NPS Form 10-900
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United States Department of the Interior
National Park Service

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Nat. Register of Historic Places
National Park Service

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.

1. Name of Property

Historic name: NASA Lewis Research Center – Development Engineering Building & Annex
Other names: K and L Buildings, Buildings 500 and 501
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: 21000 Brookpark Road
City or town: Fairview Park State: OH County: Cuyahoga
Not For Publication: N/A Vicinity: N/A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**

Barbara Power DSHPO for Inventory & Registration July 14, 2016

Signature of certifying official/Title: **Date**

State Historic Preservation Office, Ohio History Connection

State or Federal agency/bureau or Tribal Government

In my opinion, the property ___ meets ___ does not meet the National Register criteria.

Signature of commenting official: **Date**

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:) __________________

[signature]
Signature of the Keeper

8.15.2016
Date of Action

5. Classification

Ownership of Property

(Check as many boxes as apply.)

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

Category of Property

(Check only **one** box.)

Building(s)	X
District	
Site	
Structure	
Object	

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

Contributing	Noncontributing	
2	0	buildings
		sites
		structures
		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.)
COMMERCE/professional=engineering office
GOVERNMENT/government office

Current Functions
(Enter categories from instructions.)
VACANT/NOT IN USE

7. Description

Architectural Classification
(Enter categories from instructions.)
MODERN MOVEMENT/Moderne=Modernistic

Materials: (enter categories from instructions.)
Principal exterior materials of the property: ____BRICK, STONE/Limestone, METAL/Aluminum, GLASS_______

Narrative Description

Summary

The nominated property sits on a parcel fronting along Brookpark Road in the very southeast corner of Fairview Park, Ohio, with the south and east property lines bordering the City of Cleveland (Photos 1-3, Figures 1-3). To the north and west the parcel terminates at a treed hillside that drops off quickly into the Rocky River Reservation below (Photos 9, 12, 14-15, 18-19, Figures 2-5). Built across from the NASA Lewis Research Center, now known as the John H. Glenn Research Center at Lewis Field, the property consists of two associated office buildings (Photos 1, 10) that were constructed in two phases in 1963-64. Most widely known within the NASA family as the Development Engineering Building & Annex or the "DEB," the first and largest building opened in May 1964 to house 800 engineers (Photo 1). The second building followed in October 1964 to accommodate an additional 300 engineers (Photo 10). The largest, main building is K-shaped in design (Figure 4), which is said to have been to honor President John F. Kennedy. The Annex is an L-shaped building, perhaps to honor the former Director of Aeronautical Research and for whom the NASA facility across Brookpark Road was renamed in 1958, George W. Lewis. Research also revealed that the main building was also referred to as the K Building and Building 500 while the annex was called the L Building and Building 501.

Now vacant, the former office buildings are accessed from a driveway off Brookpark Road (Photo 3). The K Building runs east/west on the site, with the arms of the "K" creating the front (south) elevation (Photo 4). Between the arms of the "K" and the back wing of the building are courtyards with minimal green space and parking (Photos 16-17, 23-25). A rectangular driveway surrounds the K Building, connecting with the courtyard parking and providing vehicle access around the entire building. The L Building sits to the west of the K Building and slightly forward on the site (Photos 5, 9-10). The rectangular drive around the K Building passes in front of the L Building and provides access to a small parking lot within the "L" on the north side of the building (Photos 9, 12-13). A crescent-shaped driveway spans the front of the K Building and connects to the rectangular driveway that surrounds the site (Photos 4-5, 8).

Both the K and L Buildings were designed by the Cleveland architectural firm of Hubbell & Benes and Hoff, Inc., the firm that grew out of Hubbell & Benes (West Side Market, Cleveland Museum of Art, Wade Memorial Chapel) with Benjamin Hubbell's (1857-1935) son, Benjamin S. Hubbell (1897-1988) as the senior partner. The buildings were constructed by the Roediger Construction Co., Inc., which also built hospitals, churches, and college campus buildings in the greater Cleveland area. Both buildings are three stories, of reinforced concrete and steel construction, with flat roofs, and beige brick walls with horizontal bands of windows trimmed in stainless steel. Entrances are marked with gray granite cladding, stainless steel canopies and aluminum and glass storefront (Photos 5-7, 11, 13, 17, 23-24). The K Building has a partial basement under the middle of the building, and the L Building has a full basement, which is exposed along the south and west elevations (Photos 10, 14).

After 2000 and internal restructuring, NASA used the K and L Buildings to house administrative functions until they were closed in 2013 and sold. There were very few alterations over the years and the buildings retain historic integrity. Overall, the buildings are in good condition with isolated areas in fair condition.

Narrative Description

The K Building

The symmetrical, three-story K Building (Photos 1-9, 16-25) is constructed of beige brick on all elevations with primary and secondary entrance bays marked with large, smooth slabs of gray granite (Photos 6-7, 24). Regularly-spaced, paired, horizontal windows in horizontal bands mark every elevation. The main entrance spans three bays in the center of the front elevation, where the arms of the "K" come together (Photos 4-8). The granite cladding covers the three bays on all three floors, projecting slightly forward of the brick walls and above the brick parapet at the roof. An aluminum and glass storefront system spans the three bays on the first floor below a stainless steel and aluminum canopy that swoops up as it moves out and away from the building, reflecting the mid-century modern style. The entrance features two pairs of full light storefront doors that are several feet in front of the flanking storefront windows. Two additional pairs of storefront doors inset into the building lobby create an airlock. The banded windows appear above the canopy on the second and third floors. The arms of the "K" are each eleven bays wide, making the front elevation 25 bays wide including the entrance. The result is an expansive building that has a horizontal emphasis further magnified by the bands of windows (Photo 1). On each floor and in each section of every elevation, a stone surround frames the band of windows (Photos 24, 26-27). The top run of stone creates a continuous window lintel and the bottom run of stone creates a continuous sill. At the ends of each band, a vertical piece of stone closes the frame. On each floor the sections of brick between the paired windows are simply ornamented with random bricks set slightly forward in the wall to create a random, somewhat geometric pattern (Photos 18, 26).

The windows themselves are really quite amazing but in this setting are not surprising given the innovation and engineering that came out of these buildings (Photos 26-27). The paired windows are constructed with two panes of glass, similar to insulated glass units today. However, the spacing between the pieces of glass is about two inches—enough room to quiet the jets taking off and landing at the airport across the street and to hold an integral, operable window blind between the two pieces of glass. A patent was filed for this technology in 1963 and granted in 1965 to the Polarpane Corporation but it is unclear where the DEB windows came from. The windows are gasketed, have curved corners and are trimmed in stainless steel. Moving around the K Building, the ends of the "K" are all three bays wide, the core block within the courtyards is four bays wide with triple windows in the two center bays, and the rear elevation is 25 bays long.

Each courtyard (Photos 16-17, 23-25) has two secondary entrances, one on each side of the courtyard. The entrances are marked by the same granite slabs inset into a vertical stone surround, and a pair of full light aluminum storefront doors under a small, flat metal canopy. The doors are not centered in the bay because of the adjacent interior stairwells, which have windows at the stair landings between the second and third floors. On the west wall of the east courtyard, an exterior stair to the partial basement runs north/south along the wall below ground. The stairs are marked by a low concrete curb and painted metal railing.

A loading dock appears near the center of the rear elevation (Photos 19-21). The loading dock has a concrete stair with a metal pipe railing and a flat metal canopy over the overhead garage door. Immediately adjacent to the east, a section of the basement mechanical room appears about four feet above grade. It has a flat roof and the sides of the structure are sheathed in the same beige brick as the rest of the building. A brick ventilation shaft projects off the rear elevation over the mechanical room and some mechanical equipment sits on the roof.

Inside the K Building, the center core of the building has a cafeteria and mechanical rooms in the basement, an entrance lobby and auditorium on the first floor, and larger meeting rooms on the second and third floors. The four arms of the "K" radiate out from the center core with offices lining both sides of a central corridor on all three floors in each wing. Men's and women's restrooms are found on every floor off those corridors. Notable interior spaces (Photos 28-37), features and finishes include the terrazzo floors in the lobby (Figure 6), vertical wood cladding and paneling (possibly teak) and brick walls in the lobby and auditorium (Figure 7) ; vertical wood paneling and terrazzo floors outside the auditorium and in the open, double stairs to the cafeteria; original theater seating in the auditorium, complete with pull-up desk tops and regularly-spaced chrome ashtrays on the back of some seats; original lighting in the cafeteria line area; and stainless steel handrails on every interior stair. Corridors and offices are spartan, generally with painted drywall or plaster with carpeted floors, metal doors and jambs, and concealed spline, acoustic tile, or painted drywall ceilings. Any equipment to monitor and support space activities that existed in the buildings was removed by NASA (Figures 15-16). A pneumatic control center for the old boiler system manufactured by Johnson Controls does remain in the basement mechanical room (Photo 36).

The L Building

The L Building sits west of the K Building with its front elevation facing east. The L Building (Photos 5, 9-15) has all the same exterior detailing—same brick, brick and stone detailing, windows, window configuration and banding, secondary entrances, canopied front entrance—except that the front entrance is raised, is slightly smaller at two bays wide, and doesn't have the granite slabs on the wall above the entrance. Wide concrete steps with granite cheek walls that double as planters provide access to a single pair of storefront doors centered in the middle of the two bays, flanked by the storefront system on either side. Like the K Building, the entrance sits under a stainless steel and aluminum canopy that swoops up as it moves out and away from the building, the doors are several feet in front of the flanking storefront windows, and one additional pair of storefront doors inset into the building lobby creates an airlock.

The interior of the L Building features a paneled lobby and reception desk, the stainless steel railings at all stairs, and the original corridors (Photos 38-40). The remainder of the finishes include carpet, painted drywall and plaster, metal doors and jambs, and concealed spline, acoustic tile, or painted drywall ceilings.

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.)
ENGINEERING
OTHER: Space Exploration

Period of Significance
1963 – 1982

Significant Dates

Significant Person
(Complete only if Criterion B is marked above.)

Cultural Affiliation

Architect/Builder
Hubbell & Benes and Hoff, Inc.
Roediger Construction Co. Inc.

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.)

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

SUMMARY

The accomplishments that occurred within the Development Engineering Building (DEB) and Annex at the NASA Glenn Research Center at Lewis Field (GRCLF) in Cleveland, Ohio have been an essential part of the development of American and international space exploration. The construction of the two buildings (1963-64) was a direct response to President Kennedy's call in 1961 that landing a man on the moon was a national priority. The new NASA facility was designed and constructed to house 1,100 additional staff members engaged in research and development. The engineers and others working at the DEB and Annex played a significant role in the development of the Agena, Atlas, and Centaur rocket programs and contributed their rocket expertise directly to the manned Apollo program through the 1960s. As NASA downsized the Lewis facility in the early 1970s, the Launch Vehicle Division continued at full throttle, and for the first 35 years of the DEB building's existence, Lewis engineers managed 119 total unmanned launches from a Launch Control Room in the DEB, including interplanetary missions, lunar vehicles, and satellites.

The Development Engineering Building and Annex are eligible for listing in the National Register of Historic Places for national significance under Criterion A for Engineering and Other: Space Exploration and Criterion Consideration G for achieving significance within the past 50 years. The two buildings retain a high degree of integrity of location, design, setting, and association. The period of significance for the Development Engineering Building (DEB) and Annex begins in 1963, when building construction started, and ends in 1982, when Lewis embarked on a series of new programs for personnel housed at the DEB and Annex, including for the first time interaction with the manned space program section of NASA. These new programs included direct contributions to the manned programs of Space Station Freedom and the International Space Station. Information related to the post-1982 period is being included in this document to provide a complete history of the DEB and Annex, so that it is available in the future for use as part of a thorough evaluation of this more recent period of American and international space programs.

Justification of National Level of Significance

The NPS Theme Study *Man in Space* documents that "the most significant achievement of Lewis was in pioneering research that led to the development of hydrogen as a rocket engine fuel and in the development and testing of new materials for spacecraft and aircraft."[1] As a result of the study, only three National Historic Landmark (NHL) nominations for all of NASA

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[1] Harry A. Butowsky, *Man in Space - National Historic Landmark Theme Study* (National Park Service, 1984), https://www.nps.gov/parkhistory/online_books/butowsky4/space0a.htm

were created in the category Rocket Engine Development Facilities – and all three were at Lewis: the Rocket Engine Test Facility (built 1957, NHL 1985, removed 2005), which "pioneered in the technology necessary to handle hydrogen as a rocket fuel;" the Zero Gravity Research Facility (built 1966, NHL 1985), which "investigated the physics of handling liquids in a zero-gravity environment;" and the Spacecraft Propulsion Research Facility (B-2), Lewis Research Center Plum Brook Operations Division, Erie County, Ohio (built 1964, NHL 1985), which "enabled engineers at Lewis to hot fire full scale Centaur engines in simulated space conditions. The development of the Centaur and Saturn Rockets was crucial to both the manned and unmanned space programs of the United States."[2]

These NHL listings document the national significance of the laboratory side of Lewis to the Apollo program and U.S. space initiatives. This nomination documents that the activities that occurred in the DEB and Annex (opened 1964) are essential to understanding the success and importance of these laboratory facilities. The DEB and Annex achieve a national level of significance related to the U.S. space program as the location where the engineering, research, and development work that occurred in these two buildings produced liquid hydrogen rocket advancements in Lewis' NHL-listed laboratories, which in turn were successfully executed in the launch and management of almost 120 unmanned missions over 35 years from the DEB Launch Control Room.

ELABORATION

National Advisory Committee for Aeronautics era
1915 – 1958

The National Advisory Committee for Aeronautics (NACA) was founded on March 3, 1915, to undertake, promote, and institutionalize aeronautical research among industry, academia, and the federal government. The Congressional Act stated that the purpose of the committee was "to supervise and direct the scientific study of the problems of flight with a view to their practical solution, and to determine the problems which should be experimentally attacked and to discuss their solution and their application to practical questions." NACA's first few buildings and small staff occupied a modest portion of Langley Field in Virginia (built 1917-1920). In 1919, George W. Lewis (1882-1948) was appointed as NACA's first Executive Officer. Five years later, he was named Director of Aeronautical Research, a position he held until his retirement in 1947.

Over the next several decades, NACA research and development produced improvements in airplane aerodynamics, engine cooling, and airfoil design (wing shape). NACA researchers pursued their mission through the agency's collection of wind tunnels, engine test stands, and flight test facilities. Commercial and military clients were permitted to use NACA facilities on a contract basis.[3]

On January 23, 1941, groundbreaking ceremonies were held in Cleveland for a new NACA facility, the Aircraft Engine Research Laboratory (AERL), which evolved into today's John H.

[2] Butowksy, Table of Contents, https://www.nps.gov/parkhistory/online_books/butowsky4/spaceb.htm
[3] Roger E. Bilstein, *Orders of Magnitude: A History of the NACA and NASA, 1915-1990* (NASA History Series, National Aeronautics and Space Administration, 1989), Chapters 1 and 2. http://www.hq.nasa.gov/office/pao/History/SP-4406/contents.html.

Glenn Research Center at Lewis Field. The laboratory became a national resource for innovations in aircraft engine technology, which influenced commercial and military propulsion systems. The facility was located on the site of the annual National Air Races field, which abutted Cleveland Municipal Airport (now Cleveland Hopkins Airport). AERL was situated immediately west of the airport and had access to the runways (Figure 2). Researchers and staff from Langley Field relocated to Cleveland and initially staffed AERL. During World War II the facility produced engine improvements for U.S. fighter planes and bombers utilizing the Altitude Wind Tunnel (1944) and Icing Research Tunnel (1944).

NACA's retired Director of Aeronautical Research George W. Lewis died in 1948, and the laboratory's name was changed to NACA Lewis Flight Propulsion Laboratory. Heading into the 1950s, Lewis's focus changed from piston engines to jet propulsion and pioneering rocket engine and propellant research. Advancements were made possible with the sophisticated series of wind and icing research tunnels already in use and the construction of additional facilities, including the 8x6 Supersonic Wind Tunnel (1949) and 10x10 Supersonic Wind Tunnel (1955). As rocket research expanded in the mid- to late 1950s, Lewis developed a liquid hydrogen/fluorine regeneratively-cooled[4] rocket engine (1954), completed the Rocket Engine Test Facility (1957, NHL 1985), and in 1957 tested a Mercury[5] program escape capsule in the Altitude Wind Tunnel.[6]

National Aeronautics and Space Administration era
1958 – Present

On October 4, 1957, the Soviet Union launched the satellite Sputnik 1, which remained in orbit until January 4, 1958. This accomplishment created intense debate in American society, and one result was the creation of the National Aeronautics and Space Administration (NASA). The National Aeronautics and Space Act of 1958 (Pub. L. 85-568)[7] dissolved NACA on October 1, 1958 and transferred its activities and resources to NASA. The Act also created a Civilian-Military Liaison Committee between NASA and the Department of Defense for the purpose of coordinating civilian and military space applications, and requiring the two entities to keep each other fully informed of their space activities. In addition, the Act modified patent law to require that innovations for space travel created by either government employees or private contractors would be subject to government ownership.

NASA incorporated NACA's three research centers – Ames Research Center (at Moffett Field, California), Langley Aeronautical Laboratory (Hampton, Virginia), and Lewis Flight Propulsion Laboratory (renamed Lewis Research Center (LeRC) – into the new agency. Priorities evolved differently however, for the three centers: "Lewis had eliminated work on air-breathing engines when it shifted into space propulsion. Researchers at Ames and Langley never abandoned

[4] In a regeneratively-cooled engine, the propellant is circulated around the engine to cool it, and then the propellant is combusted.
[5] Project Mercury (1958-1963) was the first human spaceflight program of the United States. The program's goal was to put a man into Earth orbit and return him safely.
[6] NASA Glenn's Historical Timeline, accessed 28 February 2016, http://www.nasa.gov/centers/glenn/about/history/timeline.html.
[7] The Act was introduced in the U.S. House of Representatives on May 24, 1958, and signed into law by President Dwight Eisenhower on July 29, 1958.

their work in aeronautics and did few space-related projects in the 1960s."[8] Langley initially housed the Space Task Group, which planned the early space program and relocated to Houston in the early 1960s. Langley also designed the Lunar Landing Facility, used to train Apollo astronauts to land on the moon. Ames developed the blunt body concept for reentry capsules.[9]

In contrast, Lewis Research Center's priority focusing on space projects swelled its allocations of federal funds far beyond those of Ames and Langley. For example, during 1964 and 1965, Lewis received $623.1 million for research and development, compared to $279.2 million for Ames and Langley combined. For construction of facilities, Lewis received $45.1 million during 1964 and 1965, compared to $41.7 million for Ames and Langley combined.

