56-1251

National Register of Historic Places Registration Form

This form is for use in nominating or requesting determinations for individual properties and districts. See instructions in National Register Bulletin, *How to Complete the National Register of Historic Places Registration Form.* If any item does not apply to the property being documented, enter "N/A" for "not applicable." For functions, architectural classification, materials, and areas of significance, enter only categories and subcategories from the instructions.

RECEIVED MAY 12 2017 Natl. Reg. of Historic Places National Park Service

1. Name of Property

Historic name: Mine Roof Simulator
Other names/site number: N/A
Name of related multiple property listing:
N/A
(Enter "N/A" if property is not part of a multiple property listing

2. Location

Street & number: National Institute of Occupational Safety and Health (NIOSH), Bruceton Research Center, West side of Cochran Mill Road, 2 miles south of Bruceton
City or town: South Park Township State: PA County: Allegheny
Not For Publication: N/A Vicinity: N/A

3. State/Federal Agency Certification

As the designated authority under the National Historic Preservation Act, as amended,

I hereby certify that this X nomination ___ request for determination of eligibility meets the documentation standards for registering properties in the National Register of Historic Places and meets the procedural and professional requirements set forth in 36 CFR Part 60.

In my opinion, the property X meets ___ does not meet the National Register Criteria. I recommend that this property be considered significant at the following level(s) of significance:

X national **___statewide** **___local**
Applicable National Register Criteria:

X A **___B** **___C** **___D**

[signature] / Director of Projects & Construction Services Office 5/12/2017
Signature of certifying official/Title: **Date**
DHHS / Centers for Disease Control & Prevention
State or Federal agency/bureau or Tribal Government

In my opinion, the property X meets ___ does not meet the National Register criteria.
Andrea MacDonald May 2, 2017
Signature of commenting official: **Date**
Deputy SHPO Pennsylvania Historical and Museum Commission
Title : **State or Federal agency/bureau or Tribal Government**

4. National Park Service Certification

I hereby certify that this property is:

✓ entered in the National Register

__ determined eligible for the National Register

__ determined not eligible for the National Register

__ removed from the National Register

__ other (explain:) __________________

Patrick Andrus
Signature of the Keeper

6/26/2017
Date of Action

5. Classification

Ownership of Property

(Check as many boxes as apply.)

Private:	[ ]
Public – Local	[ ]
Public – State	[ ]
Public – Federal	X

Category of Property

(Check only **one** box.)

Building(s)	[ ]
District	[ ]
Site	[ ]
Structure	[ ]
Object	X

Number of Resources within Property
(Do not include previously listed resources in the count)

Contributing	Noncontributing	
1		buildings
		sites
		structures
1		objects
2	0	Total

Number of contributing resources previously listed in the National Register 0

---

6. Function or Use

Historic Functions
(Enter categories from instructions.)
EDUCATION/Research facility

Current Functions
(Enter categories from instructions.)
EDUCATION/Research facility

7. Description

Architectural Classification
(Enter categories from instructions.)
_No style____________

Materials: (enter categories from instructions.)
Principal exterior materials of the property: _CONCRETE; METAL____________________

Narrative Description
(Describe the historic and current physical appearance and condition of the property. Describe contributing and noncontributing resources if applicable. Begin with **a summary paragraph** that briefly describes the general characteristics of the property, such as its location, type, style, method of construction, setting, size, and significant features. Indicate whether the property has historic integrity.)

Summary Paragraph
The Mine Roof Simulator (MRS) is a mechanical device located in Building 155 at the Pittsburgh Research Center of the National Institute for Occupational Safety and Health (NIOSH). The NIOSH campus is located in Allegheny County, about 13 miles south of Pittsburgh on a 238-acre federally-owned property. Building 155 (Photographs 1 and 2) is one of four warehouse-type metal buildings that comprise the Mining Equipment Test Facility (METF), which was built in the 1970s on a hilltop on the south side of the Pittsburgh Research Center. The MRS is a hydraulic machine used to subject artificial roof-to-floor mine support structures to the kind of force and displacement actions that such structures typically encounter in underground coal mines. Built in 1978-79 by the U.S. Bureau of Mines (USBM) and the engineering firm MTS Systems Corporation of Minneapolis, Minnesota, the MRS was developed primarily to test and develop roof supports, or “shields,” for the longwall method of coal mining. The MRS is capable of exerting loads of up to 1,500 tons vertically and 800 tons horizontally between 20’ x 20’ steel plates, or “platens,” to simulate the effects of ground movement on mine roof supports (USMB n.d.:3). The MRS is 38’ high, 28’ wide, and 26’ deep, and it weighs 990 tons. It has a vertical opening capability of 16’. Building 155 was specifically built to house the MRS, the MRS Control Room, and staff offices. The building is historically associated with ongoing MRS research and development and therefore shares its significance. The nominated property consists of one contributing object, the MRS and its control room, and one contributing building, Building 155.

Narrative Description

Location and Setting

The NIOSH Pittsburgh Campus was originally known as the USBM's Bruceton Research Center after the nearby small town. The property is bordered by McElheny Road to the north, Cochrans Mill Road to the east, and Wallace Road to the south. The campus is shared with the Department of Energy (DOE) and the Department of Labor – Mine Safety and Health Administration (DOL-MSHA). The entire campus includes 114 buildings and two experimental coal mines.

The campus was originally set in an isolated, rural area that is now mostly suburban in character. Residential development surrounds the campus, which is located in a small east-west oriented valley on the west side of Cochrans Mill Road. It features a varied topography with steep ridges along the western edge transitioning to rolling hills followed by meadow and a stream valley along which Cochrans Mill Road runs. The elevations range from 900' to 1250', with slopes as steep as 80 percent (Jacobs 2002:3.5).

The Main Entry Drive through the campus runs through the bottom of the valley and the center's buildings are mostly arrayed along a network of terraced hillside roads to the south. The NIOSH buildings are for the most part located on the south side of the valley, though there are a few on the north side, and others are scattered in separate locations throughout the campus. The Pleasant Hills Authority Sewage Treatment Plant is situated on the east side of the campus between it and Cochrans Mill Road.

The MRS is housed in Building 155, which is one of four buildings that compose the Mining Equipment Test Facility (METF), which is located on a hilltop on the south side of the Pittsburgh Research Center, just north of Wallace Road and the DOE area. The METF is a complex where mining equipment and systems are evaluated in simulated mining environments. Other buildings of the METF include the Equipment Maneuverability Trial Area (Building 151), which tests the maneuverability of new coal cutting and hauling machines in simulated mine environments; the Cutting Trials Area (Building 152), which tests new coal cutting equipment on simulated beds of coal; and the Hydraulic Transport Facility (Building 23), which was developed to study new ways to transport coal out of mines but was never actually used.

The Mine Roof Simulator

The MRS is a dynamic, multi-axis hydraulic press designed to provide a realistic simulation of the closure of a mine roof on roof supports. It can exert force in three directions: up to 1,500 tons of force vertically (Z direction), 800 tons of force horizontally (X direction), and 800 tons of force laterally (Y direction). The main components of the MRS include two 20' x 20' platens that react against one another through a series of hydraulic actuators, which are controlled by computer equipment in the Control Room. During a testing situation, the upper platen is moved into the desired position and clamped into place on its four support columns while the testing force is provided by the lower platen, which can simultaneously move in horizontal and vertical directions (Photographs 3-5).

