A National Register Inventory and Evaluation of Launch Complex 38 at White Sands Missile Range, Otero County, New Mexico

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EPSILON SYSTEMS

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Prepared for:
White Sands Missile Range in a
Cooperative and Joint Venture Agreement with
New Mexico State University

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On the Covers: (Front) An unidentified Army Master Sergeant inspects a Nike Zeus Missile Tracking Radar at LC-38 in 1961. (Back) The Nike Zeus Acquistion Radar transmitter building (Property 24072) and radar seen through the clutter fence gate circa early 1960s. Photographs courtesy White Sands Missile Range.

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Acknowledgments

Thanks are extended to James Bowman, White Sands Missile Range (WSMR) Cultural Resources Manager, and especially William Godby, Archaeologist, who provided direction, access and key contacts as well as documents, photographs, and files necessary for the success of this project. Special gratitude is extended to Museum Specialist Jenn Jett and volunteer Andy Spear with the WSMR Museum for providing access to the extensive materials in the WSMR Museum Archives. Thanks also go to Kristen Hestir for providing mapping, and Directorate of Public Works (DPW) Master Planning Chief Michael Williams for providing access to the realty data on file with the WSMR DPW. Finally, we would also like to thank Jaime De La Cruz for helping arrange access to active test areas at LC-38.

Phillip Esser served as the project manager and Nate Myers conducted the on-site survey and field recordation for the project. Nate Myers was the principal author of the report, with essential reviews and commentary provided by Phillip Esser and Epsilon Systems Cultural Resources Program Manager Brad Beacham.

Acronyms and Abbreviations

A&E	Architectural and Engineering
A/C	Air Conditioning
AADS-70s	Army Air Defense System for the 1970s
ABM	Anti-Ballistic Missile
ABMDA	Advanced Ballistic Missile Defense Agency
ABRES	Advanced Ballistic Re-Entry Systems
ACHP	Advisory Council on Historic Preservation
AFB	Air Force Base
AFCRL	Air Force Cambridge Research Laboratory
AHTV	Advanced Hypersonic Test Vehicle
AIL	Airborne Instrument Laboratory
ALA	Army Launch Area
AMTED	Army Missile Test and Evaluation Directorate
APL	Applied Physics Laboratory (Johns Hopkins University)
APS	Accessory Power Supply
ARCAS	All Purpose Rocket for Collecting Atmospheric Soundings
ARMS	Archaeological Records Management Section
ARMTE	Army Missile Test and Evaluation
ARPA	Advanced Research Projects Agency
ASL	Atmospheric Sciences Laboratory
ASROC	Anti-Submarine Rockets
ATACMS	Army Tactical Missile System
ATBM	Anti-Tactical Ballistic Missile
BBV	Black Brant V
BCB	Battery Control Building
BCDP	Battery Control Data Processor

BMD	Ballistic Missile Defense
BMDC	Ballistic Missile Defense Center
BMEWS	Ballistic Missile Early Warning System
BOMARC	Boeing and Michigan Aeronautical Research Center (missile)
BRL	Ballistics Research Laboratory
BTL	Bell Telephone Laboratories
BTU	British Thermal Unit
C	Celsius
Caltech	California Institute of Technology
CFR	Code of Federal Regulations
CFS	Cambridge Field Station
CMU	Concrete Masonry Unit
DAC	Douglas Aircraft Company
DARPA	Defense Advanced Research Projects Agency
DMA	Defense Mapping Agency
DOD	Department of Defense
DOVAP	Doppler Velocity and Position
DPW	Directorate of Public Works
DR	Discrimination Radar (Nike Zeus)
DRAM	Dynamic Random Access Memory
EFOGM	Enhanced Fiber Optic Guided Missile
EMP	Electromagnetic Pulse
EMT	Early Missile Test
EO	Executive Order
Epsilon Systems	Epsilon Systems Solutions Inc.
ERINT	Extended Range Intercept Technology
ESRI	Environmental Systems Research Institute

ESSM	Evolved Seasparrow Missile
F	Fahrenheit
FAAD	Forward Area Air Defense
FCG	Fire Control and Guidance
FDL	Flight Determination Laboratory
FIX	Firing in Extension
FLAGE	Flexible Lightweight Agile Guided Experiment
GALCIT	Guggenheim Aeronautical Laboratory at California Institute of Technology
GE	General Electric
GFEBS	General Fund Enterprise Business System
GIS	Geographic Information System
GPS	Global Positioning System
GRLC	Green River Launch Complex
HAFB	Holloman Air Force Base
HAPDAR	Hard Point Demonstration Array Radar
HARP	High Altitude Research Project
HBIF	Historic Building Inventory Form
HCPI	Historic Cultural Properties Inventory (New Mexico)
HEDI	High Endoatmospheric Defense Interceptor
HELSTF	High Energy Laser System Test Facility
HIBEX	High Booster Experiment
HIPAR	High Power Acquisition Radar
HPD	Historic Preservation Division (New Mexico)
HSR	Human Systems Research
HVAC	Heating, Ventilation, and Air-Conditioning
HVAR	High Velocity Altitude Rocket
ICBM	Intercontinental Ballistic Missile

ICC	Interstate Commerce Commission
IFC	Integrated Fire Control
IGOR	Intercept Ground Optical Recorder
IGY	International Geophysical Year
IRBM	Intermediate Range Ballistic Missile
JATO	Jet-Assisted Take-Off
JFAADS	Joint Forward Area Air Defense
JPL	Jet Propulsion Laboratory
KEM	Kinetic Energy Missile
KMR	Kwajalein Missile Range
kVA	Kilovolt Amps
LAR	Local Acquisition Radar
LC	Launch Complex
LES	Launch Escape System (Apollo)
LLS-1	Land Locked Ship One
LOAD	Low Altitude Defense
LoADS	Low Altitude Defense System
LOPAR	Low Power Acquisition Radar
LOSAT	Line-of-Sight Anti-Tank (missile)
LPG	Liquid Petroleum Gas
LTV	Ling-Temco-Vought
MAB	Missile Assembly Building
MAD	Mutually Assured Destruction
MAR	Multi-functioning Array Radar
MARV	Maneuvering Reentry Vehicle
MCB	Mission Control Building
MEWS	Missile Exercise White Sands

MIRACL	Mid-Infra-Red Advanced Chemical Laser
MIRV	Multiple Independently Targetable Reentry Vehicle
MLRS	Multiple Launch Rocket System
MRBM	Medium Range Ballistic Missile
MSE	Missile Segment Enhancement
MSR	Missile Site Radar
MTD	Materiel Test Directorate
MTR	Missile Tracking Radar
MX	Missile System X
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NAWS	Naval Air Weapons Station (China Lake)
NEPA	National Environmental Policy Act
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
NMCRIS	New Mexico Cultural Resources Information System
NMSU	New Mexico State University
NORAD	North American Aerospace Defense Command
NOTS	Naval Ordnance Test Station
NPS	National Park Service
NRHP	National Register of Historic Places
NRL	Naval Research Laboratory
NRO	National Range Operations
NSC	National Security Council
NVA	North Vietnamese Army
OPSEC	Operations Security
ORDCIT	Ordnance and California Institute of Technology

OU	Operation Understanding
PAC	Patriot Advanced Capability
PAR	Perimeter Acquisition Radar
PATRIOT	Phased Array Tracking to Intercept of Target
PEO STRI	Program Executive Office for Simulation, Training, and Instrumentation
PRESTAGE	Primary Stage Acceleration and Guidance Experiment
PSDF	Propulsion Systems Development Facility
PSI	Pounds Per Square Inch
PSL	Physical Sciences Laboratory
R&D	Research and Development
RAM	Radar Advanced Measurement (radar)
RAM	Rolling Airframe Missile (Navy)
RAMPART	Radar Advanced Measurement for Analysis of Re-Entry Techniques
RCAT	Radio Controlled Aerial Targets
RCRC	Red Canyon Range Camp
RDT&E	Research, Development, Test, and Evaluation
RF	Radio Frequency
RFNA	Red Fuming Nitric Acid
RML	Range Measurements Laboratory
ROAD	Reorganization Objective Army Divisions
ROTI	Recording Optical Tracking Instrument
SAFSEA	Safeguard System Evaluation Agency
SALT	Strategic Arms Limitation Talks
SAM-D	Surface to Air Missile D
SCEL	Signal Corps Engineering Laboratories
SDI	Strategic Defense Initiative
SEMTR	Sprint Experimental Missile Tracking Radar

SMR	Small Missile Range
SRMSC	Stanley R. Mickelsen Safeguard Complex
SS1A	Surface-to-Surface 1A
STO	Strategic Technologies Office
SULF	Speedball Uprange Launch Facility
TACMAR	Tactical Multi-functioning Array Radar
TACOL	Thinned Aperture Computed Lens
TBM	Tactical Ballistic Missile
TDRSS	Tracking and Data Relay Satellite System (NASA)
TE-S	Weapons Test Simulation Division
THAAD	Theater High Altitude Area Defense
THEL	Tactical High Energy Laser
TIC	Target Intercept Computer
TOW	Tube-Launched Optically-tracked Wire-guided (missile)
TTR	Target Tracking Radar
TVM	Track Via Missile
UHF	Ultrahigh Frequency
UPSTAGE	Upper Stage Acceleration and Guidance Experiment
US	United States
USACE	US Army Corps of Engineers
USAF	United States Air Force
UTM	Universal Transverse Mercator
V-2	Vengeance 2
VAL	Vulnerability Assessment Laboratory (WSMR)
VHF	Very High Frequency
VLS	Vertical Launch System
WAC	Without Attitude Control

WRCC	Western Regional Climate Center
WSMR	White Sands Missile Range
WSPG	White Sands Proving Ground
WSTF	White Sands Test Facility
WWII	World War II
ZAR	Zeus Acquisition Radar
ZMAR	Zeus Multifunction Array Radar
ZURF	Zeus Up-Range Facility

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APPENDICES*

**The Appendices for this study are found on a CD attached to the back cover of the report. Additionally, a large fold-out map calling out the district boundaries, properties and features is also found in the back of the report*

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1. Management Summary

In April 2022, Epsilon Systems Solutions, Inc. (Epsilon Systems) was contracted by the White Sands Missile Range (WSMR) Environmental Division, Conservation Branch, Cultural Resources Program to conduct an inventory and evaluation of the Launch Complex 38 (LC-38) facilities and evaluate them for their National Register of Historic Places (NRHP) eligibility. LC-38 was the location of the prototype testing of the Nike Zeus system, the Army's first attempt at an Intercontinental Ballistic Missile (ICBM) defense system during the Cold War. LC-38 was constructed expressly in support of the Nike Zeus program, which required substantial, permanent facilities and infrastructure. The Nike Zeus installation at LC-38 simulated one complete unit of the Nike Zeus system as it would have been constructed across the country if the program had ultimately been funded and deployed. As advanced as Nike Zeus was at the time, its mechanically steered radars limited the number of targets it could deal with simultaneously. The system also needed improvements in differentiating targets in the upper atmosphere. The series of large, powerful radars required by the system had to be housed within hardened, permanent buildings that were also costly to construct. Due to these limitations, the Nike Zeus development was halted in 1963, and the development program shifted to designing a next generation system. This new system was referred to as the Nike X, and it was anticipated that the Nike X would be capable of defending against the Soviet ICBM threat that would be present as of the mid-1970s. The two biggest changes introduced in the Nike X were phased array radars and a second missile that could intercept ICBMs in the lower atmosphere, where differentiation of the actual warhead was much easier due to atmospheric filtering. This new high-speed missile became known as the Sprint, the addition of which added a second layer of ballistic missile defense to the system; the Sprint missile was also tested at WSMR. LC-38 continued to be used in support of the Nike X program, and its later Sentinel and Safeguard iterations, through the early 1970s. The deployment of a national ICBM defense grid was ultimately halted by the nuclear arms reduction treaties of the 1970s, but LC-38 continued to be active as a launch complex through the end of the Cold War, primarily in support of the Patriot missile program.

The scope of the inventory area was determined in consultation with WSMR Archaeologist, William Godby. In order to adequately meet the requirements set forth in Section 110 of the National Historic Preservation Act (NHPA) and NRHP guidelines, the inventory was inclusive of all the significant Cold War-era built environment resources within the launch complex boundaries.

In June through August of 2022, Epsilon Systems cultural resources staff conducted an on-site inventory and recorded 67 buildings, structures, and objects at LC-38. As one of the major WSMR launch complexes, LC-38 played a vital role in the Army materiel development process and the development of Army missile defense systems; LC-38 was therefore a significant location of the Cold War military-industrial complex as discussed by Lavin (1998). The recorded resources relate specifically to the Cold War military-industrial historic themes of Materiel Development and Air Defense, Ballistic Missile Defense, and Army Missiles (per Lavin 1998) that are significant to our national history. All of the documented resources date to the Cold War era (1946 to 1989); no prehistoric resources were recorded or evaluated. The current inventory was logged as New Mexico Cultural Resources Information System (NMCRIS) number 152307 with the Archaeological Records Management Section (ARMS).

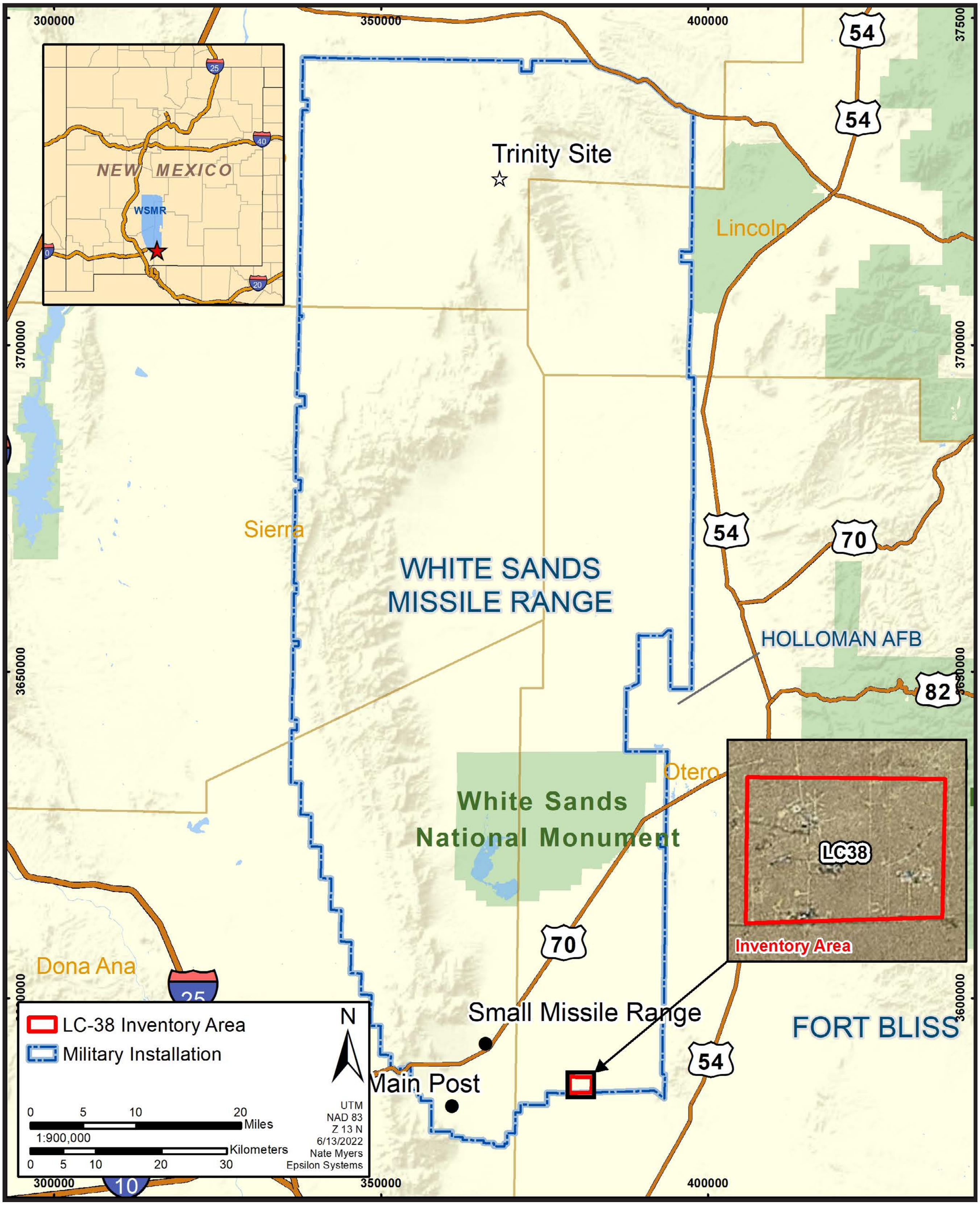

Figure 1. Map of the current inventory location within WSMR.

Six of the recorded properties were recommended for individual eligibility under Criteria A and C. Additionally, it was found that LC-38 represents a definable concentration of resources, most of which date to an identified primary period of significance associated with the Cold War at WSMR (1959 to 1964). As such, an additional 22 properties were recommended for eligibility as contributing elements to a historic district encompassing the primary concentration of Cold War-era LC-38 facilities. As an active launch complex, LC-38 has been modified through time and accrued some recent additions that post-date its Cold War period of significance; however, it is the recommendation of Epsilon Systems that LC-38 retains sufficient historic integrity of its physical features to convey its historic significance. As such, Epsilon Systems recommends that LC-38 is recognizable as a historic military landscape that is best managed as a historic district, per Department of the Army guidance (Loechl et al. 1994).

2. Introduction and Project Background

Starting in the late 1950s, the United States (US) Army developed a new version of the Nike missile that was capable of defending against ICBMs. Testing of the Nike missile at WSMR moved east down Nike Avenue (Range Road 2) as new launch complexes were established in support of the evolving system. The early prototype Research, Development, Test, and Evaluation (RDT&E) of the Nike missile was conducted at LC-33, the production version of the system was tested at LC-37, and the final generation of the system was tested at LC-38, which was established in 1959. The Nike Zeus was the first version of the Nike missile system capable of intercepting ballistic missiles and was tested at LC-38 and Kwajalein Island in the Pacific Ocean. As the political and technological background of the Nike anti-missile system shifted during the 1960s, the Nike Zeus program changed as well. Nike Zeus became the Nike X, then Nike X developed into the proposed Sentinel missile defense system, which in turn became the Safeguard system by the early 1970s. Despite the changes in name and capabilities, the core technology of these Nike antimissile systems was developed at LC-38 during the 1960s.

The Nike Zeus required substantial infrastructure to support the system components, and LC-38 also required its own dedicated support and infrastructure facilities given its distance from the Main Post. An assembly and technical area was established in the south-central part of the complex just north of Nike Avenue. A series of launchers and launch control building were constructed in the north central part of the complex, and a hazardous assembly area was constructed in the west central part of the complex. The Nike Zeus battery control and guidance radar installations were built in the central part of the complex; an additional radar designed to differentiate missiles from debris and decoys was added to this location in 1962. The massive long-range acquisition radar of the Nike Zeus, whose receiver and transmitter were installed in separate buildings, was constructed in the east central part of the complex. The east-central part of the complex also included physical plant facilities for the acquisition radar, as well as a small aircraft hangar and runway. In all, LC-38 was constructed with more substantial, permanent built environment resources than any of the other Nike Avenue launch complexes. While not all of these resources are extant at the complex today, the complex still retains many of the original Nike Zeus facilities.

Nike Zeus proved to be a fairly short-lived program at LC-38. The Nike X development program replaced the Nike Zeus by 1964, although many of the LC-38 facilities remained in use in support of the new Nike X initiative. LC-38 supported assembly and checkout of the new high-speed Sprint missile developed as part of the Nike X program, although the missiles themselves were launched from LC-50. The long-range Spartan interceptor used in the Nike X, as well as the later Sentinel and Safeguard programs, was launched from Kwajalein Island in the Pacific Ocean.

By the early 1970s, Safeguard program testing had ended at LC-38, and its primary contractor, Bell Telephone Laboratories (BTL), had mostly vacated the launch complex. By this time, contractor Raytheon had started operations at LC-38, testing a new air defense missile that would become the Patriot missile in 1976. Patriot test facilities replaced the old Nike Zeus launch facilities in the north central part of the complex and, beginning in the late 1960s, new launch facilities, access roads, and instrumentation sites were constructed in the north central part of LC-38 to support the Raytheon testing program. Raytheon's Patriot testing continued to be the major test program at LC-38 through the end of the Cold War and continues to be an active program at the complex today.

In April 2022, Epsilon Systems was retained by the WSMR Cultural Resources Program to conduct an inventory and evaluation of the area for its NRHP eligibility. This task relied upon the current boundaries of LC-38 as indicated in WSMR Geographic Information System (GIS) layers to guide the inventory, but the inventory area was also influenced by the distribution of the built environment resources of the complex. Most of the LC-38 facilities are located within discrete clusters scattered throughout the complex's interior, which are separated by undeveloped areas. While all identifiable buildings, structures, and objects were recorded throughout the complex, pedestrian survey for the project was limited to the primary areas of the complex's built environment. As part of the thematic approach to the inventory, undeveloped areas of LC-38 that lacked any obvious historic or Cold War built environment were not subjected to pedestrian resource inventory.

The documented resource types at LC-38 include Radar and Guidance Facilities, Missile Assembly and Checkout Facilities, Launch Facilities, Support Facilities, Instrumentation Facilities, and Miscellaneous Facilities. The inventory also recorded isolated historic resources that were not identifiable as buildings, structures, or objects — these resources were recorded as features. No prehistoric archaeological resources were identified as part of the inventory. In addition to the detailed recordation of the identified resources, each was evaluated for its eligibility to the NRHP. Additionally, the inventoried resources were evaluated as possible contributing elements to a larger military landscape or historic district.

The results of the inventory effort and NRHP evaluation are provided herein. Cultural resource specialist Nate Myers with Epsilon Systems conducted the on-site inventory and recording work. Nate Myers served as primary author of the report. Essential reviews and commentary were provided by Phillip Esser and Epsilon Systems Cultural Resources Program Manager Brad Beacham. William Godby, Archaeologist with WSMR, provided support and guidance throughout the process.

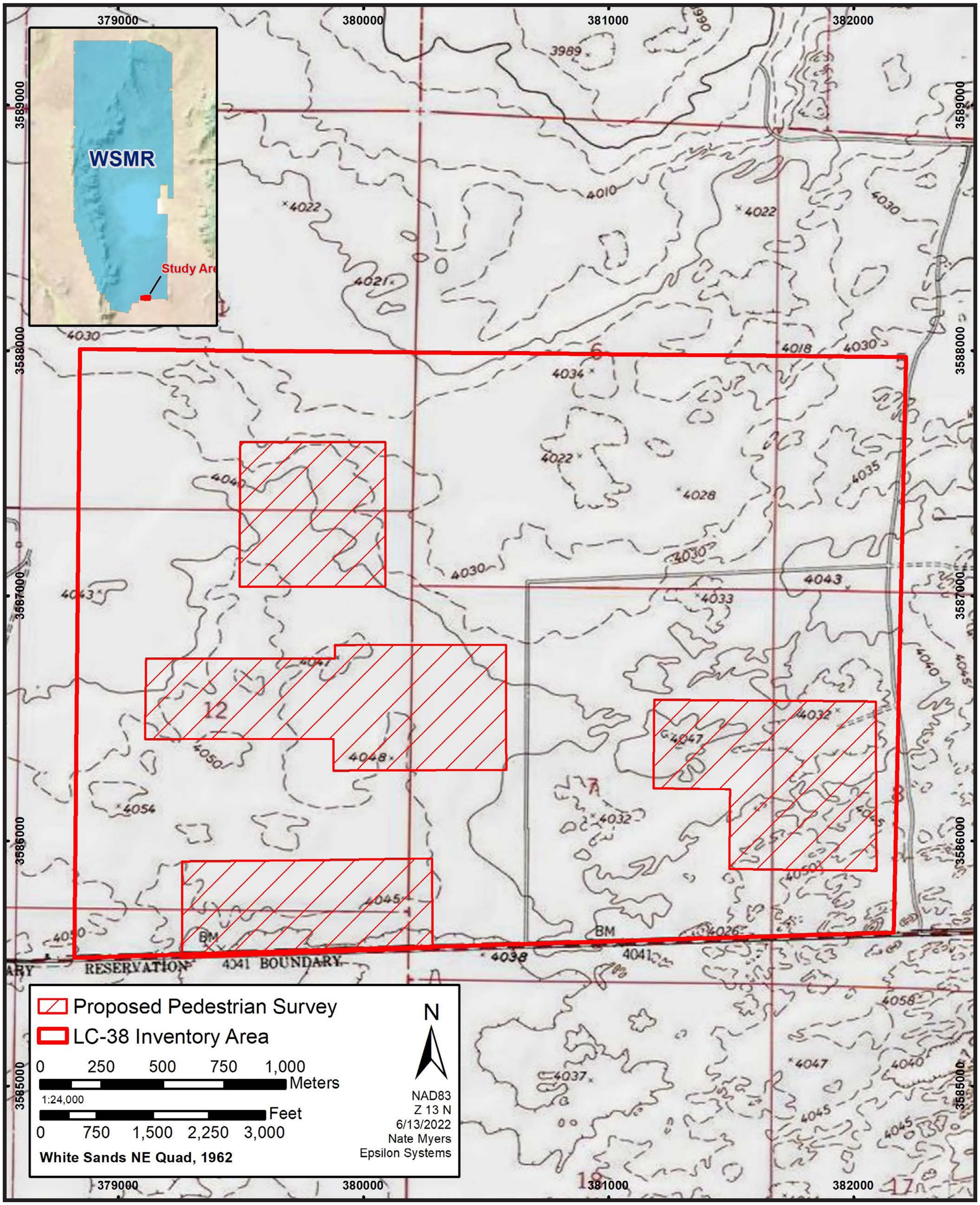

Figure 2. The limits of the current inventory at LC-38 and limits of pedestrian inventory.

3. Purpose of the Project

The purpose of the project was to inventory and evaluate the LC-38 properties for NRHP eligibility, the majority of which are over 50 years old. The project ensured the US Army's compliance with Section 110 of the NHPA. The resources inventoried are located north of Nike Avenue in the southern portion of WSMR.

Historic resource inventories and evaluations have been undertaken at military installations since the passage of the NHPA in 1966 and issuance of Executive Order (EO) 11593 in 1971. Section 106 of the NHPA requires federal agencies to "take into account" the impact of their undertakings on historic properties, whereas Section 110 directs federal agencies to inventory historic properties under their care and management, beyond considerations related to specific projects. Historic properties are buildings, structures, sites, districts, and objects that meet the criteria for listing in the NRHP (36 Code of Federal Regulations [CFR] 60). EO 11593 was a major milestone for historic preservation efforts conducted on federally administered lands for several reasons. EO 11593 established the requirement for federal agencies to locate, inventory, and nominate all eligible cultural resources to the National Register and to exercise caution until these inventories and evaluations were completed to ensure that no eligible federally-owned property was transferred, sold, demolished, or substantially altered (National Park Service [NPS] 2011). EO 11593 outlined procedures for meeting the inventory requirements of the NHPA and the National Environmental Policy Act (NEPA) and encouraged cooperation with state-level historic preservation agencies as part of the compliance process. Significantly, EO 11593 also established the principle of "interim protection," which means that until a resource has been evaluated, it must be treated as if it were eligible for listing in the National Register. EO 11593 was codified as Section 110 of the NHPA in 1980, making it a permanent addition to the NHPA compliance process (NPS 2011).

This report will assist WSMR in compliance with Section 110 of the NHPA. This document serves as a comprehensive inventory and NRHP evaluation of the extant LC-38 resources inclusive of those established in support of the Nike Zeus program during the late 1950s to those established during the late Cold War for the Patriot program. This inventory and evaluation will also expedite compliance with the NHPA and support mission requirements that may result in future expansion and alterations of the area.

4. Research and Field Methodology

Launch complexes are one of the most historically significant facility types encountered at WSMR. In recognition of this, the historic core of LC-33 was listed as a National Historic Landmark (NHL) in 1985. Other launch complexes at WSMR that were active during the Cold War (and later) include LC-32, LC-34, LC-35, LC-36, LC-37, LC-38, and LC-50 (Eckles 2013:7-9). The focus of the current inventory is LC-38, which was the final major launch complex established at WSMR in 1959.

Generally, a launch complex can be defined as a staging and launch area for missile RDT&E, and can include a wide variety of built environment resources, including launch pads, gantry cranes, blast barricades, magazines, radar installations, blockhouses, and assembly buildings. The intent behind the methodology outlined herein is to provide a comprehensive treatment and evaluation of the built environment resources found at LC-38.

Traditionally, built environment is conceived of as the net result of human activity resulting in the accumulation of physical modifications, materials, and facilities present within a defined area of the natural environment. Buildings, structures, and objects serve as the most prominent exemplars of the built environment and typically serve as the focal point of inventory efforts while minor elements of supporting infrastructure are often overlooked. For the purpose of the inventory of the launch complexes at WSMR, these elements were captured as associated features to provide a more comprehensive understanding of the launch complex built environment.

The methodology for recording launch complex facilities at WSMR was based on the four components of research and fieldwork: revisiting and updating previous evaluations; on-site recordation; contextual historic research; and research into the evolution of the construction and function of individual buildings, structures, and objects. Each of these components informs upon the other, and together can provide an in-depth understanding of the history and activities carried out at a given launch complex. Each of these components is described in greater detail, beginning with the incorporation and enhancement of previous recording efforts.

4.1 Revisiting and Updating Previous Evaluations

Prior to the initiation of fieldwork, the listing of previous inventory and evaluation efforts housed at the WSMR Environmental Division, Conservation Branch were consulted in order to identify the previously documented properties located within a given project area. Additionally, WSMR Directorate of Public Works (DPW) Real Property files were consulted and scanned, as needed, to facilitate future referral. These previous recordings were updated with current photography and any observed changes in the property's condition or physical characteristics were also noted. In some cases, the previous recordings were completed on the now obsolete New Mexico Historic Building Inventory Form (HBIF), and for these recordings a current WSMR-specific version of the New Mexico Historic Cultural Properties Inventory (HCPI) form was prepared. The previous recording was also referenced in the property's eligibility recommendation and HCPI form.

In many cases, previous recording efforts were conducted in a piecemeal fashion, which prevented a comprehensive perspective on the entire launch complex facility. This is also the case at LC-38, where partial, independent recording efforts were made in 2000, 2002, and 2010. None of these previous inventory efforts took a holistic approach to the inventory of LC-38, nor did they adequately address the historic district potential of the overall collective resources present at the complex. The current methodology expands upon the previous inventories, and *all* of the resources at LC-38 were inventoried and evaluated both individually and as elements of a possible historic district. The current approach seeks to remedy the lack of comprehensive evaluation by taking a holistic approach which considers the macro view (i.e., historic military landscape and historic district potential) in addition to evaluating each resource individually.

4.2 On-Site Recordation

In order to achieve a comprehensive inventory of LC-38, on-site fieldwork focused on the primary areas of built environment located within the boundaries of the launch complex, as visible in the WSMR GIS data and as indicated in historic aerial imagery, architectural drawings, and maps. The inventory relied upon the WSMR GIS layer of the LC-38 properties and boundaries displayed in Environmental Systems Research Institute (ESRI) Collector software. The ESRI Collector app was loaded on tablet computers linked to Trimble R1 Global Positioning System (GPS) receiver units to guide the on-site survey. There are several developed sub-areas within the boundaries of LC-38 where the primary concentrations of buildings, structures, and objects are found, with isolated facilities located in other portions of the launch complex interior. The overall LC-38 boundary encompasses large swaths of undeveloped desert that is devoid of built environment. In recognition of this, the pedestrian inventory focused on the developed area of the launch complex.

The inventory area was determined in consultation with WSMR Environmental Division, Conservation Branch. While the inventory was inclusive of the entire LC-38 area, it primarily focused on the primary concentrations of built environment resources. While all visible buildings, structures, and objects were recorded throughout the entire complex, pedestrian survey for associated features was limited to high probability areas associated with the primary areas of built environment. This included survey blocks that encompassed the launch area in the north central part of the launch complex, the hazardous assembly area in the west central part of the complex, the acquisition radar area in the southeast quadrant of the complex, and the assembly and checkout area in the south-central part of the complex. Pedestrian transect inventory (478 acres) was completed within these survey blocks to fully capture small elements of the built environment that were recorded as features. The recordation of the associated features at LC-38 is discussed in further detail below. However, some additional discussion regarding the recordation of the prominent components of the launch complex environs is required.

4.2.1 Building, Structure, and Object Recordation

NPS guidance for identifying NRHP-eligible properties recognizes buildings, structures, and objects, as well as two additional types of resources that may include multiple resources; sites and districts. The NRHP is by necessity oriented towards recognizing "physically concrete properties that are relatively fixed in location" (NPS 1995:4). The selection of categories should be dictated by "common sense and reason" (NPS 1995:4) and the *NPS Bulletin 15* provides definitions for building, structure, and object as follows:

> A building, such as a house, barn, church, hotel, or similar construction, is created principally to shelter any form of human activity. “Building” may also refer to a historically and functionally related unit, such as a courthouse and jail or a house and barn [NPS 1995:4].

In the case of LC-38 and other WSMR launch complexes, buildings are more specialized and serve specific functions related to launch control, radar and guidance, or assembly and checkout. Examples can include blockhouses, assembly buildings, and instrument shelters.

> The term “structure” is used to distinguish from building those functional constructions made usually for purposes other than creating human shelter [NPS 1995:4].

At LC-38 and other WSMR launch complexes, specialized structures are required to prepare and physically support missiles for launches, or can be related to radar, guidance, and instrumentation facilities. These specialized structures include launch pads, boresight towers, radar clutter fences, and revetments.

> The term “object” is used to distinguish from buildings and structures those constructions that are primarily artistic in nature or are relatively small in scale and simply constructed. Although it may be, by nature or design, movable, an object is associated with a specific setting or environment [NPS 1995:5].

Assorted objects at LC-38 are generally not artistic in nature, but otherwise fit the definition by being of a portable nature, small in scale, and simply constructed. Examples can include some modular instrumentation units and portable magazines.

Additionally, the NPS defines sites and districts as:

> A site is the location of a significant event, a prehistoric or historic occupation or activity, or a building or structure, whether standing, ruined, or vanished, where the location itself possesses historic, cultural, or archaeological value regardless of the value of any existing structure [NPS 1995:5].

> A district possesses a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development [NPS 1995:5].

The resources present at LC-38 primarily consist of buildings, structures, and objects, which were distinguished using the stated NPS definitions. It is likely that these collective resources may also qualify as a historic district, as the guidance states that “properties with large acreage or a number of resources are usually considered districts” (NPS 1995:4). However, the recommendation of LC-38 as a district can only be made after a comprehensive recordation of its affiliated properties, followed by a careful consideration of these properties and their relative integrity within the framework of an appropriate historic context. The potential of LC-38 as a historic district is discussed in detail in Chapter 8.

The purpose of the on-site inventory was to document previously unrecorded buildings, structures, and objects and update the recordings of those that were previously evaluated, both at the individual level and as contributing elements to a potential historic district. Additionally, built environment resources recognized as associated features were recorded via a simplified documentation process as discussed in the following section. In order to record the LC-38 properties, the survey team prepared field notes and took representative photographs of each building, structure, and object. In addition to inclusion within the body of the inventory report, the in-field recording data and information from archival research were incorporated into a WSMR-specific version of the HCPI form. The WSMR-specific version of the HCPI form eliminates many fields of the standard HCPI form that are not applicable to the properties encountered at the range, and substitutes these with fields and descriptive options that are more useful for describing WSMR properties. When accessible, building interiors were also photographed and alterations noted. In these cases, the condition of the building interior was considered when assessing the overall integrity of the property. However, not all building interiors were accessible at LC-38 due to logistical issues or Operational Security (OPSEC) concerns.

4.2.2 Associated Feature Recording

The NPS guidance does not recognize minor elements that are less substantial than buildings, structures, and objects. However, many isolated remnants of the range infrastructure are scattered across launch complexes, either in association with more substantial properties or in isolated locations. These isolated remnants can be both architectural and archaeological in nature. Although spatially and functionally associated with the launch complexes, these elements are not readily identifiable as a building, structure, or object. Nor can they always be treated as associated elements of a building or structure, as they are often located in discrete locations away from more substantial construction. As such, they were recorded as features, examples of which are provided in Section 4.2.4.

The term “feature” was used as it is commonly recognized within the NMCRIS archaeological guidelines. Although not formally defined within the New Mexico Historic Preservation Division (HPD) guidelines, features generally “include, but are not limited to, structures (i.e., something made up of a number of parts that are held or put together in a particular way), facilities (i.e., something created to serve a particular function), and other cultural remains such as middens, deposits, stains, pits, rock alignments, etc…” (NMCRIS 1993:10). Examples at LC-38 are generally historic in nature and consisted largely of small components of the built environment that fell outside the definitions of buildings, structures, and objects.

4.2.3 Pedestrian Inventory

While all visible buildings, structures, and objects were recorded throughout the entire complex, pedestrian survey for associated features was limited to high probability areas associated with the primary areas of built environment. Per consultation with WSMR cultural resources staff, the pedestrian survey was limited to four blocks; one block associated with the launch area in the north central part of the launch complex; one block associated with the hazardous assembly area in the west central part of the complex; a block associated with the ZAR area in the southeast quadrant of the complex; and a survey block associated with the assembly and checkout area in the south-central part of the complex. Pedestrian transect inventory (478 acres) was completed within these survey blocks to fully capture small elements of the built environment that were recorded as features. The pedestrian survey limits were displayed on tablet computers using the ESRI Collector app. The tablets were linked to Trimble R1 GPS receivers to collect spatial data and provide position information during the inventory. This intensive pedestrian survey was based upon the standard New Mexico HPD guidelines for cultural resource surveys which call for 15 meter transects established via GPS guidance. Pedestrian survey is not usually a component of built environment inventory as it is implicit that standing buildings, structures, and objects are readily visible and obvious. However, features are often more subtle and can be masked by vegetation or otherwise blend into the landscape. The use of pedestrian survey was borrowed from archaeological inventory methods and allowed for a more systematic and comprehensive method of encountering and recording associated features, which in turn facilitated a more complete understanding of the full range of activities and built environment at LC-38.

4.2.4 Associated Feature Types

For the purpose of the LC-38 inventory, nine general feature types were encountered. These types were defined based primarily on functional characteristics and were largely constructed in support of operations at the launch complex, or were otherwise by-products of range operations. The feature types were based on the actual features encountered during the LC-38 inventory area and consisted of:

- Electrical Infrastructure: Provided electricity in support of the facilities associated with LC-38.

  Subtypes:

  - Pullboxes
  - Electrical cabling
  - Electrical panels
  - Electrical boxes and terminals
  - Substations/Transformers
  - Above-ground cable runs

- Water and Wastewater Infrastructure: Water and wastewater systems constructed in support of the LC-38 facilities.

  Subtypes:

  - Septic Tanks
  - Water Lines and Valves
  - Fire Hydrants
  - Drain Fields

- Instrumentation Support: Supported instrumentation systems in use at LC-38.

  Subtypes:

  - Calibration Targets and Poles
  - Instrument Pedestals
  - Instrument Mount Foundations
  - Portable Pedestals
  - Pullboxes

- Launch Support: Elements constructed in support of launch activities at LC-38.

  Subtypes:

  - Concrete Platforms
  - Earthen Platforms
  - Fire Control Equipment
  - Earthen Blast Berm
  - Stand-alone Lighting Fixtures
  - Anchor Rails and Hardware
  - Cable Trench

- Liquid Propane (LP) tanks: Supplied LC-38 facilities with propane fuel.

  Subtypes:

  - LP tanks with Concrete supports
  - LP tanks with Steel supports
  - Buried LP tanks

- Refuse Dumps: Discrete deposits of historic trash, including formal and informal dumps with either individual or multiple episodes of deposition.

  Subtypes:

  - Structural Debris
  - Domestic Debris

- Commercial Debris
- Industrial Debris
- Shipping/Packaging Debris
- Launch Debris
- Mixed Debris
- Fencing Debris
- Paving Debris

- Fencing: Remnants of fence alignments within the LC-38 interior, mostly from former security perimeters.

  Subtypes:

  - Fence Posts
  - Torch-cut Steel Posts
  - Concrete-filled Post Holes
  - Pulled Concrete Post Plugs

- Signage: Various signs across the launch complex interior that are free-standing and not attached to a building or structure.

  Subtypes:

  - Buried Pipeline Signs
  - Explosive Limit Signs
  - Road Signs
  - Hazard Signs
  - Facility Signs

- Miscellaneous: Features whose functional associations were ambiguous or unknown, and therefore cannot be assigned to a more specific category.

Most of the features encountered were highly redundant and consisted largely of minor, standardized infrastructural components. The term "infrastructure" as used here refers to the basic power, communications, and water systems that were constructed in support of LC-38. By design, the basic components of these systems are highly standardized to minimize cost and facilitate simple installation and operation. As a result, these associated features have little to relate regarding the story of the launch complex, and lack the interpretative power of actual buildings, structures, or objects.

Most associated features encountered during launch complex inventories were captured via a streamlined recording process using ESRI Collector software and Trimble R1 GPS units. The Trimble units were used to take a Universal Transverse Mercator (UTM) position on the feature for inclusion in the project mapping. Within the project data dictionary in the ESRI Collector app, drop down menus were utilized based on the types and sub-types presented above to quickly describe the feature type and subtype. No additional description or photography was necessary for the typical features encountered at WSMR launch complexes. However, if a given feature was particularly complex or notable, yet still not classifiable as a building, structure, or object, a photograph and additional notes were taken in the field. The recorded features are presented in a tabular presentation in Appendix A and displayed graphically on the maps included in Appendix B. Unlike buildings, structures and objects, associated features were not documented on HCPI forms; however, a summary of the feature results is included in Chapter 7 of this report.

4.3 Contextual Historic Research

The purpose of a historic context is to allow the significance of a historic property to be judged and explained within the larger patterns of history. NPS Bulletin 15 provides the following definition:

> Historic contexts are those patterns or trends in history by which a specific occurrence, property, or site is understood and its meaning (and ultimately its significance) within history or prehistory is made clear. Historians, architectural historians, folklorists, archaeologists, and anthropologists use different words to describe this phenomena such as trend, pattern, theme, or cultural affiliation, but ultimately the concept is the same [NPS 1995:7].

Coincident with field recording of the launch complex properties, a comprehensive historic context for LC-38 was prepared that considers not only the history and activities of the launch complex itself, but also the larger historical framework of WSMR and the Cold War, and how LC-38 and its programs were intertwined with larger national and international trends. Sources for this context included a number of Department of Defense (DOD) sponsored guidance and contextual documents, Nike historical documents, as well as several historical overviews of Cold War activities at WSMR. WSMR firing records were also consulted in order to better define the lifespan of various missile programs; unfortunately these records do not include specific launch locations and are therefore limited in that regard.

Other relevant databases and depositories were also consulted during the preparation of the historic context. The recent completion of a searchable electronic archive of the WSMR base newspaper, *Wind and Sands* and later *The Missile Ranger*, is also a publicly available resource for the local history of WSMR and its numerous Cold War programs and activities. Additionally, the WSMR Museum Archives contains a large number of historic photographs, documents, and videos that offer invaluable information into the WSMR launch complexes and the myriad programs they supported. WSMR inventories of real properties were also consulted to determine property identification and construction dates. These databases included historic WSMR property inventories and the current Army General Fund Enterprise Business System (GFEBS) which was provided electronically by the WSMR Environmental Division, Conservation Branch.

4.4 Property Evolution and Function

Fieldwork was followed by research into the recorded buildings, structures, objects, and associated features. This research included review of original construction information and alterations, historic images, and a variety of other manuscript materials collected over the decades by WSMR DPW, WSMR Museum Archives, and WSMR Environmental Division.

Although limited information is available for most of the recorded features, in some cases they were identified as the remains of a more substantial property through the use of historic maps, photography, and architectural drawings, further adding to the story of the launch complex's change and evolution through time.

As much as possible, property evolution and function were established through individual property records including the disposition forms and real property forms available from the WSMR DPW. The WSMR Museum Archives, in addition to information about the larger launch complex facilities and programs, also provided period photos of the launch complex that were very helpful in identifying property modifications. Original architectural drawings and plans were an important resource for interpreting changes in building design and use, but were not available for all properties. When possible, the changes at the individual building level were tied back to the overall historic context, and the larger Cold War programs and initiatives that drove the re-use and adaptation of the built environment at LC-38.

5. Environmental Setting

WSMR lies within the Mexican Highland Section of New Mexico's Basin and Range Province. This province is characterized by narrow mountain ranges that separate internally drained structural basins and valleys of major drainages (Hawley 1986). LC-38 is located in the southern portion of WSMR, in the southwest corner of the Tularosa Basin, which is a graben basin bounded by the Organ, San Andres and Oscura Mountains to the west and the Sacramento Mountains to the east. Topographically, LC-38 is located in the basin floor in relatively flat terrain that is dotted with coppice dune formations. LC-38 occupies a mostly flat area ranging from approximately 4,020 to 4,050 feet above mean sea level, and the Organ and Jarilla Mountains provide a dramatic backdrop to the west and east, respectively.

The extant built environment at LC-38 includes radar installations, assembly facilities, and former launch areas located north of Nike Avenue that were constructed from the mid-to-late twentieth century. It transitions into LC-37 along its western margin and the mostly undeveloped area of LC-39 to its east. Unlike some of the WSMR launch complexes, the built environment of LC-38 is located in several discrete clusters separated by large undeveloped areas.

The climate of the LC-38 vicinity is characterized as semiarid (Muldavin et al. 2000b). Climatic data were collected at a weather station located at the White Sands National Monument, New Mexico from January 1, 1939 to June 7, 2016 (Western Regional Climate Center [WRCC] 2023). During this period, mean annual precipitation was 22.89 cm (9.01 inches). Rainfall was heaviest from July through September. Average minimum temperature was 5.2 degrees Celsius (C) (41.4 degrees Fahrenheit [F]), while average maximum temperature was 25.6 degrees C (78.1 degrees F). Average annual snowfall totaled 6.35 cm (2.5 inches). Snowfall was heaviest from December through January (WRCC 2023).

Vegetation typical of the area is Plains Mesa Sand Scrub (Dick-Peddie 1993). Deep-sand areas throughout New Mexico, such as coppice dunes, were historically dominated by grasslands associated with the periphery of old floodplains and playas that have given way to successional communities of expanding Plains Mesa Sand Scrub (Dick-Peddie 1993:128). Plains Mesa Scrub is typically dominated by deep-sand tolerant or deep-sand adapted species that can manifest in various combinations of floral species. White Sands serves as an oft-cited example of this successional ecotone (Dick-Peddie 1993:129). Flora in the LC-38 area were observed to be variable, defined by co-dominance of four-wing saltbush (*Atriplex canescens*) and honey mesquite (*Prosopis glandulosa*) with an understory of forbs and grasses including broom snakeweed (*Gutierrezia sarothrae*), soaptree yucca (*Yucca elata*), and mesa dropseed (*Sporobolus flexuosus*). This phenomenon of variable scrubland/shrubland has been documented by comprehensive vegetation mapping at WSMR (Muldavin et al. 2000a; Muldavin et al. 2000b). The floral community observed at LC-38 aligns with the Honey Mesquite-Fourwing Saltbush or Mesa Dropseed Coppice Dune Shrublands Plant Associations defined by Muldavin et al. (2000b) under the Mesquite Shrubland.

6. Historic Context

A historic context is fundamental for understanding the significance of any given property, as physical resources do not occur in historical vacuum but are rather by-products of larger trends and patterns (NPS 1995). These patterns occur at the local, regional, and national levels, and even at the global scale. Often, these tiered patterns are intertwined, and the significance permeates from the local level to the national and beyond.

The built environment of WSMR is largely an outgrowth of the Cold War that is generally attributed to the period between 1946 and 1989. Most of the historic properties at the range were constructed during this period, and were the result of the competitive arms race between the US and the Soviet Union. However, many programs at WSMR that were initiated during the Cold War only reached maturation in the years following the end of that era, so the historic context is often required to reach into the post-1989 years to fully account for the operational life and use of many resources.

Per NPS guidance, only resources that are 50 years of age or older are to be considered "historic" as a half-century is generally considered the minimum amount of time required to assess whether events or trends are significant to the wider patterns of history. However, the NPS guidance also allows for the inclusion of recent properties if they are of "exceptional importance" to recent history. As of this writing, properties that were constructed after 1973 would be considered for eligibility to the NRHP only if they meet the standards of exceptional importance as outlined in *NPS Bulletin 22* (Sherfy and Luce 1998).

In order to provide a complete historical perspective, a brief summary of the area prior to the establishment of WSMR is presented. The following section provides a brief overview of the Cold War and how historical events of the period influenced the programs under development at WSMR. The thematic focus then narrows to the topic of launch complexes at WSMR, providing a brief overview of the major launch areas at the range and the programs they supported. With this context established, the history of LC-38 and its major programs, with a focus on the Nike Zeus program, is then presented. Typical of many WSMR launch complexes, LC-38 underwent cycles of re-use and modification; the context also summarizes the later programs tested at LC-38 and how they modified the built environment of the launch complex.

6.1 The Tularosa Basin before WSMR

The US history of the Tularosa Basin begins with the incorporation of the region into the US by the Treaty of Guadalupe Hidalgo in 1848. Although known by the Spanish and Mexican colonial powers, the Tularosa Basin remained a remote and sparsely settled area that was considered largely uninhabitable due to the constant threat posed by the Apache. Fort Stanton was established along the Rio Bonito in 1855 in order to provide settlers with protection against the Mescalero Apache, but even so, settlement away from the fort in the Tularosa Basin remained a risky affair and the population in southern New Mexico remained focused in the Mesilla Valley of the Rio Grande.

By the 1860s however, several factors coincided to change the uninhabited nature of the Tularosa Basin. The onset of the Civil War made New Mexico a subject of military interest among both the Union and Confederate armies, and several engagements were fought for control of the Territory. These conflicts eventually saw the Union victorious, and the military presence across the area continued following the end of the war. The establishment of a series of military outposts across the region somewhat ameliorated the Apache threat, and the perceived security encouraged settlers to move into the area between the Sacramento and San Andres Mountains.

Figure 3. Colonel Albert Fountain, who disappeared in 1896 within what later became WSMR (*public domain image)*.

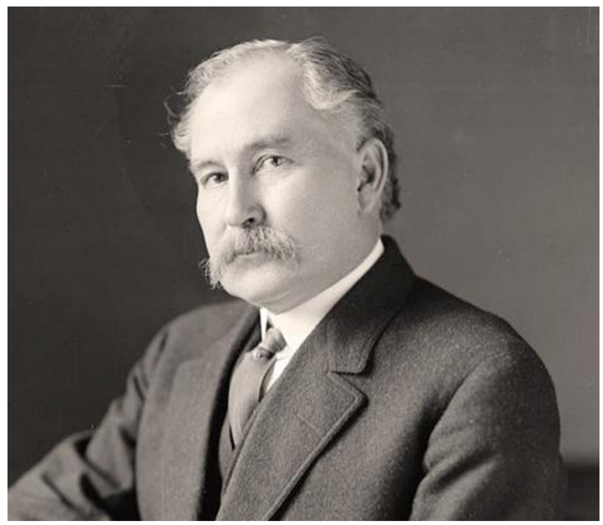

Figure 4. Albert Bacon Fall during his tenure as a New Mexico senator (*public domain image)*.

The earliest Territorial settlement in the Basin began even before the end of the Civil War. In the fall of 1862 Hispanic settlers fled the destruction wrought by the flooding of the Rio Grande in the Mesilla Valley and established a community at the mouth of Tularosa Creek at the western base of the Sacramento Mountains. This community, known as Tularosa, was carefully cultivated by its settlers and became a permanent oasis of civilization in the basin. By the early 1870s the Apache were largely contained on reservations which mostly ended the threat of further raids from that quarter (Sonnichsen 1960:15). By the early 1880s, Anglo ranchers, mostly Texans, had discovered the Tularosa Basin, which at the time was especially verdant after several years of higher-than-average precipitation. The Texas cattle ranchers found in New Mexico a continuation of the open range grazing that was under assault by waves of post-war settlers and farmers in their native state, and these roving cattlemen rapidly established cattle ranching as an industry in the Tularosa Basin (Sonnichsen 1960).

The rise of cattle ranching in the late 19th century eventually led to "range-war" type conflicts that were experienced in New Mexico and elsewhere across the west. In the Tularosa Basin, this saga culminated in the disappearance of Albert Fountain and his son Henry on February 1, 1896. The site of the disappearance is located within WSMR, at a low ridge known as Chalk Hill that Highway 70 now bisects near the Doña Ana/Otero County line (Eckles 2013:57). Although political rival Albert Bacon Fall and his associates, including prominent area rancher Oliver Lee, were suspected in the case, no convincing evidence tying them to the crime was ever found (Sonnichsen 1960). The Fountain case was a polarizing incident that encapsulated much of life in and around the Tularosa Basin at the close of the 19th century, and endures as a compelling mystery today.

The arrival of the railroad at the newly established railroad town of Alamogordo in 1898 brought the Tularosa Basin into wider contact with the rest of the nation, but after the conclusion of the turbulent events of the 1890s, the area remained little changed during the early years of the 20th century. The main economic activity continued to be cattle ranching, with ranchers relying on a mixture of their own private property and large grazing leases of federal lands in order to make a living in the sparsely vegetated Chihuahuan Desert landscape. The carrying capacity for grazing was calculated at only five or six cattle per 640 acres in some areas of the Tularosa Basin (Eckles 2013:67). With the capacity for grazing so minimal, it took many thousands of acres to make cattle grazing a feasible endeavor for ranching families in the area.

New Mexico became the 47th state of the US on January 6, 1912. Thomas Catron of Mesilla, and Albert Fall, who resided in Las Cruces, were elected as the first US Senators of the state, ensuring that southern New Mexico was well-represented. As a state, New Mexico began to benefit from infrastructural improvements, and a state highway system was well underway by the 1920s. The old trail between Alamogordo and Las Cruces through San Augustine Pass was replaced with US Highway 70 during the 1930s (Wallace 2004:118). However, the lives of the people in the Tularosa Basin area were not much affected. The area remained much the same by the time White Sands National Monument was established in 1933 to preserve the unique white gypsum dunes that formed from the winds blowing off the Lake Lucero playa in the basin interior. However, the entry of the US into World War II (WWII) would change the area forever.

With its open air space and reliably clear weather, the Tularosa Basin was an ideal place for training military pilots. The first flight training facility was under development for the training of British pilots when the attack on Pearl Harbor brought the US into the war in December 1941. The training school was subsequently re-directed into the Alamogordo Army Air Field and US bomber flight crews began training there in May 1942 (Kennedy 2009:19). The greatest conflict of the 20th century would bring many changes to the Tularosa Basin, and would also re-define concepts of offensive and defensive weapons for the remainder of the century.

6.2 The Establishment of White Sands Missile Range

Two independent developmental rocket programs required the Army to establish a sizeable overland test range in 1945. One program was domestic in origin and based in research conducted at the California Institute of Technology (Caltech). The other was captured technology from the German rocket and missile program that made its way to the US at the end of WWII.

The Caltech rocket program started in 1936, when J. Frank Malina, a graduate student from the Guggenheim Aeronautical Laboratory at California Institute of Technology (GALCIT), and a group of students under the guidance of Dr. Theodore von Karman initiated research into rocket propulsion. The GALCIT group made steady progress, and in 1939 the group began work on Jet-Assisted Take-Off (JATO) units for aircraft. This early JATO work was first supported by the National Academy of Sciences, but as the war in Europe began to loom larger the Army Air Corps offered support for the JATO development (Carroll 1974:3). The emphasis on developing a workable JATO unit shifted the GALCIT group's focus away from liquid-propellant and towards long-burning solid propellant, whose simplicity and economy was required for the expendable JATO unit.

GALCIT successfully developed solid propellant JATOs for delivery to both the Navy and Army Air Corps. The commercial production of JATO units was not practical under the auspices of GALCIT, so in 1942 GALCIT project personnel founded Aerojet Engineering Corporation. Meanwhile, the completion of the JATO solid propellant work left GALCIT available for new projects, and news of the German missile program from Europe inspired von Karman to further the liquid propellant research. Von Karman, J. Frank Malina, and Hsue-Shen Tsien prepared a memorandum outlining the proposed liquid-propellant work in 1944 (Carroll 1974:7). This memorandum was the first GALCIT document to use the title of Jet Propulsion Laboratory (JPL).

The JPL memo was a major turning point for US rocket and missile development. The German use of missiles in Europe was the major focus of the Army Ordnance Department Guided Missile Program and the JPL memo received a very positive reception by Army Colonel Gervais W. Trichel of the Rocket Development Branch of the Army Ordnance Department, who developed a contract to expand the JPL liquid propellant research effort (Kennedy 2009:14; Miles 1961). This contract was the Army Ordnance-California Institute of Technology (ORDCIT) contract with Caltech, which was instrumental in the development of the liquid propellant Private test vehicle series. The Private A launches were conducted at Leach Springs, a location within Camp Irwin, California in early 1944. The next ORDCIT rocket, the Private F, was launched at the Hueco Range at Fort Bliss, Texas.

The Corporal series was the next ORDCIT experimental prototype, which was a larger and more powerful rocket that required a larger range in order to test it safely (Kennedy 2009:16; Miles 1961). Early scale model tests of the rocket were conducted in California, but the projected range of the full-size rocket required a larger overland test range. Concurrently, intelligence gained through the course of WWII further emphasized the need for enhanced missile testing facilities comparable to those used by Germany.

As hostilities drew to a close in Europe, the US initiated efforts to capture parts, equipment, and research materials from the German V-2 rocket program at Mittelwerk prior to the Russian advance into eastern Germany. The recovery of the V-2 parts was led by Colonel Holger N. Toftoy in an operation dubbed Special Mission V-2. The parallel mission of locating and recruiting German scientists and engineers was dubbed Operation Overcast, later renamed Operation Paperclip (Lasby 2017). This mission was greatly facilitated when Wernher von Braun, chief scientist of the German missile program, and key members of his staff surrendered to Allied forces on May 2, 1945 (Ordway and Sharpe 2007:17). With both the parts and the minds behind the V-2 program in hand, the US now possessed the means to accelerate the rocket research the ORDCIT program had begun.

In anticipation of the captured German rocket and missile technology, the Army Ordnance Department had issued a research and development contract to General Electric (GE) on November 20, 1944 (Bullard 1965:8). This contract, which became known as Project Hermes, was aimed at developing a new generation of long-range missiles and required GE to develop control, guidance, and ground equipment for new missile systems. The contract included three phases: a literature search; study of the German guided missile program; and the design and development of its own experimental systems (Bullard 1965:8). Project Hermes served as a parallel contract to the existing ORDCIT program. As the prime contractor, GE was responsible for the processing of the V-2 materials that began to arrive in 1945. Both Project Hermes and ORDCIT required a suitable testing and proving ground; the Army began to search for an appropriate location for a new test range (Kennedy 2009).

The proposed proving ground required flat and open ground, a sparse population, and predominantly clear weather. Other preferred characteristics included surrounding hills or mountains for observation sites and natural barriers, access to railroad lines and utilities, and proximity to an established military post for support. The Tularosa Basin was identified as the best choice, as it possessed nearly all of the desired characteristics. The location was selected in February 1945 and named White Sands Proving Ground (WSPG) after the adjacent National Monument. Some of the land in the proposed proving ground was already under federal lease, and additional property was acquired from private landowners in the area via annual lease payments. The lease payments for the use of the ranchers' properties were used in lieu of outright purchase of their lands, as the range was conceived as being a temporary extension of the existing bombing ranges, and it was believed that the new missile mission would eventually be completed (Eckles 2013:87). This, of course, was not the case and the formation of the new proving ground effectively ended the ranching lifestyle in the Tularosa Basin which dated back to the 1870s.

WSPG was formally established on July 9, 1945. The following week, on July 16, 1945, the top-secret Manhattan Project detonated the world's first atomic bomb at the Trinity Site in the northern portion of the new range. The atomic explosion was the result of four years of focused development, and J. Robert Oppenheimer named the test site "Trinity" as an homage to a

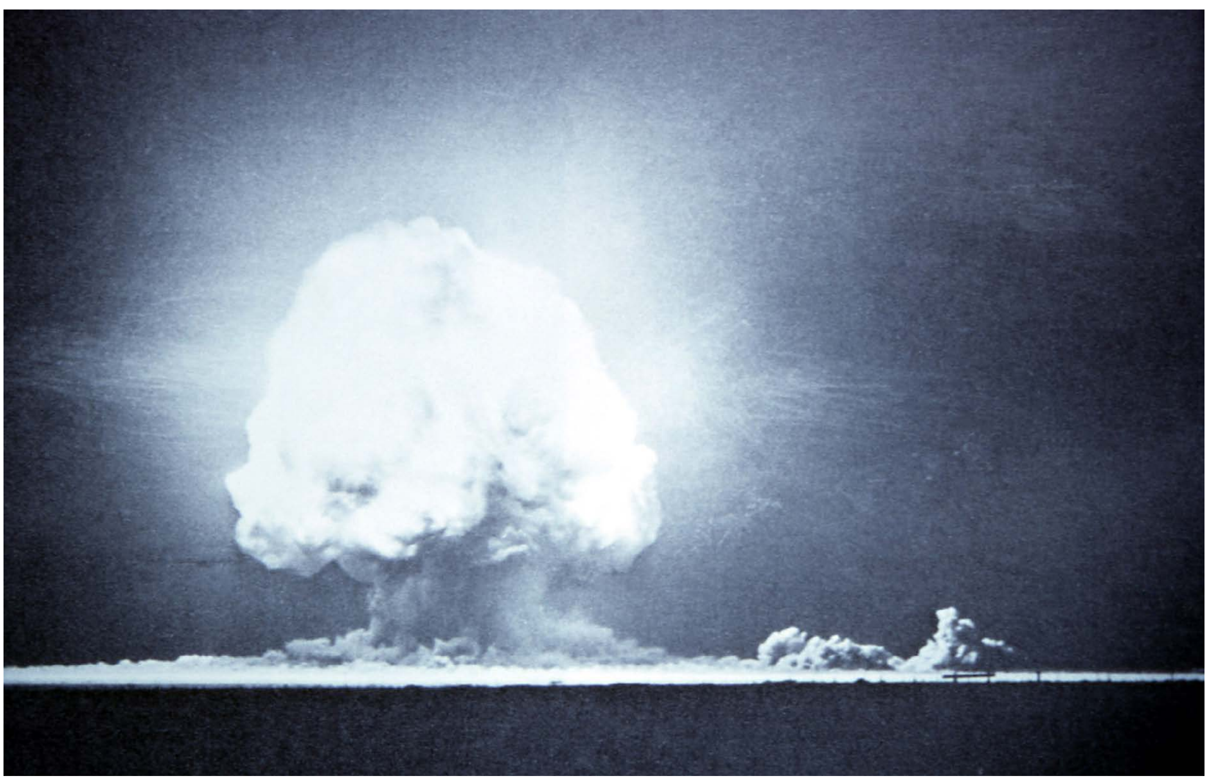

Figure 5. The flash and mushroom cloud of the world's first atomic bomb at the Trinity Site (*image from the New Mexico Air and Space Museum)*.

favored poem by John Donne. The flash and rumble of the Trinity explosion was reported as far away as Silver City, New Mexico and El Paso, Texas (Sonnichsen 1960).

On September 26, 1945 the ORDCIT project launched a Tiny Tim rocket modified as a booster for the Without Attitude Control (WAC) Corporal at the newly established WSPG, the first rocket launched at the new range (Kennedy 2009:29). On October 11, 1945, the first fully fueled WAC Corporal launch reached an altitude of 235,000 feet, the altitude record for an American rocket at the time (Kennedy 2009:29). Meanwhile, the first of the captured V-2 materials were transported to the range and GE personnel working under Project Hermes began to sort, catalogue, clean, and assemble the various German missile components. Parts that were missing or damaged were fabricated as needed. The program progressed quickly, and the first American launch of a V-2 missile took place at WSPG on April 16, 1946 (Kennedy 2009:29).

The arrival of the V-2 suddenly provided a vehicle that could collect data on upper atmospheric conditions and phenomena, data that was critical to the continuation of the fledgling American missile program. However, as the V-2 was a military program, it was not necessarily the leading academics in upper atmospheric studies that used the missile as a research vehicle, but rather a new class of pragmatically-oriented scientists from the military contract community (DeVorkin 1992). Army Ordnance saw the potential of the V-2 in conducting upper atmospheric research, but was primarily interested in the application of this research to military technology through the materiel development pro-

Figure 6. J. Frank Malina stands by the WAC Corporal launch tower at LC-33, 1945 (*US Army photo)*.

cess.

Per the interservice agreements in place at the end of the war, Holger Toftoy tasked a member of his staff, Colonel James B. Bain, to identify possible partnerships with user groups within the Army and Navy, along with various contracting agencies within the military research sphere (DeVorkin 1992:59). Toftoy tasked Bain with organizing all the interested parties into a single manageable body that was independent of, but subject to review by, Army Ordnance (DeVorkin 1992:59). Chief among the interested parties was Dr. Ernst H. Krause, head of the newly formed Rocket Sonde Research Section at the Naval Research Laboratory (NRL). Bain's efforts resulted in a series of meetings that ultimately culminated in the formation of the V-2 Upper Atmosphere Panel, whose first official meeting was on February 27, 1946 at Princeton University. Often referred to as the "V-2 Panel," the group was an informal self-constituted body that had no official status or authority, but was the primary advisory body to Army Ordnance on experimental programs and priorities as they related to the V-2 launch program.

The primary members of the V-2 Panel consisted of organizations within the sphere of military research and development: the NRL, the Army Ballistic Research Laboratory (BRL), the Army Signals Corps Engineering Laboratory (SCEL), and the Cambridge Field Station (CFS), later known as the Air Force Cambridge Research Laboratory (AFCRL). Three additional members were engineers from GE, the primary V-2 contractor under Project Hermes. Associated with the military research agencies were civilian contract laboratories such as the Applied Physics Laboratory (APL) of Johns Hopkins University, and university departments with military contracts, which included Harvard University, University of Michigan, University of Colorado, University of Utah, Boston University, University of Chicago, Princeton University, University of Rhode Island, and Rhode Island State College (DeVorkin 1992:73; Naugle 1991:1; Smith 1954). Dr. Ernst Krause of the NRL was nominated as the first chairman of the panel. The NRL made significant contributions to the V-2 launch program by providing telemetry systems, telemetry analysis, and ground support (DeVorkin 1987). The NRL telemetry systems formed the foundation for WSPG's range-wide telemetry network that was critical for future test programs. The NRL also provided special replacement nose cone assemblies for the V-2 that were needed to house instrumentation for a variety of scientific research programs that were conducted during the V-2 flight series, the last of which took place in 1952.

As the range continued to develop, the late 1940s and early 1950s proved to be a significant period of advancement for the range instrumentation and communications systems. The installation of range-wide instrumentation, communications, and timing networks was a significant, but often overlooked, part of the effort required to turn the desert landscape of the Tularosa Basin into a world-class missile test range. In many ways, the capability to precisely track, measure, record, and generate data from tests, while synchronizing these activities across long distances, is what truly defined the facility as a proving ground. Pioneering work on range instrumentation systems was undertaken by a group led by Ernst Steinhoff and a select group of optical, electronics, and geodesy experts at Holloman Air Force Base (HAFB). Steinhoff originally was brought to the US as part of Operation Paperclip and came to HAFB in 1949 after working at Fort Bliss. There he selected additional German experts that were brought into the country in 1951 as part of Project 63, which was an Air Force program to place knowledgeable German scientists and engineers into private sector positions within the aerospace industry (HAFB 1949; Mangum 1951). In addition to selecting the instrumentation locations at HAFB, Steinhoff and his instrumentation group published early guidelines and plans for range instrumentation systems and infrastructure at HAFB that were soon incorporated at WSPG as well.

Early instruments that met the requirements for range instrumentation were limited, and existing equipment had to be adapted to fit the role. Some of the best early optical instruments were Askania cinetheodolites recovered from the German rocket program and re-used at WSPG. Fastax and Mitchell high speed cameras and surplus WWII SCR-584 radars were also staples of the early range instrumentation, while more specialized instruments had to be custom fabricated. For example, the first tracking telescope was hand-assembled by planetary astronomer Dr. James B. Edson and assistant Ralph Konegan (Mabe 1958:2; Wind and Sand 1956). This early precision instrument was known as "Little Bright Eyes" and was built on a surplus M45 gun mount and relied on telescopes pieced together with spare refractors, a 35 millimeter (mm) motion picture camera, and a pair of high power Japanese Navy binoculars Edson acquired

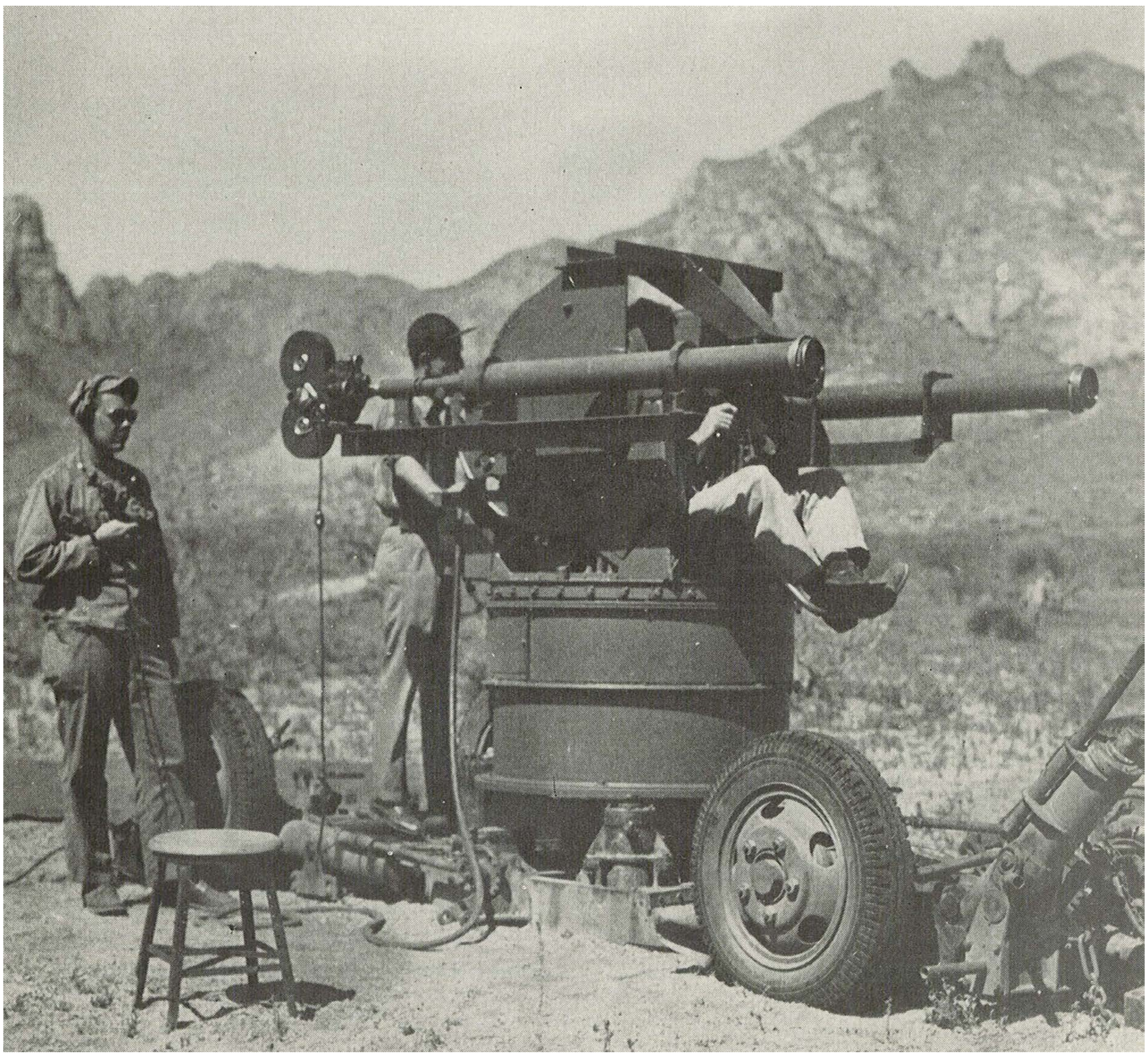

Figure 7. Little Bright Eyes, the first tracking telescope at WSMR circa 1947, with Organ Mountains in background (*photo courtesy WSMR Museum Archives)*.

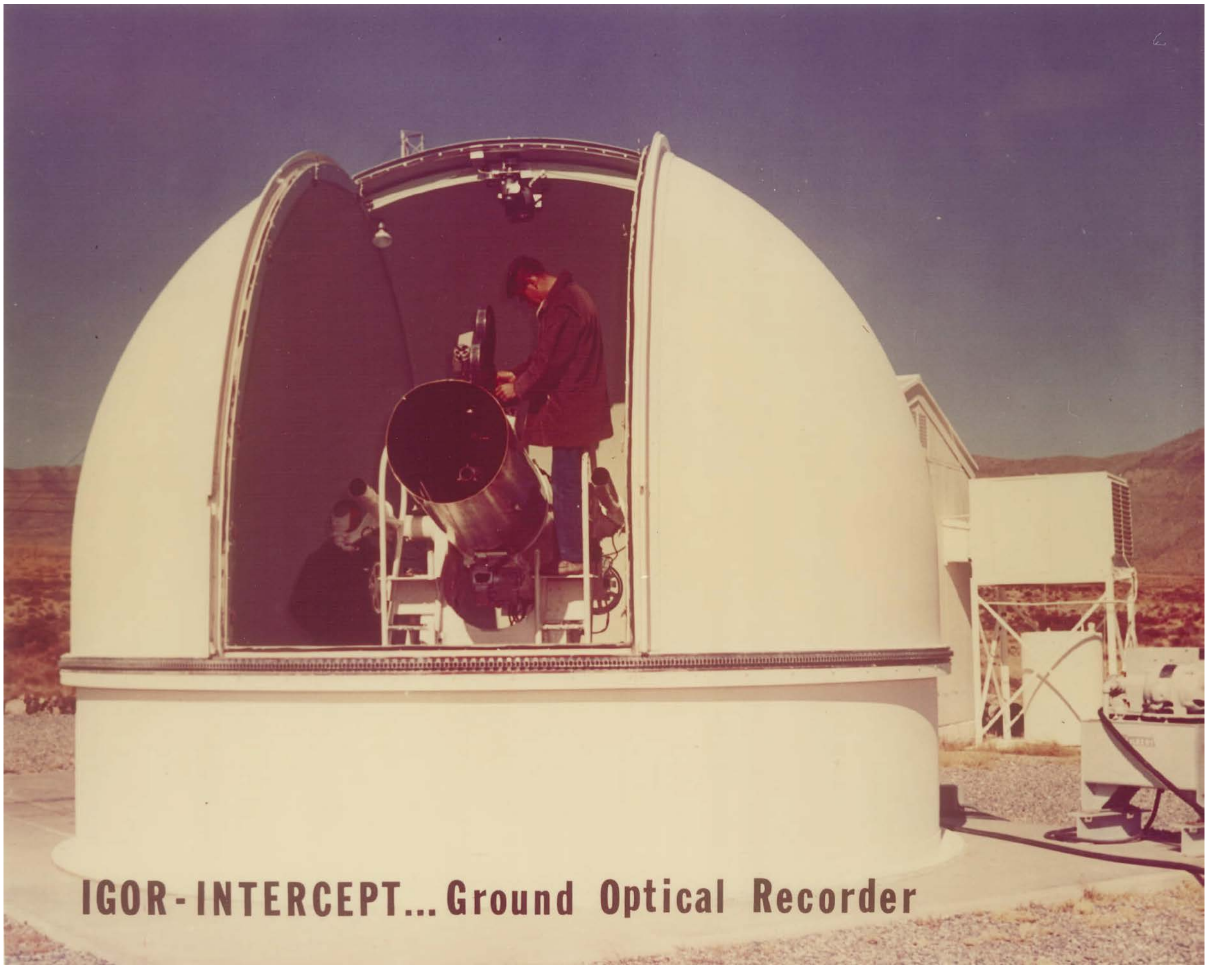

Figure 8. The IGOR tracking telescope housed in an astrodome, one of the new generation of specialized tracking instruments developed during the 1950s (*courtesy WSMR Museum Archives)*.

via barter during WWII (Delgado 1981). Edson was unable to remain at WSMR, but recruited fellow astronomer Clyde Tombaugh to continue the tracking telescope effort. Edson and Tombaugh had worked together at Lowell Observatory and Tombaugh was actually Edson's brother-in-law. Tombaugh is mostly remembered today as the discoverer of Pluto, but made major contributions to the optical tracking of missiles and satellites. In December 1946, Tombaugh captured a V-2 tumbling near the apex of its flight, a previously unknown flight characteristic (Mabe 1958:2). This landmark film heralded the tracking telescope as a revolutionary new kind of instrumentation that was critical to further missile development and remains a key data collection component in contemporary missile testing.

By the late 1950s, technology had caught up to the need for range instruments, and the instrumentation became increasingly specialized and sophisticated. New instruments included the AN/FPS-16 radar, the first tracking radar built expressly for use at test ranges. New optical instruments included two new tracking telescopes; the advanced Intercept Ground Optical Recorder (IGOR), developed by Clyde Tombaugh and the BRL, and the Perkin-Elmer Recording Optical Tracking Instrument (ROTI). Both of these devices possessed far greater ranges than the original Bright Eyes and were significant, state of the art advances at the time of their introduction. Also during this period, the Army contracted with Land-Air Corporation for the operation and maintenance of most of the range instrumentation. This greatly streamlined the compatibility and standardization of the range instrumentation, the repair and operation of which was formerly handled by a mixture of various contractors and military personnel.

6.3 WSMR through the Cold War

As WSPG was established in the desert landscape of the Tularosa Basin in the immediate post-war years, the Soviet threat coalesced and the Cold War assumed a recognizable form. Following the end of the war, the Soviets began to take an increasingly aggressive stance in Eastern Europe, prompting Winston Churchill to deliver his "Iron Curtain" speech in March 1946. This speech is widely considered by the public and many historians to mark the beginning of the Cold War. The relations between the West and Soviet Union continued to degrade, culminating in the Berlin Blockade of 1948 to 1949. Following the end of the Berlin Blockade and the inability to come to treaty terms with the Soviet Union, Germany was partitioned into the Federal Republic of Germany (West) and the German Democratic Republic (East), a division that would remain throughout the Cold War. The defense of West Germany against a potential Soviet advance was a major strategic priority for the US and its allies for the remainder of the Cold War. In the spring of 1949, contemporaneous with the Berlin Blockade, the US, Canada, and 10 western European countries signed a mutual defense treaty that created the North Atlantic Treaty Organization (NATO). NATO member countries each committed troops and resources to the defense of Western Europe against Soviet expansionism. The Soviet equivalent was the Warsaw Pact, which consisted of the communist countries of Eastern Europe including Poland, Czechoslovakia, Hungary, Romania, and Bulgaria (Lavin 1998:18).

For the early years of the Cold War, US military policy focused on the use of the atomic bomb as a deterrent against Soviet military aggression in Europe. The national defense budget was greatly reduced from $81.5 billion in 1945 to $44.7 billion in 1946, and then to $13.1 billion in 1947. However, missile research and development continued, albeit on a smaller scale than what otherwise might have been possible (Lonnquest and Winkler 1996:19).

Due to the post-war budget constraints, much of the early effort at WSPG focused on the use of the captured German V-2 missile materials and the creative use of available surplus materials. In November 1944, the Army established Project Hermes as a long-term ballistic missile research and development effort with GE as the prime contractor. GE worked in parallel with ORDCIT, and was responsible for the processing of the V-2 materials that began to arrive at WSMR in 1945. The first launch area at WSPG, Army Launch Area 1 (ALA-1), later known as LC-33, was constructed about 6.5 miles to the east of the headquarters in 1945. As the first launch complex established at WSPG, LC-33 hosted many historic programs, including the WAC Corporal, V-2, Corporal, Nike Ajax, MX-774, Viking, and various Hermes prototypes.

While American missile technology progressed at WSPG, Western strategic planners were increasingly concerned by the Soviets' technological advances. These included the introduction of the Soviet Tupolev Tu-4 long range bomber in 1947, which was a reverse engineered copy of the Boeing B-29 Superfortress. The Tu-4 had a range of nearly 3,500 miles, which would allow it to reach targets along the US coast in a one-way flight. Even more worrisome was the end of the US monopoly on nuclear weapons on August 29, 1949, when the Soviet Union detonated its first atomic bomb at the Semispalatinsk Test Site in Kazakhstan (Kennedy 2009:70). Within a few short years, the Soviets had developed both the atomic bomb and the ability to deliver it to targets in Europe and the US, and this situation demanded a serious evaluation of the capabilities of the US early warning and air defense systems against the threat of atomic-bomb equipped Soviet bombers.

In response to the evolving Communist threat, the Truman administration in 1947 pledged to contain Soviet expansion in Europe, which became known as the Truman Doctrine. The same year, the National Security Act substantially restructured the US military and intelligence agencies, creating what would become the DOD and separating the Army Air Forces into the independent service branch of the Air Force. The formation of the Air Force initiated a period of friction with the Army as both organizations struggled to delineate under whose jurisdiction the development of new rocket and guided missile technology fell. The Army and Air Force were also in close competition for funding of independent, but often parallel, programs. Funding was often determined by various DOD review panels that were tasked with evaluating the technical feasibility of the various programs offered by the different service branches. Underlying the competition for program recognition and funding between the service branches was the desire to possess control of the nascent space program.

At WSPG, the division between the Army and Air Force was expressed in a lengthy debate about how the range was to be divided between the two service branches. This issue was finally settled by the Integrated Range agreement of 1953. The Integrated Range allowed the Army, Air Force, and Navy to use the same ranges and test facilities. It also effectively combined the WSPG and Holloman ranges into a single large range accessible to all three service branches, but under the command control of the Army (Redmond 1957).

Communist expansionism in Asia contributed to a pessimistic, if not paranoid, outlook in the West during the late 1940s and the early 1950s. By 1949, Communist forces under the leadership of Mao Zedong had prevailed over the Nationalists in China, forcing Chiang Kai-Shek and the remnants of his government into exile in Taiwan. Soviet forces had occupied the northern half of Korea since 1945, ostensibly in preparation for the invasion of Japan, but continued to entrench themselves following the surrender of Japan. In agreement with the Soviet Union, the US had occupied Korea south of the 38th Parallel, and by 1948 independent governments had been established in both halves of the country. This temperamental stalemate finally broke on June 25, 1950 when North Korean forces invaded South Korea, initiating the US involvement in the Korean War.

The Korean War ended in 1953 and reestablished the boundary between North and South at the 38th Parallel which remains today. The Korean War was significant in that it clearly demonstrated that the US could no longer simply rely on the tremendous surplus of WWII-era equipment, but would need to devote more energy and funding to the development of new technology and weapons. The Korean War also demonstrated that the threat of nuclear weapons was not enough to prevent the outbreak of conventional warfare in regional conflicts, in which the consequences of deploying nuclear weapons outweighed their strategic value (Kennedy 2009:72). It also was the first of several proxy conflicts where the Cold War superpowers would indirectly engage each other via limited wars in satellite states (Salmon 2011:14).

The conventional military build-up in response to the global Communist expansion was codified in the National Security Council Report 68 (NSC-68), which was a top-secret report published in 1950. Although general containment of Communism was already a US policy priority, actual strategic policies remained vague. NSC-68 specified that Western powers should be ready to counter Communist expansion through conventional military means at any time. The NSC-68 report provided a blueprint for much of the Cold War military stance in Western Europe for the remainder of the Cold War. The NSC-68 report was published just a few months prior to the outbreak of the Korean War, which likely confirmed the report's prediction of aggressive communist expansion in the minds of many US defense strategists.

After the onset of the Korean War, the Truman administration dramatically increased defense spending, and programs such as the Nike Ajax, which had progressed slowly through the 1940s due to lack of support, were placed on expedited schedules. Kennedy (2009:72) notes that in 1951, Army spending on missile programs was increased to $55.4 million, nearly equal to the $56.5 million that had been allocated in the five-year period from 1944 to 1949. This re-invigorated the effort to develop new tactical missiles and a nationwide network of air-defense systems.

By the mid-1950s RDT&E work on missiles at WSPG had expanded to include an array of tactical and air defense missiles. This period saw the release of the Corporal missile, the Army's first surface to surface tactical missile. The Corporal was a large liquid fueled missile capable of delivering a nuclear warhead at ranges up to 75 miles. The Corporal was tested at LC-33, and the improved Type II Corporal first flew at WSPG in 1953. The Honest John artillery rocket was a contemporary of the Corporal, and was also designed to carry a tactical nuclear warhead. Air defense systems under development during the 1950s included the aforementioned Nike and the Hawk missile, a highly successful portable anti-aircraft missile system. The Navy utilized LC-35 in the development of the Talos anti-aircraft missile during the 1950s, which entered service in 1959. A short-lived prototype of a land-based Talos air defense installation, the Ground-Based Talos Unit, was also tested from 1957 to 1959 at what is now LC-34.

The build-up of conventional military troops and weapons per NSC-68 was expensive, and in 1953 the incoming Eisenhower administration advocated for the New Look defense strategy. The Eisenhower administration had campaigned on a promise to end the Korean War and avoid any repeats of similar conflicts, and Eisenhower also wanted to balance the budget and stem inflation (Howard 2004; Slantchev 2014:3). This precluded massive defense spending on a large conventional military, so Eisenhower's New Look policy relied heavily on US nuclear weapons superiority of the early 1950s as a deterrent to communist expansion. The New Look relied on a minimal conventional military that possessed technological superiority in the form of nuclear weapons and the ability to deliver them via strategic bombers and missiles. The New Look military strategy therefore relied on the threat of massive retaliation to counter communist expansion without maintenance of a large conventional military force. This was coupled with an array of mutual defense pacts with allied nations to diplomatically encircle the communist bloc and limit its expansion (Slantchev 2014:4).

An underlying premise of the New Look strategic stance was "missiles not men," and the basic unit structure of the Army was adjusted to reduce overall numbers of personnel and accommodate the use of tactical nuclear weapons on the battlefield. As of WWII, the major fighting unit of the Army, the division, was based on a tripartite organization; a division consisted of three regiments, a regiment consisted of three battalions, and a battalion consisted of three companies. The battalions within a regiment operated closely together in the field to provide mutual tactical and logistical support (Howard 2004:11; Roblin 2017). In 1957, the Army unit structure was reorganized to reflect the nuclear-centric strategy of the time. The Pentomic Army of the New Look era, derived from the Latin "penta" (five) and atomic, eliminated the mid-level regiment entirely, and divisions were formed directly by five battalions, renamed as "battle groups." The theory behind this reorganization was that regimental units would be easy targets for tactical nuclear weapons. The battle groups, each with 1,400 men, operated independently and were dispersed in the field to mitigate losses from tactical nuclear weapons (Roblin 2017). In total, the divisions contained fewer men in the Pentomic structure, in keeping with the reduced scale of the Army that was part of the New Look strategy. Extensive distribution of tactical nuclear weapons was also an important part of the Pentomic structure. Each division was equipped with nuclear-capable short-range weapons, such as the Honest John artillery rocket. By the early 1960s, even the smaller battle groups were issued the M28 and M29 Davy Crockett recoilless guns that could lob short range W54-variant nuclear warheads (Howard 2004; Roblin 2017).

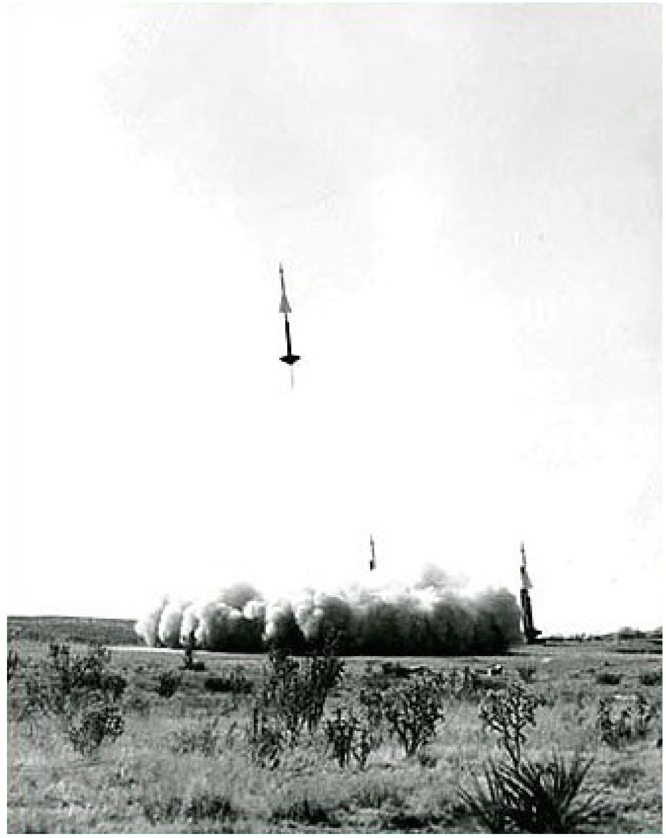

Figure 9. A Nike Ajax missile launch from Red Canyon Range Camp in 1956 (*photo courtesy JP Moore)*.

A corollary of the New Look policy was the ability of the US to defend itself against Soviet bomber aircraft carrying nuclear weapons. An advanced air defense network was an important component of the New Look's reliance on a minimalist, high-tech military that was focused on nuclear weapons and strategic bombing (Howard 2004:8). Between 1954 and 1957, Army anti-aircraft gun batteries across the country were converted to missile battalions armed with the Nike-Ajax missile, America's first guided air defense missile (Berhow 2005:19). The early testing of the Nike Ajax was conducted at LC-33 during the late 1940s and early 1950s, then final engineering and end-user tests were conducted at the newly established LC-37 beginning in 1953. The training of Nike missile battalions was a major undertaking for the Army, and in 1953 the Red Canyon Range Camp (RCRC) was established in the northeast corner of WSPG for the training of air-defense units. The camp also served as an important tool for educating foreign and public officials about the Nike Ajax; from 1953 to 1959 the camp hosted more than

10,000 visitors from 45 countries and 40 states, and approximately 3,000 Nike Ajax missiles were launched from the site (Eckles 2013:241).

The New Look policy was limited in that it had few non-nuclear options in the event of conventional conflicts or proxy wars; it assumed that in future wars tactical nuclear weapons would almost certainly be used and would largely supplant conventional troops, armor, and artillery (Howard 2004:9). This left Army commanders poorly positioned to deal with limited, "brushfire" wars that did not call for nuclear escalation. The Pentomic structure was not very well received by the Army for several additional reasons. For one, it eliminated the command and staff opportunities of the regimental level, and many regiments had distinguished histories and traditions that were lost with the reorganization. It also placed a heavier burden on officers at the division and battle group levels, who had more troops and logistics to manage than they had with the older tripartite organization (Roblin 2017). Perhaps the biggest problem was that logistical support and transportation had formerly been organized at the regimental level, and the Pentomic Army required that each divisional battle group be self-sufficient with its own transportation, air support, and communications resources (Howard 2004:11). This was not the case and trials soon discovered that the Pentomic Army structure was actually less combat effective in the field than its predecessor structure (Roblin 2017).

The mid-1950s were marked by the belief that the Soviet Union possessed, or would soon possess, a superior long-range bomber force. This notion was known as the "Bomber Gap" and contributed to the massive growth of the US Air Force (USAF) bomber fleet and the development of national air defense systems as exemplified by the Nike Ajax. The Bomber Gap grew out of several instances of the Soviet Union surprising Western observers with new

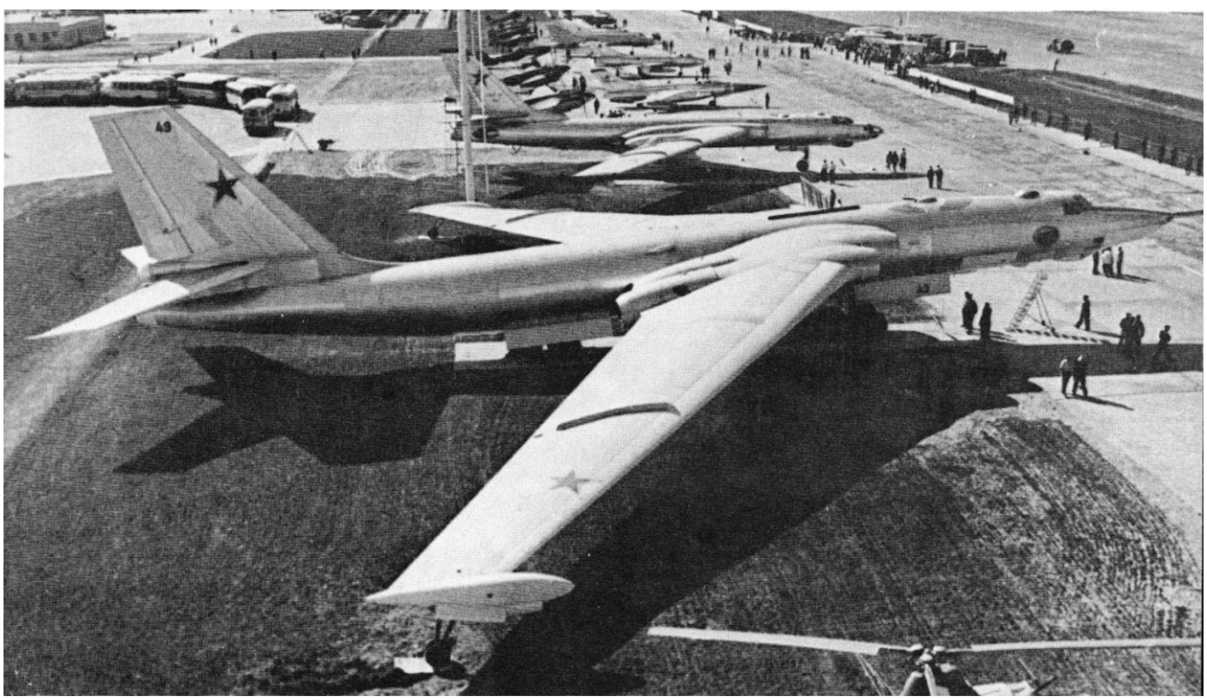

Figure 10. The Soviet M-4 "Bison" bomber, which fueled fears of the Bomber Gap during the 1950s (*public domain image*).

aircraft at public events, beginning with the sudden appearance of the Tupolev Tu-4 in 1947. The Tu-4 was a reverse-engineered copy of the American B-29 bomber, based on several aircraft that had crash-landed in Soviet territory during WWII. During the 1950s, several air defense studies suggested that the Soviet Union had produced Tu-4 bombers in the hundreds, which could overwhelm air defenses in the US and Western Europe (Global Security 2022). In 1954, the Soviet Union unveiled the Tupolev Tu-16, which NATO codenamed the "Badger," a jet-powered bomber that was capable of carrying nuclear weapons. More worrisome was the appearance of the Myasishchev "Molot" M-4, a larger strategic bomber powered by four jet engines that was capable of reaching targets deep within the continental US. The M-4, which NATO codenamed the "Bison", was first reported in 1954 and was a major contributor to the belief in a Bomber Gap. During the Soviet Aviation Day demonstration in July 1955, 10 of the new Bison strategic bombers flew past the viewing stands, then made six additional passes, creating the illusion that the Soviets possessed at least 60 of the new bombers. Western intelligence extrapolated production rates from the illusory 60 aircraft, and estimated that the Soviets would possess at least 600 of the bombers within a few years (Moeller 1998). The Bomber Gap was quickly politized; the military, particularly the USAF, cited the issue to justify increased funding and it was a nagging source of criticism for the Eisenhower administration. By the end of the decade, U-2 spy plane flights over the Soviet Union had disproved the existence of the Bomber Gap. In fact, it appeared likely that the Soviet Union never fielded more than 150 of the long-range Bison bombers (Moeller 1998; Global Security 2022). However, by this time the nation's focus was on the threat posed by Soviet long-range ballistic missiles.

By 1957, it was apparent to the military establishment that the future of long-range delivery of nuclear weapons was not with aircraft or short-range tactical missiles but with long-range ICBMs, or their medium-range counterparts, Medium and Intermediate Range Ballistic Missiles (MRBMs and IRBMs). The arcing trajectory and extremely high speeds of these missiles made their detection and interception very difficult, much more so than conventional bombers. The development of long-range ballistic missiles also provided the means for placing the first manmade satellites into orbit. The US had announced that it intended to launch a satellite during the International Geophysical Year (IGY) of July 1957 to December 1958. Unprecedented in scope, the IGY was an international year of scientific collaboration on projects that involved geography, physics, meteorology, astronomy, and related fields.

The Army, Air Force, and NRL submitted competitive proposals for the first American satellite launch as part of the IGY. The Army proposed a minimalist satellite launched by a modified version of the Redstone missile, a program that was initially referred to as Project Slug and later renamed Project Orbiter. Planning for Project Orbiter involved WSPG, primarily through the technical contributions of astronomer Clyde Tombaugh who was employed by the WSPG Flight Determination Laboratory (FDL) at the time (Wosika and Wezelman 1956). Although the Army Orbiter proposal was technically feasible, in 1955 the NRL Vanguard program was selected to launch the first American satellite into space (Green and Lomask 1970). Vanguard was a multi-stage vehicle that was based on the Viking sounding rocket that was tested at WSPG during the early 1950s.

The Vanguard program encountered numerous technical issues and delays, which allowed the Soviet Union to take the lead in the space race with the launch of Sputnik I in October 1957 (Brzezinski 2007; Missile Defense Agency 2009). The Soviet satellite launch during the IGY was a very visible coup over the West and fueled fears that the Soviets now held the strategic advantage in ICBM development, a controversy that became known as the Missile Gap. John F. Kennedy successfully used the Missile Gap as a campaign issue in his 1960 presidential bid (Werrell 2005:186), and it also added urgency to the US Space Program, energizing the Space Race. Although the Vanguard satellite was successfully orbited in 1958, it was a variant of the Redstone missile — whose origins could be traced directly to Project Hermes — that launched the first American satellite in 1958 and the first American astronaut in 1961 (Kennedy 2009:61).

The anti-aircraft missile systems fielded as of the late 1950s — the Army's Nike Ajax and Hercules and the Air Force's Boeing Michigan Aeronautical Research Center (BOMARC) missile — were rendered semi-obsolete by the advent of ICBMS and IRBMs. These systems were designed for intercepting aircraft, which approached at low angle trajectories at lower speeds and altitudes than ballistic missiles. Due to the high angle trajectories and very high speeds of IRBMs and ICBMs, the window for interception is minimal; early ICBMS traveled at speeds up to 5,000 miles per hour at altitudes up to 100 miles. This required powerful early warning radar networks, long-range precision guidance systems, rapid automated responses, and high-performance missiles that simply did not exist as of the late 1950s (Schaffel 1991:255-256). Accordingly, next generation Ballistic Missile Defense (BMD) and Anti-Ballistic Missile (ABM) systems became the primary focus of land-based air defense systems. The Army began to modify the existing Nike program into a BMD system known as the Nike Zeus in 1957, while the Air Force gradually phased out its BOMARC installations and focused on its early warning radar and ICBM programs.

WSPG was re-designated White Sands Missile Range (WSMR) in 1958, a change that reflected the emphasis on the development of ICBMs and BMD systems that were a major focus at the time due to the Missile Gap and the ongoing Cold War arms race. In 1962, WSMR became involved in the Advanced Ballistic Re-Entry Systems (ABRES) program. ABRES was a DOD joint-service and ARPA program, conceived to investigate ICBM reentry vehicle dynamics and materials and disseminate the results to the Air Force, Navy, the Advanced Research Projects Agency (ARPA), and the Army Ballistic Missile Defense Agency (ABMDA). ABRES was a high-priority defense program that was managed directly by the Deputy Secretary for Defense Research and Engineering (DDR&E). The DDR&E provided direct funding to each service branch or agency involved in ABRES. This made ABRES unique in that it wasn't subject to individual service branch or agency budgets (Jim Forman, personal communication 2023). The goals of the ABRES program were to improve both offensive and defensive systems through the study of reentry phenomena of simulated ballistic missiles (Feit et al. 2014; WSMR 1968a).

In 1962, the DOD named the Air Force Systems Command's Ballistic Systems Division (BSD), at Los Angeles Air Station, as the Executive Agency for ABRES. The larger portion of ABRES funding and research was planned and was executed on the Air Force's Western Test Range, supported by the Army operations in the Kwajalein Atoll in the Pacific. WSMR was considered as the "Inland Range" for ABRES, and ABRES research and testing operations at WSMR were under the direction of BSD's Inland Range Field Office, and directly supported by WSMR National Range Operations (NRO) division (Jim Forman, personal communication 2023).

The ABRES program established the WSMR Green River Launch Complex (GRLC), near the town of Green River, Utah. It served as a launch site for the Air Force Athena missile, which was a scaled down model of an ICBM that impacted at WSMR. Athena flew both Air Force and Navy ballistic missile payload/reentry vehicles to collect flight dynamics and material effects data and distributed that data directly to the service branches (Jim Forman, personal communication 2023). The ABRES program launched Athena missiles from the GRLC to WSMR until 1973. Following the Athena launches, the GRLC served as the launch area for the Pershing missile through the mid-1970s (Feit et al. 2014; WSMR 1968a).

A variety of radars were used to capture data from the ABRES flights, including the sophisticated Radar Advanced Measurement (RAM) and Radar Advanced Measurement Program for Analysis of Re-entry Techniques (RAMPART) systems were also used to capture data from the ABRES flights. Other radars from the Nike Zeus and Nike X programs were also used in support of the ABRES flights, which is discussed in further detail later in this document.

In addition to ICBM and BMD development, WSMR made important contributions to the American Space Program. During the late 1950s and 1960s the centralized tracking, command, and communications networks pioneered by Ozro Covington at WSMR served as the conceptual basis for the global networks created for support of the Mercury and Apollo Programs. WSMR participated in the tracking networks for the Mercury, Gemini, and Apollo Programs, using the AN/FPS-16 radar to track the orbiting spacecraft (Corliss 1974; Tsiao 2008). Across the San Andres Mountains from WSMR, the National Aeronautics and Space Administration (NASA) Johnson Space Center established the Propulsion Systems Development Facility (PSDF) in 1963 to support the development of Apollo propulsion and power systems. In 1965, the PSDF was renamed the White Sands Test Facility (WSTF) and it continues to be an important test facility of the Johnson Space Center today (NASA 2015).

WSMR also provided a launching location for testing of the NASA Little Joe II vehicle. The Little Joe II was specifically designed to test the Apollo Launch Escape System (LES), which separated the Apollo Command Module from the main vehicle body in the event of an emergency abort. The Little Joe II and the Apollo LES were tested at LC-36 between 1963 and 1966. LC-36 had formerly been the home of Redstone missile testing at WSMR.

The New Look defense policy crumbled when the Soviet Union developed ICBMs, which ended the period of US nuclear weapons superiority. The rapid growth of ICBMs during the late 1950s redefined what was considered as the “atomic age” and undermined the nuclear superiority that defined the New Look defense policy of the Eisenhower administration. From 1953 to 1960, the Army had focused heavily on tactical nuclear weapons to the detriment of conventional weapons, troops, and vehicles. With the inauguration of the Kennedy administration in 1961, the New Look policy and its overt reliance on nuclear weapons was retired in favor of a “Flexible Response” strategy, which recognized that conventional troops and weapons were still required in order to scale strategic responses accordingly (Howard 2004). During the early 1960s, the Pentomic Army structure was abandoned almost as quickly as it had been implemented. In 1962, the Army began the transition to the Reorganization Objective Army Divisions (ROAD) structure that closely resembled the WWII-era tripartite structure, with a mid-level “brigade” formed by three to four battalions that approximated the former regimental unit (Roblin 2017). The doctrine of Flexible Response would be maintained throughout the remainder of the Cold War. The renewed interest in conventional weapons would be reflected in RDT&E programs at WSMR for the remainder of the Cold War, many of which focused on tactical anti-tank and anti-aircraft weapons designed to serve troops on the non-nuclear battlefield.

Figure 11. Cover of commemorative brochure of President Kennedy's 1963 visit to WSMR (*courtesy WSMR*).