For the agency as a whole, and particularly Lewis Research Center, the new program meant that NASA would be markedly different from NACA in two important ways: "First, it was going to be operational as well as do research. So, it would not only design and build launch vehicles and satellites but it would launch them, operate them, track them, acquire data from them, and interpret the data. Second, it would do the greater part of its work by contract rather than in-house as NACA had done.[10]

The 1960 election of John F. Kennedy as U.S. president resulted in a new administration skeptical of the manned space program, but again a Soviet success changed American policy. On April 12, 1961, Soviet Cosmonaut Yuri Gagarin completed one orbit around Earth and landed safely, becoming the first human in space. In response, President Kennedy asked Vice President Lyndon Johnson to head a study to outline a space program to convincingly surpass the Soviets. Johnson, the only senior White House figure in the new administration with prior commitment to the space program, found strong support from NASA administrators who moved to accelerate central elements of NASA's long-term plans. The largest single concept in that plan had been manned circumlunar flight. The question became whether the U.S. could reach that goal first, and the answer was not clear. To blunt the current Soviet advantages, a larger commitment was crafted: a manned lunar landing and return. This escalated program would require both nations to design and construct a new family of booster rockets and spacecraft, which would equalize the challenge, and American experts were confident that the government-industry-university collaborative model would prevail. NASA administrators also encouraged the administration to frame the potential of the proposal for various objectives, including booster rockets, communications satellites, meteorological satellites, and planetary exploration. The proposal was approved by the administration, and on May 25, 1961, President Kennedy announced in a joint session of Congress a historic national goal:

> "Now it is time to take longer strides-time for a great new American enterprise-time for this nation to take a clearly leading role in space achievement, which in many ways may hold the key to our future on earth. . . . I believe that this nation should commit itself to achieving the goal, before

[8] Virginia P. Dawson, *Engines and Innovation: Lewis Laboratory and American Propulsion Technology* (NASA History Series, National Aeronautics and Space Administration, 1991), p. 196.
[9] NASA History Program Office, accessed July 13, 2016, http://history.nasa.gov/centerhistories/ames.htm, and http://history.nasa.gov/centerhistories/langley.htm.
[10] Bilstein, Chapter 4.

> this decade is out, of landing a man on the moon and returning him safely to the earth. No single space project in this period will be more impressive to mankind, or more important for the long-range exploration of space; and none will be so difficult or expensive to accomplish."

The President "correctly assessed the national mood. Editorial support was widespread. Congressional debate was perfunctory, given the size of the commitment. The decision to land an American on the Moon was endorsed virtually without dissent."[11]

Lewis Research Center – Development Engineering Building – Need and Construction

With this national mandate and expanding budgets,[12] the impact on the Lewis Research Center was almost immediate. Coinciding with this came the directorship of Abe Silverstein, considered by NASA to be the preeminent figure associated with the facility.[13] Silverstein (1908-2001), best known for his efforts in establishing NASA in the late 1950s, also made significant technical and managerial contributions in a variety of fields, including the study of complete engine systems, development of early jet engines, creation of large supersonic wind tunnels, use of liquid hydrogen as a propellant, formation of the Mercury and Apollo Programs, and success of the Centaur rocket. A NACA employee at Langley in the 1930s, Silverstein transferred to Lewis in 1943 to run the Altitude Wind Tunnel. He was named Chief of Research in 1949 and Associate Director in 1952. When NASA was created in 1958, Silverstein was brought to Washington and named Chief of Space Flight Programs, the third-highest ranking position in the agency. Among his accomplishments at NASA headquarters was his successful effort to persuade the Saturn Vehicle Team, including Wernher von Braun, to use liquid hydrogen as a propellant for the upper stages of the Saturn rocket. Silverstein had personally conducted and managed hydrogen propellant research at Lewis.[14]

When new NASA Administrator James Webb reorganized the management of the space program in 1961, Silverstein did not agree with the new structure and asked to return to Lewis to fill the vacant Center Director post. Upon his arrival in November 1961, Silverstein had to deal with the implications of the new NASA organizational structure introduced in 1958. Some Lewis staffers considered research the primary role of the Center and resisted the introduction of development and operations into the facility's work, which they feared would overwhelm basic research programs. Other employees embraced involvement in all three areas of research, development, and operations. Internal discussions at Lewis resulted in the adoption of an idea by Bruce Lundin, the Center's associate director: "divide the laboratory into two distinct parts, research and development. Silverstein, as director, could 'provide the balance between the two

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[11] Bilstein, Chapter 4.

[12] NASA's budget expanded from $1 billion 1961 to a peak of $5.1 billion in 1964. Virginia P. Dawson, *Engines and Innovation: Lewis Laboratory and American Propulsion Technology* (NASA History Series, National Aeronautics and Space Administration, 1991), p. 169.

[13] *Abe Silverstein*, NASA Biography, accessed 28 February 2016, https://www.nasa.gov/feature/abe-silverstein.

[14] Although von Braun continued to have reservations about liquid hydrogen, on November 9, 1967 he wrote a message to Silverstein on a photo of the Apollo 4 liftoff, which happened that day: "To Dr. Abe Silverstein whose pioneering work in liquid hydrogen technology paved the way to today's success." Apollo 4 was the first, unmanned test flight of the Saturn V launch vehicle, and NASA deemed the mission a complete success. See Dawson, p. 194.

and can protect one from the other.'"[15] With the support of the division chiefs, Silverstein reorganized Lewis. Lundin was put in charge of development.[16]

Strong Congressional support for the space program during the early Apollo years had an immediate effect on Lewis Research Center. In November 1961, Silverstein announced a 20% increase in the facility's payroll to $28 million and received authorization to hire 615 new staff (scientists, engineers, technicians, and support workers), a major personnel expansion. The announcement outlined the creation of "a development engineering group whose responsibilities will range beyond basic research and will include coordinating the activities of Lewis contractors building space vehicles and components for NASA missions."[17] The hiring of an additional 800 employees was announced eight weeks later.[18] The physical manifestation of the new organizational divide between research and development was the Development Engineering Building (DEB) and its Annex, designed to house 1,100 engineers:

> The location of this large office building outside the main gates (Figures 1 and 2) reflected Silverstein's commitment to keep research physically separate and untarnished by the contracting side of NASA. Lundin's staff, many newly hired under NASA's more generous salaries, worked in the Development Engineering Building, with its separate cafeteria and security. They would learn the new realities of dealing with industry as a customer rather than a provider of technology. At first, the research side of the center was shielded from responsibilities connected with contracts. People who worked under [John] Evaard, [head of research], still came through the Main Gate in the morning to work in their laboratories much as they had during the NACA era. However, even the research side of the laboratory began to be affected by the pressure of increased NASA-wide contracting.[19]

The land used for the DEB site had been previously acquired: ". . . to compensate for the loss of land no longer usable because of the expansion of the airport, the [Lewis] center acquired 9.8 acres known as the North Area in 1952 from the city of Cleveland."[20] The DEB was completed in two phases. In March 1962, NASA awarded an architectural and engineering services contract to Hubbell & Benes and Hoff, Inc. of Cleveland.[21] The overall construction cost was budgeted at $4.65 million. The construction contract was awarded in November 1962 to Roediger Construction Company of Cleveland, the low bidder at $2,999,500.[22] An early rendering showed only the DEB, without a smaller annex building to the west. The change to a two-building complex by the time of the construction contract award (Figure 3) appears to have been caused by a continued hiring surge. By late 1963, 400 Lewis employees were being

[15] Dawson, p. 181.
[16] Dawson, pp. 179-182 for a broader discussion of the Lewis Center transition.
[17] Karl Abraham, "Lewis Lab to Hire 615 as It Expands," *The Plain Dealer*, November 4, 1961, p. 1.
[18] "Kennedy Budget Steps Up Lewis Lab Expansion Pace," *The Plain Dealer,* January 9, 1962, p. 1.
[19] Dawson, p. 182.
[20] Dawson, p. 226.
[21] This firm was the successor to the prominent early 20th century architectural firm Hubbell & Benes. It was directed by Hubbell's son, Benjamin S. Hubbell (1897-1988).
[22] "1st Contract Let for Lewis Lab Addition," *The Plain Dealer*, March 3, 1962, p. 1; "Lewis Research Center Expands," *The Plain Dealer*, November 1, 1962, p. 18.

housed in leased office space at a shopping center in the neighboring city of Fairview Park.[23] The Annex is the same design as the main building, indicating that the architects modified existing drawings to create the second structure.

The main building, housing 800 engineers, opened in May 1964. According to laboratory lore, its K-shaped design honors President John F. Kennedy. An L-shaped Annex to the west opened in October 1964 and accommodated an additional 300 engineers[24] (Figures 4 and 5). One of the first events in the main building's auditorium (Figure 7), held just a few weeks after it opened, was a two-day conference on the application of aerospace technology to non-space industries. The meeting featured NASA administrator James E. Webb, who discussed the impact of the space program on U. S. technological development.[25] The size and layout of the main building also resulted in the use of escorts to greet visitors in the lobby and walk with them to the office of the person the visitor wished to see. Known as the Guardettes, the uniformed escorts wore blue dresses with red berets (Figure 8).

Lewis Research Center – Development Engineering Building – Space Program Significance – 1960s-1970s

The DEB and its Annex housed engineers into the early years of the 21st century, and the work of its employees, along with their management of private sector partners, resulted in several lasting achievements to the U.S. space program. Two major NASA programs managed by Lewis during the 1960s were the Centaur and Agena Programs, considered "the glamour programs of the laboratory."[26] The Centaur rocket was America's first high-energy upper stage launch vehicle. The Agena rocket was used for multiple programs including the Agena Target Vehicle (ATV), an unmanned spacecraft used by NASA during the Gemini program to develop and practice orbital space rendezvous and docking techniques and to perform large orbital changes, in preparation for the Apollo program lunar missions.

Centaur/Atlas[27]

In 1957, almost one year before Congress created NASA, the Air Force studied a proposal from General Dynamics/Astronautics Corp. to develop a new booster rocket that could give the U.S., in the shortest possible time, a means of orbiting heavy payloads. That vehicle was to become Centaur, a high-energy second stage booster with a new propulsion system using liquid hydrogen. Mixed with liquid oxygen, this new fuel afforded the promise of boosting heavier

[23] -------- [overcrowding issue], *The Plain Dealer*, October 25, 1963, p. 20.
[24] To employees, the K building was known as Building 500, and the L-shaped annex was known as Building 501.
[25] "Lewis Hosts Seminar on Aerospace Science," *The Plain Dealer*, May 24, 2964, p. 108.
[26] Dawson, p. 193.
[27] *Centaur: America's Workhorse in Space*, accessed 5 March 2016, http://www.nasa.gov/centers/glenn/about/history/centaur.html; *Centaur Launched a Generation of Interplanetary Missions*, accessed 5 March 2016, http://www.nasa.gov/centers/glenn/about/history/centaur_anniv.html; *Abe Silverstein*, NASA Biography, accessed 28 February 2016, https://www.nasa.gov/feature/abe-silverstein; NASA Glenn's Historical Timeline, accessed 28 February 2016, http://www.nasa.gov/centers/glenn/about/history/timeline.html; and *Glenn Launch Vehicle History*, accessed 29 March 2016, http://www.nasa.gov/centers/glenn/about/history/lvpo.html; see also Dawson, pp. 188-195.

payloads, far more than the 3,000-pound weight of the Soviet's Sputnik III. By August of 1958, the Government's Advanced Research Products Agency accepted from the Air Force a more elaborate proposal for the Centaur and assigned development authority to the Air Force.

Reflecting the new division of civilian and military space projects with the creation of NASA, on July 1, 1959, NASA took over the Centaur project from the Department of Defense. Centaur was not to be just another booster, but the rocket by which NASA would conduct extensive Earth orbit missions, lunar investigations and planetary studies. Aside from military satellite missions assigned to Centaur, which were to be considerable, NASA planned to launch one operational Centaur every month for a period extending well into the 1970s and beyond.

That schedule became hopelessly over-optimistic, dogged by an avalanche of problems, failures, test-stand explosions, and other delays. On May 8, 1962, the first Centaur was launched, but the upper stage exploded after 54 seconds. At that point, Dr. Abe Silverstein, Lewis Research Center Director, stepped forward and convinced the hard-pressed NASA organization that Lewis could de-bug and manage the problem-ridden Centaur.

Full responsibility was transferred from the Marshall Space Flight Center (near Huntsville, Alabama) to Lewis in October 1962, where the project acquired the moniker "Abe's Baby." Engineers at Lewis were familiar with the Centaur's liquid-hydrogen/liquid-oxygen cryogenic fuels, having developed the technology for safe handling of the minus 400 degree Fahrenheit propellants. During the NACA era in the 1940s and 1950s, Lewis conducted pioneering work on the high-energy liquid propellants for rockets, including accumulating valuable test data that became the technical base for the space age. While most rockets burned kerosene based hydrocarbon fuels, using a liquid hydrogen/liquid oxygen propellant combination created more thrust – pushing force – for each pound of propellant burned every second.

Lewis engineers perfected the Centaur booster, carrying out a complex research and development program to assure its reliability. They partnered with General Dynamics on the fuel tanks and Pratt & Whitney Aircraft on the RL-10 engines (Figure 9). To make certain of Centaur's success, the Lewis team also perfected and improved the Atlas booster, which would carry it off the pad. Special facilities were set up for ground testing both rockets at Lewis' Plum Brook Station in Sandusky, Ohio. On November 27, 1963 NASA successfully launched the first Atlas/Centaur (Figure 10). No payload was carried, but the powerful rocket was a significant milestone: the first in-flight burn of a liquid-hydrogen/liquid-oxygen engine.

The original Centaur rocket measured 30 feet long and 10 feet in diameter. Fully fueled it weighed more than 35,000 pounds. Payloads weighing as much as 5,000 pounds could be carried to high Earth orbit in combination with the Atlas first stage. The rocket system was assembled at General Dynamics in San Diego and shipped to Cape Canaveral, Florida. About four days prior to launch about 30 Lewis personnel would arrive at the site to perform inspections and a demonstration countdown. For the actual launch and flight, Lewis personnel – the launch team – made all decisions.

Centaur's first mission objective was to send the unmanned Surveyor spacecraft to the Moon, a mandatory step prior to sending a manned mission. Surveyor 1 was launched May 30, 1966 (Figure 11). It landed three days later, becoming the first U.S. spacecraft to land on another celestial body. Six more successful lunar landings followed through mid-1967. The Surveyors collected data on the moon's surface texture and provided high resolution photographs of the surface, knowledge which was vital to the success of the later Apollo manned lunar landing missions.

Lewis created its Launch Vehicle Division in 1969 to have responsibility for all of NASA's intermediate and large payload launches on expendable launch vehicles, including all missions to other planets. Lewis was responsible for the technical, cost and schedule management of the Centaur rocket in its Atlas-Centaur and Titan-Centaur configurations. The division addressed all rocket related problems, integrated the payload into the launch vehicle, established the correct flight trajectories, and prepared the vehicle for launch. Lewis staff worked closely with launch operations at Kennedy Space Center, the exploration engineers at several NASA centers, and eventually commercial and military organizations.

Abe Silverstein retired as Lewis Center Director in 1969, the same year the Launch Vehicles Division was created. Bruce Lundin, Lewis' Associate Director and head of development, was promoted to Director on November 1, 1969, a position he held until August 1977. Although Lewis suffered a major downsizing in the early 1970s, it did not affect the Launch Vehicles Division:

> No longer Abe's baby, Centaur belonged to the new generation of men and women who had experienced the tribulations of developing Centaur. The young engineers whom NASA had recruited in the early 1960s were just reaching their stride. Not part of the laboratory's research tradition, they had matured with the Centaur program, shaped by the constant pressure of a launch date dictated by the position of Earth in relation to the other planets. From their common focus and physical isolation from the rest of the laboratory evolved a distinctive launch vehicles culture within Lewis. . . . Some of the older "research men" at Lewis resented the privileges and high salaries of the new recruits in the Launch Vehicles Division, but they wanted nothing to do with the rough-and-tumble world of Centaur. . . . The location of the Launch Vehicles Division in the DEB emphasized its separation from the research side of the laboratory.[28]

Over the next generation, the Centaur rocket evolved into a workhorse for NASA with an extraordinary operational success record:

- In the 1970s, Centaur was combined with the Air Force Titan III booster to provide a capability to launch larger spacecraft. Together, with Atlas and Titan boosters, Centaur served as the launch vehicle upper stage for the Mariner, Pioneer, Viking and Voyager spacecraft, which included exploration of Mercury, Venus, Mars, Jupiter, Saturn, Uranus, and Neptune and established numerous "firsts" for the space program.

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[28] Virginia P. Dawson and Mark D. Bowles, *Taming Liquid Hydrogen: The Centaur Upper Stage Rocket 1958-2002* (NASA History Series, National Aeronautics and Space Administration, 2004), p. 106.

- Centaur launched the Orbiting Astronomical Observatories (OAO's) in the late 1960s and early 1970s to study space outside our solar system. OAO discovered a hydrogen cloud, the first observational evidence that such clouds exist and observed extragalactic nebulae and the ultraviolet region of the electromagnetic spectrum, observations not possible from earth. In the late 1970s the high energy, orbiting, astronomical observatories (HEAO's) pinpointed sources of cosmic and gamma rays.

- Centaur launched various communications satellites into geo-synchronous orbit above the Earth. The Application Technology Satellites (ATS) were launched in the late 1960s, followed by INTASAT, Comstar, and FLTSATCOM satellites throughout the 1970s and 1980s. These satellites were key links in the world's communication network.

- The original RL-10 Centaur engine design also proved itself, becoming the forerunner of the liquid hydrogen/liquid oxygen class of engines. The technology was incorporated into the J-2 engines used on the upper stage of the Saturn rocket for the Apollo missions, and into the Space Shuttle Main Engine.

In the early 1990s, as NASA changed from managing design, development, and launch operations to procuring commercial launch services, Centaur continued its role as America's most powerful upper stage booster rocket. During its 35 years in the business, Lewis managed 119 total launches (Figure 12), including seventeen interplanetary missions, fourteen lunar vehicles, and scores of satellites from a Launch Control Room located on the third floor of the DEB, near the center of the building (Figures 13 and 14).[29] For more detail on this phase of the Centaur program, refer to the section

Lewis Research Center – Development Engineering Building – Space Program Significance – 1980s-2000s.