The MRS has a 28' x 26' steel base structure that is secured to the concrete floor of Building 155 (Photograph 6). The base is recessed below floor level in an area called the Load Frame Pit, which is accessible via a metal staircase on the west elevation. Held by this base is the 20' x 20' lower platen, which is manipulated horizontally, vertically, and diagonally by four hydraulic vertical actuators, four horizontal actuators, and four actuators at the lower platen corners. These actuators are used to provide the testing force. The vertical actuators are positioned under each of the four lower platen corners and are used to push it up and down. The horizontal actuators are positioned at the left and right sides of the lower platen and are used to move it side to side. The diagonal swing struts are positioned at a diagonal angle across each of the four elevations of the MRS, including the front and back swing struts and the larger lateral struts on the left and right sides. The diagonal swing struts manipulate the lower platen in diagonal directions.

Extending from each corner of the base structure to the top of the upper platen are four lift cylinders that are used to adjust the height of the upper platen. Just inside the lift cylinders is another set of four cylindrical metal columns that hold the upper platen in place once it is clamped into position with hydraulic clamp cylinders. The upper platen is 20' x 20' and can move up or down to vary the working space of up to 16' in height, but it remains stationary during tests while the lower platen applies the force.

The metal tripod arrangement on the two sides of the MRS is called the Unstressed Reference Frame. It is used to reference the motion of the two plates to each other and control the center position of the lower platen.

The MRS was originally controlled via an analog control system that was replaced in 2009 with a modern digital system. The original system had a total of 11 servo controlled circuits and transducers for data readout and control settings. The analog controls were housed in a three-bay control console that contained all of the transducer conditioners, servo-control loops, summing networks, and valve controls necessary to operation of the MRS. Analog readout on the system included a Tektronix oscilloscope, Hewlett Packard XYY Recorder, and Hewlett Packard Digital Volt Meter for readout and setup. All of this was contained in the control room adjacent to the MRS, which features a 12' x 12' observation window (Photographs 7-10).

MRS Testing Procedure

The objective of a typical Mine Roof Simulator test is to determine the stress distribution and magnitude in a roof support's critical areas. The MRS has tested a variety of roof supports in the past, including wood cribs, steel columns, wood posts, and inflatable concrete posts. The main technological achievement of the MRS was its role in the testing and design improvement of the longwall roof shield's critical areas, including the canopy, caving shield, base, and the link pins that hold it together (Photographs 11-13). Through a MRS test the apparent deficiencies in any of the shield's parts can be detected and corrected through design modifications (Evans, Yavorsky, and Maayeh 1982:136).

Prior to placing the shield on the lower platen of the MRS, it is disassembled to install strain gauges and photoelastic material on its various parts to measure stress distribution. After reassembly, the shield is placed in the center of the lower platen on four square steel blocks (Photograph 15). Any one of these blocks can be removed during testing to evaluate the effects of force on the imperfectly balanced shield, a common situation on uneven mine floors. Vertical and horizontal forces are then applied to the shield in varying force combinations. The shield is also subjected to purely vertical load application, with horizontal forces applied and removed manually at predetermined percentages. As the testing forces are applied, data from the strain gauges provide continuous real time data that are stored in the Control Room computers to be analyzed later. In one test described by Bruceton MRS researchers, the most severe stress was observed in the shield base, which was addressed through the welding of additional steel plate reinforcements at strategic positions. This modification greatly improved the shield's performance, and serves as an example of the type of outcomes desired though use of the MRS (Evans, Yavorsky, and Maayeh 1982:136-139).

Building 155

Building 155 (completed in 1979), houses the MRS as well as ancillary laboratories and office space for facility personnel. The building has a metal gable roof, concrete slab foundation, steel frame structure, and insulated metal exterior walls. The rectangular building is 130' long by 100' wide with a 50' square portion on the east end of the building. It has horizontal sliding windows throughout. The cavernous bay interior of the main MRS workroom is characterized by a two-story open ceiling that holds a 20-ton overhead crane used for loading and unloading test samples from trucks, which enter from vertical sliding garage doors on the south and east elevations. There is a winch-and-cable system for positioning test samples in the MRS. Adjacent to the MRS is the Control Room, which has a 12' rectangular observation window. Recently, NIOSH has acquired updated electronics in this room. The west end of the building contains offices (USMB n.d.:11).

Integrity

Both Building 155 and the MRS retain physical integrity, in terms of location, design, setting, materials, workmanship, feeling and association. Building 155 and the MRS have never been moved and so retain their integrity of location. The property's design has not changed as Building 155 has never been added to or remodeled, and the MRS has never been redesigned. The property's setting within the METF has not changed since the late 1970s, as all buildings associated with the area remain in their original locations and have not been intruded on by new construction or demolition. The materials of Building 155 and the MRS are almost completely intact; the MRS was so well designed that it has never needed any major replacement parts or materials. The exception to the property's integrity of materials lies primarily in the replacement of the 1979 control room equipment used to manipulate the MRS. This equipment was removed and replaced with up to date, digital, computer controls, which were necessary to continue the MRS's ongoing mission of improving mine safety. The room housing the controls remains the same. The property's workmanship remains intact as the original MRS engineering has not been changed or substantially altered. The property retains its feeling as a scientific research facility used to test mine roof support systems. This feeling is reinforced by the presence of several examples of mine roof supports tested on the MRS. Given the physical integrity and its ongoing research uses, the property retains its association as a significant machine used in coal mining research.

8. Statement of Significance

Applicable National Register Criteria
(Mark "x" in one or more boxes for the criteria qualifying the property for National Register listing.)

[X] A. Property is associated with events that have made a significant contribution to the broad patterns of our history.

[ ] B. Property is associated with the lives of persons significant in our past.

[ ] C. Property embodies the distinctive characteristics of a type, period, or method of construction or represents the work of a master, or possesses high artistic values, or represents a significant and distinguishable entity whose components lack individual distinction.

[ ] D. Property has yielded, or is likely to yield, information important in prehistory or history.

Criteria Considerations
(Mark "x" in all the boxes that apply.)

[ ] A. Owned by a religious institution or used for religious purposes

[ ] B. Removed from its original location

[ ] C. A birthplace or grave

[ ] D. A cemetery

[ ] E. A reconstructed building, object, or structure

[ ] F. A commemorative property

[X] G. Less than 50 years old or achieving significance within the past 50 years

Areas of Significance
(Enter categories from instructions.)
_Industry___________

Period of Significance
_1978-ca. 1985 ______

Significant Dates
_1978______________

Significant Person
(Complete only if Criterion B is marked above.)
_N/A ______________

Cultural Affiliation
_N/A______________

Architect/Builder
_U.S. Bureau of Mines______
_MTS Systems Corporation__

Statement of Significance Summary Paragraph (Provide a summary paragraph that includes level of significance, applicable criteria, justification for the period of significance, and any applicable criteria considerations.)

The Mine Roof Simulator (MRS) is significant under Criterion A for Industry. In the area of Industry, the MRS was instrumental in the development of longwall mining, now the nation's most productive way of extracting coal. As a resource that achieved significance within the past 50 years, the MRS meets Criteria Consideration G. The period of significance begins in 1978, when the Mine Roof Simulator was installed at the Bruceton Research Center, and ends in ca. 1985, when the mine shield designs tested by the MRS were perfected.

Narrative Statement of Significance (Provide at least **one** paragraph for each area of significance.)