It is perhaps ironic then that while the Kennedy Administration was beginning to reduce military reliance on nuclear weapons, the US and Soviet Union entered the most dramatic nuclear crisis of the Cold War. Cuba, whose communist government had been established in 1959, agreed to host Soviet MRBM and IRBM installations in mid-1962. These missiles were equipped with nuclear warheads and could easily reach much of the continental US. The US promptly established a blockade against further Soviet missiles entering the country and demanded that the existing installations be dismantled, resulting in a tense 13-day standoff with the Soviet Union in October 1962. Known as the Cuban Missile Crisis, the stalemate was probably the closest that the two nations came to an actual nuclear exchange during the Cold War. A settlement was reached between President Kennedy and Soviet Premier Nikita Khrushchev, where the Soviets would remove the nuclear weapons from Cuba in exchange for the US secretly removing nuclear-equipped Jupiter MRBM installations in Italy and Turkey. As a result of the crisis, both the US and Soviet Union undertook steps to improve communications, as expressed in the establishment of the Moscow-Washington teletype hotline in 1963 (Salmon 2011:23).

On June 5, 1963, President John F. Kennedy visited WSMR to view a series of missile demonstrations, an event known as Missile Exercise White Sands or Project MEWS (Eckles 2013:291). While the visit was brief, President Kennedy viewed firings of the Honest John, Little John, Sergeant, and Hawk missiles from LC-32, then viewed launches of the Nike Hercules, Navy Talos, and a Nike Zeus missile while at LC-37 (Eckles 2013:292-293). The timing of President Kennedy's visit to WSMR was not coincidental, with the Cuban Missile Crisis less than a year behind and the Missile Gap and Space Race still very prominent in the public consciousness. Earlier in the year President Kennedy attended a similar demonstration at Redstone Arsenal, and during the same tour he also visited the US Air Force Academy and North American Aerospace Defense Command (NORAD) in Colorado. After the visit to WSMR, he continued on to the Naval Ordnance Test Station (NOTS), China Lake, California where he observed another series of weapons demonstrations. These highly publicized visits helped to encourage the public's confidence that America's military and technological prowess remained competitive against that of the Soviets (Eckles 2013:291).

Despite the thaw in US-Soviet relations following the Cuban Missile Crisis, the US soon became entrenched in another war against an expansionist Communist state in Asia. After a purported North Vietnamese attack on the USS Maddox and the USS Turner Joy in August 1964, known as the Gulf of Tonkin incident, Congress passed a resolution proposed by President Johnson to commit conventional US military forces to the conflict without an actual declaration of war (Lavin 1998:40). The military build-up on both sides of the conflict rapidly escalated in the following years, with the North Vietnamese Army (NVA) committing conventional military and supporting the massive guerrilla campaign of the Viet Cong in South Vietnam. In January 1968, the NVA and Viet Cong launched the widespread Tet Offensive across the country, which caught US forces by surprise but ultimately was a tactical failure. However, the Tet Offensive was an ideological success in that it made a victory in Vietnam seem unlikely to the American public and caused a dramatic increase in the already simmering opposition to the war (Lavin 1998:40; US Army Center for Military History 2009:214).

The 1960s were an important period of development for a variety of tactical anti-tank missiles at WSMR. The Shillelagh missile, a guided missile that was designed to be fired from the barrel of the lightweight Sheridan tank, incorporated significant developments in line-of-sight guidance technology. The Shillelagh/Sheridan system did not prove to be very successful in the field, but its guidance system was improved and incorporated into the Tube-launched, Optically-tracked, Wire-guided (TOW) anti-tank missile. The TOW was one of the most successful portable anti-tank missiles ever designed, variants of which were used well into the 21st century. Both the Shillelagh and the TOW were tested at the Small Missile Range (SMR), and the anti-tank mission continued at the SMR into the 1970s with testing of the man-portable Dragon system and the Copperhead guided artillery shell. Larger Army tactical missile systems were also upgraded throughout the decade. Just as the Sergeant replaced the complicated Corporal, the Lance missile was developed as a replacement for the Sergeant and Honest John. Engineered during the 1960s and tested at LC-33, the Lance used prepackaged, stable liquid propellant and was launched from a self-propelled launcher vehicle. It offered a major improvement in mobility over the Sergeant and better accuracy and range than the Honest John. The Lance underwent a lengthy development period and was first issued in 1972.

The incoming Nixon administration in 1969 inherited a very unpopular war, and began to take steps to withdraw US forces while leaving South Vietnam intact. These efforts finally led to the signing of the Paris Peace Accords in 1973, which established a temporary ceasefire and allowed the withdrawal of US forces from Vietnam. South Vietnam nationalist forces were expected to maintain the partition against North Vietnam without further US support. The ceasefire was short-lived, and by 1975 the South Vietnam government had collapsed and Vietnam was reunified under a Communist regime (Salmon 2011:26).

Despite reduced spending on research and development due to the cost of supporting the Vietnam War, technological advances continued to be made at WSMR. During the early 1960s, the nation's first prototype BMD system, the Nike Zeus, was developed by BTL. Testing of the Nike Zeus system was conducted at ALA-5, later re-designated as LC-38, which is the focus of the current inventory. The improved Nike X system, the successor to the Nike Zeus development, was also tested at WSMR. The Nike X system incorporated the high-speed Sprint missile

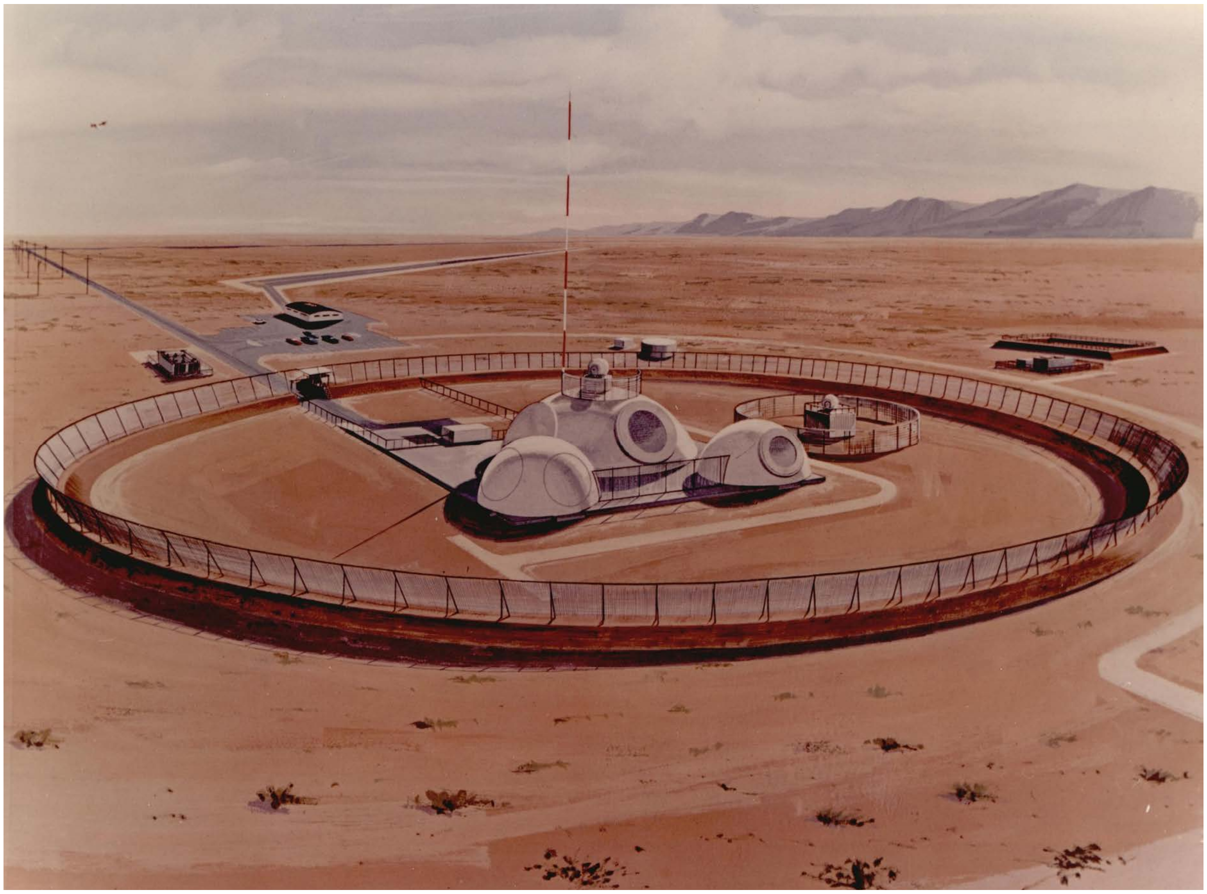

Figure 12. Illustration of the MAR installation at WSMR, circa early 1960s (*courtesy WSMR Museum Archives)*.

and early version of a phased array radar system, the Multi-Function Array Radar (MAR). The Nike X served as the basis for the Sentinel and Safeguard BMD systems proposed during the 1960s (Eckles 2013:456; Lonnquest and Winkler 1996:111). These systems and their relationship to LC-38 are described in much more detail later in this chapter.

The US development of BMD systems was paralleled by the Soviet Union during the 1960s. The Soviet Union developed and fielded a series of BMD systems, including the Griffon, Galosh, and Gammon, during this period (Werrell 2005:189-191). The Soviet investment in BMD systems was much higher than that of the US, estimated at $4 to $5 billion by 1967 compared to the $2 billion expended by the US (Werrell 2005:191). The continuing cost of developing these systems in order to maintain parity with US BMD technology likely influenced Moscow to engage in arms limitation talks.

In 1969, the first of the Strategic Arms Limitation Treaty (SALT) talks was conducted in Helsinki, Finland. The SALT talks eventually led to the signing of the ABM Treaty by the United States and Soviet Union in 1972. The ABM Treaty limited the number of both deterrent and defense missile systems, and while research and development of these concepts continued, it was at a much-diminished scale for the remainder of the Cold War. By the mid-1970s the ABM Treaty, along with increasingly negative public sentiments, ended the era of nationwide anti-aircraft and BMD systems. The funding for BMD systems dropped from around $1 billion annually in the late 1960s to one-tenth that amount by 1980 (Werrell 2005:196).

Despite the reduction in defense budgets in the 1970s, pioneering efforts in new technology continued at WSMR. Examples include early work on lasers and the study of atmospheric effects on laser beams (Eckles 2013:453). This work culminated in the Mid-Infra-Red Advanced Chemical Laser (MIRACL) which was first fired or "lased" in 1980 (Federation of American Scientists 2015). In 1976, WSMR was selected as the site of the DOD-wide laser development facility known as the High Energy Laser System Test Facility (HELSTF), construction of which was undertaken at the former MAR site during the early 1980s. By 1980, a detachment of the Navy responsible for the testing of sub-systems related to the Sea Lite Beam Director was stationed at WSMR (Bingham 1980:14). HELSTF was completed and officially operational in 1985, and the same year the MIRACL laser was used to destroy a static Titan I booster (Bingham 1985:10).

While nuclear weapons remained a public and political priority, the 1970s and 1980s were also marked by a heightened concern over a conventional war in Europe. The militaries of the Soviet Union and Warsaw Pact nations expanded significantly during the 1970s, and the threat of an armored invasion into West Germany was a major strategic concern for NATO defense planners. At the time, it appeared that the Soviet Union might be willing to gamble that the US and NATO allies would not escalate a conventional war into a nuclear exchange. New conventional weapons capable of balancing out the Soviet quantitative advantage were therefore the focus of Army RDT&E efforts during the late Cold War. The Multiple Launch Rocket System (MLRS) and related Army Tactical Missile System (ATACMS) system were developed and tested at WSMR from the late 1970s through the early 1990s and were significant programs at the range during this period.

The reduced funding levels and transition to a volunteer force in the 1970s had left the Army understaffed and poorly equipped, a period that historian Mary Lavin refers to as the "Hollow Army" (Lavin 1998:52). However, by the mid-1980s the state of readiness of the Army conventional forces was substantially improved due to the increased defense budgets of the Carter and Reagan administrations (Lavin 1998:52). The Reagan administration also launched the Strategic Defense Initiative (SDI), an ambitious plan that would protect the US from a ballistic missile attack using, in part, advanced concepts such as orbiting intercept systems and lasers. The proposed space-based technologies caused pundits to refer to the SDI as the "Star Wars" program. The SDI was promoted as an alternative to the deterrent measure of massive nuclear retaliation. The concept of massive retaliation, or Mutually Assured Destruction (MAD), as a deterrent to nuclear attack was established during the 1950s. MAD remained the major defense strategy against an ICBM attack since ABM systems had been banned by treaty in 1972. With the SDI, President Reagan sought to "create a nationwide defense shield against ballistic missiles that would make nuclear weapons impotent and obsolete" (Werrell 2005: 198; Lonnquest and Winkler 1996:116). Although the deployment of BMD systems like those proposed in the SDI would violate the ABM Treaty, there was no limitation on their research and development. The SDI program never produced a functional system, but proponents of the effort hold that it hastened the end of the Soviet Union by forcing it to invest in unproductive defense programs that overburdened its already stagnant economy (Lavin 1998:58; Salmon 2011:28; 32).

The HELSTF facility and MIRACL programs at WSMR were part of the effort to develop laser weapons for the SDI (Eidenbach et al. 1996:189; Eckles 2013:455). The Patriot Surface to Air Missile (SAM), which would later become well-known to the American public during the Gulf War, was also tested at LC-38 during this period and deployed in 1984 (Werrell 2005:202-203). The Patriot proved to be an effective defense against the Soviet-designed Scud missiles, and was the only US tactical ballistic missile defense system actually used in combat (Werrell 2005:204). Also, during the 1980s, the NASA WSTF became home to the primary ground terminal for the NASA Tracking and Data Relay Satellite System (TDRSS), which continued the long association of WSMR with the American Space Program. The TDRSS is the modern descendent of the NASA global networks used for the Mercury and Apollo Programs (Tsiao 2008). Another NASA milestone at WSMR was the space shuttle Columbia landing at White Sands Space Harbor (WSSH) on March 30, 1982. While the WSSH continued to serve as back-up landing site for the remainder of the space shuttle program, this was the only time a space shuttle actually landed at WSMR (Eckles 2013:422).

In DOD guidance, the year 1989 is generally acknowledged as the end of the Cold War period, when revolutions against the Communist regimes in Poland, Hungary, East Germany, Bulgaria, Czechoslovakia, and Romania initiated the dissolution of the Warsaw Pact and the Soviet Union. However, the Soviet Union was not officially dissolved until December 26, 1991. Even after the collapse of the Soviet Union in 1991, many SDI projects carried momentum into the post-Cold War era and became developmental programs at WSMR. Examples of these systems include the Theater High Altitude Area Defense (THAAD) missile, a modernized BMD system, and the Tactical High Energy Laser (THEL) System (Eckles 2013).

6.4 Fundamentals of Missile Ranges

Army guidance for determining historical significance under the NRHP criteria has categorized Cold War-era missile ranges as belonging to the sub-theme of *Proving Grounds* under the encompassing *Materiel Development* category (Lavin 1998). These facilities do not operate in a vacuum, however, as "the relationship between proving grounds and RDE (*sic*) centers is complimentary and mutually supportive" (Lavin 1998:70). So, it is important to make the distinction between an entire military facility dedicated to the mission of testing rockets and missiles and the individual facilities within the larger range that contribute to an actual live rocket or missile test. Missile ranges are discreet entities and, because of their potentially catastrophic failures in launch and impact phases, are typically far removed from populated areas.

There are only a handful of actual land-based missile test ranges in the US. The largest are WSMR and the Naval Air Weapons Station (NAWS), China Lake, California. There are also missile test sea ranges, such as the Eastern Test Range and the Navy's Point Mugu, where land or ship-based launches occur and fall safely into the ocean. Containing land masses of approximately two million and one million acres, respectively, WSMR and NAWS are designed to accommodate safe launches, but more importantly allow for recovery and use of land-based instrumentation that is difficult or impossible at over-water test ranges. This makes the land-based ranges particularly valuable assets, especially for types of testing that require extensive instrumentation and data collection.

A great deal of research and effort goes into getting a test missile or rocket to the actual launch phase, much of it done in partnership with private industry. A single missile is often comprised of thousands of components, the design and testing of which requires the efforts of numerous engineers, technicians, and sub-contractors. A "launch complex" serves as the final destination for a test article prior to launch, consisting of a distinct collection of buildings and structures designed to prepare the missile for lift-off. Depending on the type of launch complex, typical support facilities include launch pads, control rooms, assembly buildings, environmental conditioning chambers, general maintenance facilities, blast barricades, munitions storage magazines, instrumentation shelters and support buildings, and miscellaneous facilities. Depending on the range and the types of missiles undergoing testing, the building types, construction methods, and sizes can vary greatly.

Common to most, but not all, launch complexes is a launch or flight control building from which launches can be monitored and controlled. Again, launch control building formats are largely determined by the type of vehicles being tested and can range from simple barricades to elaborate, reinforced concrete bunkers. However, many are permanently constructed and offer some degree of impact protection. At LC-38, the launch control building (Property 23580) incorporated an underground control shelter that was beneath a surface building. Tunnels connected between the control room and the individual launcher pits, allowing for routing and access of electrical and control wiring.

As mentioned earlier, missiles are comprised of multiple sub-assemblies, most of which arrive for testing as individual components. These typically include the missile or rocket body, motor (fueled either by liquid or solid propellant), electronic guidance systems, fuze (detonator), and warhead. These are put together for testing in a specialized assembly building that usually incorporates a characteristic two or three story "high bay" portion designed to accommodate overhead cranes and upright assembly of the missile. As with other launch complex infrastructure, the types, construction methods, and sizes of assembly buildings are determined by the needs of the missile undergoing assembly. The major assembly building at LC-38 is Property 23626, which incorporates a high-bay shop area and lower one-story office and classroom wings. Separate hazardous assembly and storage facilities (Properties 23654 and 23656) are located in a separate area to the north of Property 23626.

The pre-launch process can also include environmental conditioning of test articles before launch, either to simulate operation in extreme conditions or to maintain a test vehicle at optimum temperatures prior to launch. Depending on the facility, the environmental testing may be housed in simple, steel frame buildings or in reinforced concrete structures to house the heat and cold conditioning. In other cases, the conditioning shelters are mobile units that are mounted on wheels or tracks, such as the example at the Patriot launch area in the north-central portion of LC-38.

Launch pads come in a variety of configurations from simple concrete pads to elaborately configured structures with built-in instrumentation, electrical, and control systems. Most missiles are launched from removable steel frameworks or purpose-built launchers which serve as the mounting structure. At LC-38, two 25-foot deep, angled launch pits were located in the Nike Zeus launcher area, along with a "tactical prototype launcher" that launched the Nike Zeus missile vertically from an underground silo. Only the foundation of the tactical prototype launcher (Property 23683) remains at the complex today. The other Nike Zeus launcher pits have been removed and infilled, although segments of the underground access tunnel still remain in place. Further north, a Patriot launch pad, consisting of a simple at-grade concrete slab foundation with attachment hardware, was constructed during the 1970s in support of the SAM-D/Patriot program.

Another common fixture at launch complexes are blast barricades. These barricades are designed to provide protection for personnel and properties from testing activities that produce heat and flame or that might result in an accidental explosion (Thompson and Tagg 2007). The most common type are simple earthen berms, which offer excellent protection with a minimal investment. In some cases, these berms are mantled with asphalt to protect them from erosion. Other blast barricades are constructed of reinforced concrete or heavy timber structures infilled with earth. Earthen berm barricades were positioned between the launcher pits in the Nike Zeus launch area at LC-38, but have been removed along with the launcher pits. A large gravel-surfaced revetment is located within the Patriot launch area in the north-central part of the complex.

Munitions storage magazines are also typically found in the vicinity of launch facilities. While the use of live warheads is not routine in missile testing, it does occur and accommodation for the safe storage of such components must be considered. Perhaps more often the magazines are used for storing squibs, fuzes, or arming devices that possess a small explosive charge. Assembled solid fuel missiles, which also present an explosive hazard, are also stored in such structures prior to launch. Magazines generally come in two varieties; small concrete box magazines and larger concrete magazines embedded within an earthen berm, generally referred to as “igloo” magazines. Properties 23654 and 23656 are variations on igloo storage magazines, with earthen berms stabilized by concrete cribbing surrounding individual reinforced concrete assembly and storage cells. These two properties were part of the original Nike Zeus construction and remain in use today.

Another common feature at missile launch complexes are the often-overlooked below-grade cable trenches. Cable trenches are subterranean reinforced concrete channels designed to be regularly accessible and are simply covered with heavy steel plates that can support vehicular loads. Similar features used for the installation of cables into conduit are known as pull boxes. With more permanent and often distant facilities such as camera shelters, the cables are installed into buried conduit with interspersed pull boxes, whereby technicians can pull the cables through the conduit from grade. The underground installation protects electrical and control wiring located in and around launch areas from the heat and blast impacts of the launches themselves. Subterranean routing also serves more prosaic functions; as with urban utilities, underground installation reduces surface clutter and protects cables from traffic and weathering. The underground tunnels in the former Nike Zeus launch area served a similar function, and a series of cable trenches were also installed in this area during the early 1970s in support of the SAM-D/Patriot testing.

During and after launch, a test article’s flight characteristics are captured through a variety of instruments. Missile range instrumentation consists of two major types: optical and electrical. Optical instrumentation includes tracking telescopes, fixed and tracking motion picture cameras, and cinetheodolites. Cinetheodolites combine a motion picture camera with a theodolite, recording azimuth and elevation data on the film of the test flight. Electrical instrumentation consists primarily of radar and telemetry systems. Instrumentation radars such as the AN/FPS-

16 provide high accuracy measurements of the test article's speed and position in space, and complement other data collection methods during test events. Radars are also critical for maintaining range safety as they allow range control to monitor a missile's trajectory in real time. If the missile begins to move outside its designated flight corridor, it can be shut down remotely to prevent the missile from entering populated areas. Telemetry systems use sensors on-board the test vehicle to relay information regarding its operation to ground recording stations via radio transmission. Typical telemetry data includes measurements of skin temperature, internal pressures, battery levels, fin positions, and timing information (Eckles 2013:156). Each of these instrumentation devices is carefully synchronized to a central timing station to ensure the varied types of data are precisely aligned in time. Similarly, all range instrumentation is integrated into a precisely surveyed spatial grid that covers the range horizontally and vertically. This allows all instrumentation measurements of a test article's flight path to be translated into highly accurate spatial coordinates. Support infrastructure for range instrumentation is typically substantial – entire buildings are utilized for instrumentation maintenance and storage, film processing, and workshops. High quality instrumentation allows missile ranges to capture the data needed to properly test and evaluate missile systems, and is also essential to maintaining range safety. Eckles (2013:157) relates that for every significant test at WSMR, about half of the data collection equipment used is dedicated to maintaining missile flight safety.

The destination of a missile after it is launched is an impact area or a target. Impact areas can be as simple as demarcated areas on the ground, and the missile's performance is evaluated by how closely it strikes the designated target zone. However, since the mid-1950s most missile systems are much more specialized and are designed to destroy aircraft, tanks, bunkers, or other missiles. For this type of testing more specialized targets are required. Anti-aircraft missiles targeted "droned" surplus planes and dedicated aerial target drones. In some cases, droned aircraft were intercepted with missiles armed with live warheads, such as early tests of the Nike Ajax missile. In other cases, an unarmed missile's flight was programmed to pass within a close distance of the aerial target without actually impacting it, thus saving the drone target for another test while still verifying the effectiveness of the missile. Special telescopic optical instrumentation is used to record data on "miss-distance" for this type of testing. Drone aircraft made especially for missile testing were first manufactured in the 1950s, and remain a mainstay of test range targets today. Anti-tank missiles were tested against a variety of targets, including simple targets such as wire mesh stretched across wood frames. Live anti-tank missiles were fired at steel plate targets and obsolete tanks to evaluate armor piercing capabilities. Some missiles designed to strike other missiles require the use of target missiles, which are usually retrofitted from retired surplus missile systems. For example, early 1960s tests of the Nike Zeus system targeted repurposed Nike Hercules missiles used as mock ICBMS. For some tests, WSMR launched missiles from off-range locations which safely impacted within the range boundaries, allowing for the testing of long-range systems over hundreds of miles.

While the launch complexes at WSMR are widely variable as they were each designed to support different programs, most contain the typical launch complex elements as described here. In order to provide a more comprehensive consideration of LC-38, the other primary WSMR launch complexes and their defining programs are summarized in the following section. Following this discussion, a more detailed treatment of LC-38 and the programs it supported is presented. The specifics of the LC-38 building types, their function, individual descriptions, and physical integrity are discussed in Chapter 7.

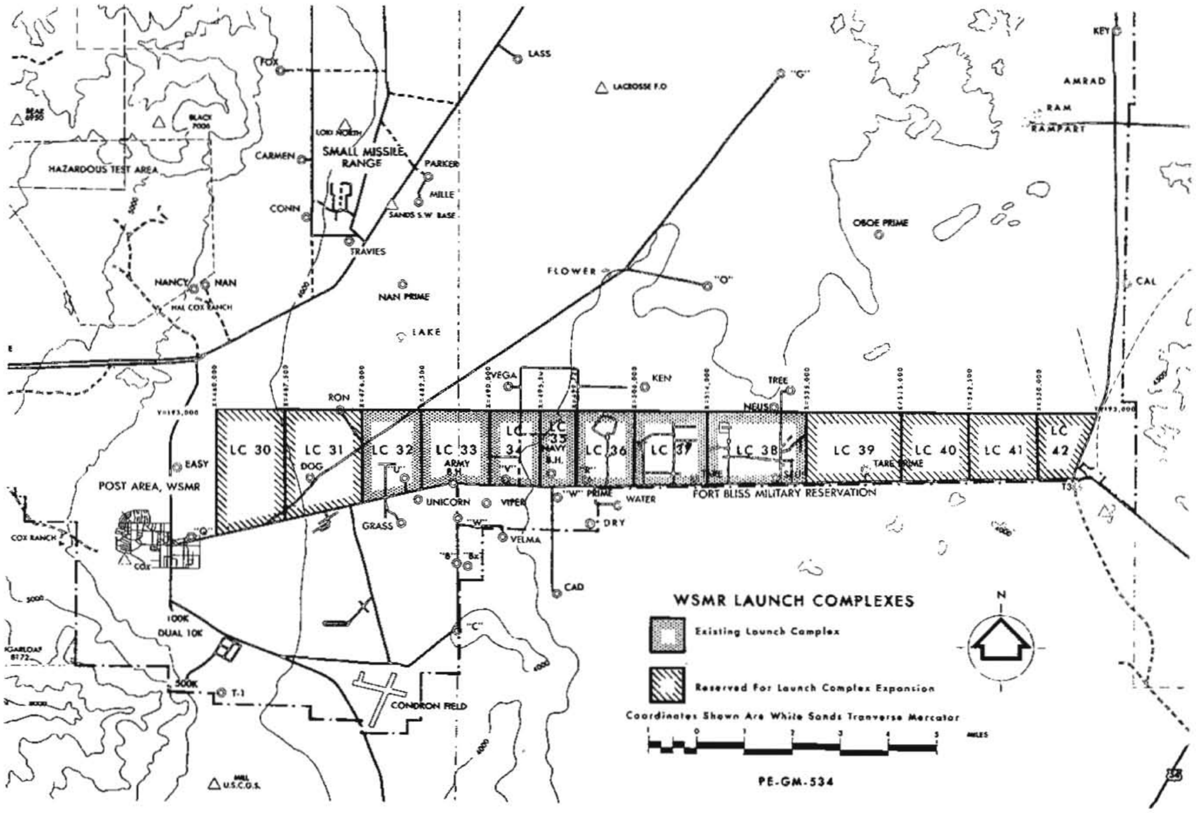

Figure 13. An overview map of the WSMR Nike Avenue launch complexes included in a 1968 summary report on the range (*adapted from WSMR 1968a)*.

6.5 WSMR Launch Complexes

The Launch Complexes at WSMR are primarily located along the north side of Nike Avenue at the southern end of the range (Figure 13). The identified launch complex areas along Nike Avenue are numbered LC-30 through LC-42, but not all of these locations have been developed. WSMR documentation indicates LC-30, LC-31, and LC-39 to LC-42 as areas "reserved for launch complex expansion" (WSMR 1968b:63). Little significant construction is known to have occurred at the proposed LC-30, LC-31, LC-39, LC-40, LC-41, and LC-42 launch complex locations, but launches of the Lance missile were undertaken at LC-39. WSMR literature indicates that LC-30 and LC-31 are the two launch complexes nearest the main cantonment; however, neither of these locations is associated with any substantial programs or construction (WSMR 1968b:63) and LC-32 is the first launch complex encountered east of the cantonment with substantial built environment (Eckles 2013:7). Originally the launch complexes at WSPG were known as "Army Launch Areas", and LC-33 was Army Launch Area 1, LC-32 was Army Launch Area 2, LC-36 and LC-37 were originally parts of Army Launch Area 3, and LC-38 was Army Launch Area 5. The most commonly cited explanation for the change in numbering, though possibly apocryphal, is that it was a product of the competition between Cape Canaveral and WSMR as launch locations for the emerging space program. WSMR advocates wanted to compare more favorably with the dozens of launch complexes at Cape Canaveral, so the launch complex numerical designations were arbitrarily started at 32 to sound more impressive

Figure 14. A 1958 aerial photograph of the Hawk area at LC-32 under construction, Property 20533 at center (*courtesy WSMR Museum Archives)*.

(Eckles 2013:7-8). The primary launch complexes are summarized beginning with LC-32, and then moving east along Nike Avenue. Other launch complexes located elsewhere at WSMR and off-range are also summarized below following the Nike Avenue areas.

6.5.1 LC-32

LC-32, originally Army Launch Area 2 (ALA-2), was established in 1955 in support of Hawk and Sergeant missile testing. The Hawk launch area was located at the east end of the complex, and the Sergeant at the west. This created a symmetrical plan for the complex, and both the Sergeant and Hawk areas were designed with roughly similar layouts and features. Each area had an independent blockhouse and launch pad connected by a subterranean cable trench, along with attendant blast barricades, assembly buildings, and assorted infrastructure. The early symmetrical design of LC-32 was gradually modified and expanded through the 1960s in support of the Hawk program, and eventually included a series of aerial target launch sites along its eastern margin. As of 1968, the complex included four launch pads, a blockhouse, and buildings for missile assembly, maintenance, check-out, communications, and storage (WSMR 1968b). The complex was still primarily identified with the Hawk and Sergeant systems into the

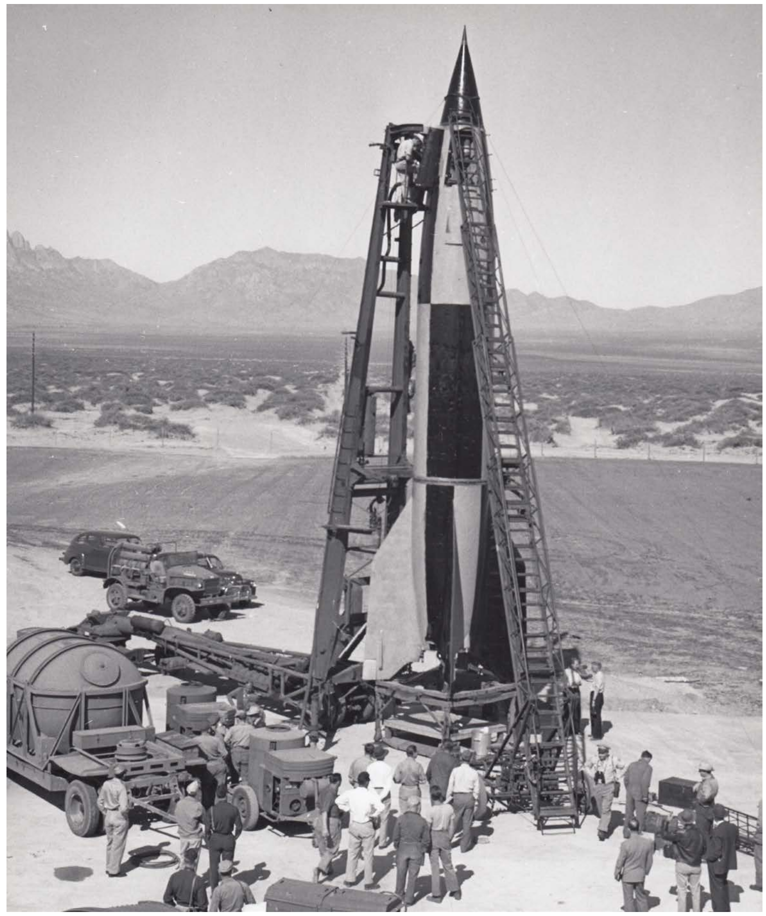

Figure 15. V-2 #2, the first actual American V-2 launch, on the launch pad at LC-33, April 1946 (*photo courtesy WSMR Museum Archives)*.

late-1960s. By the 1970s, the Sergeant missile was retired from Army service but testing of improved versions of the Hawk system continued at LC-32. The Roland anti-aircraft missile RDT&E program was conducted at LC-32 beginning in the 1970s, and aerial drone target launch sites were installed at the complex between 1975 to 1977. Other secondary programs that passed through the complex included the canceled Mauler Missile of the 1960s and the Patriot Missile. During the 1990s, the Hera target missile was launched from LC-32 and a large climate-controlled assembly building and launch pad were constructed next to the former Sergeant Launch Pad. The Hera assembly building was constructed on rails and was moved away from the missile once it was ready to launch, in the same fashion as a gantry crane. More recently, the complex hosted the NASA Orion Launch Abort System test and the development of Japanese missile systems derived from the Patriot missile (Larry Carreras personal communication 2015).

6.5.2 LC-33

LC-33, originally ALA-1, was the first launch complex established at WSMR and is the most well known for its historic associations with early rocket and missile launches at the range. The first rocket fired at WSMR, the WAC Corporal, was launched at LC-33 in the fall of 1945 (Eckles 2013:8). The first American V-2 launch took place at LC-33 on April 16, 1946 (Eckles 2013:179). It was the primary Army launch complex at WSPG until the mid-1950s, when the volume of test programs necessitated the construction of additional launch complexes such as LC-32 and LC-37.

One of the first support structures constructed at LC-33 was the Army Blockhouse, which was built at LC-33 between July and September of 1945 at a cost of $36,000. Constructed to protect personnel and control equipment during launches, the blockhouse is one of the oldest surviving buildings at WSMR (Eckles 2013:177-178). The blockhouse was intended to withstand the impact of a V-2 missile crash; although at the time of its construction no standards or guidelines existed for the construction of such a building. So the designers of the blockhouse, Dr. Del Sasso of Caltech and Lieutenant Colonel Harold Turner, simply relied on very robust reinforced concrete construction, essentially "overbuilding" the blockhouse (Kennedy 2009:28). The outer walls of the squat, square building are 10 feet of reinforced concrete; the pyramidal roof is 24 feet thick at its apex while the floor of the building is eight feet thick (Kennedy 2009:28). The building enclosed 937 square feet of interior space that housed the firing controls and telemetry equipment. It is equipped with three viewing ports of blastproof glass along with a blastproof steel door, and was also equipped with wash-down system mounted on the apex of the roof to decontaminate the building exterior in the event of a liquid propellant missile explosion (Kennedy 2009:28).

One of the other early structures at the complex was the WAC Corporal Launch Tower. Standing 102 feet in height, it was constructed approximately 600 feet to the north of the blockhouse. The tower guided the WAC Corporal through the initial portion of its flight until it gained enough speed to self-stabilize, an arrangement that would soon also be used for the Navy Aerobee sounding rocket series.

The early V-2 firings took place near the WAC Corporal Launch Tower and relied on German field equipment to transport and erect the missile. The German designed and built *Meillerwagon* was a transport trailer with a built-in lift frame and hydraulics that lifted the V-2 into an upright position on the firing stand. An extendable ladder and the *Meillerwagon* lift frame provided access to the missile for additional preparation and servicing once it was in the vertical position (Kennedy 2009:38). This system was not ideal, and an improved gantry crane was constructed between August and November 1946. The gantry crane at LC-33 is of the launch complex's most visible structures. It consists of two 60 foot tall steel towers linked at their tops by upper cross members and is nearly 30 feet wide. The towers are affixed to railroad car wheels so that it can be moved along a set of tracks set into the concrete slab foundation of the launch complex. The gantry was equipped with a hoist at its top to aid in missile assembly and three sets of adjustable work platforms allowed stable access to the vehicle along its full height. After a vehicle was erected and prepped for launch, the gantry could be moved out of the way via the rails and electric motors that powered each wheel (Eckles 2013:176). The gantry was used to assemble V-2, Hermes, Corporal, and Viking missiles at LC-33 in the early days of WSPG.

LC-33 was also the location of several other historic early rocket and missile programs. These included the Navy Viking sounding rocket, which was launched from LC-33 before the program was shifted to LC-35 in 1952 (Kennedy 2009:98). Also flown from LC-33 was the Hermes missile series, a developmental contract with GE that began with the assembly and testing of the V-2, but also included an array of experimental projects. One was the Hermes A-1, an anti-aircraft missile that was based on the German *Wasserfall* prototype. Another prototype was the Hermes II, which combined a modified V-2 booster with a second stage ramjet engine. It was a Hermes II that went off course on May 29, 1947 and crashed in the outskirts of Ciudad Juarez, Mexico (Kennedy 2009:57). The Bumper series, which combined a V-2 and a WAC Corporal into a two-stage sounding rocket, was also a Hermes project that GE developed in partnership with JPL (Kennedy 2009:49). The fifth launch in this series, the Bumper 5, reached an unprecedented altitude of 244 miles on February 24, 1949. At the time this was the highest altitude ever reached by a manmade object (Kennedy 2009:51). On October 4, 1946, a V-2 carrying a special camera assembled by Clyde T. Holliday captured the first images of the earth from space, showing the curvature of the earth clearly (Holliday 1950). Other missiles tested at LC-33 were the Corporal, the Army's first tactical missile, and early flight tests of the Nike Ajax before the program was moved to LC-37.

LC-33 remained active through the 1960s, and a 1968 range summary described it as including 13 launch sites, two gantries, three blockhouses, several types of support buildings, and several explosive storage bunkers (WSMR 1968b:62). The WAC Corporal Launch Tower was dismantled after the completion of the program, but both the Army Blockhouse and V-2 Gantry at LC-33 are preserved as historic structures. The historic core of LC-33 was named a New Mexico State Historic Monument in February 1983, and was recognized as a National Historic Landmark on October 10, 1985. Portions of LC-33 are still in use today in support of the MLRS and the ATACMS (WSMR 2010).

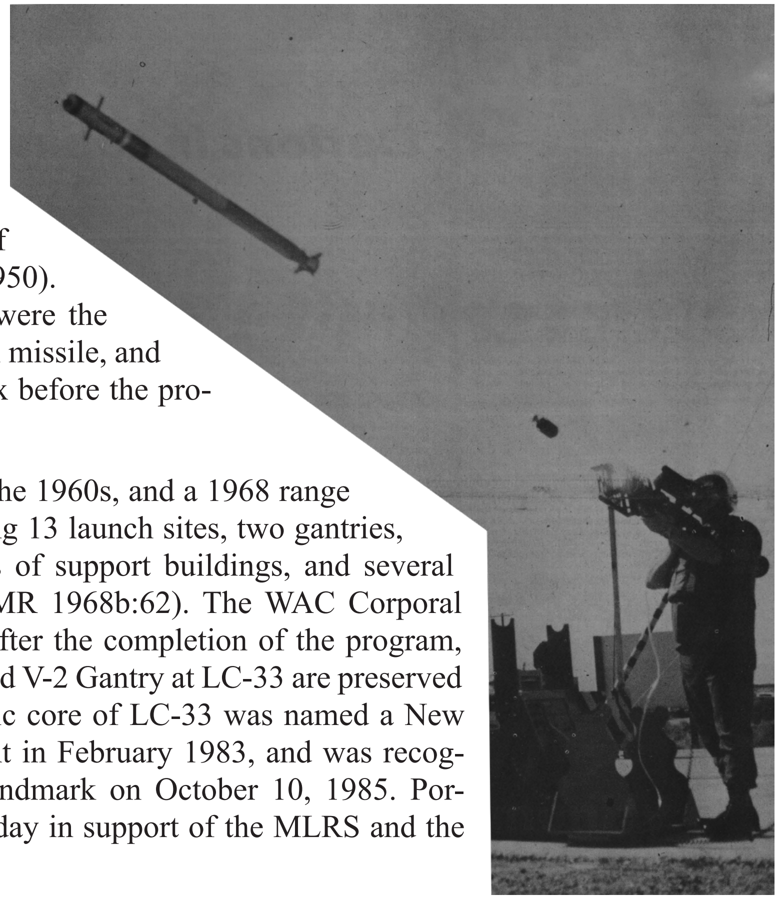

Figure 16. Sergeant Richard Vincell fires the first Stinger missile at LC-34 in 1976 (*photo by Frank Trevino, adapted from WSMR 1976)*.

6.5.3 LC-34

LC-34 supported testing of a variety of anti-aircraft missile systems during the 1960s and 1970s. As most of the systems fired at LC-34 were either mobile or man-portable, the complex lacks the extensive support infrastructure associated with many of the WSMR launch complexes.

LC-34 was originally built to support the Redeye and Mauler anti-aircraft missile vehicle programs in 1962 (WSMR 1968b:62). The Redeye was a man-portable, shoulder fired anti-aircraft missile system that was designed to counter low altitude aircraft threats. It was designed to be used with the Mauler anti-aircraft missile to provide a layered Forward Area Air Defense (FAAD) system. The Mauler was a self-propelled vehicle based system, which was ideal for its intended application. However, the concept encountered many "packaging" and technological issues that slowed its development and ultimately led to its cancellation in 1965.

After the cancellation of the Mauler program, LC-34 was used in support of the Chaparral anti-aircraft system. Like the Mauler, the Chaparral was a mobile, self-propelled system. It was designed around the established Sidewinder heat-seeker missile, and the original prototype of the system was developed and tested at NAWS China Lake, California. The Army adopted the development of the system for use in FAAD in the wake of the Mauler program cancellation.

The Redeye missile underwent a series of improvements, and by the 1970s had evolved into the Stinger missile. The Stinger was a man-portable, shoulder fired missile like the Redeye, but was significantly more advanced. As an extension of the Redeye, Stinger firings were also conducted at LC-34; in September 1976, Sergeant Richard Vincell was the first Army gunner to fire the Stinger at LC-34 (Missile Ranger 1976:1).

In 1978, LC-34 hosted a joint firing program of the Roland missile. For this program, both French and German Roland units and the American adaptation of the missile were tested to evaluate compatibility and interchangeability of the different versions of the system (Missile Ranger 1978:17).

Beginning in 1974, testing of the Navy Rolling Airframe Missile (RAM) was conducted at LC-34. The RAM was designed to protect the fleet from anti-ship cruise missile threats and was a very successful program. Modern variants of the missile have been adopted by the navies of many allied nations. The RAM underwent an extensive improvement program and flight tests of the missile against drone targets were launched at LC-34. The complex also supported testing of various configurations of RAM missiles, support equipment, and launchers (WSMR 2010).

Figure 17. A Talos missile on its launcher rail at LC-35 in 1958, USS Desert Ship in background (*courtesy WSMR Museum Archives)*.

6.5.4 LC-35

LC-35 is another early launch complex at WSMR, and was established in 1946 by the Navy Unit at WSMR. A blockhouse was constructed as part of the complex, and was essentially a slightly smaller version of the Army Blockhouse at LC-33. LC-35 is most well-known for the USS Desert Ship Land Locked Ship 1 (LLS-1) which provides a realistic replica of a Navy ship for the testing of ship-borne missile systems. The Desert Ship was added to the complex in 1951 (Eckles 2013:205). A replica deckhouse of a CG-10 class cruiser ship was added to the complex in 1954, to the east of the Desert Ship, and both remain in use today (WSMR Museum 2015a).

One of the most long-lived sounding rockets was the Aerobee, originally developed by the Johns Hopkins University APL for the NRL. The Aerobee was based on the ORDCIT WAC Corporal, but was scaled up in order to carry a larger payload. The Aerobee was produced by the Aerojet Corporation, and the name is derived from "*Aero*jet" and the APL "Bumble-

bee" project. All Aerobee sounding rockets were tower-stabilized during launch, and in 1947 the first Aerobee launch tower was constructed at LC-35. In 1965, the Aerobee launch tower at HAFB was relocated to LC-35 and established near the existing tower. The dual Aerobee launch towers allowed the Navy to effectively double the instrument payload of the Aerobee by launching two at once. The first Aerobee double launch occurred on April 14, 1966 with the Aerobee launches occurring eight minutes apart (Eckles 2013: 204). Some later launches were synchronized, with both Aerobees launching simultaneously. The last Aerobee launch from the dual towers occurred in 1986; in later years the two towers were dismantled (WSMR Museum 2015a). Most of the research and sounding rocket launches are now conducted at nearby LC-36.

A replica ship deck was constructed to the north of LC-35 in 1949 for a test known as Operation Pushover. In these early days of V-2 testing, data was needed for many aspects of V-2 launches including the question of what would happen if a ready-to-launch V-2 toppled over on a ship's deck during a sea launch. Operation Pushover provided answers to this question, and a fully fueled V-2 was rigged to topple over onto the deck during the launch sequence. This caused a large explosion that ripped a substantial hole in the steel deck (Helfrich 2007:4).

The Navy Viking research rocket launches nine through twelve were launched from LC-35 after the program was relocated there from LC-33 in 1952. A gantry crane and a blast pit were added to LC-35 to support the Viking launches, and Viking 9 blasted off from LC-35 on December 5, 1952 (Helfrich 2007:4). Viking 12, the last of the series launched at WSPG, was fired from LC-35 in 1955 (Kennedy 2009). The Viking gantry was relocated to Cape Canaveral, Florida to be used with the Vanguard program, America's first satellite launch vehicle that was based on the Viking. The blast pit was filled in sometime around 1960 as it created pedestrian and vehicular hazards (Helfrich 2007:4-5).

LC-35 was a significant testing location for the Talos missile, testing of which was conducted at WSMR for over 20 years (Helfrich 2007:5). Rail launchers for the Terrier and Tartar missiles were also installed at the complex. Although the early RDT&E testing of the Terrier and Tarter was conducted at China Lake, California, the testing program for these missiles was consolidated to LC-35 in 1966 (Helfrich 2007:5; Kennedy 2009:144). During the mid-1960s, the development of the Advanced Surface Missile System began, and this evolved into the Aegis Combat System. The Standard Missile-2 and Aegis fleet fire control system were tested at LC-35 before the system entered Navy service in 1983 (Helfrich 2007:6).

In 1977, a Navy Mk 39 5/54 Gun weighing over 73,000 pounds was relocated to LC-35 as part of the testing program for the 5-inch Guided Projectile program (Helfrich 2007:6; WSMR Museum 2015a). A Mk 5 Guided Missile Launcher was moved to LC-35 in 1977 for testing of the Standard family of missiles, which included the Terrier Extended Range and Tartar Medium Range missiles. Standard Missiles were also launched as part of the Vertical Launch System (VLS) testing at LC-35 (WSMR Museum 2015a). The VLS allowed more missiles to be carried aboard ships and launched at higher firing rates. The VLS is now the standard launch system used by the US Navy (Helfrich 2007:6).

In more recent years, LC-35 supported testing of the Evolved Seasparrow Missile (ESSM), various improved versions of the Standard Missile family, Sea Lance, and Vertical Launch Anti-Submarine Rocket (ASROC) systems (WSMR 2010). The LC-35 5-inch gun was last

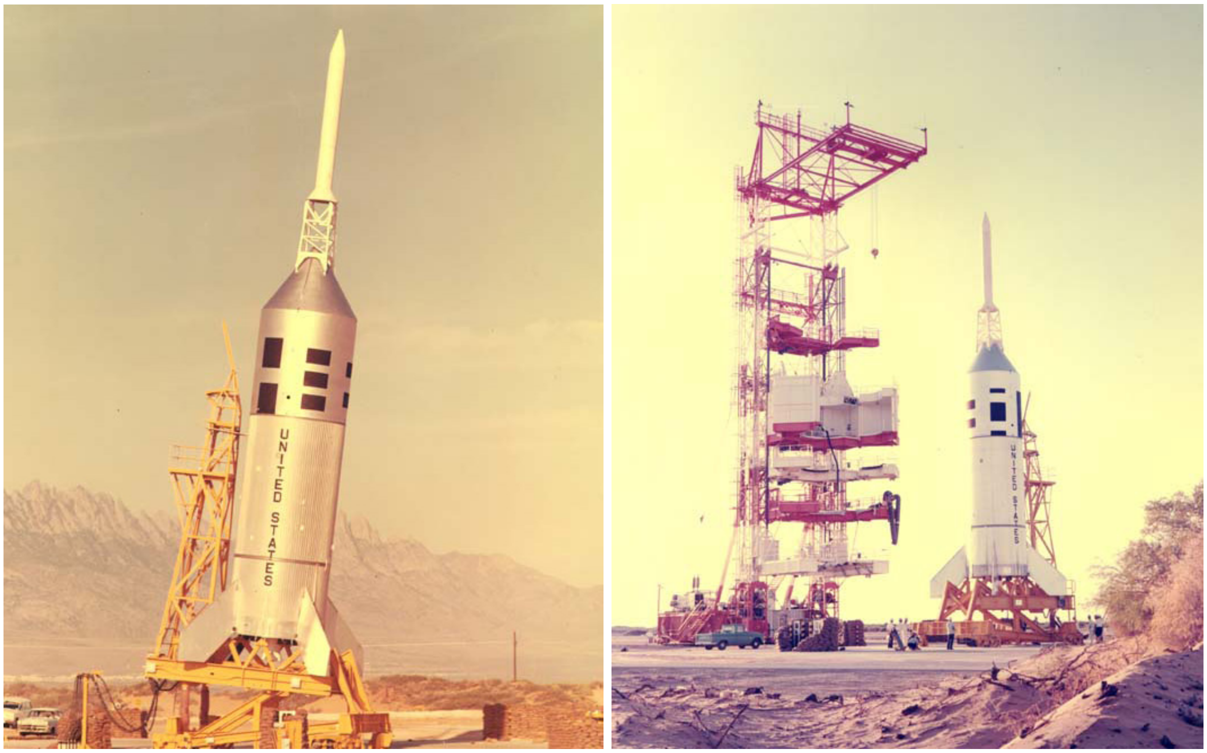

Figure 18. The Little Joe II on its launcher at LC-36 in 1966 (*left)*; the Little Joe II and its assembly gantry, which has just been removed in preparation for launch (*courtesy WSMR Museum)*.

fired in 1996, and it was moved to the WSMR Missile Park in 2006. The Mk 5 Launcher was also moved to the Missile Park in 2006 (WSMR Museum 2015a).

6.5.5 LC-36

LC-36 was originally constructed for RDT&E support of the Corporal missile, concurrent with the establishment of LC-37. Both LC-36 and LC-37 were originally laid out as part of Army Launch Area 3 (ALA-3) in 1952, with the LC-36 facilities consisting of a launch area for the Corporal missile. By the late 1950s, the complex was adapted for testing of the tactical Redstone missile. During the Redstone testing, the complex primarily consisted of a single launch pad and a track mounted gantry large enough to assemble and prepare the large Redstone missile for launch. The Redstone launches at LC-36 ended by 1962, and the launch complex was then used by NASA for launches of the Little Joe II (Eckles 2013:9). The Little Joe II was a special purpose launch vehicle designed for the testing of the Apollo LES. The LES was an emergency rocket system that would pull the Command Module away from the launch vehicle in an abort situation, launching the crew to safety. The LES would then deploy a parachute recovery system for a safe landing (Dotts 1973). The Little Joe II followed the original Little Joe, which had served the same purpose for the earlier Mercury space capsule. As the Apollo capsule was much larger than the Mercury capsule, the Little Joe II was also larger in order to properly simulate the diameter of the Saturn rockets that were used to launch the actual Apollo space capsule. The Redstone gantry was modified for use with the Little Joe II, and the system was tested at LC-36 between 1963 and 1966, with launches simulating the LES system at various flight stages (WSMR Museum 2015b). On January 20, 1966 the final Little Joe II vehicle was launched from LC-36 and began a programmed tumble maneuver 9 miles downrange at an altitude of nearly 15 miles; the LES functioned perfectly and fired the abort rocket carrying the command module away from the vehicle before landing by parachute (WSMR Museum 2015b).


Figure 19. A Nike Hercules on its launcher at Section D of LC-37 in 1971 (*photo courtesy WSMR Museum Archives)*.

Following the completion of the Little Joe testing, LC-36 was adopted by the Navy for a long series of sounding rocket launches. The Navy Research Rockets Branch at WSMR provided launch services at LC-36 for a number of organizations, often sponsored by NASA, the NRL, and the USAF (WSMR Museum 2015b). Many universities with upper atmospheric and space research projects had experimental payloads carried aloft by sounding rockets launched at LC-36, and the Navy and the New Mexico State University (NMSU) Physical Science Laboratory (PSL) provided the necessary technical support (WSMR Museum 2015b).

An Aerobee launch tower was established at LC-36 when the sounding rocket program expanded from LC-35 to LC-36 during the 1960s. Additional facilities were added in 1968 for the Aerobee 250 test program (WSMR 1968b:64). Numerous Aerobee sounding rockets, including the 150, 250, and 350 series, were launched from LC-36. The distinctive Aerobee 350 launch tower at LC-36 is enclosed in its lower portion, with the tower extending through the apex of the pyramidal roof.

Another well-known sounding rocket, the Black Brant, was also launched from LC-36 beginning in the 1970s. The Black Brant was built by Canadian firm Bristol Aerospace and it was introduced in 1961. Like the Aerobee, there were numerous versions of the sounding rocket, with the Black Brant V (BBV) being one of the most popular. The larger BBV model was launched from the Aerobee 350 tower at LC-36 beginning in 1972 (WSMR Museum 2015c). The Black Brant series has an excellent success rate and remains in use today.

LC-36 continues to be used as the primary sub-orbital rocket launch facility at WSMR. As of 2010, it is described as including four active launchers with environmental shelters and one mobile launcher (WSMR 2010).

6.5.6 LC-37

LC-37 was originally part of ALA-3, the original boundaries of which also included LC-36. LC-37 was the primary launch location for production testing of the Nike Ajax and developmental tests of the Nike Hercules. Early prototype testing of the Nike Ajax was located at LC-33, but tests of the production version of the Nike Ajax were conducted at LC-37 beginning in 1953. The Nike facilities at LC-37 were constructed to simulate the Nike missile batteries that were constructed nationwide during the 1950s. The original prototype for the Nike missile underground storage magazine and elevator launcher was also tested at LC-37. The Integrated Fire Control (IFC) complexes for the Nike systems were located near the south end of the complex, just north of Nike Avenue. The various Nike tracking and guidance radars were co-located near the IFC complexes and were replaced and modified as the Nike series progressed from the Ajax, to Hercules, to Improved Hercules (Piland 2006a:5). Near the center of the complex is an assembly and checkout area consisting of several buildings, and a fueling station for the early liquid-propellent version of the Nike Hercules was also constructed near the assembly area.

The High Booster Experiment (HIBEX) and related missile programs were active at the complex in the late 1960s (WSMR 1968b:64). The HIBEX launch area was established northwest of the Nike Assembly and Test building, and 10 HIBEX missiles were launched there in 1965 and 1966. Flights of the Squirt, a materials testbed vehicle for the Sprint missile, were launched from LC-37 during the mid-1960s, as were the early test flights of the Sprint Propulsion Test Vehicle. As the Nike Hercules missiles were phased out in the 1970s, the volume of activity at LC-37 gradually decreased. During the late 1980s and early 1990s, tests of the High Endoatmospheric Defense Interceptor (HEDI) program were launched from the former HIBEX area in the northwest part of the complex.

6.5.7 LC-38

LC-38, formerly Army Launch Area 5 (ALA-5), was originally developed to support the development of the Nike Zeus system (WSMR 1959). The Nike Zeus was the nation's first missile specifically designed to intercept ICBMs and it was a complicated and elaborate system that required state of the art radar and computer systems. The Nike Zeus development was authorized in 1957, and the first firing of the Nike Zeus A occurred in August 1959 while the first launch of Nike Zeus B took place a year later. Early flight tests of the Nike Zeus missile took place at WSMR, and launches of the missile were also conducted at Point Mugu California, and at Kwajalein Island in the Pacific (Piland 2006b:5). LC-38 is the focus of the current inventory, and details regarding its association with the Nike Zeus and later programs is discussed in further detail beginning in Section 6.6.

6.5.8 LC-39

LC-39 is mostly undeveloped, but was utilized as a location for launches of the Lance missile from the 1970s to the 1990s. A single launch area was established within the complex to support the Lance flights. The Lance, originally known as "Missile B," was conceived during the late 1950s as a replacement for the Honest John, Little John, and Lacrosse missiles. In 1962, the development contract for the Lance was awarded to Ling-Temco-Vought (LTV). The Lance concept was based on, "simplicity, ruggedness, reliability, accuracy, and low cost" (McKenney 2007:234).

The Lance was the first Army missile to use pre-packaged and storable liquid propellant. Liquid propellant motors were generally more efficient and offered better power and accuracy

Figure 20. A Lance training launch at LC-39, 1982 (*image courtesy WSMR Museum Archives)*.

than solid propellants; however, the fuels were often volatile and involved cumbersome and time-consuming fueling procedures that were poorly suited for field operations. The stable, pre-packaged propellant used in the Lance eliminated the need for fueling in the field and gave the system a rapid response time (McKenney 2007:234; Redstone Arsenal 2017).

The Lance was approved for production in September 1970, with the first Lance battalion activated in June 1972 and the first Lance unit deployed to Europe in September of the same year (Lang 2015). The Lance required minimal support equipment to launch in the field and was more accurate than the existing Honest John system. The Lance was launched from a self-propelled launcher based on the M113 armored personnel carrier. A similar loader/transporter vehicle hauled the missiles and was used to load them onto the self-propelled launcher vehicle (McKenney 2007:234).

Since the Lance was a mobile, vehicle launched system, it required little infrastructure at LC-39. Based on period newspaper articles and photography, LC-39 was mostly used for service practice flights by Army artillery units equipped with the Lance. The 1st Battalion, 12th Field Artillery, based out of Fort Sill, Oklahoma, fired its first Lance missile from LC-39 in 1972

Figure 21. LC-50 circa 1965 (*courtesy WSMR Museum)*.

(Missile Ranger 1972). Training flights of the Lance continued to be conducted at LC-39 until the end of the Cold War. In 1992, the Bush administration initiated a unilateral removal of all tactical nuclear weapons, including the Lance. The 1st Battalion, 12th Field Artillery fired the last Lance missile at LC-39 in June 1992 (Missile Ranger 1992). After it was removed from Army service, surplus Lance missiles continued to be used as targets for other missile systems.

6.5.9 LC-50

LC-50 was built expressly for the Sprint missile, which was part of the Nike X BMD system, later the Sentinel and Safeguard systems. Also known as the Sprint Site, the launch complex is located in a somewhat isolated location to the north of the Nike Avenue launch complexes and south of Highway 70 (Eckles 2013:9). The construction of the complex began in 1964 and the first Sprint launch at the complex took place on November 17, 1965 (Piland 2006c:5).

A total of 42 Sprint missiles were launched from LC-50, with the last launch occurring on August 12, 1970. During the third launch of a Sprint at LC-50 in March 1966, the missile's first stage exploded and destroyed the test cell. Fortunately, none of the personnel at the site were injured (Eckles 2013:9).

After the conclusion of the Sprint program, LC-50 was re-used for a variety of programs. It supported testing of the manportable anti-aircraft Stinger missile during the late 1970s. It was then used for testing of the Navy RAM during the 1980s. During the 1990s, the Enhanced Fiber Optic Guided Missile (EFOGM) was tested at LC-50. The EFOGM was an anti-tank and anti-helicopter missile that was optically guided, similar to the TOW missile. The last system

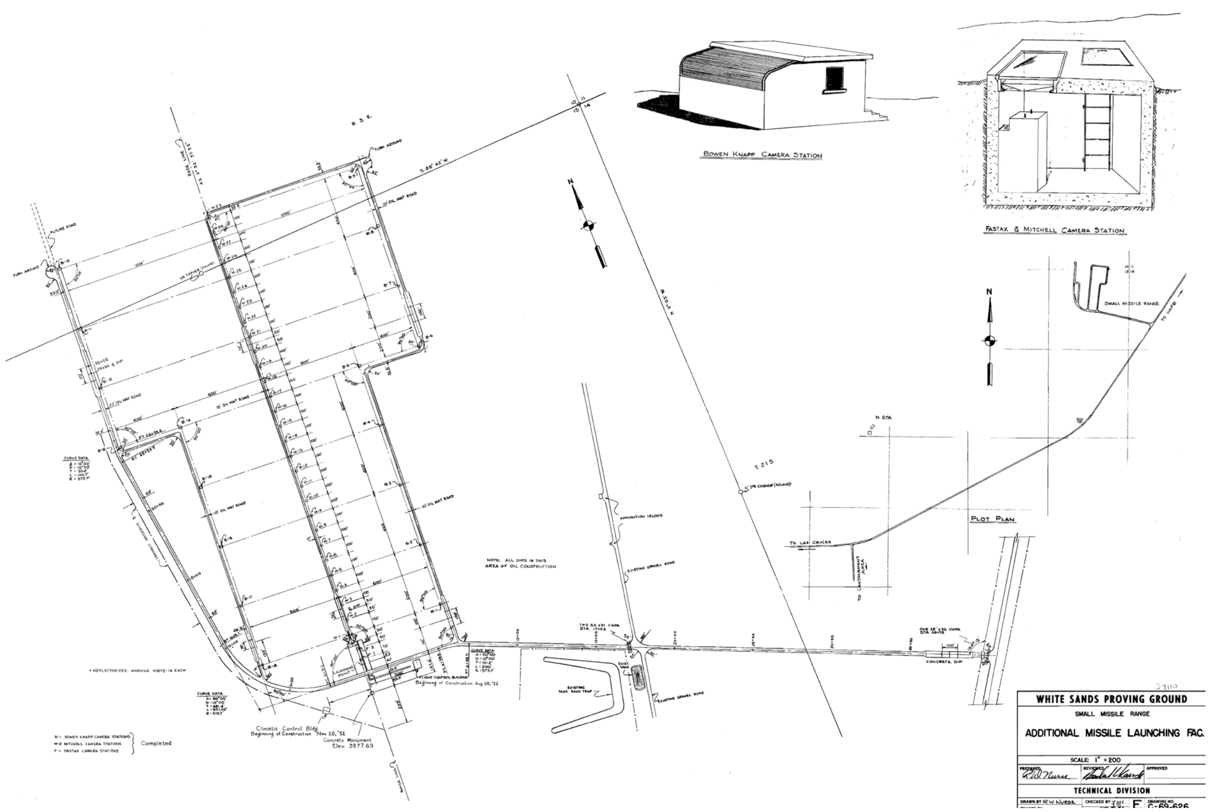

Figure 22. A 1951 map of the SMR with inset drawings of its camera shelter buildings (*drawing courtesy WSMR)*.

tested at LC-50 appears to have been the Line-of-Sight Anti-Tank (LOSAT) missile during the mid-to-late 1990s.

6.5.10 The SMR

The WSMR SMR is located north of US Highway 70 (US 70) and is not part of the Nike Avenue group of launch complexes. The SMR is a *de facto* launch complex, but also included downrange instrumentation and impact areas that allowed it to serve as a semi-independent sub-range within WSMR for the testing of small rockets and missiles. The SMR was established in 1953 to support testing of the Loki anti-aircraft rocket, a barrage rocket system that was based on the German Taifun prototype. After the cancellation of the Loki program in 1955, the SMR continued to support a number of tactical missile test programs, particularly anti-tank systems. Testing of these smaller programs at the SMR kept the main launch areas along Nike Avenue available for bigger projects and also reduced the need for road closures due to overflights of US 70 (Eckles 2013:28). The SMR also featured an independent instrumentation network that allowed it to operate in a relatively autonomous fashion from the main range instrument network. The SMR instrument network consisted mostly of high-speed cameras that were suitable for the shorter ranges and altitudes anticipated of the SMR programs, and this network of camera shelters is one of the defining attributes of the complex.

Testing activities at the SMR began with the Loki Program in 1953, although further development of the Loki as an anti-aircraft weapon was halted in 1955. However, the Loki saw a much longer service life as the Loki-Dart sounding rocket. On the heels of the Loki, testing of the Little John Rocket began in 1956, and the Dart Anti-Tank Missile underwent testing at the SMR beginning in 1954. The Dart development was canceled in 1958, but it was the first of several anti-tank developments tested at the range. The Little John was tested at the SMR through the early 1960s, and continued to be used as a range workhorse test vehicle into the 1970s. These three programs were largely responsible for the construction of many of the buildings present at the SMR today.

The Lacrosse missile was tested at the SMR during the late 1950s and early 1960s, and briefly entered service before being retired in 1964. The anti-aircraft Redeye and Mauler systems were also tested at the SMR during the early 1960s prior to the program moving to LC-34. Also during this period, the Shillelagh Program initiated testing and development at the SMR, beginning in 1963. The Shillelagh/Sheridan gun launched missile program was very active at the SMR throughout the 1960s. The TOW and Dragon anti-tank missiles were also tested at the SMR during the late 1960s and early 1970s. By the early 1970s, the Copperhead guided artillery round began testing at the SMR, and remained the major testing activity at the SMR through the 1970s. Anti-tank weapon development at the SMR continued with the Kinetic Energy Missile (KEM) testing of the 1980s, including the Air Force Hyper-Velocity Missile and the follow-on LOSAT missile in the 1990s.

The SMR was also an important location in the development of sounding rockets for the study of upper atmospheric conditions and meteorological research, and many examples of this technology were in fact pioneered at the SMR. The Loki-Dart, Super Loki, All Purpose Rocket for Collecting Atmospheric Soundings (ARCAS), XM-75, and High Altitude Research Project (HARP) gun launched probes all underwent testing and development at the SMR. Some of the sounding rockets, such as the Loki-Dart and Super Loki, were regularly launched at the SMR for many years as part of the ongoing Atmospheric Science Laboratory (ASL) meteorology program, and the spent motors of these rockets remain scattered across the SMR today. Through these sounding rockets, substantial contributions were made to the scientific study of the upper atmosphere, and the monitoring of upper atmospheric winds was also critical in plotting trajectories for missile test flights.

6.5.11 Up-Range and Off-Range Launch Complexes

By the end of the 1950s, Army missiles were capable of ranges exceeding the boundaries of WSMR, and the Army began to consider ways to extend the boundaries of the range, at least temporarily. By 1960, the Army had established land-use agreements with private land owners at the range's northern boundary which allowed a 40 by 40 mile extension to be used temporarily for long range tests. This area was known as the Firing In Extension (FIX) area (Eckles 2013:249) and allowed for additional space for longer missile flight tests and also provided a safety buffer for missiles that impacted at the northern limits of the range.

The northern range area also provided locations for launching missiles as targets to be intercepted over the central part of the range by missiles launched from the Nike Avenue launch complexes. During the 1960s, the Zeus Up Range Facility (ZURF) was established approximately 90 miles north of the main WSMR cantonment, a few miles northwest of the Trinity

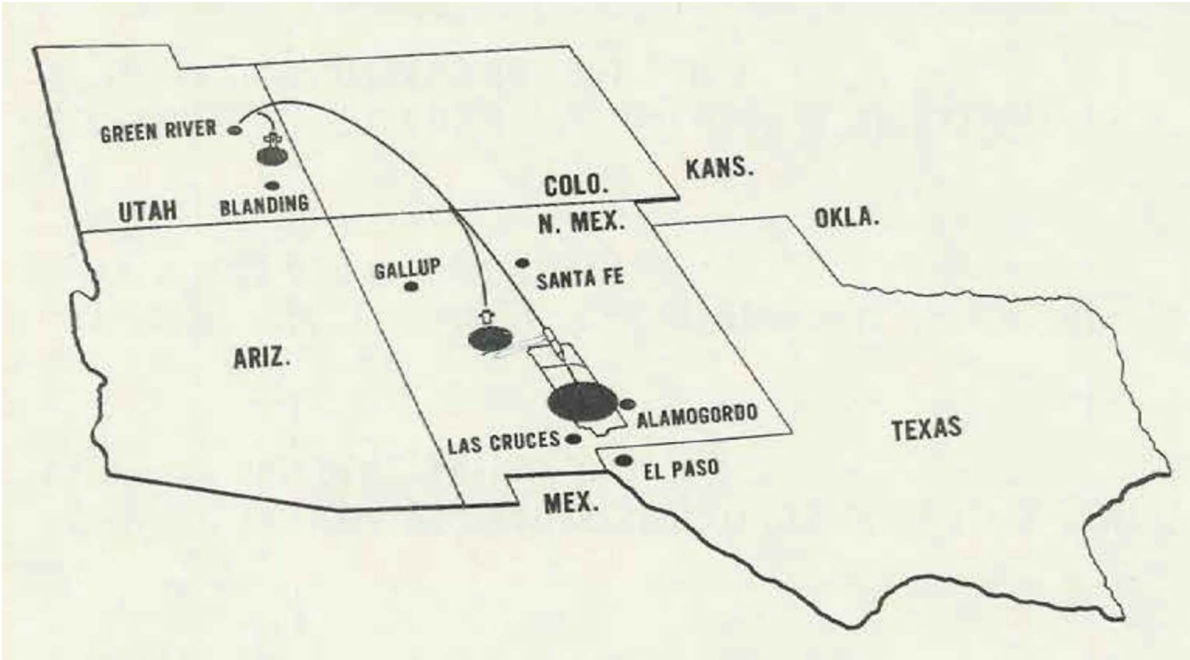

Figure 23. Flight path of Athena missiles launched from GRLC to WSMR (*adapted from WSMR 1968b)*.

Site. The small launch area was used to launch Nike Hercules missiles south as targets for the Nike Zeus missile (Eckles 2013:133; WSMR 1968b:64).

Another up-range launch complex is the Navy Satellite Uprange Launch Facility (SULF) site located at the northwest end of the range. This facility includes a blockhouse, assembly building, environmental shelter, and several Navy missile launcher rails (WSMR 2010). Refurbished Talos missiles, known as the Vandal, were launched from this site as targets for the Navy Standard Missile and the HELSTF laser. The Storm Target Missile, similar to the Hera, was also launched from this location for intercepts mid-range (Eckles 2013:23). The WSMR website also notes that this facility is used “to launch technology demonstrators or unique science and engineering payloads into sub-orbital trajectories” (WSMR 2010).

During the THAAD and Patriot Advanced Capability 3 (PAC-3) testing of the mid-1990s, a small permanent launch complex was established within the FIX area on the Donaldson Ranch. This small launch complex and supporting instrumentation sites were established in 1994 and thus dubbed LC-94 (Eckles 2013:250). The complex supported launches of the Hera and Storm Target Missiles and included a large rail-mounted environmental shelter for the assembly and pre-flight conditioning of the missile (Eckles 2013:250). The Hera was also launched at LC-32 and a similar shelter is found there.

Although the FIX improved the distance missiles could safely travel within WSMR, it was still not enough space for long distance flight tests of systems like the Redstone and Pershing. In order to adequately test the long range capabilities of systems like the Redstone, Sergeant, and Pershing, the Army began to plan for an extended firing corridor involving leased or purchased tracts of land outside of WSMR. By 1958 the Air Force had successfully flown Matador and

Mace missiles, early versions of cruise missiles, 700 miles from HAFB to Wendover, Utah (Eckles 2013:248). The concept of extended off-range firings was validated, but the logistics of land-use agreements, evacuations, safety corridors, and booster drop zones took WSPG planners several more years to overcome.

In 1960, WSPG worked out an agreement to use Fort Wingate outside Gallup, New Mexico for Redstone flight tests. Fort Wingate was a WWII-era munitions depot that was no longer used as of 1960. The plan was to launch Redstone missiles from Fort Wingate to impact areas within the large range interior of WSPG. However, even though the Army worked out most of the logistical hurdles for the off-range launches, the Redstone was never launched from Fort Wingate and the scheme was canceled in 1961. This was possibly because technical issues with the Redstone were worked out before the off-range launches could get going, or because the Redstone was nearing obsolescence by 1961 and off-range launches were simply not worth the trouble and expense for an aging missile system (Eckles 2013:251). The effort to establish Fort Wingate as an off-range launch site was not wasted, as it was later used for launches of the more sophisticated Pershing missile beginning in 1963 (Eckles 2013:253). In the 1990s, the site was used again for launches of the Hera and Storm Target Missiles for testing of the THAAD and Patriot PAC-3 missiles. Established in 1996, the Hera launch site at Fort Wingate became known as LC-96 and includes administrative offices, a missile assembly building, launch control shelter, and a launch pad with environmental shelter (WSMR 2010). The launch pad and shelter are similar to those at LC-32 and LC-94 (Larry Carreras personal communication 2015).

The earliest true off-range firings were of the Sergeant missile which was launched from a site on the San Augustin Plains outside Datil, New Mexico in 1963. The San Augustin Plains site was only a temporary location and did not include any substantial infrastructure or facilities (Eckles 2013:252; Wind and Sand 1963:1).

Perhaps the most developed and best-known off-range location is the GRLC located outside Green River, Utah. The GRLC was established in support of the ABRES program in 1962, which studied the re-entry characteristics of ICBMs using the sophisticated RAM and RAMPART systems. The goals of this program were to improve both offensive and defensive systems (Feit et al. 2014; WSMR 1968a). The ABRES program launched a sub-scale Air Force ICBM missile known as the Athena, which impacted at WSMR. The ABRES program launched Athena missiles from GRLC to WSMR from 1964 until 1973. Following the Athena launches, the GRLC served as the launch area for the Pershing missile through the mid-1970s (Feit et al. 2014; WSMR 1968a). As of the late 1960s, the GRLC included three launch pads, two AN/FPS-16 radar installations, one blockhouse, an operations building, magazines, a meteorological rocket launch facility, and a variety of pre-manufactured steel buildings (Eckles 2013:254; WSMR 1968b:64). Other off-range locations in southeastern Utah used for Pershing launches included Gilson Butte and Black Mesa, but these locations primarily consisted of permanently located survey points used for situating mobile instrumentation and tactical launcher systems (WSMR 1968b).

6.6 Overview of LC-38

LC-38, originally known as ALA-5, was established specifically for testing of the Nike Zeus system. Some preliminary planning was completed in 1957 for facilities in the ALA-5 area that would have supported a program designated as “Project Plato.” Project Plato was an early attempt at developing a missile defense system, or “anti-missile missile” as it was referred to in period literature (Sylvania Electric Company 1955). However, it does not appear to have progressed beyond the conceptual stages. The Army defined the desired characteristics for a mobile anti-missile system in 1951, and Sylvania Electric and Cornell Aeronautical Lab conducted competitive design studies for the proposed system from 1953 to 1955 (Parsch 2003). The early work on Project Plato was divided into Phase I and Phase II. Phase I focused on the conceptual design of a ballistic missile defense system based on existing technology, and Phase II continued work on the conceptual design towards an actual prototype system. Phase I was completed in April 1955 and additional work, mostly design studies, continued through the end of the decade. In 1956, the Army awarded a development contract to Sylvania Electric for its XSAM-A-19 design for the Plato system (Sylvania Electric Company 1955). The proposed interceptor missile would travel at speeds of Mach 6 to 8, so the program initially focused on studying heat-resistant materials that were suitable for hypersonic flight. Component development for the proposed Plato system continued until 1959, when the Army cancelled the program (Parsch 2003). No prototypes for the system were built, and it appears unlikely that any actual facilities were constructed in the area of ALA-5 prior to the cancellation of the program.

Major construction of the Nike Zeus facilities at LC-38 started in 1958, with additional major facilities added through 1962. The original layout of LC-38 consisted of five main developed areas. Immediately north of Nike Avenue was a technical and support area centered around the main assembly building (Property 23626). The assembly building and the neighboring elevated water storage tank (Property 23627) are both prominent from Nike Avenue. Co-located in this area, which is accessed by Range Road 242, was the cafeteria building (Property 23632), the Early Missile Test (EMT) Guidance building (Property 23620), and an administration building (Property 23630). Of these buildings, Properties 23620 and 23630 have been demolished, but Property 23632 remains in place. In 1969, a communications building (Property 23610) was also added to this general area.

To the north, in the west central part of LC-38, is a hazardous assembly and checkout area that is surrounded by a chainlink fence. The two main magazine structures in this area, Properties 23654 and Properties 23656, consist of reinforced concrete assembly bays set within earthen revetments. Associated properties in this area included Properties 23654, 23655, 23660, and 23664, and an undesignated portable building. Property 23664 has been demolished, but the other buildings remain in place in this area. This area is accessed by a short access road that branches from Range Road 239.

Located in the north-central part of the complex was the original Nike Zeus launcher area. This area originally consisted of two below-grade launcher pits (Properties 23669 and 23673) and one silo-based launcher that launched the missile vertically (Property 23683). Co-located with the launchers was a control building (Property 23680) which consisted of a pre-manufactured steel building located above a below-grade concrete control shelter. Small concrete buildings (Properties 23670 and 23672) that housed control equipment and hardware were associated with each of the launcher pits, and earthen revetments (Properties 23668 and 23671) were associated with each of the launcher pits. An underground access tunnel was attached to the below-grade control room of Property 23680. This area has been heavily modified, and the Nike Zeus launch pits have been removed from this area, as has Property 23580. Only the foundation of the Nike Zeus tactical launcher (Property 23683) and portions of the below-grade access tunnels remain intact in this area. New facilities were constructed in support of Patriot missile testing during the 1970s, including Properties 23678 and 23688. Additional launch facilities, access roads, and instrumentation sites were constructed to the north as part of the 1970s Patriot testing, and in 2000, a new operations building (Property 23700) and parking lot were constructed in the area.

The central part of the complex was dominated by the Nike Zeus radar installations and related support facilities, which were constructed along Range Road 240. The Nike Zeus radar buildings in this area included Properties 23638, 23640, 23641, 23642, 23647, and 23648. Some of these properties have been completely removed, while the other buildings have been modified and repurposed.

The final major developed area of LC-38 was the ZAR area in the east central part of the complex. The substantial Nike Zeus acquisition radar buildings were located in this area (Properties 24062, 24064, and 24072), along with a series of physical plant facilities (Properties 24065, 24066, and 24068). The ZAR area was surrounded by an extensive chainlink fence that formed an internal security perimeter around this sub-area of the complex. Details regarding the elaborate network of Nike Zeus radar and guidance facilities are described below in the sections regarding the Nike Zeus system and its operation at LC-38.

In the northeast corner of the complex is a small aircraft hangar (Property 24070) that connects to the alignment of a former runway (Property 23075) via a taxiway. The small hangar building remains in place, but the runway has been reclaimed or destroyed, and the connecting taxiway is partially covered by windblown sand. Several isolated properties are located across the complex interior. These include a boresight tower (Property 23694), guard house along Range Road 242 (Property 24025), and several small instrumentation facilities. A cluster of instrumentation properties (Properties 24008, 24010, and 24015) is located in the south-central part of LC-38 at the Seus Site. While Property 24010, a mobile instrumentation site, remains in use today, most of the other isolated instrumentation sites within the complex's interior have been abandoned.

Many of the original Nike Zeus properties remain in place, but have been adapted for other purposes, while some have been completely removed. However, the primary sub-areas of the launch complex as established for the Nike Zeus program are still evident.

This section provided a brief overview of the physical layout of LC-38 and the programs that were primarily responsible for its built environment. The historic context will now go into further detail of the major programs supported at LC-38, particularly the Nike Zeus and Nike X programs. Chapter 7 provides detailed descriptions and photographs of the resources documented during the current inventory and Chapter 8 provides an NRHP evaluation of LC-38 and its constituent resources.

6.7 The Nike Missile System

Testing of the Nike Zeus BMD system was the defining program of LC-38, with most of the launch complex's early facilities and layout dedicated to the testing of this important Cold War missile defense system. However, Nike Zeus was the third version of the Army's Nike missile, the earlier versions of which had already been deployed across the nation to provide a last line of air defense against Soviet bombers. The origins of the Nike program date back to WWII when the success of both Allied and Axis bombing campaigns made it plain to American military planners that more effective anti-aircraft weapons would be needed to ensure national security in any potential future conflicts. The development of high-speed jet aircraft in the near future, as well as the eventuality that rival superpowers would develop the atomic bomb, raised the stakes for air defense systems. In the years after WWII, these emerging technologies made effective air defense more difficult, and required defense systems more sophisticated than the existing anti-aircraft gun batteries. With these concerns in mind, the Army Ordnance Department made the development of a guided anti-aircraft missile system a priority in the nascent US missile program. In order to better understand the origins of the Nike Zeus system, the context will provide a summary of the system's predecessors, the Nike Ajax and Nike Hercules.

6.7.1 Development of the Nike Missile

In 1944, the Army Ordnance Department awarded a contract to Bell Telephone Laboratories (BTL) for a complete study of a guided anti-aircraft missile system. The project was named Nike after the Greek winged goddess of victory. The study concluded in 1945 that the existing missile, radar, and computer technologies developed during the war could be combined and improved into a complete weapon system. The Army amended the BTL contract to include the design and development of the Nike system, and BTL chose Douglas Aircraft Company (DAC) as a key subcontractor. Douglas in turn awarded subcontracts to Aerojet and JPL for work on the propulsion system in the fall of 1945 (Kennedy 2009).

The Nike design consisted of two stages; a solid propellant booster and liquid propellant second stage. The first Nike test vehicle was the Nike 46, which was primarily designed for uncontrolled vertical flight tests to provide information on launching methods, booster propulsion, separation, motor performance, and flight stability (Cagle 1959:25). Fourteen of the experimental Nike 46 missiles were produced in 1946 for flight tests at WSPG, the first four of which had weighted wood (reportedly made of mahogany) dummy upper stages mated to the booster in order to evaluate booster performance and separation. The remaining 10 Nike 46 missiles included fully functional upper stages to test the liquid propellant motor performance of the Nike missile (Cagle 1959:25). As the tests were only concerned with power plant performance and flight stability under power, the Nike 46 missiles were constructed with fixed fins and were not equipped with control surfaces (Cagle 1959:25).

In order to achieve the needed amount of thrust, the booster used in the early design of the Nike consisted of a grouping of eight 11,000-pound thrust T10E1 solid propellant boosters. By March 1946, an improved booster had been developed by Aerojet and the eight-booster design was abandoned in favor of four of the new Aerojet boosters. The cluster of the four new Aerojet boosters, rated at 22,000 pounds of thrust each, provided an equivalent amount of thrust to the original design of eight clustered boosters and greatly simplified the booster assembly (Cagle

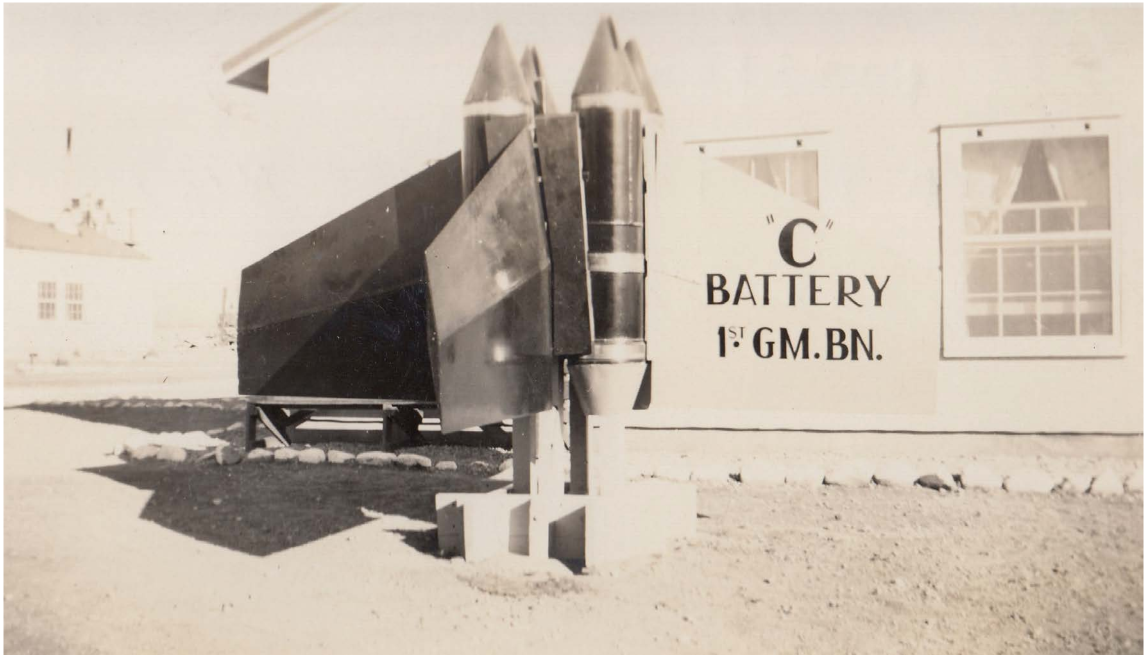

Figure 25. An early Nike four booster unit displayed at the WSPG cantonment (*photo courtesy WSMR Museum Archives)*.

Figure 24. A Nike 46 missile installed on the original Nike rail launcher at LC-33, circa 1946 (*photo courtesy WSMR Museum Archives)*.

1959:31).

Unlike the booster design, the development of the sustainer motor of the Nike missile itself progressed quickly and with minimal technical issues. The liquid propellant motor was developed by Aerojet between 1945 and 1946 and operated with a propellant mixture of aniline and furfuryl alcohol and an oxidizer of Red Fuming Nitric Acid (RFNA). The design used integral tanks, where the propellant tanks were a structural component of the missile fuselage. The Nike power plant underwent its first full-scale static test at WSPG in 1946 (Cagle 1959:32).

The first flight tests of the Nike missile were made at LC-33. The first Nike 46 launcher used at LC-33 consisted of four parallel guide rails incorporated into a pivoting base frame that allowed the missile to be installed in horizontal position and raised to near-vertical for firing. The wide four-booster assembly of the first stage rode outside the guide rails during firing (Cagle 1959:36).

The first Nike firing at WSPG was a static test conducted on September 17, 1946. The static test was successful, and the Nike 46-1 missile was returned to the DAC factory where it was refurbished. It was later launched as Nike Round 4 (Cagle 1959:37). Actual flight tests of the Nike 46 at LC-33 began on September 24, 1946 and continued through January 28, 1947. These tests included launches of the three “dummy” Nike 46 missiles that used wood upper stages to evaluate booster characteristics, all of which were successful. The flight tests of the complete two-stage Nike 46 followed, during late 1946 and early 1947, and revealed problems during the booster burnout and second stage ignition (Cagle 1959:39-40).

Exact determination of the problems with the Nike 46 was difficult due to the somewhat primitive state of instrumentation available during these very early days of WSPG. Cinetheodolites were used to track the Nike during tests, but the timing coordination between the various stations was imprecise, frame rates were slow, and evaluation of the film records slow and time consuming (Cagle 1959:40). As a result, data about the Nike flights was primarily derived from onboard flight recorders, which were contained in armored housings and recovered after the missiles impacted. Analysis of the in-flight instrumentation, recorded by cameras, indicated that the stage separation failed due to structural failures in the first and second stage interface.

The junction between the first and second stages was improved in the following Nike 47 series, which were flight tested at WSPG during 1947 and 1948. The strength and rigidity of the booster unit and tail of the Nike missile were improved to prevent uneven structural loading during the stage separation, and the propellant formulation of the booster and sustainer motors were refined as well. Five “dummy” missiles and four powered missiles were fired as part of the Nike 47 series, which were essentially a continuation of the Nike 46 tests and focused on the aerodynamic and performance aspects of the Nike during flight (Cagle 1959:46). The Nike 47 tests demonstrated sufficiently reliable performance of the booster operation and separation during flight, although some issues with uneven burn rates between the four clustered rocket units in the booster assembly were still evident (Cagle 1959:53).

To address the uneven burn rates of the clustered Nike booster, a new approach to the Nike booster was evaluated in 1948. A new booster developed by the Alleghany Ballistics Laboratory for the Navy Terrier missile program replaced the clustered booster stage with a single, powerful booster (Cagle 1959:53). The new booster gave the missile a longer and more streamlined

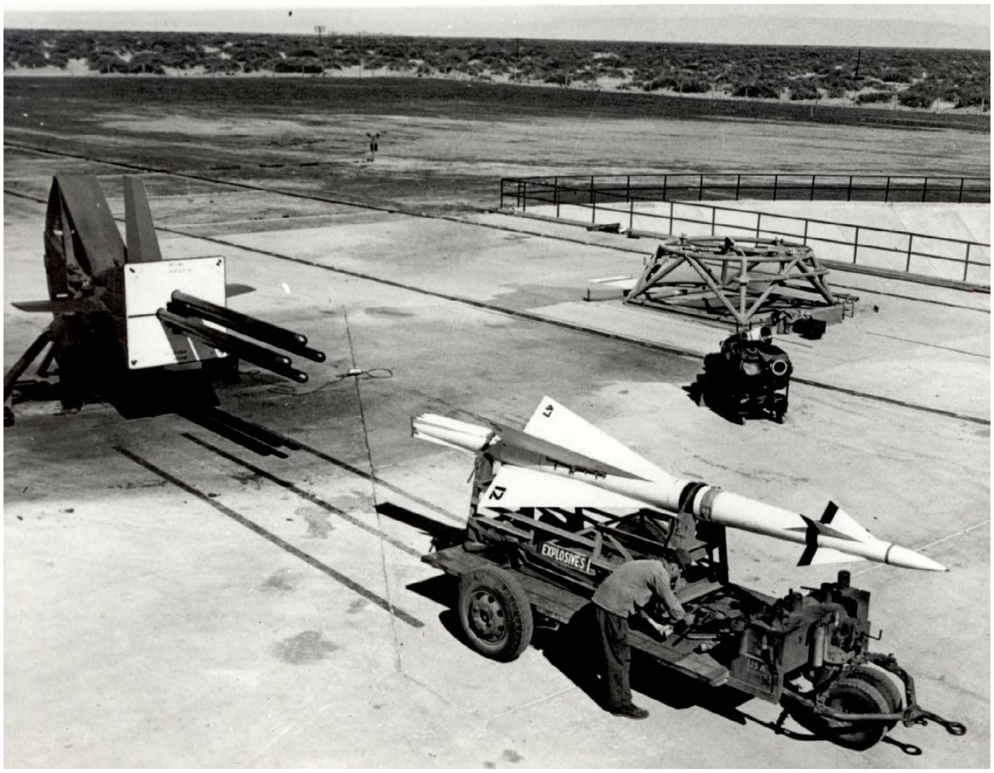

Figure 26. A Nike 47 missile being loaded onto the Nike rail launcher at LC-33, circa 1947 (*photo courtesy WSMR Museum Archives)*.

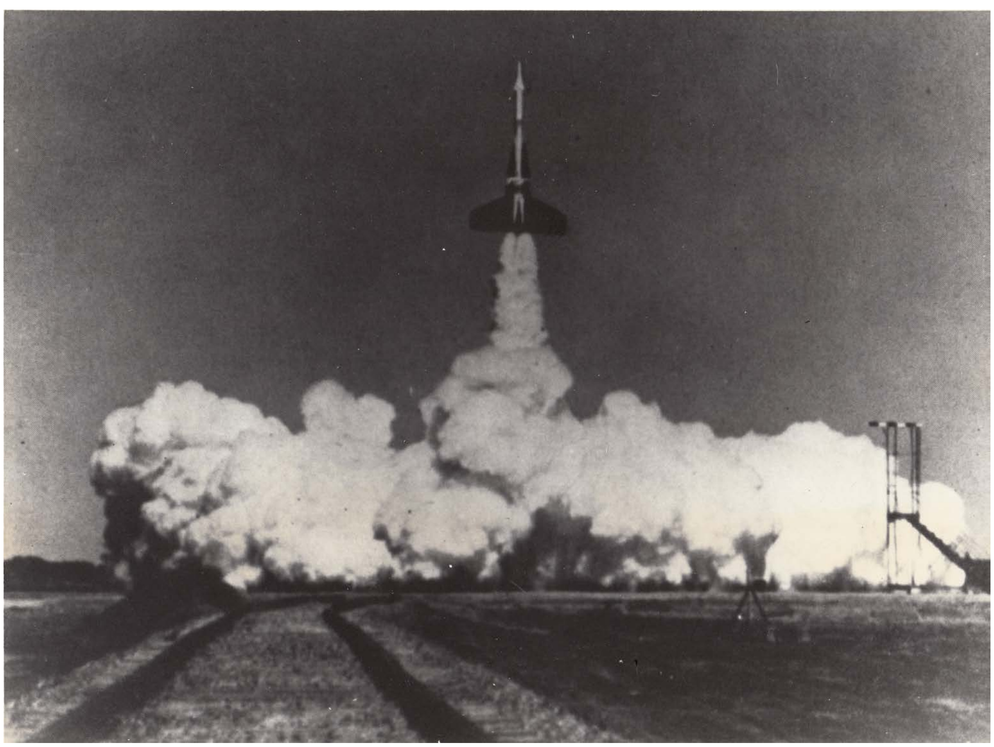

Figure 27. An early Nike with the clustered booster design launches at LC-33, circa 1946 (*photo courtesy WSMR Museum Archives)*.

Figure 28. A Nike 47 missile installed on the quad rail launcher, circa 1947 (*photo courtesy WSMR Museum Archives)*.

profile than the earlier Nike 46 and Nike 47 prototypes (Kennedy 2009:130). The same booster was later used in the Navy Terrier missile. Although the clustered boosters were subsequently phased out from the Nike design, the remaining cluster booster units were utilized during later tests as a means of economy.

Fabrication of the single booster unit to the Nike started in March 1946 and the change was incorporated into the Nike 48 test series. The Nike 48 flight tests included three "dummy" missiles and 13 complete two-stage missiles. The two-stage missiles were the same aerodynamic configuration as the Nike 47 and used the last of the cluster boosters (Cagle 1959:60). The Nike 48 vehicles were the first to be equipped with steering controls which steered the missile based on instructions from a "missile-borne programmer" (Cagle 1959:60). The Nike 48 steering tests were mostly successful, although roll stabilization proved to be a troublesome aspect and required extensive modification of the Nike gyro and steering circuits to correct (Cagle 1959:61-62). Despite this issue, the basic design of the vehicle was mostly settled with the Nike 48 and further development focused on refinement of the system and its guidance equipment.

The next Nike test series was the Nike 484, which ostensibly focused on the missile flight behavior under extreme yaw and pitch maneuvers. However, the tests also provided validation of the overall Nike system: "the sixteen missiles gave further proof of the suitability of the present configuration, components, structure, and methods of construction" (Cagle 1959:69). Additional modifications were made to the subsequent Nike 490 series; these changes were mostly focused on simplification of various aspects of production and vehicle weight reduction (Cagle 1959:75). The Nike 490 missile was the final Nike R&D vehicle and the 490 series served as the foundation for the production missile. The last Nike 490A test took place in July 1951, which paved the way for the penultimate tests against actual drone aircraft (Cagle 1959:80).

6.7.2 Deployment of the Nike Ajax

Twenty-three fully armed Nike missiles were launched during complete system tests during late 1951 to early 1952 (Cagle 1959:108). On November 27, 1951, Nike Round 69 successfully intercepted and destroyed a drone B-17 (Q-17) bomber flying at an altitude of 29,000 feet over WSPG (Kennedy 2009:133). The Nike missile exploded about 57 feet from the center of the Q-17 drone about 12 miles from the launcher — the shrapnel from the Nike's tripartite fragmentation warhead readily destroyed the bomber (Cagle 1959:112). The successful Nike Q-17 interception was not only the first major test of the system against a realistic target, but also marked the first successful intercept of an air target by a guided anti-aircraft missile (Cagle 1959:112). A dramatic photo sequence of a follow-up Nike intercept of a Q-17 bomber in April 1952 was captured by an IGOR tracking telescope, which was an early milestone for WSPG instrumentation. WSMR technician Joe Marlin was part of a team that operated the IGOR unit that captured the intercept, photographs of which won the 1955 Ernie Pyle Award for outstanding still photography in support of national security (WSMR 2017).

Due to the Korean War and concerns about security at home and overseas, many missile systems were placed on expedited development schedules (referred to as "crash programs" by the DOD), including the Nike. As a result, the first production version of the Nike, called the Nike I, was launched in early 1952 despite the need for additional R&D work on the system. The first production version of the Nike missile, the 1249 series, was successfully launched

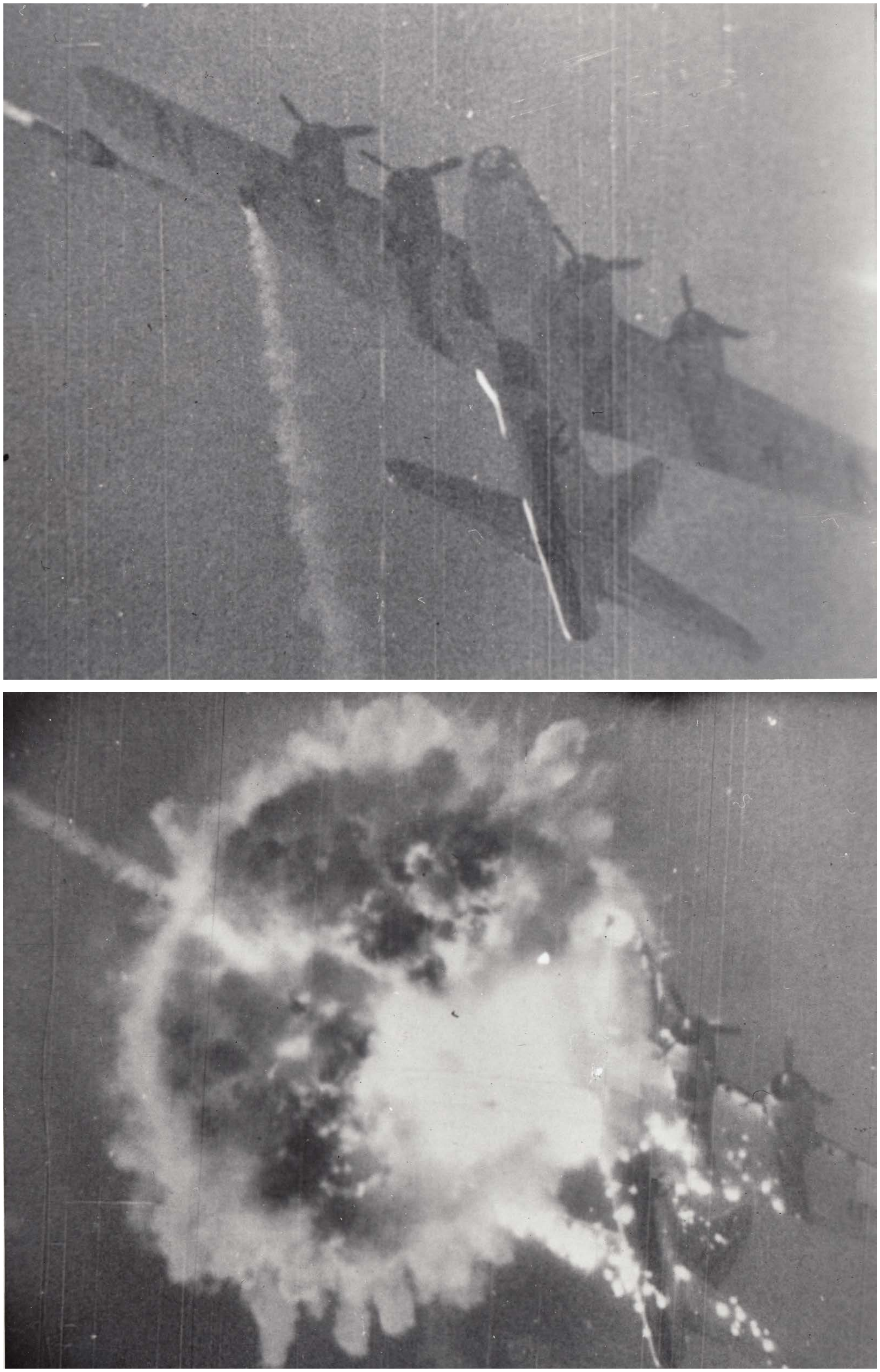

Figure 29. A Nike missile intercepts a Q-17 drone aircraft over WSPG, 1952. This series of photos won the Ernie Pyle Award for outstanding still photography in support of national security (*photo courtesy WSMR Museum Archives)*.

on July 22, 1952, just a few months after the completion of the Nike R&D test flights (Cagle 1959:122). Additional modifications and improvements were still being made to the Nike I system as late as 1955 when the Nike I was listed as a standard system by the Army (Kennedy 2009:135). The final Nike I missile was almost 20 feet long (34 feet with booster attached) and 12 inches in diameter and possessed a range of about 25 miles. The missile traveled at speeds up to 1,600 miles per hour and could reach an altitude of 15 miles. It was equipped with three warheads that would detonate into a cloud of shrapnel designed to maximize damage to enemy aircraft (Eckles 2013:245). BTL delivered the first complete production Nike Ajax battery equipment to WSPG on May 15, 1953. Service evaluation tests by Army tactical troops (also referred to as end-user tests) started in October 1953 (McMaster et al. 1984:11).

6.7.3 The Red Canyon Range Camp

The Army activated the first anti-aircraft guided missile unit in 1953, and initiated a "Package Training Program" for tactical training of troops in the use of the Nike system. This training fell under the purview of the Army Air Defense Artillery School at Fort Bliss; however, Fort Bliss lacked sufficient space for the Nike program to operate (Kennedy 2009:135). In order to safely test the Nike batteries, the Army designated a location in the northeastern corner of WSPG as the RCRC in the fall of 1953. The camp consisted of a headquarters and living area near the base of Chupadera Mesa, a missile assembly area several miles to the west of the main camp, and a launching area located several miles beyond the assembly site. Conditions at the camp were initially very primitive, with tents providing the only shelter. These conditions were gradually improved, and by the mid-1950s the camp included a mess hall, barracks, headquarters and administrative buildings, motor pool, dispensary, recreation and service clubs, shower and latrine facilities with running water, a swimming pool, a post exchange, a fire department, and even a theater (Kennedy 2009:136). One of the most unique buildings at the RCRC was a chapel that Army personnel built in their spare time mostly from scavenged materials (Eckles 2013:242). The RCRC even had its own mascot; a domesticated wild burro named Nike.

Figure 30. Lieutenant Colonel McCarthy gives Nike the burro a beer at Red Canyon Range Camp, circa mid-1950s (*photo courtesy WSMR Museum)*.

The Army established the RCRC as a temporary solution to training troops in the operation of the Nike batteries, anticipating that it would only be used for around two years. In actuality, the RCRC remained very active until 1959 when the McGregor Range northeast of Fort Bliss was established as its replacement. During its six years of operation more than 3,000 Nike missiles were launched at the RCRC. Most of the launches were aimed at Radio Controlled Aerial Targets (RCATs). The RCAT was a small propeller-driven drone aircraft with a wingspan of 12 feet equipped with radar reflectors to make it appear as a larger, bomber-sized target on the Nike targeting radar (Kennedy 2009:138; Eckles 2013:241).

The RCRC played an important role in generating positive public relations for the Nike Ajax program. The Nike Ajax batteries were to be placed around major cities to provide anti-aircraft defense, primarily against Soviet bombers carrying atomic weapons. Many cities were resistant to the installation of the Nike missiles sometimes literally in their backyards. The Operation Understanding (OU) program was an effort to educate municipal authorities about the system and ease public fears surrounding their installation. The program invited city officials from host cities to tour the RCRC and view demonstrations of the system in action, and was credited with smoothing the way for many Nike installations across the country (Eckles 2013:243).

6.7.4 Nike Installation Layout and Operation

The first Nike battery was installed at Fort Meade, Maryland and was fully operational on May 30, 1954. Nike batteries were installed in defensive locations around major cities and industrial areas across the nation with 222 Nike sites installed in the continental US and an additional 24 built in Europe by 1958 (Kennedy 2009:138).

Each Nike installation was divided into three primary sub-areas; an IFC or Battery Control Area, a Launcher Area, and an Administrative Area. The Administrative Area was often co-located at the IFC or Launcher Area, depending on physical limitations on the layout at individual sites.

Nike IFC/Battery Control Area

The IFC, also sometimes referred to as the Battery Control Area, consisted of several trailers, a generator powerplant, and three radar units (Federation of American Scientists 2014a). Most of the guidance and control equipment at the IFC was mounted in mobile trailers, a leftover from the Army's original intention that the Nike be a semi-mobile system suitable for use in the field, a legacy from anti-aircraft gun batteries.

The Battery Control Trailer and the Radar Control Trailer formed the control center of a Nike Ajax battery. These two trailers were often connected back to back to form a larger control hub for the installation (Carlson and Lyon 1994:33).