Agena

In October 1962 Lewis took over management of the Agena Program. There had been five failures and two partial failures in the seventeen Agena launches prior to Lewis' involvement. In comparison, Lewis staff oversaw 28 successful Agena missions between 1962 and 1968. For example, the Agena Target Vehicle (ATV) was an unmanned spacecraft used by NASA during its Gemini program to develop and practice orbital space rendezvous and docking techniques and to perform large orbital changes, in preparation for the Apollo program lunar missions. Each ATV consisted of an upper stage rocket built by Lockheed and a docking adapter built by McDonnell. The Agena was launched on top of an Atlas booster rocket built by General Dynamics, which had been improved several years earlier by Lewis Research Center engineers. Once the Agena was in a low circular orbit, a Gemini spacecraft was launched. The Gemini rendezvoused and docked with the Agena, and the Gemini astronauts flew the

[29] Internally, the space was known as The War Room. James L. Dolce, retired NASA Lewis Research Center employee, Lakewood, Ohio, interviews, March 20, 25, and 26, 2016. NASA Lewis/Glenn employee 1966-2008. Worked in the Development Engineering Building and its Annex 1984-1993 on the Space Station Electrical Power System as Lead: Electrical Power System Automation and Robotics Advanced Development.

combined spacecraft in a stabilized mode and performed experiments involving gravity, docking, and extra-vehicle activity. Launches occurred between October 1965 and November 1966. During the Gemini 11 mission, an elliptical orbit with an apogee of 1,375 kilometers (854 mi) was reached, which set an altitude record for manned spaceflight that held until the launch of Apollo 8, the first manned mission to the Moon.

The Agena rocket was also used to launch the Ranger and Lunar Orbiter probes, along with the Mariner Mars spacecrafts.[30] The Ranger 7, 8, and 9 probes (July 1964 – March 1965) obtained close-up images of the lunar surface. The Ranger spacecraft were designed to fly straight down towards the Moon and send images back until the moment of impact. The Lunar Orbiters 1 through 5 (August 1966 – August 1967) mapped the lunar surface before the Apollo landings. The first three missions photographed potential lunar landing sites, while the last two missions photographed the entire moon. The Mariner-D spacecraft, launched November 28, 1964, became the first successful mission to Mars. It photographed the planet on a flyby mission (Figure 15).

Lewis Research Center – Development Engineering Building – Space Program Significance – 1980s-2000s

Note: The following information mentions programs managed by personnel housed at the DEB and Annex during the 1970s, but the discussion focuses on programs managed at the two buildings after 1982. While the Launch Vehicle Division continued to manage launches of unmanned missions, vehicles, and satellites until 1998 from the third floor DEB Launch Control Room, the Lewis 1982 Strategic Plan successfully brought programs that were part of NASA's manned space program, marking a new chapter in Lewis work. This post-1982 information is being included in this document to provide a complete history of the DEB and Annex, so that it is available in the future for use as part of a thorough evaluation of this more recent period of American and international space programs.

During the early to mid-1960s, the research and development budget at Lewis increased dramatically. In 1964, Lewis received $299.9 million for research and development, which peaked at $323.2 million in 1965. As the Vietnam War and the War on Poverty federal initiative cut into NASA's budget, and the Agena project phased down, the 1966 research and development budget dropped by $73.3 million and another $87.2 million in 1967, a 50% cut in just two years.[31]

Bruce Lundin's tenure as Lewis Research Center Director, 1969-1977, coincided with the most difficult period in the Center's history to that time: space exploration was no longer a focus of public attention; Congressional appropriations fluctuated; and research programs received a low priority from NASA headquarters.[32] In 1970, Lewis had 4,200 civil service employees, but by

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[30] "Agena Target Vehicle," Wikipedia, accessed 6 March 2016, https://en.wikipedia.org/wiki/Agena_target_vehicle; "RM-81 Agena," Wikipedia, accessed 6 March 2016, https://en.wikipedia.org/wiki/RM-81_Agena; and *Mariner C Spacecraft Model*, accessed 29 March 2016. http://www.grc.nasa.gov/WWW/portal/gallery.

[31] Dawson, pp. 196-197.

[32] Dawson, pp. 201-203. For a Staff Personnel chart by year, 1941-1983, see Dawson, pp. 261-262.

1974 the total had dropped to just under 3,100.[33] The Centaur program however, was not impacted by these cuts. NASA, meanwhile, staked its future on a single, expensive, manned program that spanned well into the 1980s: the Space Shuttle reusable transport plane.

Receiving only a limited role in Space Shuttle development, Lundin attempted to direct Lewis' efforts in other directions, including jet engine noise suppression and helicopter engine research through contracts with other federal agencies. Lundin also noted the nation's rising interest in environmental concerns and agreed to work on projects involving air pollution monitoring, gas-turbine automobile engines, energy efficiency improvements to jet aircraft engines, wind turbines, and solar panels. These programs provided work but further isolated Lewis from space programs, and in 1977 NASA capped Lewis's involvement in energy programs at 350 staff.[34]

During this period, Lewis employees at the DEB made significant advances in wind turbine technology.[35] In 1970, Cruz Matos, Secretary of the Interior of Puerto Rico, formally requested Lewis to design a wind turbine to generate electricity for the Island of Culebra. The National Science Foundation (NSF) learned of the Lewis design and authorized funds to construct a 100-kilowatt wind turbine at NASA's Plum Brook facility in north central Ohio. A 1973 joint workshop sponsored by NASA and NSF brought together all existing information on wind power development, and at an NSF symposium later that same year, Lewis personnel summarized their work. In 1974 Lewis received $1.5 million for its wind energy program from NSF and the Energy Research and Development Administration (ERDA). A total of 13 experimental wind turbines, funded under ERDA and its successor, the Department of Energy, were put in operation between 1975 and 1979. The most successful project was the 1987 installation of a 3.2-megawatt Boeing MOD-5B wind turbine generator on the island of Oahu, Hawaii. It was the world's largest wind turbine built to that time (Figure 16).

Lundin retired in 1977, and the Director's post remained vacant until the late 1978 appointment of John F. McCarthy, Jr., director of the Center for Space Research at the Massachusetts Institute of Technology. Unlike Silverstein and Lundin, who did not focus on promoting Lewis outside and within NASA, McCarthy spent significant time in Washington, working to improve connections with Ohio's Congressional delegation. He also organized a strong community outreach and speaker's bureau at Lewis.[36]

McCarthy resigned in 1982 to return to MIT,[37] but left in place a group of ten division chiefs charged with the first strategic planning effort at Lewis, and known internally as the "Save Lewis Committee."[38] The 1982 Strategic Plan was ready on June 22, 1982, the first day that Andrew

[33] In the late 1980s, Lewis Research Center employed 2,700 civil servants and 1,200 support-service contractors. Dawson, p. 214.
[34] Dawson, pp. 203-210.
[35] Dawson, pp. 206-207; "World's Biggest Turbine," Hawaii Energy Options, accessed 29 March 2016, http://hawaiienergyoptions.blogspot.com/2010/05/once-touted-as-wind-energy-capital-of.html;
Ronald L. Thomas, retired NASA Lewis Research Center employee, Westlake, Ohio, interview, March 11, 2016; and Dolce, interview.
[36] Dawson, pp. 210-213.
[37] *John McCarthy Promoted Outreach, Embraced Diversity,* accessed 6 March 2016, http://www.nasa.gov/centers/glenn/about/history/mccarthy_feature.html.
[38] Dolce, interview.

J. Stofan returned to Lewis from headquarters to become Director. Stofan had been a Lewis employee from 1958 to 1978, rising through the Centaur program to direct the Launch Vehicles Program from 1974 to 1978, before being called to NASA headquarters as Deputy Associate Administrator for the Office of Space Sciences, a significant power center within NASA. His career put Stofan in a position to move Lewis away from its dependence on the weak and underfunded Office of Aeronautics and Space Technology and put Lewis into the NASA mainstream.

The Strategic Plan recommended obtaining five major programs: the electrical power system for the space station, the advanced turboprop program, refurbishing of the Altitude Wind Tunnel for an expanded icing test program, the Advanced Communications Technology Satellite (ACTS), and the Shuttle-Centaur program. The space station power system was the most controversial among the Lewis managers, because the Center, although experienced with management of large projects through the launch vehicle programs Agena and Centaur, had never interacted with the manned space flight program and its strong political overtones. Stofan believed that these large programs were key to Lewis' future viability in NASA and that he had the personal skills of persuasion to secure the programs. He obtained four of the five programs, which one division chief described as "a damn miracle." [39] Stofan's success firmly established Lewis in the mainstream of one of NASA's primary manned programs: the space station. As a result, the space station electric power system and subsequent microgravity science program for the space station resulted in important contributions to the space program by engineers working in the Development Engineering Building and Annex.[40]

Space Station Freedom – Electric Power System

Since the 1960s, NASA had wanted permission to build a space station that could be permanently occupied by rotating crews. Budget constraints, however, forced the agency to choose between a space station and a reusable space transportation system – the space shuttle. NASA decided to build the shuttle first. Soon after the first shuttle launch in 1981, NASA intensified efforts to win approval for a permanently occupied space station.[41]

Space Station Freedom was NASA's project to construct a permanently manned Earth-orbiting space station in the 1980s.[42] The station was intended to function as an orbiting repair shop for satellites, an assembly point for spacecraft, an observation post for astronomers, a microgravity laboratory for scientists, and a microgravity factory for companies. The project jointly involved the United States, Europe, Japan, and Canada. President Ronald Reagan announced the project in his 1984 State of the Union Address. A series of design changes, development cost overruns, and budget cutbacks eventually resulted in the project becoming politically unviable

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[39] Dawson, pp. 213-215.

[40] *Andrew J. Stofan*, NASA Historical Biolgraphy, accessed 6 March 2016, http://www.nasa.gov/content/historical-biography-andrew-j-stofan/#.Vtzc7sdpdSU. Stofan returned to NASA headquarters in 1986 to head the space station project.

[41] United States, House Science Committee, *NASA's Space Station Program: Evolution and Current Status*, April 4, 2001 (statement of Marcia S. Smith, Specialist in Aerospace and Telecommunications Policy, Congressional Research Service), accessed 6 March 2016, http://history.nasa.gov/isstestimony2001.pdf.

[42] "Space Station Freedom," accessed 6 March 2016, Wikipedia, https://en.wikipedia.org/wiki/Space_Station_Freedom.

by the early 1990s. In October 1993, NASA and the Russian Space Agency agreed to the addition of Russia into what became the International Space Station (ISS). The first ISS component was launched in 1998, and it remains operational today.

Although Space Station Freedom was not constructed, the development work proved to be important. At Lewis, power system work started in the DEB Annex during 1984, and Lewis eventually acquired responsibility for Work Package 4 for Space Station Freedom, the complete electrical power system.[43] After negotiating a prime contract in 1987 with Rocketdyne and its subcontractors, Ford Aerospace, Lockheed, and General Dynamics, the project team expanded and moved to the DEB, occupying most of floors one and two. In the DEB Annex, the project had three to four persons per office – and as many as five – while in the later years in the DEB the more common number was three persons per office. In 1992, space station program restructuring transferred construction of the Lewis-designed electric power system to Johnson Space Center. Except for minor modifications, this electrical power system is currently used on the ISS (Figure 17).

Microgravity Science

As the Space Station Electric Power System project personnel were dispersed to other projects after 1992, a program staffing up at that time was Microgravity Science. An estimated 30% of the Space Station staff transferred to that project, and with other staffing additions, Microgravity Science occupied most of floors one and two of DEB. Their mission was to develop experiments for the International Space Station and small sounding rockets to study the physics of matter in very low gravity environments, particularly fluid flow and combustion processes. To increase the number of research opportunities, experiments were also designed for Glenn's two Zero Gravity Drop Towers, as well as NASA's KC-135 aircraft, which is formally known as the Zero Gravity Trainer aircraft and affectionately known as the "Vomit Comet." Perhaps the program's most important project was the design and construction of the Fluids and Combustion Facility (FCF) for the United States Laboratory Module of the International Space Station. It is a permanent installation on the ISS, occupying two powered racks, which can be reconfigured to accommodate microgravity science experiments in fluids and combustion (Figure 18). The Microgravity Science program occupied DEB until 2005.[44]

Centaur[45]

[43] Dolce, interview; NASA Glenn's Historical Timeline, accessed 28 February 2016. http://www.nasa.gov/centers/glenn/about/history/timeline.html; Dawson, p. 214; and NASA Glenn's Historical Timeline, accessed 28 February 2016, http://www.nasa.gov/centers/glenn/about/history/timeline.html.
[44] *Space Flight Systems @ GRC – ISS Research Project – Fluids and Combustion Facility,* accessed 29 March 2016. https://issresearchproject.grc.nasa.gov/FCF/; and Dolce, interview.
[45] *Centaur: America's Workhorse in Space*, accessed 5 March 2016, http://www.nasa.gov/centers/glenn/about/history/centaur.html; *Centaur Launched a Generation of Interplanetary Missions*, accessed 5 March 2016, http://www.nasa.gov/centers/glenn/about/history/centaur_anniv.html; *Abe Silverstein*, NASA Biography, accessed 28 February 2016, https://www.nasa.gov/feature/abe-silverstein; NASA Glenn's Historical Timeline, accessed 28 February 2016, http://www.nasa.gov/centers/glenn/about/history/timeline.html; and *Glenn Launch Vehicle History*, accessed 29 March 2016, http://www.nasa.gov/centers/glenn/about/history/lvpo.html; see also Dawson, pp. 188-195.

In the early 1990s, as NASA changed from managing design, development, and launch operations to procuring commercial launch services, Centaur continued its role as America's most powerful upper stage booster rocket. Centaur launched the Combined Release and Radiation Effects Satellite on a commercial Atlas I rocket in July 1990, which began Lewis' management responsibility for commercial services for intermediate and large unmanned launch vehicles. The program also used Centaur to launch several Geostationary Operational Environmental Satellites (GOES) weather satellites, starting in the mid-1990s.

During this period however, NASA had difficulty funding interplanetary missions and began partnering with the European Space Agency to develop new planetary spacecraft. The first, the Solar Heliospheric Observatory (SOHO), was launched on an Atlas-Centaur on December 2, 1995 to conduct in-depth studies of the sun. The Cassini-Huygens launch on October 15, 1997 was one of the Centaur program's largest and most significant missions. The Cassini orbiter and Huygens probe arrived at Saturn in 2004. Huygens landed on Saturn's largest moon, Titan, in 2005 and became the first spacecraft to land on an object in the outer solar system. The Centaur continues to be used, although it is not cited by name in the commercial Atlas family of launch vehicles or the Titan IV.

The Cassini launch in 1997 brought an end to Glenn's management of NASA's interplanetary launches. On September 30, 1998, NASA consolidated the Launch Vehicle programs at Lewis, Goddard, and Kennedy at the Kennedy Space Center.

Development Engineering Building – Later Years

On March 1, 1999, Lewis Research Center was renamed John H. Glenn Research Center at Lewis Field to honor the pioneering Ohio-born astronaut.

As specific, major development and mission operation programs ended at Glenn from the mid-1990s to the first several years of the 21st century, program staff moved out of the Development Engineering Building and Annex to other projects on the main laboratory property. The two buildings continued to house administrative functions, and equipment was removed from the third floor Launch Control Room. An engineering contractor, Analex (later QineticQ) occupied the second floor east leg of the DEB from the mid-1990s through 2010. The firm held the task engineering service contracts for Glenn (GESS I and II), and employed engineers, draftsmen, and administrative staff. With the start of the GESS III task contract, their staff was no longer housed on Glenn property.[46] The DEB and Annex closed in 2013.

A listing of the divisions and offices that occupied DEB and its Annex in 1967, 1971, 1980, and 1994 is shown in Figure 19.

Conclusion

For more than 40 years, the Development Engineering Building (DEB) and Annex at the NASA Glenn Research Center at Lewis Field (GRCLF) in Cleveland, Ohio were at the forefront of

[46] Dolce, interview.

pioneering research and development efforts that led to significant contributions to the U.S., and later international, space programs.

The genesis of NASA Glenn was the establishment decades earlier of the National Advisory Committee for Aeronautics (NACA). Founded on March 3, 1915, and housed at Langley Field (Virginia), NACA had as its mission "to undertake, promote and institutionalize aeronautical research among industry, academia, and the federal government." The later Cleveland facility was named for George W. Lewis, the agency's first Executive Officer and long-time Director of Aeronautical Research.

Groundbreaking ceremonies for NASA GRCLF, originally the NACA Aircraft Engine Research Laboratory (AERL), occurred on January 23, 1941. The laboratory became a national resource for innovations in aircraft engine technology, which influenced commercial and military propulsion systems. Heading into the 1950s, AERL changed its focus to jet propulsion and pioneering rocket engine and propellant research. In 1957, the Soviet Union launched the unmanned satellite Sputnik 1, which remained in orbit until January 4, 1958. The ensuing intense national debate resulted in the creation of the National Aeronautics and Space Administration (NASA). On April 12, 1961, Soviet Cosmonaut Yuri Gagarin completed one orbit around the earth and landed safely, becoming the first human in space. The race to space had begun.

During this period, NASAs budget expanded from $1 billion in 1961 to a peak of $5.1 billion in 1964, in direct response to President Kennedy's call in 1961 that landing a man on the moon was a national priority. The budget for NASA Glenn Research Center at Lewis Field increased by 20% and authorization to hire more than 1,400 staff was given. In 1963-64, a new facility was designed and constructed to house 1,100 staff members engaged in research and development – primarily engineers – purposefully built outside the main gate of NASA GRCLF to physically separate research and development functions from the Center's laboratory research functions. The Development Engineering Building (DEB) and Annex had their own security and cafeteria, and the third floor of the DEB included a Launch Control Room used for 35 years to manage unmanned NASA missions.