History of the Bruceton Research Center

The Bruceton Research Center was established in 1910 by the U.S. Bureau of Mines (USBM), which was created by Congress to promote health and safety in American industry's most important and dangerous sector, coal mining. Starting with the construction of the Experimental Coal Mine in 1910, the USBM initiated a scientific research program aimed at providing the mining industry with information on permissible explosives, lighting systems, and other equipment that could be used safely in the presence of coal dust and methane gas, the main causes of coal mine explosions. From this beginning the USBM expanded the research mission of the Bruceton Research Center to related applications in industry, municipal government, and the military. In the 1950s, the USBM built an additional mine adjacent to the Experimental Coal Mine called the Safety Research Coal Mine (SRCM), the larger entries of which reflected the changes in coal mining during the twentieth century. The SRCM was used to research modern health hazards such as respirable dust, methane ventilation, and noise control. With the energy crisis of the 1970s, the USBM enhanced its programs to increase the efficiency and production of coal mining through new equipment and techniques. The USBM constructed the Mining Equipment Test Facility (METF) on nine acres at the Bruceton Research Center to test and develop new large-scale mining equipment for use in ever-larger room-and-pillar and recently developed longwall mines. The four buildings of the METF include the MRS, used to test mine roof support systems; Equipment Maneuverability Trial Area (Building 151), which tests the maneuverability of coal cutting and hauling machines in simulated mine environments; the Cutting Trials Area (Building 152), which tests continuous coal cutting equipment on simulated beds of coal; and the Hydraulic Transport Facility (Building 23), which was developed to study new ways to transport coal out of mines but was never actually used (United States Bureau of Mines n.d.:3).

History of the Mine Roof Simulator

A key feature of the METF was the MRS, which was conceived by engineers at the USBM in the early 1970s as a device with the ability to simulate the geological forces and displacements associated with a typical coal mine roof. Somewhat similar machines were in operation at the time in England and Germany, but the USBM envisioned its own testing unit that improved on these existing machines' capabilities. In 1974, Dr. Lewis V. Wade, USBM Supervisory Research Civil Engineer, published a technical bulletin that described the purpose and technical parameters of the MRS (Wade 1974). After completing the conceptual phase for the project, Wade and his colleagues selected engineering firm MTS Systems Corporation, of Minneapolis, Minnesota, to design and build the MRS based on the bureau's specifications. By 1978, the machine was built with a $10 million appropriation by Congress, to that date the largest single investment in mining technology by the U.S. government (Barczak 2008) (Photograph 16). For the next decade, the MRS was used to test the design and load capabilities of mine roof supports, especially the hydraulic "shields" essential to longwall coal mining. This work was conducted under the supervision of Dr. Lewis Wade and Claude Goode, USBM Roof Support Supervisor, as well as Dr. Tom Barczak. The machine was so successful that by the middle to late-1980s the design of longwall shields was virtually perfected. The use of the MRS was then primarily transitioned to designing roof support systems for the "gate roads" that provide access into the nation's ever larger and deeper longwall coal mines. Today the MRS continues to play a significant role in the development of a variety of different roof support technologies

Criterion A, Industry
The MRS had a significant impact on the nation's coal mining industry as a key tool used to perfect the design of mechanical roof shields and gate road supports necessary for longwall coal mining. Through the technological advancements in shield design achieved with the MRS between 1978 and 1985, longwall mining evolved into the safest and most productive method of mining coal in the U.S. In 1983, longwall mining represented only 27 percent of the nation's coal output, and by 1993 it represented 40 percent. According to the Energy Information Administration, labor productivity more than doubled during this decade and by 1995 longwall mining was the nation's most productive method of extracting coal compared to any other conventional method. By 2005, longwall mining has grown to represent nearly 52 percent of the nation's coal output (Energy Information Administration 1995: 1; Energy Information Administration 2008: http://www.eia.doe.gov/cneaf/coal/page/acr/table22.html; Peng 2006: 3).

The idea for the MRS was conceived during a period in U.S. history when the nation was confronted with massive energy supply problems. The OPEC oil embargo of 1973 triggered an economic crisis and highlighted the need to develop domestic sources of energy. "The coal industry," writes Dr. Tom Barczak, "responded to this increase in demand with unprecedented increases in productivity, largely because of the success of longwall mining" (Barczak 1992: 2). For its part, the USBM responded with government-funded research into new equipment and techniques that could enhance longwall mining and produce more coal with less work than traditional methods (Barczak 1992: 2). Much of this research was conducted at the METF and focused on developing continuous mining machines and coal face shearers, which eliminated the need to use explosives in coal mining, and perfecting the designs of longwall roof shields necessary to make longwall mining practical and profitable.

In longwall mining a coal bed that is large, flat, and thick is blocked out into a panel that averages around 800 feet in width, 7,000 feet in length, and seven feet in height by driving entry passages around its perimeter. A coal panel of this size contains about one million short tons of coal, most of which is recovered in the extraction process. The extraction of coal is a continuous process that is accomplished using three essential components, including self-advancing hydraulic roof support shields, a coal-shearing machine, and an armored conveyor belt that parallels the working face of the mine. While working under the roof shields, the coal shearer rips coal from the face of the mine, which is spilled on the conveyor that takes the coal out of the mine. When the shearer reaches the end of the coal face it automatically reverses direction without stopping and begins the next cut. As the shearer passes each roof shield, the shield automatically advances closer to the working face. The miners and equipment are protected by the shields, and the roof is allowed to collapse behind the shields as they advance, usually resulting in subsidence on the surface above the mine. Extraction in this manner is continued until all of the coal in the selected panel is removed (DiCiccio 1996: 199-200; Energy Information Administration 1995: 3).

While longwall mining is today the most productive method in the industry, it is only appropriate in certain geological conditions and requires a large amount of capital. Most U.S. mines continue to operate with the room-and-pillar method, where large pillars of coal representing from one-third to one-half of all coal in the mine are left unrecovered to support to the mine roof. While necessary from a safety perspective, these leftover pillars also represented substantial unrecovered profits. Additionally, room-and-pillar mining is generally limited to depths of less than 1,000 feet because larger pillars are required at greater depths, which results in even less coal extraction (DiCiccio 1996: 200; Energy Information Administration 1995: 3).

Though it was not made safe or practical until the 1970s, longwall mining was not a new approach to coal mining at that time. Barczak divides the history of longwall mining in the U.S. into two periods, the early period of 1875-1950, and the modern period of 1950-1990 (Barczak 1992: 2). Studies trace the roots of the early period of longwall mining to England, where people were experimenting with the method as early as the seventeenth century. The technique appeared in limited forms in the United States by 1875, imported by Welsh miners, but was limited to thin coal beds of the Pittsburgh Seam where room-and-pillar mining was not possible and where the necessary roof supports were minimal (Barczak 1992: 2). Miners would undercut a coal face of up to about 40 feet and support the hanging coal with wooden supports placed every four to six feet. When the supports were knocked out, the undercut coal would fall out under its own pressure or that of the roof, but it was often necessary to knock it out by force of picks and other tools. There were few technological improvements during the early period, which made longwall mining very labor intensive with low productivity compared to conventional room-and-pillar methods (Barczak 1992: 4; Energy Information Administration 1995: 10; Peng 2006: 2).

Barczak divides the modern period of longwall mining into five sub-periods of technological innovation: 1) the introduction of mechanized extraction equipment (1950-1960); 2) the introduction of self-advancing hydraulic roof supports (1960-1966); 3) the utilization of high-capacity powered roof supports (1966-1975); 4) the introduction and development of shield supports (1975-1985); and 5) the advent of system automation (1985-1990) (Barczak 1992: 4). Of these periods, the most significant was the introduction and development of shield supports, made possible by the MRS. During this period, the productivity of longwall mine coal production skyrocketed.

Mechanical extraction equipment introduced in the 1950s renewed interest in longwall mining in the U.S. Especially important was the introduction of the German-engineered coal plow that could scrape two to four inches of coal from a mine face, thus eliminating the need to undercut or blast coal with explosives. Roof control was provided by wood cribs and metal jacks topped with steel I-beams, items which often failed and required substantial labor to move with the advancing coal face. Problems with labor-intensive roof support advance were the primary constraint factors in longwall production during this time (Barczak 1992: 6).

