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AN ARCHITECTURAL SURVEY OF THE AREA 25 NUCLEAR ROCKET DEVELOPMENT STATION, NEVADA NATIONAL SECURITY SITE, NYE COUNTY, NEVADA

Prepared by

Ron Reno, Cheryl Collins, Maureen King, Susan Edwards, and Jeffrey Wedding

Cultural Resource Technical Report 122
Division of Earth and Ecosystem Sciences
Desert Research Institute
Las Vegas, Nevada

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Phoebus nuclear rocket engine mockup (Photo 2116_2285, facing west-northwest, DRI 2021)

Cover: Engine Test Stand 1 (Photo 2116_0104, facing north-northeast, DRI 2021)

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Prepared for

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and the
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Nevada Field Office, Las Vegas, Nevada

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EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE), National Nuclear Security Administration Nevada Field Office (NNSA/NFO), and the U.S. Department of Energy Environmental Management Nevada Program (EM NV) plan to implement corrective action activities (under the Federal Facility Agreement and Consent Order, agreed to by the State of Nevada) and demolition of the Engine Maintenance, Assembly, and Disassembly (E-MAD) facility and the Test Cell C Historic District. These are major components of the unrecorded Nuclear Rocket Development Station (NRDS) Historic District, which is eligible for inclusion in the National Register of Historic Places (NRHP, National Register). The NRDS is in Area 25 of the Nevada National Security Site (NNSS), formerly known as the Nevada Test Site, in Nye County, Nevada. Demolition and removal of the buildings and accessories constitutes an undertaking subject to review under Section 106 of the National Historic Preservation Act (54 United States Code [USC] § 306101) and its implementing regulations, 36 Code of Federal Regulations (CFR) Part 800.

The buildings and accessories scheduled for demolition were recorded in Reno et al. (2019a and 2019b). The reports concluded that some of the nine principal resources and 62 accessory resources at the Test Cell C Historic District and the two principal resources and 28 accessory resources at the E-MAD facility were individually eligible for listing in the National Register. Furthermore, essentially all were potentially eligible as contributing elements to the yet unrecorded NRDS district. The reports also found that the undertaking would result in an adverse effect to historic properties. The Nevada State Historic Preservation Officer (SHPO) concurred with the reports' findings regarding the eligibility of the buildings and structures in each Area of Potential Effect and that the E-MAD and Test Cell C Historic District undertakings would result in an adverse effect (Reed 2019, Reed 2020). The NNSA/NFO, in consultation with the SHPO, then developed *Memorandum of Agreement DE-GM58-20NA25534* (MOA) for the project.

This architectural survey report was prepared in accordance with the MOA Stipulation III parts A, B, and C. The report develops the historic context of the NRDS district and describes the district's origin, history, layout, and construction. The report establishes the boundaries of the potential NRDS district and includes findings from an architectural survey of 782 acres of developed areas in the district and a reconnaissance of the remaining 6,333-acre previously un-surveyed and relatively undeveloped area. All previously recorded architectural resources were revisited, and the condition of each at that time was documented. The architectural survey has resulted in the documentation of the NRDS Historic District (D424), which includes the Test Cell C Historic District (D346), the E-MAD Historic District (D418), five additional enclosed subdistricts, and other resources. Newly identified resources and the current condition of previously recorded resources are documented on Historic District Resource Assessment and Architectural Resource Assessment forms.

The report includes an NRHP evaluation of the NRDS district and identifies contributing and non-contributing elements. The NRHP evaluation concludes the NRDS is eligible as a historic district under the Secretary of Interior's Significance Criterion A at the national level for its role in the U.S. Space Program and advancing nuclear rocket propulsion for space travel from 1956 to 1973. It is also eligible under criteria B, C, and D. A total of 115 individual primary resources and 320 accessory resources are documented in the NRDS Historic District. All these resources and their evaluations are summarized in Tables A-1, A-2, and A-3.

ACKNOWLEDGMENTS

This project was completed by staff at Desert Research Institute (DRI). Most architectural descriptions and the major portion of this report were completed by Ron Reno, PhD, RPA, who meets the Secretary of the Interior's Professional Qualifications Standards for Architectural Historian, Historian, and Archaeologist. Reno also has direct knowledge of the NNSS during the Cold War from working there through most of the 1980s as an archaeologist with DRI. Portions of the report were written by Project Director Maureen King. Archaeologist Cheryl Collins and King contributed descriptions and evaluations for several resources and generated the ARA forms. Collins created all maps for the project. Archaeologist Susan Edwards prepared the context and contributed to portions of the district evaluation section. High-resolution digital photographs were taken by Edwards and archaeologist Jeffrey Wedding. Photo logs were compiled by Wedding. Martha DeMarre, Archivist at DRI, contributed to historical research. Archaeologists Susanne Rowe and Manuel de Cespedes Molina assisted with the ARA forms, and Ali Swallow supported formatting the final report and compiling resource forms.

We also benefitted from previous and concurrent architectural surveys conducted in the NRDS by Nancy G. Goldenberg (Carey & Company Architecture), Colleen M. Beck, Harold Drollinger, and Laura O'Neill along with other staff at DRI and previous architectural photography of now demolished portions of the facility taken by the Remote Sensing Laboratory (RSL).

Tiffany Gamero, Industrial Sites and Long-Term Monitoring Lead for Environmental Management, Nevada Program and Carrie Stewart, National Environmental Policy Act Compliance Officer for the NNSA/NFO, served as the program managers overseeing this project. Reed Poderis, Environmental Restoration Program Manager, with Mission Support and Test Services (MSTS), coordinated site access and logistics. Greg Hilbrecht (MSTS) provided on-site liaison along with much information about the recent history of the facility. Martha DeMarre, former Nuclear Testing Archive Manager with MSTS, provided access to many of the historic documents and engineering drawings essential for this report.

Finally, we wish to thank the NNSS Mercury Housing Department staff for making our stay there as pleasant as possible in difficult times.

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APPENDICES

(The NRDS Historic District Resource Assessment form is included first. Additional resource forms are included in the same order as listed in Appendix A, Table A-2 and the cover page of Appendix B.)

ACRONYM LIST

AEC	Atomic Energy Commission
ARA	Architectural Resource Assessment
CAU	Corrective Action Unit
CSA	Central Support Area
DOD	Department of Defense
DOE	Department of Energy
DRI	Desert Research Institute
E-MAD	Engine Maintenance, Assembly, and Disassembly
EM NV	Environmental Management Nevada Program
ETS-1	Engine Test Stand 1
HAER	Historic American Engineering Record
HDRA	Historic District Resource Assessment Form
LANL	Los Alamos National Laboratory
LLL	Lawrence Livermore Laboratory
LLNL	Lawrence Livermore National Laboratory
NASA	National Aeronautics and Space Administration
NERVA	Nuclear Engine for Rocket Vehicle Application
NHPA	National Historic Preservation Act
NNSA/NFO	National Nuclear Security Administration Nevada Field Office
NRDS	Nuclear Rocket Development Station
NRHP	National Register of Historic Places
NTA	Nuclear Testing Archive
NTS	Nevada Test Site
RCP	Reactor Control Point
REECo	Reynolds Electrical & Engineering Company
RIFT	Reactor In Flight Testing
R-MAD	Reactor Maintenance, Assembly. and Disassembly
RMSF	Radioactive Material Storage Facility
SHPO	Nevada State Historic Preservation Officer
SOI	Secretary of the Interior
SURF	Spent Uranium Fuel
TCA	Test Cell A
TCC	Test Cell C

I. Introduction

Project Background

Images of the towering rocket gantries at Cape Canaveral have become icons emblematic of the United States' successful crusade to begin human exploration of space in mutual competition with the former Union of Soviet Socialist Republics. In doing so, the National Aeronautics and Space Administration (NASA), some of its officials, and many of its astronauts achieved heroic status. Yet these achievements dwindle in comparison with the aspirations of many individuals and organizations to use nuclear-powered rockets for sustained exploration of the entire solar system and, perhaps, beyond. For political reasons, the project was canceled just as it was nearing a readiness for flight test. The program has been entirely forgotten except by a few serious students of space flight – few people have heard of the Space Nuclear Propulsion Office, Nuclear Engine for Rocket Vehicle Application (NERVA), Phoebus, or Kiwi. The testing facility for this program, the Nuclear Rocket Development Station (NRDS), is equally forgotten. But in the desert of southern Nevada, much of this impressive facility and the unrequited dreams of deep space exploration that it represents lie nearly intact on Jackass Flats in Area 25 at the Nevada National Security Site (NNSS) (Figure 1). The present project, occasioned by the planned demolition of parts of this facility, presents an opportunity to explore in detail the architectural legacy of this incredibly important installation in its entirety.

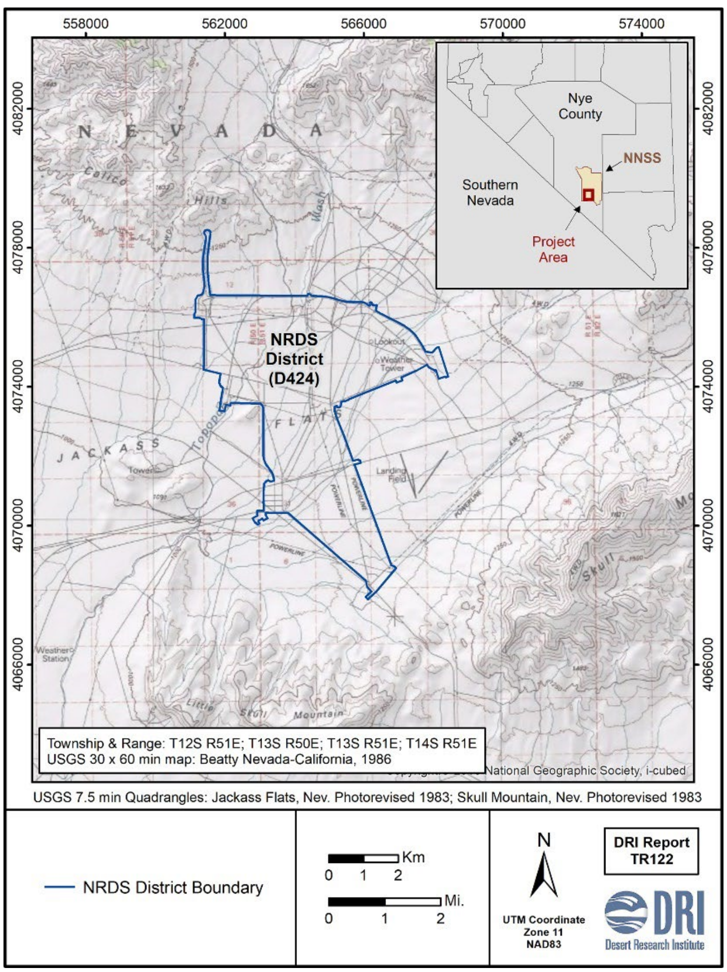


Figure 1. Location of the NRDS Historic District.

The U.S. Department of Energy (DOE) plans to implement corrective action activities at E-MAD and Test Cell C(under the Federal Facility Agreement and Consent Order, agreed to by the State of Nevada), and demolition of buildings and structures at these facilities. Demolition and removal of the buildings and accessories constitute an undertaking subject to review under Section 106 of the National Historic Preservation Act (NHPA) (54 United States Code [USC] § 306101) and its implementing regulations, 36 Code of Federal Regulations (CFR) Part 800.

The buildings and structures at the E-MAD facility and Test Cell were recorded in two separate reports: *A Revised Architectural Survey of the Nuclear Engine Maintenance Assembly and Disassembly Facility, Area 25, Nevada National Security Site, Nye County, Nevada* (Reno et al. 2019a) and *An Architectural Survey of the Test Cell C Historic District, Area 25, Nevada National Security Site, Nye County, Nevada* (Reno et al. 2019b). The E-MAD report found the E-MAD building (B4845) along with 28 contributing accessory resources and the train shed (B17966) were individually eligible for listing in the *National Register of Historic Places* (NRHP, National Register). Test Cell C was recorded as a district, and the report found this district and its contributing primary and accessory resources were eligible for NRHP listing. These reports also found that the E-MAD facility and the Test Cell C Historic District (D346) were contributing components of the unrecorded NRDS district. Finally, the reports concluded the undertakings would have an adverse effect on historic properties.