Engineering innovations and advancements in the U.S. space program that occurred during the 1960s and 1970s at the DEB and Annex included:

- Successfully harnessing the power of liquid hydrogen, the fuel that made space launches feasible and has been in use worldwide for fifty years;

- Managing the Centaur and Agena Programs, considered "the glamour programs of the laboratory" in the 1960s and beyond. The Centaur rocket was America's first high-energy upper stage launch vehicle. The Agena Target Vehicle (ATV) was an unmanned spacecraft used by NASA during the Gemini program to develop and practice orbital space rendezvous and docking techniques in preparation for the Apollo program lunar missions;

- Creating the Launch Vehicle Division (1969), and having responsibility for all of NASA's intermediate and large payload launches on expendable launch vehicles, as well as its Atlas-Centaur and Titan-Centaur rocket configurations;

- Collaborating in the use of Centaur, Titan, and Atlas boosters to provide a capacity to launch larger spacecraft including the Mariner, Pioneer, Viking, and Voyager spacecraft in the exploration of Mercury, Venus, Mars, Saturn, Uranus, and Neptune;

- Collaborating in the use of Centaur to launch the Orbiting Astronomical Observatories (OAO's) in the late 1960s and early 1970s to study space outside our solar system; and

- Collaborating in the use of Centaur to launch various communications satellites into geo-synchronous orbit above Earth.

In 1982, a new Strategic Plan for Lewis Research Center, developed in-house, brought a series of different programs to personnel housed at the DEB and Annex, including for the first time interaction with the manned space program section of NASA. These new programs included direct contributions to the manned programs of Space Station Freedom and the International Space Station.

Engineering innovations and advancements in the U.S. space program that occurred during the 1980s into the 2000s at the DEB and Annex included:

- Transitioning to management responsibility for commercial services for intermediate and large unmanned launch vehicles, as well as weather satellites;

- Collaborating with the European Space Agency to develop new planetary spacecraft, including the Solar Heliospheric Observatory (SOHO) to conduct in-depth studies of the sun and the Cassini-Huygens launch to Saturn and Saturn's largest moon, Titan;

- Developing the complete electrical power system for the unbuilt American Space Station, which was subsequently used for the International Space Station; and

- Managing the Microgravity Science program that developed experiments for the International Space Station, as well as small sounding rockets to study the physics of matter in very low gravity environments, particularly fluid flow and combustion processes.

As specific, major development and mission operation programs ended at NASA GRCLF from the mid-1990s into the first several years of the 21st century, the DEB Building and Annex continued to house administrative functions. While further restructuring at NASA GRCLF over the next decade resulted in the closure of these two buildings in 2013, for more than 40 years the significant engineering accomplishments from inside these walls lifted the United States to the lead in the race to space and captured the imagination of the American public epitomized by Neil Armstrong's quote "that's one small step for a man, one giant leap for mankind."

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Note: This document was prepared in early 2016, prior to the publication of the 75th anniversary book about NASA Glenn Research Center.

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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
_X__ Federal agency
____ Local government
____ University
____ Other
Name of repository: ______________________________

Historic Resources Survey Number (if assigned): ______________

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10. Geographical Data

Acreage of Property _5.7 acres____________

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: 41.419522 Longitude: -81.853274

2. Latitude: Longitude:

3. Latitude: Longitude:

4. Latitude: Longitude:

Or

UTM References
Datum (indicated on USGS map):

[X] NAD 1927 or [ ] NAD 1983

1. Zone: 17	Easting: 428681	Northing: 4585463
2. Zone:	Easting:	Northing:
3. Zone:	Easting:	Northing:
4. Zone:	Easting :	Northing:

Verbal Boundary Description (Describe the boundaries of the property.)

The boundary is illustrated on the attached map. Beginning at the intersection of the access road and the east driveway, the boundary runs north along the east side of the east driveway until it intersects the ridgeline of the land above the Rocky River Reservation, then turns and runs west and then south along the ridgeline of the Reservation until it intersects with the access road, then turns east running along the north curb line of the access road, back to the starting point.

Boundary Justification (Explain why the boundaries were selected.)

The boundary follows the topography created by the terrain on the north and west sides of the site, by a road on the south and a driveway and property line on the east. The land used for the DEB site had been previously acquired: "to compensate for the loss of land no longer usable because of the expansion of the airport, the [Lewis] center acquired 9.8 acres known as the North Area in 1952 from the city of Cleveland."[47]

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11. Form Prepared By

name/title: Heather Rudge, Historic Preservation Consultant (Richard Sicha & Marcia Moll – S of S)
organization: Historic Preservation Group, LLC
street & number: 2425 W. 11th Street, Suite 4
city or town: Cleveland state: OH zip code: 44113-4401
e-mail heather@hpgroup-llc.com
telephone: (216) 302-3510
date: 05/01/2015

[47] Dawson, p. 226.

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

Name of Property: NASA Lewis Research Center - Development Engineering Building & Annex (K and L Buildings)
City or Vicinity: Fairview Park
County: Cuyahoga **State:** OH
Photographer: Heather Rudge, Historic Preservation Group, LLC
Date Photographed: Winter 2016

Description of Photograph(s) and number, include description of view indicating direction of camera:
Photograph 1 of 40
Description: K Building, south (front) elevation
Camera Direction: North

Photograph 2 of 40
Description: L and K Buildings, front elevations
Camera Direction: Northwest

Photograph 3 of 40
Description: L and K Buildings, front and east elevations
Camera Direction: Northwest

Photograph 4 of 40
Description: L and K Buildings, front and east elevations
Camera Direction: West

Photograph 5 of 40
Description: L Building east elevation and K Building front elevation, main entrance
Camera Direction: West

Photograph 6 of 40
Description: K Building, front elevation main entrance
Camera Direction: Northwest

Photograph 7 of 40
Description: K Building, front elevation main entrance
Camera Direction: North

Photograph 8 of 40
Description: K Building, west and front elevations
Camera Direction: Northeast

Photograph 9 of 40
Description: L and K Building, east and west elevations
Camera Direction: North

Photograph 10 of 40
Description: L Building, south and east elevations, main entrance
Camera Direction: Northwest

Photograph 11 of 40
Description: L Building, east elevation main entrance
Camera Direction: West

Photograph 12 of 40
Description: L Building, east and north elevations
Camera Direction: Southwest

Photograph 13 of 40
Description: L Building, west and north elevations
Camera Direction: Southeast

Photograph 14 of 40
Description: L Building, west and north elevations
Camera Direction: South

Photograph 15 of 40
Description: L Building, east and north elevations
Camera Direction: Southwest

Photograph 16 of 40
Description: K Building, west courtyard and parking
Camera Direction: East

Photograph 17 of 40
Description: K Building, west courtyard and parking

Camera Direction: East

Photograph 18 of 40
Description: L and K Buildings on west driveway
Camera Direction: South

Photograph 19 of 40
Description: K Building, north elevation
Camera Direction: East

Photograph 20 of 40
Description: K Building, north elevation loading dock
Camera Direction: Southeast

Photograph 21 of 40
Description: K Building, east and north elevations
Camera Direction: Southwest

Photograph 22 of 40
Description: K Building, east elevation
Camera Direction: South

Photograph 23 of 40
Description: K Building, east courtyard and parking
Camera Direction: West

Photograph 24 of 40
Description: K Building, east courtyard, typical secondary entrance
Camera Direction: Northwest

Photograph 25 of 40
Description: K Building, east elevations
Camera Direction: West

Photograph 26 of 40
Description: K Building, south elevation window detail
Camera Direction: North

Photograph 27 of 40
Description: K Building, south elevation window detail
Camera Direction: Northwest

Photograph 28 of 40
Description: K Building, first floor lobby
Camera Direction: West

Photograph 29 of 40
Description: K Building, first floor lobby
Camera Direction: Northwest

Photograph 30 of 40
Description: K Building, first floor foyer outside auditorium and stairway to cafeteria
Camera Direction: Northwest

Photograph 31 of 40
Description: K Building, first floor auditorium stage
Camera Direction: Northwest

Photograph 32 of 40
Description: K Building, first floor auditorium seating
Camera Direction: South

Photograph 33 of 40
Description: K Building, first floor auditorium seating
Camera Direction: Southeast

Photograph 34 of 40
Description: K Building, stairway lower level cafeteria
Camera Direction: North

Photograph 35 of 40
Description: K Building, lower level cafeteria and dining room
Camera Direction: North

Photograph 36 of 40
Description: K Building, lower level mechanical equipment control panel
Camera Direction: Northwest

Photograph 37 of 40
Description: K Building, first floor south corridor, typical all corridors, all floors
Camera Direction: Southwest

Photograph 38 of 40
Description: L Building, first floor lobby
Camera Direction: Southwest

Photograph 39 of 40
Description: L Building, first floor corridor, typical all corridors, all floors
Camera Direction: North

Photograph 40 of 40
Description: L Building, first floor stairway railing detail, typical all stairs
Camera Direction: Southwest

Figures

FIGURE 1 – Street map with 1970 Census Tract boundaries, 1971; published by Real Property Inventory. The Development Engineering Building is shown as "NASA Admin Bldg" in the southwest corner of Riveredge Twp., across Brookpark Road from NASA Lewis Research Center.

FIGURE 2 – NASA Lewis Research Center, 1964, aerial view looking northeast; National Aeronautics and Space Administration (NASA), Photo C-69627, Cleveland Public Library, Picture Collection: NASA. The Development Engineering Building and Annex are located in the upper left corner of the photo.
FIGURE 3 – Development Engineering Building and Annex, rendering by Hubbell & Benes and Hoff, 1962, view looking northwest; NASA, Photo C-62000, NASA Glenn Research Center at Lewis Field (GRCLF) archives.

FIGURE 7 – Development Engineering Building Auditorium, 1967; NASA, Photo C1967-01813, NASA GRCLF archives.

FIGURE 8 – Development Engineering Building Guardettes, 1964; *Lewis News*, June 5, 1964, p. 3.

FIGURE 9 – Pratt & Whitney RL-10 Engine for Centaur Rocket, April 17, 1962; NASA, Photo C1962-60071, NASA Glenn Research Center: The Early Years - A Pictorial History, http://www.grc.nasa.gov/WWW/portal/gallery.

FIGURE 10 – General Dynamics advertisement commemorating the first successful launch of a Centaur Rocket on November 27, 1963; *The Plain Dealer*, December 3, 1963, p. 24.

FIGURE 11 – Atlas/Centaur Rocket launch of Surveyor I on May 30, 1966; NASA, http://www.nasa.gov/missions/solarsystem/slc_36.html.

FIGURE 12 – NASA Lewis Research Center Launch Vehicle Directorate standing in front of a full-scale model of the Centaur second-stage rocket, marking Centaur's fiftieth launch, May 24, 1979; NASA, Photo C1979-02339, NASA GRCLF archives.

FIGURE 13 – Development Engineering Building Launch Control Room, December 10, 1974; NASA, Photo C1974-04007, NASA Glenn Research Center: The Early Years - A Pictorial History, http://www.grc.nasa.gov/WWW/portal/gallery. This control room at Lewis was directly linked to Cape Kennedy. The Lewis staff in Cleveland could monitor and back up the Lewis launch team in the actual control room in Florida. This photograph was taken during preparations for the Titan-Centaur-Helios launch on December 10, 1974. The panels to the left list the countdown events for the Centaur rocket. The launch countdown clock can be seen above these panels. The two panels on the right list events predicted to occur during the flight and the availability of the tracking stations. The clock above the panels indicates the time remaining before the expiration of the launch window.

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FIGURE 15 – Scale Model of the Agena/Mariner C spacecraft in the 8- by 6-Foot Supersonic Wind Tunnel at NASA Lewis Research Center, March 18, 1964; NASA, Photo C1964-68848, NASA Glenn Research Center: The Early Years - A Pictorial History, http://www.grc.nasa.gov/WWW/portal/gallery.

FIGURE 16 – Wind Turbine Generator developed at NASA Lewis Research Center and installed at Kahuku, Oahu, Hawaiian Islands, late 1970s; Image: Ronald L. Thomas collection.

FIGURE 17 – International Space Station, undated; Image: NASA, courtesy of Ronald L. Thomas collection.

FIGURE 18 – International Space Station, Fluids and Combustion Facility, Combustion Integration Rack (top) and Fluids Integration Rack from rear (bottom), c.1990s;
NASA, https://issresearchproject.grc.nasa.gov/FCF/.

FIGURE 19 – Development Engineering Building and Annex, NASA Occupants throughout the Decades (1967, 1971, 1980, and 1994), undated list; NASA GRCLF archives.

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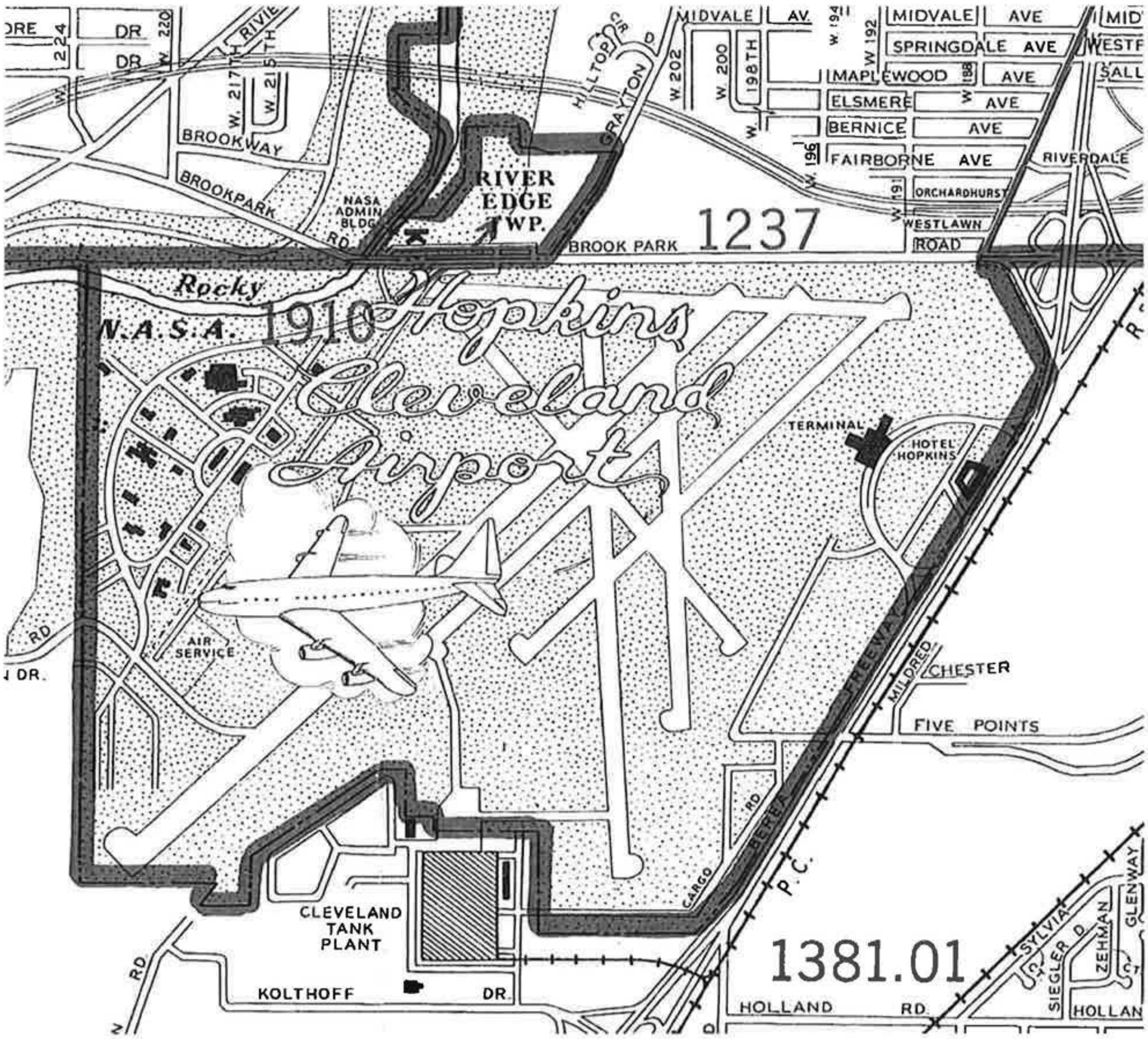

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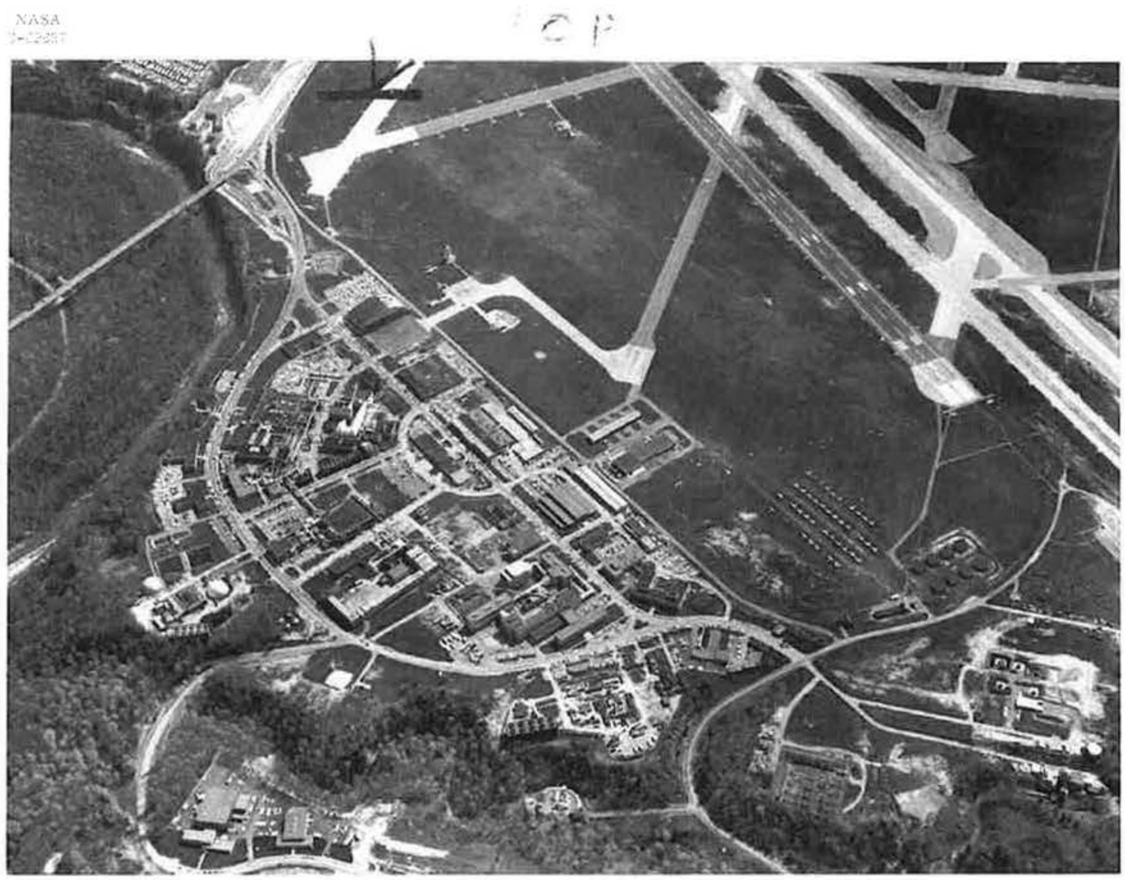

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FIGURE 4 – Development Engineering Building & Annex, 1965, view looking north; NASA, Photo C1965-01239, NASA GRCLF archives.

