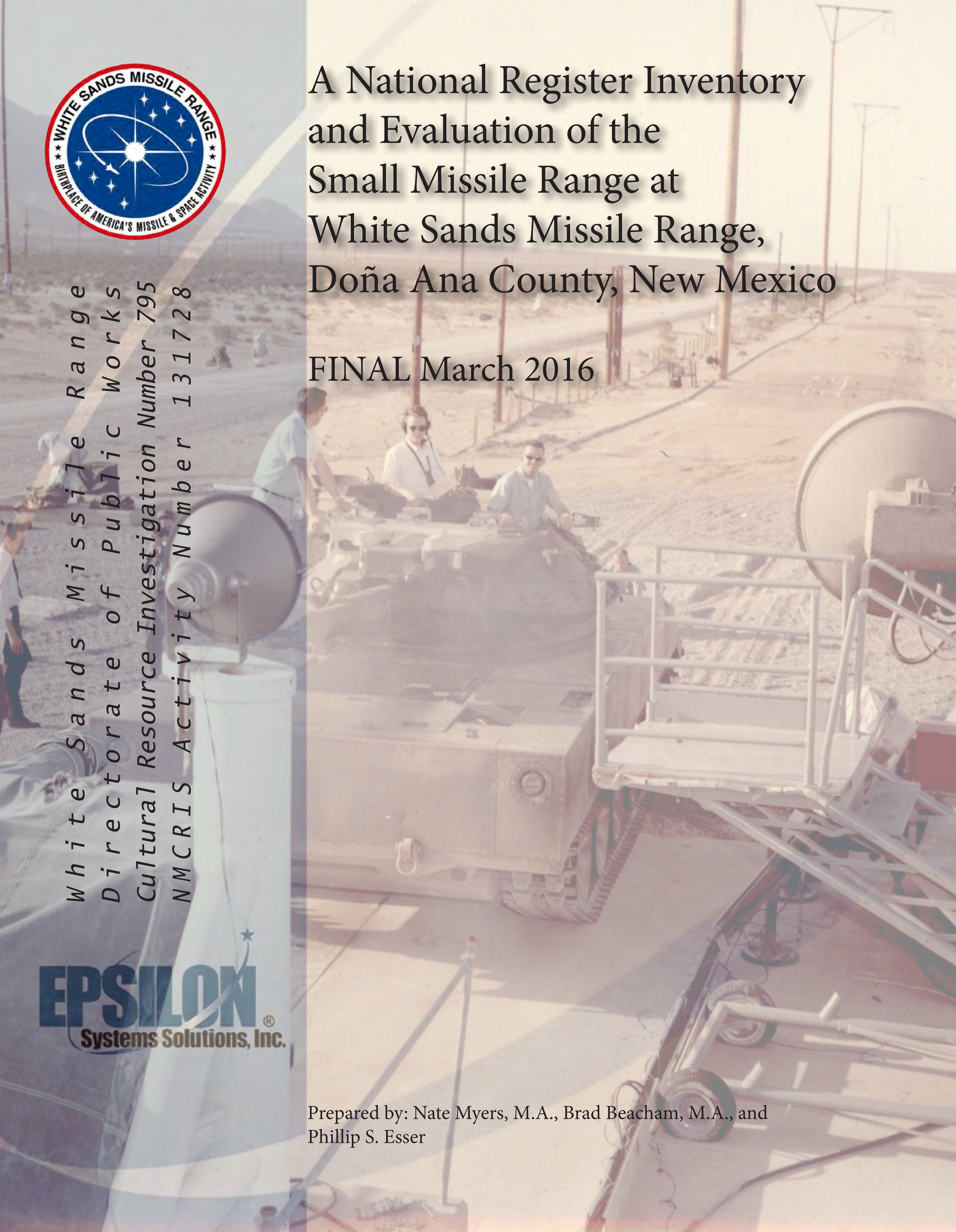

A National Register Inventory and Evaluation of the Small Missile Range at White Sands Missile Range, Doña Ana County, New Mexico

FINAL March 2016

White Sands Missile Range
Directorate of Public Works
Cultural Resource Investigation Number 795
NMCRIS Activity Number 131728

EPSILON Systems Solutions, Inc.

Prepared by: Nate Myers, M.A., Brad Beacham, M.A., and Phillip S. Esser

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WSMR Report Number 795

ESS Report Number 2014-06

REPORT DOCUMENTATION PAGE	*Form Approved* *OMB No. 0704-0188*

The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to the Department of Defense, Executive Service Directorate (0704-0188). Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

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1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
14/12/2014	Final Report	2012-2014

4. TITLE AND SUBTITLE A National Register Inventory and Evaluation of the Small Missile Range at White Sands Missile Range, Dona Ana County, New Mexico	**5a. CONTRACT NUMBER** W912PP-11-D-0023-0019 **5b. GRANT NUMBER** **5c. PROGRAM ELEMENT NUMBER**
6. AUTHOR(S) Nate Myers, M.A. Brad Beacham., M.A. Phillip S. Esser	**5d. PROJECT NUMBER** 795 **5e. TASK NUMBER** **5f. WORK UNIT NUMBER**
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Epsilon Systems Solutions, Inc. 3010 Mesilla Verde Terrace Las Cruces, NM 88005	**8. PERFORMING ORGANIZATION REPORT NUMBER** 2014-06
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) US Army Garrison White Sands Missile Range Director of Public Works Environmental Division 163 Springfield Street White Sands, NM 88002	**10. SPONSOR/MONITOR'S ACRONYM(S)** **11. SPONSOR/MONITOR'S REPORT NUMBER(S)**

12. DISTRIBUTION/AVAILABILITY STATEMENT

13. SUPPLEMENTARY NOTES

14. ABSTRACT

This attached document is a National Register of Historic Places (NRHP) evaluation of the Small Missile Range (SMR) at White Sands Missile Range (WSMR), Dona Ana County, New Mexico. The document provides a historic context and a building inventory and description of existing structures at SMR. All of the structures at SMR have been turned in and remain abandoned and unused, and are slated for demolition as part of the Facilities Reduction Program list for FY18. The National Historic Preservation Act, Section 106, requires federal agencies to review the effects of it undertakings upon historic structures. This review includes an evaluation of the structures for their eligibility to the National Register. Documents such as this are also highly important in preserving the history of the range and its activities and will become part of the public record. Presently this document will be included as a supporting document as the US Army initiates consultation with the New Mexico Historic Preservation Division regarding the proposed demolition of historic structures at WSMR.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			William C. Godby
U	U	U	UU	273	19b. TELEPHONE NUMBER *(Include area code)* (575) 678-6003

Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39.18
Adobe Professional 7.0

Acknowledgments

We are especially indebted to William Godby, Archaeologist at White Sands Missile Range (WSMR), who provided direction, access and key contacts as well as documents, photographs, and files necessary for the success of this project. We would also like to extend our gratitude to Jim Jenks, architectural historian at WSMR, for his collaboration with the documentation effort. Thanks are also due to Darren Court, Director of the WSMR Museum. Special gratitude is extended to Doyle Piland, WSMR Museum Archivist, who patiently provided access to the extensive materials in the WSMR Archival Holdings and assisted with the coordination of interviews. Thanks also go to Julie Northrop for assisting with electronic copies of archival architectural drawings, Carol Placchi for providing historical and current mapping, and Carl Krause for providing access to the realty data on file with the WSMR Public Works Department.

The authors would also like to thank retired Small Missile Range "alumni" John Dowd, Richard Overlee, Robert Watkins, and Jack Dage for their willingness to be interviewed to recall their experiences at the range – their input was invaluable in understanding the significance of the Small Missile Range during the Cold War era.

Phillip Esser served as the project manager and Nate Myers and Brad Beacham conducted the site survey work and field recordation for the project. Nate Myers was the principal author of the report, with valuable contributions from co-authors Phillip Esser and Brad Beacham. Daniel Veazey created the maps for the report and managed the project spatial data, and the report was edited by Becki Graham.

List of Acronyms and Abbreviations

AARAV	Armored Airborne Reconnaissance Assault Vehicle
AAWS-H	Army Advanced Anti-Tank Weapon System
ACTD	Advanced Concept Technology Demonstration
APG	Aberdeen Proving Ground
APL	Applied Physics Laboratory
ARC	Atlantic Research Corporation
ARCAS	All Purpose Rocket for Collecting Atmospheric Soundings
ARGMA	Army Rocket and Guided Missile Agency
ARMS	Archaeological Resource Management System (New Mexico)
ARMTE	Army Materiel Test and Evaluation
ASL	(White Sands) Atmospheric Sciences Laboratory
ATGM	Anti-Tank Guided Missile
BRL	Army Ballistic Research Laboratories
CAL	Cornell Aeronautical Laboratory
CECOM	Communications-Electronics Command
CKEM	Compact Kinetic Interceptor Missile
CLPG	Cannon Launched Guided Projectile
DOD	Department of Defense
ECOM	Electronics Command
ENTAC	Engin Teléguidé Anti-Char (missile, France)
ERDA	Electronics Development and Research Activity
ET/ST	Engineering and Service Tests
FAAD	Forward Area Air Defense
FFAR	Folding Fin Aerial Rocket aka Mighty Mouse, developed by the Navy
FLIR	Forward-Looking Infrared

GAPA	Ground to Air Pilotless Aircraft
GPS	Global Positioning System
GRLC	Green River Launch Complex (Utah)
GTV	Guidance Test Vehicle
HAW	Heavy Antitank Assault Weapon
HEAT	High Explosive Anti-Tank (rounds)
HCPI	Historic Cultural Property Inventory (New Mexico)
HVM	Hyper-Velocity Missile
HPD	Historic Preservation Division (New Mexico)
ICBM	Intercontinental Ballistic Missile
JATO	Jet Assisted Take Off
JPL	Jet Propulsion Laboratory
KEM	Kinetic Energy Missile
LAW	Light Anti-Tank Weapon
LC	Launch Complex
LOSAT	Line-of-Sight Anti-Tank (missile)
LTD	Laser Target Designator
LTV	Launch Test Vehicle
MAW	Medium Anti-tank Weapon
MICOM	Army Missile Command
MULE	Modular Universal Laser Equipment
NATIV	North American Test Instrument Vehicle
NATO	North Atlantic Treaty Organization
NHPA	National Historic Preservation Act
NOTS	Naval Ordnance Test Station China Lake, California
NPS	National Park Service
NRHP	National Register of Historic Places

ONR	Office of Naval Research
ORDCIT	Ordnance and California Institute of Technology
RDT&E	Research Development Test and Evaluation
SHPO	State Historic Preservation Officer
SMR	Small Missile Range
SMSA	Signal Missile Support Agency
TOW	Tube-Launched Optically-tracked Wire-guided (missile)
USAF	US Air Force
WASP	Weather Atmospheric Sounding Projectile
WSMR	White Sands Missile Range
WSPG	White Sands Proving Ground
WSSA	White Sands Signal Agency
WWII	World War II

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1. Management Summary

The U.S. Army Garrison White Sands Missile Range (WSMR) with the assistance of the U.S. Army Engineering and Support Center Huntsville Facilities Reduction Program (FRP) is actively developing lists of structures and buildings that are likely candidates for demolition. In accordance with Section 106 of the National Historic Preservation Act (NHPA) the WSMR's Cultural Resource Program is actively evaluating all potential candidate structures and buildings for their National Register of Historic Places (NRHP) eligibility in addition to acquiring existing historic documentation on each.

In March 2014, under a sub-contract to J.C. Palomar Inc., Epsilon Systems Solutions, Inc. (ESS) was retained by White Sands Missile Range (WSMR) to conduct an inventory and evaluation of the Small Missile Range (SMR) for its potential NRHP eligibility (Figure 1). The scope of the area was determined in consultation with William Godby, Cultural Resources Manager and Archaeologist at WSMR.

Cultural resource specialists conducted an on-site inventory in April of 2014 and recorded a total of 116 buildings, structures, and objects as well as 291 features at the SMR that related specifically to associations with testing activities in the Cold War era – from 1953 to 1989; no prehistoric features were recorded or evaluated. The current inventory was logged as New Mexico Cultural Resource Inventory System (NMCRIS) number 131728 with the New Mexico Archaeological Resource Management System (ARMS). Additionally, a Laboratory of Anthropology (LA) Site Number (LA 180221) was derived for the SMR boundaries in order to display the related features within the ARMS database. All of the recorded resources were evaluated individually for potential NRHP eligibility.

None of the newly recorded resources were recommended individually as eligible for listing to the NRHP. However, as a grouping, the SMR is recommended eligible for listing as a historic district under NRHP Criterion A for its association with specialized rocket and missile testing during the Cold War. The SMR is also significant for the role it played in atmospheric meteorological data collection, which contributed to the understanding of flight behavior in the high atmosphere. This research was applied to the development of Ballistic Missile Defense (BMD) systems, and also made contributions to the US space program. It is also recommended eligible under Criterion C, for the extant buildings, structures, and objects that collectively represent the Army's only representative of a highly-instrumented range solely dedicated for testing smaller rockets and missiles. The Period of Significance for the district begins in 1953 when facilities were constructed and testing began, to 1989, the commonly accepted end of the Cold War even though the USSR did not dissolve until 1991.

Two of the buildings, the Flight Control Building (27170) and a Bowen-Knapp Camera Shelter (27110) were previously recorded and recommended eligible for listing. The New Mexico State Historic Preservation Division (HPD) concurred with NRHP-eligibility recommendations under Criterion A for Building 27170 and Criterion C for 27110 (James Hare for Jan Biella, September 2002). Epsilon Systems disagrees with this previous determination for Property 27110 as it is one of numerous identical examples of Bowen-Knapp Camera Shelters at the SMR. Therefore, it is not recommended for individual eligibility to the NRHP.

Figure 1. Location of the current inventory project at WSMR.

Pending HPD concurrence of the Army's determination on the NRHP-eligibility of the Small Missile Range site, the potential SMR historic district should be managed so as to avoid any impacts to the elements that contribute to its eligibility. Any potential undertakings involving the removal of any contributing resources within the boundaries of the recommended historic district should include consultation with HPD beginning early in the planning stages. Any such undertakings may necessitate additional consultation for the mitigation of potential adverse effects to contributing resources of the identified district.

2. Introduction and Project Background

The Small Missile Range (SMR) at White Sands Missile Range (WSMR), New Mexico was constructed in the early 1950s for the semi-autonomous testing of small rockets and missiles. This specially delineated area, chosen to streamline testing of smaller rocket and missile systems that were vying for launch space and support with other larger vehicles, is located north of the cantonment off of US Highway 70 (Figure 2). This arrangement also allowed for the development of specialized instrumentation for shorter range launchings, particularly the purpose-built below-grade camera shelters placed along the firing line and above ground shelters flanking the range.

Programs at the SMR focused primarily on anti-aircraft and anti-tank weaponry, with anti-tank weapons becoming the primary focus of the range after the early 1960s. The SMR was not limited to the development of weapons systems. Several significant sounding rockets were tested at the SMR, and the

WSMR meteorology program played an important role at the SMR for decades. Therefore, the meteorology program at the SMR and the research rockets used by the program are also included in this summary. Through the early 2000s, the SMR was an important location for the development and testing of small missiles and guided munitions.

In March 2014, under a sub-contract to J.C. Palomar Inc., Epsilon Systems Solutions, Inc. (ESS) was retained by WSMR Environmental Stewardship to conduct an inventory and evaluation of the area for its potential for National Register of Historic Places (National Register; NRHP) eligibility. This task was limited to the built environment of the discrete area known to have been used for small missile testing. This includes a flight control building, launch facilities, camera shelters, assembly and maintenance facilities, meteorological buildings, blast barricades, and miscellaneous support buildings; the inventory did not include prehistoric archaeological resources.

Cultural resources specialists recorded and evaluated individual standing structures related to the SMR, as well as other objects and features on the site. In addition to the building evaluations, each individual feature was also documented. A pedestrian survey which included visual inspection, digital photography, mapping using Global Positioning System (GPS) with sub-meter accuracy, and detailed recordation of individual buildings, structures, features, and objects was undertaken; no subsurface excavations were conducted.

While individual resources were inventoried, a view towards the potential for a historic military landscape was taken per guidance in Loechl et al. (1994), particularly given the purpose-built nature of the facility. Despite continual additions and alterations to the site over the Cold War decades, the site as a whole represents an identifiable military landscape specifically associated with the Cold War Era and includes many of the characteristics of historic military landscapes outlined by Loechl et al. (1994). Nearly all of the 116 properties and 291 features were constructed specifically to support small missile and projectile testing between 1953 and 1989. The current inventory was logged as New Mexico Cultural Resource Inventory System (NMCRIS) number 131728 with the New Mexico Archaeological Resource Management System (ARMS). Additionally, a Laboratory of Anthropology (LA) Site Number (LA 180221)

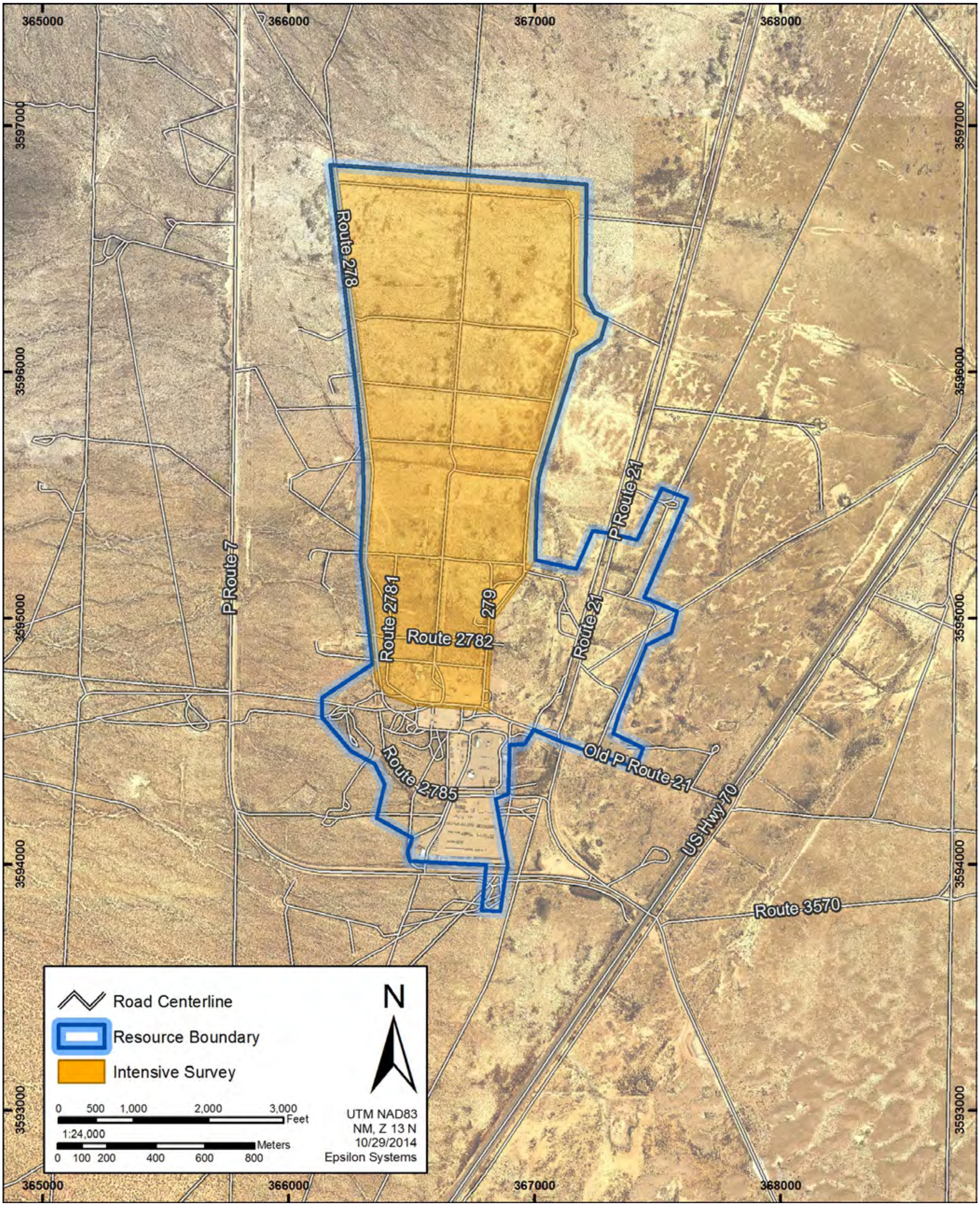


Figure 2. Map of the current inventory location within WSMR.

was derived for the SMR boundaries in order to display the related features within the ARMS database.

As part of the inventory methodology, less significant resources representing remnants of the SMR supporting infrastructure that were not classifiable as buildings, structures, or objects were recorded as features and are described separately; these can be found in Appendix A on the enclosed CD. Individual maps delineating the location of resources and features are located in Appendix B on the enclosed CD. Additionally, a large fold-out map calling out the district boundaries, properties and features is also found in the back of the report. The recorded WSMR properties were assigned a New Mexico Historic Cultural Property Inventory (HCPI) number and were documented on HCPI forms tailored for use at WSMR and can be found in Appendix C on the enclosed CD.

The results of the survey work and NRHP evaluation are provided herein. Cultural resource specialists Nathaniel Myers with J.C. Palomar, Inc. and Brad Beacham with ESS conducted the survey work and authored the report. Phillip Esser also acted as project coordinator. William Godby, archaeologist with WSMR Environmental Stewardship provided support and guidance through the process.

3. Purpose of the Project

The WSMR Directorate of Public Works, Environmental Division must conduct an initial inventory of buildings and determine their NRHP eligibility in compliance with the Army Corps of Engineers' Historic Building Inventory-Mitigation of Adverse Effects, Facility Reduction Program. The buildings to be inventoried are primarily along Nike Road and in downrange areas of WSMR, where the SMR is located. WSMR is proposing demolition of a number of National Register eligible buildings. One of two alternatives for mitigation will be chosen by WSMR cultural resources personnel in consultation with the New Mexico SHPO for documentation of the existing buildings.

Historic resource inventories and evaluations have been undertaken at military installations since the passage of the NHPA in 1966 and issuance of Executive Order 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 National Register of Historic Places (NRHP or National Register; 36 Code of Federal Regulations [CFR] 60). Executive Order 11593 requires agency heads to locate, inventory, and nominate all eligible cultural resources to the National Register and to exercise caution until these inventories and evaluations are complete to ensure that no eligible federally owned property is transferred, sold, demolished, or substantially altered. The Order outlines procedures for meeting the inventory requirements of NHPA and the National Environmental Policy Act (NEPA) and establishes 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.

This report will assist WSMR in compliance with Section 106 and Section 110 of the National Historic Preservation Act of 1966 as amended (NHPA). This document serves as a comprehensive inventory and NRHP evaluation of the Cold War period resources at the SMR from its inception in the early 1950s to the end of the Cold War in 1989.

4. Research and Field Methodology

This document is the result of completion of 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.

Research was conducted at WSMR and from relevant published and archival sources. The ample published and unpublished historical data available at WSMR provided the basis for the historic context. Previous survey approaches generally focused on individual or select groups of resources that were only evaluated for individual NRHP eligibility. The current study sought to remedy the lack of comprehensive evaluation by taking a holistic approach which considers the macro view (i.e., historic military landscape [per Loechl et al. 1994] and historic district potential) versus evaluating each resource individually.

On-site fieldwork included all those areas within the generally accepted bounds of the SMR; it did not, however, include the impact areas that at one time reached as far as 16 kilometers downrange. While the SMR boundaries are not clearly demarcated by fences or other boundaries, historic maps clearly indicate that the range complex is primarily defined by the fixed camera network along the firing line and the supporting buildings and structures at the main launch area. The internal SMR road network also serves to define the complex and its primary extent. As with any test range, the full scope of the SMR includes outlying impact areas, instrumentation sites, and targets. However, the primary concentration of buildings, structures, and objects that compose the built environment of the SMR defined the limits of the current inventory, which encompassed 635 acres of land associated with the SMR (see Figure 2).

4.1 Resource Types

The 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 courthouse and jail or a house and barn [NPS 1995:4]
>
> The term "structure" is used to distinguish from building those functional constructions made usually for purposes other than creating human shelter [NPS 1995:4]
>
> 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]

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 the SMR primarily consisted of buildings, structures, and objects, which were distinguished using the stated NPS definitions. The collective resources were also considered as a potential historic district, as the guidance states that "properties with large acreage or a number of resources are usually considered districts" (NPS 1995:4).

4.2 Historic Military Landscape Approach

The wider perspective of a historic military landscape was considered as part of the SMR inventory. Specific guidance on historic military landscapes defines them as:

> A historic military landscape is a military landscape that is significantly associated with historically important persons or events, or is an important indicator of the broad patterns of history, or represents a significant example of design or construction [Loechl et al. 1994:9].

An identified historic military landscape is usually nominated as a historic district or site. Per the guidance on DOD landscapes:

> For the purposes of the National Register, a historic military landscape is a category of property potentially eligible for listing in the National Register of Historic Places as a historic site or district. To be eligible for nomination to the Register, a historic military landscape must have sufficient integrity to convey its significance [Loechl et al. 1994:9].

As defined above, a historic district is a definable concentration of buildings, structures, or objects. A historic site is the location of a historic event or activity where the location itself possesses historical value regardless of any extant buildings or structures (Loechl et al. 1994:10).

4.3 Inventory and Feature Methodology

Many isolated remnants of the range infrastructure are scattered across the SMR interior, manifestations of which were both architectural and archaeological. Although spatially or functionally associated with the SMR, these elements were not readily identifiable as a building, structure, or object. As such, they were recorded as features. In order to properly capture these features, which generally have a much lower visibility than buildings, structures, and objects, an intensive pedestrian inventory of the SMR range interior as defined by the network of Bowen-Knapp camera buildings and Range Roads 278, 279, and 2781 was conducted (see Figure 2). This intensive pedestrian survey totaled 417 acres of the range interior, and was conducted using 15 meter transects established via GPS guidance in accordance with New Mexico HPD guidelines (Figure 2). The area of this survey was not extended beyond the limits of the traditionally defined SMR as functional and chronological relationships to the Cold War-era SMR activities are increasingly difficult to establish outside the range interior. In areas outside the limits of the pedestrian survey only clearly visible buildings, structures, objects, and features were recorded.

The survey team prepared field forms and took representative photographs of each building, structure, and object. The purpose of the inventory was to record every previously unrecorded resource and update those that had been previously evaluated, both at the individual level and as contributing elements to a potential historic district. The current inventory was logged as New Mexico Cultural Resource Inventory System (NMCRIS) number 131728 with the New Mexico Archaeological Resource Management System (ARMS). Additionally, a Laboratory of Anthropology (LA) Site Number (LA 180221) was derived for the SMR boundaries in order to display the related features within the ARMS database.

Fieldwork was followed by research into each recorded building, structure, and object. This research included review of original construction information and alterations, historic images, and a variety of other manuscript materials collected over the decades by Public Works, WSMR Museum Archives, and WSMR Environmental Stewardship. This information was then checked against the station's extensive architectural drawings collection of original as-built and project drawings.

The results of the field inventory were organized by functional categories. These functional categories were based in part on property types defined by Thompson and Tagg (2007) for DOD Cold War RDT&E installations. Information gathered from WSMR archival and realty data were also relied on for the formulation of property type categories, and provided the basis for additional property types not defined by Thompson and Tagg (2007). In particular, Thompson and Tagg did not discuss general storage and maintenance facilities that are an often referenced type of property in WSMR Realty Records.

ESS also undertook additional research to create a historic context that builds on and expands the work of others. This expanded context spans the entire history of the SMR programs, from the Loki Program in the 1950s through to when the SMR ceased significant testing activities following the end of the Cold War. Completion of this comprehensive context was aided by interviews with former branch heads and firing officers who were on-site throughout the Cold

War.

At the time of writing, any resources evaluated that were constructed after 1964 were considered with the understanding that an argument for "exceptional importance" must be made for properties less than 50 years old (NPS 1998). Although some portions of the SMR history have been previously documented, and have been used for ongoing building evaluations for Section 106 compliance, an expanded historic context for evaluating all resources from 1953 to 1989 was created for this project.

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). The SMR is located in the southern portion of WSMR, in the southwest corner of the Tularosa Basin, which is a graben basin bounded by the San Andres and Oscura Mountains to the west and the Sacramento Mountains to the east. Topographically, the SMR falls within the lower alluvial slopes, or bajadas, that extend from the eastern flank of the San Andres Mountains to the basin bottom. The San Andres Mountains consist of a west-tilting fault block with dramatic east-facing escarpments dominated by exposures of Pennsylvanian and Permian strata, and relatively gentle west-dipping slopes (Chronic 1987). The SMR occupies a low lying area ranging from approximately 4,000 to 3,960 feet (ft) above mean sea level with Black Mountain serving as a prominent feature to the west and alkali flats associated with Parker Lake to the east. The built environment associated with SMR represents a composite accumulation of military facilities and support infrastructure constructed from the mid-to-late twentieth century.

The climate of the SMR 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 March 31, 2013 (Western Regional Climate Center [WRCC] 2014). 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 2014).

Vegetation typical of the area is Chihuahuan Desert Scrub (Dick-Peddie 1993). Bajada environments in southern New Mexico were historically dominated by grasslands that have given way to successional communities of expanding Chihuahuan Desert Scrub (Dick-Peddie 1993:132). Chihuahuan Desert Scrub is typically dominated by creosotebush (*Larrea tridentata*) in combination with other species, such as tarbush (*Flourensia cernua*) or Whitethorn acacia (*Acacia constricta*). However, the flora within the SMR were observed to be variable, defined by co-dominance of creosotebush, tarbush, four-wing saltbush (*Atriplex canescens*), and honey mesquite (*Prosopis glandulosa*) with an understory of forbes and grasses including broom snakeweed (*Gutierrezia sarothrae*), bush muhly (*Muhlenbergia porteri*), and fluffgrass (*Erioneuron pulchellus*). 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 the SMR aligns with the Creosotebush/Bush Muhly and Creosotebush/Fluffgrass Plant Associations defined by Muldavin et al. (2000a) under the Creosotebush Alliance. It has been suggested that the expansion of the Creosotebush Alliance has been promoted by disturbances resulting from human agency, allowing for the establishment of shrubland in lieu of established grasslands (Muldavin et al. 2000a:80).

6. Historic Context

Due to the recent origins of the properties documented in this report, coverage of the prehistoric and early historic contexts of the area now encompassed by WSMR are not considered warranted or appropriate to the current discussion. The historic context here begins with a brief history of the area prior to the formation of WSMR, followed by an overview of the establishment and history of the range. The primary focus of the historic context is the Cold War period activities at the SMR in order to provide the relevant background for the recorded resources. The discussion of the Cold War is by necessity focused on the activities conducted at the SMR, and for broader overviews of the Cold War and corresponding activities at WSMR, the reader is referred to *Star Throwers of the Tularosa: Early Cold War Legacy of White Sands Missile Range* (Eidenbach et al. 1996), *Pocketful of Rockets: History and Stories Behind White Sands Missile Range* (Eckles 2013), and *The Rockets and Missiles of White Sands Proving Ground* (Kennedy 2009).

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 conspired 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 Mountains and the San Andres.

The earliest Territorial settlement in the Basin was begun 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 valley. 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 composed of Texans, had discovered the Tularosa Basin, which at the time was especially verdant after several years of higher-than-average precipitation. The Texas cattle growers 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 country (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 country, 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 and Otero County line (Eckles 2013:57). The Fountain case was a polarizing incident that encapsulated much of life in the Tularosa country 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 country, but after the conclusion of the turbulent events of the 1890s, the area remained little changed during the early years of the twentieth 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 supplanted by what is now US Highway 70. However, the lives of the people in 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 (WW II) 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 of 1941. The training school was subsequently re-directed into the Alamogordo Army Air Field and US bomber flight crews began training there in May of 1942 (Kennedy 2009:19). The area would soon be directly affected by the burgeoning US missile program.

6.2 Rocket Development in the US

Throughout WW II, a group at the California Institute of Technology (Caltech) had been working on an Army Air Corps project to develop a rocket booster for aircraft, referred to as the Jet Assisted Take Off (JATO). By 1944, German use of missiles in Europe led the Army to assign a new contract to the Caltech rocket group to develop a greatly expanded missile program (Kennedy 2009:14). The new Caltech project was known as the Ordnance and California Institute of Technology (ORDCIT) program, which began testing the Private series of rockets in California in 1944. The next ORDCIT series was the Corporal series, which was a larger and more powerful rocket that required a larger range in order to test it safely (Kennedy 2009:16). Concurrently, intelligence gained through the course of WW II further emphasized the need for enhanced missile testing facilities.

As hostilities drew to a close in Europe, the US was able to capture parts, equipment, and research materials from the German "Vengeance Weapon 2" (commonly referred to as the V2) rocket program at Mittelwerk prior to the Russian advance into eastern Germany. Additionally, Werner Von Braun, chief scientist of the German missile program, and key members of his staff surrendered to Allied forces on May 2, 1945 (Eidenbach et al. 1996). With both the parts and the minds behind the V2 program in hand, the US now had the means to accelerate the rocket research the ORDCIT program had begun. In support of this, Project Hermes was established by the Army in 1944 as a parallel program to ORDCIT. Both programs required a suitable testing and proving ground; the Army began to search for an appropriate location for a new test range (Kennedy 2009).

6.3 White Sands and Missile Development

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, possessing nearly all of the desired characteristics. The location was selected in February of 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 via annual lease payments from private landowners in the area. The lease payments for the use of the ranchers land were used in lieu of outright purchase of the ranchers' lands as the range was conceived as being a temporary extension of the existing bombing ranges, and the missile mission would be 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 which been ongoing since the 1870s. WSPG was formally established by July of 1945. On July 16, 1945 the world's first atomic bomb was detonated at the Trinity Site in the northwestern portion of the new range. The flash and rumble of the Trinity explosion was reported as far away as Silver City and El Paso (Sonnichsen 1960).

WSPG's main post was established in the eastern foothills of the Organ Mountains, at the western margin of the Tularosa Basin. A launch area, now known as Launch Complex Complex-33, was constructed about six and a half miles south of the headquarters. On September 26, 1945 the WAC Corporal was the first rocket launched at WSPG (Kennedy 2009:29). Around the same time, recovered German V2 rocket equipment began to arrive via railroad, generating a wave of activity at the new range. The development of the V2 program was quickly undertaken at WSPG, with the first American launch of a V2 on April 16, 1946 (Kennedy 2009:37). This technology, along with other systems, formed the basis of expanded work at WSPG through the 1950s.

The V2 program at WSPG was active through the remainder of the 1940s. The V2 was modified to become the Hermes series, various versions of which were tested well into the 1950s. The Air Force was also active at the range during this period, with the development of the MX-774, NATIV, and GAPA missile platforms, while the Navy developed the Aerobee and the innovative Viking atmospheric research rocket (Kennedy 2009). By the early 1950s, the volume of test flights between the Army, Air Force, and Navy at the range and the increased altitude and range of the tests required a more coordinated approach to range use, instrumentation systems, and command structure. This reorganization effort became known as the Integrated Range, and allowed the three branches to use the same ranges and test facilities. It also effectively combined the WSPG and Holloman Air Force Base (HAFB; formerly Alamogordo Army Air Field) ranges into a single large range accessible to all three service branches but under command control of the Army (Eckles 2013:206).

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. 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 instruments were Askania cinetheodolites recovered from the German rocket program that were re-used at WSMR. 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. One such instrument was the first tracking telescope. Called “Little Bright Eyes”, this precision instrument was assembled on a surplus M45 gun mount and relied on hand-assembled telescopes assembled from spare refractors, a 35 mm motion picture camera, and a pair of high power binoculars appropriated from the Japanese Navy (Delgado 1981). By the late-1950s, technology had caught up to the need for specialized range instruments, and the instrumentation was increasingly specialized and sophisticated. New instruments included the AN/FPS-16 radar, the first tracking radar built expressly for use at test ranges, and the advanced (Intercept Ground Optical Recorder (IGOR) and Recording Optical Tracking Instrument (ROTI) tracking telescopes, optical devices much more sophisticated than the original Bright Eyes. Also during this period, the Army contracted with Land-Air 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 had formerly been handled by a mixture of various contractors and military personnel.

6.4 White Sands Missile Range, Missile Defense, and the Space Program

The range was re-designated White Sands Missile Range in 1958, a change that reflected the emphasis on the development of Intercontinental Ballistic Missile (ICBM) and Ballistic Missile Defense (BMD) systems that were a major focus at the time due to the ongoing Cold War arms race. In 1962 WSMR initiated the Advanced Ballistic Re-Entry Systems (ABRES) program, which studied the re-entry characteristics of ICBMs to improve both offensive and defensive systems (Feit et al. 2014; WSMR 1968). The ABRES program established the WSMR

Green River Launch Complex (GRLC), in Green River, Utah. It served as a launch site for the Air Force Athena missile, which impacted at White Sands. The ABRES program launched Athena missiles from Green River to WSMR until 1973. Following the Athena launches, the GRLC served as the launch area for the Pershing II missile until the late 1970s (Feit et al. 2014; WSMR 1968). In addition to ICBM and BMD development, WSMR would make important contributions to the American Space Program.

During the late 1950s and 1960s the development of the American Space Program was also underway, and the centralized tracking, command, and communications networks pioneered at WSMR became the 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).

The signing of the Anti-Ballistic Missile Treaty with the Soviet Union in 1972 diminished the need for further development of BMD systems. The military reduction following the US withdrawal from Vietnam and the completion of the Apollo Missions also diminished funding and support for new projects. Despite this, pioneering efforts in new technology continued to be made at WSMR during the 1970s. 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 operational in 1980. The High Energy Laser System Test Facility (HELSTF) at WSMR was created in 1976 as a Department of Defense wide laser development facility, and was officially operational in 1985. The HELSTF facility and MIRACL programs were part of the effort to develop laser weapons for the Strategic Defense Initiative of the 1980s, more popularly known as the Star Wars program (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 developed in this period and deployed in 1984.

Also during the 1980s, the NASA White Sands Test Facility 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).

After the collapse of the Soviet Union in 1991, WSMR focused on the development of technology and weapons suited for the changing nature of defense programs in the Post-Cold War era. 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).

Many major strategic systems such as the Nike, Pershing, MLRS, and Patriot were developed at WSMR throughout its history, and these are often the focus of historical summaries of the range. However, many smaller systems that were developed for smaller scale tactical usage on a variety of battlefields were also developed at WSMR during the Cold War. The development of many of these systems was undertaken at the semi-independent SMR, which was established early in the history of the new proving ground.

6.5 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, by 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. Containing land masses of approximately two million and one million acres, respectively, these ranges are designed to accommodate safe launches as well as ample impact areas for modern missile systems which can travel extraordinary distances. 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. However, the logistics of locating instrumentation sites and the recovery of launch vehicles and related materials are much more complicated at these over-water 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 type of test articles, the building types, construction methods, and sizes can vary greatly.

Central to all launch complexes is a launch or flight control building where all launches are controlled. Depending on the size and type of launch article and launch complex, launch control buildings can range from simple, steel-plate barricades to elaborate, super-hardened, reinforced concrete bunkers. However, almost all are built to permanent construction standards and offer some degree of impact protection. The SMR Control Building also incorporated provisions for administrative activities and data reduction, but due to its distance from the primary launch pad and the relatively small size of the test articles at the SMR it was not specifically designed to provide safety from an inadvertent impact event.

As mentioned earlier, missiles are comprised of numerous components, 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. Again, depending on the range and type of test article, the types, construction methods, and sizes of assembly buildings can be widely variable.

The pre-launch process can also include environmental conditioning of test articles before launch, particularly subjecting a launch vehicle to extreme heat or cold in order to evaluate performance during unfavorable conditions. 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 some cases, conditioning is not used to simulate climatic extremes but instead to maintain a missile within a prescribed temperature range prior to launch to ensure its correct operation and performance.

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 articles are launched from removable steel frameworks or purpose built launchers which serve as the mounting structure. The Navy also employs actual shipboard-type missile launchers at their launch complexes, as seen at LC-35 at WSMR. In and around the launch pad are a variety of steel superstructures, some that serve as overhead gantry cranes, others for instrumentation mounts. Conversely, depending on the type of missile, the launcher could be completely mobile, mounted on a truck or even a tank.

Immediately adjacent to launch pads can be found the ubiquitous blast barricade. These substantial structures are often constructed of reinforced concrete or steel containers filled with earth. Heavy timber structures infilled with earth are often used as well and both types are found at the SMR. 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).

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. Often the magazines are used for storing fuzes or arming devices that possess a small explosive charge. The simple, "box-type" is found at the SMR; larger, igloo-types, like the one adapted for the SMR climatic chamber, are commonly found within the vicinity of missile launch sites.

Common to all missile launch complexes are the often-overlooked below-grade cable trenches. Similar features used for the installation of cables into conduit are known as pull boxes. Like blast barricades and munitions magazines that provide protection for technicians, it is critical to protect electrical and control from the force and heat generated from the launches themselves. Subterranean routing also serves more prosaic functions; like urban utilities, underground installation reduces surface clutter and protects cables from traffic and weathering. 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. 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.

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 assure 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. At the SMR, banks of purpose-built camera shelters extending out the length of the range housed high-speed motion picture cameras. 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 can be 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 such as the Ryan Firebee. In many cases, the 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 in wood frames. Live anti-tank missiles are fired at steel plate targets and surplus, 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 older, obsolete missile systems. For some tests, WSMR has launched missiles from off-range locations which safely impact within the range boundaries, allowing for the testing of long range systems over hundreds of miles. In the 1990s, the Hera Target Missile was used for this purpose and was assembled from surplus Minuteman ICBM boosters.

The SMR includes many components of a typical launch complex. It is, however, fitted with all the fundamental facilities and support infrastructure to conduct missile testing including instrumentation, firing lines, and target and impact areas. This makes the SMR an excellent example of how a larger range is organized, albeit at a small scale. Some of the SMR facilities were dedicated to the WSMR Meteorology Program. The program included the whole palette of facilities found in a typical launch complex but included some atypical buildings such as the Wind Measurement Building (Building 27200), which incorporates a high bay balloon inflation shelter. The specifics of building types, their function, individual descriptions and physical integrity are discussed at length in Chapter 7, Buildings and Structures at the Small Missile Range.

6.6 Establishment of the Small Missile Range

While much attention is garnered by the early V2-derived large rocket and missile programs at WSPG, smaller systems such as the Loki were also under development by the late 1940s. The testing of these smaller rockets from the primary launch areas south of US Highway 70 vied for launch space and support with other, larger vehicles. The launching of smaller rockets also required the closure of US 70 on a frequent basis to ensure the safety of motorists, which created logistical problems for the range and inconvenienced local residents. The Loki in particular was anticipated to be a high volume launch program, as the small rocket would be fired in rapid volleys.

As a solution to these problems, the creation of a dedicated small missile range north of US 70 was proposed in 1950. This location would require fewer highway closures and keep the main launch areas, such as LC-33 and LC-37, open for the testing of other programs. 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 (see Figure 3). More sophisticated instruments with high-powered optics, such as cinetheodolites and tracking telescopes, were not essential for most of the developmental work required of most programs at the SMR. According to WSMR realty data, the total SMR real estate encompasses 6,400 acres and is listed as Property 27064.

According to architectural drawings for the new range, the layout was designed collaboratively by the Albuquerque District Army Corps of Engineers and the architect and engineering (A&E) firm of Herkenhoff and Turney of Santa Fe. The Army Corps designed all of the buildings at SMR with the exception of the camera shelters, which were designed collaboratively. Little is known of the A&E firm – the principals, Gordon E. Herkenhoff and William F. Turney, were based in Santa Fe but their projects went as far afield as Southern California and Colorado. A former employee described the firm as surveying parcels of land in and around Santa Fe for new housing divisions, state offices, and private businesses during the post-WW II building boom (Pacheco 2013). The firm seems to have specialized in large-scale water, sewer, and paving projects for both municipalities and government projects; one identified in the partnership dissolution papers was a runway extension at Holloman Air Force Base. The partnership

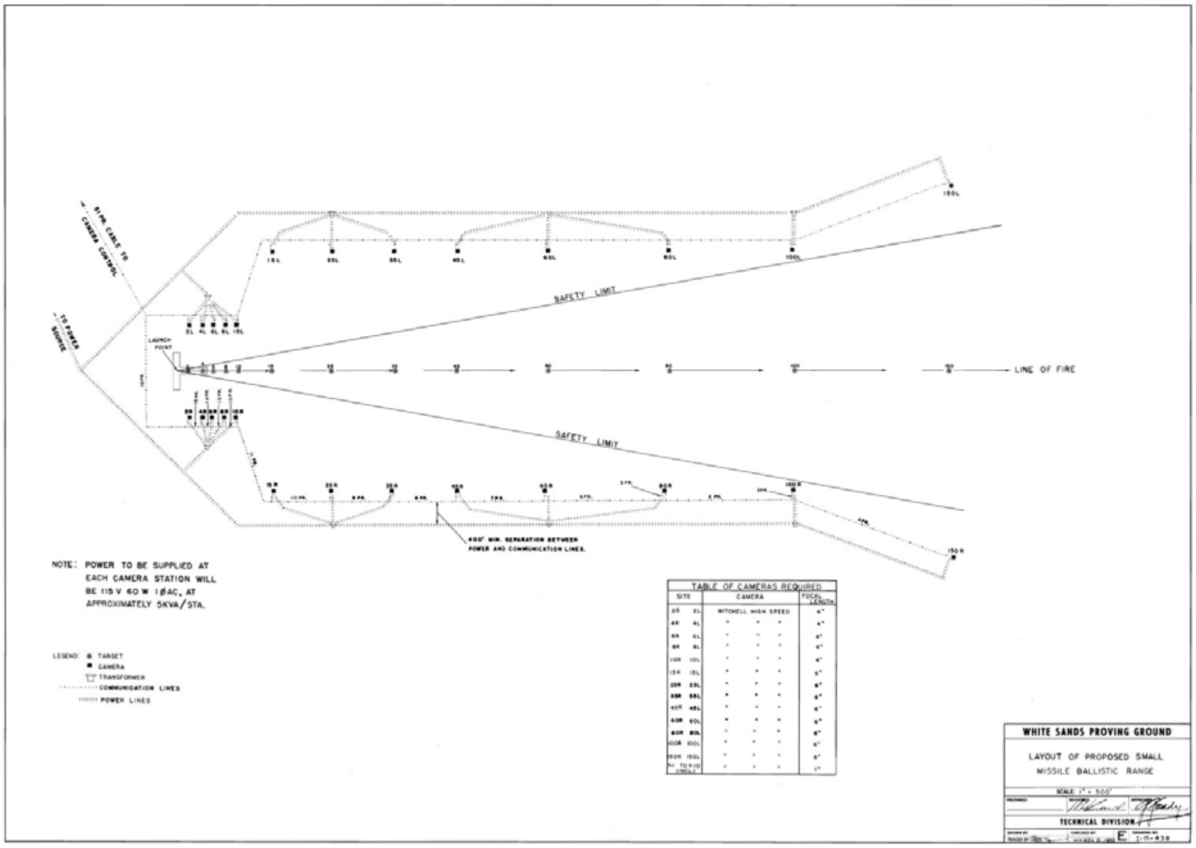


Figure 3. A 1950 Schematic map of the SMR layout showing the preliminary fixed camera locations.

was dissolved in 1953, soon after the completion of the White Sands work (City of Las Cruces 2014). Both Herkenhoff and Turney subsequently created individual entities bearing their own names.

Other names appear on architectural drawings for buildings at the SMR. The firm of Zumwalt & Vinther, A&E of Dallas, Texas were retained to design two climatic test chambers, one of which is located at the SMR proper and the other at the an area designated for assembly of Nike missiles. Both were designed concurrently and appear on the same drawings set. Mechanical engineers Ross Zumwalt and P.N. "Peanuts" Vinther had made a name for themselves through the design and development of revolutionary air-conditioning systems which had, up to that point, been the sole province of experts at the major manufacturers such as Carrier and York. In his memoirs, Vinther recounts that the Data Reduction Building at WSMR (Building 01717; demolished) was fitted with the very first "high-velocity, double-duct system as a method of local temperature control," variants of which would become industry standards (Vinther 1979). It is likely that the firm was retained to design the mechanical components of the test chambers for their expertise in air-conditioning systems. Vinther states that he and Zumwalt never collaborated on projects but simply divided up the workload. Therefore, it is safe to attribute the design work to Zumwalt alone as his signature is found on the climatic test chambers drawings. R.L. Rolfe, also of Dallas, is identified as the structural engineer; historical record searches indicate that he worked on numerous Zumwalt and Vinther projects.

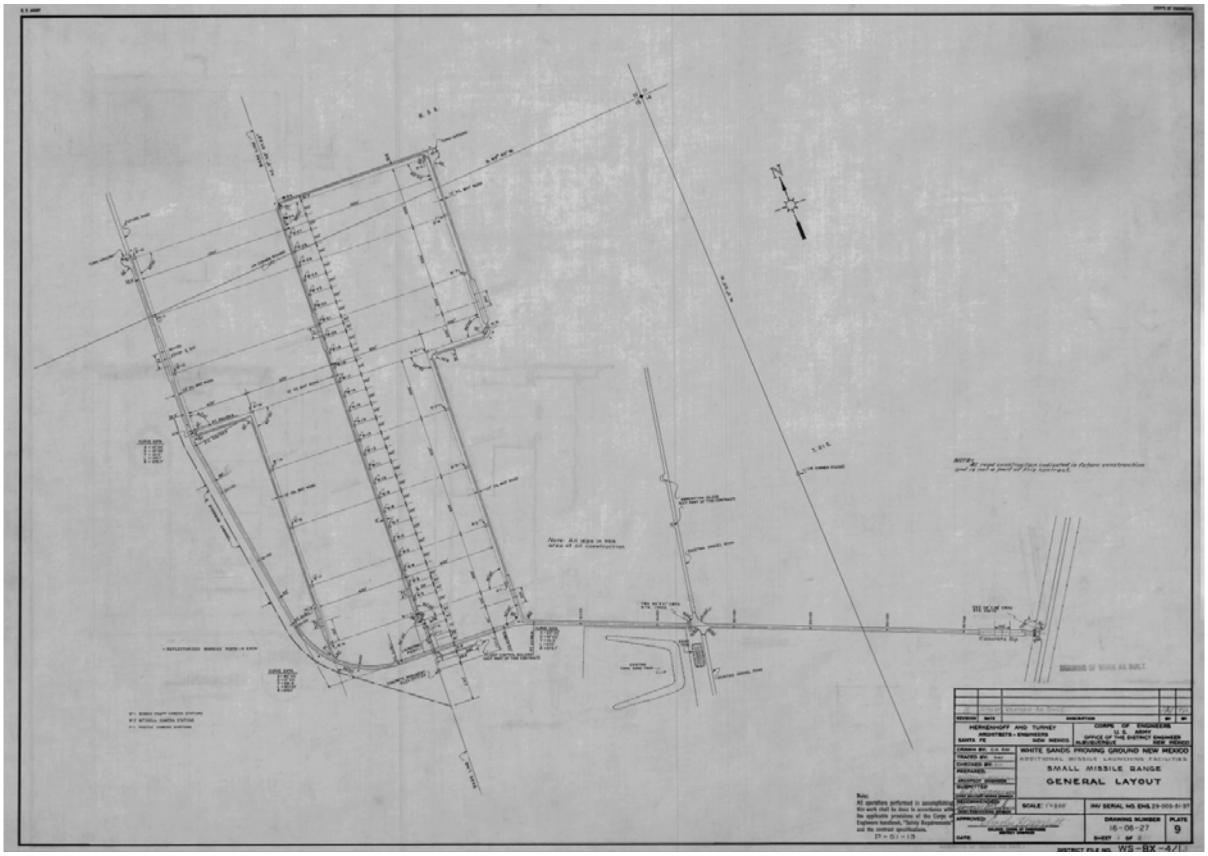


Figure 4. Schematic drawing of SMR as it was built in 1953, from WS-BX architectural plan set.

Programs at the SMR focused primarily on anti-aircraft and anti-tank weapons, with anti-tank weapons becoming the primary focus of the range after the early 1960s. After experiencing tactical difficulties defeating Soviet T-34 tanks during the Korean War, the development of better anti-tank weapons that would be able to overcome the next generation of Soviet armor became a priority for the Army. During the 1950s, the likelihood of massive tank warfare in Western Europe also began to loom as a potential scenario should the Cold War erupt into actual conflict. One location that was the focus of most European Cold War conflict scenarios was the Fulda Gap in Germany (Jack Dage personal communication 2014; Mizokami 2014; Wilson 2014). The Fulda Gap is an area of flat plains between mountainous terrain that allowed fast passage from Eastern Germany into the strategically significant areas of the Rhine River and Frankfurt (Mizokami 2014; Wilson 2014). Other routes across the inter-Germany border amenable to the travel of armored divisions existed, but none were as direct as the Fulda Gap. The geography of the Fulda Gap made a Soviet invasion via that route almost inevitable should the Cold War suddenly turn hot. As a result, for much of the Cold War as many as 1,000 tanks, backed by ground troops numbering in the tens of thousands with air and artillery support, were maintained in a ready state by both the Soviets and North Atlantic Treaty Organization (NATO) on either side of the Fulda Gap. In no other location were such large numbers of Soviet and Western forces so closely arrayed against each other during the Cold War. Had war erupted at the Fulda Gap, it would have immediately resulted in the largest tank battle in history (Wilson 2014).

With this scenario in mind, during the 1960s and 1970s the Army developed a complete family of highly effective anti-tank weapons that could be deployed at a wide variety of ranges by both individual soldiers and vehicles. Most of these weapons were tested, to one degree or another, at the SMR. To provide more detail on the role the SMR played in the development of Cold War weapons systems, the various programs tested or developed there are summarized in approximate chronological order beginning with the Loki program during the early 1950s (see summary below).

However, the SMR was not limited to the development of weapons systems. The range also was an important location for the testing and launching of atmospheric sounding rockets used for meteorological research and monitoring. The use of sounding rockets to monitor atmospheric conditions was a relatively new research avenue in meteorology that was undertaken during the late1950s. Sounding rockets helped to improve the understanding of upper atmospheric conditions and winds and how they impacted missile trajectories, particularly those of inter-continental ballistic missiles (ICBMs), in addition to benefiting general scientific knowledge. Several significant sounding rockets were tested at the SMR, and the WSMR meteorology program was very active at the SMR for decades. Therefore, the meteorology program at the SMR and the research rockets used by the program are also included in this summary.

6.7 Research, Development, Testing, and Evaluation Activities at the SMR

Research, Development, Testing, and Evaluation (RDT&E) activities were carried at the SMR throughout the Cold War. RDT&E activities can be split into two general stages: Research and Development (R&D) and Testing and Evaluation (T&E). Each stage informs the other, but emphasize different steps in the developmental process. R&D focuses on development of new technologies and is primarily conducted in laboratories, while T&E focuses on applied testing of new technologies and systems. As a test range, activities at the SMR were mostly oriented towards T&E activities. The basic sequence of T&E is summarized by Best et al. (1995:177) as:

> The process of conducting T&E for missiles consists of three levels of testing: developmental testing, technical evaluation, and operational testing. Developmental testing was done during the earliest stage of development in order to gather preliminary information about the performance of a weapon system. Information gathered during developmental testing then could be incorporated into the missile design. Technical evaluation represents the second stage of testing, intended to verify that the missile system meets the technical specifications, such as the anticipated performance characteristics. Technical evaluation was carried out by highly skilled technicians to ensure that the weapons system works as advertised. Operational testing was the third level of testing. This final test stage was intended as a check to the technical evaluation, prior to issue to the fleet. Unlike the earlier T&E stages, operational testing was carried out by military personnel.

The earliest stages of T&E are generally completed on constituent parts of a rocket or missile design, such as the propellant, motor, or warhead. These early stages of development are often conducted at contractors' facilities and were not consistently carried out at the SMR. The latter stages of T&E involving flight, guidance, and production prototypes defined SMR activities throughout the Cold War. Flight testing of rocket and missile systems usually includes unguided Launch Test Vehicles (LTVs), which are primarily concerned with verifying the function of motors and propellants. The next step is referred to as Guided Test Vehicle (GTV) testing, which adds the guidance or control system to an inert missile for testing. If GTV testing is successful, the process will move forward with warhead and fuse tests on an actual armed missile. Once these tests are successfully completed and a production prototype is produced, the production system is extensively flight tested to prove the operation of the complete system prior to issue as a combat ready weapon.

The Army also began to emphasize acceptance testing during the 1960s, which tested samples of missile production runs as a quality control measure before purchasing an entire lot. Following the approval and issue of a missile, improvements to guidance and targeting systems were also often tested at the SMR. Obsolete rocket and missile systems were also used as test platforms for the T&E of new guidance systems or other experimental equipment.

The progression of T&E activities of many systems tested at the SMR was not always so linear. Several programs in the 1950s and 1960s were placed on accelerated "crash" schedules that sought to compress developmental testing with operational testing, particularly if programs were behind schedule or over budget. This approach often resulted in less than satisfactory results.

The first system to be tested at the SMR was the Loki, and the testing needs of this program strongly influenced the original facilities and layout of the SMR (see Figure 4). These remained in use at the range through the 1960s, when the fixed camera shelter network began to fall into disuse due to the changing instrumentation needs of programs like the Shillelagh.

6.8 Loki Program 1947 to 1965 and later

The Loki rocket program was one of the most active programs at WSMR during the 1950s, and the SMR became the primary test area for the program by 1953. Although not constructed exclusively for the Loki program, the SMR layout and facilities were influenced by the needs of the program. Along with the Dart and Little John programs, the Loki program is closely associated with the original SMR built environment, particularly the network of camera buildings and the Flight Control Building. Testing of the Loki at the SMR kept the main launch areas free for bigger projects and also kept the testing of the missile north of US 70, reducing the need for road closures (Eckles 2013:28).

Background

The Loki rocket is named after the Norse god of mischief, and true to its namesake, it has gone through many changes in its character and form through its lifespan. Like many American rocket and missile programs developed after WW II, the Loki rocket was based on a German design (see Figure 5). The German "Taifun" was a rocket program under development at the

Peenemunde rocket facility during the 1940s (Kennedy 2009:112), and was also manufactured at the Mittelwerk facility. The Taifun was designed as a small, low-cost unguided rocket that would be fired in volleys as an anti-aircraft weapon. The rocket was about six ft long and used a hypergolic propellant mixture that allowed it to be safely stored in ready to fire state. The engine design of the rocket was problematic and the rocket never entered combat, although over 1,400 were fired during testing in the last year of the war (Kennedy 2009:112).

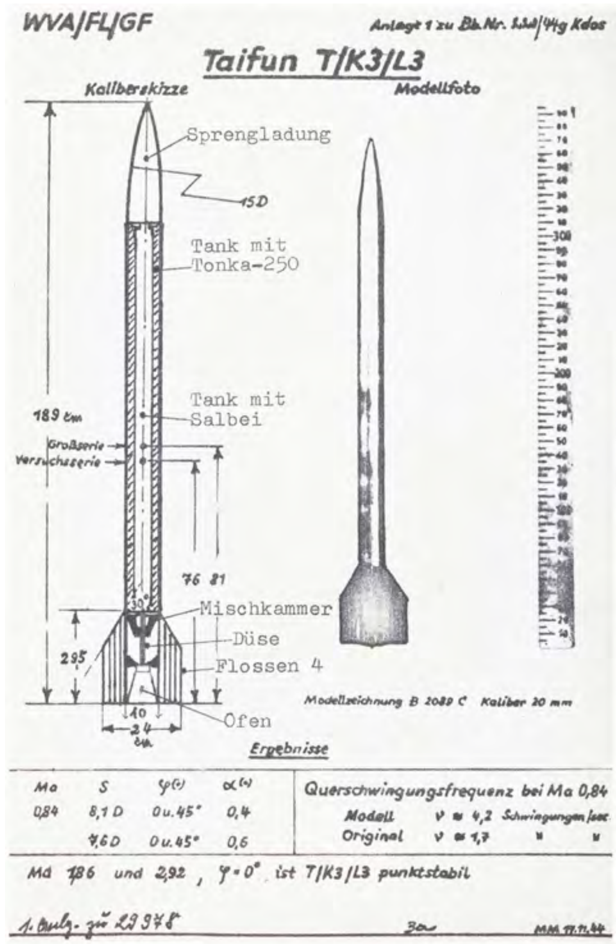


Figure 5. Schematic drawing of the German Taifun.

Defense against the next generation of jet aircraft was a primary concern among military planners following the war, as was protecting American cities and strategic military locations against a possible Soviet air strike. WW II had demonstrated that existing anti-aircraft guns were only marginally effective against high altitude bombers, and new weapons needed to be introduced to keep pace with the high performance aircraft then under development. The improvement of anti-aircraft weapons was identified as a major goal by the 1946 War Department Equipment Board headed by General Joseph W. Stilwell. This board is often referred to as the Stilwell Board, and its resulting report became a significant planning document during the early Cold War. The emphasis on the next generation of anti-aircraft weapons led to the development of the Nike-Ajax and follow-on systems, and Army planners hoped that the German Taifun rocket could also be developed into a successful anti-aircraft system. To this end, a key engineer in the Taifun program named Klaus Scheuflin was brought to the US as part of Operation Paperclip in 1946. Scheuflin and three other German scientists working out of Fort Bliss, Texas were contracted to prepare a feasibility study and development program for a liquid-fueled, unguided anti-aircraft rocket system based on the Taifun (Cagle 1957:3). The Scheuflin study was positively received by the Army Field Force Board at Fort Bliss, which formalized the plan and submitted it to higher command. The plan for the system was approved by the Department of the Army in December of 1947, which designated it the Loki (Cagle 1957:3; Kennedy 2009:112).

The 1947 Army development plan enumerated the desired military characteristics of the rocket. It was to be effective at ranges up to 27,000 yards horizontal and 20,000 yards in altitude against all types of aircraft traveling at speeds up to 1,000 miles per hour (mph). The devel-

Figure 6. Loki rocket launch from fixed launcher at SMR, December 1951 (*US Army photo)*.

opment project would also include a barrage launcher and mount, warhead, proximity fuze, and radar fire control system. According to the development plan, the Loki flight time was not to exceed 30 seconds to achieve maximum range, the fuze would self-arm approximately 100 yards from the launcher and self-destruct in the case of a miss, and fuels should be stable during extended storage and not be temperature sensitive. The launcher was to be transportable and have a capacity of least 64 rockets (Cagle 1957:3).

History of Development

With the military characteristics officially delineated, the Army Ordnance Corps selected Bendix Aviation as the prime contractor for the Loki program in 1948. Scheuflin and his team were made available to support Bendix full-time on the project, as well. Bendix considered two variants early in the Loki development: a 245 pound version and a much smaller 24 pound version. The Army selected the smaller version as it would enhance the portability of the system and likely be less expensive and faster to produce. The Bendix design consisted of a liquid fuel booster with a detachable warhead. Once the booster burned out, the aerodynamic drag would be higher on the larger booster than the smaller warhead, which would allow the two to separate. Unpowered but maintaining its momentum and course, the warhead would continue on to impact the target. To increase its flight stability, a spin of 17 revolutions per second was imparted to rocket. The liquid fueled prototype developed by Bendix accelerated to 4,570 ft per second and an altitude of 3,000 ft when the booster burned out, but the warhead would continue to an altitude as high as 84,000 ft in under 30 seconds, at which time it was still coasting at 1,800 ft per second (Kennedy 2009:113).

Figure 7. A Loki booster and warhead held by an unidentified man, July 1951 (*US Army photo)*.

The Loki prototype developed by Bendix showed promise, but problems soon emerged with the liquid fuel booster that Bendix had committed to using in the rocket. The nitric acid/aniline propellant showed signs of decomposition that would be problematic during storage. The propellant mix also had issues with ignition, operation at low temperatures, and corrosion of the rocket metal components (Cagle 1957:8). In order to resolve these problems, Bendix began to experiment with other propellant combinations, and the project soon began to lag behind schedule.