Roof support problems improved somewhat in the early 1960s after powered roof supports were introduced that could be raised, lowered, and advanced hydraulically toward the working coal face. These supports were hampered, however, by their relatively low weight capacity. Later, the coal shearing machine was first introduced in a Utah coal mine in 1961, which was a major improvement over the earlier coal plow. The shearing machine was an electronically powered rotating drum fitted with metal "teeth" that could excavate hard coal in two-foot strips. While these improvements were significant, roof control problems continued to stifle expansion, and the overall longwall mining system had yet to be perfected so that all the necessary components worked together seamlessly. Longwall mining remained a "last resort" method for extracting thin beds of high-quality coal during this time (Energy Information Administration 1995: 12; Barczak 1992: 9).

In 1966, high-capacity "chock" type roof supports were introduced and represented a significant advancement in support design. The early chocks used in longwall mines resembled boxes, with a metal top and bottom plate held together with four vertical legs. While they had a higher capacity than earlier powered supports, and they were easier to advance, they buckled under the horizontal pressures exerted by many mine roofs (Barczak 1992: 9). "And in the attempt to mine with longwall methods in Illinois," stated Dr. Lewis D. Wade, "there were catastrophic failures of these faces, and in retrospect it was determined that those failures were not the result of the unit to take vertical load but the result of the unit to take vertical load while it was also taking lateral load" (Wade 2009: 4).

It was not until the 1970s that "the last major impediment to the acceptance of longwall mining in the United States was overcome through the introduction of shield supports, a major step in the evolution of roof control" (Energy Information Administration 1995: 12). Resembling a large metal wedge, a roof shield is composed of the top canopy, the base, the caving shield, and hydraulic leg cylinders. The design of the shield is superior to chocks because they are better able to withstand both vertical and horizontal pressures while protecting the miners and equipment working under them. Additionally, they automatically advance as mining progresses while allowing the mine roof to collapse (Energy Information Administration 1995: 12-13).

But the shields first introduced in this period were far from ideal in their design and continued to pose problems for the safety and efficiency of longwall operations. According to Dr. Tom Barczak, "the [longwall] mining process that was using that type of equipment was in its infancy back then. The equipment was all built in Europe at the time, Germany and England. The conditions were different there so much of the process was to take that equipment and adapt it to the types of conditions that we had here in the United States, which required a higher loading capability" (Barczak 2009: 2). So, the challenge for the USBM was to redesign the existing supports to match mining conditions in the U.S., "and the testing that was done in the simulator and all the companies that were involved played a vital role in that part of the history" (Barczak 2009: 3).

It was during this time in the early 1970s that Dr. Lewis Wade and other USBM engineers first conceived of designing the MRS to subject shields to the simultaneous vertical and horizontal forces exerted in a typical mine roof. Wade traveled to England and Germany, where mining engineers were attempting to deal with the horizontal load issue with little satisfactory progress.

> If you look, for example, at what the Germans were doing, they would push down on a roof support with an upper platen, a load-bearing member that was slightly inclined, and now you would be getting a component of lateral load, as well as vertical load. But it wasn't something you could control, it was something that was a result of geometry. . . There were attempts to put horizontal rams and push on the support once it had vertical load, again not simulating the movement of the mine roof, but trying to engender a lateral load in the structure through artificial means. . . so we went to build a machine that could apply the right amounts of vertical and horizontal load, but you could control them by controlling the movements to the structure and that would be up to you (Wade 2009: 5).

Conceived by Wade and his colleagues but built by MTS Systems Corporation, the MRS was the first machine of its kind. "There were things done in terms of multi-axial loading," Wade continues, "there were things done in terms of large contact area. But the combination of all of them was fairly unique" (Wade 2009: 7).

Based on the conceptual designs of Wade and his colleagues, the MRS was built in 1978 by MTS Systems Corporation of Minneapolis. The machine was remarkably close in design to the original proposed concept in the 1974 USBM technical bulletin, "Mine Roof Simulator: Definition and Discussion of Parameters" (Wade 1974). It was composed of two 20' x 20' platens with up to 1,500 tons of vertical force and 800 tons of horizontal force, which could be applied in three directions: up-down (Z), side-to-side (Y), and front-to-back (X). The original 1974 concept called for a tripartite segmented upper platen to allow for more complicated directional movement but budget and technical difficulties prevented it (Barczak 2008; Wade 1974: 1-3).

Photographs from the time show that the MRS and Building 155 were built simultaneously. The MRS was shipped to the Bruceton site in large disassembled pieces and it was erected on the concrete foundation of the new Building 155, which was then completed around the machine. The MRS was then operated from an adjacent Control Room that features an observation window and banks of electronic and computer equipment. MRS operating staff were housed in the building's many offices.

Once in use, the MRS was very effective at its intended purpose and by the mid-1980s had virtually perfected the design of longwall mining shields that could each support 400 tons. According to Barczak, the MRS was instrumental in the development of longwall mining and the increased efficiency and productivity that it brought to the coal mining industry. The MRS "promoted the development of longwall mining. . . Without the machine able to play a role [the shield development process] would have taken much longer and probably created a lot more adverse conditions. . . We were able to prevent a lot of that by having a machine that [could] accelerate that design process" (Barczak 2009: 4). By the late 1980s the use of longwall mining peaked, representing nearly half of all coal mined in the U.S. In the decades that followed, the number of longwall mines declined, but production actually increased due to continued equipment improvements, better panel design, increasingly skilled labor forces, and more aggressive management (Peng 2006: 2).

The MRS had other effects beyond increasing longwall mining productivity. It also contributed to changes in labor patterns in longwall mines and increased miner safety, the major longstanding mission of the USBM, by decreasing the number of catastrophic roof falls. Overall, the labor needs of a typical longwall mine are far greater than a room-and-pillar mine because they are substantially larger operations. According to one study, in 1993 an average longwall mine employed 102 workers per shift, whereas a room-and-pillar mine employed 21. But during the decade between 1985 and 1995, the number of workers declined as longwall mining productivity increased due to a decrease in the total number of longwall mines and the introduction of better equipment such as improved roof shields and coal shearers (Energy Information Administration 1995: 28-29). As a result, far fewer miners were needed at the actual working coal face of the mine and those remaining were deployed to safer areas of the mine (Barczak 2009: 5).

Both Wade and Barczak contend that the MRS had perhaps an even bigger impact on longwall mining productivity and safety through its use to develop wholly new roof support technologies used in the gate roads, or access roads that led in and out of the mines. Wade suggests it was in this application of the MRS that:

> …you saw tremendous improvements in the technologies available to the mining industry. With the shields, it was more of an incremental evaluation that resulted in better systems. But in terms of the entry supports, it went beyond even that. Now there is a whole generation of support systems and a methodology for selecting those support systems that really wasn't on our minds at the time (Wade 2009: 9).

Open, functioning gate roads were key features because they provided access to the working face, contained the conveyors that carried out coal, served as escape routes for miners, and provided critical ventilation across the dusty and gassy working mine face (Barczak 2009: 5-6). Until the mid-1980s conventional roof supports were stacked wood or concrete cribbing that was bulky, expensive, and difficult to transport. Worse, these supports often failed resulting in roof falls and deaths, injuries, and work stoppages. In consultation with industry representatives and engineers, MRS engineers have tested and approved approximately 50 new support products that provide a range of options for mine operators (Barczak 2009: 9). One of these supports is an innovative "inflatable" concrete column, which performs much better than conventional cribbing. These columns are composed of synthetic fabric molds that are pumped with concrete and cured into a column shape. This method is superior to earlier ones because the materials are easier to transport to and within a mine, each column can be custom sized to its location in the mine, and it requires less labor to install (Barczak 2008; Mucho, Barczak, and Dolinar 1999).