The first radar was a long-range acquisition radar called the Low Power Acquisition Radar (LOPAR), which detected incoming targets. Once acquired, the target location was transferred to the Target Tracking Radar (TTR) which tracked the target and provided its coordinates to the guidance computer located in the command trailer. The third radar was the Missile Tracking Radar (MTR) which tracked the Nike Ajax missile on its way to the target and also provided its coordinates to the guidance computer. Working in concert with the guidance computer, the TTR and MTR guided the missile to the intercept point where the computer transmitted the detonation signal to the three warheads on the missile. Each launcher area included a launch control trailer, a standardized Assembly and Test Building of cinder block construction, launchers, and fueling facilities. The missiles were stored in underground magazines at most installations to

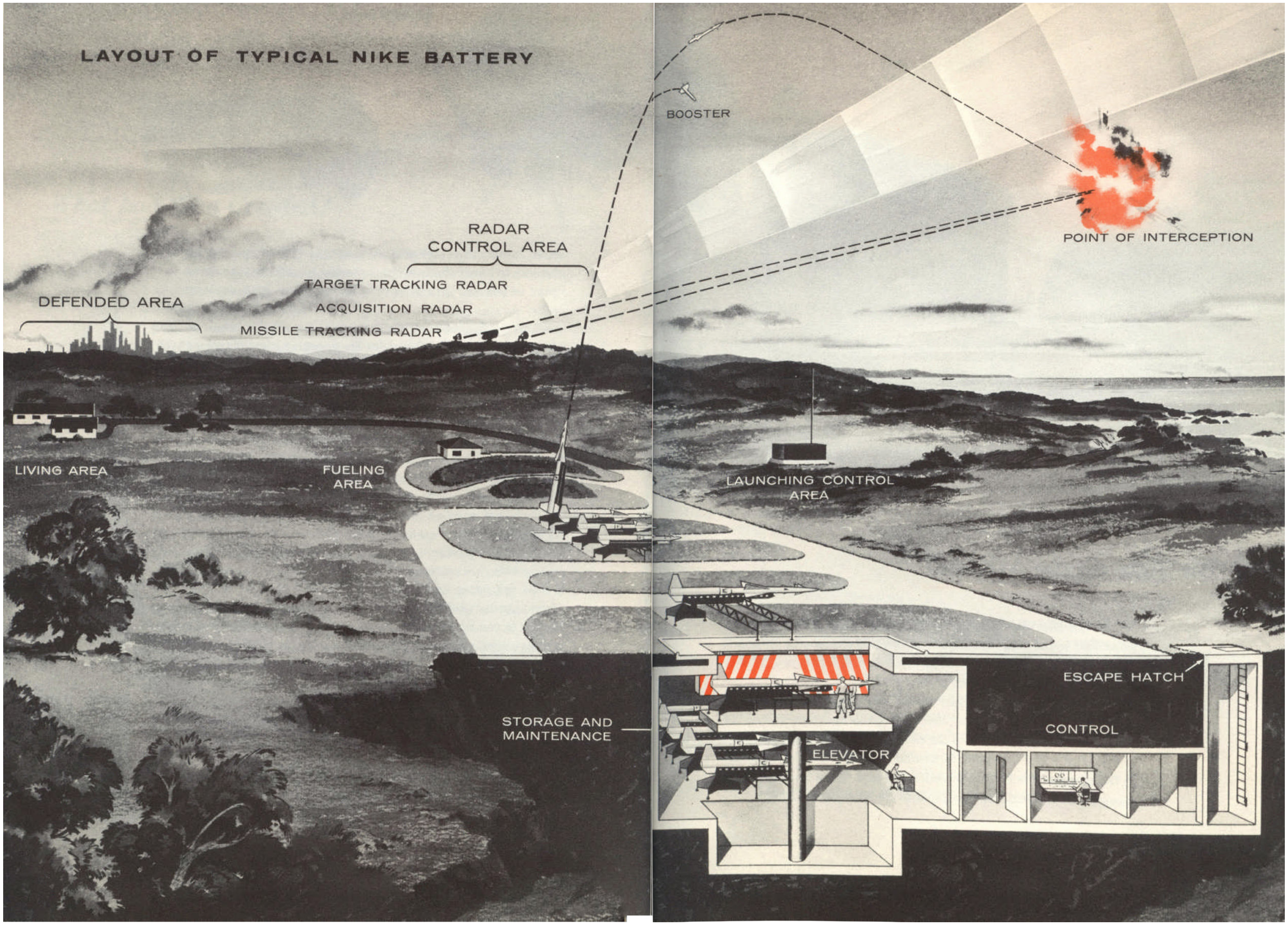

Figure 31. Illustration of a typical Nike battery installation from Nike brochure.

economize on the acreage needed for the site. While the administration area was often located adjacent to the IFC or launcher area, the IFC and launcher locations were separated by at least 1,000 yards (Federation of American Scientists 2014a). The 1,000-yard separation allowed the MTR to track the Nike missiles during take-off; any closer and the MTR servo and drive mechanisms could not turn the radar quickly enough to track the missile through its rapid initial acceleration phase. However, the IFC also required line-of-sight to the launcher area and was generally located no more than 6,000 yards from the launcher locations. In practice, the IFC was usually located about one to three miles from the Nike launchers (Thelen 2017).

Nike Launch Area

The Launch Area at Nike installations included the facilities for maintenance, storage, testing, and firing of the Nike missile. This area typically included a launch control trailer, a missile assembly and test area, an acid fueling station, a generator building, and three launching sections, each of which was equipped with four missile launchers (Carlson and Lyon 1994:34). The launching sections, also called fire units, formed the basic operational unit of the system. Each launching section/ fire unit was based around one underground magazine, and were usually lettered A through C. The missile launchers within each launching section/fire unit were numbered 1 through 4 (Carlson and Lyon 1994:33). Three launching sections/fire units formed a battery, and four batteries (12 total fire units with 48 total launchers) formed a battalion (McMaster et al. 1984:17).

The launch area at Nike installations also included the Missile Assembly and Test Area, where Nike missiles were assembled, tested, and fueled. Due to peacetime regulations of the Interstate Commerce Commission (ICC), fully assembled missiles could not be transported from a central assembly facility to Nike installations. The missiles were instead shipped to Nike sites in a partially assembled condition. At the Nike missile assembly area, the missiles were uncrated and assembled, which mostly consisted of attaching the fins, ailerons, and fairings. The missile’s hydraulic and propulsion systems were also checked out, and the complete missile was given a function test of all its operational systems (Carlson and Lyon 1994:36). The completed and checked missile was then moved to the Acid Fueling Station, where the missile was joined to the booster and fueled with JP-4 jet fuel and RFNA. The RFNA was stored in a nearby acid storage shed. Also located at the Acid Fueling Station, but sheltered behind an earthen berm, was the Warheading Area, where the warhead was attached to the missile.

Nike personnel controlled the Launch Area through the Launch Control Trailer, which housed the equipment that coordinated between the launching stations and the Battery Control Area. The launch control trailer was similar to the trailers at the Battery Control Area, and relayed missiles at the launching stations through to the Battery Control Area for firing. Only one missile could be launched at a time, which was one of the major limitations of the Nike Ajax system. Power for the launching stations and launch control trailer was provided by a Generator Building within the Launch Area, which housed diesel generators and power inverters (Carlson and Lyon 1994:37).

Nike Administrative Area

An administrative or housing area was also located at many Nike locations, usually co-located with the IFC area or launcher area, dependent on the individual site layout. The administration

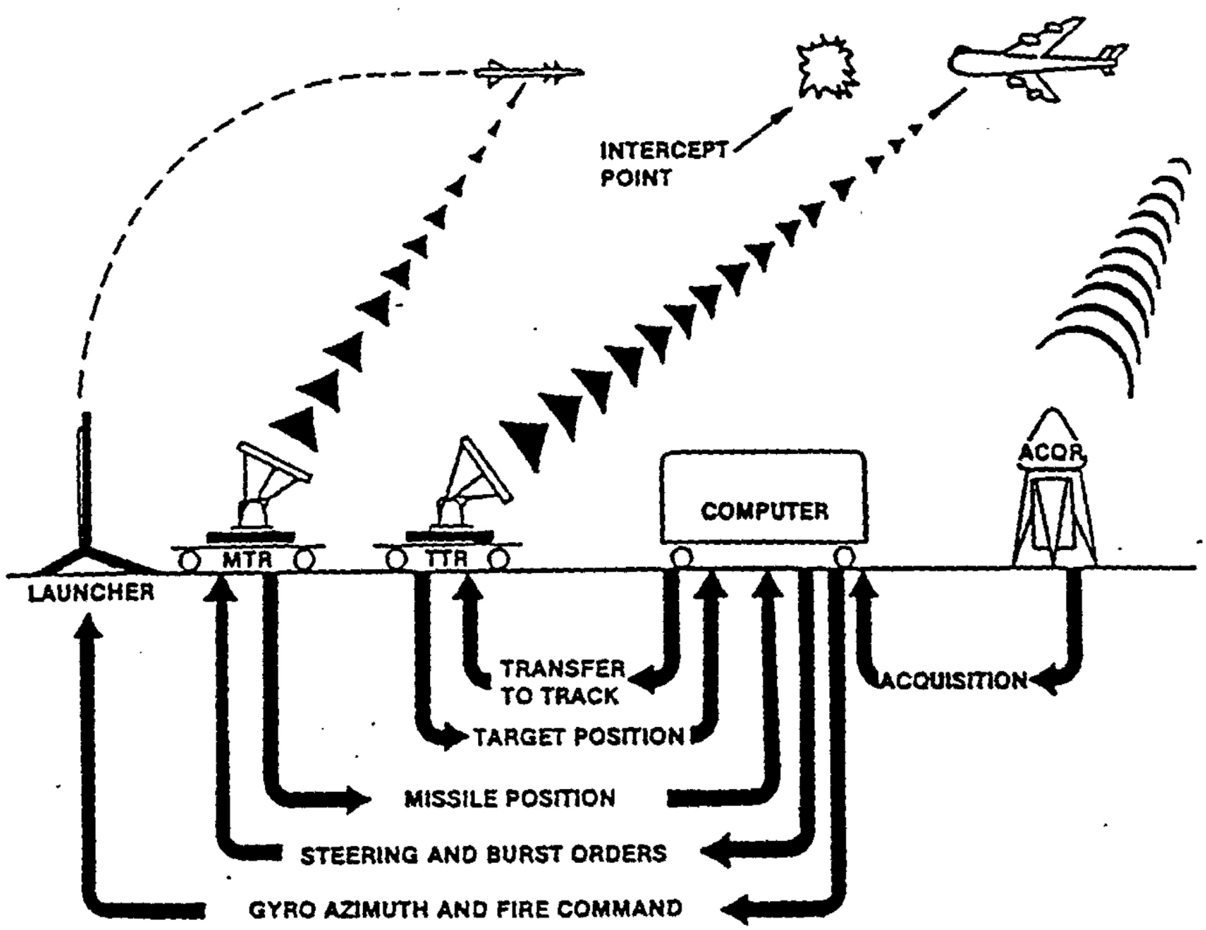

Figure 32. A diagram of how the Nike Ajax radars and the fire control computer tracked and intercepted targets (*adapted from McMaster et al. 1984)*.

area usually consisted of an administration building, which included offices, a supply room, an arms storage room, hobby room, communications room, barber shop, mail room, and restrooms. Also typically located at the administration area were a barracks, mess hall, paint and oil shed, and water and sewage treatment facilities. Some Nike installations even included a PX (supply store) and a basketball court. Most of the administration facilities were of standardized, concrete block construction.

As previously mentioned, four Nike batteries (each consisting of three fire units) formed a Nike battalion. Additional support facilities were found at the battalion organizational level, including a battalion headquarters, a headquarters battery, and a medical section. Nike battalions required around 400 personnel for operation. The Nike battalion headquarters included various support and operations sections, including an operations and intelligence section, motor maintenance section, communications section, radar section, and an assembly and service section. The assembly and service section included a team of technical experts who could provide technical support on the various aspects of the Nike missile assembly and operation (McMaster et al. 1984:18-19).

6.7.5 Nike Gets a Nuke: Nike Hercules

The development of the replacement Nike Hercules (originally known as the Nike B) system started in 1953. The Nike Hercules was a substantially larger missile, 41 feet in length and 31.5 inches diameter, compared to the 34 feet and 12-inch diameter of the Nike Ajax. The larger size boosted the operating range and payload of the Hercules, which could range out to 90 miles while carrying a nuclear warhead. The Nike Hercules was also capable of greater speed and altitude than its predecessor, traveling as fast as 2,700 miles per hour and reaching altitudes of 28 miles (Bender 2014). The nuclear capability of the Nike Hercules was an important asset to military planners who were concerned that large bomber formations would overwhelm the Nike Ajax system by sheer numbers. The greater blast radius of its nuclear warhead could also overwhelm high-speed or fast-maneuvering bombers. The Nike Ajax could only track one target at a time, and was unable to coordinate launches between batteries. It was also believed that the nuclear capability of the Nike Hercules would give the missile a larger kill radius, making a single missile more likely to disable multiple aircraft (Kennedy 2009:138-139). The nuclear warhead carried by the Nike Hercules was the W-31 variable yield unit, which could be adjusted to yields of 3, 20, or 40 kilotons (Bender 2014). The nuclear capability of the Nike Hercules provided some assurance against the fear of a Bomber Gap during the mid-1950s.

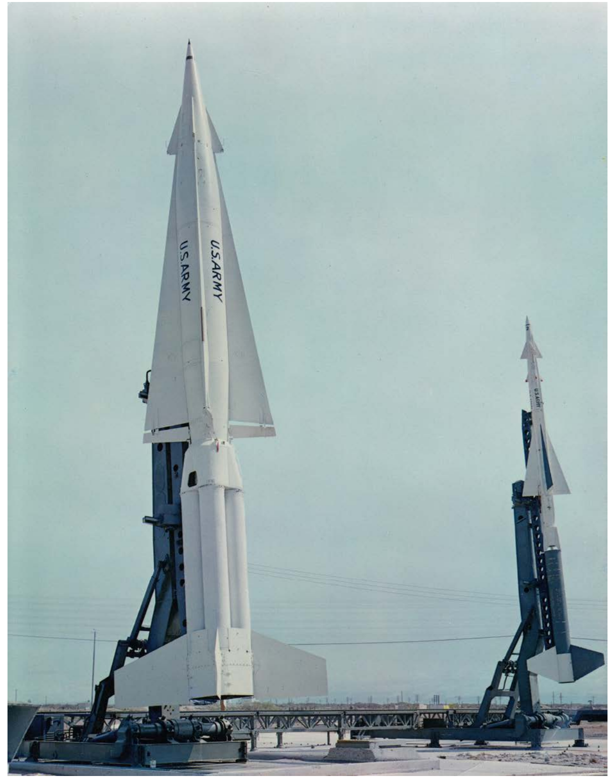

Figure 33. A Nike Hercules missile on the left and the Nike Ajax on the right (*photo courtesy WSMR Museum Archives)*.

The first stage of the Nike Hercules was actually a cluster of four Nike Ajax boosters joined together in a frame, which simplified the design and production of the missile. As a further simplification, the Nike Hercules also did away with the liquid propellant sustainer (second) stage of the original Nike, relying on a more reliable solid-fuel design. The original Nike Hercules liquid propellant sustainer proved problematic in tests during 1955 and was also involved in one of the worst accidents in the history of WSPG. During a routine static test at the WSPG Dual 10K Static Test Stand in September 1955, a Nike B liquid propellant sustainer motor exploded, killing 27-year old technician Clyde F. Wofford and injuring five other DAC employees. The accident is described in an Army history of the Nike Hercules program as:

> An employee of the White Sands ElectroMechanical Laboratory was killed, marking the first fatality of the Nike project, and five DAC employees suffered injuries from flying debris within the control room. The test stand was 6 to 8

> feet from the reinforced concrete walls of the control room, where six personnel were monitoring extra instrumentation equipment provided for the test. The force of the blast caved back the reinforced concrete wall; blew out the narrow safety glass window over the operating console and the larger window on the same wall to the rear of the control room; and snapped the 2 by 10 [inch] wooden beams of the control room roof structure. The building, though not demolished, was considered to be nonrepairable [Cagle 1973:56].

The Nike B/Hercules liquid propellant motor also failed in flight tests in early 1956, so the Army approved a parallel program to development a solid propellant sustainer for the Nike B/Hercules in March 1956 (Cagle 1973:58-59). Development of the solid propellant sustainer progressed quickly, with the first flight test taking place at WSPG in March 1957, and the liquid propellent sustainer was phased out of the Nike B R&D flight test program in 1958 (Cagle 1973:63). This also had the added benefit of simplifying infrastructure at Nike installations, since the acid fueling area was no longer needed.

The Nike Hercules radar and computer systems were also upgraded with solid state electronics as they became available during the late 1950s (Lonnquest and Winkler 1996:108). Significantly, the Hercules ground equipment was essentially the same as that used for the Nike Ajax, and the Hercules installations mostly utilized existing Ajax equipment with the exception of improved guidance and control systems (McMaster et al. 1984:38). This streamlined the process of upgrading existing Nike Ajax installations, as new facilities or property acquisitions were not required to install the more powerful Nike Hercules. The Nike Hercules began to replace the original Nike batteries in 1958, and continued to do so until the last Nike Ajax was retired in 1964. In total, the Army installed 145 Nike Hercules systems across the country (Kennedy 2009:140).

Some improved versions of the missile were also capable of targeting missiles. Fully operational in 1961, the Improved Nike Hercules could intercept higher, faster bombers and also some types of missiles. In 1960, an Improved Nike Hercules intercepted a Corporal missile during a test over WSMR, the first time a missile had been successfully intercepted in flight (Kennedy 2009:140). Later the same year at WSMR, another Improved Nike Hercules intercepted a standard Nike Hercules missile traveling at Mach 7 at an altitude of 19 miles (Carlson and Lyon 1994:15; Walker et al. 2003:26). The system could also be used as a surface-to-surface missile within ranges of about 114 miles, which was the transmission range limit of the MTR used in the system (Bender 2014). The Nike Hercules utilized the High Power Acquisition Radar (HIPAR) built by General Electric, which extended its detection range to 175 nautical miles (Carlson and Lyon 1994:14). The larger HIPAR was usually mounted on a steel tower and enclosed within a radome.

In order to accommodate the larger Nike Hercules missile, some changes were made to the existing Nike magazines. The elevator required additional lift capacity to lift the heavier Hercules missile, which in turn required additional electrical generator capacity. Eventually, four different underground magazines were found at Nike installations, which were referred to as A, B, C, and D-type magazines, which were often referred to as “boxes.” The A-type boxes were specifically designed for the Nike Ajax, but some were converted to fit the larger Hercules missile; these converted Ajax magazines were designated as type C. The C-type magazines could not launch Nike Hercules missiles from the elevator. The type B magazines were slightly larger and designed to accommodate both Nike Ajax and Hercules missiles. Finally, the type D magazines were the largest, and were specifically made to accommodate the Nike Hercules (Carlson and Lyon 1994:15-16). Most Nike installations used B or C-type magazines; new Nike installations built after 1958 exclusively used the larger D-type magazines to accommodate the larger Nike Hercules (Carlson and Lyon 1994:16).

The Nike Hercules had a longer lifespan than its predecessor the Nike Ajax, but also fell prey to the advent of ICBMs and shifting priorities in national air defense. By 1974, most of the Nike sites in the continental US had been shuttered, although four Hercules batteries remained operational in Florida and Alaska for training purposes as the missile remained in the inventories of several allied nations (Carlson and Lyon 1994). Japan phased out its last Nike Hercules battery in November 1992, replacing it with the Patriot missile. Over 25,000 Nike Hercules missiles were produced, with 2,650 exported to allied nations through the Foreign Military Sales Program and 1,764 exported as part of the Military Aid Program (Carlson and Lyon 1994).

6.7.6 Nike Evolves from Anti-Aircraft to Anti-Ballistic Missile

Since the V-2 attacks on London during WWII, defense against ballistic missiles had been a significant concern for military planners. However, since the delivery of an atomic weapon was only possible by bomber aircraft at the time, the development of defensive missile systems focused on anti-aircraft oriented systems such as the Nike. However, by 1957 the Soviets had long-range missiles capable of carrying nuclear warheads, which made bomber aircraft a secondary threat. In order to counter the threat of ICBMs, new, more sophisticated missile defenses were needed. These anti-ballistic missile systems became of the focus of defensive missile development by the late 1950s.

In 1955, BTL and the Western Electric Company initiated an 18-month long study of a new ground-to-air missile capable of defending the continental US against the threats anticipated during the 1960s (Bell Laboratories 1975). To this end, the primary focus of the study was defense against ICBMs, the next generation of nuclear warhead delivery vehicles. The BTL Nike-II study was submitted in 1956, and anticipated that a BMD system could be operational as early as 1962, given sufficient funding. WSPG was identified as the best location for testing of the system, with Cape Canaveral and Ascension Island in the Atlantic also identified as possible locations for long-range tests (Bell Laboratories 1975). As planning for the system evolved, Kwajalein Island in the Pacific was selected as the location for long-range flight tests of the system, while radar tracking was conducted from Ascension Island.

The Army decided to fund the BTL Nike II proposal, which could build upon technologies already developed for Nike Hercules anti-aircraft system. A contract for the development of this system was awarded to BTL, a division of Western Electric (who had designed the original Nike) in 1957, and the name of the program was changed from Nike II to Nike Zeus (Lonnquest and Winkler 1996:109). As proposed in 1957, the Nike Zeus program would provide an early defense capability of 30 batteries by the end of 1962 at a cost of two billion dollars, a full defense capability of 100 batteries by the end of 1965 at the cost of four billion dollars, and extended range capability at the end of 1966 and total cost of six billion dollars (Bell Laboratories 1975). These estimates proved to be exceedingly optimistic. Additional impetus was given to the development of the Nike Zeus system by the successful launch of a Soviet ICBM in August of 1957, followed by the launch of Sputnik in October of that year (Missile Defense Agency 2009).

An intense inter-service rivalry developed between the Air Force and Army over the development of ABM systems, with each branch promoting its own developments. The Air Force had been conducting its own program under Project Wizard for the development of a high-altitude missile defense system. However, in 1958 the Secretary of Defense assigned the development of ABM systems to the Army based on the promising developments of the Nike Hercules system (Lonnquest and Winkler 1996:109). From this point forward, the Army would be responsible for the development of land-based anti-missile defense systems that would shield American cities and strategic assets, including Air Force ICBM installations, from ballistic missile attacks.

Nike Zeus was designed to provide a flexible, high level defense against the contemporary ICBM threats of the late 1950s and early 1960s. The Nike Zeus system was designed as a modular installation that could be tailored to fit the needs of individual installations. Each Nike Zeus defense installation was designed to be self-contained and capable of independent operation, and was not reliant on external systems for detection and targeting (Bell Laboratories 1975:1-1). However, each installation could coordinate with other Nike Zeus installations, NORAD, and could receive early warning data from the Ballistic Missile Early Warning System (BMEWS). While Nike Zeus required more permanent infrastructure and would therefore cost significantly more to field, it would also require fewer installations overall since each Nike Zeus installation could provide missile defense for a broad area. As originally designed, Nike Zeus could intercept targets at altitudes of 500,000 feet at ranges up to 75 nautical miles (Bell Laboratories 1975:1-1).

The Nike Zeus system incorporated four different radar systems. The first was a long-range acquisition radar called the Zeus Acquisition Radar (ZAR). The remaining three radars were used for targeting and guidance of the missile; the Discrimination Radar (DR), the Target Tracking Radar (TTR), and the Missile Tracking Radar (MTR), all of which were coordinated via the Target Intercept Computer (TIC) which was housed in the Battery Control Building (BCB) (Missile Defense Agency 2009). Unlike its predecessors, the Nike Ajax and Hercules, the Nike Zeus was designed around large, permanent facilities that housed its radar systems. The Nike Zeus possessed a significantly longer intercept range than the earlier anti-aircraft systems, and its ZAR, DR, and TTR were larger and more powerful radars than those used in the earlier versions of the Nike.

Nike Zeus was planned around a Defense Center, which provided control and acquisition data for associated batteries. Each Defense Center could control up to five batteries, which was part of the modular aspect of the system. The major element of the Nike Zeus Defense Center was the ZAR, which detected potential targets at long distances, evaluated them as potential threats, and passed on trajectory information to the associated batteries (Bell Laboratories 1975:1-2). The Nike Zeus Battery consisted of the actual missile battery along with the DR, TTR, and MTR, which were responsible for the targeting and guidance of the Nike Zeus missiles. Batteries could be scaled according to their specific mission, with a minimal Nike Zeus battery consisting of one DR, three TTR units, six MTRs, and two Target Intercept Computers (TICs)

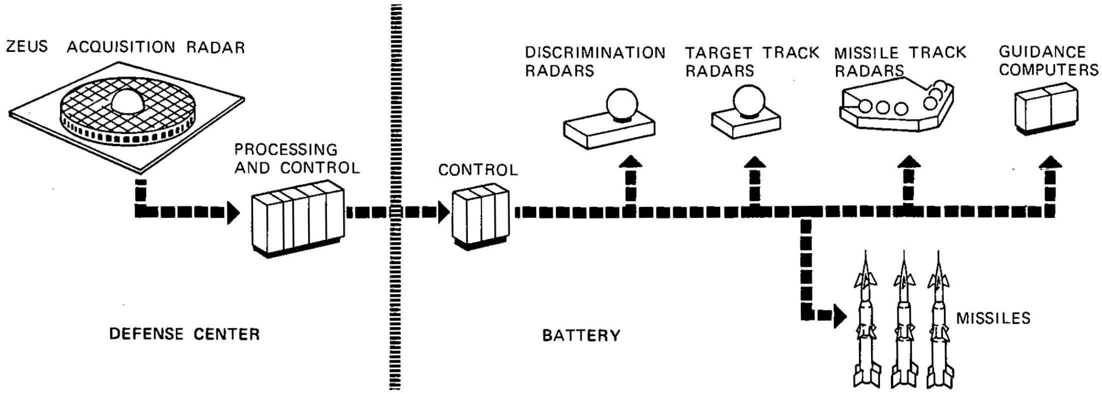

Figure 34. Block diagram of the Nike Zeus guidance control system (*adapted from Bell Laboratories 1975*).

which controlled a complement of 24 Nike Zeus missiles. The maximum effective size for a Nike Zeus Battery was three DR units, 10 TTR units, 18 MTRs, six TICs, and 72 Nike Zeus missiles. Beyond this theoretical maximum size, it was considered more efficient to simply establish separate batteries (Bell Laboratories 1975:1-4).

Zeus Acquisition Radar (ZAR)

Operation of the Nike Zeus missile system started with the ZAR, which monitored a broad swath of space for targets. The ZAR was sometimes referred to as the Local Acquisition Radar (LAR) in early documentation of the system. It should also be noted that early plans for the Nike Zeus called for two acquisition radars, the other unit was referred to as the Forward Acquisition Radar (FAR). The FAR was intended as a long-range early warning system that would be integrated with the LAR. The original proposal placed the FAR installations in Canada, which made them impractical to defend and generally made the Nike Zeus system more complicated. Due to these concerns, the FAR was eliminated from the Nike Zeus design, and the detection and acquisition role was fulfilled by the LAR/ZAR alone (Bell Laboratories 1975:I-18). The ZAR detected any objects approaching the defended area and provided data for determining if the acquired object might represent a threat. The ZAR operated at multiple frequencies within the L-band, and was split into separate installations for the receiver and the transmitter. The separate facilities and antennas for the transmitter and receiver was somewhat unique and made the ZAR distinctive among the Nike radar systems. The ZAR transmitting and receiving antennas rotated in synchronism around vertical axes to provide 360-degree coverage. Each antenna was composed of three surfaces that created fan beams that provided elevation coverage between 0 and 70 degrees. The rotation rate of the ZAR transmitter and receiver antennas was 3 1/3 rotations per minute, which provided updated position data on tracked objects every six seconds (Bell Laboratories 1975:1-5). The ZAR transmitter antenna was triangle shaped with three sections arranged 120 degrees apart around a common rotating axis in a horizontal plane. Each antenna section was powered by a transmitter with a 600-kilowatt average power output, although the maximum power output was 10 megawatts (Bell

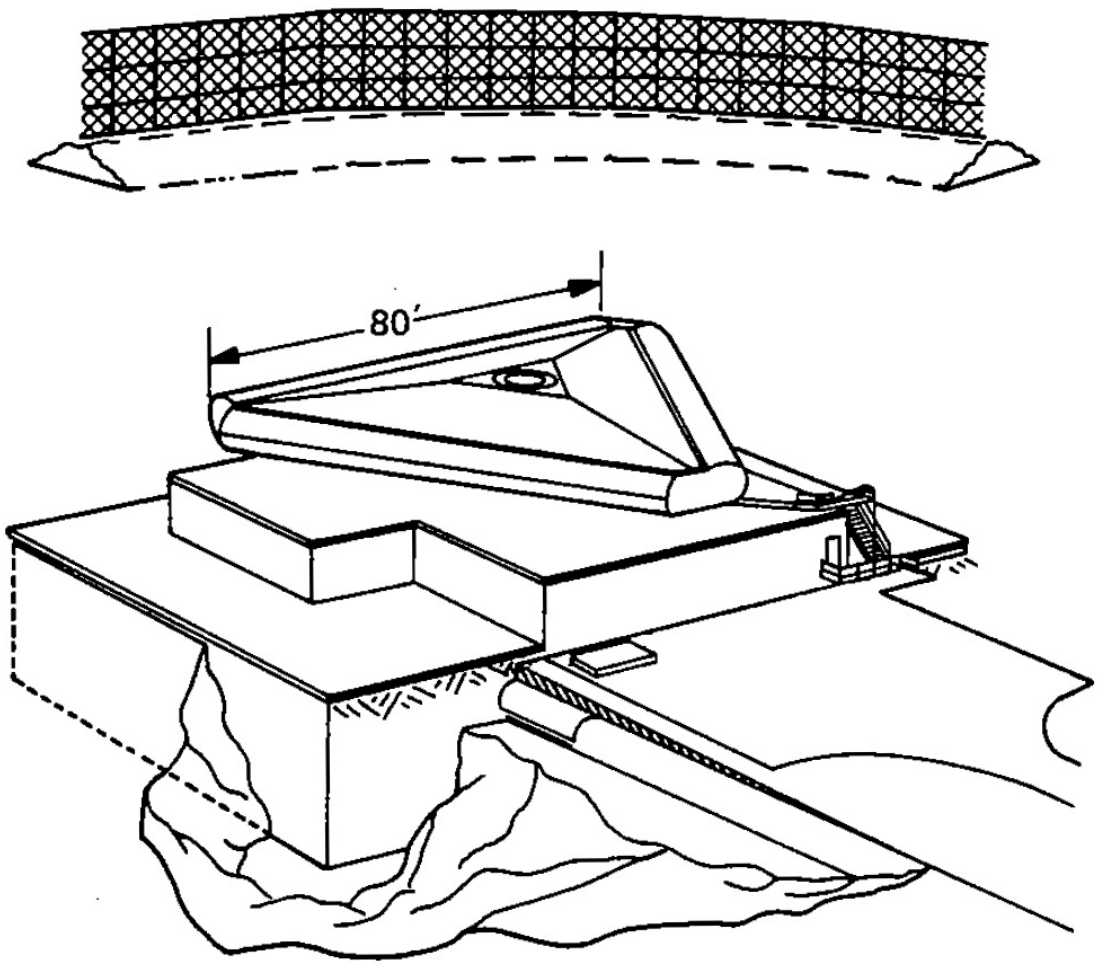

Figure 35. Drawing of ZAR transmitter and section of radar clutter fence (*adapted from Bell Laboratories 1975)*.

Laboratories 1975:1-5). The three-sided ZAR transmitter could scan 100 million cubic miles of space per second (Lang 2013). The design of the ZAR receiver antenna was based on a Luneberg lens with an associated reflecting ground plane; however, the ZAR receiver at LC-38 was not constructed with the reflecting ground plane. The ZAR receiver antenna was housed in a large radome, and the receiver equipment was housed within an associated building. The Luneberg lens of the ZAR receiver was a solid hemispherical shape composed of "thousands of polyfoam blocks containing fine metal slivers, to obtain the necessary variation in dielectric constant" (Bell Laboratories 1975:1-5). The ZAR receiver antenna rotated on one of the largest ball bearings ever produced, which was 1.35 feet in diameter (Lang 2013). The ZAR was a track-while-scan radar that could process multiple tracks simultaneously through its Target Data Consolidator. This tracking data was then transmitted to the BCB and the DR for further analysis and processing.

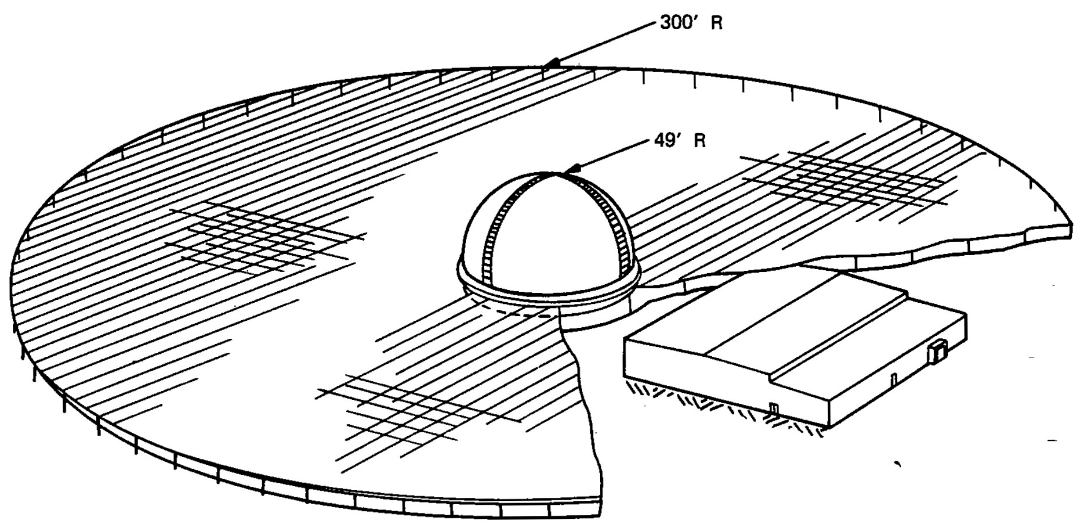

Figure 36. Preliminary design of Nike ZAR receiver with an attached 600-foot diameter ground plane (*adapted from Bell Laboratories 1975)*.

Figure 37. ZAR receiver antenna and radome under construction at LC-38 in 1960 (*photo courtesy WSMR Museum Archives)*.

Figure 38. ZAR receiver installation at LC-38 circa early 1960s (*photo courtesy WSMR Museum Archives)*.

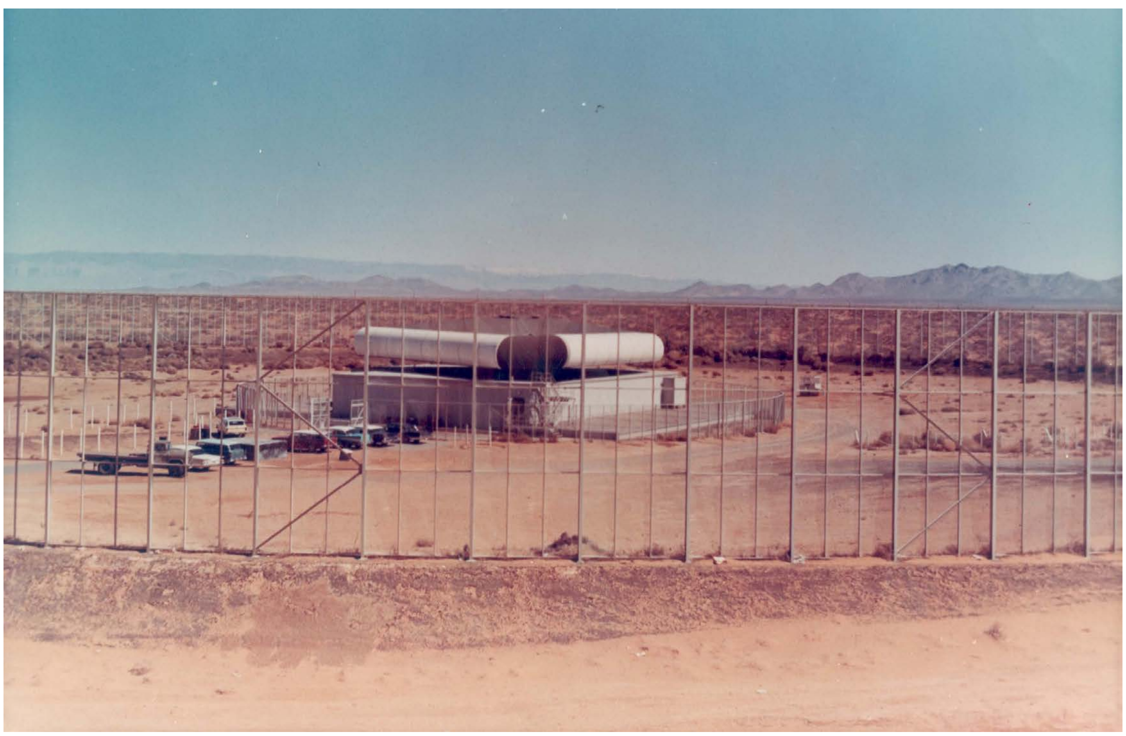

Figure 39. ZAR transmitter building and antenna (*Property 24072)* at LC-38, circa 1960 (*photo courtesy WSMR)*.

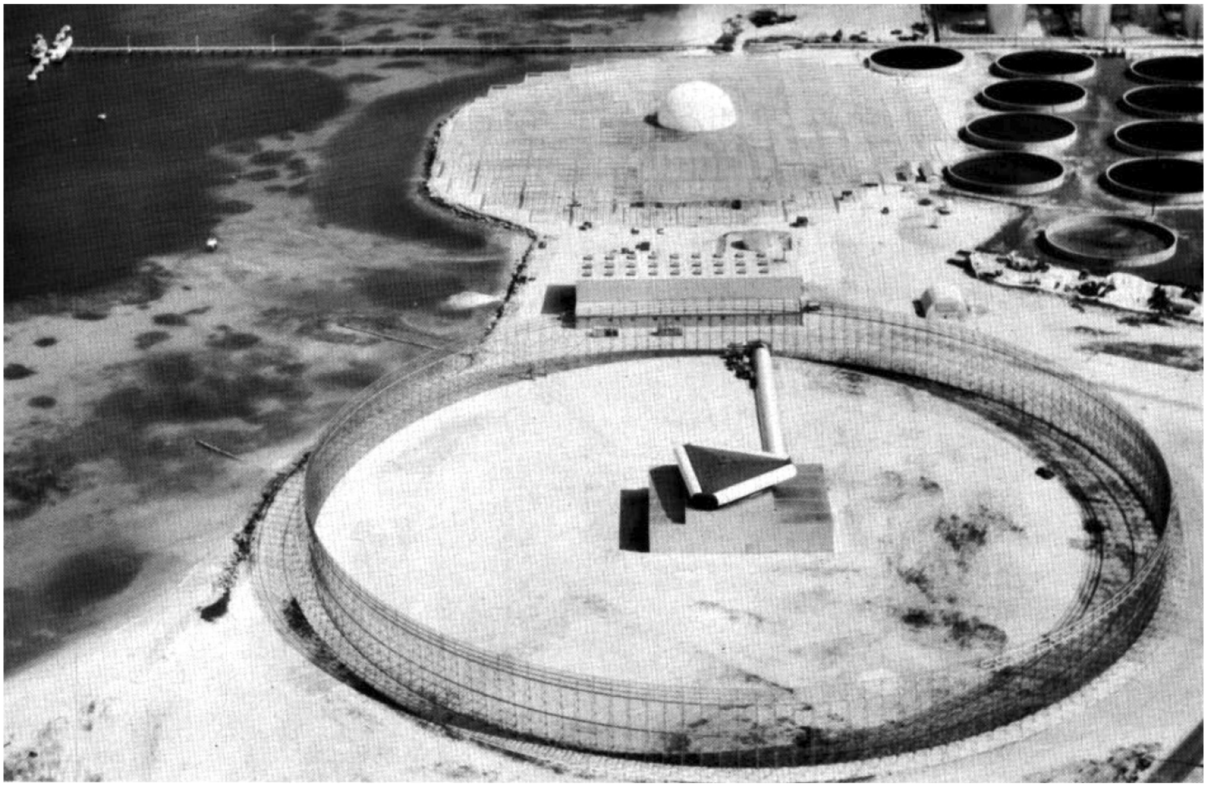

Figure 40. ZAR transmitter and receiver installations at Kwajalein Atoll circa 1962 (*US Army photograph)*.

Discrimination Radar (DR)

The original Nike Zeus radar system consisted of the ZAR, TTR, and MTR, but the DR was added during the early 1960s to help differentiate ICBM warheads from associated debris clouds. The DR was located at the Nike Zeus Battery along with the TTR, MTR, and BCB. Like the ZAR, the DR operated in the L-band. Incoming ICBM tracks would usually consist of a cloud of objects, which included the ICBM reentry vehicle itself (i.e., warhead), but also propellant tanks, spent stages, and other debris from the ICBM airframe. Target clouds were also likely to include intentional countermeasures such as chaff or dummy warheads in an attempt to defeat missile defense systems. The role of the DR was to identify the incoming warhead from the other non-lethal objects in the cloud so that it could be targeted for an intercept. Once the ZAR identified a target, it processed its position data and passed it to the DR and control computer at the BCB for further processing and analysis. The targeting computer in the BCB assigned the DR a single point within the cloud to serve as a control point for tracking the entire cloud. The DR could cover target clouds with diameters up to 22 nautical miles, and the DR could vary its beamwidth to maintain coverage of the target cloud as it approached (Bell Laboratories 1975:1-10). The DR would identify and designate a specific target within the cloud, and passed the targeting information to the TTR. The TTR could take over a target track from the DR within two seconds when the TTR was pre-positioned in the general direction of the target cloud (Bell Laboratories 1975:1-10). Much of the Nike-Zeus data-processing equipment and computers were associated with the DR and the analysis of the incoming target cloud.

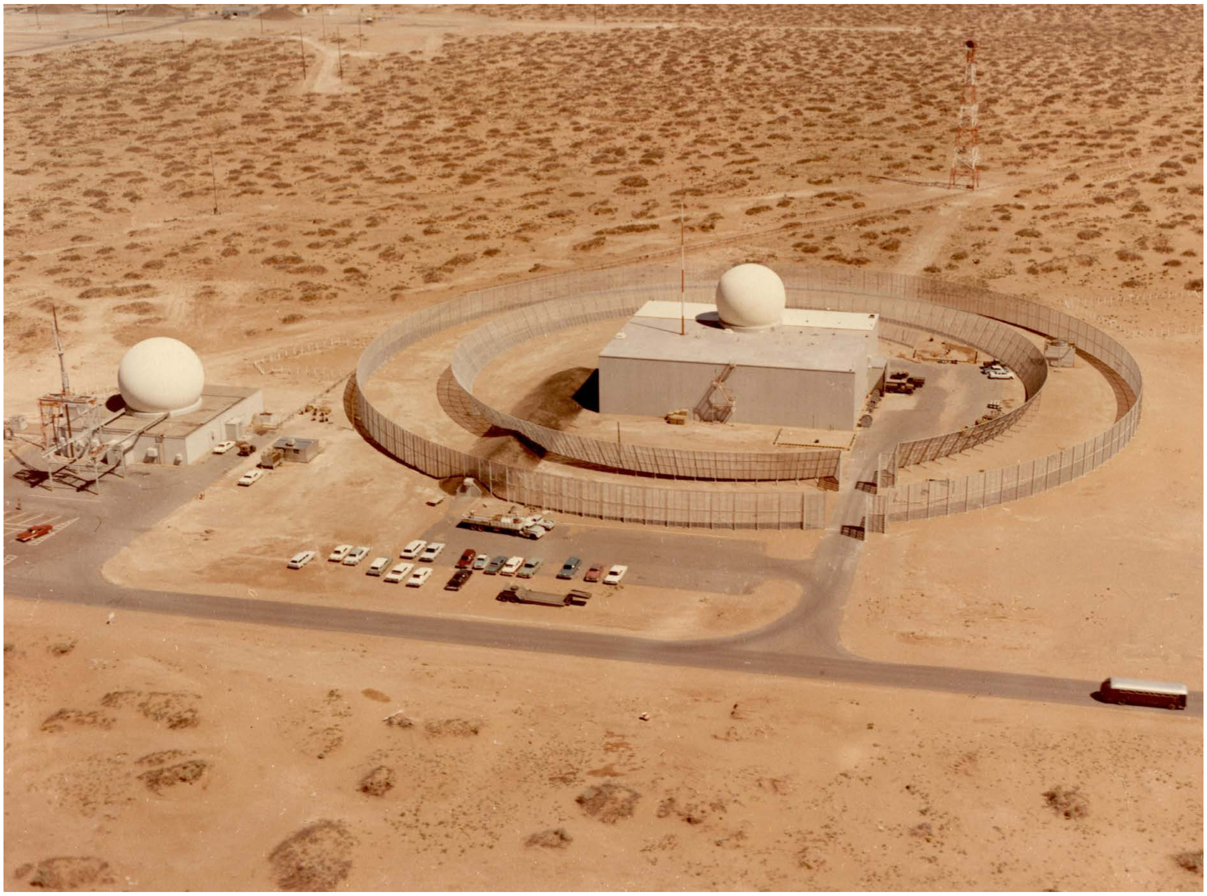

Figure 41. Nike Zeus DR (*right)* and TTR (*left)* installations at LC-38 circa early 1960s (*photo courtesy WSMR Museum Archives)*.

The DR data processing equipment consisted of the All-Target Processor and Discrimination and Control Computer (Bell Laboratories 1975:1-14). The DR was surrounded by large clutter fences, also known as beam shaping fences. These metallic fence structures were designed to eliminate confusing or misleading radar returns from low-lying objects and terrain. The fences also helped to protect personnel and equipment from the high-frequency emissions of the radar unit, which could be dangerous. The DR antenna was housed in a radome mounted atop the building that housed its transmitter equipment. The DR antenna was a parabolic reflector-sub-reflector design supported on a two-axis mount. The sub-reflector could move in relation to the main reflector, which allowed the beam width to be adjusted (Bell Laboratories 1975:1-11).

Target Tracking Radar (TTR)

Once the DR and its processing equipment selected a specific target from the target cloud for interception, tracking duties were handled by the TTR. The TTR was a precise, long-range, narrow-beam radar that could collect accurate, continuous position data on very small, fast-moving targets (Bell Laboratories 1975:1-14). The TTR antenna was a 22-foot diameter reflector-subreflector design supported on a three-axis mount that allowed tracking of fast-moving targets directly overhead at altitudes as low as 50,000 feet; targets not directly overhead could be tracked at much lower altitudes. This high-performance mount weighed

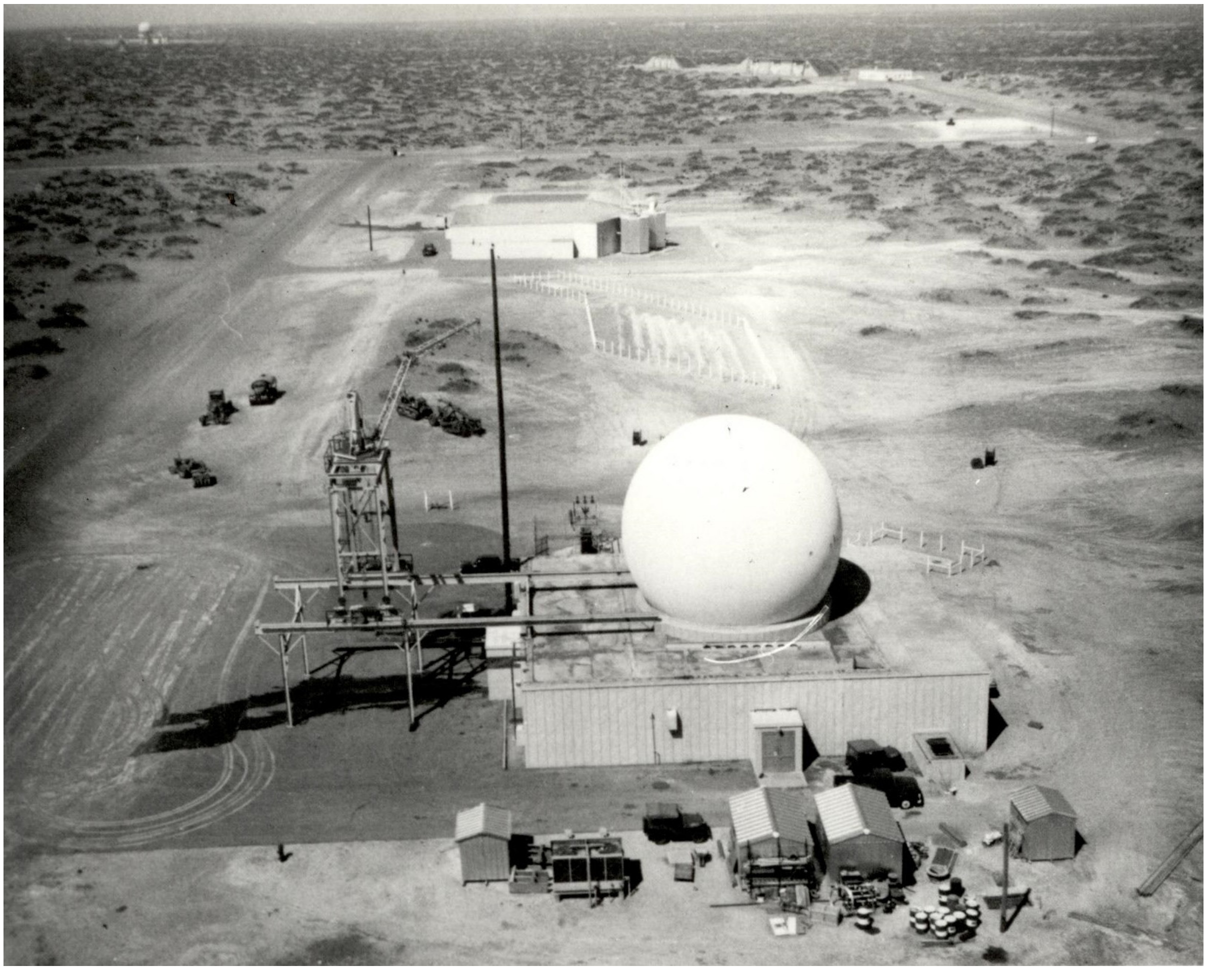

Figure 42. TTR installation and BCB at LC-38 circa early 1960s (*BTL photo)*.

approximately 150,000 pounds and was moved by pairs of hydraulic motors for each travel axis (Bell Laboratories 1975:1-17). As installed at actual Nike Zeus installations, the TTR did not possess any of its own processing computers, rather relying on commands from the TIC in the BCB (Bell Laboratories 1975:1-14). The TTR antenna was housed in a radome atop the roof of the building that housed its transmitter equipment, which was usually located near the BCB and its MTR units. A Nike Zeus TTR was constructed on Ascencion Island in the Atlantic, and tracked modified Nike Hercules missiles in flight over the Atlantic Test Range (Bell Laboratories 1975:I-32).

Missile Tracking Radar (MTR)

The MTR tracked the Nike Zeus missile on its path to intercept the target, and provided position information on the missile to the TIC. The MTR also transmitted guidance and burst instructions to the missile via its radar beam. The Nike Zeus MTR had a range of 75 nautical miles and communicated with the Nike Zeus missile through different pulse codes and frequencies to avoid interference with other missiles in flight; as many as 450 Nike Zeus missiles could be controlled in a defense area without mutual interference (Bell Laboratories 1975:1-

18). The MTR was closely associated with the BCB; in preliminary drawings for the Nike Zeus radar buildings, the MTRs were installed on the roof of the BCB and housed under a transparent plastic dome (Bell Laboratories 1975:I-14). However, in actual installations at Kwajalein Island and WSMR, the MTR antennas were installed on structurally isolated concrete towers outside the BCB, and the MTR transmitters were housed inside the BCB. The MTR relied on a 4-foot diameter Cassegrainian (parabolic with two reflector surfaces) antenna on a two-axis mount. The mount allowed the MTR antenna to rotate continuously in both azimuth and elevation from 11.5 degrees below the horizon, all the way through the zenith to 11.5 degrees below the opposite horizon. It took only 5 seconds for the MTR to shift to a new missile after the end of an engagement (Bell Laboratories 1975:1-18).

Figure 43. An unidentified Army Master Sergeant inspects an MTR unit at LC-38 circa early 1960s (*photo courtesy WSMR)*.

Battery Control Building (BCB)

The BCB was the nerve center for each Nike Zeus missile battery, and was the processing hub for data generated by the radars. The Nike Zeus BCB housed the TICs and was also the location of the MTR installations. The transmitters for the co-located MTRs were also housed within the BCB. The TICs within the BCB generated the guidance commands for the Nike Zeus missiles based on target and missile position data supplied by the Nike Zeus radar systems (Bell Laboratories 1975:1-3). The TICs guided the missiles along the most efficient intercept trajectory and sent the burst command at the critical moment. Each TIC could process three different target/missile intercept combinations simultaneously. Each BCB was also equipped with tactical control and monitoring equipment which allowed the automatic operation of the Nike Zeus radars, and displays and consoles within the BCB also allowed operators manual control of the system if needed (Bell Laboratories 1975:1-4). The Battery Control Data Processor (BCDP) was also housed within the BCB, which was primarily used to plan target engagements that involved reentry decoys. The BCDP served as a sort of pre-processor for the TICs, as it processed data from the DR computer and then provided targets and engagement directions to the TIC (Bell Laboratories 1975:1-26).

Nike Zeus Computers

The major computing elements of the Nike Zeus were distributed between the ZAR, DR, and BCB. The ZAR included the Target Data Consolidator and ZAR Data Processor, the DR

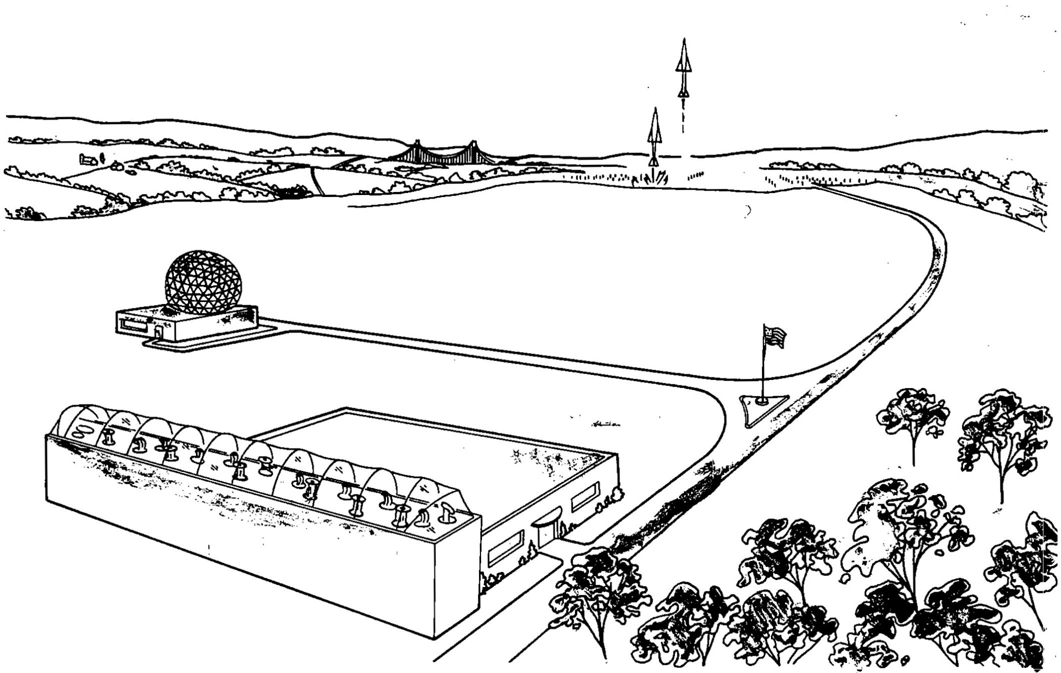

Figure 44. Early drawing of proposed Nike Zeus installation with BCB and MTRs (*adapted from Bell Laboratories 1975)*.

Figure 45. BCB and MTR tower at LC-38 circa mid-1960s during period of Nike X testing (*BTL photo)*.

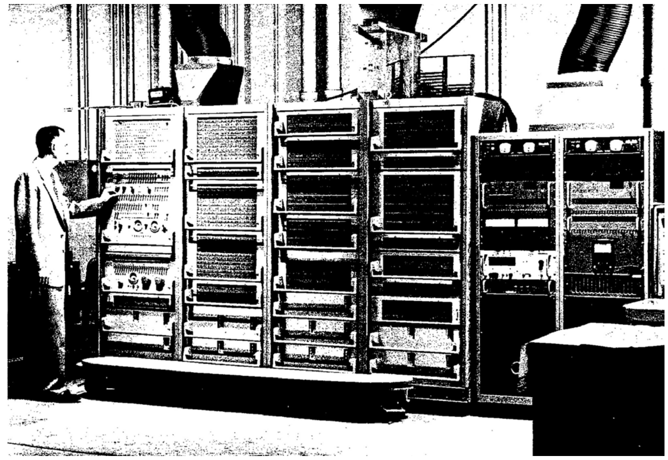

Figure 46. Nike Zeus computers within BCB (*adapted from Bell Laboratories 1975)*.

included the All-Target Processor and Discrimination and Control Computer, and the TIC and BCDP computers were housed within the BCB. All these computing elements were based on the Nike Zeus High-Speed Digital Computer, which was the largest element of the Nike Zeus computing architecture. Typical of the computing technology of the era, these computers consisted of multiple racks of hardware housed in special cabinets that were approximately 6 to 8 feet in height. As such, each computer occupied significant climate-controlled square footage. Each Nike Zeus computer was composed of D-units, which was the unit of replacement for basic field maintenance (Bell Laboratories 1975:1-26). Each D-unit was slide mounted in electronic racks. Each D-unit was composed of C-planes, the next smallest element. C-planes were flat, chassis-like assemblies that were stacked up to six vertically to form the D-unit. The smallest and most basic elements of the Nike Zeus computers were the A and B modules (Bell Laboratories 1975:1-26). The basic A-module contained four transistor inverters which could be combined to form the basic logic elements of the computer. A-modules were arranged in an array that was 7 modules wide by 10 modules long on the C-plane. Special packages in multiples of the A-module size were known as B-modules. In addition to the A-modules, about 35 special-purpose circuits were also used in the Nike Zeus computers, but these only represented about 10 percent of the computer system. Memory for the computers was based on Twistor Magnetic Memory, an electronic data storage system invented by BTL in 1957 (Bell Laboratories 1975:1-32). Twistor memory technology used a grid of thin magnetic wires that were interwoven with copper wires that conducted electrical current. This form of memory was almost exclusively used by BTL and its subsidiaries and was never a commercial success. It was replaced by modern semi-conductor based Dynamic Random Access Memory (DRAM) during the 1970s.

Nike Zeus Missile

Following the recommendations of the Nike II study, the first Nike Zeus missile design was generally similar to the existing Nike Hercules design. The early Nike Zeus was a slightly scaled up version of the Hercules, with larger and more complex fins and control surfaces. The early Nike Zeus missile was flight tested at WSMR in 1959 and 1960. As the program progressed, the Nike Zeus design was modified into a larger missile with extended range. This new design was identified as the Nike Zeus B, while the earlier version was retroactively designated as the Nike Zeus A. Former Nike technician Doyle Piland noted that the Nike Zeus A was referred to as the “winged configuration” while the Nike Zeus B was referred to as the “canard configuration” (Piland 2006b:4). The Nike Zeus B missile consisted of three major sections; the booster or first stage, the sustainer or second stage, and the nose section, also referred to as

Figure 47. Nike Zeus A launch at LC-38, circa early 1960s (*photo courtesy WSMR)*.

the "jethead" (Bell Laboratories 1975:1-22). As Nike Zeus was required to intercept missiles at very high altitudes that were essentially beyond the atmosphere, it had to be equipped with control systems for maneuvering both within and outside the atmosphere. During flight within the atmosphere, air density was sufficient to allow roll control and steering via four traditional control fins. The same control fins were equipped with jet nozzles that expelled gases to maneuver the missile when flying outside the atmosphere (Bell Laboratories 1975:1-22). Using the same control surfaces for operation both inside and outside the atmosphere eliminated the need for two separate control systems, which was a significant reduction in complexity of the missile's electronic and hydraulic systems, but required significant mechanical engineering to incorporate the gas-thrust system into the control fins (Bell Laboratories 1975:1-22). Guidance signals were received by four identical antennas positioned at 90-degree intervals on the outer housing of the guidance unit, which were protected by strakes; two of the antennas were used for transmitting and all four acted as receivers (Bell Laboratories 1975:1-22).

The Nike Zeus B missile was a successful design that was soon adapted to extend its range as part of an experimental satellite interceptor program that was tested at the Kwajalein Test Site in 1962 and 1963 (Bell Laboratories 1975:I-31). These upgraded versions of the Nike Zeus successfully demonstrated the capability to intercept orbital satellites, and served as the basis for the long-range Spartan interceptor missile that was later used in the Sentinel and Safeguard programs (Bell Laboratories 1975:10-1).

Figure 48. Nike Zeus B on launcher rail at LC-38 (*photo courtesy WSMR)*.

Testing of the Nike Zeus

As with the predecessor Nike Ajax and Nike Hercules systems, preliminary development of Nike Zeus took place at WSMR. Testing of the Nike Zeus was carried out primarily at WSMR and at Kwajalein Island in the Marshall Islands. Due to the high altitudes achieved by the Nike Zeus, it was possible to exceed the range available at WSMR, so some early flight tests were also conducted from the Naval Test Range at Point Mugu, California (Bell Laboratories 1975:I-21). However, Point Mugu was not a good location due to its range safety requirements, which resulted in "a number of good missiles being destroyed early in flight without obtaining any useful data" (Bell Laboratories 1975:I-21).

Kwajalein Island (actually an atoll) was critical to the Nike Zeus testing as it allowed the entire system to be installed and tested against realistic offensive targets. However, this location was not yet established when BTL, Western Electric, and Army planners were searching for a suitable test location during the late 1950s. The Atlantic Test Range was considered, but the best locations were Antigua, Barbuda, and the Ascension Islands, none of which were US possessions. The search then turned to the Pacific Ocean, where Kwajalein Island was identified. Kwajalein was not a US possession, but had been under Navy stewardship since WWII, and the Navy had periodically maintained a base on the atoll. Kwajalein was remote, but still within a day's flight of Hawaii, and Kwajalein already had basic infrastructure, including an airstrip, harbor, housing, school, and hospital. In a fortunate quirk of geography, Kwajalein was approximately 5,000 miles from the US West Coast, an ideal distance for intercepting Atlas missile targets launched from Vandenburg Air Force Base in California (Bell Laboratories 1975:I-21).

WSMR also proved to be a critical location for early flight tests of the Nike Zeus, which began in 1959 before the system installation was completed. The Nike Zeus ground facilities were constructed at ALA-5, later designated LC-38. The initial operation of the ZAR was completed in June 1961, with the ZAR successfully detecting and tracking balloons, aircraft, parachutes deployed by Highball target missiles, and Nike Hercules missiles. The early system testing successfully transferred these target tracks to the BCB and the TTR (Bell Laboratories 1975:I-24). Testing of the Nike Zeus system components progressed quickly, and tests of the complete system started in November 1961. On December 14, 1961, a Nike Zeus successfully intercepted a Nike Hercules, a major development milestone for the system. A second successful intercept of a Nike Hercules was completed in March 1962 (Bell Laboratories 1975:I-24). These successful early tests paved the way for tests against true ICBM targets at Kwajalein.

A complete Nike Zeus system, including the ZAR, DR, two TTRs, three MTRs, and BCB was completed at Kwajalein by mid-1962. The first intercept test on June 26, 1962 was a failure, although the ZAR and TTR successfully tracked the incoming ICBM launched from Vandenburg Air Force Base (AFB). A partially successful intercept took place on July 19, 1962, when a Nike Zeus passed within 2 kilometers of an Atlas D ICBM launched from Vandenburg AFB. A completely successful intercept occurred on December 12, 1962 when a Nike Zeus launched from Kwajalein passed well within the miss-distance of an Air Force ICBM (Bell Laboratories 1975:I-26). Another successful intercept took place on December 22, 1962. Additional intercept tests from Kwajalein continued through November 1963. Of the 13 intercepts attempted, nine were considered successful, three were considered partially successful, and one (the first attempt) was a complete failure (Bell Laboratories 1975:I-26). By this time, the decision had been made not to deploy the Nike Zeus, and further Nike Zeus intercepts against live targets were not conducted. System tests against pre-recorded target trajectories or simulated ICBMs continued at Kwajalein until June 1965 (Bell Laboratories 1975:I-26).

The Nike Zeus B missile was a successful design that was adapted into longer-range versions referred to as the DM-15C and DM-15S series for an experimental satellite interceptor program codenamed Project Mudflap. At the behest of Secretary of Defense McNamara, Project Mudflap was initiated to counter orbital nuclear weapons that were then under development by the Soviet Union (Bell Laboratories 1975:I-31; Walker et al. 2003:47). The first DM-15B was flown at WSMR and reached an altitude of 100 nautical miles, a new altitude record for vehicles launched from WSMR. In February 1963, a follow-up flight test of the Zeus DM-15S at WSMR reached an altitude of 151 nautical miles (Bell Laboratories 1975:I-31). The early tests at WSMR did not intercept actual targets, but rather passed through designated spatial locations to demonstrate the missile's ability to reach an orbiting satellite. The next Nike Zeus DM-15S was flown from Kwajalein Island in March 1963 and attempted to intercept a simulated satellite target at an altitude of 112 nautical miles. A second flight test from Kwajalein in April attempted an intercept of a simulated satellite target at an altitude of 160 nautical miles. Neither of these Kwajalein tests were successful due to tracking failures, although the missiles themselves performed as expected. The first fully successful satellite intercept test took place on May 24, 1963, when the Nike Zeus intercepted an orbiting Air Force Agena D satellite booster that had been modified as a target for the test (Bell Laboratories 1975:I-31). After this test, the DOD mandated that BTL and McDonnell-Douglas personnel at Kwajalein maintain at least one Nike Zeus satellite interceptor missile in a ready state in case it was needed for a real satellite intercept mission. If an actual satellite intercept mission had occurred, Army personnel would have taken over the launch and armed the missile with a nuclear warhead. This readiness state for the Nike-Zeus anti-satellite missile was maintained until 1964, when the ready requirement was ended (Bell Laboratories 1975:I-32; Walker et al. 2003:47). The upgraded versions of the Nike Zeus successfully demonstrated the capability to intercept orbital satellites, and served as the basis for the long-range Spartan interceptor missile that was later used in the Sentinel and Safeguard programs (Bell Laboratories 1975:I-45).

Nike Zeus Becomes Nike X

Despite the apparent need for an ABM system like the Nike Zeus and the promising early results from testing, the system was controversial and had many skeptics in the scientific and political arenas. In particular, President Eisenhower and his defense secretaries were concerned that the available technology was not sufficiently advanced and that the estimated $15 billion required to deploy the system would be spent on an ineffective and quickly outmoded system (Missile Defense Agency 2009). As a result, the Eisenhower administration decided against pushing the Nike Zeus into deployment but authorized funding for continuing R&D on the system, a situation that persisted into the Kennedy administration (Lonnquest and Winkler 1996:110). The new Secretary of Defense under the Kennedy administration was Robert S. McNamara. McNamara was not a proponent of nationwide ICBM defense, instead believing that a powerful nuclear retaliatory capacity was the better and more proven approach to the arms race with the Soviet Union.

Although successful in test scenarios, the Nike Zeus possessed several critical shortcomings that would have limited its effectiveness in real-world situations. The limitations of the system were pointed out by Hans Bethe of Cornell University and Jerome Wiesner of the Massachusetts Institute of Technology (MIT), who were vocal opponents of deploying Nike Zeus (Lonnquest and Winkler 1996:110). These limitations were mostly related to the ability of the Nike Zeus radars to differentiate real targets from decoy countermeasures or other debris (such as discarded booster stages) associated with incoming ICBMs. The Nike Zeus was designed to intercept incoming ballistic missiles at high altitudes out of the atmosphere in order to allow sufficient time for interception. However, it is much easier to differentiate a warhead from other objects in the lower atmosphere due to the filtering effects of aerodynamic drag. In the atmosphere, the heavier warhead would continue to move quickly while lighter objects such as dummy warheads or chaff would be slowed by drag or destroyed from frictional heat. Unfortunately, intercepting targets at lower altitudes in the atmosphere pushed the minimum response time of the system. The other major limitation of the Nike Zeus was that only one target and defending missile pair could be tracked by each TTR and MTR. Tracking multiple targets and interceptor missiles required multiple pairs of TTRs and MTRs, which made scaling the system impractical. The other underlying problem was that early 1960s computer technology lacked the processing speed needed to direct a defense against multiple, simultaneous targets. For these reasons, Bethe and Wiesner argued that the Soviets were more likely to launch a barrage of ICBMs in an attempt to overwhelm the Nike Zeus system, thus making a nuclear attack all the more catastrophic (Lonnquest and Winkler 1996:110; Missile Defense Agency 2009:11-12). The arguments of Bethe and Wiesner strongly influenced Secretary of Defense McNamara's views of the Nike Zeus system.

Due to the limitations of Nike Zeus, Secretary of Defense McNamara halted further work on the system in 1963. On January 5, 1963, McNamara directed the priority development of a new ABM system based on the most advanced technology then available (Bell Laboratories 1975:I-36; Walker et al. 2003:49). This new ABM system was temporarily designated as Nike X until a more suitable name was selected, but the Nike X designation stuck. The Army officially changed the name of the project office from Nike Zeus to Nike X on February 1, 1964 (Walker et al. 2003:49). Western Electric and BTL remained as the prime contractors for Nike X. As part of the transition to Nike X, the Army also assumed command responsibility for Kwajalein Island from the Navy, and the location became known as Kwajalein Test Site. A few years later, the Army changed the name to Kwajalein Missile Range (KMR). Although officially Nike X was the new priority, various tests of the Nike Zeus system components continued until 1965.

The Nike X was not a single ABM system concept, but rather encompassed a number of studies and technological developments that bridged the gap between Nike Zeus and the anticipated next generation ABM system (Bell Laboratories 1975:2-1). The goal of the Nike X was to develop a new ABM system that would be able to defend against the future Soviet ICBM threat of the mid-1970s. This was a departure from the Nike Zeus system, which was designed to defend against a relatively light ICBM attack based on the Soviet missile technology of the late 1950s (Bell Laboratories 1975:2-1). The two biggest changes introduced in the Nike X were phased array radars and a second missile that could intercept ICBMs in the lower atmosphere, where differentiation of the actual warhead was much easier due to atmospheric filtering. This new high-speed missile became known as the Sprint, the addition of which created a second layer of ICBM defense in the Nike X system.

Phased Array Radar and the WSMR MAR

The Nike X incorporated a new phased array radar system that could detect and track multiple targets simultaneously, a major advance over the Nike Zeus. The prototype of this system, the Multi-Function Array Radar (MAR), was under development in 1963 and influenced the decision to halt deployment of the Nike Zeus system. The prototype was originally named the Zeus Multifunction Array Radar (ZMAR), but was renamed the MAR (sometimes referred to as the MAR-I) after the development of Nike Zeus was halted. Ground breaking for the MAR at WSMR took place in March 1963 and it was completed in June 1964. The MAR had separate transmitting and receiving subsystems, and was designed to have two transmitting and two receiver arrays, although the WSMR prototype was only equipped with a single receiver and transmitter array. The WSMR MAR prototype incorporated aspects of nuclear hardening, anticipating its use in ABM installations. To this end, the MAR-I building was constructed of reinforced concrete and much of its 90,000 square feet was constructed below ground, with only the upper part of the building that held the radar array faces actually above grade (Korfmacher 2020).

Although MAR was built as part of the Army's Nike X program, it was also used in support of the ABRES program, tracking Athena flights launched from the GRLC in Utah. The Army's support of the ABRES program was funded directly from the DOD's DDR&E and was therefore not subject to Army-specific program budgets (Jim Forman, personal communication 2023). During the mid-to-late 1960s, DDR&E funding supported the continuing use of the Nike Zeus DR and TTR to track the ABRES Athena flights after the end of the Nike Zeus program. Stephen Squires, Director of HELSTF, recalls being told that the MAR was specifically constructed with an orientation to the northwest to facilitate tracking of the Athena flights as they entered WSMR's airspace from that direction (Stephen Squires, personal communication 2023). The first full test of the MAR tracking an Athena missile occurred on March 2, 1967 (Hayward 2016).

The MAR successfully tracked its first target, a balloon, in September 1964, and then suc-

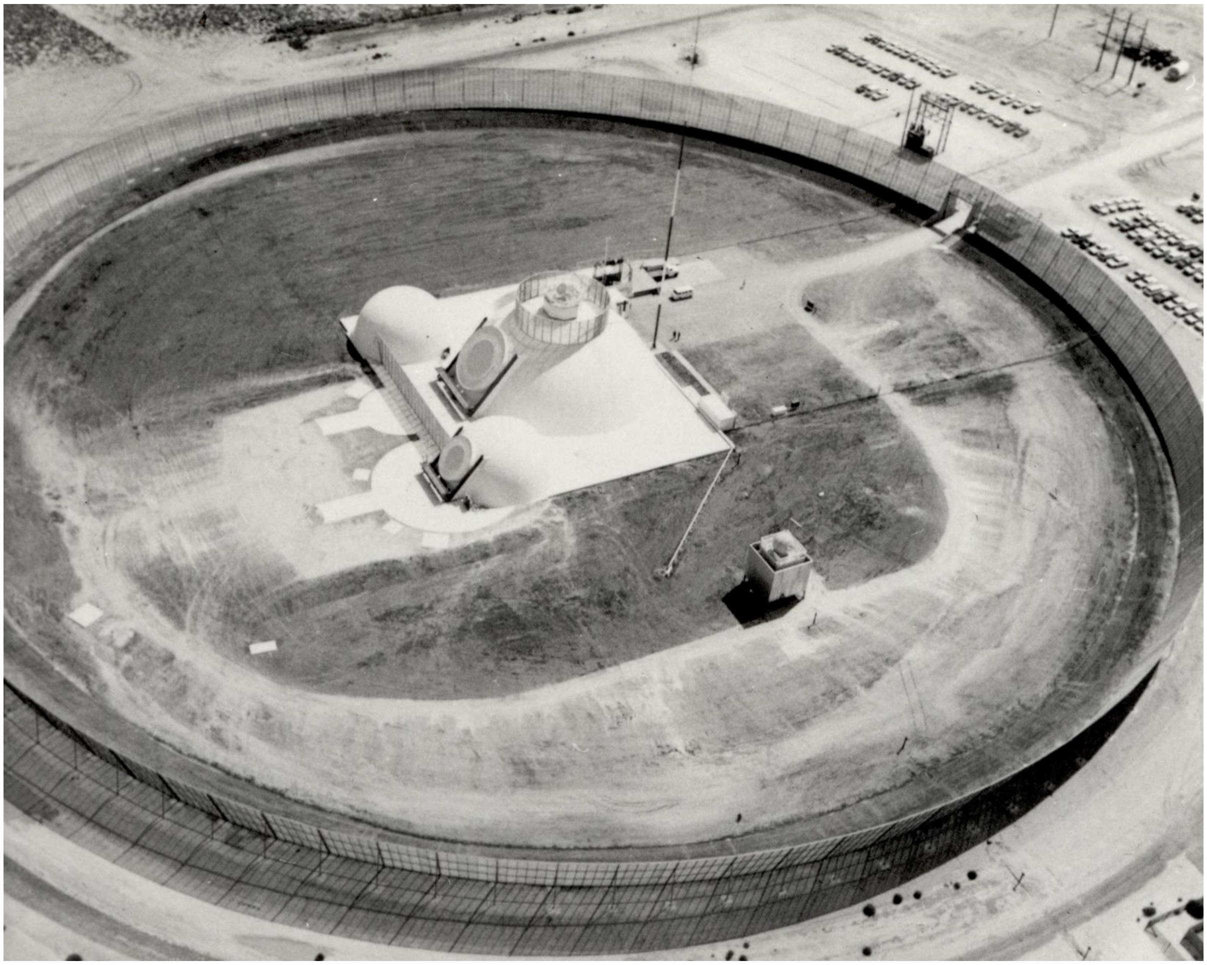

Figure 49. MAR installation at WSMR circa 1965 (*BTL photo)*.

cessfully tracked Highball and Speedball rockets the same month. The MAR then tracked a Pershing missile in November 1964, which was a significant test. The MAR transmitter was shut down and rebuilt during March to October 1965, although work with the receiver continued during this time. The MAR successfully tracked the Soviet *Polynot II* satellite on May 20, 1966, a successful demonstration of its ability to track very small and fast-moving targets at great distances (Hayward 2016). After numerous successful test runs, the MAR test program ended on September 30, 1967, although it continued to be used as part of the Sentinel program into 1969 (Hayward 2016).

The MAR testing successfully demonstrated that phased array radars could accomplish multiple radar functions through microsecond frequency switching and beam arrangements, and that these multiple functions could successfully be managed by a centralized digital computer (Bell Laboratories 1975:I-36). The MAR operated in the L-band and performed four functions: (1) search and verification, (2) threat evaluation, (3) target track, and (4) missile track. The MAR essentially combined the operation of the Nike Zeus ZAR, DR, TTR, and MTR into a single radar. Not only did the MAR combine the operation of multiple radars in a single unit, it also allowed simultaneous tracking of multiple targets. The MAR successfully demonstrated the phased array radar concept, which was a paradigm shift in radar technology. Phased array radars were fundamental to the operation of the Nike X, Sentinel, and Safeguard ABM systems that replaced the Nike Zeus.

A larger and more powerful phased array radar was initially planned as part of the Nike X, which was referred to as the MAR-II. The MAR-II was planned as the major radar unit for Nike X batteries that defended cities and urban areas, and would have performed the roles of search, track, and target discrimination. BTL planned to construct a prototype MAR-II on Kwajalein Island as part of the Nike X development program. However, the costs of the MAR-II were substantial and construction of the prototype was postponed. In 1968, the MAR-II design was scaled down to create a less expensive version, which was referred to as the Tactical MAR (TACMAR). However, the TACMAR was eventually eliminated entirely in favor of the more economical Perimeter Acquisition Radar (PAR) that was incorporated into the Sentinel ABM system. The TACMAR design was modified into an R&D prototype known as the Common Aperture Multifunction Array Radar (CAMAR). The CAMAR building was constructed at the west end of the Kwajalein Atoll at the KMR, but the system was never completed (Hayward 2016).

The concept of the PAR was initially developed in 1965 as part of the system studies for the Nike X. Initially, the PAR was to be an unhardened, early warning radar that would operate in the Very High Frequency (VHF) bandwidth to be used in a limited Nike X deployment. The

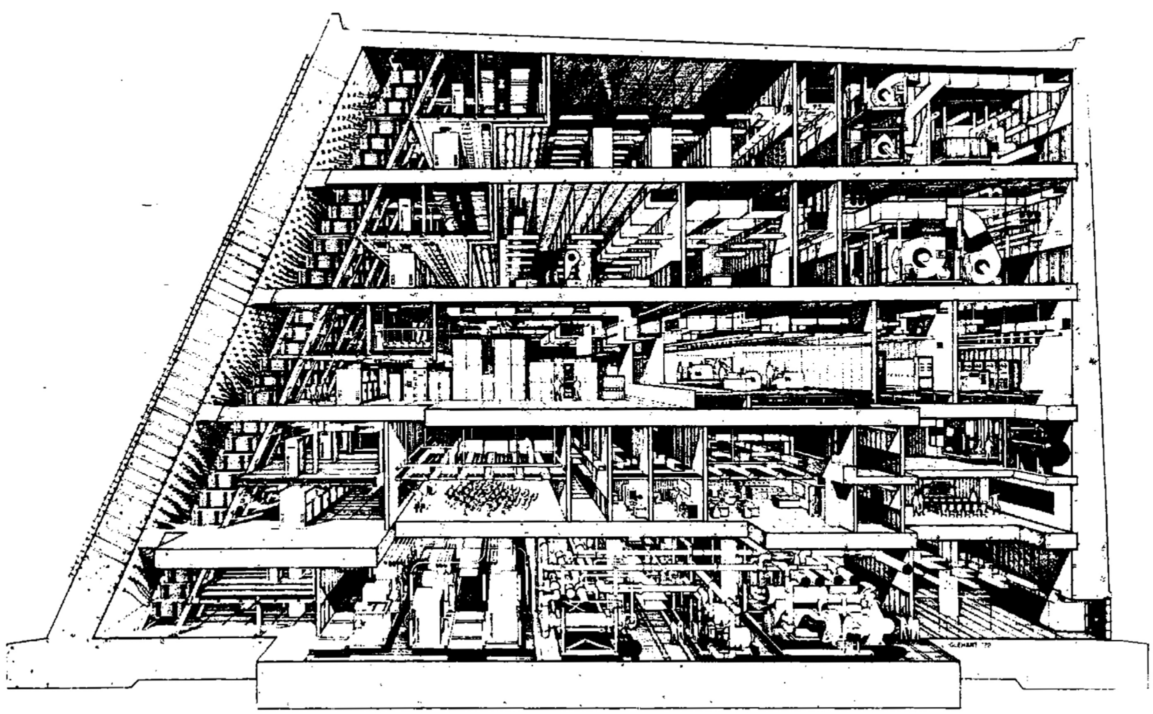

Figure 50. Cutaway view of the PAR building (*adapted from BTL 1975)*.

PAR was a simplified version of the MAR that incorporated a single north-facing phased array that acted as both a receiver and transmitter. BTL selected GE as the PAR sub-contractor in 1966. However, in 1967, the PAR design was modified for inclusion into the then-under development Sentinel system that was based on the Nike X system studies. The PAR was redefined from just an early warning radar to a multi-function radar that could provide initial target detection, discrimination, and tracking for Spartan missile intercepts. As part of its expanded role, the PAR would be in the forward portion of the defended area and be exposed to possible nuclear blast effects. This required PAR to be a nuclear hardened structure, and its operational frequency was changed from VHF to Ultrahigh Frequency (UHF), which was less susceptible to interference from nuclear blast effects (Bell Laboratories 1975:8-1). The PAR was based on technology that had already been established in the MAR, and was therefore considered to be an "off the shelf" system. As such, a complete prototype installation was omitted in favor of an R&D unit that would become part of an operational Sentinel installation once it was completed. This location was originally planned outside of Boston, but eventually the PAR was constructed in North Dakota as part of the Safeguard system (Bell Laboratories 1975:8-2). As constructed, the PAR was housed in a 128-foot high hardened reinforced concrete building that provided protection against nuclear thermal radiation and EMP effects. The north-facing front of the building is inclined at a 25-degree angle and supports a phased-array of 6,888 antenna elements. The building required 17 million pounds of steel reinforcing bars and more than 58,000 cubic yards of concrete. The base of the PAR building is 200 feet square and 11 feet thick, and the phased array face is 7 feet thick (Bell Laboratories 1975:8-8).

A second smaller radar named the Missile Site Radar (MSR) also underwent preliminary development as part of the Nike X program beginning in 1964. The MSR was to provide tracking for defensive missiles and short-range target tracking that supplemented the primary MAR-II. However, in 1965 the MSR role was expanded to include search, acquisition, and target tracking when the MAR-II development proved too costly. The MAR was soon eliminated from the Nike X system entirely as the capabilities of the MSR were expanded (Bell Laboratories 1975:7-4). The MSR operated in conjunction with the PAR, and would be the primary system responsible for guiding Sprint interceptor missiles to their targets and also housed the system data processing equipment. The Prototype MSR was constructed at Meck Island in the Pacific, while the Tactical MSR was constructed in North Dakota as part of the Safeguard installation. The Tactical MSR was constructed partially underground and, like the PAR, was hardened against nuclear blast effects. The MSR building was 120 feet in height and its base was 230 feet square. The visible portion of the pyramid-shaped building contained four phased array faces. The outer walls of the building were 4 feet thick and sloped at 35 degrees, standing approximately 80 feet above the ground. Each of the antenna arrays were approximately 13 feet in diameter and composed of 5,000 phased array elements (Bell Laboratories 1975:7-5). The phased array PAR and MSR became the primary radars used in the Sentinel and Safeguard ABM systems which followed the Nike X development program.

The Spartan Missile

The high-altitude interceptor missile of the Nike X system was based on the Zeus DM-15C configuration. The Spartan externally resembled the Nike Zeus, but was modified with higher performance solid propellant motors, improved guidance, and a higher yield warhead (Bell Laboratories 1975:10-1). Development of the Spartan began in January 1965, and focused on adding a higher yield warhead to the existing Nike Zeus to improve its outside the atmosphere kill radius. This modified version of the Nike Zeus was renamed Spartan in January 1967, and could reach operational altitudes up to 350 miles. The first flight test of the Spartan missile was conducted from the KMR in March 1968 (Bell Laboratories 1975:10-1). Spartan was based on the already proven Nike Zeus design and the lengthy engineering and hardware design phase ensured that it was a very reliable design. The Spartan missile was developed as part of the Nike X program, but was also the long-range interceptor for the Sentinel and Safeguard programs.

The Spartan missile was partnered with a low-altitude interceptor, the new high-speed Sprint missile, which operated at altitudes of 20 to 30 miles. The Sprint program was mostly conducted from LC-38 and LC-50, but early tests of the Sprint propulsion test vehicle were flown from the former Squirt launcher at LC-37 in early 1965. The Sprint missile and its testing at WSMR is discussed in additional detail in a separate section below.

Nike X Becomes Sentinel

Although the Nike X promised to overcome the technical shortcomings of the Nike Zeus system it replaced, deployment of the system was met with public and political opposition. Jerome Wiesner and former ARPA chief scientist Herbert York co-authored a 1964 article in *Scientific American* that argued deployment of an ABM system like Nike X would increase the risk of nuclear war by upsetting the strategic balance; if an ABM system could truly protect against a retaliatory attack, they argued that mutual destruction was no longer assured in the event of nuclear war. This in turn might provoke

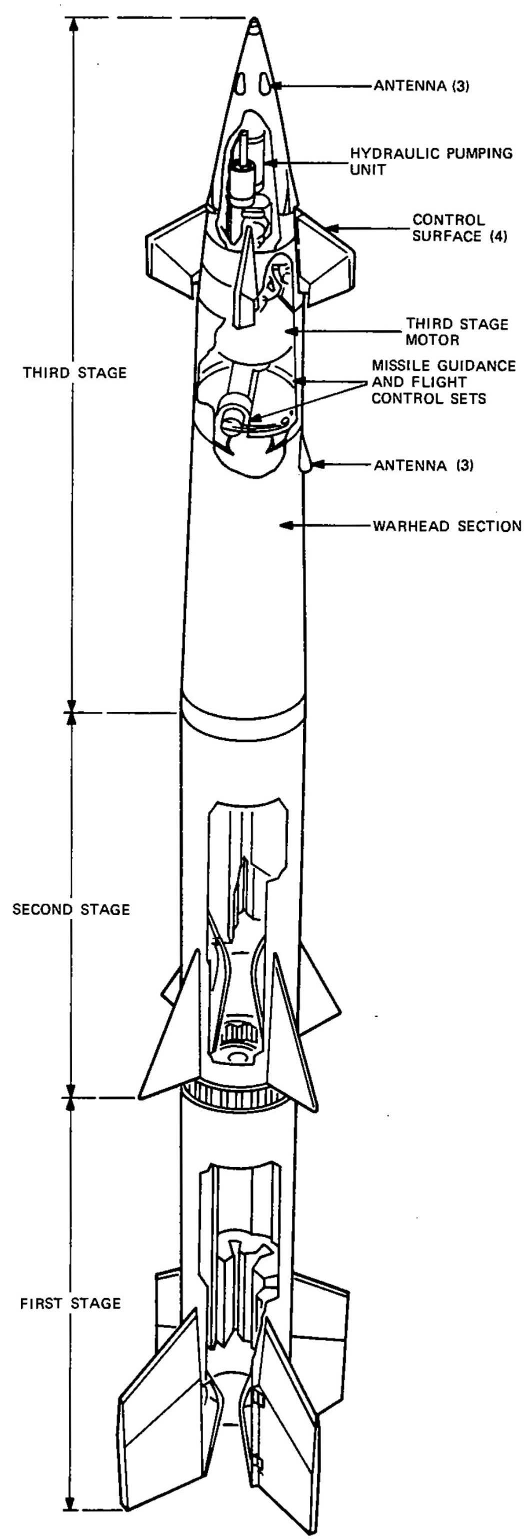

Figure 51. Diagram of Spartan missile (*adapted from BTL 1975)*.

a preemptive strike by the Soviet Union (Lonnquest and Winkler 1996:111). This argument against ABM deployment was used by opponents of the system throughout the 1960s and early 1970s. Additionally, the war effort in Vietnam made funding the deployment difficult, and the growing anti-war sentiment among the American public was extended to the installation of ABM systems (Lonnquest and Winkler 1996:111).

While public opposition to a national BMD system grew during the mid-1960s, new potential threats to national security also emerged, generating support for at least a minimal BMD network amongst some politicians and DOD planners. By 1965, DOD planners were increasingly concerned about a new nuclear threat from a so-called “Nth Country.” By the mid-1960s, it was becoming apparent that nations other than the Soviet Union could hit the continental US with a limited nuclear strike, with China’s nascent nuclear arsenal being a particular concern (Bell Laboratories 1975:I-41; Walker et al. 2003:52). The Peoples Republic of China detonated an atomic bomb in 1964, and defense analysts anticipated that the Chinese would develop ICBMs by the 1970s. The potential Nth Country threat shifted Secretary of Defense McNamara’s opposition to nationwide ABM systems, possibly because defense against these threats was perceived as less likely to destabilize the strategic balance with the Soviet Union. Around the same time, it became known that the Soviets had deployed the Galosh ABM system around Moscow, which added further pressure to deploy some kind of ABM system in the US (Walker et al. 2003:53).

The Secretary of Defense and the DOD had commissioned a series of studies during the mid-1960s to evaluate a light defense shield against a limited nuclear strike from China or other unknown nation. In December 1966, the DOD requested that Western Electric and BTL provide a streamlined deployment proposal for the Nike X system that would provide both area defense and hardsite defense. The proposed plan, titled “Plan I-67/Hardsite Defense,” proposed the deployment of a minimal ABM system that would protect against limited attacks from China or the Soviet Union (Bell Laboratories 1975:I-44; Walker et al. 2003:53). The I-67 plan emphasized cost effectiveness and was based on three conditions (1) specific design threat (2) total investment not to exceed five billion dollars, and (3) initial operating capability within 54 months. The I-67 deployment recommended six PARs, 17 MSRs, 480 Spartan missiles, and 455 Sprint missiles (Bell Laboratories 1975:I-45). The BTL I-67 study was significant as it became the basis for the Sentinel ABM system, America’s next attempt at a nationwide ICBM defense system since deployment of the Nike Zeus system was halted in 1963.

Secretary of Defense McNamara announced the deployment of a light ABM system based on the I-67 study recommendations on September 18, 1967 (Walker et al. 2003:54). McNamara modified the planned deployment to initially consist of nationwide defense against an attack on cities and industrial centers by the Chinese People’s Republic and to protect against an accidental ICBM launch from any nation. The deployment plan also included the option to expand the system capabilities to defend critical Minuteman ICBM bases against an attack from the Soviet Union. Nike X was renamed the Sentinel system in October 1967 (Bell Laboratories 1975:7-4). The Sentinel system consisted mostly of technology and components that already had been developed as part of the Nike X program, including the Sprint and Spartan missiles, coupled with the long-range PAR for early detection and the shorter range MSR for targeting and guidance (Bell Laboratories 1975:I-45; Lonnquest and Winkler 1996:112).

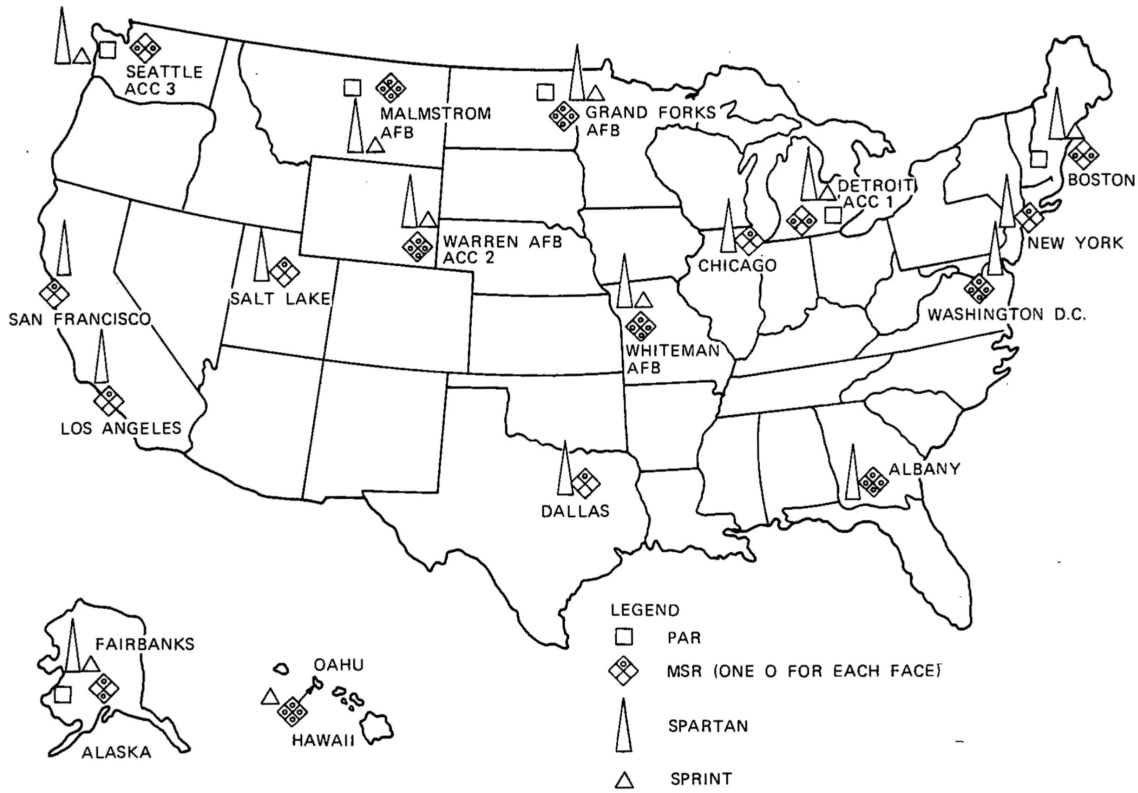

Figure 52. Proposed installations of the Sentinel ABM system (*adapted from BTL 1975)*.

The DOD announced the first 10 locations for Sentinel on November 1, 1967. These locations were Boston, Chicago, Grand Forks AFB (North Dakota), Salt Lake City, Detroit, Seattle, Hawaii, New York, and Albany (Georgia). Several additional planned locations were not announced, which included Washington DC, New York, Dallas, San Francisco, Los Angeles, Malmstrom AFB in Montana, and Warren AFB in Wyoming (Bell Laboratories 1975:I-45; Walker et al. 2003:54). Construction began on the first Sentinel installation outside Boston in late 1968.

The Sentinel program established a large administrative presence in the Army. The program was under centralized control of the Sentinel System Manager, who reported directly to the Chief of Staff of the Army and functioned as an element of the Office of the Chief of Staff. The Sentinel System manager oversaw the three primary Sentinel system organizations, which were the Sentinel System Office in Washington DC, the Sentinel System Command based at Huntsville, Alabama, and the Sentinel System Evaluation Agency at WSMR. A parallel command, the Ballistic Missile Defense Research Office, was also created to manage ongoing ballistic missile defense research (Walker et al. 2003:54).

The construction at Sharpner's Pond, the proposed Sentinel site outside Boston, quickly became a focal point for opposition to the system. An Army community relations meeting on January 29, 1969 failed to assuage the public opposition to the Sentinel system. After the contentious public relations meeting, Massachusetts Senator Edward Kennedy wrote a letter to President Nixon's new Secretary of Defense, Melvin Laird, that challenged the need for the Sentinel ABM system (Lonnquest and Winkler 1996:112). Senator Kennedy's letter was the beginning of another intense round of debate in the Senate about the Sentinel system. Faced with political pressure and public scrutiny, Secretary of Defense Laird halted construction at Sharpner's Pond pending results of a program review. President Nixon also had reservations about Sentinel, as he believed there was validity to the argument that the Soviet Union might perceive the system as providing a safety net for an American first strike capability (Lonnquest and Winkler 1996:112).

There was also an aspect of not-in-my-backyard opposition to Sentinel. Citizens of urban areas scheduled for the installation of Sentinel missile batteries worried that in the case of a nuclear assault, the presence of the system might subject their cities to heavier nuclear bombardment in an attempt to overcome the capabilities of the system (Lonnquest and Winkler 1996:112).

Faced with widespread public opposition and diplomatic difficulties with the Soviet Union, President Nixon opted to re-structure the Sentinel system. The system would only be deployed to protect the nation's nuclear assets in order to preserve its retaliatory strike capability. This also meant the system would be installed away from major cities, thus avoiding most public opposition. The Nixon administration referred to the new system as the Safeguard to emphasize its defensive nature, anticipating that by not defending the nation's cities with ABM systems, the Soviets would be reassured that the US would never conduct a first strike (Lonnquest and Winkler 1996:113).

On March 14, 1969, President Nixon officially announced the new Safeguard program. The President stated that the three goals of the Safeguard system were to preserve the US retaliatory strike capability by protecting ICBM installations; protect the American people from the type of nuclear attack China might be able to mount within the coming decade; and provide protection against an accidental nuclear launch of any sort (Walker et al. 2003:64). The basic components of the new Safeguard system remained unchanged from the prior Sentinel program.

6.8.7 Death by Treaty: Safeguard and the End of Nike

As proposed in 1969, Safeguard was a phased deployment, the first phase of which would construct Safeguard sites to protect the Minuteman batteries at Malmstrom AFB in Montana and Grand Forks AFB in North Dakota, along with the construction of the Ballistic Missile Defense Center (BMDC) at Cheyenne Mountain, Colorado (Walker et al. 2003:6465). Safeguard was in many ways just a re-branding of the Sentinel system, and many of the administrative entities established for Sentinel simply changed names. Preliminary plans were to gradually build 12 Safeguard sites across the country, most of which were in the same general regions as sites proposed for the prior Sentinel program. Safeguard remained controversial in the Senate and Congress, and reduced funding appropriations were only passed by slim margins. In 1970, additional funding was allocated for a Safeguard site at Whiteman AFB in Missouri and preliminary work for a Safeguard installation at Warren AFB in Wyoming. A Safeguard installation was also in the planning stages for Washington DC (Lonnquest and Winkler 1996:114; Walker et al. 2003:67).

By the time construction was underway on the Grand Forks AFB and Malmstrom AFB Safe-

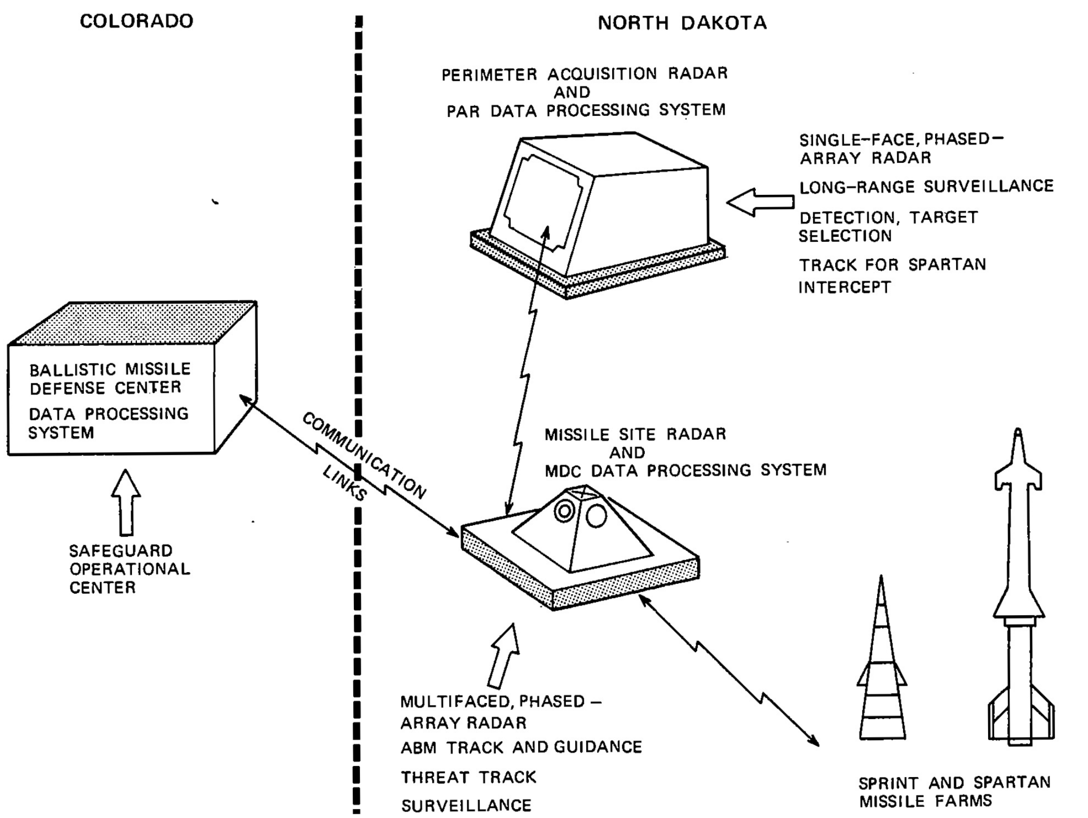

Figure 53. Block drawing of Safeguard installation (*adapted from BTL 1975)*.

guard sites, the ABM Treaty of 1972 had been signed. The ABM Treaty was the end result of the SALT conferences that began in 1969 with the Soviet Union. The ABM Treaty limited the development and deployment of ABM systems, which significantly changed national defense planning. In particular, the ABM Treaty limited the US to one Safeguard installation at an ICBM site and one to protect Washington DC (Lonnquest and Winkler 1996:115; Walker et al. 2003:67). Since construction of the Grand Forks, North Dakota site was well underway, by default it became the single treaty-permitted ICBM Safeguard installation. Work at the Malmstrom AFB Safeguard installation had been slowed by labor and contract disputes, so the project was terminated. All the useable material was salvaged and the foundations of unfinished structures were buried with topsoil, leaving only the partially complete walls of the PAR still visible (Lonnquest and Winkler 1996:115). The Grand Forks Safeguard installation was designated the Stanley R. Mickelson Safeguard Complex (SRMSC), and was the only Safeguard complex ever built. An amendment to the ABM Treaty in 1974 limited the number of ABM sites to one, so the Washington DC Safeguard location was never completed (Walker et al. 2003:68-69).