In light of the issues Bendix was experiencing with their liquid propellant booster, the Army Ballistic Research Laboratories (BRL) at Aberdeen Proving Ground (APG) in Maryland began to study the use of a solid fuel booster for the Loki in 1950. The BRL was motivated by an independent study completed by the Jet Propulsion Laboratory (JPL) in 1947 that presented a persuasive case for solid propellants instead of liquids. After a series of flight tests at APG in 1951, the BRL concluded that a solid propellant booster was a viable alternative. The Army then contracted with JPL in March of 1951 to develop a solid fuel booster for the Loki in parallel to the Bendix liquid fuel program, anticipating that the competitive development would provide a superior product (Cagle 1957).

Bendix was also responsible for the Loki launcher and considered several variants, all based on the firing of multiple rockets. Launcher concepts considered by Bendix included a belt-fed single tube repeater, a launcher that could be fed rocket magazines by trucks, a revolver type

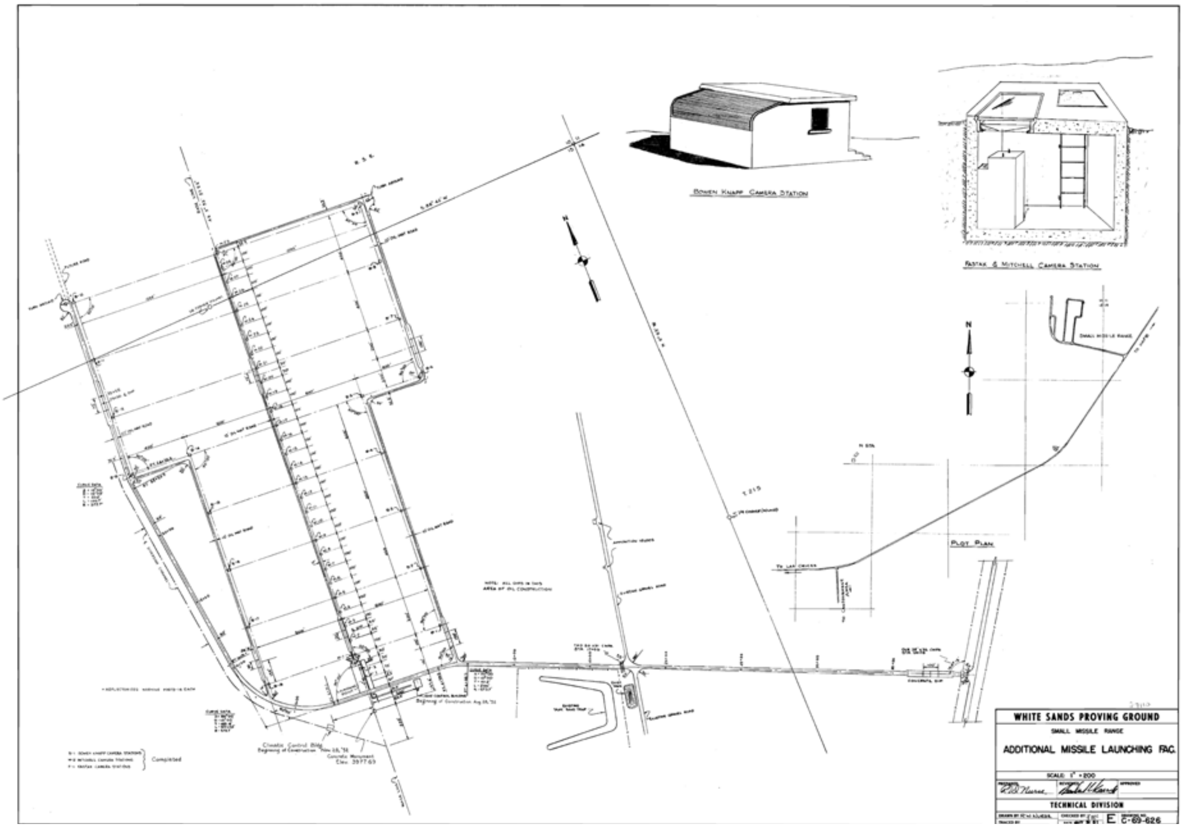


Figure 8. A 1951 map of the SMR Camera Stations, with inset drawings of the Bowen-Knapp and Fastax/Mitchell Camera Shelters.

launcher with six magazines, and a radial type launcher that could automatically load and align a series of six magazines (Cagle 1957:12). The radial type launcher was chosen as the best option, was built on the WW II 90 millimeter (mm) anti-aircraft gun mount, and incorporated 64 round magazines of Loki rockets (Kennedy 2009:114).

The fire control system for the Loki was contracted to Bell Telephone Laboratories and was to be based on the existing Western Electric M-33 anti-aircraft fire control system. The M-33 was based on WW II technology and used X-band radars that were tied to a targeting computer. Based on the radar position data, the targeting computer directed 90 and 120 mm anti-aircraft guns at incoming aircraft. Adaption of this system to the Loki required that detailed flight time and trajectory data be developed for the Loki so the targeting computer could be programmed to direct this new type of projectile (Cagle 1957:38).

Loki Testing at the SMR

JPL quickly developed a prototype, and the first Loki fired at WSPG was the JPL solid propellant design. The first launch took place at WSPG on June 22, 1951, possibly at the Army Blockhouse (WSMR n.d.), although early photographs of the 1951 Loki launches appear to have been conducted at the SMR (see Figure 9). Thirteen Loki rockets were fired as of July, and an additional 23 JPL Loki rockets were launched over the next five months. These tests clearly showed the superiority of the solid propellant booster for the Loki, and the Army direct-

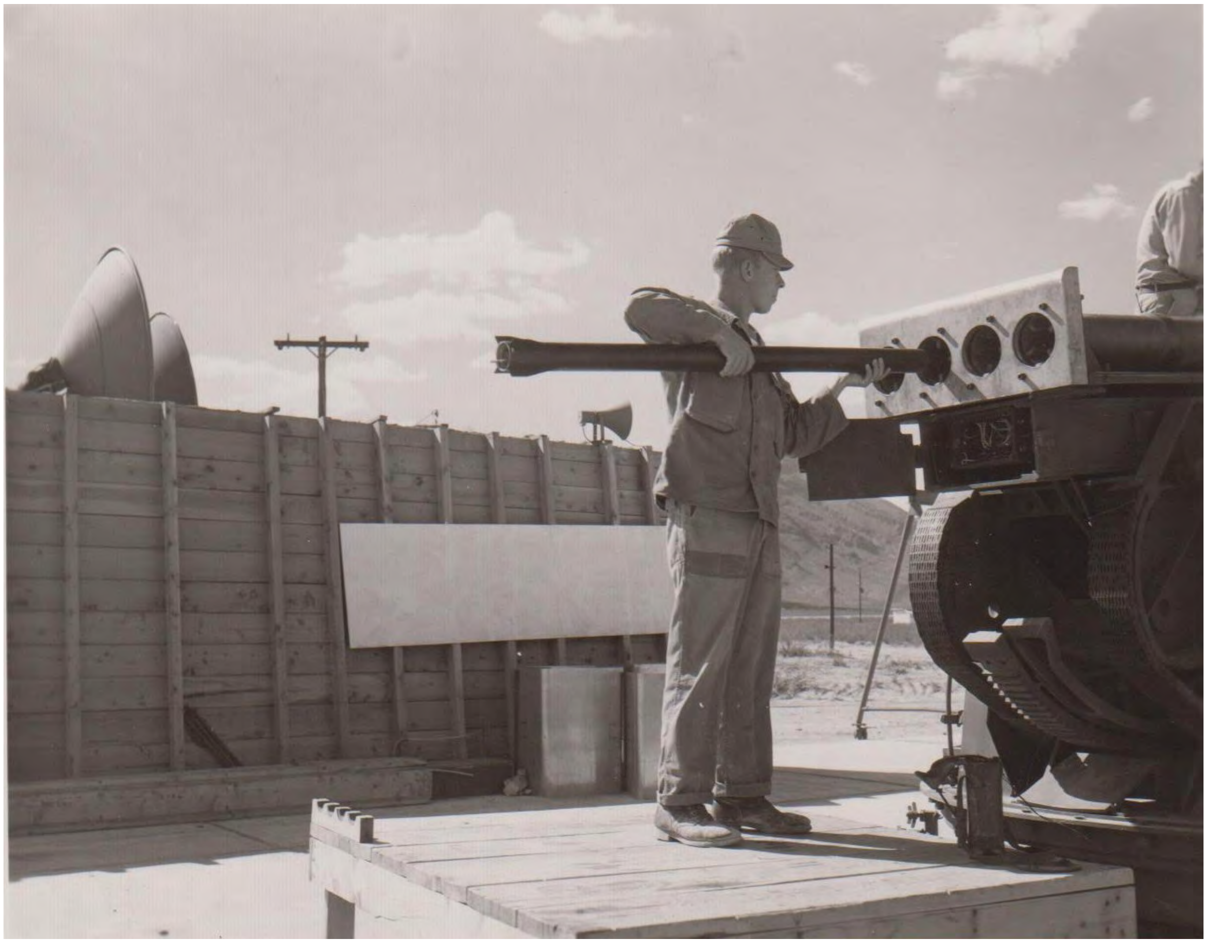


Figure 9. Loading a Loki into the launcher at appears to be the SMR, July 1951 (*US Army photo)*.

ed Bendix to restructure the program around the new booster in 1952.

By the time the Loki liquid fuel development was dropped in favor of the solid fuel design, Bendix had built a prototype automatic launcher with radial magazines referred to as the Anti-aircraft T-128 Launcher. However, the solid fuel Loki was slightly larger than the Bendix version, which necessitated a significant redesign of the T-128. This included reducing the magazine capacity from 64 to 46 and numerous other changes. After initial testing at the Bendix plant in Teterboro, New Jersey, the launcher was shipped to WSPG in the fall of 1953 (Kennedy 2009:115). Prior to this, launches at the SMR had been conducted with a single four-tube launcher (see Figure 9).

The SMR facilities were very important to the development in the Loki. Beyond basic prototype testing, an important goal of the Loki firings was the creation of ballistic firing tables that were required to calibrate the M-33 fire control system. The solid fuel Loki had been proven reliable enough to begin collecting this data by October of 1952 (Cagle 1957:29). The firing tables required accurate time, range, and trajectory data from the test flights, and collecting this data required proper range facilities and instrumentation. The network of high speed cameras, including Bowen-Knapp, Fastax, and Mitchell cameras, were housed in reinforced concrete

Table 1. List of Properties at the SMR Constructed in Association with the Loki Program.

Building	Year Built	Building Name
27110	1952	Bowen-Knapp Camera Building
27111	1952	Bowen-Knapp Camera Building
27112	1952	Bowen-Knapp Camera Building
27113	1952	Bowen-Knapp Camera Building
27114	1952	Bowen-Knapp Camera Building
27115	1952	Bowen-Knapp Camera Building
27116	1952	Bowen-Knapp Camera Building
27117	1952	Bowen-Knapp Camera Building
27118	1952	Bowen-Knapp Camera Building
27119	1952	Fastax or Mitchell Camera Building
27120	1952	Fastax or Mitchell Camera Building
27121	1952	Fastax or Mitchell Camera Building
27122	1952	Fastax or Mitchell Camera Building
27123	1952	Fastax or Mitchell Camera Building
27124	1952	Fastax or Mitchell Camera Building
27125	1952	Fastax or Mitchell Camera Building
27126	1952	Fastax or Mitchell Camera Building
27127	1952	Fastax or Mitchell Camera Building
27128	1952	Fastax or Mitchell Camera Building
27129	1952	Fastax or Mitchell Camera Building
27130	1952	Fastax or Mitchell Camera Building
27131	1952	Fastax or Mitchell Camera Building
27132	1952	Fastax or Mitchell Camera Building
27133	1952	Fastax or Mitchell Camera Building
27134	1952	Fastax or Mitchell Camera Building
27135	1952	Fastax or Mitchell Camera Building
27136	1952	Fastax or Mitchell Camera Building

structures at intervals along the SMR. The Bowen-Knapp cameras collected data on pitch (vertical orientation along the long axis), which required them to be located along the margins of the Loki firing line. The Fastax and Mitchell cameras collected data on yaw (right or left orientation along the long axis), which is best observed from a position under the rocket firing line. Therefore, these cameras were housed in 30 subterranean shelters that allowed them to record the rocket flight path as it passed overhead (see Figure 8). The camera line served as the primary firing line at the SMR and was referred to as the Yaw Line (Jack Dage personal communication 2014). All the cameras were tied into the WSPG geodetic network for spatial data and coordinated via the range central timing network.

Although the SMR facilities were intended to support multiple programs in the long term, the facilities were also structured around the immediate needs of the Loki program. Most of the primary infrastructure at the SMR, particularly the camera network, was built when Loki was a significant developmental program and reflected the requirements of supporting it. The

Table 1 Cont. List of Properties at the SMR Constructed in Association with the Loki Program.

27137	1952	Fastax or Mitchell Camera Building
27138	1952	Fastax or Mitchell Camera Building
27139	1952	Fastax or Mitchell Camera Building
27140	1952	Fastax or Mitchell Camera Building
27141	1952	Fastax or Mitchell Camera Building
27142	1952	Fastax or Mitchell Camera Building
27143	1952	Fastax or Mitchell Camera Building
27144	1952	Fastax or Mitchell Camera Building
27145	1952	Fastax or Mitchell Camera Building
27146	1952	Fastax or Mitchell Camera Building
27147	1952	Fastax or Mitchell Camera Building
27148	1952	Fastax or Mitchell Camera Building
27149	1952	Fastax or Mitchell Camera Building
27150	1952	Bowen-Knapp Camera Building
27151	1952	Bowen-Knapp Camera Building
27152	1952	Bowen-Knapp Camera Building
27153	1952	Bowen-Knapp Camera Building
27154	1952	Bowen-Knapp Camera Building
27155	1952	Bowen-Knapp Camera Building
27156	1952	Bowen-Knapp Camera Building
27157	1952	Bowen-Knapp Camera Building
27158	1952	Bowen-Knapp Camera Building
27170	1953	Flight Control Building
27104	1954	Climatic Test Magazine Building
27108	1954	General Storehouse (Quonset Hut)
27190	1953*	Launch Pad

buildings and structures that were constructed in the period 1952 to 1954 at the SMR and used in support of the Loki program are summarized in Table 1. The early 1950s was a very busy period for the Loki program (see Table 2). Following the initial 1951 testing, the number of Loki rockets fired increased to 302 in 1952. The firing volume substantially increased upon the arrival of the Bendix T-128 launcher in 1953, at which time the Loki program was definitely established at the SMR. The launcher allowed volleys from the 46 round magazines to be fired, which boosted the number of firings to 1,157 in 1953 and 1,125 in 1954. The launcher was damaged in a storm in early 1955 and was not repaired until April, but 902 Loki rockets were launched by September of that year (Kennedy 2009:114-115).

Program Cancellation

Many delays occurred as the program was restructured around the JPL solid fuel version of the Loki, particularly with re-outfitting the T-128 Launcher for the slightly larger rocket. Additional problems with the launcher were encountered due to the high performance booster of the Loki. The high temperature of the rocket tended to expand the adjacent launch tubes upon

Table 2. Loki Firings from 1951 to 1965 at WSMR (*Kennedy 2009; WSMR Museum 2014)*.

Year	Type	Total Fired
1951	Loki Anti-aircraft	34
1952	Loki Anti-aircraft	302
1953	Loki Anti-aircraft	1,157
1954	Loki Anti-aircraft	1,125
1955	Loki Anti-aircraft	902
1956	Loki-Wasp	25
1957	Loki	5
1958	N/A	0
1959	Loki-Naka	7
1960	Loki	39
1961	Loki	161
1962	Loki	115
1963	Loki-ERDA	207
1964	Loki	198
1965	Loki	207

firing, which in turn affected the dispersion pattern of the remaining rockets. As of 1955, a solution was still being sought for this problem.

By 1955 a series of setbacks had seriously hampered the Loki testing and development program. A sub-contractor that produced metal components for the booster failed to produce parts on schedule, which prevented additional loaded rounds from being delivered on time. The data needed to calculate firing tables had yet to be fully collected and processed, which prevented progress on the vital M-33 fire control system. In addition, the T-128 launcher was struck by lightning in January of 1955 and took several months to repair, causing the program to fall even further behind schedule.

More fundamentally, support for unguided rocket systems like the Loki had eroded in the years since its inception. The development of guided missiles like the Nike and the Homing All the Way Killer (HAWK) had demonstrated the superiority of guided systems in engaging maneuvering aircraft. Unlike these guided missiles, the Loki could be evaded by relatively simple maneuvers, which made it comparatively ineffective. Therefore, the Loki rocket, already substantially behind schedule, was essentially obsolete. As a result, the program was discontinued in September of 1955, and the launch equipment at WSPG was transferred to Redstone Arsenal for storage (Cagle 1957:43-44). Although it never served as a practical weapon system, the Loki was soon found to be an excellent candidate for upper atmospheric research and its use in this role is discussed in the section on the meteorological program at the SMR.

6.9 Dart Missile 1953 to 1958

The Dart was a small, portable guided anti-tank missile that the Army developed during the 1950s (see Figure 10). It was to be the smallest guided missile in the Army inventory, at only 6 ft in length and weighing less than 100 pounds (Kennedy 2009:147; Wind and Sand 1956). However, Dart development was never completed and other systems were selected to fill its role during the late 1950s. The program was tested at the SMR from 1954 to 1958, making it a contemporary to the Loki, Little John, and Lacrosse program that were also tested at the SMR in the same time period.

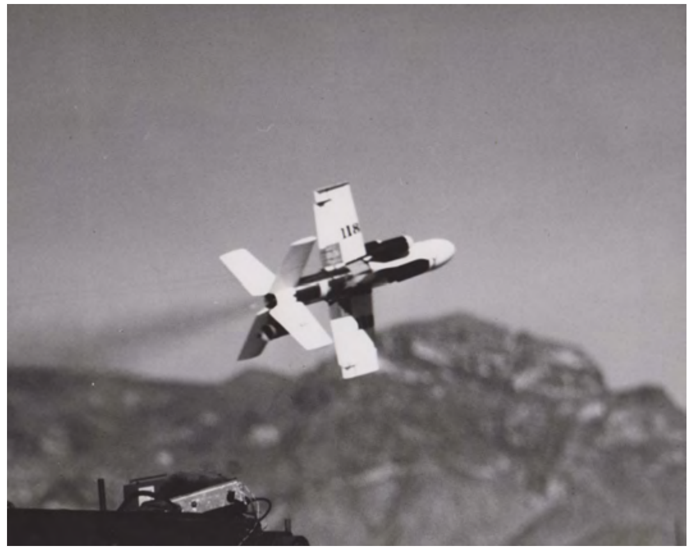


Figure 10. A Dart in flight at the SMR, December 1957 (*US Army photo)*.

Background

The evolution of tank warfare during WW II had precipitated the advent of numerous anti-tank weapons, including the 2.36 and 3.5 inch bazookas, recoilless rifles, anti-tank cannon, rifle grenades with shaped charges, and armor piercing shells (Cagle 1977). However, by the end of the war and in the years following, improvement of tank armor was outpacing the development of effective, portable anti-tank weapons. This situation became very obvious during the Korean War, as the North Korean Army deployed Soviet T-34 tanks, which were an advanced design for the era. The T-34 was arguably the best tank to emerge from WW II, and it incorporated thick and heavily sloped armor plates against which the standard US army 2.36 inch bazooka was ineffective (Kennedy 2009:71). More effective weapons, such as the 3.5 inch Super Bazooka were quickly brought to bear against the T-34, but the experience spurred military planners to develop more powerful anti-tank weapons that would be effective against the next generation of Soviet tanks and armored vehicles. These weapons needed to be portable for use by ground forces in the field and also capable of greater accuracy at extended ranges than the widely fielded 2.36 and 3.5 inch bazookas.

The US Army naturally looked to the development of small, portable Anti-Tank Guided Missiles (ATGMs) as the next generation of anti-tank weapon. Guided missiles could be fired from cover and at angles where standard anti-tank weapons could not. An ATGM was also capable of destroying tanks throughout its usable range, unlike standard anti-tank weapons whose effectiveness diminished as ranges to the target increased. An ATGM could also completely destroy an armored vehicle, rather than just temporarily disabling it (Cagle 1977:4). Preliminary studies of ATGM were conducted after WW II, but it was not until after the outbreak of the Korean War in 1950 that development of the system became a priority.

Figure 11. Photo sequence of a Dart missile destroying a tank during July 1958 Operation AMMO demonstration at WSMR (*US Army photo)*.

Characteristics for the proposed missile system were prepared in January of 1952 by the Army Field Forces. The desired characteristics for the ATGM called for a maximum range of 6,000 yards, a minimum range of 500 yards, and a 90 percent hit and kill probability against the heaviest tank armor then available. The system would incorporate some form of infrared or other guidance system, preferably with automatic capabilities (Cagle 1977:6). By 1952, the French had already developed an ATGM based on the experimental German Ruhrstahl X-7 guided anti-tank missile. This system was the “Sol-Sol-10”, or Surface-to-Surface 10 (SS-10) missile. Low-cost and lightweight at 34 pounds, the SS-10 was optically guided remotely by an operator via a wire that unspooled from the missile as it flew. The Army procured 500 sets of the SS-10 for testing in 1952 and evaluated the system through 1953. The Army was not satisfied that the SS-10 met the desired requirements for use in the field. Concurrent with the SS-10, the Army Ordnance Corps had initiated preliminary studies of what would become the Dart ATGM. The Army believed that the Dart would provide a better anti-tank weapon and opted to develop the system instead of continuing work with the French SS-10 (Cagle 1977).

Figure 12. The Jeep mounted Dart prototype produced in 1958 (*US Army photo)*.

Development

The Dart ATGM program, officially designated the SSM-A-23, became an official Army Ordnance Corps project in 1953, and the Aerophysics Development Corporation was designated as the prime contractor. The Dart was similar in design and profile to the cruciform winged SS-10, but larger. It was 64 inches long with a wing span of 2.64 ft and weighed about 85 pounds (Cagle 1977:8). Similar to the SS-10, the Dart was controlled via wire by an operator who would use a joystick to visually guide onto the target. However, unlike the SS-10, which relied entirely on manual guidance by wire, the Dart would incorporate an infrared homing device that would assume control from the operator in the final stage of its flight (Cagle 1977:8).

The Ordnance Corps transferred technical supervision of the project to Redstone Arsenal in 1954, with the exception of the fuze and warhead which continued to be developed by the Ordnance Corps. Although several variants of the Dart were designed, the program was slow to produce results through 1955 to 1956, which led to reduced funding of the program in 1957. As a result of the reduced funding and scope of the project, it was reoriented to focus on the development of a Jeep mounted system (see Figure 12). Prototypes of this system were completed in 1958 but never field tested (US Army Redstone Arsenal 2014a).

Testing at the SMR

The first Dart missiles were fired at the WSPG SMR in 1954 (Wind and Sand 1956; WSMR Museum 2014). Tests of the Dart missile continued through 1958, when the program devel-

Table 3. Summary of Dart Firings from 1954 to 1958 at WSMR (*WSMR Museum 2014)*.

Year	Type	Total Firings
1954	Dart Anti-Tank	15
1955	Dart Anti-Tank	32
1956	Dart Anti-Tank	34
1957	Dart Anti-Tank	39
1958	Dart Anti-Tank	62

opment was canceled (see Table 3). The program is significant to the SMR as it was the first of a series of anti-tank weapon systems that would be there, including the Shillelagh, Tube-Launched Optically-tracked Wire-guided (TOW), Dragon, Copperhead, and Line-of-Sight Anti-Tank (LOSAT) systems. These anti-tank systems would define the SMR for most of the Cold War. Testing for the Dart program also initiated the use of surplus tanks for use as realistic targets, a practice that was later expanded during the Copperhead testing into the Tank Farm that exists at the SMR today.

Several buildings (WSMR Properties 27164, 27165, and 27166) were established at the SMR in support of the Dart Program (see Table 4). Most of these buildings were constructed in 1956 and 1957 and later modified with additions or other modifications for use with other developmental programs at the range.

Figure 13. A surplus tank burns after a Dart missile impact, March 1957 (*US Army photo)*.

Table 4. Buildings Constructed in Support of the Dart Program at the SMR.

Property Number	Property Name	Year Built
27164	Dart Assembly Building	1956
27165	Dart Electrical Checkout Building	1957
27166	Dart Operations Building	1957

Cancellation

In 1952 the Aerophysics Development Corporation anticipated that the Dart development could be completed in about two years, in part due to the advanced state of the French SS-10 from which the Dart borrowed design and technological elements. This proved to be considerably over-optimistic, and by 1958 an acceptable version of the system had yet to be developed. With the Dart years behind schedule and substantially over budget, the Army once again looked at the French SS-10 system as an interim solution. The SS-10 had undergone significant improvements since the earlier evaluations, and the US performed additional tests in 1958 on the updated version. These tests proved the reliability of the SS-10, and in consideration of the general dissatisfaction with the Dart development, it was chosen as an interim weapon system to be used in place of the Dart. As a result, the Army officially discontinued the Dart program in September of 1958. Although never deployed, about 105 Dart missiles were produced (US Army Redstone Arsenal 2014a).

The SS-10 was issued for use by US forces as an interim weapon in 1959. Delivered in 1960, the SS-10 remained in service until 1963 when it was replaced by the French MGM-32 Engin Teléguidé Anti-Char (ENTAC) missile, a more sophisticated wire-guided ATGM also produced by France. The ENTAC missile remained in US service until 1969, when it was replaced by the Army developed Tube-launched Optically-tracked Wire-guided (TOW) anti-tank missile, which was also tested at the SMR.

Figure 14. Dart missile launch at the SMR, 1956 (*US Army photo)*.

6.10 Lacrosse Missile Program 1949 to 1964

Figure 15. Lacrosse missile and truck-mounted launcher (*US Army photo)*.

The Lacrosse missile was designed as a high accuracy, portable short range ballistic missile that could be deployed in close tactical support of ground forces (see Figure 15). Development of the Lacrosse began as early as 1952 at WSPG, and continued through the early 1960s. A high volume of Lacrosse missiles were fired at the WSPG SMR during the late 1950s in efforts to perfect the system. The missile was fired in the general direction of the target and then guided via radio link to the target by a forward observer, analogous to how the ball is passed downfield between players in the game of lacrosse. This analogy provided the basis for the name of the missile (Cagle 1962:2).

Background

The idea for the Lacrosse missile was born out of the difficulty the Navy and Marines experienced in destroying fortified Japanese positions during WW II, particularly on the island of Iwo Jima (Cagle 1962:2). Following the war, the Navy concluded that a form of close range, surface-to-surface fire support capable of destroying fortified targets was needed. The Lacrosse was developed as a precision "bunker buster" missile, capable of carrying low-yield nuclear or conventional high-explosive warheads that could penetrate reinforced concrete bunkers and pillboxes (Army 1959; McKenney 2007:222-223; Parsch 2002a).

Development

With deployment by the Marines in mind, the project originated with the Navy in late 1947. Early feasibility studies for the project were conducted by Applied Physics Laboratory (APL) of Johns Hopkins University during 1947 and 1948. A feasibility study by APL and the Cornell Aeronautical Laboratory (CAL) in 1948 did not determine a practical guidance method for the system. The project was dormant for about a year before a subsequent study by CAL identified two potential guidance systems for the Lacrosse: a homing system and a radio command system (Cagle 1962:5-6). The homing system relied on an electronic homing beacon fired onto a target by an artillery mortar. Of course, it was unlikely that the mortar could accurately fire the beacon onto the target, and the electronic beacon was subject to damage from being fired. Therefore, the CAL study recommended the radio command system as the better alternative

Table 5. Summary of Lacrosse Firings from 1952 to 1962 at WSMR (*WSMR Museum 2014)*.

Year	Type	Total Firings
1952	Lacrosse Jato Missile	3
1953	Lacrosse Missile	3
1954	Lacrosse Missile	5
1955	Lacrosse Missile	12
1956	Lacrosse Missile	5
1957	Lacrosse Missile	19
1958	Lacrosse Missile	49
1959	Lacrosse Missile	69
1960	Lacrosse Missile	36
1961	Lacrosse Missile	7
1962	Lacrosse Missile	7

(Kennedy 2009:147). In order to speed the engineering process, CAL based the Lacrosse on the Navy's Lark missile, allowing them to use the extensive test and engineering data already available from this earlier design.

Following these preliminary feasibility studies, the Navy awarded a contract to the CAL in 1949 to develop a prototype of the Lacrosse missile system. However, the project did not remain under Navy guidance for long. In an effort to eliminate duplication of missile projects between the service branches, the Joint Chiefs of Staff assigned the development of all anti-aircraft and short-range surface to surface ballistic missiles to the Army. As part of this reorganization, the Lacrosse missile project shifted to Army management in 1950 (Cagle 1962:17).

While CAL was responsible for the Lacrosse R&D effort, it did not possess the facilities or manufacturing capacity to put the Lacrosse into production. The Army awarded the Lacrosse production contract to the Glenn L. Martin Company in 1955 and Martin gradually took over the technical responsibility of the system through the late 1950s (Cagle 1962).

Testing at WSPG and the SMR

Various tests of the Lacrosse were conducted at multiple locations at WSPG from 1952 to 1962 (see Table 5). The firing records do not record the locations of these launches, so the number that occurred at the SMR is unknown. As the Lacrosse launching pad at the SMR was not constructed until 1959, it is likely that most early tests of the Lacrosse occurred elsewhere on the range.

The earliest tests of the Lacrosse system were conducted at WSPG by equipping eight modified Lark airframes with Lacrosse guidance equipment and dropping them from B-26 bombers. The Lark airframes were then guided to targets using ground equipment, which demonstrated the feasibility of the guidance system (Cagle 1962:46). These early guidance tests, called the Group 0 series, were completed by CAL in 1954. The first full scale firing of the Lacrosse, called the Group A program, took place at WSPG from August of 1954 to December of 1955, with a series of 15 Lacrosse prototype missiles fired (Cagle 1962:46; US Army Redstone Arsenal 2014b). This was followed by the Group B firing program, which tested guidance system

Figure 16. A Lacrosse launches from LC-37, September 1961 (*US Army photo)*.

improvements and was completed by September of 1956. The Martin production team was incorporated into the Lacrosse development during the Phase B firings.

Following the Phase B test program, the Lacrosse production program was initiated, which essentially combined the production and R&D programs into a single telescoped program in hope of expediting the release of the Lacrosse. The next firings of the Lacrosse were of eight Martin Task II production prototypes, conducted at WSPG between January and June of 1957. Testing of the Task III production prototypes immediately followed, and 16 Lacrosse firings were carried out at WSPG from June of 1957 to March of 1958. Only five of these were considered successful; ten of the missiles failed due to guidance or control system malfunctions and one launched successfully but landed outside the impact zone (Cagle 1962:123). The next test series, the Martin Task IV Lacrosse prototype, was essentially the final tactical version that would be issued for field use. The testing for this series combined Martin's final R&D testing with the Army's field evaluation trials into a composite program (Cagle 1962:134-135).

The Task IV series of firings began at WSPG on March 19, 1958 and continued through April of 1960 and tested 181 Lacrosse missiles, not all of which were fired successfully (Cagle 1962:135). The results were initially disappointing; by the end of 1958 it was obvious that the system suffered from reliability problems, with almost half of the launches aborted due to problems with the equipment and radio command linkage. As a result, the Army conducted a special firing program dubbed Operation Pickle Barrel in late 1958 in order to identify and correct problems with the system. Operation Pickle Barrel fired 12 missiles, eight of which successfully impacted the target (Cagle 1962:136-137). As a result of this program, improvements were made to the Lacrosse and the Task IV firings resumed at WSPG (now WSMR) in February of 1959 and continued through June. These firings resulted in a much improved reliability record of the Lacrosse, and the first Lacrosse system was delivered to an Artillery Battalion at Fort Sill, Oklahoma in July of 1959.

A dedicated, semi-permanent launch pad for the Lacrosse missile, WSMR Property Number 27199, was built at the SMR in 1959. The 27199 launch pad is identified on several late 1950s maps of the SMR, and is located west of Property 27154 and east of Property 27138 (see Figure 17). No other documentary evidence exists that any other dedicated buildings or structures were constructed to support the program, and existing facilities were likely used for this purpose. Lacrosse firings at the SMR were conducted at this launching area, and the missile was also tested at LC-37. Unfortunately, WSMR firing records do not contain specific information on which complex the firings took place, only annual totals of the number of missiles fired. Thus, it is not possible to determine how many Lacrosse firings occurred at the SMR.

Deployment

The final tactical stage of the Lacrosse system consisted of three primary components: the missile itself, the truck-mounted launcher, and the missile guidance computer (Army 1959:7). Compared to the contemporary Little John short range tactical missile, the Lacrosse was relatively large. It was approximately 19 ft in length with a diameter of 20 inches and weighed about 2,300 pounds. The missile featured a distinctive set of swept, cruciform wings with interdigitated tailfins that steered the missile. Powered by a Thiokol solid propellant motor, the missile could carry a 500 pound warhead to a maximum range of 18 miles (Kennedy 2009:148).

The logistics of launching the missile in the field were fairly complex (see Figure 18). In addition to the modified 2½ ton truck that carried the launcher, a five ton cargo truck was needed to haul two Lacrosse missiles, and another 2½ ton truck equipped with a crane was required to transfer the missiles from the cargo truck and install them on the truck-mounted launcher. An additional ¾ ton truck and trailer carried the checkout and assembly equipment (US Army 1959). The forward guidance unit required an additional two jeeps and one ¾ ton truck (Cagle 1962:133).

The Lacrosse guidance system relied on optical angle measurements and radio range measurements from the forward guidance unit that were fed into the guidance computer, which calculated course correction commands that were relayed to the missile via a radio link. This system was capable of achieving very high accuracy, and at the time of its first delivery in July of 1959, it was the most accurate missile in the Army arsenal (Kennedy 2009:149).

Problems and Removal from Service

Despite its accuracy, the practicality of the system in actual field applications was limited by several factors. The optical basis of the forward guidance control meant that the Lacrosse

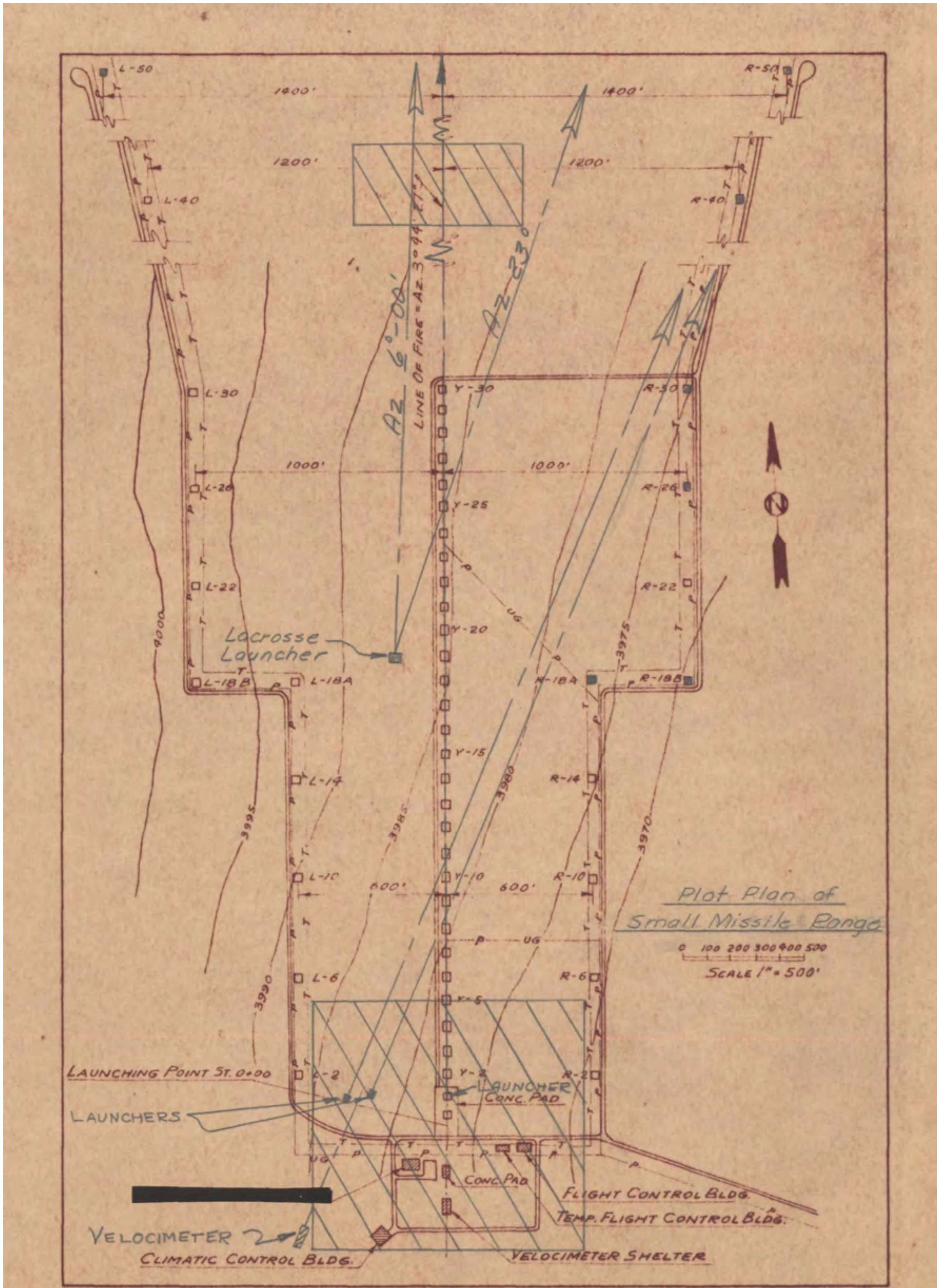


Figure 17. An undated map, probably circa the late 1950 or early 1960s, showing location of Property 27199, the Lacrosse launch pad, at the SMR (*US Army photo)*.

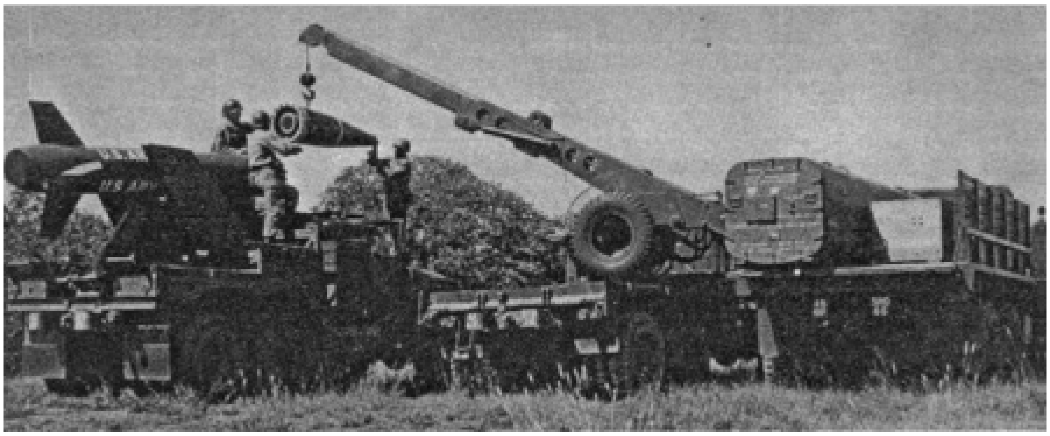


Figure 18. A 1959 photo from *Artillery Trends* magazine showing the transport, crane truck, and launcher truck with the Lacrosse missile under assembly.

could not be fired at night or in low visibility. The radio command link was also subject to enemy detection, jamming, or countermeasures, which created the dangerous possibility of losing control of the missile once it was launched. This was of particular concern given the nuclear capability of the Lacrosse (McKenney 2007:224-225). As reported in Cagle (1962:115-116), Brigadier General H.C. Tschirgi of the Marine Corps testified before the House of Representatives in 1960 about problems with the Lacrosse:

> It takes a very simple device to interfere with the control of the Lacrosse…If you put a nuclear warhead on one of these things it is going to be a little bit unfortunate if somebody guided it to the wrong place, or if it got to the wrong place without any guidance. It is a $70,000 missile and it can be interfered with by another local station.

In addition to the problematic guidance system and its logistical complexity, reliability issues continued to plague the Lacrosse after its official release (Cagle 1962:150). Due to budget limitations, the Army did not pursue efforts to correct the shortcomings of the Lacrosse in a modified version called the MOD I (US Army Redstone Arsenal 2014b). As a result, the Marine Corps decided not to field the missile in 1959, leaving it in the hands of the Army. The Army decided to field the Lacrosse on an interim basis despite the issues with the system and deployed it to battalions in Europe and Korea during the spring of 1960 (US Army Redstone Arsenal 2014b). In October of 1960, the Army subjected the system to "kill or cure" field trials to determine if the system was worth further investment.

As a result of these trials, the Army decided to halt any further procurement of the Lacrosse, and began reducing its inventories of the missile and its support systems in 1961. The system was officially classified as obsolete in 1964 and all remaining units withdrawn from service (Kennedy 2009:149). Today the Lacrosse is mostly a forgotten system. After almost 13 years of development and nearly $300 million invested, the Lacrosse was in service for less than half a decade.

6.11 Little John Program 1953 to 1977

The Little John rocket was a scaled down, readily transportable version of the larger Honest John (see Figure 19). It was designed for use by Army airborne divisions and was the smallest nuclear capable rocket ever deployed by the US Army. The Little John was extensively tested at the SMR of WSPG beginning in 1956, soon after the cancellation of the Loki Program. Testing continued at the SMR during the late 1950s and 1960s, and buildings and facilities were constructed at the SMR in support of the program in 1957 and 1959. The rocket entered service in 1961 and was retired in 1969, but continued to be used as a test platform for various programs through the 1970s.

Figure 19. Phase I Little John rocket on mobile launcher (*US Army photo)*.

History of Development

The Honest John had proven itself for use in artillery units, but was too large and heavy to be used for airborne forces. Accordingly, the Army Chief of Ordnance conceived the Little John as a small rocket that would be easily transportable by truck or helicopter, with a range of about ten miles and capable of delivering a small nuclear warhead. As outlined in 1953, the John rocket family would include the long range Honest John Senior, the middle range Honest John, and the short range Honest John Junior (US Army Redstone Arsenal 2014c). Douglas Aircraft was the major contractor on the Honest John Junior rocket, which became known as the Little John by 1954. The Army formally established the Little John project in 1955. The Redstone Arsenal was the primary project manager for the development of the system and eventually took over contracting responsibilities from Douglas due to disagreements over the contract proposal (US Army Redstone Arsenal 2014c).

The earliest design of the Little John called for a 440 mm (17.35 inch) diameter rocket, but the Army Ordnance Division decided in late 1955 that a smaller diameter rocket suited to carry an 11.5 inch diameter nuclear warhead would be preferable. The smaller size would also optimize the transport of the rocket either by truck or helicopter. The Little John in its final form was only 14 ft in length and 12 inches in diameter (Keller 1960). In February of 1956, Redstone Arsenal awarded a contract to Emerson Electric Company for the design and manufacture of

Little John airframe components. Around the same time, the Little John project was organized into two phases: the development of an initial interim system (Phase I) and the later development of an optimized system (Phase II).

Figure 20. The Little John was a portable system that was easily towed by a Jeep (*US Army photo)*.

The first firing of the interim system was on July 26, 1956 at WSPG, with final testing of the rocket taking place a year later in 1957. The Phase I Little Johns were designated as the XM47 and were delivered to the 101st Airborne Division at Fort Campbell, Kentucky later the same year. As delivered to the 101st, the Phase I Little John fell short of the design expectations. In particular, it lacked the desired accuracy in the delivery of the nuclear warhead it was designed to carry. After some preliminary testing by ground troop units, the Continental Army Command decided that the Phase I Little John was not suitable for use in the field and relegated it to reserve status, to be used for training purposes by 101st Airborne Division at Fort Campbell (Kennedy 2009; US Army Redstone Arsenal 2014c). In the spring of 1958, the responsibility for the development of the Phase II Little John system was transferred to the Army Rocket and Guided Missile Agency (ARGMA).

Testing at the SMR

Based on WSMR firing records, both the Phase I and Phase II Little John rockets were tested at WSPG. The first firing of a Little John occurred on July 26, 1956 at the SMR, and hundreds more were fired through the early 1960s (Eckles 2013:28). The Phase II Little John Testing was complete by 1961, but variants and quality assurance tests of the Little John were fired throughout the 1960s at the SMR (see Table 6). Even after the system was withdrawn from service, the Little John served as a range workhorse for various test programs through the 1970s.

Based on architectural drawings and realty data on file at WSMR, properties 27180, 27181, 27182, 27183, 27184, 27185, and 27186 at the SMR were constructed in support of the Little John Program in 1957 (see Figure 22).

Three additional properties – 27173, 28187, and 27188 – were constructed for the program in 1959 (see Table 7). This suggests that these facilities were built in support of the Phase II Little John developmental testing, as the Phase I testing was complete by 1957. The late 1950s Little John Assembly Area at the SMR is the location of the “Tank Farm” area today. Properties 27182 and 27183, two small fuze storage magazines, have been removed, but the other Little John buildings are still extant in this area. However, they have been repurposed and

Table 6. Summary of Little John Firings from 1956 to 1977 at WSMR (*WSMR Museum 2014)*.

Year	Type	Total Firings
1956	Little John	19
1957	Little John	139
1958	Little John	56
1959	Little John	119
1960	Little John	112
	Little John T-54 WH	15
1961	Little John	75
1962	Little John	29
1963	Little John	13
	Little John XM 189 WH	5
1964	Little John	16
	Little John XM 189 WH	5
1965	Little John	11
1966	Little John Whd XM 185	2
	Little John QA	2
	Little John Whd XM 189	6
1967	Little John XM 189 Whd	2
	Little John QA	4
	Little John XM 185 Whd	2
1968	Little John XM 185	2
	Little John XM 189	2
1969	Little John XM 185	2
1970	Little John Laser Guided	6
	Little John XM-188	1
1971	Little John Laser Guided	10
1972	Little John Payload	1
1973	Little John/GRM	4
	Little John Laser Guided	1
	Little John RSLP XM18	1
1974	Little John Advanced Tech	3
	Little John Disper Tech	4
	Little John Massive test	2
	Little John Rockeye	5
1975	Little John Massive Test	1
	Little John Rockeye	1
1976	Little John Massive Test	2
1977	Little John Massive Test	1

Figure 21. A Little John launch from the Property 27191 Launch Pad at the SMR, June 1958 (*US Army photo)*.

Table 7. Buildings Constructed at the SMR in Support of the Little John Program.

Building Number	Building Name	Year Built
27100	Launching Pad	1959
27101	Launching Pad	1959
27173	Launcher and Camera Maintenance Building	1959
27180	Main Assembly and Telemetry Check	1957
27181	Boiler Room	1957
27182	Fuze Magazine	1957
27183	Fuze Magazine	1957
27184	Warhead Assembly Building	1957
27185	Grain Loading Building	1957
27186	Pre-Assembly and Inspection Building	1957
27187	Instrument Calibration Building	1959
27188	Pre-Assembly Inspection Building	1959

modified and are now used by the contractor (Trax International) that maintains the Tank Farm. Two launching pads, WSMR Property numbers 27100 and 27101, which are located west of the main Loki launch pad, were also built for the Little John Program (see Figure 22). These launch pads were partially superimposed by the construction of a magazine structure (Property 27103) in 1981, but are still mostly visible.

Deployment

The ARGMA Little John Phase II program addressed the shortcomings of its predecessor and the system was issued as combat ready in 1961. The Little John Phase II, designated the XM51 by the Army, was 14.5 ft in length, 318 mm in diameter, and weighed approximately 780 pounds (Keller 1960). It was distinguishable from the previous XM47 by its small square fins; the XM47 design had slightly larger triangular fins. The XM51 Little John was fired via a portable XM34 launcher rail that weighed 1,200 pounds and could be affixed to a XM449 trailer. The rocket and launcher combined weighed around one ton, which was about half the weight of a 105 mm howitzer (Keller 1960). The rocket affixed to the launcher and trailer could be airlifted by helicopter or towed into position by jeep, and could be fired about ten minutes after it was delivered (see Figure 20). The Little John was a true rocket as it lacked any internal guidance mechanism; its trajectory was determined by the angle of the launcher and preset corrections for wind deflection, much like traditional artillery.

The most unique characteristic of the Little John was that it spun on the launcher rail prior to firing. The spin was necessary to stabilize the rocket during flight. The spin was accomplished on the larger Honest John rocket by small lateral rockets that fired immediately after launch (often visible in photos), but the smaller Little John created the spin via a mechanical action while still on the launcher just prior to launch. A large flat coil spring was mounted under the rear of the XM34 launching rail, which was manually wound eight and a half turns. The spring would be released when the launch lanyard was pulled, which turned a driveshaft and ring gear meshed to a pinion gear in the rocket nose. Once the rocket spin rate reached three and a half revolutions per second, it would automatically fire and the fins of the Little John were canted

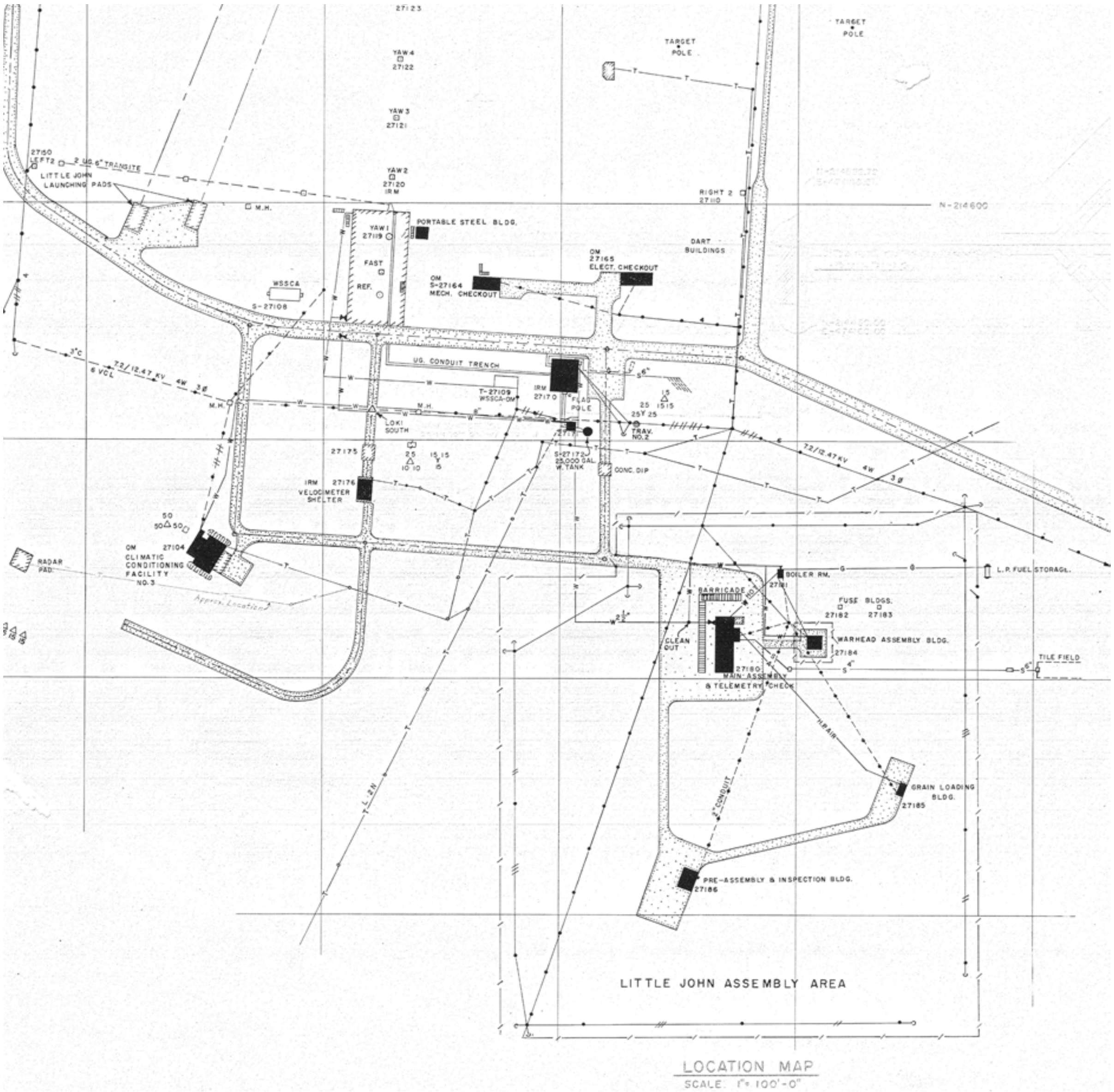


Figure 22. Overview map of the SMR from 1957 architectural drawing showing the Little John Assembly Area and launching pads.

to maintain the spin during flight (Keller 1960:24-25).

The Little John was not manufactured in large quantities as it was issued only to airborne units. Seven Little John units were deployed in 1961, and by 1966 only four of these remained active. As of the late 1960s, two active Little John units were stationed in the south Pacific and two in the continental US (US Army Redstone Arsenal 2014c). It did not play a significant role in any major conflict, and though it performed as intended, it was not a particularly influential weapon system.

Figure 23. Little John launch at the SMR Property 27100 Launch Pad, June 1958 (*US Army photo)*.

End of Service

The XM51 Little John was in service from 1961 to 1969, when it was declared obsolete and pulled from service. The Army did not officially state the reasons for discontinuing the Little John, but the decision was probably influenced by the development of low-yield nuclear shells compatible with standard 155 mm and 203 mm howitzers. The Little John did not exceed the range of conventional artillery guns, and the development of these nuclear projectiles during the late 1950s and early 1960s largely superseded the role of the Little John as a nuclear delivery device (McKenney 2007:230). Additionally, much more sophisticated guided tactical missile systems which offered superior accuracy and versatility over the unguided Little John were becoming available by the late 1960s.

6.12 Redeye Program 1958 to 1972

The Redeye was developed as a lightweight, shoulder-fired anti-aircraft missile that would serve as a partner system to the self-propelled Mauler anti-aircraft system (see Figure 24). Both systems were envisioned as part of the Forward Area Air Defense (FAAD) concept, which focused on the development of anti-aircraft systems to defend front line troops from attacks by low-flying, high performance jet aircraft and ballistic missiles (Cagle 1968:21). During its service life, it was the smallest guided missile in the Army inventory.

Figure 24. A Redeye launch during testing at WSMR (*US Army photo, courtesy Redstone Arsenal)*.

Background

Throughout the late 1940s and 1950s, defense against the rapidly evolving threat of high-speed aircraft was a primary concern among military planners. In 1955, Convair (the Pomona, California Division of General Dynamics) conducted an unsolicited study for a man-portable anti-aircraft weapon, and by 1956 had created a scale model of the missile along with a detailed presentation of the proposed system. Convair presented the results of their efforts to the Army and Marine Corps in November of 1956 in hopes of securing a contract to develop the system. The system incorporated a bazooka-type launcher and infrared homing system that was similar to the recently developed Sidewinder heat-seeking air-to-air missile. The infrared seeker in the nose of the missile provided the basis for its name. As a result of the Convair presentation, in 1957 the Army published the desired military characteristics for a low-altitude air defense system that was based on the Convair Redeye proposal (US Army Redstone Arsenal 2014d).

The military characteristics of the proposed system described it as an anti-aircraft weapon for defense against low flying aircraft, drones and light aircraft of fixed wing and rotary type (helicopters), effective against targets moving at speeds up to 600 knots, altitudes up to 9,000 ft, and horizontal ranges up to 4,500 yards. The missile was to remain effective against maneuvering targets at the stated speeds and altitudes (Cagle 1974:44). The system would have a high lethality and a single shot kill capability, and would rely on a human operator to visually detect and acquire the target, which simplified the system. Some compromises were eventually made in these characteristics, with the production Redeye being slightly heavier, slower, and less accurate than the original specifications (Cagle 1974:85). However, the system would still be extremely capable of engaging low altitude enemy aircraft, especially for a man-portable system. No equivalent system existed in any military inventory at the time. The Army intended the Redeye would reduce the need to deploy larger, more complicated systems such as the Mauler,

Figure 25. An early launch of the Redeye, location not identified (*US Army photo, courtesy Redstone Arsenal)*.

HAWK, or Nike missiles to provide air defense for troops in combat zones (Cagle 1974:45).

The system was not to exceed 20 pounds, would be easily carried by one man in the field, and would use a solid propellant motor that would not require field maintenance or adjustment (Cagle 1974:44). The military characteristics also called for the system to be rugged and reliability in extremes of temperature, resilient to saltwater exposure, and to remain operational after being stored outdoors, unprotected, for a period of up to two years (Cagle 1974:45).

History of Development

The Army awarded Convair a contract for a one year feasibility study in 1958, which consisted of three test programs: human aspects of the weapon system, infrared signature testing of common aircraft targets, and flight testing of 30 missile prototypes to test guidance and control systems (Cagle 1974:37). The early test vehicles for the program were 2.75 inch FFAR (Folding Fin Aerial Rocket aka Mighty Mouse, developed by the Navy) rockets equipped with Sidewinder infrared seeker guidance systems (Cagle 1974:37). All the 1958 flight tests and infrared signature testing was carried at Naval Ordnance Test Station (NOTS) China Lake, California, which was close to the Convair plant at Pomona, California and convenient for testing. NOTS had also developed the Sidewinder missile and had proper facilities and experienced personnel to work with infrared systems. It was able to provide the aerial targets and aircraft for infrared signature testing as well (Cagle 1974:37). The NOTS firings included both LTV and GTV firings (Cagle 1974:40), which extended into 1959.

Figure 26. An early launch of the Redeye, location not identified (*US Army photo, courtesy Redstone Arsenal)*.

The human aspects of the system were tested at the Human Engineering Laboratories at APG, Maryland. Operator tests to determine the ability of personnel to detect, track and fire at aerial targets were carried out using simulators at Twentynine Palms and Camp Pendleton bases in the spring and summer of 1958 (Cagle 1974:37).

Originally scheduled for delivery in 1961, the feasibility programs were considered complete before all tests had been conducted. Due to funding shortages, the delivery date was pushed to 1962 in 1959. Convair won the Mauler contract in March of 1960, and together the two missile systems were to provide a complete solution to Forward Area Air Defense (FAAD) (Cagle 1974:54). Both programs had many problems, some internal to Convair, but also due to inadequate funding and planning from the Army. The technical difficulties of both systems were underestimated by both the Army and the contractor. In particular, Convair engineers encountered difficulties with the flight stability and the guidance system of the Redeye (Cagle 1974:99). By the time the Mauler project was canceled in 1965, the Redeye missile was just nearing completion of its development, four years behind the original schedule (Cagle 1974:54).

Testing at WSMR and the SMR

Motor qualification tests were conducted at WSMR in 1961, but the majority of the early testing was undertaken at NOTS (Cagle 1974:94). The most significant testing of the Redeye that occurred at WSMR was the integrated engineering test and service test (ET/ST) program that began in September of 1965, with service evaluation tests initiated about two months later. Cagle (1974:136) does not provide much information about these tests, but they were of the Block I design, the first production run of the Redeye missiles. It does not appear that any permanent buildings or structures were built at the SMR in support of the program. Being a small, portable system the Redeye required minimal support facilities to conduct the ET/ST program tests.

Table 8. Summary of Redeye Firings at WSMR from 1966 to 1972.

Year	Type	Total Firings
1966	Redeye Anti-Aircraft	7
1967	Redeye Anti-Aircraft	61
1968	Redeye Anti-Aircraft	93
1969	Redeye Anti-Aircraft	77
1970	Redeye Anti-Aircraft	77
	Redeye ASDP	6
1971	Redeye Anti-Aircraft	29
1972	Redeye Anti-Aircraft	2

According to WSMR firing records, Redeye missiles were fired at the range beginning in 1966 as part of the service evaluation tests. The Redeye service evaluation testing continued to be an active program at WSMR through 1970, with firings conducted at both the SMR and LC-34 (Eckles 2013). Unfortunately, the WSMR firing records do not include a summary of which facilities the missiles were fired, only annual firing totals. Redeye testing quickly drew to a close in 1971-1972 as the replacement Redeye II (Stinger) system was developed (see Table 8).

Deployment and Replacement

Deployment of the Redeye finally occurred in October of 1967 (Cagle 1974:56). Total development costs for the Redeye from the 1958 to 1967 period was nearly $77 million, much more than original cost projection of $24 million. This total also included the Marine Corps contribution of $10.5 million dollars to the program (Cagle 1974:55). Though it produced a serviceable weapon, the Redeye was a very costly and delayed system for the Army.

The Redeye missile itself was 43 inches long and 2.75 inches in diameter, and weighed 15.6 pounds. The total weapon weight, including the launcher, was around 30 pounds (Eckles 2013:28). When fired, the primary motor in the missile would not engage until it was 25 ft away from the launcher in order to protect the operator from the blast of its ignition. The acceleration force of the primary motor engaging also activated the self-arming fuze at about 90 to 150 ft from the point of launch, which provided an extra margin of protection to the operator in the case of a failed or obstructed launch.

Production of the Redeye continued through Block II and Block III series. In 1971, the improved Redeye II was selected as a replacement for the original, and this system became the Stinger missile in 1972. The Redeye missile was widely deployed, and was gradually phased out by the Stinger system during the 1980s and 1990s.

6.13 Mauler Missile 1960 to 1965

The Mauler was envisioned as part of the FAAD concept developed by the Army during the late 1950s and early 1960s. The missile and fire control systems were integrated into an armored vehicle platform as a self-contained system (see Figure 27). It was designed to defend front line troops from strikes by enemy ballistic missiles and strafing attacks from low-flying, high performance jet aircraft. No weapon in the Army arsenal at the time possessed such capabilities. It was intended as a partner system to the Redeye shoulder-fired anti-aircraft missile, capable of engaging targets at higher altitudes and longer ranges than the small, portable Redeye (Wind and Sand 1960:6).

Figure 27. The XM546 Mauler anti-aircraft vehicle system (*US Army photo*).

Background

Efforts to develop an effective air defense weapon for front line combat troops against attacks by missiles and strafing by low-flying aircraft had been initiated by the Army Ordnance Corps following WW II, but the proposed systems were based on conventional artillery weapons and were insufficient against high-speed missile and jet aircraft. The Mauler concept emerged as the best solution against the rapidly evolving aircraft threat during 1957 to 1958 after the cancellation of several more conventional anti-aircraft programs such as the Duster and Vigilante anti-aircraft gun platforms (Cagle 1968:19-20). The Mauler was developed as a companion system to the Convair Redeye, which was under development at the same time and also tested at the SMR (Cagle 1968:21).