With one exception, the Nevada State Historic Preservation Officer (SHPO) in consultation with the DOE concurred with the findings regarding the eligibility of the buildings and structures in each Area of Potential Effect and that Test Cell C was eligible as a historic district. The exception was for the eligibility of the Test Cell C primary building (B2444). This building was demolished and, therefore, the SHPO found it is no longer individually eligible. However, the SHPO concurred the remaining accessory resources are NRHP-eligible as contributing resources to the Test Cell C Historic District. In addition to the eligibility determinations, the SHPO concurred that the E-MAD and Test Cell C undertakings would result in an adverse effect and acknowledged that the DOE considers the E-MAD facility and the Test Cell C Historic District as contributing resources to the unrecorded NRDS Historic District (Reed 2019, Reed 2020). The DOE, in consultation with the SHPO, then developed the *Memorandum of Agreement DE-GM58-20NA25534 Between the U.S. Department of Energy and the Nevada State Historic Preservation Officer Regarding Corrective Action Activities and Demolition of the Engine Maintenance Assembly and Disassembly Facility and the Test Cell C Historic District, Major Components of the Nuclear Rocket Development Station Historic District Located in Area 25 at the Nevada National Security Site, Nye County*, hereafter referred to as the MOA.

This report satisfies several of the mitigation stipulations set out in the MOA. It includes a historic context related to the NRDS (Stipulation III.A), results of the documentation of the NRDS Historic District, including an NRHP evaluation of the district (Stipulation III.B), and serves as the final NRHP evaluation report to be submitted to the SHPO for review (Stipulation III.C). Details of the MOA are currently available at https://shpo.nv.gov/uploads/documents/DOE_-_Closure_and_Demolition_of_the_E-MAD_Facility_and_the_Test_Cell_C_Historic_District_MOA.pdf.

The present survey resulted in the documentation and evaluation of the NRDS Historic District (D424), which includes the Test Cell C Historic District, the E-MAD Historic District, five additional subdistricts, and other resources (Table 1). This report presents the identified resources in the larger NRDS Historic District by resource type in the following order: the maintenance, assembly, and disassembly facilities, test cells, support areas, and other resources.

Following this introduction, Chapter II provides the research design for the architectural survey. Chapter III develops the historic context for the NRDS Historic District. The NRDS district is described in Chapter IV. This chapter focuses on the architectural styles and functions found at the NRDS. It is useful at this point to introduce an aerial panorama of the entire district in 2013 taken by the Remote Sensing Laboratory (RSL) from over the E-MAD Facility (Figure 2). The NRDS Historic District boundary is described in Chapter VI. Chapter VII summarizes the subdistricts and other resources documented during the present survey and during the extensive previous research already conducted in the area. Combined, the NRDS district encompasses a total of 115 primary resources and 320 accessory resources. A count of all resources by district, subdistrict, or area is in Appendix A, Table A-1. Table A-2 provides a summary of primary resources, accessory resources, and recommended contributing status to the NRDS district. Table A-3 is a list of primary resources within the district previously evaluated for individual eligibility. Finally, Table A-4 provides a concordance of SHPO and NNSS or field resource designations. The HDRA forms and ARA forms for individual resources are in Appendix B. Acronyms are included where each term is first introduced and provided in an acronym list on page xii. Complete terms are used periodically throughout the report to remind the reader of the meanings of acronyms associated with this project.

Table 1. List of Districts, Subdistricts, and Other Resources in the NRDS Historic District.

Districts and Subdistricts	**Other Resources**
Reactor Maintenance, Assembly, and Disassembly (R-MAD) subdistrict (D419)	Radioactive Material Storage Facility
Engine Maintenance, Assembly, and Disassembly (E-MAD) Historic District (D418)	Resources at the main gate (Gate 500) area and in the vicinity
Test Cell A subdistrict (D421)	NRDS other resources
Test Cell C Historic District (D346)	Linear resources
Engine Test Stand 1 (ETS-1) subdistrict (D423)	
Reactor Control Point subdistrict (D420)	
Central Support Area subdistrict (D422)	

NNSS Nomenclature

The continental nuclear test site, now known as the NNSS, has gone through several name changes, from South Site, Alternate Test Site B, Site Mercury, and Nevada Test Site (NTS) in 1950-51 to Nevada Proving Grounds in 1952 and back to NTS in January 1955. Its name remained NTS for the rest of the Cold War. The facility was renamed for the last time in 2010 because of mission changes and it is currently managed as the NNSS (NNSA/NFO 2013a). For the sake of consistency and clarity, it will be referred to as the NNSS herein regardless of the period being discussed.

Buildings and major structures are identified on the NNSS by numbers or letters with their area number in the prefix. For example, buildings and structures located both within the NRDS district and in the broader vicinity are designated with the prefix “25”; the “25” refers to NNSS Area 25. The prefix is followed by a unique identifying number or combination of letters and numbers. The NNSS identifiers are often tied to the existing archival documentation and source materials.

Figure 2. Aerial photographs of Jackass Flats with E-MAD in foreground (RSL 2013).

1st Row: Calico Hills with ETS-1, facing north (left); Kiwi Mesa and Lookout Mountain with TCC and TCA, facing northeast (right).

2nd Row: Pass to Frenchman Flat with R-MAD and RCP, facing east (left); Skull Mountain with RCP, facing east-southeast (right).

3rd Row: Pass between Skull and Little Skull Mountains with road to Mercury and CSA, facing southeast (left); Little Skull Mountain with Amargosa Desert in background, facing south-southwest (right).

II. Research Design

Objectives

The immediate objective of this survey is to comply with the specifications of the NRDS MOA. Operationally, this means recording and evaluating the NRDS Historic District and the resources contained therein using the methods detailed below.

In addition, it serves to further two goals identified in the *Nevada Historic Preservation Plan 2020-2028* (Nevada SHPO 2020). Specifically, it fulfills Goal 1 – to "Identify and formally recognize significant cultural resources." Under this Goal's Objective A, Task I is to "Encourage federal, state, and local agencies to mitigate the adverse effects of their projects through historic architectural and archaeological surveys…." Objective B is to "Expand and improve documentation in key areas of Nevada's past." This survey builds on Task VI to "Create a framework for the recordation, evaluation, and preservation of Nevada's mid-century Modern resources…." And finally, it relates specifically to Task VII to "Identify and interpret the influence of the military on the culture of the State and the federal role in Nevada's development."

Goal 4 is to "Provide Nevadans with access to information about cultural resources…." This report, like all other recent cultural management reports relating to the NNSS produced by DRI, will be declassified and published on www.osti.gov. This allows the public to have easy, free, and unrestricted access to these materials.

Previous Research

Summaries about previously recorded resources related to NRDS are largely based on the original E-MAD survey report (Beck et al. 1996) and a synopsis of the Rover and Pluto Programs (Drollinger 2017). In addition, records from the NNSS cultural resources program archives at DRI and the Nevada Cultural Resource Information System were reviewed for information on existing cultural resource inventories and previously identified cultural resources within the NRDS Historic District boundary. Both previously and newly recorded historic resources within the NRDS Historic District are listed in Table A-2 and Table A-3 provides a list of resources previously determined eligible to the National Register. Updated ARA forms for previously recorded resources are also included in Appendix B.

Three surveys related to the Yucca Mountain Project and one concerning a landfill for the MX Project investigated portions of the NRDS Historic District (Table 2). All previous surveys were completed except for the Topopah Wash reconnaissance (Canaday and Buck 1992), which was modified at the request of the client. During these projects, all identified resources were prehistoric. Archaeologists recorded isolates, small lithic scatters, and eligible lithic scatters at the edges of alluvial bajadas along Topopah Wash, which runs north to southwest through the NRDS area.

Table 2. Prehistoric resources identified inside the NRDS district boundary during past surveys.

Report No.	Resources	Author/Date	Purpose
SR062491-2	21 prehistoric sites (26NY7943-7948, 7950-7953, 7958-7963) on Topopah Wash including 7 ineligible small lithic scatters and 14 eligible medium lithic scatters.	Canaday and Buck 1992	YMP Flood Study
SR041389-1	26NY5831 (eligible lithic scatter) and 3 isolates.	Durand 1989	YMP Meteorological Stations
SR051287-1	Two 2-artifact lithic scatters (26NY5193, 5194), both collected.	Henton 1987	MX Landfill
SR050391-1	26NY7816 ineligible lithic scatter.	Rhode 1991	YMP Radiation Monitors

Table 3 presents the previous cultural resources projects in Area 25 associated with the Rover program. Sixteen individual historic properties and one historic district in the NRDS district have previously been determined eligible to the NRHP for their role in the development and testing of nuclear reactors and engines as part of the Rover program for nuclear-powered rockets in the United States space program and in the national defense strategy of the United States during the Cold War. Adverse effects from the Decontamination and Decommissioning program have been mitigated for four of them by way of Historic American Engineering Record (HAER) documents submitted to the National Park Service. The HAER for the E-MAD facility was for the removal of some equipment. Other facilities in Area 25 contemporary with those listed in Table 3—such as ETS-1, the Reactor Control Point, and the Central Support Area—were not recorded prior to the present survey.

Table 3. Previously Recorded Historic Resources Associated with the Area 25 Rover Program.

Resource	Report No.	Author/Date	Purpose
E-MAD 25-3900, B4845	SR082696-1	Beck et al. 1996	Survey and Evaluation
E-MAD 25-3900, B4845	HAER Nv-25	NPS 1997	Mitigation: Manipulator Removal Only
E-MAD 25-3900, B4845	TR116	Reno et al. 2019a	Survey and Evaluation
E-MAD L-2 Locomotive	HE072710-1	Jones and Drollinger 2010	Survey and Evaluation
E-MAD Train Shed 25-3901, B17996	TR116	Reno et al. 2019a	Survey and Evaluation
Railroad Transport System (RTS)*	SR070799-1	Drollinger 1999	Survey and Evaluation
RTS - Jackass and Western Railroad 26NY14637**	HE072610-1	Drollinger 2012	Survey and Evaluation
R-MAD 26NY9277	SR022900-1	Drollinger, Goldenberg, and Beck 2000b	Survey and Evaluation
R-MAD 26NY9277	HAER Nv-29-A	NPS 2000a	Mitigation: Main Bldg. Only
R-MAD Jr. Hot Cell 26NY9277	SR032095-1	Beck et al. 1995	Survey and Evaluation (removed)

(Table 3 is continued on the next page.)

(Table 3 is continued from the previous page.)

Resource	Report No.	Author/Date	Purpose
RMSF 26NY11769	SR052003-1	Drollinger 2003	Survey and Evaluation
Test Cell A (Main Building) 25-3113, 26NY11260	SR021400-1	Beck, Drollinger, and Goldenberg 2000	Survey and Evaluation
Test Cell A (Main Building) 25-3113, 26NY11260	HAER Nv-33	Beck, Drollinger, and Goldenberg 2001	Mitigation: Main Bldg. & Moveable Shed Only
Test Cell C (TCC) Historic District D346	TR117	Reno et al. 2019b	Survey and Evaluation
TCC 25-3110, 26NY11258	SR021500-1	Drollinger, Goldenberg, and Beck 2000a	Survey and Evaluation
TCC 25-3110, 26NY11258	HAER Nv-30-A	NPS 2000b	Mitigation
TCC (Main Building) 25-3210, B2444	TR117	Reno et al. 2019b	Survey and Evaluation
TCC Cryogenics Bldg 25-3230-32, B18114	TR117	Reno et al. 2019b	Survey and Evaluation
TCC Equipment Bldg. & Local Control Center 25-3220, B18110	TR117	Reno et al. 2019b	Survey and Evaluation
TCC Kiwi-TNT S2287	TR117	Reno et al. 2019b	Survey and Evaluation
TCC North Camera Bunker 25-3226, B18111	TR117	Reno et al. 2019b	Survey and Evaluation
TCC Operations Bldg. Foundation 25-3229, B18113	TR117	Reno et al. 2019b	Survey and Evaluation
TCC Powerhouse 25-3233, B18115	TR117	Reno et al. 2019b	Survey and Evaluation
TCC Shed Drive Funicular Railroad Foundations 25-3214, B18109	TR117	Reno et al. 2019b	Survey and Evaluation

* The Railroad Transport System consisted of a manned control car, a prime mover engine, and the engine installation vehicle. Flatcars were sometimes used as spacers between locomotives and reactors after tests. It was also used in the late 1970s to transport and emplace nuclear fuel assemblies in dry holes at the E-MAD facility for studying procedures on the handling and storing of high-level radioactive materials. The L-3 prime mover engine was donated to the Boulder City Railroad Museum in southern Nevada in 2006. The two other vehicles are still at the E-MAD facility where they were recorded as Accessory Resources to the E-MAD Building by Reno et al. (2019a). Recently they have been assigned separate resource numbers by O'Neill and Wedding (2022). See Table A-2.