As the Sentinel and Safeguard deployments were steadily downsized, the nature of the ICBM threat had evolved. By the mid-1970s, the Soviet Union had developed Multiple Independently

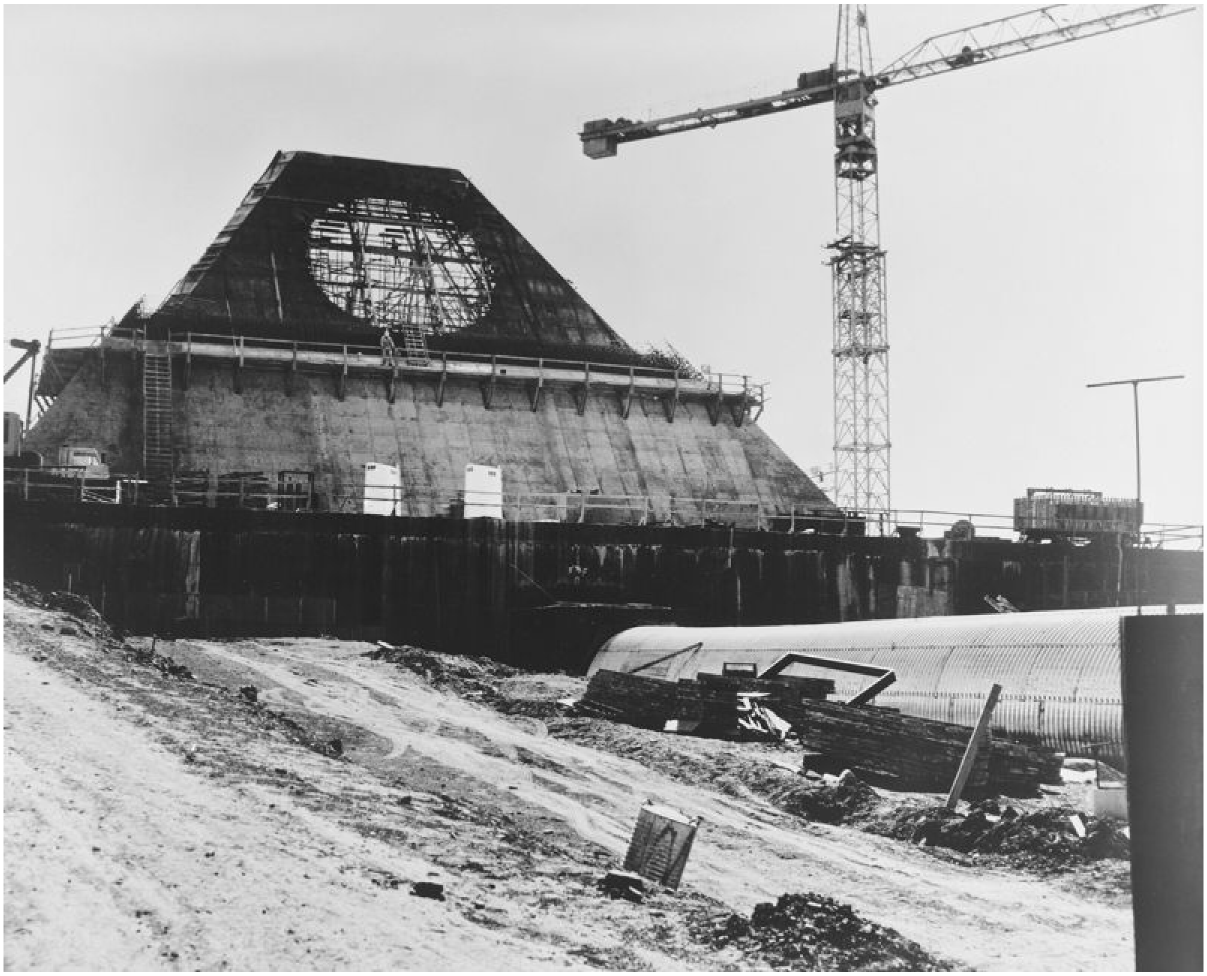

Figure 54. MSR under construction at the Stanley R. Michelson Safeguard Complex in North Dakota, circa 1973 (*public domain image)*.

Targetable Reentry Vehicle (MIRV) equipped ICBMs. MIRV technology allows a single ICBM to carry multiple warheads, each of which can be directed at separate targets, maximizing the threat posed by each ICBM. The US developed MIRV warheads for the Minuteman ICBM in 1970, and by 1975 the Soviet Union had developed MIRVs as well (Federation of American Scientists 2014b).

The SRMSC was only in operation for a year as it became obvious that the single location would be of minimal viability in the case of a massed missile bombardment, particularly against Soviet MIRV-equipped missiles. On September 28, 1975, the same day the SRMSC became fully operational, the House Appropriations Committee recommended the deactivation of the facility by the end of the fiscal year (Walker et al. 2003:76). The Army operated the SRMSC for a year in order to gain operational experience of the system, and the complex was decommissioned in 1976. The PAR long range detection radar at the site did remain operational as part of the North American Aerospace Defense Command (NORAD) beginning in 1977 (Walker et al. 2003:77). Mostly forgotten today, the short-lived SRMSC represented the culmination of 20 years of ABM development that dated back to the mid-1950s Nike II Study.

Though Sentinel and Safeguard dropped the "Nike" designation, these later systems directly descended from BTL's work on the Nike Zeus and Nike X systems.

6.7.8 Nike Testing at LC-38

Nike launches at WSMR took place over 40 years (Table 1). LC-38, originally known as ALA-5, was established specifically for testing of the Nike Zeus system. Major construction started in 1958, with additional major facilities added through 1962 in support of the Nike Zeus RDT&E effort. The initial wave of construction included the grading and surfacing of 8,670 feet of gravel roads and 6,250 feet of paved roads that connected to Nike Avenue. The main north-south access roads within LC-38 were Range Road 242 in the eastern part of the complex, and Range Road 239 in the western part of the complex. Range Road 240 was the east-west road that connected between the main north-south roads. Range Road 238 was another east-west road that extended west from Range Road 239 and continued west into the neighboring LC-37. The water utility infrastructure at the complex consisted of approximately 22,250 linear feet of 8-inch diameter water lines, a 200,000-gallon capacity elevated water storage tank (Property 23637), fire hydrants, and shutdown valves at intervals throughout the system. The original LC-38 electrical utility system included one 5,000 Kilovolt Amps (kVA) substation, 12,380 feet of overhead distribution lines, 12,000 feet of underground distribution lines, 2,000 feet of overhead 115 KV distribution lines hung on heavy double-pole H-frame structures, and several small transformer and sub-stations distributed throughout the complex (WSMR 1959:5).

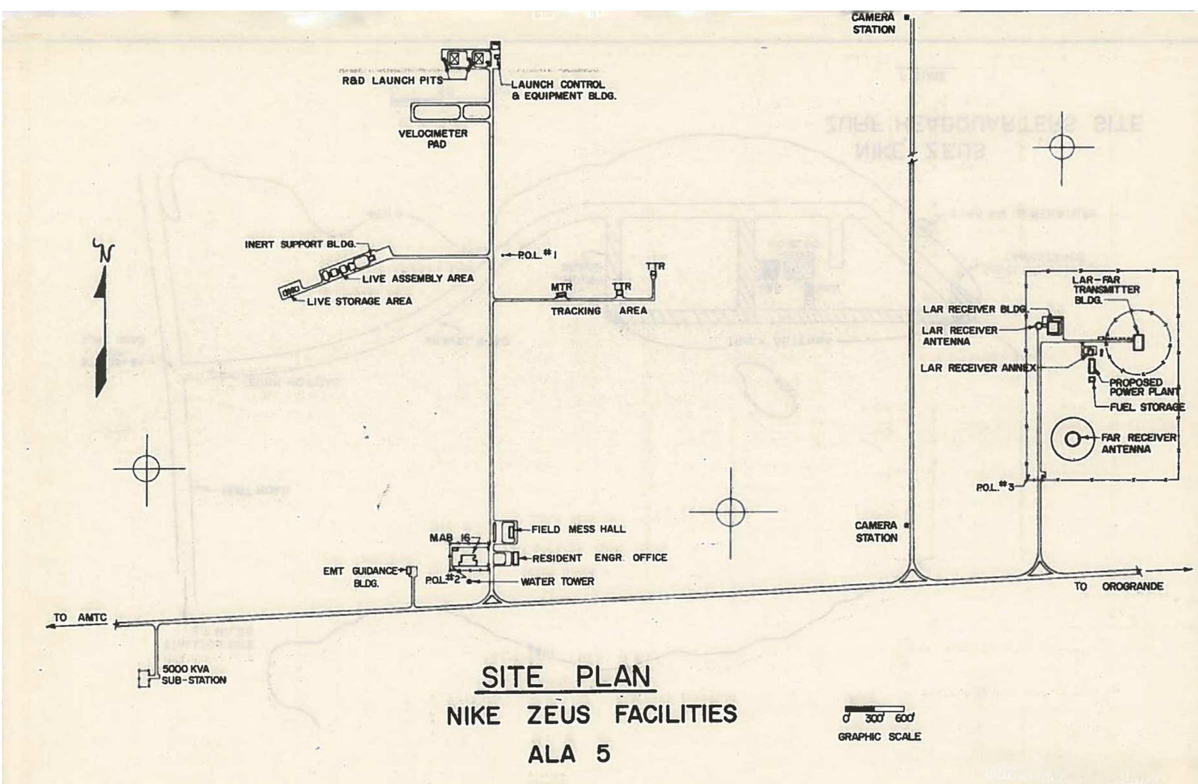

Figure 55. Early map of the Nike Zeus facilities at LC-38 (*adapted from WSMR 1959)*.

Table 1. Nike Missile Launches at WSMR 1946 to 1986.

Year	Type	Total Launches
1946	Nike Dummy	3
	Nike Research	6
1947	Nike Dummy	5
	Nike Research	7
1948	Nike Dummy	9
	Nike Ajax	17
1949	Nike Ajax	5
1950	Nike Ajax	26
1951	Nike Ajax	14
1952	Nike Ajax	87
1953	Nike Ajax	223
1954	Nike Ajax	382
1955	Nike Ajax	597
1956	Nike Ajax	781
	Nike Hercules	1
1957	Nike Ajax	721
	Nike Hercules	133
1958	Nike Ajax	738
	Nike Hercules	180
1959	Nike Ajax	317
	Nike Hercules	168
1960	Nike Hercules	68
	Nike Zeus	62
1961	Nike Hercules	37
	Nike Zeus	64
1962	Nike Hercules	10

Table 1. Nike Missile Launches at WSMR 1946 to 1986, Cont.

Year	Type	Total Launches
	Nike Zeus	66
1963	Nike Hercules Contr.	10
	Nike Hercules ATBM	1
1964	Nike Hercules	8
	Nike Zeus	1
	Nike Zeus Target	19
1965	Nike Hercules	12
	Nike X	17
1966	Nike Hercules	15
	Nike X PGM	6
1967	Nike Hercules	3
	Nike X PGM	22
1968	Nike X PGM	15
1969	Nike X/Safeguard	11
1971	Nike Hercules	19
1973	Nike Hercules	2
1975	Nike Hercules	2
	Nike Series*	1
1976	Nike Hercules	4
	Nike Series*	1
1977	Nike Series*	5
1978	Nike Series*	3
1979	Nike Series*	3
1981	Nike Series*	1
1982	Nike Series*	1
1983	Nike Series*	2

Table 1. Nike Missile Launches at WSMR 1946 to 1986, Cont.

Year	Type	Total Launches
1984	Nike Series*	1
1985	Nike Series*	2
1986	Nike Series*	2

*"Nike Series" appears to denote Nike-based sounding rockets or target missiles.

A series of permanent buildings and structures were constructed as part of the establishment of LC-38, which represented a significant investment. Construction of a large assembly building north of Nike Avenue (Property 23626) was completed in mid-1959. The EMT Guidance Building (Property 23620) was also constructed in roughly the same period, located west of Property 23626; this property has been demolished.

An area for hazardous assembly and checkout work was established in the west central part of the complex as part of the original Nike Zeus infrastructure. Two large hazardous assembly and storage structures (Properties 23654 and 23656) were constructed between 1958 and 1959, along with an attached test cell building (Property 23660). A one-story building, referred to as the Inert Support Building (Property 23664) served as an office and laboratory building for the neighboring Properties 23654 and 23656; this building has been demolished.

The launch area for the Nike Zeus missile was constructed in the north central part of the complex as part of the initial wave of Nike Zeus construction. The launch area initially consisted of two R&D launch pits (Properties 23669 and 23673) that angled below grade to a depth of approximately 25 feet, with blast plates and deflectors in the lower portion of the pit

Figure 56. Overview of Nike Zeus launch area at LC-38, circa early 1960s (*courtesy WSMR Museum Archives)*.

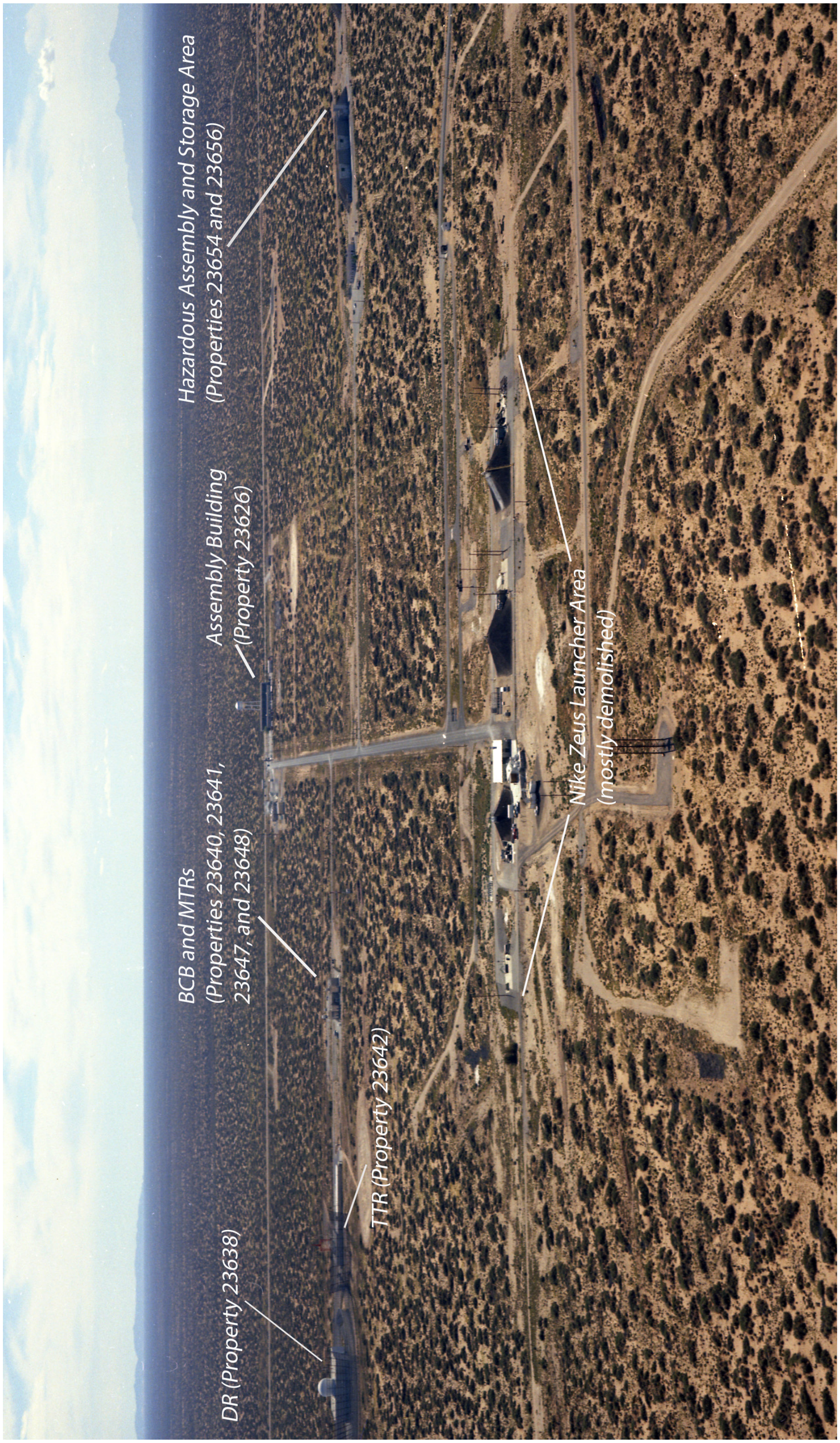

Figure 57. Overview of Nike Zeus installation at LC-38 looking south from the launch area in 1971 (*courtesy WSMR Museum Archives*).

for investigation of heating and erosion (WSMR 1959). Each launch pit was equipped with a small concrete shelter that housed instrumentation and control equipment (Properties 23670 and 23672). Large pyramidal revetments separated the launchers from the associated launch control building (Properties 23668 and 23671). The launch control building (Property 23680) consisted of a subterranean concrete control room, above which was a pre-manufactured steel frame building, referred to as the launch equipment building (WSMR 1959:31). An underground access tunnel, approximately 8 feet in diameter, connected the launch control shelter with the launcher pits, but was not physically attached to the launchers for safety reasons. The tunnel was used for the routing of all control cabling, heating and cooling lines, and electrical wiring. The tactical launch cell (Property 23683) was constructed to the east of the R&D launch pits, and consisted of an underground control room and launch silo for the Nike Zeus, along with a surface-mounted test cell.

The massive radar facilities that were at the core of the Nike Zeus system were also constructed as part of the initial wave of construction. The ZAR receiver (Properties 24062 and 24064) and transmitter (Property 24072) were constructed between 1958 and 1959. Early documentation of the LC-38 ZAR installation sometimes referred to it as the LAR, a leftover from the abandoned FAR/LAR terminology that was part of the early Nike Zeus system design. Constructed in support of the ZAR installation were a series of physical plant facilities, including a water-condensing tower (Property 24065), and an annex building that housed refrigeration and heating equipment (Property 24066). A power plant building (Property 24068) that provided supplemental power to the ZAR was added to these facilities in 1960. The ZAR area and its associated physical plant facilities were originally surrounded by a chainlink perimeter fence that formed a separate security area within LC-38; this large rectangular fenced area measured approximately 2,150 feet north-south and 1,560 feet east-west. Near the southwest corner of this fence, a guardhouse (Property 24025) was constructed along Range Road 242 to control access into the fenced security area. The fence has been removed, but numerous concrete filled postholes and post stubs remain to indicate its alignment, and Property 24025 also remains in place.

To the north of the ZAR installation, a 2,000-foot long compacted earth runway (Property 23075), small aircraft hangar (Property 24070), taxiway (Property 24076), and pads for modified Nike Hercules radars (Properties 24077 and 24078) were constructed between late 1959 and early 1960 (Stevenson et al. 1961:57). These facilities were for the Airborne Instrument Laboratory (AIL), which was a special aircraft outfitted with radar instrumentation used to calibrate the ZAR receiver and transmitter. The ZAR calibration work with the AIL was completed by mid-1960 (Stevenson et al. 1961:70). The runway and taxiway are no longer in useable condition today, but Property 24070 remains in place.

The remaining Nike Zeus radar facilities at LC-38 were mostly completed by 1960. These included the TTR installation (Property 23642), the BCB (Property 23640), and the three MTR units (Properties 23641, 23647, and 23648). A slightly later addition to the LC-38 Nike Zeus installation was the DR (Property 23638), which was completed in 1962. The DR was surrounded by three clutter fences (Properties 23657, 23658, and 23659); only the outer clutter fence remains intact today (Property 23659). Property 23638, which housed the DR installation, has also been demolished.

Figure 58. Two views of Nike Zeus R&D launch pit at LC-38, circa early 1960s (*courtesy WSMR Museum Archives [left] and Ryan Criere [right]*).

Figure 59. Property 23680 launch control building circa early 1960s (*courtesy WSMR Museum Archives)*.

Nike Zeus Test Flights

Prior to the test flights of the actual Nike Zeus missile, DAC conducted test flights of the Advanced Hypersonic Test Vehicle (AHTV), a test vehicle designed to test skin materials for the Nike Zeus missile. DAC also conducted flight tests using 5-inch High Velocity Altitude Rockets (HVAR) to test various system components of the Nike Zeus missile, particularly hardware associated with stage separation (Stevenson et al. 1961:75). The AHTV bore no resemblance to the Nike Zeus, and was a three-stage, fixed-fin unguided ballistic missile that used a Nike Hercules booster. Flight tests of the AHTV and HVAR were conducted from late 1957 to late 1959, mostly from LC-33 at WSMR. Beginning in late 1959, DAC conducted additional Nike Zeus R&D tests using the scaled down Nike Zeus launching cell at LC-33. These tests confirmed design criteria for the design of the full-size Nike Zeus launch cell at LC-38 (the so-called Tactical Launch Cell [Property 23683]). These tests were conducted using Falcon and HVAR motors to evaluate blast effects on the launcher cell prototype and evaluate its hardware design (Stevenson et al. 1961:79). These tests continued through early 1960. DAC also conducted two special tests using Nike Ajax missiles in the scaled down Nike Zeus launcher. These tests evaluated the effects of the firing on both the launch cell and the missile, and measured cell pressure, temperature, and stresses, and also evaluated the exhaust exit angle and deflection configuration. These tests were successful; the launcher cell was undamaged and the missile fight was normal (Stevenson et al. 1961:81). One final test by DAC, conducted just a week before the first actual Nike Zeus test flight, used a modified Honest John artillery rocket to evaluate the Nike Zeus instrumentation system (Stevenson et al. 1961:82).

Flight tests of the early Nike Zeus winged configuration, designated as the DM-15A model, started in the summer of 1959. After several delays, the first Nike Zeus flight test, codenamed "Firebird," was launched on August 26, 1959 at LC-38 from the R&D Launch Pit #1 (Property 23673) (Stevenson et al. 1961:96). The Nike Zeus radars were not yet operational, but this did not matter for these early flight tests, which focused on the flight characteristics of the missile itself. Test criteria for this early flight included the performance of the first and second stage motors, skin temperature and erosion, launcher operation, and guidance antenna operation. Sound levels and back pressures in and around the launcher were also recorded (Stevenson et al. 1961:96). This first test flight failed early in the flight and was considered only partially successful. Additional early test flights of the Nike Zeus continued at LC-38 through 1960, and were conducted from the R&D Launch Pits (Properties 23673 and 23669).

On April 28, 1960, the sixth Nike Zeus (round ZW-6, code named 'Blackfish') was launched from the Nike Zeus underground launch silo, referred to as the "Tactical Cell Launcher" (Property 23683). This was the first launch from the Nike Zeus underground launch silo, and the first time a motor generating 450,000 pounds of thrust had been fired from an underground launch silo (Wind and Sand 1960:1). The main objectives of this launch were to demonstrate the launch capability from an underground cell, gather data on the cell environment during the launch, obtain missile booster data during the launch, and to investigate missile radar contact during the launch (Stevenson et al. 1961:107). The test objectives were met and the launch from the underground silo was considered successful, although the missile booster broke up during the flight (Stevenson et al. 1961:108). The Army coverage on the launch stated that underground facilities were less expensive to construct than surface launch facilities, provided more uniform temperatures, and provided some protection against enemy attacks (Wind and

Figure 60. Nike Zeus B launch from LC-38, circa early 1960s (*photo courtesy WSMR)*.

Sand 1960). A later test of an "unported" or "blind" version of the tactical cell launcher ruptured the booster approximately 0.25 seconds into the test, apparently due to stresses created within the unported launcher cell environment (Stevenson et al. 1961:111).

After the successful flight test of Nike Zeus missile ZW-7 on May 25, 1960, the Army considered the first phase of the Nike Zeus test program to be successfully completed. The first phase of testing evaluated the capability of the missile airframe to survive the extreme frictional heat generated during the first part of its flight within the atmosphere, and also tested the launcher hardware, launch techniques, handling procedures, booster and sustainer motors, and other internal components (Stevenson et al. 1961:110). According to WSMR firing records, 12 Nike Zeus missiles were launched in 1959, and 62 Nike Zeus missiles were launched in 1960 (WSMR Museum 2016).

The first test of the canard configuration, or DM-15B model, of the Nike Zeus missile took place on August 10, 1960. The missile, code named "Comet," was launched from the R&D Launch Pit #1 (Property 23673) at LC-38 and tested many aspects of the missile airframe and its internal components (Stevenson et al. 1961:112). Tests of the DM-15B configuration continued through the remainder of 1960, and most of these test flights resulted in catastrophic failures of the missile. The Nike Zeus flew at such high speeds in the lower atmosphere that friction heating of its airframe proved to be a problem in these early missiles. After several catastrophic failures, recovery of missile debris from WSMR finally helped identify the problem. Aerodynamic heating was so severe that it cut through the hardened steel control shafts of the fins, causing the missile to spin out of control (Bell Laboratories 1975:I-22). Changes were made to the Nike Zeus airframe design to eliminate the high-pressure areas that generated the heat shearing problem. Some of these Nike Zeus design alterations were later used by Martin Marietta in the Sprint missile. This problem would have been much more difficult to diagnose on an over-water range, as noted in the BTL ABM project history:

> One important lesson learned from the Zeus development firings, and reaffirmed years later with Sprint, is that there is no substitute for missile testing over a ground range where the pieces can be recovered and the cause of failure found. This is especially true where the state of missile art is being advanced significantly and where there is a limit to the number of missile-borne sensors capable of detecting the cause of failures [BTL 1975:I-23].

Highball and Speedball Targets

The Highball and Speedball targets were cost-effective, high-speed targets developed for testing of the Nike Zeus. In 1958, BTL awarded a contract for a feasibility study of low cost, high velocity targets to the NMSU PSL. The feasibility study was to, "determine whether small, inexpensive vehicle systems could be developed to provide satisfactory targets for use in the R&D testing program of the Nike Zeus system" (Stevenson et al. 1961:82-83). The PSL developed two target vehicle options under the feasibility contract: the unguided, single stage, solid propellant Highball rocket, and the unguided, two stage, solid propellant Speedball rocket. The Highball targets were powered by either Asp or Apache solid propellant boosters, while the Speedball was powered by a Nike booster first stage and an Asp or Apache motor in the second stage (Stevenson et al. 1961:82-83). The Highball was launched from a mobile four

Figure 61. PSL technicians pose with a Highball target rocket in 1960 (*adapted from McCune et al. 2011)*.

rail launcher, while the Speedball was launched from modified Nike Ajax launchers. Several versions were developed for each of the targets.

The Highball I carried a radar target that consisted of either a 6-inch diameter aluminum sphere, 20-inch diameter inflatable metallic sphere, or a parachute. The Highball operational altitude was approximately 250,000 feet. The Highball II carried an intercept target consisting of a small, metallic, hemispherical parachute attached to a nosecone that carried an electronic miss-indicator system. The miss distance indicator was a Navy AN/US Q-11 radio-doppler unit that PSL was also contracted to adapt to the Highball/Speedball operational environment (Bell Laboratories 1975:I-31). The Highball II had a maximum operational altitude of 180,000 feet, but was better suited for altitudes between 80,000 and 140,000 feet. Highball III carried 10 radar targets split between two single stage vehicles that were launched simultaneously. The radar targets deployed at altitudes between 150,000 and 200,000 feet and dispersed over a ground distance of about 20,000 yards. The targets consisted of small metallic parachutes or spheres.

Speedball was a two-stage vehicle that was capable of higher speeds and altitudes than the Highball. Its second stage could serve as the target, or it could carry a metallic sphere or eject a corner reflector from the second stage. The Speedball could achieve operational altitudes between 500,000 and 1,000,000 feet (Stevenson et al. 1961:86).

In 1961, BTL approved PSL's feasibility study and issued a $3,379,000 contract (reported as $2,379,000 in the *Wind and Sand* newspaper [Kroehnke 1960]) with PSL for development and construction of these targets for the Nike Zeus system. This was the largest R&D contract ever issued to an educational institution in New Mexico at the time, with a duration through July of 1963 (Kroehnke 1960:2). The targets were to simulate some of the characteristics of incoming ICBMs for realistic testing of the Nike Zeus system. Testing of the various Highball and Speedball targets began November 1959. By the end of 1960, PSL had launched seven Highball I targets, 10 Highball II targets, seven Highball III targets, and two Speedball II targets (Stevenson et al. 1961:87). Testing of the PSL targets ran behind schedule, mostly due to competition for range time with higher-priority programs. The testing was nonetheless successful, and the PSL Highball and Speedball targets, along with the modified AN/US Q-11 miss indicator, were important targets for testing of the Nike Zeus at WSMR and at Kwajalein Island. The PSL target rockets and miss indicator system continued to be used at Kwajalein for testing of the Nike X and the later Sentinel and Safeguard derivatives.

Although the Highball and Speedball targets played an important role in the Nike Zeus testing, they do not appear to have been launched from LC-38. Rather, period documentation states that they were launched from LC-33 and the Speedball Uprange Launch Facility (SULF) Site in the northern part of WSMR (McCune et al. 2011; Stevenson et al. 1961). There does not appear to be any physical resources located at LC-38 (launch pads, support buildings, etc.) that supported the Highball and Speedball launches.

Nike Zeus and the WSMR FIX Area

The WSMR FIX area, which is now called the northern call-up area, originated with the Nike Zeus program. In 1957, planning for the testing of Nike Zeus at WSPG was already underway. It was realized early on in the planning process that the projected range of Nike Zeus would exceed the physical limitations of WSMR. To address this, WSMR planners identified an area, roughly 40 miles square, adjacent to the northern range boundary that could be used as a temporary range extension. WSMR completed the requirements of the northern range extension for the Nike Zeus project in May 1959, and submitted them for review by the Acting Secretary of the Army and Assistant Secretary of Defense (Stevenson et al. 1961:26). The request was approved in August 1959, and Dewey Short, Assistant Secretary of the Army for Manpower, Personnel, and Reserve Forces conducted a public meeting in Socorro, New Mexico that explained the need for the northern range extension and the protocols for protecting people, property, and livestock (Stevenson et al. 1961:27). The range extension was subsequently approved by Congress and the Department of the Interior, and the New Mexico State Highway Commission authorized WSMR to block traffic on US Highway 380 and State Highway 41 for no longer than one and a half hours during scheduled tests. The final agreement with landholders in the extension was signed in December 1959, and the first call up of the WSMR FIX area took place on February 3, 1960 (Stevenson et al. 1961:28). However, in this first use of the range extension, the Nike Zeus missile (round ZW-4) actually fell slightly short and its flight was terminated within the normal WSMR boundaries. The first Nike Zeus (round number ZW-5, codenamed 'Xochimilco') that actually entered the range extension was launched on March 9, 1960 (Stevenson et al. 1961:105).

Nike Zeus System Testing

The complete Nike Zeus system at LC-38 was operational by 1961, and system demonstrations started in November 1961. The ZAR successfully detected and tracked balloons, aircraft, parachutes deployed by Highball target missiles, and Nike Hercules missiles during testing in

1961. The Nike Zeus system successfully transferred these target tracks from the ZAR to the BCB and the TTR (Bell Laboratories 1975:I-24). On December 14, 1961, a Nike Zeus missile successfully intercepted a Nike Hercules target missile, which was a major development milestone. This initial success was repeated in March 1962 with a second successful intercept of a Nike Hercules target missile. The years 1961 and 1962 were busy years for the Nike Zeus program at WSMR, with 64 Nike Zeus missiles launched in 1961 and 66 launched in 1962. The focus of the Nike Zeus testing then shifted to the system tests at Kwajalein Island against actual ICBM targets, the first of which occurred on June 26, 1962 (Bell Laboratories 1975:I-24). Most flight tests of the Nike Zeus took place at Kwajalein after this time.

In 1963, Nike Zeus launches at WSMR slowed considerably, with only four Nike Zeus missiles and 33 Nike Zeus Targets indicated in WSMR firing records (WSMR Museum 2016). The “Nike Zeus Targets” area likely Highball or Speedball targets for the Nike Zeus program rather than the actual Nike Zeus missiles, and were probably used for Nike Zeus radar tracking missions. This is consistent with the majority of Nike Zeus flight tests being conducted from Kwajalein Island beginning in 1963. In 1964, only one Nike Zeus missile is listed in the firing records, along with 19 Nike Zeus Targets (WSMR Museum 2016). In 1965, 17 Nike X flights are indicated in the firing records, along with only one Nike Zeus Target. After 1965, no additional Nike Zeus flights of any kind are identified in WSMR firing records, reflecting the end of Nike Zeus testing and the transition to the Nike X developmental program. Test flights at WSMR for the Nike X program consisted of tests of the Sprint missile, which is discussed in further detail in a separate section below.

Work continued at LC-38 in support of the Nike X, and many of the Nike Zeus radar facilities were modified in support of Nike X or other programs. Details regarding the re-use of these properties for other programs are provided in separate sections of the historic context below, and are also discussed by individual property in Chapter 7.

6.8 The Sprint Missile and LC-38

The Sprint missile was initially developed as part of the Nike X system as a low attitude, fast response interceptor missile which operated at altitudes of 20 to 30 miles. The Sprint program was mostly conducted from LC-38 and LC-50, but early tests of the Sprint propulsion test vehicle were launched from the former Squirt launcher at LC-37 in 1965. The Sprint was a short range, high-speed missile designed to intercept incoming ICBMs in the lower reaches of the atmosphere if they escaped interception by the longer-range Spartan missile. At this stage in their flight, ICBM reentry vehicles are traveling at maximum speeds and the Sprint had to fly extremely fast to intercept them. The Sprint missile was most likely the fastest man-made object in the world at the time; it reached a speed of Mach 10 in approximately 5 seconds and generated acceleration forces of 100 Gs during its boost phase (Eckles 2013:9). For comparison, the average human being can withstand about 5 Gs of vertical acceleration forces. In the words of Doyle Piland who worked with the Spartan system at WSMR and the KMR:

> In unclassified briefings, they would say that the time from launch until it had traveled a mile was less than a heartbeat. The words fast, quick, etc. are grossly inadequate to describe the Sprint. Sudden and instant are more appropriate words [Piland 2006a:4].

Due to the low altitude of the planned Sprint intercept, the blast effects of the Sprint nuclear warhead could cause collateral damage to ground installations. It was therefore mostly planned for deployment at "hardened" sites such as ICBM installations. The Sprint was also equipped with a neutron bomb warhead, which presented less pronounced thermal and blast impacts compared to a traditional thermonuclear warhead. In theory, the blast from the neutron warhead would damage electronics and the actual incoming warheads themselves without causing them to detonate (Parsch 2004). The Sprint was eventually incorporated into the Safeguard ABM system.

Sprint at LC-38

After Nike Zeus development was halted and the program redirected into the Nike X, many of the facilities at LC-38 were used in support of Sprint testing, although some properties were adapted for programs other than Sprint. Assembly and checkout of the Sprint missile was conducted at LC-38, along with some aspects of guidance and radar tracking. Properties 23626, 23654, and 23656 were used for assembly and checkout of the Sprint missile, with Property 23626 also housing office space for the Safeguard program as well. Properties 23654 and 23656 remained assigned to BTL after the end of the Nike Zeus testing and were used in support of the Sprint missile program. A large addition was made to the north elevation of Property 23656 in support of the Sprint program. The 1964 plans for the modification are labeled "Live Assembly Bay No. 3 Modifications" (Plan Set WS-JR). The addition allowed assembly and checkout of the Sprint missile in the vertical position, which was then removed and transported to LC-50 for launching (Piland 2007b:4). The Sprint vertical assembly addition included a below-grade assembly pit that is not visible from the exterior of the property.

The Nike Zeus BCB (Property 23640) and the associated MTR units (Properties 23641, 23647, and 23648) were adapted to support the Sprint missile program as well (Plan Set WS-MX). Between 1964 to 1970, Property 23640 housed the launch control and missile tracking functions for the Sprint missile, which was launched from LC-50 (Piland 2007b). Plans for the Sprint program alterations to the MTR antenna towers suggest that Properties 23641 and 23648 supported an "Antenna Receiver Group Missile Tracking" and a "Radiometry Mount Assembly" during the Sprint testing (Plan Set WS-OK). The outer "shield wall" was extended over the top of both towers as part of the transition to Sprint testing. Additionally, Property 23652 was constructed in support of the Sprint missile program and was part of the Sprint modifications made to LC-38. The building is a shelter that housed support equipment for the associated boresight tower that was used to calibrate the MTR units installed outside the nearby Property 23640.

The TTR housed in Property 23642 and the DR at Property 23638 continued to operate with ARPA funding in support of Project Defender and the ABRES programs from 1964 to 1969. However, it does not appear that they were used in support of the Sprint missile testing, since their functions would have been taken over by the Nike X phased array MSR and PAR. In October 1968, operation of the TTR and DR installations was transferred to the ABMDA. In September 1969, the ABMDA halted operation of both the TTR and DR installations, and the radar equipment was removed from both installations soon after (Piland 2007b). The ZAR receiver (Properties 24062 and 24064) and transmitter (Property 24072) apparently ceased operation as Nike Zeus transitioned to Nike X. Property 24064 was modified with a phased array radar installation in 1965, which is discussed in further detail below. Records do not indicate

Figure 62. Photo mosaic sequence of Sprint launch from LC-50 (*courtesy WSMR Museum)*.

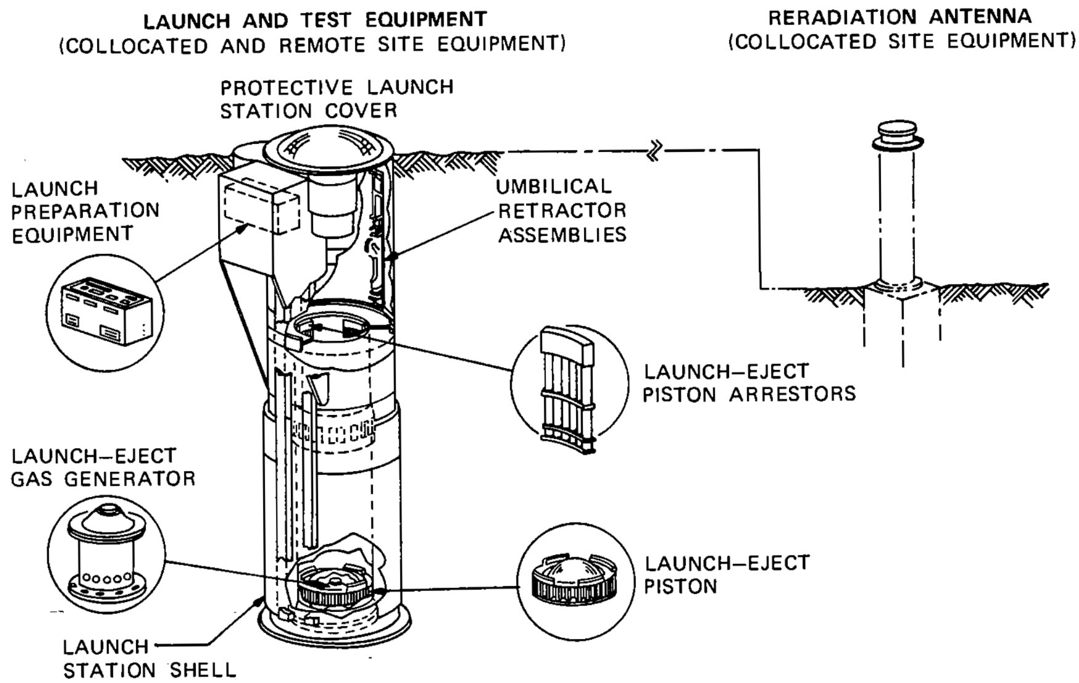

Figure 63. Drawing of the Sprint launch silo design used with the Safeguard program (*adapted from BTL 1975)*.

that any of the ZAR properties were used in support of the Sprint program. The below-grade west elevation of Property 24072 was exposed and modified with an access drive and overhead rolling door in 1969, according to property records. The clutter fences outside Property 24072 appear to have been removed as part of this project as well. A request for sealed bids for the removal and scrapping of the ZAR transmitter antenna was issued in March 1971.

The Sprint operations at LC-38 ended by 1970, when the Sprint testing program was completed. According to real estate disposition records, BTL's assignment of Properties 23626, 23640, 23654, and 23656 was terminated in October 1970 (Field 1970; Piland 2007b). Many of the LC-38 properties were then used in support of the Patriot program, which had began operations at LC-38 in 1969. The Patriot program and its activity at LC-38 are discussed in further detail in a separate section below.

Sprint at LC-50

Following the completion of the Sprint PTV-1 tests from LC-37, flight tests moved to the dedicated Sprint launch complex known as LC-50. Construction of LC-50 started in 1964 and was completed in 1965. Also known as the Sprint Site, the launch complex is located in a somewhat isolated location to the north of the Nike Avenue launch complexes and south of Highway 70 (Eckles 2013:9). The first official Sprint launch took place on November 17, 1965 at LC-50 (Piland 2006a:5).

The Sprint was designed to be housed and launched from a protective silo, and several of these

Figure 64. Aerial view of LC-50 circa 1965 (*photo courtesy WSMR Museum Archives)*.

were constructed at LC-50. The silos were designed to be built underground, but the proximity to the water table at the LC-50 location required that the silos be constructed into an artificial hill to avoid inundating them. These above ground, but buried, silos at LC-50 were referred to as "test cells" (Eckles 2013:9). The Sprint missile was assembled and inspected at LC-38, then was transported to LC-50 on a transporter/loader vehicle and loaded into the test cell (Piland 2006a:4). The mound included four such test cells, one of which was used for instrumentation only. A long ramp extending from the mound allowed access for the transporter/loader vehicles that delivered the missiles to the test cells. Built into the central portion of the mound was a reinforced concrete bunker structure that served as a control room and a personnel shelter (Piland 2006a:4). At the bottom of each test cell, beneath the loaded Sprint missile, was a dome shaped device. This device acted as a piston, which was driven by an explosive charge. Upon launch, the Sprint was blasted out of the cell vertically by the piston device. The Sprint launched so quickly and with such minimal delay that ordinary test cell doors would not open quickly enough. Instead the Sprint used expendable fiberglass and foam lids that were perforated by explosive charges as the missile launched, allowing the Sprint missile to blast through them as it exited the test cell (Missile Ranger 1968:4). The first stage of the missile fired after it cleared the cell by a few feet, rapidly accelerating it towards the target (Piland 2006a:4-5). At its maximum speed, the air drag on the missile's skin heated it hotter than the interior of the missile's solid propellant motor, causing it to glow incandescently (Federation of American Scientists 1998).

One significant mishap occurred during the testing of the Sprint at LC-50. During the third Sprint launch on March 15, 1966, the missile misfired on launch, resulting in a "hangfire" situ-

Figure 65. Overview of the damaged north launch cell at LC-50, 1965 (*photo courtesy WSMR Museum Archives)*.

ation with the unfired missile still in its test cell. Standard protocol called for a 30 minute wait prior to investigating the cause of the failure, and after the half hour had passed, the Sprint crew cautiously exited the control bunker and started preparations for investigating the cause of the failure. At that moment, the missile exploded in its test cell. The explosion frightened the crew on the ground at the base of the test cell mound, but caused no injuries (Eckles 2013:9; Piland 2006a:5). The explosion destroyed the test cell and as a result of the close call, standard wait times for hangfire malfunctions were extended to two hours (Piland 2006a:5).

A total of 42 Sprint missiles were launched from LC-50, with the last launch occurring on August 12, 1970. Further tests of the Sprint were launched at the KMR in the Pacific, where most of the operational tests of the Safeguard missile system were conducted.

6.9 ARPA Project Defender at LC-38

During the mid-1960s, ARPA investigated the technology behind a high-acceleration, short-range anti-ballistic missile interceptor (Van Atta et al. 1991). This research program was known as Project Defender, a broad program that investigated detection and interception technologies for ballistic missile defense during the 1960s. The primary goal of Project Defender was to develop a short-range, quick-response ABM defense system to protect relatively small, hardened, high-strategic value locations, which ARPA referred to as “hard point defense.” Specifically, these hard point defense locations would be Air Force ICBM batteries. Providing these ICBM installations with a last-ditch defense system would preserve America’s retaliatory nuclear strike capability in the worst-case scenario of a preemptive nuclear attack. Part of Project Defender was the Hard Point Demonstration Array Radar (HAPDAR), a relatively low-cost phased array system. The prototype HAPDAR unit was constructed at LC-38 in 1965. The HAPDAR was to be used with a short-range, high acceleration interceptor missile. The prototype program for this interceptor missile was the HIBEX, an abbreviation for “High Booster Experiment,” a two-year research project conducted as part of the larger ARPA Project Defender.

Figure 66. HIBEX on display at WSMR Missile Park (*photo courtesy WSMR Museum)*.

ARPA planners considered hard point defense to be more manageable than protecting large urban areas for several reasons. For one, the defended target (likely an Air Force ICBM silo) was likely to be hardened, and much less susceptible to blast damage than unprotected urban targets, and thus allowed for intercepts at lower altitudes. The radar ranges required were shorter and confined to a relatively smaller threat corridor, and also allowed for atmospheric filtering of the actual target. The project goals also included the development of lower cost alternatives to the hardened phased array radars developed for the Nike X program, of which HAPDAR was the prototype (Van Atta et al. 1991).

Flight tests of HIBEX were conducted at LC-37 during 1965 and 1966. An addendum program was conducted from 1965 to 1968, which was known as Primary Stage Acceleration and Guidance Experiment (PRESTAGE). PRESTAGE investigated external burning and the associated issues of axial and lateral thrust control. McDonnell-Douglas was the prime contractor for the PRESTAGE work, and experimented with both lateral jets and disposable vanes as guidance mechanisms for the HIBEX. During the tests, HIBEX achieved an axial acceleration of about 362 Gs and about 60 Gs lateral acceleration (Van Atta et al. 1991:3-9).

During the early 1970s, ARPA became the Defense Advanced Research Projects Agency (DARPA), but the renamed agency continued to work on its high-speed interceptor program. The follow-up to the HIBEX and PRESTAGE flights was the Upper Stage Acceleration and Guidance Experiment (UPSTAGE). UPSTAGE added a maneuverable second stage to the HIBEX, which served as the first stage to the vehicle. UPSTAGE included research into second stage separation, control systems, thrust vector generation techniques and mechanisms, guidance, aerodynamics, and structure and communications (Van Atta et al. 1991:3-9). Tests of the UPSTAGE were conducted at WSMR between November 1971 and August 1972 (Parsch 2006). UPSTAGE also incorporated a DARPA-developed laser optical gyro that offered improved response times over traditional mechanical gyros (Parsch 2006; Van Atta et al. 1991:3-9). The UPSTAGE was externally guided by a command guidance link and tracked by the Nike Zeus TTR. Transverse thrust was provided by "finlet injections," and the UPSTAGE generated several hundred lateral Gs with response times in milliseconds. The UPSTAGE was maneuvered through a simulated Maneuvering Reentry Vehicle (MARV) chase during the testing, but an actual target intercept was not attempted (Van Atta et al. 1991:3-9).

ARPA's Project Defender was initiated around the same time as the Nike X and Sprint program, but had more specific, limited goals. The HIBEX was primarily intended as a technology demonstration program, and unlike the Sprint program, was not constrained by the need to develop a practical production system. Per a DARPA summary of HIBEX:

> While HIBEX is often compared with the Sprint system then being built under the Army's BMD program, it must be recognized that Sprint had the major constraints of a system being engineered for production deployment on a limited time schedule. UPSTAGE also had a very ambitious objective of demonstrating a capability for chasing MARVs, a mission not emphasized in the Sprint system design, and possibly coming close enough for a non-nuclear kill [Van Atta et al. 1991:3-10].

There are obvious similarities between the HIBEX and the Sprint missiles; both are extremely high-speed interceptors whose developmental programs operated during the mid-1960s. This has apparently led many sources to indicate that there is some evolutionary or developmental relationship between the HIBEX and the Sprint missile; however, in actuality they were two concurrent but independent programs. The HIBEX program was a dedicated hard-point defense system intended to operate at much lower altitudes than Sprint. The Sprint missile was designed for intercepts at altitudes of 20 to 30 miles (105,000 to 158,000 feet). The HIBEX was intended for intercepts at even lower altitudes of less than four miles (20,000 feet or less). The two systems were also developed by separate defense agencies using different contractors. ARPA was the lead agency for the HIBEX program, with Boeing as the prime contractor and Hercules contracted for propellant development (Van Atta et al. 1991:3-5). The Sprint program was part of the layered Nike ABM defense program, with the Army Air Defense Command (ARADCOM) as the lead agency and Martin Marietta as the prime contractor. HIBEX also did not have an associated high-altitude interceptor system like the Sprint system. Although the missiles themselves shared a conical shape, the HIBEX was a smaller, single stage vehicle at 17 feet and 2,600 pounds compared to the two-stage Sprint at 27 feet and 7,500 pounds. Additionally, the tenure of the Sprint missile ended with the closure of the only Safeguard ABM installation ever built (the SRMSC) but the HIBEX program was later revived as the Low Altitude Defense System (LoADS).

6.9.1 HAPDAR at LC-38

The HAPDAR phased array radar was built into the north elevation of Property 24064, the ZAR receiver building at LC-38. The initial contract for the system was awarded in June 1964, and construction on the project started in 1965 and was completed in 1966 (Kahrilas 1968). The objective of the HAPDAR prototype was, "to demonstrate the feasibility of producing a low-cost, high-performance, electronically scanned array radar design, construction, and system test of a full-scale model" (Kahrilas 1968:1967). The HAPDAR array was based on the Thinned Aperture Computed Lens (TACOL) electronic scan concept which minimized the number of elements needed to form the array face; compared to a fully filled array, the HAPDAR TACOL design used approximately 50 percent fewer elements, which minimized the cost of the system (Kahrilas 1968:1970). The HAPDAR tracked both aircraft and Athena reentry missions during its evaluation, completing over 80 tracking missions by 1968. A 1970 Missile Ranger article also notes that the DR and TTR were also used as part of the HAPDAR testing, illuminating targets for Athena, Pershing, and other missile firings (Missile Ranger 1970:1). Test aircraft were T-33 or F-100 aircraft that were flown on a racetrack pattern. These aircraft were tracked by both the HAPDAR and the AN/FPS-16 radar, which was the most accurate tracking radar then available. The HAPDAR results generally compared favorably with the AN/FPS-16 tracking, and met the design specifications of the system (Kahrilas 1968:1974-1975). While the HAPDAR operated concurrently with the flight tests of the HIBEX, it does not appear that the HAPDAR was actually used to track the HIBEX. While both efforts were part of ARPA's Project Defender, it does not appear that the parallel HAPDAR and HIBEX test programs progressed to the point of actual system integration.

It is not clear how long the HAPDAR remained in operation at LC-38. Management of the major Project Defender projects and physical assets were transferred from ARPA to the newly formed ABMDA in 1967. Within ARPA, the remaining Project Defender programs were managed by the Strategic Technologies Office (STO) (Van Atta et al. 1991:1-17). Doyle Piland

Figure 67. Construction of the HAPDAR addition to Property 24064 in 1965 (*photo courtesy WSMR)*.

Figure 68. The HAPDAR addition to the northeast corner of Property 24064 soon after it was completed, ZAR receiver in background, circa 1966 (*photo courtesy WSMR)*.

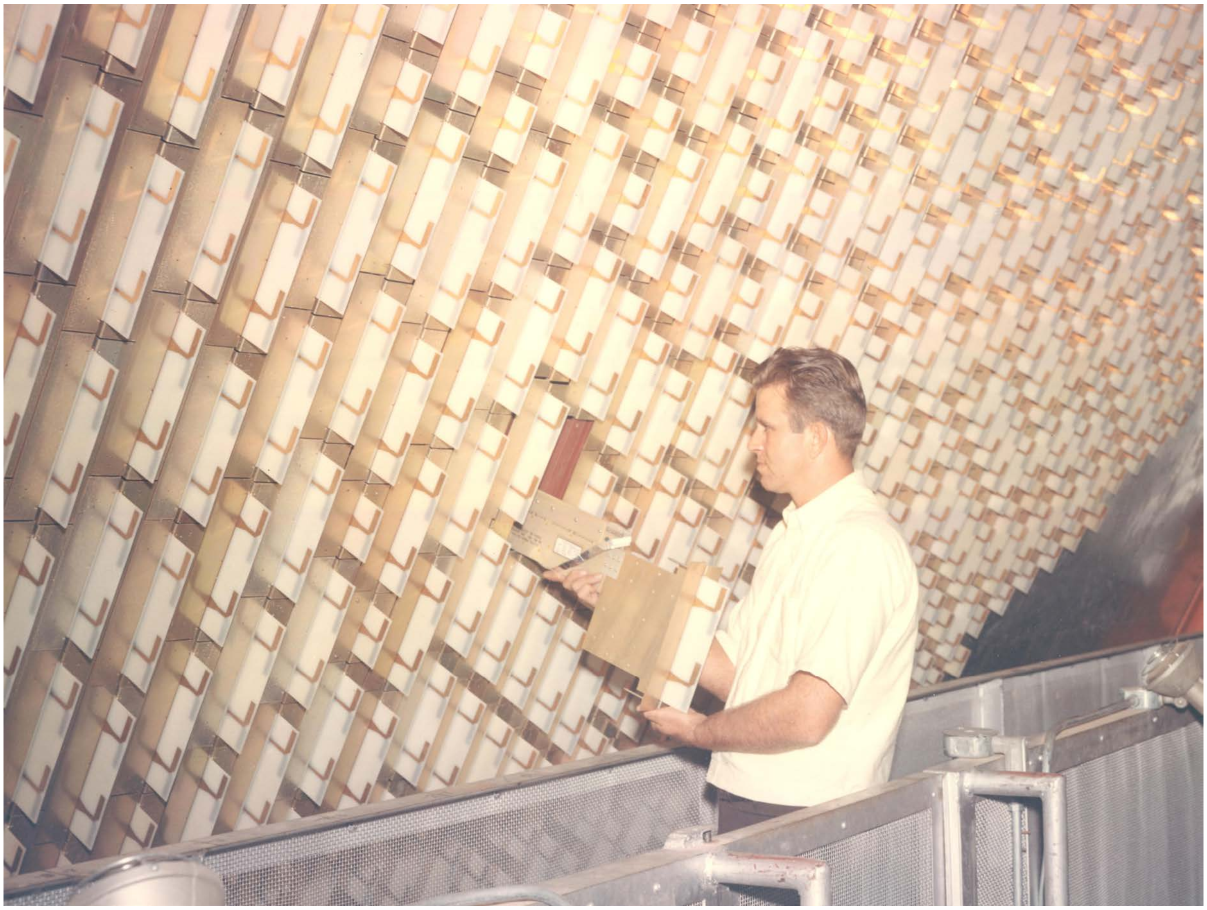

Figure 69. The interior of the HAPDAR phased array grid soon after it was completed in 1966 (*courtesy WSMR Museum Archives)*.

notes in his LC-38 history that, "the HAPDAR continued operation until around 1970" (Piland 2007b:5). The HIBEX-derived PRESTAGE and UPSTAGE programs were tested into the early 1970s, after which the Project Defender work appears to have ended at WSMR. Property 24064, the building that supported the HAPDAR installation, was demolished in 2011.

Program Legacy

The technology and concepts developed for the HIBEX interceptor were later incorporated into the LoADS program, which was closely associated with the development of the Air Force Missile, Experimental (MX) ICBM (later known as the Peacekeeper) during the 1970s and early 1980s. The LoADS was also sometimes referred to as the Low Altitude Defense (LOAD) system. The LoADS was a proposed defensive system that would have been deployed alongside the MX/Peacekeeper missiles. In 1982, the LoADS system was re-designated as the Sentry Interceptor Program as part of a renewed development program (Lang 2007). However, the deployment of ABM systems like Sentry was limited by the 1972 ABM Treaty, so the Army system remained as a developmental, "on the shelf" system that could be deployed rapidly on an as-needed basis. In February 1983, the Sentry Interceptor was terminated, and one month later the Reagan administration announced the SDI, which would take ballistic missile defense in an entirely new direction (Lang 2007).

6.10 The Patriot Missile

The Patriot missile is a mobile, short-to-medium range anti-aircraft and Anti-Tactical Ballistic Missile (ATBM) system. The Patriot is probably the most recognized Army missile due to its highly publicized role in the Persian Gulf War, but its origins date back to the mid-1960s. Prior to its use in the Gulf War, the system had been under gradually accelerating development at WSMR for over 20 years.

6.10.1 History of Development

The Army originally conceived the Patriot as a projected replacement for the Hawk and Nike air defense systems and was originally planned for deployment in the early 1970s. First known as the Army Air Defense System for the 1970s (AADS-70s), the Secretary of Defense renamed the developmental program the Surface-to-Air Missile Developmental (SAM-D). Three teams competed in the system concept phase of the program; Raytheon/Martin Marietta, Hughes/Douglas, and RCA/Beech (Redstone Arsenal 2015).

In 1967, the Army awarded a contract to Raytheon for an advanced development stage of the system, an incremental step that was less costly than full engineering design of the system. The first SAM-D test missile was launched in 1969 (Redstone Arsenal 2015). Progress on the system remained modest due to budget limitations, and only after an Army evaluation of the SAM-D program in 1970 was an additional contract for the actual engineering development of the SAM-D awarded (Redstone Arsenal 2015).

Figure 70. A Patriot missile launch from its boxy portable launcher (*US Army photo)*.

The program lingered through several reductions in funding and changes in scope during the following years, but gained momentum during the mid-1970s when it was supported by the incoming Carter Administration (Schubert and Kraus 1995:236). During this period, the missile was improved with the Track Via Missile (TVM) guidance system, which was an on-board guidance system that homed in on reflected radar energy from the target and took over guidance of the SAM-D during the terminal portion of the intercept (Schubert and Kraus 1995). The first TVM intercept against an aerial drone target occurred at WSMR in 1976 (Redstone Arsenal 2015).

The program was renamed the Patriot in 1976 in recognition of the country's bicentennial and a production contract with Raytheon was awarded in 1980 (Schubert and Kraus 1995:237). The acronym Phased Array Tracking to Intercept of Target (PATRIOT) has also been retroactively applied (a so-called 'backronym') to the system's name. The timing of the contract award was fortuitous for the Patriot program as it was well-positioned for the more expansive defense funding of the new Reagan administration. The generous budgets of the period allowed many early issues with the Patriot to be resolved and the system was fielded with European units of the Army Air Defense Command in 1985 (Schubert and Kraus 1995:237). The first version of the system was only capable of targeting aircraft, including helicopters, but the scope and capabilities of the system were expanded under the aegis of the SDI (Schubert and Kraus 1995:238).

The Patriot missile battery consisted of linked launcher stations, each equipped with four missiles; Patriot batteries could include as many as eight launcher stations. The launchers doubled as shipping containers for the missiles and were boxy and ungainly in appearance; they were often described as "dumpsters on hydraulic lifters" (Schubert and Kraus 1995:237). The nerve center for the battery was the engagement control station, an air conditioned van outfitted with computers and control equipment. Vital to the operation of the system was the radar set, which was based around a sophisticated multifunction phased-array radar unit, a descendant of similar radars developed for Nike X during the 1960s. The other battery components included the antenna mast group, command post, and electric power plant (Schubert and Kraus 1995:238-239).

The Patriot missile benefitted from its association with the well-funded SDI, and a technical improvement program had substantially improved the capabilities of the missile by the late-1980s. The Patriot Anti-tactical Ballistic Missile Capability 1 (PAC-1) version of the missile consisted solely of software upgrades that improved the missile's likelihood of achieving a "warhead kill", a direct hit on the warhead of an incoming missile. Less desirable but still effective was a "mission kill", where the incoming tactical missile was damaged and its course diverted. The PAC-1 upgrades were first tested at WSMR in 1986, during which a Patriot intercepted a Lance missile. In 1987, a PAC-1 Patriot intercepted another Patriot over WSMR. While the tests achieved mission kills of incoming missiles, the Army found that the PAC-1 was unlikely to make warhead kills. Despite this limitation, the Army issued a production contract for the PAC-1 version of the Patriot in 1988 (Schubert and Kraus 1995:238). Additional improvements to the warhead and fuze followed, and by the end of the decade the improved PAC-2 version of the system was nearing production. The PAC-2 upgrade substantially improved the missile's chance of making a warhead kill and was scheduled to gradually replace the existing PAC-1 version. However, before the PAC-2 rollout was completed the Patriot was called to duty as part of Operation Desert Shield in August 1990, beginning the most well-known chapter of the Patriot's story (Schubert and Kraus 1995:238).

6.10.2 Patriot in the Gulf War

Although the Patriot was a highly influential system in the Persian Gulf War of early 1991, it was only by extraordinary measures that it arrived in time to be decisive in the conflict. The primary threat in the war was from Iraqi tactical ballistic missiles. These missiles were based on the outmoded Soviet Surface-to-Surface 1A (SS1A) Scunner, known as the Scud, which the Soviet Union retired during the 1970s but delivered in large numbers to affiliated states through the 1980s. Iraq improved the Scud into a version known as the Al-Hussein, which had an extended range of 400 miles at the expense of a lighter warhead and heavier motor and airframe (Schubert and Kraus 1995:239). This made the Iraqi Scud poorly balanced aerodynamically, which caused it to tumble when it reentered the atmosphere and break up into parts, with the primary pieces being the warhead, fuel tanks, and motor. This was known as the blossoming effect, and it acted as an unintentional but nonetheless effective countermeasure against interception (Schubert and Kraus 1995:239). The blossom effect of fragmenting Scuds made it significantly more difficult for the Patriot missile to distinguish and target the warhead amongst the rain of incoming Scud constituent parts, particularly since the Patriot PAC-2 was rushed into the field.

The Patriot PAC-2 version was required for maximum effectiveness against the Scud missile, although it was pushing the limits of the system's design (Zimmerman 1992). The production of the PAC-2 version had barely begun when Patriot batteries were deployed to Saudi Arabia as part of Operation Desert Shield in August 1990. The production schedule called for the PAC-2 missiles not to be delivered until January 1991, so the production was drastically accelerated to meet the need in the Gulf. The only PAC-2 Patriot missiles available, actually the only three then in existence, were pulled from tests at WSMR and shipped overseas still bearing their "EXPERIMENTAL" stenciled labels (Schubert and Kraus 1995:243). Production of PAC-2 missiles continued around the clock; Martin-Marietta, the sub-contractor who manufactured the missiles, shipped them directly from the factory to Saudi Arabia (Schubert and Kraus 1995:243). The Desert Shield Patriot build-up proceeded just in time for the launch of Operation Desert Storm in January 1991.

The first engagement of Scud missiles by the Patriot occurred on the morning of January 17, 1991 when two Patriot PAC-2 missiles were fired to protect the Dhahran airport. The engagement appeared to be successful, marking a historic first for the system. Patriot batteries were placed to protect the Israel cities of Tel Aviv and Haifa in a diplomatic arrangement to prevent Israel from retaliating against Iraqi Scud missile strikes. Israeli involvement would have been extremely detrimental to the fragile US/Saudi coalition, and the protection offered by the Patriot batteries against Scud attacks helped deter Israel from entering the fray (Schubert and Kraus 1995:247). After the first two weeks of Operation Desert Storm, the Scud attacks quickly tapered off, mostly due to Coalition airstrikes against Scud launch sites. However, in a desperate maneuver as its ground forces suffered heavy losses, Iraq fired another salvo of Scuds on February 24 and 25 at targets in Israel and Saudi Arabia. The Scud missiles launched at Israel missed their targets and landed harmlessly in the desert, but one of the Scuds launched towards Saudi Arabia breached the Patriot defenses and impacted a temporary barracks building, killing 28 American Soldiers and injuring 97 (Schubert and Kraus 1995:250). This was the worst single incident of US casualties during the war and called into question the effectiveness of the Patriot. Within two days of this attack, Iraqi resistance had mostly crumbled and President Bush suspended military operations, effectively ending the conflict. In total, 158 Patriot PAC-2s were launched against Scud missiles, but about 3,000 PAC-1 and PAC-2 Patriots were available to Coalition forces by the end of the conflict (Schubert and Kraus 1995:243).

The Patriot missile was reported by the Army and the media as highly effective and the

Figure 71. Patriot missiles launched against incoming Scud missiles over Tel Aviv in 1991 (*courtesy Atlantic Sentinel)*.

"Scud-Buster" missile became emblematic of the conflict and American technological and military superiority over the Iraqi forces. Yet post-war Congressional investigation of the missile's effectiveness did not support the initial positive reports, rather finding that Patriot may have had a success rate as low as nine percent (Cirincione 1992). Critics of the system argued that the widely televised images of Patriots exploding against Scud missiles in the sky were likely the result of proximity fuzes triggering the Patriot warhead against Scud blossoming debris, or the self-destruct fuze destroying the missile as it passed the target. The Scuds themselves, inherently inaccurate, often broke up in terminal flight and missed their target due to aerodynamic drag (Cirincione 1992). However, definitive measures of intercept success during the war were lacking. Most estimates of the Patriot intercept success rate were based on analysis of low resolution commercial video footage, eyewitness accounts, and ground damage, all of which suffered from interpretative issues (Zimmerman 1992). Other congressional testimony provided during the investigation suggested that the Patriot success rate may have been as high as 50 percent in Israel and 80 percent in Saudi Arabia (Zimmerman 1992). Regardless of the actual figure, an Army history of the Gulf War describes the role of the Patriot as being particularly significant to the allied campaign as it allowed Coalition forces to cope with the Scud threat, freeing air and ground forces from the time-consuming hunt for mobile Scud launchers, "in short, the Patriot reduced the Scud to a minor operational irritant" (Schubert and Kraus 1995:250).

6.10.3 Patriot PAC-3

The next generation of Patriot missile was the Patriot Advanced Capability-Three (PAC-3), which was introduced during the mid-to-late 1990s and continues to be the latest generation of the missile system available today. The PAC-3 system relied on a new missile design, which is produced by Lockheed Martin, with a seeker unit produced by Boeing; Raytheon continues to be the contractor responsible for the guidance and control systems and the overall system integration. The PAC-3 incorporates improved capabilities against Tactical Ballistic Missiles (TBMs) as well as advanced cruise missile and aircraft threats. Compared to the PAC-2, the PAC-3 is more likely to achieve a "warhead kill," also referred to as "hit-to-kill," intercept where the missile strikes the incoming warhead directly. The Army began development of the hit-to-kill capability in the mid-1980s, and successfully intercepted a Lance ballistic missile with the Flexible Lightweight Agile Guided Experiment (FLAGE) vehicle on May 21, 1987 (Missile Defense Project 2018). The follow-on Extended Range Intercept Technology (ERINT) project completed design review in 1989 and was flight tested from 1992 to 1994; the ERINT served as the basis for the PAC-3 missile. The PAC-3 project office had been established in 1991, and the ERINT was selected for further development into the PAC-3 (Missile Defense Project 2018). The PAC-3 development was broken into three phases; the first two phases, known as Configurations 1 and 2, consisted of radar and software upgrades that entered service in 1995 and 1998, respectively. Configuration 3 involved integration of the new interceptor missile, which started flight tests in 1997. The complete PAC-3 system was declared combat ready in 2002, and the first PAC-3 units were used in combat during Operation Iraqi Freedom in 2003 (Missile Defense Project 2018). The PAC-3 has been upgraded with a new interceptor, known as the PAC-3 Missile Segment Enhancement (MSE), which nearly doubles the range of the missile. The PAC-3 MSE underwent testing from 2010 to 2016, and entered full production in 2018 (Missile Defense Project 2018).

In support of its role as the manufacturer of the PAC-3 missile, Lockheed Martin occupies several new buildings in a fenced area in the southwest corner of LC-38. These buildings include Properties 23602, 23603, and 23661, all of which were constructed in the post-Cold War period and were therefore not included in the current inventory effort. The area currently occupied by the Lockheed Martin PAC-3 support facilities was undeveloped during the Cold War period.

6.10.4 Patriot at WSMR and LC-38

Realty records indicate that the SAM-D program began to occupy space at LC-38 in 1969, when the program moved into the former Nike Zeus Assembly Building (Property 23626). The classroom facilities on the south elevation of the building were assigned to Raytheon and Martin/Orlando engineers in 1970 (Ferdig 1970). In 1970, storage space in the hazardous assembly area began to be occupied by SAM-D test vehicles, as Sprint missile testing neared its end. After completion of the Sprint missile testing, the SAM-D program occupied both Properties 23654 and 23656 (Piland 2007b).

Beginning in 1971, SAM-D facilities were constructed in the former Nike Zeus launcher area. Property 23678 was constructed to house the prototype phased array radar system under development for the SAM-D program. Nearby was Property 23688, which served as a staging location for SAM-D generator units, and power cables were routed through the associated cable trenches from the generators to the SAM-D control and guidance equipment. The pad to the northwest of Property 23688 is labeled as the Fire Control and Guidance (FCG) Pad in the 1971 WS-RK Plan Set. To the north of these properties, a concrete launch pad was constructed in 1973 as part of the SAM-D Remote Launch Facilities; this launch pad does not appear to have a WSMR real property number. While the SAM-D launcher was originally anchored to the launch pad, later launches were conducted from a trailer-mounted Patriot launcher tube (Plan Set WS-81-76). A concrete extension to the southwest and rails for a moveable conditioning shelter were added to the launch pad in 1976. Based on associated architectural plans, this structure was constructed in 1976 as the "Environmental Enclosure for Patriot Missile" (Plan Set WS-81-76). This mobile conditioning shroud does not possess a WSMR property number, possibly because it is a contractor-owned property. Drawings indicate that the shelter was designed to enclose a trailer mounted Patriot launcher that was positioned on the associated launch pad. At the time of the launch, the shelter was retracted along its rail system to clear the Patriot missile for launch. Concurrent with the construction of the launch pad, access roads, electrical boxes, and instrumentation pedestals were constructed in the area around the launch pad. The roads and instrumentation network were expanded during the mid-1970s. A large revetment surrounding a concrete slab foundation, possibly a secondary launch site, was later constructed to the northwest of the original launch pad.

In 1976, disposition records note that an Army field office for the Patriot missile program was established within Property 23626. This is the first time the "Patriot" name appears in the building's property records, which was previously referred to as the SAM-D program (Donner 1976). In the launch area, Raytheon used the former Nike Zeus launch control building (Property 23680) as their operations building. In 2000, a new Raytheon operations building (Property 23700) was constructed in this area, and Property 23680 was apparently demolished around this time to make way for the new building.

7. Description of Resources

The LC-38 inventory effort resulted in the recordation of 67 buildings, structures, and objects. As part of the inventory methodology, less significant resources representing remnants of LC-38 supporting infrastructure were recorded as features and are described separately. A total of 1,218 features were recorded in association with the buildings, structures, and objects at LC-38. The recorded WSMR properties were assigned HCPI numbers, documented on WSMR-specific HCPI forms, and the inventory was logged as NMCRIS activity number 152307. The HCPI-documented properties include buildings, structures, and objects. The recorded resource locations are displayed in Appendix B.

The NPS defines buildings as properties that principally provide shelter for any form of human activity. Per New Mexico HPD guidance, only properties that fit the definition of a building in the common sense of having four walls and a roof are referred to as buildings. Structures are constructed properties that fall outside the typical definition of buildings; typical examples are launch pads, boresight towers, and instrumentation sites. Objects are less formal properties that are often of pre-manufactured origin and mobile in nature.

The following section presents a descriptive overview of each property followed by a summary of its use and evolution. For additional details of the recorded properties, see the HCPI forms included within Appendix C. The properties are organized by the functional types defined below.

7.1 Property Types

The recorded properties at LC-38 are grouped into functional types whose purposes are reflected architecturally and structurally. Six such property categories were identified for the recorded LC-38 properties: Launch Facilities, Radar and Guidance Facilities, Missile Assembly and Checkout Facilities, Instrumentation Facilities, Support Facilities, and Miscellaneous Facilities.

7.1.1 Radar and Guidance Facilities

Like its predecessors, the Nike Ajax and Nike Hercules, the Nike Zeus relied on a series of radar systems that allowed the missile to detect and track incoming targets and guide the Nike missile to an intercept. However, unlike these earlier Nike systems, the Nike Zeus operated at much longer ranges in order to have sufficient time to detect and intercept incoming ICBMs. Therefore, the Nike Zeus radars were much larger and more substantial than the radars used with Nike Ajax or Hercules, which were mostly semi-mobile units. The Nike Zeus radar and guidance facilities were housed in permanent facilities that usually incorporated some degree of blast resistance through reinforced concrete and Concrete Masonry Unit (CMU) construction. The Nike Zeus radar and guidance facilities were the largest and most substantial properties constructed at the complex, and included the Nike Zeus ZAR, BCB, TTR, DR, and MTR installations. While not all of the Nike Zeus radar and guidance facilities have survived, Properties 23640, 23641, 23642, 23647, 23648, 23659, 23694, and 24072 remain in place. These remaining properties help to illustrate the layout and operation of the Nike Zeus system to modern viewers.

7.1.2 Missile Assembly and Checkout Facilities

A series of properties dedicated to the assembly, checkout, and storage of Nike Zeus missiles were constructed at LC-38. Property 23626 is a large hangar-type assembly building located just north of Nike Avenue that also incorporates office, classroom, and workshop spaces. Located to the north within a fenced security area is a hazardous assembly and storage area, which is dominated by two large explosive storage structures (Properties 23654 and 23656). These two properties consist of reinforced concrete bays surrounded by earthen fill, which is held in place by concrete panels. Two smaller buildings that were dedicated to specific aspects of the checkout process (Properties 23655 and 23660) are also located in this area. While these properties were originally built in support of the Nike Zeus program, they were also used in support of the Sprint missile program, and since the 1970s, have remained in use as part of the Patriot missile program.

7.1.3 Launch Facilities

Compared to other WSMR launch complexes, LC-38 did not possess extensive launch facilities. The original Nike Zeus facilities incorporated two R&D launch pits and one tactical launcher that were associated with a partially-subterranean launch control building. Most of these launch facilities have been demolished, and only a portion of the tactical launcher (Property 23683) remains intact today. Several launch facilities were constructed in support of the later Patriot missile program during the 1970s.

7.1.4 Support Facilities

A number of properties at LC-38 were constructed to support some aspect of the Nike Zeus testing program that was not directly related to the functions described above. For the purposes of this inventory, these properties are considered as general support properties. A series of physical plant facilities were constructed for the Nike Zeus installation (Properties 24065, 24066, and 24068) along with properties that supported the LC-38 water supply (Properties 23627 and 23635). A dedicated security checkpoint building (Property 24025) and cafeteria building (Property 23632) were also part of the original Nike Zeus facilities, and remain at the complex today. A landing strip and hangar were also constructed for a specially-equipped aircraft that was used for the early calibration of the ZAR (Properties 24070 and 24075). These properties help illustrate the substantial investment in permanent facilities and infrastructure that make LC-38 unique among the WSMR launch complexes.

7.1.5 Instrumentation

The major defining characteristic of a missile test range is the ability to collect and analyze data on the performance of a missile throughout all stages of its flight, from launch to intercept. Missile range instrumentation can be divided into three major groups: optical, electrical, and telemetry. Optical instruments include cinetheodolites, high-speed cameras, and tracking telescopes. Optical range instrumentation can be grouped into two large categories: surveillance and metric. At LC-38, a series of optical instrumentation properties are located at the Seus Site (Properties 24008, 24010, and 24015). Electrical systems are primarily radars of various types. Velocimeters were also used near launch areas to measure acceleration and speed during the early flight phase when other instruments could not yet track the vehicle. Two velocimeter installations were located south of the Nike Zeus launch area, and their concrete pads remain in place today. Several other isolated instrumentation properties of various ages are scattered throughout the interior of LC-38.

Associated with instrumentation are communications systems that relay data from instrumentation locations to data processing centers, as well as hard-line timing and voice communications. One small building along the south boundary of LC-38 (Properties 23629) provided access to buried hard-line communication wiring and are part of a series of such installations along the north side of Nike Avenue.

7.1.6 Miscellaneous Facilities

Not all facilities fit neatly into categories and, depending on the type of site, the function of launch complex facilities can vary greatly. LC-38 includes a variety of general-purpose buildings that were used for storage, supplemental workspace, or some other temporary use. The most common type of miscellaneous facility encountered at LC-38 are portable, pre-manufactured steel buildings employed for a variety of uses across the complex, usually in association with a larger structure or building. These buildings were mass-produced by many companies, with some of the most common Cold War-era manufacturers being the Armco and Butler companies.

7.2 Building Styles

In terms of "style," the buildings, structures, and objects recorded at LC-38 are primarily determined by functional aspects and not easily categorized. These facilities were purpose-built for function and lack most attributes typical of defined architectural styles. The permanent facilities constructed for the Nike Zeus program are examples of this kind of function-driven architecture. However, DOD guidance recognizes that some utilitarian facilities derive stylistic cues from the Modern movement. These permanent buildings follow a consistent design of post and lintel concrete structures infilled with CMU walls, or all CMU construction. Many WSMR buildings possess stylistic cues such as a horizontal emphasis in elevations and windows, flat or very shallow gabled roofs, and a complete lack of decorative elements, all of which point to International Modernism. However, most of the documented properties at LC-38 are very functionally oriented and this loosely Modernistic design style is not in evidence among the recorded properties. LC-38 is typical of many RDT&E facilities in this manner, in that it emphasizes functional considerations over form or style.

The steel frame buildings found at LC-38 are common at most ranges and include examples of the most common variants of these pre-manufactured buildings. Extremely popular for their inexpensive construction, durability, and adaptability, the steel frame building has its origins in the Quonset hut, the hugely successful WWII-era pre-manufactured building with its characteristic half-round shape. Other major manufacturers of these common pre-manufactured buildings were the Butler and Armco companies. These "Butler-type" buildings, which were functionally equivalent to Quonset huts, were capable of being assembled quickly and inexpensively and were adapted for many uses. The pre-manufactured steel frame buildings located across LC-38 are mostly small, portable units constructed on wood timber or steel I-beam skid foundations. One larger example, Property 23680, was constructed above the underground control room in the Nike Zeus launch area; however, Property 23680 has been demolished.

The following presentation of the resources recorded during the current inventory is organized by functional types which are discussed separately. Each property summary consists of a descriptive overview followed by a summary of its use and evolution. For additional details of the recorded properties, see the HCPI forms included within Appendix C. A full discussion of National Register eligibility and historic district considerations is presented in *Chapter 8*. The individual property eligibility discussions are included as part of the HCPI forms attached in Appendix C.

7.3 Radar and Guidance Facilities

In order to accomplish the difficult mission of detecting and intercepting incoming ICBM missiles, the Nike Zeus system required a series of large, powerful radars that were housed in robust permanent facilities. This was a significant departure from the guidance radars used in the predecessor Nike Ajax and Nike Hercules systems. The Nike Zeus radars consisted of the ZAR, which was divided into separate installations for the receiver (Properties 24062 and 24064) and transmitter (Property 24072), the TTR (Property 23642), the DR (Property 23638), and three MTRs (Properties 23641, 23647, and 23648). The radars were coordinated through the targeting computers housed in the BCB (Property 23640). Today, most of these radar facilities still remain at LC-38, although they have been altered and modified through time. Exceptions are the ZAR receiver and DR buildings, which have been demolished; however, the DR outer clutter fence (Property 23659) remains intact. The radar installations were arranged across the central portion of the launch complex, with the ZAR installation and its associated power plant and cooling facilities located near the eastern boundary of the complex. Later radar installations at LC-38 include Property 23678, which housed the early prototype phased array radar that was developed for the SAM-D system.

7.3.1 Property 23640

Property 23640 is a large one-story building located along the north side of Range Road 240 in the central portion of LC-38. While the building is not high-bay, it does have high interior ceilings of approximately 15 feet. The building is of CMU construction with a plan that it mostly square, except along the north elevation where the building walls extend outward diagonally then angle to form a blunted triangular tip at the north end of the building. This somewhat unusual plan was apparently designed to accommodate the placement of three radar antenna towers outside the building's north elevation. These antenna towers each have assigned WSMR property numbers and are described separately. Like most of the LC-38 buildings, the building's exterior is painted tan with brown trim elements. The building's flat roof is of built-up, gravel-surfaced construction with a grounding system, gutters, and downspouts installed on all elevations. Two mast assemblies with overhead flood lights are also installed on the roof of the building. These masts could be lowered horizontally across the roof using their ratchet-operated, pivoting bases and are described as "lightning protection masts" in the building's architectural plans (Plan Set WS-JO). Like some of the other dedicated technical buildings constructed for the Nike Zeus program, Property 23640 lacks windows. At the time of the recording, a chainlink fence surrounded the south, north, and west sides of the building.

The building's south elevation acts as the principal elevation, facing the building's parking lot and Range Road 240. A lower, shed roof block spans most of the south elevation, which

Figure 72. Plan view of Property 23640 from modern WSMR pictometry imagery.

is an addition to the original building plan. This lower shed roof block does not extend all the way to the building's west elevation, instead leaving an inset corner at the southwest corner of the building. This corner is occupied by a recently installed water cooler unit and an Heating, Ventilation, and Air-Conditioning (HVAC) unit. A double-leaf entrance with steel slab doors is located in the south elevation of the lower shed roof block. In the upper portion of the south elevation, in the original building wall above the lower shed roof block, is a series of four sealed vent openings. Three of the vent openings have been sealed with CMUs, while the fourth opening is covered with sheetmetal.

The west elevation of the building has two double-leaf entrances in the south end of the wall. Both of these entrances are hung with plain, steel slab doors. The northern of these two entrances is taller and opens into the building's electrical and air conditioning equipment room. A steel flammable materials cabinet is located outside this entrance. A large louvered panel is located in the upper part of the west elevation above the southern entrance. This vent panel has been replaced, and the opening resized as indicated by replacement CMUs above the vent panel. The north end of the west elevation wall angles out to the northwest, and then the angle reverses back to the northeast to form the triangular north elevation. Installed high on the angled portion of the wall is a faded sign from the Sprint missile program. Outside the northwest corner of the building is a collection of steel cabinets that were apparently removed from the building's interior.

The building's distinctive angled, triangular north elevation is mostly hidden behind three radar pedestal towers (Properties 23641, 23647, and 23648) constructed along this side of the building. However, the building's north elevation is mostly plain behind these towers. Large conduits (approximately 10-inch diameter) span the gap between the north elevation of Property 23640 and the south elevation of each radar tower, along with multiple smaller diameter conduits. Aside from the radar towers, which are described separately, the main feature of the building's north elevation is a CMU entry block located at the center of the triangular north elevation, between two of the radar towers (Properties 23241 and 23247). This shed roof entry block houses a double-leaf entrance hung with plain steel slab doors. Along the east side of the entry block is a steel roof access staircase. The first flight of steps runs along the east side of the entry block, then uses the roof of the entry block to support a steel landing platform that connects to the second flight of steps up to the roof. The steps and the northern perimeter of the roof are both equipped with pipe handrails; the pipe handrails along the north perimeter of the roof have hinged bases so they can be folded down. Several trees have taken root at the base of the radar towers, and died, leaving a substantial scatter of downed and broken limbs outside the north side of the building. Adding to the mess is a downed and damaged antenna dish that

Figure 73. Property 23640, south and east elevations, view to the northwest.

Figure 74. Property 23640, west and south elevations, view to the northeast.

was apparently a later addition to the building.

The building's east elevation has a shed roof, CMU entry block near the north end of the wall. A single-leaf entrance is located in the south-facing side of the entry block, and is equipped with a steel slab door. A post supporting an antenna dish is attached to the building wall above the entry block. Similar to the west elevation, the north end of the east elevation wall angles out, then angles back to form the triangular north elevation. A variety of electrical conduits are installed along the east elevation wall, along with a vent hood and two overhead floodlights. A curbed landscaping area runs along the base of the wall.

History of Use

Property 23640 was constructed in 1960 as the "Battery Building" according to a 1963 WSMR property inventory (WSMR 1963). The building's Form 2877 Real Property Record describes it as an "Elct Eqp Fac" of 10,650 square feet constructed in 1960. The original 1959 architectural plans for Property 23640 identify it as the "Battery Control Building" (per WS-JO Plan Set). The building was designed by the Architectural and Engineering (A&E) firm of Burns and Roe of New York for BTL, in cooperation with the US Army Corps of Engineers (USACE) Albuquerque District.

Figure 75. Property 23640 in 1960 soon after it was completed, view of west and south elevations (*US Army photograph)*.

The Nike Zeus prototype system at LC-38 relied on an array of radars similar to those used in the predecessor Nike Ajax and Nike Hercules, but the Nike Zeus radars were generally larger and more powerful. The Nike Zeus system also incorporated the new DR installation. Targets for the Nike Zeus were initially acquired by the long-range ZAR (also sometimes identified as the LAR). Unlike most Nike radars, the ZAR was split into separate installations for the receiver (Properties 24062 and 24064) and the transmitter (Property 24072). Once the ZAR identified a target, it processed its position data and passed it to the DR (Property 23638) and the guidance computer located in Property 23640, which served as the BCB for the Nike Zeus testing. The DR helped to identify the incoming ICBM warhead from associated debris such as spent boosters, as well as intentional decoys meant to confuse the radars and make interception more difficult. The DR transmitted targeting information about specific targets within the target cloud to the processing equipment in the BCB, where the tracking and targeting information was then sent to the TTR (Property 23642) and the MTRs installed along the north side of the BCB (Properties 23641, 23647, and 23648). Using the targeting data provided by the DR, the TTR provided accurate position data on small, fast-moving targets to the control equipment in the BCB. The MTRs tracked the Nike Zeus missile on its way to the target and also provided its coordinates to the guidance computer. Working in concert with the guidance computer, the TTR and MTR guided the missile to the intercept point where the computer transmitted the detonation signal to the Nike Zeus missile through the MTR.

Like Properties 23642 and 24072, Property 23640 was also shielded against Radio Frequency (RF) interference. However, the shielding was applied to the interior of the building, surrounding the portions of the building used to house electronic equipment. The electrical and air conditioning room in the south part of the building was not shielded since it did not house any sensitive electronic equipment (Plan Set WS-JO). The building's original floor plan included an Electrical and Air Conditioning Room in the south part of the building, and an Electronic Equipment Room, Battery Control Room, MTR Equipment Room, Projection Equipment Room, Communications Room, and Maintenance and Storage Room in the central and north portions of the building. A basement is located beneath the former Communications Room,

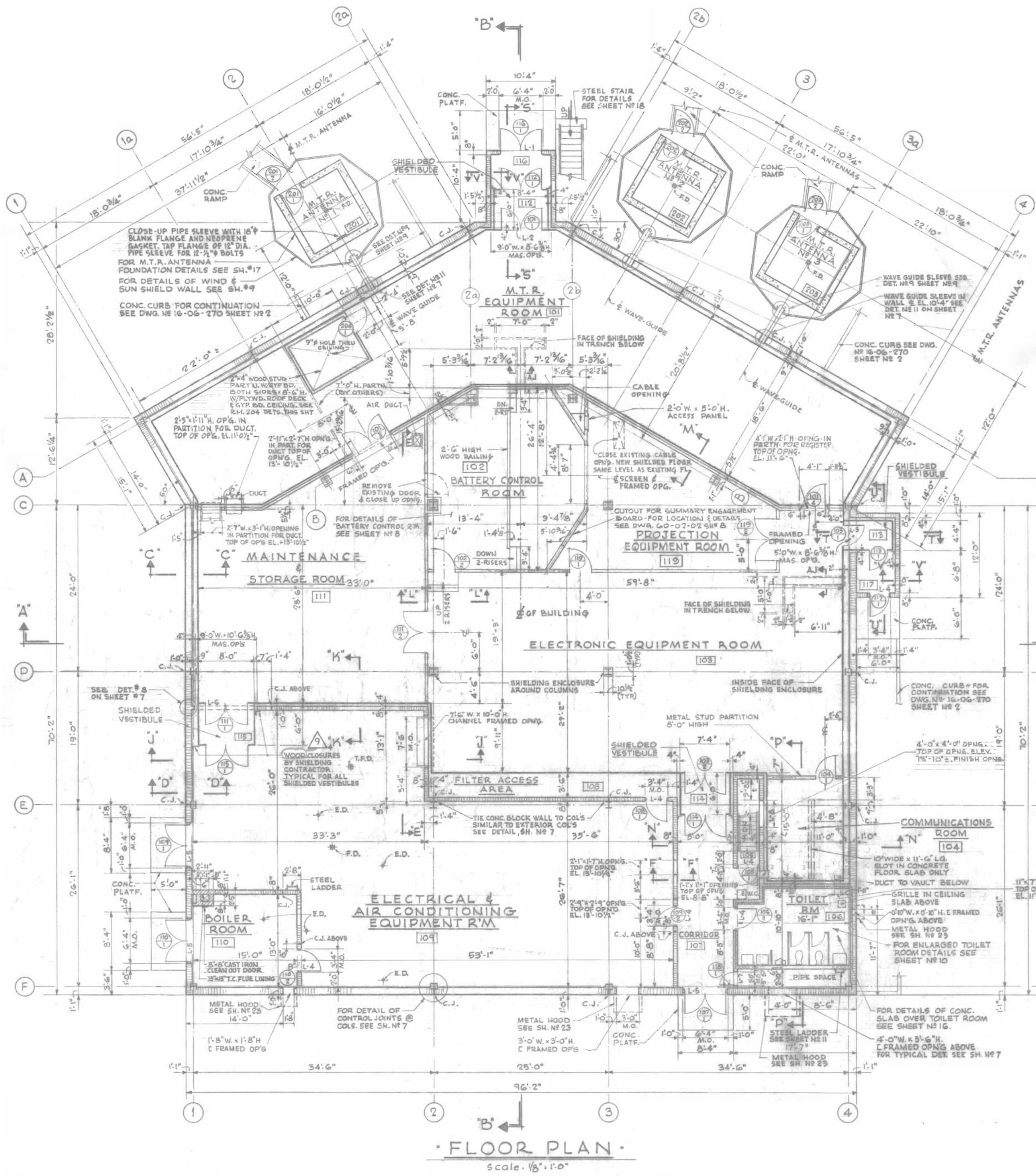

Figure 76. Property 23640 floor plan from 1959 WS-JO plans.

which is referred to as a “Vault” in the architectural plans (Plan Set WS-JO). The low shed roof addition along the south elevation currently houses office space, restrooms, and an entry passage into the main building. This addition was constructed in 1962 or 1963; the addition plans indicate an as-built date of September 29, 1962, while the Real Property Record notes the addition was made in 1963. The addition housed a women’s restroom with a “lounge” area and a storage room for spare parts (Plan Set WS-KD).

The planned construction of Property 23640 is described in a 1959 summary of the WSMR Nike Zeus facilities as:

> The MTR building will be reinforced concrete construction approximately 110 by 50 feet. The building is fundamentally one level with roof mounted antenna assemblies. The building will be divided into four major areas, (1) Radar Equipment and Antenna Support, (2) Maintenance and Storage Area, (3) Equipment Control Area, and (4) Air Conditioning and Electrical Equipment Room. This building will house all MTR equipment and multiple antenna. These antennae will be covered by a curved transparent plastic protective cover [WSMR 1959:84].

The constructed version of Property 23640 obviously does not quite match the 1959 description, particularly in that the radar antennas were not mounted on the building roof, nor were they covered by a transparent plastic cover. Property 23640 was used in support of the Nike Zeus program until 1964, when Nike Zeus transitioned into the Nike X program. The Nike X was an improved version of the ABM system that Nike Zeus had pioneered, and relied on the new MAR, a significant advancement in radar technology that consolidated the functions of the numerous, infrastructure-heavy Nike Zeus radars. As LC-38 transitioned to the Nike X program, many of its technical facilities were re-purposed for other programs (Piland 2007b).

Property 23640 was modified to support the Sprint missile development as part of the Nike X program. The Nike Zeus control equipment and MTR units were modified to make them compatible with the Sprint missile (Plan Set WS-MX). Between 1964 to 1970, Property 23640 housed the launch control and missile tracking functions for the Sprint missile, which was launched from LC-50 (Piland 2007b). The Sprint missile testing at WSMR ended in August 1970, and assignment of Property 23640 to BTL was terminated in October 1970 (Field 1970; Piland 2007b).

In February 1971, a request was filed to remove all of the remnant electronics equipment from the building so that it could be “recabled” for installation of equipment belonging to the Army Materiel Test and Evaluation (ARMTE) Weapons Test Simulation Division (TE-S) (Jackson 1971). The ARMTE TE-S had been located within Property 1526, but needed to be relocated as the building’s second floor required “shoring” (Ferdig 1971; Jackson 1971). Doyle Piland, in his historical summary of LC-38, mentions that Property 23640 housed the ARMTE Hybrid Computer system and continued to be used by ARMTE’s successor, the Materiel Test Directorate (MTD) (Piland 2007b:5). At the time of the current recording, the building was scheduled to be used by an IT services contractor, but was not currently in use. The building was in good overall condition and generally well-maintained, but needed some exterior cosmetic work.

7.3.2 Property 23641

Property 23641 is the west radar antenna tower structure located outside the north elevation of Property 23640. The tower is composed of two parts; an inner concrete core that actually provided the structural support for the radar antenna, and an outer shell that consists of a steel framework that is clad in corrugated sheetmetal. The outer steel frame and sheetmetal shell actually extends up and over the top of the concrete inner tower, giving the tower its unusual profile. The concrete inner tower has a square plan, but supports a thick hexagonal shaped concrete slab at its top that supported the radar. The walls of the interior tower are constructed of 12-inch thick reinforced concrete, and the open interior of the inner concrete tower allowed for personnel access to the underside of the radar for installation and maintenance. Within the concrete tower is a steel staircase that ascends to a steel maintenance deck below the concrete mounting slab. From this maintenance deck, a short steel access ladder allows a hatch in the concrete radar slab to be accessed. Also accessible from the maintenance deck is a sliding steel maintenance platform affixed to the tower walls with rails. The maintenance platform provided maintenance access to portions of the radar that were out of reach from the main maintenance deck. Visible from the maintenance deck are three recessed attachment points in the radar mounting slab where the radar was bolted to the slab. Several lights with protective

Figure 77. Property 23641, east side of tower, view to the west.

Figure 78. Property 23641, north and west sides of tower, view to the southeast.

wire shields are mounted to the underside of the radar mounting slab within the maintenance area. At the time of the recording, the area of the tower inside the entrance was filled with assorted wood shipping containers and discarded equipment.

The upper part of the tower is accessible from the roof of Property 23640. As mentioned above, the outer shell extends up and over the radar mounting slab, mostly enclosing the top of the tower, leaving only an opening at its top. The outer shell forms a catwalk around the perimeter of the top of the tower. A steel staircase provides access to this upper catwalk from the roof of Property 23640. The catwalk along the perimeter of the tower is equipped with a handrail, and the outer support posts of this handrail are hinged so that they can be lowered, presumably to facilitate operation of the radar unit when it was still installed on the tower. The interior of the enclosed portion of the upper tower is accessed via a steel slab access door and short steel catwalk from the roof of Property 23640. A safety net system is attached to the upper part of the tower, consisting of a steel pipe framework that supported a cargo net, which has mostly decayed. Of the three MTR radar towers, only Property 23641 was equipped with this safety net system.

History of Use

Property 23641 was constructed in 1959 as the "MTR Antenna #1" according to a 1963 WSMR property inventory (WSMR 1963). The structure's Form 2877 Real Property Record describes it as an "Elct Eqp Fac" that was constructed in 1960. The original 1959 architectural plans for the adjacent Property 23640 include plans for Property 23641, and identify it as "MTR Antenna No. 1" (per WS-JO Plan Set). The A&E firm of Burns and Roe of New York, in cooperation with the USACE Albuquerque District, prepared the WS-JO plans for BTL. The original architectural plans describe the outer shell of the antenna tower as a, "wind and sun shield wall around foundation" (per Plan Set WS-JO). The plans indicate that the original shape of all three of the MTR antenna towers (Properties 23641, 23647, and 23648) were identical, but Properties 23641 and 23648 were later modified. In its original configuration, Property 23641 resembled Property 23647, which remains mostly true to its original design.

The Nike Zeus prototype system at LC-38 relied on an array of radars similar to those used in the predecessor Nike Ajax and Nike Hercules, but the Nike Zeus radars were generally larger and more powerful. The Nike Zeus system also incorporated the new DR installation. Targets for the Nike Zeus were initially acquired by the long-range ZAR (also sometimes identified as the LAR). Unlike most Nike radars, the ZAR was split into separate installations for the receiver (Properties 24062 and 24064) and the transmitter (Property 24072). Once the ZAR identified a target, it processed its position data and passed it to the DR (Property 23638) and the guidance computer located in Property 23640, which served as the BCB for the Nike Zeus testing. The DR helped

Figure 79. Property 23641, top of tower, access door, and staircase from Property 23640 roof, view to the north.

Figure 80. Property 23641, view down on top of tower from upper platform, view to the north.

Figure 81. Property 23641, view down on top of tower from upper platform, view to the north.

to identify the incoming ICBM warhead from associated debris such as spent boosters, as well as intentional decoys meant to confuse the radars and make interception more difficult. The DR transmitted targeting information about specific targets within the target cloud to the processing equipment in the BCB, where the tracking and targeting information was then sent to the TTR (Property 23642) and the MTRs installed along the north side of the BCB (Properties 23641, 23647, and 23648). Using the targeting data provided by the DR, the TTR provided accurate position data on small, fast-moving targets to the control equipment in the BCB. The MTRs tracked the Nike Zeus missile on its way to the target and also provided its coordinates to the guidance computer. Working in concert with the guidance computer, the TTR and MTR guided the missile to the intercept point. Property 23641 was the west MTR, one of three radar towers constructed along the north side of Property 23640. The MTR provided position data on the Nike Zeus missile to the system's targeting computer. It also transmitted steering, burst, and other orders from the targeting computer to the Nike Zeus missile via the radar beam (Bell Laboratories 1975:1-18).

Figure 82. Property 23641, pole framework for safety net around top of tower, view to the northwest.

Figure 83. Property 23641, radar mounting slab at top of tower, view to the southeast.

The MTR transmitter was installed inside the BCB (Property 23640) and was not part of the actual antenna installation. This allowed the rotating portion of the antenna to be smaller with less weight (Bell Laboratories 1975:1-18). The MTR antenna that was formerly mounted to the Property 23641 tower was a 4-foot diameter Cassegrainian (parabolic with two reflector surfaces) antenna on a two-axis mount that allowed it to rotate continuously in both azimuth and elevation from 11.5 degrees below the horizon, all the way through the zenith to 11.5 degrees below the opposite horizon. It took only five seconds for the MTR to shift to a new missile after the end of an engagement (Bell Laboratories 1975:1-18).

Property 23641 was used in support of the Nike Zeus program until 1964, when Nike Zeus transitioned into the Nike X program. The Nike X was an improved version of the ABM system that Nike Zeus had pioneered, and relied on the new MAR, a significant advancement in radar technology that consolidated the functions of the numerous, infrastructure-heavy Nike Zeus radars. As LC-38 transitioned to the Nike X program, many of its technical facilities were re-purposed for other programs (Piland 2007b). During 1964 and 1965, the Nike Zeus control equipment and MTR system were modified to make them compatible with the Sprint missile (Plan Set WS-MX). From 1964 to 1970, the neighboring Property 23640 housed the launch control and missile tracking functions for the Sprint missile, which was launched from LC-50 (Piland 2007b).

Property 23641 was also modified to support the Sprint missile development as part of the Nike X program. In 1965, the outer "shield wall" was extended over the top of the tower, mostly enclosing its upper portion, resulting in the current configuration of the structure. The safety net system around the top of the tower and the handrails and walkway around the upper perimeter were also added as part of these alterations (Plan Sets WS-OK and WS-MX). Property 23641 retains this configuration today, although the radar unit itself has been removed from the tower.

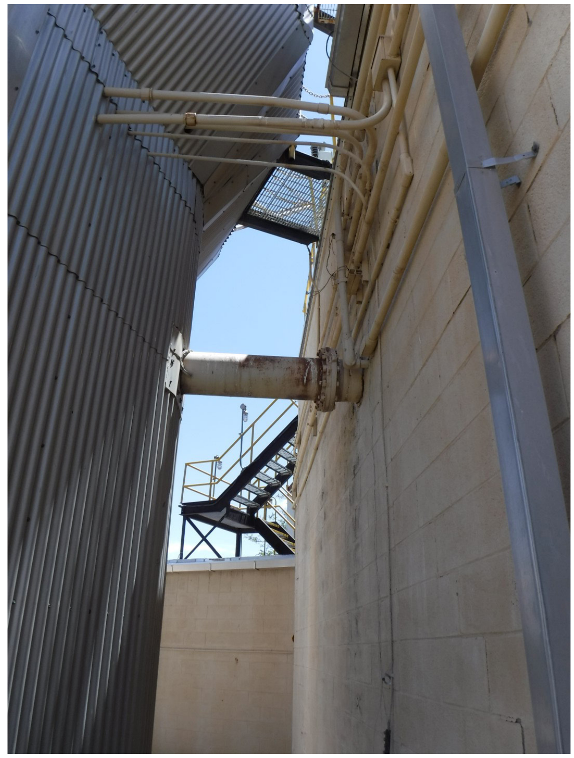

Figure 84. Property 23641, connections between tower and north elevation of Property 23640, view to the east.

There are some discrepancies between the labeling of the MTR antenna towers in the WS-OK Plan Set and labeling in other sources, but the WS-OK plans indicate that Property 23641 supported an "Antenna Receiver Group Missile Tracking" or a "Radiometry Mount Assembly" during the Sprint testing (Plan Set WS-OK). The Sprint missile testing at WSMR ended in August 1970, and assignment of Property 23641 to BTL was terminated in October 1970 (Field 1970; Piland 2007b). Property records provide no additional information on the use of Property 23641 after 1970. The neighboring Property 23640 was reassigned to the ARMTE TE-S in 1971 (Jackson 1971), but it does not appear that Property 23641 was re-used by ARMTE. At the time of the current recording, Property 23641 did not appear to have been used or maintained for decades, with the exception of the lower part of the tower being used for storage. The structure was in fair overall condition.

Figure 85. Property 23641, entrances in tower base, view to the south.

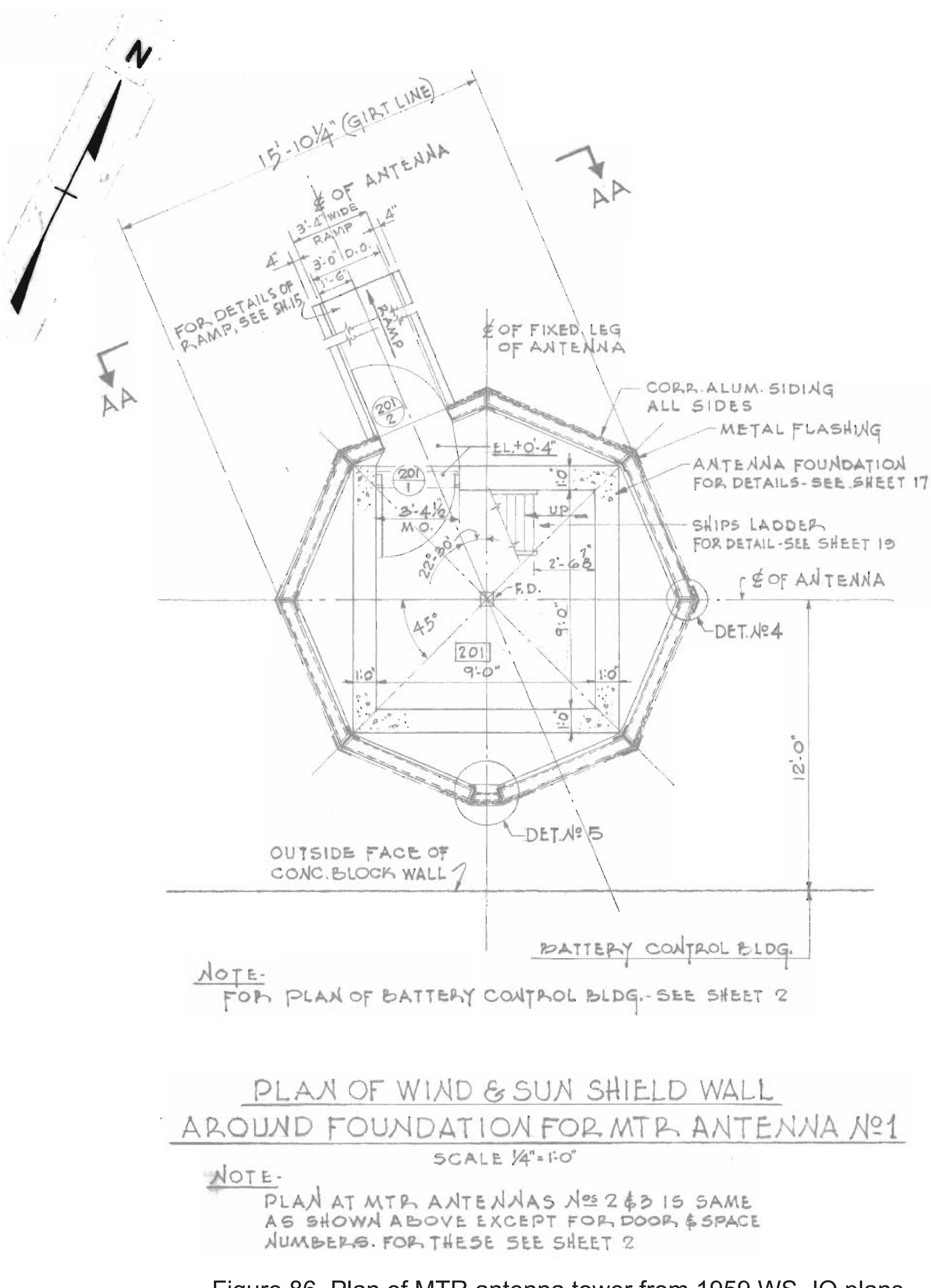

Figure 86. Plan of MTR antenna tower from 1959 WS-JO plans.