The technical requirements of the proposed Mauler system were outlined in February of 1958, at which time management of the project was transferred from Redstone Arsenal to the ARGMA. After an extensive period of proposal review and funding difficulties, the Army awarded a contract for the development of the Mauler system to Convair in 1960. The system was built onto a XM-546 tracked vehicle, which was a modified version of the M-113 Armored Personnel Carrier (24). The Mauler missile was based on a beam-rider guidance system, which used an acquisition radar to detect the target and an illumination radar that tracked the target with

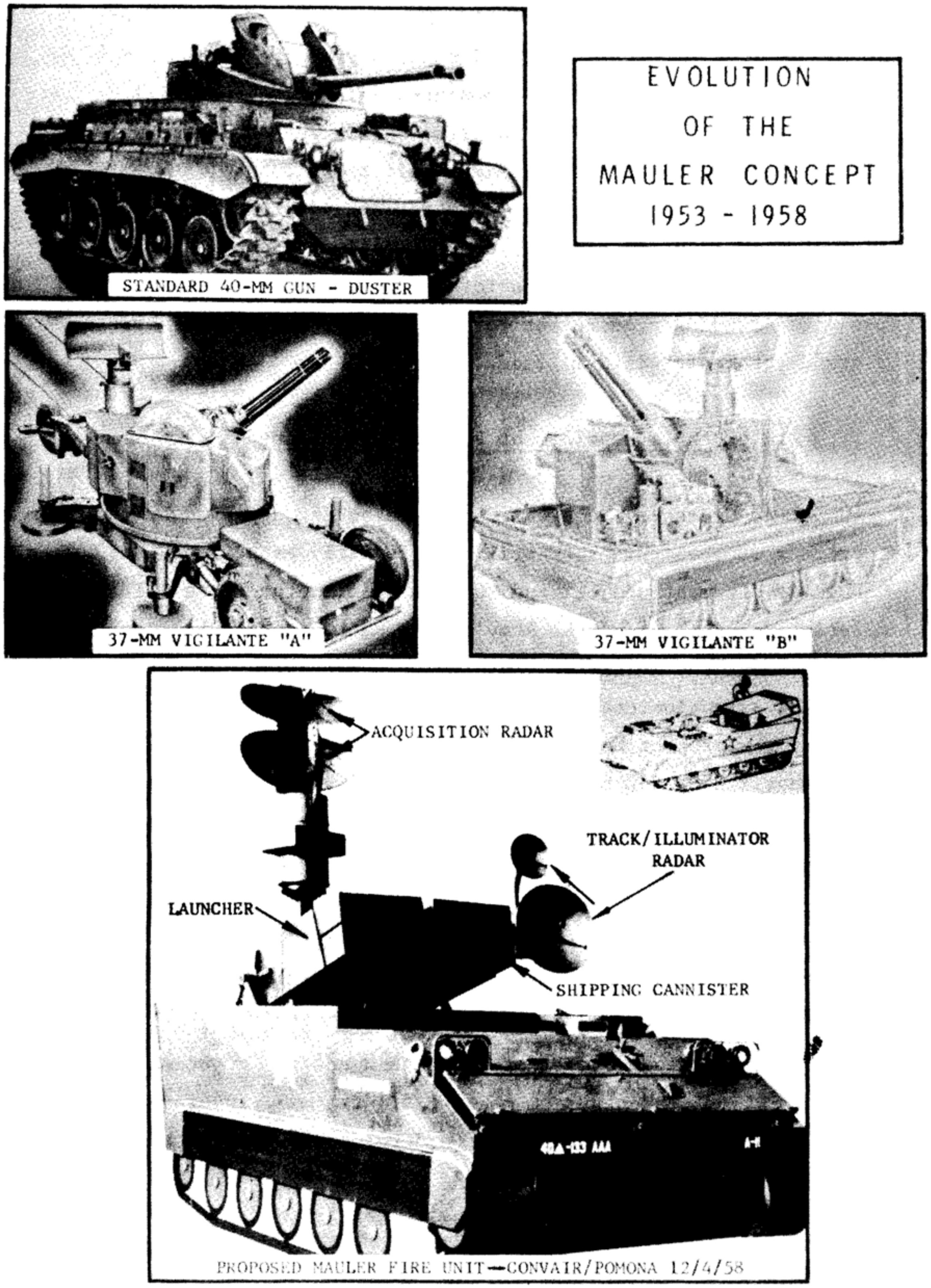


Figure 28. The evolution of the Mauler concept from the Duster and Vigilante anti-aircraft gun concepts (*figure reproduced from Cagle 1968)*.

an infrared beam via a fire control computer (see Figure 28). When launched, the Mauler missile would fly into the illumination beam and track it all the way to the target (Cagle 1968).

Figure 29. A Mauler launch at WSMR (*US Army photo)*.

The short range, surface-to-air Mauler system was unique in that it was contained on a self-propelled vehicle that also incorporated an internal power supply, target and guidance systems, and a complement of multiple missiles (Wind and Sand 1960:6). The single vehicle package of the Mauler was very appealing compared to the complicated, multiple vehicle convoys required for contemporary missile systems such as the Lacrosse and HAWK. Unlike the contemporary Nike systems that were fired from static defense positions, the Mauler was self-propelled and mobile, making it a much more effective system for forward deployment.

Development at WSMR and the SMR

The actual range testing of the Mauler began with LTV launches, which were uncontrolled and unguided Mauler missiles with that were used to test flight characteristics of the missile airframe and motor as well as the operation of the launcher pod, both on and off the vehicle (Cagle 1968). Three LTV firings were conducted at the SMR from late September through December of 1961 (see Table 9). Results from the LTV firings showed that improvements needed to be made, which were incorporated into the follow up Control Test Vehicle (CTV) firings.

The CTVs were guided Mauler vehicles that were flown through basic maneuvers to test the flight characteristics of the missile control systems. The six Mauler CTV firings at the SMR began on December 15, 1961 and extended over a period of ten months (Cagle 1968:171). During these tests, it was found that the firing canisters bulged during the launch, potentially affecting the function of neighboring missile canisters. The missiles also experienced severe wing vibrations and excessive drag during flight, causing one missile (CTV-5) to break apart mid-flight. Another serious issue was the tendency of the target illumination radar to lose target lock upon firing due to the blast from the launch (Cagle 1968:172; Parsch 2002b). In order to simplify the guidance circuitry in the missile, the Mauler was not designed to automatically reacquire target lock, so when the target lock was lost upon launch the missile continued to fly unguided.

The commanding general of WSMR had recommended to ARGMA in 1961 that a new launch area needed to be constructed at WSMR to support testing beyond the CTV stage, which would cost about $288,750. The Army finalized these construction contracts in April of 1962 (Cagle

Table 9. Summary of Mauler Firings at WSMR from 1960 to 1965.

Year	Type	Total Firings
1960	Mauler Anti-aircraft	4
1961	Mauler Anti-aircraft	31
1962	Mauler Anti-aircraft	7
1963	Mauler Anti-aircraft	16
1964	Mauler Anti-aircraft	23
1965	Mauler Anti-aircraft	16

1968: 151-152) and the new launch area, named Launch Complex 34 (LC-34), was the site of all remaining Mauler testing (Eckles 2013:8, 28). By late October of 1962, the Convair Mauler test group moved from the SMR to the newly constructed LC-34 for the beginning of the GTV firing program (Cagle 1968:173). The GTV was essentially a complete prototype of the actual tactical Mauler vehicle that would be used in the field. The prototype was assigned the military designation of XMIM-46A (Parsch 2002b).

The first firing of the Mauler missile from the GTV prototype took place at LC-34 on June 27, 1963, which was unfortunately eight months behind the project schedule. This firing resulted in the same loss of target lock as previous firings. The second GTV launch was delayed until October of 1963 due to a variety of technical problems, but also experienced the same loss of target lock upon launch (Cagle 1968:190).

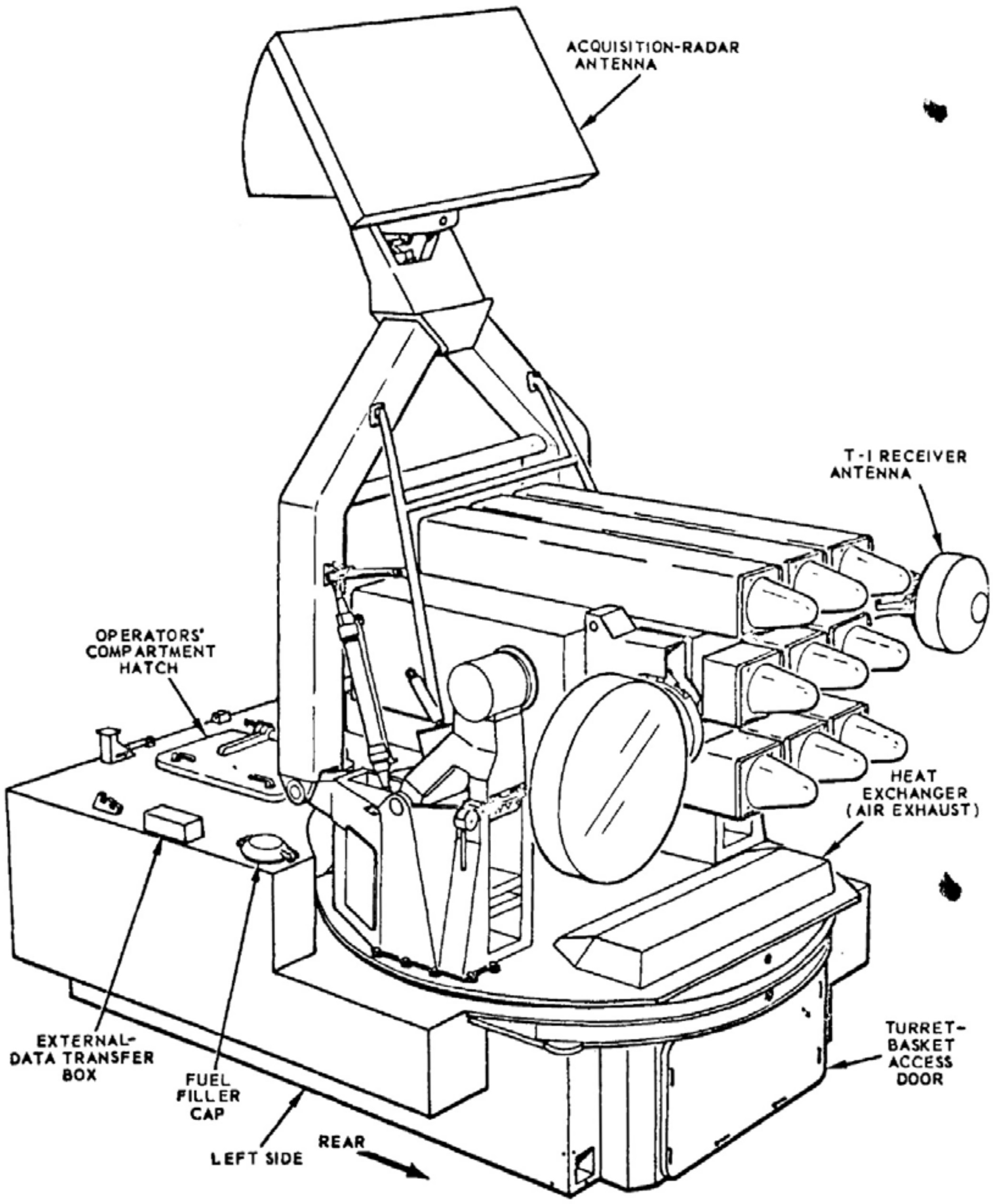
Problems and Cancellation

Despite being classified as high priority project by the Army, the development of the system suffered many setbacks due to funding gaps and shifting levels of commitment in the Army high command (Cagle 1968:57-58). The futuristic system was beyond the technology available and suffered numerous problems in development, which prevented it from advancing beyond the prototype stage. The fundamental problems with the Mauler development are summarized by Cagle (1968:168) as:

> Beyond the backdrop of sporadic funding and constant program adjustments, the development of the engineering model weapon system floundered in a maze of complex electronic and packaging problems that clearly skirted the periphery of existing technology.

Problems with the Mauler prototype mostly stemmed from the mounting of the guidance system and launcher on the same vehicle. The blast, heat, and smoke of the launch caused the illumination radar to lose its target lock, rendering the guidance system useless.

After the unsatisfactory results of the 1963 GTV launches at LC-34, further testing was delayed and the entire Mauler program was reoriented as a Feasibility Validation Program (FVP) rather than as a tactical weapon development program (Cagle 1968:200; Parsch 2002b). The Mauler FVP was conducted into 1965 with additional launches at WSMR and successfully demonstrated the functionality of many aspects of the system. However, the program could not recover from the negative impressions it had created during the earlier testing phases. After a final evaluation, the Secretary of Defense approved the termination of the Mauler program on July 19, 1965. Nearly $200 million had been spent on the program from 1958 to 1965 (Cagle 1968:248). With the termination of the Mauler, the Army developed the Chaparral and Vulcan weapon anti-aircraft systems as interim solutions for FAAD deployment.



(U) R&D Prototype Weapon Pod - 1962-63

Figure 30. Schematic of the Mauler weapon pod prototype (*reproduced from Cagle 1968)*.

6.14 Shillelagh Anti-Tank Missile 1961 to 1976

Figure 31. A Shillelagh missile being fired from the main gun of the M551 Sheridan Tank (*US Army photo)*.

The Shillelagh was a guided, anti-tank missile that was fired from a conventional 152 mm tank mounted gun, the first such design completed by the US. Officially designated as the MGM-51, it was designed in concert with the M551 Sheridan light tank as a complete weapon system (see Figure 31). The 152 mm gun of the Sheridan was designed so that it could also fire conventional rounds through the same rifled barrel to improve its versatility. The Sheridan light tank could be deployed via parachute from a C-130 and was capable of "swimming" across rivers, feats not possible with larger and heavier main battle tanks (Beatty 1963:51). The system was named after a traditional Irish wooden walking stick that also served as a cudgel.

History of Development

Similar to the Dart missile, the development of the Shillelagh and Sheridan tank were undertaken during a significant effort by the US military to modernize anti-tank weaponry during the 1950s and early 1960s. This effort was initiated by experiences with improved Soviet tanks during the Korean War and sustained by the Cold War arms race. As tank armor improved, military planners sought new ways to defeat it without resorting to excessively large guns that would require ungainly armored vehicles to support them. The rocket powered Shillelagh missile did not require a large gun to be effective and the system could be mounted to comparably light vehicle (Wind and Sand 1964:1). The Shillelagh allowed a lightweight Sheridan tank the capability of engaging and destroying much heavier tanks, giving it firepower disproportionate to its size. The 152 mm gun that fired the Shillelagh could also fire caseless M409 High Explosive Anti-Tank (HEAT) rounds, which used a shaped charge warhead to penetrate armor in lieu of the large caliber and high velocity provided by a heavier gun. A typical Sheridan would carry eight Shillelagh rounds and 20 M409 conventional rounds (Parsch 2002c).

The Shillelagh used an optical based guidance system that simply required the operator to keep the optical crosshairs on the target, and the guidance system would relay commands to the missile and maneuver it to the target. This type of guidance is referred to as Semi Automatic Command Line Of Sight (SACLOS), and it was a significant technological innovation that would also be used with the later TOW and Dragon systems.

Figure 32. Captain Daniel E. Duggan guides AARAV Sheridan tank prototype into position at the SMR 27190 Launch Pad, April 1964 (*US Army photo)*.

The Shillelagh missile was developed as part of a 1958 to 1959 Army study for a new tank primary armament system. The Shillelagh would be fired from the same barrel as more conventional anti-tank rounds, and the system would rely on an infrared guidance system that could be used for both projectiles. Aeronutronic, a subsidiary of Ford Motor Company, was selected as the prime contractor for the project in 1959. The missile and guidance system was very advanced at the time, and the project experienced many setbacks, which prevented the Shillelagh from being released as a combat ready system until 1967.

The Shillelagh missile was designated as the MGM-51 and carried a 15 pound shaped charge warhead. The original missile had a line-of-sight range of about 6,600 ft, making it a short range weapon. It also required a minimum range or about 2,400 ft for the guidance system to operate, which created a fairly restricted engagement distance for the system (Parsch 2002c). To address this situation, a version of the Shillelagh with an improved range of 10,000 ft, called the MGM-51B, was developed at WSMR during 1965 to 1966. Modifications to the keyway system that prevented the Shillelagh from spinning as it exited the rifled Sheridan barrel resulted in a third variant, the MGM-51C (Parsch 2002c).

Figure 33. The just-delivered AARAV at the SMR, April 1964. Properties 27108 and 27164 are visible in the background (*US Army photo)*.

Testing at WSMR and the SMR

The majority of the Shillelagh development occurred at the SMR, and the first guided flight of the missile occurred at the SMR on September 15, 1961 (Delong et al. 1984:65). Additional flight testing of the missile continued at SMR throughout 1962 (Delong et al. 1984:68). Final developmental flight testing of the missile continued from 1963 to 1964, with the first firing by a military gunner occurring on September 23, 1964. The system was approved for production by Army Missile Command (MICOM) in November of 1964, and continued until 1971. The first fielding of the Shillelagh/Sheridan weapon system was in June of 1967 (Delong 1984:76).

The SMR was also the location of Shillelagh testing conducted as part of the "fly before buy" program, which flight tested a sample of 18 missiles from every lot of 1,650 produced. If less than three failures occurred in the sample, the Army would purchase the entire lot (Delong 1984:79). The final round of the fifth proof and acceptance phase of the missile was fired at the SMR on May 24, 1971, and a Shillelagh missile was presented to WSMR officials for display in the Missile Park (Poisall 1971:1). Since April 20, 1961 over 1,200 Shillelagh missiles were fired at the SMR (Poisall 1971:6; Missile Ranger 1971a). Early tests of the Shillelagh were from a special launcher that fired the rounds on a vertical trajectory (Jack Dage personal com-

Table 10. Summary of Shillelagh Firings at WSMR from 1961 to 1976.

Year	Type	Total Firings
1961	Shillelagh	18
1962	Shillelagh	28
1963	Shillelagh	82
1964	Shillelagh R&D	84
1965	Shillelagh	83
1966	Shillelagh ER	28
	Shillelagh Proof	56
1967	Shillelagh C	83
	Shillelagh ER	10
	Shillelagh P	41
1968	Shillelagh D	111
	Shillelagh C	228
1969	Shillelagh C	230
	Shillelagh ER	5
	Shillelagh P	9
1970	Shillelagh C	209
1971	Shillelagh C	96
1972	Shillelagh C	5
1973	N/A	0
1974	Shillelagh Surv	168
1975	N/A	0
1976	Shillelagh Low Altitude Parachute Extraction System (LAPES)	9

munication 2014). In 1964, the Armored Airborne Reconnaissance Assault Vehicle (AARAV), a prototype of the Sheridan, (see Figure 33) was delivered to the SMR as a Shillelagh launch vehicle (Wind and Sand 1964). Historic photos suggest that two concrete platforms recorded during the field inventory (Features 241 and Feature 242) were used for the Shillelagh launches around 1964 (see Figure 36). In 1966 a large concrete platform and ramp (Property 27215) was constructed at the northwest corner of the 27190 launch pad and is identified as the Shillelagh launch pad in WSMR realty data. This platform likely served as the launch location for the 1966 and later Shillelagh firings. For the 1964 firings, a sandbag blast barricade was present behind the launch area. This was replaced by a large wood and earth blast barricade, Property 27216, which was constructed in 1966. Based on its age and association with the Shillelagh launch platforms, it can be assumed that it was also constructed for the Shillelagh testing. No other permanent structures or buildings are known to have been built for the Shillelagh testing at the SMR, and existing buildings such as Properties 27166 and 27170 were used to support the program. These existing facilities were sufficient to provide support for the mobile, tank-based system. The instrumentation needs for the Shillelagh were also slightly different. As a command line-of-sight system, the most important instrument was a bore line camera that monitored the missile trajectory in relation to the gun barrel. A modified HAWK illumination radar was also used to track the missile during testing. The fixed camera instrumentation net-

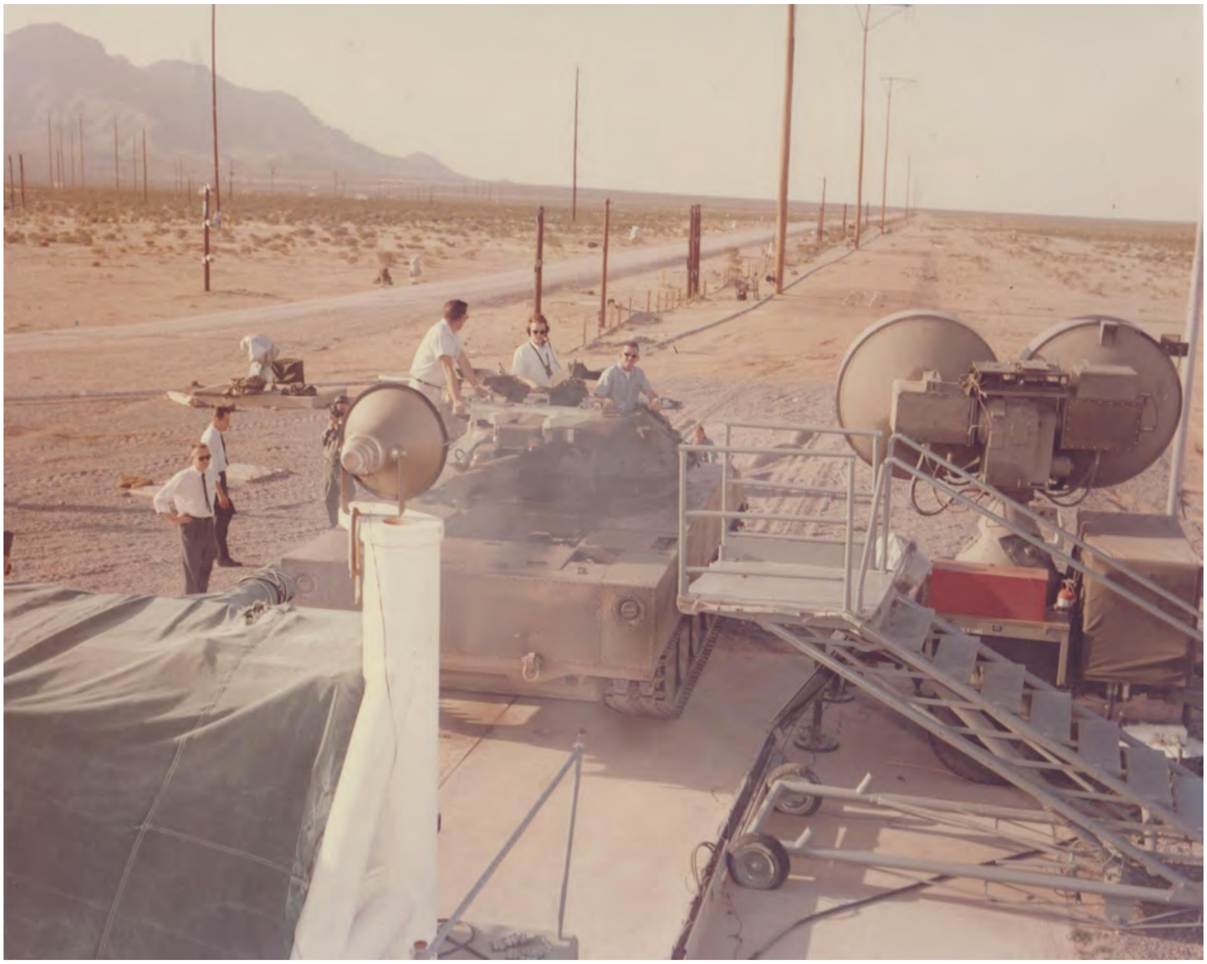


Figure 34. The AARAV on the SMR launch platform, April 1964. The Yaw line and aerial camera poles stretch downrange to the north. Radar at right is modified HAWK radar used as instrumentation in the Shilllelagh testing (*US Army photo)*.

work at the SMR was of limited use in the Shillelagh testing, and it appears that during this period the camera shelter network at the SMR entered into obsolescence (Jack Dage personal communication 2014).

Although the WSMR firing records do not contain information on where firings occurred (only annual summaries), photography on file at the WSMR Museum Archives suggests that the majority of Shillelagh testing took place at the SMR. The first firings occurred in 1961 and the program was very active in the years 1963 to 1971 (see Table 10). Most test phases of the Shillelagh were completed at WSMR and the SMR, including the Component Development, Engineering Design, Engineering Test, Initial Production, Product Improvement, and Proof and Acceptance stages (Poisall 1971:6).

Problems and End of Service

During the developmental testing of the Shillelagh missile, it had proven itself to be an accurate anti-tank weapon, with its guidance system capable of scoring hits on moving targets.

However, field operators soon found that the missile guidance system could shift into misalignment by travel over rough terrain or even by the recoil of the gun itself. Due to the misalignment, the guidance system would fail to operate until a manual alignment procedure was undertaken, which was difficult to perform under combat conditions. Due to the reliability issues with the Shillelagh guidance systems, the Army decided against issuing it with the Sheridan tanks deployed to Vietnam in 1969, instead relying on the recently developed HEAT conventional rounds for the Sheridan's 152 mm gun. The Shillelagh missile was deployed with the Sheridan tank in other locations across Europe, South Korea, and the US (Delong 1984:101).

Figure 35. Some targets used for the Shillelagh testing were simple wood frames filled with wire mesh (*US Army photo, courtesy Jack Dage)*.

In addition to the reliability issues of the Shillelagh MGM-51, there were also problems with the M551 tank platform that supported it. The biggest liability of the Sheridan was that it was based on an aluminum hull in order to reduce vehicle weight. The aluminum hull and armor was capable of stopping heavy-machine gun rounds, but was susceptible to rocket-propelled grenades and land mines. The caseless ammunition used in the 152 mm gun exacerbated this problem; compared to conventional cased munitions, these rounds were easily ignited if the hull was breached explosively. The combination of these factors resulted in the total loss of multiple Sheridan tanks and their crews during the Vietnam War. Although the Sheridan offered excellent mobility, extended range, and high speeds, its lack of survivability under combat conditions created a negative impression of the vehicle among Army commanders. As a result, in 1978 the Army began to gradually phase out both the Sheridan and the Shillelagh missile. Since there was not a suitable air-transportable replacement, both remained in service with the 82nd Airborne Division into the mid-1990s, and the Sheridan/Shillelagh was deployed during Operation Desert Storm. Although approximately 88,000 Shillelagh missiles were produced, the only ones fired during combat were a small number during the Gulf War. The Shillelagh was completely removed from the Army inventory by the late 1990s.

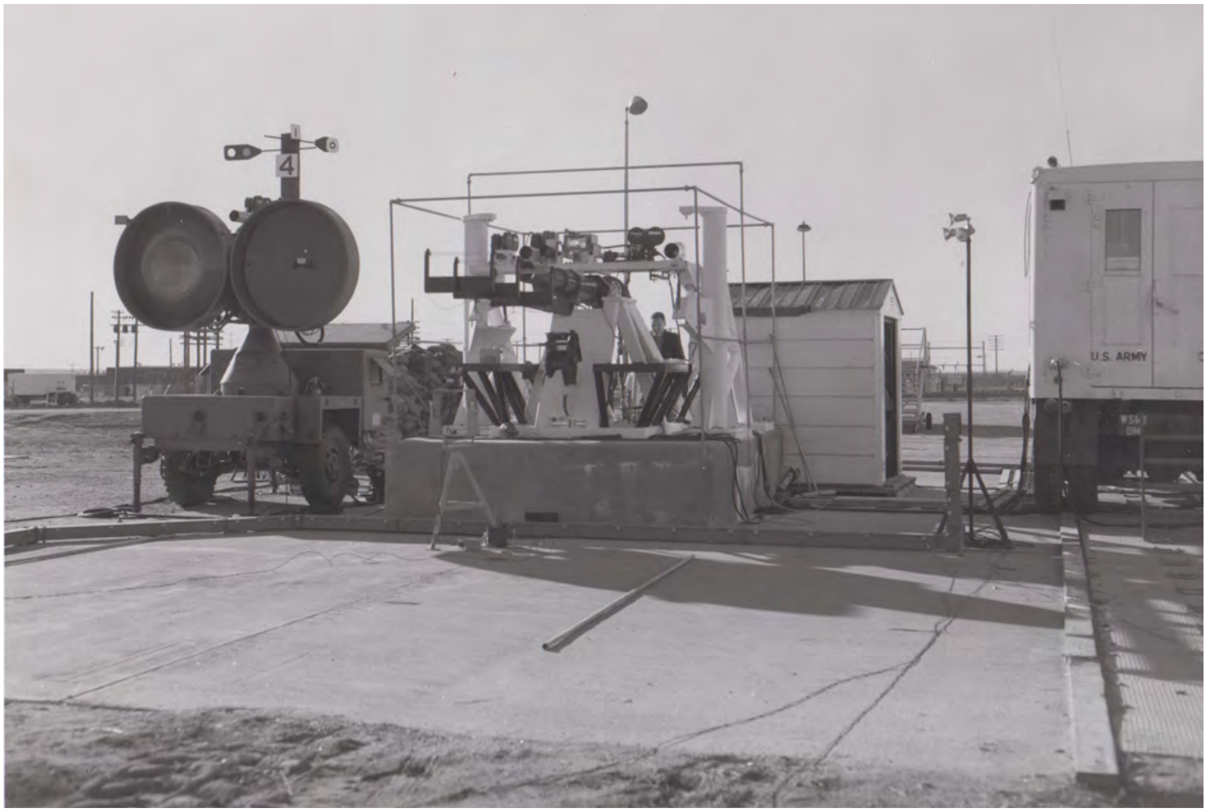


Figure 36. The Shillelagh fixed launcher installed at the north end of the 27190 Launch Pad, early 1960s. HAWK radar at left (*US Army photo, courtesy Jack Dage)*.

The Army also equipped M60 tanks with the Shillelagh missile, the first firing of which took place on October 2, 1965 (Poisall 1971:6). The Shillelagh-equipped M60 was deployed in 1975, but problems with the missile and turret caused these units to be phased out by 1981 (DeLong 1983:104-105). The Shillelagh was also incorporated into the MBT-70 prototype, a complicated joint US and German project that was initiated in 1965. A simplified MBT-70 prototype, the XM-803, first fired a Shillelagh missile at the SMR on April 18, 1969 (Poisall 1971:6). Testing of the XM-803 mounted Shillelagh system continued through 1971 (Missile Ranger 1971b). However, the MBT-70/XM-803 tank was never completed due to a series of cost overruns and design issues, and the project was canceled in 1972 (DeLong et al. 1984:118). The mobile TOW missile system, developed at WSMR and the SMR during the mid-to-late 1960s, served as the primary replacement for the Shillelagh. Additionally, improvements to standard tank projectiles such as the Copperhead, tested at the SMR during the 1970s, provided a more versatile solution to the problem of guided anti-tank weapons.

6.15 TOW Missile 1963 to 1977

Figure 37. The TOW mounted on a tripod, one of several possible mounting configurations (*US Army photo, courtesy Redstone Arsenal)*.

The TOW Heavy Anti-tank Assault Weapon (HAW) is a lightweight, mobile guided missile system developed by the Army during the 1960s (see Figure 37). Its development was contemporary to that of the Shillelagh, and its optically based guidance system was also similar to that system. However, the portable TOW proved to be more rugged and versatile than the Shillelagh and has proved to be a much more influential weapon system.

History of Development

Early preliminary studies for the HAW were conducted in 1958 as an outgrowth of the Dart program. After the cancellation of the Dart ATGM project, the Army used the French SS-11 and ENTAC systems and the 106 mm recoilless rifle as interim anti-tank weapons during the 1960s. However, the development of a guided heavy anti-tank weapon remained an important strategic priority for military planners, as evidenced by the development of the Shillelagh missile. During 1960-1961, the Army conducted a research program at APG to determine the best technological solution for a universal HAW system. From this study, the initial specifications of the TOW system emerged.

The TOW development was considered a high priority program, and in 1961 the Army Ordnance Division briefed 40 contractors on the program specifications and requested concept systems to be developed. The concept systems would be unfunded projects developed at the contractors' own expense. The Ordnance Corps also initiated an internal developmental program to act as an experimental control to which the contractor programs would be compared. Eighteen project proposals were received in response, and after careful evaluation, the Army review committee narrowed the proposals down to those from three companies: Hughes Aircraft Company, Martin Marietta Corporation, and McDonnell Aircraft Company. Each of these companies was awarded a six month contract to develop a basic prototype system that would demonstrate the feasibility of their proposal (Cagle 1977:18).

Based on the submitted proposals, the tentative military requirements for the system were established in March of 1962. It was to have a first-round hit probability of 90 percent up to 1,500 meters (m), and 75 percent hit probability at ranges up to 2,000 m. The system was to demonstrate at least a 95 percent reliability rate, and weigh less than 200 pounds. The developmental program would include three types of rounds: an anti-tank round with the 6 inch, 14 pound warhead used with the Shillelagh missile; a soft target round; and a chemical round. The system would also be capable of being mounted and fired from vehicles, a ground position, or from a helicopter (Cagle 1977:18). The program requirements were later modified to include night-firing capability and testing of a range extension to 3,000 m (Cagle 1977:40-41).

Figure 38. Photo sequence of a jeep mounted TOW launch (*US Army photo)*.

The prototype demonstration of the three finalists was conducted at APG in July of 1962, and the selection committee found the Hughes Aircraft prototype to be the best candidate. However, it was apparent that the 6 inch Shillelagh warhead requirement would make the system exceed the maximum weight requirement, and the Hughes developmental program was re-directed to design the system around a 5 inch warhead. The internal Army Ordnance Corps program did not develop a comparable system, and further developmental efforts were halted (Cagle 1977:21). Due to a reorganization of Army missile programs, supervision of the program shifted to the newly established MICOM later in 1962. The TOW development program was formally initiated in 1963 by Hughes Aircraft. Six experimental flight tests of the TOW began on September 18, 1963, and guided test firings were conducted from November of 1963 to December of 1964 at the MICOM facility at the Redstone Arsenal, Alabama (Cagle 1977:31).

Unlike the predecessor Dart and SS-10 systems that relied completely on human guided control, the TOW was more similar to the Shillelagh and merely required the operator to track the target with the optical crosshairs and pull the trigger to fire (Cagle 1977:14). While in flight, the missile dispensed hair-thin wires from two 5 inch spools at the rear base plate of the missile. Each spool contained 7,000 ft (2,135 m) of wire, enough to cover the maximum range of the missile. The missile guidance signals would be transmitted via these wires, providing a hard-wired link that was essentially impervious to jamming or countermeasures. The missile would transmit position data relative to the line-of-sight back to the launcher via the wires, and a targeting computer would send adjustments to the missile to bring its course and the line-of-sight together into the same line. As long the operator kept the optical sight on the target, the system would guide the missile to an intercept course with the target (Cagle 1977:15).

The warhead-equipped TOW missile was 5.85 inches in diameter and 44.3 inches long, and

Figure 39. Photo of a TOW launcher installed on launch platform at the SMR, December 1969 (*US Army photo)*.

weighed just over 35 pounds. The shipping container the missile was carried in also served as part of the launch tube, which facilitated rapid reloading of the system and firing rates up to three times a minute. The launcher could be easily mounted to a variety of light vehicles and could be mounted on a tripod for ground use (see Figure 38). The missile was equipped with two motors. The first motor launched the TOW from a 152 mm tube at approximately 250 ft per second, and the second booster engaged at about 40 ft from the launcher to ensure gunner safety. It was designed to be effective at point blank ranges (a minimum safe distance for the operator was 100 m) to 2,000 m, with later versions capable of ranges out to 3,000 m (Cagle 1977:26-27).

Testing at WSMR and the SMR

WSMR was one of several locations where TOW testing was conducted. Other test locations were the Redstone Arsenal, Alabama and Fort Greely, Alaska. An additional 20 TOW missiles were fired by the Marine Corps at Twentynine Palms, California.

Non-firing field tests were conducted at WSMR in December of 1966, and the WSMR flight

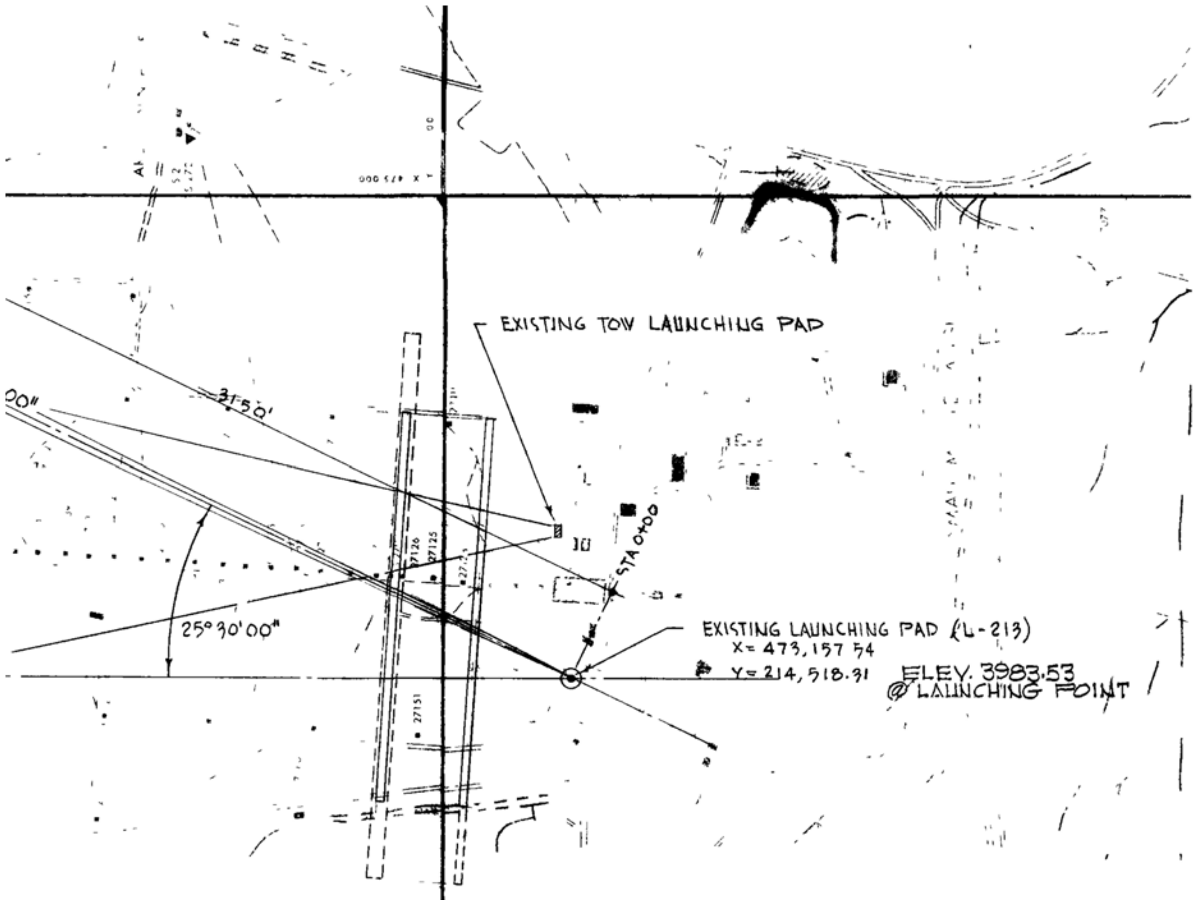


Figure 40. Location of TOW launch pad at the SMR as indicated on overview map included with 1966 architectural drawing for targets.

tests of the TOW began in March of 1967, with 32 rounds fired through July. These early tests at WSMR and elsewhere showed a limited reliability (67 percent) of the TOW, resulting in a suspension of testing to address problem areas (Cagle 1977:71). Tests at WSMR resumed in December of 1967 and continued through 1968, with some additional firings in 1969. Additional limited tests of the TOW continued at WSMR through the 1970s, with a series of tests for the TOW Night Sight modification conducted in 1976 and 1977, and testing of a vehicle mounted TOW in 1977 and 1978 (see Table 11).

While WSMR firing records do not contain data about firing locations, archival photography and maps included in architectural drawings demonstrate that TOW equipment and a launch area were established at the SMR (see Figure 40). It is also likely that additional tests took place elsewhere on the range, but the SMR would have been a natural location as it was used extensively in the testing of the Shillelagh missile, which was ongoing from 1966 to 1968. A dedicated launching pad for the TOW is indicated on a 1966 overview map of the SMR, and this pad remains today at the SMR (Feature 248). No other TOW dedicated facilities are known to have been established at the SMR. It is likely that the program shared the existing range facilities with the Shillelagh program, and as a lightweight, mobile system, little additional infrastructure would have been required to support the tests.

Table 11. Summary of TOW Firings at WSMR from 1967 to 1978.

Year	Type	Total Firings
1967	TOW	46
1968	TOW	13
1969	TOW	12
1970	N/A	0
1971	TOW	2
1972	TOW Night Sight	1
1973	N/A	0
1974	N/A	0
1975	N/A	0
1976	TOW Night Sight	42
1977	TOW Night Sight	22
	TOW SSTL	23
	Improved TOW Vehicle	58
1978	Improved TOW Vehicle	6

Deployment

Completion of a production version was anticipated by February of 1965, but typical of many sophisticated systems of the 1960s, the program encountered many unexpected developmental problems and funding shortfalls. As a result, a ground based TOW system was not approved for limited production until April of 1968. As of this date, over $96 million had been invested in the system, with additional investment of $6 million required to finalize the production system. This was double the original 1963 program cost estimate of $51,377,000 (Cagle 1977:40).

The release of the system to operational field units did not occur until 1970, when three TOW training battalions became operational. The system served as a direct replacement for the French ENTAC and M140 106 mm recoilless rifle (Redstone Arsenal 2014e). During the spring of 1972 in Vietnam, the TOW became the first guided missile to be fired by US ground forces during combat. The system proved itself to be very effective during the Vietnam War, and was also fitted to helicopters as an air-to-ground missile (McInnish 1972). The prototype airborne TOW system was also very effective in Vietnam, and according to Hugh McInnish, the chief airborne TOW engineer, the system "…never failed to destroy a target once seen" (Redstone Arsenal 2014e).

The TOW system, along with numerous variants, continued to be a mainstay weapon for the Army and Marines well into the 1990s, seeing service in Vietnam, the Gulf War, Afghanistan, and Iraq. When the Bradley and Humvee were introduced, the TOW missile was adapted for use with these vehicles as well. Now produced by Raytheon, the system remains in production and a wireless variant is currently in production. It has been widely adopted (and reverse-engineered) by numerous nations around the world. It is likely the most successful system to have passed through the SMR.

6.16 Dragon Anti-Tank Missile 1965 to 1973

Figure 41. The Dragon missile and launcher (*US Army photo, courtesy Redstone Arsenal)*.

The Dragon is a lightweight guided anti-tank missile that can be carried by a single soldier in the field (see Figure 41). The origins of the M47 Dragon are contemporaneous with those of the TOW. Both systems were envisioned as part of a family of light, versatile anti-tank systems that would be the next generation replacements for the French SS-10 and ENTAC missiles and recoilless rifles that were in use during the 1960s. The Dragon was conceived as a Medium Anti-tank Weapon (MAW), as opposed to the HAW designation of the TOW (Cagle 1977:10). In a dichotomy similar to the anti-aircraft Redeye/Mauler systems, the Dragon would serve as a light, man-portable system with a shorter range than the larger TOW.

History of Development

The development of a MAW system originated with the Army Ordnance Command in 1959, and by 1961 Douglas Aircraft had submitted a proposal for a prototype system. The Army issued the desired military characteristics for the system in 1962. Similar to the TOW, the development of the MAW was opened up to competitive proposals from the industry in 1962; 19 proposals were received. Also in 1962, the project was transferred from Army Ordnance to MICOM as part of a re-organization of Army missile program management. A proposal submitted by Douglas (now McDonnell-Douglas) was selected for an additional one year exploratory development contract (US Army Redstone Arsenal 2014f). At the same time, MICOM initiated its own internal program for a MAW in order to provide a gauge to measure the success of the McDonnell-Douglas development.

The dual McDonnell-Douglas and MICOM exploratory programs were completed in 1965, with the McDonnell-Douglas program considered the best technical solution. The MICOM MAW program was re-oriented towards improving the existing Light Anti-Tank Weapon (LAW) system. An engineering contract for the system was awarded to McDonnell-Douglas in 1966, and the MAW program was officially named the Dragon in 1967. The first unguided Dragon missile was fired at Cape Canaveral in 1967, and additional test flights of the system occurred at the Redstone Arsenal where the first manned firing of the missile occurred in September of 1968. The Dragon program also incorporated night image intensifier and thermal imaging sights, which were tested through the late 1960s and early 1970s. By 1970, the system had advanced into the early production prototype stage (Missile Ranger 1971c; US Army Redstone Arsenal 2014f). The Army awarded a $12,233,000 production contract for the Dragon to McDonnell-Douglas in 1972 (Missile Ranger 1972a).

Table 12. Summary of Dragon Firings at WSMR (*WSMR Museum 2014)*.

Year	Type	Total Firings
1972	Dragon	64
1973	Dragon NS	32

The Dragon MAW possessed a maximum range of about 1,000 m, significantly less than the 3,000 m range of which the TOW was capable. But at around 30 pounds total weight, the Dragon was light enough that it could be carried by a single man in the field, making it more portable than the TOW. The operation of the Dragon was similar to that of the TOW as it used a similar optically based, wire guided system that required a line-of-sight with the target. As long as the operator kept the target in the optic crosshairs, the missile would be guided onto the target. As it launched, an infrared flare was ignited at the rear of the missile, which the optic and target computer tracked and calculated against the position of the crosshairs. The missile course would be corrected via the wire link, bringing its flight path in line with the optic line-of-sight (Missile Ranger 1971c; US Army Redstone Arsenal 2014f).

The Dragon was shoulder fired by an operator in a seated or kneeling position, with the front end of the launch tube supported by a folding bipod. In order to prevent injury to the operator, the missile motor burned out while still in the tube, essentially coasting on towards the target. The launcher tube was smooth bore and disposable, also serving as the transport container of the missile. The optic and tracking computer were reusable and simply detached from the launcher tube after firing. The 140 mm caliber Dragon missile was spin-stabilized in flight, and its exterior was equipped with 32 pairs of small booster motors which were fired to correct the course of the missile and sustain its flight downrange. The firing of these small boosters caused the Dragon to make a distinctive popping sound as it moved downrange. Equipped with a powerful shaped charge of high explosive, the missile was capable of defeating all forms of tank armor known at the time of its release (US Army Redstone Arsenal 2014f).

Testing at the SMR

By the time it reached WSMR, the Dragon was relatively far along in its development, most of which had taken place at the Redstone Arsenal facility in Alabama (Missile Ranger 1971c). WSMR firing records note that the Dragon was only fired during 1972 and 1973 (see Table 12). While WSMR firing records do not contain data about firing locations, former Copperhead project officer Jack Dage identified the SMR as the primary location for these tests. The launch location for the Dragon testing at the SMR is unknown, but the tests were probably co-located with the TOW (Feature 248) given the similarities between the two systems. Some optics and training and support equipment were interchangeable between the two systems, according to Cagle (1977). The portable system would have required minimal support facilities, and personnel and equipment for the Dragon were probably housed in the existing buildings at the range.

Deployment and Legacy

The Dragon was released in 1975 and was first fielded in that year by American forces in Europe. The system was the primary replacement for the 90 mm recoilless rifle (Missile Ranger 1971c). Despite providing a powerful and lightweight anti-tank weapon, the system was not

Figure 42. The substantial blast and shockwave of the Dragon upon firing, May 1975 (*US Army photo, courtesy Redstone Arsenal)*.

particularly well-received by soldiers. Firing the shoulder-balanced missile subjected the operator to substantial blast and noise, making it hard to keep the optical crosshairs on a target (see Figure 42). Although designed as a recoilless system, the launch blast was still sufficient to cause an operator to flinch and inadvertently ground the missile. The shift in weight on the operator's shoulder as the missile left the launcher tube also could cause the crosshairs to drop. The 1,000 m range of the Dragon also kept the operator exposed to return fire as the missile was guided to the target. Compared to the TOW, the Dragon was more difficult to hit targets with and a much riskier proposition for the person manning the launcher.

Despite these limitations, the M47 Dragon remained in service with the Army for nearly 20 years, and the system was deployed alongside the TOW during the Invasion of Grenada and the first Gulf War. The system was also sold to various foreign militaries, including Iran, Israel, and several Western European countries. Versions with improved armor penetration capabilities, the Dragon II and Super Dragon, were introduced in the 1980s and early 1990s. The next generation of MAW, the Javelin, was also developed during the 1980s and early 1990s and began to the replace the Dragon in 1996. The Javelin has a true target-lock, fire-and-forget capability, allowing the operator to move under cover after firing. Although it has been phased out, the Dragon was significant as the first anti-tank weapon in its size class offering a semi-automatic guidance system (US Army Redstone Arsenal 2014f).

6.17 Copperhead Program 1972 to 1984

Figure 43. An inert Copperhead round impacts against an M-47 tank target at the SMR (*US Army photo)*.

The M712 Copperhead Guided Projectile is a cannon-launched, 155 mm artillery projectile that guides itself onto a laser designated target, and was the first "smart" artillery round ever developed (see Figure 43). Primarily an anti-tank round, it is fired from a standard 155 mm field artillery howitzer or 155 mm gun equipped tank. The Copperhead is essentially an artillery round equipped with guidance seeker and control fins that allow it to maneuver in flight. It is not rocket-powered; rather, it is propelled by the propellant charge igniting in the gun chamber and barrel like a standard artillery round. The Copperhead flies to the apex of its ballistic arc, at which point its guidance system is activated and the laser seeker locks onto the laser-designated target. The control fins and tail are then used by the guidance system to guide the round onto the target (McKenney 2007:286-287).

Background

The Copperhead guided round is 54 inches long and weighs about 138 pounds, making it longer and heavier than a standard 155 mm artillery projectile. The Copperhead is a substantial projectile; for comparison, the TOW missile weighs just over 35 pounds. It is equipped with a HEAT warhead that contains almost 15 pounds of Composition B high-explosive. The round consists of three sections: a forward section that contains the guidance seeker and associated electronics, a middle section that contains the warhead, and a control section that contains the fold-out fins and wings that deploy mid-flight to guide the round onto the target. A forward operator must identify the target using a laser. This is accomplished with either a Laser Target Designator (LTD) or Modular Universal Laser Equipment (MULE). The Copperhead guidance unit homes in on the reflected energy of the target designation laser, and the laser can also be applied to the target via an unmanned vehicle (drone). The Copperhead round's effective range was from 1.9 to 12.4 miles (McKenney 2007:286). Copperhead was unique from many of the SMR programs in that it was not under the direction of MICOM and Redstone Arsenal. MICOM preferred to test its programs, whenever possible, at the Redstone Arsenal as it was more economical to test them "in-house" than to establish a test program at WSMR in cooperation with Army Materiel Test and Evaluation (ARMTE). Since it was a guided munition and not a rocket or missile, the program was under the direction of the ARMTE, as part of the Direct Support Anti-Tank branch (Missile Ranger 1976a). This difference in project management meant that WSMR was the primary locality for the Copperhead development. Therefore, unlike the preceding TOW and Dragon anti-tank programs, all the primary Copperhead development and testing occurred at WSMR and the SMR (Jack Dage, personal communication 2014). The ARMTE awarded the primary Copperhead engineering development contract to the Martin Marietta Corporation of Orlando, Florida in 1975 (Missile Ranger 1976b).

Copperhead Testing at the SMR

The Copperhead Program was originally known as the Cannon Launched Guided Projectile (CLGP), and developmental testing of the munition began at the SMR in 1972. It was the most active program at the SMR through the remainder of the 1970s and through the 1980s (see Table 13). The CLGP/Copperhead firings took place in the same location as the Shillelagh launches, at the north end of the 27190 Launch Pad. The Shillelagh concrete platform and ramp at this location (27215) was identified by former Copperhead project officer Jack Dage as a possible location of the Copperhead firings at the SMR (Jack Dage personal communication 2014). Support services and personnel offices for the program were housed in existing buildings at the SMR. Project personnel had offices in the SMR Flight Control Building (27170), and the former Dart Program building (27166) housed program support services.

Range roads and targets were established at the SMR for the Copperhead testing at one, three, and five kilometer distances from the firing line. The range roads allowed easy positioning and access for the placement of targets. Many of the targets used for the Copperhead testing were actual obsolete tanks; the stockpiling and

Figure 44. A Copperhead projectile armed with a live warhead impacts with a tank target at the SMR with spectacular results (*US Army photo)*.

Table 13. Summary of Copperhead Firings at WSMR from 1972 to 1989 (*WSMR Museum 2014)*.

Year	Type	Total Firings
1972	CLGP Flt	6
1973	CLGP Flt	47
1974	CLGP Flt	93
1975	CLGP Flt	70
1976	CLGP Flt	29
1977	Copperhead	60
1978	Copperhead	270
1979	Copperhead	161
1980	Copperhead	26
1981	Copperhead	33
1982	Copperhead	430
1983	Copperhead	183
1984	Copperhead	68
1985	Copperhead	99
1986	Copperhead	134
1987	Copperhead	78
1988	Copperhead	168
1989	Copperhead	27

maintenance necessitated the establishment of the Tank Farm area at the SMR.

The Copperhead Program and the SMR Tank Farm

The Copperhead Program spurred the establishment of a fleet of derelict tanks at the SMR to be used as targets. The storage and maintenance area for these tanks, known as the Tank Farm, is located in the former Little John Missile assembly and support area. The Tank Farm is one of the more well-known aspects of the SMR today, and was used as a backdrop for at least one recent film. Prior to the Copperhead, nine retired M-48 tanks were used as targets for the Dart, Shillelagh, and TOW programs at the SMR. All of these programs used inert warheads when deployed against the M-48 tanks, and the relatively low weight of these projectiles (under 50 pounds) caused little damage to the M-48 tanks, allowing them to be re-used almost indefinitely (Boyle 1977). However, the Copperhead was a substantially larger and heavier projectile. Impacting at high velocities, even inert Copperhead rounds were capable of causing damage. According to Dick Dysart, who was in charge of the target tank program in the 1970s, “One inert round smashed through the engine grate of a target tank. It destroyed the engine, ignited the leaking fuel and wiped out the tank. With that kind of clout, our survivability rate goes way down” (Boyle 1977:3). Additionally, many of the later Copperhead firings were of live, high explosive rounds designed to destroy a tank in a single shot (see Figure 44).

In order to provide the Copperhead Program with a steady supply of targets, decommissioned M-47 tanks were recovered from across the US and Europe and shipped to White Sands. As of 1977, WSMR had acquired 44 tanks and had placed a bid on a lot of another 20 (Boyle 1977:3). Many of these tanks were listed as “excess and disposable”, and were essentially

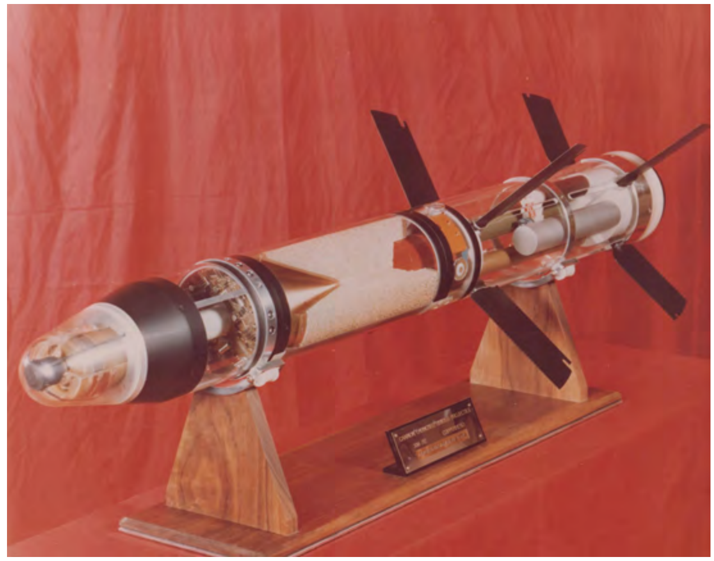


Figure 45. A full size model of the Copperhead round with transparent body produced by Martin-Marietta (*US Army photo)*.

free, save for the cost of transporting them. The derelict status of the tanks meant that most were inoperable, but the Copperhead testing required mobile targets. A team of 25 Army mechanics was assigned the task of getting as many of the tanks as possible into running condition, maintaining them, and installing radio control systems so they could be operated remotely. In cases where tests required a non-mobile target, the tanks were stripped of any useful working parts that could be reused and the empty hull would be towed out to the range (Boyle 1977:3). When the program was initiated in 1977, Army personnel performed the maintenance work at the Tank Farm, but today this task is accomplished by a contractor, Trax International. Not only does Trax maintain a large fleet of tanks for use in testing, but also keeps an inventory of various armored vehicles, heavy trucks, and light military vehicles such as pick-ups and jeeps.

Service and Legacy

The Copperhead was approved for production in 1979 and was issued to artillery units in 1984 (McKenney 2007:286). It proved to be an extremely accurate and effective anti-tank round. Unlike the Shillelagh, which relied on a rocket powered projectile fired from a specialized gun and optical system, the Copperhead can be fired from any 155 mm gun. This makes the system much more versatile and reliable than the Shillelagh, and along with the TOW missile, it served as one of the replacements for that system.

The Copperhead has also been combat tested. It was used during Operation Desert Storm, where in addition to being deployed against tanks, it was also used against fixed targets such as radar installations, bunkers, and command posts. It was also used in the more recent conflicts in Afghanistan and Iraq.

The system does have drawbacks. The Copperhead was an expensive unit to produce, and typically there were cheaper anti-tank measures available (McKenney 2007:287). The effectiveness of the laser designation was limited by low-lying cloud cover and ground clutter (such as jungle or urban environments), which prevented the guidance seeker from acquiring the laser signal on the target. Smoke-screens could also be deployed as a countermeasure against the laser designator (McKenney 2007:287) The Copperhead is currently being phased out by the introduction of the 155 mm Excalibur, a guided projectile that relies on GPS positioning for guidance which overcomes most of the limitations of the Copperhead round.

6.18 Hyper-Velocity Missile and LOSAT 1982 to 2004

The Hyper-Velocity Missile (HVM) was an early Kinetic Energy Missile (KEM) program initiated by the US Air Force (USAF) and tested at the SMR during the early 1980s. The KEM weapon did not use a warhead or fuze. Rather, the missile relied on its accuracy and speed for the kinetic-energy penetration of armor. Inside the missile was a high density penetrator rod, the mass of which coupled with the high speed of the missile would penetrate an armored target.

Figure 46. A Humvee mounted LOSAT firing at the LOSAT Launch Complex at the SMR circa late 1990s or early 2000s (*US Army photo)*.

History of Development

The HVM was initiated as an Air Force project and managed by a project office at Eglin Air Force Base, Florida. The USAF Armament Laboratory awarded a development contract for the missile to the Vought Corporation of Dallas in 1981 (Bingham 1982a). The system was intended to provide a small, lower cost option for an air-to-surface anti-armor missile. The production unit cost was originally projected at around $5,000 per missile, while the anti-tank AGM-65 Maverick air-to-surface missile cost about $20,000 to $30,000 per missile during the 1970s (Flight International 1972; Bingham 1982a).

Though managed by the USAF, the test and instrumentation facilities at the SMR were vital to the development of the missile. The WSMR Army Materiel Test and Evaluation Directorate worked in close cooperation with the Vought Corporation and the Air Force to test the HVM during the early 1980s (Bingham 1982a). The HVM was an adaptable design, and in 1984 it became a joint development between the USAF, Army, and Marine Corps that was to include a surface-to-surface version of the missile.

The HVM was aerodynamically stabilized by spin and a short cone section on the rear that provided some stability in lieu of more traditional fins. The missile made in-flight corrections by firing reaction jets through two small opposed nozzles on its forward section. The missile was guided by following a laser beam projected from the launcher, and theoretically, multiple missiles could be guided to independent targets simultaneously (Bingham 1982a). The missile motor case was a composite of lightweight materials, and the HVM traveled at speeds in excess of 5,000 ft per second. Due to the small size of the missile, it was anticipated that up to 20 HVM missiles could be loaded onto an aircraft, much more than the typical capacity of four to six Maverick missiles. It was designed to be launched from attack helicopters or the A-10 Warthog, and could also be used against other aircraft or hardened ground installations

(Bingham 1982a; 1982b). The final prototype of the HVM weighed approximately 60 pounds and was just under 4 inches in diameter (Parsch 2003).

By 1989 development of the air-to-surface HVM had been halted, but the program was re-directed towards the Army Advanced Anti-Tank Weapon System (AAWS-H) developmental program. The AAWS-H was an Army initiative to develop the next generation of guided anti-tank missiles. In 1988, Vought teamed with Texas Instruments to develop the HVM into a mobile, ground based system to meet the AAWS-H requirements. This system was designated the LOSAT, also referred to as the KEM program (Parsch 2004). Flight tests of the system began around 1990 at the SMR, and a dedicated launch complex was constructed in support of the test program.

By 1992, the system had encountered technical difficulties and was reduced from a weapon development program to a technology demonstration program. In 1996, the Department of Defense (DOD) recommended that the program be canceled. However, the Army appealed the termination of the program and it was reestablished as an Advanced Concept Technology Demonstration (ACTD) program in 1997 (Parsch 2004). The new ACTD contract was awarded to Lockheed-Martin, which by the early 1990s had bought out the missile division of Vought. This version of the LOSAT was mounted on the High Mobility Multipurpose Wheeled Vehicle (HMMWV), now commonly known as the Humvee (see Figure 46). The contract called for Lockheed-Martin to deliver 12 vehicles and 144 KEM missiles to the Army by 2003 (Parsch 2004). The Humvee mounted LOSAT was readily air-transportable and could be dropped via parachute, making it a very versatile system for light infantry and airborne forces. The LOSAT KEM missile was capable of defeating all known and projected armored vehicles by a substantial margin, and its range allowed the Humvee to fire from outside the range of conventional tank main guns. The system was to replace the TOW system on the Humvee and Bradley fighting vehicles, and also replace the Dragon (Missile Ranger 1990).

The Humvee system included four ready-to-fire LOSAT missiles in launch tubes on the roof of the vehicle and eight additional missiles towed in a trailer behind the vehicle. The LOSAT fire control system was based around a Forward-Looking Infrared (FLIR) that allowed the operator to find and lock onto targets. The system was designed to be very quick-reacting, requiring only seconds to acquire and lock targets and fire the missile (Parsch 2004). The LOSAT KEM missile, designated the MGM-166A, rapidly accelerated to 5,000 ft per second and reached its maximum range in less than five seconds.

Testing at the SMR

Since the missile was a short-range air-to-surface missile, the facilities at the SMR were well suited for the preliminary proof-of-concept ground launches of the system. Early tests of the HVM at WSMR were initiated in 1982 and were primarily focused on the operation of the laser guidance system, with interruption of the laser beam by the missile exhaust identified as a significant developmental concern. These proof-of concept tests were successful, with the initial series of five flight tests completed in 1983 (Bingham 1983). Documentary information about further tests of the HVM after the initial 1982 to 1983 flight tests is scanty. A 1986 Missile Ranger article mentions that additional testing of the HVM by the Air Force was scheduled for that year, but offers no further detail (Creek 1986).

Table 14. Summary of Hypervelocity Missile Firings at WSMR from 1982 to 1989 (*WSMR Museum 2014)*.

Year	Type	Total Firings
1982	Hypervelocity Missile	5
1983	Hypervelocity Missile	1
1984	N/A	0
1985	N/A	0
1986	Hypervelocity Missile	1
1987	N/A	0
1988	Hypervelocity Missile	4
	Hypervelocity Missile Tech Demo	1
1989	Hypervelocity Tech JSPD	1

By 1989, the HVM development had evolved into the new LOSAT missile, and a dedicated launch complex (Property 27090) at the SMR was constructed to support the program in 1993. The LOSAT testing also constructed a series of instrumentation locations across the western half of the range, extending from the Yaw line west towards Range Road 7. These locations typically consist of leveled gravel pads with pairs of concrete instrumentation pedestals. Most of these locations had an aluminum datum cap stamped with the year of installation, with the dates ranging from 1989 to 1995. Many of these locations were documented within the current SMR inventory area. Target mounds were also constructed for the LOSAT testing, located on a northwestern line-of-sight from the launch complex. The three demolished Bowen-Knapp camera buildings (Properties 27153, 27156, and 27157) on the range were removed due to their obstruction of the LOSAT flight line.