**This resource includes only the main lines (grades, culverts, switches, etc.). Portions of the railroad system within NRDS complexes including sidings, wyes, maintenance buildings, and the railroad control rooms are recorded as parts of those complexes. Rolling stock is also recorded separately, either with the storage facilities at the RMSF and E-MAD, or as individual structures as noted above.

Although it is outside the NRDS Historic District, an additional, closely related complex of National Register-eligible resources should also be mentioned. The Pluto nuclear ramjet program is located east of the NRDS in Area 26. Although the Pluto compound covers a smaller area, many of its facilities have marked similarities to those at NRDS including a hot bay, railroad, circular radiation monitoring array, and a control facility recorded as a district (Drollinger et al. 2005). This district was recommended eligible as a historic district (Drollinger et al. 2005) with SHPO concurrence (James 2010).

Survey Methods

General methods used for this survey were designed to comply with *Nevada Architectural Survey and Inventory Guidelines* (Nevada SHPO 2017). Because the resource forms need to stand alone as individual documents, much of the material in the report is duplicated in each. Specific goals, field methods, and reporting products detailed in Stipulation III. B. of the MOA can be summarized as follows:

Identify, evaluate, and complete a current condition assessment for previously recorded elements, excluding the E-MAD facility and TCC Historic District, which were updated and re-evaluated in 2019.

1. Base the preliminary boundary of the NRDS historic district on archival research and the results of the fieldwork.
2. Document and evaluate for the NRHP the unrecorded components of the NRDS Historic District on ARA forms. These include Engine Test Stand 1, the Control Point, the Support Facilities, and the NRDS infrastructure system.
    a. Record any additional architectural or archaeological resources discovered within the boundary of the historic district on ARA forms or NNSS site recording forms, as appropriate.
    b. Submit draft versions of the ARA or NNSS site forms as an appendix in the NRDS Historic District historical evaluation report [Appendix B].
3. Complete a current condition assessment for the previously recorded elements of the NRDS. These include R-MAD, Test Cell A, the Railroad Transport System, and the Radioactive Material Storage Facility. Record these resources on ARA forms or NNSS site forms, as appropriate [also in Appendix B].

The levels of documentation completed of the various resources are noted in Table A-2.

Architectural recording was limited to resources dating to the Cold War (1951-1992). No pre-Cold War resources were encountered other than two prehistoric isolates. Remarkably, few architectural resources dating from 1993 to the present are in the district. These buildings, not formally recorded on ARA forms, include Modulars 25-3141 and 3142 and metal prefabricated Building 25-3143 at the Reactor Control Point. There is also a metal prefabricated Shop Building (25-4228) at the Central Support Area. These buildings are illustrated in Figure 3. Much more widespread are areas which were completely bladed after the Cold War period. In addition to surface disturbance areas, there are numerous subsurface landfills, radioactive debris dumps, and septic systems that have been subject to remediation and demolition as Corrective Action Units (CAUs). Examples of these kinds of disturbance are shown in Figure 4. The CAU reports document in detail the remediation activities undertaken at all these locations.

Specific recording methods follow those developed by DRI in consultation with SHPO for the survey of the Mercury Historic District (Reno et al. 2018) and refined through subsequent recording of the Area 12 Camp Historic District (Reno et al. 2021). A few changes in methodology were appropriate for the present survey as detailed below.

Figure 3. Buildings at the NRDS constructed after 1992.
Photos – clockwise from top left: RCP Buildings 25-3141, facing northwest (Photo 2116_9304), 25-3142, facing north (9306), 25-3143, facing southeast (9280), and CSA Building 25-4228, facing southeast (1116, all DRI 2021).

Figure 4. Examples of completely disturbed areas not formally recorded.
Top: Closed MX Landfill at the Central Support Area (Photos 2116_1610 [*left*], 2555, facing south [*right*]).
Bottom: Closed sewer system at Test Cell A (Photos 2116_1946, facing southwest [*left*], 1948 [*right*], all DRI 2021).

Boundaries of the NRDS district were identified from a preliminary review of the survey data. The intention was to include the major elements of the district, concentrations of resources, and samples of widely scattered resource types. Historically, the NRDS extended all the way west to wells located along Fortymile Wash, which is approximately 4 miles west of the boundary shown in Figure 1. The intended expansion of the Reactor In Flight Testing (RIFT) phase of operations never took place, leaving the western portion of Jackass Flats undeveloped except for scattered minor resources. Hence, this large area was not included in the NRDS district. Similarly, resources such as radiation monitors, weather towers, and communications towers are scattered in an extremely large area surrounding the core area. These outlying resources were also not included in the district boundary. Finally, linear resources and radiation arrays were recorded up to the edges of the boundary of the historic district. The boundary shown in this report is equivalent to that approved by SHPO (Reed 2022a), with only minor modifications to include the boundaries of identified subdistricts and small areas found to further encompass resources identified during more extensive survey activities.

Within the NRDS are seven highly concentrated and function-specific activity areas. Following the methods developed at Test Cell C (Reno et al. 2019b) each was recorded as its own subdistrict within the encompassing NRDS Historic District boundary. While the subdistricts are considered potential historic districts, developing contexts would involve a major research effort well beyond the scope of this project. Therefore, except for the Test Cell C and E-MAD, the subdistricts are not individually evaluated.

The DOE previously determined Test Cell C to be a historic district eligible to the NRHP under criteria A, C, and D with SHPO concurrence (Reed 2020). During the current survey, observation showed that the Test Cell C Historic District has not been altered since it was recorded in 2019 (Reno et al. 2019b). No further recording was done within its boundaries. Other than some ongoing wind and water damage, E-MAD is also in the same condition as when recorded in 2019 (Reno et al. 2019a). A recent, separate evaluation project documented the rolling stock within the E-MAD fenced area (O’Neill and Wedding 2022). For the current survey, the E-MAD facility is evaluated as a potential historic district.

The principal Test Cell A and R-MAD buildings have both been previously recorded, evaluated, and, to a certain extent, mitigated for demolitions. Both are contaminated areas surrounded by perimeter fences. Field methods were altered to avoid these contamination zones but also collect adequate information to update resource forms to current standards. All recording of resources inside the fences was from just outside the fence lines using a mobile elevated camera platform as needed. Visibility from the platform was quite good. Minor standing buildings and structures were recorded as accessory resources to the demolished primary resources, which are now only foundations. Normal survey procedures were followed outside the perimeter fences. Major standing buildings or structures were recorded as separate primary resources. Resources not designated primary resources, regardless of condition, were recorded as accessory resources.

Given the immense size of the NRDS Historic District and lack of vehicular access to most of it, it was impossible to closely examine every part of it. Therefore, this survey is complete only in the highly developed nodes such as the Reactor Control Point, Central Support Area, the maintenance, assembly, and disassembly complexes (R-MAD and E-MAD), and the three test stands (Test Cell A, Test Cell C, and Engine Tests Stand 1). For the rest, an effort was made to at least record samples of the various low-visibility resources scattered about the district while driving accessible roads that have not yet been washed out by flash floods. In summary, of over 7,100 acres in the NRDS Historic District about 782 acres were surveyed for architectural resources. The remaining approximately 6,333 acres were viewed by vehicular reconnaissance on most of the drivable roads in the district. Coverage is supplemented by the work performed during numerous previous architectural surveys in the area. All previously recorded architectural resources were revisited subject to the constraints noted above.

Fieldwork was conducted by architectural historian and industrial archaeologist Ron Reno, PhD RPA, accompanied by the photography team of archaeologists Susan Edwards and Jeffrey Wedding, both of whom have extensive experience with the architecture, history, and prehistory of the NNSS. Major fieldwork was done from January 3 through 15, 2021 and was supplemented with site visits by Edwards and Wedding for further recording. Data concerning railroad rolling stock at the E-MAD complex has been supplemented by a survey by DRI Architectural Historian Laura O'Neill and Wedding (2022).

The survey crew maintained daily contact with NNSS Operations Command Center in Mercury and monitored radio communications from the center while in the field. Area 25 is an active military and anti-terrorism training area; therefore, the survey had to be timed to fit into a break in training schedules. The crew met daily with Greg Hilbrecht of Mission Support and Test Services (MSTS) at the Reactor Control Point to coordinate travel and access to the various parts of Jackass Flats. Hilbrecht also informed the crew about various details of site history and about certain areas to be avoided due to hazards such as beryllium contamination. Although all crew members regularly receive General Employee Radiological Training, it was not necessary to enter posted contaminated areas during this survey. Resources within such areas were recorded from a safe distance outside the posted perimeters. In all cases, visibility was sufficient from these vantages to assess the present condition of the resources.

Meticulous Covid-related restrictions mandated by the State of Nevada and by the NNSA/NFO were strictly complied with by the field crew. Contacts with other personnel at the NNSS were limited to those necessary for completion of the project.

Although this is primarily an architectural survey project, all field crew have extensive experience with prehistoric archaeological resources at the NNSS. Isolated prehistoric items found in completely disturbed areas were noted but not formally recorded on site forms due to their lack of integrity. No prehistoric sites were encountered. This survey did not include complete coverage for prehistoric or low-visibility historic archaeological sites in the area.

Most resource dates are derived from the 1993 REECo NTS Facilities Inventory, which provides dates of completion. Many support resources were under planning for two or more years prior to construction. Mission-related resources tended to be built about a year after drawings were first developed. In a few cases, as-built notations on plans indicated an earlier completion date than present in the Inventory. The earlier dates were used on the ARA forms. Only a small number of the immense number of available engineering drawings were consulted for this survey. With further research, construction dates of many resources may slightly change.

Resource descriptions are limited to exteriors only. It was beyond the scope of this project to record the interiors, which would be required to determine the individual NRHP significance of each resource. In a few cases, such as the discussions of control rooms, selected information from previous interior recordings is included in this report. As this is not a detailed engineering study, most dimensions are rounded to the nearest foot. Building orientations are described as cardinal directions if they are reasonably close to a true north-south orientation. Actual orientations are shown on the historic district maps and on resource maps in the ARA forms.

Archival data were reviewed primarily for development of the historic context for the NRDS Historic District detailed in Chapter III.

The report text includes an extensive set of photographs, maps, and drawings. There are cross-references to figures representing resources discussed in more than one section. Cross-references are indicated by “(see Figure x).” Identification numbers of photos taken by DRI for this project have a prefix of “2116,” which is a portion of the DRI project number. NNSS building numbers were used as field numbers when possible. Other resources were given field numbers based on the district or subdistrict they are in, using the following prefixes:

- Central Support Area CS
- E-MAD EM
- Engine Test Stand 1 TS
- Reactor Control Point RCP
- R-MAD RM
- Test Cell A TCA
- Test Cell C TCC

Resources that contribute to the NRDS district but are not within the boundaries of a subdistrict were generally given field numbers that begin with “NRDS.” These field numbers are used in the discussion below, along with SHPO numbers.

Expectations

Because this survey was aimed at a highly visible collection of resources within a well-defined area, it was possible to anticipate an approximate number of resources in advance of recording and the appropriate boundaries for the NRDS district prior to fieldwork activity. The degree of removal of historic buildings and structures during recent years was already known. All field crew had participated in previous architectural projects in the district and elsewhere at the NNSS and surrounding areas. In addition, Reno had traversed it numerous times during the 1980s while conducting extensive archaeological work related to the Yucca Mountain and MX projects.