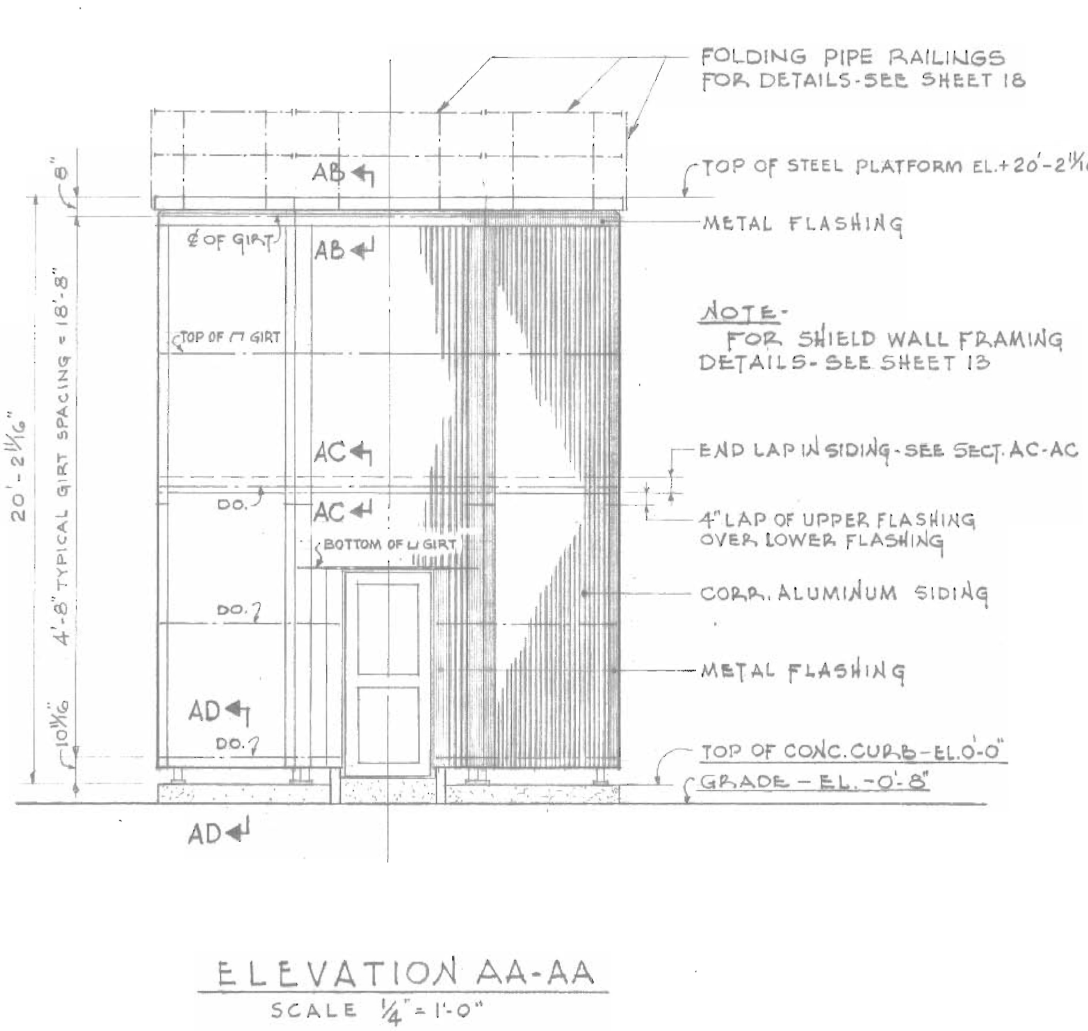

Figure 87. Elevation view of MTR antenna tower from 1959 WS-JO plans.

7.3.3 Property 23642

Property 23642 is a large one-story building located along the north side of Range Road 240 in the central portion of LC-38. The building is of CMU construction with an L-shaped plan formed by a west wing and an east wing. The east wing was constructed to support the TTR installation for the Nike Zeus program, and the west wing was constructed a few years later as an office and administrative wing. Both wings of the building are constructed on at-grade concrete foundations. The two wings are joined only by a narrow corridor, which creates a sort of dead-end alley between the two wings along the north elevation. The building's exterior, like most of the LC-38 buildings, is painted tan with brown trim elements. The building's roof consists of the two separate rooflines for each of the building wings. The flat roofs of both wings are of built-up construction, with gutters and downspouts installed along the north elevation. The roof fascia is clad in sheetmetal flashing along all elevations. The roof of the east radar block retains the circular base of the former radar installation, which has been clad with corrugated sheetmetal around its circumference and capped with a built-up roof that includes gutter downspouts and a grounding system.

The building's south elevation acts as the principal elevation, facing the building's parking lot

Figure 88. Property 23642, south and west elevations of west wing, view to the northeast.

Figure 89. Property 23642, south and east elevations of east wing, view to the northwest.

and Range Road 240. The south elevation is formed by the south elevations of the west office wing and the east radar wing. The south elevation of the west office wing has two entrances and 10 windows spaced along the length of the wall. Both of the entrances are sheltered within CMU entry porches with flat built-up roofs. The west entrance is double-leaf with steel slab doors, while the east entrance is single-leaf with a steel slab door. The windows along the south elevation of the west office wing are fixed anodized aluminum units with tinted glass and concrete sills; these windows appear to be modern replacements. The south elevation of the east radar block has a central CMU entry block with a flat roof of built-up construction. The single-leaf entrance consists of a steel slab door with a steel frame sidelight panel with three lights and a narrow transom light. The south wall of the entry block has been finished with stucco, but the remainder of the elevation consists of painted CMUs. A steel rooftop access ladder is mounted to the wall east of the entry block, and a large HVAC unit is installed on a concrete slab foundation to the west of the entry block. Outside the entry block is a variety of office furniture, including filing cabinets, a refrigerator, and a desk.

A variety of new and old support equipment is located outside the south and east elevations of the building. The eastern portion of the south elevation is surrounded by a chainlink fence, and a fenced electrical substation is also located outside the south elevation. Outside the south elevation of the east wing is a recently-installed refrigerated electrical equipment enclosure affixed to a concrete slab foundation. Also outside the south elevation of the east radar wing, within the fenced area around this part of the building, is an old mobile home in poor condition. Property tags on the trailer read "Property of US Army Contract DA 29-040-AMC-416 (R)" and "Contractor: Bendix F.E. Corp. DO NOT REMOVE." A series of missile fuselage fragments are laid out near the trailer, having apparently been recovered from tests. Outside the east elevation is a defunct water cooling tower installed on a concrete slab foundation and an associated plumbing vault (Property 23643). The water cooling tower was manufactured by "Evapco."

Figure 90. Property 23642, sealed radar base on roof of east wing, view to the northwest.

The building has two distinct west elevations formed by the east and west wings. The west elevation of the west office wing has a CMU entry block with a flat built-up roof on its north side. The entry block doors have been removed and replaced with a full-height windows with anodized aluminum frames and tinted glass. Two exterior light fixtures are mounted to the west wall of this entry block. The west elevation of the east radar wing has two CMU entry blocks with flat, built-up roofs. The south block has a double-leaf entrance with steel slab doors. The north entry block is built into the corner formed by the junction of the east and west wings. This entry block has a single-leaf entrance hung with a steel slab door with a narrow vertical upper light. A steel storage cabinet is located outside the door. Both entry blocks are equipped with overhead light fixtures. A portable barbeque grill is parked along the wall between the two entry blocks.

Figure 91. Property 23642, west elevation of east wing with entry blocks, view to the northeast.

The building's east elevation is formed by the east wall of the east radar wing. A

Figure 92. Property 23642, west and south elevations of west wing, view to the northeast.

CMU entry block with a flat built-up roof is located near the north end of the wall. The entry block houses a double-leaf entrance hung with tall steel slab doors. At the north end of the wall, at the building's northeast corner, is an elevated vault for communications cable access. Several old filing cabinets, wood pallets, and plastic barrels are located outside the east elevation.

The building's north elevation, which is formed by the east and west wings, is plain and lacks fenestration. Near the east end of the west wing is a small CMU block that protrudes from the wall, but this block does not house an entrance. Visible at the junction of the east and west wings is a narrow, dead-end alley formed by the partial gap between the east and west wings where they are joined together by a narrow corridor. A large HVAC unit on a concrete slab foundation is located outside the north elevation of the east wing, with associated ductwork that is routed through the upper wall.

History of Use

Property 23642 was constructed in 1960 as the "Target Track Radar" according to a 1963 WSMR property inventory (WSMR 1963). The building's Form 2877 Real Property Record describes it as an "Elct Eqp Fac" that enclosed 14,374 square feet; this square footage includes the west wing office addition. The original 1959 architectural plans for Property 23642 identify it as the "T.T.R Building" (per WS-IY Plan Set). The building was designed by the A&E firm of Burns and Roe of New York for BTL, in cooperation with the USACE Albuquerque District. The west wing addition to the building was completed in 1963 according to the building's Real Property Record and architectural plans (Plan Set WS-KR). The

Figure 93. Property 23642, north and west elevations, view to the southeast.

Figure 94. Property 23642, east end of north elevation of east wing, view to the southwest.

Figure 95. Property 23642, alley or niche between east and west wings along north elevation, view to the south.

Figure 96. Property 23640 in 1960 soon after it was completed, view of south and east elevations. The terne metal shielding on the exterior is visible (*US Army photograph)*.

exterior of the east radar wing was originally clad in sheetmetal panels referred to as "Terne metal shielding" in the architectural plans (Plan Set WS-IY). Terne is an alloy of lead and tin that is used to coat steel sheet to provide a durable corrosion resistance. It is no longer commonly used today because of its lead content. The metal shielding was continuous around the building's exterior, with horizontal seams all sealed by continuous solder joints. The shielding has been removed from building, and today the exterior of this part of the building consists of painted CMUs.

The Nike Zeus prototype system at LC-38 relied on an array of radars similar to those used in the predecessor Nike Ajax and Nike Hercules, but the Nike Zeus radars were generally larger and more powerful. The Nike Zeus system also incorporated the new DR installation. Targets for the Nike Zeus were initially acquired by the long-range ZAR (also sometimes identified as the LAR). Unlike most Nike radars, the ZAR was split into separate installations for the receiver (Properties 24062 and 24064) and the transmitter (Property 24072). Once the ZAR identified a target, it processed its position data and passed it to the DR (Property 23638) and control computer at the BCB (Property 23640) for further processing and analysis. The DR

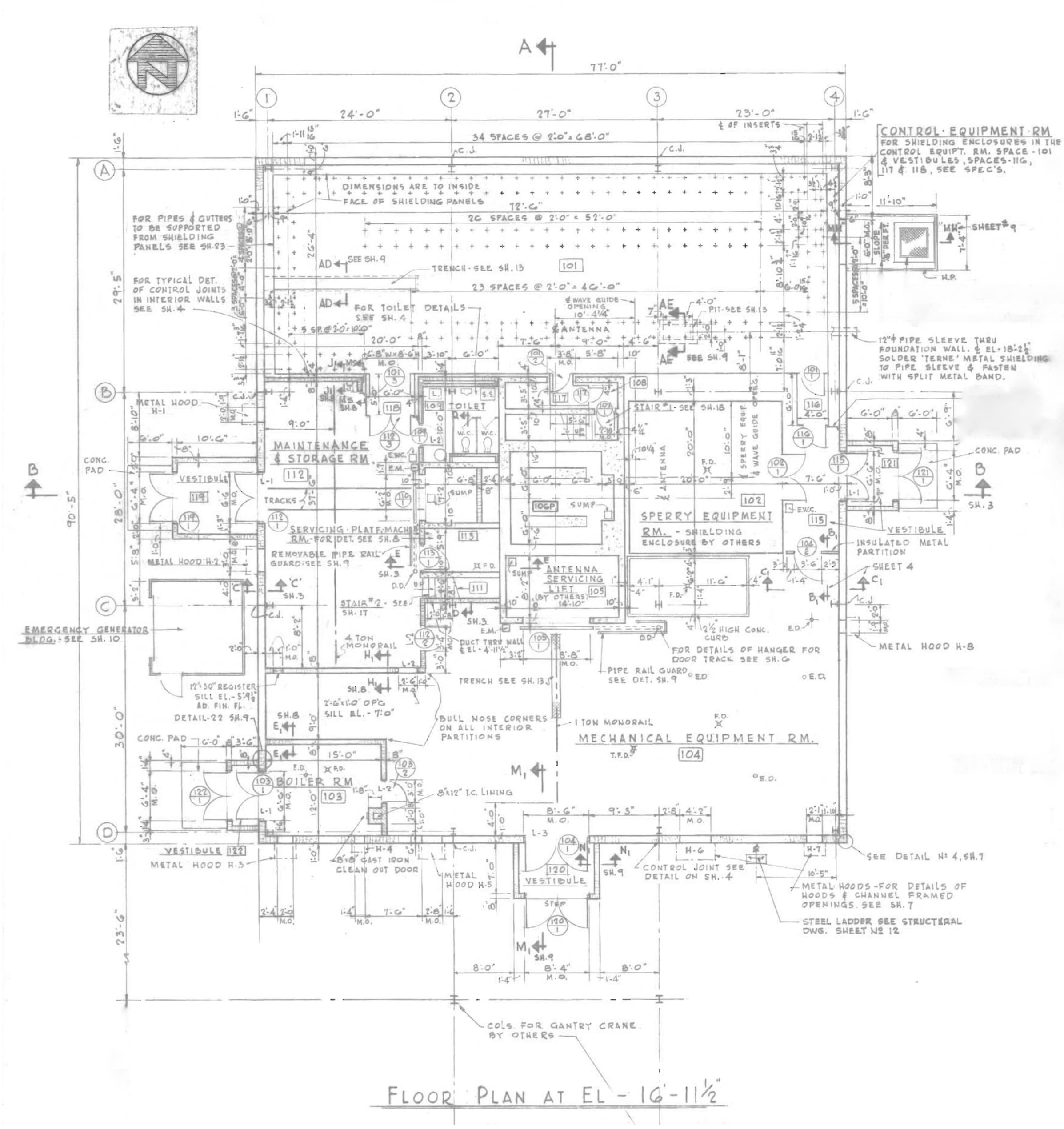

Figure 97. Floor plan of Property 23642 from 1959 WS-IY architectural drawings.

helped to identify the incoming ICBM warhead from associated debris such as spent boosters, as well as intentional decoys meant to confuse the radars and make interception more difficult. The DR transmitted targeting information about specific targets within the target cloud to the processing equipment in the BCB, where the tracking and targeting information was then sent to the TTR housed at Property 23642 and the MTRs installed along the north side of the BCB (Properties 23641, 23647, and 23648). Using the targeting data provided by the DR, the TTR provided accurate position data on small, fast-moving targets to the control equipment in the BCB. The MTRs tracked the Nike Zeus missile on its way to the target and also provided its coordinates to the guidance computer. Working in concert with the guidance computer, the TTR and MTR guided the missile to the intercept point where the computer transmitted the detonation signal to the Nike Zeus missile through the MTR.

The interior of the east radar wing included two control equipment rooms that were lined with shielding panels to protect the control equipment and an unshielded mechanical equipment room. One of the shielded rooms was labeled as the "Sperry Equipment Room" in the original drawings (Plan Set WS-IY). Both 1-ton and 4-ton monorail hoists were installed across the mechanical equipment room's ceiling. Between the control equipment and mechanical rooms were concrete walls constructed atop a separate concrete slab foundation that supported the rooftop radar antenna installation. A servicing hoist provided access to the underside of the radar antenna from within the building interior. The building is described in a 1959 summary of the WSMR Nike Zeus facilities as:

> This building is of reinforced concrete construction approximately 77 by 90 by 17-feet high. The TTR antenna will be mounted in the center of the roof. This building houses the radar transmitter and receiver equipment, air conditioning equipment, storage and maintenance space and the necessary supporting electronic and mechanical equipment required by the radar [WSMR 1959:76].

Property 23642 was used in support of the Nike Zeus program until 1964, when Nike Zeus transitioned into the Nike X prototype program. The Nike X was an improved version of the ABM system that Nike Zeus had pioneered. Nike X relied on phased array radars, a significant advancement in radar technology that consolidated the functions of the numerous, infrastructure-heavy Nike Zeus radars. As LC-38 transitioned to the Nike X program, many of its technical facilities were re-purposed for other programs (Piland 2007b). The TTR housed in Property 23642 and the DR at Property 23638 continued to operate with ARPA funding in support of the ARPA Project Defender and the ABRES programs from 1964 to 1969. The TTR provided external guidance and tracking for the UPSTAGE tests, and also was used for tracking of the Athena flights from Green River, Utah (Van Atta et al. 1991:3-9; WSMR 1968a). In this role, Property 23642 and the TTR continued to operate much as it had during the Nike Zeus program. A 1970 *Missile Ranger* article also describes how the DR and TTR were used in ARPA's HAPDAR and Rondo projects. Rondo was based on three temporary radar sites at WSMR and was unique in that the system only received radar returns; it relied on other radars to actually illuminate the targets (Moyer and Korfmacher 2020:21). The DR and TTR at LC-38 were used to illuminate targets for Rondo from 1965 to 1970, after which Rondo used the Advanced Research Projects Agency Terminal (ARPAT) Measurements Radar (AMRAD) to illuminate targets (Missile Ranger 1970; White Sands Missile Range 1971). According to the *Missile Ranger* article:

> Under HAPDAR, the facility's function was to illuminate targets for Athena, Pershing, and other missile firings. After 1965, the facility was used primarily to support ARPA's Rondo radar project and for tracking of other missiles and satellites. For these functions, the operating contractors were Western Electric Co. and the Bell Telephone Laboratories of White Sands [Missile Ranger 1970:1].

In October 1968, operation of the TTR and DR installations was transferred to the ABMDA. In September 1969, the ABMDA halted operation of both the TTR and DR installations. Soon after, in March 1970, it was announced that the LC-38 TTR and DR were to be transferred to the Air Force Range Measurements Laboratory (RML), an element of Patrick Air Force Base, Florida (Missile Ranger 1970). The RML planned to update the TTR and DR to "advanced sensor status" and use them "as a research and development facility for state-of-the-art developments in microwave and optics technology" (Missile Ranger 1970:1). However, the RML effort to revamp the DR and TTR appears to have been short-lived. A 1971 summary of the radars in use at WSMR describes the DR and TTR as, "presently being phased out of all activity at WSMR and will be surplused" (WSMR 1971). The radar equipment appears to have been removed from both installations soon after this time (Piland 2007b). By the early 1970s, the SAM-D program was rapidly gearing up at LC-38, and the west office wing of Property 23642 was used as office space for SAM-D personnel. The east radar wing's large shielded room that housed the MTR signal generation equipment was converted to a secure facility for housing the SAM-D testing database (Piland 2007b). The building continues to be used by IT service contractors today and is in good overall condition.

7.3.4 Property 23647

Property 23647 is the middle of three radar antenna tower structures located outside the north elevation of Property 23640. The tower is composed of two parts; an inner concrete core that actually provided the structural support for the radar antenna, and an outer shell that consists of a steel framework that is clad in corrugated sheetmetal. The concrete inner tower has a square plan, but supports a thick hexagonal shaped concrete slab at its top that supported the radar. The walls of the interior tower are constructed of 12-inch thick reinforced concrete, and the open interior of the inner concrete tower allowed for personnel access to the underside of the radar for installation and maintenance. Within the concrete tower is a steel staircase that ascends to a steel maintenance deck below the concrete mounting slab. From this maintenance deck, a short steel access ladder allows a hatch in the concrete radar slab to be accessed. Also accessible from the maintenance deck is a sliding steel maintenance platform affixed to the tower walls with rails. The maintenance platform provided maintenance access to portions of the radar that were out of reach from the main maintenance deck. Visible from the maintenance deck are three recessed attachment points in the radar mounting slab where the radar was bolted to the slab. Several lights with protective wire shields are mounted to the underside of the radar mounting slab within the maintenance area. At the time of the recording, the area of the tower inside the entrance was filled with debris, rodent nests, and old electronics equipment,

Figure 98. Property 23647, north and west sides of tower, view to the southeast.

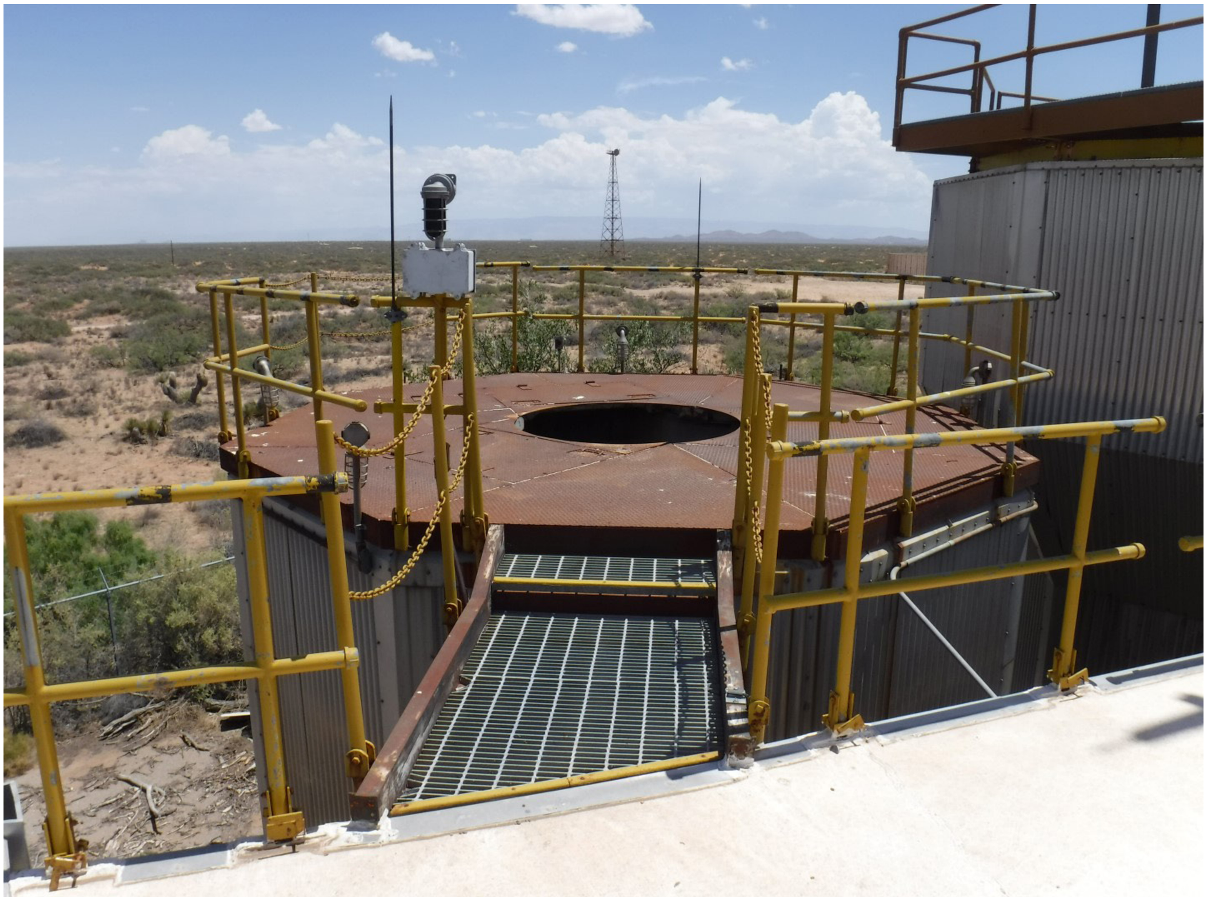

Figure 99. Property 23647, view of upper tower deck and catwalk from roof, view to the northeast.

including a vintage IBM electric typewriter.

The upper deck of the tower is accessible from the roof of neighboring Property 23640 via a short steel catwalk. Installed on the roof of Property 23640, between Properties 23647 and 23648, is a mast assembly with a ratchet-operated, pivoting base that is described as a "lightning protection mast" in architectural plans (Plan Set WS-JO). The top of the tower is covered with a deck surface of tread-pattern steel plate, with an opening in the center for the MTR antenna, which has been removed from the tower. Several hatches are incorporated into the surface of the upper deck, which appear to allow access to the antenna mounting hardware from the surface of the upper deck. A tubular steel handrail is installed along the perimeter of the tower deck. Each of the support posts of the handrail has a hinged base so that the handrail can be folded down, presumably to facilitate operation of the radar unit when it was still installed on the tower. Two sealed light fixtures are also installed along the deck handrail. Property 23647 appears to be the only MTR radar tower that retains its original Nike Zeus configuration, while the other two MTR antenna towers (Properties 23641 and 23648) were modified after the end of Nike Zeus testing.

History of Use

Property 23647 was constructed in 1959 as the “MTR Antenna #2” according to a 1963 WSMR property inventory (WSMR 1963). The structure’s Form 2877 Real Property Record describes it as an “Elct Eqp Fac” that was constructed in 1960. The original 1959 architectural plans for the adjacent Property 23640 include plans for Property 23647, and identify it as “MTR Antenna No. 2” (per WS-JO Plan Set). The A&E firm of Burns and Roe of New York, in cooperation with the USACE Albuquerque District, prepared the WS-JO plans for BTL. The original architectural plans describe the outer shell of the antenna tower as a, “wind and sun shield wall around foundation” (per Plan Set WS-JO). The plans indicate that the original shape of all three of the MTR antenna towers (Properties 23641, 23647, and 23648) were identical, but Properties 23641 and 23648 were later modified. Property 23647 is the only one of the three antenna towers that retains its original design from the Nike Zeus testing during the early 1960s.

The Nike Zeus prototype system at LC-38 relied on an array of radars similar to those used in the predecessor Nike Ajax and Nike Hercules, but the Nike Zeus radars were generally larger and more powerful. The Nike Zeus system also incorporated the new DR installation. Targets for the Nike Zeus were initially acquired by the long-range ZAR (also sometimes identified as the LAR). Unlike most Nike radars, the ZAR was split into separate installations for the receiver (Properties 24062 and 24064) and the transmitter (Property 24072). Once the ZAR identified a target, it processed its position data and passed it to the DR (Property 23638) and the guidance computer located in Property 23640, which served as the BCB

Figure 100. Property 23647, upper deck and view of radar mount, view to the northeast.

Figure 101. Property 23647, view of radar mount at top of tower.

Figure 102. Property 23647, interior working platform trolley track, view to the southeast.

for the Nike Zeus testing. The DR helped to identify the incoming ICBM warhead from associated debris such as spent boosters, as well as intentional decoys meant to confuse the radars and make interception more difficult. The DR transmitted targeting information about specific targets within the target cloud to the processing equipment in the BCB, where the tracking and targeting information was then sent to the TTR (Property 23642) and the MTRs installed along the north side of the BCB (Properties 23641, 23647, and 23648). Using the targeting data provided by the DR, the TTR provided accurate position data on small, fast-moving targets to the control equipment in the BCB. The MTRs tracked the Nike Zeus missile on its way to the target and also provided its coordinates to the guidance computer. Working in concert with the guidance computer, the TTR and MTR guided the missile to the intercept point. Property 23647 was the middle MTR, one of three radar towers constructed along the north side of Property 23640. The MTRs provided position data on the Nike Zeus missile to the system's targeting computer. They also transmitted steering, burst, and other orders from the targeting computer to the Nike Zeus missile via the radar beam (Bell Laboratories 1975:1-18).

The MTR transmitter was installed inside the BCB (Property 23640) and was not part of the actual antenna installation. This allowed the rotating portion of the antenna to be smaller with less weight (Bell Laboratories 1975:1-18). The MTR antenna that was formerly mounted to the Property 23647 tower was a 4-foot diameter Cassegrainian (parabolic with two reflector surfaces) antenna on a two-axis mount that allowed it to rotate continuously in both azimuth and elevation from 11.5 degrees below the horizon, all the way through the zenith to 11.5 degrees below the opposite horizon. It took only five seconds for the MTR to shift to a new missile after the end of an engagement (Bell Laboratories 1975:1-18).

Figure 103. Property 23647, view of outer tower shell and inner tower, view to the east.

Figure 104. Property 23647, inner tower entrance door, discarded equipment and refuse within interior, view to the south.

Figure 105. Property 23647, IBM electric typewriter included within discarded equipment at base of tower, plan view.

Property 23647 was used in support of the Nike Zeus program until 1964, when Nike Zeus transitioned into the Nike X program. The Nike X was an improved version of the ABM system that Nike Zeus had pioneered, and relied on the new MAR, a significant advancement in radar technology that consolidated the functions of the numerous, infrastructure-heavy Nike Zeus radars. As LC-38 transitioned to the Nike X program, many of its technical facilities were re-purposed for other programs (Piland 2007b). During 1964 and 1965, the Nike Zeus control equipment and MTR system were modified to make them compatible with the Sprint missile (Plan Set WS-MX). From 1964 to 1970, the neighboring Property 23640 housed the launch control and missile tracking functions for the Sprint missile, which was launched from LC-50 (Piland 2007b).

While the upper portions of the neighboring Property 23641 and Property 23648 antenna towers were extensively modified for the Sprint program, Property 23647 mostly maintained its original configuration. Period photographs show an MTR antenna installed on Property 23647 during the period of Sprint testing at WSMR. The Sprint missile testing at WSMR ended in August 1970, and assignment of Property 23647 to BTL was terminated in October 1970 (Field 1970; Piland 2007b). Property records provide no additional information on the use of Property 23647 after 1970. The neighboring Property 23640 was reassigned to the ARMTE TE-S in 1971 (Jackson 1971), but it does not appear that Property 23647 was re-used by ARMTE. At the time of the current recording, Property 23647 did not appear to have been used or maintained for decades, with exception of the lower part of the tower being used for storage. The structure was in fair overall condition.

7.3.5 Property 23648

Property 23648 is the west radar antenna tower structure located outside the north elevation of Property 23640. The tower is composed of two parts; an inner concrete core that actually provided the structural support for the radar antenna, and an outer shell that consists of a steel framework that is clad in corrugated sheetmetal. The outer steel frame and sheetmetal shell actually extends up and over the top of the concrete inner tower, giving the tower its unusual profile. The concrete inner tower has a square plan, but supports a thick hexagonal shaped concrete slab at its top that supported the radar. The walls of the interior tower are constructed of 12-inch thick reinforced concrete, and the open interior of the inner concrete tower allowed for personnel access to the underside of the radar for installation and maintenance. Within the concrete tower is a steel staircase that ascends to a steel maintenance deck below the concrete mounting slab. From this maintenance deck, a short steel access ladder allows a hatch in the concrete radar slab to be accessed. Also accessible from the maintenance deck is a sliding steel maintenance platform affixed to the tower walls with rails. The maintenance platform provided maintenance access to portions of the radar that were out of reach from the main maintenance deck. Visible from the maintenance deck are three recessed attachment points in the radar mounting slab where the radar was bolted to the slab. Several lights with protective wire shields are mounted to the underside of the radar mounting slab within the maintenance

Figure 106. Property 23648, north side of tower, view to the south.

Figure 107. Property 23648, access staircase from Property 23640 roof, upper part of tower, view to the northeast.

area. At the time of the recording, the area of the tower inside the entrance was filled with debris, rodent nests, and cardboard boxes.

The upper part of the tower is accessible from the roof of Property 23640. As mentioned above, the outer shell extends up and over the radar mounting slab, mostly enclosing the top of the tower. In addition, a rectangular steel deck has been added to the top of the outer shell that encloses the top of the tower. A steel staircase provides access to this upper deck from the roof of Property 23640.This steel deck has a perimeter handrail made of tubular steel and two pole-mounted light fixtures illuminate the steel deck. Two square apertures are located within the steel deck addition, but no equipment is attached to the deck. The interior of the enclosed portion of the upper tower is accessed via a steel slab door and short steel catwalk from the roof of Property 23640. Installed on the roof of Property 23640, between Properties 23647 and 23648, is a mast assembly with a ratchet-operated, pivoting base that is described as a "lightning protection mast" in architectural plans (Plan Set WS-JO).

History of Use

Property 23648 was constructed in 1959 as the "MTR Antenna #3" according to a 1963 WSMR property inventory (WSMR 1963). The structure's Form 2877 Real Property Record describes it as an "Elct Eqp Fac" that was constructed in 1960. The original 1959 architectural plans for the adjacent Property 23640 include plans for Property 23648, and identify it as "MTR Antenna No. 3" (per WS-JO Plan Set). The A&E firm of Burns and Roe of New York, in cooperation with the USACE Albuquerque District, prepared the WS-JO plans for BTL. The original architectural plans describe the outer shell of the antenna tower as a, "wind and sun shield wall around foundation" (per Plan Set WS-JO). The plans indicate that the original shape of all three of the MTR antenna towers (Properties 23641, 23647, and 23648) were identical, but Properties 23641 and 23648 were later modified. Property 23647 is the only of three antenna towers that retains its original design from the Nike Zeus testing during the early 1960s.

The Nike Zeus prototype system at LC-38 relied on an array of radars similar to those used in the predecessor Nike Ajax and Nike Hercules, but the Nike Zeus radars were generally larger and more powerful. The Nike Zeus system also incorporated the new DR installation. Targets for the Nike Zeus were initially acquired by the long-range ZAR (also sometimes identified as the LAR). Unlike most Nike radars, the ZAR was split into separate installations for the receiver (Properties 24062 and 24064) and the transmitter (Property 24072). Once the ZAR identified a target, it processed its position data and passed it to the DR (Property 23638) and the guidance computer located in Property 23640, which served as the BCB for the Nike Zeus testing. The DR helped to identify the incoming ICBM warhead from associated debris such as spent boosters, as well as intentional decoys meant to confuse the radars and make interception more difficult. The DR trans-

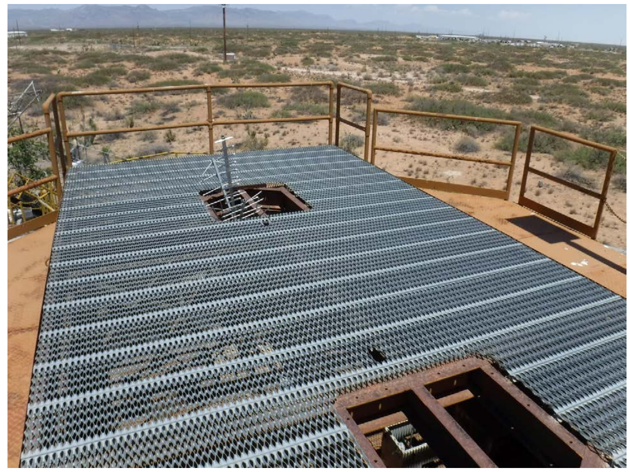

Figure 108. Property 23648, replacement deck surface on top of tower, view to the west.

Figure 109. Property 23648 tower base, view to the northeast.

Figure 110. Property 23648, view of interior at base of tower, various discarded boxes and refuse, view to the south.

mitted targeting information about specific targets within the target cloud to the processing equipment in the BCB, where the tracking and targeting information was then sent to the TTR (Property 23642) and the MTRs installed along the north side of the BCB (Properties 23641, 23647, and 23648). Using the targeting data provided by the DR, the TTR provided accurate position data on small, fast-moving targets to the control equipment in the BCB. The MTRs tracked the Nike Zeus missile on its way to the target and also provided its coordinates to the guidance computer. Working in concert with the guidance computer, the TTR and MTR guided the missile to the intercept point. Property 23648 was the east MTR, one of three radar towers constructed along the north side of Property 23640. The MTR provided position data on the Nike Zeus missile to the system's targeting computer. It also transmitted steering, burst, and other orders from the targeting computer to the Nike Zeus missile via the radar beam (Bell Laboratories 1975:1-18).

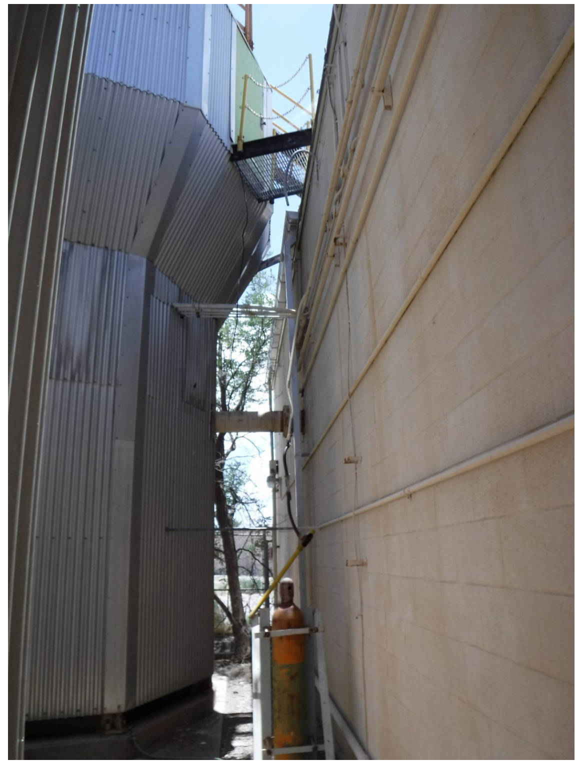

Figure 111. Property 23648, connections between tower and north elevation of Property 23640, view to the east.

The MTR transmitter was installed inside the BCB (Property 23640) and was not part of the actual antenna installation. This allowed the rotating portion of the antenna to be smaller with less weight (Bell Laboratories 1975:1-18). The MTR antenna that was formerly mounted to the Property 23648 tower was a 4-foot diameter Cassegrainian (parabolic with two reflector surfaces) antenna on a two-axis mount that allowed it to rotate continuously in both azimuth and elevation from 11.5 degrees below the horizon, all the way through the zenith to 11.5 degrees below the opposite horizon. It took only five seconds for the MTR to shift to a new missile after the end of an engagement (Bell Laboratories 1975:1-18).

Figure 112. Property 23648 tower entrance, refuse within interior, view to south.

Property 23648 was used in support of the Nike Zeus program until 1964, when Nike Zeus transitioned into the Nike X program. The Nike X was an improved version of the ABM system that Nike Zeus had pioneered, and relied on the new MAR, a significant advancement in radar technology that consolidated the functions of the numerous, infrastructure-heavy Nike Zeus radars. As LC-38 transitioned to the Nike X program, many of its technical facilities were re-purposed for other programs (Piland 2007b). During 1964 and 1965, the Nike Zeus control equipment and MTR system were modified to make them compatible with the Sprint missile (Plan Set WS-MX). From 1964 to 1970, the neighboring Property 23640 housed the launch control and missile tracking functions for the Sprint missile, which was launched from LC-50 (Piland 2007b).

Property 23648 was also modified to support the Sprint missile development as part of the Nike X program. According to 1964 plans for the Sprint installation at LC-50, the outer "shield wall" was extended over the top of the tower, mostly enclosing its upper portion, similar to the alterations made to Property 23641 (Plan Set WS-OK). Property 23641 retains this configuration today, although the radar unit itself has been removed from the tower. The rectangular steel deck across the top of the tower appears to be a separate, later addition to the structure.

There are some discrepancies between the labeling of the MTR antenna towers in the WS-OK Plan Set and labeling in other sources, but the WS-OK plans indicate that Property 23641 supported an "Antenna Receiver Group Missile Tracking" or a "Radiometry Mount Assembly" during the Sprint testing (Plan Set WS-OK). The Sprint missile testing at WSMR ended in August 1970, and assignment of Property 23641 to BTL was terminated in October 1970 (Field 1970; Piland 2007b). Property records provide no additional information on the use of Property 23648 after 1970. The neighboring Property 23640 was reassigned to the ARMTE TE-S in 1971 (Jackson 1971). It is not known if Property 23648 was re-used by ARMTE, but the steel deck addition to the top of the tower seems to be a later alteration that might have been related to the ARMTE use of Property 23640. At the time of the current recording, Property 23648 did not appear to have been used or maintained for many years, with exception of the lower part of the tower being used for storage. The structure was in fair overall condition.

7.3.6 Property 23652

Property 23652 is a small CMU building and boresight tower located north of Property 23640. The building has a square plan and is constructed on an above-grade concrete slab foundation. The flat roof is of built-up construction and has an enclosed eave on all elevations. The roof fascia is clad in sheetmetal flashing, and the roof is equipped with a grounding system with lightning rods at each corner. The only fenestration on the building is a single-leaf entrance on the north elevation, which is hung with a steel slab door that has a large upper light of wire-embedded safety glass. A concrete entry stoop is located outside the entrance. Remnant ductwork is routed through the upper portion of the east elevation, while the west elevation is completely plain. Two electrical switch boxes are mounted on the east elevation wall near the building's northeast corner. A boresight tower is located just off the building's south elevation. The boresight tower is stencil-painted as "23641," which appears to be a misnomer since Property 23641 is one of the MTR towers outside Property 23640. A sealed cable tray runs from the base of the tower into the south elevation wall of Property 23652; this elevation is otherwise plain. The interior of the small building is empty.

Figure 113. Property 23652, north and east elevations, view to the southwest.

History of Use

Property 23652 was constructed in 1965 as a "Elect Eqp Fac" the building's Form 2877 Real Property Record. The building was constructed in support of the Sprint missile program and was part of the Sprint modifications made to LC-38. The original 1964 architectural plans for Property 23652 identify it as the "SEMTR Shelter" (per WS-MX Plan Set). The WS-MX plans do not provide a definition for "SEMTR," but the acronym is likely some variation on "Sprint Missile Tracking Radar." The building appears to be a shelter that housed support equipment for the associated boresight tower, which was used to calibrate the MTR units installed outside the nearby Property 23640. At the time of the recording, the building remained in good overall condition but did not appear to be used.

Figure 114. Property 23652, south and east elevations, view to the northwest.

Figure 115. Property 23652, overview of boresight tower and building, view to the north.

7.3.7 Property 23659

Property 23659 is a large radar clutter fence associated with the former DR installation (Property 23638) at LC-38. The fence is approximately 500 feet in diameter and stands 21 feet in height. The entire fence has been painted a uniform tan color. The main support posts in the fence are 8-inch steel I-beams set into 24-inch diameter concrete footings; the I-beam posts form sections or bays in the fence that are 11 feet 6 inches wide. Within each of these larger bays, braces of 3-inch steel channel divide each bay into three equal-width sections, with horizontal cross braces mid-height across the three sections. Two pairs of diagonal braces are installed at every fourth bay of the fence. The surface of the fence is composed of heavy ¼-inch wire mesh, which is identified as "hardware cloth" in the architectural plans (Plan Set WS-KD). A low berm is located around the perimeter of the fence from the leveling and grading of the fenceline.

A vehicle gate is located in the southeastern margin of the fence, which is set within a perpendicular extension that forms a right angle to the circular line of the main fence. The sliding gate is constructed of angle steel stock and ¼-inch hardware cloth. The sliding gate is mounted to an overhead beam and track which is supported by triangular supports set on concrete foot-

Figure 116. Property 23659, overview of clutter fence from the east, view to the southwest.

Figure 117. Property 23659, clutter fence construction detail, view to the northeast.

ings. The gate does not appear to still be used and is fixed in the open position; a conventional chainlink fence gate is installed across the old gateway. An extensive growth of old vines has climbed the fence along the west side of the gate. A sign outside the gate reads, "ELECTROMAGNETIC ANALYSIS FACILITY / EMAF / ARL / SURVIVABILITY / LETHALITY ANALYSIS DIRECTORATE." Two smaller personnel access gates are located in the east and west margins of the fence, each approximately 6 feet high and constructed of steel angle stock and ¼-inch hardware cloth.

The main personnel access through the fence into the demolished Property 23638 was a tunnel in the southwest margin of the fence. The tunnel was collapsed as part of the demolition of Property 23638, but the entrance remains mostly intact. The entrance consists of a buttressed concrete retaining wall that houses a steel slab entry door. A remnant ventilation hood is located above the door, along with an overhead light. A separate concrete headwall is located to the south of the entrance retaining wall, but is freestanding and not connected to the entrance retaining walls. The buttressed entrance wall connected to a 7-foot diameter corrugated sheet-metal pipe that formed the entrance tunnel to Property 23638. The entrance tunnel was covered with compacted earth fill, gravel, and asphalt, and connected to the west elevation of Property 23638. The tunnel is referred to as the "shielded walkway" in architectural plans (Plan Set

WS-KD).

The west side of the original fence was modified by an additional section of fence that was installed north of Property 23642, which apparently served as clutter fence for the TTR installation. The east end of this section of fence extends through the existing fenceline of Property 23659 by a few feet, which required the old fence to be cut and modified to accommodate it. A concrete footing located within the original fenceline supports the east end of the added fence section. The added fence is angled at approximately 110 degrees where it passes through the original fence, and the existing fence was cut accordingly. A series of cable guy lines are attached to the new fence section, some of which are routed through the original fence.

History of Use

Property 23659 was constructed in 1962 as the "Outer Shielded Fence" according to a 1963 WSMR property inventory (WSMR 1963). The property's Form 2877 Real Property Record simply describes it as an "Elct Eqp Fac" with a radius of 250 feet. The original 1959 architectural plans for Property 23659 are more specific, identifying the fence as one of the "R.F. Shield Fences" associated with the "D.R. Building" (per WS-KD Plan Set). The DR building and clutter fence were designed by the A&E firm of Burns and Roe of New York for BTL, in cooperation with the USACE Albuquerque District.

The Nike Zeus prototype system at LC-38 relied on an array of radars similar to those used in the predecessor Nike Ajax and Nike Hercules, but the Nike Zeus radars were generally larger and more powerful. The Nike Zeus system also incorporated the new DR installation, which was added in 1962, a couple years after

Figure 118. Property 23659, view of clutter fence interior along western side, view to the southwest.

Figure 119. Property 23659, gate supports detail, view to the northwest.

Figure 120. Property 23659, personnel gate in western side of clutter fence, view to the east.

Figure 121. Property 23659, additional clutter fence panel spliced into original fence, view to the northwest.

the other radar installations were completed. Targets for the Nike Zeus were initially acquired by the long-range ZAR (also sometimes identified as the LAR). Unlike most Nike radars, the ZAR was split into separate installations for the receiver (Properties 24062 and 24064) and the transmitter (Property 24072). Once the ZAR identified a target, it processed its position data and passed it to the DR (Property 23638) and control computer at the BCB (Property 23640) for further processing and analysis. The DR helped to identify the incoming ICBM warhead from associated debris such as spent boosters, as well as intentional decoys meant to confuse the radars and make interception more difficult. The DR was designed to cover target clouds with diameters up to 22 nautical miles in diameter, and could vary its beam width to fine-tune tracking of target clouds that varied widely in size and distance (Bell Laboratories 1975:1-9). The DR transmitted targeting information about specific targets within the target cloud to the processing equipment in the BCB, where the tracking and targeting information was then sent to the TTR (Property 23642) and the MTRs installed along the north side of the BCB (Properties 23641, 23647, and 23648). Using the targeting data provided by the DR, the TTR provided accurate position data on small, fast-moving targets to the control equipment in the BCB. The MTRs tracked the Nike Zeus missile on its way to the target and also provided its coordinates to the guidance computer. Working in concert with the guidance computer, the TTR and MTR guided the missile to the intercept point where the computer transmitted the detonation signal to the Nike Zeus missile through the MTR.

Property 23659 is what is commonly referred to as a radar clutter fence and surrounded the DR installation (Property 23638). Radar clutter fences prevented radar returns from surrounding terrain and nearby buildings and structures, and are sometimes referred to as beam forming fences (Piland 2007b). The fences also kept personnel and equipment at a safe distance when the high-power radar units like the Nike Zeus DR were operating. At LC-38, the ZAR transmitter (Property 24072) was also equipped with a similar clutter fence. In its original configuration, the DR installation (Property 23638) was surrounded by three clutter fences; the outer fence (Property 23659); an inner clutter fence (Property 23658); and a partial-length center clutter fence (Property 23657). The smaller inner clutter fence (Property 23658) had a diameter of 384 feet while the innermost fence (Property 23657) was only a partial fence that formed an arc outside the north elevation of the DR building (Property 23638). Only the outer clutter fence remains intact today, the inner fences were removed in 1988 as part of a renovation project that built a new parking area outside Property 23638 and re-painted Property 23659 (Harris 1988).

The history of Property 23659 is closely associated with the DR installation within Property 23638. Property 23638 was used in support of the Nike Zeus program until 1964, when Nike Zeus transitioned into the Nike X prototype program.

Figure 122. Property 23659, tunnel access outer wall, view to the northeast.

Figure 123. Property 23659, tunnel access door, view to the north.

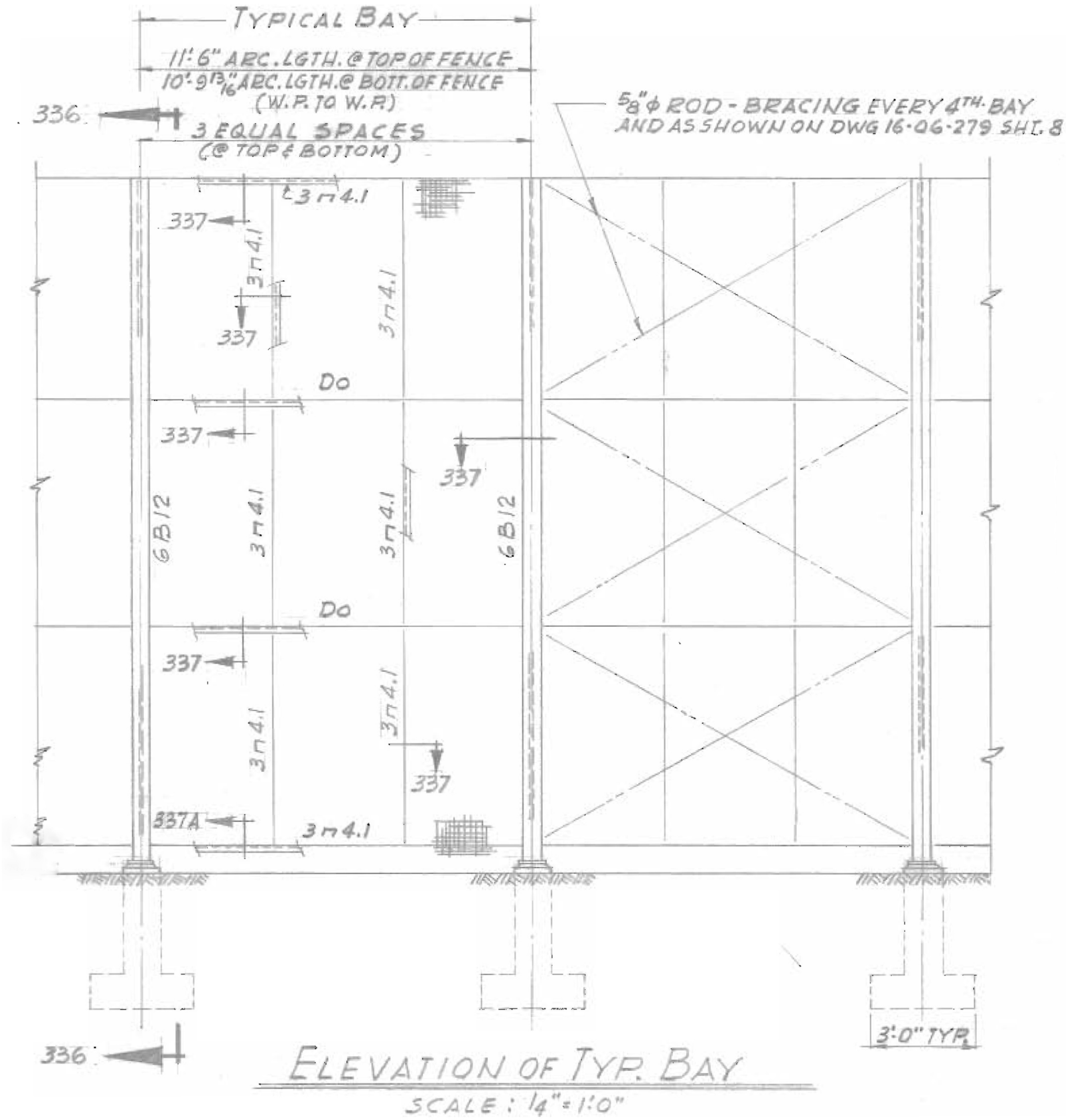

Figure 124. Property 23659, typical fence section from 1961 WS-KD plan set.

As LC-38 transitioned to the Nike X program, many of its technical facilities were re-purposed for other programs (Piland 2007b). After the end of the Nike Zeus testing, the TTR housed in Property 23642 and the DR at Property 23638 continued to operate with ARPA funding in support of the ARPA Project Defender and the ABRES programs from 1964 to 1969. As part of the ABRES program, the DR tracked the Athena flights from Green River, Utah and provided data on a variety of reentry phenomena (Van Atta et al. 1991:3-9; WSMR 1968). In this role, the DR housed within Property 23638 continued to operate much as it had during the Nike Zeus program, and Property 23659 likewise continued to serve as a clutter fence for the DR.

A 1970 *Missile Ranger* article also describes how the DR and TTR were used in ARPA's HAPDAR and Rondo projects. Rondo was based on three temporary radar sites at WSMR and was unique in that the system only received radar returns; it relied on other radars to actually illuminate the targets (Moyer and Korfmacher 2020:21). Rondo was designed to gather data on reentry phenomena and was used to track the ABRES Athena flights. The DR and TTR at LC-38 were used to illuminate targets for Rondo from 1965 to 1970, after which Rondo used the AMRAD to illuminate targets (Missile Ranger 1970; White Sands Missile Range 1971). According to the *Missile Ranger* article:

> Under HAPDAR, the facility's function was to illuminate targets for Athena, Pershing, and other missile firings. After 1965, the facility was used primarily to support ARPA's Rondo radar project and for tracking of other missiles and satellites. For these functions, the operating contractors were Western Electric Co. and the Bell Telephone Laboratories of White Sands [Missile Ranger 1970:1].

In October 1968, operation of the TTR and DR installations was transferred to the ABMDA. In September 1969, the ABMDA halted operation of both the TTR and DR installations. Soon after, in March 1970, it was announced that the LC-38 TTR and DR were to be transferred to the Air Force Range RML, an element of Patrick Air Force Base, Florida (Missile Ranger 1970). The RML planned to update the TTR and DR to "advanced sensor status" and use them "as a research and development facility for state-of-the-art developments in microwave and optics technology" (Missile Ranger 1970:1). However, the RML effort to revamp the DR and TTR appears to have been short-lived. A 1971 summary of the radars in use at WSMR describes the DR and TTR as, "presently being phased out of all activity at WSMR and will be surplused" (WSMR 1971). The radar equipment appears to have been removed from both installations soon after this time (Piland 2007b). When the DR finally ceased operation, the role of Property 23659 as a radar clutter fence also ended.

Like many of the Nike Zeus buildings at LC-38, the DR building had a large shielded room within its interior, and this room was converted to an Anechoic Chamber by the Vulnerability Assessment Laboratory (VAL) during the 1980s. In 1988, the two inner clutter fences around Property 23638 were removed and hauled to the WSMR metal salvage yard (Harris 1988). In 2007, a historical summary of LC-38 mentioned that, "a few years ago, the RF absorbing material inside the Anechoic Chamber caught fire and the chamber was completely destroyed" (Piland 2007b). Sometime after this, Property 23638 was completely demolished, but Property 23659 was left in place. Today, two new buildings have been constructed within the clutter fence (Properties 23653 and 23673). Property 23659 appears to serve as a physical security measure for these buildings. The fence structure was in good overall condition at the time of recording.

7.3.8 Property 23678

Property 23678 is a concrete and steel building constructed in the former Nike Zeus launcher area in the north central portion of LC-38. The property consists of a lower level constructed of concrete, with an upper level that is constructed with a steel frame and corrugated sheetmetal cladding. The building has a distinctive north elevation that is angled at approximately 70 degrees. The north elevation wall is also approximately 2 feet higher than the south elevation. The building has a steeply-pitched shed roof that slopes between the different wall heights, giving the building a distinctive, asymmetric profile when viewed from the east or west.

The building is built along a concrete retaining wall that runs along the north edge of the former Nike Zeus launcher area, north of Properties 23683 and 23688. The retaining wall is associated with a significant grade separation in this area; the ground surface along the north side of the wall is approximately 6 to 8 feet lower than the grade along the south side of the retaining wall. The split-level construction of Property 23678 spans this grade separation, with the south elevation of the building abutting the retaining wall. The concrete lower level of the building is accessible from the north side of the retaining wall, while the upper level is accessible from grade along the south side of the retaining wall. A steel staircase and catwalk are

Figure 125. Property 23678, north and east elevations, view to the southwest.

Figure 126. Property 23678, south and west elevations, view to the northeast.

installed along the building's east elevation, which allows the upper portion of the building to be accessed from the lower grade north of the retaining wall.

The east elevation of the building has a double-leaf entrance with steel slab doors in the lower concrete level, and a single-leaf entrance with a steel slab door in the upper half, which is accessed via the staircase and catwalk. A low concrete buttress extends from the northeast corner of the building, which acts as a low retaining wall for the concrete apron outside the lower east elevation entrance. The north elevation of the lower level is plain, with a catwalk section installed along the base of the wall. This catwalk section is mounted to an electric screw-lift and scissor jack system that allowed it to be raised to a working height along the upper level of the building. When in the raised position, the catwalk was at the same height as the fixed catwalks along the east and west elevations of the building. It appears that the lift equipment remains installed, but is probably no longer operational. The upper part of the north elevation consists of the angled north wall of the steel frame upper level. This distinctive wall originally housed a phased array radar face, but this portion of the wall has been sealed with sheetmetal panels. An upper rail installed on the wall remains in place, which likely originally supported sliding covers for the radar face. A hand-painted sign remains affixed to the lower portion of the north elevation and reads, "CAUTION HAVE KEYS IN POSSESSION BEFORE GOING

Figure 127. Property 23678, north elevation radar array face, view to southeast (*right)*; caution sign on north elevation, view to the south (*left)*.

Figure 128. Property 23678, east elevation, view to the west (*left)*; east elevation lower entrance, view to the southwest (*right)*.

Figure 129. Property 23678, HVAC unit installed at base of west elevation wall, view to the south (*left)*; stenciled property number on base of south elevation, view to the north (*right)*.

IN FRONT OF ARRAY FACE."

A steel catwalk section is also installed on the west elevation along the base of the upper steel wall. The west elevation of the building is plain and lacks fenestration on either the upper or lower level. This catwalk is accessed via a short set of steps from the higher grade along the south side of the building. The upper steel portion of the building extends beyond the lower concrete level along the west elevation. Installed beneath the west elevation catwalk along the lower concrete wall is a large HVAC unit and associated ductwork, along with several electrical boxes and conduits.

A double-leaf entrance with steel slab doors is located in the south elevation. A sheetmetal patch is located in the upper wall of the south elevation, likely covering where ductwork was routed through the wall. Three elevated sections are built into the south edge of the roof, which resemble dormers. These dormer-like sections provide level platforms for the installation of three large HVAC units on the building's roof. The building's roof is equipped with a gutter system with a single downspout installed near the southwest corner of the building. Lightning rods are also installed on the northwest and northeast corners of the roof, which are the highest points of the building.

History of Use

Property 23678 was constructed in 1971 as an "Antenna Support Facility" according to a 1974 WSMR property inventory (WSMR 1974). The building's Form 2877 Real Property Record describes it as an "Elct Eqp Fac" constructed in 1971, and further describes it as an "instrument room with movable platform." The original 1969 architectural plans for Property 23678 identify it simply as an "Antenna Support" (per WS-RK Plan Set). The building was designed by the A&E firm of Kenneth S. Clark of Santa Fe, in cooperation with the USACE Albuquerque District.

Property 23678 housed a prototype phased array radar installation for the SAM-D/Patriot program. In his 2007 LC-38 history article, Doyle Piland describes Property 23678 as, "Just north of the LCB [Property 23680], they built a building that housed the very early version of the [SAM-D] R&D phased array radar. That building remains but is only used for storage, if it is used at all" (Piland 2007b:5). The building's Real Property Record also notes that the property was equipped with a 68,000 BTU refrigeration system, an impressive capacity given that the building only encloses 360 square feet. This is consistent with the building supporting a phased array radar, whose signal generation equipment would have generated a substantial amount of heat. The phased array radar equipment and array face on the north elevation have long been removed from the building. While the building did not appear to be used at the time of the current recording, it remained in good overall condition.

7.3.9 Property 23694

Property 23694 is a freestanding, steel lattice boresight tower constructed of angle steel. According to WSMR realty records, the tower is 150 feet in height and its square base measures 27 feet per side. It is located approximately 150 meters north of the Property 23659 clutter fence. The tower is free-standing and tapers along its height. The tower is constructed mostly of angle steel, with four primary legs of 6-inch wide angle steel anchored to concrete footer foundations with 1 ¼-inch diameter hardware. The tower is built on a slightly elevated and leveled earth and gravel mound. The four primary legs of the tower are supported by an internal network of diagonal braces, which are made of 3 by 5-inch and 2 by 2-inch angle steel stock. An electrical panel is attached to the southeast support leg of the tower, and the panel is illuminated by an overhead light with a green enamel shade. An enclosed access ladder is mounted to the northeast support leg of the tower and provides service access to the tower's upper antenna deck. Located at intervals along the length of the ladder are four small landing platforms, each of which has a small sealed light fixture. At the time of recording, a large raptor nest was visible on each of the landing platforms, and a pair of hawks appeared to be nesting on the tower. A rectangular antenna deck constructed of corrugated steel decking is affixed to the top of the tower, and a single antenna dish is mounted above the deck, which is oriented to

Figure 130. Property 23694, overview of tower, view to the northeast.

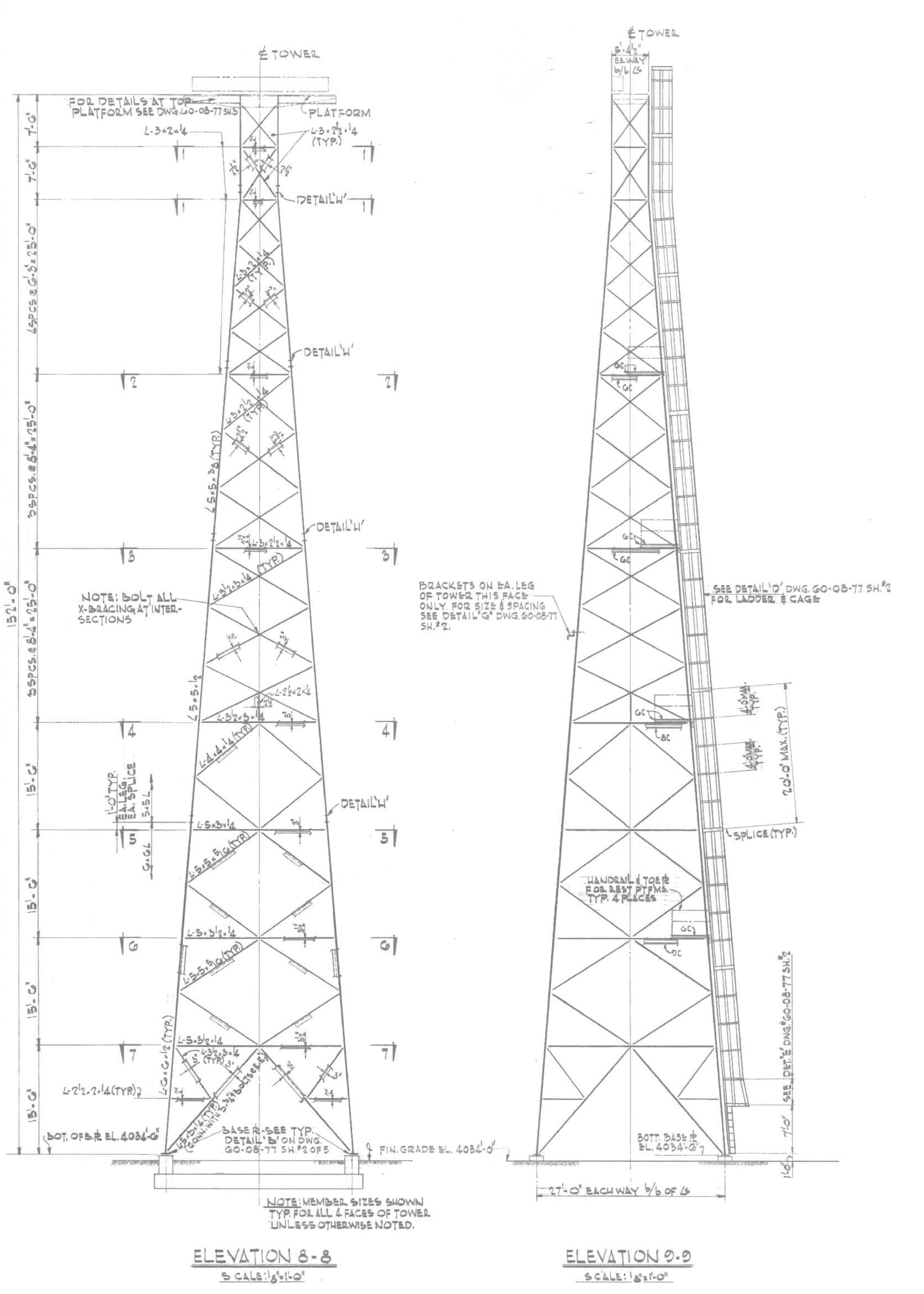

Figure 131. Property 23694, elevation views from 1961 WS-KL plans.

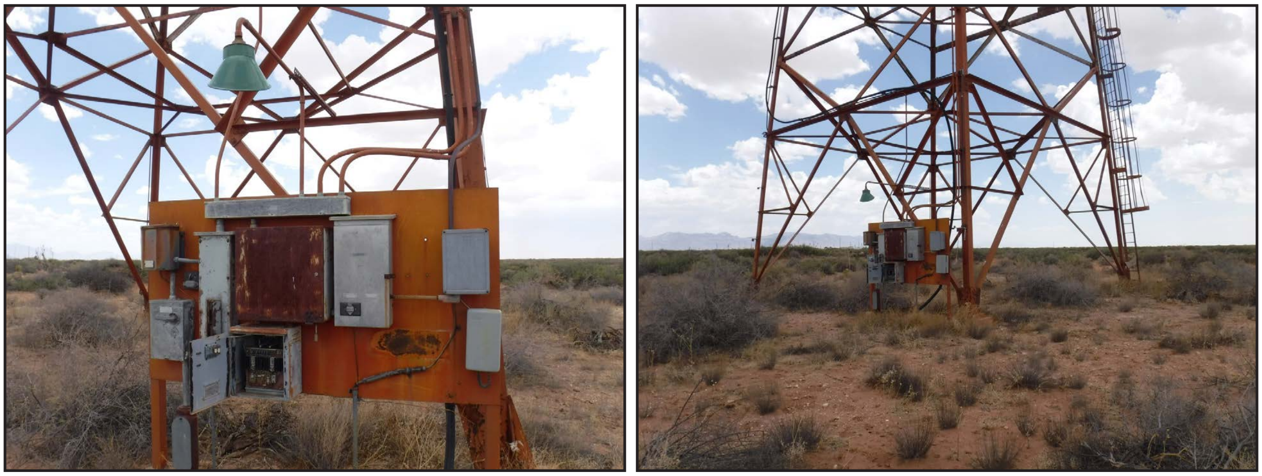

Figure 132. Property 23694, electrical panel on south side of tower base, view to the south (*left)*; view of tower base, view to the north (*right)*.

Figure 133. Property 23694, view of top of tower with antenna dish, view to the north (*left)*; plan view of northwest tower footer, plan view (*right)*.

the south. A detached sheetmetal property ID sign lies on the ground near the southeast tower leg, which (misleadingly) reads "23745." The tower was originally painted in a contrasting red and white color scheme, but the paint has weathered significantly.

History of Use

Property 23694 was constructed in 1961 as the "DR Test Tower" according to a 1963 WSMR property inventory (WSMR 1963). The property's Form 2877 Real Property Record simply describes it as a "Elct Eqp Fac." The original 1961 architectural plans for Property 23694 also describe it as the "D.R. Test Tower" (per WS-KL Plan Set). Property 23694 was designed by the A&E firm of Burns and Roe of New York for BTL, in cooperation with the USACE Albuquerque District.

Property 23694 served as a boresight tower for calibrating the nearby DR radar installation (Property 23638). Similar to optical instrumentation, radar units of the period also required calibration to a known object at a predetermined angle and distance, and boresight towers such as Property 23694 served this purpose. Based on period photographs, the tower is essentially unaltered from its original construction, and does not appear to have been repurposed or modified. The nearby Nike Zeus DR installation supported the Nike Zeus program until 1964, when Nike Zeus transitioned into the Nike X prototype program. The Nike X was an improved version of the ABM system that Nike Zeus had pioneered. Nike X relied on phased array radars, a significant advancement in radar technology that consolidated the functions of the numerous, infrastructure-heavy Nike Zeus radars. As LC-38 transitioned to the Nike X program, many of its technical facilities were re-purposed for other programs (Piland 2007b).

The associated DR at Property 23638 continued to operate with ARPA funding in support of the HAPDAR and the ABRES programs from 1964 to 1969. Property 23694 was likely still used to calibrate the DR during this period, as Property 23638 continued to operate much as it had during the Nike Zeus program. In October 1968, operation of the DR installation was transferred to the ABMDA. In September 1969, the ABMDA halted operation of both the TTR and DR, and the radar equipment was removed from both installations soon after (Piland 2007b). With the cessation of operations and removal of the DR from Property 23638, Property 23694 fell out of use. Sometime after this, Property 23694 was transferred to ARMTE. In 1976, a series of property disposition forms and memos documented plans to disassemble Property 23694 and relocate it to the KMR in the Pacific, since it was no longer used at WSMR (Pender 1976; Pate 1976). However, this effort was obviously never completed, possibly because the Safeguard program was defunded in 1976, which likely impacted operations at the KMR. The tower does not appear to have been used or maintained since the late 1960s, but still remains in good overall condition.

7.3.10 Property 24072

Property 24072 is a large, partially below-grade building located at the east end of Range Road 240 in the east portion of LC-38. The building is located at the center of a circular earthen berm that once supported a clutter fence. The earthen berm is continuous around the building except for a gap at its west side where the building's access drive (a continuation of Range Road 240) passes through. This outer clutter fence, also known as a "pattern shaping fence," had a diameter of 330 feet and a height of 35 feet when it was installed (WSMR 1959:68). The building was also originally equipped with an inner clutter fence, which was much smaller in diameter, running just outside the building footprint. The inner clutter fence was installed at-grade, without the elevated earthen mound. Both of the clutter fences have been completely removed. The alignments of both clutter fences are indicated by torch-cut support posts embedded in continuous concrete footers. Outside the berm of the outer clutter fence, on the north side of the access drive, is a mounded tunnel entrance with a concrete retaining wall that houses the tunnel entrance. The entrance was equipped with a laminated, solid-core wood slab door which has detached from its hinges and is on the ground outside the tunnel entrance. The access tunnel connects to the below-grade portion of the building's west elevation.

Figure 134. Property 24072, west elevation, view to the east.

Figure 135. Property 24072, west and south elevations, view to the northeast.

Property 24072 is of poured, reinforced, concrete construction with two distinctive levels when viewed from the exterior. The above-grade portions of the building are clad in flat sheetmetal panels with soldered seams, identified as “Terne metal shielding” in the building’s architectural plans (Plan Set WS-HZ). Terne is traditionally defined as sheetmetal coated with an alloy of lead and tin to make it corrosion resistant. The lower level is mostly below-grade, with only approximately 24 to 30 inches of its upper walls extending above grade. Installed on the roof of the below-grade portion of the building is an above-grade block, which has a smaller plan than the below-grade portion. The juxtaposition of the upper level on the lower level leaves a large area of the lower level roof exposed on the north and south sides of the building. In its original configuration, the roof of the upper level supported a large radar antenna, but the antenna has been removed. Both the lower and upper level roofs are flat and of gravel-surfaced, built-up construction, and are equipped with grounding systems, gutters, and downspouts.

The building’s primary access is via the west elevation. In its current configuration, the west elevation houses a large, overhead roll-up door that provides direct access to the below-grade portion of the building. The access road angles steeply below grade to the roll-up door, and the sides of the below-grade road cut are stabilized by substantial concrete-clad embankments. The roll-up door is a later addition to the building; a substantial concrete lintel was added to

Figure 136. Property 24072, east and north elevations, view to the southwest.

the west elevation wall above the door as part of the door's installation. In its original configuration, the west elevation was almost entirely below-grade, similar to the opposite east elevation. Visible along the excavated portion of the west elevation is the corroded lower edge of the terne metal shielding panels, visually indicating where this portion of the shielding was once below grade and exposed to ground moisture. To the north of the roll-up door and road cut, at the northwest corner of the building, is a large protruding block of poured, reinforced concrete construction. This block does not have exterior access, but the top of the block has a large, galvanized steel cover that is removable. In the building's original configuration, most of this block would have been below-grade and not visible. The west elevation of the building's upper level has a single-leaf entrance in the south end of the wall, which is hung with a plain steel slab door. The excavation along the building's west elevation left this entrance suspended over a drop of approximately 20 feet; however, the entrance is accessible via a stairwell and catwalk attached to the southwest corner of the building.

The building's south elevation consists of the upper walls of the below grade portion of the building, and the smaller footprint of the upper level. A large section of the lower level roof is exposed along the south side of the building. The south elevation of the upper level is devoid of fenestration, with the exception of a full-height louvered vent panel at the east end of the wall. This vent panel is enclosed behind a large sheetmetal windbreak, which is referred to as a "sand baffle" in the building's architectural plans. At the west end of the south elevation is the steel staircase that provides access to the building's roof, which includes a landing that provides access to the personnel entrance around the corner on the west elevation.

The east elevation of the building is composed mostly of the upper level, with the upper walls of the lower block visible on its north and south ends. Near the middle portion of the elevation is a double-leaf entrance with steel slab doors. This entrance is accessed via a steel landing and steps. An overhead rolling door is located in the south portion of the east elevation; based on architectural plans, this door replaced a louvered vent panel that was originally located in this location. At the north end of the east elevation, a projecting block on the upper level of the building creates a prominent corner. Located outside this portion of the east elevation are a series of concrete footings, two of which support a water-cooling unit. Plumbing from the water-cooling unit is routed through the adjacent portion of the east elevation, and a louvered vent panel is also located in this portion of the wall. The water cooler unit is surrounded by steel pipe bollards and is associated with an electrical supply switch and conduits. Located outside the east elevation are several large steel panels of ¾-inch steel plate, measuring approximately 10 by 10 feet. One of these plates has a heavy-duty attachment point for lifting. Outside the east elevation is the foundation for the inner clutter fence access gate.

The building's north elevation consists of the upper walls of the below grade portion of the building, and the smaller footprint of the upper level, which includes a pro-

Figure 137. Property 24072, sheetmetal vent shroud, east end of south elevation, view to the northwest.

Figure 138. Property 24072, overhead rolling door on west elevation, view to the east.

Figure 139. Property 24072, steel plate box covering on top of west elevation block, view to the southeast.

jecting block. A large section of the lower level roof is exposed along the north side of the building. The north elevation is devoid of fenestration, with the exception of a louvered vent panel near the middle of the wall.

History of Use

Property 24072 was constructed in 1959 as the "ZAR Transmitter Bldg" according to a 1963 WSMR property inventory (WSMR 1963). The building's Form 2877 Real Property Record describes it as an "Elct Eqp Fac" that enclosed 36,441 square feet, and gives 1960 as the construction date. The original 1958 architectural plans for Property 24072 identify it as the "LAR Transmitter Building" and states that the plans were updated "as-built" on December 9, 1959 (per WS-HZ Plan Set). The building was designed by the A&E firm of Burns and Roe of New York for BTL, in cooperation with the USACE Albuquerque District.

The Nike Zeus prototype system at LC-38 relied on an array of radars similar to those used in the predecessor Nike Ajax and Nike Hercules, but the Nike Zeus radars were much larger and more powerful. The Nike Zeus system also incorporated the new DR installation. Targets for the Nike Zeus were initially acquired by the long-range ZAR (also sometimes identified as the LAR). Unlike most Nike radars, the ZAR was split into separate installations for the receiver, which was installed at Properties 24062 and 24064, and the transmitter, which was installed in Property 24072. Once the ZAR identified a target, it processed its position data and passed it to the DR (Property 23638) and control computer at the BCB (Property 23640) for further processing and analysis. The rest of the target engagement was managed by the DR, TTR, and MTRs

Figure 140. Property 24072, detail of concrete footer and torch-cut posts from removed clutter fence, view to the south.

Figure 141. Property 24072, tunnel entrance and detached door, view to the southeast.

Figure 142. Property 24072, view into access tunnel, view to the east.

through the processing equipment within the BCB. The role of the ZAR was primarily limited to long-range detection and tracking of potential targets for the system.

Property 24072 is described in a 1959 summary of the WSMR Nike Zeus facilities as:

> This building is a three-level structure of reinforced concrete and masonry block construction 140 by 101 feet. The floor of the lowest level is 27 feet below grade. The second floor has a main floor that is fifteen feet below grade with a balcony section at one end which is nine feet below grade. The floor of the third level is three feet above grade. The roof level is 14 feet above grade [WSMR 1959:68].

The summary of the Nike Zeus facilities goes on to describe how the radar equipment was installed within the building:

> This building houses the high-power transmitter and associated equipment. The lowest level contains the major cooling system components, transformer and rectified values, capacitor banks and switch gear. The second level houses the I.P.A., H.P.A. transmitter control center and the associated cabinets and control consoles. The third level houses a traveling crane, air intake and exhaust room, and antenna drive equipment. The transmitter antenna is located on the roof [WSMR 1959:68].

During the period of Nike Zeus testing, the outside access tunnel was the primary means of personnel access into the building because of the clutter fences. This was similar to the arrangement used at the DR installation (Property 23638). The ZAR transmitter antenna on top of the building was a flat, triangular shape that actually incorporated three antennas that were separated by 120 degrees and rotated on a single axis (Glenn Montgomery, quoted in Piland 2007a). Architectural plans indicate that a "corrugated cement asbestos wind fence" was installed around the base of the antenna on the roof of the building (Plan Set WS-HZ).

Property 24072 was used in support of the Nike Zeus program until 1964, when Nike Zeus transitioned into the Nike X program. The Nike X was an improved version of the ABM system that Nike Zeus had pioneered, and relied on the new MAR, a significant advancement in radar technology that consolidated the functions of the numerous, infrastructure-heavy Nike Zeus radars. As LC-38 transitioned to the Nike X program, many of its technical facilities were re-purposed for other programs (Piland 2007b). The ZAR receiver and transmitter apparently ceased operation as the Nike Zeus program transitioned into the Nike X program. The west elevation of the building's lower level was exposed and modified with the access drive and overhead rolling door in 1969, according to property records. The clutter fences appear to have been removed as part of this project as well. A request for sealed bids for the removal and scrapping of the ZAR transmitter antenna was issued in March 1971. According to the bid request, the antenna measured 100 feet per side and was estimated to weigh 600,000 pounds, including its drive motors and related gear (DOD 1963).

The building was used for a variety of purposes after the end of the Nike Zeus program, including a "small helicopter drone program" during the 1980s (Piland 2007b:5). At the time of the current recording, a sign for the "Program Executive Office for Simulation, Training, and

Instrumentation [PEO STRI] Aerial Target Operations" was attached to the building's exterior, but it did not appear to be recently used or maintained. The building's exterior sheetmetal cladding is very oxidized, giving the building a rough appearance. However, it is actually in good condition and structurally sound despite the lack of recent exterior maintenance.

7.3.11 Property 24078

Property 24078 is an elevated earthen mound that is located to the northeast of the former ZAR receiver building (Property 24064, now demolished). The earthen mound stands approximately 8 to 10 feet above grade and is approximately 40 by 40 feet at its top. Eight 12 by 12 inch concrete footings are installed across the top of the mound, along with two larger 30 by 30 inch concrete footings. Concrete debris is also scattered across the top and sides of the earthen mound. The concrete footings do not appear to have any embedded hardware or anchor attachments. The mound has eroded substantially and is partially covered with vegetation.

History of Use

Property 24078 was constructed in 1959 as a "Track Radar" according to a 1963 WSMR property inventory (WSMR 1963). The property's Form 2877 Real Property Record describes the property as the "TTR Antenna Base." Property 24078 was constructed to support a modified Nike Hercules radar installation that was apparently part of the equipment used to calibrate the ZAR early in the operation of the Nike Zeus system at LC-38:

Figure 143. Property 24078, overview from base of earthen mound, view to the north.

> On 12 November 1959, H.B. Zachary & Company of San Antonio, Texas, under a $30,380 contract, began to construct the AIL facilities, which consisted of a 2,000-foot compacted earth runway, a small aircraft hangar, and pads for various Hercules radars and instrument vans [Stevenson et al. 1961:57].

Figure 144. Property 24078, remnant concrete footings on top of the mound, view to the west.

These facilities were for the AIL, which was a special aircraft outfitted with radar instrumentation used to calibrate the ZAR receiver and transmitter. The ZAR calibration work with the AIL was completed by mid-1960 (Stevenson et al. 1961:70). WSMR disposition records note that Property 24078 was reassigned in 1963, and the property appears to have remained unused after this time (Larson 1963). The property was associated with another temporary radar installation (Property 24077), but it appears that Property 24077 has been demolished. The modified Nike Hercules radar has long been removed from Property 24078, and it does not appear that the earthen mound was re-used after the early 1960s. Due to weathering and erosion, the property is in poor overall condition.

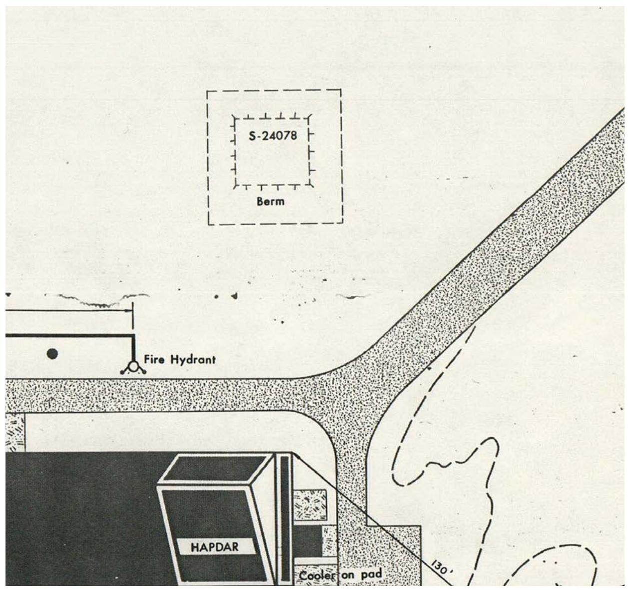

Figure 145. Property 24078 as indicated on 1971 map (*adapted from WSMR PE-GM-2607)*.

7.4 Missile Assembly and Checkout Facilities

Missile assembly and checkout buildings were constructed at LC-38 in support of Nike Zeus testing beginning in 1959, and nearly all of these facilities remain in use today. Property 23626 was the major assembly building at LC-38, and supported the Nike Zeus, Spartan, Sprint, and SAM-D programs. Hazardous assembly and storage facilities (Properties 23654, 23655, 23656, and 23660) were constructed in the west-central part of the complex in support of the Nike Zeus, and were also used in support of later programs.

7.4.1 Property 23626

Property 23626 is a large assembly building located in the south-central portion of LC-38, just north of Nike Avenue. Property 23626 is a large steel frame and CMU building with a rectangular footprint constructed on an above-grade concrete foundation. The building consists of a high-bay assembly wing with lower one-story wings along both the north and south elevations. The original portion of the building consists of the central high-bay assembly wing and the lower office wing along the north elevation. The high-bay portion of the building is of steel frame wall construction while the north office wing is constructed of CMUs. The exterior

Figure 146. Property 23626, overview of east and north elevations, view to the southwest.

of the high-bay assembly wing is clad in corrugated cement asbestos (sometimes known as transite) panels. The lower wings along the south elevation are a series of additions of both CMU and steel frame construction, and house office and laboratory space. The entire building is surrounded by a chainlink fence that also encloses a storage yard area along the north and west sides of the building.

The principal elevation of the building is the east elevation, which faces Range Road 239 and houses the main entrance to the building. The east elevation is formed by the east walls of the high-bay assembly wing and north office wing. A double-leaf bay door entrance is located in the high-bay assembly wing, with sheetmetal doors with horizontal sliding operation. A single-leaf personnel door entrance is located to the south of the bay doors, which is hung with a steel slab door with a narrow upper light. One of the cement asbestos panels is missing from the upper wall of the high-bay wing on this elevation. The CMU office wing abuts the north side of the high-bay wing, and includes a recessed entry area along its east elevation. Within the recessed entry area is a single-leaf entrance into the high-bay wing that is equipped with a steel slab door. Just north of the recessed entry area is a single-leaf entrance into the north office wing, which is hung with a steel slab door with a square upper light. Above this entrance is a sign reading "Raytheon." Outside the east elevation of the office wing is a landscaped area with a mature shade tree.

The north elevation is formed by the upper wall of the high-bay wing and the north wall of the lower CMU office wing. The entire central part of the office wing's north elevation wall is slightly recessed beneath the eave of the wing's built-up

Figure 147. Property 23626, north elevation and shipping containers, view to the southeast.

Figure 148. East and north elevations of Property 23626A addition, view to the southwest.

Figure 149. Property 23626, connecting corridor between 23626A addition and main building, view to the east.

shed roof. Attached to the north elevation of the office wing via a short corridor is a pre-manufactured steel building mounted on a substantial steel skid foundation. A series of shipping containers are also parked outside the north elevation of the office wing, which limited its visibility. A curbed landscaping area is located along the base of the north elevation wall, and a single-leaf entrance is located near the middle of the wall, which is hung with a steel slab door with a narrow upper light. A steel roof access ladder is mounted to the wall near this entrance. A series of windows are located along the north elevation of the office wing, including both original and replacement units. Three replacement windows are located in the west end of the office wing wall, while six original windows remain in the east portion of the wall. The original windows are paired installations of steel, 4-light windows with awning operation of the middle 2-light panels and hopper operation of the lower lights. One of these original windows has been truncated by the connecting corridor that connects to the portable pre-manufactured building. At the far east end of the office wing's north elevation is a ribbon window set in the upper wall, probably associated with an interior restroom. The ribbon window consists of six individual windows, each with six lights, awning operation, and opaque glass. All of the windows on the office wing have protruding concrete sills. Outside the north elevation, near the northwest corner of the building, are two HVAC units mounted on a raised concrete slab foundation.

The portion of the north elevation formed by the high-bay portion of the building hosts an impressive bank of clerestory windows in its upper wall; based on the original architectural drawings (Plan Set WS-GZ), this bank of clerestory windows

Figure 150. Property 23626, replacement windows along north elevation of CMU wing, view to the southeast.

Figure 151. Property 23626, original windows along north elevation of CMU wing, view to the south.

Figure 152. Property 23626, west elevation, view to the southeast.

consists of 86 individual window units. These windows provided both natural lighting and ventilation in the high-bay assembly wing. A steel roof access ladder is attached to the west end of the wall, providing access to the roof of the high-bay wing.

The pre-manufactured steel frame building connected to the north elevation of the office wing is signed as Property 23626A, but basically serves as an addition to the main building. The walls of the building are clad in ridged sheetmetal panels, while the low-pitch gable roof is clad in standing seam sheetmetal. The building lacks any manufacturer branding or identification. The building's east and west elevations are generally identical in layout. Both elevations have a single personnel door located at the south end of the wall. These entrances are equipped with steel doors that have large upper lights. Both of these entrances are sheltered by shallow sheetmetal surrounds that act as entry porches. A set of steel steps provides access to both entrances, which are elevated above grade due to the building's tall I-beam skid foundation. Both elevations are equipped with three aluminum sliding windows, and two additional windows of the same type are located on the building's north elevation. An HVAC unit installed on a cantilevered steel mount is attached to the north elevation wall between the two windows. The south elevation has one identical window next to the corridor connection to the main building. The corridor connection to the main building appears to be of wood construction and is clad in asbestos cement shingles.

The west elevation is formed by the west walls of the high-bay assembly wing and north office wing. Identical to the east elevation, a double-leaf bay door entrance is located in the high-bay assembly wing,

Figure 153. Property 23626, north elevation of middle, steel frame addition outside west elevation, view to the southeast.

Figure 154. Property 23626, south and east elevations of original south addition, view to the northwest.

Figure 155. Property 23626, window and entry detail of original south addition, west end of wall, view to the northwest.

Figure 156. Property 23626, south and east elevations, view to the northwest.

and is equipped with sheetmetal doors with horizontal sliding operation. A single-leaf entrance is located north of the bay doors, which is protected by a windbreak of steel frame and corrugated sheetmetal construction. The south portion of the high-bay wall is abutted by a steel frame addition that is a continuation of an addition on the south elevation. The west elevation of the north CMU office wing houses two entrances. A double-leaf entrance with steel faux-panel doors is located near the north part of the wall, above which is a large louvered vent panel. A single-leaf entrance with a steel faux-panel door is located near the junction with the high-bay wing. A sealed vent panel is located above this entrance. The high-bay wing extends slightly further west than the CMU office wing, creating a corner where the two wings meet; in this corner a shed roof equipment shelter has been constructed for a scissor lift. Just outside the office wing's west elevation is a fenced electrical sub-station.

The south elevation is formed by the south wall of the high-bay wing and a series of one-story additions along the west end of the south elevation. A series of ribbon windows is located in the lower wall of the high-bay wing, some of which are original units and some are modern replacements. The original windows are steel, 6-light units that appear to be fixed in place. Many of the original windows have been replaced with modern windows, or have lights replaced with sheetmetal, or have HVAC units routed through them. The upper wall of the high-bay wing is clad in asbestos cement panels and lacks the clerestory windows of the north elevation. A modern portable steel pre-manufactured building mounted on wood planks is located outside the south elevation, as is a modern shade structure. A one-story addition of CMU construction occupies the west half of the south elevation. This addition has a lower, shed roofline that extends from the wall of the high-bay wing, and the roof eave extends over the south elevation of the addition, which has a corresponding concrete walkway. The south elevation of the CMU addition has three single-leaf entrances spaced along the length of the wall. Each of the entrances is hung with a plain steel slab door and has a sealed transom above the door. Additionally, three groupings of windows are interspaced with the entrances along the south elevation. Each of the window groupings is formed by large, fixed steel frame windows, each with 24 small rectangular lights. The east grouping associated with the east entrance is formed by three of the 24-light windows. The other two window groups, located near the middle and west ends of the addition's south elevation, are formed by four of the 24-light windows. Some of the windows have been boarded over with sheetmetal or plywood, and several have conduits routed through them from mini-split A/C units located outside the south wall on the concrete walkway.

Extending from the west end of the CMU addition are two more additions, which extend past the west elevation of the main building. Both of these additions are of steel frame construction and clad in corrugated sheetmetal, and are generally much more utilitarian than the CMU addition. The addition that directly abuts the CMU addition has a low-pitch gable roof and is constructed on an above grade concrete foundation. This addition wraps around onto the west elevation of the high-bay wing. Several fixed windows are located in the upper wall of its south elevation. The western addition is of more recent construction, and its exterior is clad in tan sheetmetal. This addition is also constructed on an above grade concrete foundation and has a shed roof that slopes west from the middle addition. A louvered vent panel and ductwork from an evaporative cooler are located along the south elevation of this addition, which is otherwise devoid of fenestration. The west elevation of this addition is plain and lacks fenestration. The two steel frame additions extend beyond the west elevation of the main building and form a separate wing along the west end of the building. The north elevation of this addition wing houses a bay door and two single-leaf entrances with steel slab doors. A shed roof lean-to is also attached to the north elevation of the addition wing, under which a variety of equipment and materials are stored.

A variety of equipment, portable buildings, trailers, and vehicles are located on the east, west, and north sides of the building within the fenced enclosure that surrounds the property lot. The portable buildings within the fenced enclosure that appear to be of historic construction are described separately.

History of Use

Property 23626 was constructed in 1959 as "Assembly Building 16" according to a 1963 WSMR property inventory (WSMR 1963). The designation as Missile Assembly Building (MAB) 16 appears on many period documents related to the building. The origin of the specific MAB designation and sequential numbering is unknown. It appears to have been applied sometime in the late 1950s and applied to mostly existing facilities, and ended sometime during the early 1960s. While the building's Form 2877 Real Property Record simply describes it as a "GM Fa-

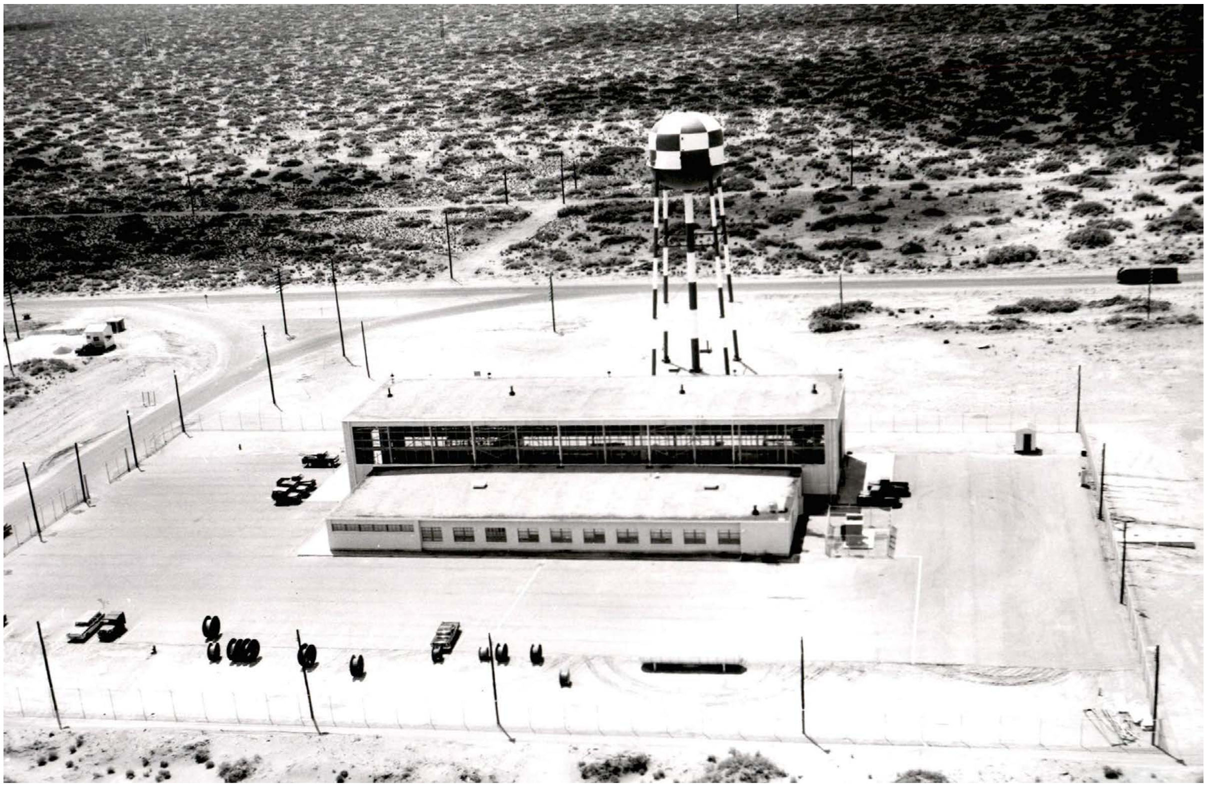

Figure 157. Photograph of Property 23626 taken soon after it was completed, circa 1959 (*courtesy WSMR Museum Archives)*.

cility," its original 1958 architectural plans also identify it as "Missile Assembly Building No. 16" (per WS-GZ Plan Set). The building was designed by the A&E firm of Kenneth S. Clarke and Philippe Register of Santa Fe, in cooperation with the USACE Albuquerque District.

Property 23626 was constructed in support of the Nike Zeus program at LC-38. The building is described in a 1959 summary of the WSMR Nike Zeus facilities as:

> This facility is constructed of structural steel, masonry block, and corrugated asbestos siding. The overall dimensions are 113 by 190 feet. This building includes a high-bay assembly area, laboratory space, and engineering office space. The building is enclosed with an 8-foot chain link fence with perimeter flood lights. The building is used to house the Army Missile Project and also serves as a facility for field modification or repair of missiles, missile system components and instrumentation, and fabrication of materials used in the installation of Nike Zeus equipment [WSMR 1959:7].

In its original configuration, the building housed the assembly area in the high-bay portion of the building, which was equipped with a network of cable trenches and a bridge crane. The low bay north wing was divided into a double row of smaller rooms divided by a central corridor. The rooms in this part of the building included laboratories, a stock room, mechanical room, electrical room, administrative office, engineering offices, a drafting room, and a conference room.

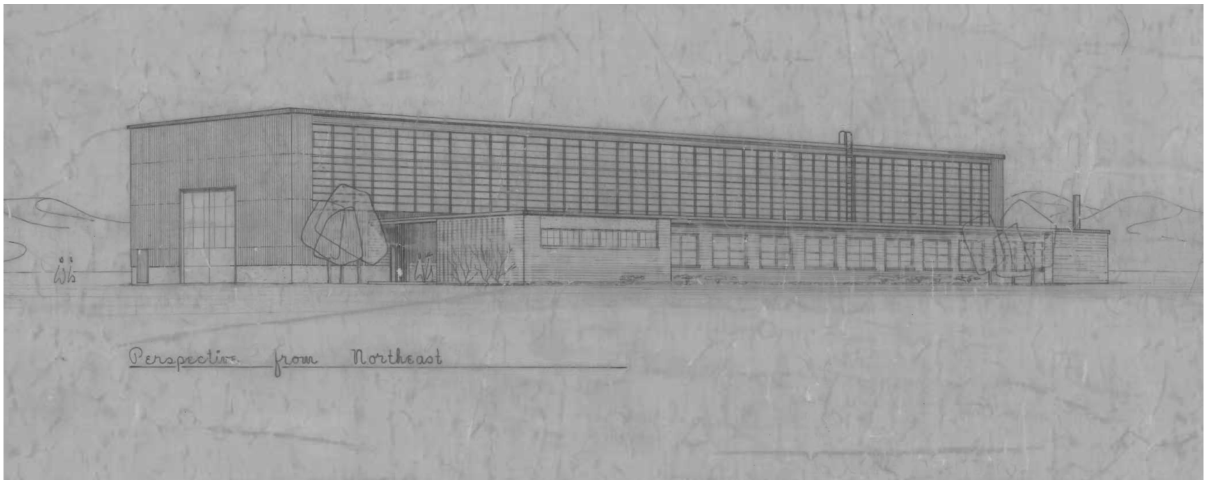

Figure 158. Conceptual drawing of Property 23626, circa 1959 (*courtesy WSMR Museum Archives)*.

Figure 159. Photograph of Properties 23626 and 23627 taken soon after both were completed, circa 1959 (*courtesy WSMR Museum Archives)*.

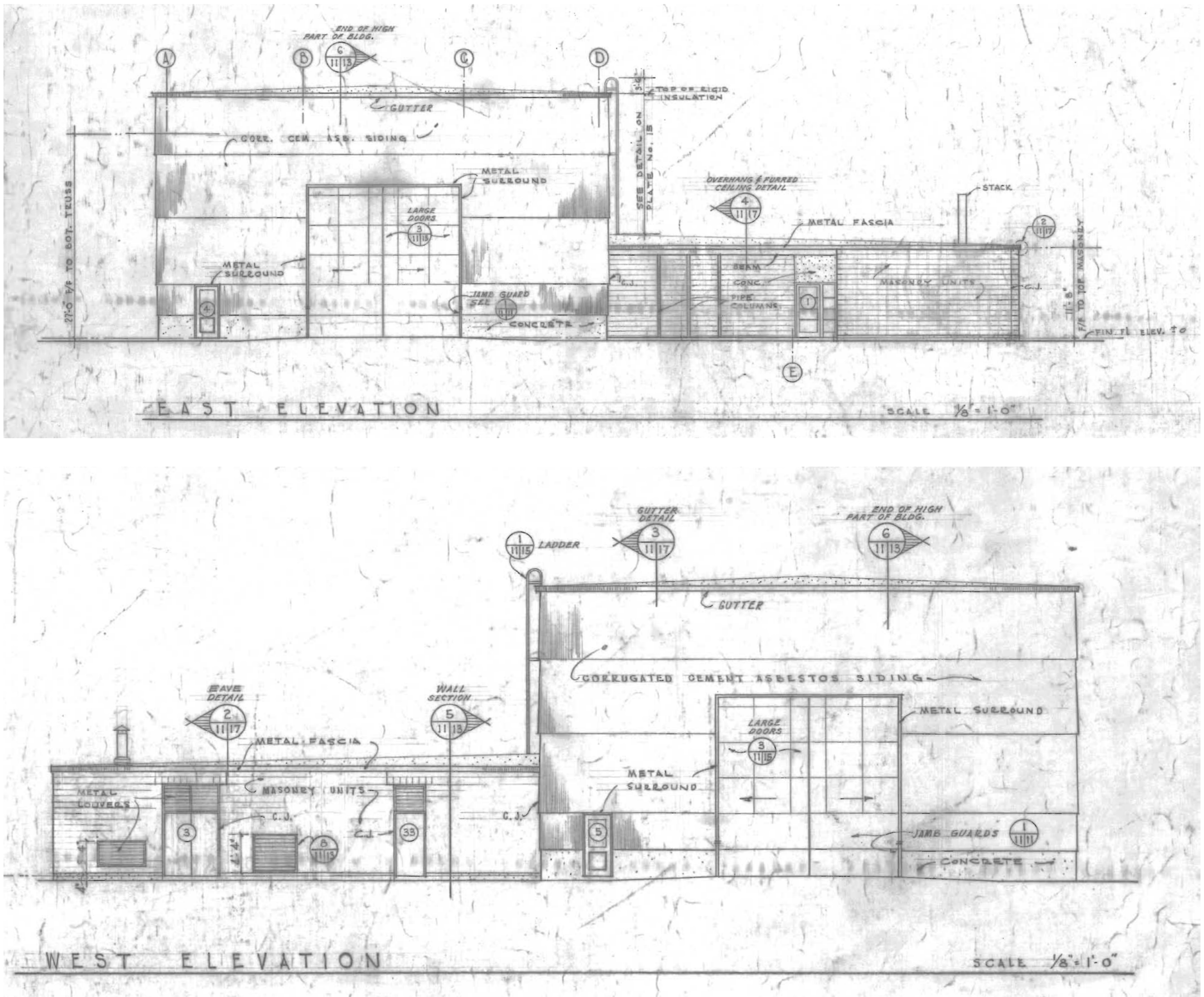

Figure 160. Property 23626, east and west elevations from 1958 WS-GZ plans.

In 1961, the first of several additions was made to the building when the CMU addition along the south elevation was added to house a training school. The addition, which measures approximately 78 feet by 25 feet, originally housed two classrooms separated by a central office space. This classroom space addition was assigned to BTL until 1968, when it was reassigned for use by the Army. Around the same time, it was requested for use by Ryan Aeronautical Company, which was denied. In 1970, the space was requested for use by SAM-D (Patriot) contractors Raytheon and Martin/Orlando.