After the brief cancellation in 1996, the LOSAT program was reinstated as an ACTD program led by contractor Lockheed-Martin in 1997. Lockheed-Martin received an additional production contract for the program in 2002 for 108 LOSAT missiles, and test firings of the production missiles were conducted at the SMR from August 2003 to March 2004. All documentary evidence and physical indications suggest this was most recent period of testing activity at the SMR. These firings used the same LOSAT launch complex and instrumentation network that had been established in the 1990s.

The HVM/LOSAT testing was the last major testing program at the SMR and also the last major construction effort at the range. The program facilities are major components of the range today, and the LOSAT Launch Complex is one of the most prominent features of the SMR when viewed from Highway 70.

Additional KEM Development

The LOSAT also underwent some limited field tests at Fort Bliss in 2004, but further production of the system was halted after the initial production contract. The Army chose to halt further procurement of the LOSAT in favor of the next generation Compact Kinetic Interceptor Missile (CKEM) a smaller variant of the LOSAT with a longer range. Lockheed-Martin suc-

Figure 47. The LOSAT Launch Complex at the SMR, constructed during the 1990s and currently abandoned.

cessfully tested the CKEM as recently as 2007, but little recent information about the program is currently available suggesting that further development has been halted. None of the post-2004 testing occurred at the SMR.

The LOSAT and follow-on CKEM systems were never released into service. This is likely partially due to unit costs being substantially higher than what was originally envisioned back with the USAF HVM system. In particular, the high speed of the LOSAT and its lack of stable launch platform requires a very sophisticated and expensive guidance system to strike a target. Critics claim that a single LOSAT missile costs $238,000, while a TOW costs about $20,000 per unit (Meyer 2014). The LOSAT was also heavier and larger than the original HVM concept, weighing about 200 pounds, making it less portable than other anti-tank systems. The lack of a warhead also makes the LOSAT less adaptable as an anti-personnel weapon. The changing nature of warfare over the last 20 years has also deemphasized the need for anti-tank and anti-armor weapons. During the Cold War, defeating large numbers of Soviet tanks was a priority for strategic planners, but this is no longer a major consideration on today's battlefields. As the emphasis has shifted away from conventional warfare and weapons, sophisticated and specialized anti-tank weapons like the CKEM are less likely to be allocated developmental funding.

6.19 The WSMR Meteorology Program at the SMR

Beginning in the late 1950s, the White Sands Signal Agency (WSSA), a field agency of the Army Signal Corps, established the meteorology research program at the SMR. The program sought to better understand upper atmospheric conditions and winds to inform the launches and guidance of missile programs. This information was particularly important for ballistic missile systems that were then under development. In 1962, the various Signal Corps agencies, including the WSSA, were grouped under the newly established Electronics Command, which later became the Communications-Electronics Command (CECOM). Research conducted under CECOM was part of the Electronics Research and Development Activity (ERDA) group at WSMR. After this reorganization, the meteorological research at the SMR was conducted under ECOM as part of the WSMR Atmospheric Sciences Laboratory (ASL). The ASL was established at WSMR in 1965 (Missile Ranger 1974a).

Figure 48. Mrs. Gayle Churillo poses with models of ARCAS (*left*), Loki-Dart (*center)*, and XM-75 (right) rockets, October 1970 (US Army photo).

Meteorological facilities at the SMR were located along the margins of the range and included properties 27200, 27207, 27204, 27206, 27208, 27208B, and 27214. The launch pad associated with Property 27214 (property number unknown) was the focus of the ASL meteorology rocket launches during the 1960s and 1970s. This launch area appears as the WSSA Launch Area on overview maps of the SMR along its western edge, and is identified on a map included in a 1981 architectural drawing as the All Purpose Rocket for Collecting Atmospheric Soundings (ARCAS) Launch Area. The map identifies three properties at the launch area: S-27203, S-27208, and S-27209. WSMR property records do not contain any information on S-27208 or S-27203. For the sake of clarity, this area will be referred to as the ASL Launch Complex in this discussion.

Today, the complex consists of a large concrete pad, two buildings, a launcher rail, and a series of concrete blast barricades. The blast barricades are constructed on a concrete pad adjacent to the original meteorology launch pad and post-date the early 1970s. Little is known about this modification and what program it was associated with. Most of the buildings associated with the meteorology program at the SMR appear to have been abandoned sometime in the mid-1990s based on dated materials left behind in building interiors.

The programs used for the atmospheric and meteorology research program at the SMR included the Loki-Dart, the ARCAS, the Super Loki, the XM-75, and the HARP gun probe (see Figure 48). These rockets and their development and use at the SMR are discussed in more detail below.

6.19.1 Loki-Dart

Like its mythological namesake, the Loki was to reemerge in a new guise. The high performance and low cost of the Loki made it an excellent candidate for upper atmospheric and meteorological research (see Figure 49). Bollerman and Walker (1967) note that Loki was first used in this role during the Castle and Redwing nuclear tests in the Pacific from 1954 to 1956. Beginning in March of 1955, the Navy also adopted the Loki as an inexpensive method to measure winds between 100,000 and 150,000 ft. The Office of Naval Research (ONR) modified the rocket to carry a radar target to the desired altitude and release it into the wind stream. The Loki in its original configuration could attain altitudes of up to 180,000 ft, which made it ideal for this purpose. The ONR referred to the rocket as the Loki-WASP, or WASP (Weather Atmospheric Sounding Projectile), which released strips of reflective metal chaff (see Figure 51). The chaff would be carried aloft by the winds and allowed the wind speed and direction to be tracked by ground based radars (Kennedy 2009:115).

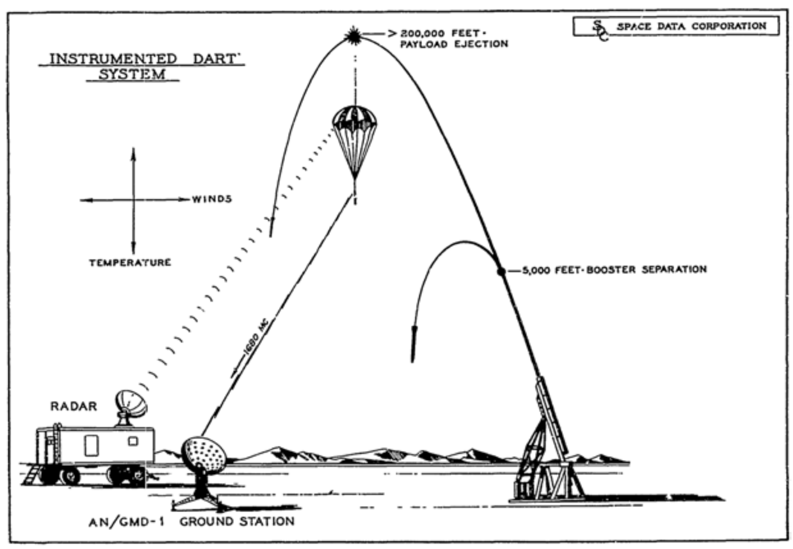


Figure 49. Illustration of the operation of the instrumented Loki-Dart sounding rocket (*reproduced from Bollerman and Walker 1967)*.

This system was also tested at WSPG, where the chaff was tracked for as long as 27 minutes at 102,000 ft before it dispersed. A metallized silk parachute was also developed by the Navy and tested at WSPG, which did not have the dispersion problems of chaff and offered a much longer tracking window. On June 1, 1956, a metallized parachute was tracked by radar from 97,000 ft to 24,000 ft over WSPG, while a chaff round launched on the same day was only tracked from 117,000 to 102,000 ft (Kennedy 2009:115-116). The Loki-Dart measurements of high atmospheric winds, which can reach speeds of 200 mph, provided data critical to the accu-

Figure 50. Delbert Bynum holds a Loki-Dart at the ASL Launch Complex outside Building 27214, circa early 1970s. Several launchers visible in the background, including ARCAS and Boosted ARCAS launchers (*US Army photo)*.

rate firing of long range missiles (McClean 1958). The development of low-cost atmospheric sounding rockets was a technological advance in the 1950s, and Kenneth Jenkins of the WSSA was a key figure in their development (McClean 1958; Wind and Sand 1958). Understanding the behavior of atmospheric winds in something close to real-time allowed the trajectory of long range missile launches to be adjusted accordingly, an important contribution to the development of Intercontinental Ballistic Missile (ICBM) programs (McClean 1958).

A series of improvements to the Loki motor by various companies allowed the Loki to reach altitudes up to 230,000 ft (Bollerman and Walker 1967:96). The Loki was produced commercially for atmospheric and meteorological research; these variants are known as the Loki-Dart, the Dart referring to the instrumentation package carried aloft by the rocket (see Figure 52). A Robin inflatable sphere was also adapted to use with the Loki-Dart to serve as a radar target (Bollerman and Walker 1967:96).

The Loki-Dart was improved in a joint research program between the Space Data Corporation and the Electronics Development and Research Activity (ERDA) program at WSMR during the 1960s. The ERDA program adapted a low-cost radiosonde instrument package to be carried

Figure 51. A Navy Loki-WASP sounding rocket being held by two unidentified man outside the Navy Blockhouse at WSMR, circa mid-1950s (*WSMR Museum photo)*.

by the Loki-Dart, which transmitted temperature and wind data. The radiosonde was carried by a metallized parachute which could be tracked by ground based radar systems (Bollerman and Walker 1967).

Loki-Dart rockets were also launched at the Green River Launch Complex (GRLC) in Utah to provide data on upper atmospheric winds in support of the Air Force Athena ICBM Program. The Loki-Dart provided data on the upper atmospheric conditions that would impact the trajectory of the Athena ICBM, allowing the Athena launches to adjust accordingly. A Loki was the first rocket fired at the GRLC in 1964, and 199 Lokis were fired at the GRLC through 1968 (Missile Ranger 1968:1).

The Loki-Dart would become a mainstay for atmospheric and meteorology research, and Kennedy (2009:116) notes that over 10,000 were launched in this role. Updates and modifications to the basic Loki resulted in several variants, with the Viper III and the Super Loki types remaining in use as recently as 2001. An almost identical meteorological rocket called the Owl was developed by the Air Force in the 1960s (Kennedy 2009:115-116).

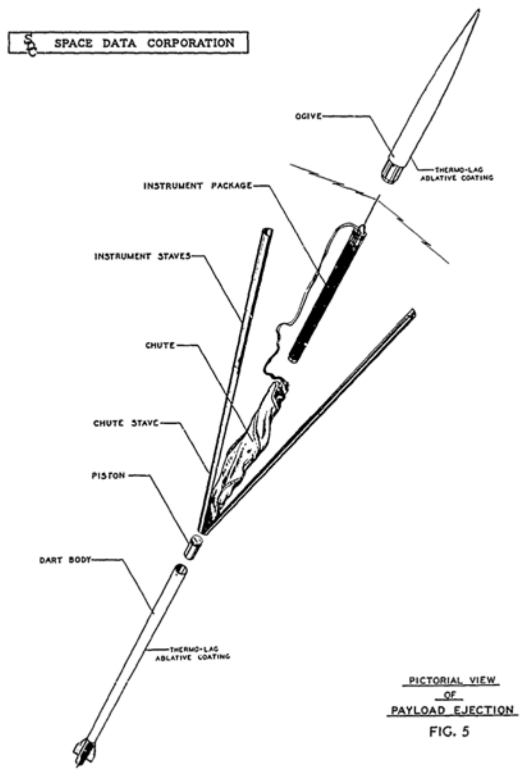


Figure 52. Drawing of Loki-Dart deploying a radiosonde instrument package (*reproduced from Bollerman and Walker 1967)*.

Figure 53. An unidentified man carries a Loki-Dart rocket outside Property 27214 at the SMR, September 1973 (*US Army photo)*.

Figure 54. The reflective metallic parachute that was deployed as a radar target by the Loki-Dart sounding rocket (*US Army photo)*.

6.19.2 ARCAS Rocket

The ARCAS rocket was developed to provide an inexpensive high-atmospheric sounding rocket (see Figure 55). The ARCAS was unique in that it was custom designed as a meteorology and atmospheric sounding rocket, whereas other rockets used for atmospheric research were re-purposed weapons systems, such as the Loki. It was capable of reaching altitudes up to 200,000 ft with a payload of 12.5 pounds. Later versions could carry payloads up to 20 pounds. The system included the rocket itself, a launcher, and a parachute recoverable instrument package.

Figure 55. An ARCAS launch from the ASL launch area circa late 1960s or early 1970s. The three panels detaching from the rocket are plastic sleeves that sealed the rocket within the launcher tube (*US Army photo)*.

History of Development

In January of 1958, the ONR contracted with the Atlantic Research Corporation (ARC) to develop a low-cost, single-stage, high altitude weather and atmospheric sounding rocket. By the end of 1958, ARC had developed a prototype of the rocket and was ready to commence flight testing. The Navy arranged for the WSSA to conduct the test firings at WSMR due to the agency's previous experience firing the Loki and Nike-Cajun atmospheric sounding rockets (McClean 1959).

The ARCAS was fired from a unique closed-breech launcher that was one of the more significant innovations of the program (see Figure 56). The launcher employed the exhaust gases of the rocket to accelerate the rocket by piston action. Plastic sleeves protected the rocket and kept it centered as it accelerated through the launcher tube and flew free once it exited. The launching velocity could be tuned, altering the amount of free volume in the launcher tube, the launcher

Figure 56. Technicians load the ARCAS rocket into its launcher, showing the breech loading operation of the system (*photo courtesy NASA)*.

tube length, and the launcher bypass vents. The launcher was built in both fixed and mobile versions (Webster et al. 1960).

The development of a frangible fiberglass case for the rocket was also tested at WSMR. Having delivered its instrumentation package, the fiberglass ARCAS motor housing could be destroyed with a small explosive charge. When detonated, its fiberglass construction would disintegrate into harmless fragments, which would allow it to be used over populated areas (McClean 1959; Webster et al. 1960). However, it does not appear that the fiberglass case became part of the standard ARCAS production model.

The ARCAS was 7 ft in length and 4.5 inches in diameter. At only 77 pounds, it could be quickly launched by a two man crew (McClean 1959). The breech loaded launcher was operated in a similar fashion to an artillery piece, and was easy to manipulate with only minimal crew training. The solid-fuel motor was slow burning, running for 29 seconds, and produced low acceleration forces during launch (Webster et al. 1960). Compared to the short-duration, high-acceleration motor burn of the Loki rocket, the ARCAS was much gentler with sensitive instrument packages (Parsch 2002e; Smithsonian National Air and Space Museum 2014). It also offered a larger payload capacity than the smaller Loki-Dart.

A two-stage version of the rocket, the Boosted ARCAS, was also developed. The Boosted ARCAS used an ARC booster stage to launch a modified ARCAS to altitudes up to 290,000 ft. The first firing of a Boosted ARCAS was at WSMR, probably at the SMR, in 1961 (Parsch 2002e). Another two-stage variant of the ARCAS was the ARCAS-Sidewinder, which used a Sidewinder motor as the first stage.

Table 15. Summary of ARCAS Firings at WSMR from 1960 to 1965 (*WSMR Museum 2014)*.

Year	Type	Total Firings
1960	ARCAS	50
1961	ARCAS	98
1962	ARCAS	141
1963	ARCAS	105
1964	ARCAS ERDA	115
1965	ARCAS	157

Testing at WSMR

The WSSA conducted seven vehicle flight tests of the ARCAS at the SMR from November of 1958 to June of 1959, under Project Officer Ken Jenkins (McClean 1959). The Navy contract also called for additional flights to test the data gathering capabilities of the ARCAS. Thirteen additional ARCAS rockets were fired, and another 28 equipped with an Air Force Robin inflatable sphere (whose fall rate was tracked by radar to precisely measure atmospheric drag) were launched. These launches were nearly entirely successful, with the system operating as anticipated. One Robin sphere-equipped ARCAS reached an altitude of 280,000 ft during these tests, substantially exceeding the altitude requirements of the rocket.

The two-stage variants of the ARCAS did not use the breech loading launcher, instead relying on a more common launcher rail. One of the remaining launcher rails at the SMR ASL Launch Complex was likely used to fire these ARCAS variants. The other launcher rail remaining at the complex appears to be a Super-Loki launcher. The ASL Launch Complex is labeled as the "ARCUS Launch Site" (sic) on an overview map of the SMR included in a set of 1981 architectural plans (see Figure 57). The ARCAS Tower (Property 27204) identified in the WSMR property records is the steel lattice antenna tower located at the ASL Launch Area. This tower held aerometer instrumentation that provided important data on wind speeds for the ARCAS launch. As the ARCAS left its launcher at a relatively slow velocity, its early trajectory was strongly influenced by surface winds. The wind speed provided by the ARCAS tower instrumentation provided impact predictors with critical data that was used to adjust the launch azimuth in order to ensure that the rocket would impact in a safe area within the range (Bruce Kennedy, personal communication 2014).

According to WSMR firing records, ARCAS firings were very common from 1960 to 1965, but no additional launches are listed after 1965 (WSMR Museum 2014). However, a 1975 article in the Missile Ranger describes ARCAS rockets being launched as part of an atmospheric research program (Missile Ranger 1975b). This suggests that ARCAS rockets continued to be fired at WSMR after 1965, but weren't logged in the firing records (see Table 15). This practice appears to be consistent with other meteorology rockets such as Loki-Dart and Super Loki, which do not appear in the primary WSMR firing records after 1965.

The ARCAS was a popular sounding rocket during the 1960s, used along with the Loki-Dart for atmospheric research. The ARCAS was used extensively by the Air Force for meteorological monitoring, and as many as 42 a week were fired by the Air Force during the early 1960s

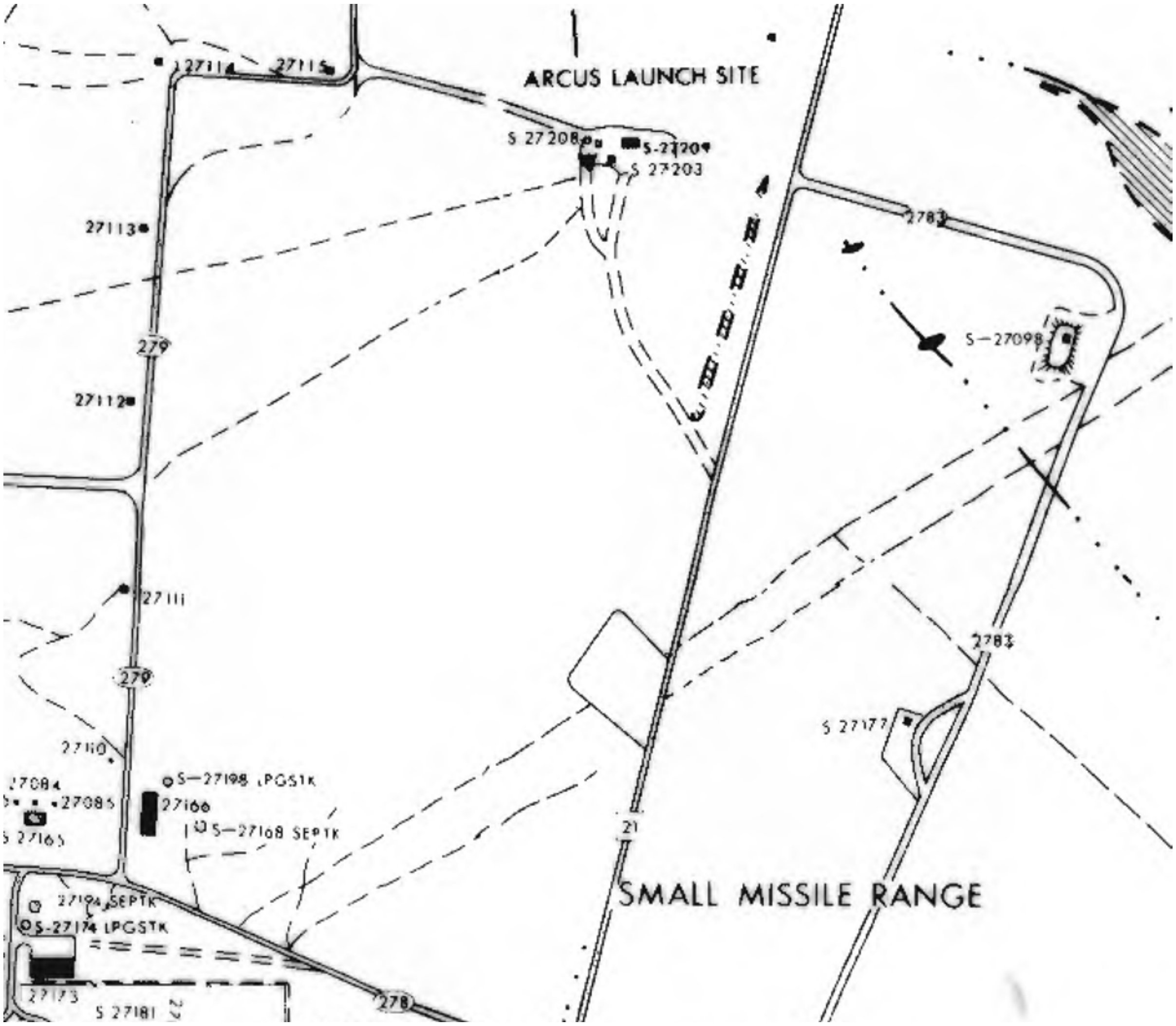


Figure 57. The ARCAS Launch Site location at the SMR as shown on a 1981 overview map, misspelled as “ARCUS”.

(Astronautix 2014). It was also used by the National Weather Service, NASA, and the Army. The ARCAS was mostly supplanted by the development of the Super-Loki in the late 1960s, which offered comparable performance at a lower cost (Parsch 2002e). The XM-75 and XM-77 were also developed as replacements for the ARCAS in the early 1970s. Despite this, the ARCAS remained in the Army inventory of sounding rockets and was still used into the 1970s and possibly later (Missile Ranger 1975b).

6.19.3 Super-Loki

The Super Loki was one of most popular and long lived of the Loki-Dart variants. It was developed by the Space Data Corporation for NASA as a low-cost sounding rocket for altitudes up to 278,000 ft. The Super Loki was larger than the standard Loki (see Figure 58), with the motor section about 16 inches longer (78.5 inches) and 1 inch larger in diameter (4 inches). The Dart section was correspondingly larger, and delivered metallic chaff that could be used for radar tracking of upper atmospheric currents (Bollerman and Walker 1968).

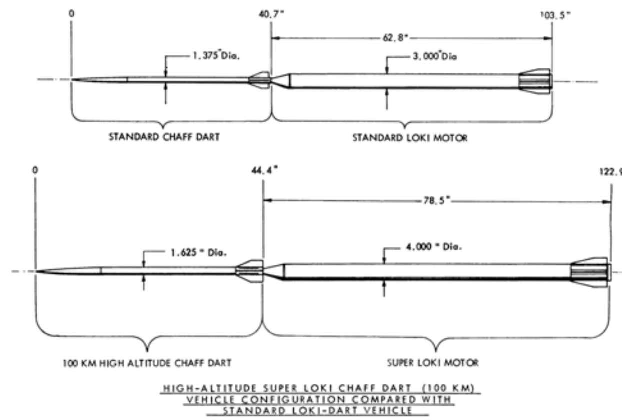


Figure 58. Comparative drawings of the standard Loki-Dart, top, and the Super Loki, bottom (*reproduced from Bollerman and Walker 1968)*.

The Super-Loki developmental flights were conducted at WSMR, likely at the SMR, during April and May of 1968. Five flights were conducted, three of which were radar tracked with apogees of up to 410,105 ft, much higher than the design expectations. These tests were so successful that the remaining 20 rockets in the contract were shipped to Cape Kennedy for operational use with no further improvements to the design (Bollerman and Walker 1968).

The Super Loki was launched from the ASL Launch Complex along with the Loki-Dart and the ARCAS. A Super-Loki launcher is still attached to the pad just north of Property 27214. According to Eckles (2013:29), the WSMR ASL launched Loki rockets daily for decades to collect wind and temperature data. The practice was eventually supplanted by modern meteorological instruments such as Doppler radar. Numerous Loki and Super Loki motors are scattered across the SMR in evidence of these launches (see Figure 67).

Figure 59. Discarded Loki and Super Loki boosters at the SMR.

Figure 60. John Quast holds a Loki with a Viper booster at left, and a Super Loki at right. Photo taken at the ASL Launch Complex in 1970 (*US Army photo)*.

SUPER LOKI ROCKET MOTOR

Figure 61. A drawing of the Super Loki motor (*reproduced from Bollerman and Walker 1968)*.

6.19.4 XM-75 Quanah Rocket

The XM-75 was an atmospheric rocket developed as a multi-agency atmospheric testing rocket that was a joint venture between the US and Canada, with NASA also contributing funding to the project. The XM-75 was intended as a replacement for the existing ARCAS and Loki sounding rockets and was used in the Cooperative Meteorological Rocket Network across the US and abroad (Missile Ranger January 7, 1972b). The XM-75 development was led by the WSMR ASL, and the primary contractor was the Canadian aerospace firm Bristol Aerospace Limited of Winnipeg. The XM-75 was also known as the Research Development Test and Evaluation (RDT&E) project, and a smaller XM-77 version was known as the "MDSS" rocket (Missile Ranger 1972b).* Both rockets underwent developmental testing at the SMR beginning in 1969 (WSMR Museum 2014).

Figure 62. Specialist Four Glenda Dukes, a WSMR administrative assistant, watches a XM-75 being prepared for launch at the SMR, December 1970 (*US Army photo)*.

The XM-75 was a single stage rocket that used a solid propellant motor to deliver a 7.5 pound payload to altitudes of 235,000 ft above sea level. The rocket weighed about 112 pounds, and was about 9.25 ft long with a diameter of slightly less than 5 inches (see Figure 63). The smaller XM-77 was 3.5 inches in diameter and weighed 42 pounds, and was designed to carry a 4 pound payload to 110,000 ft above sea level (Missile Ranger 1972b; 1974b). The XM-75 was also named the Quanah, after the Texas hometown of project officer Kenneth R. Jenkins (Missile Ranger 1974b). The first firing of the final production XM-75 was on May 20, 1974. Jenkins was a pioneer in meteorological sounding rockets who had been at WSMR since 1956. He retired in 1974, soon after the completion of the XM-75 project (Missile Ranger 1974c).

WSMR firing records indicate that the RDT&E rocket, the developmental version of the XM-75, was fired from 1969 to 1973 (see Table 16). The launches most likely took place from the

* The XM-77 does not appear to have moved past the developmental stage. It is referred to as the MDSS rocket in the January 7, 1972 Missile Ranger article, but the acronym is not defined there.

Table 16. Summary of XM-75 (*RDT&E)* Firings at WSMR from 1969 to 1970 (*WSMR Museum 2014)*.

Year	Type	Total Firings
1969	XM-75 (RDT&E)	6
1970	XM-75 (RDT&E)	52
1971	XM-75 (RDT&E)	18
1972	XM-75 (RDT&E)	20
1973	XM-75 (RDT&E)	16

ASL Launch Complex on the eastern side of the SMR, although the firing data does not include information about launch locations. Post-1973 firings of the XM-75 probably occurred, but these do not appear to have been tracked in the firing records as with the RDT&E firings (WSMR Museum 2014). The XM-75 appears to have been used alongside other meteorological sounding rockets such as the ARCAS and Super Loki through the 1970s (Missile Ranger 1975b).

Figure 63. Glenda Dukes and the XM-75 RDT&E rocket at the ASL Launch Complex at the SMR, December 1970 (*US Army photo)*.

6.19.5 The HARP Gun Launched Atmospheric Probe

Parallel to the ASL sounding rocket testing at the SMR during the 1960s, the High Atmosphere Research Program (HARP) was also tested at the range. HARP was a developmental effort to launch high atmospheric sounding probes via a gun launcher as a less costly alternative to rocket delivered probes (Graf 2014a). The development of a gun launched atmospheric probe was the brainchild of Dr. Gerald Bull during his tenure at the Canadian Armament and Research Development Establishment (CARDE), where he began testing the system in the mid-1950s. His work attracted the attention of the Army BRL who was interested in the development of low-cost atmospheric sounding vehicles for research in support of the development of ICBMs and supersonic aircraft. The partnership between the BRL and Dr. Bull led to a series of HARP gun launcher firings at Army facilities in the mid-1960s (Graf 2014a).

Although HARP eventually developed a 16-inch diameter gun for launching atmospheric probes and satellites, the gun used in the testing at the SMR was a smaller 5-inch gun. The 5-inch gun launcher was a modified 120 mm T123 artillery piece, which was fitted with a smoothbore barrel lengthened to 29 ft. The barrel was equipped with stabilizer wires that allowed for an adjust-

Figure 64. The 5-inch HARP gun being installed on the angled 45-degree platform at the SMR in 1965 (*US Army photo)*.

able alignment of the barrel relative to the firing angle (Graf 2014b). The T123 gun carriage was mounted to a 45-degree angled platform (see Figure 64) in order to allow it to be adjusted to a vertical position for atmospheric launches (Graf 2014b). The 5-inch gun probe launcher retained the easy transportability of the T123 gun, and the unit was towed via truck to the SMR (see Figure 65).

Figure 65. The 5-inch HARP gun being towed through Las Cruces en route to the SMR in 1965 (*US Army photo)*.

Testing of the 5-inch HARP gun probe was conducted at the SMR during 1965 and 1966, with the testing primarily focused on determining the gun's muzzle velocities and the range and trajectory of the probe (Williamson 1966). The system was also tested at Fort Greeley, Alaska and Yuma Proving Ground, Arizona. The 5-inch gun was also fired at Wallops Island and at the HARP Barbados facility (Graf 2014a).

Figure 66. Sign for the SMR HARP gun probe found at dump location southwest of the SMR at Site LA 174035 (*photo by R. Goodwin and Associates)*.

The testing conducted at the SMR was only a small portion of the much more ambitious and complex development of the HARP program. The story of the program and its chief developer, Gerald Bull, is beyond the scope of this context.* Ultimately, the program turned toward the development of a gun-launched satellite system, but funding issues halted the work in 1967 before such a system was completed (Graf 2014a). The gun launched atmospheric probe, though successful at achieving the required altitudes for atmospheric probes, generated G-forces that were beyond what onboard electronics in the probe could survive. This limited the system to delivering radar reflective chaff, which was a very basic method of observing upper atmospheric winds. Due to this, the gun probe was not as viable as the ARCAS and Loki-Dart rockets which could carry onboard electronics in addition to radar reflective chaff or parachutes (Bruce Kennedy, personal communication 2014). The Super-Loki and XM-75

* After the end of HARP, Bull worked on more conventional military ordinance projects through the Space Research Corporation but still hoped of completing his gun-launched satellite project. During the 1980s he was contracted by the Iraqi government to develop a massive 1,000 mm bore, satellite launching gun known as the "Babylon Gun". Apparently as a result of his cooperation with the Iraqis in this project, he was shot to death outside his home in 1990. Though an unsolved murder, his assassination is widely speculated to have been orchestrated by the Israeli government due to apprehension of Bull's potential contributions to the Iraqi arsenal.

Figure 67. The 5-inch gun probe launcher at the EMRTC in 2014 (*photo courtesy William Godby)*.

systems developed during the late 1960s and early 1970s provided lower cost sounding rockets which further reduced the appeal of the gun launched probes.

According to Bruce Kennedy (personal communication 2014), the 5-inch HARP launcher was located just east of the ASL Launch Complex on the east side of Range Road 21. This location allowed the firing of the gun to be supported by the nearby launch complex and its associated instrumentation. The gun was later relocated following the 1965-1966 testing and the angled gun mount and related equipment were dumped at a location southwest of the SMR just off of Range Road 7. When the gun launcher was dismantled is unknown, and the dump site was only recently recorded as an archaeological site (LA 174035). No identifiable remains of the SMR gun launcher location were observed during the current inventory. However, the 5-inch HARP launcher itself was recently found in a storage yard of the Energetic Materials Research and Testing Center (EMRTC) in Socorro, New Mexico. Plans are currently being made to relocate the 5-inch HARP launcher from EMRTC back to WMSR, where it can be maintained as an interpretative display (William Godby, personal communication 2014).

6.20 Historic Context Summary

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 range 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 in part at the SMR during the early 1960s, although only the Redeye entered service with the Army, eventually evolving into the Stinger system. 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 projectile, a non-rocket guided artillery round, began testing at the SMR. The Copperhead testing was the major testing activity at the SMR through the 1970s.

The Shillelagh, TOW, Dragon, and Copperhead programs defined the SMR as an important anti-tank weapon testing ground, and the range's role in the development of these weapons was significant to the Cold War at a national level. In the words of Jack Dage, who served as a project engineer for the Shillelagh and Copperhead programs:

> I still think (the SMR testing) helped win the Cold War. One of the big fears in the Cold War was that the Russians were going to send thousands of tanks through the Fulda Gap into Germany, and we had to have some way to stop them. And the anti-tank missiles were designed specifically to do that (Jack Dage personal communication 2014).

Anti-tank weapon development at the SMR continued with the KEM testing of the 1980s, including the Air Force Hyper-Velocity Missile and the follow-on LOSAT missile in the 1990s.

The SMR also was 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, ARCAS, XM-75, and 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 ASL 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 conditions was also an important component to ICBM programs such as the Athena launches from the GRLC.

The preceding historic context has provided the story of the SMR; now the specific properties and their role in this history can hopefully be better appreciated. Therefore, this document now turns to the description of the buildings, structures, objects, and features recorded during the current inventory effort.

7. Description of Resources

Based on guidance provided in *Thematic Study and Guidelines: Identification and Evaluation of U.S. Army Cold War Era Military-Industrial Historic Properties* (Lavin 1998), the activities at the SMR fall into three Cold War sub-themes, which are discussed at length in *Chapter 8*. While not easy to ascribe property types in two of those sub-themes due to the wide range of activities on the site, the types found at the SMR generally fall under the sub-theme of *Materiel Development*, and are: *calibrated firing ranges* and *equipment for test-firing missiles*.

The SMR inventory effort resulted in the recordation of 116 buildings, structures, and objects. As part of the inventory methodology, less significant resources representing remnants of the SMR supporting infrastructure that were not classifiable as buildings, structures, or objects were recorded as features and are described separately. The recorded WSMR properties were assigned a New Mexico Historic Cultural Property Inventory (HCPI) number and were documented on HCPI forms tailored for use at WSMR. The HCPI forms for the recorded SMR properties are included in Appendix C of the enclosed CD. The HCPI documented properties include buildings, structures, and objects. Encompassing the boundaries of the SMR, a Laboratory of Anthropology (LA) number was assigned to the district as a whole.

The NPS NRHP Bulletin 15 defines buildings as properties that principally provide shelter for any form of human activity (NPS 1996). Per New Mexico Historic Preservation Division guidance, only properties that fit the definition of 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, and include blast barricades, launch pads, transmission towers, cranes, and instrumentation sites. Objects are typically small in scale and simply constructed. Whether affixed to the ground or mobile, it must be associated with a specific setting or environment; examples include liquid propane tanks, loose items associated with launchings or even, camera equipment.

7.1 Building Types

As "types", the facilities form a discrete cluster that shares a common history and purpose, and physically express the Army mission of RDT&E on the landscape. These building and structure types within the framework of missile testing "launch complexes" are discussed in *Section 6.3, Fundamentals of Missile Ranges*. Within this general cluster at the SMR are identifiable functional categories whose purpose is reflected architecturally and through physical expression. Eight such property categories were identified for the recorded SMR properties: Flight Control, Launch Facilities, Instrumentation and Instrumentation Support Facilities, Assembly and Maintenance Facilities, Meteorology Program Facilities, Blast Barricades, Magazines, and Miscellaneous Facilities. Within these types are a whole range of construction methods that vary from simple, wood-framing and CMU block support structures to substantial reinforced concrete and steel-frame buildings and structures.

At the SMR, the first phase of construction consisted of the Flight Control Building (27170), below-grade Fastax and Mitchell (27119-27149) camera shelters and above-grade, Bowen-Knapp camera shelters (27110-27118 and 27150-27158). With the exception of the reinforced concrete, below-grade camera shelters, these buildings are all constructed with a post-and-lintel type superstructure infilled with concrete masonry units (CMU), or concrete blocks. Only one permanent post-and-lintel type building was constructed for the Dart program in 1957 – the Dart Operations Building (27166); a second generation of above-ground Mitchell camera shelters was added in 1957 (27160-27163), but was constructed of reinforced concrete with a retractable roof panel and hinged wall panels for exposure to the sky. This was followed two years later by the Little John program in 1959 which saw the greatest number of permanent post-and-lintel type buildings erected. These include the Radar Instrumentation Building (27106), Little John Launcher and Camera Maintenance Facility (27173), Little John Instrument Calibration Building (27187), and Little John Pre-Assembly Inspection Building (27188). Most substantial construction from that point forward was executed in CMU block only and includes the Wind Measurement Building (27200), Assembly Building (27206), General Maintenance Building (27208), Instrument Building (27214), Unknown Building 1, and the Communications Building (27200).

The vast majority of building types found at the SMR are the type found at most ranges, the ubiquitous pre-manufactured, steel-frame type, clad in a variety (mostly metal) of panels. 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.

Quonset huts were built by the thousands, perhaps hundreds of thousands, on military posts throughout the United States and abroad during World War II. The surviving Quonset huts at WSMR include buildings that have been moved and modified, as well as many that are in situ and generally unmodified. These steel-frame buildings remain in use to this day and are found in virtually every area of the station. The efficient, simple half-round shape of these metal-clad buildings with characteristic semicircular arched roofs used a steel frame and sheet-metal (usually corrugated) sheathing, and had a variety of options and sizes depending on climate and utilitarian needs that ranged from housing to field hospitals. At the SMR only one Quonset hut was found, the Radar Building (27108), which was likely repurposed for the Loki program in 1954.

The SMR also retains a number of pre-manufactured, steel-frame, gable-roofed buildings, typically manufactured by the Butler and Armco companies. Functionally equivalent to Quonset huts, Gable-roofed Butler-type buildings (named for the leading manufacturer of such buildings, the Butler Manufacturing Company) were designed with prefabricated rigid, wedge-beam steel frames and sided with seamed sheet metal. Butler buildings were commonly used throughout the military after World War II, supporting the military's need for structures of variable widths and lengths. More flexible than the popular World War II Quonset hut, Butlers often had interchangeable parts and could be combined in various fashions. They had "truss clear" or "clear span" interior spaces that provided more room and were preferred for the ease and speed with which personnel could construct them. Armco was another major manufacturer of steel-frame utility buildings favored by the military, and these are also found at the SMR. Many of these buildings remain essentially unmodified at the SMR and elsewhere at WSMR.

The last building type is the reinforced concrete munitions storage magazine. Magazines are typically associated with the safe storage of munitions and found primarily at military depots and training areas. However, magazines are found at missile test ranges as volatile fuels and warheads pose an explosive threat to technicians. Of the five magazines at SMR, three are standard explosive-type, used chiefly for storage. The stand-alone, box-like, reinforced concrete structures each contain heavy duty steel doors and frames, lighting rods, and electrical grounding cables. The Climatic Conditioning Building (27104) is basically a modified "igloo-type" (named for their earthen-bermed storage areas) magazine consisting of a reinforced concrete, approximately semicircular barrel arch springing from a foundation at grade. The igloo-type is found at military installations all over the US and can vary greatly in size. The end walls are typically concrete and the central area infilled with earth over a flat or semicircular storage area. The design is intended to have any explosions directed upward. Hence the rigid end walls and more malleable earthen covering.

7.2 Building Styles

In terms of "style," the SMR contains buildings, structures, and objects that are not easily categorized. These facilities were purpose-built for function and are typically found in more remote locations with limited access. However, the DOD recognizes that some facilities, such as the flight control building and Little John program buildings, derive stylistic cues from the Modern movement. Whether designed "in-house" by the Army Corps of Engineers or by such notable architect-engineer partnerships like Kenneth S. Clark and Philippe Register of Santa Fe, 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 point to International Modernism. Kenneth S. Clark's loosely Modernistic design theme is expressed in the Radar Instrumentation Building (Property 27106), Little John Instrument Calibration Building (Property 27187), based essentially on the Army Corp's Flight Control Building (Property 27170). Pre-manufactured buildings such as WW II Quonset huts and gable-roofed, steel-frame, Butler-type semi-permanent buildings are easily identifiable. Most of these secondary buildings, including the heavily reinforced concrete Climatic Building (27104) are typically described as Industrial Vernacular – that is, they do not fall into recognized, high-style categories but are designed and utilized for their function. Therefore, the all-encompassing term "vernacular" applies to these support buildings.

7.3 Building Integrity

In regard to the NRHP guidance on questions of "integrity," a discussion can be found in *Section 8.4, Integrity of SMR Resources.* In a more general sense, particularly in terms of the individual resources, some aspects of physical integrity should be noted. At first glance, one might assume that the extant collection of buildings and structures are more compromised than they appear, simply due to the fact that the site is now unoccupied and ground cover is inevitably taking back the areas around these facilities. For the major buildings at the SMR, constructed to be permanent and long-lasting, their physical integrity can be said to be quite high. Most of the character-defining features remain intact and all of these appear to have been well maintained and not adversely affected by the often harsh desert climate. Again, despite an appearance of abandonment, the launch facilities are all functionally intact and are reinforced concrete construction. The Bowen-Knapp camera shelters (Properties 27110-27118, 27150-27158, and 27160-27163) and Fastax below-grade camera shelters (Properties 27119-27149) are also physically intact and retain most of their character-defining features; however, the element that gives these facilities their significance are the cameras themselves, all of which have been removed. While this does not undermine the interpretive value from a district perspective, they must be considered in determining individual significance. The secondary building types, primarily pre-manufactured, steel-frame buildings like Quonset huts and gable-roofed Butler and Armco-types are all in varying degrees of slow decay from environmental factors but are functionally intact.

In the following analysis, each functional type of building and structure found at the SMR is discussed separately. The discussion will introduce the attributes or characteristics in terms of that function at the range. It will then briefly discuss the resources that represent that functional type. The building and structure type discussions are followed by detailed descriptions of each individual resource with information regarding the physical changes and/or changes in use over the last six decades. Wherever possible, the interiors of the buildings were examined and none, especially the Flight Control Building, were significant in terms of architecture or engineering, nor did they retain any fixtures that were associated with the Period of Significance.

As none of the SMR resources were found to be individually NRHP-eligible, no discussion within the description and evolution section was included regarding eligibility. A full discussion of National Register eligibility and historic district considerations can be found in *Section 8, Discussion of National Register Eligibility and Historic District Consideration.*

7.4 Flight Control

The independent flight control of the SMR was conducted at Property 27170, the SMR Flight Control Building. The building was hardwired to the 27190 Launch Pad via the underground concrete cable run that runs west and north and joins the launch pad. Designed by the Army Corps of Engineers in 1952, the building was designed to not only serve as the control hub for the firings on the launch pads, but as the central gathering point for disseminating flight data (data reduction). Other functions within the building included complete service, preparation and storage area for the cameras on the range, a laboratory room, an electronic laboratory, and missile contractor office. The building was retrofitted in 1964 with plans prepared by Kenneth S. Clark, but did include any substantive changes to the footprint or floor plan. Flight control was eventually consolidated to Building 300 in 1980. It is the only flight control building at the SMR, which is reflected in its unique design; for much of the operation of the range, the Flight Control Building served as its nerve center.

7.4.1 Property 27170

This building is a two-story, square-plan, concrete post and lintel building infilled with CMU walls; all of the window opening in the walls are fitted with concrete sills. Placed on the north side of the flat-roofed building is a flat-roofed, rectangular observation room or "control tower," with splayed upper walls infilled with glazed panels; the northern side is covered with a

Figure 68. Property 27170, north and west elevations, view to the southeast.

plywood panel (see Figure 68). By virtue of the supporting concrete posts, each of the four elevations of the building is divided into four bays; the north and west mimicking the south and east, respectively. The west elevation is recessed at the second story level at the north and south ends, creating exterior landings with steel pipe handrails. Both landings are accessed by personnel doors that are placed on the west elevation; a paired set on the north side with upper glazed panels, and a single slab on the south side. The landing on the south side has a steel-frame circular staircase that leads to the rooftop. The first floor of the west elevation has a steel-slab personnel door in the middle-north bay that is accessed by a concrete staircase with a steel pipe handrail. A bank of three 1/1, horizontally-oriented steel-frame windows is located in the middle-south bay. A small air handling unit is placed in the center of the elevation and feeds into the second story. The second story middle bays are infilled with a continuous bank of steel-frame windows covered on the exterior layer by a single sheet of glazing, likely Plexiglas. Above this bank of windows the flat roof projects out further than the rest of the building creating additional shade. The north elevation has a single steel slab personnel door accessed by a concrete staircase with a steel pipe handrail in the middle-west bay. The staircase is flanked by large metal panels that act as a windbreak; these panels are supported by upper brackets attached to the walls. The second floor has horizontally-oriented, three-light awning-type steel-frame windows in the middle bays; a single unit on the west and a paired one on the east. A single unit is also placed in the landing recess on the east end. The northernmost bay on the east elevation has a set of steel personnel doors with upper glazed panels that are accessed by a concrete staircase with a steel pipe handrail. The middle bays of the first story contain single, horizontally-oriented, three-light awning-type steel-frame windows, while the second floor middle bays each have a three-part type. A large electrical transformer is placed slightly away from the elevation, with insulated pipes leading to the building. The south elevation has a single steel slab personnel door accessed by a concrete staircase with a steel pipe handrail in the middle-east bay. The staircase is flanked on the west side by a large metal panel that acts as a windbreak, identical to those on the north elevation. The middle-east bay contains a set of three 1/1 horizontally-oriented awning type sash while the second story contain similar, but three-light sash in the middle bays – a single on the east and a double on the west.

Property 27170 was completed in 1953 as a Flight Control Building for the SMR and along with the network of camera buildings and the 27190 Launch Pad, was an important part of the primary infrastructure of the range. The building provided office and technical support space for most of the programs that passed through the range. A 1951 architectural plan for the building shows dedicated bench spaces for the loading and unloading (on separate sides of the room) of Bowen-Knapp and Mitchell cameras, demonstrating that these cameras were prepped and unloaded within 27170 during the early years

Figure 69. Property 27170, east and north elevations.

Figure 70. Property 27170, east and south elevations.

Figure 71. Property 27170, first floor interior.

Table 17. The Room Numbers and Assigned Activities in Property 27170 as of 1969.

Room Number	Number of Assigned Personnel	Designation
First Floor		
105	N/A	Battery Room
106	N/A	Janitor
107	N/A	Women's Latrine
108	N/A	Men's Latrine
109	6	Commo
110	N/A	Boiler Room
112	N/A	Commo Storage
114	N/A	EML Storage
115	N/A	Janitor Supplies
116	2-6	M.P. Ready Room
117	N/A	Janitor Supplies
118	3	Commo Frame and Microwave
Second Floor		
203	N/A	Vacant
205	2	Control Room
206	1	SMR Coordinator
207	N/A	Vacant
208	3	Gun Probe Prod.
209	2	Timing

of the SMR operations. These duties appear to have been moved to other buildings later in the decade when more building space was available. Specific information from the disposition data discusses the assignment of Room 118 in the building for use as a mess hall in 1961, which had been temporarily located in Building 27166. The mess hall was subsequently moved to Room 102, then to Room 111 in 1963, so that Rooms 101 and 102 could be used for communications. Room 208 in the building was assigned for use by the TOW Program during 1966 to 1967. A 1969 buildings inventory listed how the rooms were assigned in 27170 at that time (see Table 17).

The building was used in support of the Copperhead Program during the 1970s, and Copperhead Project Engineer Jack Dage recalls having an office located in the building. According to the disposition data, the range control function for the SMR was relocated from Building 27170 to Building 300 in 1980. The firing and target operations for the SMR continued to be operated out of 27170 via a communications net to the range controller at Building 300. At the time of the current inventory, the building did not appear to be currently used or occupied but recent repairs and maintenance were evident.

7.5 Launch Facilities

Launch facilities at the SMR consist primarily of concrete slabs and platforms of various sizes and complexity. Some are simple concrete slab foundations that provided a solid surface to anchor launchers to, while others are more sophisticated and include built-in electrical conduits and alignment rails. The primary launch facility at the SMR is the 27190 Launch Pad, which was the primary launch area at the range. This launch pad incorporated a built-in subterranean cable trench, a fire control system plumbed along its west edge, and two subterranean Fastax camera shelters (Properties 27119 and 27120). The Property 27199 Lacrosse Launch Pad incorporates electrical plugs and conduits into the concrete slab. Other smaller and less complex launch pads include the 27100 and 27101 Little John Launch Pads and the 27215 launch pad constructed atop the 27190 pad for the Shillelagh launches. The other primary launch area at the SMR is the ASL Launch Complex on the eastern margin of the range, where firings of the Loki-Dart, Super Loki, ARCAS, and XM-75 atmospheric sounding rockets were conducted.

7.5.1 Property 27190

Property 27190, the SMR Launch Pad, is a large rectangular concrete slab placed in a north/south orientation. Measuring 100 ft wide by 200 ft long, the pad is intersected by four embedded, continuous steel tie-down tracks; they are placed 10 ft apart from each other and run down the center of the pad in alignment with the firing line (see Figure 73). Two embedded camera vaults (see 27119 and 27120) are placed directly into centerline of the pad – the first lies 75 ft from the south end of the pad and the second 75 ft from the first vault. The underground cable run, Feature 245, is built into the launch pad and runs its full length, extends beyond the pad to the south, then turns 90 degrees east and connects to the west side of Building 27170 (see Figure 72). Overhead light poles with distinctive hinged bases are spaced along the southern margins of the launch pad. The remains of a temporary, circular structure with a hinged, folding steel tubing framework and canvas cover is located on the south half of the pad. This unusual shelter appears to be of relatively recent origin, probably contemporaneous with the LOSAT testing. Various parts related to this structure, mostly additional steel tubing segments are located on the pad, and some office chairs and pile of mannequin parts are located within the shelter.

Figure 72. Property 27190, detail view of underground cable trench.

Figure 73. Property 27190, SMR Launch Pad, view to the north from the south end.

Two concrete access vaults for water valves, part of a fire extinguisher system, are located along the west side of the launch pad, one of which is abutted by the 27215 Shillelagh Platform. These vaults are 3.5 ft north-south by 4.5 ft east-west and approximately 7 ft deep, and are covered by steel plate access hatches. A third such access box at the southwest corner of the pad is indicated on architectural plans but was not observed during the recording. A second concrete underground cable run (Feature 239) originates near the southwest corner of the pad and heads west and north before disappearing beneath the LOSAT Complex. Several electrical panels and boxes are installed along the west side of the pad as well. Numerous anchor studs, bolts, and torch cut I-beams are imbedded into the 27190 pad, indicating a long history of re-use and modification.

Structure 27190 was constructed in 1953 as part of the primary range infrastructure of the SMR.* This structure was the primary launch area at the SMR from the early 1950s into the 1980s. As such, it was the focal point for many of the Cold War-era launches at the SMR. Period photos from the 1950s show that the pad was mostly open and unencumbered, but during the 1960s several features were constructed on the pad in support of the Shillelagh Program.

* WSMR Realty Data records this build date as 1957, which is erroneous as it postdates the as-built dates of the architectural plans. It may be derived from a later addition or modification to the pad.

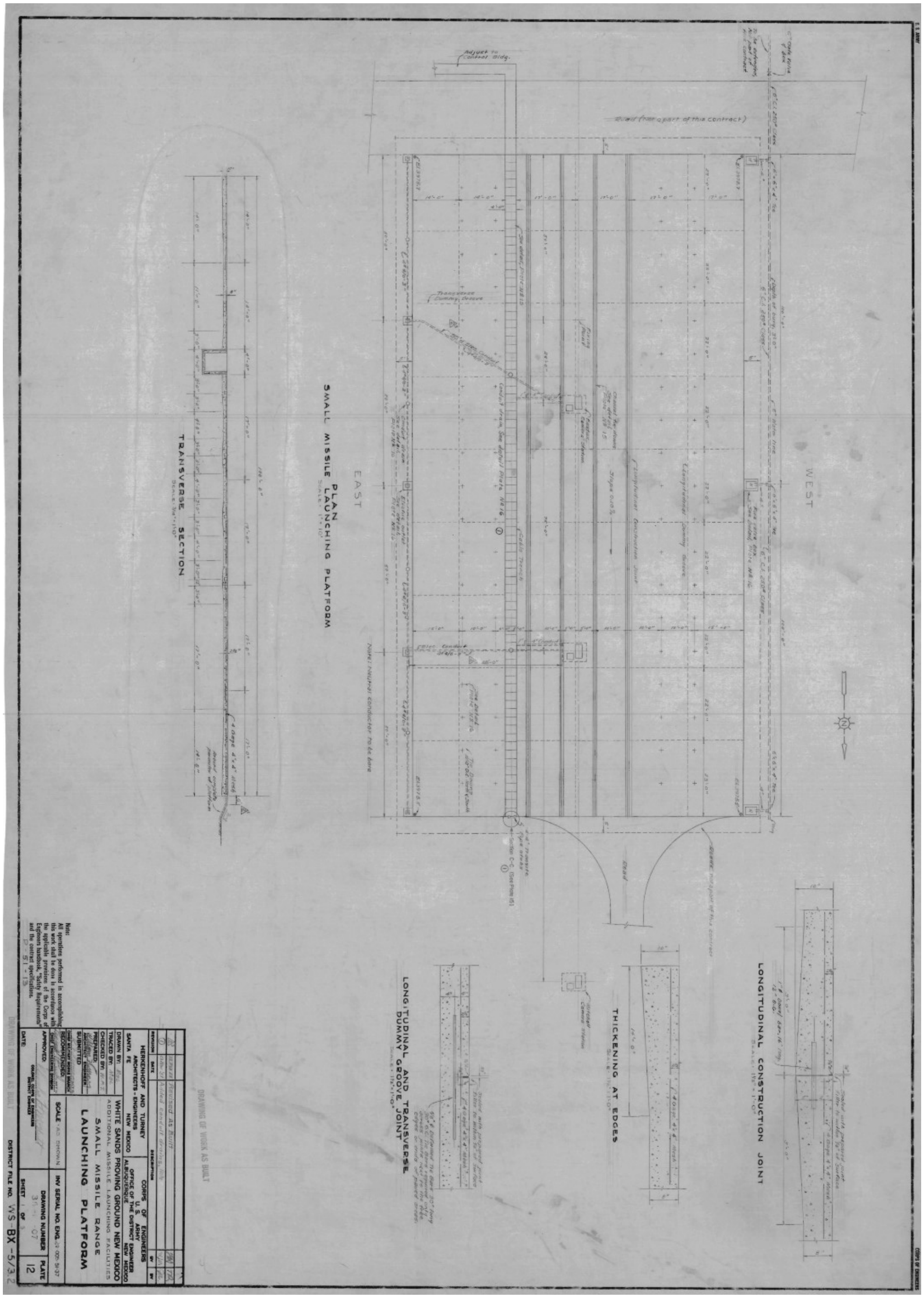


Figure 74. Architectural drawing for Property 27190 from 1953 WS-BX plans (*courtesy WSMR Environmental Directorate*).

These include Structures 27215 and 27216, and Features 241 and 242. These additions partially obscured the tie-down rails and cable run of the pad, indicating that the use of these features was discontinued by the 1960s. The pad supported the Shillelagh Program through the early 1970s, and also likely hosted some Copperhead firings. Most of the pad is currently surrounded by an extension of the chain link fence of the LOSAT Launch Complex, with only the north end accessible.

7.5.2 Property 27199

Property 27199 is an outlying launch area located on the west side of the Yaw line between Property 27134 (Mitchell camera shelter) and Property 27154 (Bowen-Knapp camera shelter). The property consists of a concrete launch pad that measures approximately 50 ft north-south by 30 ft east-west (see Figure 75). The northern edge of the pad extends into a road where it is buried. Built-in electrical access ports are visible along the east edge of the launch pad, and capped electrical conduits are located at the center of the pad's south edge. A partially buried coil of electrical wiring is located at the pad's eastern edge. A subterranean concrete pull box is attached to the southwest corner of the pad. The pull box is square and measures 64 inches per side and is approximately 5 ft deep. Two hatch covers (partially dislodged) of steel plate enclose its top, and an access ladder is built into its south wall. An electrical switch box with a conduit coupler is mounted on a post near the southwest pad corner, and a terminal box, control box, and other debris are located near the base of the post. On the north side of the pad is a yellow electrical locker with two cabinets that is set on a concrete pad. One cabinet is empty while the other contains an electrical control box. A fuse box and electrical inlet are located on the locker's north side. A dedicated overhead power line conveyed power to the site from the southwest, three poles of which remain upright. The pole nearest the concrete launch pad of this line is equipped with two main switches and an overhead light.

Figure 75. Property 27199, view to the southwest.

Figure 76. Property 27199, underground pull box.

According to WSMR realty records, the property was constructed as a launch pad in 1959. It is identified as the Lacrosse Launch Site on several late-1950s and early-1960 maps of the SMR. Documentation regarding the property is very limited, and it is not known if the property was used for the testing of any other programs following the Lacrosse.

7.5.3 Property 27215

Property 27215 is an elevated concrete platform that is constructed on the northeast corner of the 27190 launch pad (see Figure 77). The south side of the platform abuts the Property 27215 Blast Barricade, while the north side of the platform forms a full width ramp down to ground level. Measured along its east edge the platform is elevated 3 ft above the level of the 27190 pad. The east edge of the pad features a yellow-painted safety railing constructed of steel pipe. At its southeast corner where it abuts a short wing of the 27216 Blast Barricade, a short concrete access staircase is cast into the platform. The platform is also ramped along its western edge, except where it abuts a subterranean access vault to the water valves of a fire control system for the 28190 Launch Pad. This vault is 3.5 ft north-south by 4.5 ft east-west and approximately 7 ft deep. Although directly abutting the 27215 platform, this access vault pre-dates the construction of the platform. A similar feature is attached to the west side of the southern portion of the 27190 Launch Pad as well. An aluminum survey datum is set into the platform, and is stamped “DMA / L570 / 08-2”.

Figure 77. Property 27215, view to the southwest.

Figure 78. Property 27215, east side, view to the west.

This structure was constructed in 1966 according to WSMR realty data, and is documented as the Shillelagh Missile Launch Pad. Richard Overlee and Jack Dage believed the platform was also used in for firings of the Copperhead guided projectile during the 1970s (Richard Overlee and Jack Dage personal communication 2014). The platform appears to have been built contemporaneously with the adjacent 27216 Blast Barricade.

7.5.4 Property 27100

Property 27100 is a Little John Launcher Pad. The remains of the structure include a large at-grade concrete pad located to the west and outside of the fenced enclosure associated with Building 27103 (see Figure 79). The roughly rectangular pad measures approximately 65 ft north-south by 23 ft east-west. A grid pattern of approximately 50 recessed square anchor points with inset steel loops is located on the northern half of the pad. The central portion of the pad is occupied by a raised, rectangular steel mounting plate with one piece of welded angle iron at the center and 16 heavy gauge mounting bolts lining the perimeter. The plate measures 107 inches north-south by 64 inches east-west and is mounted on a series of low concrete risers. Three clusters of cut mounting bolts are present immediately south of the plate. A sub-terranean, electrical pull box abuts the eastern edge of the pad. The concrete box measures 52 by 52 inches, includes a two-panel, hinged plate steel cover, and is oriented at an oblique angle to the pad. A rectangular extension overlaps with southern end of the launch pad. The extension or addition appears to post-date the original construction of the launch pad. The launch pad predates Property 27103.

Property 27100 was constructed in 1959 as a launch pad. Little information exists for its use

Figure 79. Property 27100, former Little John Launch Pad, view to the northwest.

in the years following the pad's use in association with the Little John Program; however, at the time of the current inventory the superstructure of the launch pad has been completely removed.

7.5.5 Property 27101

Property 27101 is a Little John Launcher Pad. The remains of the structure include a large at-grade concrete pad located immediately east and within the fenced enclosure of Building 27103 (see Figure 80). The roughly rectangular pad measures approximately 65 ft north-south by 23 ft east-west. A grid pattern of numerous recessed square anchor points with inset steel loops is located on the northern half of the pad. The central portion of the pad is occupied by a raised, rectangular steel mounting plate with a welded angle iron at the center and heavy gauge mounting bolts lining the perimeter. An impression of similar dimensions is located to the north of the mounting plate. A subterranean, electrical pull box abuts the eastern edge of the pad. The concrete box measures 52 by 52 inches, includes a two-panel, hinged plate steel cover, and is oriented at an oblique angle to the pad. The launch pad predates Property 27103.

Property 27101 was constructed in 1959 as a launch pad. Little information exists for its use

Figure 80. Property 27101, former Little John Launch Pad, view to the southeast.

in the years following the pad's use in association with the Little John program; however, at the time of the current inventory the superstructure of the launch pad has been completely removed.

7.5.6 ASL Launch Complex

This property consists of a large concrete slab foundation that served as the main launch pad of the ASL Launch Complex, where numerous meteorological rocket launches occurred during the 1960s-1970s and later. One launcher rail and two buildings (Property 27214 and one unknown property) are currently located on the pad (see Figure 81). An extension to the original pad, described below, was added to the property at an unknown date. A WSMR property number for this property could not be located in archival records, but the complex is clearly identified in period maps and photographs. Numerous meteorology rocket launchers were installed on the pad during the 1970s as visible in period photos, and various anchor points are visible in the concrete where these were formally located. The pad measures approximately 100 ft east-west and 45 ft north-south. Two wood-pole overhead lights with green enamelware light fixtures are installed along the southern edge of the pad. Four brass survey datums are installed on the pad, each of which is stamped "WHITE SANDS GEODETIC CONTROL /

Figure 81. The ASL Launch Complex, view to the east from its west end.

TRAVERSE STATION" and are numbered 670, L473, L472, L471 from east to west. Two aluminum survey datums are numbered L471 AZ and L473 AZ. There is also evidence that several survey datums have been removed from the pad.

The remaining launcher rail installed on the pad east of the unknown building is constructed of steel plate and I-beams, and is adjustable 360 degrees horizontally and 90 degrees vertically (see Figure 82). It has an electrically powered, hydraulic mechanism for positioning the rail. The launcher rail itself, from pivot to tip, is approximately 20 ft in length. Based on photographs of the launcher in use, it appears to be a Boosted ARCAS launcher.

A steel framework is installed near the south edge of the launch pad, east of the unknown building. It has a welded steel box (with numerous drilled holes) with a sliding lid welded to an angle iron frame. Two unattached steel pipe fixtures rest on the frame as well. The steel box and pipe fixtures are all equipped with grounding straps. A folding metal "EXPLOSIVES" sign is installed adjacent to the feature. The entire assembly appears to have been painted in a crude camouflage pattern at some point in the past. It use and function are unknown, but it might be a temporary storage receptacle or assembly stand for rocket ignition or arming devices.

An additional concrete slab foundation with a series of concrete walls abuts the original ASL launch pad on its north side (see Figure 84). The slab foundation supports a series of six parallel concrete blast walls that form five partially enclosed bays or stalls. The slab foundation measures approximately 80 ft east-west by 30 ft north-south. The plywood-formed concrete walls measure 12 inches thick, 16 ft in length and 7 ft high, and spaced 12 ft apart. The eastern wall measures 20 ft in length. The western bay has

Figure 82. Boosted ARCAS launcher rail at the ASL Launch Complex, view to the west.

Figure 83. Super Loki launcher rail at the ASL Launch Complex, view to the north.

Figure 84. Concrete slab addition with concrete barricade walls on north side of original ASL launch pad, view to the northeast.

two steel plates on its floor, one of which has a circular pattern of eight mounting studs, possibly for anchoring a launcher. The other plate appears to be loose and simply resting in place. The middle bay has three long mounting studs set into its floor, but the other bays are empty of any mounting hardware. On the western end of the bays is what appears to be a Super-Loki launcher mounted to the concrete slab. Each bay is equipped with an electrical connection on its south wall edge and an overhead light. A row of three aluminum-pole overhead lights are mounted to the southern edge of the slab near where it abuts the original ASL launch pad. A raised concrete pad is located at the east end of the slab and has a circular pattern of six 1 ½ inch diameter anchor studs and four risers of 4-inch diameter electrical conduit. Nearby is a 4 ft square by 3 ft deep concrete box, possibly an uninstalled electrical pull box.