Based both on the literature search and on extensive personal knowledge of archaeology at the NNSS, only prehistoric isolates or very small lithic scatters were anticipated on active fan surfaces. The potential for more complex sites is much higher on old fan surfaces, particularly if they happen to contain dispersed raw lithic material sources. The edges of fan surfaces overlooking deeply incised major washes, particularly Topopah Wash, have the highest potential for complex prehistoric archaeological sites. Due to long-term stability of old fan surfaces in such areas, surface sites can sometimes be as old as the late Pleistocene. Because of the extremely aggressive blading typically done during the construction of the main activity areas, no intact prehistoric or pre-testing-era historic resources were anticipated in the main built-up portions of the district.

III. HISTORIC CONTEXT

In 1956, the Atomic Energy Commission (AEC) (now the U.S. Department of Energy [DOE]) and the National Advisory Committee for Aeronautics (soon to become the National Aeronautics and Space Administration [NASA]) selected an area on the western edge of the Nevada Test Site (today's National Nuclear Security Site) to test reactors and engines developed by Los Alamos National Laboratory (LANL) and a host of private contractors under the Rover and NERVA nuclear thermal rocket propulsion programs. The program's objective was to design an efficient and reliable system to boost both piloted and autonomous rockets to the moon, Mars, and beyond.

To that end, construction began in 1957 on the specialized test stands, reactor maintenance, assembly, and disassembly buildings, transportation system, and infrastructure that became the Nuclear Rocket Development Station (NRDS). The facility supported the nuclear rocket program over the next 16 years until its unceremonious cancellation in 1973. Its storied history spanned four different administrations and was the focus of protracted battles between competing interests within NASA, the AEC, and Congress over funding and shifting mission priorities. During its nearly two decades of operation, numerous reactor prototypes and engine configurations were tested, resulting in the successful demonstration of several working nuclear rocket engines capable of powering a spacecraft. Some of these prototypes and much of the experimental data generated by the Rover and NERVA programs continue to inform today's nuclear propulsion research and NASA's renewed goal to send astronauts to Mars and more distant planets in the coming decades.

Although several of the NRDS facilities have already been dismantled as part of the DOE's deactivation and decommissioning responsibility, the agency tasked DRI with continuing their work to preserve the history and heritage of these unique resources of the early space age. This section provides an interpretive context for evaluating the resource's historic significance and highlights the field test station's contribution to the success of the Rover and NERVA programs as well as its unique place in America's space history.

Space and the Atom

> "…only through the liberation of atomic energy could we obtain the means which would enable man not only to leave the earth but to leave the solar system." Leo Szilard 1932 (Szilard 1968:100)

Physicist Leo Szilard made that observation over two decades before the United States began its first fledgling efforts to develop a nuclear-powered rocket, but he was not the first to express this idea. American rocketry pioneer, Robert Goddard had proposed a similar theory even earlier in 1906 when he was a graduate student. However, Goddard received ridicule from his peers rather than encouragement causing him to sequester his early writings on nuclear propulsion. They re-emerged only after his death in 1945 (Goddard and Pendray 1971:74-75; Lehman 1963:25-26) (Figure 5). During the 1920s and 1930s, other prominent scientists such as Robert Esnault-Pelterie in France, Konstantin Tsiolkovsky in Russia, Herman Oberath, the founder of German rocketry, and Phillip Cleator of the British Interplanetary Society all speculated on atomic powered space travel at some point in the future (Dewar 2004:4-5). The notion of atomic-propelled spacecraft even found its way into pre-World War II popular culture through works of fiction such as the 1933 novel, *When World's Collide* and the 1940 short story by Robert Heinlein entitled "Blowups Happen." (Heinlein 1940; Balmer and Wylie 1933) (Figure 6). However, any activity on nuclear propulsion remained either theoretical or fanciful, and no practical applications or experiments were undertaken.

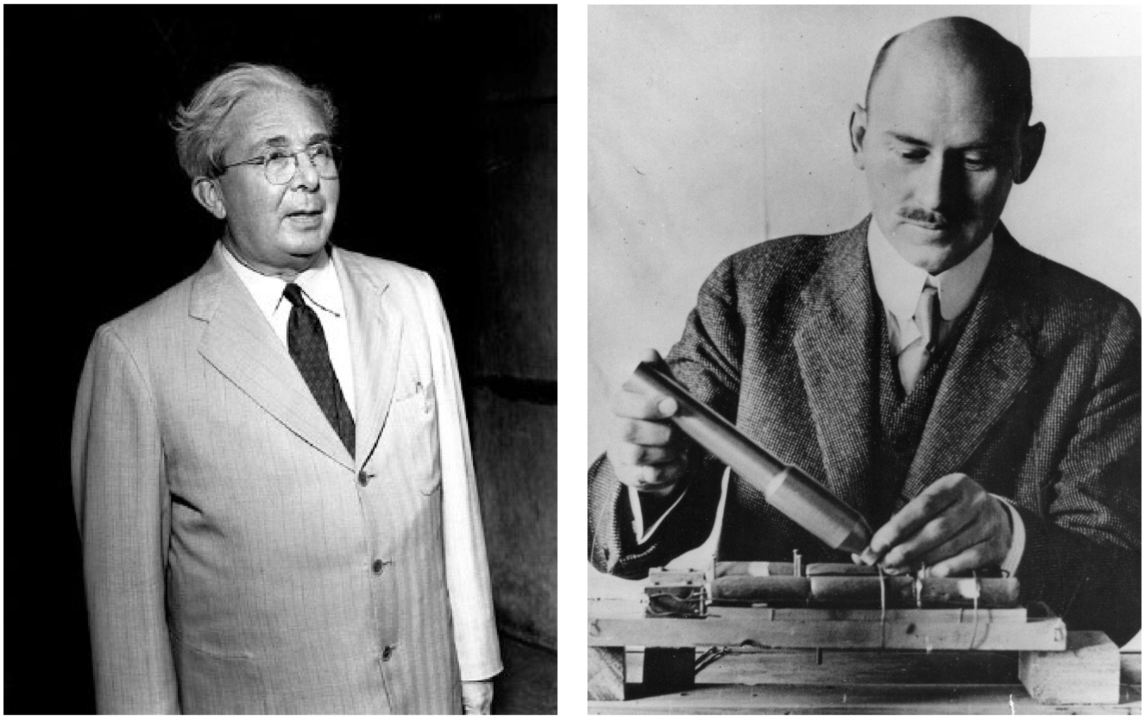


Figure 5. Physicists Leo Szilard c. 1960 and Robert H. Goddard c. 1940 envisioned nuclear powered rockets for space travel long before the rest of the scientific community (Photo credits: DOE and NASA).

Figure 6. Early popular fiction from the 1930s imagined space flights aboard rockets propelled by pulsed nuclear energy (Heinlein 1940; Balmer and Wylie 1933).

By the mid-1940s, however, the world's understanding of the atom's energy potential changed dramatically once the Manhattan Project and the atomic bomb were revealed. The nuclear propulsion ideas expressed by a handful of visionaries in the first half of the 20th century would finally take hold in the post-World War II years.

Turning Theory into Action

Born out of advances in nuclear physics and rocketry research made during WWII, it is not surprising these two new sciences were combined in the post-war years when peaceful uses of the atom were being explored. The first serious consideration of using nuclear energy for the propulsion of rockets occurred in 1946 when Robert Serber, a consultant with the Douglas Aircraft Company, Robert Cornog, a project engineer for Northrop Aircraft, and a third group led by A. E. Ruark from the Applied Physics Laboratory at Johns Hopkins University (APL/JHU) all produced separate studies concluding that nuclear propulsion for rockets, ramjets, and other aircraft could be a viable technology and deserved more investigation (Cornog 1946; Ruark 1947; Serber 1946). Yet little more was done until 1952. It was a study conducted by Robert W. Bussard and two colleagues at Oak Ridge National Laboratory (ORNL) showing the potential superiority of nuclear propelled rockets over chemical rockets for both large payloads and longer distances that attracted substantive interest from the U.S. Air Force and the AEC Aircraft Reactors Branch for the first time (Bussard 1956:32-49; 1962:32-35). At the request of the Air Force, researchers from the Oak Ridge, Los Alamos, and Livermore laboratories, along with selected industrial contractors restarted their efforts to assess the potential of nuclear propulsion for rockets. The reports from these groups presented to the U.S. Air Force Scientific Advisory Board (SAB) in October 1954 indicated reactor-powered flight was worth exploring. Nuclear propulsion's appeal was its potential for powering spacecraft farther, faster and with less weight than rockets relying on conventional fuel.

The initial space nuclear propulsion research was centered at Lawrence Livermore National Laboratory (LLNL) in California and Los Alamos National Laboratory (LANL) in New Mexico (Figure 7). Both institutions moved swiftly to establish 'thinking groups" comprised of personnel already interested in and informally working on nuclear rocket propulsion concepts. Their objective was to design an efficient and reliable system to boost both autonomous and piloted rockets to the moon, Mars, and beyond.

Figure 7. Los Alamos National Laboratory Administration Building TA-3 (left) and aerial view of Lawrence Livermore National Laboratory in 1956 (Photo credits: LANL Archive and LLNL Archives).

Herbert York, the LLNL director, christened his cohort of scientists the "Rover Boys" after a fictional book series about the adventurous deeds of three brothers to mirror the three stages of the nuclear propulsion program (Dewar 2004; Dyson 2002; York 2008). Los Alamos formed their group as well and shrewdly invited Bussard to participate in their discussions in late 1954 (Figure 8). His insights would prove critical for advancing the studies to the next level and convincing the SAB to fund more research (Aamodt et al. 1955). Bussard would eventually move from ORNL to Los Alamos in June 1955, shortly after LANL Director Norris Bradbury established the new Nuclear Propulsion (N) Division (Bussard 1962:33).

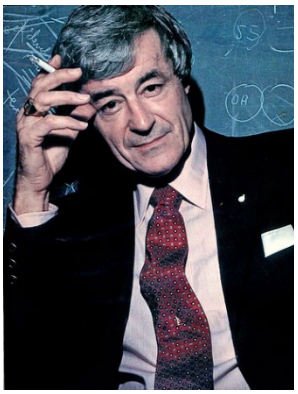


Figure 8. Physicist Robert Bussard (c. 1970) was a key figure in the early development of aerospace nuclear propulsion and the success of the Rover Program (Photo credit: Atomic Heritage Foundation).

In the scientific community's version of a street rumble, the two laboratories maneuvered to gain the upper hand in the competition for the development contract. In the end, Los Alamos's approach won out aided in large part by the political clout of New Mexico's U.S. Senator Clinton Anderson, the foresight of Bradbury, the laboratory's dynamic N-Division leader, Raemer Schreiber, and their exceptional scientific track record (Figure 9) (Dewar 2004). However, LLNL did not walk away empty handed. Its Rover moniker was adopted for the program because it echoed the three-phase strategy that was planned for the nuclear rocket's development. And, more importantly, the Livermore group received funding to pursue the development of a nuclear ramjet aircraft dubbed Project Pluto (Dewar 2004).