By the late 1960s, the DOD side of the Safeguard program was known as the Safeguard System Evaluation Agency (SAFSEA). SAFSEA was the primary occupant of Property 23626 until the late 1960s, when the occupancy of the building gradually shifted towards the SAM-D program as the work on the Safeguard missile program ended. In 1969, a request was filed to reassign the former SAFSEA office within MAB 16 to the SAM-D program (Billups 1969). The classroom facilities on the south elevation of the building were assigned to Raytheon and Martin/Orlando engineers in 1970 (Ferdig 1970). In 1976, disposition records note that an Army field

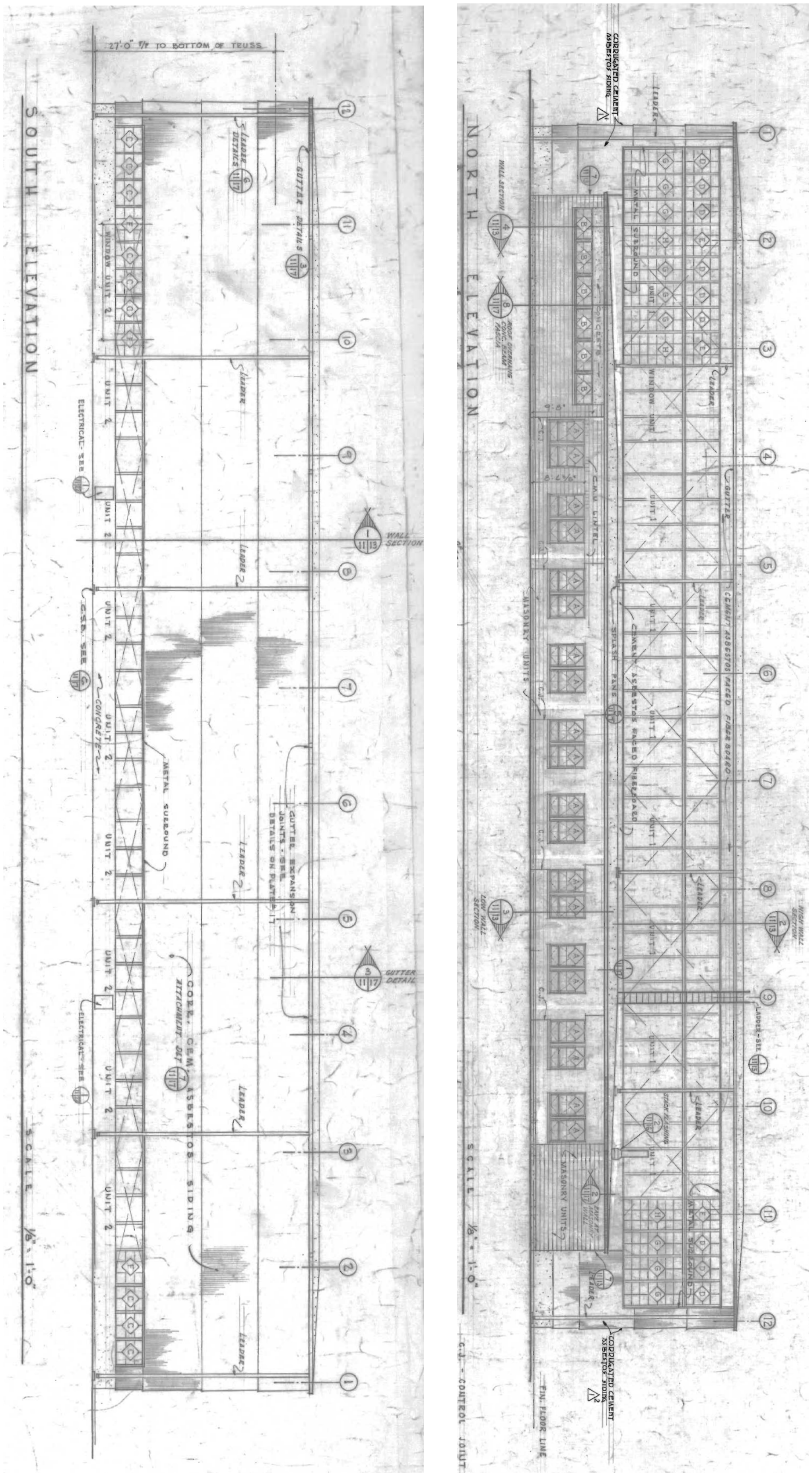

Figure 161. Property 23626 north and south elevations from 1958 WS-GZ architectural drawings.

office for the Patriot missile program was established within Property 23626. This is the first time the "Patriot" name appears in the building's property records, which was previously referred to as the SAM-D program (Donner 1976). The same records also note that Property 23626 was primarily used as administration space by Raytheon, who was the prime contractor for the Patriot missile program.

Two additions were made to MAB 16 during the 1970s, likely related to the Patriot/SAM-D missile development. The pre-manufactured steel frame building (Property 23626A) was added to the north elevation of the building sometime around 1973 according to property disposition records, although there is a discrepancy in the stated dimensions. The first addition to the existing CMU classroom addition on the south elevation was likely added during the 1970s. These additions further altered the original linear building footprint into its current irregular plan.

Although realty records after the late 1970s are not on file, it is well-documented from other sources that Property 23626 continued to be used by Raytheon through the remainder of the Cold War in support of the Patriot missile program. The building continues to be used today by Raytheon, primarily as an administrative facility (Piland 2007b). At the time of the recording, Property 23626 was in good overall condition and well-maintained.

7.4.2 Property 23654

Property 23654 is a one-story magazine structure constructed of reinforced concrete, earthen fill, and what the architectural plans identify as concrete “cribbing.” Cribbing generally consists of timbers stacked in a square or rectangular pattern, and is often used for supporting heavy objects (i.e., leveling or lifting a building) or building retaining walls and buttresses. The exterior cribbing used for Properties 23654 and 23656 consists of stacked square concrete panels that are filled with earth. These cribbed wall sections serve as retaining walls for the earthen fill that covers the top and sides of the structure. The core of the structure is formed by three separate bays constructed of reinforced concrete, each of which is 40 feet long, 16 feet wide, and 16 feet high. The concrete walls of the bays are 15 inches thick, with 16-inch thick reinforced concrete roofs. The concrete slab roof of each bay incorporates a concrete parapet, approximately 4 feet in height, along the north and south elevations, which acts as a retaining wall for the earthen fill applied to the top of the structure. The concrete slab roof of each bay also includes a waterproof membrane topped by ½-inch thick fiberboard, along with a centrally-located ventilator. A 16-foot thick dividing section of earthen fill separates each of the three bays. Earth-filled concrete cribbing panels are stacked between the exterior walls of the interior concrete bays, retaining the earthen fill between the bays. Earthen fill is also piled across

Figure 162. Property 23654, south and east elevations, view to the northwest.

Figure 163. Property 23654, north and west elevations, view to the southeast.

the top of the bays to a depth of approximately 3 feet, forming the "roof" of the structure. The earthen fill across the top of the structure is extended down to ground level, forming ramps on the east and west sides, which are supported by retaining walls formed by the structure's exterior concrete cribbing.

When it was originally constructed, each of the three explosive storage bays was equipped with overhead rolling bay doors on the north and south elevations of the structure. Through time, some of the rolling doors have been replaced or modified. The south elevation is formed by three reinforced concrete wall sections associated with the storage bays, separated by sections of earth-filled concrete cribbing that retain the earthen fill between the concrete bays. The exterior concrete cribbing steps down along the east and west ends of the south elevation to support the earthen ramps that form the east and west elevations of the building. The east bay entrance on the south elevation has been modified with a replacement steel wall section that houses both an overhead rolling door and a single-leaf entrance with a steel slab door. The middle bay on the south elevation retains its original overhead rolling door that includes a single-leaf entrance in the lower right corner of the rolling door. This single-leaf entrance is hung with a steel faux-panel door with a large upper light. Steel bollards located outside the door protect the edges of the door from vehicles. The west bay on the south elevation has been modified with a large sheetmetal housing that houses ventiliation equipment. A large vent housing attached to the top of the sheetmetal housing extends above the roofline of the structure. Property records indicate that this large sheetmetal ventilation housing was added when the west storage bay was converted to a paint booth during the late 1970s. Conduits are routed along the upper wall the length of the south elevation, and a variety of electrical boxes and conduits are located along the wall as well. Signage on the east part of the south elevation reads “PAC-2 MISSILE ASSEMBLY BAY BLDG 23654” and describes the explosive and personnel limits of the building.

The north elevation is generally similar to the south elevation. Like the south elevation, it is formed by three reinforced concrete wall sections associated with the explosive bays, separated by sections of concrete cribbing retaining wall sections. The exterior concrete cribbing steps down along the east and west ends of the south elevation and supports the earthen ramps that form the east and west elevations. Like the south elevation, the north elevation originally included overhead rolling bay doors for each of the explosive storage bays. The west and middle bays retain their original rolling bay doors, which include single-leaf entrances added to the lower right corner of each door. Steel bollards are located outside both of these bay door entrances. The east bay on the north elevation has the rolling door entirely removed, and the opening enclosed with corrugated sheetmetal. Just outside the sealed door opening is an elevated steel platform that supports a large HVAC unit. Ductwork from the HVAC unit is routed through the adjacent portion of the sheetmetal wall that encloses the former bay door opening. An array of electrical

Figure 164. Property 23654, east bay entrance area on south elevation, view to the north.

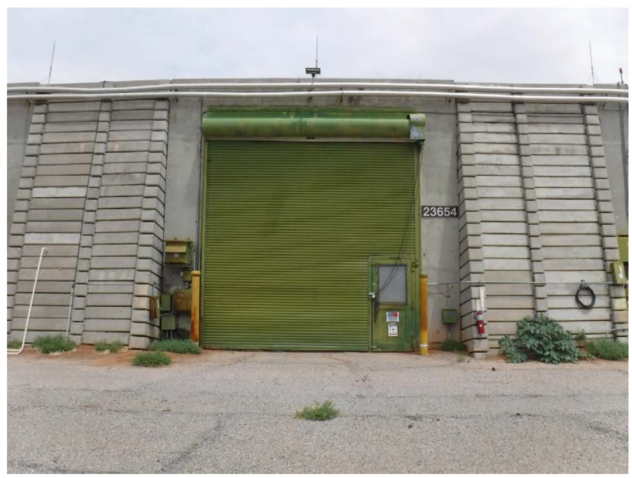

Figure 165. Property 23654, middle bay entrance area on south elevation, view to the north.

Figure 166. Property 23654, large ventilation unit installed on south bay of south elevation, view to the north.

Figure 167. Aerial photograph of Properties 23654 (*right*) and 23656 (*left*) taken in 1959 (*courtesy WSMR DPW*).

switches, fuse boxes, and conduits is mounted to the sheetmetal wall below the steel HVAC platform. While the door has been removed and the opening enclosed, the original protective steel bollards still remain outside the east bay.

The east and west elevations of the structure are formed by the earthen ramps that extend down from the roofline to ground level, flanked by the concrete cribbing along the north and south elevations. These slopes are clad in gravel for stability and erosion prevention, and vegetation has taken root along the east and west elevations and across the top of the structure.

History of Use

Property 23654 was constructed in 1959 as the "Live Storage Bay" according to a 1963 WSMR property inventory (WSMR 1963). The building's Form 2877 Real Property Record describes it as a "GM Facility" that enclosed 1,944 square feet. Although the structure appears larger from the exterior, much of it is actually composed of earthen fill. The original 1958 architectural plans for Property 23654 identify it as the "Live Storage Bay" (per WS-IA Plan Set). The building was designed by the A&E firm of Burns and Roe of New York for DAC and BTL,

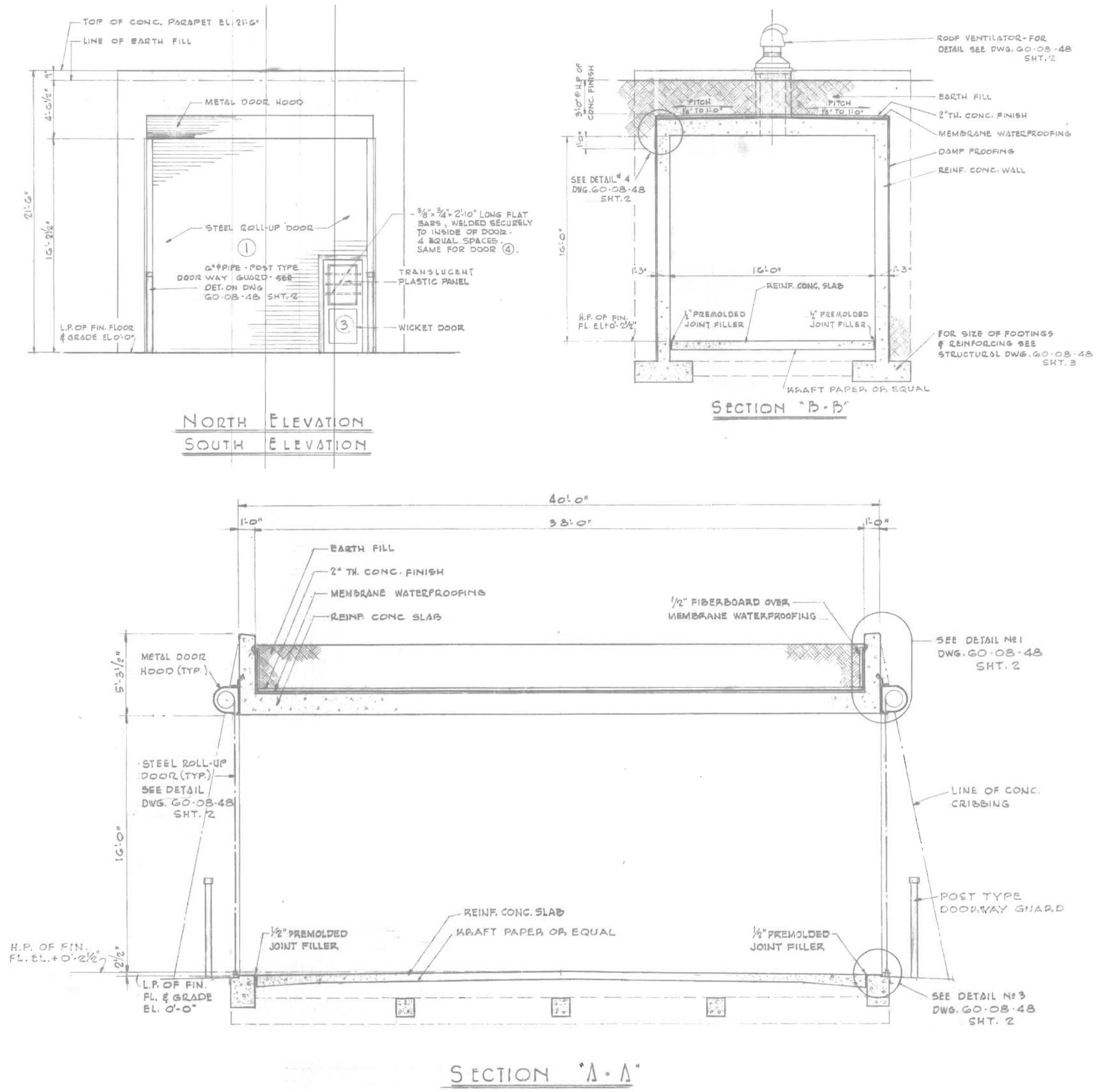

Figure 168. Property 23654, bay north elevation and section view from 1959 WS-IA plans.

in cooperation with the USACE Albuquerque District. The structure is described in a 1959 summary of the WSMR Nike Zeus facilities as:

> This area is composed of three storage bays each 40 feet long, 16 feet wide, and 16 feet high. The walls, floors, and ceilings are reinforced concrete. Earth fills 16 feet thick are used between each bay. This area is used to store completely assembled missiles, less boosters, until they are required at the launch area [WSMR 1959:27].

Property 23654 was used in support of the Nike Zeus program until 1964, when Nike Zeus

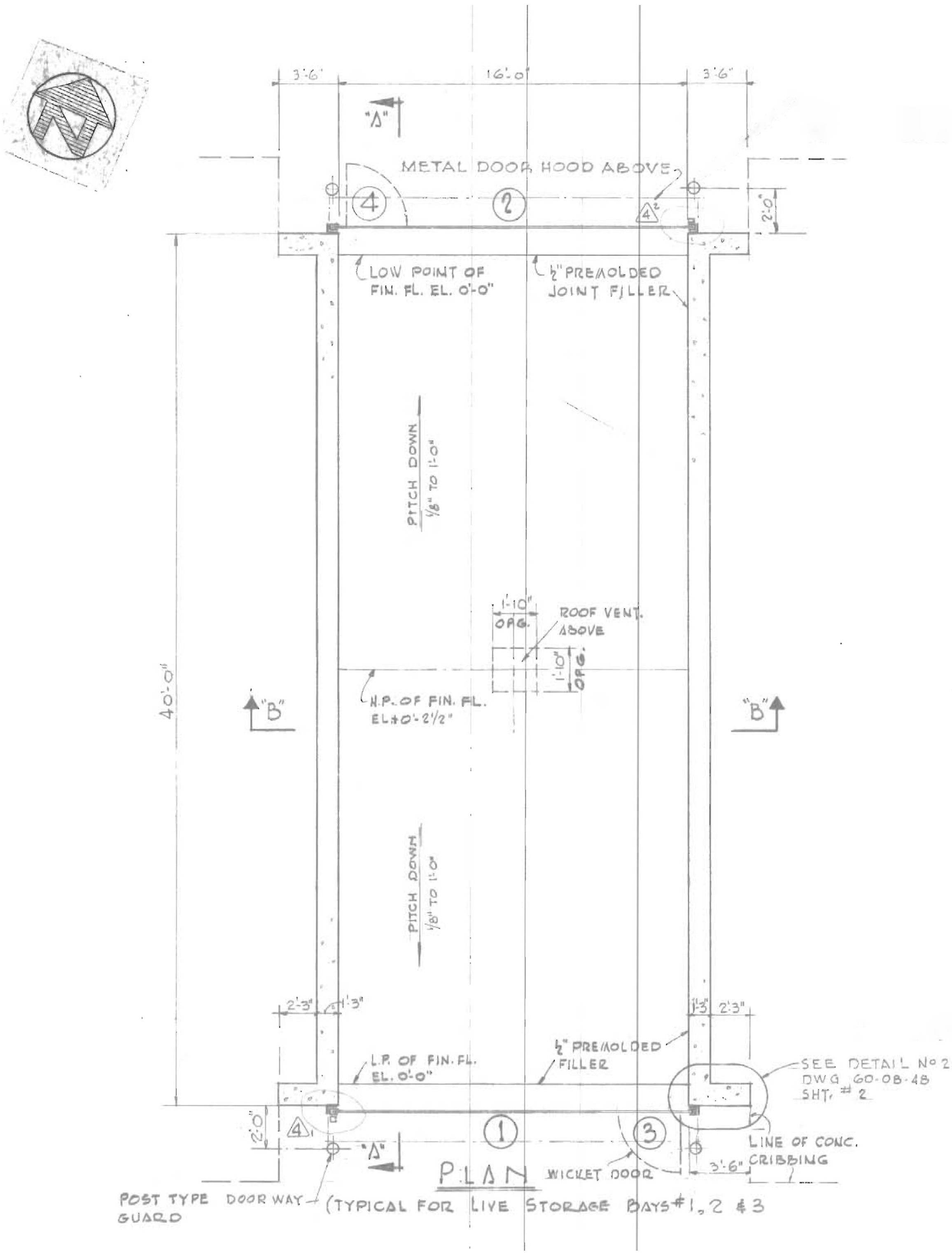

Figure 169. Property 23654, bay plan view from 1959 WS-IA plans.

transitioned into the Nike X program. Property 23654 remained assigned to BTL after the end of the Nike Zeus testing and was used in support of the Sprint missile program, as was the neighboring Property 23656. The Sprint missile testing at WSMR ended in August 1970, and the assignment of Properties 23654 and 23656 to BTL was terminated in October 1970 (Field 1970; Piland 2007b). Concurrent with the termination of the BTL assignment, both Properties 23654 and 23656 were assigned to the SAM-D program, which became the Patriot program. The west explosive storage bay was converted into a paint spray booth in 1978, which included the addition of the large ventilation assembly on the south elevation of the bay. Today both properties continue to be used by Raytheon for the Patriot PAC-2 missile. At the time of the current inventory, Property 23654 was in good overall condition and generally well-maintained.

7.4.3 Property 23655

Property 23655 is a small, one-story CMU building located west of Property 23655 within the former Nike Zeus Assembly and Storage Area. The building has a square footprint and is constructed atop an elevated concrete slab foundation. The building has a flat concrete slab roof that extends over the walls about 6 inches on all elevations; the roof is supported by a continuous concrete bond beam that is incorporated into the top of the building walls. The roof is equipped with two large round vent hood assemblies, each of which is topped with a lightning rod and grounding system. Likewise, the roof perimeter is equipped with a grounding system with lightning rods at each corner. While the building lacks windows, it does have two entry doors. The east elevation is equipped with a wide access door made of heavy steel plate. This steel plate door is equipped with two locking hasps and a small louvered vent panel in the lower door. A sign describing the explosive limits for the building is located next to this door. On the north elevation, a narrow single-leaf entrance is located at the west end of the wall. This entrance was hung with a steel slab door, but the door has detached from its hinges and lies on the ground on the north side of the building. The north entrance accesses a narrow room on the north side of the building that is isolated from the rest of the interior. The south and west elevations of the building are plain and lack fenestration.

Figure 170. Property 23655, south and east elevations, view to the northwest.

Figure 171. Property 23655, north and west elevations, view to the southeast.

History of Use

Property 23655 was constructed in 1962 as the “Pyrogen Storage” building according to a 1963 WSMR property inventory (WSMR 1963). The building’s Form 2877 Real Property Record describes it as a 120-square foot “GM Magazine.” The original 1962 architectural plans for Property 23655 identify it as an “Explosive Service Igloo” for “Missile Component Storage” (per WS-KD Plan Set). The building was designed by the A&E firm of Burns and Roe of New York for BTL, in cooperation with the USACE Albuquerque District. According to the architectural drawings, the main room of the building was used for the storage of “Pyrogen Units, Third Stage Motors, and Solid Propellant Gas Generators,” while the small room in the northwest corner of the building was used for the storage of “Shape Charges” (Plan Set WS-KD). Pyrogen is a type of flammable ignitor used for the ignition of solid propellant motors. The building was an addition to the Nike Zeus Assembly and Storage Area that was used in conjunction with Properties 23654 and 23656. Property 23655 allowed for the separate storage of ignitors and charges away from the missile motors and boosters, providing an additional measure of safety.

Little additional information was available in WSMR realty records regarding the use of the building after its construction. A monorail and one-ton hoist were added to the building's interior in 1961. In 1964, the Nike Zeus program transitioned into the Nike X program. The nearby Properties 23654 and 23656 were used in support of the Sprint missile from 1964 to 1970, and it is possible that Property 23655 also remained in use as part of the Sprint support work at LC-38. In 1970, Sprint testing ended and the former Nike Zeus Assembly and Storage Area was re-used for the SAM-D missile program, later known as Patriot, but it does not appear that Property 23655 was part of the later SAM-D use. The building appears to have been unused and unmaintained for decades, and is in fair overall condition.

Figure 172. Property 23655, west and north elevations, Property 23654 in background, view to the east.

Figure 173. Property 23655, north elevation doorframe, view to the south.

7.4.4 Property 23656

Property 23656 is a one-story magazine structure constructed of reinforced concrete, earthen fill, and what the architectural plans identify as concrete "cribbing." Cribbing generally consists of timbers stacked in a square or rectangular pattern, and is often used for supporting heavy objects (i.e., leveling or lifting a building) or building retaining walls and buttresses. The exterior cribbing used for Properties 23654 and 23656 consists of stacked square concrete panels that are filled with earth. These cribbed wall sections serve as retaining walls for the earthen fill incorporated throughout the structure. The core of the structure is formed by three separate bays constructed of reinforced concrete, each of which is 56 feet long, 35 feet wide, and 28 feet high. The concrete walls of the bays are 21 inches thick, with 24-inch thick reinforced concrete roofs. The concrete slab roof of each bay incorporates a concrete parapet, approximately 4 feet in height, along the north and south elevations, which acts as a retaining wall for the earthen fill applied to the top of the structure. The concrete slab roof of each bay also includes a waterproof membrane topped by ½-inch thick fiberboard. As originally built, each of the assembly bays was equipped with a bridge crane within the interior. A 38-foot thick dividing section of earthen fill separates each of the three bays. Earth-filled concrete cribbing is stacked between the exterior walls of the interior concrete bays, retaining the earthen fill between the bays.

Figure 174. Property 23656, south and east elevations, view to the northwest.

Figure 175. Property 23656, north elevation overview, view to the southeast.

Earthen fill is also piled across the top of the bays to a depth of approximately 3 feet, forming the "roof" of the structure. The earthen fill across the top of the structure is extended down to ground level, forming ramps on the east and west sides, which are supported by retaining walls formed by the structure's exterior concrete cribbing.

The south elevation is formed by three reinforced concrete wall sections associated with the assembly bays, separated by sections of earth-filled concrete cribbing that retain the earthen fill between the concrete bays. The exterior concrete cribbing steps down along the east and west ends of the south elevation to support the earthen ramps that form the east and west elevations of the building. The assembly bay entrances on the south elevation all share the same configuration. Along the south elevation, each assembly bay has a sheetmetal bay door with horizontal sliding operation near the middle of the bay wall. The bay door is protected by steel bollards, and a single-leaf entrance with a steel slab door is located just west of the bay door. A concrete wing wall that acts as a windbreak is located just west of the single-leaf entrance. At the east end of the assembly bay wall is a concrete entry block with a flat roof. A single-leaf entrance is located in the east-facing wall of the entry block, within which is a second entry door. This small entry block is labeled as an "airlock" in architectural plans (Plan Set WS-KR) and provided controlled entry into the bay while assembly work was underway. The portion of the wall around the doors is clad in corrugated asbestos-cement panels, with a section of translucent panels located above the sliding bay door. Two vent openings are located in the upper corners of the asbestos-cement clad portion of the wall. A variety of electrical conduits, electrical boxes, and overhead lights are mounted along the length of the south elevation. Outside the south elevation, between the east and middle assembly bays, is a portable pre-manufactured steel building on a steel skid foundation. This portable building appears to be of modern manufacture and recently moved to the site. A freestanding basketball hoop is located outside the west assembly bay entrance. A small pre-manufactured steel frame storage building is located southwest of the west assembly bay entrance, which also is a recent addition to the site. An electrical transformer set on a concrete slab is located near the southwest corner of the structure, which is protected by a ring of steel bollards.

The north elevation differs somewhat from the south elevation, but is formed by the same three reinforced concrete wall sections associated with the explosive bays, separated by sections of concrete cribbing retaining wall sections. The exterior concrete cribbing steps down along the east and west ends of the south elevation to support the earthen ramps that form the east and west elevations of the building. The north elevation of the west assembly bay has a large addition to accommodate missile assembly and checkout activities. The addition is of steel frame construction and is clad with fiberboard panels, and is topped with a flat roof of built-up construction. The central portion of this addition has an elevated section in order to accommodate a missile in the vertical position. This portion of the addition is

Figure 176. Property 23656, south elevation, east bay entrance area, view to the north.

Figure 177. Property 23656, north elevation of west bay with vertical staging addition, view to the southwest.

Figure 178. Property 23656, north elevation, east bay entrance area, view to the south.

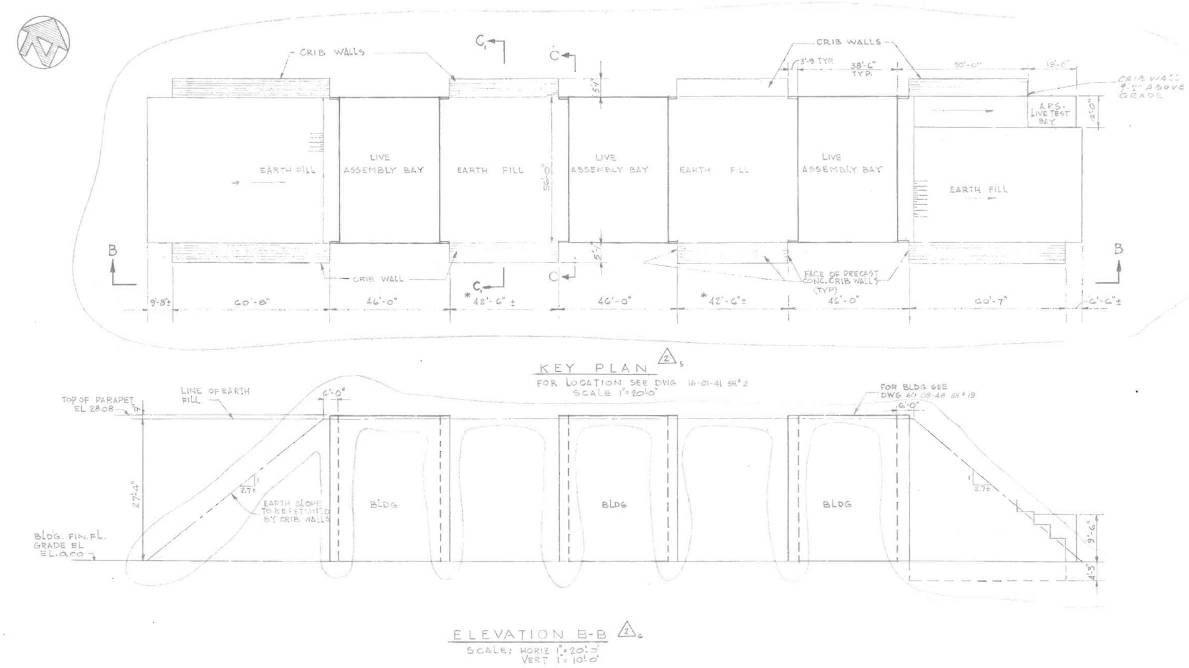

Figure 179. Property 23656, plan and elevation drawings from 1959 WS-IA plans.

equipped with full-height steel doors mounted on heavy-duty steel hinges, allowing the missile to be removed from the building while still vertical. These doors no longer appear to be used; a pressurized gas tank storage rack is currently located at the base of the doors which would prevent them from opening. A similar, but shorter, set of steel doors is located immediately east of the full-height doors, and these doors are also blocked by a pressurized gas tank storage rack. Large HVAC units with associated ductwork are located on steel stands along the east, north, and west sides of the addition.

The north elevations of the middle and east assembly bays each have central sliding bay doors similar to those of the south elevation. On both sides of the sliding bay doors are single-leaf entrances with steel slab doors with opaque upper lights. Sealed light fixtures are located above each of the personnel doors. Large HVAC units are located near the east personnel door entrance, each with ductwork routed through the upper wall. As with the south elevation, the portion of the wall around the doors is clad in corrugated asbestos-cement panels, with a section of translucent panels located above the sliding bay door. Notably, the north elevation lacks the airlock entry blocks and concrete windbreak walls seen along the south elevation. A shipping container used for storage is located outside the north elevation between the east and middle assembly bay, and another shipping container is located near the northwest corner of the structure.

The east and west elevations of the structure are formed by the earthen ramps that extend down from the roofline to ground level, formed by the concrete cribbing along the north and south elevations. Built into the northwest corner of the structure is a separate poured concrete building

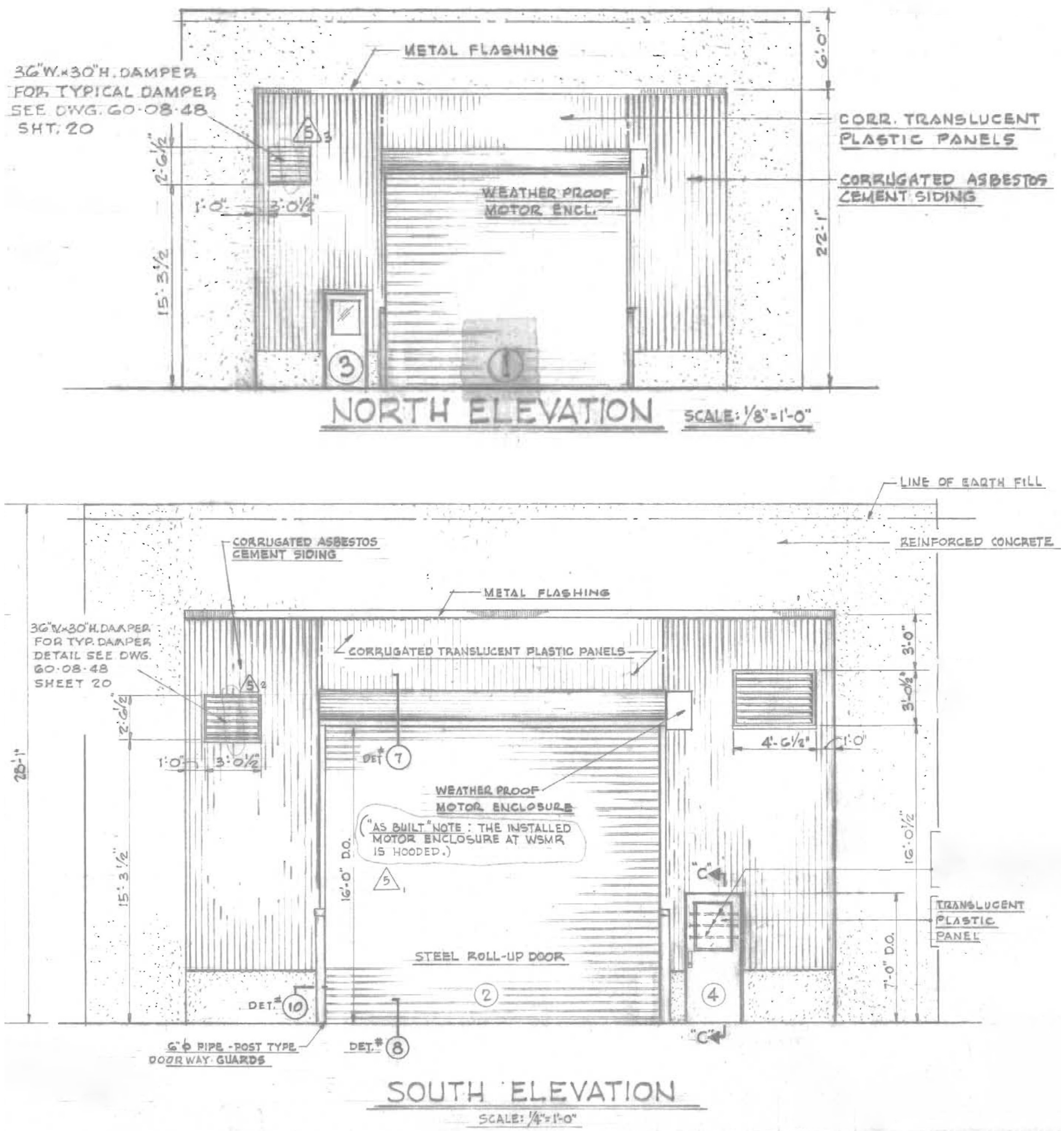

Figure 180. Property 23656, north and south elevation drawings from 1959 WS-IA plans.

that has a separate property number (Property 23660). Unlike the neighboring Property 23654, these earthen ramps have been stabilized with pneumatically-applied concrete (shotcrete), but some vegetation has still managed to take root along the roofline.

History of Use

Properties 23654, 23656, and 23660 formed the core of the Nike Zeus Assembly and Storage Area at LC-38, where storage and assembly work on Nike Zeus missiles was carried out. The area was later used by the Sprint and SAM-D programs. Property 23656 was constructed in 1959 as the “Live Assembly Bay” according to a 1963 WSMR property inventory (WSMR 1963). The building’s Form 2877 Real Property Record describes it as a “GM Facility” that enclosed 6,468 square feet. Although the structure appears larger from the exterior, much of it is actually composed of earthen fill. The original 1958 architectural plans for Property 23656 identify it as the “Live Assembly Bay” (per WS-IA Plan Set). The building was designed by the A&E firm of Burns and Roe of New York for DAC and BTL, in cooperation with the USACE Albuquerque District. The structure is described in a 1959 summary of the WSMR Nike Zeus facilities as:

> The Live Assembly Group is composed of three assembly bays. Each bay is 56 feet long, 35 feet wide, and 28 feet high. The walls, floors, and ceilings are reinforced concrete with three feet of earth fill on top of each bay. Each bay is separated by a 38-foot earth fill. The assembly bays will be used during the hazardous assembly of the missile [WSMR 1959:16].

The fenestration of the assembly bays underwent a major overhaul in 1962. When Property 23656 was originally completed in 1959, each of the three assembly bays was equipped with overhead rolling bay doors on the north and south elevations of the structure, along with single-leaf personnel door entrances. These are depicted in the original architectural plans (Plan Set WS-IA) as well as period photographs. The remainder of the assembly bay walls on the north and south elevations were clad in corrugated asbestos cement panels, sometimes referred to transite panels. In 1962, the original large overhead rolling doors were removed and replaced by smaller sheetmetal doors with horizontal sliding operation. Along the south elevation, the concrete entry blocks were added to each of the assembly bays, east of the sliding door, which were referred to as “airlocks” in the architectural plans (Plan Set WS-KR). An additional single-leaf entrance was located on the west side of the sliding door as well; this entrance was protected by a concrete “windwall” that buffered the predominant southwest winds. Along the north elevation, the overhead rolling doors were also replaced by smaller sheetmetal doors with horizontal sliding operation, and single-leaf entrances were located to the east and west of the sliding doors. These doors were steel slab doors with upper lights. The rest of the wall around the fenestration on both the north and south elevations of the assembly bays retained the asbestos cement panels. The 1962 modification to the north and south elevations of the assembly bays established the configuration of the assembly bays that is still visible today, with some additional minor alterations. However, the north elevation of the west assembly bay (Bay #3) was subject to an additional major addition in 1965 for the vertical assembly and checkout of the Sprint missile.

Property 23656 was used in support of the Nike Zeus program until 1964, when Nike Zeus transitioned into the Nike X program. Property 23656 remained assigned to BTL after the end of the Nike Zeus testing and was used in support of the Sprint missile program. The addition to the north elevation of the west assembly bay was added in support of the Sprint program. Plans for the modification are labeled “Live Assembly Bay No. 3 Modifications” and dated

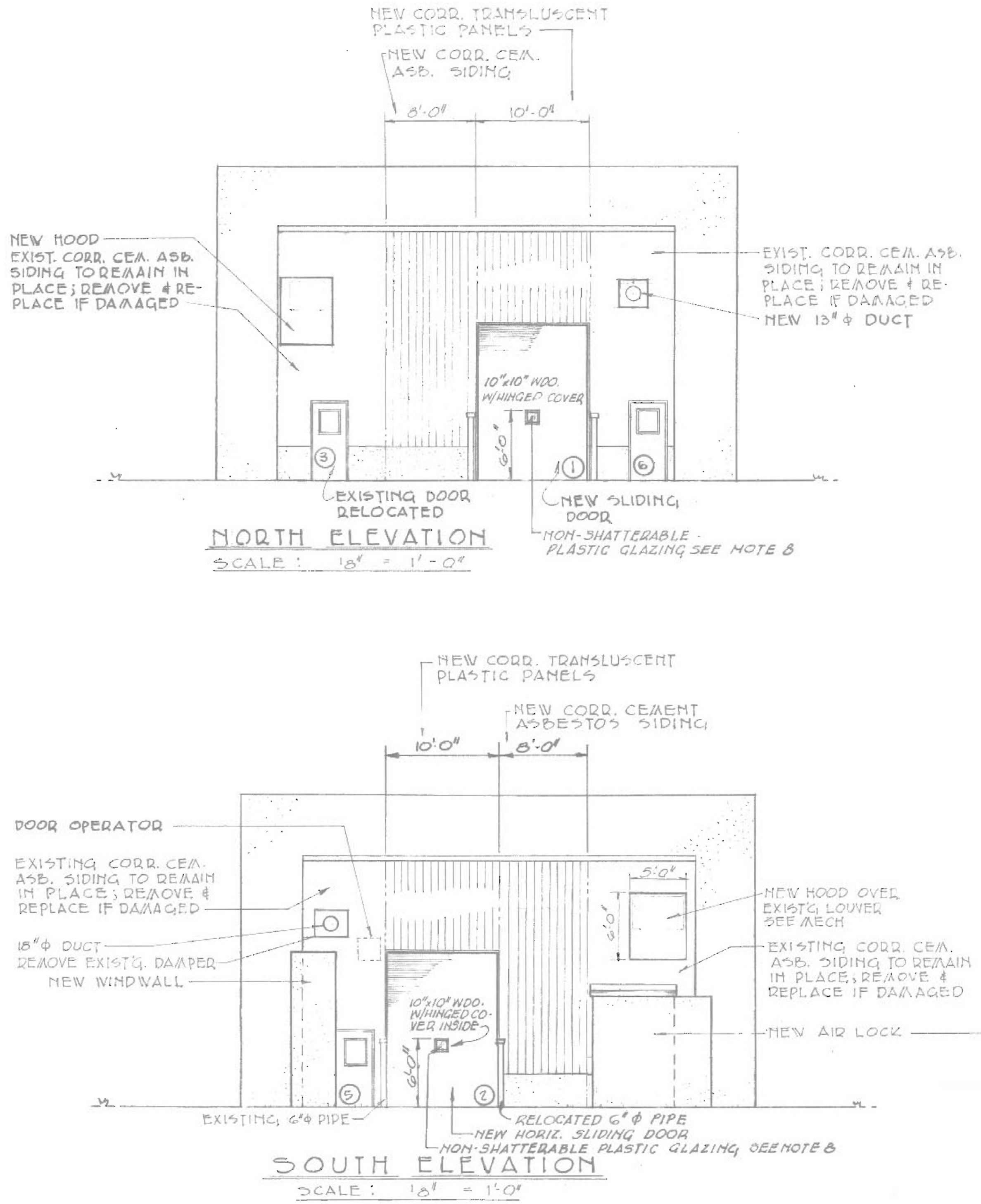

Figure 181. Property 23656, alterations to north and south elevations from 1962 WS-KR plans.

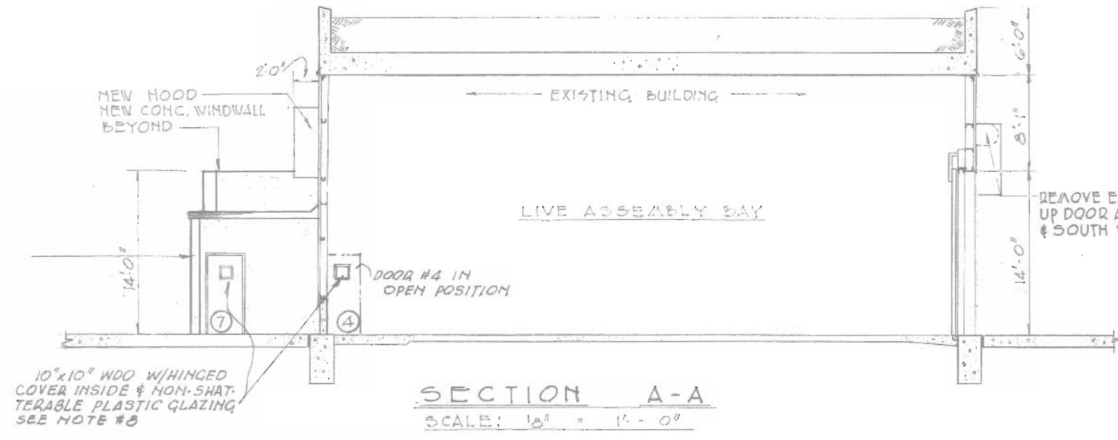

Figure 182. Property 23656, alterations to north and south elevations from 1962 WS-KR plans.

to 1964 (Plan Set WS-JR). The alteration to Bay 3 was designed by the Ralph M. Parsons Company out of Los Angeles in cooperation with the USACE Mobile, Alabama District, and the property's Form 2877 Real Property Record indicates that the addition was completed in January 1965. The addition allowed assembly and checkout of the Sprint missile in the vertical position, which was then removed and transported to LC-50 for launching (Piland 2007b:4). The Sprint assembly addition included a below-grade assembly pit that is not visible from the exterior of the property.

Beginning in 1969, the SAM-D program began to use the assembly and storage area facilities for missile assembly work (Piland 2007b). The Sprint missile testing at WSMR ended in August 1970, and the assignment of Properties 23654 and 23656 to BTL was terminated in October 1970 (Field 1970; Piland 2007b). Concurrent with the termination of the BTL assignment, both Properties 23654 and 23656 were assigned to the SAM-D program, which became the Patriot program. Today both properties continue to be used by Raytheon for the Patriot PAC-2 missile, with Patriot missiles stored within Property 23656 prior to launch. At the time of the current inventory, Property 23656 was in good overall condition and generally well-maintained.

7.4.5 Property 23660

Property 23660 is a small reinforced concrete building built into the northeast corner of Property 23656. The building is constructed on a below grade concrete slab foundation. The building's flat roof is formed by a concrete slab that is sealed with a layer of built-up roofing, and includes a slight eave on the north, south, and east elevations. The roof edge is clad with sheetmetal flashing and several vent risers extend from the roof. The building's north elevation has two heavy steel plate blast doors with small upper viewing ports that open onto the two separate rooms within the building's interior. Sealed overhead lights are mounted above each door. An angled sheetmetal vent hood is located between the two doors on the east elevation. The east and west elevations are plain and lack fenestration; the west elevation abuts the earthen mound of Property 23656 and is not visible. The south elevation is also plain and lacks fenestration, and is partially hidden by the slope of the earthen mound extending from Property 23656.

History of Use

Property 23660 was constructed in 1959 as the "APS Live Test Bay" according to a 1963 WSMR property inventory (WSMR 1963). The original 1958 architectural plans for Property 23660 also identify it as the "APS Live Test Bay" (per WS-IA Plan Set). The building was designed by the A&E firm of Burns and Roe of New York for DAC and BTL, in cooperation

Figure 183. Property 23660, east and north elevations, view to the southwest.

Figure 184. Property 23660, east and north elevations, view to the southwest.

with the USACE Albuquerque District. The building is described in a 1959 summary of the WSMR Nike Zeus facilities as:

> The APS [Accessory Power Supply] test cell is a small reinforced concrete building 19 by 10 feet. This building is divided in half by a reinforced concrete wall to form a test bay and a viewing room. This building is located adjacent to the assembly cells and will be used for static testing of the APS units prior to installation [WSMR 1959:16].

The APS unit deserves a little further explanation. The APS powered the Nike missile steering fin movements during flight, which were actuated by high-pressure hydraulics operating at approximately 2,000 Pounds Per Square Inch (PSI). In the Nike Ajax, the steering hydraulics were operated from a hydraulic accumulator located behind the warhead, which stored several quarts of pressurized hydraulic fluid. For the Nike Hercules, the onboard APS was used to pressurize the hydraulic fluid. The early APS was a small engine that ran on highly volatile liquid fuel. During the 1960s, a battery-powered APS was introduced, which eliminated the maintenance intensive liquid-fueled motor, which had to be operated and then carefully refu-eled during maintenance and checkout procedures (Davis 2000). The early Nike Zeus missile

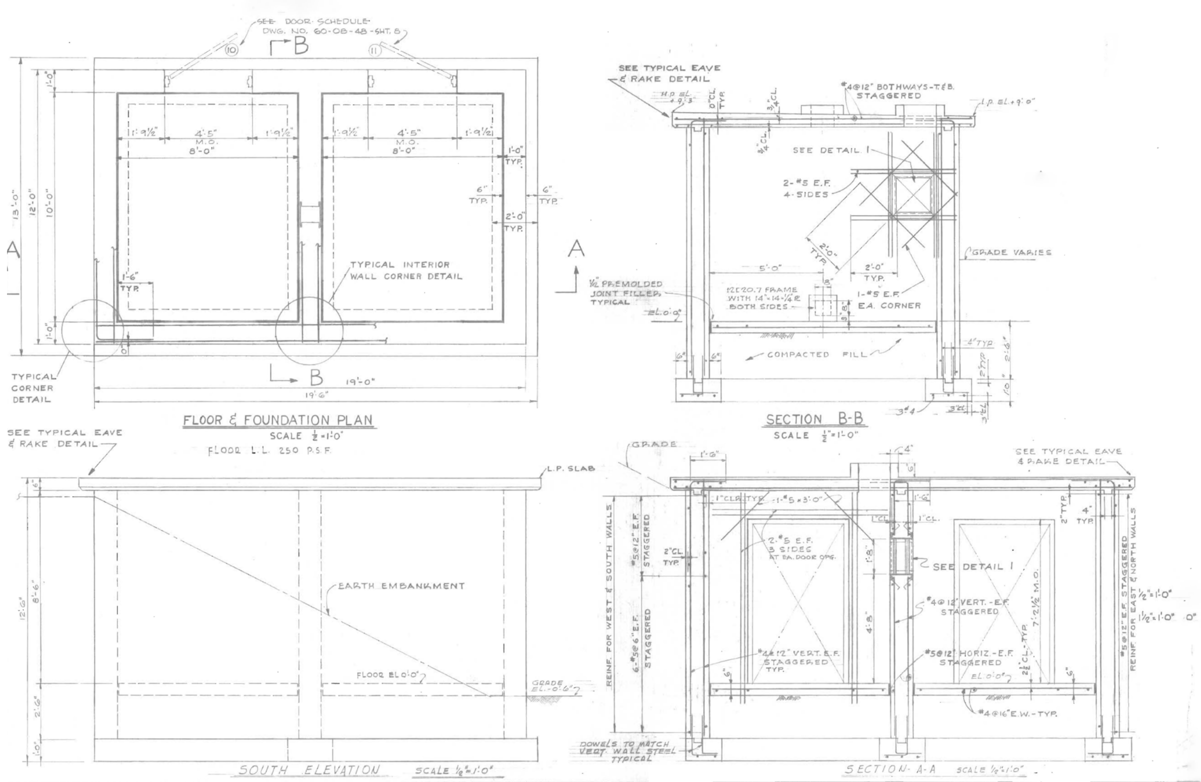

Figure 185. Property 23660 plan, section, and elevation drawings from WS-IA plans.

likely used the same liquid fueled APS that Nike Hercules did, and Property 23660 provided a safe facility for the testing and operation of these volatile APS units.

Property 23660 likely remained in use until October 1970 when the assignment of Properties 23654 and 23656 to BTL was terminated (Field 1970; Piland 2007b). Concurrent with the termination of the BTL assignment, Property 23660 (along with Properties 23654 and 23656) was assigned to the SAM-D program, which became the Patriot missile. Today, both Properties 23656 and 23660 are used by Raytheon in support of the Patriot PAC-2 missile. At the time of the current inventory, Property 23660 was in good overall condition and generally well-maintained.

7.5 Launch Facilities

Launch facilities are character-defining components of most WSMR launch complexes, but are actually limited in number at LC-38. The original LC-38 launch area consisted of a discrete series of launchers for the Nike Zeus in the north central part of the complex. However, after 1964 actual flight testing of the Spartan and Sprint missiles was relocated away from LC-38. Eventually, the old Nike Zeus launchers were removed and new facilities constructed over the former launchers. Today, only the remnants of one Nike Zeus launch structure (Property 23683) and portions of the Nike Zeus Launch Area Tunnel remain extant at LC-38. During the 1970s, additional launch structures were constructed in the north central part of the complex in support of the SAM-D/Patriot program.

7.5.1 Property 23683

Property 23683 is a concrete launcher structure located in the north central portion of LC-38, in the former Nike Zeus launcher area that is occupied by the Raytheon Mission Control Building (MCB; Property 23700) and its neighboring support facilities. Property 23683 consists of a concrete slab foundation that includes at-grade and elevated sections, as well as an integral

Figure 186. Property 23683, overview to the northwest.

Figure 187. Property 23683, view of elevated portion of launch pad, view to the southeast.

underground control shelter. As originally designed, the structure consisted of three sections; the Tactical Prototype Cell, the Simulated Cell, and the Launch Support Shelter (per WS-KR Plan Set).

The Launch Support Shelter is the underground control room beneath the west portion of the launch pad structure. This portion of the pad is slightly above grade, approximately 4 to 6 inches, and its upper surface is flat and mostly plain. The north and west edges of this pad are capped with protective steel angle stock, and pipe guard rails are installed along the west and south margins of this portion of the structure. The south portion of the upper surface of the pad is slightly elevated to house a tread plate steel bulk head door that accesses a concrete stairwell that leads down into the control room area of the Launch Support Shelter. From the interior of the shelter, a short tunnel connects the north end of the control room to the utility access tunnel that connected the Nike Zeus launcher pits and Property 23680. An electrical box on a conduit riser protrudes from the northeast corner of this part of the structure, which includes a short section of cable trench that is surrounded by a separate concrete pour. To the west, the ground surface is approximately 6 to 8 feet lower in elevation, and partial-height concrete walls form an open-air enclosure. This open-air enclosure surrounds a steel rack assembly and a large HVAC unit, along with two heavy-duty vent openings constructed of steel plate that protrude from the exposed west wall of the Launch Support Shelter. Based on architectural drawings and period photos, this below-grade area along the west side of Property 23683 was once defined by gravel-stabilized slopes, but it is now a poorly defined bowl depression that retains water. The interior of the open-air enclosure is partially filled with mud and accumulated sediment, along with a variety of discarded refuse and debris.

The Tactical Prototype Cell formed the central part of the launch pad structure. Based on period descriptions and architectural drawings, this portion of Property 23683 was an underground silo that launched the Nike Zeus from a vertical orientation. The current concrete slab over this portion of the structure appears to have capped the launch silo and is a structurally isolated, separate pour from the surrounding concrete slab foundation. The surface of the concrete cap slab is approximately 36 inches above grade along its southern end and approximately 24 inches above grade along its northern end. A triangular stoop, raised a few inches above the surrounding concrete pour, extends from the north end of this elevated section and incorporates an embedded steel plate. The surface of the slab is devoid of any attachment hardware. Along the south edge of the cap slab, there is a significant separation between it and the surrounding foundation.

The east section of the structure is formed by the “Simulated Cell,” which was apparently an above-grade model of the Nike Zeus launch silo. This portion of the launch pad structure is indicated by a rectangular outline of demolished concrete walls that measures approximately 10 by 20 feet. Architectural drawings indicate that a rectangular base with two interior crosswalls was built on this sec-

Figure 188. Property 23683, view of elevated portion of launch pad, view to the northwest.

Figure 189. Property 23683, separation along south and east sides of elevated launch pad platform, view to the northwest.

Figure 190. Property 23683, removed section of launch pad, view to the north.

tion of the launch pad structure, but provide few other details (Plan Set WS-KR). The Simulated Cell base was built as a separate pour that was separated from the surrounding concrete slab foundation by expansion joints. All of the above grade portion of the Simulated Cell has been removed and this portion of the launch pad structure leveled off, leaving only its outline in the surface of the pad. Along the east side of the launch pad structure, the slope drops several feet to a lower grade, and this slope is stabilized with gravel and vegetation. Separate pours form an apron extension of the launch pad structure that extend along its north side. At the time of recording, two control trailers for Patriot radars were parked on this portion of the launch pad, along with a trailer-mounted generator unit.

History of Use

Property 23683 was constructed in 1960 as the "Tactical Launcher" according to a 1963 WSMR property inventory (WSMR 1963). The architectural plans for Property 23683 identify it as the "Tactical Prototype Cell No. 1" (per WS-KD and WS-KR Plan Sets). This launcher cell was an addition to the existing two Nike Zeus R&D launch pits associated with the launch control building (Property 23680). The structure was designed by the A&E firm of Burns and Roe of New York for DAC and BTL, in cooperation with the USACE Albuquerque District.

A 1959 summary of the WSMR Nike Zeus facilities mentions plans for the installation of "Tactical Prototype Launchers" at LC-38:

> From two to four tactical prototype cellular type launchers will be constructed of reinforced concrete. These cells are presently

Figure 191. Property 23683, bulkhead door into underground tunnel access, view to the west.

Figure 192. Property 23683, enclosure along west side of launch pad, view to the east.

Figure 193. Property 23683, view inside enclosure on west side of launch pad, view to the southeast.

Figure 194. Property 23683 schematic drawing from 1962 WS-KR plans showing parts of launch structure.

> under design and details are not available. It is expected that the cell configuration will be that of the "Murphy Bed" type, constructed partially above ground and properly revetted [WSMR 1959:84].

Of course, the only tactical prototype launcher constructed was Property 23683, not the two to four indicated in the above summary. The development of the Nike Zeus tactical prototype launcher was related to a structure constructed at LC-33, the Nike Zeus Reduced Scale Facility. This testbed structure is described in the same 1959 Nike Zeus facilities summary as:

> The Reduced Scale Launching Facility was constructed in Army Launching Area No. 1 to assist the contractor designers in obtaining R&D information for the design of the Nike Zeus Tactical Cellular Launchers. The Reduced Scale Facility is a small reinforced cell constructed above ground and large enough to accommodate a Nike Ajax missile in the elevated position. Successful firings have been conducted from this facility [WSMR 1959:46].

The other Nike Zeus launchers, referred to as "R&D Type Launch Pits," were mostly below-grade structures. The 1959 summary of the LC-38 Nike Zeus facilities describes these launcher pits as:

> Two R&D type launch pits have been constructed. These pits are reinforced concrete structures slanting downward below grade. The lower portion of the pit has blast plates, deflectors, etc., for investigation of heating and erosion. This lower portion is approximately 25 feet below grade. Associated with each launch pit is a small concrete shelter that houses instrumentation equipment and

> main control equipment. The Launchers and the Launch Control Building are separated from one another by large pyramidal shaped earthen embankments for safety [WSMR 1959:38].

Property 23683 differed from the Nike Zeus R&D launch pits in that it appears to have launched the missile vertically from an underground silo rather than the angled sub-surface launcher rails in the R&D launcher pits. On April 28, 1960, the sixth Nike Zeus (round ZW-6, code named 'Blackfish') was launched from the "tactical cell launcher," which appears to have been Property 23683 (Wind and Sand 1960:1). This was first launch from a Nike Zeus underground launch silo, and the first time a motor generating 450,000 pounds of thrust had been fired from an underground launch silo (Wind and Sand 1960:1). The main objectives of this launch were to demonstrate the launch capability from an underground cell, gather data on the cell environment during the launch, obtain missile booster data during the launch, and to investigate missile radar contact during the launch (Stevenson et al. 1961:107). The test objectives were met and the launch from the underground silo was considered successful, although the missile booster broke up during the flight (Stevenson et al. 1961:108). The Army press release on the launch stated that underground facilities were less expensive to construct than surface launch facilities, provided more uniform temperatures, and provided some protection against enemy attacks (Wind and Sand 1960). A later test of an "unported" or "blind" version of the tactical cell launcher ruptured the booster approximately 0.25 seconds into the test, apparently due to stresses created within the unported launcher cell environment (Stevenson et al. 1961:111). It should be noted that the successor to the Nike Zeus missile, the Spartan interceptor missile that was part of the Safeguard program, was launched vertically from an underground silo.

The other Nike Zeus launch cells have long been removed from LC-38, and Property 23683 is the only Nike Zeus launcher structure that still remains extant at the complex today. The silo appears to have been decommissioned during the mid-1960s when the Nike Zeus testing was phased out in favor of the Nike X developmental program. It appears that the structure was capped with the current concrete slab by the mid-1970s. Property 23683 is in poor overall condition, and at the time of recording served as a staging area for Raytheon's Patriot radar equipment.

7.5.2 Property 23688

Property 23688 is a concrete slab foundation and barricade wall located in the former Nike Zeus launcher area in the north-central portion of LC-38. The structure primarily consists of a concrete slab foundation that incorporates a network of cable trenches. A concrete wall, approximately 7 feet in height, is built into the slab foundation along its west side. The slab foundation measures 54 feet in length and 32 feet in width. The cable trench runs down the center of the foundation's long axis, with four short perpendicular branches spaced at even intervals along the length of the main north-south trench. The main trench is 24 inches wide, and the short perpendicular branches each measure 12 by 36 inches. The cable trenches are all equipped with plain (non-tread pattern) steel cover plates. Four large hexagonal cover plates, measuring roughly 48 by 36 inches, are located at each junction of the main cable trench and the short perpendicular trenches. Near the south end of the main cable trench, the cover plates have been removed and two large electrical cabinets installed along the trench, which are connected to conduits routed through the trench. It is not clear what electrical equipment these cabinets house, but they might be some type of transformer units. The main branch of the cable trench extends beyond the north edge of the foundation for approximately 10 feet, then turns to the west. The cable trench extends west for approximately 40 feet, with two perpendicular branches to the north and one additional branch to the south. Pole-mounted overhead lights are

Figure 195. Property 23688, overview from the east side, view to the southwest.

Figure 196. Property 23688, cable trench down center of pad, view to the southwest (*left)*; electrical cabinets installed along south end of cable trench, view to the northeast (*right)*.

Figure 197. Property 23688, concrete wall along the west side, view to the northeast (*left)*; extension of cable trench west of pad, view to the west (*right)*.

Figure 198. Property 23688, electrical cabinets installed along the south end of cable trench, view to the southwest (*left)*; extension of cable trench west of pad, view to the east (*right)*.

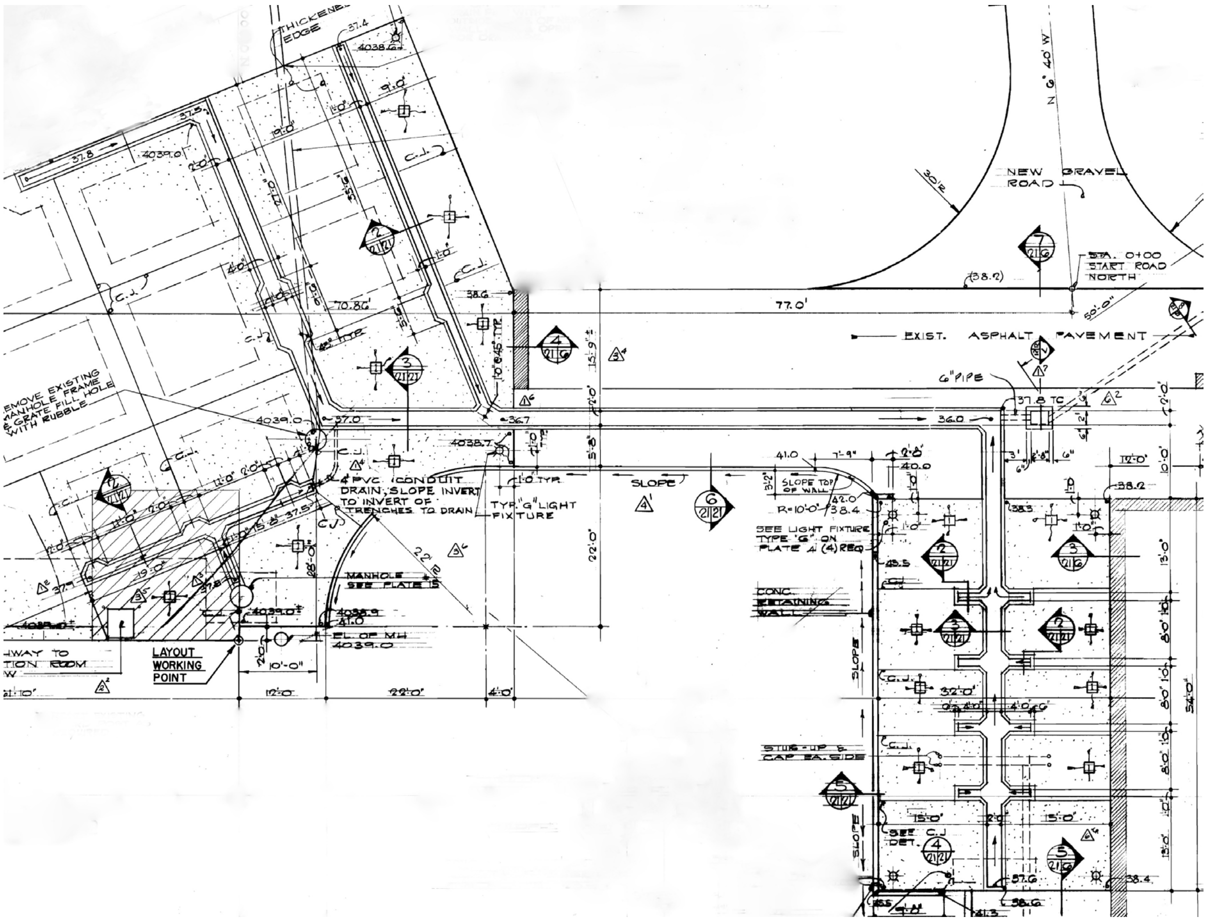

Figure 199. Property 23688, plan view from 1969 WS-RK plans.

located at each corner of the pad to provide nighttime illumination.

History of Use

Property 23688 was constructed in 1971 as a "Generator Pad" according to a 1974 WSMR property inventory (WSMR 1974). The building's Form 2877 Real Property Record describes it as a "Con Gen Pad" constructed in 1971, and further describes it as a "generator pad 32 feet by 54 feet by 7 inches thick." The original 1969 architectural plans for Property 23688 also refer to it as a "Generator Pad" (per WS-RK Plan Set). The structure was designed by the A&E firm of Kenneth S. Clark of Santa Fe, in cooperation with the USACE Albuquerque District. The property was designed as a staging location for SAM-D / Patriot battery generator units, and power cables were routed through the associated cable trenches from the generators to the SAM-D control and guidance equipment. The pad to the northwest of Property 23688 is labeled as the Fire Control and Guidance (FCG) Pad in the 1971 WS-RK Plan Set. The concrete wall along the west side of the pad likely served as a noise and safety buffer between the SAM-D FCG equipment and the generator units. Today, the structure is mostly used for outdoor storage and there are no generator units located on the pad. A variety of equipment and parts are stored on pallets across the structure's surface, and a shipping container is parked along the east side of the foundation. At the time of the recording, the structure was in good overall condition.

7.5.3 Nike Zeus Launch Area Tunnel

The Nike Zeus Launch Area Tunnel is a linear tunnel that connected between the original Nike Zeus Launch Control Building (Property 23680), the two R&D Launch Pits (Properties 23669 and 23673), and the Tactical Launcher Cell (Property 23683). The tunnel is approximately 8 feet in diameter and constructed from corrugated drain pipe (i.e., culvert pipe) that is buried to a depth of approximately 7 feet below the surface of the former Nike Zeus launch area. The bottom of the pipe is covered with plywood, which provides a level walking surface. Cable trays and racks run the length of the tunnel, along with various conduits, although much of the wiring has been removed from the tunnel. Overhead lights are installed along the top of the tunnel, but are no longer functional. Steel access ladders to the surface access hatches remain in place. A rectangular chamber of reinforced concrete and CMU construction is located along the tunnel in the vicinity of the demolished Property 23680, and a series of ceiling-mounted cable trays are located in this chamber. This chamber is labeled as a “junction room” in the 1959 WS-IA plans for Property 23680.

There are currently four surface access hatches for the Nike Zeus Launch Area Tunnel, as well as one additional access through the subterranean control room of Property 23683 at the east

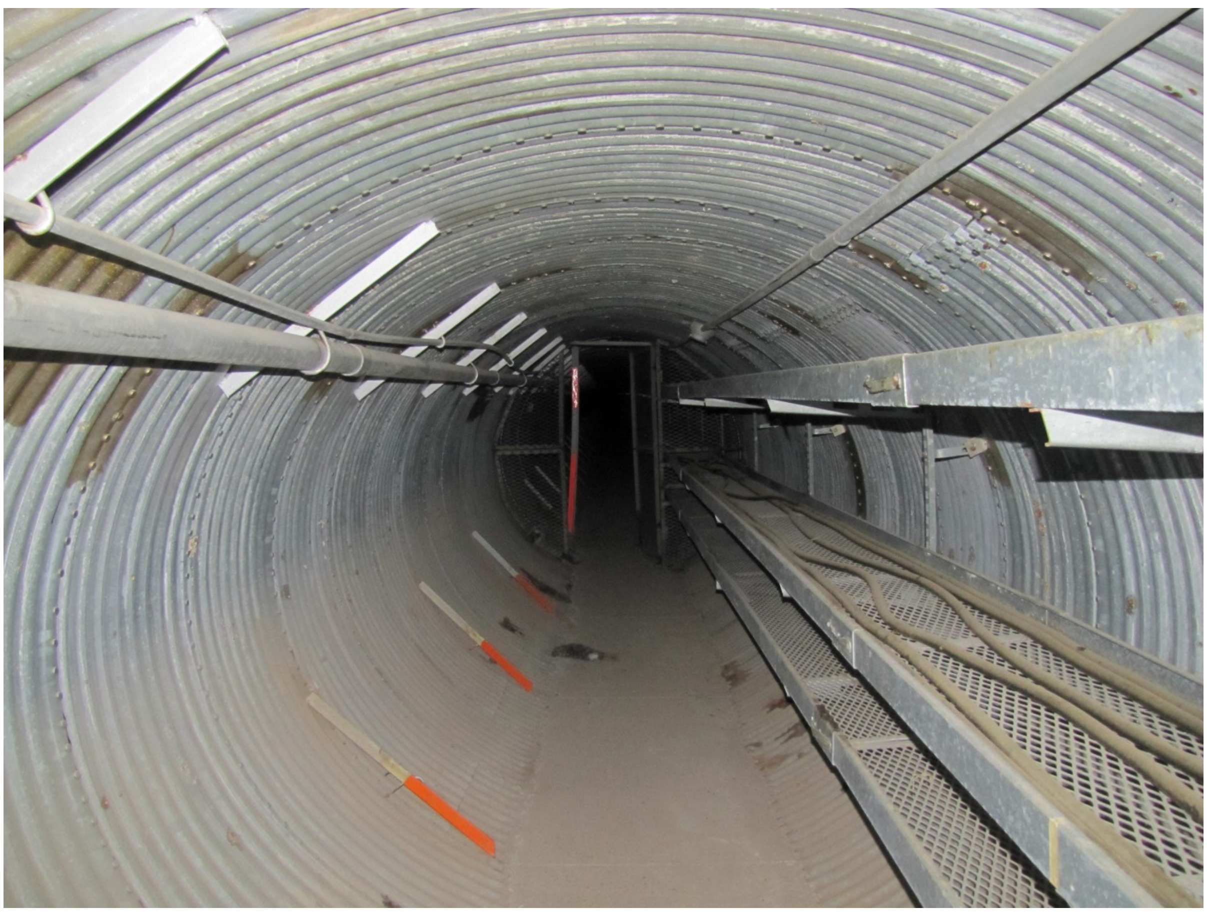

Figure 200. Typical section of the Nike Zeus Launch Area Tunnel.

Figure 201. Concrete and CMU vault located along tunnel near Property 23680 control room (*WSMR Archaeologist Jim Bowman in left foreground)*.

end of the former Nike Zeus launch area. Three of the surface access hatches are spaced along the former tunnel alignment, one near the west end of the former Nike Zeus launcher area, one near the central part of the former launcher area (east of the modern Property 23700), and one near the east end of the old launch area, just northwest of Property 23683. These three access hatches are generally similar in construction. The steel access hatches are mounted to elevated concrete curbs that are incorporated into concrete slabs that also house arched sheetmetal vent housings. One additional access hatch is located near the south side of Property 23688, which was along the north elevation of Property 23680 (now demolished). The access via Property 23683 is through the underground control room, via a short connecting tunnel that travels north from the control room to the east end of the original tunnel. Today, these access hatches are the only surface indications of the Launch Area Tunnel, and the associated Properties 23669, 23673, and 23680 have all been demolished. Based on the location of the access hatches, the tunnel alignment is located just north of the modern Property 23700. In its original configuration, the main east-west tunnel was approximately 1,050 feet (320 m) in length, and the north-south connecting tunnel to Property 23683 was approximately 50 feet (15 m) in length. However, the remaining tunnel segments are not continuous, as the portions near the demolished R&D Launch Pits appear to have been infilled and sealed. As such, it appears that only an eastern leg and a western leg of the Launch Area Tunnel remain intact today.


Figure 202. Cable trays and racks mounted to tunnel wall (*left)*; connecting section of tunnel from Property 23683 (*right)*.


Figure 203. View of ladder and access hatch from tunnel interior (*left)*; east surface access hatch, view to the southeast (*right)*.


Figure 204. West access hatch, view to the southwest (*left)*; central access hatch, view to the southeast (*right)*.

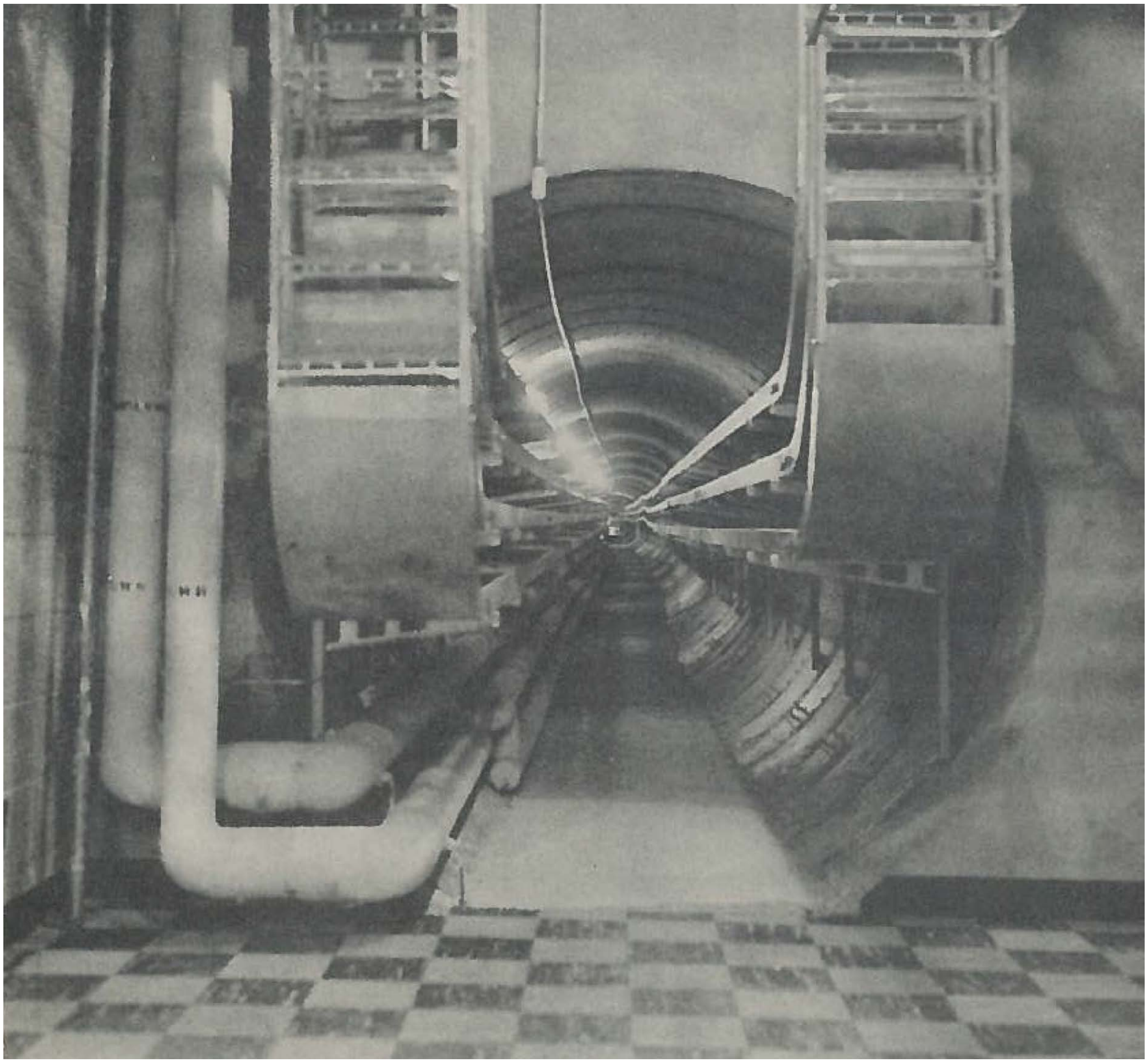

Figure 205. Photo of the tunnel soon after it was constructed (*adapted from WSMR 1959)*.

History of Use

Property 23680 and the associated Nike Zeus Launch Area Tunnel were originally constructed in 1959 as part of a larger $1,057,000 contract issued to the C.H. Leavell Company. The same contract also included construction of the associated launcher pits and the hazardous assembly area properties. The 1959 summary of the LC-38 Nike Zeus facilities describes the control building as:

> The Launch Control Building is constructed below-grade with a launch equipment building attached above grade and directly over the Launch Control Building. The below-grade portion is constructed of reinforced concrete and the above-grade portion of prefabricated steel. Approximate overall dimensions of both portions are 57 by 60 feet. The lowest level is 18’ 6” below grade. The

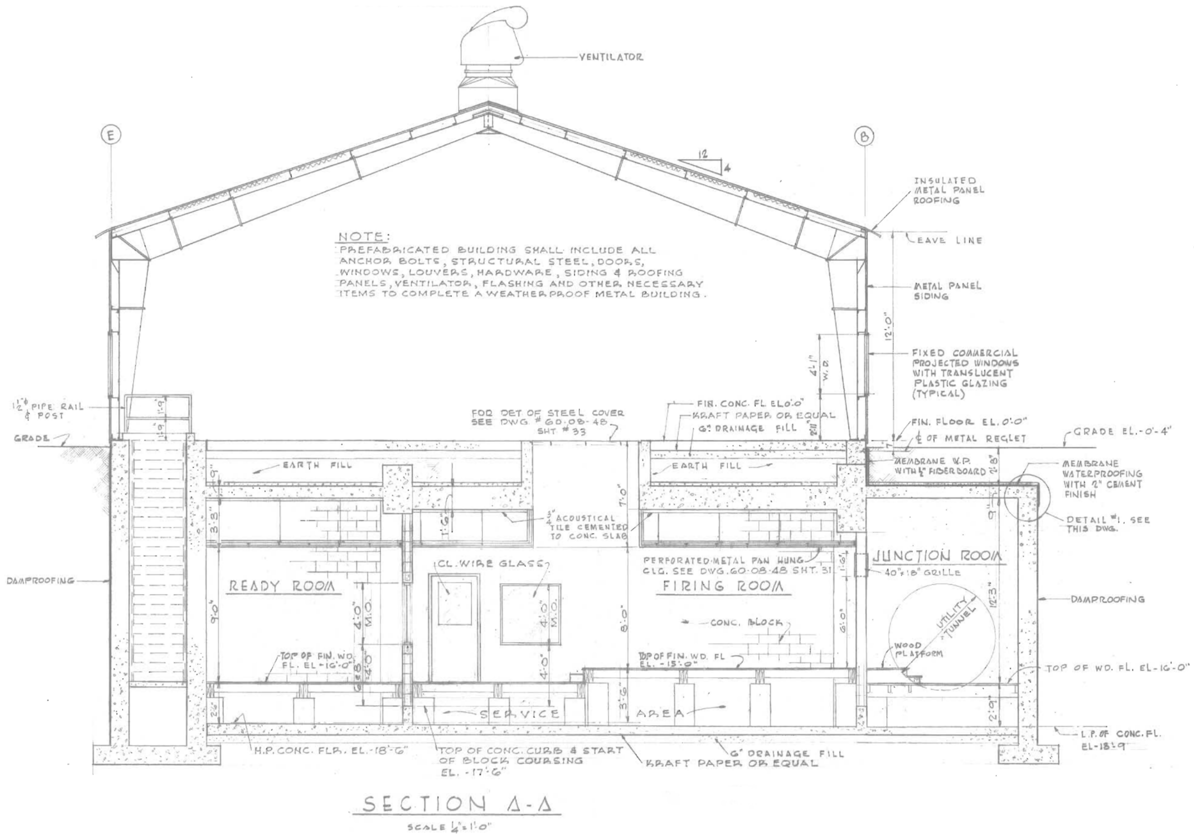

Figure 206. Property 23680 and junction room along Nike Zeus Launch Area Tunnel, as shown in 1959 WS-IA plans.

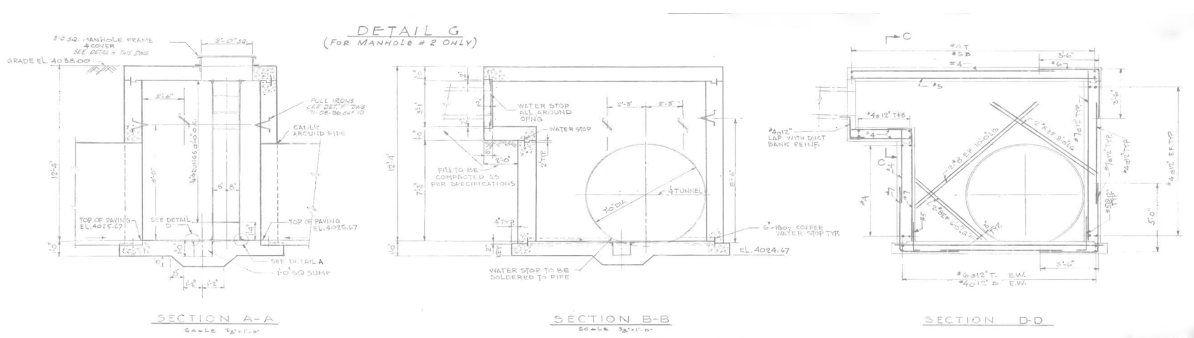

Figure 207. Nike Zeus Launch Area Tunnel section views from 1959 WS-IA plans.

> launch control building will house all personnel during operations and contains all launch control equipment and necessary Electro-Mechanical equipment [WSMR 1959:31].

Specifically, the Launch Area Tunnel is described as:

> An 8-foot diameter utility tunnel located approximately seven feet below grade connects the launcher area with the Launch Control Building. The tunnel is used to route all control cables, heating and cooling lines and all circuits between the launchers and Launch Control Building. The tunnel is not physically attached to the launchers for obvious safety reasons [WSMR 1959:31].

Based on period maps and photographs of the Nike Zeus launch area, the tunnel passed along the north side of the R&D Launch Pits (Properties 23669 and 23673). However, as mentioned in the description above, the tunnel did not directly connect to the launcher pits. Wiring and utility connections to the launcher pits were probably routed through smaller conduits or pipes to isolate the tunnel from the blast effects of the launcher pits.

While the remaining tunnel segments remain in good overall condition, they are no longer used today. The modern Property 23700 and its associated Patriot test facilities do not make use of the tunnel. Aside from Property 23683, the Nike Zeus Launch Area Tunnel is one of the few remaining remnants of the original Nike Zeus launch facilities.

7.5.4 Patriot Launch Pad

This property is an at-grade concrete slab foundation that served as a launch pad in the Patriot Launch Area at LC-38. It measures 50 feet long (north-south) by 40 feet wide (east-west), with an angled extension to the southwest that is approximately 65 feet in length. This extension aligns with the Patriot Conditioning Shelter tracks, which end at the west edge of the launch pad. A cable trench with tread-pattern steel plate covers extends into the launch pad extension at an angle. Several sets of torch-cut mounting hardware are embedded in the surface of the launch pad, including two sets of 18 anchor studs arranged in semi-circular rows and two sets of four anchor studs. Two brass survey datums are also affixed to the surface of the launch pad. One is a brass plate stamped with “L557” and the other is a DMA survey monument stamped with “DMATC / TS 977 / 1974.” The area surrounding the launch pad is surfaced with asphalt pavement, and a portable steel frame building is located to the west of the launch pad. At the time of the recording, several mobile equipment vans and trailers were parked on the launch pad.

Figure 208. Patriot Launch Pad, overview to the northwest.

Figure 209. Patriot Launch Pad, torch-cut mounting bolts, view to the north (*left)*; datum plate, plan view (*right)*.

Figure 210. Patriot Launch Pad, cable trenches and enclosure rails, view to the northwest (*left)*; Patriot Enclosure and rails (*right)*.

History of Use

This launch pad does not possess a WSMR property number, and therefore records regarding the use, history, and age of the structure are not maintained at WSMR DPW. Based on architectural drawings (WS-TI Plan Set), the launch pad was constructed in 1973 as part of the SAM-D Remote Launch Facilities. The launch pad is labeled as “Concrete Launcher Pad” and “Concrete Blast Deflector” on the architectural drawings (Plan Set WS-TI). The concrete extension to the southwest and rails for the Patriot conditioning shelter were added to the launch pad in 1976. While the SAM-D launcher was originally anchored to the launch pad, later the launches were conducted from a trailer-mounted Patriot launcher tube (Plan Set WS-81-76). The launch pad was likely used for Patriot launches into the 1990s, and is possibly still occasionally used by Raytheon for Patriot testing today. At the time of recording, the launch pad was in good overall condition.

7.5.5 Patriot Pad and Revetment

This property consists of an at-grade concrete slab foundation set within a substantial earthen berm. This property is located approximately 100 meters west of the Patriot Launch Pad. The concrete foundation measures approximately 30 feet north-south by 20 feet east-west and lacks any hardware or anchors. The pad is surrounded on its south, east, and west sides by a large U-shaped earthen mound or revetment. The mound is approximately 20 feet in height along its south side, and slopes down to grade along its east and west sides. The U-shaped mound is approximately 150 feet long and 100 feet wide. The interior surface of the mound has been stabilized with pneumatically-applied concrete (shotcrete), and remnants of wood framing are embedded along the east and west sides. Based on recent aerial imagery, the wood framing was part of much larger wood framework that spanned across the east and west sides of the mound, across the north half of the concrete pad. The majority of this wood framework has been removed, leaving only the remnants visible during the current inventory. Placed atop the south side of the mound is a portable aluminum tripod mount, possibly as a mount for optical instrumentation or surveyor total station.

Figure 211. Patriot Pad and Revetment, overview to the north.

Figure 212. Patriot Pad and Revetment, concrete slab foundation, view to the north (*left)*; view to the northeast (*right)*.

Figure 213. Patriot Pad and Revetment, overview of foundation from top of revetment, view to the northeast (*left)*; tripod on south side of revetment, view to the north (*right)*.

Figure 214. Patriot Pad and Revetment, “WIEBEL-A” datum atop earthen berm, plan view (*left)*; wood framework incorporated into berm, view to the north (*right)*.

History of Use

This property does not possess a WSMR property number, possibly because it is a contractor-developed property. As such, records regarding the use history and age of the structure are not maintained at WSMR DPW. The purpose of the pad and associated earthen berm is unknown, but it likely served as a protected launch location for Patriot missile launches. Alternatively, it might have served as a protected installation for some type of mobile instrumentation. This property does not appear on either 1969 or 1973 architectural plans for development of the SAM-D/Patriot facilities, so it was likely constructed in the mid-1970s or later. It does not appear to have been recently used or maintained, and is in fair overall condition.

7.5.6 Patriot Conditioning Shelter

This moveable conditioning shelter is located north of the former Nike Zeus launch area in the Patriot launch area of LC-38. The one-story, high-bay structure has a roughly rectangular footprint and is mounted on a wide set of tracks that connect to the Patriot Launch Pad to the northeast. The shelter structure is built around a steel interior frame and is clad in corrugated sheetmetal. The walls of the enclosure are thickly insulated. The structure was designed to be moved along a set of tracks with rail rollers located on the north and south elevations. The shelter is positioned at the end of the tracks, with the base of the west elevation up against steel chock plates. While concrete track footings extend further to the southwest past the shelter's current position, no rails are attached to this section of footings.

A large set of bay doors encompass most of the shelter's east elevation. The bi-folding bay doors are well-insulated and clad in galvanized sheetmetal, and mounted with heavy-duty hinges. The upper corners of the east elevation wall extend past the north and south elevations, and the wall tapers along its length so that the bottom corners are even with the north and south elevation walls. The north and south elevations are equipped with single-leaf entrances consisting of heavily insulated doors that resemble those used in commercial walk-in freezers.

Figure 215. Patriot Conditioning Shelter, east and north elevations, view to the southwest.

Figure 216. Patriot Conditioning Shelter, north and west elevations, view to the southeast (*left)*; view of rails, view to the southwest (*right)*.

Figure 217. Travel stop at base of Patriot Conditioning Shelter rails, plan view (*left)*; travel stops and hitch assembly, view to the north (*right)*.

Figure 218. Patriot Conditioning Shelter, north elevation entrance, view to the south (*left)*; “Bally” tag on north elevation door, view to the south (*right)*.

Brand tags on the doors and an associated temperature gauge read "Bally." Large diameter conduits are routed through the middle of both the north and south elevation walls. The west elevation is plain and devoid of fenestration. A hitch assembly is attached to the frame along the bottom of the west elevation wall, and a roof access ladder is attached to the south side of the wall. Two large capped conduits are located in the lower third of the west elevation wall, similar to the conduits in the north and south elevations.

History of Use

Based on associated architectural plans, this structure was constructed in 1976 as the "Environmental Enclosure for Patriot Missile" (Plan Set WS-81-76). This mobile conditioning shelter does not possess a WSMR property number, possibly because it is a contractor-owned property. As such, records regarding the use history and age of the structure are not maintained at WSMR DPW. Due to this, little archival information is available for the shelter. However, a limited set of architectural plans for the structure were prepared in 1976 (Plan Set WS-81-76). Drawings in the plans indicate that the shelter was designed to enclose a trailer-mounted Patriot launcher that was positioned on the associated launch pad. At the time of launch, the shelter was retracted along its rail system to clear the Patriot missile for launch. The shelter likely continued to be used as a conditioning enclosure for the Patriot missile program into the 1980s. At the time of recording, the shelter did not appear to have been recently used or maintained, and was in fair overall condition.

7.5.7 Patriot Support Building

This property is a small portable steel-frame building associated with the Patriot Launch Pad. The building is constructed atop a wood skid foundation and has a low-pitch shed roof. The walls of the building are clad in flat sheetmetal panels, and the roof is clad in standing seam sheetmetal. The building is typical of buildings produced by Armco, but no manufacturer branding is visible on the building. A single-leaf entrance is located on the east elevation, which is equipped with a steel faux-panel door with a sealed overhead light fixture. A faded painting of a missile launch is visible to the left of the entrance. The north and south elevations have 4-light steel frame windows with awning operation. A window A/C unit is mounted to the north elevation wall with a cantilevered steel mounting bracket. The west elevation is plain and lacks fenestration, but is painted with an image of a missile launch (presumably Patriot). A wood utility pole is located immediately outside the west elevation. While a property sticker and a stenciled property number are visible on the building exterior, neither is fully legible.

Figure 219. Patriot Support Building, east and north elevations, view to the southwest.

Figure 220. Patriot Support Building, west and south elevations, view to the northeast.

History of Use

Portable buildings like this one are classified as equipment rather than as permanent properties, and as such are not assigned a formal WSMR property number. Therefore, records regarding the use history and age of the building are not maintained at WSMR DPW. The building is likely contemporaneous with the other nearby Patriot launch facilities, which were constructed during the early to mid-1970s. At the time of recording, the building did not appear to be used or maintained, but remained in fair overall condition.

7.6 Support Facilities

A series of buildings and structures that supported the personnel and utilities infrastructure at LC-38 were constructed as part of the original layout of the complex. These properties included water infrastructure properties (Properties 23627 and 23635), a dining hall (Property 23632), an air strip and hangar (Properties 24070 and 24075), a guardhouse (Property 24025), and dedicated power, heating, and cooling facilities for the Nike Zeus ZAR installations (Properties 24065, 24066, and 24068). These properties fulfilled specific infrastructure and support requirements for the Nike Zeus testing at LC-38, and reflected the significant facilities investment made at LC-38. LC-38 was the furthest east of the developed WSMR launch complexes, so having some dedicated support properties on-site eased logistical considerations and facilitated the overall RDT&E mission.

7.6.1 Property 23627

Property 23627 is an elevated water storage tank structure located within a fenced enclosure south of Property 23626, just north of Nike Avenue. The tower has four main support legs built on at-grade concrete footers that provide support for the upper tank, all of which are painted tan. According to the WSMR Real Property Record for the facility, the tower stands 101 feet

Figure 221. Property 23627, overview from the west side, view to the east.

Figure 222. Property 23627, overview from the east side, view to the west.

high and the tank is 36 feet in diameter and slightly over 36 feet deep. The tank's central standpipe is routed through the legs to ground level where it connects to subterranean plumbing. The standpipe is mounted to a concrete footing. The main support legs of the tower are constructed of welded tubular steel sections with diagonal steel tensioning braces, with three sets of these braces on each side of the tower. Two tiers of horizontal braces connect the legs, which are in turn stabilized by the diagonal tensioning braces. Each of the main support legs is anchored to an elevated concrete footing with large diameter hardware. An access ladder is attached to the southeast tower leg and an overflow pipe runs down the west side of the tower and empties into a concrete drain basin. Two additional drainage basins, supplied by underground pipes, are located along the north side of Nike Avenue.

History of Use

Property 23627 was constructed in 1959 as an "Elevated Water Storage Tank" with a 200,000-gallon capacity, according to its Form 2877 Real Property Record. The water tank was constructed alongside the neighboring Property 23626 as part of the original Nike Zeus support facilities at LC-38. The water system at LC-38 is described in a 1959 summary of the WSMR Nike Zeus facilities as, "the water supply system consists of approximately 22,250 linear feet of 8-inch water lines, a 200,000-gallon elevated storage tank, fire hydrants, and necessary valves along the line. Water is lifted to the storage tank by gravity flow from the existing

WSMR system" (WSMR 1959:5). Property 23627 not only acts as a reservoir, but also pressurizes the LC-38 water supply plumbing via hydrostatic pressure, which maintains water pressure even during power outages until the reservoir tank is drained. Maintaining local water pressure was an important consideration for ensuring the operation of fire suppression systems at LC-38. Property 23627 remains in use today and appears to be in excellent, well-maintained condition.

Figure 223. Overflow/drain pipe and drain basin south of Property 23627, view to the northwest.

Figure 224. Property 23627, southeast tower leg with access ladder, view to the northwest.

7.6.2 Property 23632

Property 23632 is a one-story building of CMU wall construction located along the east side of Range Road 239 in the south part of LC-38. The building's plan is roughly rectangular, but entry blocks along its east and west elevations make the plan somewhat irregular. Large areas of landscaping with mature trees, mostly varieties of mesquite, are located outside the south and west elevations of the building, along with a small landscaped mound at the building's northeast corner. The building is constructed on an above-grade concrete foundation. The building's exterior, like most of the LC-38 buildings, is painted tan with brown trim elements. The building's low-pitch shed roof is of built-up construction and drains to the east. The roof incorporates an extended enclosed eave along its east and west elevations, while the north and south elevations lack the extended eave. The roof fascia is clad with sheetmetal flashing on all elevations, with guttering and downspouts installed along the east elevation. The building retains most of its original fenestration, with its original windows consisting of aluminum two and three light windows with projecting concrete sills.

The building's west elevation acts as the principal elevation, facing the main parking lot in front of the building and Range Road 239. The main feature of the west elevation is a large

Figure 225. Property 23632, west elevation and landscaping, view to the southeast.

Figure 226. Property 23632, south and east elevations, view to the northwest.

entry block that projects from the central part of the wall. The entry block houses the building's main entrance, which is accessed by a concrete stoop and ramp with steel railings. The entry block has an independent shed roof with a substantial eave along its west side that shelters the entrance. The entry block houses an entry foyer area with restrooms on the north and south sides of the interior. An inner set of entrance doors is located in the main wall of the building opposite the foyer. The exterior doors of the entry block are recessed into the wall, further sheltering the entrance from the elements. A substantial concrete lintel supports the roof above the wide recess of the entry area. The exterior entryway consists of two single-leaf wood doors with large upper lights, which are separated by two fixed sidelight panels. The door lights and sidelights are all of wire-embedded safety glass. Above the entryway is a transom with fixed lights. A steel bracket is mounted across the outside of the transom, which supports two exterior air ventilation units. Each of these ventilation units is labeled "UJI Air Curtain," manufactured by Universal Jet Industries Inc. of Hialeah, Florida. The entryway doors, sidelights, transom, and associated framing are all of wood construction. The inner entrance within the foyer is generally similar to the exterior entrance, but has one single-leaf and one double-leaf doorway separated by a single sidelight. Like the exterior entrance, the inner entrance has a fixed transom above the doors, and the doors, sidelight, transoms, and framing are all wood construction.

Figure 227. Property 23632, west elevation entry area, view to the southeast (*left)*; west elevation outer entryway, view to the east (*right)*.

Figure 228. Property 23632, inner entry doors inside entry area, view to the east (*left)*; South end of west elevation, view to the east (*right)*.

Figure 229. Property 23632, windows along south elevation, view to the north (*left)*; south entry block on east elevation, view to the northwest (*right)*.

Figure 230. Property 23632, interior view of kitchen area, view to the west (*left)*; air curtain unit label, "Universal Jet Industries Air Curtain" (*right)*.

Figure 231. Property 23632, "bottle washer" area between entry blocks mid-elevation, view to the southwest (*left)*; large entry block in middle of east elevation, view to the northwest (*right)*.

Figure 232. Property 23632, north part of east elevation with entry blocks, view to the southwest (*left)*; east and north elevations, view to the southwest (*right)*.

On the north and south sides of the main entrance are two-light aluminum windows, and an identical window is located around the corner on the north elevation of the large entry block. The portion of the west elevation north of the entry block has two window pairings. The windows are aluminum with three horizontal lights, with exterior screens on the two upper lights. The operation of these windows is unclear, but they appear to have interior hopper operation of the upper 2-light panel. An identical window pairing is located in the portion of the west elevation that is south of the entry block. This part of the west elevation also has an anodized aluminum 3-light window with a fixed center light and casement operation of the outer two lights. This window appears to have been added to the building sometime after its original construction.

The south elevation has a series of four window pairings located high in the wall, which open into the kitchen area of the building's interior. Each of the window pairings consists of two aluminum windows with two horizontal lights. Two of these windows have exterior screens. A

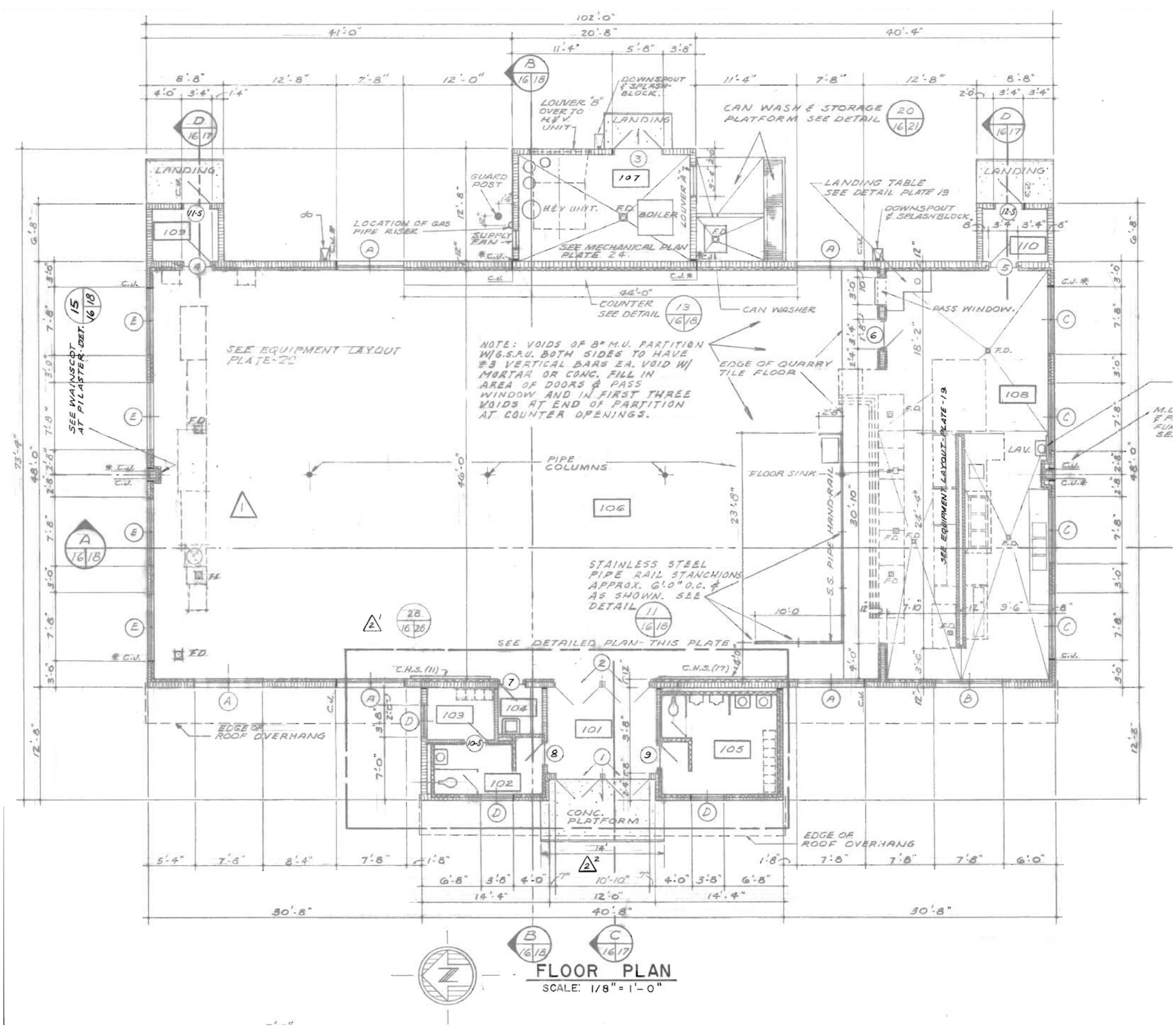

Figure 233. Property 23632, floor plan from 1959 WS-IE plans.

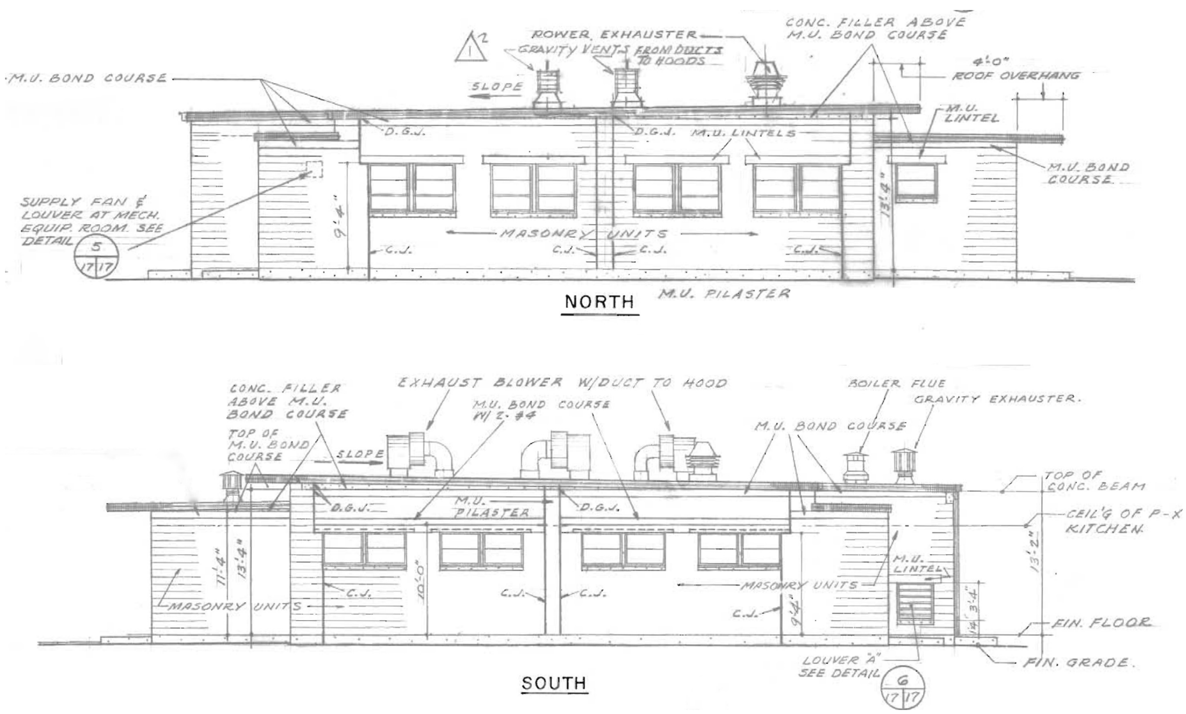

Figure 234. Property 23632, north and south elevations from 1959 WS-IE plans.

large area of landscaping with several mature trees is located outside the south elevation.

The building's east elevation has three entry blocks, two small blocks at the north and south ends of the wall, and one large block at its center. The smaller blocks have low, independent shed roofs while the larger central block is enclosed by an extension of the main building roof. The south block has an exterior aluminum storm door, which was a relatively recent alteration. The storm door was imperfectly fitted to the door opening, leaving some wood framing and broken stucco exposed. An aluminum drip guard is fitted to the wall above the door along with a sealed exterior light. Inside this entry block is a single-leaf interior door, which is an original wood door similar to those used in the main entrance. Like the west entrance, a UJI air curtain unit is mounted above the door. This entrance opened into the kitchen area of the building. The large center block has a double-leaf entrance with steel slab doors, above which is an aluminum drip guard affixed to the wall and a sealed exterior light. A louvered vent panel is located high in the wall north of the entrance, and another louvered vent panel is located around the corner from the entrance low in the wall. This entry block provided access to the building's mechanical room, which was not accessible from the building's interior per fire safety regulations. The mechanical room housed the building's boiler, water heaters, water softener, and HVAC unit (Plan Set WS-IE). The small entry block at the north end of the east elevation has a single-leaf entrance with a steel slab door. An aluminum drip guard is mounted to the wall above the entrance, which is also equipped with a sealed exterior light that appears to be a replacement. This door provides secondary access into the dining area of the building.