This structure appears to be a relatively recent addition to the launch area, as it is not visible in photos of the complex from the early to mid 1970s. It is unknown whether it was constructed in support of the ASL meteorological sounding rocket research or was part of a divergent reuse and adaptation of the complex. The ASL Launch Complex does not appear to have been used in recent years, and is currently abandoned.

7.6 Instrumentation

One of the key components of rocket and missile testing is the ability to collect and analyze all types of in-flight information ranging from speed to trajectory to performance characteristics – the whole point of a test range is to create a controlled environment to collect data; what works, what doesn't, and why. As such, a number of instrumentation types were developed in the WW II years and during the early Cold War era and have been continually improved over the decades. This includes optical devices such as high-speed motion picture cameras; cinetheodolite and instrumentation radar devices for tracking azimuth and elevation; and telemetry, where information is typically sent from the item being tested to ground receivers. Collectively, this data helps to paint an accurate picture of a test item moving at speeds that do not allow for casual observation or measurement.

Optical range instrumentation can be grouped into two large categories: surveillance and metric. Surveillance optical instrumentation is primarily concerned with creating a record of an event not intended for precision measurements. Metric optical equipment, on the other hand, produces film or plate records from which precise measurements can be calculated (Delgado1981). The cameras used at the SMR were metric optical devices – short-focal length, high speed cameras from which precise measurements of test events could be made. Metric optical instrumentation can be further divided into tracking and fixed devices, and the cameras at the SMR were of the latter category (Delgado 1981). At the SMR, the fixed cameras were oriented along the anticipated trajectory of the missile and housed in specialized buildings that provided rigid mounting, shelter against the elements, and some level of protection against an errant launch. The short focal lengths of these cameras allowed them a wide field of view but also required them to be located close to the firing line.

The SMR flight line is defined by two types of cameras and shelters. Along the east and west periphery of the flight line are above ground buildings that sheltered Bowen-Knapp cameras (see Figure 85). Down the center of the flight line are mostly subterranean buildings that contained either Fastax or Mitchell high speed cameras (see Figure 86). As noted by a 1966 Army procedural manual on photographic instrumentation, early trajectory data was best captured with "…fixed cameras, which are located beneath and to the side of the trajectory" (US Army 1966:1). This requirement is readily apparent in the layout of the SMR camera buildings. All the buildings in the SMR fixed camera network were constructed in 1952, with the exception of Properties 27160, 27161, 27162, and 27163, which were constructed in 1955.

Together, the SMR camera instrumentation captured critical flight data in approximately the first 10,000 ft of the trajectory, which is where most of the important events occur in a short-range missile, such as engine ignition and the pre-burnout flight details of yaw, pitch, roll, space position, velocity, and acceleration which determine the final, post-motor burnout trajectory of the missile (Ehling 1967). The positioning of the cameras at the SMR therefore allowed a three-station solution for these data points along the entire early trajectory of the flight. The fixed camera building network delineates the shape of the SMR on the landscape and makes the range unique. Seldom was such an investment in infrastructure made for the locating of fixed cameras, and elsewhere at WSMR and other proving grounds fixed cameras were located with more temporary mounting solutions.

Figure 85. A Bowen-Knapp camera and operators within a camera shelter at the SMR, circa mid-1950s (*photo courtesy WSMR)*.

Figure 86. A Fastax camera ad circa 1955 (*reproduced from Missile Away! Fall 1955 Issue)*.

7.6.1 Bowen-Knapp Camera Buildings

Figure 87. Property 27110, a good example of the typical Bowen-Knapp Camera Shelter, view to the northeast.

Properties 27110-27118 and 27150-27158 are Bowen-Knapp camera shelters (see Figure 87). These buildings were specially designed and constructed to house Bowen-Knapp high speed cameras. The Bowen-Knapp camera was a high speed ribbon frame camera developed by Dr. Ira Bowen of Caltech, a pioneer in optical design.* Dr. Bowen developed the CIT-1 Ribbon Frame Camera as part of a collaborative effort between Caltech and the US Naval Ordnance Test Station at Inyokern, California during the 1940s (Bowen 1968; Delgado 1981). The hyphenated "Bowen-Knapp" designation of the camera is apparently due to the role of a Mr. Knapp, a government contact responsible for the funding of the project (Delgado 1981). The ribbon-frame camera was distinctive from standard cine camera equipment in that the speed of the film transport mechanism is continuous throughout the camera, while cine equipment uses an intermittent speed film transport mechanism. The continuous speed mechanism never slows the movement of the film even while it is being exposed, relying on very high shutter speeds to keep the image from being blurred. Intermittent speed film transport mechanisms used in cine equipment halt the film movement while the image is being exposed (Ehling 1967). The Bowen-Knapp CT-1 camera was developed into the CZR-1 series, which during its operational tenure was regarded as a state-of-the art high speed camera (Delgado 1981).

These buildings were built on a standardized plan and are essentially identical except for various modifications made to some examples of the building since they were constructed. Fifteen of the buildings remain extant at the range; three of the buildings (Properties 27153, 27156, and 27157) have been razed to the foundations.

The Bowen-Knapp camera shelter buildings at the SMR are one-story, rectangular plan buildings with a reinforced concrete foundation that terminates 25 inches above grade. The slightly recessed walls are constructed with CMUs and coated with a stucco finish. The periphery of the uppermost sections of the four walls is finished in a continuous concrete beam, or lintel, that follows the contours where the outer walls drop, creating a large sloped opening on

* Dr. Ira Sprague Bowen is better remembered as a physicist and astronomer, fields in which he made significant contributions. He received awards from the National Academy of Sciences and the American Academy of Sciences, and was a member of the National Academy of Science. The Bowen Ratio (a mathematical expression of heat transfer), a moon crater, and an asteroid were named after him.

the range-facing elevation. Designed specifically as ballistic range camera shelters, each unit faces the range area perpendicularly as evidenced by an east (or west) facing weather-protection, roll-up steel door. Each of the remaining 15 duplicate buildings is a mirror-image of their cross-range counterpart, each containing a single personnel door that faces away from the range; the steel, recessed panel doors contain two glazed panels divided by a horizontal muntin bar. The door is flanked by reinforced concrete posts and accessed by a simple, 3-step concrete flight due to the raised foundation. The roof is comprised of a one-piece, slightly crowned concrete slab that ranges from 4 inches thick at the outer edges to 6 inches thick at the peak; the roof slab overhangs the walls on three elevations by 12 inches. The roll-up doors, almost in the manner of a roll-top desk, follow the contours of the sloped opening. This opening is the primary field of vision for a fixed camera mounted on an interior concrete pedestal placed close to the opening. Each building is fitted with a small, steel-frame 2/2, double hung sash placed on the north elevation. Electrical power for the buildings comes from an overhead line which connects to the pole line that runs downrange. The interiors are straightforward—each unit contains a centrally-placed concrete pedestal (camera mount) and electrical components are mounted on the outside walls. A second, lower pedestal appears to have been added to some of the buildings. Each of the now vacant structures vary in condition; they have been left to the elements. Other than the demolition of Buildings 27153, 27156, and 27157, most of the

Figure 88. Property 27110, east and south elevations.

Figure 89. Property 27110, north and west elevations.

Figure 90. Property 27110, north and east elevations.

buildings have had no major alterations other than electrical conduits have been added and many of the overhead wires have been disconnected from the power lines.

7.6.1.1 Property 27110

Property 27110 is the furthest south of the east line of Bowen-Knapp camera buildings. It is associated with a concrete electrical pull box (Feature 29) which is offset from the southwest corner of the building. A 110 volt electrical outlet has been fitted to the north elevation wall, in addition to a milled lumber doorstop mounted to the east elevation wall.

7.6.1.2 Property 27111

Property 27111 is associated with a concrete instrumentation pad (Feature 26) which is adjacent to the north elevation of the building. The north elevation of the building has been modified to allow for an electrical conduit that extends from the north elevation to the adjacent pad. Based on the noted modification, it is likely that the instrumentation pad post-dates the construction of the camera shelter. Additionally, Property 27111 includes a milled lumber doorstop mounted to the east elevation wall.

7.6.1.3 Property 27112

Property 27112 has had a standard 110 volt electrical outlet fitted to the south elevation wall, in addition to a milled lumber doorstop mounted to the east elevation wall. The building is otherwise unmodified and a typical example of these camera buildings.

7.6.1.4 Property 27113

Property 27113 is associated with six metal equipment panels that have been dumped adjacent to the building's north elevation. Other than a milled lumber doorstop mounted to the east elevation wall, it is otherwise unmodified and a typical example of these camera buildings.

7.6.1.5 Property 27114

Property 27114 is unmodified and a typical example of these camera buildings. A milled lumber doorstop has been added to the east elevation wall, a typical modification along this line of the camera shelters.

7.6.1.6 Property 27115

Property 27115 is a typical example of the roll-top Bowen-Knapp Camera Shelter, with the addition of a standard 110 volt electrical outlet fitted to the south elevation wall the only notable modification.

7.6.1.7 Property 27116

Property 27116 also possesses the commonly seen milled lumber doorstop mounted to the east elevation wall. The building is otherwise unmodified and a typical example of these camera buildings.

7.6.1.8 Property 27117

Property 27117 also possesses the common modifications of an electrical conduit mounted on the south elevation wall, and a milled lumber doorstop mounted to the east elevation wall. Otherwise, the building is a typical example of these shelters.

7.6.1.9 Property 27118

Property 27118 is the northernmost of the east line of the original 1952 Bowen-Knapp camera shelters, opposite of Property 27158 on the west side of the SMR. It has an electrical conduit mounted on the south elevation wall, a length of milled lumber mounted to the reinforced concrete framing of the north elevation, and a milled lumber doorstop mounted to the east elevation wall. More interestingly, impact damage is present on the building's west elevation. The damage appears to be the result of an impact with a relatively large airborne object that collided with the shelter, perforating the roll top and deflecting into the adjacent reinforced concrete rail (see Figure 91).

Figure 91. Property 27118, impact damage to the rolling steel door.

7.6.1.10 Property 27150

Property 27150 is associated with a wood frame, earth filled blast barricade (Structure 27074) which is located just to the north of the building. Two electrical boxes have been affixed to the south elevation, one if which is a terminal/pull box, while the other houses a main breaker switch. This building is also the furthest south of the west line of Bowen-Knapp camera buildings.

Figure 92. The interior of Property 27118, which is typical of the Bowen-Knapp camera shelters.

7.6.1.11 Property 27151

Figure 93. Modified window aperture of Property 27151.

Figure 94. Interior view of Property 27151 with modified window and added pedestal.

Property 27151 has been modified by the removal of the north elevation window and the enlargement of the window portal to approximately 58 inches by 38 inches (see Figure 93). This enlarged portal was framed with milled lumber, but not fitted with a replacement window. Crude plywood shutters were attached to cover the portal when not in use, one of which has detached from the wall and fallen to the ground. An empty electrical terminal box rests on the portal sill, and another similar box is located on the ground nearby. A rusted piece of 2 inch diameter conduit or pipe is associated with this box. Within the building interior, a second concrete camera pedestal was added to the floor, aligned with the center of the enlarged window portal (see Figure 94). A small fuel tank rests on the building floor near to the pedestal. It is obvious that the building was modified to provide a north-oriented fixed camera placement, but when and for what program is unknown. Additionally, another camera pedestal was anchored in concrete approximately two meters north of the north elevation (recorded as Feature 217). Perhaps related to these modifications, a 110 volt electrical outlet has been fitted to the south elevation wall.

7.6.1.12 Property 27152

Property 27152 is mostly identical to the other Bowen-Knapp camera shelters, but a pole constructed of 3 inch diameter pipe or conduit is located on the ground just off the east elevation. The pole is capped with a heavy iron housing fitted with four ceramic insulators (one of which is shattered), possibly a transformer. A downed pole is located approximately 20 m to the northeast of the building, but does not possess the signs or targets typical of calibration target poles.

7.6.1.13 Property 27153

Property 27153 is one of the three Bowen-Knapp camera shelters that have been demolished, with only the raised concrete slab foundation remaining. Electrical conduits and concrete debris rest on the foundation surface. This building, along with Buildings 27156 and 27157, appear to have been razed to provide a clear flight path for the LOSAT testing as these buildings were located within the line-of-sight between the LOSAT Launch Complex and a target mound at the west margin of the range. This speculation would explain why only these three of the Bowen-Knapp buildings were selectively demolished.

Figure 95. Detail of the double-hung steel window that is present in all the Bowen-Knapp Camera Shelters.

7.6.1.14 Property 27154

Property 27154 has a wood post with 2 x 4 inch lumber braces attached to the north elevation, which is anchored to the roof by wire wrapped around the eave. The purpose of the post is unknown, and the entire assembly appears to be very expedient in nature. Some electrical wires are routed under the rolling steel door. The building is otherwise unmodified and very typical of these camera buildings.

7.6.1.15 Property 27155

Property 27155 has a broken, but still intact, light in its entry door and wiring routed under the rolling steel door. The building is otherwise unmodified and a typical example of these camera buildings.

7.6.1.16 Property 27156

Property 27156 is one of three (27153 and 27157) demolished Bowen-Knapp camera buildings, with only the concrete slab foundation remaining (see Figure 96). A rectangular pattern of drilled holes in a diagonal northwest-southeast orientation indicate that the foundation was repurposed, possibly as platform for a temporary launcher installation. An aluminum datum installed in the center of the foundation is stamped “DMA-WSMR / KEM-2 / L694” indicates that the re-use was part of the 1990s LOSAT Kinetic Energy Missile (KEM) testing. A large area to the east of the foundation has been cleared of vegetation and surfaced with gravel, and the calibration target poles in this general vicinity have been removed. This cleared area is likely a staging area for the activities carried out on the 27156 foundation, supporting the hypothesis that it served as a temporary launch location. A wood pallet currently rests atop the foundation.

Figure 96. Property 27156, one of the three demolished Bowen-Knapp Camera Shelters.

7.6.1.17 Property 27157

Property 27157 is another of the three demolished Bowen-Knapp camera buildings, which also include 27153 and 27156. Only the concrete slab foundation of the building remains. Debris consisting of steel pipe and wiring is located near the east side of the foundation, and several pieces of bent electrical conduit protrude from the foundation. The foundation is becoming overgrown with vegetation, including a cactus growing from the inset conduit channel in the concrete. This building, along with Buildings 27153 and 27156, appear to have been razed to provide a clear flight path for the LOSAT testing as these buildings were located within the line-of-sight between the LOSAT Launch Complex and a target mound at the west margin of the range. This speculation would explain why only these three of the Bowen-Knapp buildings were selectively demolished.

7.6.1.18 Property 27158

Property 27158 is the northernmost of the west line of the original 1952 Bowen-Knapp camera shelters, opposite Property 27118 on the east side of the SMR. It has been modified by the addition of a ¼ inch steel plate to seal the upper panel of the two-panel entryway door, and the adjacent utility pole has been cut down at the base.

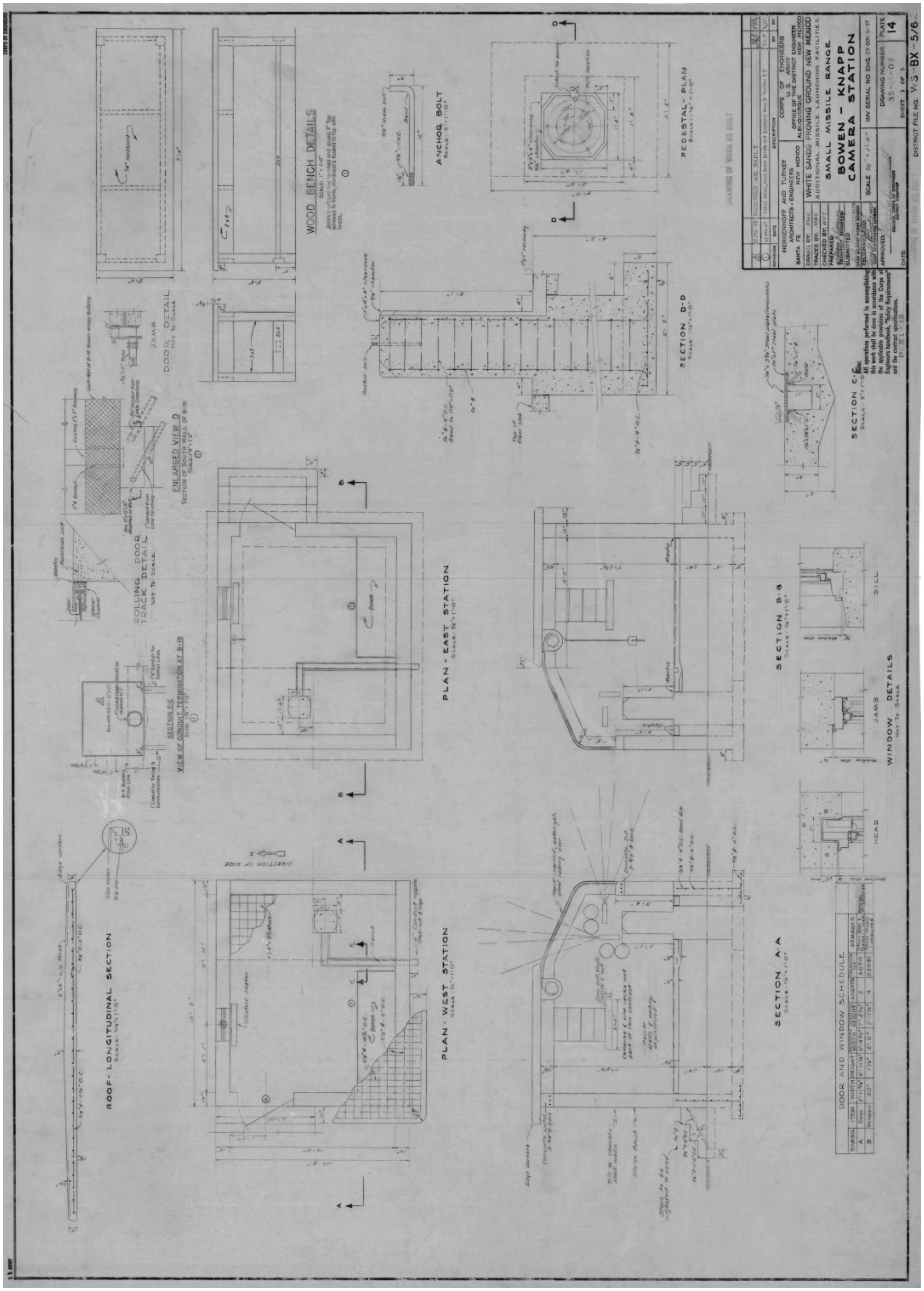


Figure 97. Architectural drawing for Bowen-Knapp Camera Station from 1953 WS-BX plans.

7.6.2 Folding-Panel Camera Shelters (Properties 27160-27163)

Four additional camera shelter buildings were added to the north end of the line of Bowen-Knapp shelters on both the east and west sides of the range (two per row) in 1955, post-dating the construction of the other camera shelters by three years. These camera buildings extended the camera coverage of the SMR further north, possibly for enhanced coverage of the Little John testing which began in 1956. The buildings diverge from the architectural pattern of the earlier Bowen-Knapp buildings in that they do not incorporate the overhead rolling door, but instead use a tripartite hinged panel system and sliding roof panel (see Figure 98). Documentation on these buildings is scanty, but they appear to have used the same Bowen-Knapp cameras as the other buildings.

These four duplicate properties are one-story, irregular plan, reinforced concrete buildings with flat roofs. The six-sided unfinished concrete structure gets its fifth and sixth elevations through a three-part bay that faces the central yaw line of the SMR. Designed specifically as missile range camera shelters, each unit faces the range area perpendicularly with the upper portion of each bay containing an outward-opening metal panel. Each panel is supported by a pair of steel adjustable sliding track mechanisms that can hold the downward folding

Figure 98. Property 27160, showing operation of folding panels on west elevation, view to the southwest.

panels in any fixed position; the two outside panels are fitted with single, square, glazed panels. Each of the four buildings is a mirror-image of its cross-range counterpart and contains a two-panel, steel personnel door that faces away from the range. The door is accessed by a simple, 2-step concrete flight due to a raised foundation. A four light, steel-frame fixed sash is placed on the north elevations; the glazing is wire-embedded. The concrete flat roof covers only half the roof area. Two steel I-beams attached with brackets at the roofline run the length of the north and south elevations. A moveable steel-frame roof section that covers half the roof on the range-facing bay side slides on mechanical rollers; this exposure along with the open bay panels provides a ninety-degree opening. The fixed roof section is comprised of a concrete slab that overhangs at the personnel entry elevation. Electrical power for the buildings comes from an overhead line which connects to the pole line that runs downrange. The interior of the buildings, unlike the other Bowen-Knapp shelters, contains two rooms divided by a full height concrete wall with a pair of sliding metal doors that separates the two spaces. Each of the now vacant structures do not appear to have had any significant alterations.

Figure 99. Property 27161, south and west elevations.

Figure 100. Property 27161 east elevation entry.

Figure 101. Property 27161, north and east elevations.

7.6.2.1 Property 27160

Property 27160 is in relatively poor condition compared to the other shelters of this type. Two of the three panels located on the west elevation appear to be jammed in the open position, which has resulted in the weathering of the interior features as exhibited by rust and peeling paint. Four notable modifications are present on the north and south elevations. These include a metal pipe penetration present on the east elevation, conveying three electrical wires from the interior of the building; a metal electrical conduit mounted below the roofline on the east elevation that extends to a fuse box before terminating at a 110 volt outlet on the north elevation; a metal electrical conduit mounted vertically on the north elevation and extending to the ground surface from a wall penetration; and an informal penetration on the north elevation allowing for the passage of an unprotected electrical wire.

7.6.2.2 Property 27161

Property 27161 is the northernmost camera shelter along the east side of the SMR. No modification or alterations to the building were observed, and it is a good example of the 1955 folding-panel Bowen-Knapp Camera Shelters.

7.6.2.3 Property 27162

Property 27162 is associated with a concrete instrumentation pad (Feature 35) which is located to the south, in addition to a concrete buried cable marker (Feature 37) that is located to the north of the building. The building is typical of the 1955 folding-panel Bowen-Knapp Camera Shelter variant; however, this particular example is constructed atop a graded earthen mound. The mound was probably required to elevate the building in order to provide the proper field of view for the camera.

7.6.2.4 Property 27163

Property 27163 is associated with a portable concrete instrumentation pedestal (Feature 33) which is located to the north of the building. It has a 110 volt electrical outlet fitted to the north elevation wall and on the west elevation the entryway light fixture has been removed. A fuse box has been mounted below the power line connection on the west elevation. As seen with Property 27162, this camera shelter was built atop a graded earthen mound, presumably to elevate the building and thereby improve the camera field of view.

7.6.3 Fastax and Mitchell Camera Buildings

Properties 27119-27149 are specialty shelters designed to house and protect either Fastax or Mitchell high speed cameras. Like the Bowen-Knapp, the Fastax camera used a continuous speed film transport mechanism and incorporated a high-speed rotating prism to synchronize the film speed and image velocity to keep the image exposure from being blurred (Ehling 1967). The Fastax camera, which could film at speeds up to an impressive 5,000 frames per second due to its rotating prism, was originally developed by Bell Laboratories in the 1930s to film and troubleshoot problems in telephone relay boards. The Fastax camera design was later sold to Western Electric, than again to Wollensak Optical Company, where it was modified to operate at speeds up to 10,000 frames per second during the 1940s. Multiple Fastax cameras were used to record the Trinity Test explosion in 1945 (Mills 2014). Mitchell cameras are a renowned brand of 35mm and 16mm motion picture cameras that were mainstays of the film industry from the 1920s to the 1960s. Mitchell produced a high-speed Government Camera (GC) model that operated at film speeds up to 128 frames per second and was mostly purchased by the military; however it is not clear if this was the particular model used in the SMR camera shelters.

Figure 102. Property 27132, a good representative of the identical Fastax and Mitchell Camera Shelters installed at the SMR. View is to the southeast.

The Fastax /Mitchell camera vault buildings were built on a standardized plan and are essentially identical except for various modifications made to some examples of the building since they were constructed. Two of the buildings, 27119 and 27120, are incorporated into the 27190 Launch Pad and are difficult to view. According to architectural plans, these two shelters were also the only two that housed Fastax cameras. Likely the very high filming speed of the Fastax made them more desirable for recording the numerous critical high speed events that occur during the launch such as steps in the firing sequence, engine combustion, and launcher release (Ehling 1967). The remainder of the buildings contained Mitchell cameras, whose speeds were sufficient to capture the flight path of the rocket or missile after the launch. The Mitchell cameras were also probably more economical to purchase than the specialized Fastax. Due to its very high speeds, the Fastax could only operate in brief bursts before it used the entire 100 ft of film in its canister and required reloading. This made the Fastax impractical to use in applications where it needed to operate for longer than a few seconds. For these reasons, the Mitchell was the more practical choice for the downrange camera shelters. All the Fastax/ Mitchell camera shelters at the SMR remain intact; none have been demolished, although some have been lightly modified or repurposed.

The 31 equidistant duplicate structures laid out along the SMR firing line, are reinforced concrete, subterranean vaults whose uppermost sections project anywhere from seven to 12 inches above grade due to erosion (see Figure 102). Measuring roughly 8 ft x 6 ft with an interior depth of 7 ft from floor to ceiling, the plywood and board-formed structures have 6 inch thick walls, floor and ceiling, reinforced with steel rods throughout. Designed to house specialty camera equipment, the relatively small vaults have two openings at the top. Placed in the northeast portion, the smaller of the two (24 inches square) is covered by a steel-plate personnel door that leads to a steel-frame ladder which provides access to the interior space. The second opening (45 inches by 30 inches), placed in the southwest portion, is covered by a double, diamond-plate steel door; this opening is designed to allow a full vertical view for a camera mounted on an 18 inch square concrete pedestal below (a plate glass cover was inserted during use). Adjacent to the pedestal is a small wooden bench. A small drain opening is found on the floor in the northwest corner. Electrical and control conduits run from the pedestal along the wall where they lead to two subterranean cable ducts. Each of the now vacant structures vary slightly in condition; they have been left to the elements.

7.6.3.1 Property 27119

Property 27119 is one of only two of the vaults designed to house Fastax cameras which were incorporated into large concrete slab that makes up the first launch pad (27190) at the SMR. Unlike the remaining 29 camera vaults downrange, the Fastax vaults only project slightly above the surrounding concrete slab. A brass datum marked “F.AST” is embedded in the top of the structure. Water has seeped into the building and the floor of the building is currently submerged under approximately 2 ft of accumulated water.

7.6.3.2 Property 27120

Property 27120 is one of only two of the vaults designed to house Fastax cameras which

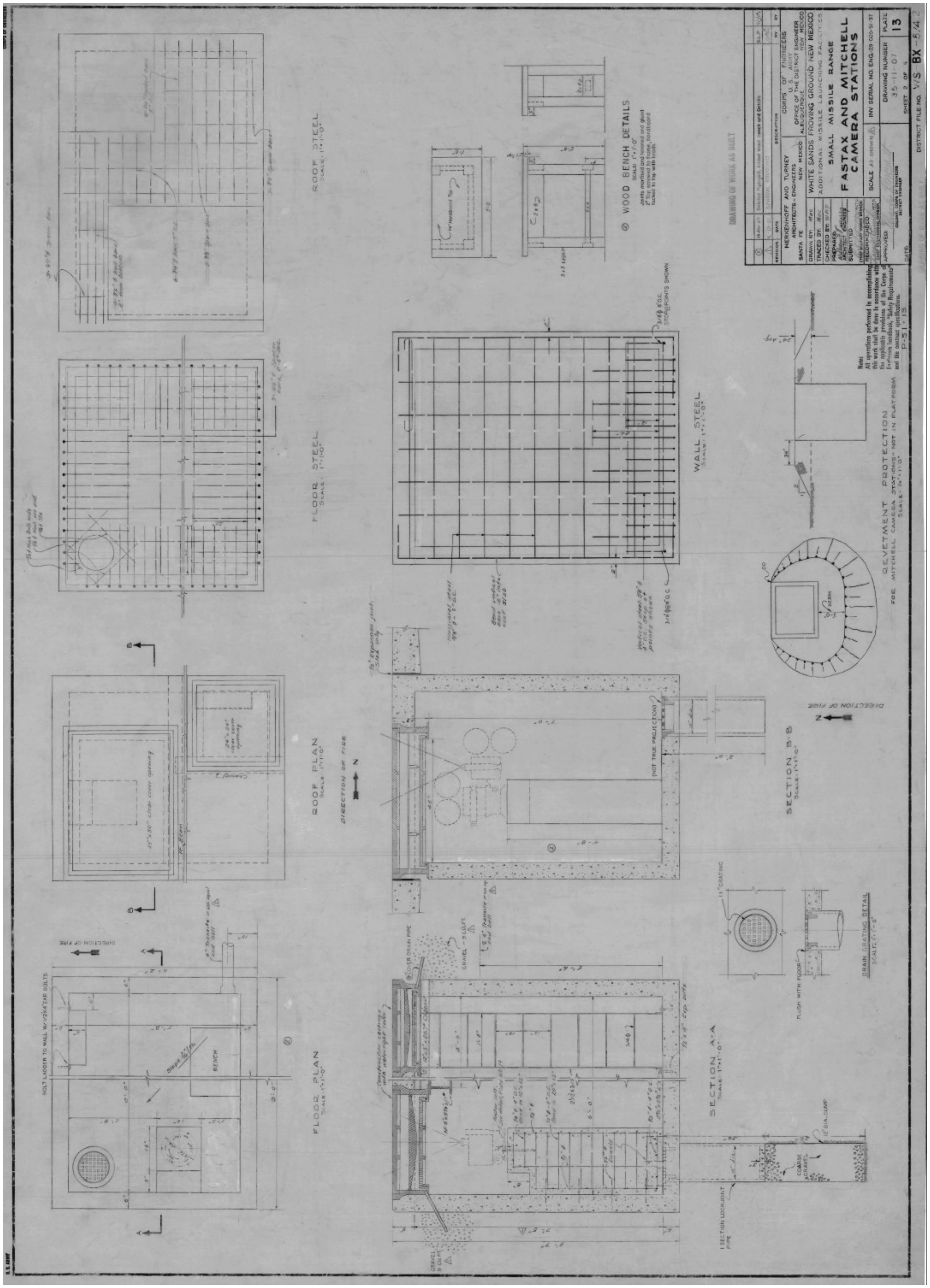


Figure 103. Schematic drawing of Fastax/Mitchell Camera Shelter from 1953 WS-BX plans.

were incorporated into large concrete slab that makes up the first launch pad (27190) at the SMR. Unlike the remaining 29 camera vaults downrange, the Fastax vaults only project slightly above the surrounding concrete slab. The addition of timber blasts shields (or "berms"), a chain link fence surrounding the launch pad (27190) and vegetation have obscured the camera vault, but it remains intact. A brass datum marked "YAW-1" is embedded in the top of the structure.

Figure 104. Property 27119, constructed within the Property 27190 Launch Pad, view to the south.

7.6.3.3 Property 27121

Property 27121 is the first of 29 camera vaults designated to house the Mitchell camera and which are essentially buried in the earth along the center yaw line of the range. Mounted atop the concrete structure in the center is a steel, hand-cranked, wire spool; a small metal control, or distribution box, is attached on the south side. Placed very close to the west side of the vault is a square, board-formed concrete pedestal with four steel bolts protruding from the top. A brass datum marked "YAW-2" is embedded in the top of the structure.

Figure 105. Typical Fastax/Mitchell Camera Shelter access hatch.

7.6.3.4 Property 27122

Property 27122 is one of the 29 Mitchell camera vaults along the yaw line of the SMR. Partially obscured by vegetation, the personnel door is lying open atop the structure and a small metal control, or distribution box, is attached on the south side. A brass datum marked "YAW-3" is embedded in the top of the structure. A metal spool with cable is lying adjacent to the vault.

7.6.3.5 Property 27123

Property 27123 is one of the 29 Mitchell camera vaults along the yaw line of the SMR. A small metal control, or distribution box, is attached on the south side. A brass datum marked "YAW-4" is embedded in the top of the structure. Three recessed lag bolt receivers in a triangular pattern are placed on the north side of the camera covers and two sets of nails are hammered into the concrete between the covers.

7.6.3.6 Property 27124

Property 27124 is one of the 29 Mitchell camera vaults along the yaw line of the SMR. Three recessed lag bolt receivers in a triangular pattern are placed on the north side of the camera covers and a capped pipe fitting projects from the surface adjacent to a brass datum marked "YAW-5."

7.6.3.7 Property 27125

Property 27125 is one of the 29 Mitchell camera vaults along the yaw line of the SMR. Four recessed lag bolt receivers in a square pattern are placed in the center of the top. A threaded pipe fitting and embedded bolts project from the surface adjacent to a brass datum marked "YAW-6." A small metal control, or distribution box, is lying adjacent to the structure on the east side where a small, projecting section of pipe is embedded in the concrete. Placed very close to the west side of the vault is a square, board-formed concrete pedestal with four steel bolts protruding from the top.

7.6.3.8 Property 27126

Property 27126 is one of the 29 Mitchell camera vaults along the yaw line of the SMR. Four recessed lag bolt receivers in a square pattern are placed in the center of the top. A threaded pipe fitting and embedded bolts project from the surface adjacent to a brass datum marked "YAW-7." A small metal control, or distribution box, is lying adjacent to the structure on the east side where a small, projecting section of pipe is embedded in the concrete. Placed very close to the west side of the vault is a square, board-formed concrete pedestal with four steel bolts protruding from the top.

7.6.3.9 Property 27127

Property 27127 is one of the 29 Mitchell camera vaults along the yaw line of the SMR. Four recessed lag bolt receivers in a square pattern are placed in the center of the top. The personnel hatch door appears to have had an impact on the south side. A mangled threaded pipe fitting projects from the surface in the southwest corner; on the east side a small, projecting section of pipe is embedded in the concrete. Placed very close to the west side of the vault is a square, board-formed concrete pedestal with four steel bolts cut level to the surface.

7.6.3.10 Property 27128

Property 27128 is one of the 29 Mitchell camera vaults along the yaw line of the SMR. Four recessed lag bolt receivers in a square pattern are placed in the center of the top. A capped pipe fitting projects from the surface adjacent to a brass datum marked "YAW-9."

7.6.3.11 Property 27129

Property 27129 is one of the 29 Mitchell camera vaults along the yaw line of the SMR. The personnel hatch door is no longer extant. Four recessed lag bolt receivers in a square pattern are placed in the center of the top. A capped pipe fitting and embedded bolts projects from the surface adjacent to a brass datum marked "YAW-10." Placed very close to the west side of the vault is a square, board-formed concrete pedestal with four steel bolts cut level to the surface; there are three other in the immediate vicinity laid out in an "L" pattern on the north and west sides. Each is fitted with a single steel bolt and the one on the southwest is no longer perpendicular with grade.

7.6.3.12 Property 27130

Property 27130 is one of the 29 Mitchell camera vaults along the yaw line of the SMR. Partially obscured by vegetation, the camera hatch doors are no longer extant (see Figure 106). Four recessed lag bolt receivers in a square pattern are placed in the center of the top. A threaded pipe fitting and embedded bolts projects from the surface adjacent to a brass datum marked "YAW-11." A partially buried small metal control, or distribution box, is lying adjacent to the structure on the east side of the structure. Placed very close to the west side of the vault is a square, board-formed concrete pedestal with four steel bolts cut level to the surface; erosion or impact has canted the pedestal to the west.

7.6.3.13 Property 27131

Property 27131 is one of the 29 Mitchell camera vaults along the yaw line of the SMR. Four recessed lag bolt receivers in a square pattern are placed in the center of the top. A threaded pipe fitting and embedded bolts projects from the surface adjacent to a brass datum marked "YAW-12." On the east side wall, a partially buried small metal control, or distribution box, is attached to the concrete where a small, projecting section of pipe is embedded in the concrete. Placed very close to the west side of the vault is a square, board-formed concrete pedestal with four steel bolts cut level to the surface.

Figure 106. Property 27130, damaged Fastax/Mitchell Camera Shelter, view to the southeast.

7.6.3.14 Property 27132

Property 27132 is one of the 29 Mitchell camera vaults along the yaw line of the SMR. Four recessed lag bolt receivers in a square pattern are placed in the center of the top. A threaded pipe fitting projects from the surface adjacent to a brass datum marked "YAW-13." A small, projecting section of pipe is embedded in the concrete on the east side wall; a slightly large threaded pipe projects from the wall just below. Placed very close to the west side of the vault is a square, board-formed concrete pedestal with four steel bolts cut level to the surface.

7.6.3.15 Property 27133

Property 27133 is one of the 29 Mitchell camera vaults along the yaw line of the SMR. Four recessed lag bolt receivers in a square pattern are placed in the center of the top. A capped pipe fitting projects from the surface adjacent to a brass datum marked "YAW-14." Placed very close to the west side of the vault is a square, board-formed concrete pedestal with four steel bolts cut level to the surface.

7.6.3.16 Property 27134

Property 27134 is one of the 29 Mitchell camera vaults along the yaw line of the SMR. Four recessed lag bolt receivers in a square pattern are placed in the center of the top and a brass datum marked "YAW-15" is embedded in the top of the structure. A small, projecting section of pipe is embedded in the concrete on the east side wall; it has been bent flush to the side wall surface. Placed very close to the west side of the vault is a square, board-formed concrete pedestal with four steel bolts cut level to the surface; there are three other in the immediate vicinity laid out in an "L" pattern on the north and west sides. Each is fitted with a single steel bolt.

7.6.3.17 Property 27135

Property 27135 is one of the 29 Mitchell camera vaults along the yaw line of the SMR. Four recessed lag bolt receivers in a square pattern are placed in the center of the top and a steel bracket is sitting in the immediate area. A mangled pipe fitting projects slightly from the surface adjacent to a brass datum marked "YAW-16." A small, projecting section of pipe is embedded in the concrete on the east side wall. Placed very close to the west side of the vault is a square, board-formed concrete pedestal with four steel bolts cut level to the surface.

7.6.3.18 Property 27136

Property 27136 is one of the 29 Mitchell camera vaults along the yaw line of the SMR. Four recessed lag bolt receivers in a square pattern are placed in the center of the top and a brass datum marked "YAW-17" is embedded in the top of the structure. A sizeable capped steel pipe projects from the top on the south side of the personnel hatch. A small, projecting section of pipe is embedded in the concrete on the east side wall. Placed very close to the west side of the vault is a square, board-formed concrete pedestal with four steel bolts cut level to the surface; there are three other in the immediate vicinity laid out in an "L" pattern on the north and west sides. Each is fitted with a single steel bolt.

7.6.3.19 Property 27137

Property 27137 is one of the 29 Mitchell camera vaults along the yaw line of the SMR. Four recessed lag bolt receivers in a square pattern are placed in the center of the top. A capped pipe fitting projects from the surface adjacent to a brass datum marked "YAW-18." A small, projecting section of pipe is embedded in the concrete on the east side wall. Placed very close to the west side of the vault is a square, board-formed concrete pedestal with four steel bolts cut level to the surface.

7.6.3.20 Property 27138

Property 27138 is one of the 29 Mitchell camera vaults along the yaw line of the SMR. Partially obscured by vegetation, four recessed lag bolt receivers in a square pattern are placed in the center of the top. A capped pipe fitting projects from the surface adjacent to a brass datum marked "YAW-19." A small, projecting section of pipe is embedded in the concrete on the east side wall. Placed very close to the west side of the vault is a square, board-formed concrete pedestal with four steel bolts cut level to the surface.

Figure 107. A typical "YAW" datum found at the southeast corner of each Fastax/Mitchell Shelter.

7.6.3.21 Property 27139

Property 27139 is one of the 29 Mitchell camera vaults along the yaw line of the SMR. Four recessed lag bolt receivers in a square pattern are placed in the center of the top. A capped pipe fitting projects from the surface adjacent to a brass datum marked "YAW-20." A small, projecting section of pipe is embedded in the concrete on the east side wall. Placed very close to the west side of the vault is a square, board-formed concrete pedestal with four steel bolts cut level to the surface. There are two others on the north elevation and west sides; each is fitted with a single steel bolt and the one on the west side has been unearthed completely and is canted significantly.

Figure 108. Property 27141, impact damage on south elevation.

7.6.3.22 Property 27140

Property 27140 is one of the 29 Mitchell camera vaults along the yaw line of the SMR. Four recessed lag bolt receivers in a square pattern are

Figure 109. Property 27141, impact damage on north elevation.

placed in the center of the top. A threaded pipe fitting projects from the surface adjacent to a brass datum marked "YAW-21." A small, projecting section of pipe is embedded in the concrete on the east side wall. Placed very close to the west side of the vault is a square, board-formed concrete pedestal whose top section has been damaged.

7.6.3.23 Property 27141

Property 27141 is one of the 29 Mitchell camera vaults along the yaw line of the SMR. Four recessed lag bolt receivers in a square pattern are placed in the center of the top. A capped pipe fitting projects from the surface adjacent to a brass datum marked "YAW-22." A small, projecting section of pipe is embedded in the concrete on the east side wall. The north and south sides of the structure appears to have received impacts which have resulted in broken concrete exposing the steel reinforcing rods (see Figure 108). Placed very close to the west side of the vault is a square, board-formed concrete pedestal with four steel bolts cut level to the surface.

7.6.3.24 Property 27142

Property 27142 is one of the 29 Mitchell camera vaults along the yaw line of the SMR. Four recessed lag bolt receivers in a square pattern are placed in the center of the top. A capped pipe fitting projects from the surface adjacent to a brass datum marked "YAW-23." A small, projecting section of pipe is embedded in the concrete on the east side wall. Placed very close to the west side of the vault is a square, board-formed concrete pedestal with four steel bolts cut level to the surface; there are three other in the immediate vicinity laid out in an "L" pattern on the north and west sides. Each is fitted with a single steel bolt.

7.6.3.25 Property 27143

Property 27143 is one of the 29 Mitchell camera vaults along the yaw line of the SMR. The northern half of the camera opening cover is no longer extant and four recessed lag bolt receivers in a square pattern are placed in the center of the top. A capped pipe fitting projects from the surface adjacent to a brass datum marked "YAW-24." A small, projecting section of pipe is embedded in the concrete on the east side wall. Placed very close to the west side of the vault is a square, board-formed concrete pedestal with four steel bolts cut level to the surface.

7.6.3.26 Property 27144

Property 27144 is one of the 29 Mitchell camera vaults along the yaw line of the SMR. The camera opening cover is no longer extant and due to a broken section of the steel frame and an earthen berm pushed up against the south side, vegetation is growing in the opening. Four recessed lag bolt receivers in a square pattern are placed in the center of the top. A capped pipe fitting projects from the surface adjacent to a brass datum marked "YAW-25." A small, projecting section of pipe is embedded in the concrete on the east side wall. Placed very close to the west side of the vault is a square, board-formed concrete pedestal with four steel bolts cut level to the surface; the wood used to form the pedestal remains intact. An unidentified, embedded rectilinear steel grate is partially exposed on the north side of the vault.

Figure 110. Fastax/Mitchell Camera Shelter interior, camera mount along west wall.

7.6.3.27 Property 27145

Property 27145 is one of the 29 Mitchell camera vaults along the yaw line of the SMR. Four recessed lag bolt receivers in a square pattern are placed in the center of the top. An electrical pipe fitting projects from the surface adjacent to a brass datum marked "YAW-26." A small, projecting section of pipe is embedded in the concrete on the east side wall. Placed very close to the west side of the vault is a square, board-formed concrete pedestal with four steel bolts cut level to the surface; there are three other in the immediate vicinity laid out in an "L" pattern on the north and west sides. Each is fitted with a single steel bolt.

Figure 111. Fastax/Mitchell Camera Shelter interior, remnants of work bench, discarded wiring, and wall heater along north wall.

7.6.3.28 Property 27146

Property 27146 is one of the 29 Mitchell camera vaults along the yaw line of the SMR. Mounted on the north door of the camera hatch is a steel, three-point mount camera stand. A capped pipe fitting projects from the surface adjacent to a brass datum marked "YAW-27." A small, projecting section of pipe is embedded in the concrete on the east side wall.

7.6.3.29 Property 27147

Property 27147 is one of the 29 Mitchell camera vaults along the yaw line of the SMR. Four recessed lag bolt receivers in a square pattern are placed in the center of the top. A capped pipe fitting projects from the surface adjacent to a brass datum marked "YAW-28." A small, projecting section of pipe is embedded in the concrete on the east side wall. Placed very close to the west side of the vault is a square, board-formed concrete pedestal with four steel bolts cut level to the surface.

Figure 112. Property 27147 interior, access ladder beneath personnel hatch.

7.6.3.30 Property 27148

Property 27148 is one of the 29 Mitchell camera vaults along the yaw line of the SMR. Four recessed lag bolt receivers in a square pattern are placed in the center of the top. A capped pipe fitting projects from the surface adjacent to a brass datum marked "YAW-29." A small, projecting section of pipe is embedded in the concrete on the east side wall. Placed very close to the west side of the vault is a square, board-formed concrete pedestal with four steel bolts cut level to the surface; the wood used to form the pedestal remains intact. There are three other in the immediate vicinity laid out in an "L" pattern on the north and west sides. Each is fitted with a single steel bolt.

7.6.3.31 Property 27149

Property 27149 is the northernmost of 29 camera vaults designated to house the "Mitchell" camera and are essentially buried in the earth along the centerline of the range. Mounted on the north door of the camera hatch is a steel, three-point mount camera stand and four recessed lag bolt receivers in a square pattern are placed on the north side of the camera opening. A threaded pipe fitting projects from the surface adjacent to a brass datum marked "YAW-30." A small, projecting section of pipe is embedded in the concrete on the east side wall.

7.6.4 Instrumentation Support Facilities

By 1955, the SMR had a dedicated instrumentation support building, a modest, pre-manufactured Butler-type steel frame building (Property 27176). Radar Instrument Building (Property 27106) was constructed in 1959 and was used for radar equipment maintenance and storage, although it was repurposed as a briefing room in 1962 according to WSMR Realty disposition files. Additional instrument support buildings were constructed as part of the Little John Program, including an instrument calibration building (Property 27187) and a launcher and camera maintenance building (Property 27173). According to original construction drawings for the Little John Assembly Area, the steel-frame high bay Little John Assembly Building (27180) was at one point assigned a secondary role as a telemetry check facility as well. However, these buildings were likely used in maintenance and testing of on-board instrumentation for telemetry monitoring of the Little John launches rather than in support of the general SMR instrumentation. Numerous instrumentation pads are also found throughout the SMR. Some are no more complicated than a simple reinforced pad, while others have bolt patterns, and a few are accompanied by control stanchions; most do not have facility numbers and are recorded as features.

7.6.4.1 Property 27087

Property 27087 is an elevated steel instrument platform supporting an astrodome manufactured by Parabam (see Figure 113). The location is located across Range Road 7 from the south end of the SMR and as such is southernmost property recorded in association with the SMR. The platform is constructed atop a gravel mound that is accessed via a circular access drive off of Range Road 7. The square steel platform is constructed of I-beams with diamond pattern steel mesh decking and is approximately 15 ft per side and elevated approximately 10 ft above the ground. The astrodome is accessed by a steel staircase on the east side of the platform. The platform is built upon a central column constructed of concrete poured into a vertical sheet metal form. The corners of the platform are supported by I-beam legs, and hydraulic and power drive equipment for rotating the astrodome is installed under the steel platform. Various electrical and hydraulic connections are also routed on the underside of the platform. The astrodome atop the platform is identified by a plate on the door reading “ASTRODOME SHELTER CYLINDER / MODEL C-1 / SERIAL 6 / CONTRACT DA-29-040-ORD-1368 / PARABAM INC. EL SEGUNDO CALIFORNIA”. A WSMR property notice placed on the door notes that the “PREVIOUS OWNER AS TURNED THIS BUILDING IN AS EXCESS”. The interior of the astrodome is devoid of any equipment, and while no indications of the type of instrument the astrodome housed were found it is likely that a Contraves cinetheodolite was formerly located within (see Figure 114).

Several survey datums are set into the mound around the platform. To the south of the platform is a brass datum stamped “US COAST AND GEODETIC SURVEY / REFERENCE MARK / TRAVES NO. 1 1964” while near the northeast corner is another brass datum stamped “WHITE SANDS PROVING GROUND / GEODETIC CONTROL F.D.L. / TRAVERSE STATION / 468”. Nearly underneath the platform is the primary US Coast and Geodetic Survey brass datum, which is stamped “US COAST AND GEODETIC SURVEY / TRAVES 1964”. A final datum is located in the middle of the access drive opposite the platform and is stamped "DMA-WSMR / TS80 / 1984".

According to WSMR realty data, Property 27087 was constructed in 1962 as an instrument platform. It is identified in the realty records and on maps as the Traves Site, a name that is also referenced on the survey datums located at the site. The name is likely a derivative of the Contraves cinetheodolite; a very similar instrument platform housing a Contraves cinetheodolite is to be found in the WSMR Missile Park at the main cantonment. Despite its proximity to the SMR, it is unlikely that the site was part of the dedicated SMR instrumentation network as most test programs at the SMR were of short range systems that did not require optical instrumentation with the long focal length and high magnification optics of the Contraves cinetheodolite. Nonetheless, it may have provided instrumentation support to some of the 1960s and 1970s test programs at the SMR.

Figure 113. Property 27087 elevated instrument platform, view to the northwest.

Figure 114. Property 27087 interior, instrument and supporting equipment have long been removed.

7.6.4.2 Property 27098

Figure 115. Property 27098 Instrument Pad, view to the northwest.

Figure 116. Property 27102 Instrument Pad, view to the southeast.

Property 27098 is a 16 x 16 ft square concrete pad built upon a low gravel mound (see Figure 115). Centrally located on the pad is a steel instrument pedestal of half-inch thick plate steel. A ring of 14 anchor studs protrude from the pad in an approximate 10 ft diameter circle, likely the remnants of an astrodome installation on the pad. A series of three four-inch square steel plates are affixed to the concrete at intervals within the ring of anchor studs. Two two-inch diameter electrical conduits are set into the concrete of the pad, each with flexible connectors. Another pair of built-in electrical conduit risers is located at the base of the instrument pedestal. The number "27096" is spray painted onto the pad, although archival resources indicate that the property number associated with the pad is actually 27098.

According to WSMR realty data, Property 27098 was constructed in 1960 as an instrument pad. Little information exists for its use in the years following construction. An undated map, probably from the early 1960s, indicates the property as the "Minnie Site" but does not indicate what type of instrument was installed at the site. The property is the northernmost of a line of three instrumentation sites along the east margin of the SMR that also includes Properties 27177 and 27178. The pad appears to have been stripped of its instrumentation and abandoned for a substantial period.

7.6.4.3 Property 27102

Property 27102 is an at-grade concrete instrument pad constructed in 1959 (see Figure 116). The structure maintains a square footprint, measuring 12 x 12 ft, atop a leveled gravel mound. A 3 ft diameter steel plate mount with six mounting bolts is centered on the pad and is encircled by a 125 inch diameter ring of ten mounting bolts and is further delineated by a white painted line. Remnants of red, square linoleum tiling are glued directly to the concrete pad within the area demarcated by the white line. Two electrical conduits extend from the east side of the central mounting plate through the concrete pad, terminating at two, yellow electrical boxes mounted on a steel I-beam and offset from the southeast corner of the pad. The mounted boxes house breakers, a volt meter a large dial control panel, in addition to a line of five outlets mounted above the boxes. Immediately to the east of the pad are the remnants of a large milled lumber platform. Based on observations of comparable structures, the outer ring of mounting bolts served as anchor points for an astrodome or similar shelter mounted on the pad.

Property 27102 was constructed in 1959 as an instrument pad. Little information exists for its use in the years following construction; however, at the time of the current inventory the pad had been abandoned for quite some time.

7.6.4.4 Property 27106

Property 27106 is a one-story radar instrumentation building (see Figure 117). According to as built architectural drawings dated November, 1958 (revised September 24, 1959), Property 27106 was grouped among the Little John Facilities present at the SMR. The tan painted

Figure 117. Property 27106 radar instrument building, north and east elevations, view to the southwest.

Figure 118. Property 27106, south and east elevations, view to the northwest.

Figure 119. Property 27106, north and west elevations, view to the southeast.

building is of reinforced concrete post and lintel construction with CMU infill, with a rectangular floor plan on an above grade, concrete slab foundation. The very low-pitch, concrete slab gable roof of the building includes aluminum clad, over-hanging eaves with a flood light positioned above the east elevation. The east elevation includes an extension of the above grade foundation accommodating two entryways, inclusive of one steel, two-panel personnel door, in addition to a loading dock entryway, flanked by two bollards, and consisting of two over-sized steel, three-hinge two-panel doors. The entryway doors of the east elevation are painted brown, set in metal frames, and are equipped with overhanging globe light fixtures. Fenestration of the west elevation includes one brown, steel, slab personnel door set in a steel frame, and a square metal vent with a louvered cover positioned above the entryway. The north elevation is unadorned with the exception of mounted electrical conduit, an outlet, two junction boxes, and three protruding pipes, one of which is capped. Fenestration of the south elevation includes one metal frame window with four lights above a protruding concrete sill. An HVAC unit and a large, rectangular, plywood crate are offset from the south elevation by approximately 4 ft. The crate is filled with large metal electrical panels. The HVAC unit is mounted on a steel frame set on four concrete footers with a large condenser beneath a milled lumber shade structure, and is connected to the building by a length of copper pipe.

Property 27106 was constructed in 1959 as a radar instrumentation building for the Little John Program. Disposition paperwork from this year indicates that the building was used for the “HAWK Prototype Schedule C” radar. By 1962 the building was no longer used in this capacity and it was reassigned as a conference/briefing building for the SMR. It was later used in support of the Shillelagh Program, an assignment that was complete by 1970 according to disposition paperwork from that year. Later the same year, the building was assigned to ERDA as the Operations Building for Project Gun Probe, the HARP gun launched sounding projectile. The building was primarily an administrative facility for Project Gun Probe, as safety protocols allowed for no more than two pounds of smokeless powder in the building at a time. Disposition paperwork dating from 1974 indicates that ERDA and the ASL was no longer using the building in support of Project Gun Probe, and the building was subsequently reassigned to the CLGP (Copperhead) program for equipment maintenance and storage, and office space for three personnel. The building was assigned to the Copperhead Program until 1980. No additional disposition paperwork was available regarding the use of the building beyond 1980. The building was vacant at the time of the current inventory.

7.6.4.5 Property 27175

Property 27175 is an at-grade concrete pad with adjacent electrical infrastructure (see Figure 120). The concrete pad measures 30 x 30 ft and is divided into four equal parts. A White Sands Proving Grounds brass cap survey marker is set into the pad. An electrical panel is present at the east edge of the pad, and includes a mounted electrical box and two 100 amp outlets. A green fuse box is offset approximately 3 m from the west edge of the pad. Additionally, a timber post is located at the northeast corner of the pad. The radar platform is located 41 ft to the north of Property 27176.

Property 27175 was constructed in 1955 as a radar platform. Little information exists for its use in the years following construction; however, at the time of the current inventory none of the superstructure was present.

Figure 120. Property 27175 radar platform, view to the east/southeast.

Figure 121. WSPG brass survey datum associated with Property 27175.

7.6.4.6 Property 27176

Figure 122. Property 27176, north and west elevations.

Figure 123. Property 27176, north and east elevations.

Property 27176 is a pre-manufactured steel Butler building with a rectangular floor plan oriented on a north-south long axis (see Figure 122). The galvanized metal superstructure includes 26 inch wide panels, and a medium pitch, gabled roof of standing seam metal construction with a short eave over the east and west elevations. The metal superstructure is mounted on a plywood form, reinforced concrete wall that extends to a height of 4 ft, 2 inches from the above grade concrete slab foundation. Fenestration of the north and south elevations is identical, consisting of a green, rolling metal, full-height bay doors manufactured by Cornell Iron Works Inc. Each elevation includes a globe light fixture mounted above the bay door, an oval-shaped, metal "BUTLER" placard mounted adjacent to the fixture, and an embossed "BUTLER" logo beneath the roof gable. The property number for the building is indicated on rectangular signage and stenciled in black paint adjacent to the bay doors on both elevations. Fenestration of the west elevation includes a plain steel personnel door set in a metal frame above the base course, concrete wall, offset from the northwest corner of the building. A metal, yellow-painted, mobile stairway with a hand rail and rubber wheels abuts the west elevation, providing access to the raised entryway.

Building 27176 was constructed in 1955 as an Instrument Building. According to Disposition data, the building was subsequently reassigned to a succession of uses including tank maintenance in 1962, vacancy in 1964, the storage or target materials in 1968, and the storage of launch vehicles in 1975. As of the 2002 HSR recording, the use of the building is unknown. The previous 2002 recording noted a radar platform (Property 27175) to the north, a small fiberglass building set on metal skids to the east, and a large metal shipping container (Feature 74) offset from the east elevation of Property 27176. Both the platform and the container remain in association with Property 27176.

7.6.4.7 Property 27177

Figure 124. Property 27177 instrument mound, view to the west/southwest.

Property 27177 is a 16 x 16 ft square concrete pad built upon a low gravel mound that is mostly identical to Properties 27098 and 27178, except that the steel instrument pedestal has been removed (see Figure 124). The center of the pad is instead occupied by a three ft diameter steel mounting plate with a circular pattern of six large bolts and hex leveler nuts. A ring of 12 anchor studs protrude from the pad in an approximate 10 ft diameter circle, likely the remnants of an astrodome installation on the pad. A series of three four-inch square steel plates are affixed to the concrete at intervals within the ring of anchor studs. A large 17 x 8 inch steel plate is also bolted to the concrete pad, which is associated with two two-inch diameter electrical conduits set into the concrete of the pad, each with flexible connectors. Another pair of built-in electrical conduit risers is located near the southeast corner of the instrument pad. Located just to the north of the gravel mound that underlies the instrument pad is a galvanized sheet metal casing embossed with "CABLE STRUT / THE GLOBE COMPANY CHICAGO PAT PEND" and the remnants of a wood crate. At the northwest corner of the pad is a brass survey datum stamped "WHITE SANDS PROVING GROUND / GEODETIC CONTROL F.D.L. / TRAVERSE STATION / TS 433".

According to WSMR realty data, Property 27177 was constructed in 1959 as an instrument mound. Little information exists for its use in the years following construction. An undated map, probably from the early 1960s, indicates the property as the "Ribbon Site" but does not indicate what type of instrument was installed at the site. The property is the center location of a line of three instrumentation sites along the east margin of the SMR that also includes Properties 27098 and 27178. The pad appears to have been stripped of its instrumentation and abandoned for quite some time.

7.6.4.8 Property 27178

Property 27178 is a 16 x 16 ft square concrete pad built upon a low gravel mound that is mostly identical to Properties 27098 and 27177, although the gravel mound in this case has ramps that extend off its southeast and northeast corners (see Figure 125). Like Property 27177, the steel instrument pedestal has been removed and only a three ft diameter steel mounting plate with a circular pattern of six large bolts remains. A ring of 12 anchor studs protrude from the pad in an approximate 10 ft diameter circle, likely the remnants of an astrodome installation on the pad. A series of three four-inch square steel plates are affixed to the concrete at intervals within the ring of anchor studs. A large 17 x 8 inch steel plate is also bolted to the concrete pad, which is associated with two two-inch diameter electrical conduits set into the concrete of the pad. Another pair of built-in electrical conduit risers is located near the southeast corner of the instrument pad. As seen with Property 27177, a brass survey datum is placed at the northwest corner of the pad. This datum is stamped "WHITE SANDS PROVING GROUND / GEODETIC CONTROL F.D.L. / TRAVERSE STATION / TS 432", identical to that of Property 27177 except for the station number.

According to WSMR realty data, Property 27178 was constructed in 1959 as an instrument mound. Little information exists for its use in the years following construction. An undated map, probably from the early 1960s, indicates the property as the "Frame Site" but does not indicate what type of instrument was installed at the site. The property is the southernmost location of a line of three instrumentation sites along the east margin of the SMR that also includes Properties 27098 and 27177. The pad appears to have been stripped of its instrumentation and abandoned for a lengthy period of time.

Figure 125. Property 27178 instrument mound, view to the northeast.

7.7 Assembly and Maintenance Facilities

Assembly facilities are critical components for missile and rocket testing and given the specialized function and relatively remote location of ranges like the SMR, maintenance facilities are necessary for the continuous testing that took place at the range. With missile and rocket testing, the test item typically comes in multiple components that are assembled on site for a specific test or series of tests. These are typically comprised of a casing, solid rocket motor (as opposed to liquid fuel), or "grain," a warhead (ordnance component) and, in the case of guided missiles, a guidance system. With many variants in these components in the testing phase, an assembly facility was necessary to provide a setting in which to safely prepare test items for the range. This building type usually consisted of an open floor plan, overhead crane and hoist assemblies, and large doors for ease of egress. The assembly buildings at SMR were mostly constructed for the Little John Program and were substantial, permanent buildings. The Little John assembly buildings were step-by-step process oriented, where each building served as the facility for a single assembly component: Pre-Assembly Inspection Building (27188), Pre-Assembly *and* Inspection Building (27186), Grain Loading Building (27185), Warhead Assembly Building (27184), and Main Assembly and Telemetry Check Building (27180). It is likely that the high bay for 27180 was designed for assembly work with the missile in a vertical position. One steel-frame pre-manufactured building from the Dart program remains as well (27165).

7.7.1 Property 27085

Figure 126. Property 27085 Target Maintenance Building, south and east elevations.

Property 27085 is a two-part, rectangular plan, metal panel-clad, pre-manufactured steel-frame building placed on a concrete slab (see Figure 126). The northern half is a double "high bay," a roughly two-and-one-half story tall space with no floor separations. The southern half consists of a one-story section; both sections have shallow gable roofs, also clad in metal panels. The high bay portion has no windows but the south elevation contains two tall, steel roll up doors. On the west elevation two evenly spaced evaporative cooler units are placed on steel-frame stands and the east elevation contains two steel-slab personnel doors placed on the outer edges of the section. The one-story, northern section contains steel roll-up doors opposite each other on the high bay end of the east and west elevations and a stylistically-similar, shed-roofed vestibule acts as a weather shield for a steel-slab personnel door on the west elevation. Three evenly spaced two-light sliding casement windows complete the fenestration on the elevation and four identical windows are placed on the south elevation, offset to the west. The east elevation mimics the west but has no vestibule and door. Otherwise finished in white, a tall "belt course" of neutral-colored panels run the upper perimeter of the high bay section. A small plaque on the gable end identifies the building as "A&M Building Systems, Inc., Clovis, NM."

Building 27085 was constructed in 1989 as a Target Maintenance Building. The building is part of the fenced area referred to as the Tank Farm, which is the former Little John Assembly Area. It houses a large shop area and the offices for Trax International, the contractor that currently maintains the Tank Farm area. The 27085 property number is also applied to a small magazine structure north of Building 27165 and a modern mobile trailer building inside the Tank Farm. The rationale behind this recycling of property numbers is unknown.

7.7.2 Property 27108

Property 27108 is a modified, tan-painted Quonset hut building set on an above-grade concrete foundation (see Figure 127). Based on architectural plans, a grid of cable runs were built into the foundation in the interior of the building. The east elevation of the building is equipped with a sliding overhead bay door of unfinished plywood, with a track that extends beyond the north wall of the building. This entrance has a concrete entry slab. The west elevation has a single personnel door constructed of unfinished plywood with a concrete entry slab. A window opening to the south of the door has been sealed with plywood and a sheet metal panel. Stencil painted on this panel is the lettering "SUBDIVISION OF MAXMETAL INC". A yellow-painted electrical locker is located next to the west elevation entry slab. Beneath the folding, hinged lid of the locker is an outlet panel with labeled connections. These connection labels include "IRIG A", "IRIG B", "SHIL A", "220", "E 0565 HYCAM", and "SHIL A,B,C,D". Louvered vent panels are located above both the east and west elevation doorways. Both the north and south elevations have

Figure 127. Property 27108, east and north elevations, view to the southwest.