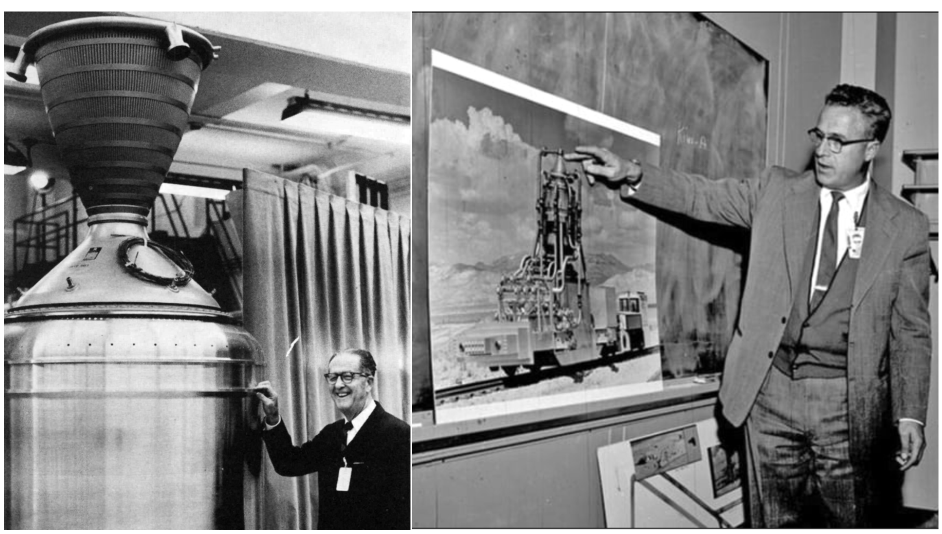


Figure 9. U.S. Senator Clinton P. Anderson with a Rover Program Kiwi-B series reactor at Los Alamos in 1962 and Dr. Raemer Schreiber explaining a detail of the first Kiwi-A test reactor in 1959 (Photo credits: LANL and Atomic Heritage Foundation).

The Nuclear Rocket Development Station

Finding a place to ground test and refine the rocket reactor propulsion and engine systems was critical to the success of the Rover program. Los Alamos personnel successfully pushed for a 318,000-acre (~480 square miles) tract of U.S. Air Force–controlled land adjacent to the southwest corner of the Nevada National Security Site (NNSS) (Dewar 2004). In April 1956, the request for additional land was made public but the specific purpose remained under wraps. The AEC indicated the land transfer would be used for experimental projects developed by both Los Alamos and Livermore (*Reno Evening Gazette* 1956:6).

It was an ideal location for testing. Los Alamos personnel were already very familiar with the area after nearly a decade of supporting the nuclear weapons testing program at the NNSS. The gently sloping terrain was covered with sparse desert vegetation and surrounded by hills and low mountain ranges. The valley offered unimpeded visibility between the planned test facilities, while the higher surrounding terrain shielded views of the work area from unauthorized personnel although some of the facilities can be glimpsed in the distance from U.S. 95 near Amargosa, formerly known as Lathrop Wells. The site was only 25 miles from the Mercury support area but was sufficiently distant from large populations centers to minimize the radiological concerns.

By early 1957, the boundary survey encompassing the broad, undeveloped valley known as Jackass Flats was completed. Although the land would not be formally withdrawn until 1961, the AEC and National Advisory Committee for Aeronautics ([NACA]—predecessor to NASA) forged ahead with development. Engineering design and construction bids were solicitated. Contracts were awarded and the desert solitude was broken as a frenzy of construction began on the infrastructure and first phase of the testing facilities. Water wells, roads, power, communications, and rail systems were not even complete when work started on the testing and support buildings.

It is likely that the project proponents felt additional pressure to move rapidly because of the Soviet Union's October 1957 launch of Sputnik, the first artificial satellite to orbit the earth. Less than three weeks earlier, the Russian's boast of sending rockets to the moon, Mars, and Venus by 1965 had been dismissed by most scientists (Los Angeles Evening Citizen News 1957:1). Sputnik altered the space supremacy equation virtually overnight as the U.S.S.R. took the lead in the space race (Figure 10).

The original Rover development plan called for phased construction of more than a dozen complexes plus a cluster of dormitories and an airstrip exclusively for NRDS (House 1963, figure 6; Pan Am 1965). However, the full complement of structures was never built because of changing priorities driven in large part by an ever-shrinking budget after 1963. In the end, eight complexes were erected in two major phases. Test Cell A, the Reactor Maintenance, Assembly, and Disassembly Building (R-MAD), the Reactor Control Point (RCP), the Central Support Area (CSA), Test Cell C (TCC), and the initial segment of the railroad were established first because they were critical to the Rover reactor testing schedule. The second phase focused on facilities to support more powerful reactor prototypes and to service the NERVA engine testing program. Phase two construction started in 1961 and included Engine Test Stand 1 (ETS-1), the Radioactive Material Storage Facility (RMSF), the Engine Maintenance, Assembly, and Disassembly Building (E-MAD), significant additions to TCC, and an expansion of the railroad system.

ALL ABOARD, RUSSKIES!

Rockets Going to Moon, Venus, Mars

MOSCOW (UP) — The Moscow newspaper Literary Gazette today published detailed plans of a Soviet project to send manned rockets to the moon, Venus and Mars by 1965.

An article by missile scientist Y. C. Khlebtsevich said the Soviet Union is now prepared to launch interplanetary flight.

Khlebtsevich outlined plans to assault each of the three objectives in turn—the moon between 1960 and 1965, and Venus and Mars between 1962 and 1965.

The plans call for attacking space in three stages.

In the first, unmanned rockets guided by radio from the earth would blaze the trail.

In the second, unmanned "armored laboratories" would be fired to positions on the planets to reconnoiter them by television.

In the third, multi-stage rockets would deliver a manned "scientific station."

Klebtsevich estimated the trip to Venus would take 146 days and to Mars 258 days. The actual distance of the flights would depend on their positions at the time of takeoff since they, like the earth, revolve about the sun.

The Literary Gazette article revealed that the space-conquering project already has been assigned the code name LVM, the Russian initials for Moon-Venus-Mars.

Klebtsevich referred in his article to the Soviet Union's recent announcement of a successful intercontinental ballistic missile test.

It referred to the test as evidence of "possession of all the necessary means to build cosmic rockets."

Rockets Along at 18,000 mph

Russians Gloat At Winning Race

MOSCOW (AP) — The Soviet Union announced today it has launched the earth's first man-made satellite 560 miles out in space and it now is circling the globe at tremendous speed.

The dramatic claim that Russia had beaten the United States in the satellite race came in an announcement saying the artificial moon was launched yesterday by multiple-stage rockets. The site of the launching was not given.

The instrument-laden globe was described as 23 inches in diameter and weighing 185 pounds. The announced weight is about nine times that of a projected 22-inch U.S. earth satellite.

Figure 10. Newspaper stories just weeks apart confirmed the Soviet Union's space program was ahead of the U.S. and their earlier claims of lunar and interplanetary travel within the next few years could no longer be dismissed (Sources: Los Angeles Evening Citizen 1957 and Chester Times 1957).

On paper, the nuclear rocket propulsion program's research divisions and funding streams were clear. In practice they would be less straightforward, sometimes overlapping and occasionally contradicting each other (see Dewar 2004:44-59). The stated mission of the AEC was to fund and oversee the development of nuclear propulsion reactors and reactor technology, whereas NASA, who had taken over the role from the U.S. Air Force, assumed responsibility for nuclear engine design and engineering, and integrating the reactors into engines (AEC 1963:168). Administration of the program was by a newly created joint AEC/NASA Space Nuclear Propulsion Office located in Georgetown, Maryland—which was the headquarters of the AEC—with operating extensions in Albuquerque, New Mexico; Cleveland, Ohio; and Las Vegas, Nevada. Harold B. Finger was tapped to be its first manager, a position he held from 1960 until 1967 (American Nuclear Society 2019).

The primary mission of the NRDS at the NNSS was to support the Rover program in developing and field-testing nuclear rocket reactors and engines for the space program (AEC 1961:69; House 1963; Miller 1984:1). Named by Herbert York after the Rover Boys fictional book series about the adventurous deeds of three brothers, the program was initially envisioned in three stages (Dyson 2002:23). The first stage involved three tasks: 1) to develop and test reactors to investigate and solve various problems in achieving a high-power density, 2) to develop and test reactor materials capable of withstanding high temperatures, and 3) to generate new concepts for converting nuclear energy into useful propulsion forms (AEC 1960:77). The second stage was to design and test a nuclear engine for actual flight, and the third stage, performed by NASA, was to incorporate the engine into a Saturn V launch vehicle for flight-testing (AEC 1964:109; Schreiber 1961:33). All these tasks were done in coordination with LASL and the private industry contractors participating in the original Rover program and its second phase designated the NERVA program, which began in 1961.

As work on the Rover prototype reactor designs and engineering progressed at LASL, ground was broken on the first NRDS test facility and supporting infrastructure. Building began at Test Cell A in 1957 with R-MAD and a portion of the railroad and the control point following soon after in 1958 (Beck et al. 1996:26-30). The reactors were assembled at R-MAD and mounted on a flatbed railroad car for transport to Test Cell A for the test run, and then trundled back to R-MAD for disassembly and post-test analysis.

The first nuclear rocket reactor test at the NRDS, designated Kiwi-A, was conducted in 1959 (AEC 1961a:69; Bussard and DeLauer 1965:3; Schreiber 1961:29) using the newly completed Test Cell A and R-MAD (U.S. Congress 1960:831). The nuclear rocket program evolved quickly in its first five to six years. Modifications to the reactors and testing facilities came rapidly. For example, early in the program, even before the first Kiwi reactor test took place, LASL engineers recognized that another test cell was needed. Newly recognized limitations in the Test Cell A configuration led to a funding request for the immediate construction of another test cell that incorporated the ability to simultaneously test the combination of both reactor and flow system dynamics using a full-scale turbopump system and a gas drive generator. Two million dollars were appropriated for fiscal year (FY) 1960 for the accelerated construction of Test Cell C (U.S. Congress 1959:777-778). Beginning with the Kiwi-B4 reactor, Test Cell C would become the workhorse for the program by hosting all the full-scale reactor and engine tests until ETS-1 came online in 1968 (Figure 11).

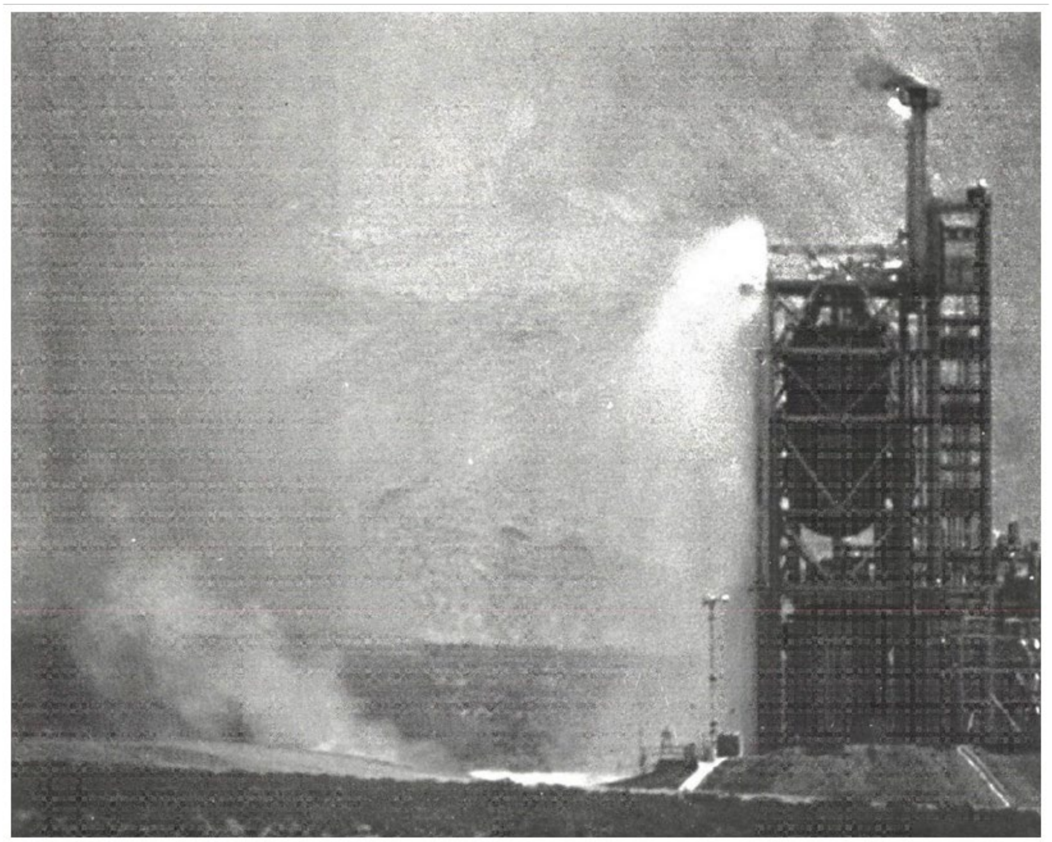


Figure 11. One of the NERVA XE Prime engine hot test runs at Engine Test Stand 1 in September 1969 (Photo credit: NASA).