After the MRS was introduced in 1978, the growth of longwall mining was rapid and now represents just over 50 percent of all underground coal production in the U.S. It is the safest and most productive method of coal mining in the nation. While the idea of longwall mining had a long history in European and American mining, it was the perfection of roof shields that, according to Barczak, represented “the most significant technological advance of the era” (Barczak 1992: 14). Today, the MRS continues to fulfill its mission through the testing of gate road support systems that ensure the safety and productivity of today’s ever larger and deeper coal mines.

9. Major Bibliographical References

Bibliography (Cite the books, articles, and other sources used in preparing this form.)

Barczak, Thomas M.

1992 *The History and Future of Longwall Mining*. U.S. Bureau of Mines Information Circular 9316.

2008 Senior Research Engineer/Mining Engineer. NIOSH Pittsburgh Research Laboratory, Bruceton, PA. Interview with author. Interview Transcript on file with the CDC Museum and the NIOSH Pittsburgh Research Laboratory.

2009 Senior Research Engineer/Mining Engineer. NIOSH Pittsburgh Research Laboratory, Bruceton, PA. Interview with author. Interview Transcript on file with the CDC Museum and the NIOSH Pittsburgh Research Laboratory.

DiCiccio, Carmen

1996 *Coal and Coke in Pennsylvania*. Pennsylvania Historical and Museum Commission, Harrisburg, PA.

Energy Information Administration

1995 *Longwall Mining*. Washington, D.C.: U.S. Department of Energy.

2009 Underground Coal Mining Productivity by State and Mining Method. Internet; available online at http://www.eia.doe.gov/cneaf/coal/page/acr/table22.html; accessed June 30, 2009.

Evans, Robert J., Paul M. Yavorsky, and Fuad S. Maayeh

1982 "U.S. Department of Energy's Mine Roof Simulator: Performance Evaluation of Longwall Roof Supports," in *State of the Art of Ground Control in Longwall Mining and Mining Subsidence*. American Institute of Mining Engineers.

Mucho, Thomas P., Thomas M. Barczak, and Dennis R. Dolinar.

1999 *Design Methodology for Standing Secondary Roof Support in Longwall Tailgates*. National Institute for Occupational Safety and Health, Pittsburgh Research Laboratory, Bruceton, PA. Internet; available from https://www.cdc.gov/niosh/mining/works/coversheet1514.html. Accessed July 8, 2008.

Peng, Syd S.

2006 *Longwall Mining*. Second Edition. Morgantown, WV: West Virginia University.

United States Bureau of Mines

n.d. *Mining Equipment Test Facility*. Booklet on file at the NIOSH Research Library, Pittsburgh Research Laboratory, Bruceton, PA.

Wade, Lewis V.
1974 *Mine Roof Simulator: Definition and Discussion of Parameters*. Bureau of Mines Report of Investigations RI 7971. On file at the NIOSH Research Library, Pittsburgh Research Laboratory, Bruceton, PA.

2009 Former USBM Supervisory Research Civil Engineer. Interview with author. Interview Transcript on file with the CDC Museum and the NIOSH Pittsburgh Research Laboratory.

Previous documentation on file (NPS):

____ preliminary determination of individual listing (36 CFR 67) has been requested
____ previously listed in the National Register
____previously determined eligible by the National Register
____designated a National Historic Landmark
____ recorded by Historic American Buildings Survey #____________
____recorded by Historic American Engineering Record # __________
____ recorded by Historic American Landscape Survey # ___________

Primary location of additional data:
____ State Historic Preservation Office
____ Other State agency
____ Federal agency
____ Local government
____ University
____ Other
Name of repository: _____________________________________

Historic Resources Survey Number (if assigned): ____N/A____________

---

10. Geographical Data

Acreage of Property _less than one acre__

Use either the UTM system or latitude/longitude coordinates

Latitude/Longitude Coordinates (decimal degrees)
Datum if other than WGS84:__________
(enter coordinates to 6 decimal places)
1. Latitude: 40.302845 Longitude: -79.978362

2. Latitude: Longitude:

3. Latitude: Longitude:

4. Latitude: Longitude:

Or
UTM References
Datum (indicated on USGS map):

☐ NAD 1927 or ☐ NAD 1983

1. Zone: Easting: Northing:

2. Zone: Easting: Northing:

3. Zone: Easting: Northing:

4. Zone: Easting : Northing:

Verbal Boundary Description (Describe the boundaries of the property.)
The boundary is shown on the "Mine Roof Simulator, Allegheny County, PA, Site Plan" at a scale of 1"=200'.

Boundary Justification (Explain why the boundaries were selected.)
The proposed boundary includes all resources historically associated with the Mine Roof Simulator, including Building 155 and the Mine Roof Simulator.

---

11. Form Prepared By

name/title: David Price/Historian/Architectural Historian
organization: New South Associates
street & number: 118 South 11th Street
city or town: Nashville state: TN zip code: 37206
e-mail dprice@newsouthassoc.com
telephone: (615) 262-4326
date: June 18, 2008

Additional Documentation

Submit the following items with the completed form:

- **Maps:** A **USGS map** or equivalent (7.5 or 15 minute series) indicating the property's location.

- **Sketch map** for historic districts and properties having large acreage or numerous resources. Key all photographs to this map.

- **Additional items:** (Check with the SHPO, TPO, or FPO for any additional items.)

Photographs

Submit clear and descriptive photographs. The size of each image must be 1600x1200 pixels (minimum), 3000x2000 preferred, at 300 ppi (pixels per inch) or larger. Key all photographs to the sketch map. Each photograph must be numbered and that number must correspond to the photograph number on the photo log. For simplicity, the name of the photographer, photo date, etc. may be listed once on the photograph log and doesn't need to be labeled on every photograph.