Figure 128. Property 27108, south and east elevations, view to the northwest.

three window openings that have been sealed with semi-transparent corrugated fiberglass panels. The top of the building is equipped with three sheet metal vent housings.

The building was constructed in 1954 as a Radar Building to replace radar equipment vans that had been parked at the same location. It was therefore likely used to support the Loki Program early in its career. Little information about the use of the building exists in the WSMR disposition data, but it is currently listed as a "General Storehouse" in the WSMR realty data. The "SHIL" labels of the electrical locker associated with the building hint that the building may have been used in support of the Shillelagh Program.

7.7.3 Property 27164

Figure 129. Property 27164, Dart Assembly Building, view to the northeast.

Figure 130. Property 27164 east and north elevations, Property 27205 Barricade visible along north elevation.

Property 27164 is a pre-manufactured steel Armco building built on an at-grade concrete foundation (see Figure 129). The building has a steel frame and is clad in sheet metal panels, and is painted a tan color with brown trim and doors. The building has a rectangular plan with small metal shed additions on its north and south elevations. The addition in the center of the south elevation is identified as an air compressor shelter in the 2002 recording by HSR, while the north elevation addition is identified as a battery room (Connelly and Jackson 2002). WSMR disposition forms indicate that these additions were added between 1962 and 1963. The medium-pitch gable roof of the building is clad with standing seam sheet metal, with a minor eave on all elevations. The roof peak is equipped with lightning rods and grounding wires, as well as two sheet metal vent housings. The roof gable ends are trimmed in flashing and incorporate three louvered vents, and the gable end caps are embossed with the "ARMCO" logo. A double entryway with steel two-panel doors and a concrete entry slab is located in the east elevation, and a similar double entryway is located on the south elevation. A single steel two-panel personnel door is located on the west elevation, and similar doors are built into the shed additions of the south and north elevations. All the doors are set in metal frames, and the entrances into the main building are equipped with overhanging globe “explosion-proof” light fixtures. The south and west elevations of the building both possess two windows. These identical windows are four-light, steel casement windows with an interior grid of security bars.

A wood framework to support an evaporative cooler is attached to the north elevation adjacent to the shed addition. At the northwest corner of the shed addition is an eye wash station that is stamped with “Woodford / Des Moines / Iowa / Variable Flow”. Also along the north elevation of the building, offset by approximately 4 ft, is the 27205 Blast Barricade, which is described separately. Near the northwest building corner (but still on the north elevation), are two electrical lockers and a portable sheet metal equipment box painted olive drab. The larger yellow and black locker is built on a small concrete pad, and is mostly empty. The other locker is also mostly empty, housing only a few shelves and several 220 volt outlets.

According to architectural plans of Property 27164, the west half of the building was originally constructed as the Loki Conditioning Building. The east half of the building was added to this existing portion to create the Dart Assembly Building in 1956. The new half was also pre-manufactured by Armco, so the building exterior therefore appears quite continuous. The building was used as the Dart Assembly Building until 1958 when the program was canceled. Based on WSMR disposition data, it appears that the Signal Misisle Support Agency (predecessor to the ASL meteorology program at the SMR) requested and received the east half of the building for installation of a telemetry ground station during 1959, but never occupied the space. Meanwhile, the west half of the building was used to store parts leftover from the Dart Program into 1959, while the east half of the building was reassigned for instrumentation support of the Little John Program. This work included the preparation and assembly of brackets, stands, and electrical connectors, as well film processing and handling that required a dark room space. Apparently, working areas at the SMR were at a premium in 1959, and this work was carried out in mobile vans when building space was unavailable. By 1960 the building was also used to support the Honest John Program briefly before being turned over to the Shillelagh program. A 1969 memo relates that the east half of the building was allotted to the Army ERDA for storage in order to create space in other buildings for the XM-75 meteorology rocket program. Based on this documentation, it is assumed that during the period 1960 to 1969 that 27164 was used primarily in support the Shillelagh Program. The east half of the building was briefly considered as a lunchroom for the SMR personnel in 1960, but its small size and lack of running water made it poorly suited for the purpose, and the lunch area was instead established in Building 27166. Disposition forms from 1972 to 1973 indicate that the east end of the building was vacant, while the west end was utilized as a machine shop in support of the CLGP (Copperhead), Roust Jab, Shillelagh, Dragon Night Sight, and TOW Night Sight developmental programs.[*] In 1979 Building 27164, along with several other buildings at the SMR, were assigned for use by the Copperhead Program for the remainder of its duration. Information about the more recent use of the building was not available, and it appeared to be vacant as of the current inventory.

* This is only reference to the Roust Jab program at the SMR that was encountered during archival research and very little is known about this program.

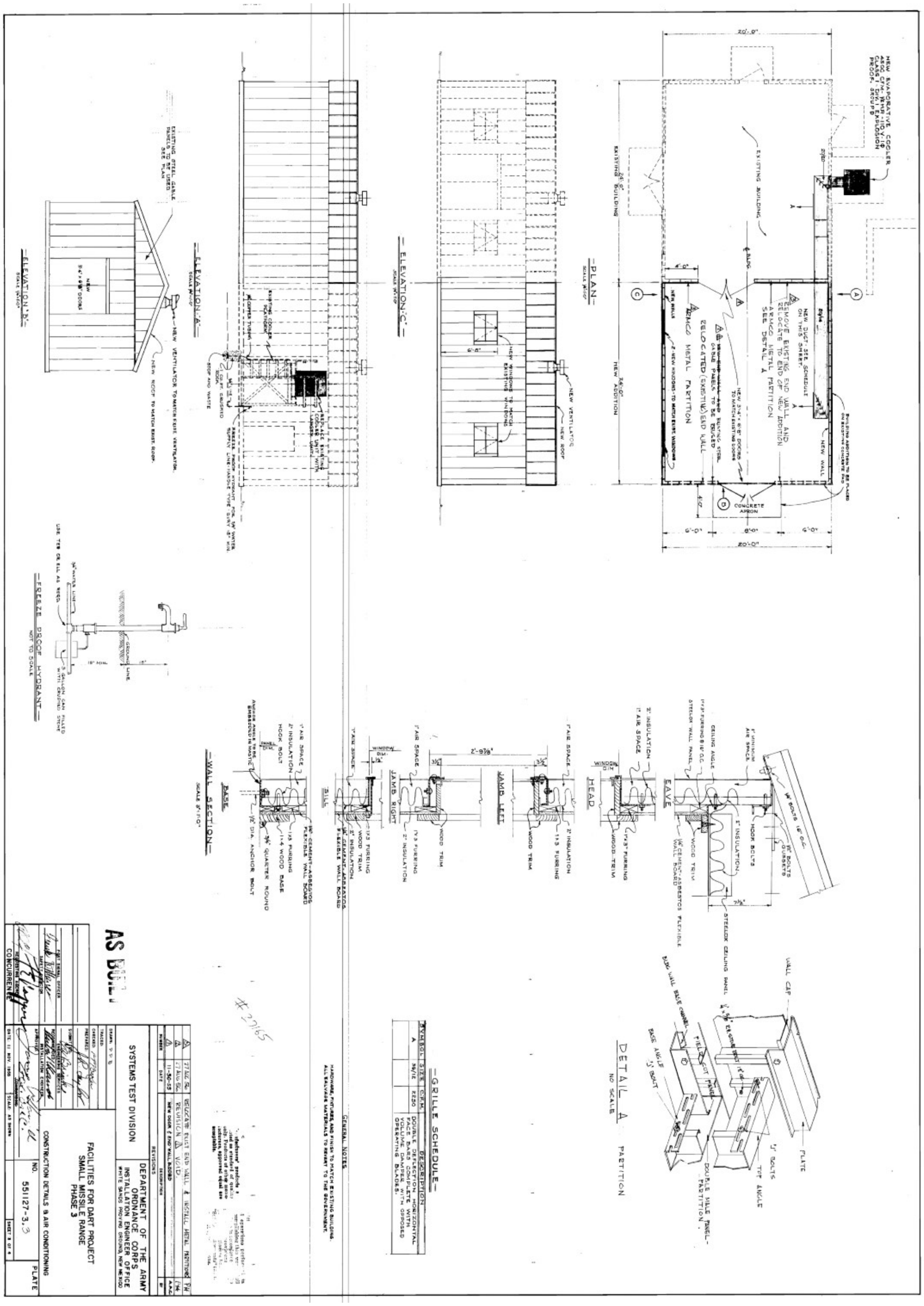


Figure 131. Architectural drawing for Property 27164 from 551127-3 plan set, finalized in 1956.

7.7.4 Property 27165

Property 27165 is a pre-manufactured steel Armco building built on an at-grade concrete foundation (see Figure 132). It is generally similar to 27164, another Armco building. The building has a steel frame and is clad in sheet metal panels, and is painted a tan color with brown trim and doors. The building has a rectangular plan with entry ramps on the east and west elevation gable ends. The medium-pitch gable roof of the building is clad with standing seam sheet metal, with a very minor eave on all elevations. The gable ends are trimmed with flashing and gable end caps embossed with the “ARMCO” logo. Each gable has three louvered vents. The roof peak is equipped with lightning rods and grounding wires, as well as two sheet metal vent housings. On each gable end of the building, a sliding door support constructed of angle iron and steel beam extends to the south, allowing conveyance of the overhead sliding door. However, the sliding door on both elevations has been welded in place to infill the door opening. On the west elevation the entry has fitted with double steel slab doors, while the east elevation now houses a slab personnel door and a four-light casement window. Two additional steel slab personnel doors are located along the south elevation, as well as one four light steel casement window. A second window opening in the south elevation has been filled with welded sheet

Figure 132. Property 27165, north and west elevations, view to the southeast.

metal. Three four-light steel casement windows and a single steel slab personnel door adorn the north elevation, as do two sheet metal duct assemblies and a small louvered metal shed. The duct assemblies are probably the remnants of evaporative coolers that were mounted on elevated stands, similar to the installation on Building 27164. The metal shed is not attached to the building and its small size suggests that it once housed a heating unit or air compressor. All windows in the building are identical and are backed by an interior grid of security bars. All doors in the building are hung in steel frames, and above the east and west elevation doorways are overhanging globe "explosion-proof" light fixtures.

Figure 133. Property 27165, Dart Electrical Checkout Building, view to the northwest.

Figure 134. Property 27165, north and east elevations, view to the southwest.

According to architectural plans of Property 27165, it was originally constructed as Dart Electrical Checkout Building in 1957. The Form 2877 "Birth Certificate" of the building indicates that a 20 ft x 48 ft addition was added in the spring of 1958, suggesting the building was constructed in two stages (similar to Building 27164). Following the cancellation of the Dart Program in the fall of 1958, the building was reassigned to the White Sands SMSA for storage of weather balloons and related radars and equipment the same year. The building was reassigned for use by the Shillelagh Project in 1961, and it appears to have been utilized in support of that project for the remainder of the decade. The use of the building during most of the 1970s is unknown, but in 1979 it was assigned for use by the Copperhead Program. No additional information was available about the use of the building following the completion of the Copperhead Program.

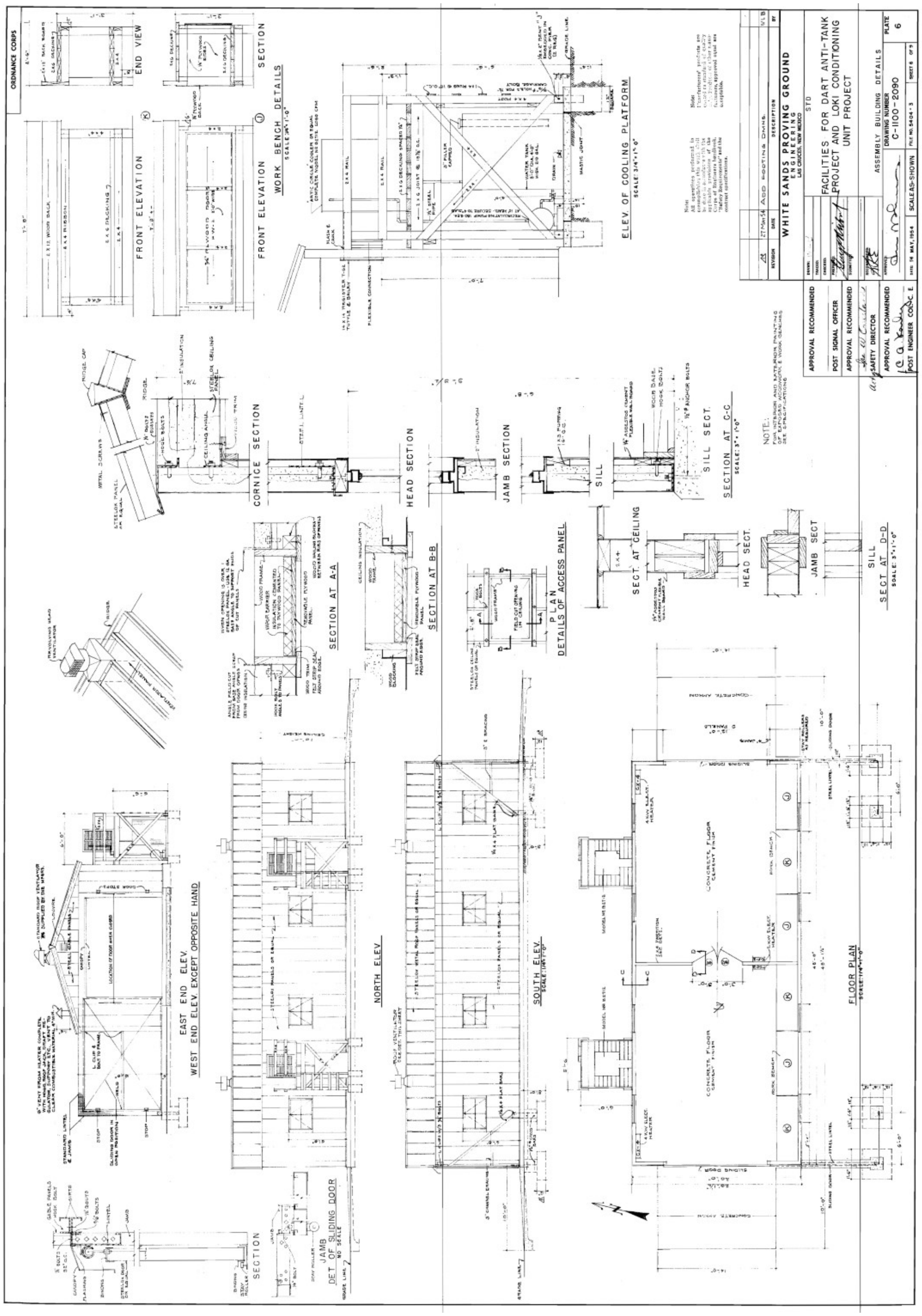


Figure 135. Architectural plan for Property 27165 from 1954 C-110-2090 plan set.

7.7.5 Property 27166

Property 27166 is a one-story, rectangular-plan, concrete post and lintel building infilled with CMU walls (see Figure 136). It is built on an above-grade concrete foundation and is painted tan with brown trim and doors. The flat roof of the building is sealed with tar and gravel material and covered in flashing along its edges. The roof is equipped with rain gutters and downspouts, and a series of lightning rods and ground wires. Two large evaporative cooler units are mounted to the roof as well.

The concrete post supports of the building divide the east and west elevation of the building into five bays, and the north and south elevations of the building into two bays. The east elevation has five windows set high in the wall, with each window occupying a separate bay. These include four pairs of 12-light windows, the center two of which have four panes replaced by a louvered vent panel. The fifth window is centered in the east elevation and is a single 12-light window. The 12-light windows are a combination of awning openings and fixed panes. All the windows are fitted with steel security grates. Gutter downspouts are placed at the ends and middle of this elevation, running down the concrete post supports.

Figure 136. Property 27166, Dart Operations Building, south and west elevations, view to the northeast.

The west elevation has three, horizontally-oriented, pairs of 8-light windows set into separate wall bays, and two smaller windows on either side of the double steel personnel door side entrance built into the central wall bay. This entrance has a concrete entry slab and an overhead explosion-proof globe light fixture. *A four-light steel hopper window is located north of the doorway and a narrow steel frame hopper window is located to the south of the doorway. Above and slightly north of the doorway is a louvered vent panel. The second wall bay from the south end of the elevation lacks a window and instead has an air conditioning unit surrounded by a steel mesh cage mounted to the wall. Similar to the east elevation windows, the 8-light windows are a combination of awning openings and fixed panes. As with all the building windows, the east elevation windows are fitted with steel security grates. Mirroring the east elevation, gutter downspouts are mounted to the concrete support posts at the middle and north and south ends of this elevation.

The south elevation of the building is dominated by an overhead steel roll-up door set into the east wall bay, which has an extended concrete entry ramp. The west wall bay contains a single steel personnel door with a single window protected by a steel security grid. This doorway has a small concrete entry slab and an overhead explosion-proof light fixture. No windows are present on the south eleva-

* Explosion-proof light fixtures are specially approved for hazardous environment applications and are specifically identified on some architectural plans. They feature metal housings and protective, vapor-barrier metal and glass cages for the bulbs.

Figure 137. Property 27166, south and east elevations.

Figure 138. Property 27166, north and west elevations.

Figure 139. Sign located near Property 27199 that references Property 27166.

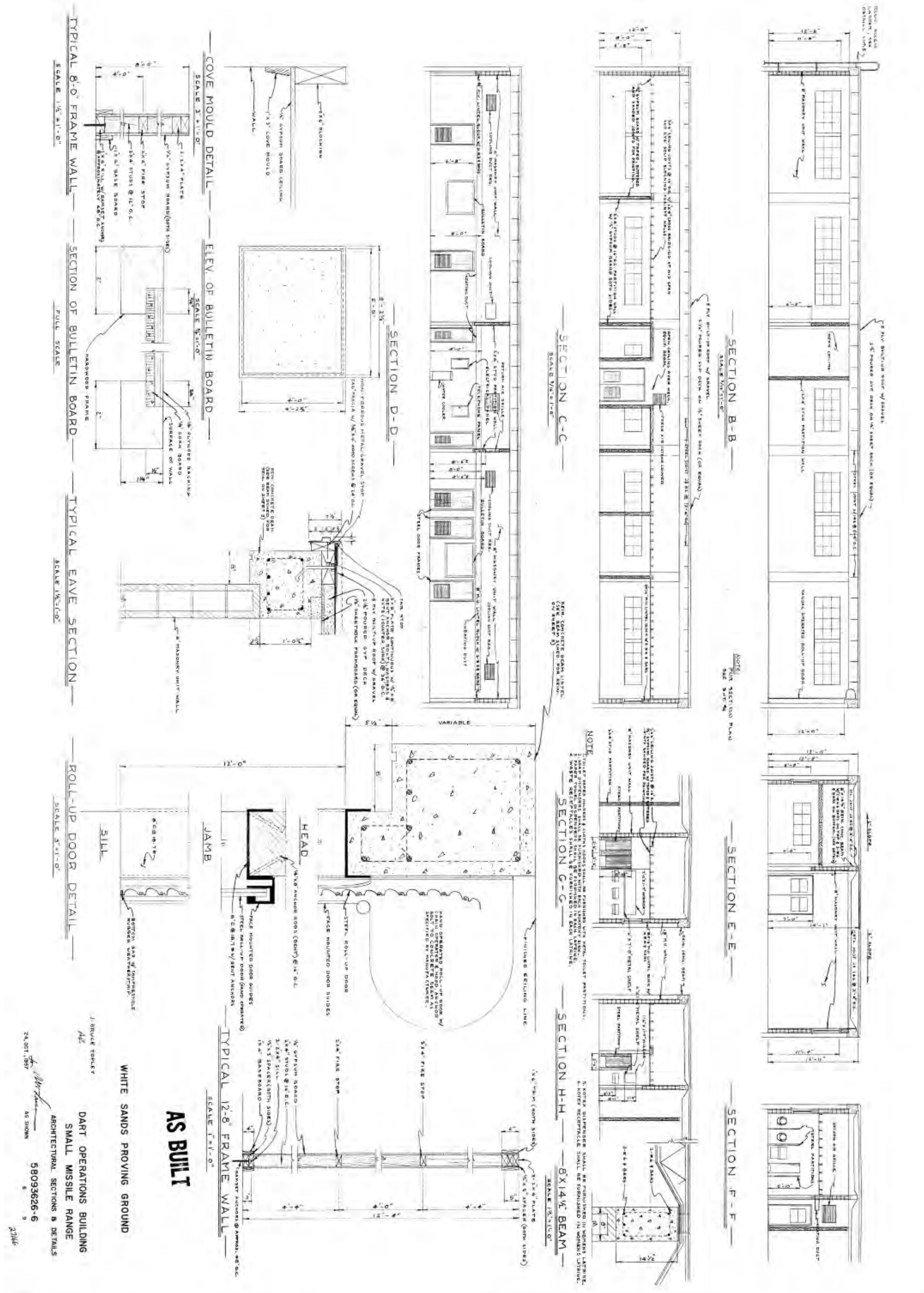


Figure 140. Architectural drawing of Property 27166 from 58093626 plans, finalized in 1957.

tion.

The north elevation of the building has a double steel personnel door entry with a concrete entry slab, illuminated by the same explosion-proof light fixture seen with the other entryways. Both doors have upper windows guarded by steel security grates. A steel ladder providing rooftop access is bolted to the wall east of the doorway, and an antenna is attached to the upper rail of the ladder. Adjacent to this ladder near the top of the wall is a louvered vent panel identical to those used elsewhere in the building. A single 8-light fixed window with a grid of security bars is located on the west side of the entry doors.

Property 27166 was originally built as the Dart Operations Building in support of the Dart Anti-tank Missile Program. However, according to WSMR disposition data, the Dart Program was canceled before the construction of Property 27166 was completed. The building was therefore never used for the Dart missile, but the construction of the building was completed in anticipation that the building could be used in support of other programs. Despite this, the building is consistently referred to as the Dart Operations Building in WSMR records. In September of 1958, it was recommended that the construction of the building be completed in order to prevent paying a penalty to the contractor if the project was canceled, which would be more expensive than just completing the building. It was anticipated that the building could be used as a Launcher and Camera Maintenance Building, as a mess hall for the SMR, or for the upcoming Redeye or Combat Vehicle Weapon System projects.[*]

The building was complete and ready for inspection in November of 1958, and WSMR disposition data reveals that several programs competed for assignment of the brand new building, particularly the Ballistic Research Laboratories (BRL) branch at WSMR. After several months of deliberation and meetings, the BRL was not assigned the building, at least in part because the antenna and radar work that the program would have conducted there was not sufficiently hazardous to merit a location outside the main cantonment area. The disposition data relates that in late 1958 the north portion of the building was assigned to contractor Minneapolis Honeywell for work on the Honest John, Little John, Lacrosse, and the Sergeant XM-91 Warhead Program. The south portion of the building was allocated to the Target Missiles Project, which was developing the RP-77D Radioplane target drone. The SMSA requested use of this space as well, but the Target Missiles Project was given a higher priority and the SMSA request was denied. By April of 1960, the north half of the building was again vacant and established as an interim lunch room for the SMR. A portion of the Little John Launcher and Camera Maintenance Building (Property 17173) had been serving as a lunchroom area, but it only accommodated approximately 20 people, but another 40 to 50 SMR employees commuted to the main cantonment for lunch. The north half of 27166 was large enough to accommodate this number of people and had the necessary running water. This use was short lived, as in March of 1961 the entire building was assigned to the Shillelagh Program, and the lunch room was relocated to Room 118 of the Flight Control Building (Building 27170).

The disposition data offers little additional information about the use of the building through

* The Launcher and Camera Maintenance Facility (Property 27173) for the Little John Program was built in the Little John Assembly Area in 1959. Building 27166 was therefore never used for that purpose; neither does it appear to have been used in support of the Redeye Program. However, it was used for the "Combat Vehicle Weapon System" which was an early reference to the Shillelagh Missile/Sheridan Tank development.

the 1960s, but it was probably occupied by the Shillelagh Program for the remainder of the decade and into the early 1970s. In 1979, it was assigned to the Copperhead Program which utilized the space until 1981. During 1982 to 1983 the High Energy Laser Program used the building for temporary storage of furniture and equipment. The building was then assigned as office, laboratory, and storage space for both the Remote Ground Target Robotics Operations (RGTRO) and the “ARMTE Omnibus Contractor” in 1985.

No post-1985 information about the use of the building was available in the disposition forms, and the building appears to be used for miscellaneous storage today. The parking lot to the west of the building is occupied by a wide variety of materials, including office furniture, electronic equipment, some missile parts, plumbing parts, crates, shipping containers, and a collection of portable generator/overhead light units.

7.7.6 Property 27173

Figure 141. Property 27173, north and east elevations.

Property 27173 is a one-story maintenance shop and storage building, painted tan with brown trim (see Figure 142). The building is of reinforced concrete post and lintel construction with CMU in-fill, with a rectangular floor plan on an above grade, concrete slab foundation. The very low-pitch, concrete slab gable roof of the building includes aluminum clad, over-hanging eaves. The roof is equipped with rain gutters along the north and south elevations, with downspouts placed at intervals along these elevations. Several large, dome-shaped vents and two evaporative cooling units are visible on the roof. Additionally a series of ten overhead lights with distinctive green and white enamelware shrouds are present along the perimeter of the roofline. The fenestration of the north elevation includes three entryways and one window. The lone window, located on the west end of the façade is a fixed frame window with six lights, set in a metal frame above a protruding, pre-cast concrete sill, and covered by a metal security grate. Included among the entryways of the north elevation are two pairs of three-panel, bi-parting horizontal sliding service bay doors, one horizontal, and one central two-panel personnel door with an upper glass panel consisting of two lights, set in metal frame. The personnel door is flanked by sidelights, each with three horizontal lights, and a transom consisting of three horizontal lights. A narrow concrete apron extends along the majority of the north elevation, in addition to paired, yellow concrete bollards flanking each of the sliding bay doors, and overhanging globe light fixtures mounted above each of the three entryways. The fenestration of the west elevation includes one fixed frame window with two lights set in a metal frame above a protruding, pre-cast concrete sill, a pair of two-panel, steel personnel, set in a steel frame above a concrete apron, and a square metal vent with a louvered cover above and offset from the entryway. Fenestration of the south elevation includes one entryway and five windows. The entryway consists of a two-panel personnel door with an upper glass panel with two lights, set in metal frame above a concrete apron. The five windows on the southern façade are each fixed frame windows, set in a metal frames above protruding, pre-cast concrete sills. Two of the windows have four vertical lights and three of the windows have six vertical lights. Access to the roof is provided on the south elevation by a steel ladder mounted at the midpoint of the façade. The east elevation is entirely unadorned, with no windows or entryways present.

Property 27173 was constructed in 1959 as the Little John Launcher and Camera Maintenance Building. WSMR disposition records indicate that the building was consistently used as a shop for the maintenance, repair, and storage of camera equipment, in addition to a brief period in 1959 when the east half of the building was designated for use as a telemetry station and later released for reassignment. The 2002 recording by HSR described the building as being used by the Ground Target Office for rebuilding engines, the Target Maintenance Division occupied an office and the east end of the building; however, the eastern service bay was vacant and the boiler room was shutdown. At the time of the present recording, the building was vacant and did not appear to be in use.

Figure 142. Property 27173 north and west elevations, view to the southeast.

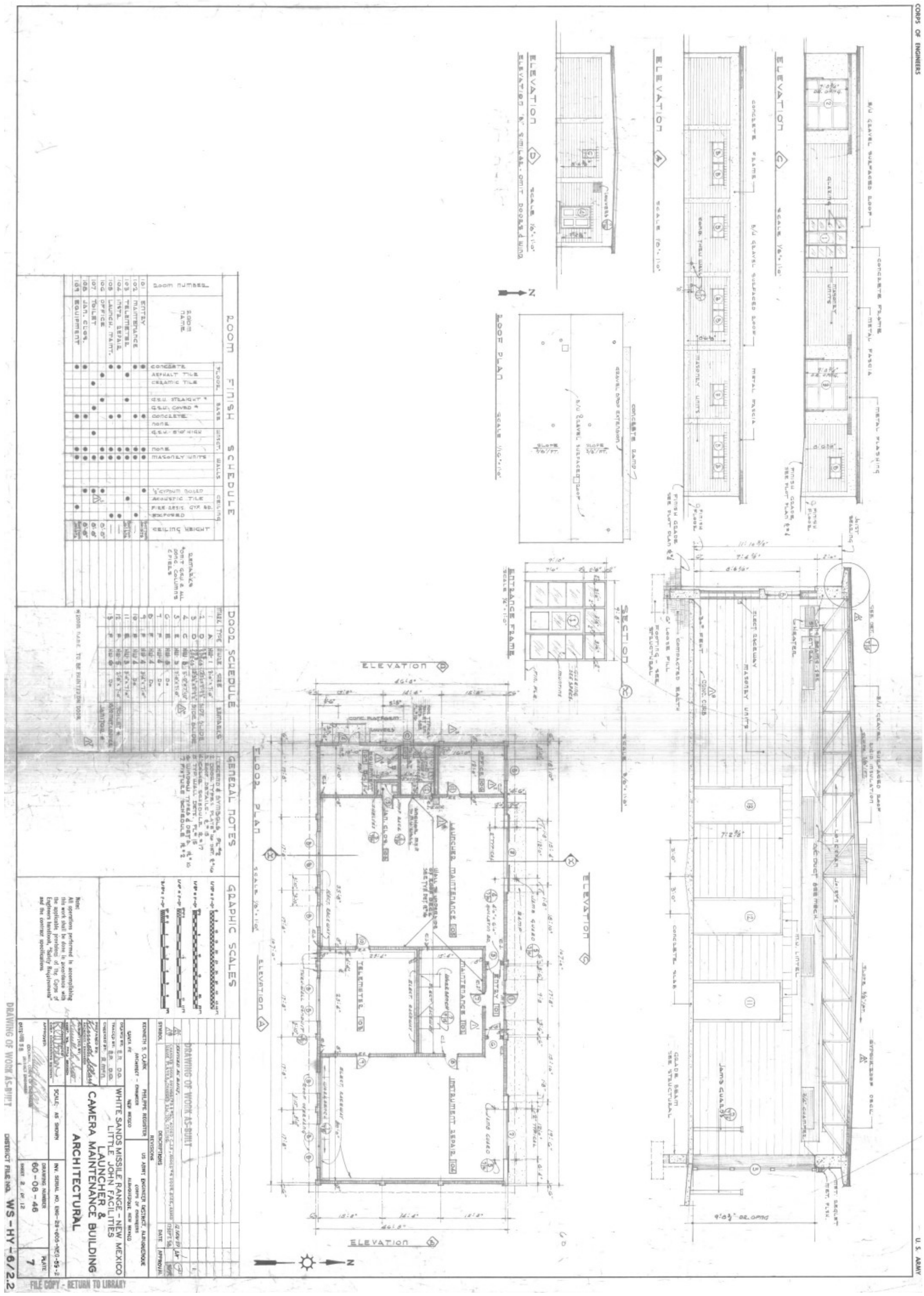


Figure 143. Architectural drawing of Property 27173 from 1958 WS-HY plans.

7.7.7 Property 27180

Property 27180 is a pre-manufactured, galvanized metal building built on an above grade concrete slab foundation with an irregular floor plan oriented on a north-south long axis (see Figure 144). The I-beam superstructure of the building is clad in 16 inch wide unpainted, galvanized metal panels. The northern third of the building's "high assembly bay" consists of two-stories, while the remaining southern portion or the "low assembly bay" of the building is one-story (see Figure 145). The assembly bay includes a medium pitch gable roof of standing seam metal construction. The peak of the gable roof is equipped with eight lightning rods and associated grounding cables, as well as six sheet metal vent housings, and three dome shaped vents. The roof gable ends are trimmed in flashing with the vestiges of an I-beam monorail system protruding from the north and south elevations. A one-story, shed addition extends from the northern half of the east elevation on an extension of the above grade slab foundation. The shed appears to be part of the original building design and served as a mechanical equipment room.

The fenestration of the north and south elevations of the building includes one entryway each, consisting of an off-center, metal, rolling bay door with overhanging globe light fixtures. A

Figure 144. Property 27180 Little John Assembly Building, south and west elevations, view to the northeast.

Figure 145. Property 27180, north and west elevations, view to the south/southeast.

concrete ramp extends from each of the bay door entryways. Fenestration of the east elevation includes five entryways and one window. The entryways include four, two-panel, steel personnel doors, and one pair of hinged, 12-panel steel bay doors, each set in metal frames and painted green or white. One casement window with six horizontal lights set in a green metal frame, and two of the aforementioned two-panel doors are associated with the mechanical equipment room on the east elevation. With one exception, each of the entryways is set above a raised, concrete stoop (or ramp in the case of the bay doors), with overhanging globe light fixtures and associated conduit mounted above. Fenestration of the west elevation includes three duct portals and two entryways. The duct portals each extend from evaporative cooling units, mounted on metal platforms equipped with safety rails and a ladder, and set on a raised concrete foundation. Each of the entryways consists of slab steel personnel doors set in steel frames above a concrete stoop.

Property 27180 is surrounded by a various vehicles (e.g., jeeps and graders), pallets, tube steel frames, storage containers, and other supplies. A blast barricade (Property 27179) is offset from the west elevation by approximately 16 ft, extending the length of the façade. Additionally, a small portable, pre-manufactured, Butler building set on metal skids abuts the northeast corner of Property 27180. The Butler building consists of one room, and is painted white with a green, two-panel personnel door. The Property number WS00537 is indicated on signage mounted below the upper glass panel of the Butler building's door.

As built design plans dating to January 7, 1956, suggest revisions to the design of Property 27180 were incorporated prior to construction. Though minor in kind and quality, the aforementioned mechanical equipment room placement was indicated on the south end of the west elevation. It is likely that the modification was driven by the placement of a blast barricade (Property 27179) constructed along the west elevation. Further post-construction modifications to the building are suggested in design plans dating from 1980. Plans indicate the building's two-ton monorail hoist system was to be salvaged and the interior superstructure modified to accommodate a four-ton monorail hoist. It is unknown whether the proposed upgrades were undertaken; however, the exterior jib or portion of the I-beam monorail protruding on the north elevation has been torch cut, as have two high tension braided cables anchored on the elevation. At the time of the 2002 HSR recording, both the I-beam and the tension supporting high tension cable on the north elevation were intact. Additionally the entryways on the north and south elevations have been modified to accept the aforementioned rolling service bay doors in place of pairs of hinged, steel, 12-panel bay doors. The upper panel of the hinged bay doors remains in place filling the area between the replacement rolling doors and the jib of the monorail system on the north and south elevations.

Property 27180 was constructed in 1957 as the Little John Missile Assembly Building. According to archival records, the building was used for various purposes, inclusive of missile assembly, storage of inert components, maintenance of test equipment, as well as construction and storage of anti-tank missile targets. Disposition data indicates that the building was used in support of both Shillelagh and Little John programs. As of the 2002 HSR recording, the building was used for storage. At the time of the current inventory, Property 27180 was used as a vehicle maintenance garage by Trax International, LLC.

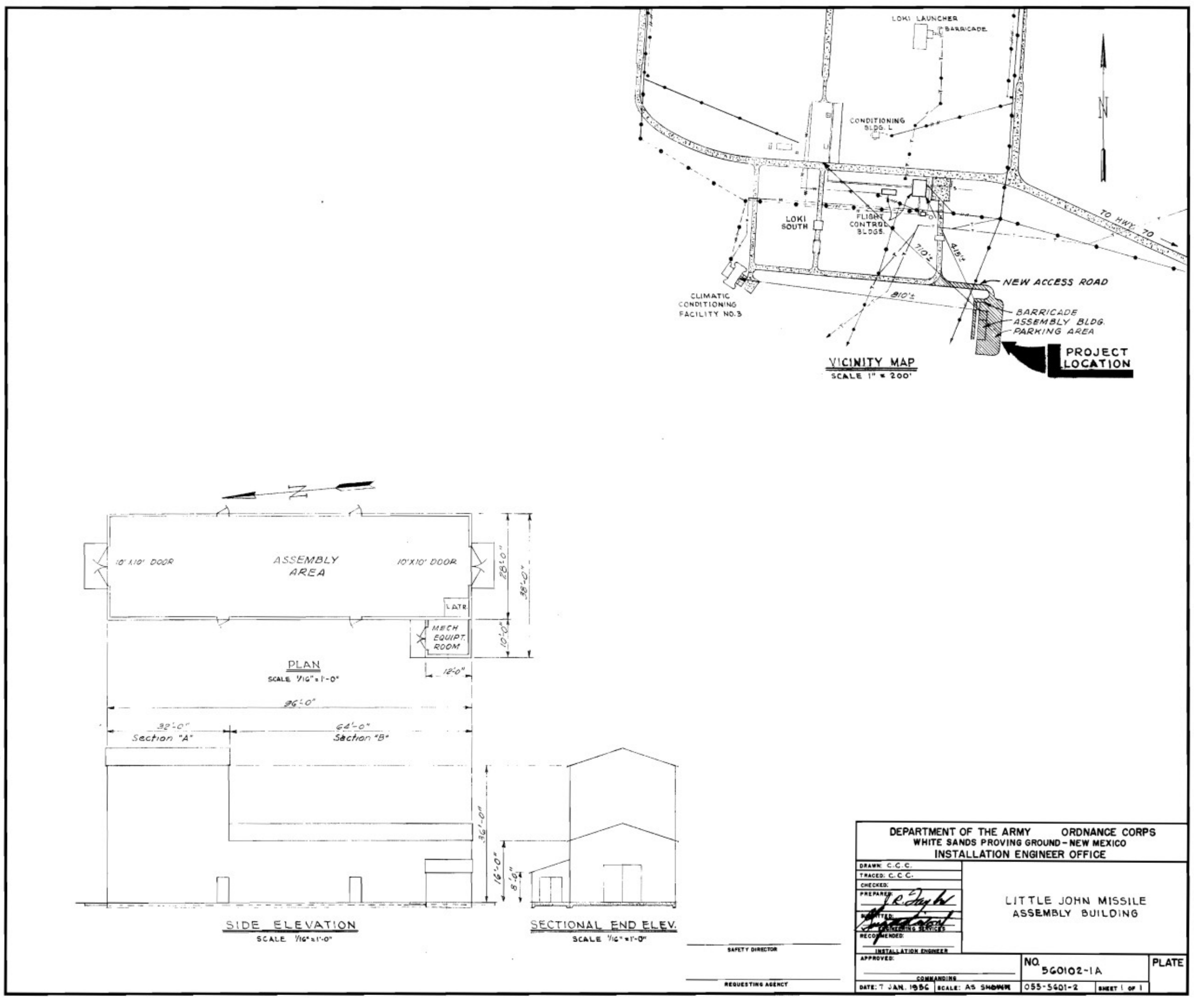


Figure 146. Architectural plan drawing of Property 27180, undated.

7.7.8 Property 27184

Property 27184 is a one-story, one room, pre-manufactured, galvanized metal Armco building built on an above grade concrete slab foundation (see Figure 147). The building has a rectangular floor plan and is clad in 16 inch wide unpainted, galvanized metal panels. The medium pitch gable roof is of standing seam metal construction. The roof peak is equipped with four lightning rods and associated grounding cables, as well as two sheet metal vent housings. The roof gable ends are trimmed in flashing and the gable end caps are embossed with the "ARMCO" logo.

The south elevation of the building is unadorned with a single shrouded flood light mounted at the roofline. A robust metal shelving unit abuts the south elevation, running the length of the façade. The shelving unit appears to house a variety of vehicle parts and accessories. The fenestration of the east elevation of the building includes one duct portal located high on the façade, adjacent to a mounted switch box, a shrouded flood light fixture, and an antennae capped by a lightning rod. The duct portal extends from an evaporative cooling unit, mounted on a metal platform equipped with a safety rail, and set on a raised concrete foundation extending from the building. Access to the cooling unit platform is provided by a metal ladder. Fenes-

Figure 147. Property 27184, west and south elevations, view to the northeast.

tration of the north elevation includes one entryway consisting of one, green two-panel steel personnel door, with a glass upper panel consisting of two horizontal lights covered by security bars. The entryway is located offset from the northeast corner of the building above a raised concrete step. One shrouded flood light is mounted at the roofline of the north elevation. Fenestration of the west elevation includes one entryway, consisting of bi-parting horizontal sliding service bay doors beneath a shrouded flood light. A concrete entry ramp extends from the base of the entryway. The building is encircled by a security fence capped by three stands of barbed wire. Signage mounted on the fence reads, “PEO STRI FOREIGN MOBILE GROUND TARGETS OPERATIONS.” Shipping containers are present along the exterior of the east and north sides of the fence, and a missile mounted on a steel stand set in a concrete pad is present along the exterior of the west side of the fence.

Figure 148. Property 27184, east and north elevations, view to the southwest.

Property 27184 was constructed in 1957 as the Little John Warhead Assembly Building. Little information exists for its use in the years following the end of the Little John Program; however, HSR noted that the building was utilized for storage. As of the 2002 HSR recording, the building was being used for storage, consistent with the observed usage during the current inventory.

7.7.9 Property 27185

Property 27185 is a pre-manufactured steel Armco building built on an above-grade concrete foundation (see Figure 149). The building has a simple rectangular plan with large double doors at both of the gable ends. The building is clad in unpainted, galvanized metal panels and has a medium pitch gable roof of standing seam metal construction with a short eave over the east and west elevations. The roof peak is equipped with three lightning rods and grounding wires, as well as a sheet metal vent housing. The roof gable ends are trimmed in

Figure 149. Property 27185, north and west elevations, view to the southeast.

flashing and the gable end caps are embossed with the “ARMCO” logo (see Figure 151).

Figure 150. Property 27185, south and east elevations.

Figure 151. Property 27185, embossed “ARMCO” gable end cap.

The east elevation of the building lacks any doors or windows, and has a heavy equipment wheel and tire leaning against it. The west elevation also lacks doors or windows, with only an electric breaker box mounted to the wall near its north end. Two sheet metal panels and a bin of miscellaneous wiring are located near the northwest corner of this elevation, and a dumpster is placed near the southwest corner of the building. Heavy steel double doors are located on both the north and south (gable end) elevations. A concrete entry ramp extends from the base of both these doorways. The steel panel doors are constructed of thick gauge sheet metal and are supported by four hinges each within a steel frame. The bay openings of these doors are sufficiently large to allow vehicle entry into the building. Above each doorway is an explosion proof globe light fixture. The west door of the north doorway has been fitted with an inset steel slab personnel door, allowing entry into the building without opening the larger double doors. This personnel door has an opening for an upper light, but this window has been removed and replaced with a steel panel.

Property 27185 was constructed in 1957 as the Little John Grain Loading Building. Little information exists for its use in the years following the end of the Little John Program. As of the 2002 HSR recording, the building was being used for storage and it appeared to be used for this purpose during the current inventory as well. The previous 2002 recording noted that three pre-manufactured portable metal buildings built on wooden skids were parked along the west elevation of the building. These three buildings were no longer present during the current recording.

7.7.10 Property 27186

Property 27186 is a pre-manufactured sheet metal building with a large, steel frame, sheet metal clad shed addition attached to its south elevation (see Figure 152). The addition is substantially larger than the original building, which is centered on the north elevation of the newer section. The sheet metal clad roof of the original building has a short eave on all elevations (except the south where it abuts the addition) and is equipped with lightning rods and ground wires along its peak. The north elevation of the original building has an evaporative cooler mounted high in the wall, supported by a steel stand installed on a concrete slab that appears to be a re-purposed portable observation deck. A single steel personnel door is located just west of the evaporative cooler stand, and opens onto a concrete slab that continues around the west elevation of the building. Next to the doorway is a window opening that has been sealed with an unpainted corrugated metal panel. Above this window, set high in the wall, is an exhaust fan and duct that is supported by a cantilevered steel platform. The west elevation of the original building lacks any windows, doors, or other features. Immediately offset from the west elevation of the building is a plywood-formed, “U” shaped concrete blast barricade structure whose open end faces west. This structure is similar to Structure 27205, but has been modified with a roof and west wall to act as a storage shed (see Figure 155). The roof is constructed of

Figure 152. Property 27186, north and east elevations of the original building, view to the southwest.

a steel frame and fiberglass corrugated panels. The open west end of the barricade has been enclosed with an angle iron frame and clad in plywood, with a double steel panel door entry. However, these modifications are in poor condition, with the roof mostly open and the west wall missing sections of plywood. Adjacent to the blast barricade are several tire racks. Two air compressors with simple angle iron and corrugated metal shelters are located along the east elevation of the original building, which is otherwise devoid of any features.

The large addition is a rectangular plan, metal panel-clad, pre-manufactured steel-frame building built on an above-grade concrete foundation. It is a double "high bay," a two story tall space with no floor separations. The flat, low-pitch roof of the addition is of sheet metal construction and drains to the north roof edge, which is equipped with a gutter and downspouts. A pre-manufactured Butler portable steel building, built on a wooden skid, is located against (but not attached to) the west elevation of the large metal shed addition. It has gable roof and single steel personnel door with a window protected by a steel mesh panel. The south elevation of the addition includes two tall, steel roll-up doors with a common concrete entry ramp, east of which is a steel personnel door. Next to the door is a steel mesh hazardous materials locker for gas cylinders. Both the east and west elevations of the shed addition have three semi-transparent fiberglass panels set high in the wall for interior light, and overhead lights mounted to the walls. Racks of steel stock are located along the east eleva-

Figure 153. Property 27186, north elevation of original building.

Figure 155. Modified concrete blast barricade, west elevation.

Figure 154. Property 27186, south and west elevations of high bay shop addition.

tion of the addition.

Based on architectural drawings, Property 27186 was originally constructed in 1957 as the Little John Pre-Assembly Building. Little additional information about the use of the building is available in WSMR disposition records, but these records do indicate it was modified for use as welding shop in 1983 which included the installation of the evaporative cooler on the north elevation. The records also document that the large addition was constructed in April of 1989. The 2002 recording by HSR described the building as being used as a welding shop, and it appeared to still be used for that purpose at the time of the current recording.

7.7.11 Property 27187

Property 27187 is a one-story calibration building, painted tan with white trim. The building is of reinforced concrete post and lintel construction with CMU in-fill (see Figure 156). The building maintains a rectangular floor plan constructed on an above grade, concrete slab foundation. The very low-pitch, concrete slab gable roof of the building includes over-hanging eaves clad with aluminum flashing. The roof is equipped with rain gutters along the north and south ele-

Figure 156. Property 27187, south and east elevations, view to the northwest.

Figure 157. Property 27187, south and west elevations.

Figure 158. Property 27187, east elevation, view to the southwest.

vations, and downspouts are present at intervals along these elevations. A series of seven overhead lights with distinctive green and white enamelware shrouds are present along the perimeter of the roofline. Lightning rods and associated grounding cables also adorn the perimeter of the roofline; however, it appears that some of the lightning rods have been damaged or otherwise bent from a vertical to horizontal orientation. Fenestration of the south elevation includes one entryway and one duct portal. The entryway consists of a single-panel, steel personnel door set in a metal frame with signage that reads, "CORROSIVES." The duct portal extends from an evaporative cooling unit, offset from the southeast corner of the building below the roofline. The green personnel door appears to be a replacement, and is offset from the southwest corner of the building adjacent to a palette housing several automobile batteries. The evaporative cooling unit is mounted on an angle iron frame atop a square concrete pad adjacent to an electrical switch box and associated conduit mounted on the façade. Two tube steel racks are adjacent to the cooling unit, abutting the south elevation. Fenestration of the east elevation includes two entryways set in steel frames. Included among the entryways are one single-panel green steel door below an uncovered light fixture and slightly offset from the center of the façade, and a pair of green, two-panel, steel personnel doors offset from the southeast corner of the building. The single-panel door is located beneath an entryway porch consisting of a corrugated metal flat roof with flashing that extends from the eastern façade of the building and is supported by one metal post and a CMU wall. A concrete apron extends along the majority of the east elevation between the two entryways. A yellow-painted, metal, mobile stairway with a hand rail and rubber wheels is present on the apron near the buildings southeast corner. The north elevation is unadorned, with no windows or entryways present; however, a shade structure constructed of corrugated metal panel mounted on a steel frame extends from beneath the roofline of the façade to the adjacent blast barricade (Property 27191). The shade structure is located below two uncapped pipe penetrations. A metal pipe rack is located beneath the corrugated metal shade structure. In addition to the shade structure, a small

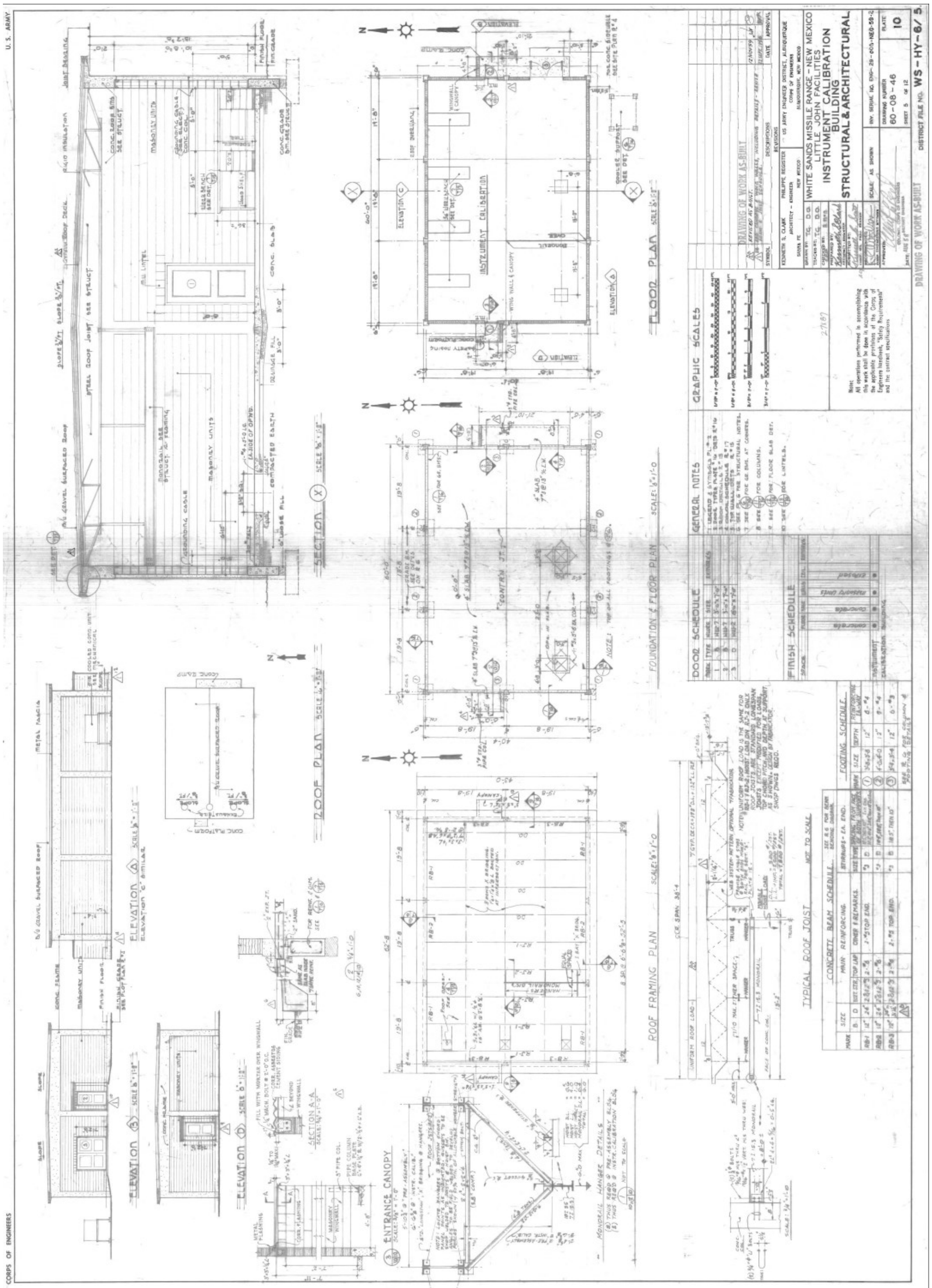


Figure 159. Architectural plan for Property 27187 from 1958 WS-HY plans.

cylindrical metal instrument mounted on a square concrete slab abuts the central portion of the north elevation. The pad is associated with a network of horizontal, 3 inch PVC and metal pipe mounted on the façade with metal brackets. Fenestration of the west elevation includes one entryway below an uncovered light fixture that is offset from the center of the façade above a raised concrete slab platform. The steel, single-panel, green door is located beneath an entryway porch of identical configuration to that described on the east elevation. Five electrical boxes and associated conduit are also mounted on the west elevation of the building below one capped and one open pipe penetration. A radio tower, constructed of a triangular metal framework set on a raised, 3 ft x 3 ft concrete foundation is offset from the northwest corner of the building, between the building and the adjacent blast barricade.

Property 27187 was constructed in 1959 as the Little John Instrument Calibration Building. WSMR disposition records indicate that the building vacillated between a variety of uses under the Little John, ARCAS, and the XM-75 Sounding Rocket Programs. During the late 1950s and 1960s, Property 27187 was referred to as an instrument calibration building, an electronic equipment facility, and a pre-assembly and inspection building, in addition to being used for the storage of inert ARCAS missile components. The 2002 recording by HSR described the building as being used as a machine shop. At the time of the present recording, the building remained in use by Trax International, LLC as a machine shop. Prior to use by the current occupants, Property 27187 was purportedly used for the storage of materials associated with the Copperhead Program.

7.7.12 Property 27188

Property 27188 is a one-story, rectangular-plan, concrete post and lintel building infilled with CMU walls (see Figure 161). It is built on an above-grade concrete foundation and is painted tan with faded orange trim and doors. The very low pitch gable roof of the building is sealed with tar and gravel material and has a concrete eve on all elevations. The roof eave and door openings of the building are trimmed with flashing. The roof is equipped with rain gutters along the north and south elevations, with downspouts placed at intervals along these elevations. Several large, dome-shaped vents are located along the roof, as well as red safety lights. A series of lightning rods and ground wires are located across the roof, and overhead lights with distinctive green and white enamelware shrouds are visible along the roof edges of the south and east elevations. The visibility of the building is limited by a wood and earth blast barricade (Structure 27189) that surrounds the west and north elevations. A chain link fence extends from the blast barricade ends to fully surround the

Figure 160. Property 27188, view of north and east elevations.

Figure 161. Property 27188, south elevation, view to the northeast.

building.

The north elevation is devoid of any windows or doors, and faces the Structure 27189 blast barricade wall. The west elevation is likewise devoid of any doors or windows, and is also directly opposed by the wall of the 27189 barricade. The east elevation has a single steel personnel door set into the northern wall bay, with a concrete entry pad and an associated sidewalk. Outside the southern wall bay is a HVAC unit set on a concrete pad with associated ductwork installed into the wall. An air compressor is located under a sheltering shed roof constructed of corrugated metal in the middle of the east elevation, and a standalone walk-in refrigeration unit is installed on a concrete foundation just beyond the air compressor. The primary building elevation is the south, which features two sets of large, steel panel double doors, very similar to those of Property 27185. These doors are installed into both sides of the south elevation, with a single steel slab personnel door located between them. The double door entrances are equipped with overhead hoists mounted on I-beam tracks that extend from the wall above each doorway. The central I-beam tracks are supported by two diagonal I-beam cross braces, and by another horizontal I-beam support mounted on steel pipe support posts outside each doorway. A short concrete entry skirt runs the length of the south elevation. An explosion-proof dome light fixture is mounted above the personnel door on this elevation. Notable is the lack of windows in the building, which along with the 27189 Blast Barricade, protected adjacent areas

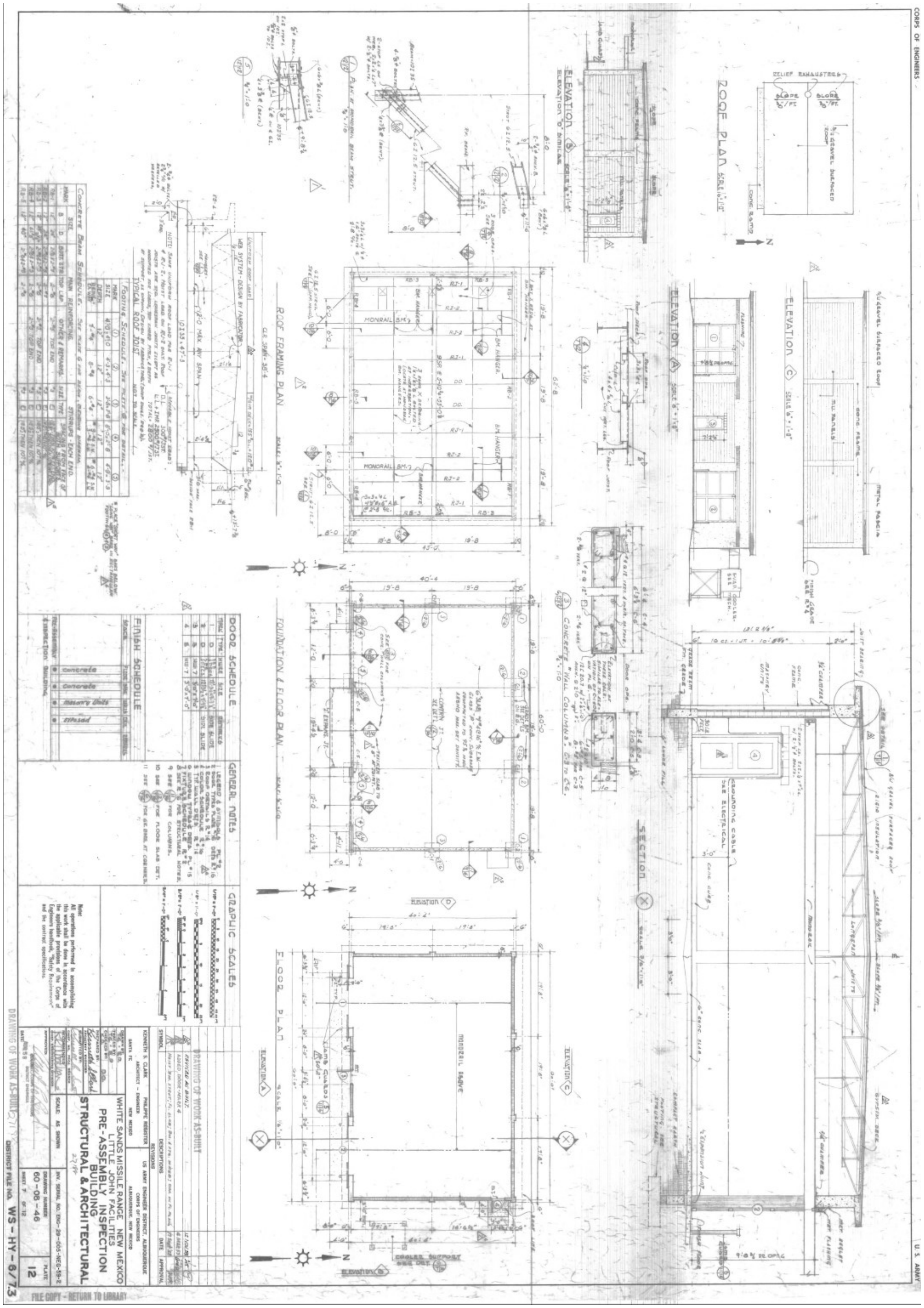


Figure 162. Architectural drawing of Property 27188 from 1958 WS-HY plans.

from an inadvertent explosion within the building (see Figure 164).

Property 27188 was built in 1959 as the Little John Pre-Assembly Inspection Building. Based on WSMR disposition data it was apparently used in this capacity until 1963. In late 1963, the WSMR ERDA requested the use of the building to service and store propellant for various meteorological rocket motors, including the Cajun, Apache, Genie, ARCAS, Nike, and Loki rockets. The ERDA program needed to place up to 4,000 pounds of propellant in storage, and the design of Property 27188 had previously accommodated up to 5,000 pounds of propellant for the Little John Program. However, the ERDA request for the use of the building was denied, as it was required for support of the Shillelagh Anti-Tank Program beginning in September of 1964. Little additional information about the use of the building after 1964 is present in the WSMR records, but it was probably used for the Shillelagh Program through the rest of the 1960s. As of the 2002 recording by HSR, it was being used for the preparation of aerial targets. The building appeared to be in use during the current inventory, but its current role and function is unknown.

Figure 163. Property 27188, east elevation, view to the southwest.

Figure 164. Property 27188 and surrounding Property 27189 blast barricade, view to the northeast.

7.8 Meteorology Buildings

The ASL meteorology research and sounding rocket program was very active at the SMR from the 1960s through the 1990s. The ASL used several buildings across the range, but primarily operated out of properties situated along the margins of the range. While in a class of buildings with a specialized purpose, meteorological buildings do not typically represent any unique structural or construction type. These properties were used in support of meteorological data collection and some housed sensitive climactic equipment with sensors typically mounted on the rooftop. The balloon inflation shelter such as the Wind Measurement Building (27200) is the most recognizable type with its high-bay component, used to protect a weather balloon during inflation. At SMR there are seven meteorological buildings, most of which are of CMU construction with the exceptions of two balloon inflation shelters (27167 and 27208B) which are steel-frame, high-bay buildings clad in corrugated metal panels.

7.8.1 Property 27167


Figure 165. Property 27167, north and east elevations, view to the southwest.

Property 27167 is a one-story, weather balloon inflation shelter constructed on an above grade concrete slab foundation with a rectangular footprint (see Figure 165). The building is clad in horizontal, sheet metal paneling and includes a standing seam, shed roof. The foundation extends beyond the superstructure of the east-facing façade, creating an entryway pad that measures 5 ft in length by 12 ft wide. The fenestration of the east elevation includes two, full length, three-panel, metal bay doors, each with four hinges. Each door maintains a central panel consisting of four horizontal lights. Fenestration of the north and south elevations includes one central casement window with four lights. The west elevation is unadorned with the exception of a portal for a wall mounted A/C unit. The unit remains in place with metal flashing lining the edges of the portal. The building is immediately west of and likely associated with Property 27200.

Property 27167 was constructed in 1959 as a balloon shelter. Little information exists for its use in the years following construction; however, at the time of the current inventory the building was vacant.

