n wing. The cafeteria doors shall be locked and the double doors leading to the auditorium area will be kept locked."

Building 7143 Chemical Laboratory

- Plans with the date of 1963 for lighting and power possible renovation? Former ACE building 276/724 (USE?).
- Both 1974 and 1982 have this building as active—all areas occupied. "The building will be occupied by the on-site service contractor personnel for laboratory, electronics, and instrument repair work."
- More information?

Building 7194 Recreation Building, 7195 Recreational Shelter No. 1, 7196 Rec Shelter No. 2, 7197 Rec Service Bldg, 7198 Comfort Station in Rec Area

- 7194 is a former ACE Building. Known as Building 412. USE?
- 1982 listed as 2 and 3—excessed to GSA. In 1974 listed as active and occupied only for social functions.
- 1982 lists 7196 as active, excessed to GSA and currently occupied by Dept of Interior.

WHEN WAS PBS HOOKED TO COUNTY SYSTEM? Bob puzak WITHIN THE LAST FIVE YEARS? Environmental files?

Building (Pump Station), 8332 (Pump & CL2 Bldg), 8337 (Chemical Bldg), 8352 (Cl2 Contact tank), 8353 (mixing chamber), 8391 (primary set tank) 8392 (digestion tank) and 8393 and 8394 sludge drying beds, 8395 (FLOCC and final settling tank), 8396 (diversion chamber) and 8397 (trickling filter)

- 8331, 8332, 8333, 8334, 8351, and 8370 are all former ACE buildings.
- All located on Taylor Road and active in 1982 expect for sludge beds which were abandoned. They are currently abandoned.
- Statement in 1982 "The Taylor Road sewage plant shall remain active to serve PBS and the Columbus Avenue residences, except for the sludge drying beds which had previously been abandoned." The sludge beds had been abandoned prior to 1974.

Building 8333 Campbel Road Sewage Lift Station

- 3 Abandoned in 1982

Building 8334 Ransom & Maintenance Sewage Lift Station

- 2 in 1982

Building 8335 Pentolite Road Sewage Lift Station

- 2 in 1982

Building 8351 Columbus Ave Sewage Lift Station

- Active in 1982

Building SPF Local Package Plant

- In 1982, active

Building 8131 (Big Island), 8132 (Rye Beach), 8133 (pump house), 8151 and 8152 (towers), 8170 (distribution system), 8191 and 8192 (reservoirs) Rye Beach

- Building 8131 was constructed by ACE and known as Building 412 called Lakeside (Double Check). Building 8132 was also constructed by ACE and known as Building 412E Lakeside. Double Check. The pump house building 8133 is also a former ACE building. Along with 8151 the raw water tower which was known as fire protection tower by ACE. Building 8170 is a former ACE building too. Building 8190 was a former ACE building known as a 500,000 gallon reservoir it must have been decommissioned before 1973 shutdown since it does not appear in the files. Rye BEACH NOT ACTIVE ASK BOB NOT USED IN THE LAST TEN YEARS??

- 8191 and 8192 two reservoir both built by ACE and used for the same purpose by NASA.
- In 1982 all listed as active except for 8192 which is abandoned and excessed to GSA. Note, on tape, Rye Beach has been blocked and not servicing PBS for the last several years.
- Need information on construction.
- Was **Building 8134** Pump house was abandoned in both 1982 and 1974 and its not included with the other system. Is it located somewhere else?

Building Domestic Water System 8231 (Pump House), 8270 (Distribution System) 8291 (500M reservoir), 8251 (Water tower Maintenance Road), 8252 (water tower W Fox Road), 8253 (water tower Taylor & Fox Road) and 1452 (SPF water tower)

- Building 8231 is a former ACE building known as building 430. 8291 is another ACE structure.
- Building 8253 is a former ACE water tower. Building 8270 is another ACE building.
- 8231, 8270, 8251 are all active, 1982. 8252 is excessed to GSA. 8253 is excessed and removed. 1452 us active and operated by Garrett.