After the conclusion of the Kiwi reactor runs, more test series followed, including NRX, Phoebus, Pewee, XE, and Nuclear Furnace (Angelo and Buden 1985:179-183; DOE NOO 1985a:2-2, Table 6.2.1, 1985b; Friesen 1995). Following the initial outline of the Rover program, the objective of the Kiwi test series was to develop and refine the proof-of-concept reactor technology and design (Schreiber 1961:70). The ground-based Kiwi reactor, appropriately named after a flightless New Zealand bird, would become the basic design for the NERVA engine to be flight-tested in the Reactor In-Flight Test (RIFT) vehicle (AEC 1963:168, 1965:111). The RIFT vehicle would then be developed for an upper stage on an advanced Saturn rocket capable of putting large payloads on the moon for lunar-based missions. As planned, the module would also be used for manned missions to Mars or Venus (AEC 1967:181).

NRDS, Economics, and Social Change

The years of 1961 and 1963 were relatively flush times for the nuclear rocket program, with the largest budget appropriations it would ever receive flowing into reactor and engine development and expanding the NRDS facilities (U.S. Congress 1960, 1961, 1962, 1963a). The Kennedy administration's support of the space program, including nuclear rocket technology, helped preempt some of the inevitable congressional budget cuts. Aerojet General and Westinghouse won the NERVA design and development contract in 1961. Both expanded their Southern California facilities to accommodate the increased workflow (Dewar 2004:81-83). During this period, Congress also appropriated funds for E-MAD, ETS-1, the Control Point, and expanded support facilities.

Billions of dollars were added to the nation's economy over the course of the nuclear propulsion rocket program. Across the country, federal agency offices sprang up, development laboratories were expanded, and new laboratories and manufacturing facilities were created. Money flowed to university and college campuses to prepare the much-needed nuclear engineers, physicists, chemists, and designers who would develop and operate the reactors and engines, and ultimately test them at the Jackass Flats complex in Nevada. Because Nevada had a small population, impacts on the state and local economies from the construction of the NRDS complex and its nearly 18 years of operations should not be underestimated. More than $140 million dollars was awarded for the nuclear rocket ground-testing facilities at the NNSS. Although many of the awards went to out-of-state companies, a significant portion of the NRDS funding circulated through the Nevada economy. Local businesses garnered a sizeable share of the construction work for both the buildings and the infrastructure associated with the complex.

In his testimony for the annual Senate hearing on the NASA appropriations for FY1969, Milton Klein (successor to Harold Finger), Manager of the Space Nuclear Propulsion Office for NASA/AEC, noted that the NERVA program capitalized heavily on the strong industry–government relationship that had developed over the last decade (U.S. Congress 1968:879-880). Evidence of this is reflected in the promotional materials that the industry distributed to their congressional representatives and other government agencies. Participation in the nuclear rocket propulsion program was a point of pride for the companies involved in all aspects of its development. Many used their roles in the Rover and NERVA programs and their specific efforts in the construction of the NRDS facilities to enhance their marketing campaigns. Los Alamos, Westinghouse Astronuclear, Aerojet General and Catalytic Construction Company were just a few of the companies that smartly ran advertisements touting their work on the Rover and NERVA program facilities in Nevada in popular-press magazines such as *Newsweek* and *Time*, as well as in trade publications.

The existing southern Nevada workforce was not sufficient to fill the many openings for construction and maintenance workers, skilled technicians and engineers, and scientists, which created employment opportunities and brought workers from across the country to take up residence in Clark, Nye, and Lincoln Counties. Companies involved in the development of the Rover and NERVA reactors and engines—such as LASL, Aerojet, and Westinghouse—began recruiting personnel to relocate to Nevada for the ground-testing phase starting in the early 1960s. Additional recruiting efforts continued as work on the first phases of the ETS-1 and E-MAD facilities neared completion (*Boston Globe* June, 1962:28; *Cincinnati Enquirer* August, 1963:127; *Los Angeles Times* October, 1964:15; *Pittsburg Press* December, 1962:2; *San Francisco Examiner* May, 1965:75).

Beyond population growth, the influx of people started to shift the social fabric of the community. The establishment and expansion of the NRDS complex combined with the evolving nuclear testing activities brought individuals and families from across the United States with more diverse backgrounds and interests to southern Nevada. Although tourism, gambling, and the service and hospitality industries would continue to dominate the economy and community focus, the NNSS and the NRDS rocket programs would provide much of the impetus for increased residential development, the establishment of fledgling cultural programs, and expanded educational opportunities for all southern Nevadans in the 1960s (Moehring 1989:112-115).

It was pressure from the NRDS workers making the daily commute from Las Vegas that finally tipped the scales, leading to the widening of the road between Las Vegas and Camp Mercury from a two-lane "widow-maker" to a four-lane highway (*Reno Gazette-Journal* 1962). As documented in congressional testimony (U.S. Congress 1963a:935-936, 1963b:25-27), it was the long commute from Las Vegas and an expected increase in the NRDS workforce to almost 2,700 once E-MAD became operational that led the AEC to consider building an "atomic city" in Nye County. The city was planned for a location near Mercury but outside the boundaries of the NNSS because AEC and NASA administrators argued that eliminating the two-plus-hour commute between Las Vegas and Mercury would make it easier to recruit the technically skilled personnel they needed for the growing nuclear rocket program (U.S. Congress 1963b:19-25). At one time, estimates for the size of the community ranged as high as 12,000, based on the anticipated increase in nuclear-testing activity and the build-out of the NRDS facility, which would include four additional engine and stage test stands, as well as numerous ancillary shops, and have a robust testing schedule (Dewar 2004:89; U.S. Congress 1963a, 1963b).

Initial committee support and public enthusiasm for Nevada's own "atomic city" was cut short by a changing political climate and budget woes. The Kennedy assassination in November 1963, mission creep in Southeast Asia, civil rights concerns, and budget pressures resulted in a realignment of the Rover program that would shelve any test site community plans by early 1964 (M&R 1964:13-14).

Budget Battles and Changing Fortunes

Except for the halcyon days of the Kennedy Administration between 1961 and 1963, funding was always a challenge for the nuclear rocket program (Figure 12). Evidence of the budget struggles is readily found in all the planned and never built facilities but can also be seen in modifications to those that were constructed. The test cells appear to have had the highest funding priority and most of the modifications or expansions requested for those facilities were completed. Instead, money was saved for their operations by significantly scaling back the number of reactor prototypes and total number of tests conducted. In contrast, the support facilities were constantly being trimmed. For example, some of the E-MAD design features shown in the original engineering drawings were eliminated after construction was underway. Others were installed but never activated such as the capacity to work on two engines and reactors at the same time. Planned viewing windows and remote handling stations were never installed. Temporary trailers became the rule rather than the exception as planned expansions and upgrades to E-MAD were postponed or canceled. Similar modifications and downsizing occurred at the other NRDS support facilities.

Figure 12. President Kennedy toured the NERVA Programs facility ETS-1 still under construction (left). Kennedy also tried his hand using the remote manipulator arms at R-MAD while an American Car & Foundry technician and Glenn Seaborg, Chairman of the AEC look on [Dec. 1962] (Photo credit: REECo).

The fight for appropriations continued to plague the Rover and NERVA programs as the deadline for NASA's primary mission—Project Apollo and the challenge to land astronauts on the moon before the end of the decade—drew closer.

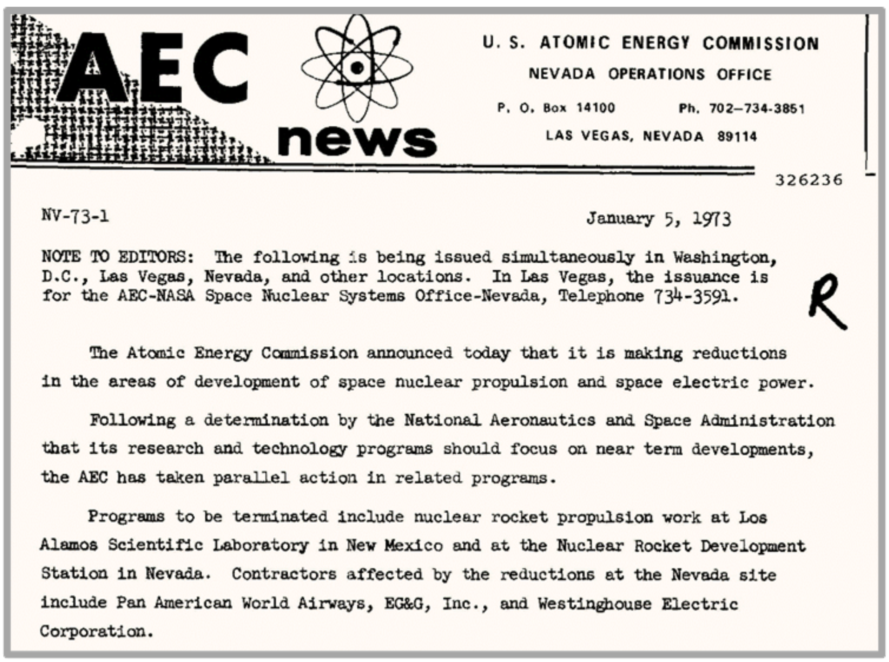
However, successes with the ongoing Rover reactor test series and the early NERVA engine ground tests and good diagnostic data coming from the E-MAD operations underscored the technical strength of the program (U.S. Congress 1969, 1970).

NRDS, An Unceremonious End

Although he publicly celebrated the success of the moon landings in July and November 1969, President Richard Nixon was no friend of human-piloted space exploration (Logsdon 2015). The new president and his senior advisors had no affinity for the space program, especially for projects that had no underlying defense applications. In addition, Nixon was badly shaken by the near-tragic Apollo 13 mission the following April. As he saw it, the potential for failure was too great and the financial commitment too high. Support in Congress also waned and then finally collapsed during the same period as long-time advocates of manned missions to Mars and nuclear rocketry retired or passed away. Even the vaunted Apollo Program felt the sting of budget cuts once the moon landing was accomplished (U.S. Congress 1971, 1972).

Early in 1972, the NERVA project was canceled while the Rover reactor development funding suffered another round of cuts (AEC 1973a:25). The last Rover test, the Nuclear Furnace Experiment, was conducted at Test Cell C in July 1972 (Friesen 1995:4, 90). That field trial successfully demonstrated a new scrubber system to eliminate atmospheric radioactive emissions during reactor testing. The releases had always been a concern from the start of the program, but it became a focal point of opposition as the environmental movement gained momentum in the early 1970s. If nuclear rockets were ever to be publicly palatable, the emissions from field testing would have to be eliminated.

However, success was no defense against an uncooperative administration, a gutted budget, and an apathetic public. On January 5, 1973, AEC and NASA abruptly announced the end of the nuclear rocket program (AEC 1973b; Dewar 2004:192-203) (Figure 13). The pronouncement occurred just days after the program's most vocal and powerful political advocate, Senator Clinton Anderson, retired. The entire NRDS program was phased out by June 1973. All management responsibilities and upkeep for the NRDS area were assumed by the AEC's Nevada Operations Office (AEC 1974:23; Miller 1984:5).



AEC news

U. S. ATOMIC ENERGY COMMISSION
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LAS VEGAS, NEVADA 89114

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R

The Atomic Energy Commission announced today that it is making reductions in the areas of development of space nuclear propulsion and space electric power.

Following a determination by the National Aeronautics and Space Administration that its research and technology programs should focus on near term developments, the AEC has taken parallel action in related programs.

Programs to be terminated include nuclear rocket propulsion work at Los Alamos Scientific Laboratory in New Mexico and at the Nuclear Rocket Development Station in Nevada. Contractors affected by the reductions at the Nevada site include Pan American World Airways, EG&G, Inc., and Westinghouse Electric Corporation.