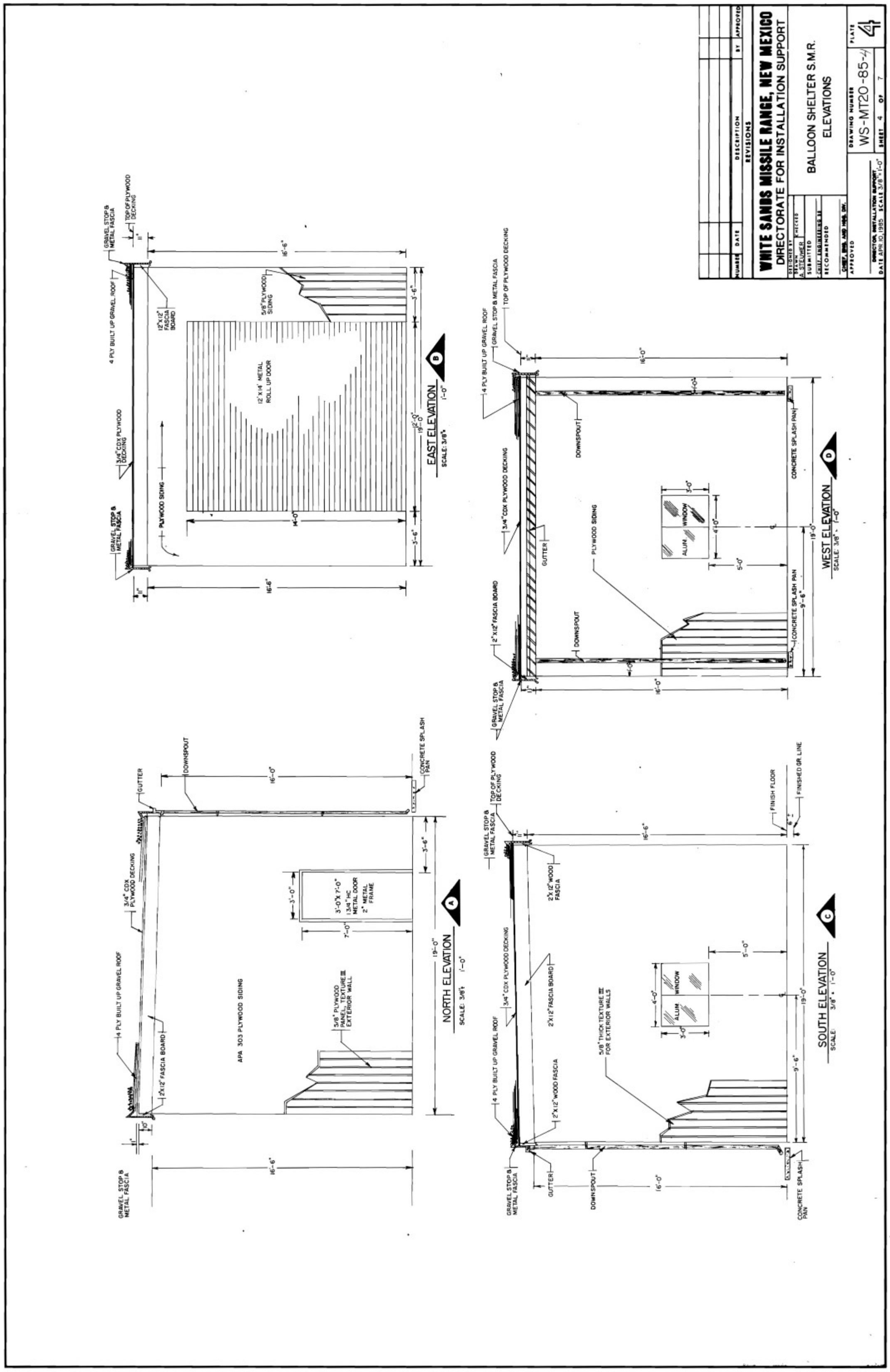


Figure 166. Architectural drawing of Property 27167, undated.

7.8.2 Property 27200

Property 27200 is a one-story wind measurement building. The building is of CMU construction with a roughly rectangular floor plan on an above grade, concrete slab foundation (see Figure 167). The flat roof is lined with gravel and clad in galvanized metal flashing with a black pipe safety railing encompassing the perimeter, excepting the northwest quadrant of the building. Six curved metal pipe vents extend from the roofline. The building is painted tan with brown trim and doors. The northeast quadrant of the building consists of a two-story-height, flat roof service bay, with a rolling metal, full-height bay door (see Figure 169). The footprint of the service bay extends beyond the façade of the building by 8 inches on the east elevation and by 16 inches on the north elevation. Fenestration of the east elevation includes the aforementioned rolling service bay door, a slab steel personnel door set in a steel frame above a single concrete step, and a rectangular metal, fixed-frame window with 16 lights, with a protruding concrete block sill. Signage along the roofline of the east elevation reads, “Air Defense Shelter Small Missile Range Area ‘C’ Shelter: Bldg. 20850.” On the east elevation a low concrete ramp extends from the service bay measuring approximately 18 ft wide by 6 ft long. Fenestration of the south elevation includes two slab steel personnel doors set in a steel frames, a square met-

Figure 167. Property 27200, east and south elevations, view to the northwest.

al square vent with a louvered cover, and a rectangular metal, fixed-frame window with 16 lights, with a protruding concrete block sill. An evaporative cooling unit is offset from the south elevation, mounted on an angle iron frame. An aluminum gutter runs the length of the south elevation roof line with downspouts located at the southeast and southwest building corners. A steel frame ladder mounted to the façade of the south elevation provides access to the roof. Signage identifying the building number is present below the roofline offset from the southwest corner of the building on the south and west elevations. The west elevation is unadorned, with the exception of a mounted, galvanized metal electrical panel and associated electrical conduit, four conduit pipe penetrations, and a galvanized metal vent. Fenestration of the north elevation includes a slab steel personnel door set in a steel frame, and two rectangular metal, fixed-frame windows, each with 16 lights, and a protruding concrete block sill. An aluminum gutter runs the length of the north elevation roofline on the northeast quadrant service bay with a downspout present at the northeast corner of the building. Light fixtures and associated electrical conduit are mounted on the southeast and northwest corners of the building below the roof line.

Figure 168. Property 27200, north and west elevations.

Figure 169. Property 27200, east and north elevations, view to the southwest.

Property 27200 was constructed in 1961. According to as built architectural drawings dated November 4, 1959 (revised September 7, 1960), Property 27200 was conceived of as a wind measurement building at the SMR for missile geophysics. The design plans indicate that the facility was intended to house storage space, a balloon inflation bay, in addition to three labs. The plans identify a Little John Lab, a Ballistic Wind Measurement Lab, and a Rawinsonde Lab. At the time of the present inventory, Property 27200 did not appear to be in use, but remains in good condition, with no apparent modification from the original design plans.

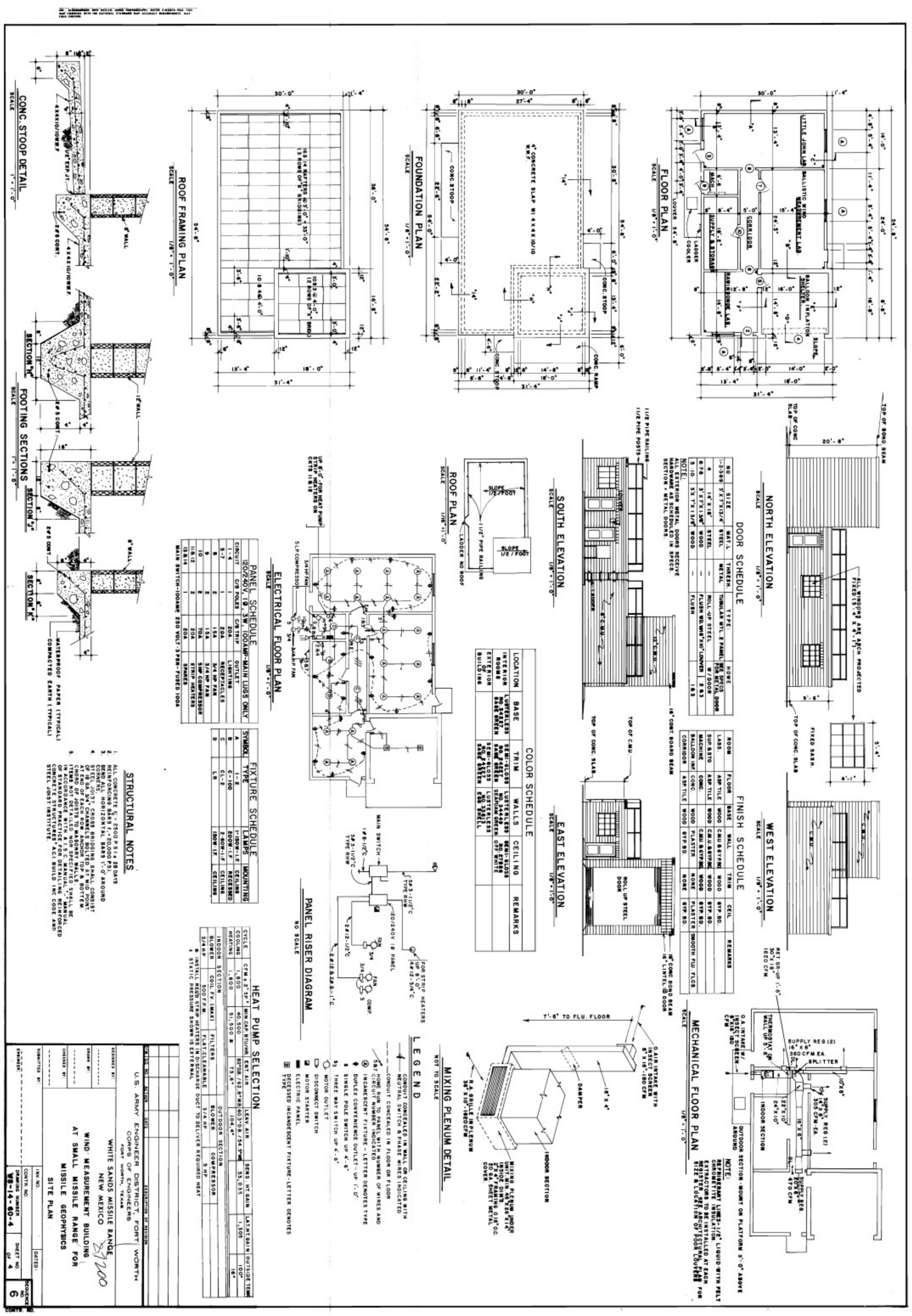


Figure 170. Architectural drawing of Property 27200 from 1959 WS-14 plans.

7.8.3 Property 27204

Figure 171. Property 27204, ARCAS Tower, view west/southwest.

Property 27204 is a red and white radio tower, constructed of a triangular metal framework in four vertical sections, topped by a red beacon light and instrumentation (possibly an anemometer). The object is stabilized by three anchor points, each with three sets of three guy wires set in concrete (see Figure 171). The tower is mounted atop a raised 2 x 2 ft concrete foundation adjacent to a timber post with a mounted electrical box (Feature 84). Property 27204 is located to the south of Property 27214.

Property 27204 was constructed in 1961 as the ARCAS Tower. Little information exists for its use in the years following construction; however, at the time of the current inventory the tower remains standing.

7.8.4 Property 27206

Figure 172. Property 27206 interior, view to the west.

Property 27206 is a square building of CMU construction which is built on an at-grade concrete slab foundation (see Figure 173). The building is painted tan with brown trim. The low pitch, gable roof of the building is a built up roof covered in asphalt roll and gravel material, and is supported by steel trusses. The roof edges are covered in flashing and gutters and downspouts are installed on the north and south elevations. An exhaust vent protrudes from the center of the roof. A double steel slab personnel door is located on the east elevation, which has a concrete entry slab and overhead explosion-proof dome light. The west elevation has a centrally located, single steel slab personnel entry door, which is sheltered by a windbreak constructed of green fiberglass corrugated panels. An evaporative cooler is also installed on the west elevation, with

Figure 173. Property 27206, south and east elevations, view to the northwest.

ductwork routed through the upper part of the wall. The evaporative cooler is installed on a steel platform set on concrete footers, possibly a repurposed portable observation platform. Windows in the building consist of fixed steel frame windows with 12 rectangular lights. Three of these windows are installed in a row in the upper walls of the north and south elevations of the building. Electrical conduit is mounted to the building walls just below the roof, which provides power to overhead lights mounted at the center of each exterior elevation. The eastern doors were ajar during the recording, and the building interior consists of a single room equipped with overhead explosion-proof dome lights.

The building was constructed in 1962 as an electrical equipment building and identified as an "Assembly Building" in WSMR realty data. According to former WSMR project engineer Bruce Kennedy, this building was used by the ASL sounding rocket launch crew for tool and equipment storage as well as a location for "…coffee and poker" (Bruce Kennedy, personal communication 2014). No additional information about the use and history of the building is available in the WSMR records. The spatial location of the building, near Properties 27208 and 27208B, fits with its role in the ASL meteorological research program. The building is currently vacant and abandoned, and appears to no longer be regularly maintained.

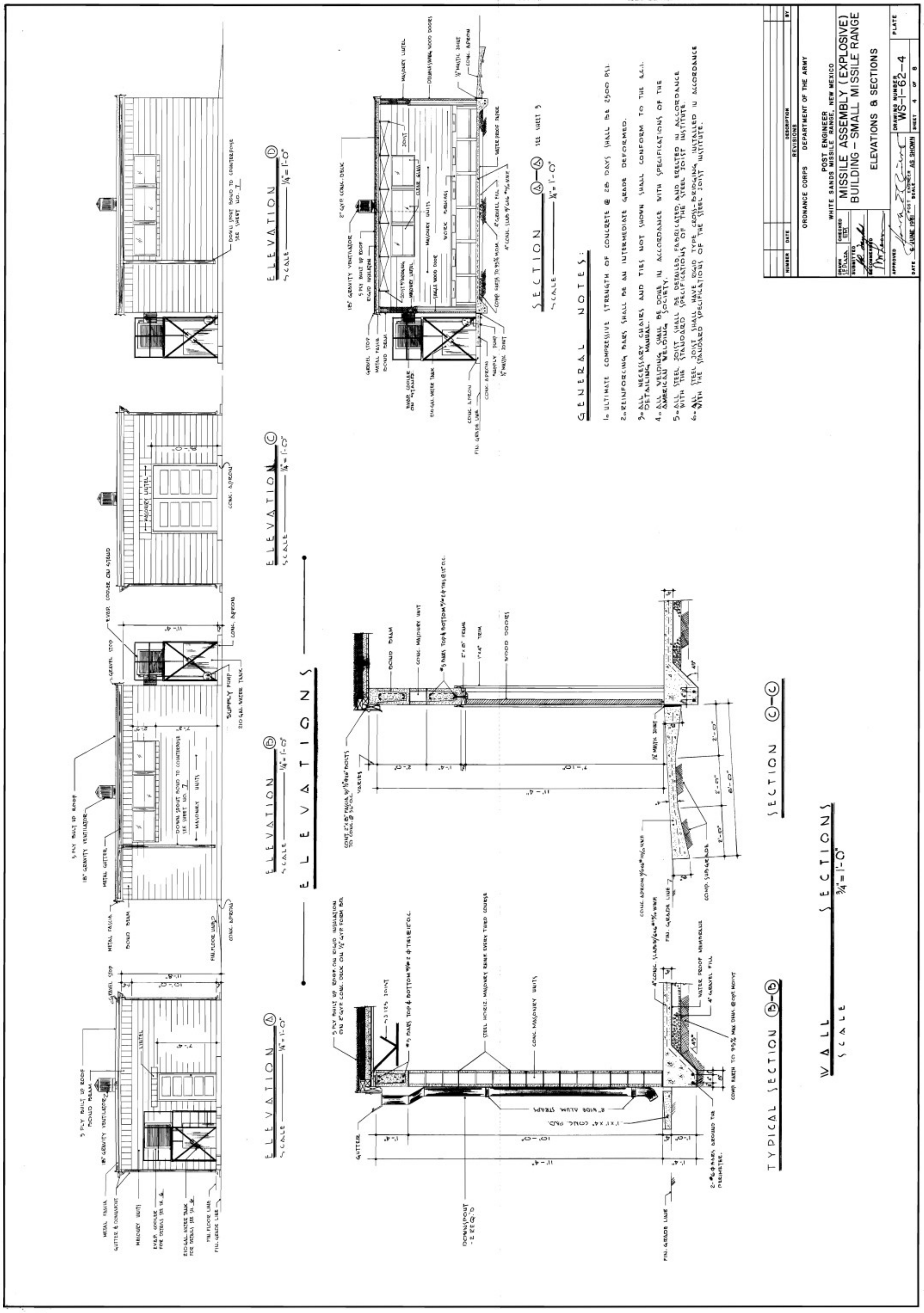


Figure 174. Architectural drawing of Property 27206 from 1961 WS-1-62 plans.

7.8.5 Property 27208

Property 27208 is a one-story building of CMU construction built on an at-grade concrete foundation (see Figure 175). Two additions, on the north and west elevations, have modified the original rectangular footprint of the building into an irregular plan. The building is painted tan with brown window and door frames, with the north elevation addition finished in pink stucco. The built-up, flat roof of the building is surfaced with tar and gravel material, and the west addition has a flat roof of similar construction. The roof edges are trimmed with flashing, and the north and south elevations are equipped with gutters and downspouts. Lightning rods and ground wires are installed the edge of the roof on all elevations, and the roof supports a wide variety of antennas.

The north elevation has a wood-frame, stucco clad addition attached to the northeast corner of the building (see Figure 178). This shed roof addition has a single fixed window of reinforced glass on its north elevation, along with a gutter and downspout. A radio antenna protrudes from the roof of this addition. The north elevation of the original portion of the building has a row of four windows set high in the wall. These metal frame windows each have 12 rectangular lights

Figure 175. Property 27208, east and south elevations, view to the northwest.

of frosted glass. The two eastern windows have awning openings while the others are fixed. The windows are protected by metal mesh screens and have a protruding concrete block sill. Near the western end of the original section of the building on this elevation is a steel ladder that provides rooftop access, which has an antenna bolted to its upper rail. The addition on the west elevation of the building serves to extend the north elevation to the west, although its roofline is lower than that of the original building (see Figure 176). The north elevation of the addition has a steel slab personnel door with an entry slab, and a fixed aluminum frame window. This window is protected by a hinged steel mesh screen. Several electrical terminal and access boxes are also located along the north elevation.

Figure 176. Property 27208, north and west elevations.

A flat roof, CMU addition to the west elevation of the original building extends approximately halfway across this end of the building. The west elevation of this addition has a nine-light metal frame window with casement opening side panels. Like the other building windows, this one is shielded by a steel mesh security screen. The south wall of this addition has a window A/C unit set in its upper wall with a cantilevered bracket. A concrete slab on the south side of the addition and the west side of the original west wall of the building supports a large HVAC unit with ductwork that enters the west wall of the original building and south wall of the west addition.

Figure 177. Property 27208, west and south elevations.

The south elevation of the building consists entirely of the original portion of the building. This elevation has a row of five 12-light windows

Figure 178. Property 27208, east and north elevations.

set into the upper portion of the wall, identical to those of the north elevation. A single steel slab personnel door with a concrete entry slab is located in the eastern portion of this elevation, and what appears to be a flag pole is located near this entrance. An overhead floodlight is mounted just above the doorway, and the remains of a fiberglass panel windbreak are located on the ground outside the entrance. This windbreak was still intact during the 2002 recording by HSR.

Figure 179. Visibility chart referencing landmarks visible from the SMR found on interior wall of Property 27208.

The east elevation of the original portion of the building has two awning type windows set high in the wall, identical to those of the north and south elevations. These windows are also covered by protective steel mesh screens. The east elevation of the addition on the north side of the building has a single steel slab personnel door with an entry slab attached to the sidewalk, and a single fixed window north of the entrance.

An elevated steel platform is located just off the east elevation. It is approximately 15 ft in height and the deck portion is approximately 13 ft north-south by 14 ft east-west. The platform support tower is constructed of four uprights of 4 inch diameter tubular steel with welded diagonal braces, and the platform deck is constructed of I-beams with a central section of steel plate with bordering sections of steel mesh. A steel staircase extends down from the north side of the platform deck in front of the east elevation of the building, connecting to the sidewalk. The lower part of an antenna tower is located near the bottom of the steps. At the top of the stairs is a red warning light tagged “NORTH AMERICAN SIGNAL”. According to the 2002 HSR documentation, this platform supported a radar or communications dish and wind measurement instruments at the time of that recording, all of which have subsequently been removed.

Other features immediately associated with the building include a concrete slab at the end of the sidewalk with three bent anchor studs that may have formerly supported some variety of instrumentation. Just east of the platform base is a rectangular concrete septic tank with two steel vents. On the east and south sides of the building are concrete parking curbs.

Although little data exists for Property 27208 in WSMR records, it was originally constructed in 1963 as a GM Facility and was used by the ASL for meteorological research and testing.

The WSSA and ASL meteorological research programs were active in this portion of the SMR throughout the 1960s and 1970s and beyond. Retired WSMR project engineer Bruce Kennedy (personal communication 2014) recalls this building as the "Track Shack" which contained the fire control room in the west side of the building and instrumentation in the east side of the building. Visitors to the range were brought into the fire control room and allowed to press the "fire" button to launch a sounding rocket, a practice which is recounted by Jim Eckles (Eckles 2013:29).

Maintenance records note that several updates were made to the building in 1969, including the sealing of a doorway in the west wall, adding an entry and windbreak on the south elevation, the addition of a lavatory and septic system, and the installation of a water line and work bench. Around this time, the Super-Loki and XM-75 atmospheric sounding rockets were being developed at the SMR, and these improvements to Property 27208 may have been in support these programs. Weather balloon and radiosonde equipment remain inside the building, while a 1997 calendar suggests that the building was still being used in support of atmospheric research as of that year.

7.8.6 Property 27208B

Figure 180. Property 27208B, south and east elevations.

Property 27208B is a pre-manufactured wood and metal frame shed building clad in galvanized corrugated metal panels (see Figure 180). It is a "high bay", an approximate two-story high space with no interior floor separations. The wood frame of the building is constructed of milled 1 x 4 inch boards supplemented with an angle iron grid that retains the corrugated metal panels. The building is constructed on an at-grade concrete slab foundation, and appears to be semi-modular. The medium pitch gable roof of the building is constructed of galvanized corrugated metal and has a projecting eave over the north and south elevations. The gable ends of the roof are filled with semi-transparent fiberglass panels to allow light into the building. The galvanized metal of the building is unpainted, but the angle iron frame is painted green.

The concrete slab foundation extends beyond the walls of the building on its north and south elevations, at the corners of which are 3 inch diameter steel pipe posts that serve as anchors for guy lines that are attached to the upper corners of the building. A wood rack built along the north elevation of the building provides storage for sections of a modular antenna tower, which appears to be identical to an intact section located near the east side of Property 27208. The guy line anchor posts on the south side of the building have been used to construct a shed roof that projects from the south elevation. This roof is of milled lumber and corrugated metal construction, and provides a covered storage space on this side of the building. The 2002 HSR recording noted that two helium tanks were stored in this area, but these are no longer present. This shed roof is in poor condition with several panels missing or damaged. The south elevation has electrical conduit that routes wire from a nearby overhead power pole to a switch box mounted on the wall. This box is also wired to an outdoor light switch and overhead light. The east and west elevations are equipped with horizontal sliding bay doors that are of the same construction as the rest of the building. The east sliding door has a bent frame and other damage, possibly from vandalism. No windows are present in the building.

Figure 181. Property 27208B, north and west elevations.

Items associated with the building include antenna parts, several portable antenna bases, cables, two sets of metal access stairs, and a concrete pad west of the building (Feature 260). A utility pole located just off the south elevation is equipped with an overhead flood light and routes power to the south wall of the building.

Property 27208B does not have an entry in the WSMR realty data but is positively identified by a property number tag on its door. An entry does exist for Property 27207 as a Balloon Inflation Shelter, which was constructed in 1962. While Property 27207 is no longer extant at the SMR, it is likely that 27208B was contemporaneous and constructed in or around 1962 as well. Little additional data is available regarding 27208B, but it remained in use as recently as 2002 based on the previous HSR recording. It currently is unused and abandoned, and appears to no longer be maintained.

7.8.7 Building 27214

Building 27214 is a one-story instrument building (see Figure 182). The one room, white painted building is of concrete block construction with a rectangular floor plan on an at-grade, concrete slab foundation. The flat, wood frame roof is clad in aluminum flashing and includes over-hanging eaves with exposed rafters. The four corners of the roofline are adorned with a series of lightning rods and associated braided grounding cables, extending to the ground surface. The roof line and foundation are extended on the east elevation, creating an entryway porch supported by two metal posts. A single light fixture is mounted on an exposed rafter of the entryway porch. Fenestration of the east elevation includes one steel slab personnel door set in a steel frame and painted green. The property number is stenciled in black paint below the roofline and offset from the northeast corner of the east elevation. Fenestration of the north elevation includes a fixed frame window with two vertical Plexiglas lights set in a metal frame

Figure 182. Property 27214, east and north elevations, view to the southwest.

above a protruding concrete block sill. The west elevation is completely unadorned. The south elevation is similarly unadorned with the exception of the property number stenciled in black paint offset from the southeast corner, mounted electrical conduit, as well as signage mounted below the roofline. The metal signage reads, “ASL, MSTA WSMR MET TEAM,” indicating the buildings association with and past use by the Atmospheric Sciences Lab.

Property 27214 was constructed in 1970 as an instrument building. Little information exists for its use in the years following construction; however, at the time of the current inventory the building was vacant.

7.8.8 Unknown Building 1

This undesignated building is located east of Property 27214 at the ASL Launch Complex (see Figure 183). The building has a square footprint with walls of CMU construction with a flat built-up roof surfaced in tar gravel material. The building is constructed on an above grade concrete foundation that overlies the concrete slab of the ASL launch pad. The roof edges trimmed in flashing and each corner of the roof has a lightning rod and ground wire. The exterior of the building is painted white with green trim and door, although the paint is substantially worn.

A green steel slab personnel door is located in the south side of the east elevation. A WSMR property sign is located on the door but it does not include a property number. Above and to the right of the doorway is an overhead light. The north elevation of the building has two fixed, single light windows with metal frames and protruding CMU sills. The west elevation has two electrical terminal boxes and a row of electrical conduits attached to the wall. A red warning light and an antenna that extend above the roofline are also mounted to the west wall. The south elevation has a window A/C unit set mounted to the wall via a cantilevered support.

No property number is visible on the building or the WSMR property sign on the door. The

Figure 183. Unknown Building 1, north elevation, view to the south.

WSMR GIS layer indicates this building as 27215, but this number is clearly marked on the Shillelagh Launch Pad and recorded as such in the WSMR realty data. Therefore, the WSMR GIS layer appears to be in error regarding this building. Due to this conflation of property numbers, no additional information about this building could be located in the WSMR records. The building is not present in photos of the ASL Launch Complex circa 1970, so the construction of the building is more recent and may be related to the northern extension of the original ASL launch pad. Viewed through the south elevation windows, several benches, an electronic console, three possible launchers, and a radio are visible within the single room interior of the building. Various items inside the building (such as a laserjet printer box) hint that it was in use as recently as the 1990s.

Figure 184. Unknown Building 1, east and north elevations, view to the southwest.

Figure 185. Unknown Building 1, west and south elevations, view to the northeast.

7.9 Blast Barricades

Blast barricades are structures designed to protect personnel and equipment from the blast, shockwave, and shrapnel resulting from an explosion. These barricades also acted as shields from the concussion that accompanied a rocket or missile launch. The barricades were often constructed around assembly or storage buildings where warheads or propellant were handled to isolate the building in the case of an accident. At the SMR, these barricades are wood frameworks constructed of milled lumber that are filled with earth. In addition to being cost effective and expedient, sediment acts as an efficient dissipater of an explosive blast and offers excellent mass and density. The timber framed barricades are a much more durable alternative to simple earthen mounds (berms) or barriers constructed of stacked sandbags. Some examples are constructed of poured, reinforced concrete as well, but are of less massive construction than the wood and earth barricades. Blast barricades recorded at the SMR during the current inventory are Properties 27073, 27074, 27080, 27179, 27189, 27191, 27196, 27205, and 27216.

7.9.1 Property 27073

Figure 186. Property 27073, view to the east/northeast.

Property 27073 is an "L" shaped blast barricade structure located on the western side of the SMR Launch Complex (see Figure 186). It is open towards the southwest, with a concrete slab foundation within its interior that is offset from the barrier walls approximately three and half ft along the slab's north side and four and half ft along its east side. The barricade walls measure 21 ft along the north-south oriented wall by 17 ft along the east-west oriented wall. The earth filled barricade is constructed of 2 x 12 and 4 x 4 inch milled boards, and is lined with tar paper roofing material or "felt" to seal the gaps between the boards, which also appears to have overlapped the wall tops. The walls are held in place by rebar cross braces with welded threaded ends for the attachment of nuts and washers. The slab foundation within the barricade measures 18 ft east-west and 12 ft north-south, and was poured in two sections. The west portion of the slab has a series of anchor bolts along its outer edge and two electrical conduits set into the concrete of its southwest corner, suggesting that it once supported a temporary structure or building. Based on a 1963 WSMR Property Inventory, this structure was constructed in 1960 and was assigned to ERDA. No additional archival information could be located about its history of use. It is in generally poor condition and appears to have been abandoned for some time.

7.9.2 Property 27074

Property 27074 is a "U" shaped blast barricade structure located north of Property 27150 off the east side of Road 2781 (see Figure 187). The open side of the structure faces west, and is approximately 15 ft north-south by 12 ft east-west, with walls approximately 5 ft in height. The earth filled barricade is constructed of 2 x 12 and 4 x 4 inch milled boards, and is lined with tar paper roofing material or "felt" to seal the gaps between the boards. Asphalt roll roofing material was applied to the wall tops to enclose the structure, but this material is in poor condition. The walls are held in place by rebar cross braces with welded threaded ends for the attachment of nuts and washers. A square concrete pad is located within the barricade walls, but is mostly buried by fill material that has slumped from the walls. A 3/8 inch diameter steel compression line attached to a valve and bracket assembly is mounted to the southwest corner of the structure, possibly the remnants of a fire suppression system. Based on a 1963 WSMR Property Inventory, this structure was constructed in 1960 and was assigned to ERDA. No additional archival information could be located about its history of use. It is in a state of advanced deterioration and appears to have been abandoned for some time.

Figure 187. Property 27074, view to the northeast.

7.9.3 Property 27080

Property 27080 is a "U" shaped blast barricade structure located off the west side of Road 278 in the central portion of the SMR (see Figure 188). The barricade is open on its west side and measures approximately 14 ft north-south by 10 ft east-west, and its walls stand approximately 5 ft high. The earth filled barricade is constructed of 2 x 12 and 4 x 4 inch milled boards, and is lined with tar paper roofing material or "felt" to seal the gaps between the boards. The walls are held in place by rebar cross braces with welded threaded ends for the attachment of nuts and washers. Based on a 1963 WSMR Property Inventory, this structure was constructed in 1960 and was assigned to ERDA. No additional archival information could be located about its history of use. Portions of the barricade walls have collapsed and it is poor condition, evidently abandoned for some time.

Figure 188. Property 27080, view to the southeast.

7.9.4 Property 27179

Property 27179 is a large north-south oriented blast barricade structure constructed of milled timbers and filled with compacted earth (see Figure 189). The barricade is offset by approximately 16 ft from the west elevation of Property 27180, providing explosive protection for the surrounding area. The barricade is framed with 8 x 6 inch timbers and clad with 3 x 12 inch boards, with 4 x 4 inch timbers as additional vertical supports on the wall ends. The frame is held together with ½ inch diameter bolts and nuts. Tar paper roofing material, or "felt", is applied to the interior of the frame to prevent any of the earthen fill from spilling out between gaps in the boards. The barricade walls are approximately 9.5 ft wide near the base, and taper to a

Figure 189. Property 27179, north end and west elevation.

width of 3.5 ft at the top. The top of the barricade is capped by additional 3 x 12 inch boards and 2 x 4 inch spacers and trimmed with metal flashing. The top of the barricade is equipped with lightning rods and ground wires.

Figure 190. Property 27179, west elevation, view to the northeast.

Property 27179 was constructed in 1959 as a protection barrier for the adjacent Property 27180, isolating the building from the rest of the Little John Assembly area. This met safety requirements for the building to be used for missile assembly and propellant storage. The barricade was originally constructed in an "L" shaped configuration; however, the east-west oriented section of the structure has since been removed. The presence of the barrier was an incentive to use 27180 for the same purposes during the Shillelagh testing, and possibly later programs as well. It is not known if the presence of the 27179 barricade is a significant consideration in the current use of Property 27180.

7.9.5 Property 27189

Figure 191. Property 27189, north and west elevations.

Property 27189 is a large "L" shaped blast barricade structure constructed of milled timbers and filled with compacted earth (see Figure 191). The barricade wraps around the north and west elevations of Property 27188, providing explosive protection for the surrounding area. The barricade is framed with 8 x 6 inch timbers and clad with 3 x 12 boards, with 4 x 4 inch timbers as additional vertical supports on the wall ends. The frame is held together with ½ inch diameter bolts and nuts. Tar paper roofing material, or "felt", is applied to the interior of the frame to prevent any of the earthen fill from spilling out between gaps in the boards. The barricade walls are approximately 9.5 ft wide near the base, and taper to a width of 3.5 ft at the top. The top of the barricade is capped by additional 3 x 12 boards and 2 x 4 inch spacers and trimmed with metal flashing. The top of the barricade is equipped with lightning rods and ground wires.

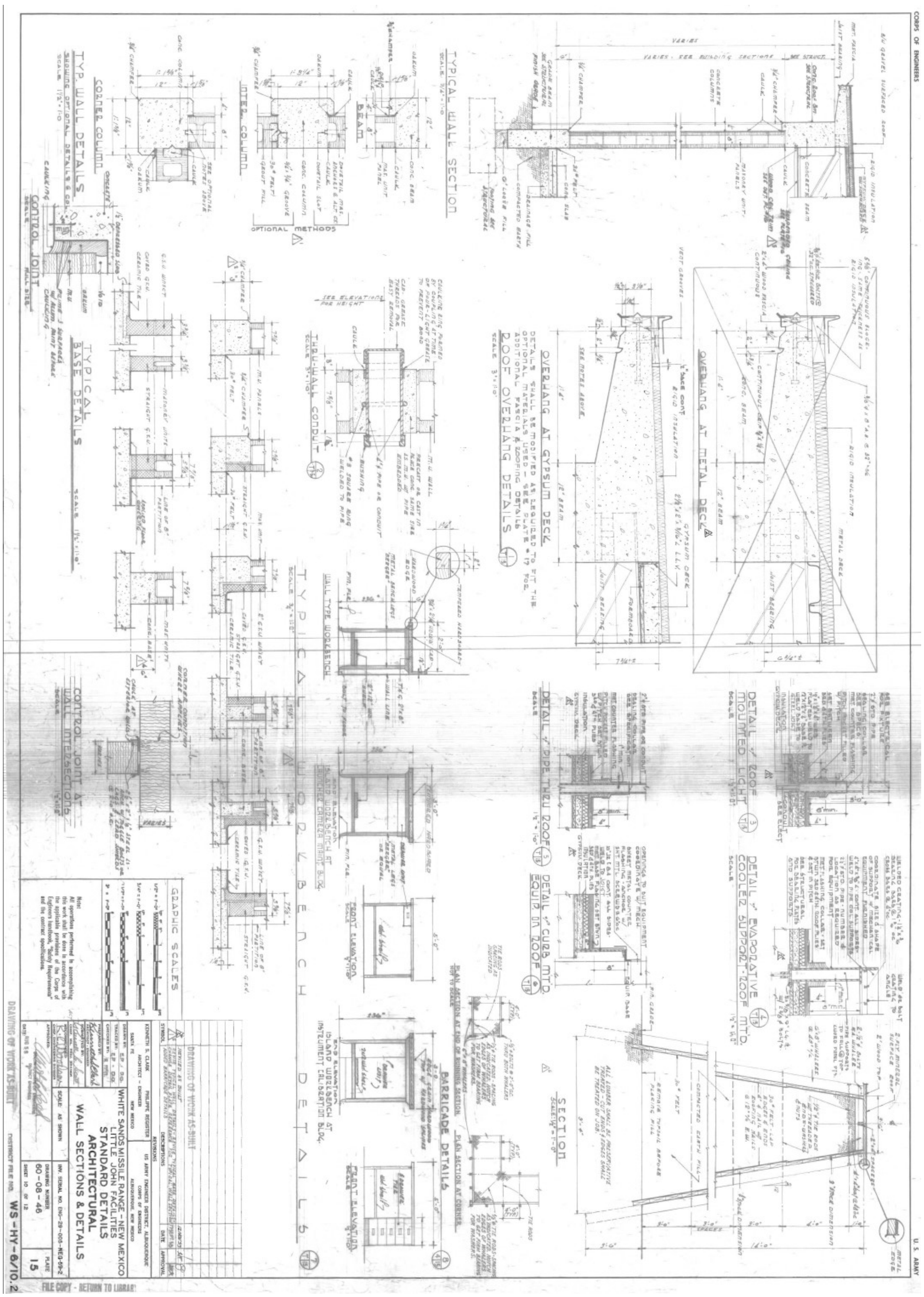


Figure 192. Architectural plan for wood frame, earth filled barricades found in the Little John Assembly Area, from 1958 WS-HY plans.

Property 27189 was constructed in 1959 as a protection barrier for the adjacent Building 27188, isolating the building from the rest of the Little John Assembly area. This met safety requirements for the building to be used for missile assembly and propellant storage. The presence of the barrier was an incentive to use 27188 for the same purposes during the Shillelagh testing, and possibly later programs as well. It is not known if the presence of the 27189 barricade is a significant consideration in the current use of Property 27188.

Figure 193. Property 27189, east and north elevations.

7.9.6 Property 27191

Property 27191 is a large "L" shaped blast barricade structure constructed of milled timbers and filled with compacted earth (see Figure 194). The barricade is offset by approximately 10 ft from the north and west elevations of Property 27187, providing explosive protection for the surrounding area. The barricade is framed with 8 x 6 inch timbers and clad with 3 x 12 inch boards, with 4 x 4 inch timbers as additional vertical supports on the wall ends. The frame is held together with ½ inch diameter bolts and nuts. Tar paper roofing material, or "felt", is applied to the interior of the frame to prevent any of the earthen fill from spilling out between gaps in the boards. The barricade walls are approximately 9.5 ft wide near the base, and taper to a width of 3.5 ft at the top. The top of the barricade is capped by additional 3 x 12 inch boards and 2 x 4 inch spacers and trimmed with metal flashing. The top of the barricade is equipped with lightning rods and ground wires. A metal post with electrical cabling is mounted on the east-facing façade of at the north end of the north-south oriented section of the barricade. The post extends above the barricade, adjacent to an offset radio tower.

Figure 194. Property 27191, east and south elevations.

Property 27191 was constructed in 1959 as a protection barrier for the adjacent Property 27187, isolating the building from the rest of the Little John Assembly area. This met safety requirements for the building to be used for missile assembly and propellant storage. The presence of the barrier was an incentive to use 27187 for the same purposes during the Shillelagh testing, and possibly later programs as well. It is not known if the presence of the 27191 barricade is a significant consideration in the current use of Property 27187.

Figure 195. Property 27191, south and west elevations.

7.9.7 Property 27196

Property 27196 is a large blast barricade structure constructed of milled timbers and filled with compacted earth, located northeast of Building 27164 (see Figure 196). It approximates an inverted "L" in shape; the main wall of the barricade is on a northeast to southwest alignment, and it has short leg that extends to the east on its north end. The barricade is framed with 8 x 6 inch timbers and clad with 3 x 12 boards, and fastened with ½ diameter bolts and nuts. Tar paper roofing material, or "felt", is applied to the interior of the frame to prevent any of the earthen fill from spilling out between gaps in the boards. The barricade walls are approximately 9 ft wide near the base, and taper to a width of three ft at the top. The top of the barricade is capped by additional 3 x 12 boards and 2 x 4 inch spacers and trimmed with metal flashing. On the east side of the barricade are two electrical breaker boxes mounted on a plywood panel supported by three metal posts, along with two other electrical boxes. An overhead light mounted on a wood pole is also installed on this side of the barricade, and two small electrical terminal boxes are mounted to the south and east barricade walls. Locat-

Figure 196. Property 27196, south and east elevations.

Figure 197. Property 27196, north and west elevations.

ed just southwest of the barricade is a metal sign in an angle iron frame that bears the painted lettering "EXPLOSIVE LIMIT 20 LB / EXPLOSIVES 1 UNIT / OPERATIONS PERSONNEL 4 / CASUAL PERSONNEL 2". An additional hinged panel below the sign reads "EXPLOSIVE" (see Figure 198).

Figure 198. Metal sign associated with Property 27196 and TOW launch pad.

The WSMR realty data does not contain an entry for Property 27196, so the construction date of the building is unknown. Architectural drawings associated with the barricade suggest that it was constructed in 1954 and originally used as a protective barricade for the Loki Conditioning Van. This barricade is also associated with Feature 248, the TOW launch pad, and was therefore also likely used to protect personnel and equipment during firings of the TOW in the late 1960s and early 1970s.

7.9.8 Property 27205

Property 27205 is a "U"-shaped concrete blast barricade structure located immediately north of Property 27164. The blast barricade is open on its north side and its rear (south) wall parallels the north elevation of Property 27164. The barricade is constructed of plywood formed, reinforced concrete with walls that are 12 inches in thickness. The dimensions of the barricade are 12 ft north-south and 13 ft east-west, with walls that stand 8 ft 8 inches in height. An electrical connection is attached to the west interior wall, and several pieces of conduit and a small anchor studs are located throughout the interior of the structure.

Figure 199. Property 27205, view to the southwest.

According to WSMR realty data, Property 27205 was constructed in 1961. The purpose of the structure and why it was built in such close proximity to the 27164 building is unknown. Given this construction date, it was probably built in support of programs during the 1960s or 1970s such as Shillelagh, Dragon, TOW, and Copperhead. Based on WSMR disposition data, the adjacent Property 27164 was used to support all of these efforts at various times during this period.

7.9.9 Property 27216

Property 27216 is a large two-part blast barricade structure constructed of milled timbers and filled with compacted earth. The structure is divided into two halves by a central gap that provides access through the barricade. Both portions are "L" shaped, with short legs that flank the central portal. The east barricade has an additional short "dogleg" that extends to the south along the east edge of the 27190 Launch Pad. The barricade is framed with 8 x 6 inch timbers and clad with 3 x 12 boards, with 4 x 4 inch timbers as crossbeams between the walls. The frame is held together with ½ diameter bolts and nuts. Tar paper roofing material, or "felt", is applied to the interior of the frame to prevent any of the earthen fill from spilling out between gaps in the boards. The barricade walls are approximately 9 ½ ft wide near the base, and taper to a width of 3 ½ ft at the top.

Figure 200. Property 27216, north and east elevations.

Figure 201. Property 27216 western portion, north elevation.

This structure was built as a replacement for a sand bag barricade previously used for the Shillelagh launches in the same approximate location. The sandbag barricade is visible in 1963 and 1964 photos of the early Shillelagh testing at the SMR. The barricade is constructed over the subterranean cable run and inset guide rails built into the 27190 Launch Pad, limiting the operation of these features. However, the gap between the two portions of the barricade accommodates the 27120 Fastax Camera Shelter that is built into the 27190 slab. This is was likely due to structural considerations rather than to ensure functionality of the camera shelter, as by then the Fastax/Mitchell camera shelters had fallen out of use.

7.10 Magazines

Magazines are a relatively common sight on military test ranges. They come in a variety of sub-types but essentially serve to safely store ordnance. Of the five magazines at SMR, three are standard explosive-type, used chiefly for storage. The stand-alone reinforced concrete structures each contain heavy duty steel doors and frames, lighting rods, and electrical grounding cables. The Climatic Test Building (27104) is basically a modified "igloo-type" (named for their earthen-bermed storage areas) magazine consisting of a reinforced concrete, approximately semicircular barrel arch springing from a foundation at grade. Climatic test facilities are used to subject test articles to extremes of temperature, humidity, and other climactic factor that might affect performance or usability in combat or long-term storage. Not always housed in magazine-type facilities, the precautionary effort may have been due to the proximity of other buildings.

7.10.1 Property S-27085

Property S-27085 is a small, board-formed concrete explosive storage magazine placed on a concrete slab (see Figure 202). The roughly square body is placed on a 3 inch concrete base that extends roughly 3 inches on all sides. The east elevation is mostly taken up by a pair of steel plate doors with heavy duty latches and braided grounding wires on the upper hinges. Large circular steel lift hooks and lightning rods project from the four corners of the top, all of which are connected by a continuous steel cable. A grounding cable is attached on both sides. This property number is also applied to the 27085 Target Maintenance building in the Tank Farm area; the rationale behind the reuse of the property number is unknown.

Figure 202. Property S-27085, south and east elevations.

7.10.2 Property 27103

Property 27103 is a small, one-story high explosive magazine. The building is of plywood-formed concrete construction and includes a roughly square floor plan on a slightly above grade concrete slab foundation (see Figure 203). The corners of the flat roofline are adorned with lightning rods with braided grounding cables running along the perimeter of the roof and extending to ground level. The fenestration of the north and south elevations is identical in configuration, each with two slab steel, hinged personnel doors. Four square vents are offset from the corners of the entryway doors. Each vent is hinged with an external plate steel cover, a security grill, and an internal louver. Overhanging globe light fixtures are mounted above each doorway in addition to electrical conduit and extending along the edge of the door frame and terminating at two electrical outlets and a panel with a red plastic light. In addition to the noted elements, the south elevation has been spray painted with the building number and includes two additional mounted junction boxes and associated electrical conduit. The east elevation includes the building number stenciled in white paint, in addition to three mounted electrical boxes and associated electrical conduit. Two hinged metal boxes and an antennae array are propped up against the east elevation. The west elevation is completely unadorned. The magazine is encircled by a chain link security fence with light posts (Features 42 and 43, described separately) present at the southeast and northwest corners of the paddock.

Property 27103 was constructed in 1981 as a high explosive magazine. Little information exists for its use in the years following construction; however, at the time of the current inventory the magazine did not appear to be in use.

Figure 203. Property 27103, south and west elevations, view to the northeast.

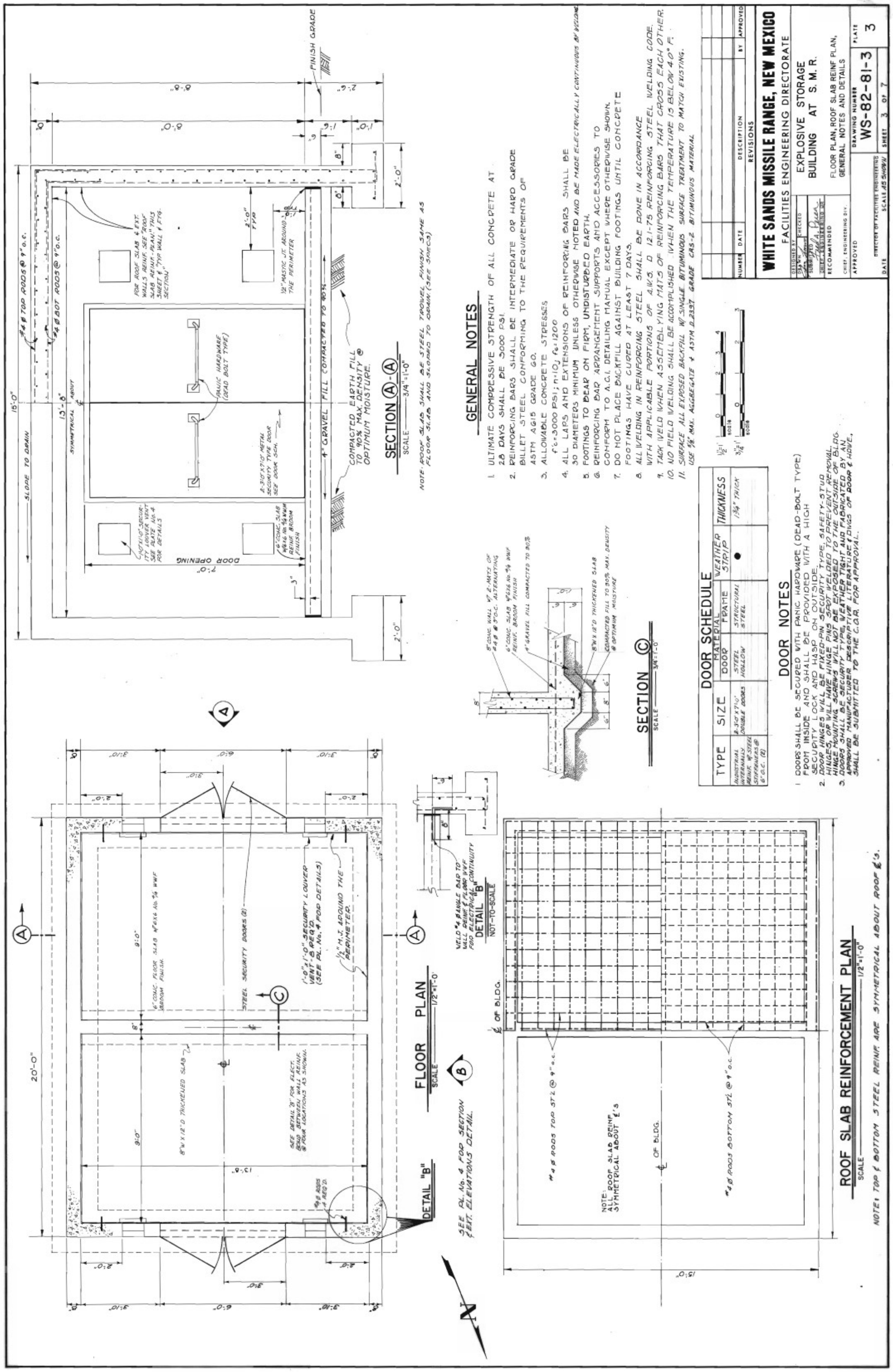


Figure 204. Architectural plan for Property 27103 from WS-82-81 plans.

7.10.3 Property 27104

Property 27104 is a one-story, mounded igloo storage magazine (see Figure 206). The building is on an at-grade concrete slab foundation with an irregular footprint, oriented on a southeast-northwest long axis. The building is of plywood form, reinforced concrete construction with a concrete slab, flat-roof. The roofline is adorned with a series of lightning rods and associated braided grounding cables, in addition to overhead lights mounted near each of the building corners on the southeast and northwest elevations. The magazine can be visually and functionally divided into two portions: the northwestern portion houses the mechanical equipment room, inclusive of large compressors and climate control infrastructure; and the southeastern portion is subdivided into High and Low Temperature vaults used for the storage of explosives and liquid propellant. The southeastern and northwestern limits of the climate controlled vaults are demarcated by 12 inch thick reinforced concrete wing walls. The vaults are further reinforced by earthen fill capped with a bituminous protective coating mounded between the wing walls on the roof and sloped at a 50 percent grade on the southwest and northeast elevations of the eastern half of the building. Two White Sands Proving Grounds brass cap survey markers set in concrete are present on the roof of the southeastern portion of

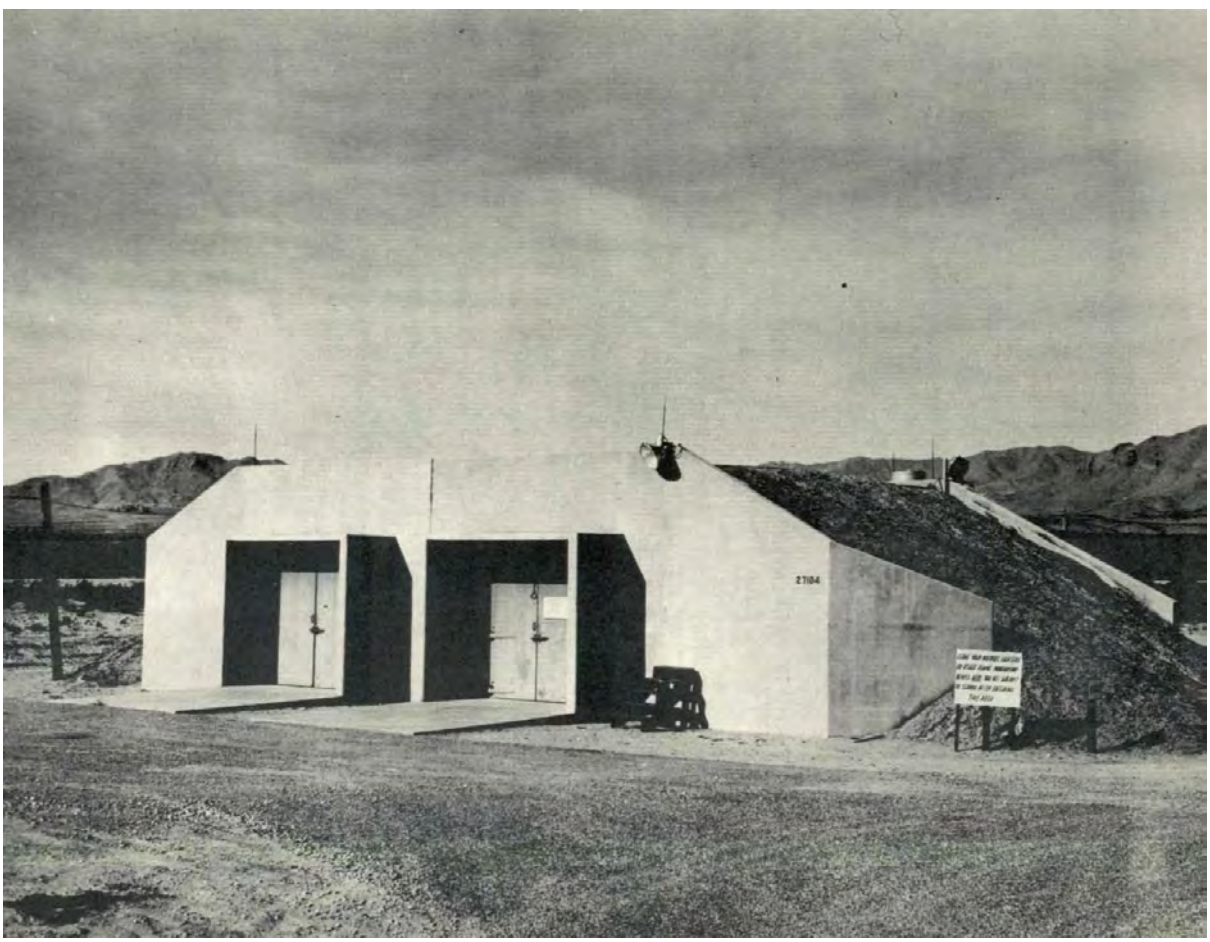


Figure 205. Property 27104 as it appeared in 1956 (*adapted from WSPG 1956)*.

the building. Unlike the southeastern portion of the building, the northwestern portion is not reinforced with wing walls or mounded earth. The roof line of northwestern portion is divided along the long axis of the building by a low wall clad in galvanized metal. The roof is lined with gravel, clad in galvanized metal flashing, and includes three prominent aluminum vents.

Fenestration on the southeast elevation includes two hinged, insulated steel doors set within reinforced concrete porticos, providing access to the climate controlled vaults. The vault doors are adorned with signage and painted green. Signage on the vault doors reads, “Explosive Limits 4000 LBS HE Liquid Propellant Limit 10, Personnel Limit 15; Operations 10, Casual 5.” Concrete aprons extend from each of the vault doors on the southeast elevation and overhanging globe light fixtures are mounted in each portico above the entryway. The fenestration of the northeast elevation includes two slab steel personnel doors set in a steel frame above an at grade concrete apron. Signage is offset from the northeast elevation that reads, “Army Materiel Test and Evaluation Applies Sciences Division Climatic Environments Branch.” Fenestration on the northwest elevation includes two rectangular metal, casement windows, each with eight horizontal lights, above a protruding pre-cast concrete sill. An 18 x 12 ft concrete pad abuts the northwest elevation and houses a large HVAC unit. The perimeter of the pad is lined by eight concrete bollards, with the exception of the side facing the building. The southwest elevation

Figure 206. Property 27104 Climatic Test Magazine, view to the west/southwest.

of the building is devoid of windows and doors; however, the as-built design plans indicate the presence of one window of similar configuration to those noted on the northwest elevation. This window was sealed with concrete block and subsequently modified to accept the duct from an evaporative cooling unit mounted on a raised concrete pad abutting the southwest elevation of the building. An electrical substation (Feature 81) is located approximately 50 ft north of Property 27104.

Figure 207. Property 27104, west and south elevations.

Property 27104 was constructed in 1954 as a climatic test magazine, and is a somewhat unique configuration in that combines a climatic conditioning chamber with a typical "igloo" style explosive storage magazine. The conditioner allowed conditions of extreme heat or cold to be simulated in order to test the effects of these conditions on a given test article. This allowed potentially deleterious environmental impacts on a missile system to be discovered in days rather than after months or years of actual exposure in the field (WSPG 1956). The two chambers within Property 27104 were known as Units 108 and 109 during the 1950s. Unit 108, the cold chamber, could freeze a test article between 0 °F and -65 °F, while the adjacent heating chamber of Unit 109 could generate heat from 40 °F to 180 °F (WSPG 1956). Little information exists regarding when use of the conditioning magazine halted; at the time of the current inventory it appeared to have been unused and unoccupied for many years.

Figure 208. Property 27104 north elevation "igloo" mounding and associated signage.

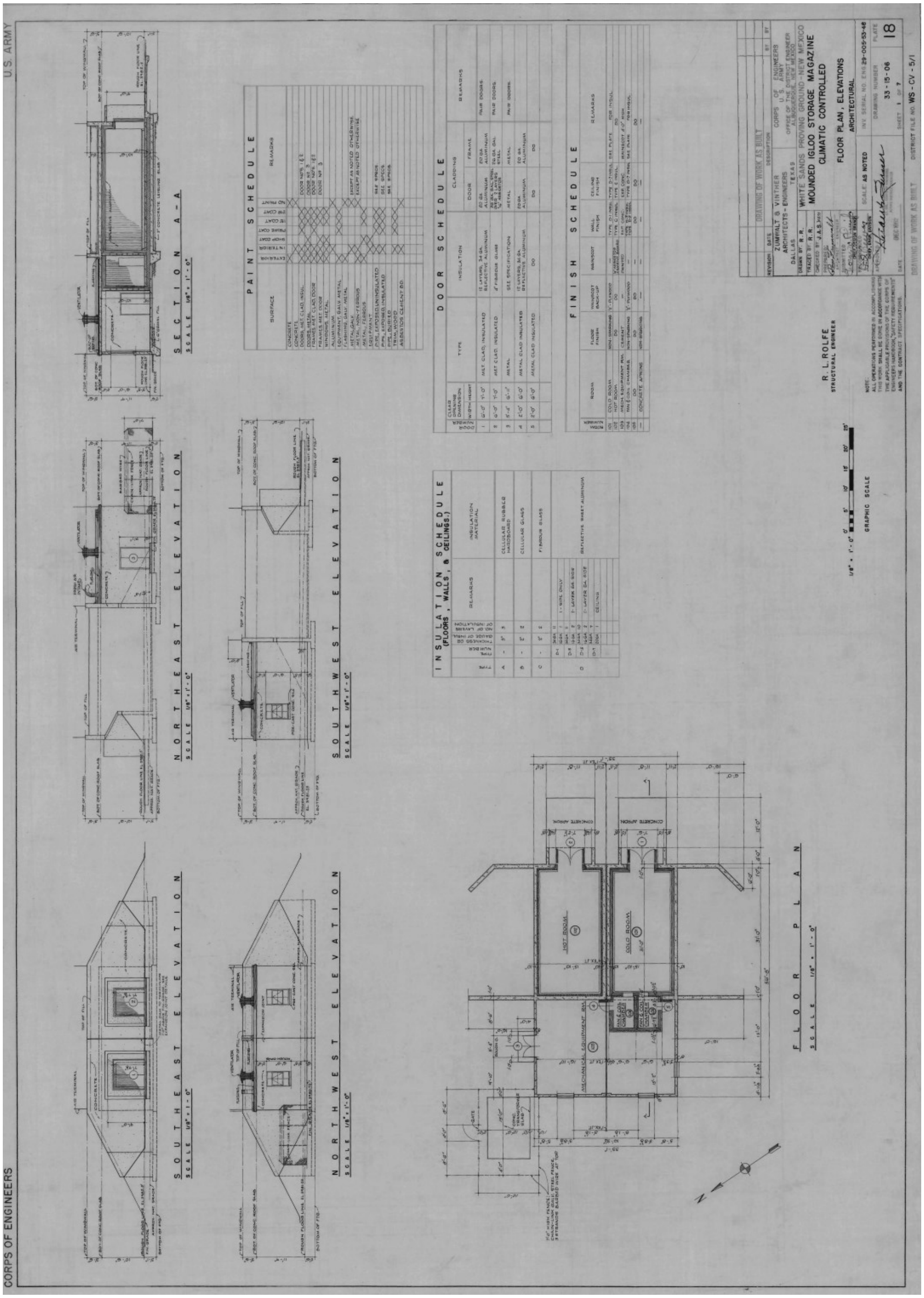


Figure 209. Architectural drawing of Property 27104 from WS-CV plans, 1952.

7.10.4 Property 27230

Property 27230 is a small, one-story magazine (see Figure 210). The building is of plywood-formed concrete construction, includes a rectangular floor plan on an at-grade concrete slab foundation, and measures 20 ft x 15 ft x 9 ft tall. The corners of the flat roofline are adorned with lightning rods with braided grounding cables running along the perimeter of the roof and extending to ground level. The fenestration of the east elevation includes one slab steel, hinged single-panel door. Four square vents are offset from the corners of the entryway door. Each vent is hinged with an external plate steel cover, an inset metal grate, and an internal louver. An overhanging globe light fixture is mounted above the doorway, in addition to four electrical coxes and associated electrical conduit. At least one of the electrical boxes with a touch key pad appears to be a more recent addition or replacement. The north, south, and west elevations are unadorned. The magazine is encircled by a chain link security fence with light posts (Features 85 and 86, described separately) present at the southeast and northwest corners of the paddock. Signage on the security fence reads, "Explosive Limits 5000 Pounds, Personnel Limits 4 Operators, 2 Casual."

Property 27230 was constructed in 1979 as a special weapons magazine. Little information

Figure 210. Property 27230, east and north elevations, view to the southwest.

exists for its use in the years following construction, and at the time of the current inventory the magazine did not appear to be in use.

7.10.5 Property 27231

Property 27231 is a very small, one-story magazine (see Figure 211). The building is of plywood -formed concrete construction, includes a square floor plan on an at-grade concrete slab foundation, and measures 64 by 64 by 57 inches high. The corners of the flat roofline are adorned with lightning rods with braided grounding cables running along the perimeter of the roof and extending to ground level. The fenestration of the east elevation includes one small, reinforced steel, hinged door, measuring 3 ft high by 2 ft wide. The door is presently stuck in the frame and slightly ajar. An overhanging globe light fixture is mounted above the doorway in addition to an electrical box, a switch box, two outlets, and associated electrical conduit. The south elevation includes one mounted electrical box while the north and west elevations are unadorned. The magazine is encircled by a chain link security fence with light posts (Features 87 and 89, described separately) present at the southeast and northwest corners of the paddock.

Figure 211. Property 27231, east and north elevations.

Figure 212. Property 27231, north and west elevations.

Property 27231 was constructed in 1979 as a special weapons magazine. Little information exists for its use in the years following construction; however, at the time of the current inventory the magazine did not appear to be in use.

7.11 Miscellaneous Facilities

Not all facilities fit neatly into categories and, depending on the type of site, the function of support facilities can vary greatly. The SMR includes facilities that fall into the general category of "infrastructure" and general support buildings. Examples range from simple maintenance buildings to Liquid Propane (LP) gas tanks on support structures. Other types at the SMR include electrical vaults, storage buildings, a boiler room, communications building, steel container structures, and two portable buildings. Construction types include simple, reinforced concrete structures, CMU buildings, steel-frame pre-manufactured buildings, and one Quonset hut. None of the miscellaneous facilities are notable for design or construction.

7.11.1 Property 27181

Property 27181 is a small pre-manufactured steel Armco building constructed on an above-grade concrete foundation (see Figure 213). The steel frame building is clad in steel panels and has a low pitch gable roof of standing seam metal construction. The roof is equipped with a cylindrical vent at the center of its peak and a round vent is located on the east side of the roof.

Figure 213. Property 27181, west and south elevations, view to the northeast.

Lightning rods and ground wires are also fixed to both ends of the short roof peak. The gable end caps are embossed with "ARMCO 56". The walls and roof of the building are painted tan and the entry doors on the south elevation are painted green.