FIGURE 5 – Development Engineering Building & Annex in foreground, 1964, view looking southwest; NASA Lewis Research Center across Brookpark Road adjacent to Cleveland Hopkins International Aiport property. NASA, Photo C1964-72154, NASA GRCLF archives.

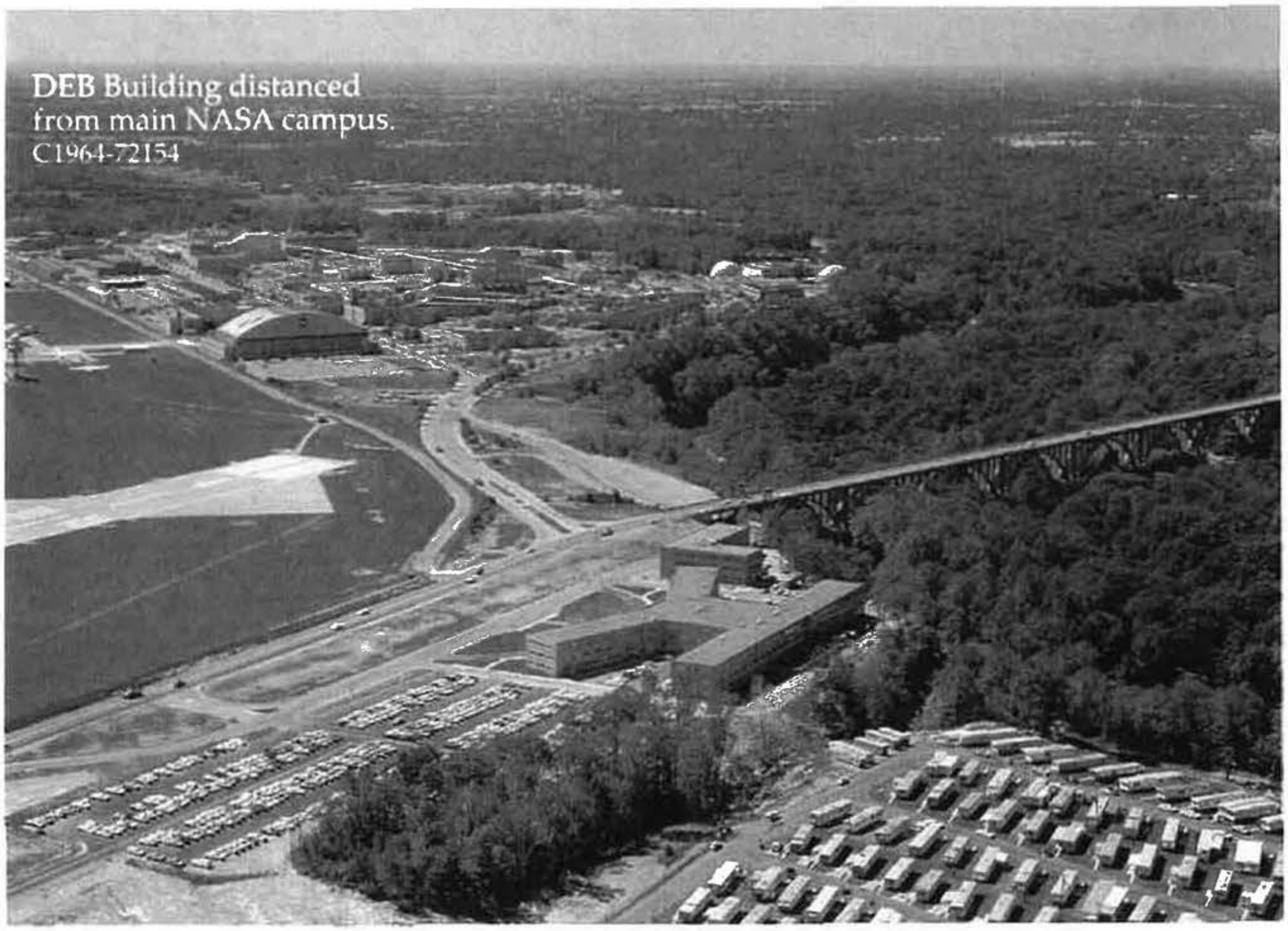
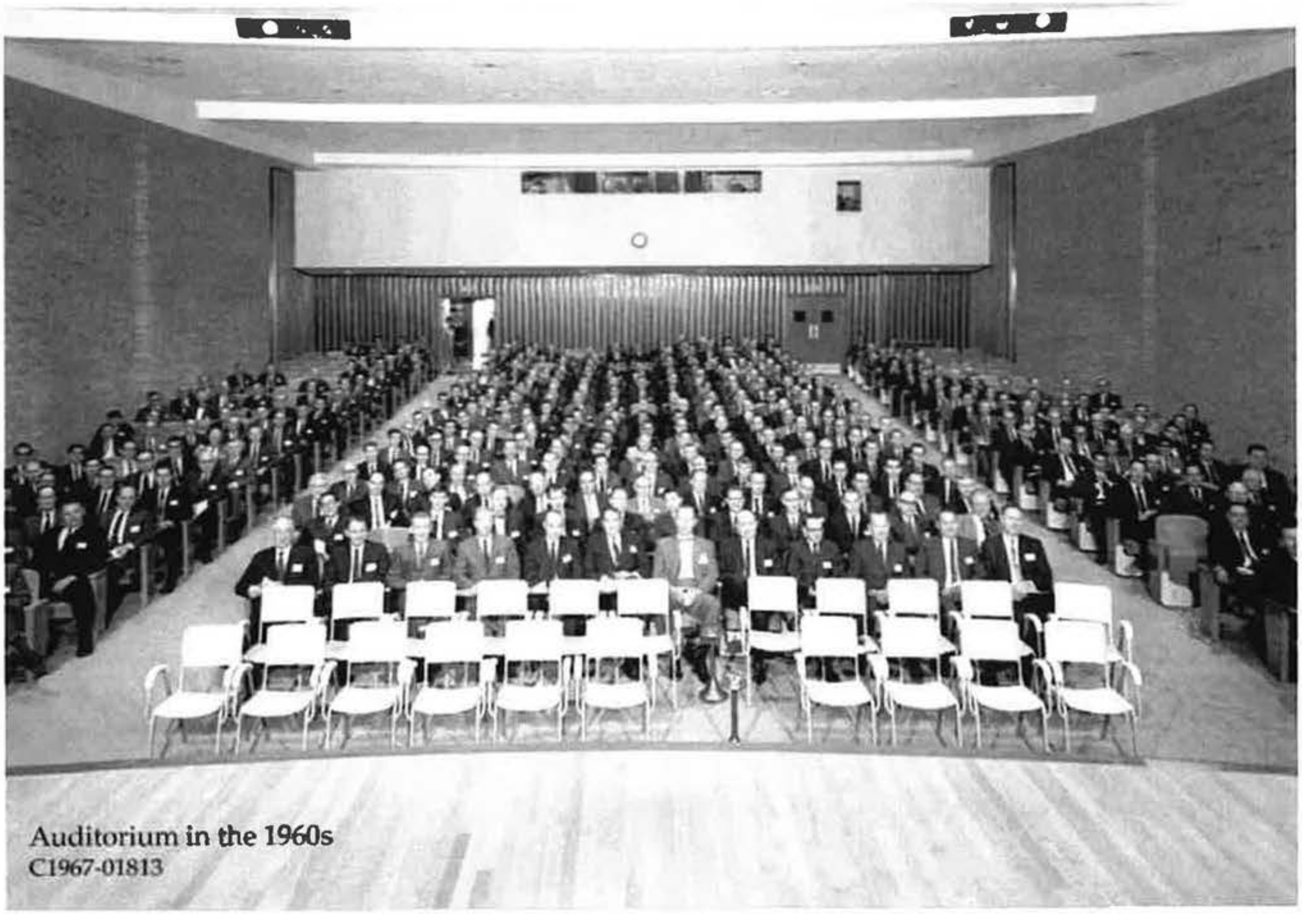


FIGURE 6 – Development Engineering Building Lobby, 1965; NASA, Photo C1965-74466, NASA GRCLF archives.

FIGURE 7 – Development Engineering Building Auditorium, 1967; NASA, Photo C1967-01813, NASA GRCLF archives.



Auditorium in the 1960s
C1967-01813

FIGURE 8 – Development Engineering Building Guardettes, 1964; *Lewis News*, June 5, 1964, p. 3.

GUARDETTES — Penny Giza, left, and Carol Kodger.

Guardettes On Duty At The New Building

Two Guardettes — the feminine version of guards — are performing escort services, checking badges, and taking care of other general security functions at the Development Engineering Building.

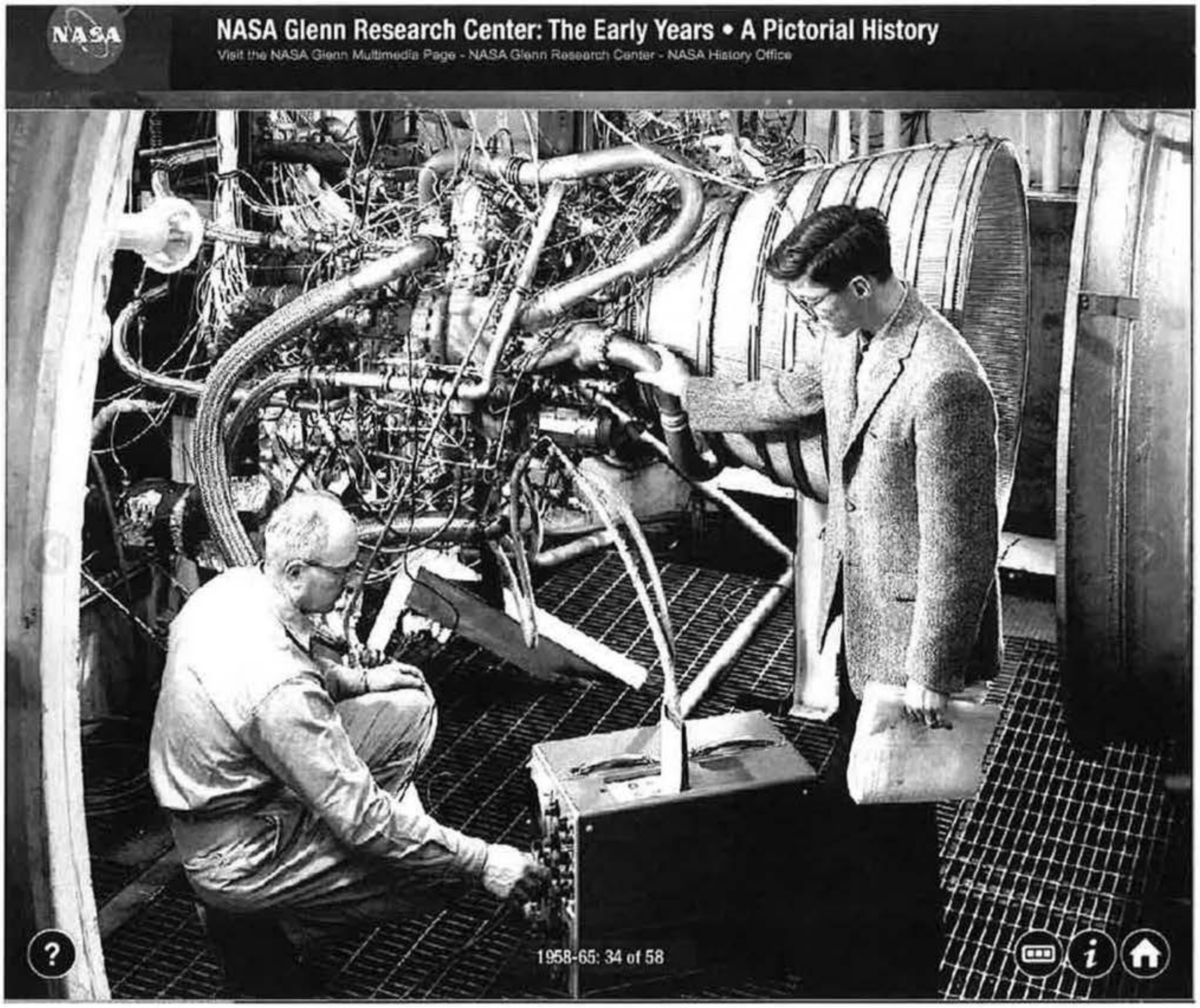
The unique additions to the security force are Miss Carol Kodger and Mrs. Penny Giza. They began their guardette duties on May 12.

Mrs. Giza is the wife of Charles A. Giza, who is a sergeant on the security force at the Center. He was transferred here by Wackenhut Services, Inc., seven months ago from Wichita, Kans., where he worked in protection of missile sites.

Miss Kodger, a native of North Olmsted, held a number of jobs before her work here. She has been a cashier, a file clerk, and an assistant to a designer in a coat and suit manufacturing firm.

Mrs. Giza had also held various jobs before becoming a Guardette.

FIGURE 9 – Pratt & Whitney RL-10 Engine for Centaur Rocket, April 17, 1962; NASA, Photo C1962-60071, NASA Glenn Research Center: The Early Years - A Pictorial History, http://www.grc.nasa.gov/WWW/portal/gallery.



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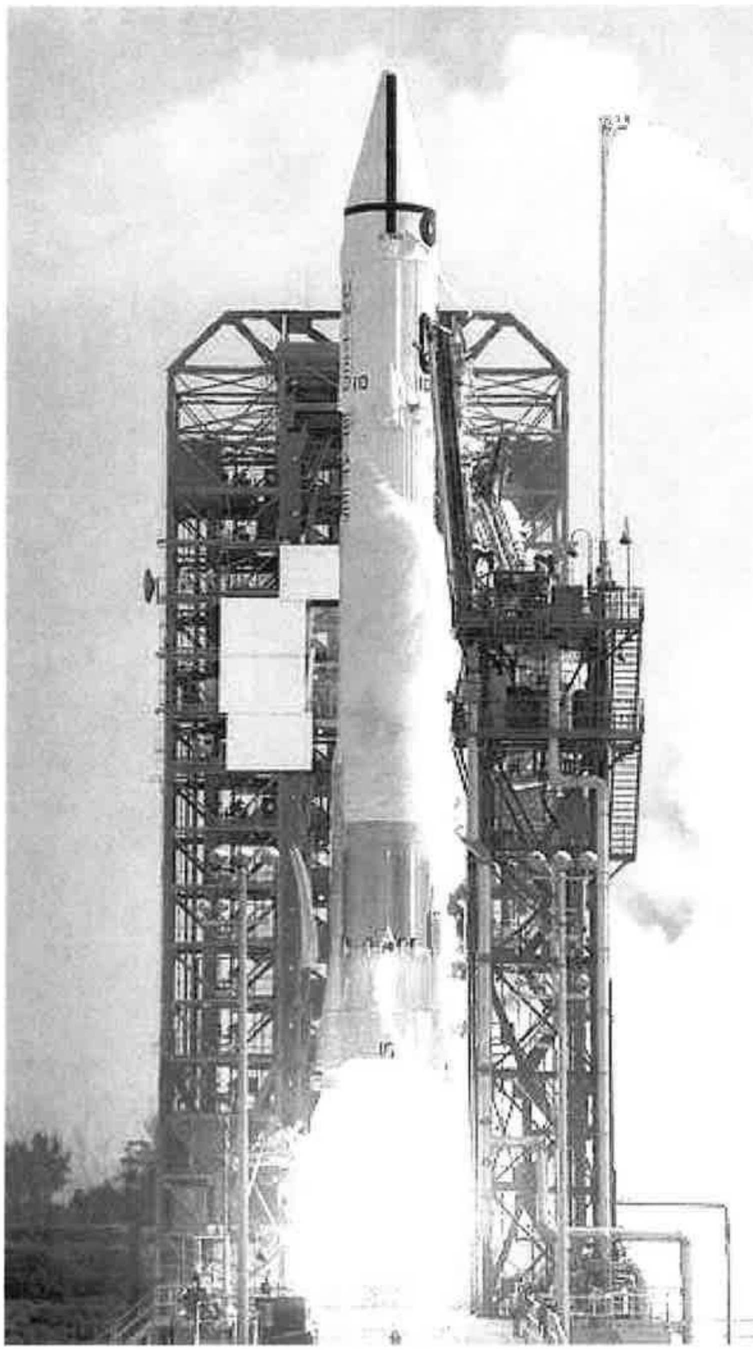