Figure 13. AEC announces the cancellation of the nuclear rocket propulsion program, the closure of NRDS, and the dismantling of the joint AEC - NASA Space Nuclear Propulsion Office. (Source: Nuclear Testing Archive).

Nevada Research & Development Area

When they turned out the lights on the Rover Program the NRDS was rebranded as the Nevada Research & Development Area (Figure 14). The similarity of the two names and their acronyms has been a source of confusion ever since (for example, see Coolidge 1996:38-39). The AEC started looking for new tenants, a process continued by the DOE and its contractors to the present. Despite the attractions of its facilities, particularly the large and well-equipped hot cells at the two-maintenance, assembly, and disassembly buildings, costs of decontamination and of operating in such a remote area defeated intentions of private industry to make use of the place. Aside from use as a training facility by private contractors, all subsequent uses have been for a small number of federal projects.

Figure 14. Rebranding the Nuclear Rocket Development Station as the Nevada Research & Development Area. Note the original site designation is still visible at the top of the sign in this 2009 image (Photo credit: DRI).

Nuclear Fuel Removal Project

Beginning in late 1973 and extending into 1975, the two primary NERVA contractors, Aerojet and Westinghouse Astronuclear, spent two years disassembling and packaging the uranium fuel from all the Rover and NERVA reactors that had been stored on site in the RMSF and R-MAD. Secured in special transport containers, the material was shipped to the Idaho National Laboratory for reprocessing (Bechtel BWXT Idaho 2005:1-1). The companies used R-MAD and E-MAD for this task and in the process, partially remediated the radiological issues at both complexes setting the stage for other programs to move into the former NRDS facilities.

Spent Fuel (SFHPP/SURF) Program

The Spent Fuel Handling and Packaging Program (SFHPP) [also known as Spent Uranium Fuel (SURF)] used the E-MAD facility and the rail transport system from 1978 until 1982 (Unterzuber et al 1982, Westinghouse Electric Corporation 1981). E-MAD's enormous hot bay and remote handling systems were ideal for a pilot program to evaluate various dry cask storage concepts for spent fuel from commercial nuclear power plants. Components of the NERVA Program's Railroad Transport System (RTS) were modified to accommodate the specially designed cylindrical spent fuel storage casks trucked in from the Turkey Point Nuclear Power Plant. The RTS was used to maneuver the casks secured in and out of the E-MAD hot bay as well as to insert and extract the fuel containers from several below ground dry well vaults on the west side of the building. O'Neill and Wedding (2022) provide a more detailed history of the RTS and its use during the Rover and Spent Fuel Programs.

Peacekeeper (MX) Tests

The Peacekeeper (MX) missile was a land-based intercontinental ballistic missile (ICBM) developed by the United States during the Cold War. The testing of the Peacekeeper missile was conducted at the NNSS from 1978 through 1982 in Area 25 of the NNSS (NNSA/NFO 2013b). The USAF tested components of its planned shelter, transportation, and cold gas launch systems for the missile (NTS News 1979:8-9; NTS News Bulletin 1985:1; 1986:2-3) (Figure 15). Some new areas towards the U.S. 95/Amargosa Valley (formerly known as Lathrop Wells) gate were developed for the missile transporter test runs, but portions of the existing NRDS facilities were also utilized. MX program personnel, military and civilian, occupied a portion of the CSA Administration & Engineering Building (25-4015) (NTS News 1979:9). The MX test launch facility was built at the western end of the R-MAD compound.

Figure 15. Mock MX missile launch conducted at the mothballed R-MAD facility in 1982. Note the new launch tower and camera towers in the foreground built for the missile program (Photo credit: National Archives).

Yucca Mountain Project (NNWSI/YMP)

The Nevada Nuclear Waste Storage Investigation (NNWSI), which would later become known as the Yucca Mountain Project (YMP), occupied portions of the complex beginning in the late 1970s until 2011. The YMP made extensive use of the administrative and maintenance buildings in the Central Support Area as well as the former NRDS security controls and emergency services facilities. The R-MAD High Bay was used by both YMP and REECo to store equipment (SAIC 1994).

Training Programs

Test Cell C, ETS -1, and the RCP have been used for various training activities including industrial area emergency response exercises for several decades. Due to a general lack of other competing programs, much of Area 25 including the NRDS has been used for specialized military training since at least the 1980s.

Recycling

Other test site projects repurposed and relocated various components from the NRDS facilities including demountable and prefabricated buildings, as well as many of the smaller dewars. Buildings and equipment not reused on site were often transferred or sold as surplus to other government facilities or to the public.

Nuclear Space Propulsion after 1973

Over the intervening years there have been several attempts to revive nuclear thermal propulsion for space travel including Project Timber Wind (1987-1991), the Space Exploration Initiative (1989-1993), the Space Nuclear Thermal Propulsion Project (1992-1994), and Project Prometheus (2000-2005) (Angelo and Buden 1985:194; Dewar 2004:205-207; Porta 1995; Watson 1994). Though all of them considered limited reuse of the NRDS facilities, none of these programs ever really found traction. Economic crises, social strife, political polarization, public apathy, and a myriad of other distractions kept the country's eyes focused on the ground and low-earth orbit instead of on the stars.

However, recent events may have finally altered the political climate and renewed the American public's interest in human space exploration. The last five years ushered in the commercialization of space flight along with the rise of a new and serious national competitor with bold plans and deep pockets – the People's Republic of China. China's latest series of successful piloted and unpiloted space flights lend credence to their plan to send a crewed mission to Mars in 2033 (Kharpal 2021a).

China's ambitious goal of becoming the leading global space power by 2045 seems to have lit a fire inside the Beltway (Kharpal 2021b). The U.S. loathes to come in second and memories of Russia's 1957 Sputnik launch probably echoed through the halls of Congress and NASA (Figure 16).

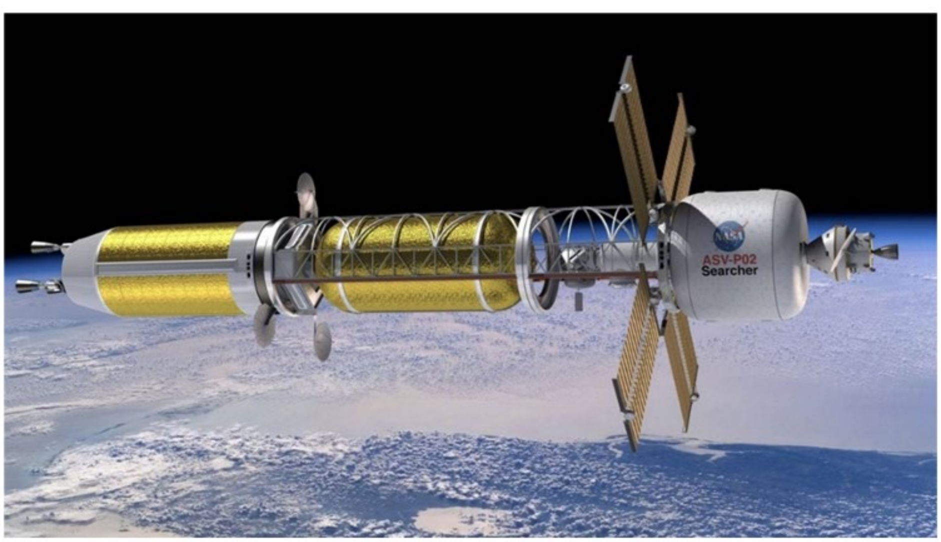

Figure 16. Nuclear thermal propulsion spacecraft concept (Illustration credit: NASA).

Not surprisingly, NASA recently reaffirmed its objective to send humans to Mars in the 2030s and to that end, the agency announced three contract awards for nuclear thermal propulsion reactor designs on July 13, 2021 (NASA 2021). Some of the awardee names are familiar — Aerojet Rocketdyne, Lockheed Martin, General Atomics, and General Electric Research — harkening back to the original efforts to harness the atom for interplanetary travel. Others — Ultra Safe Nuclear Technologies, Blue Origin, BWX Technologies, Framatome, and Materion — are new entries into the space nuclear propulsion field. Yet no matter their history or experience, these companies will all build on the work of the researchers, engineers, and technicians that came to Nevada's Jackass Flats 60 years ago. Most of those first nuclear rocketeers are long gone, but the remnants of the Nuclear Rocket Development Station remain to remind us of their contributions to the technology that may one day take humans to Mars and beyond.

IV. THE NRDS HISTORIC DISTRICT (D424)

The NRDS Historic District covers portions of the Jackass Flats and Skull Mountain USGS 7.5' topographic maps. The unrecorded portion of the NRDS extends west onto the Busted Butte quadrangle. All three maps were produced in 1961, showing the Reactor Control Point, R-MAD, Test Cell A, and Test Cell C. The 1983 revision of the maps adds the complete buildout of the NRDS. The entire district is also portrayed with somewhat less detail on the 1988 Beatty 1:100,000-scale map, which shows projected townships and sections.

Natural Setting

Nearly surrounded by a ring of low mountain ranges at the northern edge of the Mojave Desert, the broad expanse of Jackass Flats seems unremarkable at first glance. However, a closer examination of the terrain reveals a landscape dotted with massive structures of concrete and steel connected by a railroad that snakes across the valley floor. This is where field testing for America's first effort to harness the power of the atom for interplanetary travel took place.

Jackass Flats is roughly rectangular, about 12 miles wide from east to west and 8 miles north to south. It is bounded on the west by Fortymile Wash with the long expanse of 4,951-foot Yucca Mountain immediately to the west of the wash. The brilliantly colored Calico Hills rise to around 5,000 along the north edge of Jackass Flats (Figure 17).

Figure 17. The Calico Hills as seen looking north-northwest from just outside Gate 500. The Reactor Control Point is beyond the gate and Test Cell C is lined up on the road in the far distance (Photo 2116_7270, DRI 2021).

Between these two mountain masses Fortymile Wash transitions into Fortymile Canyon, a natural route of travel to the north. The pass to Mid-Valley is at the northeast corner of the basin which is bordered on the northeast by 4,959-foot Kiwi Mesa and the foothills of 5,651-foot Lookout Peak. Kiwi Mesa has the distinction of being the only landform named after part of the testing program at the NRDS. The Kiwis were the first generation of reactors tested at the facility. The east end of the Flats gradually ascends to Wahmonie Flat, site of the mining camp by the same name, which is on the wide pass leading to Frenchman Flat. Skull Mountain forms the southeast boundary with elevations up to 5,975 feet (Figure 18).

The relocated BREN Tower experimental facility was located on the flanks of Skull Mountain in this area outside the boundary of the NRDS Historic District. Centered in the south end of Jackass Flats is the pass to Rock Valley and beyond that to Mercury which is the principal entry to the NRDS. Little Skull Mountain at 4,666 feet rises immediately west of the pass and forms the last definite border of Jackass Flats. The southwest corner of Jackass Flats just west of Little Skull Mountain slopes gently to the southwest and soon merges with the Amargosa Desert (Figure 19).

Figure 18. Skull Mountain fills the center skyline in this view southeast from the ETS-1 Water Tank on the flanks of the Calico Hills. The pass for the road to Mercury is to its right and Wahmonie Flat is to the left of the mountain (Photo 2116_0364, DRI 2021).

Figure 19. This view southwest from near R-MAD shows Jackass Flats gently descending toward the Amargosa Desert in the far distance. Yucca Mountain fills the right skyline (Photo 2116_7440, DRI 2021)

The Reactor Control Point in the center of Jackass Flats is at an elevation of 3,600 feet. The highest point in the NRDS Historic District is the upper water tank at Engine Test Stand 1 at 4,240 feet. The radioactive waste dump at R-MAD at the east end of the district is at an elevation of 3,860 feet. The Communications Building at the south edge of the district on the road from Mercury is at 3,520 feet. The lowest NRDS improvement is Well J-12 on Fortymile Wash at 3,120 feet.