Gas Distribution System 8470 with Meter House Buildings 8431, 8432, 8433. 8434, and 8435

- All listed as active in 1982. "PBS natural gas system will be left in the present operating condition with each of the 6 separate systems maintained at the prsent regulated pressure." "Meter house windows will be secured and doors will continue to be padlocked with both NASA and Columbia Gas Company padlocks." "ColumbiaGas of Ohio, Inc. is responsible for operation and maintenance of equipment and systems within the meter houses."
- Is this the same arrangement? Where meter houses added by NASA or ACE/? GAS MONITOR ONE METER NOT ALL HOUSES INTERNALLY MONITOR EACH METER

Building 8562 Power House No. 1 and Substation B

- Building 8562 is a former ACE building. Also known as Substation B.
- Building 8531 is listed in mode 1 and used as warehouse. The switchgear room and substaion B are listed as active in 1982. "7.2 kV power is supplied from the main transformer at Substation A." "The 7.2 kV circuits with the exception of circuit number 3 to Bldg 5131 will remain energized to provide 7.2 kV power to various facilities" (ASK HANK FANNER, DOUBLE FEED AT SUB A EVERYTHING CAN FEED IN TWO DIFFERENT STATIONS do we know which ones?). Same info (minus used as warehouse) in 1974.

Building 8532 and Substation C

- 1982 notes that Bldg 8532 has been excessed to GSA and used as warehouse with readiness mode 1. It lists switchgear room and Substation C as active. I believe this has changed—when? Bldg 8532 was transferred btw 1974 and 1982. In 1974 end of condition it is listed as 1 mode.

Building 8561 and Substation A

- Listed as active in 1982. Substation A is listed as operated with two line breakers closed under the direct supervision and control of the Ohio Edison Company. Same info in 1974. FEEDS EVERYONE FROM THE OUTSIDE TWO OUTSIDE FEEDS, BOB AND HANK What about today?

Building 8931 Incinerator Building

- In 1982 it was noted on readiness mode 2 and used as a storage warehouse.
- Any more information on this building?

Plum Brook Ordnance Works, Army Records, Real Property, located in vitals records room of NASA-Plum Brook. (Date from 1955)

- ACE owned 3180.33 acrees of fee-owned land and 45.03 acres of easements in Erie County, Ohio.
- Surface roads included Columbus Ave, Fox Road, Ransom Road, Scheid Rd., N. Mag Area Rd., Box Factory Rd., Short Cut Rd., Taylor Rd., Campbell St., Emergency "B", Loading Dock Rd., Pentolite Accees Rd., Pentolite Line 1, 2, and 3 Roads, Classification Yd. "B" East Road and West Road., also Old Patrol Rd., Johnson Rd., Powerhouse 901 Rd., Waste Disposal #3 Rd., Oleum Rd., Ammonia Rd., Acid Rd., Powerhouse 201 Rd., Reservoir Rd #203, Waste Disposal #1 Rd., etc…
- Railroads included approximately 32.4 miles of 85 lbs., 4 miles of which are located in magazine area which includes class. Yard "A", they also have an underpass at Fox Road B&O RR Acid Area 3 and railroad trestle-crossing pipe creek on track CC. PG 158 "Originally the B&O RR's S.M. &N branch constituted the westerly line of the reservation. Therefore, in order to permit expansion of productive facilities, the Government acquired additional land lying between the RR and the Patten Track Road. This extension to the west necessitated relocation of the RR's S.M. & N. branch between Bogart Raod and a point approximately 3800 feet south of Mason Road. The Government and RR, under a contracte dated 23 March 1942, agreed to an exchange of deeds whereby the Government coveyed to the RR land for the relocation and constructed thereon tracks, structures, and facilities for RR's use during the operation of PBOW, and whereby the RR conveyed ROW and station parcel to the Government." Industrial Facilities Inventory, PBOW, Sandusky, Ohio prepared by ACE1944.
- PG 163 same document Land cost $1,599,865* land improvements $3,004,700. *: Cost to date is $1,599,865, estimated cost of areas still in condemnation is $460,172, total cost is $2,133,330.
- Buildings aquired with land are listed on pages 172a-h.
- PG 161 "The plant, however, was laid out on the basis of explosive manufacturer's standards and the distance between operating areas are many times those which are normally used in non-hazardous industries. Therefore the burden of maintaining an

operating utility layout such as now exists at Plum Brook would no doubt be prohibitive in a competitive field." .