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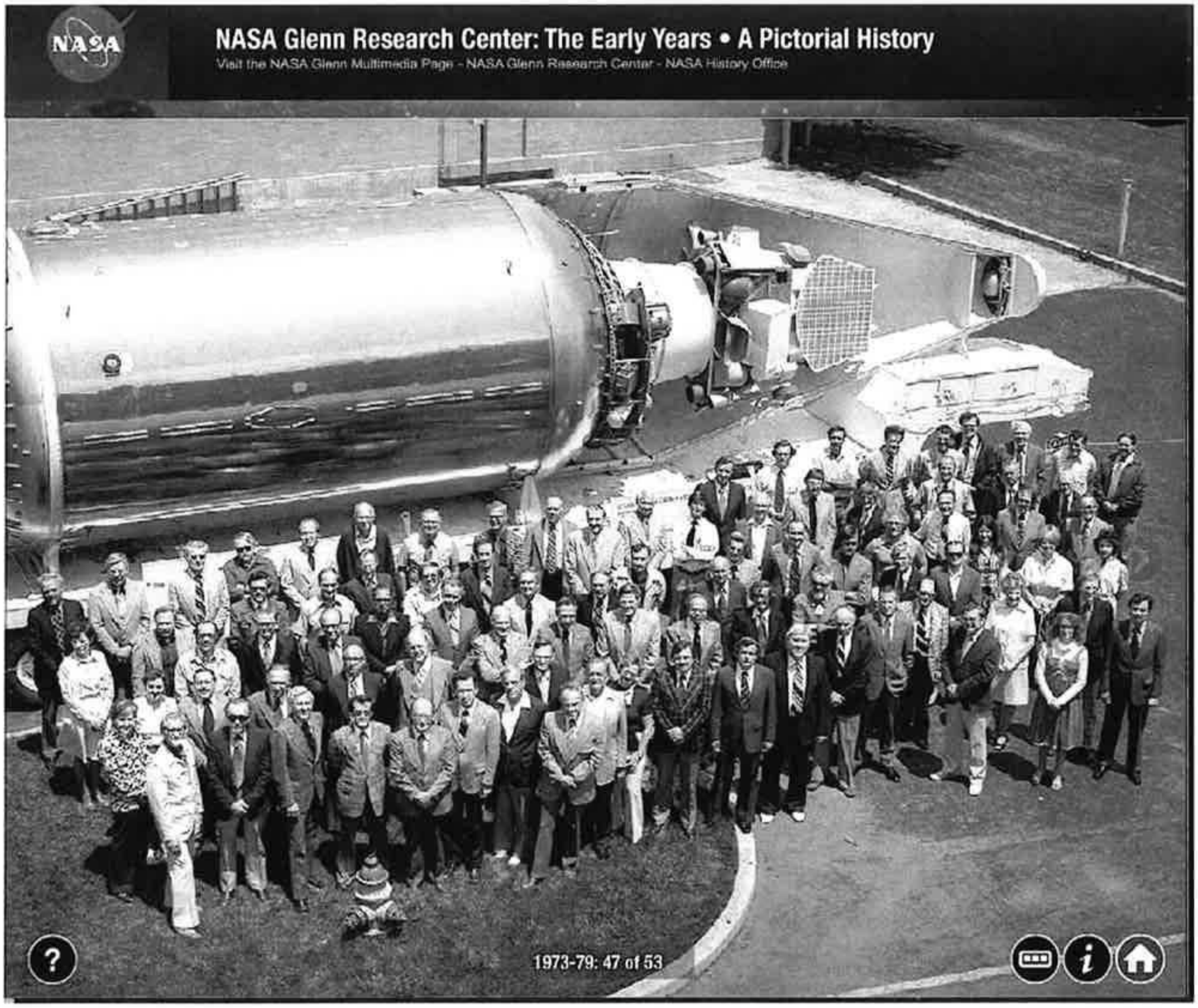

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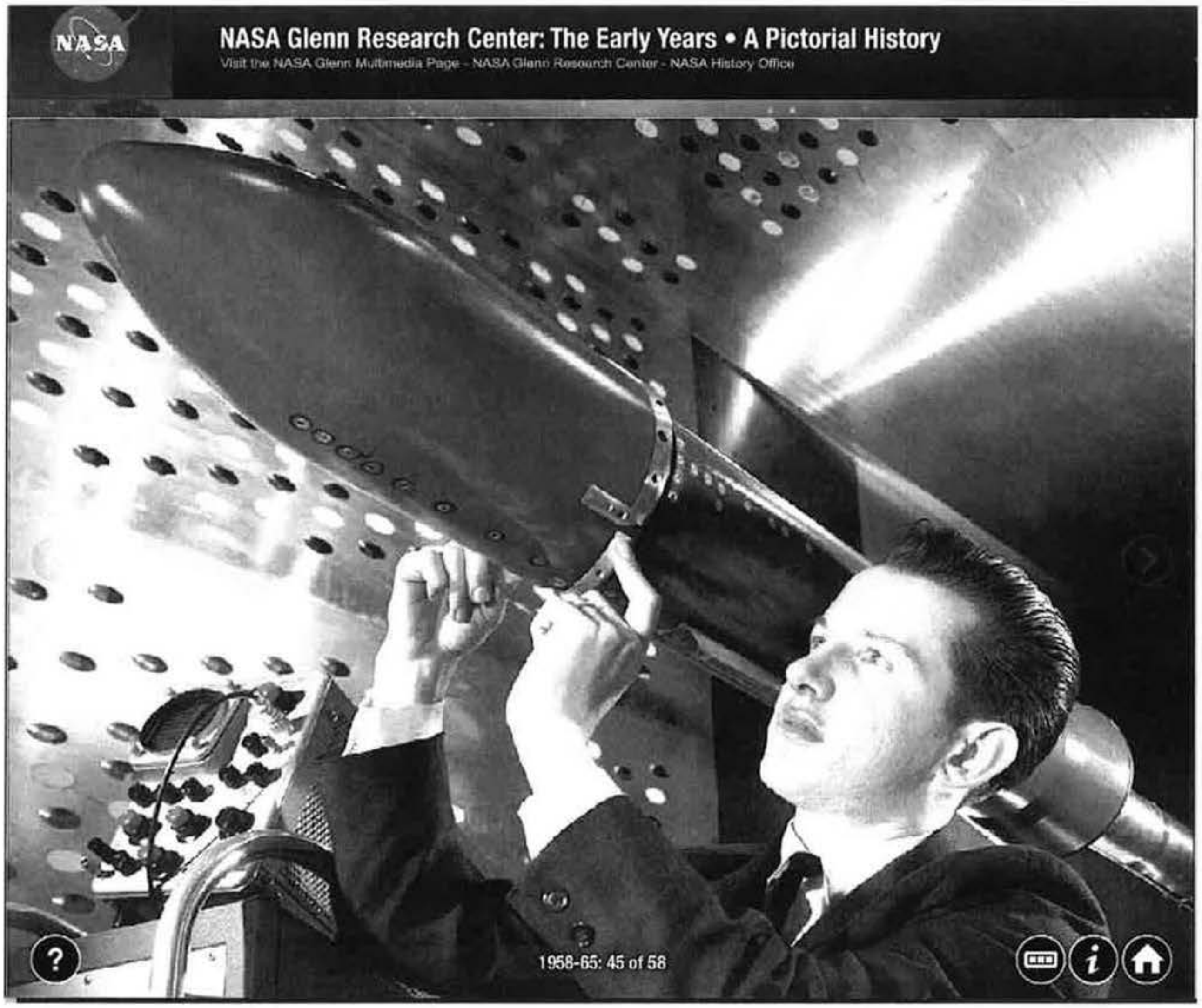

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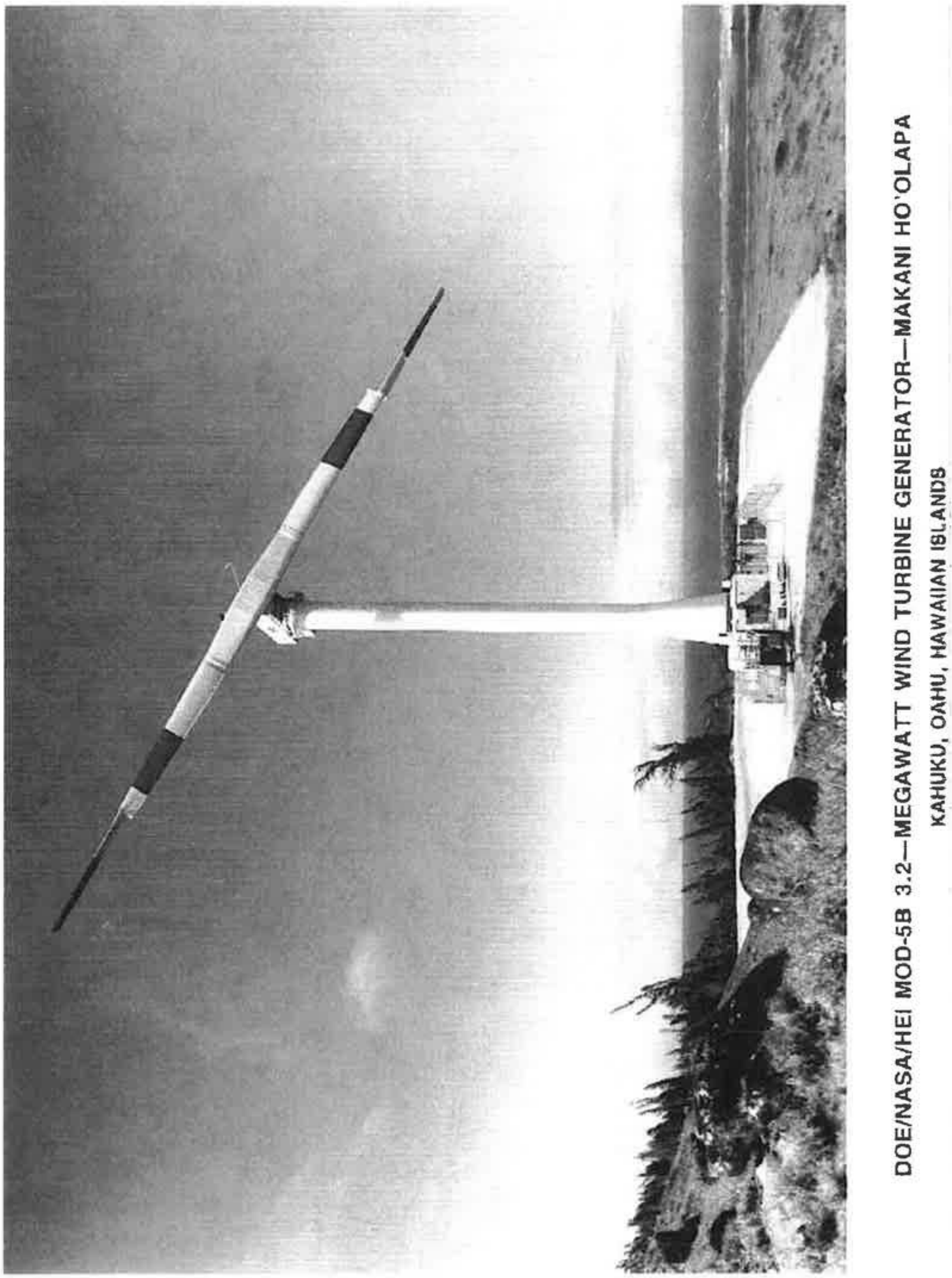

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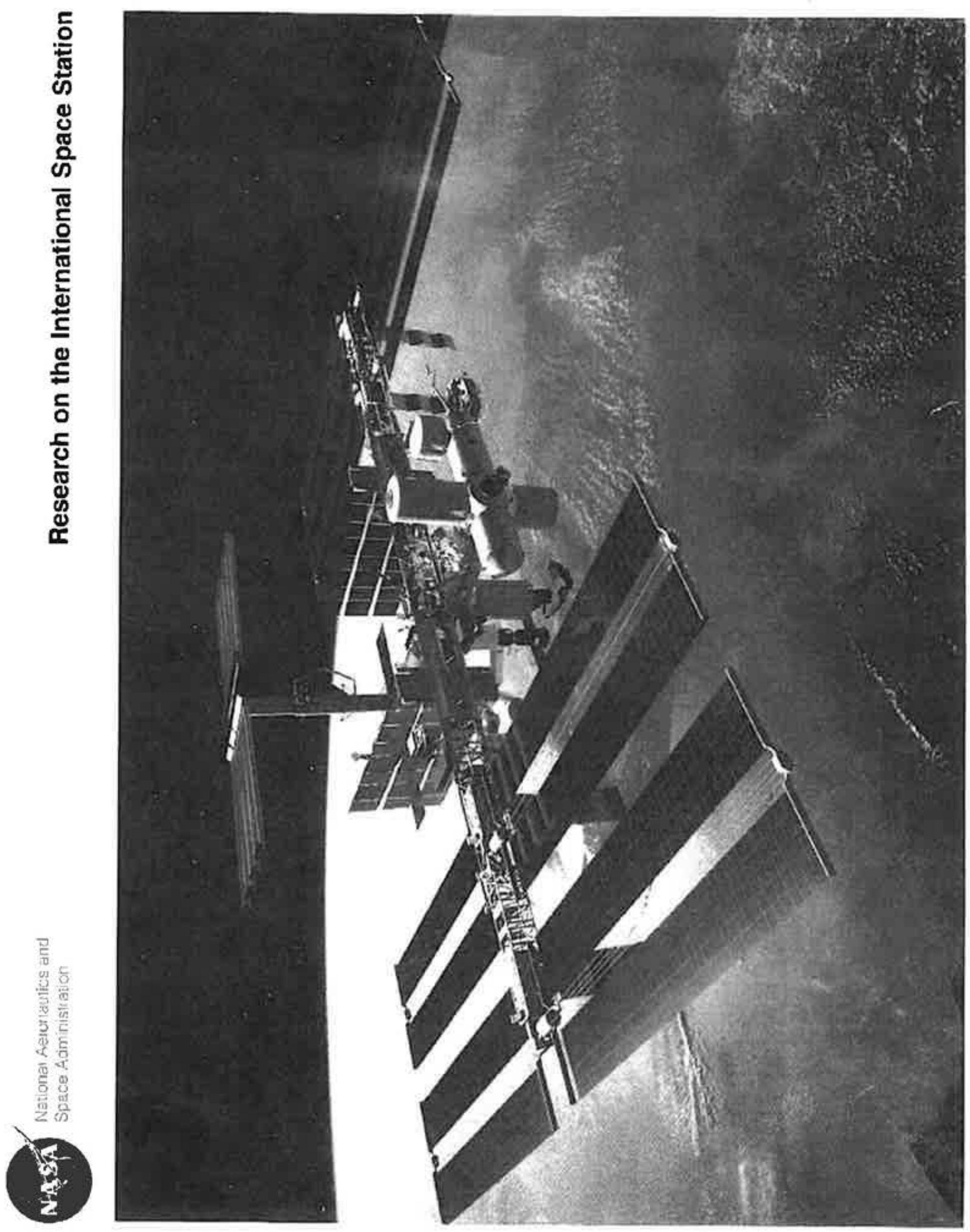

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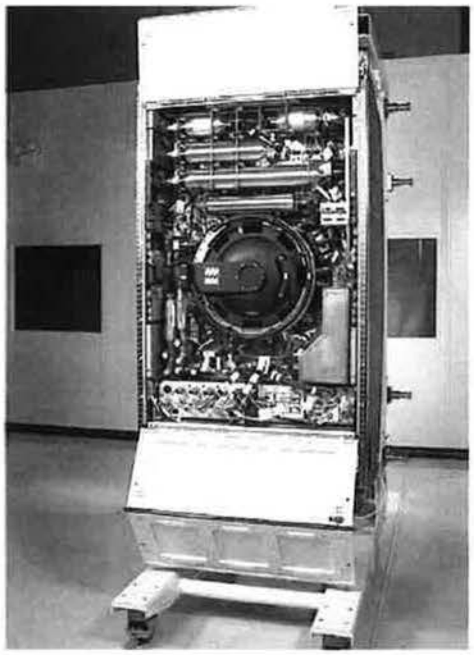


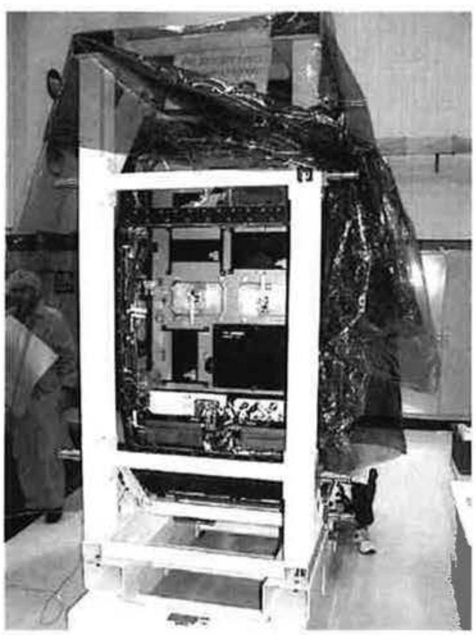


FIGURE 19 – Development Engineering Building & Annex, NASA Occupants throughout the Decades (1967, 1971, 1980, and 1994), undated list; NASA GRCLF archives.