On the south elevation of the building is a double door entry with a concrete entry slab. The doors of this entry have louvered vent panels in the lower part of the door, and appear to have originally possessed upper lights that have been replaced with sheet metal panels. Affixed to the east door is a warning sign about the presence of asbestos in the building. Above this doorway is an overhead light fixture that is missing the bulb and globe. Below and to the west of the doorway is a rectangular subterranean concrete valve box with a sheet metal cover is located at the southwest corner of the building. The north, east, and west elevations of the building are plain with no windows, doors, or other distinguishing features.

Building 27181 was constructed in 1957 as a "Gas Heat Plant" and is identified on architectural drawings as a Boiler Room built in support of the Little John Program. These plans indicate that it supplied Building 27180, the Little John Assembly Building, with hot water via an underground pipeline. The building was no longer in use during the 2002 recording by HSR, and it appeared unused during the current recording as well.

7.11.2 Property 27220

Property 27220 is a one-story rectangular-plan building of CMU construction built on an above-grade concrete foundation (see Figure 215). The building is painted tan with a brown foundation and vent panels. The built-up, shed roof of the building is surfaced with tar and gravel material and drains to the east. The east roof edge is equipped with a gutter and two downspouts spaced evenly along the east elevation. The roof has a minimal eave, which is trimmed with flashing. Lightning rods and ground wires are installed the edge of the roof on all elevations.

Figure 214. Property 27220, sign on south elevation near entrance.

The south elevation is the primary elevation of the building and has two double door entrances with a partial length concrete entry slab. The doors of these entrances are steel slab doors set into metal frames. The eastern set of these doors is sheltered by a shed roof entry porch with CMU walls. Dome light fixtures adorn the interior of this entry porch. A metal sign next to this entry reads "COMMUNICATIONS STATION / SMALL MISSILE RANGE". A middle line on the sign that has been painted over, but remains legible, reads "USAISC -WHITE SANDS". A large louvered vent panel is placed high in the wall above the west entry doors, and smaller louvered vent panel is located low in the wall just east of this entry. Mounted to the wall above the upper vent panel are a sealed exterior flood light and a loudspeaker. A second flood light is mounted to the upper east corner of the south elevation. Two red warning lights are mounted to this elevation above the entrances, and an electrical main switch and conduit coupler are mounted near the east corner of this building wall.

A single steel slab personnel door is located at the north end of the west elevation, which has a concrete entry slab and an explosion-proof overhead dome light. A red emergency flasher is located above this entrance. A round exhaust vent housing is located midway up the wall in the middle of this elevation. Ground wires from the lightning rods, and antenna, electrical boxes, and a vent pipe are installed along this elevation; however no windows or other entrances are present on this side of the building. Near the southwest corner of the building are two HVAC units set on concrete slabs. A short wood pole is located near these units, which bears two antennas. A cable from the antennas connects to the west elevation.

The east elevation of the building lacks any windows or doors, but does a large louvered vent panel set high on the wall on its southern end. Below this vent panel is metal “COMMUNICATIONS STATION” sign identical to that on the south elevation. A trapdoor set into a square concrete foundation is located at the base of the wall near its midpoint; this trapdoor leads into a large crawlspace that runs horizontally under the building. This tunnel provides access to

Figure 215. Property 27220, south and east elevations, view to the northwest.

the building sump pump and electrical wiring. Above the trapdoor access an explosion-proof dome light fixture is mounted to the building wall. On the north side of the crawlspace access is a pipe support for an antenna; two electrical boxes are bolted to the support pole as well. Near the north of end of the west elevation is a triangular lattice antenna tower built on a triangular concrete foundation. A series of nine pipe cable access ports protrude from the north half of the east elevation, located approximately ten ft high on the wall and spaced four ft apart. A wire and a sheet metal cover connect from the lattice radio tower to one of these ports near the north end of the west elevation.

Figure 216. Property 27220, north and west elevations.

The north elevation of the building lack any doors or windows and is almost entirely plain, with the exception of a corrugated metal shed-style addition that abuts the west side of the wall (see Figure 216). This small addition is constructed on a concrete slab and has a steel slab personnel door set in its north elevation. A louvered vent panel is located in the upper part of the west wall. The addition houses additional cylinders for the Inergen fire suppression system installed in the building, and does not provide access into the main building. This addition was not mentioned in the 2002 recording by HSR, so it appears to have been added to the building relatively recently. Two trailers, one equipped with a diesel generator and one with a diesel fuel tank, are parked in front of the south elevation of the building.

Property 27220 was built in 1970 as a telecommunications building. According to the 2002 recording by HSR, six other buildings with the same Use Category Code (13120, Comm Center) were built across WSMR around 1970 as communications centers. While 27220 is therefore not an integral part of the history of the SMR missions, it is significant to the WSMR communications network and has been used continually for this purpose since it was built. The building appears to still be utilized as a communications center, but is not currently staffed.

7.11.3 Transformer Vaults

Two transformer vaults are located along the SMR Yaw line and were constructed along the Fastax/Mitchell camera shelters. These are only two such examples known to exist at the SMR.

7.11.3.1 Property 27091

This reinforced concrete, subterranean transformer vault is located as between two Mitchell camera vaults (Properties 27142 and 27143) along the SMR Yaw line (see Figure 217). The structure measures eight-foot square with an interior depth of roughly 7 ft, 6 inches from floor to ceiling, and the uppermost section projects approximately 3 ft above grade. The plywood and board-formed structure has 8 inch thick walls, floor and ceiling, reinforced with steel rods throughout. The southwest area of the top is covered by a thick, steel plate cover of 3/8 inch thick plate steel. Inset within this steel cover is a hinged personnel hatch with "TRANS. 105" painted in large letters. This hatch leads to a steel-frame access ladder on the interior wall. Two sheet metal vents are mounted on the vault – one for exhaust mounted on the top in the northwest corner and one for air intake on the north end of the east sidewall; an exhaust fan is mounted on the ceiling below the vent. A roughly 2 inch steel pipe protrudes from the top in the northeast corner.

Property 27091 is identified on a 1963 WSMR Properties inventory as a "Power Vault", but current WSMR realty data indicates Property 27091 as a "Septic Tank and Drain Field" constructed in 1993. The 27091 and 27092 transformer vaults are indicated on the original 1951 architectural plans for the SMR infrastructure, and were probably constructed in 1952 along with the camera buildings. The property number therefore appears to have been re-issued to the more recent septic field for reasons unknown. The vault likely remained in use along with the Fastax/Mitchell camera vaults it supplied power to until the 1960s, when this system fell out of use due to the changing requirements of the SMR instrumentation.

Figure 217. Property 27091, north and west elevations.

Figure 218. Property 27091 personnel hatch.

Figure 219. Property 27092, interior view from personnel hatch.

7.11.3.2 Property 27092

A second transformer vault, identical in construction to 27091, is located further south along the Yaw line, between Mitchell camera vaults 27126 and 27127. While basically identical to the other vault, this vault has a roughly 8 inch thick "L" shaped concrete extension or buttress added as a repair to the south and west elevations of the structure (see Figure 220). When viewed from the interior, damage to these portions of the original vault wall is obvious, probably from an errant impact. The personnel hatch of this vault was unlocked at the time of recording, and it retains the original transformer and associated electrical equipment. Like the other vault, a designation is painted on the personnel hatch, but only "TRA… 10…" remains legible. Like 27091, the vault probably fell out of use along with the yaw line cameras during the 1960s.

Figure 220. Property 27092, west and north elevations, view to the southeast.

7.11.4 LP Tanks

Numerous liquid propane (LP) storage tanks are associated with buildings across the SMR (see Figure 221). Most of these tanks are original installations that were installed at the time of the buildings construction. Although not as prominent as buildings and structures at the SMR, these tanks were assigned individual WSMR property numbers in the same fashion.

Figure 221. Property 27169 is a typical LP Tank installation at the SMR. View is to the northwest.

7.8.4.1 Property 27078

Property 27078 is a cylindrical steel LP tank located just east of Building 27186. It is supported by steel legs that rest on a concrete pad. It is surrounded by a safety enclosure constructed square steel stock. Warning signs are located at the north and south ends of the tank, and it is identified by a stencil painted number. According to WSMR realty data, the tank was installed in 1995 and supplies Building 27186 with propane.

7.8.4.2 Property 27084

Property 27084 is a cylindrical steel LP tank located just south of the Property 27085 Target Maintenance Building. It is supported by steel legs that rest directly on the ground and is enclosed by a welded steel fence. It is identified by a stencil painted number. According to WSMR realty data, the tank was installed in 1989 and supplies Property 27085 with propane.

7.8.4.3 Property 27210

Property 27210 is a cylindrical steel LP tank located just east of Building 27208. It is supported by steel legs that rest on two concrete footers, and it is identified by a handwritten number. It is surrounded by four steel and concrete bollards and marked with a warning sign. According to WSMR realty data, the tank was installed in 1963 and supplies Building 27208 with propane.

7.8.4.4 Property 27169

Property 27169 is a cylindrical steel LP tank located just north of Building 27166. It is supported by steel legs that rest on two concrete footers, and it is identified by a stencil painted number. According to WSMR realty data, the tank was installed in 1959 and supplies Building 27166 with propane.

7.8.4.5 Property 27174

Property 27174 is a cylindrical steel LP tank located approximately 50 ft north of Property 27173. The object is oriented east-west and supported by two sets of two steel legs that rest on raised concrete footers. The LP tank is surrounded by 12 steel reinforced, concrete bollards. Warning signs are located at the west end of the tank, and it is identified by a stencil painted number. The tank was manufactured by Wendland Mfg Co in 1957 and supplies Property 27173 with propane. Property 27174 was constructed in 1959. Little information exists for its use in the years following construction; however, at the time of the current inventory the liquid propane tank appeared to be operational.

7.8.4.6 Property 27270

Property 27270 is a cylindrical steel LP tank located to the east of Property 27170. The object is oriented north-south and supported by steel legs that rest on a 16 by 4 ft concrete pad. The LP tank is surrounded by 16 steel reinforced, concrete bollards. Warning signs are located at the north and south ends of the tank, and it is identified by a stencil painted number. The tank appears to be of relatively recent construction and supplies Property 27170 with propane.

7.11.5 Portable Buildings

Multiple examples of portable buildings are found across the SMR, most parked in locations near more significant buildings or structures as storage or support facilities. Many are small, single room versions of pre-manufactured steel buildings constructed on wooden skid platforms. Due to their portable nature and lack of formal WSMR property numbers, the histories of these buildings are mostly unknown.

7.11.5.1 Property WS 294

Property WS 294 is a portable, pre-manufactured steel building that is constructed on wood skids (see Figure 222). It is located just off the southwest corner of the building of Property 27220. The building is of steel frame and steel clad construction similar to those produced by Butler and Armco, although this example does not indicate its manufacturer. The medium pitch gable roof of the building is constructed of standing seam metal. Several numbers are stencil painted on the building, including WS294, H5027, and 422926. A double door entry is located on the east elevation of the building, which has steel doors with upper lights protected by steel mesh screens. A window on the south elevation is likewise protected by steel mesh screen. A metal stand and a duct on the west elevation indicate that an evaporative cooler has been removed from this elevation. The north elevation is plain, without any doors, windows, or other features. An electrical cable from an overhead pole set just off the southwest corner of the building is connected to an electrical conduit in the south elevation, demonstrating that the building does have a power supply.

Figure 222. Property WS 294, south and east elevations.

7.11.5.2 Property WS 689

Property WS 689 is a steel shipping container retrofitted to serve as a one-story observation building (see Figure 223). The container measures 93.5 inches deep by 76.5 inches wide by 82 inches high. The flat roofed building rests on two parallel steel skids with four welded steel rings serving as lift points on the corners of the roof line. The white painted exterior of the shelter remains unmodified with the exception of the east and west elevations. The west elevation serves as the entryway and includes two, four-hinge panel doors that have been welded in place. Signage mounted on the panel identified the structure as "WS 689", with complimentary labeling stenciled in black paint. The east elevation includes a torch cut, 18 inch by 10 inch viewing port, fitted with an externally mounted, rectangular, ½ inch thick Plexiglas panel. A 1¾ inch diameter portal is also present on the east elevation, below the viewing port. Modifications to the interior of the container include mounted milled lumber framing, in addition to electrical conduit and three paired electrical outlets on the north wall. Adjacent to the viewing port on the east interior wall is labeled "EAST" in block lettering. The shelter is presently used for storage.

Figure 223. Property WS 689, north and east elevations, view to the southwest.

7.11.5.3 Property WS 690

Property WS 690, similar and adjacent to WS 689, is a steel shipping container retrofitted to serve as a one-story storage building (see Figure 224). The container measures 93.5 inches deep by 76.5 inches wide by 82 inches high. The flat roofed building rests on two parallel steel skids with four welded steel rings serving as lift points on the corners of the roof line. The white painted exterior of the container remains unmodified with the exception of two, four-hinge panel doors that have been welded in place on the west elevation. One of the panel doors has fallen off and includes mounted identifying the building as "WS 690", with complimentary labeling stenciled in black paint. Modifications to the interior of the container include mounted milled lumber framing on the north, south, and east walls. Overturned signage resting against the east elevation reads, "Notice All visitors must report to Anti-Tank Opns. Building 27166 prior to entering pad area." The structure is presently vacant.

Figure 224. Property WS 690 south and west elevations, view to the northeast.

7.11.5.4 Unknown Building 2

Unknown Building 2 is a portable pre-manufactured steel building located just west of the Property 27087 instrument platform and mound (see Figure 225). The whitewashed building is of metal frame and metal clad construction, with a medium pitch gable roof of standing seam metal. The building is a typical example of steel pre-manufactured building such as those produced by Butler or Armco, but this particular example did not have any identifiable label of its manufacturer. The entire building is constructed on a wood skid, rendering it easily transportable. A steel panel door set into a steel frame is located on the east elevation, above which is an explosion-proof globe light fixture and a vent in the roof gable. The north elevation has a single fixed steel

Figure 225. Unknown Building 2 south and east elevations, view to the northwest.

Figure 226. Unknown Building 2, south and west elevations, view to the northeast.

frame window with four safety glass lights. A faded identification number next to the window appears to read "14179", a number that does not appear in WSMR realty records. A window mount A/C unit is set into the wall adjacent to the window. The west elevation is entirely plain except for a vent panel in the roof gable. The south elevation has the same fixed four-light safety glass window as the north elevation, as well as several electrical connections that connect through the wall.

The building appears to be functionally connected to Property 27087 and appears to have been wired for communications and electricity. It likely housed supporting equipment for the adjacent instrumentation site, but no documentation regarding the history and use of the building exists in archival records.

7.12 Isolated Features

While buildings, structures, and objects serve as the most prominent exemplars of the built environment, supporting aspects, such as infrastructural components, are no less important. For the purpose of the SMR Inventory, these elements were captured as features. This broad classification is inclusive of architectural and historic archaeological manifestations that are spatially or functionally associated with activities at the site, but not readily identifiable as a building, structure, or object. In most cases these are isolated elements, such as a lone terminal box mounted on a timber post. In some cases features include multiple associated elements, such as an array or alignment of calibration target poles.

Documented features at the SMR were categorized under five different types. These types were defined primarily based on functional characteristics and are largely considered as infrastructure constructed in support of range operations. The five feature types include Electrical Infrastructure, Instrumentation, Launch Infrastructure, Targets, and Miscellaneous.

Features attributed to the Electrical Infrastructure type are defined as those elements or remnants of constructed infrastructure intended to provide electricity in support of the facilities associated with the SMR. Examples include concrete pull boxes, as well as mounted electrical cabling, panels, fuse boxes, and terminal boxes (see Figure 227).

Features attributed to the Launch Infrastructure type are defined as those elements or remnants of infrastructure constructed as launch sites for the various programs tested at the SMR (see Figure 228). These features include launch pads and platforms

Figure 227. Common examples of Electrical Infrastructure features at the SMR (*top to bottom)*: electrical junction and switch panel, terminal box on post, and electrical breaker box mounted on post.

Figure 228. Feature 248, the TOW Launch Pad, is typical of Launch Infrastructure features.

of both earthen and concrete construction. One such launch pad feature is the TOW launch pad where firings of the TOW missile were carried out (Feature 248). Other similar features lack documentary evidence as to what programs they supported.

Target Features include those constructed elements or remnants of targets used for testing of programs at the SMR. Various wood and steel frames and earthen target mounds where targets were placed are common features in this category (see Figure 229).

Instrumentation features are defined as those elements or remnants of constructed infrastructure intended to support directly support instrumentation systems in use at the SMR. These features include elements supporting optic and telemetry systems, such as calibration target poles, concrete pads, and pedestals used to mount instruments (see Figure 230). These features also included a network of poles along the Yaw Line that suspended aerial cameras (see Figure 231). Only one of these poles remains standing today, the remainder were uprooted and laid horizontally along the Yaw Line (see Figure 230).

The Miscellaneous feature type was defined as a catch all for those remaining elements encountered within the confined of the SMR, where no clear connection to supporting infrastructure could be surmised. Examples include rocket motor dumps and burned trash concentrations

Figure 229. Common examples of Target features at the SMR (*top to bottom)*: steel plate target, wood target frame, and steel target frames.

Figure 230. Common examples of Instrumentation features at the SMR (*top to bottom)*: instrument calibration target poles, a downed aerial camera support pole, and a portable instrument pedestal.

Figure 231. The series of aerial camera suspension poles along the SMR Yaw line, circa 1950s (*undated photo on file at WSMR Environmental Directorate)*.

Figure 232. A camera is mounted on the “cart” that is winched to the boom at the top of the aerial camera suspension pole, circa 1950s (*undated photo on file at the WSMR Environmental Directorate)*.

(see Figure 233).

A total of 291 features were documented during the current inventory of the SMR. Of those, a small number (n=11) were found to have assign WSMR property numbers and were reclassified as historic buildings, structures, or objects. Of the remaining 280 features, instrumentation was the most common feature type (n=153), accounting for approximately 54.6 percent, followed in decreasing frequency by Electrical Infrastructure (n=54, 19.2 percent), Miscellaneous (n=44, 15.7 percent), Target Infrastructure (n=18, 6.4 percent), and Launch Infrastructure (n=11, 3.9 percent). A complete description of all documented features is provided in Appendix A.

Figure 233. Various dump features are the most type of miscellaneous features encountered at the SMR. A dump of collected Loki motors (*top)* and a dump of torch cut barrels and other metal debris (*bottom)*.

8. NRHP Eligibility Recommendations

Cultural resource specialists collected data on a total of 115 buildings structures, and objects as well as 291 features at the SMR within a contiguous 635 acres that related specifically to associations with testing activities in the Cold War era – from 1953 to 1989; no prehistoric features were recorded or evaluated. The purpose of this study has been to record and document the SMR and its component parts.

To guide the selection of properties included in the National Register, the National Park Service has developed the National Register Criteria for Evaluation. These criteria are standards by which every property that is nominated to the National Register is judged. In evaluating the potential for individual eligibility, the SMR resources were accessed in terms of the applicable National Register Criteria. The four primary eligibility criteria are described as properties:

> (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.

None of the newly recorded resources were recommended individually eligible for listing to the NRHP. However, as a grouping, the site is recommended eligible at the national level for listing as a historic district under NRHP Criterion A and C. The Period of Significance for the district begins in 1953 when facilities were constructed and testing began, to 1989, the commonly accepted end of the Cold War, even though the USSR did not dissolve until 1991.

Throughout the resource evaluation process the historic context of the SMR was consulted in order to determine the events that might constitute significance, facts about the people who were important to the history of the range and the attributes of design in the various periods of construction. Criteria B and D were considered in evaluation of the SMR resources wherever possible; however, the more systematic application was made with respect to Criteria A and C.

8.1 Eligibility Criterion A

The SMR is recommended eligible under NRHP Criterion A for its association with specialized rocket and missile testing during the Cold War that was integral to the plan to be prepared for tank warfare, particularly in Eastern Europe. The SMR is also significant for the role it played in atmospheric meteorological data collection, which contributed to the understanding of flight behavior in the high atmosphere. This research was applied to the development of Ballistic

Missile Defense (BMD) systems, and also made contributions to the US space program. The US Army provides guidance for evaluating Cold War resources, and the discussion of eligibility under Criterion A is based upon this established framework.

8.1.1 Historic Themes

Specific guidance for the evaluation of US Army Cold War era military-industrial properties is provided by the Army (Lavin 1998). This guidance is relevant to the evaluation of the SMR as it played an active role in the Army's military-industrial complex during the Cold War. As a test facility for tactical rockets and missiles, the SMR operated within the nexus of collaboration between the military, federal legislation, and the private defense industry, coined as the "military-industrial complex" by President Dwight Eisenhower in 1961. Additionally, the SMR was active throughout 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. The SMR was active throughout all but the earliest part of this period, with the range operational by 1953 and regularly used by the Army for testing and development into the 1990s.

Based on the guidance provided by the US Department of 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 Army military-industrial properties. Three specific themes are applicable to the SMR: Basic Scientific Research; Materiel Development; and Air Defense, Ballistic Missile Defense, and Army Missiles.

The theme of Basic Scientific Research is applicable to the SMR due to the research efforts of SMSA and ERDA, which eventually developed into the Atmospheric Sciences Laboratory (ASL). Lavin (1998:64) identifies the ASL at WSMR as one of the seven Army Laboratories that were active at the end of the Cold War; an Army laboratory, which is generally more an activity or group rather than facility. The ASL conducted the basic scientific research that supported the development of new weapons and equipment (Lavin 1998:64). Though secondary to missile testing at the SMR during the Cold War, the ASL research at the range provided substantial gains in atmospheric research and sounding rockets. Through the Loki, ARCAS, Super-Loki, and XM-75 programs, the SMR made a significant contribution to the knowledge of the upper atmosphere that was important to the refinement of Ballistic Missile Defense (BMD) systems. This research was also important to the wider field of meteorology, and many of the atmospheric sounding rockets developed and launched at the SMR were used for national and international meteorological research.

The theme of Material 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". Materiel development activities were carried out at Army designated Research, Development, and Engineering (RDE) centers and proving grounds, where WSMR is identified as a significant Army Proving Ground (Lavin 1998:69). As a semi-independent range within WSMR that was active in materiel development during the Cold War, the SMR qualifies for consideration under this historic theme.

The general theme of Air Defense, Ballistic Missile Defense, and Army Missiles is also relevant to the SMR, as numerous Army tactical and research missile systems were developed and tested at the range. Lavin outlines three subcategories under this broader theme: air defense, ballistic missile defense, and research and development.

Specific to the air defense sub-theme, several SMR programs were anti-aircraft weapon systems. The first of these programs, the testing requirements of which influenced the layout of the SMR, was the Loki anti-aircraft rocket. The Loki was intended to act as an unguided barrage anti-aircraft rocket that could be deployed to protect against squadrons of Soviet bombers, similar to the intent behind the Nike missile. The defensive importance of these systems declined by the late 1950s as ICBM missiles replaced aircraft as delivery vehicles for nuclear weapons. However, during the same period, the protection of front-line forces against low-flying strafing attacks by high-speed jet aircraft and strikes by short and medium range ballistic missiles became a significant strategic concern, referred to as Forward Area Air Defense (FAAD). FAAD anti-aircraft weapons needed to be mobile so they could be transported by troops in the field, yet provide guided, accurate strikes against enemy aircraft or missiles. The FAAD systems tested at the SMR were the Redeye and Mauler systems.

Activities at the SMR also played a small but significant role in the development of Ballistic Missile Defense (BMD) systems. Through the SMSA, ERDA, and ASL atmospheric activities at the SMR, important information about the conditions and behavior of the upper atmosphere was gathered, which was regularly applied to flight path predictions important for launches at the GRTS of the Athena ICBM program. The effects upon ICBM missiles reentering the atmosphere were part of the knowledge required to improve radar differentiation and early detection systems that are a major part of BMD systems.

Specific to the Research and Development subtheme of Army missiles, the SMR played an important role in the testing and development of new technologies, particularly with anti-tank missiles. The effectiveness, or lack thereof, of anti-tank weapons became a concern in the Korean War, when readily available WW II-era weapons were outmatched by the armor of the Soviet T-51 tanks. The need for the continuing development of anti-tank weapons was intensified by the requirement of defending Western Europe against possible Soviet assault. In some areas, particularly the Fulda Gap of Germany, a large scale Soviet tank assault was considered a near certainty if hostilities erupted. To address such strategic scenarios, a variety of ground based anti-tank systems were developed by the Army during the Cold War. Many of these were tested or developed at the SMR including the Dart, Shillelagh, TOW, Dragon, and the Copperhead guided projectile. While some of these programs were not successful, such as the Dart, the Semi-Automatic Command Line Of Sight (SACLOS) guidance developed with the Shillelagh missile and later modified for use with the TOW and Dragon systems was a significant technological advance that made these systems very influential. The Shillelagh missile and the Copperhead guided projectile were both launched from standard 155 mm guns and were significant innovations in the field of anti-tank weapons.

With three specific themes applicable to the SMR—Basic Scientific Research, Materiel Development, and Air Defense, Ballistic Missile Defense, and Army Missiles, it is recommended that the SMR meets the criteria for eligibility under NRHP Criterion A.

8.2 Eligibility Criterion B

Of the evaluation criteria, Criterion B appears to be the least applicable to the buildings, structures, objects, and districts on the SMR. No persons in particular could be associated with the concept or execution of the SMR or any of its follow on programs. Generally, any such associations are taken into account under the historical trends treated under Criterion A. Therefore the SMR is not recommended eligible under NRHP Criterion B.

8.3 Eligibility Criterion C

The majority of the SMR's buildings, structures, and features are relatively mundane; simply executed facilities that are common to military complexes. This includes even the primary resources such as the Flight Control Building and the many lesser, pre-manufactured steel-frame buildings that populate the site. However, as a collective, particularly with the extant launch sites and camera shelters, the SMR is representative of a missile test range and identifiable as such. It is for this reason that the SMR is also recommended eligible under Criterion C, as the Army's only highly-instrumented range, solely dedicated for testing smaller rockets and missiles; the site is unique in dedicated small missile test ranges.

In respect to individual resources that might not rise to the level of historic significance, NRHP guidance directs that resources "that represent a significant and distinguishable entity whose components may lack individual distinction" are called districts. In the Criteria for Evaluation districts are defined within the context of Criterion C, even though districts may be considered eligible under a single criterion. Therefore, despite the fact that many of the buildings, structures, and features lack individual distinction, as a collective, they are distinctive and most are considered contributing resources to the district. The interiors of the major SMR buildings were inspected and none of these examples were found to exhibit significance in terms of architecture or engineering, and none retained any fixtures that were associated with the Period of Significance.

A district derives its importance from being a unified entity, even though it is often composed of a wide variety of resources. The identity of a district results from the interrelationship of its resources, which can convey a visual sense of the overall historic environment or be an arrangement of historically or functionally related properties.

8.4 Eligibility Criterion D

As historic resources of relatively minimal age, the SMR resources are well-documented and lack any associated resources or extant detritus beyond the recorded features that might provide additional data. There are no physical or engineering attributes of the resources that would warrant further investigation. Further, existing as-built architectural drawings, realty data, historic and contemporary photo-documentation, and interviews with personnel familiar with the site provide ample documentary information. Therefore, Criterion D is not applicable in this case as any additional information about the resources would be garnered from archival resources rather than from the study of the resources themselves.

8.5 Criterion Consideration G

Special Criteria Considerations are also applied in specific circumstances. Only one of these criteria considerations is applicable to the SMR resources, which is Criterion Consideration G. This consideration allows for properties to be considered for NRHP-eligibility that are younger than 50 years old, provided that they are of exceptional importance.

The core infrastructure of the SMR was constructed in 1953, including the network of camera buildings, the Flight Control Building, and the main launch pad, and as such, is more than 50 years old. Most of the significant buildings and structures at the range were built prior to 1964, so the primary period of significance is arguably more than 50 years old. However, the range was active throughout the Cold War, and the original buildings were used throughout this period to support new programs. Thus, the period of significance for the SMR spans the entire Cold War period, and is inclusive of properties that are younger than 50 years in age.

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 year old. Phrased another way, an argument for special inclusion per Criterion Consideration G is not necessary for districts where most of the contributing properties are 50 years of age or older, even if some of the contributing elements were built within the last 50 years. As the more recent additions at the SMR 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 Criterion Consideration G.

8.6 Period of Significance

As Lavin (1998:115) emphasizes, it is important that only resources directly associated with the Cold War should be considered as Cold War resources, rather than general properties that happened to be developed within the same period. The development of the SMR and the testing activities carried out there were a direct outgrowth of the Army's response to the tactical and technological requirements of combating Soviet influence at home and abroad, and defending the US against any possible foreign attack. Therefore, the SMR is strongly associated with the Cold War Period and cannot be considered as a mundane military facility with an incidental association with the period. Thus, the period of significance for the SMR is considered 1953 to 1989, spanning from the range's initial construction to the end of the Cold War. Additional resources at the SMR, such as the LOSAT Launch Complex, post date the end of this period and are therefore not considered contributing elements to the district. These resources are much less than 50 years of age and are not of the exceptional importance necessary to be considered under Criterion Consideration G. Therefore, they were not recorded as resources during the current inventory.

8.7 Previous NRHP Evaluations

Human Systems Research (HSR) conducted an inventory and evaluation of seventeen buildings at the SMR in 2002. These buildings consisted of the primary buildings at the range with the exclusion of the network of camera buildings. Only one Bowen-Knapp camera building (Property 27110) was recorded, while the Fastax and Mitchell camera shelters were identified as concrete-walled accesses for underground cable races and were not included in the inventory and evaluation. Of the 17 buildings documented by HSR, 11 were recommended as not eligible. Six buildings were recommended as potentially eligible by HSR. However, only two buildings received SHPO concurrence as eligible: the Bowen-Knapp camera shelter (Property 27110) under Criterion C and the Flight Control Building (Property 27170) under Criterion A. This inventory did not include a district consideration, and SHPO concurred with the 2002 recommendations. Epsilon Systems disagrees with this previous determination for Property 27110 as it is one of numerous identical examples of Bowen-Knapp Camera Shelters at the SMR. Therefore, it is not recommended for individual eligibility to the NRHP.

An inventory conducted in 2010 by Ecological Communications Corporation (ECC) documented 19 of the SMR camera buildings on HCPI forms. The ECC inventory recommended sixteen of these buildings as eligible to a potential historic district, but did not discuss their recommendations in terms of the evaluation criteria. The ECC HCPI forms recommended that the SMR facilities could be part of a historic district if further research was conducted on the associated properties.

Although the previous 2002 and 2010 inventory efforts made valuable contributions to the documentation of the SMR resources, both efforts were too limited in scope to adequately address the range as a potential district. The eligibility recommendations were therefore mostly limited to addressing the individual eligibility of the resources, rather than as contributing elements to a defined district. Additionally, neither effort identified the historic themes relevant to addressing the historic significance of the SMR properties.

8.8 The SMR as a Military Landscape and District

The wider perspective of a historic military landscape was considered as part of the SMR 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. 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 potential 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 the SMR 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). As the pace of rocket and missile testing missions increased rapidly during the 1950s, planners at WSPG attempted to organize launch locations and schedules to meet the needs of multiple ongoing test programs. Most of the WSPG launch complexes are aligned along the north side of Nike Avenue in the southern portion of the Range, with firing lines and impact areas located in open areas of the Basin floor further to the north. The launches from Nike Avenue required the closure of US 70 on a frequent basis to ensure the safety of motorists, which created logistical problems for the range and inconvenienced local residents. These road closures had become increasingly common as test firings increased during the 1950s. The launching of small rockets and missiles, such as the Loki, from the primary launch areas south of US Highway 70 vied for launch space and support with other, larger vehicles. The Loki in particular was anticipated to be a high volume launch program, as the small rocket would be fired in rapid volleys. This would require frequent road closures and create scheduling bottlenecks with other test programs launched from the Nike Avenue launch complexes.

As a solution to these problems, the creation of a dedicated small missile range north of US 70 was proposed in 1950. This location would require fewer highway closures and keep the main launch areas, such as LC-33 and LC-37, open for the testing of other programs. 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 also hosted its own flight control facility (Property 27170) which remained in use through 1980 when the flight control function was consolidated into Building 300 at the main cantonment.

The location of the SMR was strategic in that it avoided interference with the primary launch complexes and flight lines, while still allowing for easy access from US 70 and proximity to the main WSPG cantonment. According to architectural drawings for the new range, the layout was designed collaboratively by the Albuquerque District Army Corps of Engineers and the architect and engineering (A&E) firm of Herkenhoff and Turney of Santa Fe. The Army Corps designed all of the buildings at SMR with the exception of the camera shelters, which were designed collaboratively. The SMR was considered a sub-range within the larger range of WSPG, listed as Property 27064 with a total assigned area of 6,400 acres. The SMR was spatially organized into two primary functional areas; the control, assembly, and maintenance facilities clustered near the firing area and the downrange instrumentation facilities that recorded performance and spatial data during the missile flight. The SMR served as an important test range for the testing of small antiaircraft and tactical missiles through the end of the Cold War, a mission that was important to the larger Cold War arms race between the US and the Soviet Union. In particular, the development of anti-tank weapons was an important mission at WSMR during the Cold War given the strategic likelihood of a Soviet tank invasion into Western Europe through the Fulda Gap in Germany (Jack Dage personal communication 2014).

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 the SMR and its response to the natural environment, the location of the range on the lower bajada slopes of the San Andres Mountains provided a flat, open expanse of ground along the western margin of the basin that avoided downrange impact areas and primary test flight corridors. The flat ground and relatively minimal vegetation was conducive to the line of sight required for the operation of optical instrumentation. The location of the SMR also allowed the eastern slopes of the mountains to be used as impact areas for systems such as the Loki and Little John.

However, the natural environment was likely not the most important consideration in the location selection for the SMR. Due to the open expanses of the Tularosa Basin, there were few natural barriers or environmental constraints on the siting of the SMR and the desired characteristics likely could have been found at alternative areas within the abundant acreage of WSPG. Rather, the SMR location was situated primarily in response to the logistical considerations of easy highway access, proximity to the main cantonment, and avoidance of the Nike Avenue launch complex flight lines.

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 the SMR is a technically driven facility. As such, the SMR expresses the technical requirements of the testing process rather than the hierarchical or patriotic values that would be displayed at military barracks or housing areas. Despite this, the values of uniformity and utility as defined by Loechl et al. (1994:38) can still be found at the SMR. The Bowen-Knapp and Fastax/Mitchell camera shelters are highly uniform in both their design and positioning at the SMR. The instrumentation buildings are also very utilitarian in nature, as are the various support buildings near the firing line. The utilitarian nature of the buildings and structures at the SMR reflect the pragmatic nature of the Army 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 the SMR, circulation networks were used for the movement of equipment and materials specific to RDT&E efforts at the complex rather than the movement of Army troops and supplies.

The SMR circulation networks include both regionally significant highways and small local access roads. SMR is situated for easy access from US 70, which is a major regional primary route that was established in the 1930s (Wallace 2004). US 70 serves as both a military and civilian transportation route, while several other roads near SMR are military only routes. Range Road 7 (RR 7) travels along the south and west margins of the SMR, and is the primary north-south arterial at WSMR. The Tank Farm area and the western edge of the SMR are accessible from this road. RR 21 provides access from US 70 and connects to the main firing line area at the SMR, then parallels the east margin of the SMR as it travels further north.

Specific roads within the SMR proper were dedicated access routes for circulation within the facility. Range Road 278 ran along the west edge of the SMR and provided access to the western line of Bowen-Knapp camera shelters, and Range Road 279 provided the same access along the east side of the Bowen-Knapp camera shelters. These two roads connected across the north end of the SMR, forming a loop between the two northernmost camera shelters, Properties 27161 and 27163. Cross roads ran between RR 278 and 279 at 500 meter intervals down the length of the instrumented firing line, providing access to the central line of Fastax/Mitchell camera shelters. A dirt access road also paralleled the central firing line of the SMR, but was not a numbered WSMR road. Many other minor undesignated driveways and access roads connect between various buildings and building clusters within the SMR firing line area. Many of the interior roads within the SMR are no longer used and are gradually being reclaimed by natural processes, but still help to define the layout of the SMR on the landscape in lieu of more traditional fences or other boundary markers.

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). However, in the case of the SMR the limits of the complex are not clearly indicated. As a sub-range located within the larger range at WSMR, the Army apparently did not consider it necessary to demarcate the SMR in any specific manner on the ground. This lack of demarcation is typical of many areas at WSMR and reflects the notion that these sub-areas are part of the larger range at WSMR and specific demarcation is not necessary unless required by specific security or safety concerns.

Despite the lack of a formal overall boundary, some properties and activity areas within the complex are fenced for these reasons. Magazines at the SMR, such as Property 27085, are generally secured behind locked chain link fences. The Little John Assembly area, now the Tank Farm, was surrounded by a chain link fence when it was constructed in 1958. Property 27190, the main launch pad at the SMR, is now surrounded by a fence, but this is a recent addition that was not present during the historic operation of the SMR.

As indicated by Loechl et al. (1994:39), other delineations, such as roads and paths, can serve in place of fences or other formal boundary markers. At the SMR, the east, west, and south margins of the complex are roughly indicated by Range Roads 278, 279, and 7. The actual northern limits of the SMR include impact areas that extend much further downrange and are indistinct from the general range interior of WSMR. In lieu of more formal boundaries, the built environment and attendant road network were used to define the current inventory area.

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 a RDT&E facility situated within a larger range, SMR is somewhat of an exception to the patterns suggested by Loechl et al. (1994).

Vegetation typical of the SMR is Chihuahuan Desert 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 flora within the SMR were observed to be variable, defined by co-dominance of creosotebush, tarbush, four-wing saltbush (*Atriplex canescens*), and honey mesquite (*Prosopis glandulosa*) with an understory of forbes and grasses including broom snakeweed (*Gutierrezia sarothrae*), bush muhly (*Muhlenbergia porteri*), and fluffgrass (*Erioneuron pulchellus*).

This desert scrub vegetation was extensive enough that much of it was cleared from the range interior when the SMR was established. Period photography shows that the main firing line of the range was cleared of most vegetation, providing a clear field of view for both operational personnel and instrumentation. While other areas within WSMR have been planted with landscaping plants, particularly within the main cantonment, no such landscaping efforts were made at the SMR. The clearing of the vegetation was in keeping with the RDT&E mission of the SMR, which was expressed in a utilitarian landscape shaped by technical requirements. Today, these cleared areas are gradually being reclaimed by desert scrub, demonstrating the dynamic role that vegetation plays in characterizing the landscape.

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 the SMR are the primary expression of the military mission on the landscape and define the orientation and layout of the complex. Most of the resources were buildings, with relatively few structures or objects recorded. Many of the recorded structures were concrete launch or instrumentation pads, and the majority of the recorded objects were liquid propane tanks.

The SMR inventory effort resulted in the recordation of 116 buildings, structures, and objects. As part of the inventory methodology, less significant resources representing remnants of the SMR supporting infrastructure that were not classifiable as buildings, structures, or objects were recorded as features and are described separately. Most of these properties were located in definable clusters or linear layouts which were an expression of the functional activities they supported.

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 is one of the most important characteristics of military landscapes. Organizational clusters at the SMR define two primary functional areas; the firing line facilities for assembly, maintenance, and launch support and the downrange fixed camera instrumentation sites for recording flight data. The SMR is therefore mostly divided into property clusters that emphasized pre and post firing activities at the complex.

The Tank Farm, originally the Little John Assembly area, at the SMR is an identifiable sub-cluster within the larger group of firing line support properties at the SMR. The recent LOSAT complex is also an identifiable sub-cluster within the group of firing line properties at the SMR.

Of course, there are exceptions to this general layout at the SMR. The ASL Launch Complex is segregated on the eastern edge of the SMR and many of the rockets launched there were relatively simple solid-propellant vehicles that were prepped on-site at the launch pad. These vehicles also used radar tracking, recoverable instrument package, and radisonde instrumentation that did not require the use of the fixed camera instrumentation sites along the main SMR firing line.

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 the SMR. Archaeological manifestations related to this thematic approach were captured as features, which were generally associated with buildings, structures, and objects.

The perspective of historic military landscapes is thematically limited to military use of the landscape, but 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 United States 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. No prior military missions are known to have been conducted in this part of WSPG in the short interval between the founding of the proving ground in 1945 and the establishment of the SMR in 1953. Accordingly, no historic archaeological sites related to the military use of the area prior to the establishment of the SMR were encountered during the inventory. Prehistoric sites have been previously documented in the northern part of the SMR 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 than the 20th century military use of the landscape. As a result, the presence of these sites was not incorporated into the present landscape perspective.

8.8.10 The SMR as a Historic District

Consideration of the SMR 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 the SMR an identifiable expression of the military mission on the land, it also possess 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 eligibility Criterion C.

Historic districts are nominated under the important final clause of Eligibility 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). The SMR is a significant concentration of buildings, structures and objects that are united both by plan and purpose. In addition to being an intentionally planned and discrete spatial entity, the SMR resources represent the manifestation of a military mission on the land. The consistent Cold War mission of the range was the development and testing of small, tactically oriented rocket and missile systems, and this mission weaves a common thread through the variety of resources present at the SMR. While most of the resources at the SMR 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 the SMR is a recognizable historic military landscape eligible to the NRHP as historic district under Criteria A and C due its significant associations with the identified Cold War themes of Basic Scientific Research, Materiel Development, and the combined theme of Air Defense, Ballistic Missile Defense, and Army Missiles (Lavin 1998).

8.9 Comparative Resources

According to NRHP guidelines "Comparative information is particularly important to consider when evaluating the integrity of a property that is a rare surviving example of its type. The property must have the essential physical features that enable it to convey its historic character or information. The rarity and poor condition, however, of other extant examples of the type may justify accepting a greater degree of alteration or fewer features, provided that enough of the property survives".

Although many locations across the country were used for the RDT&E of rockets and missiles during the Cold War, the SMR stands out as a unique location. The establishment of the semi-independent SMR within the larger range of WSMR was a decision driven not only by the logistical considerations of segregating smaller test programs north of Highway 70, but also was influenced by the nature of funding at the time. Early in the operation of WSMR, the range operated with block funding, where a large sum was budgeted for the operation of the range annually. Under this system, project managers could bring programs under development to WSMR for testing without paying for it out of their own program budgets. Rather, the cost of the testing was covered by the annual block funding for the range operation (Jack Dage personal communication 2014). This permitted a higher investment in range instrumentation, which can be seen in the SMR camera network. The SMR was constructed as a dedicated test range that could provide instrumentation for the testing of any small missile program. By the 1960s, block funding had largely disappeared and funding became program specific, so the money for investing in general range infrastructure outside specific programs was much more limited (Jack Dage personal communication 2014). This scenario makes the SMR rather unique among DOD proving grounds. Although other ranges for small missiles existed, most notably at the Redstone Arsenal created in the late 1960s and 1970s, none possessed the land area, dedicated facilities, and instrumentation support that were available at the SMR.

Since 1948, Redstone Arsenal has been the Army's designated center for research and development of rockets and missiles. It later became the home of the Army Ballistic Missile Agency in 1956, the Army Ordnance Command in 1958, and the various later permutations of these organizations. As such, most of the Army rocket and missile programs during the Cold War were managed out of Redstone, and many programs underwent initial design and component testing there as well. Some of the programs that underwent design and early development at Redstone but were primarily tested at the SMR include the Loki, Little John, Lacrosse, Dart, and Shillelagh. Other Redstone programs that were partially tested at the SMR include the Redeye and Lacrosse. Much of the testing at Redstone consisted of static firings; there was insufficient space at the Arsenal for free-flight testing of medium and large systems. However, some smaller missiles did undergo free flight testing at Redstone. Range 1 Area was established in 1953 as a free-flight testing area, with static test facilities at the neighboring Range 5 Area. These locations are known as Test Areas 1 and 2 today (Stamps 2015). In the 1960s and 1970s, the TOW and Dragon systems were flight tested at Redstone, as these anti-tank missiles possessed ranges that were safe to test within the limits of the Arsenal. However, Redstone Arsenal is primarily known for its large static test stands such as Test Stand B, a National Register listed property, and Test Stand C, the largest in the Army inventory (Stamps 2015).

Other comparative resources in determining the relative uniqueness of the SMR include an existing Eglin Air Force Base, Florida test site known as Site D-3A. This site has been used in the past to launch small missiles and rockets. It was also used in 1995 to launch PATRIOT missiles in surface-to-air intercept tests. It is not known to compare to the SMR as it was designed for interception of airborne aircraft. At the Naval Air Weapons Station (NAWS) China Lake California, considered by some to be the "sister" range to WSMR, the only dedicated area for small missiles is known as Redeye site; it has no dedicated infrastructure, instrumentation or facilities that could compare to SMR. McGregor Range at Fort Bliss has been suggested as a comparative resource where, in 1957 its anti-aircraft personnel began using Nike Ajax, Nike Hercules, Hawk, Sprint , Chaparral, and Redeye missiles. However, as a training range, live-fire exercises do not constitute missile testing in the RDT&E sense.

A few other minor sites were used by the Army for the testing of the same systems as at the SMR. However, these locations were used primarily for reliability in extreme climates. These sites included Fort Greely, Alaska for winter testing, Panama for performance in high heat and humidity, and Yuma, Arizona for dry and hot conditions. However, these areas had very minimal instrumentation as the reliability testing required less complicated data that the RDT&E activities conducted at the SMR. (Jack Dage personal communication 2014). The SMR therefore represents a significantly unique entity as a dedicated Army facility for small missile testing that was active in this role throughout the Cold War.

8.10 Integrity of SMR Resources

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. 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 individually applied to the characteristics of the SMR:

With Location being the place where the historic events occurred, and Setting being the "character of the place", there is no question that these two aspects remain intact at the SMR. NRHP guidelines state "The actual location of a historic property, complemented by its setting, is particularly important in recapturing the sense of historic events and persons."

The aspect of Design is evident in the layout and organization of the SMR and its component parts; "Design is the combination of elements that create the form, plan, space, structure, and style of a property" The same can be said for Materials, all of which are used for these types of resources in this particular environment. "Design can also apply to districts, whether they are important primarily for historic association, architectural value, information potential, or a combination thereof."

Workmanship "is 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". The relatively unaltered extant components of the SMR, even with the accumulation of resources over time, have not obscured the functional expression of the district as whole, nor its component parts. This aspect is tied to the Feeling conveyed by the SMR, the "results from the presence of physical features that, taken together, convey the property's historic character."

Lastly, Association, "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." The SMR gains it significance primarily from its aspect of association, the unique role it played in testing small-scale rockets and missiles during the Cold War.

Viewed as a whole, the integrity of the SMR is generally strong, and consideration of these seven qualities demonstrates that most of the original range facilities circa 1953 are present and readily identifiable. This does not mean the SMR remained static though, and many additions and modifications, particularly the addition of the Tank Farm, were made to the original properties and layout to accommodate the changing needs of the range mission throughout the years.

However, for Cold War properties, change or evolution does not necessarily diminish its integrity if the changes are representative of the technological advancements required to maintain parity with the communist bloc (Lavin 1998:117). This is an important consideration at the SMR. While many of the original buildings at the SMR remain intact with minimal changes, buildings have been added through time, some facilities were modified, and others vacated.

However, these changes were made to meet the testing requirements of new programs, and the basic purpose of the range never changed. For example, the original 27190 Launch Pad was modified to meet the needs of the Shillelagh Program, but this was the most recent evolution of missile technology to be tested at that point in time. Therefore, it is a change made to the SMR in order to keep pace with technological development and is part of the general evolution of the SMR. Though slightly postdating the end of Cold War, the addition of the LOSAT Complex is a similar example. A further discussion on integrity of the SMR resources is found in Section 7.3 Building Integrity.

8.11 NRHP Eligibility Overview

As individual resources, most of the buildings and structures at the SMR do not meet the requirements for being individually eligible for listing in the NRHP. Under Criterion A, the historic association of any individual building or structure with significant Army developments during the Cold War is not particularly compelling, as most programs relied on multiple locations for support. In regards to Criterion B, none of the individual SMR properties are known to be closely associated with any persons whose lives or achievements are individually important to the history of WSMR, the Army, nor the Cold War. The various properties at the SMR are primarily utilitarian concrete or pre-manufactured steel buildings that lack any architectural distinction and are not representative of any particular artistic or engineering achievement which make them ineligible under Criterion C. Finally, under Criterion D, the data potential of the resources themselves is limited, as the design and construction details of most of the buildings are well documented in period architectural drawings, industrial publications, military manuals, or other publications; any pertinent information on the use and history of the SMR resources would be drawn from additional archival research or oral history interviews, rather than derived from the physical resources themselves. For these reasons, the SMR properties are generally not recommended as individually eligible under the four primary NRHP eligibility criteria. The individual eligibility recommendations for the SMR properties are discussed in detail on the individual HCPI forms included in Appendix C on the enclosed CD, and the resource eligibility is summarized in the table below (see Table 18).

However, the various resources at the SMR are integral to the understanding of the SMR mission and association with the development of weapons systems during the Cold War. The SMR is important in that its small scale as a test range is much more evocative and informative to a viewer than the larger expanses of the greater WSMR range. At the SMR, the launch pad, flight line, target locations, and instrumentation locations are all visible from a single viewpoint and represent the operation of the larger WSMR range in microcosm. As a holistic group, the SMR resources provide a powerful understanding of the range's activities during the Cold War that is not conveyed by any individual resource. Thus, while most the SMR resources are not eligible at the individual level for inclusion into the NRHP, they would qualify as contributing elements to a potential district. The properties recommended as contributing elements to the proposed district are summarized in Table 18.

The various weapons programs tested at the SMR were directly related to meeting the evolving needs of Cold War scientific research and battlefield technology, particularly in the arenas of anti-aircraft and anti-tank rockets and missiles. The SMR is therefore recommended as eligi-

Table 18. Summary of NRHP Eligibility for the Properties Identified During the Current Inventory of the SMR.

Property	Property Name	HCPI Number	Individually Eligible?	Contributing to Potential District?
27073	Blast Barricade	34374	No	Yes; Criteria A and C
27074	Blast Barricade	34375	No	Yes; Criteria A and C
27080	Blast Barricade	34377	No	Yes; Criteria A and C
27084	LP Tank	34378	No	No
27085	Target Maintenance Bldg.	34379	No	No; lack of significance to historic themes
27087	Instrument Platform	34380	No	Yes; Criteria A and C
27091	Transformer Vault	34381	No	Yes; Criteria A and C
27092	Transformer Vault	36010	No	Yes; Criteria A and C
27098	Instrument Pad	34381	No	Yes; Criteria A and C
27100	Launcher Pad	36010	No	Yes; Criteria A and C
27101	Launcher Pad	34382	No	Yes; Criteria A and C
27102	Instrument Pad	34386	No	Yes; Criteria A and C
27103	Explosive Magazine	34387	No	Yes; Criteria A and C
27104	Climatic Test Magazine	34388	No	Yes; Criteria A and C
27106	Radar Building	34389	No	Yes; Criteria A and C
27108	Quonset Storage Bldg.	34390	No	Yes; Criteria A and C
27110	Bowen-Knapp Camera Shelter	34391	No*	Yes; Criteria A and C
27111	Bowen-Knapp Camera Shelter	34392	No	Yes; Criteria A and C
27112	Bowen-Knapp Camera Shelter	34393	No	Yes; Criteria A and C
27113	Bowen-Knapp Camera Shelter	34394	No	Yes; Criteria A and C
27114	Bowen-Knapp Camera Shelter	34395	No	Yes; Criteria A and C
27115	Bowen-Knapp Camera Shelter	34396	No	Yes; Criteria A and C
27116	Bowen-Knapp Camera Shelter	34397	No	Yes; Criteria A and C
27117	Bowen-Knapp Camera Shelter	34398	No	Yes; Criteria A and C
27118	Bowen-Knapp Camera Shelter	34399	No	Yes; Criteria A and C
27119	Fastax Camera Shelter	34400	No	Yes; Criteria A and C
27120	Fastax Camera Shelter	34401	No	Yes; Criteria A and C

Table 18. Summary of NRHP Eligibility, Cont.

Property	Property Name	HCPI Number	Individually Eligible?	Contributing to Potential District?
27121	Mitchell Camera Shelter	34402	No	Yes; Criteria A and C
27122	Mitchell Camera Shelter	34403	No	Yes; Criteria A and C
27123	Mitchell Camera Shelter	34404	No	Yes; Criteria A and C
27124	Mitchell Camera Shelter	34405	No	Yes; Criteria A and C
27125	Mitchell Camera Shelter	34406	No	Yes; Criteria A and C
27126	Mitchell Camera Shelter	34407	No	Yes; Criteria A and C
27127	Mitchell Camera Shelter	34408	No	Yes; Criteria A and C
27128	Mitchell Camera Shelter	34409	No	Yes; Criteria A and C
27129	Mitchell Camera Shelter	34410	No	Yes; Criteria A and C
27130	Mitchell Camera Shelter	34411	No	Yes; Criteria A and C
27131	Mitchell Camera Shelter	34413	No	Yes; Criteria A and C
27132	Mitchell Camera Shelter	34414	No	Yes; Criteria A and C
27133	Mitchell Camera Shelter	34415	No	Yes; Criteria A and C
27134	Mitchell Camera Shelter	34416	No	Yes; Criteria A and C
27135	Mitchell Camera Shelter	34417	No	Yes; Criteria A and C
27136	Mitchell Camera Shelter	34418	No	Yes; Criteria A and C
27137	Mitchell Camera Shelter	34419	No	Yes; Criteria A and C
27138	Mitchell Camera Shelter	34420	No	Yes; Criteria A and C
27139	Mitchell Camera Shelter	34421	No	Yes; Criteria A and C
27140	Mitchell Camera Shelter	34422	No	Yes; Criteria A and C
27141	Mitchell Camera Shelter	34423	No	Yes; Criteria A and C
27142	Mitchell Camera Shelter	34424	No	Yes; Criteria A and C
27143	Mitchell Camera Shelter	34425	No	Yes; Criteria A and C
27144	Mitchell Camera Shelter	34426	No	Yes; Criteria A and C
27145	Mitchell Camera Shelter	34427	No	Yes; Criteria A and C
27146	Mitchell Camera Shelter	34428	No	Yes; Criteria A and C
27147	Mitchell Camera Shelter	34429	No	Yes; Criteria A and C

Table 18. Summary of NRHP Eligibility, Cont.

Property	Property Name	HCPI Number	Individually Eligible?	Contributing to Potential District?
27148	Mitchell Camera Shelter	34430	No	Yes; Criteria A and C
27149	Mitchell Camera Shelter	34431	No	Yes; Criteria A and C
27150	Bowen-Knapp Camera Shelter	34432	No	Yes; Criteria A and C
27151	Bowen-Knapp Camera Shelter	34433	No	Yes; Criteria A and C
27152	Bowen-Knapp Camera Shelter	34434	No	Yes; Criteria A and C
27153	Bowen-Knapp Camera Shelter	34435	No	No; demolished
27154	Bowen-Knapp Camera Shelter	34436	No	Yes; Criteria A and C
27155	Bowen-Knapp Camera Shelter	34437	No	Yes; Criteria A and C
27156	Bowen-Knapp Camera Shelter	34438	No	No; demolished
27157	Bowen-Knapp Camera Shelter	34439	No	No; demolished
27158	Bowen-Knapp Camera Shelter	34440	No	Yes; Criteria A and C
27160	1955 Camera Shelter	34442	No	Yes; Criteria A and C
27161	1955 Camera Shelter	34443	No	Yes; Criteria A and C
27162	1955 Camera Shelter	34444	No	Yes; Criteria A and C
27163	1955 Camera Shelter	34445	No	Yes; Criteria A and C
27164	Dart Assembly Bldg.	34447	No	Yes; Criteria A and C
27165	Dart Electrical Checkout Bldg.	34448	No	Yes; Criteria A and C
27166	Dart Operations Bldg.	34449	No	Yes; Criteria A and C
27167	Balloon Inflation Shelter	34450	No	Yes; Criteria A and C
27169	LP Tank	34451	No	No; lack of significance
27170	Flight Control Bldg.	34452	Criterion A	Yes; Criteria A and C
27172	Water Storage Tank	34453	No	No; lack of integrity
27173	Little John Launcher and Camera Maintenance Bldg.	34454	No	Yes; Criteria A and C
27174	LP Tank	34441	No	No; lack of significance
27175	Radar Platform	34460	No	Yes; Criteria A and C
27176	Instrument Bldg.	34455	No	Yes; Criteria A and C
27177	Instrument Mound	34457	No	Yes; Criteria A and C

Table 18. Summary of NRHP Eligibility, Cont.

Property	Property Name	HCPI Number	Individually Eligible?	Contributing to Potential District?
27178	Instrument Mound	34458	No	Yes; Criteria A and C
27179	Blast Barricade	34459	No	Yes; Criteria A and C
27180	Little Assembly Bldg.	34461	No	Yes; Criteria A and C
27181	Little John Gas Heat Plant	34462	No	Yes; Criteria A and C
27184	Little John Warhead Assembly Bldg.	34463	No	Yes; Criteria A and C
27185	Little John Grain Loading Bldg.	34464	No	Yes; Criteria A and C
27186	Little John Pre-Assembly Bldg.	34465	No	Yes; Criteria A and C
27187	Little John Instrument Calibration Bldg.	34466	No	Yes; Criteria A and C
27188	Little John Pre-Assembly Inspection Bldg.	34467	No	Yes; Criteria A and C
27189	Blast Barricade	34468	No	Yes; Criteria A and C
27190	SMR Launch Pad	34469	No	Yes; Criteria A and C
27191	Blast Barricade	34471	No	Yes; Criteria A and C
27196	Blast Barricade	34472	No	Yes; Criteria A and C
27199	Lacrosse Launch Pad	34473	No	Yes; Criteria A and C
27200	Wind Measurement Bldg.	34474	No	Yes; Criteria A and C
27204	ARCAS Tower	34475	No	Yes; Criteria A and C
27205	Blast Barricade	34476	No	Yes; Criteria A and C
27206	ASL Assembly Bldg.	34477	No	Yes; Criteria A and C
27208	ASL GM Facility	34478	No	Yes; Criteria A and C
27208B	Balloon Inflation Shelter	34488	No	Yes; Criteria A and C
27210	LP Tank	34479	No	No; lack of significance
27214	ASL Instrument Bldg.	34480	No	Yes; Criteria A and C
27215	Shillelagh Launch Pad	34482	No	Yes; Criteria A and C
27216	Blast Barricade	34483	No	Yes; Criteria A and C
27220	Communications Bldg.	34484	No	No; lack of significance to historic themes
27230	Explosive Magazine	34485	No	Yes; Criteria A and C

Table 18. Summary of NRHP Eligibility, Cont.

Property	Property Name	HCPI Number	Individually Eligible?	Contributing to Potential District?
27231	Explosive Magazine	34486	No	Yes; Criteria A and C
27270	LP Tank	34487	No	No; lack of significance
S-27085	Explosive Magazine	34489	No	Yes; Criteria A and C
N/A	Unknown Building 1	34494	No	Yes; Criteria A and C
N/A	Unknown Building 2	34490	No	No; lack of significance and integrity
N/A	ASL Launch Complex	38959	No	Yes; Criteria A and C
WS 294	Portable Bldg.	34491	No	No; lack of significance and integrity
WS 689	Portable Bldg.	34492	No	No; lack of significance and integrity
WS 690	Portable Bldg.	34493	No	No; lack of significance and integrity

*Property 27110 was previously determined to be eligible under Criterion C and received SHPO concurrence in 2002. However, Epsilon Systems disagrees with this previous determination for Property 27110 as it is one of numerous identical examples of Bowen-Knapp Camera Shelters at the SMR.

ble on the national level under Criterion A for listing in the NRHP as Historic District for its significant associations with the Cold War themes of Basic Scientific Research; Materiel Development; and Air Defense, Ballistic Missile Defense, and Army Missiles (per Lavin 1998).

As discussed above, the SMR represents a significant and distinguishable entity the contributing elements of which lack individual distinction. It also embodies distinctive characteristics of a small test range that is inclusive of specialized architectural forms, such as the Bowen-Knapp and Fastax/Mitchell camera shelters. For these reasons, and their role in national defense, the SMR Historic District is also recommended as eligible on the national level under Criterion C.

8.12 Summary

Although previous evaluations of resources at the SMR have been completed, these did not evaluate the range at the district level. The current inventory has provided a complete inventory of the SMR resources and evaluated them within the framework of an appropriate historic context. This effort has demonstrated that the SMR is a distinguishable entity on the landscape and is best approached as a potential historic district whose components largely lack individual distinction. Several Cold War Historic Themes as defined by Lavin (1998) are applicable to the SMR, which was an important location for the development of anti-tank weapons as well as the RDT&E of anti-aircraft systems and atmospheric sounding rockets used in meteorological research. The SMR was a unique test range during the Cold War and was significant due to its high quality instrumentation and dedicated infrastructure. It also retains a relatively high degree of integrity, with many of its original facilities intact and identifiable. Due to its contributions to Cold War scientific research and battlefield technology that are significant to our national history, the potential SMR Historic District is recommended as eligible under Criterion A. As a distinguishable entity that embodies distinctive characteristics of a small test range that is inclusive of specialized architectural forms, the SMR District is also recommended as eligible under Criterion C.

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Preparers' Qualifications

Phillip Esser, B.S. (Historic Preservation, Roger Williams University), is an architectural historian with more than 15 years of experience who meets the U.S. Secretary of the Interior's Professional Qualification Standards (as defined in 36 CFR Part 61) for architectural history and history. Mr. Esser has a wide range of historic preservation expertise, particularly historic building documentation ranging from individual buildings to large building surveys for state and National Register landmarking as well as Federal Tax Rehabilitation projects. Mr. Esser has extensive experience with Section 110 and 106 evaluations, preparation of National Register of Historic Places Determinations of Eligibility studies and preparation of nominations as well as historic building surveys. Mr. Esser acted as project manager and contributing author for the current inventory, in addition to conducting archival research and conducting oral history interviews.

Nathaniel Myers, M.A. (Anthropology, Eastern New Mexico University) is a professional archaeologist with more than seven years of experience. He has performed prehistoric and historic archaeological studies throughout New Mexico and meets the SOI's Professional Qualification Standards (36 CFR Part 61) for Archaeology. Mr. Myers has worked on a broad range of Section 106 and 110 compliance projects for federal, state, municipal, and private clients. As an archaeologist, Mr. Myers has dealt with a wide range of temporal and cultural manifestations across the Southwest. He has also worked on a variety of historic preservation projects, including historic building inventories, archival research, artifact analysis, and individual and district nominations for the NRHP. Mr. Myers also has significant experience with late-nineteenth-century homestead and mining sites and Cold War-era military programs and related facilities. For the current inventory, Mr. Myers served as the primary report author, conducted fieldwork and in-field resource documentation, performed archival research, assisted with oral history interviews, and completed HCPI forms.

Brad Beacham, M.A. (Anthropology, Eastern New Mexico University) has worked as a professional archaeologist for over 12 years in the Great Basin, Southwest, and Mid-Atlantic, the last eight of which have been specific to New Mexico and Texas. He has broad experience in all phases of cultural resources management (CRM) for a wide variety of federal, state, municipal, and private clients. Mr. Beacham has managed Section 106, National Environmental Policy Act (NEPA), NEPA, and Tribal coordination projects, including the direction of fieldwork, the preparation of compliance documents, and client consultation. As an archaeologist, Mr. Beacham has dealt with a wide range of temporal and cultural manifestations across the Southwest. His demonstrated prehistoric expertise includes Ancestral Puebloan, Jornada Mogollon, Mimbres, and Apache sites. His demonstrated historic expertise includes urban landscapes, late-nineteenth-century mining, railroad and irrigation sites and districts, as well as Cold War-era military programs and related facilities. In addition to serving as co-author for the current inventory, Mr. Beacham conducted fieldwork and in-field resource documentation, compiled GPS and GIS data for the resource mapping, completed HCPI forms, and provided valuable assistance in conducting oral history interviews.