Photo Log

Name of Property: Mine Roof Simulator

City or Vicinity: South Park Township

County: Allegheny State: PA

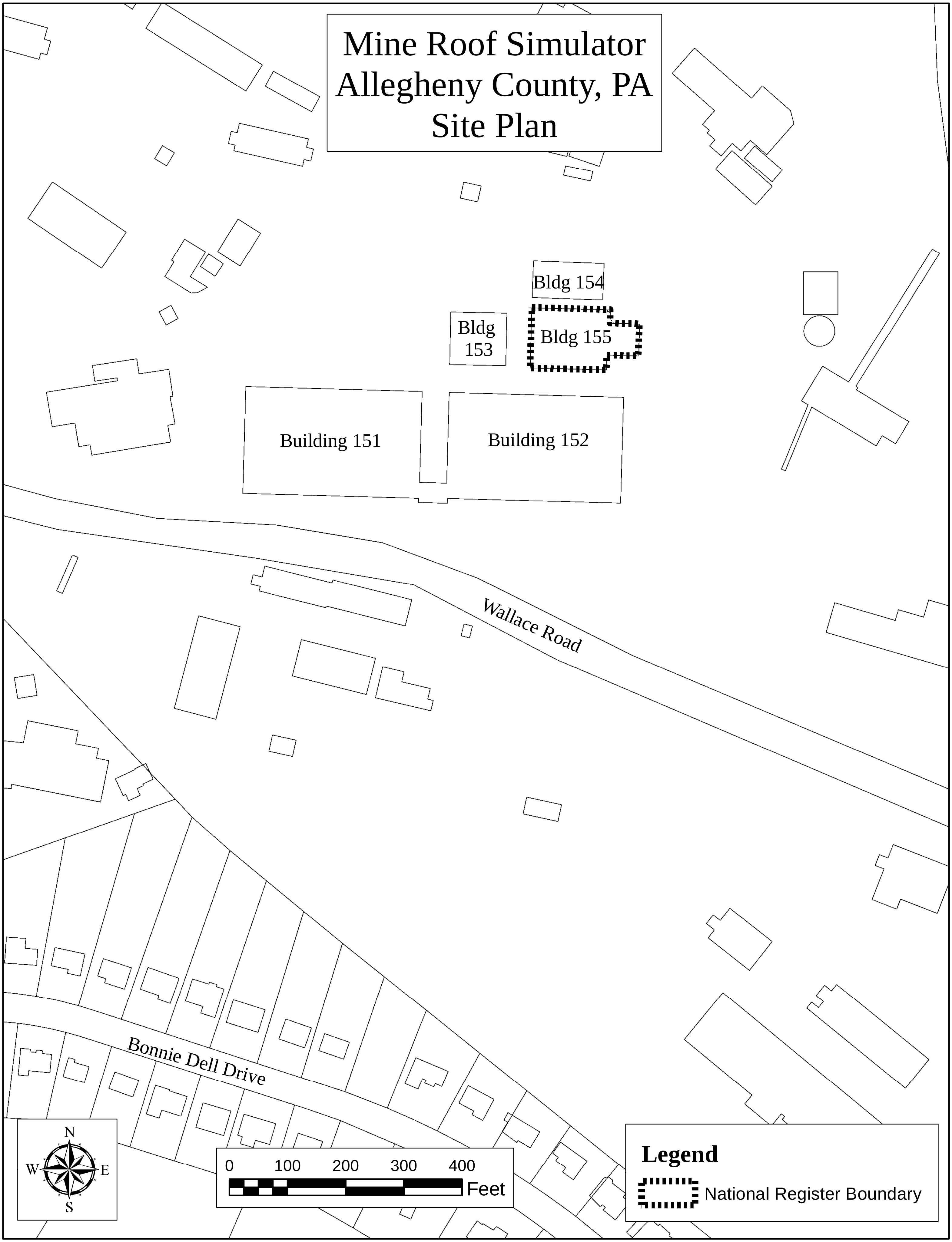
Photographer: David Price (1-14) and the National Institute for Occupational Safety and Health (15-16).

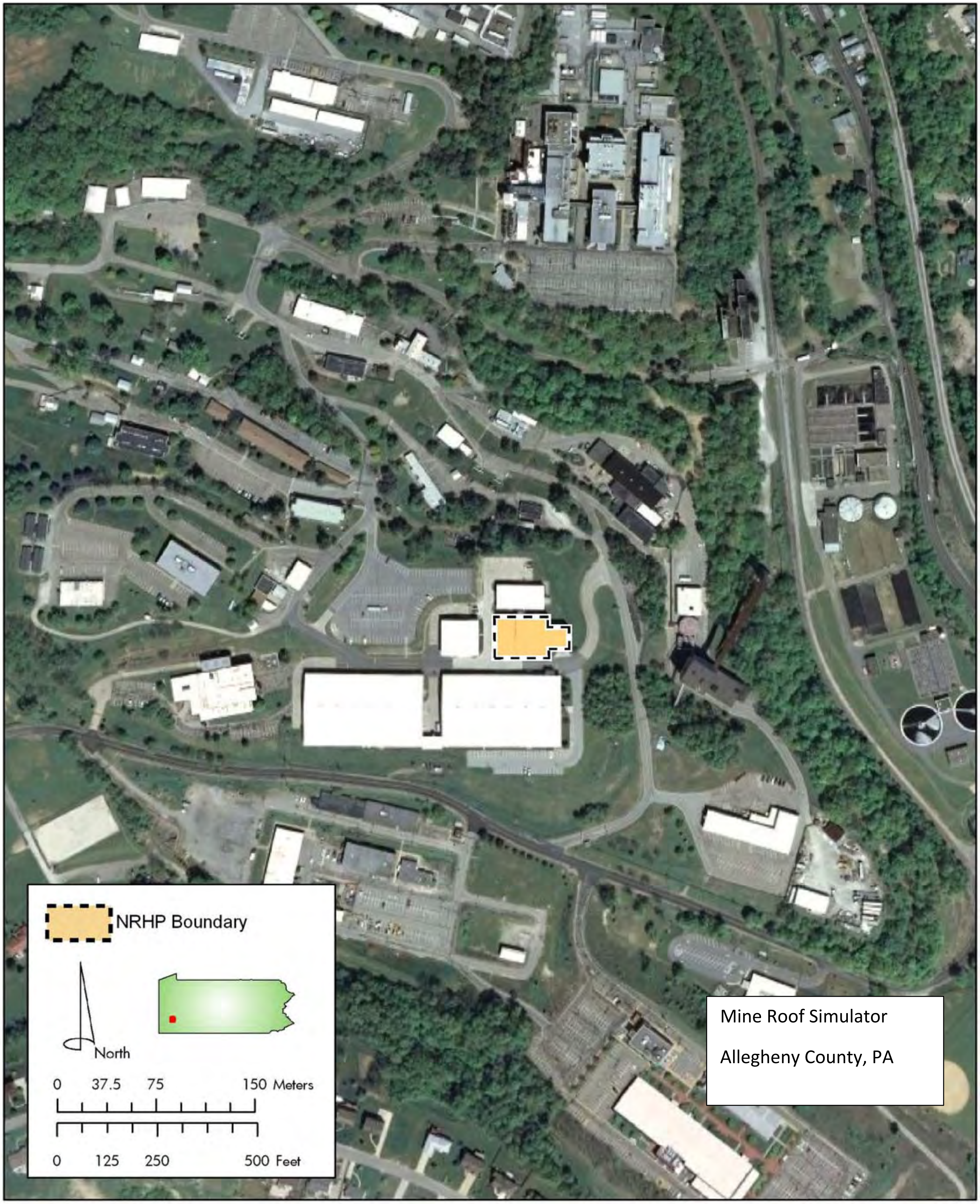
Date Photographed: June 2008 (1-14), ca. 1980 (15); 1978 (16).

Description of Photograph(s) and number, include description of view indicating direction of camera:

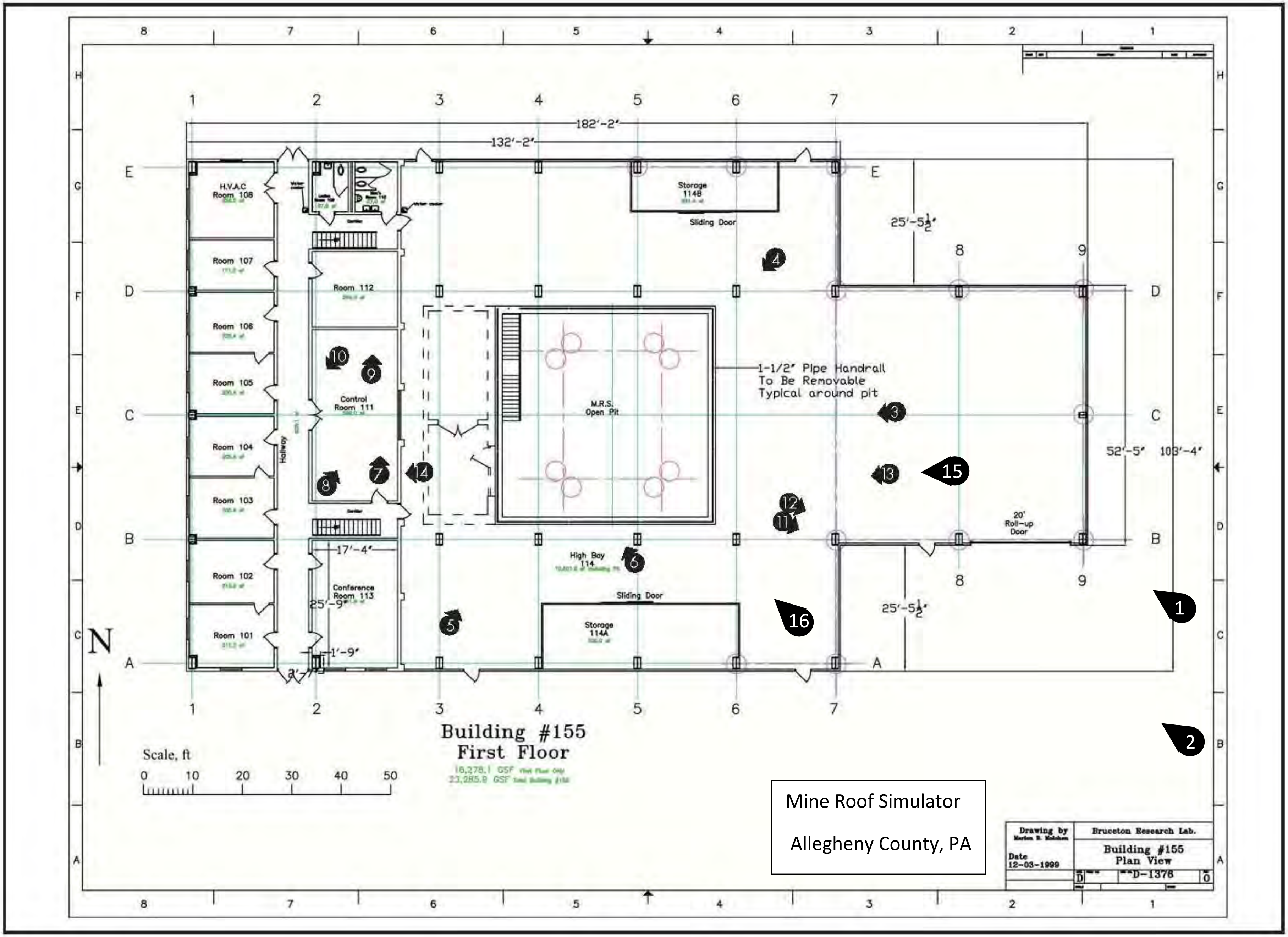
Photo Number	Description	Direction
1	Building 155, South Elevation	NW
2	Building 155 South and East Elevations	NW
3	Mine Roof Simulator, East Elevation	W
4	Mine Roof Simulator, Oblique View	SW

Photo Number	Description	Direction
5	Mine Roof Simulator, Oblique View	NE
6	Mine Roof Simulator, Detail of Mechanicals at Foundation on Southwest Corner of Device	NW
7	Mine Roof Simulator Control Room Featuring Original Electronic Control Equipment and Monitoring Windows	N
8	Mine Roof Simulator Control Room Featuring Original Electronic Control Equipment	N
9	Original Mine Roof Simulator Electronic Control Equipment	N
10	Original Mine Roof Simulator Electronic Control Equipment	SW
11	Mine Roof Support Pillars Tested with the Mine Roof Simulator	SE
12	Detail of Mine Roof Support Pillars Tested with the Mine Roof Simulator	SE
13	Longwall Shield Mine Roof Support Device Tested with Mine Roof Simulator	W
14	Photographs and Information Posted on the Control Room Wall about Mine Roof Support Structures Tested with the Mine Roof Simulator	W
15	The Mine Roof Simulator in Use	W
16	The Mine Roof Simulator Under Construction	SW


Mine Roof Simulator
Allegheny County, PA
Site Plan
Bldg 154
Bldg 153
Bldg 155
Building 151
Building 152
Wallace Road
Bonnie Dell Drive
N
W
E
S
0
100
200
300
400
Feet
Legend
National Register Boundary

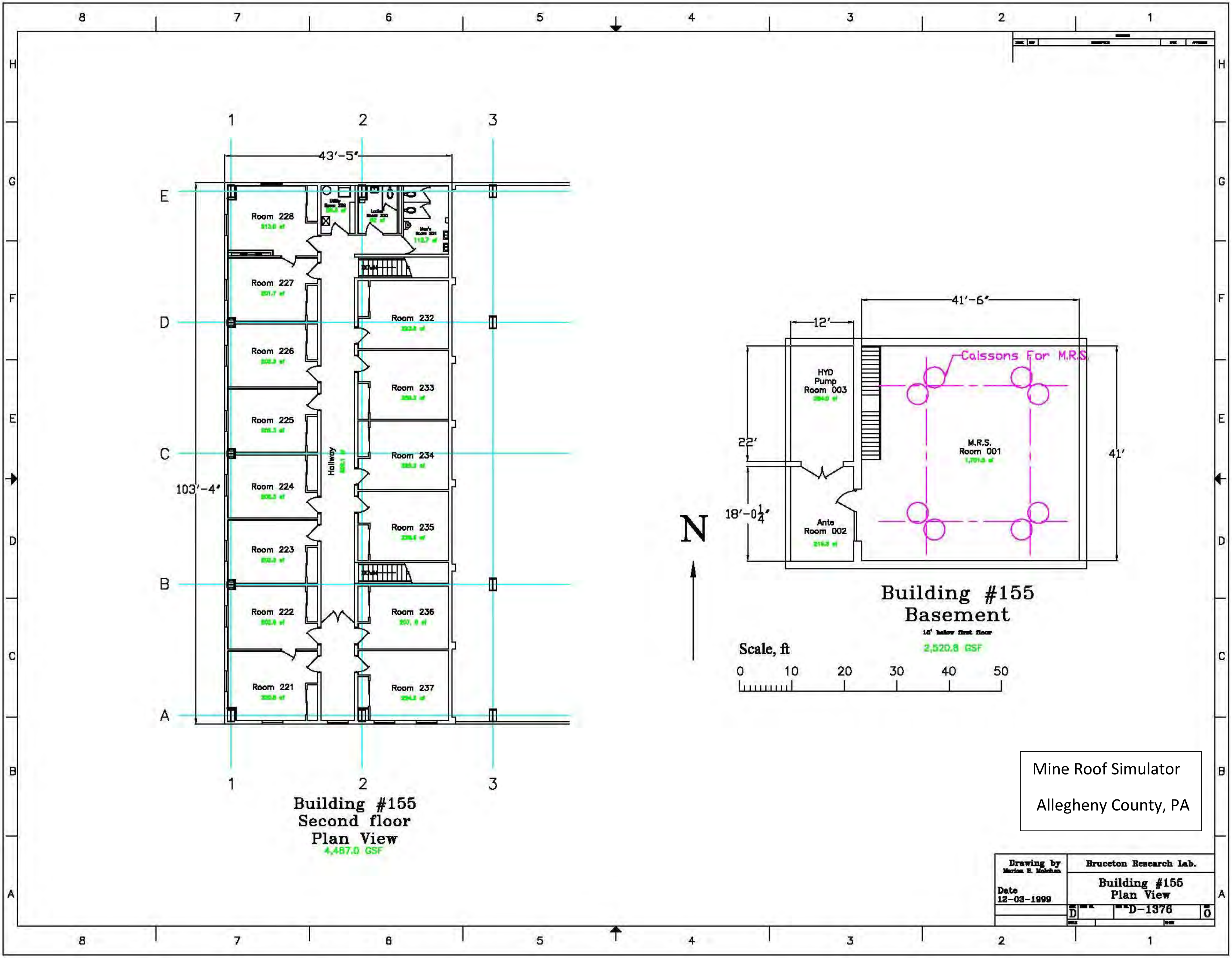


Source: Google Earth (2008)