- ACE built various bridges and culverts including a bridge on Timber Highway Crossing Pipe Creek in Acid Area, one located near Gate # 9, and various culverts. Both bridges were later replaced with culverts. No date or agency named with the replacement.
- ACE created the infrastructure for the station including a fire water system, process water system, clarified water system, domestic water system, sewerage and waste disposal, electrical distribution, fire alarm plant, time clock plant, auto call plant, road and fence lighting (with traffic signals), telephone cable plant, gas system, and steam lines.
- ACE installed galvanized woven wire fence, approximately 7' high tipped with three strains of barbed wire making it non-climbable.
- Building #15 was a guard house at north entrance to Admin area on Columbus Road. NASA moved it to Columbus and Fox Road in 1964.
- ACE had sewer pump station/admin area, it was gov't #12 and const # 412-D. Along with this building was a water clarifier tank gov't #13, const. #412-D1, a pump clorination Bldg., and digest tank. There was also sludge beds 1 &2.
- Building 245, const. #727 was a fuel oil tank storage for Building #279, Locomotive Shop, power & maint. #1.
- Gov't #250, Const. #706-A-1 was the main TNT Laboratory, power and Maintenance Area #1. It was converted in to an office area in 1964 by NASA.
- Building 258/PWT-1 was a tower tank in admin area, ne of toluene storage tank.
- Building 16 is flagpole in admin area
- Bldg 1/1 is the hospital and adminstration building
- Building #2/11, is the communications building
- Building #4/6 is fire dept., No. 1
- Building #5/5 is guard house & office building in admin area
- 6/7
- Building #7/4 is personnel building
- Building #4-A is small boiler house in rear of fire station, building #4.

Located in TNT AREA A

- Building #188/DW-B is a tower tank located near corner of fox Rd and Columbus Ave.

Located in TNT Area B

- Building #418/PW 3 Tower Tank located about 300' SW of ACE Building #294 in field
- Building #558/PW 4 Tank Tower located west of intersection of Fox Rd and B&O RR
- Building #1030/F-1 Located 200 yds e of Building #291 on Fox Road inside area controlled by Ordnance Dept US Army but still used for fire protection of the PBOW

Located in TNT Area C

- Building #689/812-8 Acid & Fume Recovery House
- Building #672/141-B Barn, Campbell Road note by ACE is repairs needed, poor condition. Structure now used for rough storage only.

Located in Area A

- Building #203/412B, reservoir pumping station-Building 202/402, 1964 NASA razed.
- Building #288/DWA tower tank, Box Factory, near corner Fox and Taylor Roads
- Building #200/412-A Lakeside Pumping Station #1
- Building #201/401 Power House included hoist house and fuel oil pump shelter
- Building #225/412-E Lakeside Pumping Station No. 2 (Rye Beach I believe). Includes guard house, diversion wall, breakwater wall, manhole, intake well
- Building #271/713, Light material warehouse
- Building 272/714, heavy materials warehouse
- Building #273/723, Laundry Building
-
- Building #275/715 Grease, Oil, & Waste Storage Building
- Building #276/724, Yard Tool & Storage Building, converted in 1964 by NASA to Rocket Area Laboratory
- Building #277/716-B Garage & Auto Repair Shop
- Gov't #278/ Const. #728
- Building #279/718 Locomotive shop
-
- Building #308/308 Sulphuric Acid Building included fuel oil pump house which was razed by NASA in 1964, and fuel oil tank, again razed in 1964 by NASA.
- Building #310/302, Pump House
- Building #313/713-A, Warehouse , note by NASA that porch was removed.
- Building #314/713-B Warehouse, note by NASA that porch was removed.

Located in Box Factory

- Building #292/815, Box Shook Storage Warehouse
- Building #291/729, Drum Reclaiming & Repair Shop

Located in Area 2

- Building 501/401-1, Power house including hoist, and fuel oil pump shelter
- Bulding 503/412-F, Reservoir pumping station including reservoir, and surge tank which was razed by NASA in 1964.
- Building 520/722, shop and warehouse
- Building 550/706-A-2 main TNT laboratory

Located in Area 3

- Building 813/741, Warehouse

Located in Penolite Area

- Building 901/401-3, power house, including hoist house razed by NAS in 1964, coal conveyor house, razed in 1964, large fuel oil pump house, again razed by NASA 1964 along with fuel oil storage tanks, and coal elevator tower and building. Does appear to have water softener and heating tower associated with it that does not appear to have been demolished.
- Building 2033/239, Sanitary sewer booster pump station
- Building 2018/236, ingredient stores
- Building 2019/234, box store
- Building 1000 Change House
- Building 1002, barn note by NASA building down November 1964
- Building 1007, change house
- Building 1007A clock house

- Building 1007 B, search alley
- Building 1001, yardmaster and track scale office
- Building 1001A, latrine
- Building 1030 elevated water tank
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CHAPTER V. CONCLUSIONS AND RECOMMENDATIONS