NASA Occupants throughout the Decades

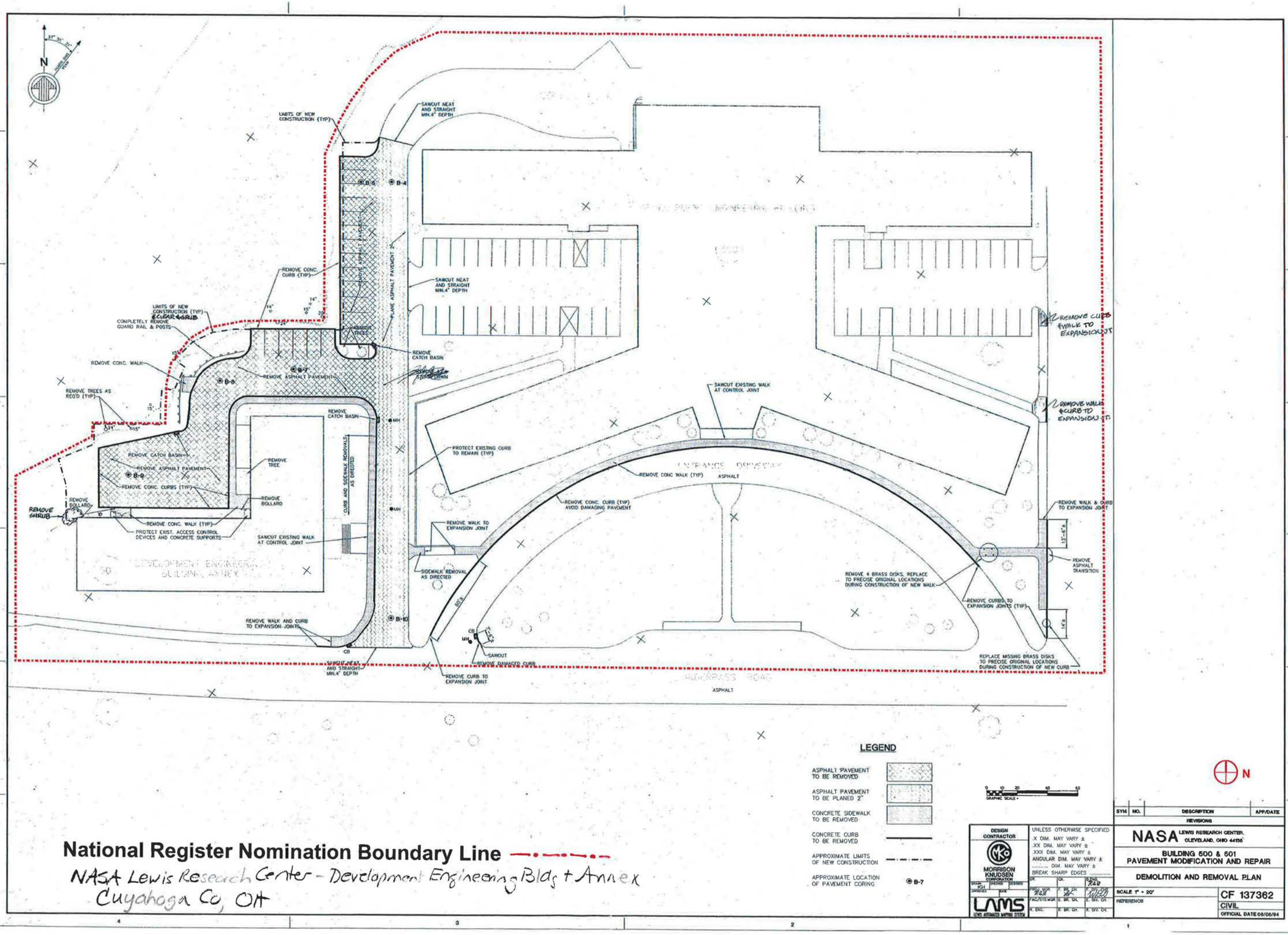
Original staff arrived May-September 1964

1967
Personnel Division
Finance Division
Quality Assurance
Atlas Project Office
Space Power Systems Division
Centaur Project Office
Agena Project Office
Chemical Rocket Division
Advanced Systems Division (501)

1971
Quality Assurance
Personnel Division
Procurement Division
Finance Division
Turbodrive Branch
Power Systems Division
Launch Vehicles Division
Titan/Centaur Project Office
Atlas/Centaur Project Office
Chemical Rocket Division
Advanced Systems Division (501)

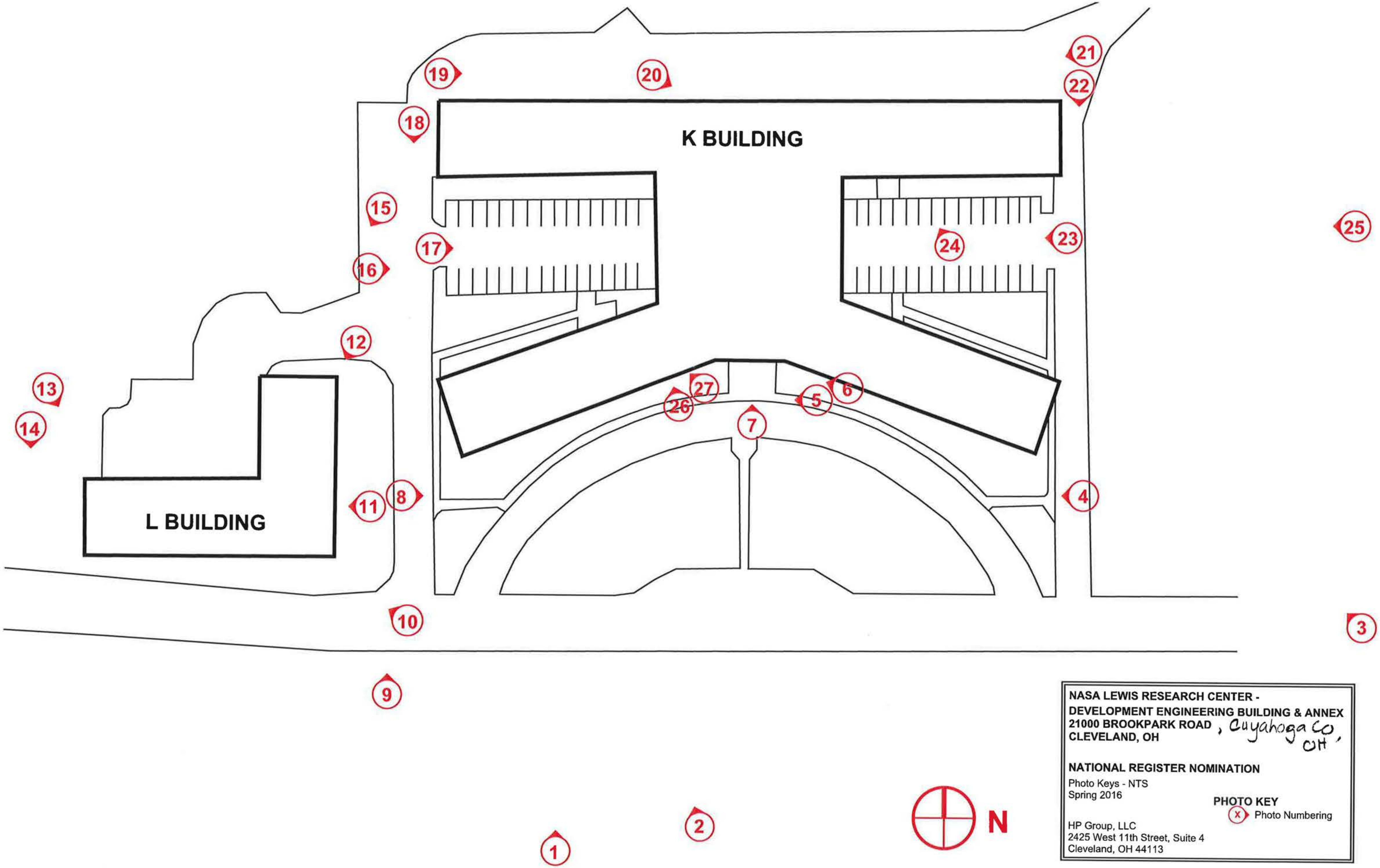
1980
Patent Office
Personnel Division
Financial Management Division
Acquisition Division
Aeronautics Division
Transportation Propulsion Division
Wind and Stationary Power Division
Propulsion Systems Research Branch
Space Directorate management
Launch Vehicles Division
Reliability and Quality Assurance
Space Propulsion and Power (501)
Inspector General (501)
Air Force Liaison (501)
Health Clinic (501)

1994
Wind Tunnel Program Office
Multicultural Affairs
Equal Opportunity
Human Resources
Procurement Division
Space Experiments Division
Power Systems Project
Legal
Space Exploration
Financial Management
Resource Analysis Management
Air Force Liaison (501)
Quality Assurance (501)
Facilities Engineering Division (501)



National Register Nomination Boundary Line

NASA Lewis Research Center - Development Engineering Bldg + Annex
Cuyahoga Co, OH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NASA LEWIS RESEARCH CENTER -
DEVELOPMENT ENGINEERING BUILDING & ANNEX
21000 BROOKPARK ROAD , Cuyahoga Co, OH.
CLEVELAND, OH
NATIONAL REGISTER NOMINATION
Photo Keys - NTS
Spring 2016
PHOTO KEY
X Photo Numbering
HP Group, LLC
2425 West 11th Street, Suite 4
Cleveland, OH 44113

NASA LEWIS RESEARCH CENTER -
DEVELOPMENT ENGINEERING BUILDING & ANNEX
21000 BROOKPARK ROAD
CLEVELAND, OH
Cuyahoga Co, OH
NATIONAL REGISTER NOMINATION

Photo Keys - NTS
Spring 2016

PHOTO KEY
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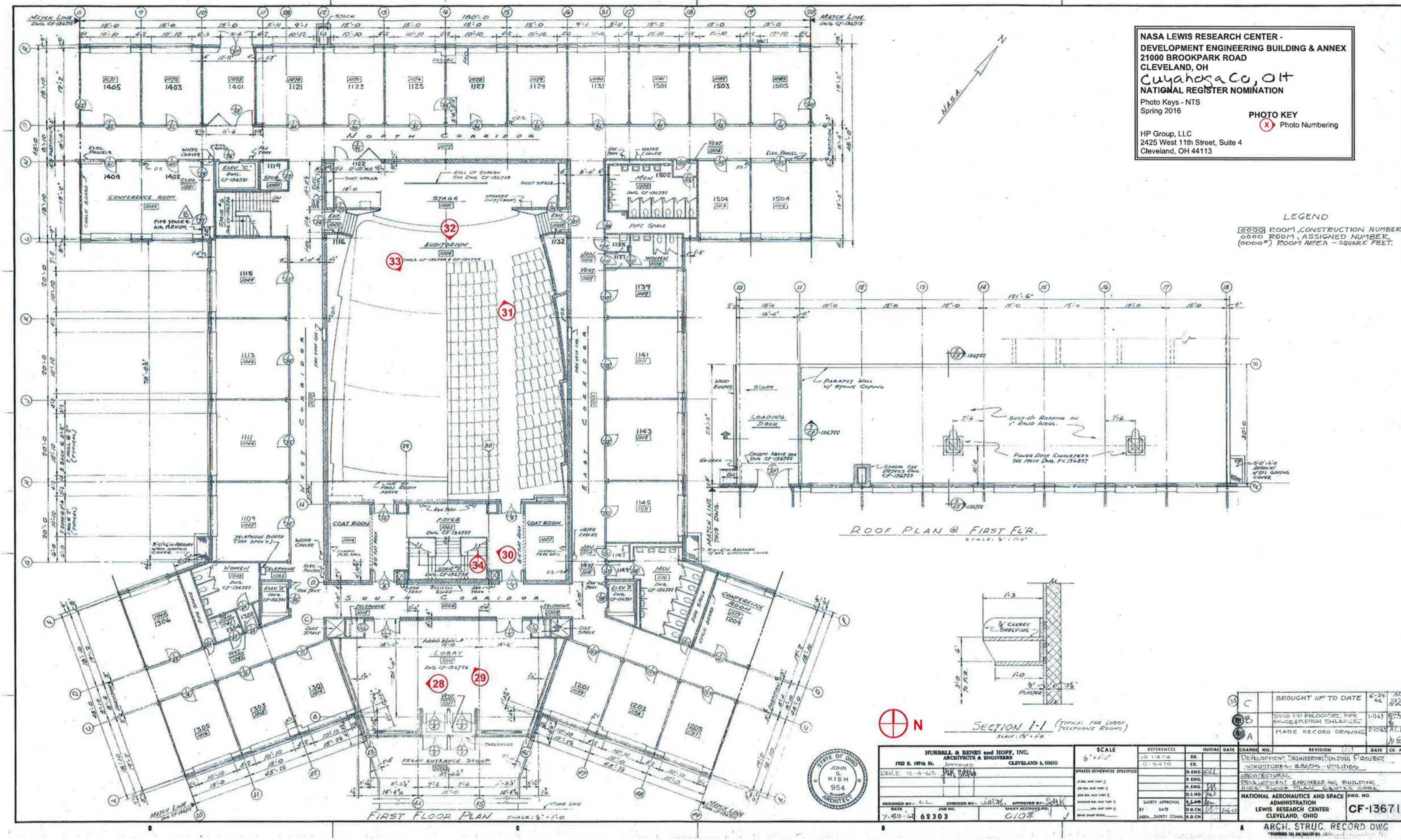

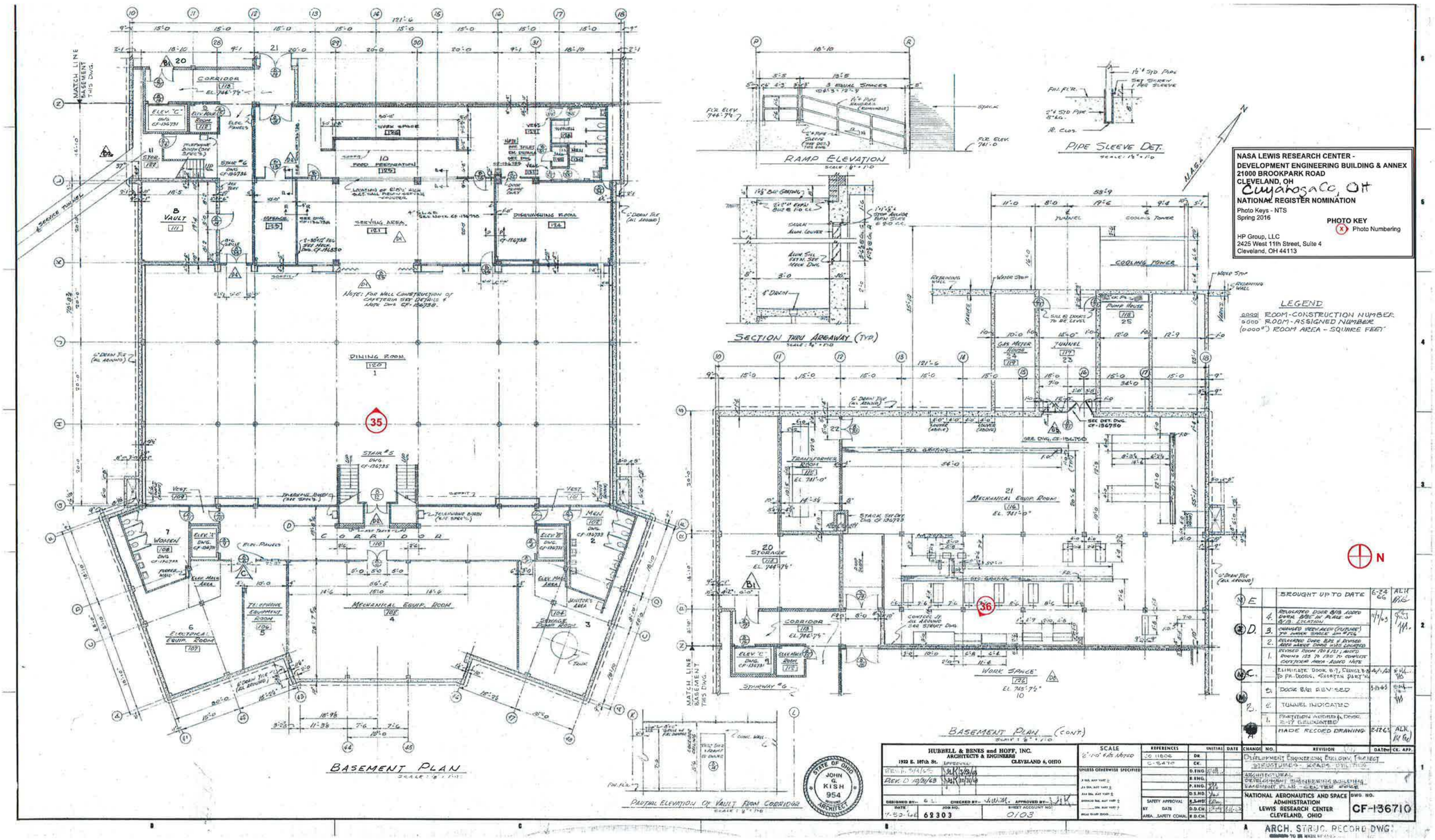
NASA LEWIS RESEARCH CENTER -
DEVELOPMENT ENGINEERING BUILDING & ANNEX
21000 BROOKPARK ROAD
CLEVELAND, OH
Cuyahoga Co, OH
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Photo Keys - NTS
Spring 2016
PHOTO KEY
Photo Numbering
HP Group, LLC
2425 West 11th Street, Suite 4
Cleveland, OH 44113
35
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N
BASEMENT PLAN
BASEMENT PLAN (CONT.)
RAMP ELEVATION
PIPE SLEEVE DET.
SECTION THRU AREAWAY (TYP.)
PARTIAL ELEVATION OF VAULT FROM CORRIDOR
LEGEND
ROOM-CONSTRUCTION NUMBER
ROOM-ASSIGNED NUMBER
ROOM AREA - SQUARE FEET
DINING ROOM
MECHANICAL EQUIP. ROOM
SERVING AREA
DISHWASHING ROOM
FOOD PREPARATION
WORK SPACE
CORRIDOR
VAULT
STORAGE
TRANSFORMER ROOM
COOLING TOWER
TUNNEL
PUMP HOUSE
GAS METER HOUSE
ELECTRICAL EQUIP. ROOM
TELEPHONE EQUIPMENT ROOM
SEWAGE PUMP ROOM
WOMEN
MEN
HUBBELL & BENES and HOFF, INC.
ARCHITECTS & ENGINEERS
CLEVELAND 6, OHIO
STATE OF OHIO
JOHN G. KISH
954
ARCHITECT
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LEWIS RESEARCH CENTER
CLEVELAND, OHIO
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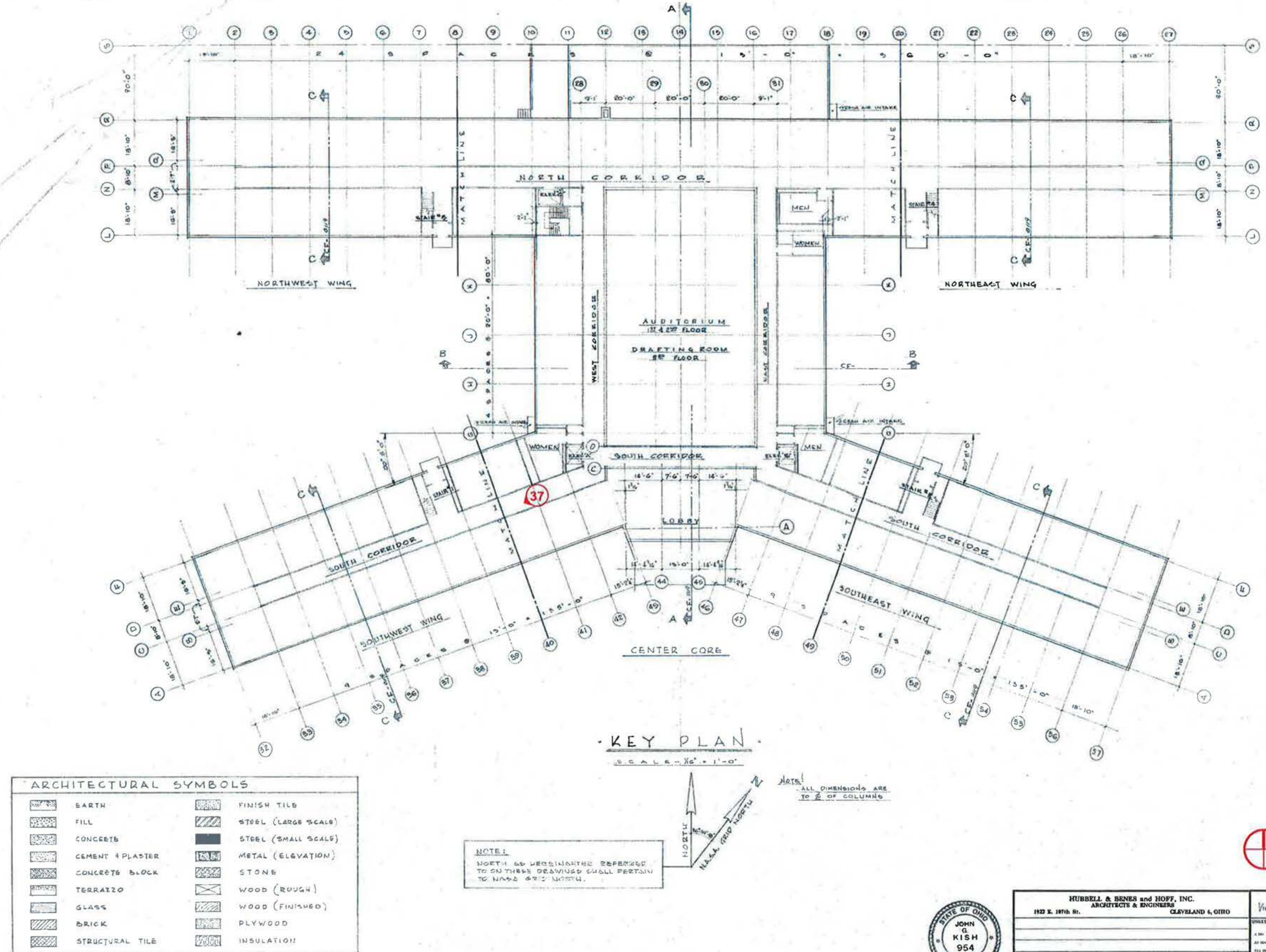
0103
ARCH. STRUC. RECORD DWG.
BROUGHT UP TO DATE
MADE RECORD DRAWING
TUNNEL INDICATED