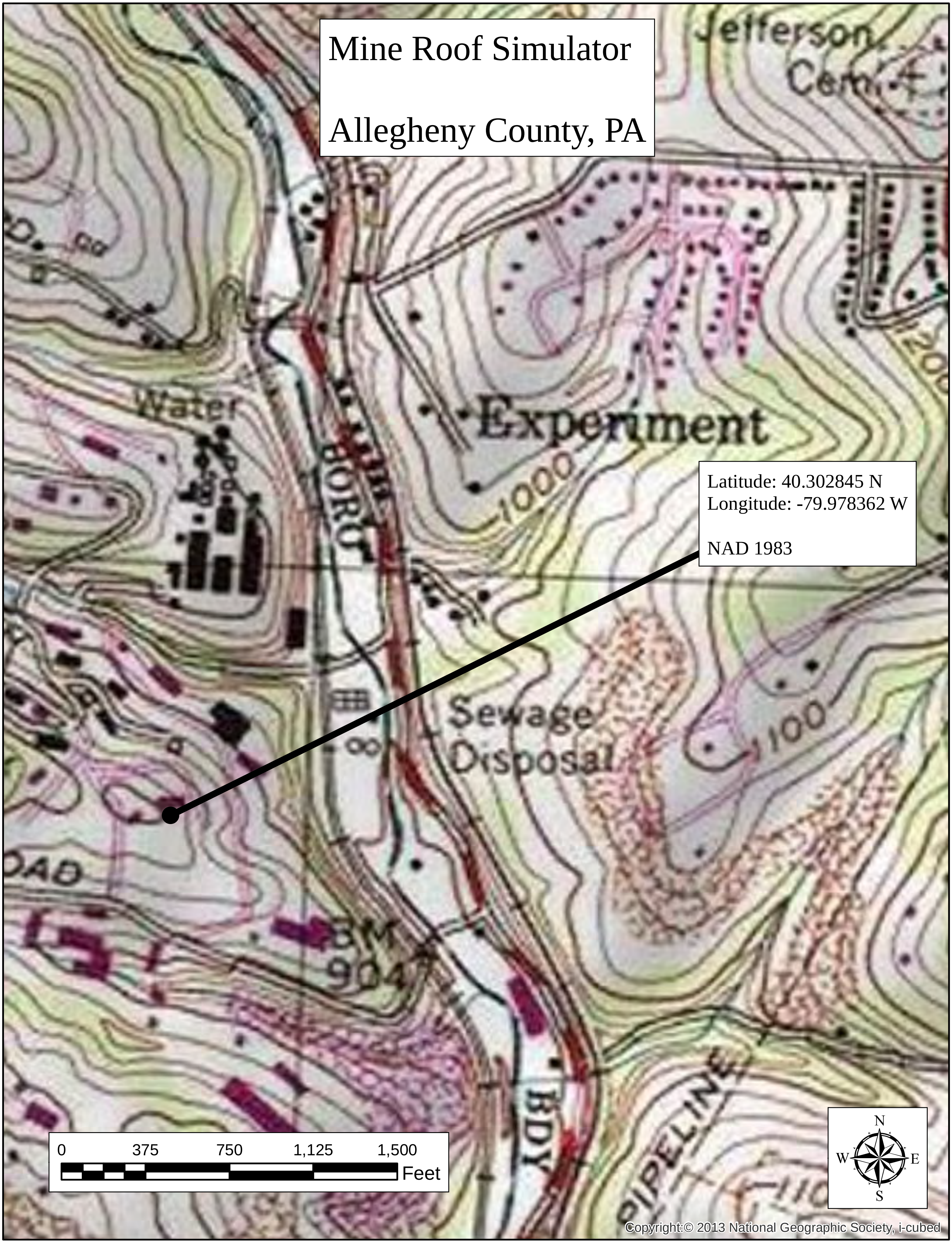


Mine Roof Simulator

Allegheny County, PA



Building #155
Second floor
Plan View
4,487.0 GSF
43'-5"
103'-4"
Room 228
Room 227
Room 226
Room 225
Room 224
Room 223
Room 222
Room 221
Room 232
Room 233
Room 234
Room 235
Room 236
Room 237
Hallway
Building #155
Basement
2,520.8 GSF
41'-6"
12'
22'
18'-0 1/4"
41'
HYD Pump Room 003
Ante Room 002
M.R.S. Room 001
Caissons For M.R.S.
N
Scale, ft
0 10 20 30 40 50
Mine Roof Simulator
Allegheny County, PA
Drawing by
Date
12-03-1999
Bruceton Research Lab.
Building #155
Plan View
D-1376


Mine Roof Simulator
Allegheny County, PA
Latitude: 40.302845 N
Longitude: -79.978362 W
NAD 1983
Jefferson
Cem.
Experiment
Water
BORO
Sewage
Disposal
1000
1100
BM
904
ROAD
BDY
PIPELINE
0
375
750
1,125
1,500
Feet
N
W
E
S


155


155
153

MTS
CAUTION
TRIPPING HAZARD
CAUTION
HARD HATS REQUIRED
MRS


MTS


MTS
CAUTION
HARD HATS
REQUIRED
MRS


MTS
DANGER
HIGH VOLTAGE


MTS


FIRE
EXTINGUISHER


HYSTER 100


SEND
MRS
VELVET
ON
OFF


LONGWALL
SHIELD
CAPACITY 400 TONS
EXIT


MINE ROOF SUPPORT STRUCTURES

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

NATIONAL REGISTER OF HISTORIC PLACES
EVALUATION/RETURN SHEET

Requested Action: Nomination

Property Name: Mine Roof Simulator

Multiple Name:

State & County: PENNSYLVANIA, Allegheny

Date Received:	Date of Pending List:	Date of 16th Day:	Date of 45th Day:	Date of Weekly List:
5/12/2017			6/26/2017	

Reference number: SG100001251

Nominator: State

Reason For Review:

__X__ Accept ______ Return ______ Reject __**6/26/2017**__ Date

Abstract/Summary Comments:

Recommendation/Criteria: Accept, National Register Criterion A and Criteria Consideration G (Exceptional Significance).

Reviewer Patrick Andrus Patrick Andrus Discipline Historian

Telephone (202)354-2218 Date 6/26/2017

DOCUMENTATION: see attached comments : No see attached SLR : No

If a nomination is returned to the nomination authority, the nomination is no longer under consideration by the National Park Service.

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Centers for Disease Control
and Prevention

May 5, 2017

J. Paul Loether, Deputy Keeper and Chief
National Register and National Historic Landmarks Program
National Register of Historic Places
Mail Stop 7228
1849 C Street, NW
Washington, D.C. 20240

Re: NR Nomination Discs

Dear Mr. Loether:

The following nomination forms are being submitted electronically per the "Guidance on How to Submit a Nomination to the National Register of Historic Places on Disk Summary (5/06/2013)":

Experimental and Safety Research Coal Mines, Allegheny County, PA
Mine Roof Simulator, Allegheny County, PA

The enclosed discs contain the true and correct copies of the nominations for the Experimental and Safety Research Coal Mines and the Mine Roof Simulator. The proposed action is listing in the National Register.

If you have any questions regarding the nominations please contact Sam Tarr at 770-488-2408.

Sincerely,

Sam Tarr

Sam Tarr
Centers for Disease Control and Prevention