Along the main east elevation wall of the building between the middle and south entry blocks is a long window and a concrete platform that projects from the wall. The window opening is a

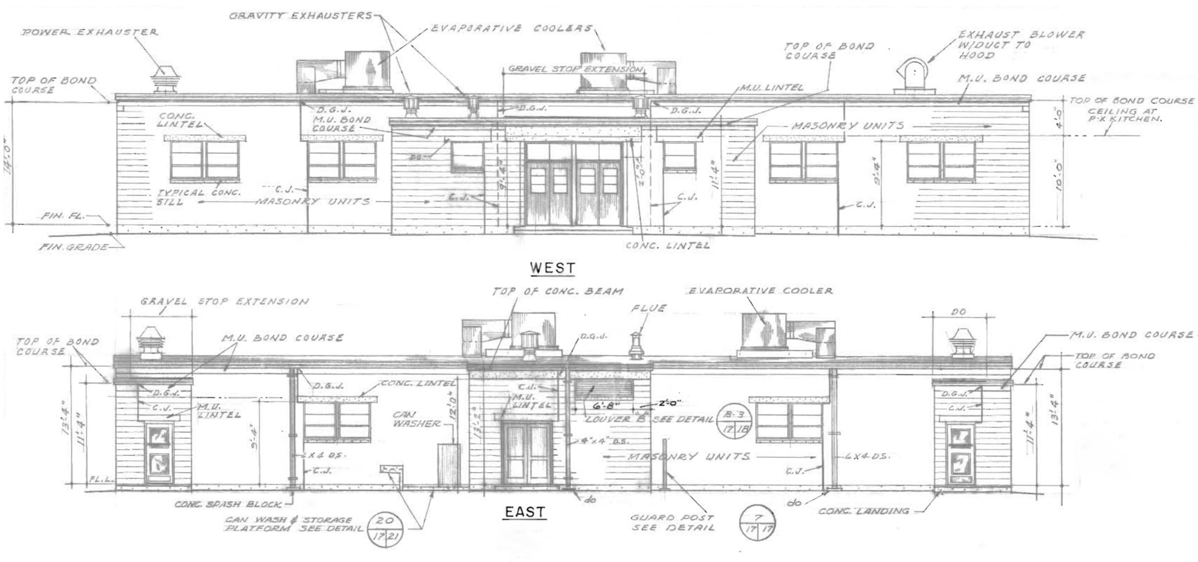

Figure 235. Property 23632, west and east elevations from 1959 WS-IE plans.

later addition to the building, and is fitted with a pairing of anodized aluminum windows similar to the unit in the west elevation. A steel support post is located in the middle of the window opening to support the wall above. Below the window is a concrete platform that extends about 12 feet from the wall. The platform is about 30 inches high and 30 inches wide, and is located along the south side of a concrete slab foundation that abuts the south side of the central entry block. According to the building's architectural plans, the concrete slab supported a "can washer" and the concrete platform was a "can wash and storage platform" (Plan Set WS-IE). The portion of the east elevation wall between the middle and north entry blocks houses a window pairing of the same 3-light aluminum frame windows used elsewhere in the building. A rooftop access ladder is mounted to the wall next to the window.

The building's north elevation has four window pairings located mid-height in the wall. The window pairings all consist of the same 3-light aluminum frame windows that are original to the building. The north elevation windows are all fitted with exterior screens that cover the upper two lights.

History of Use

Property 23632 was constructed in 1959 as the "Exch Service Outlet" according to a 1963 WSMR property inventory (WSMR 1963). The building's Form 2877 Real Property Record describes it as a "Cafeteria" that enclosed 5,757 square feet. The original 1959 architectural plans for Property 23632 identify it as the "Field Mess" (per WS-IE Plan Set). The building was designed by the A&E firm of Neuner and Cabaniss of Albuquerque in cooperation with the USACE Albuquerque District. Old signs along Nike Avenue and outside the building refer to the building as "The Cantina."

Property 23632 is described in a 1959 summary of the WSMR Nike Zeus facilities as, "A Field Mess Building constructed of masonry blocks. The building is 102 by 73 feet and is divided

Figure 236. 1959 aerial photograph of Property 23632 as it neared completion (*courtesy WSMR DPW*).

into two sections. One section is a PX Snack Bar and the other is an Army Field Mess Area" (WSMR 1959:76). This provides some insight as to why the building was described as both a field mess and snack bar.

Whether officially considered a mess hall, snack bar, or both, Property 23632 was distinctive in that it was the only dedicated dining facility at a WSMR launch complex. Dining facilities outside the Cantonment were rare at WSMR, and Property 23632 and the dining facility at Stallion Range Center (Property 34216) are the only known examples. Most of the time, personnel working along Nike Avenue either brought their own food or had to travel back to the Main Post at mealtime, if they could. The dining facility at LC-38 was, "appreciated by those who work at LC-38 since it is a long drive to anywhere else to find something to eat" (Piland 2007b:4). Property 23632 is another example of the investment put into substantial, permanent facilities at LC-38 during its formative years.

The building appears to have operated as the LC-38 Mess Hall until at least 1965. In 1965, the disposition records indicate that the building shifted from being a "Service Exchange Outlet" to a "PX Service Outlet," seeming to indicate a reduction in services. By 1972, Property 23632 was apparently closed and the equipment scheduled for removal. Realty disposition records indicate that the SAM-D program manager requested that the building's equipment not be removed, anticipating that the SAM-D program would soon bring about 250 Raytheon personnel

Figure 237. Photograph of Property 23632 under construction in 1959 (*adapted from WSMR 1959)*.

to LC-38. Along with upcoming work on a variable speed training target by other contractors at LC-38, it was anticipated that 350 to 400 personnel would soon be working at the complex. It was therefore recommended that the equipment be retained in the building so that it might be re-opened as a snack bar that could be operated at a profit (Ferdig 1972). It appears that the building was re-opened as a snack bar soon after the 1972 memo. In 1977, a partition wall was added across the interior of the building separating the north half from the snack bar/cafeteria operation in the south half. The north half of the building was assigned to the SAM-D (now Patriot) program for parts storage (Sedillo 1977). The north half of the building was re-assigned to the JFAADS project in 1987, while it appears that the south half continued to operate as a snack bar. After this time, there is little additional information about the use of Property 23632. In a 1997 *Missile Ranger* article, the building is described as still operating as a snack bar/cafeteria, now referred to as the LC-38 Cantina (Flores 1997). The building apparently was still in operation around 2007, when it was mentioned in Doyle Piland's historical summary of LC-38 (Piland 2007b:4). However, at the time of the current inventory, the building did not appear to have been used for several years. All the food service equipment has been removed from the south half of the building, while the north half appeared to have been most recently used by contractor Lockheed-Martin. The building still appears to be in good overall condition.

7.6.3 Property 23635

Property 23635 is a small CMU building within a fenced enclosure north of Nike Avenue in the southern part of LC-38. The building is constructed on an elevated concrete foundation and has a flat concrete slab roof. A domed ventilation unit is located in the center of the roof. Like most of the LC-38 buildings, it is currently painted tan with brown trim elements. The south elevation features a center single-leaf entrance with a steel slab door. An entry slab is located outside the doorway and a sealed light fixture is located above the door. The west elevation has an anodized aluminum window with tinted glass and single-hung operation in the middle of the wall; this window is a modern replacement. The east elevation is plain, but has a window opening that has been sealed with CMUs; an A/C unit is mounted in the upper part of the sealed window. The north elevation also has a former window opening that has been sealed with CMUs. A sealed port, probably for plumbing, is also located in the lower part of the north elevation wall.

Figure 238. Property 23635, west and south elevations, view to the northeast.

Figure 239. Property 26635, east and north elevations, view to the southwest.

History of Use

Property 23635 was constructed as a "Water Pump House" in 1961 according to a 1963 WSMR property inventory (WSMR 1963). It is described as a "Water Pump P" on the building's Form 2877 Real Property Record. Based on these descriptions, it likely houses a water well and associated pumping equipment for the LC-38 water supply. A 1959 summary of the WSMR Nike Zeus facilities does not mention this water well, and based on the construction date of the building, the well was likely drilled and developed a couple years after the complex was established to improve its water supply. The building appears to remain in use today, and is in good overall condition.

7.6.4 Property 23643

Property 23643 consists of two cooling towers located outside the east elevation of Property 23642. The larger of the two cooling towers was manufactured by "Evapco," but the other unit lacks any visible manufacturer's branding. The cooling tower units are installed on separate steel I-beam platforms installed on concrete footings. Both of the units are based around rectangular steel and sheetmetal housings that contain electric fans and condensing baffles. Plumbing for the cooling tower is routed through the east side of the cooling units and a plumbing vault is located to the northwest of the cooling towers. The plumbing on the east side of the cooling towers is set into a concrete slab foundation that is limited to the east side of the cooling tower platforms. Several yuccas have grown around the tower installation.

History of Use

Property 23643 was constructed in 1960 as a "Cooling Tower" according to a 1963 WSMR property inventory (WSMR 1963). The Form 2877 Real Property Record describes the property as "Cooling Towers" that were constructed in 1960. The unit was installed to cool the radar transmission equipment installed within the neighboring Property 23642, which was

Figure 240. Property 23643 cooling towers, view to the northwest.

the TTR installation for the Nike Zeus system. The neighboring Property 23642 was used in support of the Nike Zeus program until 1964, when Nike Zeus transitioned into the Nike X prototype program, which replaced the TTR with phased array radar systems. However, the TTR housed in Property 23642 and the DR at Property 23638 continued to operate with ARPA funding in support of the HAPDAR and the ABRES programs from 1964 to 1969. In this role, the TTR installed within Property 23642 continued to operate much as it had during the Nike Zeus program, and Property 23643 likely continued to be used during this period to cool the radar equipment. In October 1968, operation of the TTR and DR installations was transferred to the ABMDA. In September 1969, the ABMDA halted operation of both the TTR and DR installations, and the radar equipment was removed from both installations soon after (Piland 2007b). It was likely at this time that Property 23643 ceased operation as well, since it was no longer needed. The cooling tower units do not appear to have been used in many years and are in poor overall condition.

Figure 241. Property 23643 and associated plumbing vault, view to the southeast.

Figure 242. Property 23643 cooling towers, view to the northeast.

7.6.5 Property 24025

Property 24025 is a small, one-story building of CMU wall construction located along the east side of Range Road 242 in the southern portion of LC-38. The building has a rectangular plan and is constructed on an at-grade concrete slab foundation. The building exterior is painted mostly white, although the paint has weathered significantly. The building has a flat roof of built-up construction with sheetmetal flashing along the fascia. The roof has a broad enclosed eave on all elevations, with an additional projection over the south elevation. The building retains its original fenestration, which consists of wood double-hung windows and a wood door, but the fenestration is in generally poor condition.

The building's principal elevation is the west elevation, which opens onto an asphalt pull-out along the east side of Range Road 242. Located in the middle of the west elevation is a single-leaf entrance with a solid-core wood door with a large upper light. The wood door is very weathered and no longer closes, leaving the interior exposed to the elements and wildlife. Just south of the entrance is a wood frame window with 2/2 horizontal lights and double-hung operation. Below the window is a projecting concrete sill that is typical of all the building's windows.

Figure 243. Property 24025, west and south elevations, view to the northeast.

Figure 244. Property 24025, east and north elevations, view to the southwest.

The south elevation is shaded by the projection of the roof eave, and the corresponding portion of the foundation slab is also extended along this wall. This creates a sheltered area along the south elevation. The south elevation has two wood frame windows installed side-by-side, which together span the width of the south wall. Combined with the adjoining windows on the east and west elevations, these windows allowed a broad view from the entire south half of the building's small interior. The south elevation windows are identical to those in the east and west elevations; wood frame double-hung units with 2/2 lights. The south elevation windows have been covered by plywood installed on the exterior. The east window unit has one broken lower light.

The east elevation is generally identical to the west elevation, but lacks an entrance. A wood frame window, identical to the units installed in the west and south elevations, is installed in the south portion of the wall. Like the south elevation windows, this window is covered by plywood. Mounted to the center of the wall is a large sheetmetal electrical box with several conduits routed into it. At the base of the wall are two large conduits that pass into the building interior.

The north elevation has a single window in the middle of the wall, which has also been covered

Figure 245. Property 24025, south and east elevations, view to the northwest.

with plywood from the exterior side. This window is also a wood frame unit with 2/2 lights and double-hung operation, but is smaller than the other building windows. It is associated with a small restroom within the building's interior.

History of Use

Property 24025 was constructed in 1959 as the "Sentry House" according to a 1963 WSMR property inventory (WSMR 1963). The building's Form 2877 Real Property Record describes it as a 94-square foot "Sentry Station." The original 1959 architectural plans for Property 24025 identify it as the "Guard House" (per WS-IO Plan Set). The building was designed by the A&E firm of Burns and Roe of New York for BTL, in cooperation with the USACE Albuquerque District. Property 24025 was part of the original LC-38 facilities that were built in support of the Nike Zeus program. This building served as a guard station that controlled access into the ZAR radar area of LC-38. According to real property records, the building entered service in 1960 and likely remained in use through the duration of the original Nike Zeus testing. In 1964, the Nike Zeus program transitioned into the Nike X program. After Nike Zeus testing ended at LC-38, Property 24025 likely received sporadic use through the end of the decade before being decommissioned in 1975. A 1975 memo describes the disposal plans

Figure 246. Property 24025, interior window detail, view to the southeast.

Figure 247. Property 24025, interior view, conduits through foundation, view to the east.

for the building, which included removal of its electrical equipment, disconnecting its utilities, and abandoning the septic tank in place (Field 1975). No additional information was available in WSMR realty records regarding the use of the building after 1975, but it appears to have remained unused for decades. At the time of the current inventory, Property 24025 was in poor overall condition; portions of the roof have collapsed and much of its wood fenestration is weathered and decayed.

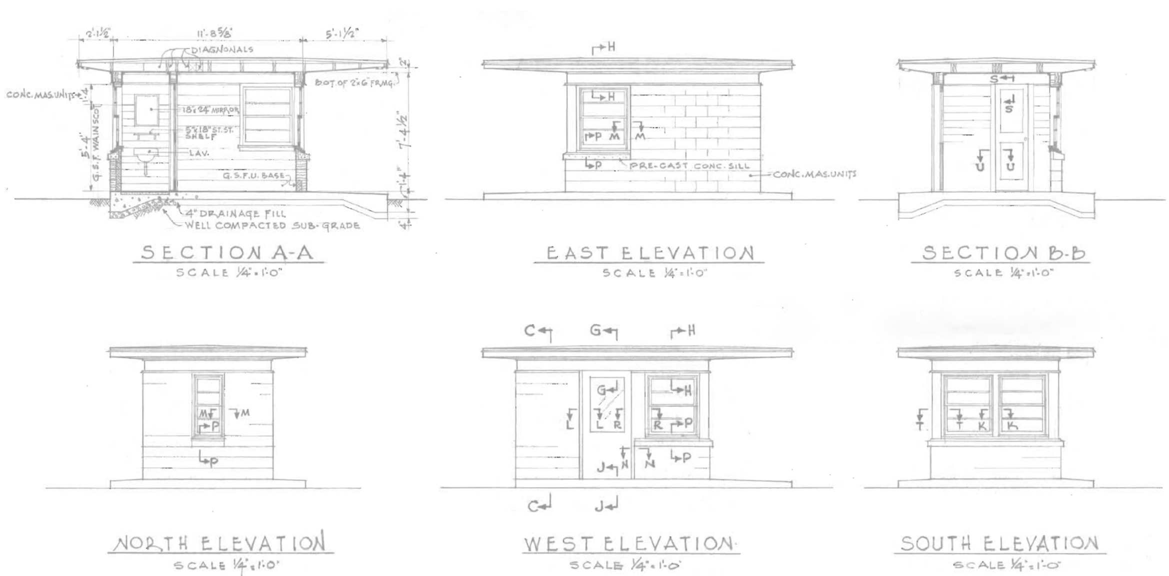

Figure 248. Property 24025, elevation and section drawings from 1959 WS-IO plans.

7.6.6 Property 24060

Property 24060 is an underground LP fuel storage tank located just north of Property 24065 in the eastern portion of LC-38. The underground tank is set within an at-grade rectangular concrete curb that resembles a foundation. This curb is partially buried by windblown sand and overgrown with vegetation. Within the rectangular curb is a smaller rectangular concrete valve access box with walls that extend approximately 12 inches above grade. Within this valve access box are several valves and plumbing associated with the underground tank. An elevated vent flue, approximately 10 feet high, stands within the eastern part of the concrete curb that defines the tank installation. The vent flue is built from four risers of 2-inch diameter steel pipe and is topped with a conical sheetmetal cap. The base of the vent flue is located within a buried steel valve access vault which is mostly infilled with sediment. The tread-pattern steel cover for this vault have been removed and are located on the ground nearby.

History of Use

Property 24060 was constructed in 1959 as a "U-LP Gas Stor Tank" (presumably short-hand for 'Underground LP Gas Storage Tank') according to a 1963 WSMR property inventory (WSMR

Figure 249. Property 24060, overview to the northwest.

1963). The building's Form 2877 Real Property Record describes the property as "Gas Str Tanks" and both sources state that the storage tank (or tanks) had a capacity of 2,500 gallons. Property 24060 is associated with the installation of the Nike Zeus system at LC-38, specifically the physical plant facilities constructed for the ZAR. Property 24060 likely supplied fuel to furnaces located within the nearby Property 24066, which was sometimes described as the "Heating Plant Building." While it is possible that Property 24060 stored fuel for the generators housed within Property 24068, these are described specifically as diesel, not LP, generators (WSMR 1959). It therefore seems more likely that Property 24060 supplied LP fuel to the heating equipment housed in Property 24066.

In 1964, the Nike Zeus program transitioned into the Nike X program. The ZAR receiver and transmitter apparently ceased operation as Nike Zeus progressed to Nike X, and these facilities were adapted for other purposes. However, as the fuel storage tank for heating equipment housed within Property 24066, Property 24060 likely remained in use through the late 1960s. A 1967 property management memo for the use of Properties 24062 and 24064 for the HAPDAR program noted that, "this will also necessitate operating 24066 and 24065 [central cooling and heating plant]," which was estimated to cost $50,000 per year (Goodrich 1967:2). Property 24060 was probably emptied and left in place when the heating and cooling equipment was removed from Property 24066 sometime in the early 1970s. At the time of the current inventory, the tank appeared to have been abandoned in place. The visible components of the tank installation suggested that it was likely in poor overall condition.

Figure 250. Property 24060, overview to the southeast.

Figure 251. Property 24060, concrete access vault, plan view.

Figure 252. Property 24060, access vault at base of vent, plan view.

7.6.7 Property 24063

Property 24063 is a concrete slab foundation located west of Property 24068 in the eastern portion of LC-38. The foundation is roughly T-shaped, with a narrow extension along its west side. The main part of the foundation is 12 by 12 feet, and the west extension is 4 feet wide by 6 feet long. The entire slab foundation is approximately 10 inches above grade. Pairs of ½-inch diameter anchor studs are located at the corners of the main part of the slab, and single anchor studs are located at the end of the west extension. The property number has been stencil-painted onto the surface of the foundation. No equipment remains installed on the pad today.

History of Use

Property 24063 was constructed in 1960 as a "Cooling Tower" according to a 1963 WSMR property inventory (WSMR 1963). The Form 2877 Real Property Record for the property also describes the structure as a cooling tower that was constructed in 1960. The cooling tower was apparently only in place for a few years, as realty records indicate that a Drayer-Hanson Model PF402 cooling tower was removed from the foundation and transferred to the Albuquerque District Engineer in 1966 (Goodrich 1966). This is consistent with the re-purposing of the as-

Figure 253. Property 24063, overview to the northwest.

sociated Property 24068, which took place in 1964 as LC-38 transitioned away from Nike Zeus testing to Nike X development, and the ZAR radars ceased operation. It does not appear that the foundation has been reused since the cooling tower was removed in 1966. Due to the removal of the cooling tower, the property is in poor overall condition.

Figure 254. Property 24063, view to the west.

Figure 255. Property 24063, stenciled property number, plan view.

7.6.8 Property 24065

Property 24065 is a wood-frame cooling tower structure located south of Property 24068 and east of Property 24066. The structure's outer walls are constructed on an above-grade concrete stem wall, while the interior portion of the concrete foundation is below-grade. Located across the below-grade portion of the foundation are square concrete footers that provide a base for the wood 4x4-inch beams that support the interior baffle of the cooling tower. The exterior cladding of the cooling tower is composed mostly of transite (asbestos and concrete composite) panels. Most of the tower's exterior wood framing consists of 1x4-inch (nominal) lumber, with interior framing of 2x4-inch and 2x6-inch (nominal) lumber. The flat wood frame roof of the structure supports three large cooling fans powered by electric motors, and the perimeter of the roof is equipped with a wood railing. The cooling fans are enclosed within wood frame housings. The body of the cooling tower is composed of wood framing and plastic baffles that cooled and condensed steam as it flowed down through the tower, with airflow provided by the large fans on the tower roof. The water collected in the below-grade portion of the tower foundation, which slopes towards the collection trench along its west side.

The east and west elevations of the cooling tower are generally similar in construction. The

Figure 256. Property 24065, north and west elevations, view to the southeast.

Figure 257. Property 24065, south and east elevations, view to the northwest.

east and west elevation walls are mostly clad in transite panels, angled to channel runoff into the tower. The lower part of both walls consists of wood louvers covered by construction mesh screens. Three steel 8-inch diameter pipes with valves are routed from the ground into the upper portion of the east elevation; these are the intake pipes that introduced heated water and steam into the top of the cooling tower. The west elevation is essentially identical, but a concrete outlet trench with steel tread cover plates is located along the base of the wall. Just west of the outlet trench feature are three cast-iron valve assemblies with 3-foot high risers and 20-inch diameter valve wheels. An electric pump and associated conduit are located at the base of the middle valve assembly. The outlet trench, approximately 8 feet deep, pooled the condensed steam and cooled water that passed through the tower. The collected water was then piped to the neighboring Property 24066, and the three valves controlled the outlet flow.

The north and south elevations of the tower are essentially identical as well. Transite panels cover both elevations, with narrow gaps along the lower walls above the foundation stem wall covered in construction mesh. The upper row of transite panels on the north elevation have fallen to the ground. The south elevation has a steel roof access ladder mounted to the wall, which connects to a wood landing that extends from the roofline.

Figure 258. Property 24065, east and north elevations and vents along foundation, view to the southwest (*left)*; drain into collection basin along west side of tower, view to the west (*right)*.

Figure 259. Property 24065, underside of condensing panels within tower (*left)*; footing and support hardware within tower base (*right)*.

Figure 260. Property 24065, cooling fans along roof of tower, view to the north (*left)*; drains along base of west wall of tower foundation, view to the southwest (*right)*.

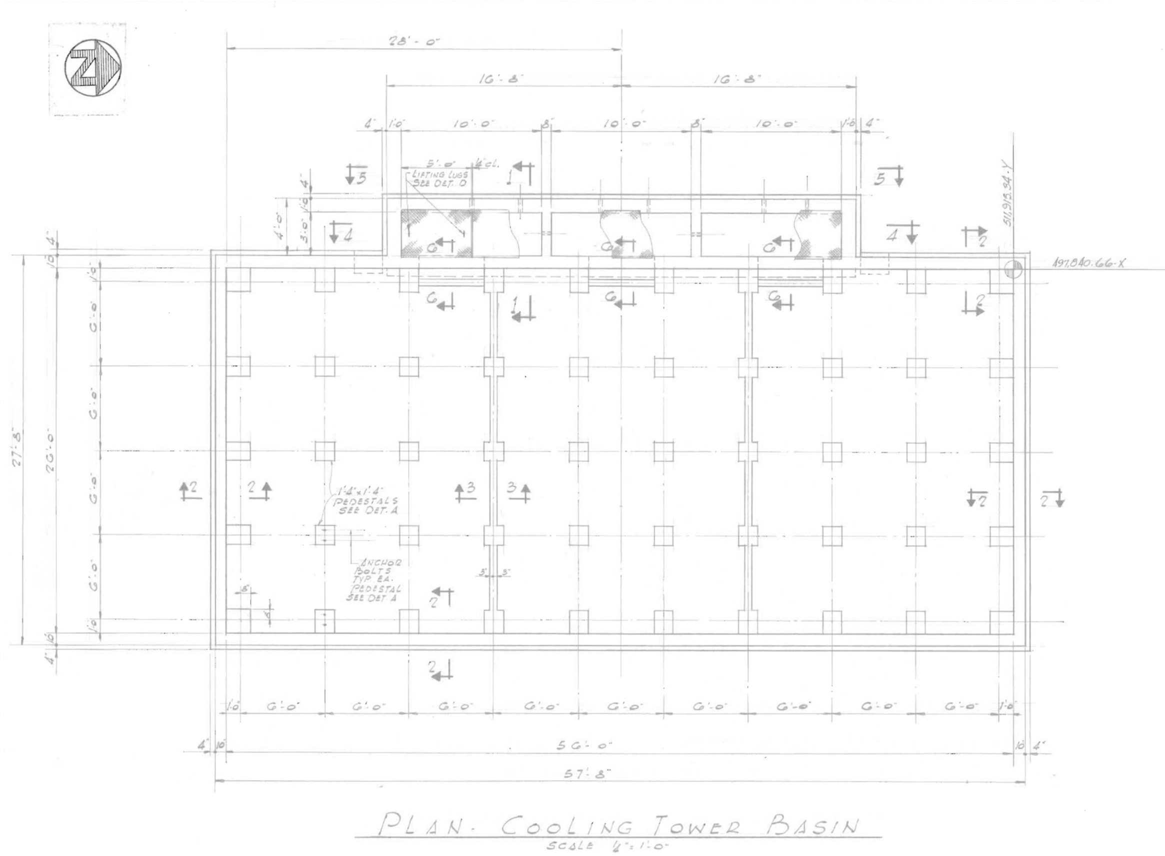

Figure 261. Property 24065, foundation plan from 1959 WS-IO plans.

History of Use

Property 24065 was constructed in 1959 as a "Cooling Tower" according to a 1963 WSMR property inventory (WSMR 1963). The building's Form 2877 Real Property Record describes it as "Cooling Towers" that were constructed in 1959. The original 1959 architectural plans for the structure refer to it as a "Cooling Tower" (per WS-IO Plan Set). The structure was designed, at least in part, by the A&E firm of Burns and Roe of New York for BTL, in cooperation with the USACE Albuquerque District. Property 24065 was part of the physical plant facilities that supported the nearby ZAR radar installations. The ZAR receiver and transmission equipment generated a substantial amount of heat, and keeping this equipment at proper operating temperatures required substantial heating and cooling facilities. Early in the development of LC-38, the designation "LAR" was often used for the ZAR facilities, which was divided into separate installations for the receiver (Properties 24062 and 24064) and the transmitter (Property 24072).

Property 24065 was closely associated with the operation of the neighboring Property 24066. Hot water and steam that had already passed through the ZAR receiver and transmitter installations were piped into Property 24065 through the inlet pipes along the east elevation. The heated water and steam were condensed and cooled as they passed through the tower into the collection trench along the west elevation. The water was then piped into Property 24066, where the water was chilled by the refrigeration units and again circulated back through the ZAR facilities. Smaller cooling towers are scattered across LC-38, but Properties 24065 and 24066 are the most impressive examples of this type of temperature control infrastructure.

Little additional information was available in WSMR realty records regarding the use of the structure after its construction. In 1964, the Nike Zeus program transitioned into the Nike X program. The ZAR was not utilized in the Nike X system, which incorporated early versions of phased array radar. Consequently, the ZAR receiver and transmitter ceased operation soon after Nike Zeus transitioned to Nike X, and these facilities were adapted for other purposes. The ZAR transmitter building (Property 24072) was eventually adapted as a hangar for aerial target drones, while the ZAR receiver building (Property 24064) was used for the ARPA HAPDAR program during the mid-1960s. As part of the heating and cooling plant for these properties, Property 24065 likely remained in use through at least the late 1960s. A 1967 property management memo for the use of Properties 24062 and 24064 for the HAPDAR program noted that, "this will also necessitate operating 24066 and 24065 [central cooling and heating plant]," which was estimated to cost $50,000 per year (Goodrich 1967:2). At the time of the current inventory, Property 24065 had not been used or maintained for quite some time, and was in fair overall condition.

Figure 262. Property 24065, collection trench and valves along base of west elevation, view to the south.

Figure 263. Property 24065, detail of wheel valve outside west elevation, plan view.

Figure 264. Property 24065, valves and collection trench along west elevation, view to the northeast.

7.6.9 Property 24066

Property 24066 is a one-story building of CMU wall construction located just north of Property 24068 and west of Property 24065. The building has a rectangular plan and is constructed on an above-grade concrete slab foundation. The building exterior, like most of the LC-38 buildings, is painted tan with brown trim elements. The upper course of CMU masonry on the east and west elevations incorporates a concrete bond beam for the attachment of the steel roof joists. The building has a flat roof with gutters and downspouts installed on each elevation. A grounding system with lightning rods is installed along the perimeter of the roof. The building lacks any windows, but has several entrances.

The building's east elevation has an overhead roll-up bay door near the center of the wall, above which is a sealed floodlight fixture. A short concrete ramp is located at the base of the door. To the south of the bay door is a louvered vent panel in the upper wall. Near the north end of the wall, a pipe riser is routed into a valve assembly that is covered by a large sheetmetal box. Four discarded file safes are located outside the east elevation. The file safes are constructed of heavy gauge steel and equipped with combination locks, and two are labeled as "1,090 LB." The locking mechanisms on several of the safes has been cut through with an electric saw.

Figure 265. Property 24066, east and north elevations, view to the southwest.

Figure 266. Property 24066, west and south elevations, view to the northeast.

The north elevation is mostly plain, with a single-leaf entrance located near the west end of the wall. This entrance is equipped with a steel faux-panel door with a sealed overhead light fixture. At the center of the elevation, a rectangular concrete curb surrounds a concrete slab at the base of the wall. Within this curbed area is an old steel pressure vessel, the base of a rusted-out tank, and large eroded block of salt. A small, square wood-framed port is located in the center of the wall near the pressure vessel. At the base of the pressure vessel is a large pile of bat guano, and a few bats were nested in the square wall port. This arrangement is the remains of a water softener unit that was installed outside the north elevation.

The west elevation is plain and devoid of fenestration. A fenced electrical substation enclosure abuts the south half of the west elevation, and is signed as "GROUND-BANK STATION NO. 73." Along the portion of the west elevation within the fenced enclosure, several electrical boxes and panels are mounted to the wall, and a cable tray is routed through the upper wall. Outside the fenced enclosure, near the north end of the wall, a louvered vent panel is installed in the upper wall. The vent panel is covered by a sheetmetal housing or baffle. Near the northwest corner of the building is a small steel LP tank, which has the stenciled property number "21633."

The south elevation has a single-leaf entrance located near the west end of the wall, which is equipped with a steel faux-panel door and a sealed overhead light. Routed through the upper wall of this elevation are two large pipes that connect to the north elevation of the neighboring Property 24068. The pipes are elevated on steel supports approximately 10 feet above the ground, allowing the passage of personnel and most vehicles beneath the elevated pipes.

History of Use

Property 24066 was constructed in 1959 as the "ZAR Annex Rec Bldg" according to a 1963 WSMR property inventory (WSMR 1963). The building's Form 2877 Real Property Record describes it as a "Heating Plant Bldg" of 2,880 square feet. The original 1959 architectural plans for Property 24066 identify it as the "LAR Receiver Annex" (per WS-IO Plan Set). The building was designed by the A&E firm of Burns and Roe of New York for BTL, in cooperation with the USACE Albuquerque District. Property 24066 was part of the physical plant facilities that supported the nearby ZAR radar installations. Early in the development of LC-38, the designation "LAR" was often used for the ZAR facilities, which was divided into separate installations for the receiver (Properties 24062 and 24064) and the transmitter (Property 24072). The ZAR receiver and transmission equipment generated a substantial amount of heat, and keeping this equipment at proper operating temperatures required substantial heating and cooling facilities. The construction of Property 24066 is described in a 1959 summary of the WSMR Nike Zeus facilities as:

> This building is of masonry construction and is approximately 51

Figure 267. Property 24066, file safes outside east elevation. view to the west.

Figure 268. Property 24066, south and east elevations, view to the northwest.

Figure 269. Property 24066, former water softener unit outside north elevation wall, view to the north.

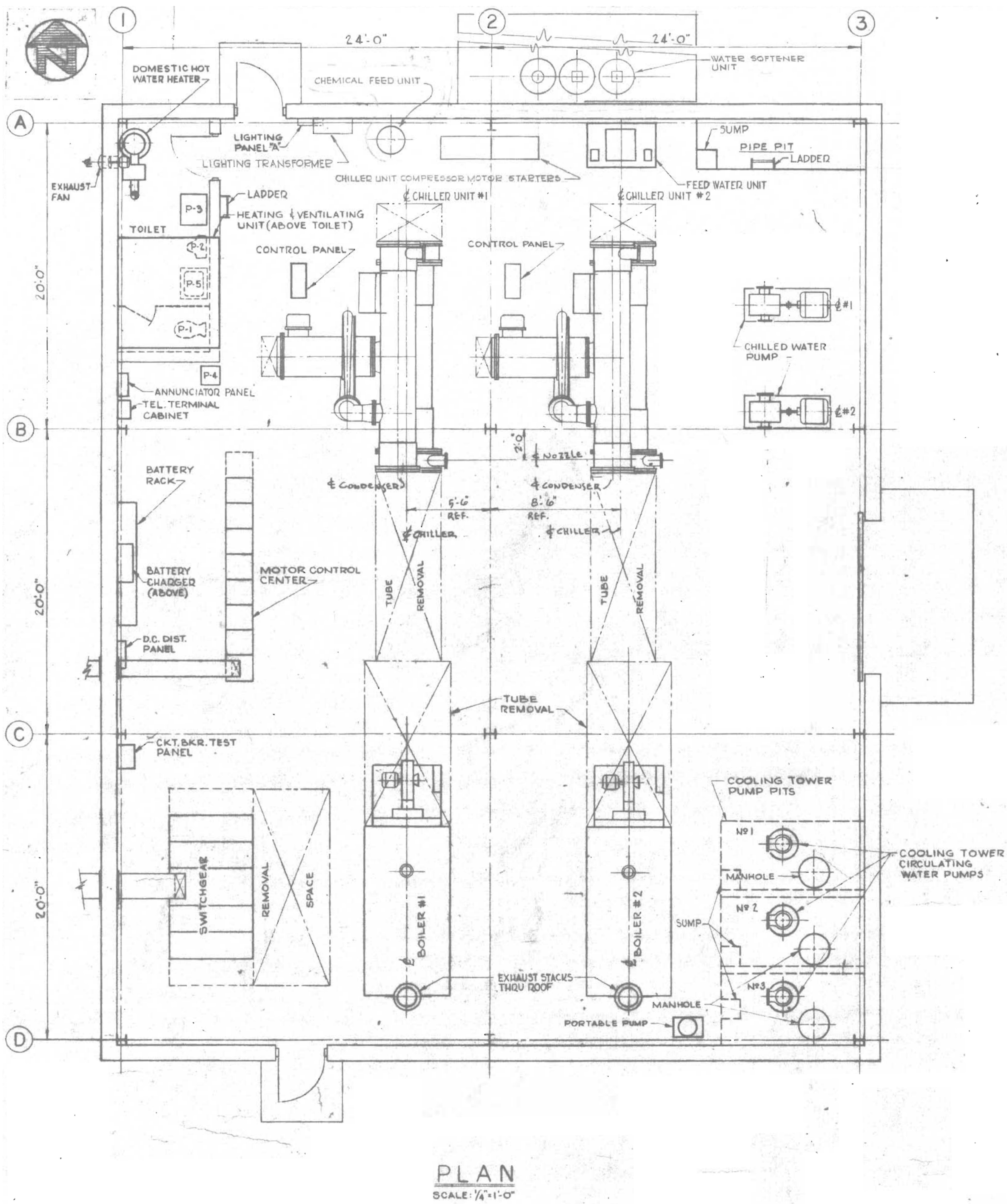

Figure 270. Property 24066 floor plan from 1959 WS-IO plans.

> by 63 feet. The building houses refrigeration and heating equipment for the LAR area as well as a 5,000 KV-A transformer station. Associated with the structure is a cooling tower. Two 350-ton refrigeration units are located within the building. Chilled water and steam are piped from this building to the LAR Receiver and Transmitter buildings [WSMR 1959:63].

As the above description indicates, Property 24066 was associated with the nearby cooling tower structure (Property 24065). Heated water and steam that had already passed through the ZAR receiver and transmitter installations were piped into the cooling tower, where they were condensed and cooled before being piped into Property 24066. Within this building, the water was chilled by the refrigeration units and again circulated back through the ZAR facilities. Smaller cooling towers are scattered across LC-38, but Properties 24065 and 24066 are the most impressive examples of this type of temperature control infrastructure.

Little additional information was available in WSMR realty records regarding the use of the building after its construction. A monorail and 1-ton hoist were added to the building's interior in 1961. In 1964, the Nike Zeus program transitioned into the Nike X program. The ZAR receiver and transmitter apparently ceased operation as Nike Zeus progressed to Nike X, and these facilities were adapted for other purposes. The ZAR transmitter building (Property 24072) was eventually adapted as a hangar for aerial target drones, while the ZAR receiver building (Property 24064) was used for the ARPA HAPDAR program during the mid-1960s. As the primary heating and cooling plant for these properties, Property 24066 likely remained in use through at least the late 1960s. A 1967 property management memo for the use of Properties 24062 and 24064 for the HAPDAR program noted that, "this will also necessitate operating 24066 and 24065 [central cooling and heating plant]," which was estimated to cost $50,000 per year (Goodrich 1967:2). At the time of the current inventory, Property 24066 did not appear to be regularly used or maintained, and was in good overall condition.

7.6.10 Property 24068

Property 24068 is a large physical plant building of mixed steel panel and CMU construction. Structural portions of each elevation are constructed of CMUs, with sections of steel panel construction identified as “structural insulating wall panels” in the building’s architectural plans (Plan Set WS-JE). The two-story building has a mostly square plan, with a projecting CMU block along the south elevation. The building is constructed on an at-grade concrete slab foundation with separate concrete foundation pedestals for the main support columns. A below grade portion of the foundation is located beneath the projecting block on the south elevation. Like most of the LC-38 buildings, the building’s exterior is painted tan with brown trim elements. The building’s gable roof has a very shallow pitch and is of built-up construction atop steel joists. A series of square housings are located along the east roof slope. The largest of these square housings, at the south end of the roof, is described in the architectural plans as a “penthouse,” that housed a “heat recovery silencer” exhaust unit (Plan Set WS-JE). The four additional square housings along the east roof slope are smaller and housed “condensing coil roof ventilators” per the architectural plans (Plan Set WS-JE). The roof also originally supported three large silencer (muffler) units for the large diesel generators housed within the building, but these have been removed.

Figure 271. Property 24068, north elevation, view to the south.

Figure 272. Property 24068, west and south elevations, view to the northeast.

The building's north elevation serves as the principal elevation, approached via a short access road from Range Road 240. The east and west portions of the wall are of CMU construction, with the center portion of the wall of steel panel construction. The upper portion of the south elevation's east side is composed of louvered vent panels, a continuation of the vent panels found along the east elevation. In the central steel panel portion of the south elevation is an overhead roll-up bay door. Based on comparison with the building's architectural plans, this bay door is a later alteration to the building. To the west of the bay door is a single-leaf personnel entrance with a steel slab door. In the upper portion of the steel panel wall section is a ribbon window panel composed of six windows. The individual windows each have three horizontal lights with opaque glass and fixed operation. This ribbon window originally consisted of eight window units, but the center two units have been replaced with a louvered vent panel. In the lower west portion of the south elevation, several pipes and conduits from the neighboring Property 24066 are routed through the wall.

The building's west elevation includes narrow sections of CMU at its north and south ends, but the majority of the wall is constructed of steel panels. In the upper middle portion of the wall is a ribbon window section composed of seven windows. The individual windows are fixed with two horizontal lights with opaque glass. Below the ribbon window panel, at the base of the wall, are two large HVAC units mounted on steel stands. Each of the HVAC units has associated ductwork routed through the adjacent portion of the building wall. At the north and south ends of the wall are single-leaf entrances with steel slab doors. Two circular vent assemblies are located near the south entrance. Above each of the entrances, in the upper wall, are large square openings that have been covered with plywood; these were originally louvered intake vents. A vent panel in the upper south portion of the wall has an exterior steel cover that is labeled as a "sand baffle" in the architectural plans (Plan Set WS-JE). Overhead flood lights are attached to the upper wall near the roofline, and this elevation is equipped with gutters and downspouts.

The building's south elevation is generally similar to the north elevation in its construction, with CMU construction at the east and west ends and steel panel construction composing the center of the elevation. However, the east end of the wall is occupied by a projecting two-story CMU block. Like the north elevation, the south elevation has an overhead roll-up bay door in the center of the wall, which is a later alteration to the building. To the west of the bay door is a single-leaf personnel entrance with a steel slab door. In the upper portion of the steel panel wall section is a ribbon window panel identical to the arrangement described in the north elevation. Additional single-leaf entrances are located in the east and west CMU wall sections, each of which are equipped with steel slab doors. Two circular vent housings are located in the west end of the wall, similar to the housings on the west elevation. Visible above the south elevation roofline is a tall exhaust stack and the exhaust penthouse near the southeast corner of the roof.

The east elevation has a section of CMU

Figure 273. Property 24068, north and west elevations, view to the southeast.

Figure 274. Property 24068, north and west elevations, view to the southeast.

Figure 275. Property 24068, east and north elevations, view to the southwest.

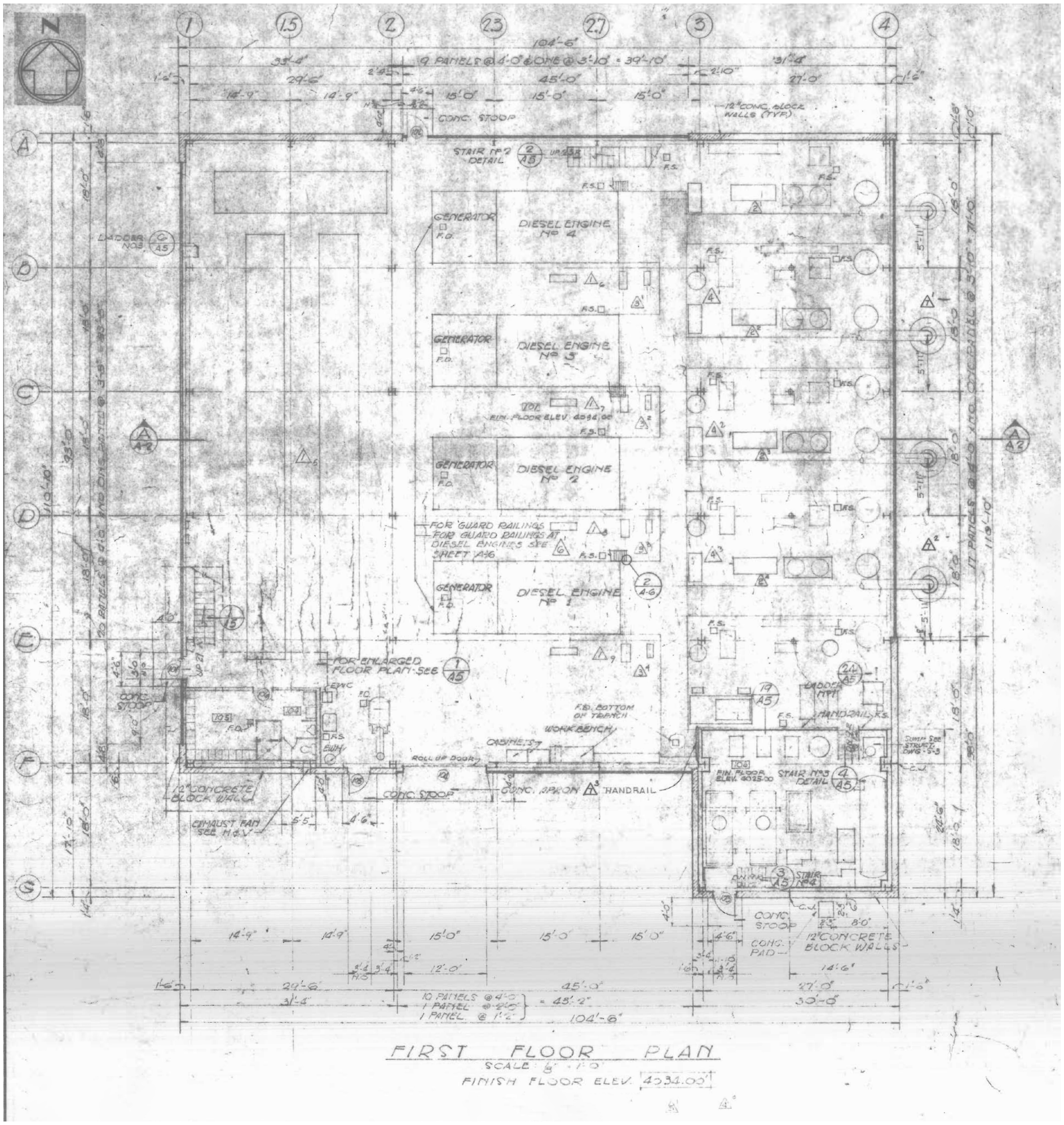

Figure 276. Property 24068, first floor plan from 1960 WS-JE plans.

wall construction that forms the southern third of the wall, while the remainder of the wall is constructed of steel panels and louvered vent panels. No fenestration is located in this elevation. The louvered vent panels form the upper half of the steel wall section, and wrap around onto the north elevation. Visible above the roofline along the east elevation are the exhaust penthouse and smaller square housings for the roof ventilators. Three wall-mounted HVAC units are installed along the lower portion of the steel panel wall section. A series of shipping containers are parked outside the east elevation, along with truck tires, pallets, oil drums, and wheel chocks.

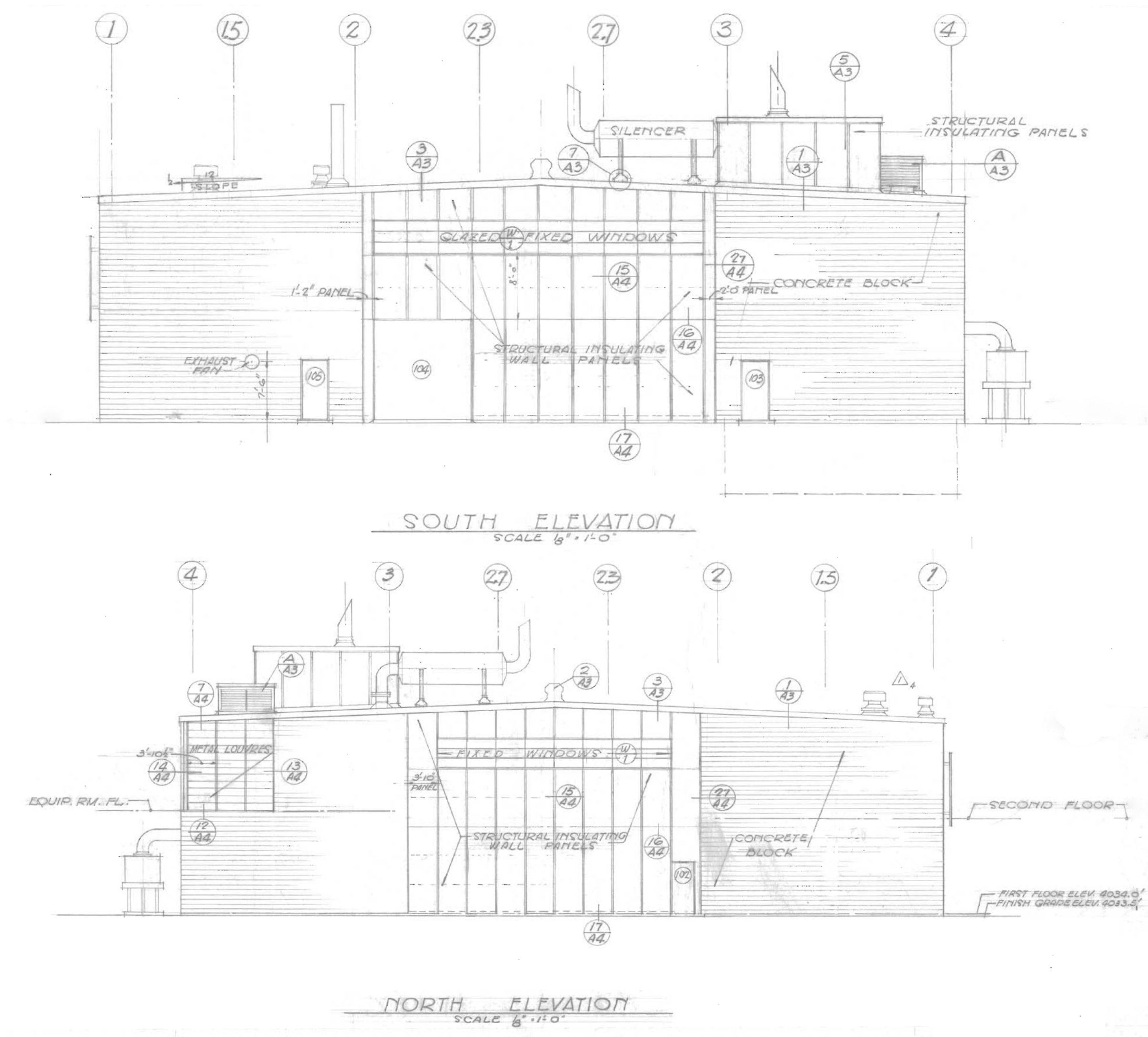

Figure 277. Property 24068, south and north elevations from 1960 WS-JE plans.

History of Use

Property 24068 was constructed in 1960 as the "Generator Bldg" according to a 1963 WSMR property inventory (WSMR 1963). The building's Form 2877 Real Property Record describes it as a "GM Mnt Fac" of 14,888 square feet constructed in 1960. The original 1959 architectural plans for Property 24068 identify it as the "Diesel Engine Power Plant" (per WS-JE Plan Set). The building was designed by the Ralph M. Parsons Company, an A&E firm based in Los Angeles, in cooperation with the USACE Office of the District Engineer out of Mobile, Alabama.

Property 24068 was a power plant facility that supplied the Nike Zeus radars at LC-38 with a power supply that was independent of the area power grid. The numerous large radars involved in the Nike Zeus system would have required a substantial amount of electrical power to oper-

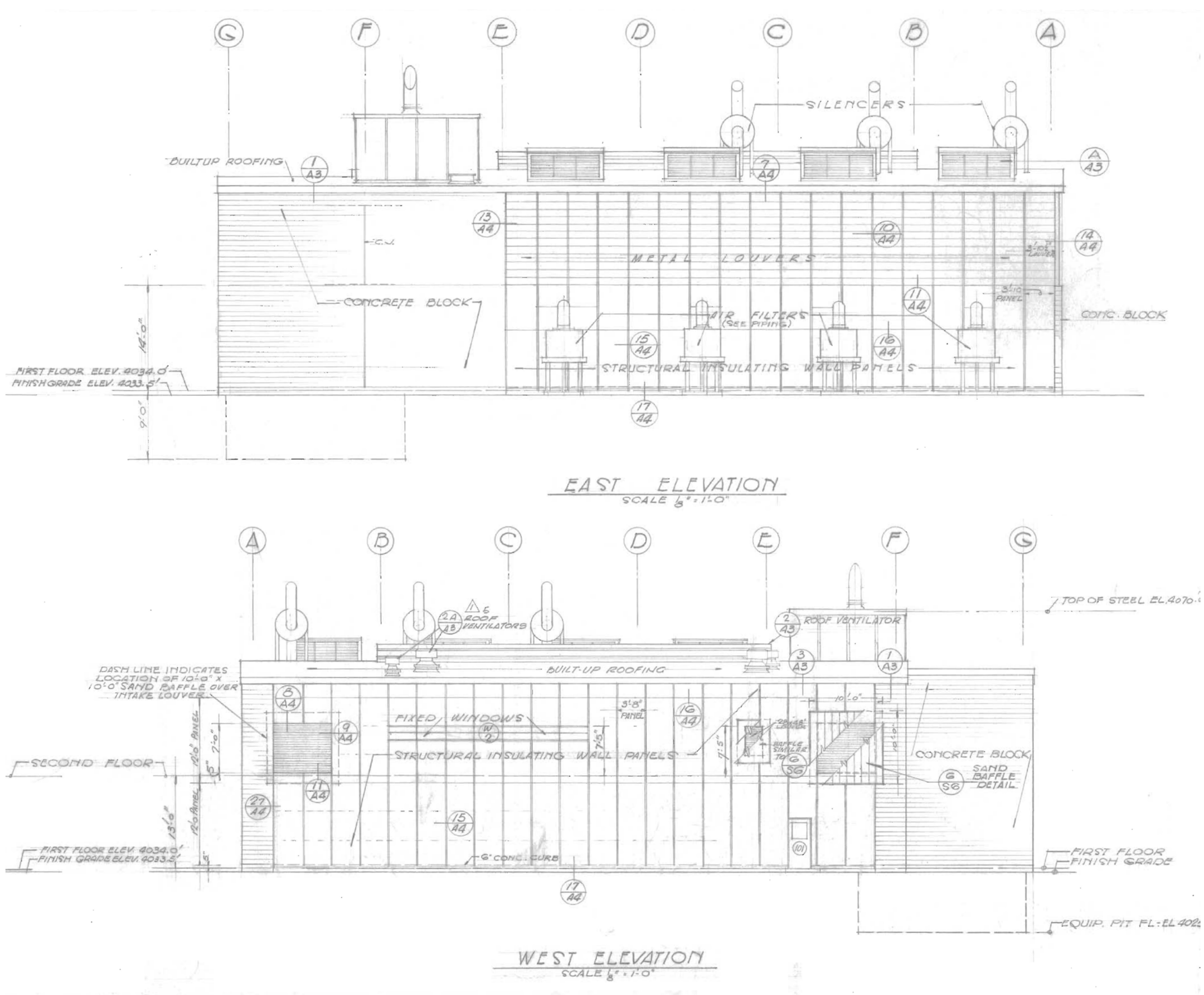

Figure 278. Property 24068, east and west elevations from 1960 WS-JE plans.

ate, much more than the shorter range, semi-mobile radars that were used in the original Nike Ajax system. Based on period descriptions, Property 24068 allowed BTL to evaluate how well the Nike Zeus system operated when using an off-grid, independent power plant. An independent power source similar to the power plant housed within Property 24068 would have been part of Nike Zeus installations had the system actually been deployed, and it was important to understand how the system tolerated a generator-based off-grid source of electrical power. The purpose of Property 24068 is described in a 1959 summary of the WSMR Nike Zeus facilities as:

> Details of this construction are not finalized for bid as yet. It is expected that four 1,750 KV-A diesel units with the necessary control and switching equipment will be located in a concrete building. Associated with this building will be a diesel fuel storage area. This power plant will be used to assure system compatibility when operating from an electric source of this nature. The power

> plant will be completely isolated from the commercial power system presently in use in ALA 5. The building will contain special equipment as required for satisfactory maintenance and operation [WSMR 1959:85].

The building served as a power plant for the Nike Zeus program at LC-38 until 1964, when Nike Zeus transitioned into the Nike X program. According to property disposition records, Property 24068 was temporarily transferred to the USACE Albuquerque District in 1964 so that the power generation equipment could be removed from the building, and some repairs and alterations made so that the building could be used for other purposes (LaTourrette 1964; Niles 1964). The USACE transferred the power generation equipment to the NASA George C. Marshall Space Flight Center Mississippi Test Site through a joint agreement between WSMR, NASA, and the USACE (Goodrich and Nagle 1963). In December 1964, the building was assigned to AMTED to provide temporary storage for the ARPA Rondo and HAPDAR programs (Atha 1964). The building continued to be used for the HAPDAR program until mid-1965, and was then assigned to the Fort Bliss Centralized Training School for storage of equipment used for Nike X training activities (Estep 1965; Rottstedt 1967). A 1967 memo requested that this assignment be terminated and the equipment removed from the building so that it could be used for target missile assembly activities (Ferdig 1967; Rottstedt 1967). A 1968 property transfer record states that the building was converted to a "Guided Missile Maintenance Facility" used for assembly purposes (Kearns 1968). No additional information was available in WSMR realty records regarding the use of the building after 1968, but it was likely used by Raytheon for the SAM-D program, as was the case with many of the LC-38 facilities.

At the time of the current inventory, the building appeared to remain in use and was well-maintained. The equipment stored in the parking areas to the south and east of the building suggested that it is probably used as a storage and maintenance facility for ongoing work with the Patriot missile.

7.6.11 Property 24069

Property 24069 is a concrete slab foundation located west of Property 24068 in the eastern portion of LC-38. This rectangular slab foundation measures 20 by 29 feet and is partially obscured beneath windblown sediment. There are no anchors or attachment hardware visible on the foundation and it does not appear to have ever supported a building or structure. A variety of equipment that is apparently related to the Raytheon Patriot PAC-2 program was stored on and around the foundation at the time of recording.

History of Use

Property 24069 was constructed in 1969 as a “Con Instrument Pad” according to its Form 2877 Real Property Record; however, notes on the Form 2877 clarify that the structure was an “engine stand east of 24068.” No further information regarding the history of the property is available. The use of the foundation as a location for testing or “run-up” of engines is consistent with the lack of hardware installed in the foundation, since this type of activity would not require a building or structure to be constructed on the foundation. The property does not appear to have received any meaningful use in many years, and remains in fair overall condition.

Figure 279. Property 24069, overview to the southeast.

7.6.12 Property 24070

Property 24070 is a one-story steel frame building built on concrete footings. The concrete footings support the building's main support posts with a separate concrete slab within the interior. The edges of the interior slab are eroded and undermined around its exposed outer edges. The walls and low pitch gable roof of the building are clad in corrugated sheetmetal. The south, east, and west elevations of the building are plain and devoid of fenestration. The only doors in the building are located on the north elevation, which is equipped with six sliding doors hung on an overhead support frame. The support posts for the door frame are anchored to concrete footings outside the northeast and northwest corners of the building. The doors are constructed with steel frames and clad in corrugated sheetmetal, and guide rails in the foundation keep the sliding doors aligned with the upper support frame. The support frame for the doors extends past the ends of the building, which allows the north elevation to be opened along its entire width when the doors are fully retracted. A wide concrete apron runs along the base of the north elevation, providing an exterior work area. A small electrical transformer is located on a concrete slab outside the northwest corner of the building, and a water hydrant is located outside its northeast corner. Various items of discarded equipment and materials are located around the building, including electronics cabinets, milled lumber, and a generator

Figure 280. Property 24070, north and west elevations, view to the southeast.

Figure 281. Property 24070, south and east elevations, view to the northwest.

unit. At the time of the inventory, the building appeared to unused and unmaintained, but it remained in good overall condition.

History of Use

Property 24070 was constructed in 1960 as an "Aircraft Hangar" according to a 1963 WSMR property inventory (WSMR 1963). Property records for the building were not available at WSMR DPW, so little information is available regarding its history and use. The building is connected to a landing strip to the north (Property 24075) via an asphalt taxiway, and apparently served as a hangar for small aircraft. The sliding hangar doors on the north elevation would have facilitated the movement of small aircraft in and out of the building. The LC-38 aircraft runway and hangar are unique among the WSMR launch complexes along Nike Avenue; none of the other launch complexes possessed its own aircraft runway facilities.

Property 24070 and the associated taxiway and runway were constructed as part of the AIL facilities at LC-38, which were used to calibrate the ZAR. These facilities supported a special aircraft outfitted with radar instrumentation used to calibrate the ZAR receiver and transmitter. The ZAR calibration work with the AIL was completed by mid-1960 (Stevenson et al. 1961:70). A 1961 summary of the Nike Zeus program at LC-38 describes the construction of these facilities:

On 12 November 1959, H.B. Zachary & Company of San Antonio, Texas, under a $30,380 contract, began to construct the Airborne Instrument Laboratory [AIL] facilities, which consisted of a 2,000-foot compacted earth runway, a small aircraft hangar, and pads for various modified Hercules radars and instrument vans. Zachary completed the project on 8 January 1960, and the modifications to it, costing an additional $14,837.81, on 18 February 1960. Meanwhile, the Nike Zeus Project had accepted the AIL facility from the contractor on 11 December 1959 [Stevenson et al. 1961:57].

Figure 282. Property 24070, east and north elevations, view to the southwest.

Property 24075 is shown on 1970s maps as a helipad, and Property 24070 likely remained in use through the 1970s in association with the use of Property 24075 as a helipad. However, at the time of recording, the associated Property 24075 runway is in an advanced state of deterioration and is no longer useable as a runway, so it is unlikely that Property 24070 is used as a hangar today. However, it remains in good overall condition and is likely used as a storage building.

Figure 283. Property 24070, detail of north elevation sliding doors, view to the west.

Figure 284. Property 24070, detail of southwest foundation corner, view to the northwest.

7.6.13 Property 24075

Property 24075 is a decommissioned compacted earth runway located in the east-central portion of LC-38, north of Range Road 240. Property 24075 was approximately 3,000 feet in total length, with vegetation cleared to a width of 150 feet, while the actual graded portion of the runway was approximately 50 feet in width. The entire runway surface has been destroyed and is only visible on the ground as a cleared linear alignment associated with a notable amount of structural debris, including concrete, asphalt, and rebar. Fragmentary elements of light bezels, conduit, and structural tile (sometimes referred to as "pen-tile") are also mixed into the debris associated with the runway alignment. At the ends of the runway alignment are L-shaped wood frames built of milled lumber, mostly 2x4-inch boards and plywood, each measuring approximately 5 feet tall by 3 feet wide. Neither of the wood frames are located on foundations. These might be the remnants of "runway markers" identified at each end of the runway in architectural plans (Plan Set WS-JP). Near the northeast end of the runway is a thick wood framework held together with steel straps. The purpose of this frame is unknown, but it might have served as some sort of barricade at the end of the runway. A two-track road has been established along portions of the former runway alignment. Near the midpoint of the landing strip alignment is an associated parking apron area, and an asphalt taxiway (Property 24076) connects the parking

Figure 285. Property 24075, view of landing strip alignment from northeast end, view to the southwest.

Figure 286. Property 24075, wood frameworks at northeast end of landing strip, view to the east (*left)*; detail of wood framework at northeast end of landing strip, view to the northeast (*right)*.

Figure 287. Property 24075, heavy wood barricade framework near northeast end of landing strip, view to the southeast (*left)*; cast steel conduit debris along runway, plan view (*right)*.

Figure 288. Property 24075, brick fragment in runway debris, plan view (*left)*; view down taxiway towards Property 24070, view to the south (*right)*.

Figure 289. Property 24075, view down landing strip from southwest end, view to the northeast.

apron with an associated hangar building (Property 24070). None of these properties are used today, and the entire length of the Property 24075 runway alignment is unusable for aircraft.

History of Use

Property 24075 was constructed in 1959 as an "Aircraft Runway" according to a 1963 WSMR property inventory (WSMR 1963). The 1959 architectural drawings for the runway indicate that the southwest half of the runway was already established, and a 1,000-foot extension was added, along an additional 500-foot cleared safety area at the end of the runway (Plan Set WS-JP). The architectural drawings were prepared by the A&E firm of Burns and Roe of New York for BTL, in cooperation with the USACE Albuquerque District.

Property 24075 was constructed along with a small aircraft hangar (Property 24070), taxiway (Property 24076), and pads for modified Nike Hercules radars (Properties 24077 and 24078) in support of the AIL, which was a special aircraft outfitted with radar instrumentation used to calibrate the ZAR receiver and transmitter. The ZAR calibration work with the AIL was completed by mid-1960 (Stevenson et al. 1961:57, 70). The LC-38 aircraft runway and hangar are unique among the WSMR launch complexes along Nike Avenue; none of the other launch complexes possessed its own aircraft runway facilities.

The runway was originally constructed with a compacted-earth surface, but might have been surfaced with bituminous asphalt paving later. Maps from 1978 show Property 24075 as the "Launch Complex 38 Helipad" with designated takeoff safety zones and approach departure zones both in line with the runway alignment and perpendicular to it. In its role as a helipad, the runway might have been asphalt-surfaced at this time. No additional property records or documentation are available for Property 24075, so it is not known how long it remained in use after 1978. The runway and taxiway are no longer in useable condition today, and any paved surfacing has been removed. The associated Property 24076 taxiway is unmaintained and overgrown. Structural debris associated with the runway was likely introduced from the demolition and removal of nearby Properties 24062 and 24064. It appears that some of the structural debris from the removal of these properties was spread along the Property 24075 runway alignment, or that the runway was used as a staging area for loading the debris into trucks. Property 24075 is in poor overall condition and retains minimal integrity.

7.7 Instrumentation Facilities

A variety of instrumentation facilities are located within the boundaries of LC-38, although they were not necessarily dedicated to the Nike Zeus testing mission. For the purposes of this report, these properties are therefore considered to be functionally separate from the Nike radar and guidance facilities constructed at LC-38 as part of the 1950s Nike Zeus testing effort. The Seus Site includes several examples of standardized instrumentation properties that were constructed across WSMR (Properties 23629, 24008, and 24015). Several additional instrumentation properties were constructed throughout LC-38 in support of later programs. In addition to these range instrumentation sites, one small building (Property 23629) along the south boundary of LC-38 provides access to buried communications installations along the north side of Nike Avenue.

7.7.1 Property 23605

Property 23605 is a concrete slab foundation associated with a mobile radar site in the southwestern corner of LC-38. Both this concrete foundation and the adjacent radar site are located atop an elevated, gravel-surfaced earthen mound. A similar mobile radar site and associated pad are located approximately 200 meters to the west. The property consists of an at-grade concrete slab foundation that measures approximately 50 by 16 feet. According to its Form 2877

Figure 290. Property 23605, overview to the southeast.

Real Property Record, the 9-inch thick concrete slab foundation was constructed atop 6 inches of compacted subgrade and included 6 by 8-foot stabilized shoulders. Property 23605 is accessed via a dirt access road that extends north from Nike Avenue. Four T-shaped steel anchors are bolted to the concrete pad near each corner and appear to have served as guy line anchors. The property number is stencil-painted on the northwest corner of the concrete foundation.

Figure 291. Property 23605, pad surface with anchors, view to the east.

History of Use

Property 23605 was constructed in 1972 as an "Elect Eqp Fac" according to its Form 2877 Real Property Record. Notes on the Form 2877 form further describe the property as, "BORESIGHT" and "control pad for van." Based on this information, Property 23605 appears to have served as a location for a mobile control van that operated the radar on the neighboring radar pad to the north, which includes a concrete mounting pedestal for a trailer mounted radar. While the radar pad installation to the west is nearly identical, the associated control van pad lacks a concrete slab and was not assigned a WSMR property number. Property 23605 and the associated radar pedestal pad were both constructed in the early 1970s, when the SAM-D/Patriot program was the most active program at LC-38. While the property does not appear to have been recently used, it remains in good overall condition.

Figure 292. Property 23605, anchor detail, plan view.

7.7.2 Property 23610

Property 23610 is a large, one-story building of CMU wall construction, which is located along the east side of Range Road 239, north of Property 23632. The building has a rectangular plan and is constructed on an above-grade concrete slab foundation. The building exterior, like most of the LC-38 buildings, is painted tan with brown trim elements. The building's low-pitch shed roof is of built-up construction atop steel joists, and drains to the east. The roof lacks an eave, but its fascia is clad with sheetmetal flashing with guttering and downspouts installed along the east elevation. A grounding system with lightning rods is installed along the perimeter of the roof. The building is mostly devoid of fenestration, except for entrances on the south and west elevations.

The building's south elevation acts as the principal elevation, with a double-leaf entrance enclosed within a CMU entry porch with a concrete slab roof. The entry doors are steel slabs with large square upper lights with wire-embedded safety glass. Another double-leaf entrance is located on the west side of the south elevation. This entrance accesses a utility room within the interior, and has plain steel slab doors. Between the two entrances is a louvered vent panel mid-wall and an HVAC unit on a concrete slab at the base of the wall. Floodlights are attached

Figure 293. Property 23610, south and east elevations, view to the northwest.

Figure 294. Property 23610, north and west elevations, view to the southeast.

to the upper corners of the south elevation wall. Outside the southwest corner of the building is a generator unit installed on a concrete slab within a fenced enclosure.

The west elevation has a single-leaf entrance at the north end of the wall. The plain steel slab door is accessed via a concrete entry stoop and a sealed floodlight is mounted to the wall above the door. At the south end of the wall are two louvered vent panels located mid-wall. The east elevation is plain and lacks fenestration, with a row of conduits located at mid-height along its north half. Several small vent hoods and electrical boxes are mounted to the west elevation wall, and an old barbeque grill made from a barrel is located along this side of the building.

The north elevation is also plain and lacks any fenestration. The east and west elevation walls extend slightly beyond the north elevation wall, giving it a recessed presentation. Two HVAC units are located on a concrete slab foundation outside the building's northeast corner.

History of Use

Property 23610 was constructed in 1969 as the "Xmtr Bldg Rdo" that enclosed 2,986 square feet according to its Form 2877 Real Property Record. The original 1969 architectural plans for Property 23610 identify it as a "Communications Building" (per WS-QE Plan Set), and a

1974 WSMR property inventory identifies it as the "Communications Relay Building" (WSMR 1974). An identical building (Property 20803), was constructed at LC-33 as part of the same contract. Both buildings supported the WSMR communications network, and later supported the broader transition to fiberoptic communications cable that took place across WSMR during the 1980s. There is little additional information in WSMR realty records regarding the use of the building after 1969, and it appears to be little changed since it was originally constructed. Property 23610 is well-maintained and in good overall condition.

Figure 295. Property 23610, south elevation, view to the north.

Figure 296. Property 23610, east elevation, view to the northwest.

Figure 297. Property 23610, north and east elevations, view to the southwest.

7.7.3 Property 23615

Property 23615 is a concrete slab foundation located north of Property 23626 in the southern part of LC-38. This slab foundation is located south of the former Balloon Support Building (demolished). The foundation measures 50 feet east-west by 15 feet north-south, and the property number is stencil-painted on the northwest corner of the foundation. A recessed anchor loop is located in the middle of the slab foundation. A variety of discarded equipment and materials are associated with the foundation, including a rectangular steel frame with remnants of dry-rotted canvas, various pieces of ductwork, and milled lumber. An electrical service box is located to the north of the foundation, between it and the Balloon Support Building foundation. There is no indication that a building was located on the foundation, as there is no visible attachment hardware on the foundation.

History of Use

Property 23615 was constructed in 1968 as a "Detect Eqp Fac" according to its Form 2877 Real Property Record. Disposition records describe the property as an "engine runup pad" for "Target Missile - Ryan Contractor use" (Jackson 1969:1). Ryan was the major contrac-

Figure 298. Property 23615, overview to the southeast.

tor at WSMR for operation of aerial target drones, so it seems that this pad was used for static testing of drone motors and other target vehicles. The pad was re-assigned to ARMTE in 1969 (Field 1969). The property does not appear to have been used in many years and is in fair overall condition.

Figure 299. Property 23615, steel frames on foundation, view to the southeast.

Figure 300. Property 23615, ductwork sections on foundation, view to the east.

7.7.4 Property 23619

Property 23619 is an elevated antenna platform located in the southern part of LC-38, west of Property 23626. The tower is accessed via a short dirt access road that extends north of Nike Avenue. The platform is supported by four wood poles with horizontal timber cross braces. Each pole is stabilized with three cable guy lines, which are connected to opposing tower supports and to the ground. The upper platform of the tower is built around a steel frame that is surfaced with corrugated sheetmetal. The rectangular platform has a perimeter hand rail made of tubular steel, and is accessed by a steel ladder enclosed within a safety cage attached to the southeast support pole. Located between the tower support legs is a remnant circular concrete foundation that the tower was apparently constructed over. Several square concrete footers are associated with the circular foundation. A brass survey datum associated with these older footers is marked "WHITE SANDS PROVING GROUND / GEODETIC CONTROL STATION / F.D.L 272."

Figure 301. Property 23619, overview to the southwest.

History of Use

Property 23619 was constructed in 1978 as an "Elct Eqp Fac" according to its Form 2877 Real Property Record. Notes on the Form 2877 provide some additional details: "the antenna tower is located on an earth mound consisting of four each wooden poles and is a fixed elevated platform." No additional information is available regarding how the property was used or what programs it might have supported. There is some discrepancy in the "23619" property number assigned to the property. The "23619" number was originally assigned to the former support building at the VEE Balloon Support Area, located to the north of Property 23626. This building has been demolished, and only the foundation remains today. The property number was apparently re-assigned to the antenna tower after the balloon support facility was demolished. At the time of recording, the current tower structure appeared to be in good overall condition.

Figure 302. Property 23619, WSPG brass datum near base of tower, plan view.

Figure 303. Property 23619, remnant concrete footings at base of tower, view to the north.

Figure 304. Property 23619, round concrete slab under tower, view to the east.

7.7.5 Property 23629

Property 23629 is located on the northeast corner of the intersection of Nike Avenue and Range Road 239 in the southern portion of LC-38. Property 23629 is a small, reinforced concrete building that provides below-grade access to fiber optic and electrical cable installations. The building measures approximately 7.5 feet square and is sheltered by a concrete slab roof that extends over the walls about 6 inches on all elevations. A steel plate personnel access door is located on the north elevation and downward-facing steel vent tubes are located on the east and west elevations. Though the building appears to be constructed at grade on an at-grade concrete foundation, the building actually extends partially below grade to provide access to the fiber optic and electrical cable installations installed along the north side of Nike Avenue. Within the building interior, a narrow ledge along the base of the wall would have supported floor panels, but no such panels remain within the building.

History of Use

Property 23629 is a cable terminal building constructed in 1959. It allows subterranean access to electrical and communication wiring installed along Nike Avenue, and similar buildings are

Figure 305. Property 23629, east and north elevations, view to southwest.

found at intervals along the north side of Nike Avenue. Identical buildings are located at the south end of LC-37 as well. These properties provided access to electrical and communications wiring at regular intervals along Nike Avenue, which facilitated installation, maintenance, and troubleshooting. While the building does not appear to have been recently maintained, it remains in good overall condition.

Figure 306. Property 23629, south and east elevations, view to the northwest.

Figure 307. Property 23629, interior view, view to the south.

7.7.6 Property 23665

Property 23665 is a concrete slab foundation located in a paved loop road south of the former Nike Zeus launcher area in the north-central portion of LC-38. It is associated with a similar foundation that is located approximately 150 meters to the east. The square concrete foundation measures 20 feet per side and has some remnant attachment hardware embedded in its surface. A small separate concrete footer is located along the west side of the main foundation. An electrical panel is located on the east edge of the foundation, which is mostly overgrown within a mesquite bush. A downed utility pole is located at the base of the electrical panel. A communications junction box is mounted on a wood post near the northeast corner of the foundation as well.

History of Use

Property 23665 was constructed in 1960 as an "Instrument Pad" according to a 1963 WSMR property inventory (WSMR 1963). The Form 2877 Real Property Record describes the property as an "Elct Eqp Fac" that was constructed in 1959. Architectural drawings indicate that Property 23665 and the identical instrument pad to the east (which lacks a WSMR property number) were both established for velocimeter instrumentation (Plan Set WS-HO). Veloci-

Figure 308. Property 23665, overview to the northeast.

meters played an important role in tracking and instrumentation and filled a gap in tracking coverage immediately after launch. Velocimeters were generally used close to the launch position and provided velocity data during the initial launch and flight phase, when it was very difficult for radar and optical instrumentation to immediately acquire the target vehicle. Velocimeters were often used with longer range tracking radars to provide complete velocity data on a given test flight (Emmett Savage, personal communication 2015). Velocimeters operated on similar principles to Doppler Velocity and Position (DOVAP) systems but relied on a single radar unit, whereas DOVAP required a network of receivers. The velocimeter radar unit transmitted a continuous wave signal onto a test article, and the same radar unit received the reflected return signal. As the test article moved away from the radar unit, the resulting doppler frequency shift was used to generate velocity data. The doppler frequency data was recorded onto magnetic tape, processed, and digitized so that it could be calculated by computer (WSMR 1962). Velocimeters only provided information on velocity and did not provide position data; however, velocimeters required much less infrastructure than DOVAP. Typically, a mobile S-band radar unit was used, with the Hawk Low Power Acquisition Radar (LOPAR) often employed in this role (Emmett Savage, personal communication 2015). These velocimeter pads were probably used for early flight testing of the Nike Zeus missile during the early 1960s, when Nike Zeus missiles were flown from the launch area to the north. The velocimeter radar equipment has long been removed from the property, and it is no longer used or maintained. The instrument pad is in fair overall condition.

Figure 309. Property 23665, overview to the southeast.

Figure 310. Property 23665, associated electrical panel, view to the east.

Figure 311. Property 23665, downed utility pole east of pad, view to the east.

7.7.7 Property 23698

Property 23698 is a concrete slab foundation and instrument pedestal located northeast of Property 23640. The at-grade concrete foundation measures 6 feet square and an aluminum instrument tripod is anchored to the foundation. The aluminum instrument tripod was likely for a fixed cinetheodolite installation. The instrument pad was demarcated by four wood posts at each corner, which were painted in contrasting yellow and black. These posts are in poor condition; the southeast post has decayed and fallen to the ground. The property number is stencil-painted on the southwest corner of the pad. The concrete pad is partially buried by sediment and overgrown with vegetation, and rolls of wiring have also been discarded on the pad. A brass survey datum set into the pad's center is stamped, "WHITE SANDS GEODETIC CONTROL / TRIANGUATION STATION / BATTERY 2."

History of Use

Property 23698 was constructed in 1961 as an "Elct Eqp Fac" according to its Form 2877 Real Property Record. The structure appears to be a "Theodolite Pad" shown in architectural drawings for the Nike Zeus radar installations (Plan Set WS-KD). It is likely that optical instrumentation installed at Property 23698 supplemented the Nike Zeus radars during development

Figure 312. Property 23698, overview to the north.

testing, probably as a calibration or acquisition aid. The instrument has long been removed from the tripod, and the instrument pad is no longer used or maintained. At the time of recording, the instrument pad was in poor overall condition.

Figure 313. Property 23698, brass survey datum marked "BATTERY 2," plan view.

Figure 314. Property 23698, overview to the southeast.

7.7.8 Property 24008

Property 24008 is a concrete slab astrodome foundation situated atop an elevated, gravel-surfaced earthen mound. It is associated with two neighboring instrumentation properties at the Seus Site (Properties 24010 and 24015) in the southeastern part of LC-38. The concrete pad at the top of the mound measures 16 feet per side with a circular imprint and anchor studs at its center from a removed astrodome shelter; the circular imprint has a diameter of approximately 10 feet. Remnants of asbestos tiles remain adhered to the pad within the former astrodome imprint. Several electrical conduit risers and two small electrical pullboxes are embedded into the concrete slab foundation near its northeast corner. Centered within the astrodome imprint is a circular steel instrument mounting plate of 3/4-inch thick steel plate atop a 2-inch thick concrete pad. The instrument mounting plate has a diameter of 3 feet and includes a circular pattern of six 5/8-inch diameter anchor studs. Two electrical conduit risers are located at the northeast edge of the instrument mount plate. Located at the northeast corner of the concrete slab foundation is a series of conduit risers and a cast aluminum electrical panel manufactured by Crouse-Hinds.

Figure 315. Property 24008, overview to the northeast.

History of Use

Property 24008 was constructed in 1959 as an "Instrument Pad" according to a 1963 WSMR property inventory (WSMR 1963). Property records describe the astrodome as a 10-foot diameter unit manufactured by the Houston-Fearless Corporation (Serial Number 15). The same property records state that the instrument at the Seus Site was a fixed camera and that the astrodome was not equipped with a drive unit. An identical instrumentation installation was located north of LC-38 and named the Neus Site, both names apparently being a play on "Zeus." Both the Seus and Neus sites are identified as ribbon frame camera stations in early architectural drawings for LC-38 that were drawn up in 1958 (Plan Set WS-HO). The WS-HO plans depict electrical wiring for a drive unit on the astrodome, but later property records indicate that the Seus and Neus astrodomes were not equipped with drive units. These instrumentation sites were part of a larger range-wide instrumentation improvement program as WSMR transitioned to astrodome-type shelters. The astrodome shelters offered improved functionality and lower maintenance requirements compared to the earlier CMU and concrete buildings. The camera and astrodome have long been removed from the site. It is unknown when Property 24008 was decommissioned, but it appears to have remained unused for decades. Given the removal of both the site's instrumentation and its astrodome shelter, Property 24008 is in poor overall condition.

Figure 316. Property 24008, instrument mount and remnant tiles, plan view.

Figure 317. Property 24008, detail of Crouse-Hinds panel cover, view to the east.

Figure 318. Property 24008, overview to the southwest.

7.7.9 Property 24010

Property 24010 is a mobile instrumentation site located atop an elevated, gravel-surfaced earthen mound. It is associated with two neighboring instrumentation properties at the Seus Site (Properties 24008 and 24015) in the southeastern part of LC-38. The property consists of an at-grade concrete slab foundation that measures approximately 36 by 10 feet and several associated electrical and communications boxes. The instrument pad is accessed via a gravel road that forms a loop off of Range Road 241. No anchor hardware or other attachment points are visible on the concrete slab, consistent with its use with mobile instrumentation. A small survey datum installed in the concrete slab reads "G249 1981." The instrumentation pad is associated with an electrical conduit connection mounted on a steel post, and two terminal boxes (one sheetmetal and one fiberglass) along its east edge. One of the terminal boxes is labeled "SUS."

History of Use

Property 24010 was constructed in 1970 as a "Cinetheodolite Facility" according to its Form 2877 Real Property Record. The original architectural plans for the property describe it as a "Mobile Cinetheodolite Facility" (per Plan Set WS-QV). Mobile instrumentation gradually

Figure 319. Property 24010, overview to the north.

replaced fixed instrumentation sites such as the neighboring Properties 24008 and 24015 at the Seus Site. Mobile instrumentation was more versatile and eliminated the upkeep required for fixed sites. Mobile instrumentation still required positioning at precisely surveyed locations with known coordinates, which often took the form of simple, concrete slab instrumentation pads like Property 24010. Mobile instrumentation sites of this type did not incorporate substantial infrastructure, with only a concrete slab foundation, electrical receptacle panel, and communications terminal usually located at each site. No additional information on the site history or instrumentation it supported is available in DPW records. The property appears to still be used occasionally and is in good overall condition.

Figure 320. Property 24010, view of pad and mound from base, view to the north.

Figure 321. Property 24010, electrical boxes and terminals associated with pad, view to the north.

Figure 322. Property 24010, datum in pad, “G249 1981,” plan view.

7.7.10 Property 24015

Property 24015 is an elevated steel instrument platform supporting an astrodome manufactured by Parabam. It is associated with two neighboring instrumentation properties at the Seus Site (Properties 24008 and 24010) in the southeastern part of LC-38, accessed by Range Road 241. An associated support building (Property H4098) is located at the base of the platform. The elevated platform stands approximately 20 feet above the ground, and due to its height, required two flights of steps and two platforms. The upper platform supports the astrodome installation while the lower platform acts as a service platform for the electrical and hydraulic connections routed to the astrodome on the upper platform. The astrodome is accessed by a steel staircase on the east side of the platform, which has a steel landing between the two flights of steps; the landing also provides access to the lower service platform. The instrument platform is built upon a central column constructed of concrete poured into a vertical corrugated sheetmetal form (i.e., culvert pipe). The corners of the platform are supported by I-beam legs, and hydraulic and power drive equipment for rotating the astrodome is installed on the underside of the upper platform. Various electrical and hydraulic connections are also routed on the underside of the platform. The astrodome installed on the upper platform is identified by a plate on the door reading “ASTRODOME SHELTER CYLINDER / MODEL

Figure 323. Property 24015, east and north elevations, view to the southwest.

Figure 324. Property 24015, astrodome entry hatch, view to the west (*left)*; Parabam ID tag on door, view to the west (*right)*.

Figure 325. Property 24015, interior and instrument mount, view to the west (*left)*; staircase landing, view to the northeast (*right)*.

Figure 326. Property 24015, platform addition on south side of upper platform, view to the west (*left)*; middle platform from staircase landing, view to the west (*right)*.

Figure 327. Property 24015, west and south elevations, view to the northeast.

C-8 / SERIAL 36 / CONTRACT DA-29-040-ORD-1822 / PARABAM INC. HAWTHORNE CALIFORNIA." The interior of the astrodome is devoid of any equipment and the instrument itself has long been removed from the property.

History of Use

Property 24015 was constructed in 1961 as an "Instrument Platform" according to a 1963 WSMR property inventory (WSMR 1963). An identical instrumentation installation was located north of LC-38 and named the Neus Site, both names apparently being wordplays on "Zeus" and the "south" and "north" site locations. Similar instrument platforms were constructed at a series of instrumentation sites across WSMR as part of the same project (per Plan Set WS-KI). While the Seus and Neus instrument platforms may have contributed to the tracking effort for Nike Zeus missiles, they were apparently constructed as part of the broader range-wide instrumentation network and were not dedicated solely to the Nike Zeus program. It is unknown when the instrumentation was removed from Property 24015, but most fixed instrumentation was retired at WSMR during the late 1960s to early 1970s as part of a general shift to more versatile and less maintenance intensive mobile instrumentation. At the time of the current inventory, Property 24015 appeared to have remained unused for decades. While the instrumentation has been removed from the property, its astrodome remains intact, and the property is in fair overall condition.

7.7.11 Property 24171

Property 24171 is a collapsed antenna tower located in the northeastern corner of LC-38. The tower has fallen and lies on the ground in several sections, and is associated with a small portable Butler building (Property H3024). The tower does not appear to have been intentionally dismantled, since several sections are damaged. The tower was a guyed mast of tubular steel or aluminum construction, and its cable guy lines are found nearby. It appears that each of the guy line anchors, which are mostly buried in sand but are likely set in concrete, had an attached manual winch mechanism for tensioning the guy lines. An electric cable winch mounted to a piece of steel plate, which also has the property number stenciled onto it, is located on the ground near the tower segments. A bent sheetmetal dish and an unknown instrument in an aluminum housing are also located among the tower sections.

History of Use

Property records were not on file at WSMR DPW for Property 24171, so little is known about its history and use. Property 24171 is identified in a 1963 WSMR property inventory as an "Antenna Tower" that was constructed in 1961. It is also listed as being constructed by the WSMR Post Engineer, and therefore no architectural plans were prepared for the property. The

Figure 328. Property 24171, downed tower segments, view to the southeast.

Figure 329. Property 24171, electric winch assembly with stenciled property number (*left)*; manual winch attached to guy line anchor (*right)*.

Figure 330. Property 24171, damaged antenna dish, view to the south (*left)*; tower segments and Property H3024, view to the west (*right)*.

limited available information suggests that it might have served as a boresight tower. As a collapsed structure, the tower is in poor condition and damaged to the extent that it is irreparable.

7.7.12 Property H4098

Property H4098 is a pre-manufactured steel frame building constructed on a wood skid foundation. The building is located at the southeast corner of an elevated instrumentation platform (Property 24015) at the Seus Site in the southeast quadrant of LC-38. The building walls are clad in flat steel wall panels and its low-pitch gable roof is clad in standing seam sheetmetal. This construction is typical of buildings produced by Armco, but no branding is visible on the building. The gable portions of the upper walls on the north and south elevations have small vents. The south elevation is equipped with a single-leaf entrance; the entry door is a steel faux-panel type, but has detached from its hinges and lies on the ground in front of the building. A sealed overhead light is located on the wall to the left of the doorway, and a hydraulic door return unit remains attached to the wall. The west elevation has a 4-light steel frame window with awning operation located in the center of the wall. A series of electrical conduits, most of which connect to the neighboring Property 24015 instrumentation platform, are also routed through the west elevation wall. The east elevation is generally similar to the west elevation, with an identical steel frame, 4-light window located in the center of the wall. A vent panel associated with an interior heating unit is located in the upper wall south of the window, below which is a wall-mounted electrical box. The north elevation is plain and lacks

Figure 331. Property H4098, south and east elevations, view to the northwest.

Figure 332. Property H4098, north and west elevations, view to the southeast.

fenestration. The interior of the building is vacant, and all electrical or instrumentation support equipment has been removed from the building. The interior of the building was finished with an asbestos tile floor, most of which remains in place, although in poor condition.

History of Use

Portable buildings such as Property H4098 are considered equipment rather than a real property, and as such are not assigned a formal WSMR property number. Therefore, records regarding the use, history, and age of the building are not maintained at WSMR DPW. The building appears to have housed support equipment for the associated Property 24015. It was likely installed as a “moveable instrumentation shelter” that provided storage and working space at instrumentation sites; shelters of this type were installed at instrumentation sites across WSMR in 1959 (Plan Set WS-IN). At the time of the current inventory, the building was unused and unmaintained, and in fair overall condition.

7.7.13 Velocimeter Pad

This property is a concrete slab foundation located in a paved loop road south of the former Nike Zeus launcher area in the north-central portion of LC-38. It is associated with a similar foundation (Property 23665) that is located approximately 150 meters to the west. The square concrete foundation measures 20 feet per side and has some remnant attachment hardware embedded in its surface. An electrical panel is located on the east edge of the foundation, along with a communications junction box mounted on a wood post.

History of Use

This property was constructed contemporaneously with the nearby Property 23665, but was not assigned a WSMR property number. Architectural drawings indicate that both this property and Property 23665 were constructed in 1959 to support velocimeter instrumentation (Plan Set WS-HO). Velocimeters played an important role in tracking instrumentation and filled a gap in tracking coverage immediately after launch. Velocimeters were generally used close to the launch position and provided velocity data during the initial launch and flight phase, when it was very difficult for radar and optical instrumentation to immediately acquire the target vehicle. Velocimeters were often used with longer range tracking radars to provide complete

Figure 333. Velocimeter Pad, view to the northeast.

velocity data on a given test flight (Emmett Savage, personal communication 2015). Velocimeters operated on similar principles to DOVAP systems but relied on a single radar unit, whereas DOVAP required a network of receivers. The velocimeter radar unit transmitted a continuous wave signal onto a test article, and the same radar unit received the reflected return signal. As the test article moved away from the radar unit, the resulting doppler frequency shift was used to generate velocity data. The doppler frequency data was recorded onto magnetic tape, processed, and digitized so that it could be calculated by computer (WSMR 1962). Velocimeters only provided information on velocity and did not provide position data; however, velocimeters required much less infrastructure than DOVAP. Typically, a mobile S-band radar unit was used, with the Hawk missile system LOPAR often employed in this role (Emmett Savage, personal communication 2015). These velocimeter pads were probably used for early flight testing of the Nike Zeus missile during the early 1960s, when Nike Zeus missiles were flown from the launch area to the north. The velocimeter radar equipment has long been removed from the property, and it is no longer used or maintained. The instrument pad is in fair overall condition.

7.7.14 Balloon Support Building

This property is the remnant concrete slab foundation of a support building associated with the VEE Balloon Support Facility. The property consists of an at-grade concrete slab foundation located in a paved pullout area along the south side of the access road. The foundation measures 36 feet east-west by 16 feet north-south. Anchor studs are located around the perimeter of the foundation for anchoring the building walls. An electrical conduit riser is located along the east end of the foundation.

History of Use

Constructed in 1963, this property is identified as part of the "VEE Balloon Support Facility" in architectural plans (Plan Set WS-KR). This support building originally consisted of a pre-manufactured building installed on a concrete slab foundation; only the foundation remains in place today. The support building was numbered Property 23619 in period maps, but this number was later re-assigned to an antenna tower located to the southwest. Most of the information about the property comes from its architectural plans, which do not define "VEE" or provide much insight into how the balloons were used at LC-38. The WS-KR plans are associated with the Nike Zeus program, and it is documented elsewhere that balloons carried radar targets aloft

Figure 334. Balloon Support Building, overview to the southeast.

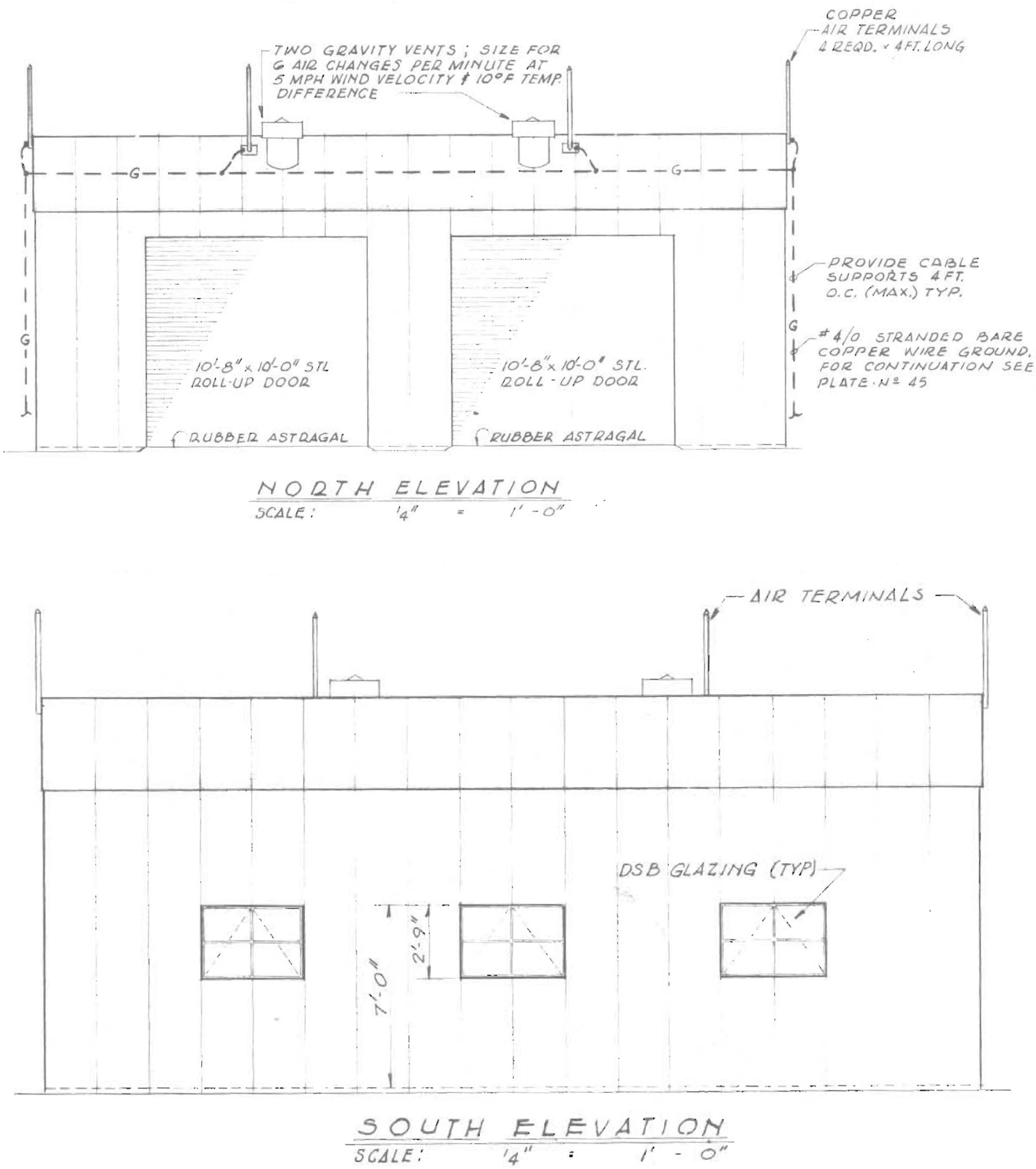

Figure 335. Balloon Support Building, north and south elevations from 1963 WS-KR plans.

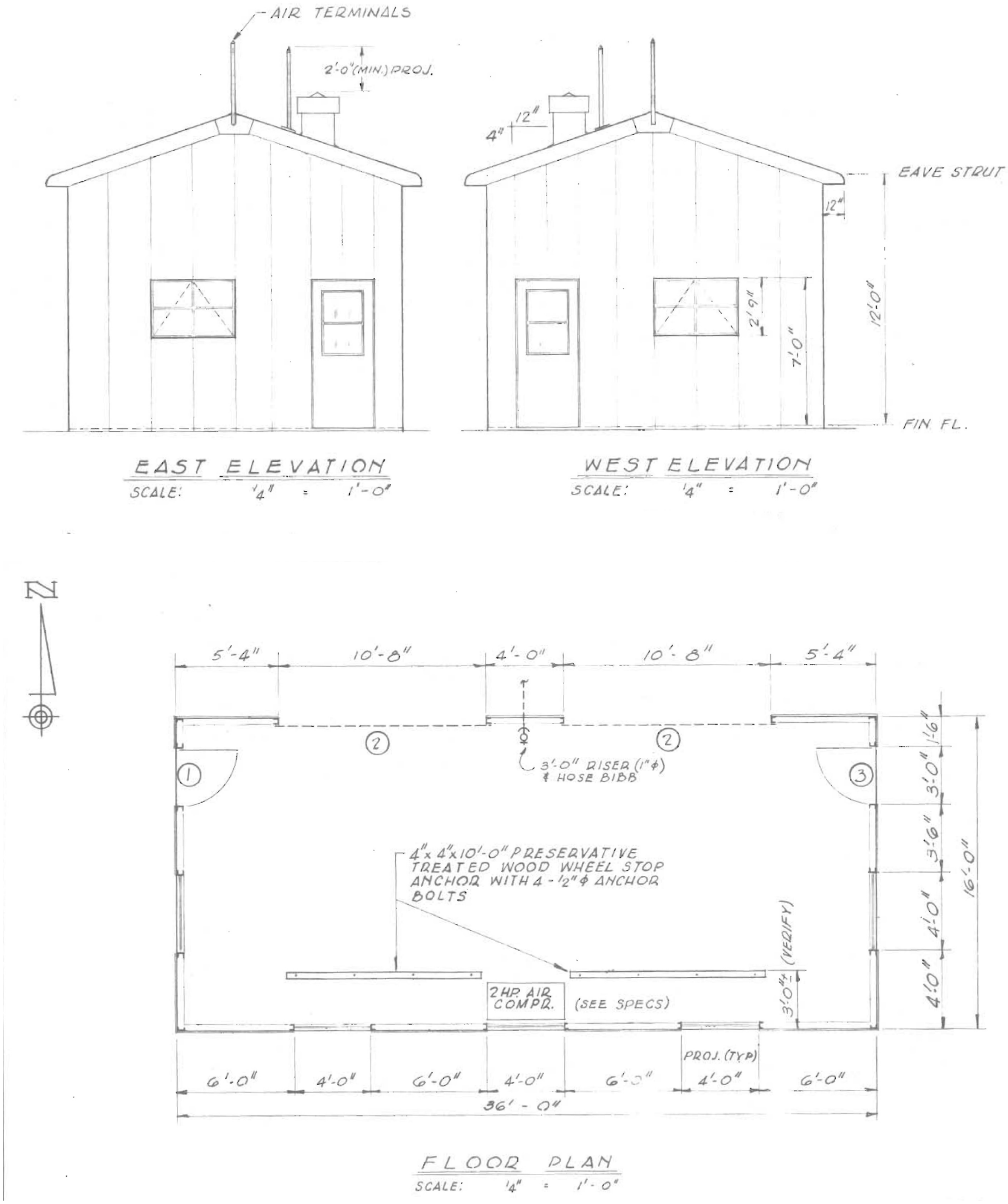

Figure 336. Balloon Support Building, floor plan, east and west elevations from 1963 WS-KR plans.

for testing of the elaborate Nike Zeus radar systems. Balloon-mounted radar reflectors were also used as targets for early flight tests of the Nike Zeus missiles. Property disposition records record that BTL's assignment of the "V-Balloon Area" and its associated support building was terminated in 1968 (Jones 1968). The balloon inflation site was reassigned to ARMTE and the support building (referred to as Property 23619 on the disposition form) was assigned to the Post Engineer (Ferdig 1970). There was no further documentation regarding the use of this building after this time, and it was likely decommissioned sometime in the 1970s. Due to the removal of the building, the property is in poor overall condition.

7.7.15 VEE Balloon Support Facility

This property consists of a former open-air balloon inflation site located north of Property 23626 in the southern portion of LC-38. This property is accessed by a paved access road off of Range Road 239. The extant property consists of a circular paved area with a ring of concrete footers. The ring of concrete footers consists of 18 at-grade concrete footers with torch-cut rebar anchor loops. Three additional footings are located outside the main ring to the north, east, and south, for a total of 21. Each of these footers measure 18 inches per side. At the center of this ring is a larger, above-grade concrete footer that measures approximately 59 inches by 41 inches, and a steel plate is installed on the footing that measures 40 inches by 36 inches. This central concrete footing supported a pulley system, with four 6-inch diameter sheaves (rollers that are part of the pulley system) installed on the section of steel plate bolted to the footer. The sheaves are embossed with the manufacturer's name and location; "SAUERMAN BROS INC. BELLWOOD ILL." Electrical connections are incorporated into the east side of this central footing as well. As originally constructed, these concrete footers were encircled by a 16-foot high circular fence. Per architectural drawings, the fence mesh extended 4 inches below grade, and remnants of the fencing material is visible in the asphalt surfacing of the site. Two additional concrete footers are located outside the east and west sides of the former fence alignment. These footings anchored diagonal support posts for vehicle gates on the east

Figure 337. Overview of Balloon Inflation Facility, view to the west.

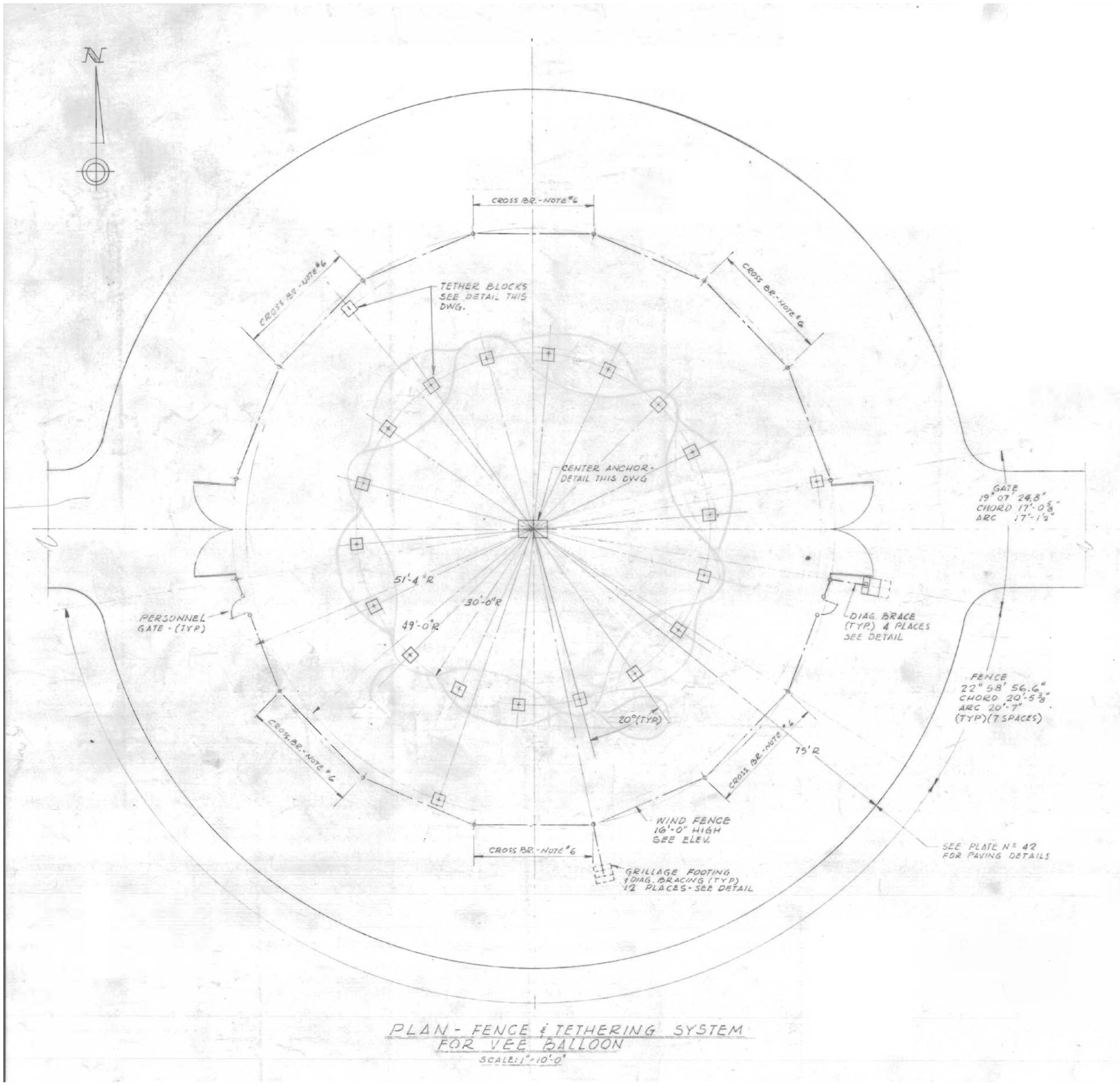

Figure 338. Plan view of Balloon Inflation Facility from 1963 WS-KR plans.

and west sides of the former fence. Near the southeast margin of the paved area is an electrical panel and lighting installation, most of which has been removed.