NASA LEWIS RESEARCH CENTER -
DEVELOPMENT ENGINEERING BUILDING & ANNEX
21000 BROOKPARK ROAD
CLEVELAND, OH
Cuyahoga Co, OH
NATIONAL REGISTER NOMINATION

Photo Keys - NTS
Spring 2016

PHOTO KEY
(X) Photo Numbering

HP Group, LLC
2425 West 11th Street, Suite 4
Cleveland, OH 44113

HUBBELL & BENES and HOFF, INC.
ARCHITECTS & ENGINEERS
1922 E. 107th St. CLEVELAND 6, OHIO

SCALE 1/16" = 1'-0"
REFERENCES JC 11806, C-5470
DESIGNED BY R.S.Toth CHECKED BY J.W.M. APPROVED BY JGK
DATE 7-30-62 JOB NO. 62303 SHEET ACCOUNT NO. 0118

DEVELOPMENT ENGINEERING BUILDING PROJECT
ARCHITECTURAL

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LEWIS RESEARCH CENTER
CLEVELAND, OHIO
DWG. NO. CF-136702

NASA LEWIS RESEARCH CENTER
CLEVELAND, OHIO
PROPRIETARY PROTECTIVE SIGNALING SYSTEM

NASA LEWIS RESEARCH CENTER -
DEVELOPMENT ENGINEERING BUILDING & ANNEX
21000 BROOKPARK ROAD
CLEVELAND, OH
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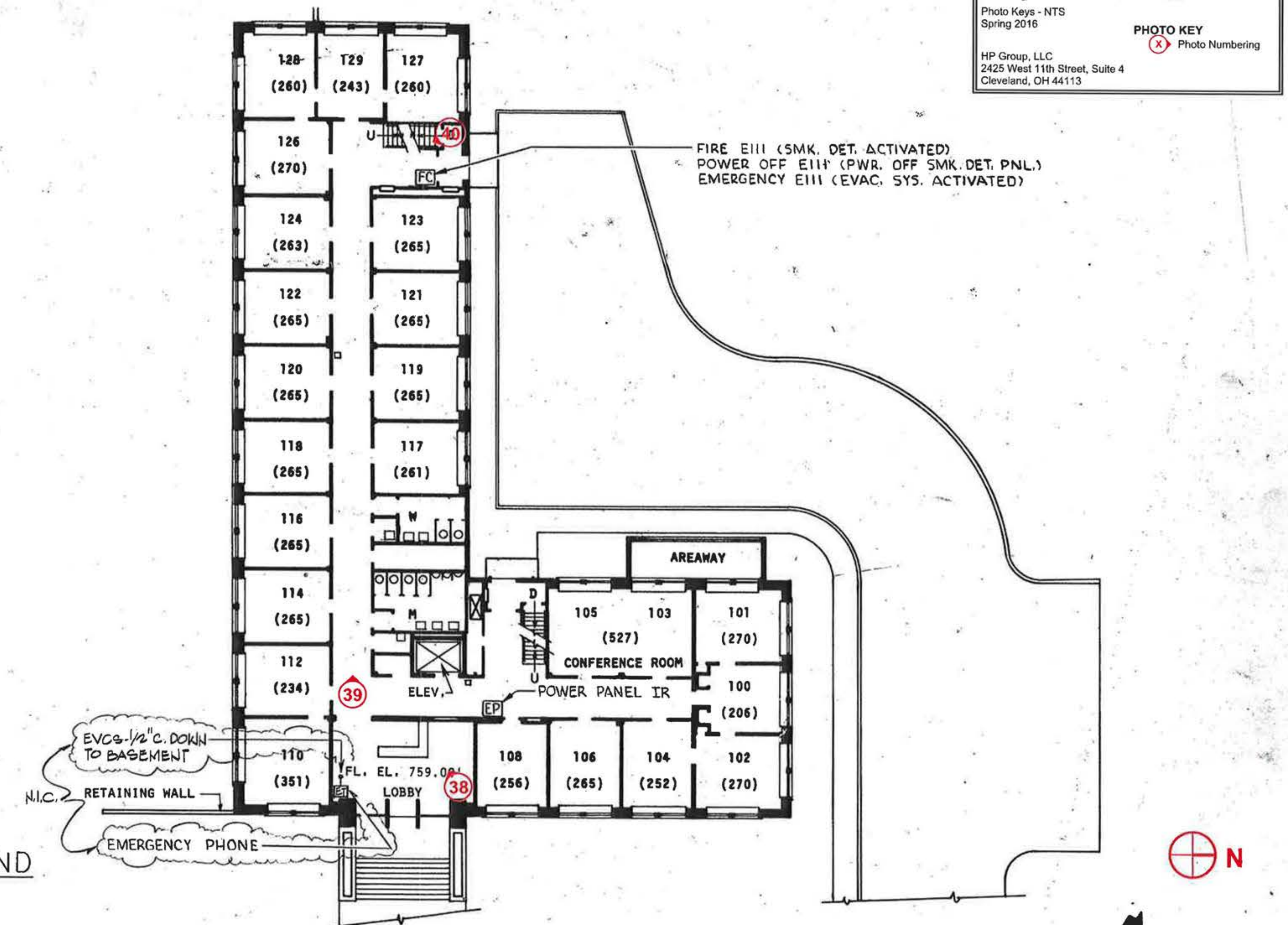


SYMBOL LEGEND

- ET EMERGENCY PHONE
- EP POWER PANEL
- FC FIRE ALARM CONTROL PANEL

FIRST FLOOR PLAN
REF. DWG. NO. CF-137006

( ) AREA, SQ. FT.

DEVELOPMENT ENGINEERING BUILDING ANNEX

BUILDING NO. 501

REVISED NOV. 1984

SCALE 1" =16'-0"

R.E. WARNER & ASSOC.
LORAIN, OHIO
JOB NO. 8501465
P.ENGR KJA SR.ENGR. WLB
DR. GEY CK. RKC DES. GEY

AUTHORIZED BY DATE

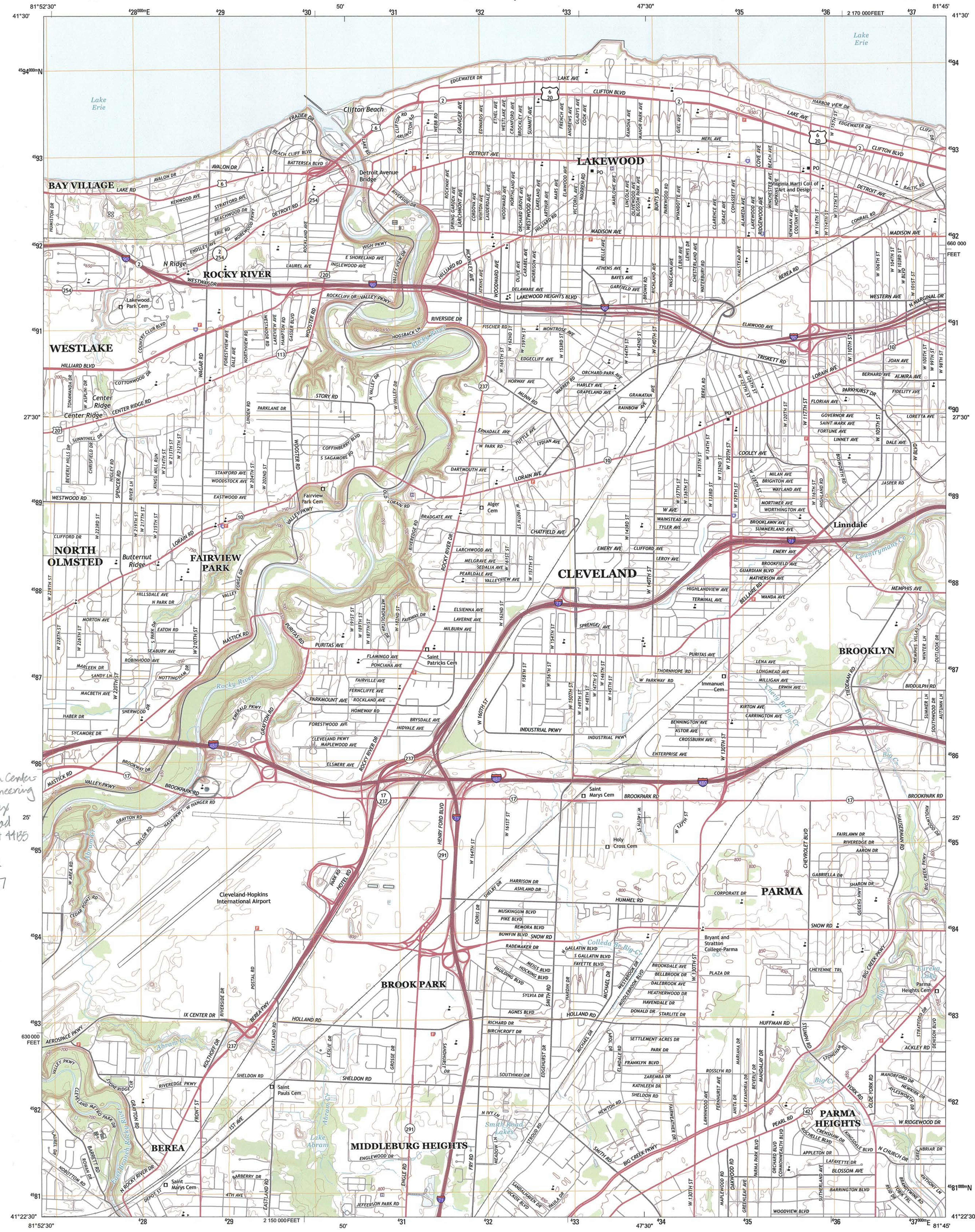
NASA DR. NO. CC-182720

USGS science for a changing world

U.S. DEPARTMENT OF THE INTERIOR
U. S. GEOLOGICAL SURVEY

The National Map US Topo

LAKEWOOD QUADRANGLE
OHIO-CUYAHOGA CO.
7.5-MINUTE SERIES



NASA Lewis Research Center-
Development Engineering
Building & Annex
21000 Brookpark Road
Fairview Park, OH 44135

Lat: 41.41952
Long: -81.85327

UTM
Z 17
E 428681
N 4585463

Produced by the United States Geological Survey
North American Datum of 1983 (NAD83)
World Geodetic System of 1984 (WGS84). Projection and
1 000-meter grid: Universal Transverse Mercator, Zone 17T
10 000-foot ticks: Ohio Coordinate System of 1983 (north zone)

This map is not a legal document. Boundaries may be generalized for this map scale. Private lands within government reservations may not be shown. Obtain permission before entering private lands.

Imagery	NAIP, August 2011
Roads	©2006-2013 TomTom
Names	GNIS, 2013
Hydrography	National Hydrography Dataset, 2011
Contours	National Elevation Dataset, 2010
Boundaries	Census, IBWC, IBC, USGS, 1972 - 2012
Public Land Survey System	BLM, 2013

8° 11′ / 145 MILS
0° 32′ / 10 MILS
MN GN

UTM GRID AND 2013 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

U.S. National Grid
100,000-m Square ID
MF
Grid Zone Designation
17T

SCALE 1:24 000

KILOMETERS 1 0.5 0 1 2
METERS 1000 500 0 1000 2000
MILES 1 0.5 0 1
FEET 1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000

CONTOUR INTERVAL 10 FEET
NORTH AMERICAN VERTICAL DATUM OF 1988

This map was produced to conform with the National Geospatial Program US Topo Product Standard, 2011. A metadata file associated with this product is draft version 0.6.15

OHIO

QUADRANGLE LOCATION

North Olmsted OE N		Cleveland North
North Olmsted	Lakewood	Cleveland South
West View	Berea	Broadview Heights

ADJOINING 7.5' QUADRANGLES

ROAD CLASSIFICATION

Expressway	Local Connector
Secondary Hwy	Local Road
Ramp	4WD
Interstate Route	US Route
State Route	

LAKEWOOD, OH
2013


STOP


DO NOT
ENTER
DO NOT
ENTER


EXIT


JOHNSON CONTROL
AUDITORIUM AND DRAFTING ROOM UNIT
DINING ROOM UNIT
MULTI-ZONE UNIT
RETURN WATER SYSTEM
FLOW SYSTEMS
PUMP SYSTEMS
N.A.S.A.

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

NATIONAL REGISTER OF HISTORIC PLACES
EVALUATION/RETURN SHEET

REQUESTED ACTION: NOMINATION

PROPERTY NAME: NASA Lewis Research Center-- Development Engineering Buildin g & Annex

MULTIPLE NAME:

STATE & COUNTY: OHIO, Cuyahoga

DATE RECEIVED: 7/22/16 DATE OF PENDING LIST: 8/10/16
DATE OF 16TH DAY: 8/25/16 DATE OF 45TH DAY: 9/06/16
DATE OF WEEKLY LIST:

REFERENCE NUMBER: 16000599

REASONS FOR REVIEW:

APPEAL:	N	DATA PROBLEM:	N	LANDSCAPE:	N	LESS THAN 50 YEARS:	N
OTHER:	N	PDIL:	N	PERIOD:	N	PROGRAM UNAPPROVED:	N
REQUEST:	N	SAMPLE:	N	SLR DRAFT:	N	NATIONAL:	N

COMMENT WAIVER: N

✓ ACCEPT ___RETURN ___REJECT 8-15-2016 DATE

ABSTRACT/SUMMARY COMMENTS:
Exceptional importance in NASA development & operations.

RECOM./CRITERIA Accept A

REVIEWER J Gabbert DISCIPLINE

TELEPHONE DATE

DOCUMENTATION see attached comments Y/N see attached SLR Y/N

If a nomination is returned to the nominating authority, the nomination is no longer under consideration by the NPS.

July 15, 2016

J. Paul Loether, Deputy Keeper and Chief of National Register and
National Historic Landmark Programs
National Register of Historic Places
1201 Eye St. NW, 8th Fl. (2280)
Washington D.C. 20005

Dear Mr. Loether:

Enclosed please find three (3) new National Register nominations for Ohio. All appropriate notification procedures have been followed for the new nomination submission.

NEW NOMINATION	COUNTY
Grossman Paper Company	Cuyahoga
Lewis Research Center, Development Engineering Building and Annex	Cuyahoga
Edward Ford Plate Glass Company Employee Relations Building	Wood

The enclosed disks contain the true and correct copy of the nomination to the National Register of Historic Places for the Grossman Paper Company, Cuyahoga County, OH.

All three of these nominations must be listed before September 30, 2016 in order to qualify for the next round of the Ohio Historic Preservation Tax Credit. In order to expedite the listing of these three nominations I am requesting waiving the 15-day commenting period in the Federal Register for the nomination and that the nomination is listed as soon as possible. The chief elected officials in Cleveland, Fairview Park, and Rossford (the communities of each of the properties) and the Certified Local Government contact in Cleveland each have received the appropriate notification from the State Historic Preservation Office. Each of the property owners have received the appropriate notification from the State Historic Preservation Office and are in full support of the nomination of their property.

If you have questions or comments about these documents, please contact the National Register staff in the Ohio Historic Preservation Office at (614) 298-2000.

Sincerely,

Barbara Power

Burt Logan
Executive Director and CEO
State Historic Preservation Officer

Enclosures

RECEIVED 2280

JUL 22 2016

Nat. Register of Historic Places
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
NPS TRANSMITTAL CHECK LIST

OHIO HISTORIC PRESERVATION OFFICE
800 E. 17th Avenue
Columbus, OH 43211
(614)-298-2000

The following materials are submitted on July 15, 2016
For nomination of the Lewis Research Center, DEB + Annex to the National Register of Historic Places: Cuy Co, OH

✓ Original National Register of Historic Places nomination form
✓ Paper ___ PDF

___ Multiple Property Nomination Cover Document
___ Paper ___ PDF

___ Multiple Property Nomination form
___ Paper ___ PDF

✓ Photographs
✓ Prints ✓ TIFFs

✓ CD with electronic images

✓ Original USGS map(s)
✓ Paper ___ Digital

✓ Sketch map(s)/Photograph view map(s)/Floor plan(s)
✓ Paper ___ PDF

___ Piece(s) of correspondence
___ Paper ___ PDF

___ Other ___

COMMENTS:

___ Please provide a substantive review of this nomination

___ This property has been certified under 36 CFR 67

___ The enclosed owner objection(s) do ___ do not ___ Constitute a majority of property owners

✓ Other: nom is for National level of significance

* request to waive Fed Reg. publishing to expedite nomination