History of Use

This property was constructed as the "VEE Balloon Support Facility" in 1962 according to architectural plans (Plan Set WS-KR). The fence protected the balloon inflation work from the wind and the 18 footings with the torch-cut rebar loops served as "tether blocks" (Plan Set WS-KR). The central footing supported a pulley system that was probably powered by an electric winch; this system was likely used for controlling the balloon ascension as it inflated. The inflation site was associated with a "Balloon Support Facility" that was located in the paved pull-out area along the south side of the access road. This support facility consisted of a pre-manu-

Figure 339. VEE Balloon Inflation Area, gate footer and electrical footers, view to the southwest (*left)*; copper wire from removed wind fence embedded in pavement, view to the west (*right)*.

Figure 340. VEE Balloon Inflation Area, view of center slab with "sheaves," plan view (*left)*; tiedown footers along north side, view to the east (*right)*.

Figure 341. VEE Balloon Inflation Area, sheave embossing detail, plan view (*left)*; west gate support footers, view to the south (*right)*.

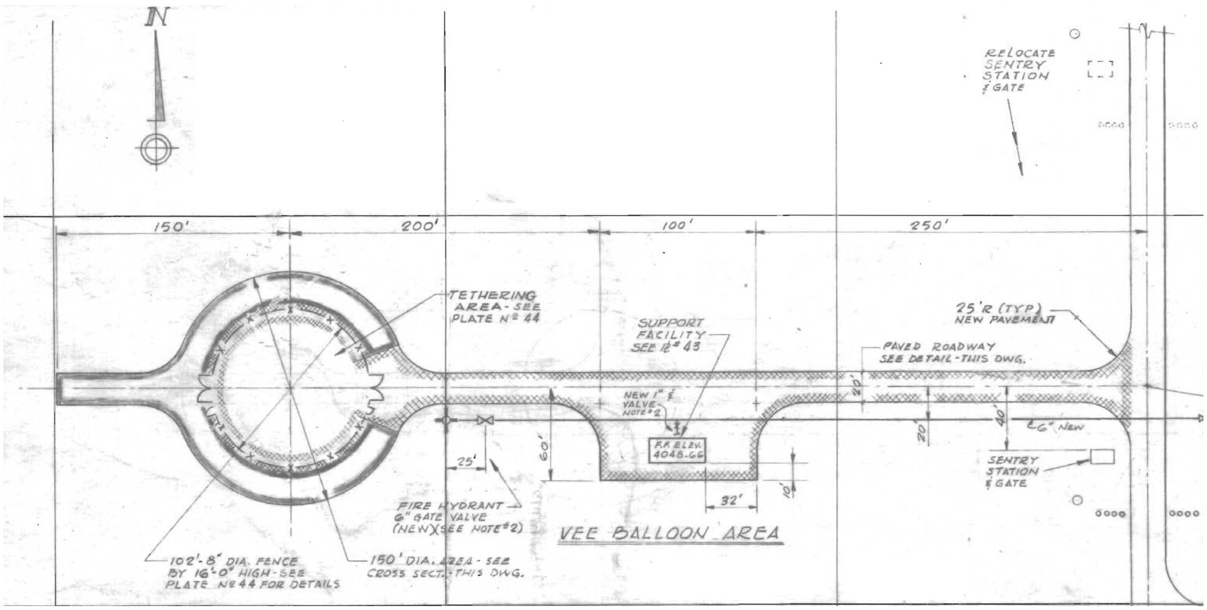

Figure 342. Layout plan of VEE Balloon Inflation Area from 1963 WS-KR plans.

factured building installed on a concrete slab foundation; only the foundation remains in place today. The support building was numbered Property 23619 in period maps, but this number was later re-assigned to an antenna tower located to the southwest. Most of the information about the property comes from its architectural plans, which do not define “VEE” or provide much insight into how the balloons were used at LC-38. The WS-KR plans are associated with the Nike Zeus program, and it is documented elsewhere that balloons carried radar targets aloft for testing of the elaborate Nike Zeus radar systems. Balloon-mounted radar reflectors were also used as targets for early flight tests of the Nike Zeus missiles. Property disposition records state that BTL’s assignment of the “V-Balloon Area” and its associated support building was terminated in 1968 (Jones 1968). In 1970, the balloon inflation site was reassigned to ARMTE and the support building (referred to as Property 23619 on the disposition form) was assigned to the Post Engineer (Ferdig 1970). There was no additional documentation regarding the use of this facility after 1970. Based on the lack of any additional disposition records after this time, the facility was likely decommissioned during the early 1970s. Little remains of the property today, and it is in poor overall condition.

7.7.16 East Mobile Radar Pedestal

This property is a concrete slab foundation that incorporates a concrete and steel mounting pedestal for a radar antenna. This location is one of two similar radar pedestal sites in the southwestern corner of LC-38; a nearly identical radar antenna pad is located approximately 200 meters to the west. An associated concrete slab foundation that supported a mobile equipment van (Property 23605) is located a few meters to the south. Both of these concrete slab foundations are located atop an elevated, gravel-surfaced earthen mound, although Property 23605 is lower and closer to grade. The radar pedestal pad consists of a concrete slab foundation that measures approximately 50 by 21 feet. The radar pedestal measures 60 inches by 53 inches, and is raised 10 inches above the surface of the larger concrete slab foundation. Six inset steel anchor points are positioned along the outside edge of the pedestal, each 10 by 10 inches, with circular openings in the top of each anchor. Concrete ramps are located on the north and south sides of the radar pedestal, so that the trailer-mounted radar antenna could be positioned directly above the pedestal and lowered into place. The pedestal is part of a structurally isolated concrete pour that is separated from the remainder of the concrete slab foundation by expansion joints. The pedestal foundation measures 11 by 11 feet and is 3 feet thick. This is substantially thicker than the surrounding concrete slab, which is approximately 10 inches thick. A survey datum

Figure 343. East Mobile Radar Pedestal, overview to the northwest.

set into the pedestal's center is stamped "R 354." Another brass survey datum set into the southwest corner of the slab foundation is stamped "D.M.A [Defense Mapping Agency] TS 966 1972." Two overhead lights are mounted on a wood utility pole near the southeast corner of the radar pad. A 6-foot wide concrete slab extension is located along the west edge of the main slab foundation, which architectural plans indicate supported an "optical acquisition aid" (Plan Set WS-SD). The radar pedestal and the associated Property 23605 are accessed via a dirt road that extends north from Nike Avenue.

History of Use

The East Mobile Radar Pedestal lacks a WSMR property number, and therefore records regarding the use history and age of the structure are not maintained at WSMR DPW. However, it was likely constructed contemporaneously with the neighboring Property 23605, which was built in 1972. The property is identified on architectural plans as the "Pedestal/Antenna Transporter Pad" (Plan Set WS-SD). The nearly identical West Mobile Radar Pedestal supported a mobile MPS-36 radar, and it is likely that the East Mobile Radar Pedestal supported a similar radar. These radar pedestals and the associated Property 23605 were constructed during the early 1970s, when the SAM-D/Patriot program was the most active program at LC-38. While the property does not appear to have been recently used, it remains in good overall condition.

Figure 344. East Mobile Radar Pedestal, view of pad from base of mound, view to the southeast.

Figure 345. East Mobile Radar Pedestal, detail of radar pedestal, view to the northwest.

Figure 346. East Mobile Radar Pedestal, USACE/ DMA 1972 brass datum, plan view.

7.7.17 West Mobile Radar Pedestal

This property is a concrete slab foundation that incorporates a concrete and steel mounting pedestal for a radar antenna. This location is one of two similar radar pedestal sites in the southwestern corner of LC-38; a nearly identical radar antenna pad is located approximately 200 meters to the east. A graded and gravel surfaced area is located a few meters to the south and slightly below the radar pedestal pad, probably for parking a mobile equipment van associated with the radar pedestal. The radar pedestal pad is located atop an elevated, gravel-surfaced earthen mound. The radar pedestal pad consists of a concrete slab foundation that measures approximately 50 by 21 feet. The radar pedestal measures 60 inches by 53 inches, and is raised 10 inches above the surface of the larger concrete slab foundation. Six inset steel anchor points are positioned along the outside edge of the pedestal, each 10 by 10 inches, with circular openings in the top of each anchor. Concrete ramps are located on the north and south sides of the radar pedestal, so that the trailer-mounted radar antenna could be positioned directly above the pedestal and lowered into place. The pedestal is part of a structurally isolated concrete pour that is separated from the remainder of the concrete slab foundation by expansion joints. The pedestal foundation measures 11 by 11 feet and is 3 feet thick. This is substantially thicker than the surrounding concrete slab, which is approximately 10 inches thick. A brass survey datum set into

Figure 347. West Mobile Radar Pedestal, overview to the northeast.

the southwest corner of the slab foundation is stamped “DMATO TS937-2 1973.” An electrical panel installation is located near the southeast corner of the concrete slab foundation, but the electrical panel has been removed. The graded equipment van pad also has several electrical panels and switches. Two overhead lights are mounted on a wood utility pole near the south side of the associated graded control van pad. A 6-foot wide concrete slab extension is located along the west edge of the main slab foundation, which architectural plans indicate supported an “optical acquisition aid” (Plan Set WS-SD). The radar pedestal is accessed via a dirt road that extends north from Nike Avenue.

History of Use

The West Mobile Radar Pedestal lacks a WSMR property number, and therefore records regarding the use history and age of the structure are not maintained at WSMR DPW. However, architectural plans indicate that it was constructed in 1970, as the “MPS-36 Radar at LC-38” (Plan Set WS-163-1970). The nearly identical East Mobile Radar Pedestal and Property 23605 were constructed a couple years later, in 1972. These radar pedestals and the associated Property 23605 were constructed during the early 1970s, when the SAM-D/Patriot program was the most active program at LC-38. While the property does not appear to have been recently used, it remains in good overall condition.

Figure 348. West Radar Mobile Pedestal, pedestal detail, view to the northwest.

Figure 349. West Radar Mobile Pedestal, USACE/DMA 1973 brass datum, plan view.

Figure 350. West Radar Mobile Pedestal, electrical riser at southeast corner of pad, view to the northwest.

7.8 LC-38 Miscellaneous Facilities

A series of miscellaneous facilities were identified within LC-38 during the current inventory. These properties mostly consist of small portable buildings that serve as minor support buildings across the launch complex. These portable buildings were employed for a number of uses, such as office space, storage, and housing of electrical equipment. Miscellaneous properties identified at LC-38 include Properties H3024, H3115, H4170, WS00131, WS00651, and WS00585, along with several undesignated properties.

7.8.1 Property H3024

Property H3024 is a portable steel building manufactured by Butler. The small building is located in the northeast corner of LC-38 and is associated with a downed boresight tower (Property 24171). The building is constructed atop a wood skid foundation. The construction is typical of most Butler buildings of this size, with walls and low-pitch gable roof clad in ridged sheetmetal panels. The only fenestration in the building is a single-leaf entrance in the north elevation, which is equipped with a rusted steel slab door. The east, west, and south elevations are plain and devoid of fenestration. An embossed “BUTLER” panel is located on

Figure 351. Property H3024, east and north elevations, view to the southwest.

the south elevation roof peak. An electrical service panel mounted on a wood post and fire extinguisher are located outside the east elevation. The interior of the building is unfinished and empty.

History of Use

Portable buildings such as Property H3024 are considered equipment rather than permanent properties, and as such are not assigned a formal WSMR property number. Therefore, records regarding the use, history, and age of the building are not maintained at WSMR DPW. At the time of the current inventory, the building was not used or maintained, but remained in good overall condition.

Figure 352. Property H3024, west and south elevations, view to the northeast.

Figure 353. Property H3024, overview with Property 27141 tower remains, view to the south.

7.8.2 Property H3115

Property H3115 is a small, portable steel frame building manufactured by Butler. It is currently located north of Property 23626, within the fenced storage yard that surrounds the assembly building. The building is constructed atop a wood skid foundation and is associated with a storage cage for LP gas bottles. The construction is typical of most Butler buildings of this size, with walls and low-pitch gable roof clad in ridged sheetmetal panels. The east elevation of the building has a single-leaf entrance that is hung with a steel slab door. A different property number, "H3032," is also stencil-painted outside the doorway, but the "H3115" number is more prominent and appears to have been more recently applied. The north elevation is equipped with a single steel frame window with four lights and awning operation. Two flammable material storage lockers are located outside the building's south elevation. The west elevation is plain and devoid of fenestration, and a storage cage for LP bottles abuts this wall. Embossed "BUTLER" panels are located on the roof peaks of the east and west elevations.

Figure 354. Property H3115, east and north elevations, view to the southwest.

History of Use

Portable buildings such as Property H3115 are considered equipment rather than permanent properties, and as such are not assigned a formal WSMR property number. Therefore, records regarding the use, history, and age of the building are not maintained at WSMR DPW. At the time of the current inventory, the building was used for storage in association with a flammable materials storage area outside Property 23626, and remained in good overall condition.

Figure 355. Property H3115, north and west elevations, view to the southeast.

Figure 356. Property H3115, east elevation, view to the west.

Figure 357. Property H3115, south and east elevations, view to the northwest.

7.8.3 Property H4170

Property H4170 is a pre-manufactured steel frame building constructed on a steel I-beam skid foundation. The building is located to the southeast of Property 23610 and north of Property 23632 in the southern portion of LC-38. The building walls are clad in flat steel wall panels and its low-pitch gable roof is clad in standing seam sheetmetal. This construction is typical of buildings produced by Armco, but no branding is visible on the building. The gable portions of the upper walls on the north and south elevations have vented panels. Of note are insulators that have been added just below the roof peak on the north and south elevations. The west elevation is equipped with a double-leaf entrance equipped with steel faux-panel doors with upper lights. The upper lights are wire-embedded safety glass with exterior steel mesh security screens. A sealed overhead light is located above the doorway. Stenciled on the wall next to the doorway is "WS00150," although this does not appear to be the correct property number for the building. A public address "bullhorn" speaker is located on the upper north corner of the west elevation wall. The east elevation has two 4-light steel frame windows, which are also equipped with exterior steel mesh security screens. The north and south elevations are plain and lack fenestration. An A/C unit is mounted to the wall with a cantilevered steel mount, and electrical power is routed to the building via two electrical boxes that are also mounted to the

Figure 358. Property H4170, south and west elevations, view to the northeast.

south elevation.

History of Use

Property H4170 does not have a formal WSMR property number, and is therefore likely categorized as equipment rather than as real property. As such, records regarding the use, history, and age of the building are not maintained at WSMR DPW. At the time of the current inventory, the building did not appear to be used, but remained in good overall condition.

Figure 359. Property H4170, east and north elevations, view to the southwest.

Figure 360. Property H4170, north and west elevations, view to the southeast.

Figure 361. Property H4170, west elevation entrance detail, view to the east.

7.8.4 Property WS00131

Property WS00131 is a pre-manufactured steel frame building constructed on a wood plank foundation. The building is located to the northeast of Property 24050 in the east-central portion of LC-38. The building was manufactured by Armco, and its walls are clad in flat steel wall panels and its low-pitch gable roof is clad in standing seam sheetmetal, which is typical construction for Armco buildings. The gable portions of the upper walls on the east and west elevations have vented panels and the gable ends of the roof peak have "ARMCO" embossed end caps. The west elevation is equipped with a single-leaf entrance equipped with a steel door with upper light. The north and south elevations both have 4-light steel frame windows with awning operation. The east elevation is plain and lacks fenestration with a large "NO SMOKING" sign attached to the wall. An evaporative cooler unit is attached to the north elevation wall just east of the window.

History of Use

Property WS00131 does not have a formal WSMR property number, and is therefore likely categorized as equipment rather than as real property. As such, records regarding the use,

Figure 362. Property WS00131, north and west elevations, view to the southeast.

history, and age of the building are not maintained at WSMR DPW. According to Raytheon personnel working at the neighboring Property 24050, Property WS00131 has been in its current location for several decades, and was used as supplemental shop space. However, it is no longer used since Raytheon now has shop space within Property 24068. At the time of the current inventory, the building remained in good overall condition.

Figure 363. Property WS00131, west and south elevations, view to the northeast.

Figure 364. Property WS00131, east and north elevations, view to the southwest.

7.8.5 Property WS00585

Property WS00585 is a small, portable steel frame building located northwest of Property 23626, within the fenced storage yard that surrounds the assembly building. It abuts the west elevation of a recently constructed pre-manufactured steel frame building. The building is a commercial storage shed, although the manufacturer is not identified on its exterior. The building walls are clad in corrugated sheetmetal, as is the low-pitch gable roof, and the building is built on a wood skid foundation. A single-leaf entrance is cut into the south elevation wall, while the north, east, and west elevations are plain and lack fenestration. Small louvered vents are punched into the upper walls of the east and west elevations. A steel storage locker, probably for flammable materials, is located outside the north elevation.

History of Use

Portable buildings such as Property WS00585 are considered equipment rather than real property, and as such are not assigned a formal WSMR property number. Therefore, records regarding the use, history, and age of the building are not maintained at WSMR DPW. At the time of the current inventory, the building was used for storage and remained in fair overall condition.

Figure 365. Property WS00585, south and west elevations, view to the north.

7.8.6 Property WS00651

This property is a small portable steel building currently located in the parking lot south of Property 23659, although it has only recently been moved to this location. The building has a very small footprint, and is typical of a guardhouse or gatehouse. While no manufacturer's branding is visible on the exterior, the building is typical of units manufactured by Armco. The narrow building is constructed atop a wood skid foundation and has an extension on the south elevation that forms an entry deck. The walls of the building are clad in flat sheetmetal panels, and the low-pitch roof is clad in standing seam sheetmetal. A single-leaf entrance is located on the south elevation, which is equipped with a steel slab door with two upper lights; the door has been badly dented and the lights are broken. Louvered windows with clear plastic louvers are located in the east and west elevations. A window A/C unit is mounted to the north elevation wall with a cantilevered steel mounting bracket.

History of Use

Portable buildings like this one are considered equipment rather than real property, and as such are not assigned a formal WSMR property number. Therefore, records regarding the use, his-

Figure 366. Property WS00651, south and east elevations, view to the northwest.

tory, and age of the building are not maintained at WSMR DPW. While the building is of historic manufacture, it has only recently been moved to its current location, so it is unlikely to be associated with the nearby DR installation (Property 23659). At the time of the current inventory, the building was not used or maintained, and was in poor-to-fair overall condition.

Figure 367. Property WS00651, south and west elevations, view to the northeast.

Figure 368. Property WS00651, east and north elevations, view to the southwest.

7.8.7 Unknown Portable Building 1

This property is a pre-manufactured steel frame building constructed on a steel I-beam skid foundation. The building is located northeast of Property 23654 within the former Nike Zeus Assembly and Storage Area. The building walls are clad in flat steel wall panels and its low-pitch gable roof is clad in standing seam sheetmetal. This construction is typical of buildings produced by Armco, but no branding is visible on the building. The gable portions of the upper walls on the north and south elevations have vented panels. The south elevation is equipped with a double-leaf entrance hung with steel faux-panel doors. A sealed overhead light is located above the doorway. West of the entrance is a 4-light steel frame window with an exterior steel mesh security screen. The north elevation has two of the same 4-light steel frame windows, which are also equipped with exterior steel mesh security screens. The west elevation has a large square opening cut into the upper wall, probably for HVAC ductwork that was been removed from the building. A smaller square port for ventilation or wiring is located near the middle of the west elevation. The east elevation is mostly plain, with only a small vent cowling in the upper wall. No property ID or identification was found on the building. The steel doors are rusted and missing panels. The rusted doors and large opening on the east elevation have left the interior exposed to the elements and rodent nesting. The interior was originally

Figure 369. Unknown Portable Building 1, west and south elevations, view to the northeast.

Figure 370. Unknown Portable Building 1, east and north elevations, view to the southwest.

semi-finished, but is now in poor condition.

History of Use

This building does not have a formal WSMR property number, and is therefore likely categorized as equipment rather than as real property. Therefore, records regarding the use, history, and age of the building are not maintained at WSMR DPW. The building was likely used as a support facility in the Nike Zeus Assembly and Storage Area, possibly for Nike Zeus or follow-up programs during the 1960s. At the time of the current inventory, the building was unmaintained and had not been used for quite some time. Due to exposure to the elements and lack of upkeep, the building was in poor overall condition.

7.8.8 Unknown Portable Building 2

This unnumbered portable steel building is currently located in the parking lot south of Property 23659, although it has only recently been moved to this location. This pre-manufactured Butler building is mounted atop a wood skid foundation. The construction is typical of most Butler buildings of this size, with walls and low-pitch gable roof clad in ridged sheetmetal panels. The south elevation of the building has been modified with two fixed windows that are not original to the building. These steel frame windows appear to be viewing ports for instrumentation or personnel. A stencil-painted warning along the top of the south elevation wall reads, “CAUTION / HEARING [illegible] REQUIRED.” Within the building’s finished interior, a wood work bench is installed along the base of the windows and runs the full length of the wall. The front of the work bench is equipped with electrical outlets. The west elevation has a single-leaf entrance that is hung with a steel slab door. The east and north elevations are plain and lack fenestration, but an evaporative cooler unit is mounted to the north elevation wall; the cooler is damaged and missing its outer housing. Several electrical switch boxes are also mounted to the north elevation wall. An embossed “BUTLER” panel is located on the west elevation roof peak.

Figure 371. Unknown Portable Building 2, north and west elevations, view to the southeast.

History of Use

Portable buildings like this one are considered equipment rather than permanent properties, and as such are not assigned a formal WSMR property number. Therefore, records regarding the use history and age of the building are not maintained at WSMR DPW. While the building is of historic manufacture, it has only recently been moved to its current location, so it is unlikely to be associated with the nearby DR installation (Property 23659). At the time of the current inventory, the building was not used or maintained, and was in fair overall condition.

Figure 372. Unknown Portable Building 2, west and south elevations, view to the northeast.

Figure 373. Unknown Portable Building 2, view of interior, view to the southeast.

7.8.9 Unknown Portable Building 3

This property is a portable pre-manufactured steel building located near the former Nike Zeus launch area at LC-38. The steel frame building has a rectangular footprint and is constructed on a steel I-beam skid foundation. The walls of the building are clad in ridged sheetmetal panels, while the low-pitch gable roof is clad in standing seam sheetmetal. The building lacks any manufacturer branding or identification. The building is currently located south of Property 23683.

The building's north elevation has a center entrance equipped with a steel personnel door with a large upper light. On either side of the door are aluminum frame windows with horizontal sliding operation, the east window has a window-mounted evaporative cooler attached to it. A set of steel steps provides access to the entrance, which is elevated above grade due to the buildings I-beam skid foundation. The building's east and west elevations are generally identical in layout. Both elevations have a single personnel door located at the north end of the wall. These entrances are equipped with steel doors with large upper lights, identical to the north elevation door. Both of these entrances are sheltered by shallow sheetmetal surrounds that act as entry porches. Both elevations are equipped with three aluminum sliding windows. Two

Figure 374. Unknown Portable Building 3, east and north elevations, view to the southwest.

Figure 375. Unknown Portable Building 3, east and south elevations, view to the north.

additional windows of the same type are located on the building's south elevation. The south elevation does not have an entrance, but a large HVAC unit is attached to the center of the wall between the two windows. A smaller evaporative cooler unit is attached to the west window of the south elevation. A placard attached to the north elevation wall reads "28," while stenciled property numbers on the building's southwest corner have deliberately been rendered illegible.

History of Use

Portable buildings such as this are considered equipment rather than permanent properties, and as such are not assigned a formal WSMR property number. Therefore, records regarding the use history and age of the building are not maintained at WSMR DPW. Due to this, little or no archival information is typically available for buildings of this type. The building appears to be a relatively recent addition to the former Nike Zeus launch area, probably from the 1970s to 1980s period of Patriot missile testing. Based on its design and materials, the building is of more recent manufacture than the Butler and Armco buildings that were common during the 1950s and 1960s. A tag on the east elevation entrance indicates that the building is assigned to Raytheon, and it appears to be in good overall condition and currently used for storage.

7.8.10 Unknown Portable Building 4

This property is a portable pre-manufactured steel building located near the former Nike Zeus launch area at LC-38. The steel frame building has a rectangular footprint and is constructed on a steel I-beam skid foundation. The walls of the building are clad in ridged sheetmetal panels, while the low-pitch gable roof is clad in standing seam sheetmetal. The building lacks any manufacturer branding or identification. The building is currently located west of the modern Property 23700.

The building's east elevation has a center entrance equipped with a steel personnel door. The door's original upper light has been covered with sheetmetal. On either side of the door are aluminum frame windows; the south window has horizontal sliding operation, while the north window is fixed. A set of steel steps provides access to the entrance, which is elevated above grade due to the buildings I-beam skid foundation. A sign mounted to the wall next to the door orders that "ALL VISITORS MUST CHECK-IN at BLDG 23626 PRIOR TO ENTERING RSB." The building's north and south elevations are generally identical in layout. Both elevations have a single personnel door located at the north end of the wall. These entrances are equipped with steel doors with large upper lights. Both of these entrances are sheltered

Figure 376. Unknown Portable Building 4, east and north elevations, view to the southwest.

Figure 377. Unknown Portable Building 4, north and west elevations, view to the southeast.

by shallow sheetmetal surrounds that act as entry porches. Both elevations are equipped with three aluminum sliding windows. Two additional windows of the same type are located on the building's west elevation. The west elevation does not have an entrance, but a large HVAC unit is attached to the center of the wall between the two windows. No property ID or number was visible on the exterior of the building.

History of Use

Portable buildings such as this are considered equipment rather than permanent properties, and as such are not assigned a formal WSMR property number. Therefore, records regarding the use history and age of the building are not maintained at WSMR DPW. Due to this, little or no archival information is typically available for buildings of this type. The building appears to be a relatively recent addition to the former Nike Zeus launch area, probably from the 1970s to 1980s period of Patriot missile testing. Based on its design and materials, the building is of more recent manufacture than the Butler and Armco buildings that were common during the 1950s and 1960s. A tag on the east elevation entrance indicates that the building is assigned to Raytheon, and it appears to be in good overall condition.

7.8.11 Unknown Foundation

This structure is an elevated concrete foundation located east of the modern Property 24050 in the eastern portion of LC-38. This rectangular foundation measures approximately 25 feet east-west by 9 feet north-south, with 6-inch stem walls that are approximately 20 inches high. The foundation has a concrete slab base, with an interior partition wall that divides the foundation into east and west interior compartments, with the west being the larger of the two. A loose sheetmetal cover is located within the inside of the foundation, and PVC pipe drain is incorporated into its north wall. There are no anchors or attachment hardware visible on the foundation and it does not appear to have ever supported a building. It appears similar to the overflow or catchment basins sometimes associated with fuel or chemical storage tanks.

History of Use

This foundation does not have a formal WSMR property number, and therefore no records regarding its use and history are maintained at WSMR DPW. It does not appear to be indicated on any historic drawings or maps of the original Nike Zeus facilities, and the presence of the PVC pipe drain suggests that it post-dates the Nike Zeus activity at LC-38. PVC pipe was manufactured in the US beginning in the 1950s, but was not widely used until the 1970s. Sediment

Figure 378. Unknown Foundation, overview to the southwest.

Figure 379. Unknown Foundation, overview to the east.

and windblown debris had accumulated within the interior of the foundation, suggesting that it has remained unused for an extended period. At the time of recording, it remained in fair overall condition.

7.8.12 Unknown Magazine

This structure is a small concrete box magazine with an attached concrete slab foundation, located approximately 170 meters south of Property 24068. The magazine is essentially a concrete cube that measures 4 feet per side, and its concrete slab base measures approximately 5 feet per side. Small double steel doors set into a steel frame are located on the magazine's north side, and the magazine's concrete top overhangs the doors slightly. Three rebar lifting points are incorporated into the top of the magazine.

History of Use

This magazine does not have a formal WSMR property number, and is therefore likely categorized as equipment rather than as real property. As such, records regarding the use and history of the building are not maintained at WSMR DPW. It does not appear that this magazine has been recently used and it was apparently discarded in its current location. It is in fair overall condition.

Figure 380. Unknown Magazine, east and north sides, view to the southwest.

7.8.13 Unknown Pedestal Structure

This property consists of an at-grade concrete foundation that houses a rotating pedestal unit. The square foundation measures approximately 10 by 10 feet, and the pedestal is approximately 18 inches in height. The pedestal is anchored to the center of the foundation with substantial 1¼-inch diameter hardware. The upper mounting flange of the pedestal is 6 inches square with four mounting holes. The pedestal is of cast steel or aluminum construction and includes grease fittings for maintaining its internal lubrication. There are no visible electrical connections associated with the property. No equipment is mounted to the pedestal or pad. This structure and a neighboring concrete slab with an interior turntable are associated with the former LC-38 runway alignment (Property 24075), and are located near the junction of the runway and the taxiway (Property 24076) that connects to the hangar building (Property 24070).

History of Use

This structure does not appear to have been assigned a formal WSMR property number. Therefore, records regarding the use, history, and age of the building are not maintained at WSMR DPW. It and the neighboring property likely supported some kind of minor instrumentation related to the associated runway, such as an anemometer or wind direction indicator, or pos-

Figure 381. Overview with turntable structure in background, view to the northeast.

Figure 382. Detail view of pedestal, view to the west.

sibly some type of surveillance radar antenna. No equipment or instrumentation is currently associated with the property, and it is in fair condition.

7.8.14 Unknown Turntable Structure

This property consists of an at-grade concrete foundation that houses an internal steel turntable unit. The square foundation measures approximately 14 by 14 feet, and the turntable is approximately 10 feet in diameter. The round turntable consists of a tread-pattern steel plate surface with four hinged, spring-loaded rectangular anchor points or tiedowns. Cables are attached to the turntable to limit its rotation. The center of the turntable has a round cover plate that is 16 inches in diameter. The bearings that support the turntable are located below grade in a portion of the foundation that extends approximately 24 inches below grade. No equipment is mounted to the turntable. This structure and a neighboring concrete slab and pedestal are associated with the former LC-38 runway alignment (Property 24075), and are located near the junction of the runway and the taxiway (Property 24076) that connects to the hangar building (Property 24070).

History of Use

This structure does not appear to have been assigned a formal WSMR property number. Therefore, records regarding the use, history, and age of the building are not maintained at WSMR DPW. It and the neighboring property likely supported some kind of minor instrumentation re-

Figure 383. Overview with pedestal structure in background, view to the southwest.

lated to the associated runway, such as an anemometer or wind direction indicator, or possibly some type of surveillance radar antenna. No equipment or instrumentation is currently associated with the property, and it is in fair condition.

Figure 384. Detail of turntable unit in pad, view to the southwest.

Figure 385. Detail of hinged tiedown bracket on turntable, plan view.

8. NRHP Eligibility Recommendations

In evaluating the recorded properties for individual eligibility, the LC-38 resources were assessed in terms of the applicable National Register Criteria. The four eligibility criteria are:

> (a) that are associated with events that have made a significant contribution to the broad patterns of our history; or
>
> (b) that are associated with the lives of persons significant in our past; or
>
> (c) that embody distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
>
> (d) that have yielded, or may be likely to yield, information important in prehistory or history.

Special Criteria Considerations are also applied in specific circumstances. One of these criteria considerations is applicable to the LC-38 resources: Criterion Consideration G. This consideration allows the NRHP nomination of properties that are less than 50 years in age, provided that they are of exceptional importance. Criterion Consideration G and how it applies to the recorded resources is discussed in further detail in the Period of Significance section below.

Throughout the resource evaluation process, the historic context of LC-38 was consulted in order to determine events that might constitute significance, facts about the people who were important to the history of the range, and attributes of design in the various periods of construction. Of the evaluation criteria, Criterion B appears to be the least applicable to the buildings, structures, and objects at the complex. Generally, any such associations are better accounted for as part of the historical trends treated under Criterion A. Criterion D is not applicable in this case as the resources are unlikely to provide additional information about their design and construction. Criteria B and D were considered in the evaluation of the LC-38 resources wherever possible; however, the more systematic application was made with respect to Criteria A and C.

During the current inventory, a total of 67 resources were recorded, which were categorized into six different property types. The property types are Radar and Guidance Facilities, Assembly and Checkout Facilities, Launch Facilities, Support Facilities, Instrumentation Facilities, and Miscellaneous Facilities. The NRHP eligibility of the individual LC-38 properties is discussed in detail within the HCPI forms included in Appendix C. The property eligibility is also summarized in the table below.

Of the 67 properties recorded as part of the current inventory, six were recommended for individual eligibility under Criteria A and C. Additionally, it was found that LC-38 represents a definable concentration of resources, most of which date to the primary period of significance (1959 to 1964). As such, an additional 22 properties were recommended for eligibility as contributing elements to a historic district encompassing the primary concentrations of Cold War-era LC-38 facilities (Table 2).

Table 2. LC-38 Property Eligibility Summary.

Property	Property Function	Build Date	HCPI #	Individually Eligible?	Contributing Element?
23605	Instrumentation	1972	53765	No	No
23610	Instrumentation	1969	34038	No	No
23615	Instrumentation	1968	53766	No	No
23619	Instrumentation	1978	53767	No	No
23626	Missile Assembly and Checkout	1959	34039	Yes	Yes
23627	Support Facilities	1959	53768	No	Yes
23629	Instrumentation	1959	34040	No	No
23632	Support Facilities	1959	34046	No	Yes
23635	Support Facilities	1961	53769	No	No
23640	Radar and Guidance	1960	34041	Yes	Yes
23641	Radar and Guidance	1959	53770	No	Yes
23642	Radar and Guidance	1960	34042	Yes	Yes
23643	Support Facilities	1960	53810	No	No
23647	Radar and Guidance	1959	53771	No	Yes
23648	Radar and Guidance	1959	53772	No	Yes
23652	Radar and Guidance	1965	34043	No	Yes
23654	Missile Assembly and Checkout	1959	34044	Yes	Yes
23655	Missile Assembly and Checkout	1962	53773	No	Yes
23656	Missile Assembly and Checkout	1959	34045	Yes	Yes
23659	Radar and Guidance	1962	53774	No	Yes
23660	Missile Assembly and Checkout	1959	53775	No	Yes
23665	Instrumentation	1960	53776	No	No
23678	Radar and Guidance	1971	53778	No	Yes
23683	Launch Facilities	1960	53777	No	Yes
23688	Launch Facilities	1971	53779	No	Yes
23694	Radar and Guidance	1961	53780	No	Yes

Table 2. LC-38 Property Eligibility Summary, Cont.

Property	Property Function	Build Date	HCPI #	Individually Eligible?	Contributing Element?
23698	Instrumentation	1963	53781	No	No
24008	Instrumentation	1959	53782	No	No
24010	Instrumentation	1971	53783	No	No
24015	Instrumentation	1961	53784	No	No
24025	Support Facilities	1959	34048	No	Yes
24063	Support Facilities	1960	53785	No	No
24065	Support Facilities	1959	53786	No	Yes
24066	Support Facilities	1959	34050	No	Yes
24068	Support Facilities	1960	34051	No	Yes
24069	Support Facilities	1969	53787	No	No
24070	Support Facilities	1960	34055	No	Yes
24072	Radar and Guidance	1959	34056	Yes	Yes
24075	Support Facilities	1959	53788	No	No
24078	Instrumentation	1959	53789	No	No
24171	Instrumentation	1961	53790	No	No
H3024	Miscellaneous	Unknown	53791	No	No
H3115	Miscellaneous	Unknown	53809	No	No
H4098	Instrumentation	1961	53792	No	No
H4170	Miscellaneous	Unknown	53793	No	No
WS00131	Miscellaneous	Unknown	53811	No	No
WS00585	Miscellaneous	Unknown	53808	No	No
WS00651	Miscellaneous	Unknown	53795	No	No
Balloon Support Bldg	Instrumentation	Unknown	53796	No	No
Nike Zeus Launch Area Tunnel	Launch Facilities	1959	53929	No	Yes
East Radar Pedestal	Instrumentation	1970	53798	No	No
West Radar Pedestal	Instrumentation	1973	53799	No	No

Table 2. LC-38 Property Eligibility Summary, Cont.

Property	Property Function	Build Date	HCPI #	Individually Eligible?	Contributing Element?
Patriot Pad and Revetment	Launch Facilities	Unknown	53801	No	Yes
Patriot Launch Pad	Launch Facilities	c. 1970s	53802	No	Yes
Patriot Condition-ing Shelter	Launch Facilities	1976	53800	No	Yes
Patriot Support Bldg	Launch Facilities	c. 1970s	53803	No	No
Unknown Magazine	Miscellaneous	Unknown	53812	No	No
Unknown Pedestal Structure	Miscellaneous	Unknown	53807	No	No
Unk. Portable Bldg 1	Miscellaneous	Unknown	53804	No	No
Unk. Portable Bldg 2	Miscellaneous	Unknown	53805	No	No
Unk. Portable Bldg 3	Miscellaneous	Unknown	53927	No	No
Unk. Portable Bldg 4	Miscellaneous	Unknown	53928	No	No
Unknown Turntable Structure	Miscellaneous	Unknown	53806	No	No
VEE Balloon Infla-tion Facility	Instrumentation	1962	53797	No	No
Velocimeter Pad	Instrumentation	1959	53794	No	No

In addition to the 67 recorded properties, 1,218 features were also recorded at LC-38. As these features are by definition insubstantial manifestations that cannot be categorized as buildings, structures, or objects, they do not possess any significant associations with historic events or people, lack any distinction of architectural form or method of construction, and do not possess additional information relevant to LC-38 or WSMR. As such, they cannot be recommended for eligibility to the NRHP, either individually or as contributing elements to any possible district.

8.1 Eligibility Criterion A

Criterion A allows for recognition of resources “that are associated with events that have made a significant contribution to the broad patterns of our history” (NPS 1995:2). This association can be with a specific event that marks “an important moment in American prehistory or history” or with a longer-term “pattern of events or a historic trend that made a significant contribution to the development of a community, a State, or the nation” (NPS 1995:12).

LC-38 is associated with both historic events and historic trends. After WWII, defense against strategic bombing was a priority for military planners, and the invention of the atomic bomb had raised the stakes considerably. Aerial bombing would no longer require squadrons of bombers dropping hundreds of bombs to devastate a city or industrial area, now one plane and one bomb could level a city. The Nike Ajax and Nike Hercules air defense systems provided a viable defense against the threat of Soviet bombers but by the late 1950s, the advent of long-range ballistic missiles capable of carrying nuclear warheads had again changed the calculations of strategic defense. The event that made this starkly apparent to both the US military establishment and the public was the successful orbiting of the Sputnik satellite by the Soviet Union on October 4, 1957. Not only was Sputnik a national embarrassment to the US, but it indicated that the rival Soviet missile program had developed a launch vehicle capable of carrying a payload into low orbit, and such a vehicle could be readily adapted to carrying a nuclear warhead. Comparatively, the US missile and space programs were lagging behind, and this anxiety became known as the Missile Gap.

The existing Nike Ajax and Nike Hercules (in the later stages of development) were ineffective against even first-generation ICBMs. Due to the significantly higher speeds and high angle trajectories, the interception of nuclear warheads delivered by ICBMs was a major technological hurdle that would require advances in long range detection, radar discrimination and targeting, and new types of "anti-missile" missiles. The Army anticipated that a ballistic missile system would be needed in the coming years, but Soviet advancements in missilery came much sooner than expected. In 1957, a contract for the development of this new type of system was awarded to BTL, a subsidiary of Western Electric, and the new missile was named the Nike Zeus (Lonnquest and Winkler 1996:109).

The Nike Zeus system was the first attempt at incorporating all these new technologies into a single integrated system that could protect the continental US against the Soviet missile threat. While Nike Zeus was a technology test bed, it was also intended as a practical program, the end result of which could be replicated at installations across the country. This was a massive undertaking as of the late 1950s, an era before the introduction of solid-state electronics, when computers still relied on vacuum tubes and the US was still struggling to deploy the Atlas missile, its first nuclear-warhead equipped ICBM.

Nike Zeus was also more important strategically than its Nike Ajax and Nike Hercules predecessors, which were considered as the last line of defense against Soviet bombers. In theory, the primary defense against Soviet bombers would have been USAF fighter aircraft that would have been alerted by early warning radar systems, with Nike Ajax and Nike Hercules providing a supplemental defensive role for cities and strategic assets. Nike Zeus was a paradigm shift in that was designed to intercept the new threat of nuclear warhead equipped ICBMs, thus making it the first and effectively only line of defense against the Soviet nuclear threat. Nike Zeus was therefore a high-profile and well-funded Army RDT&E effort and the substantial investment in the testing infrastructure at LC-38 reflects this.

The Nike Zeus ground facilities were constructed at ALA-5, later designated LC-38. The initial operation of the LC-38 ZAR was completed in June 1961, with the ZAR successfully detecting and tracking balloons, aircraft, parachutes deployed by Highball target missiles, and Nike Hercules missiles. On December 14, 1961, a Nike Zeus successfully intercepted a Nike

Hercules, a major development milestone for the system. A second successful intercept of a Nike Hercules was completed in March 1962 (Bell Laboratories 1975:I-24). These successful early tests paved the way for tests against true ICBM targets at Kwajalein Island in the Pacific, where a complete Nike Zeus installation (including the ZAR, DR, two TTRs, three MTRs, and BCB) was completed by mid-1962. There, the Nike Zeus made a series of successful and partially successful intercepts of Atlas ICBMs launched from Vandenburg AFB in California. By November 1963, the decision had been made not to deploy the Nike Zeus, and further intercept tests against live targets were not conducted. However, system tests against pre-recorded target trajectories or simulated ICBMs continued at Kwajalein until June 1965 (Bell Laboratories 1975:I-26).

Progress on the Nike Zeus system was halted in late 1963 because rapid technological advances on the near horizon ensured that the system would soon be outmoded. However, the Nike Zeus system testing provided important lessons in system integration, long range detection, computer programing, target discrimination, and interceptor missile designs that served as the baseline for later, more advanced systems. The Nike Zeus missile design served as the basis for the long-range Spartan interceptor missile that was later used in the Sentinel and Safeguard programs (Bell Laboratories 1975:I-45). Although largely forgotten today, Nike Zeus was the great grandfather of modern BMD systems and was a watershed military and technological development at the time. The development of such a system helped allay fears of the so-called Missile Gap, and provide assurance to the American public that the nation remained at the technological forefront. It was no coincidence that Nike Zeus demonstrations were an important part of President Kennedy's highly publicized 1963 visit to WSMR.

LC-38 played an important role in the historical events and trends of the Cold War as the only complete installation of the Nike Zeus BMD system within the continental US. LC-38 also supported the later Nike X, Sentinel, and Safeguard programs. Beginning in 1969, LC-38 also hosted the SAM-D program, which was renamed the Patriot missile in 1976, and the Patriot continues to be the major test program at LC-38 today. As an Army facility, LC-38 is a unique type of historic property that is subject to more specific guidance published by the Army for Cold War-era military industrial properties (Lavin 1998). Per the guidance published by Lavin (1998), Cold War-era properties considered as eligible under the four criteria must be related to a specific historic theme related to the Cold War. Per the guidance offered in Lavin (1998), two specific themes are applicable to LC-38: Materiel Development; and Air Defense, Ballistic Missile Defense, and Army Missiles. This discussion will first explore in greater detail the relevant historic themes under which the resources were evaluated. This is followed by a discussion of the historic significance and eligibility of the LC-38 properties under Criterion A.

8.1.1 Historic Themes

Historic themes are used to define and categorize patterns of historic association. Per NPS guidance:

> A [historic] theme is a means of organizing properties into coherent patterns based on elements such as environment, social/ethnic groups, transportation networks, technology, or political developments that have influenced the development of an area during one or more periods of prehistory or history [NPS 1995:8].

Broad historic themes are presented within NPS Bulletin 15, which identifies general themes under "Areas of Significance." Among these, several are applicable to LC-38, such as Engineering, Invention, Military, and Science (NPS 1995:8). More specific guidance for the identification of historic themes relevant to Cold War-era military-industrial properties is provided by the Army (Lavin 1998). This guidance is relevant to the evaluation of LC-38 as it played a major role in the Army's military-industrial complex during the Cold War. From its establishment, LC-38 was mostly occupied and operated by contractors; mostly BTL through the late 1960s, and by Raytheon from the early 1970s through the end of the Cold War. As the only prototype installation of the BTL Nike Zeus system within the continental US, LC-38 was representative of the collaboration between the military, federal legislation, and the private defense industry, coined as the "military-industrial complex" by President Dwight Eisenhower in 1961. Additionally, LC-38 was active during the Cold War period, generally defined as beginning with Winston Churchill's "Iron Curtain" speech in 1946 and ending with the fall of the Berlin Wall in 1989. Established in 1959, LC-38 remained an active launch site at WSMR throughout the Cold War and into the new millennium.

Based on the guidance provided by the Army (Lavin 1998), Cold War-era properties considered as eligible under the four criteria must be related to a specific historic theme related to the Cold War. Lavin (1998) defines nine such Cold War themes, some with specific sub-themes or facilities, for Cold War military-industrial properties. Two of these Cold War historic themes —Materiel Development and Air Defense, Ballistic Missile Defense, and Army Missiles — are applicable to the LC-38 resources.

The theme of Materiel Development is defined by Lavin (1998:66) as "the process of transforming a concept into an actual weapon or piece of equipment… [in order to]…use superior technology to gain an advantage over the Warsaw Pact Forces." The themes of Materiel Development and Basic Scientific Research are related, as both were concerned with "obtaining sufficient quantities of technologically superior equipment" (Lavin 1998:63). Scientific research expanded technological knowledge, which in turn could be used to develop new weapons and equipment through the materiel development process (Lavin 1998:64).

Materiel development activities were carried out at Army designated Research, Development, and Engineering centers and proving grounds, with WSMR being a significant Army proving ground (Lavin 1998:69). LC-38 was a significant launch complex at WSPG during the 1960s, and hosted much of the early testing of the Nike Zeus radars and missiles, and later, tests of the SAM-D/Patriot missile. LC-38 was an important location for the development and testing of the long-range detection, target and missile tracking, and discrimination radars needed to make BMD systems like Nike Zeus and its successors viable. Although Nike Zeus development was halted in favor of the more advanced Nike X system (and later Sentinel and Safeguard derivations), LC-38 remained an important location for Army materiel development throughout the Cold War.

The related theme of Air Defense, Ballistic Missile Defense, and Army Missiles is also relevant to LC-38. Lavin outlines three subcategories under this broader theme: air defense, ballistic missile defense, and research and development, all of which are directly relevant to the historic resources at LC-38. LC-38 was home to testing of the Nike Zeus missile system, the first American attempt at a BMD system. LC-38 hosted both flight tests of the missile itself and the radar systems that were critical to its successful operation. While flight tests of the later Nike X, Sentinel, and Spartan missiles were mostly carried out at the Army KMR in the Pacific, LC-38 continued to serve as an important system development test bed for radars and computers through the rest of the 1960s, and also served as the checkout and assembly area for Sprint missiles that were launched from LC-50.

The Sprint missile was an incredibly advanced missile as of the mid-1960s; it was at the time, and possibly still is, the fastest manmade object ever produced. The Sprint missile was designed for high speed interceptions of incoming ICBM missiles in the lower atmosphere, and as such was one of the most sophisticated and high performance air defense systems developed during the Cold War. Of the four major ABM systems developed by the Army during the 1960s, Nike Zeus (1956 to 1963), Nike X (1963 to 1967), Sentinel (1967 to 1969), and Safeguard (1969 to 1976), only the Safeguard system became fully operational (Lonnquest and Winkler 1996:117). The early Nike Zeus was limited by its mechanically steered radars, which could only manage one intercept at a time, and the radars also lacked the sophistication to discern actual warheads from decoys, countermeasures, and MIRVs. Discerning warheads from decoys and countermeasures is more easily accomplished in the lower atmosphere due to the effects of aerodynamic drag, but the Nike Zeus lacked the speed and response time for intercepts at lower altitudes. Solutions to these shortcomings were developed as part of the Nike X system, which introduced the Sprint missile and the concept of layered defense (Lonnquest and Winkler 1996:110). The Sprint missile was designed to intercept incoming ICBMs in the lower atmosphere where atmospheric reentry burned up lighter objects and aerodynamic drag separated spent booster stages or decoys from the heavier, higher-speed warhead. The longer range, high-altitude interceptor missile used in the system was named the Spartan, and provided the first layer of ICBM defense. The other major technological advancement developed as part of the Nike X was electronically-steered, phased array radars that could track multiple target intercepts simultaneously. The first prototype of the Nike X phased array radar was constructed north of LC-38 at the MAR Site.

The BMD RDT&E efforts that began with the Nike Zeus system eventually came to fruition in the SRMSC in North Dakota, the only Safeguard installation ever completed. By this time, the deployment of national BMD systems was strictly limited by the 1974 ABM Treaty, which allowed for only one ABM installation to be constructed. The SRMSC became operational in 1975, but was only operated for one year before being mostly decommissioned. However, the PAR long range detection radar at the site did remain operational as part of NORAD. More importantly, the technological advancements made during the heyday of BMD development were myriad, including phased array radar systems, computers and programming, long-range detection, and target discrimination. These advances were the real end-products of the 1960s Army BMD research, and have provided dividends to air and missile defense ever since.

For all these reasons, LC-38 possesses significant associations with the identified historic themes of Army Materiel Development and the combined theme of Air Defense, Ballistic Missile Defense, and Army Missiles per Lavin (1998). The other major test location used for development of the Nike Zeus missile was the KMR in the Pacific, making LC-38 unique as the only Nike-Zeus installation in the continental US. The initiative to protect American strategic assets against ICBMs is an often-overlooked chapter in Cold War history, or conflated with the later SDI initiative of the Reagan administration. As noted in a history of US Cold War air defense programs:

> In contrast to the thousands of ICBM silos and hundreds of air defense missile batteries that the United States built during the Cold War, there are few physical reminders of the enormous sums of money the nation invested in developing an ABM capability (Lonnquest and Winkler 1996:107).

LC-38 is one such physical reminder of the US effort to develop a nationwide ABM defense network, and physical remnants of this effort are relatively rare at the national level. While the PAR installation of the SRMSC was retained and continues to be operated today as part of the USAF space tracking and early warning system, other areas of the SRMSC complex have been decommissioned and sold to private land owners. LC-38 is one of the few remaining locations in the nation that possesses significant associations with the Nike Zeus, Nike X, Sentinel, and Safeguard BMD programs and the identified historic themes. As such, several of the distinctive buildings that housed the mechanically steered radars of the Nike Zeus system are recommended for individual eligibility under Criterion A. Along with these radar and guidance facilities, several of the assembly and checkout facilities, which continued to be used for the Sprint missile through the late 1960s, are also recommended for individual eligibility under Criterion A. The overall complex possesses significant associations with the Cold War themes of Materiel Development and Air Defense, Ballistic Missile Defense, and Army Missiles. These themes are represented at the individual level by the numerous LC-38 constituent properties, although the themes are better illustrated when the complex is viewed as a whole. Accordingly, some of the individual LC-38 properties are not recommended for individual eligibility under Criterion A, but they are recommended as contributing elements to the identified LC-38 historic district. The district discussion for LC-38 is discussed in further detail below.

8.2 Eligibility Criterion B

According to guidance in *National Register Bulletin 32*, nomination under Criterion B requires clear associations with a specific *individual's* life and works (Boland 1989). The missile RDT&E work conducted at LC-38 was conducted by numerous contractors, service members, and technicians, which makes it difficult to identify the accomplishments of any specific individual. Additionally, for a property to be nominated based on association with an individual significant to history, it must possess a meaningful association with that person's life or works during the period when they achieved significance. No such association is known to exist with any of the documented LC-38 properties. Accordingly, Epsilon Systems recommends that the historic associations of the LC-38 resources are generally more appropriately considered under the broader scope of Criterion A.

8.3 Eligibility Criterion C

LC-38 includes many utilitarian building and structure types that are commonplace at DOD test ranges. However, the launch complex also includes several unique buildings and structures that are notable for their design and construction.

Many of the buildings at LC-38 are of poured concrete or CMU construction and are typical of military vernacular buildings found across WSMR and other military installations nationwide during and after the Cold War. Poured concrete or CMU buildings recorded at LC-38 include Properties 23610, 23632, 23640, 23642, 23654, 23656, 24066, and 24072. Buildings of mixed CMU and steel frame construction include Properties 23626 and 24068. Many of these properties are typical, utilitarian DOD properties that do not represent any particular technological advances or innovations in their actual construction. These utilitarian buildings are driven by function rather than form, and lack distinction in their type, period, or method of construction. Nor do they represent the work of a master or possess high artistic value. For these reasons, many of the recorded LC-38 properties are not recommended for individual eligibility under Criterion C. For additional discussion of the recorded properties' eligibility under Criterion C, the reader is directed to the individual property HCPI forms included in Appendix C.

However, several properties at LC-38 were specially designed and constructed to support the Nike Zeus program, and possess architectural significance at the individual property level. These properties embody "distinctive characteristics of a type, period, or method of construction" per the wording of eligibility Criterion C. Each of the buildings discussed below are recommended for individual eligibility under Criterion C.

Property 23626 is a large assembly building located in the south-central portion of LC-38, just north of Nike Avenue. Property 23626 is a large steel frame and CMU building with a rectangular footprint constructed on an above-grade concrete foundation. The building consists of a high-bay assembly wing with lower one-story wings along both the north and south elevations. The original portion of the building consists of the central high-bay assembly wing and the lower office wing along the north elevation. The large assembly wing of the building possesses several attributes specific to its role as a missile assembly building. Large bay doors are located on the east and west elevations of the main assembly bay. The exterior walls of the assembly wing are clad in asbestos-cement (transite) exterior cladding, which was frequently used on large assembly buildings at WSMR, likely due to its durability and fire-resistant qualities. The portion of the north elevation formed by the assembly wing hosts an impressive bank of clerestory windows in its upper wall; based on the original architectural drawings (Plan Set WS-GZ), this bank of clerestory windows consists of 86 individual window units. The clerestory windows provided the assembly bay area within the interior with abundant natural lighting. These attributes make the building's design and construction distinctive and evoke the building's purpose to the viewer. Property 23626 therefore possesses architectural distinction as a type and in its method of construction, per the language of Criterion C. For these reasons, it is recommended for individual eligibility under Criterion C.

Property 23640, the former Nike Zeus BCB, is a large one-story building of CMU construction with an irregular plan. The somewhat unusual plan along the building's north elevation was apparently designed to accommodate the placement of three radar antenna towers. The interior of the building included shielded rooms to protect electronics from RF interference, although the electrical and air conditioning service room in the south portion of the building was not shielded as it did not house sensitive electronics equipment. While the CMU construction of the building is commonplace in DOD settings, other aspects of its design, including the irregular north elevation plan, shielded interior rooms, and lack of windows make the building distinctive as a type and in its method of construction, per the language of Criterion C. It is therefore recommended for individual eligibility under Criterion C.

Property 23642, the former Nike Zeus TTR installation, is a large one-story building of CMU construction with an L-shaped plan formed by a square block east wing and an elongated west wing. The east wing was specifically built to support the TTR installation for the Nike Zeus program, and the west wing was constructed a few years later as an office and administrative wing. The exterior of the east radar wing was originally clad in terne sheetmetal shielding to protect against RF interference, although this has been removed from the building. The interior of the radar wing incorporated structurally independent concrete walls that supported the roof-mounted TTR radar antenna. Although the antenna has been removed and its base sealed, the interior structural supports for the radar remain within the building. While the CMU construction of the building is commonplace in DOD settings, other aspects of its design, including the interior structural supports for the radar, antenna base on the roof, and lack of windows in the original radar wing, make the building somewhat distinctive architecturally. As the building possesses architectural distinction as a type and in its method of construction, per the language of Criterion C, it is recommended for individual eligibility under Criterion C.

Properties 23654 and 23656 are one-story magazine structures constructed of reinforced concrete, earthen fill, and exterior concrete cribbing panels. Variations of explosive storage magazines are common in DOD settings, but Properties 23654 and 23656 are distinctive variations that incorporate aspects of both concrete box magazines and earthen igloo magazines. The exterior concrete cribbing that retains the earthen fill of the structures is also a distinctive element of the structure. These buildings therefore possess architectural distinction in type and method of construction, per the language of Criterion C. As such, Properties 23654 and 23656 are both recommended for individual eligibility under Criterion C.

Property 24072, the former ZAR transmitter building, is a large, partially below-grade building located in the east portion of LC-38. The building is located at the center of a circular earthen berm that once supported a clutter fence. A subterranean access tunnel located outside the west edge of the clutter fence permitted personnel access to the building while maintaining a safe distance from the high-frequency hazard of the radar antenna. The building is constructed of reinforced concrete, and the exposed portions of its exterior were clad in soldered metal panels, referred to as terne shielding in the architectural drawings for the building (Plan Set WS-HZ). While the reinforced concrete construction of the building is fairly commonplace in DOD settings, other aspects of its design, including its partially below-grade construction, terne cladding, lack of windows, associated clutter fence, and subterranean access tunnel make the building distinctive. The massive ZAR transmitter antenna was removed from the roof of the building during the early 1970s, and the building was substantially modified for other purposes. Even in the building's current reduced state, its unique design and features make it obvious to even casual observers that Property 24072 was specially constructed for its specific, technical function as part of the ZAR. The building therefore possesses architectural distinction as a type and in its method of construction, per the language of Criterion C. For these reasons, it is recommended for individual eligibility under Criterion C.

For additional discussion of the recorded properties' eligibility under Criterion C, the reader is directed to the individual property HCPI forms included in Appendix C. The final clause of Criterion C, "…a significant and distinguishable entity whose components may lack individual distinction" (NPS 1995:2), refers to districts. The district considerations for the LC-38 properties are discussed in Section 8.8.10.

8.4 Eligibility Criterion D

Per NRHP guidance, Criterion D is most often applied to archaeological districts and sites, but can be applied to buildings, structures, and objects (NPS 1995:21). However, for buildings, structures, and objects to be eligible under Criterion D, the properties themselves must be the principal source of important information, which is usually related to design and construction details (NPS 1995:21). This is not the case with the LC-38 resources, as the design and construction details of most of the properties are already well documented and additional data is unlikely to be derived from the physical resources themselves. As such, no information potential exists in further study of the LC-38 buildings, structures, and objects. Therefore, none of the LC-38 properties are recommended as eligible under Criterion D.

8.5 Previous Research

Several previous recording efforts have been conducted at LC-38 (Table 3). In 2000 and 2002, inventory projects conducted by Human Systems Research (HSR) recorded 21 properties at LC-38 (NMCRIS Numbers 131262, 131296, and 131315). Of these 21 previously recorded properties, seven have been demolished since they recorded by HSR (Properties 23620, 23630, 23638, 23664, 23680, 23685, and 24064). Since these properties are no longer extant at LC-38, they are not relevant to the current inventory effort.

Of the remaining 14 previously documented properties, six were recommended as eligible to the NRHP by HSR (Properties 23640, 23642, 23654, 23656, 24070, and 24072). HSR recommended Properties 23640 and 23642 as eligible to the NRHP under Criteria C and D. WSMR did not agree with this recommendation, stating that both properties remained in use and, "due to changing mission requirements we do not feel it is appropriate to evaluate their eligibility at this point in time" (Ladd 2002a). The submittal letter also stated that, "none of these buildings are part of a Historic District, or an area where we plan to have such a district, ergo they are not contributing" (Ladd 2002a). The New Mexico SHPO did not provide any response regarding the eligibility of these properties, but asked that, "WSMR refrain from forwarding architectural survey files to our office until such time as a WSMR initiated undertaking requires a formal determination of eligibility from the SHPO" (Hare 2002a; HPD Log Number 65856).

HSR also recommended Properties 23654 and 23656 as NRHP-eligible under Criteria C and D. WSMR agreed with this recommendation, but argued that Properties 23654 and 23656 were eligible under Criteria A, C, and G, stating:

> These buildings are eligible under Criteria A, C, and G as Cold War fall-out shelters with their unusual design criteria and high human carrying capacity. They achieved exceptional significance due to their value in protecting human survivability, and someday, here at WSMR, may be the most significant visible remnant of the Cold War threat to the world [Ladd 2002b].

This justification of eligibility overlooked the actual Cold War associations of Properties 23654 and 23656, instead narrowly focusing on their later designation as fallout shelters. During the Cold War, some subterranean and blast resistant properties at WSMR were designated as emergency fallout shelters, but this use was largely incidental to the original function of these

Table 3. Previously Recorded Properties at LC-38, with past and current recommendations.

Property	Year Recorded	Recorder	Recommended Eligible?	WSMR Determination	SHPO Concurrence	HCPI	NMCRIS	Epsilon Recommendation
23610	2000	HSR	No	N/A	N/A	34038	131262	Not Eligible
23620	2000	HSR	Yes	N/A	N/A	-	-	N/A, Demolished
23626	2000	HSR	No	Not Eligible	Yes	34039	131262	Eligible A and C; Contributing Element
23629	2002	HSR	No	Not Eligible	Yes	34040	131262	Not Eligible
23630	2000	HSR	No	N/A	N/A	-	-	N/A, Demolished
23632	2000	HSR	No	Not Eligible	Yes	34046	131296	Contributing Element
23638	2000	HSR	Yes	Not Eligible	None	34047	131296	N/A, Demolished
23640	2000	HSR	Yes	Not Eligible	None	34041	131262	Eligible A and C; Contributing Element
23642	2000	HSR	Yes	Not Eligible	None	34042	131296	Eligible A and C; Contributing Element
23652	2002	HSR	No	Not Eligible	None	34043	131296	Contributing Element
23654	2000	HSR	Yes	Eligible	No	34044	131296	Eligible A and C; Contributing Element
23656	2000	HSR	Yes	Eligible	No	34045	131296	Eligible A and C; Contributing Element
23664	2000	HSR	Yes	N/A	N/A	-	-	N/A, Demolished
23680	2000	HSR	Yes	N/A	N/A	-	-	N/A, Demolished
23685	2000	HSR	No	N/A	N/A	-	-	N/A, Demolished
24025	2002	HSR	No	Not Eligible	Yes	34048	131296	Contributing Element
24064	2000	HSR	Yes	Not Eligible	None	34049	131315	N/A, Demolished
24066	2002	HSR	No	Not Eligible	Yes	34050	131315	Contributing Element
24068	2002	HSR	No	Not Eligible	None	34051	131315	Contributing Element
24070	2002	HSR	Yes	Not Eligible	Yes	-	-	Contributing Element
24072	2002	HSR	Yes	Not Eligible	Yes	34056	131315	Eligible A and C; Contributing Element

properties. The New Mexico SHPO did not concur with WSMR's determination, stating that Properties 23654 and 23656 were not of exceptional importance and not eligible to the National Register (Hare 2002b; HPD Log Number 65855).

HSR recommended Properties 24070 and 24072 NRHP-eligible under Criterion C. HSR recommended Property 24070 as eligible under Criterion C, primarily because of the hangar doors on the north elevation. WSMR did not agree with this recommendation, and instead determined that the building lacked significance and was, "not eligible for nomination" (Ladd 2002a:1). The New Mexico SHPO concurred with WSMR's determination (Hare 2002a; HPD Log Number 65856). HSR also recommended Property 24072 as eligible under Criterion C, but WSMR did not agree with this recommendation, stating that, "Building 24072 has been modified and is not eligible for nomination" (Ladd 2002b:2). The New Mexico SHPO concurred with WSMR's determination, stating that Property 24072 was not eligible due to lack of integrity (Hare 2002b; HPD Log Number 65855).

Previous NRHP evaluations resulted in none of the remaining LC-38 properties being recommended as eligible. Specific to the removal of Properties 23680 and 24064, WSMR published an interpretative pamphlet that summarized the role these properties played in the Nike Zeus program and provided a general historic context for LC-38 (WSMR 2010). While these previous recordings were useful contributions towards the documentation of the LC-38 resources, they did not adequately address the possibility of a historic district and the possibility that the documented resources might be eligible as contributing elements to a larger historic district. Aside from the 2010 interpretative brochure, these previous recording efforts also did not provide a comprehensive historic context for the LC-38 resources. The previous evaluations are also over 20 years old, and occurred before most of the recorded properties were 50 years old. Therefore, they are being re-evaluated as part of the current inventory and evaluation effort. The current effort also seeks to provide a complete inventory of all the extant LC-38 resources and will evaluate them within an appropriate historic context. This will facilitate an informed recommendation regarding the historic district potential of the documented LC-38 resources.

8.6 Period of Significance and Criteria Consideration G

The primary period of significance at LC-38 begins with the establishment of the launch complex in 1959 and ends in 1964, when further development of the Nike Zeus system was halted. LC-38 was established expressly in support of the Nike Zeus program, and most of the launch complex's infrastructure and primary facilities were built during this initial wave of construction. As such, Nike Zeus is the defining program for LC-38, and the duration of the Nike Zeus system testing is therefore considered as the launch complex's primary period of significance.

Despite demonstrating promising early results, Nike Zeus was met with opposition in political and scientific circles. Although successful in test scenarios, critics of the Nike Zeus system argued that it lacked the ability to reliably identify ICBM warheads amongst reentry debris and decoys in the upper atmosphere, and that its radars lacked the ability to engage multiple targets simultaneously. Due to these concerns, Secretary of Defense Robert McNamara halted further work on the system in 1963 and directed the priority development of a new ABM system based on the most advanced technology then available (Bell Laboratories 1975:I-36; Walker et al. 2003:49). This new ABM system was temporarily designated as Nike X until a more suitable name was selected, but the Nike X designation stuck. The Army officially changed the name of the project office from Nike Zeus to Nike X on February 1, 1964 (Walker et al. 2003:49). This marked the end of Nike Zeus testing at LC-38, although some testing of Nike Zeus system components continued until 1965. BTL and Western Electric continued to serve as the prime contractors for Nike X, and many of the existing LC-38 properties were adapted for testing of the Nike X program.

The secondary period of significance defined for LC-38 begins in 1965, when work at the complex transitioned to the Nike X program, with a focus on the Sprint missile. As discussed in the historic context, the Nike X incorporated the new Sprint missile and phased array radar systems. Both the Sprint and phased array radar systems would be integral components of not only the Nike X program, but also the later Sentinel and Safeguard derivatives. During the mid-to-late 1960s, both Sentinel and Safeguard maintained test programs and offices at LC-38. The Sprint operations at LC-38 ended by 1970, when the Sprint testing program at WSMR was completed. The assignment of most of the LC-38 facilities to BTL and Western Electric also ended around 1970, so this year makes a useful end date for the secondary period of significance at LC-38. The end of Sprint testing marked the end of the various BTL ICBM interceptor programs at LC-38. After 1970, testing activity at LC-38 shifted to new programs and new contractors.

The third and final period of significance defined for LC-38 begins in 1971 and extends to the end of the Cold War. This late period of significance at LC-38 is primarily associated with the SAM-D/Patriot missile program. Realty records indicate that the SAM-D program began to occupy space at LC-38 in 1969, when the program moved into the former Nike Zeus Assembly Building (Property 23626). The hazardous assembly area properties (Properties 23654 and 23656) began to be occupied by SAM-D test vehicles in 1970 as Sprint missile testing wound down. Also, new facilities were constructed in the former Nike Zeus launcher area in support of the SAM-D program during the early 1970s. SAM-D was renamed the Patriot in 1976 in recognition of the country's bicentennial and a production contract with Raytheon was awarded in 1980. The use of the Patriot missile during both Operation Desert Shield and Operation Desert Storm in 1990 and 1991 made the Patriot missile internationally well-known, although debates over its actual effectiveness continued for many years after the end of the Persian Gulf War conflict (Schubert and Kraus 1995). The year 1989 is cited by many historians as the end of the Cold War, when revolutions against the Communist regimes in Poland, Hungary, East Germany, Bulgaria, Czechoslovakia, and Romania initiated the dissolution of the Warsaw Pact and marked a point of no return for the Soviet Union. However, 1991 is also sometimes cited as the final year of the Cold War, as the Soviet Union was officially dissolved on December 26, 1991.

Although the primary period of significance for LC-38 is associated with the Nike Zeus program from 1959 to 1964, the complex remained very active throughout the Cold War and continues to be actively used today, primarily by contractors Raytheon and Lockheed Martin. The term "historic," per NRHP guidance, represents events, activities, and properties that are over 50 years old — post-1973 as of this writing. Post-1973 activities and properties might still be meaningful to recent history but are not technically considered historic. As the third period of significance for LC-38 extends to the end of the Cold War in 1989, it potentially might include associations with properties and events that are less than 50 years old.

The post-1973 activities and properties at LC-38, being less than 50 years of age, are considered within the framework of Criteria Consideration G. This consideration applies to both properties and events that are less than 50 years old. Additionally, per guidance in *National Register Bulletin 15*, properties that are more than 50 years old but possess significant associations with events less than 50 years old must be evaluated under Criteria Consideration G (NPS 1995:43). NRHP guidance is clear that for properties to be eligible under Criteria Consideration G, they must be of "exceptional importance" to recent history. However, almost all the primary LC-38 properties were constructed during the late 1950s and early 1960s and therefore are considered historic in nature.

The major RDT&E activity at LC-38 within the last 50 years is the SAM-D/Patriot program, which remains active at the complex today. This program falls into the latter period of significance defined for LC-38 but is still relevant to the identified historic themes. Most of the infrastructure for the SAM-D program was constructed during the early 1970s, and is therefore technically historic in nature. Some of the SAM-D/ Patriot elements that are not yet 50 years old still date to the later years of the Cold War. Specific to the recommendation of LC-38 as a historic district, it is not necessary to demonstrate exceptional importance of these later properties under Criteria Consideration G as the majority of the contributing properties are historic. Per NRHP guidance, a district with a majority of properties over 50 years old can also include contributing resources that are less than 50 years old without demonstrating exceptional importance of the district itself or those contributing elements that are less than 50 years old (Sherfy and Luce 1998:10). As the relatively few recent additions at LC-38 are a continuation of the same mission and historical patterns that were responsible for the construction of the older properties, they therefore are considered as integral and contributing elements to the district without the necessity of making a separate argument for their inclusion under Criteria Consideration G.

8.7 Integrity of LC-38

Per the guidance in Lavin (1998), Cold War-era Army military-industrial properties that are eligible for consideration under one or more specific Cold War themes must be judged in terms of historic integrity. This discussion primarily focuses on the integrity of the complex as a whole as a prerequisite for addressing the possibility of a NRHP district in the following section. For details regarding the integrity of individual properties, the reader is directed to the property descriptions in Chapter 7 and the HCPI forms in Appendix C.

Integrity, or the ability of the property to convey its significance via its physical attributes, is evaluated by seven qualities. These are the qualities of location, design, setting, materials, workmanship, feeling, and association. These specific qualities are derived from NRHP guidance and can be considered individually in regards to the historic character of LC-38.

The quality of location is related to, yet distinctive from, the quality of setting. The quality of location simply refers to the place where the historic events occurred, while setting refers to the "character of the place" and "how, not just where, the property is situated and its relationship to surrounding features and open space" (NPS 1995:45). NPS guidance states, "the actual location of a historic property, complemented by its setting, is particularly important in recapturing the sense of historic events and persons" (NPS 1995:44). As such, it is clear that the aspect of location has remained almost entirely consistent for LC-38, as the launch complex's location and relationship to its surroundings has not changed since it was established in 1959. However, the slightly subtler aspect of setting has changed somewhat through time, mostly due to the demolition of some older properties and the addition of some newer ones. The removal and demolition of some of the Nike Zeus properties is discussed in additional detail below. Despite these impacts, LC-38 retains significant integrity in regard to the aspects of location and setting.

The aspects of workmanship and materials are more applicable to individual properties, but can be applied to consideration of the general historic fabric of LC-38. Workmanship is defined as "the evidence of artisans' labor and skill in constructing or altering a building, structure, object, or site. Workmanship can apply to the property as a whole or to its individual components" (NPS 1995:45). Materials are "the physical elements that were combined or deposited…to form a historic property" (NPS 1995:45). As a whole, the integrity of the launch complex's worksmanship and materials has been diminished by the removal of some of the principal Nike Zeus properties, which is discussed in further detail below. Specific to the extant properties at the complex, the integrity of workmanship and materials has been diminished by alterations and modifications made to some of the individual properties. The exterior of the east radar wing of Property 23642 was originally clad in lead and tin alloy (terne) panels, which was also used on Property 24072. The shielding has been removed from Property 23642, and today the exterior of this part of the building consists of painted CMUs. A west office wing was also added to the original radar block of Property 23642, although this addition is historic in origin. The original radar antennae have been removed from both Properties 23642 and 24072. The TTR antenna and its enclosing radome on the roof of Property 23642 have long been removed, and the base of the radome has been covered and sealed with built-up roofing material. Likewise, the massive ZAR transmitter antenna was removed from the roof of Property 24072 during the early 1970s. According to the bid request for the removal of the antenna, it measured 100 feet per side and was estimated to weigh 600,000 pounds, including its drive motors and related gear (DOD 1963). Other alterations made to Property 24072 include a below-grade access ramp and rolling overhead door that were added to the building's west elevation in 1969. The clutter fence that originally surrounded Property 24072 was also removed as part of this project. Properties 23642 and 24072 are not the only properties at LC-38 whose workmanship and materials have been altered through time. Properties 23626, 23640, 23641, 23648, and 24068 have also been modified, but these alterations did not drastically change the exterior appearance and physical features of these properties. While these properties have been subject to various alterations and removal of components through time, they retain significant integrity of their basic workmanship and materials.

Related to setting, workmanship, and materials is the quality of design, which is defined as "the combination of elements that create the form, plan, space, structure, and style of a property" (NPS 1995:44). Viewing LC-38 as a whole, the original layout and design intent of the complex remains apparent and intact. LC-38 was originally designed with several sub-areas that were fairly distinct both spatially and functionally. The south-central part of the complex was the location of the main assembly building (Property 23626) as well as several administrative, support, and technical buildings. The main launch area was located in the north central part of the complex, and the hazardous assembly and storage area located in the west central part of the complex. The Nike Zeus radars and related properties were located in the east central part of the complex along Range Road 240, with the ZAR located near the eastern boundary of the complex. This basic layout and design of LC-38, with its fairly discrete functional sub-areas, is still evident today, even though individual properties have been removed and replaced through time.

At the individual property level, many of the LC-38 resources have been subject to changes that have impacted their integrity of design to some degree, along with their workmanship and materials. As discussed above, Properties 23642 and 24072 are probably the most modified of the remaining original Nike Zeus properties at LC-38. The designs of other original properties at LC-38, including Properties 23626, 23640, 23641, 23648, and 24068, have also been modified through time, although to a lesser degree. However, this is the nature of RDT&E properties, and some degree of re-use and adaptation is required in order for these properties to remain in place for over a half-century. The Advisory Council on Historic Preservation (ACHP) guidance on technical and scientific facilities states that:

> Many of the sites and much of the equipment that facilitated modern scientific and technological development are still in active use; *it is by their continued long-term use, in fact, that they have become a part of America's heritage*, where they stand as historic monuments to America's ability to invent and exploit technology and advance scientific and engineering knowledge [ACHP 2009:6; emphasis in original].

The guidance further notes that continuity of use actually may help preserve association, despite the modifications that might be necessary: "Few structures in use today will undergo modification to such an extent that all integrity is lost. In most cases there should be continuity in function, and thus in integrity of design and materials, and there may always be integrity of association" (ACHP 1991:33). The ACHP guidance on highly technical and scientific facilities was considered when judging the integrity of the workmanship, materials, and design of the individual LC-38 resources.

Cumulatively, the aspects of setting, design, workmanship, and materials contribute to the more general aspects of feeling and association. According to NPS guidance, feeling "is a property's expression of the aesthetic or historic sense of a particular period of time" and "results from the presence of physical features that, taken together, convey the property's historic character" (NPS 1995:45). Closely related to feeling is association, which is "if it is the place where the event or activity occurred and is sufficiently intact to convey that relationship to an observer. Like feeling, association requires the presence of physical features that convey a property's historic character" (NPS 1995:45). NPS guidelines are clear that not only must a property be "associated with an important historic context" but must also retain "historic integrity of those features necessary to convey its significance" in order to be eligible to the NRHP (NPS 1995:3).

Some significant properties have been removed or demolished at LC-38, which has diminished its integrity of feeling and association. The two properties that formed the ZAR receiver installation (Properties 24062 and 24064) have been completely demolished, leaving only the ZAR transmitter building (Property 24072). Property 24062, the large radome structure that housed the ZAR receiver antenna was demolished first, while Property 24064 remained in place until

2010 when it was also completely demolished. Property 23638, which housed the Nike Zeus DR, has also been demolished, along with two of its radar clutter fences (Properties 23657 and 23658). However, Property 23659, the larger outer clutter fence, still remains intact to indicate the DR location. The original Nike Zeus launch area has been significantly impacted by the removal of its Nike Zeus-era properties. Property 23680, the launch control building at the Nike Zeus launch area, has been demolished, along with the two Nike Zeus launcher pits (Properties 23669 and 23673), launcher equipment buildings (Properties 23670 and 23672), and earthen revetments (Properties 23668 and 23671). Only the Nike Zeus tactical launch cell (Property 23683) remains in the launcher area, although all of its launch equipment has been removed and its underground launch cell capped. Sections of the access tunnels that connected the launchers to the underground control room also remain in place in the launch area. Several Nike Zeus technical and administrative buildings have also been removed from LC-38, including the EMT Guidance Building (Property 23620), Inert Support Building (Property 23664), and the CE Admin Building (Property 23630).

Despite the removal of these properties, the layout and configuration of the original Nike Zeus installation at LC-38 is still discernable to the modern viewer. The major functional areas within the launch complex remain evident, and many of the original Nike Zeus properties remain in place. The remaining Nike Zeus radar installations are particularly important here, since these impressive radar properties truly defined LC-38's distinctive character. The later Cold War use of the complex for the testing of the SAM-D/Patriot program re-used many of these earlier facilities, but did not significantly alter their important physical characteristics. Much of the current layout and configuration of the launch complex remains much the same since the mid-1970s, when the Patriot test facilities were added to the north central part of the complex. Although some new buildings have been added to the complex within the last 20 years, much of LC-38 bears a strong resemblance to its historic Cold War configuration. The individual properties mostly retain key physical features that are relevant to the identified historic themes and pertinent to the Cold War programs identified in the historic context.

8.8 LC-38 as a Military Landscape and District

The wider perspective of a historic military landscape was considered as part of the LC-38 inventory. Military landscapes are those that have been uniquely shaped in support of military missions, and historic military landscapes are those that have significant associations with historically important persons, events, or patterns or represent significant examples of design or construction (Loechl et al. 1994:9). Per the guidance, an identified historic military landscape is typically recorded as a historic district or site (Loechl et al. 1994). Historic military landscapes are evaluated within the framework of an appropriate historic context that allows for the associated military mission, chronological period, geographic context, and historic themes of a military landscape to be identified and understood (Loechl et al. 1994:19-20). For the purpose of the present undertaking, this historic context is provided within Chapter 6 of this report.

In addition to the historic context of a military landscape, the physical characteristics of the landscape must also be considered. Landscape characteristics are "the tangible evidence of the activities and habits of the people who occupied, developed, used, and shaped the land to serve human needs; they may reflect the beliefs, attitudes, traditions, and values of these people" (Loechl et al. 1994:36). Specific to the evaluation of historic military landscapes, nine such characteristics are identified. These characteristics are Spatial Organization and Land Use; Response to Natural Environment; Expression of Military Cultural Values; Circulation Networks; Boundary Demarcations; Vegetation; Buildings, Structures, and Objects; Clusters of Buildings, Structures, and Objects; and Archaeological Sites (Loechl et al. 1994:36-40). Each of these characteristics is discussed in relation to LC-38 below.

8.8.1 Spatial Organization and Land Use

The implementation of military missions directs the way the land of a military installation is utilized and how it is spatially organized (Loechl et al. 1994:36). At LC-38, the primary mission that drove the establishment of the complex was testing of the Nike Zeus system, the nation's first attempt at a BMD system. Major construction of the Nike Zeus facilities at LC-38 started in 1958, with additional major facilities added through 1962. The original spatial organization of LC-38 consisted of five main developed areas. An assembly, technical, and administration area centered around a large assembly building (Property 23626) was located north of Nike Avenue. North of this area was a hazardous assembly and checkout area centered around two large magazine structures (Properties 23654 and 23656). The launch area was located in the north central part of LC-38, and was based around a control building (Property 23680) and several launcher structures (Properties 23669, 23673, and 23683). Located in the central part of the complex and slightly east were the Nike Zeus BCB, MTRs, TTR, and DR. The fifth and final major developed area of LC-38 was the ZAR area in the east central part of the complex. Here, the large ZAR receiver and transmitter buildings were located, along with a series of physical plant facilities. The ZAR area was surrounded by an extensive chainlink fence that formed an internal security perimeter around this sub-area of the complex.

Many of the original Nike Zeus properties remain in place, but have been adapted for other purposes, while some have been completely removed. However, the primary sub-areas of the launch complex as established for the Nike Zeus program are still evident. While additional properties have been added to the complex over time, they have been primarily added to the existing developed areas of the complex. The exception is a sub-area used by Lockheed-Martin in the southwest corner of the launch complex. These facilities were constructed in support of the Patriot PAC-3 missile testing operation during the early 2000s; this area was undeveloped during the Cold War period.

Like all the Nike Avenue launch complexes, the actual boundaries of LC-38 include a large amount of undeveloped desert landscape. According to WSMR GIS, the overall boundary of LC-38 encompasses some 2,002 acres, but only a small portion of this acreage is occupied by built environment resources.

8.8.2 Response to Natural Environment

Significant natural features often influence the location and organization of military installations, and climatic factors can influence the types of facilities constructed at these installations (Loechl et al. 1994:37). The natural environment was a critical factor in the selection of the Tularosa Basin as the location of WSPG in 1945. The proposed proving ground required attributes of flat and open ground, a sparse population, and predominantly clear weather. Other preferred characteristics included surrounding hills or mountains for observation sites and natural barriers, access to railroad lines and utilities, and proximity to an established military post for support. The Tularosa Basin was identified as the best choice by the Army, possessing nearly all of the desired characteristics.

More specific to LC-38 and its response to the natural environment, the location of the complex in the floor of the Tularosa Basin provided a huge extent of flat and open ground that allowed for excellent line of sight for optical instrumentation and flight lines clear of topographical barriers to the north. However, the natural environment was likely not the most important consideration in the location selection for LC-38. Rather, the complex was likely located based on logistical considerations such as proximity to the main cantonment and technical support areas, as well as the existing and future locations of other launch complexes along Nike Avenue. By the late 1950s, the series of launch complexes along Nike Avenue were well-established, with LC-32, LC-33, LC-35, LC-36, and LC-37 already present. Given the substantial infrastructure required by the Nike Zeus system, the system required more space than was available at any of the existing launch complexes. As such, LC-38 was established east of LC-37 in the next large block of available land, making it the easternmost of the major Nike Avenue launch complexes. The establishment of LC-38 solidified the status of Nike Avenue as "launch complex row" at WSMR, with nearly all the major launch complexes at the range laid out in a linear series along the north side of Nike Avenue by the end of the 1950s.

8.8.3 Expression of Military Cultural Traditions

According to Loechl et al. (1994), military cultural traditions are expressed at military installations in both organizational and aesthetic senses. These military values include hierarchy, uniformity, discipline, utility, and patriotism (Loechl et al. 1994:38). However, these values are more specific to personnel and administrative areas of military installations, while LC-38 is a technically-oriented facility. The original layout of LC-38, which influenced the organization of the complex throughout the Cold War, was intended to simulate a Nike Zeus anti-ICBM installation, along with various assembly and support properties. LC-38 therefore expresses the technical requirements of the Nike Zeus system testing rather than the hierarchical or patriotic values that would be displayed at military barracks or housing areas. As the complex grew in an accretional fashion through time, new facilities were either added to the existing Nike Zeus areas or constructed in the extensive undeveloped areas of the complex to avoid interference with existing facilities that remained in use.

However, the military value of utility is expressed in the types of buildings and structures encountered at the complex. Several of the Nike Zeus radar and guidance properties at LC-38 are of reinforced concrete construction, including Properties 23640, 23642, 23654, 23656, and 24072, which provided durability and blast protection. Other properties at the complex are of steel frame or CMU construction, and all these construction methods provided a high degree of utility at the expense of architectural style or ornamentation. The utilitarian nature of the buildings and structures at LC-38 reflect the pragmatic nature of the military testing mission, which emphasizes function rather than form in order to meet the requirements of the RDT&E process.

8.8.4 Circulation Networks

Loechl et al. (1994) defines circulation networks as roads and transportation routes that facilitate the movement of troops and supplies across military installations. These networks can include major primary and secondary roads as well as smaller local roads and access routes to specific areas (Loechl et al. 1994:38). At LC-38, circulation networks were mostly used for the movement of personnel, equipment, and materials required of RDT&E efforts at the complex rather than the movement of Army troops and supplies.

The initial wave of construction at LC-38 included the grading and surfacing of 8,670 feet of gravel roads and 6,250 feet of paved roads that connected to Nike Avenue. The main north-south access roads within LC-38 were Range Road 242 in the eastern part of the complex, and Range Road 239 in the western part of the complex. Range Road 240 was the east-west road that extended east from Range Road 239 to access the MTR, TTR, and DR radar installations. Eventually, Range Road 240 was extended further east to connect to Range Road 242 and the ZAR area, but early maps indicate that it originally dead-ended near the location of the DR. Range Road 238 was another east-west road that extended west from Range Road 239 and continued west into the neighboring LC-37; this also appears to have been added during the mid-1960s. A short access road also extended west from Range Road 239 to provide access to the hazardous assembly and storage area. An unnumbered gravel road also traveled north from Nike Avenue to access the Seus and Neus instrumentation sites. It appears that the initial roads at LC-38 were mostly direct access roads to specific areas within the complex, but some of these roads were later extended to form an actual road network by the end of the 1960s. The LC-38 road network was therefore fairly well-developed and provided good connectivity within the complex's interior. The LC-38 road network therefore helps to define the complex as a discrete area of military testing activity. The LC-38 roads remain accessible and are frequently used today.

8.8.5 Boundary Demarcations

Boundary demarcations on military installations define the limits of the overall installation as well as specific areas of land use within the larger installation, and unlike city limits, are often quite visible (Loechl et al. 1994:39). LC-38 largely lacks such boundary demarcations. However, a few sub-areas within the complex are enclosed behind chainlink fences for added access control, generally reflecting recent or ongoing re-use and some level of heightened security. Originally, the ZAR area and its associated physical plant facilities were surrounded by a chainlink perimeter fence that formed a separate security area; this large rectangular fenced area measured approximately 2,150 feet north-south and 1,560 feet east-west. Near the southwest corner of this fence, a guardhouse (Property 24025) was constructed along Range Road 242 to control access into the fenced security area. The fence has been removed, but numerous concrete filled postholes and post stubs remain to indicate its alignment. A security fence still surrounds the main assembly building (Property 23626) and Properties 23654, 23655, and 23656 in the former Nike Zeus assembly and storage area. The substantial radar clutter fences that surrounded the Nike Zeus DR and ZAR transmitter also acted as de facto physical barriers that kept personnel at a safe distance from these powerful radars. A barbed wire fenceline is located along the west and north sides of the modern Property 23700, but is in poor condition and incomplete. The actual limits of the larger LC-38 boundary are not indicated by fences or other markers, but this is typical of most WSMR launch complexes. As with many of the Nike Avenue launch complexes, the actual boundaries of LC-38 encompass significant acreage beyond the developed portions of the complex. The west boundary is shared with the neighboring LC-37, and the east boundary is shared with LC-39, which is largely undeveloped. Since the mapped limits of the WSMR launch complexes often include hundreds of acres of undeveloped desert, it is impractical to demarcate the boundaries of each complex with fencing.

8.8.6 Vegetation

Vegetation can be important to the definition of landscapes as it bears a direct relationship to long-established patterns of land use. Landscaped residential areas or intentionally cleared areas both communicate different aspects of the military mission on the land. Forests or groves of trees can be used as boundary markers or buffers against surrounding communities (Loechl et al. 1994:39). However, as an RDT&E facility situated within the larger confines of WSMR, LC-38 is somewhat of an exception to the patterns suggested by Loechl et al. (1994).

Vegetation typical of the area is Plains Mesa Sand Scrub (Dick-Peddie 1993). It is likely that the current vegetation community in the Tularosa Basin developed from disturbances introduced by human agency during the 19th century, allowing for the development of shrubland in lieu of established grasslands (Muldavin et al. 2000a:80).

The desert scrub vegetation was cleared to facilitate construction within the complex; however, since most of the LC-38 built environment consisted of relatively discrete and small clusters of development, the vegetation clearing was fairly limited. Based on period aerial imagery, areas of cleared vegetation were the most significant around the assembly and technical area in the southern part of the complex and around the ZAR installation in the eastern part of the complex. It also appears that significant clearing and earthmoving occurred north of the BCB and TTR installations in order to level the site for their construction. Many of the formerly cleared areas within the interior of LC-38 have largely been reclaimed by vegetation. Only the portions of the complex that remain in use today remain mostly clear of vegetation. As such, vegetation does not serve as a proxy marker for the limits or extent of LC-38.

8.8.7 Buildings, Structures, and Objects

Buildings, Structures, and Objects are often the most prominent features on the landscape and traditionally the focus of the NHPA compliance process. As defined by the NPS, buildings are designed to shelter some sort of human activity, while structures are designed for functions other than sheltering people and their works (NPS 1995). Objects are generally smaller and can be moveable, and are often commemorative or artistic in nature such as water fountains or statues (Loechl et al. 1994:40). The buildings, structures, and objects at LC-38 are the primary expression of the military mission on the landscape and define the orientation and layout of the complex. Most of the documented resources were buildings, along with a relatively high number of structures; few objects were recorded.

The LC-38 inventory effort resulted in the recordation of 62 buildings, structures, and objects. Many of these properties were located within definable clusters which are an expression of the functional activities they supported. As part of the inventory methodology, less significant resources representing remnants of LC-38 supporting infrastructure were recorded as features and are described separately in Appendix A. A total of 1,218 features were recorded in association with the buildings, structures, and objects at LC-38. These less-substantial manifestations of the LC-38 built environment contribute to a broader understanding of the scope and extent of activities at the complex. The recorded features generally are associated with more substantial built environment and occur at much lower frequencies in undeveloped portions of

LC-38. Fencing Features, primarily torch cut post stubs and pulled concrete post plugs, were the most commonly encountered feature type at the complex (n=339, 27.83 percent). These fencing features were primarily found along the alignment of the removed security fence that surrounded the ZAR area of the complex. Refuse Dumps, mostly of structural and concrete debris, were the next most common feature type encountered (n=242, 19.87 percent), followed in decreasing frequency by Electrical Features (n=178, 14.61 percent), Water/Wastewater Features (n=147, 12.07 percent), Instrumentation Features (n=131, 10.76 percent), Miscellaneous Features (n=107, 8.78 percent), Signage Features (n=59, 4.84 percent), LP Tanks (n=11, .90 percent), and Launch Support Features (n=4, .33 percent).

8.8.8 Clusters of Buildings, Structures, and Objects

According to Loechl et al. (1994:40), the organizational and spatial relationships among buildings, structures, and objects at military installations are one of the most important characteristics of military landscapes. The built environment of LC-38 is mostly distributed across the interior of the launch complex in several large and relatively discrete clusters of buildings, structures, and objects. These clusters reflected different functional areas within the launch complex, the locations of which were predicted in part by the safety and technical requirements of the Nike Zeus system. As discussed above, the modern built environment of LC-38 still reflects the original five functional areas constructed for the Nike Zeus program. These clusters of buildings, structures, and objects include the assembly, technical, and administration area in the southern part of LC-38; a hazardous assembly and checkout area in the west central part of the complex; the launch area in the north central part of the complex; the former Nike Zeus radar and BCB area near the center of the complex; and the former ZAR area in the east central part of the launch complex. These clusters of built environment resources are clearly separated by undeveloped areas and are fairly well-defined. Most of the built environment resources at LC-38 are located in these functional sub-areas, although a few isolated properties are also found within the launch complex boundaries, mostly instrumentation properties.

8.8.9 Archaeological Sites

Military installations often include prehistoric and historic archaeological sites, but most predate the military use of the land and are unrelated to the military mission of the installation (Loechl et al. 1994:40). Accordingly, the current inventory was thematically oriented towards extant Cold War buildings, structures, and objects at LC-38. Archaeological manifestations related to this thematic approach were captured as features, which were generally associated with buildings, structures, and objects.

Prehistoric sites have been previously documented in undeveloped areas within the boundaries of LC-38 as part of prior archaeological inventory efforts. The land use of these prehistoric occupations occurred during different environmental conditions and was motivated by widely divergent factors from the 20th century military use of the landscape. As a result, the presence of these sites was not incorporated into the present landscape perspective.

The perspective of historic military landscapes is thematically limited to military use of the landscape, but historic archaeological sites can nonetheless inform on past military missions of the installation (Loechl et al. 1994:40). Some military forts and training areas in the Southwest have long histories that began with the concession of the region to the US by Mexico as part of the Treaty of Guadalupe Hidalgo in 1848. Fort Bliss is an excellent example, which was first established in 1849 and has steadily transitioned from a small isolated frontier outpost to a major center for Army training and maneuvers. WSMR is a different case, as the earliest significant military use of the Tularosa Basin occurred during WWII, predating the establishment of WSPG by only a few years. Accordingly, no historic archaeological sites related to the military use of the area prior to the establishment of LC-38 were encountered during the inventory.

8.8.10 LC-38 as a Historic District

Consideration of LC-38 within an appropriate historic context and analysis of its physical landscape characteristics show that it meets the definition of a historic military landscape as presented by Loechl et al. (1994). Not only is LC-38 an identifiable expression of the military mission on the land, it also possesses significant associations with patterns and events significant to history. Per the guidance offered in Loechl et al. (1994), historic military landscapes are nominated as historic sites or districts. The language specific to historic districts is contained within Criterion C.

Historic districts are nominated under the important final clause of Criterion C, which allows for properties "that represent a significant and distinguishable entity whose components may lack individual distinction" (NPS 1995:2), to be nominated to the NRHP. In essence, the district clause of Criterion C allows recognition of groups of properties whose whole is greater than the sum of their parts (King 2004:113).

According to NPS guidance, "A district possesses a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development" (NPS 1995:5). LC-38 is a significant concentration of buildings, structures, and objects associated with the testing of the Nike Zeus system. As the Nike Zeus system evolved into the Nike X, then Sentinel, and finally Safeguard, LC-38 continued to support testing of various aspects of these systems as well, particularly testing of the Sprint missile. LC-38 was also home to the ARPA-sponsored HAPDAR phased array prototype during the late 1960s. As the Safeguard and Sprint testing ended during the early 1970s, the new SAM-D program began testing at LC-38. SAM-D, later known as Patriot, kept LC-38 active throughout the remainder of the Cold War and continues to be a major program at the complex today. Given its extensive history of supporting nationally significant Army missile test programs, LC-38 represents the manifestation of a military mission on the land, which is conveyed to the modern viewer via the many unique properties that date to the launch complex's primary period of significance. While many of the resources at LC-38 lack distinction when considered as individual resources, they achieve greater significance when considered as a collective within the context of the Cold War historic themes discussed above.

It is therefore the recommendation of Epsilon Systems that LC-38 is a recognizable historic military landscape eligible to the NRHP as a historic district under Criteria A and C due to its significant associations with the identified Cold War themes of Materiel Development and Air Defense, Ballistic Missile Defense, and Army Missiles (Lavin 1998).

Defining the limits of the recommended LC-38 historic district is complicated by the uneven distribution of built environment resources across the interior of the complex; clusters of historic properties are separated by large undeveloped areas. For this reason, LC-38 is recom-

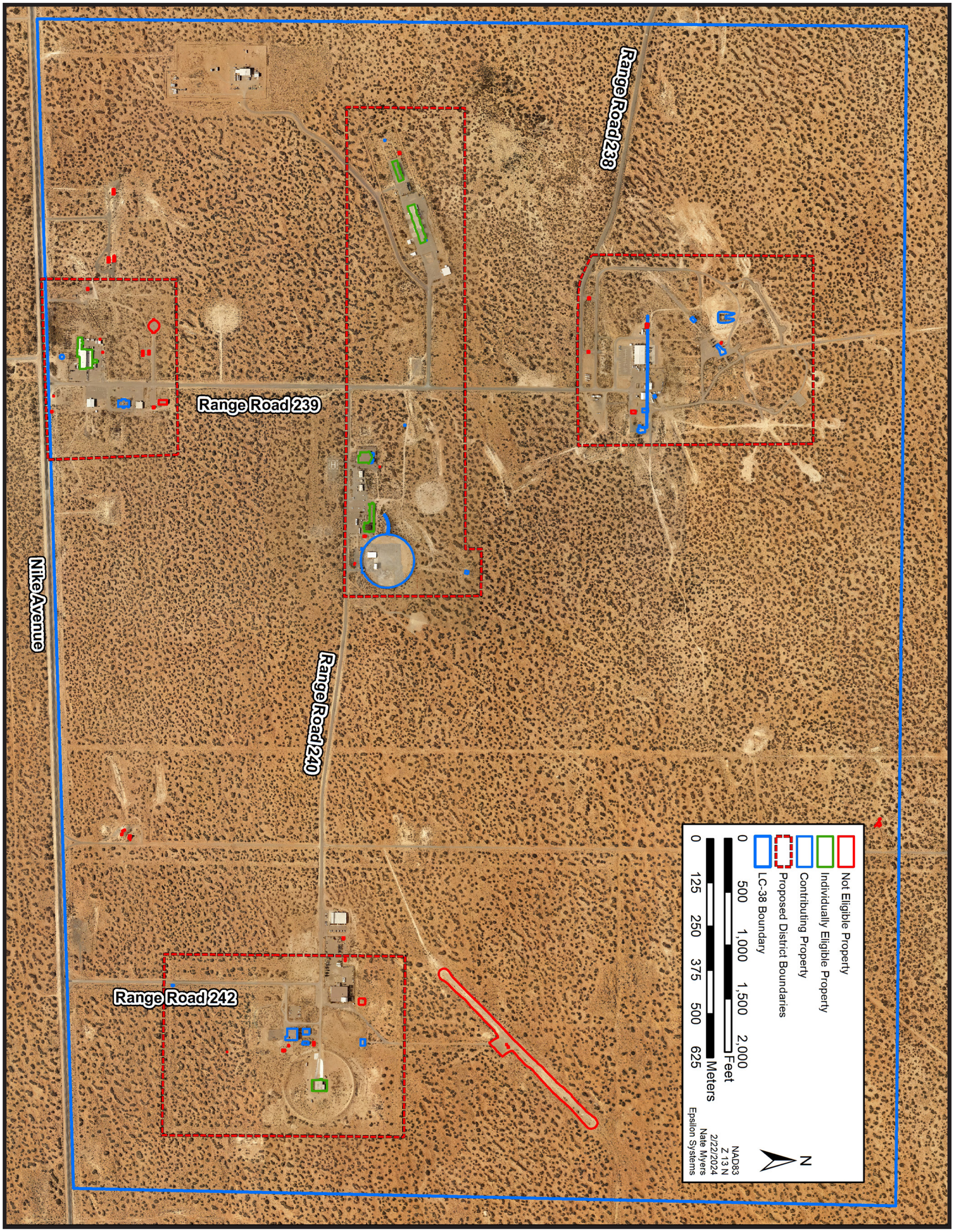

Figure 386. Map showing recommended discontiguous historic district boundaries for LC-38.

mended as a discontiguous historic district. NRHP guidance defines a discontiguous historic district as a district that is composed of two or more definable significant areas separated by non-significant areas. In discontiguous districts, district elements are spatially discrete, spaces between the district elements are not related to the significance of the district, and visual continuity is not an important aspect of the district's significance (NPS 1995:6). Per this guidance, it is recommended that the LC-38 historic district be organized into four discontiguous units or blocks. The first of these blocks would extend north from Nike Avenue along Range Road 239, encompassing the assembly and technical area in this part of the complex that is organized around Property 23626. The second unit of the proposed historic district would encompass the historic properties located in the central part of the complex, including the hazardous assembly and storage area properties and the series of Nike Zeus radar facilities along Range Road 240. A third unit of the district would encompass the former Nike Zeus launch area and the Patriot launch area in the north central part of LC-38. While this area largely lacks integrity of the primary period of significance, the later Patriot launch properties are eligible to the recommended district as contributing elements. The last unit of the proposed historic district would encompass the former ZAR area in the east central part of LC-38, roughly paralleling the alignment of the old security fence that once surrounded this area. Figure 369 is an overview map of the proposed discontiguous district units. Epsilon Systems believes that the discontiguous approach will avoid the arbitrary inclusion of non-contributing and non-significant portions of LC-38 that lack built environment resources. This approach will facilitate future management of the LC-38 historic district and its surrounding environs, which is a dynamic environment that remains in use today for the RDT&E mission at WSMR.

Additional minor features and properties recorded within the inventory area outside the recommended district boundary do not make any meaningful contribution to the LC-38 historic district and are thus not included. At the individual level, six of the inventoried properties are individually eligible under one or more of the four primary criteria (see Table 2). Other properties either lack significance, or more commonly, have diminished integrity of the physical characteristics relative to the period of significance. As such, they are not recommended for individual eligibility, but in many cases are recommended for eligibility as contributing elements to the identified LC-38 historic district.

9. Summary and Conclusions

LC-38 was the location for the prototype testing of the Nike Zeus system, the Army's first attempt at an ICBM defense system during the Cold War. LC-38 was constructed expressly in support of the Nike Zeus program, which required substantial, permanent facilities and infrastructure. The Nike Zeus installation at LC-38 simulated one complete unit of the Nike Zeus system as it would have been constructed across the country if the program had ultimately been funded and deployed. As advanced as Nike Zeus was at the time, its mechanically steered radars limited the number of targets it could deal with simultaneously. The system also needed improvements in differentiating targets in the upper atmosphere. The series of large, powerful radars required by the system had to be housed within hardened, permanent buildings that were also costly to construct. Due to these limitations, the Nike Zeus development was halted in 1963, and the development program shifted to designing a next generation system. This new system was referred to as the Nike X, and it was anticipated that the Nike X would be capable of defending against the Soviet ICBM threat of the mid-1970s. The two biggest changes introduced in the Nike X were phased array radars and a second missile that could intercept ICBMs in the lower atmosphere, where differentiation of the actual warhead was much easier due to atmospheric filtering. This new high-speed missile became known as the Sprint, the addition of which added a second layer of ballistic missile defense to the system. LC-38 continued to be used in support of the Nike X program, and its later Sentinel and Safeguard iterations, through the early 1970s. The deployment of a national ICBM defense grid was ultimately halted by treaty, but LC-38 continued to be active as a launch complex through the end of the Cold War, primarily in support of the Patriot missile program.

In April 2022, Epsilon Systems was contracted by the WSMR Environmental Division, Conservation Branch, Cultural Resources Program to conduct an inventory and evaluation of the LC-38 facilities and evaluate them for their NRHP eligibility. During the current inventory, a multi-disciplinary team of archaeologists and architectural historians conducted an on-site inventory from June to August 2022 and recorded a total of 67 buildings, structures, and objects as well as 1,218 features at LC-38. All the recorded resources related specifically to RDT&E activities in the Cold War era (1945 to 1989) and immediate post-Cold War years; no prehistoric features were recorded or evaluated. The current inventory was logged as NMCRIS number 152307 with ARMS.

LC-38 played an important role in the historical events and trends of the Cold War as the only complete installation of the Nike Zeus BMD system within the continental US, and also supported the later Nike X, Sentinel, and Safeguard programs. Beginning in 1969, LC-38 also hosted the SAM-D program, which was renamed the Patriot missile in 1976, and the Patriot continues to be the major test program at LC-38 today. LC-38 therefore represents a significant location of the Cold War military-industrial complex as discussed by Lavin (1998). The recorded resources relate specifically to the Cold War military-industrial historic themes of Materiel Development and Air Defense, Ballistic Missile Defense, and Army Missiles (per Lavin 1998) that are significant to our national history.

Six of the recorded properties were recommended for individual eligibility under Criteria A and C. Additionally, it was recommended that LC-38 represents a definable concentration of resources, most of which date to an identified primary period of significance associated with the Cold War at WSMR (1959 to 1964). As an active launch complex, LC-38 has been modified through time and accrued some recent additions that post-date its Cold War period of significance; however, it is the recommendation of Epsilon Systems that LC-38 retains sufficient historic integrity of its original physical features to convey its historic significance. As such, Epsilon Systems recommends that LC-38 is recognizable as a historic military landscape that is best managed as a historic district, per Department of the Army guidance (Loechl et al. 1994).

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On the Covers: (Front) Two unidentified figures standing near the HAPDAR installation at LC-38 in 1966. (Back) The Nike Zeus Acquistion Radar transmitter building (Property 24072) and radar seen through the clutter fence gate circa early 1960s. Photographs courtesy White Sands Missile Range.