There is no permanent source of surface water in or near Jackass Flats. However, the mountain masses surrounding Jackass Flats can generate impressive flash floods during storm events. Topopah Wash, which originates in the Calico Hills and splits Jackass Flats in half on its way to the Amargosa, is deeply incised as is Fortymile Wash. The other washes do not have well established channels, so they are prone to changing course without warning (Reno once nearly lost a field vehicle to one of these unpredictable storms on the flanks of the Calico Hills when a major drainage suddenly changed direction). Prehistoric and contact-period native occupants of the region depended on bedrock catchment basins for ephemeral water sources. The NRDS needed a more dependable source so three deep wells were drilled. The floor of Jackass Flats and the drainages trend from northeast to southwest for the most part. Those drainages west of Topopah Wash trend increasingly north to south as they progress westward. Drainages in the east end of the district trend nearly westward once they pass beyond the flanks of the surrounding mountains.

There are only two small geologic features to break up the expanse of the valley floor. One tiny hill between the Reactor Control Point and E-MAD rises 120 feet about the surrounding valley floor to a height of 3,660 feet. A pair of larger hills just northwest of Little Skull Mountain rises over 300 feet to heights of 3,644 and 3,579 feet. Their location makes them ideal for a weather tower on one summit and a benchmark on the other. Topopah Wash and all other drainages to the east converge to squeeze through the narrow gap between this pair of hills and a ridge protruding north from the main mass of Little Skull Mountain.

Vegetation is dominated by a creosote-bursage plant community. Joshua trees and yucca are very sparse on the valley floor but increase in density in the higher areas. Disturbed areas are mainly revegetated by rabbitbrush and annuals.

Built Environment

Facilities related directly to the development of nuclear rocket engines at the NNSS as part of the Rover and NERVA programs were deliberately dispersed throughout much of Area 25, comprising all of Jackass Flats and portions of surrounding mountains (Figure 20). They also included Road A (now called the Jackass Flats Road) through Mercury to Highway 95, a new road to the town of Lathrop Wells located south-southwest of the NNSS, and the four-lane expansion of Highway 95 from Mercury to Las Vegas. Lathrop Wells has since been renamed Amargosa Valley. Other facilities constructed for the NRDS included extensive power and communications links between the various complexes, Mercury, and elsewhere. If the focus is expanded to the entire nuclear rocket development infrastructure not physically connected with the NRDS, it would extend to include many major administrative, research, and development centers throughout much of the continental United States, although the closest ties are to laboratories and firms in California and New Mexico.

Outside the north edge of the district, faint traces of concentric circular dirt roads can be seen on satellite imagery. These were placed to install and maintain radiation monitoring arrays centered on the two test cells. There are also two more towers associated with the test cells in this area. Representative examples of resources such as towers, monitoring stations, and signage were recorded within the district.

Representative portions of extensive linear resources were also visited and recorded within the district. Portions of the arrays extending outside the district were identified based on maps and aerial photos, which is essentially the methodology used for other linear resources such as roads or utility lines. Radiation monitoring associated with the NRDS and other programs at the NNSS extended well beyond Jackass Flats and far outside the boundaries of the NRDS district and even outside the NNSS, especially to the northeast, which was normally downwind during hot reactor tests.

Although defined by its primary role as the NRDS, the NRDS Historic District contains facilities related to other Cold War programs and activities, some of which continue to the present. Resources related to these programs, which re-used NRDS facilities to varying degrees, extend far beyond the district. The distribution of these resources emphasizes the elaborate interconnectedness of all portions of the NNSS. This interconnectedness of resources over wide expanses continues to characterize many activities at the NNSS.

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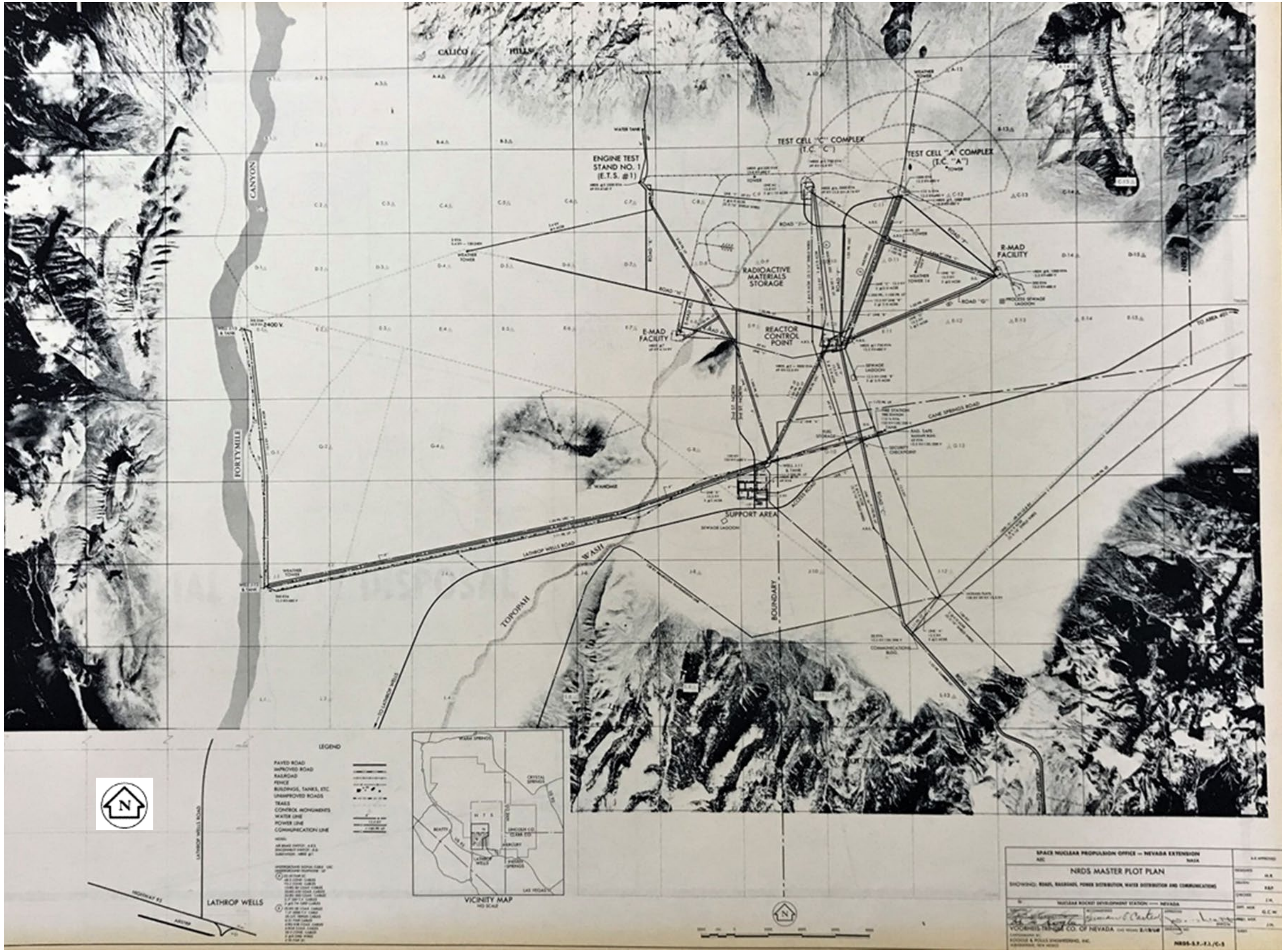

Figure 20. NRDS master plan (Voorheis-Trindle 1965).

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Architectural Styles

The NRDS exhibits a narrow range of modern architectural styles. In the following discussion it is important to keep in mind that scholarship has not quite caught up with resources that are so recent, and therefore many competing stylistic categories exist. The difficulties and pitfalls of assigning buildings to particular styles were well explored by Marcus Whiffen (1992:ix-xiii).

The styles selected here were chosen to organize the specific kinds of architecture present at the NRDS in relation to other architecture previously recorded at the NNSS and similar facilities.

NO STYLE

<u>Prefabricated</u>

Prefabricated metal buildings such as Quonset huts, straight-sided Quonset huts, and Butler Buildings comprised much of the built environment of Mercury in the 1950s. Due to its later construction, NRDS entirely lacks Quonset huts, although many Butler-type buildings were constructed along with major metal-framed prefabricated buildings designed by other firms (Figure 21). Most of these buildings have moderate to very low pitch metal roofs.

Figure 21. Examples of prefabricated buildings at the NRDS.
Top: CSA Warehouse #2, Building 25-4320 (B19017), facing northwest (Photo 2116_9208, DRI 2021).
Bottom left: Well J-11 Pump House Building 25-3121 (accessory resource to S3136), a small Butler Building, facing west (2116_7342, DRI 2021).
Bottom Right: RCP Administration Building 25-3104 (B18995), facing southwest (2116_9206, DRI 2021). The building retains its original framing and arrangement of openings, but all exterior materials are recent replacements.

Portable

Portable buildings and structures were extremely common at the NRDS during the Cold War, and many remain. They were often also called trailers on the NNSS because they were used in the same way. The smaller ones were often called "Brock houses" on the site. The origin of that name could not be determined. Purpose-built portable buildings normally were constructed on wood or steel skids and often had lifting rings in the corners of the roof as well so that they could be hoisted by a crane.

A curious type of portable building had the brand name "Transa-House." These "pop-up" buildings were towed to the site as a single-wide trailer. They were placed on temporary pier foundations, sides folded downward as floors, and other components unfolded, creating the exterior walls and extensions of the roof. Service areas were arranged along the center of the unit. The result was a building which looked just like a modern double-wide modular. Two were installed as Los Alamos offices at the Reactor Control Point but none remain on site. A much more extensive array of these buildings was at Area 12 Camp. This building type is discussed in more detail by Reno et al. (2021a:40-42). Examples of portable buildings and structures at the NRDS are shown in Figure 22.

Figure 22. Examples of portable buildings.
Top left: The guard shack at the intersection of Roads K and H, leading to the ETS-1 Historic District, facing northeast (Photo 2116_0278, DRI 2021).
Top right: The guard shack at the security gate at the ETS-1 complex, facing northwest (2116_0462, DRI 2021).
Bottom: Two preserved plywood Brock houses in the yard of Maintenance Shop 25-4222 (B19015), facing northwest (2116_1132, DRI 2021).

Trailer

Unlike portable buildings, trailers were equipped with their own wheels and did not require extensive installation work. At the height of operations during the Cold War, large numbers of trailers were used throughout the site for extra office space or specific testing purposes and often exhibited extensive retrofitting by the REECo shops. Two residential trailer parks were installed at the Reactor Control Point, but none remain on site today. Like other residential trailers at Mercury and Area 12 Camp, these had two bunk beds at each end and a shared room in the center with a sink, toilet, and shower. If housing demands were low, the upper bunks could be removed (Reno et al. 2018). A few examples have survived at Area 12 Camp. Examples of the small number of trailers still at the NRDS are shown in Figure 23.

Figure 23. Examples of trailers used at the Central Support Area.
Top: Two trailers reused as storage buildings at the Radiographic Facility Building 25-4919 (B19020), facing northeast (Photo 2116_1168).
Bottom left: The communications trailer Building 25-5004 (B19021), facing northeast (Photo 2116_1096).
Bottom right: The Shop trailer at the Maintenance Shop 25-4222 (B19015), facing northeast (Photo 2116_1135, all DRI 2021).

MID-CENTURY MODERN STYLES AT THE NRDS

Mid-century Modern is a cover category with many subtypes, all of which share an interest in breaking with past architectural traditions. There was considerable room for decorative elements in varieties before and after the brief anti-ornament phase of International Style dominance in the late 1940s through 1950s. When viewed in this way, the Mid-century term expands considerably in time with early examples in the 1920s and late examples still being widely constructed to this day. Modern Style variants are the only formal architectural styles present at the NNSS.

Many different architects competed for contracts (see the following section on Architectural and Engineering Firms), which is reflected in the considerable variability among buildings, although all are within the parameters of this style. It is known for its emphasis on simplicity, usually with the form of the building following its function, the use of curtain walls and exposed structural elements as decoration, and a preference for roofs that are either flat or of such low pitch that they appear at first glance to be flat or nearly so (Michael and Smith 2011). Commonly used construction materials include concrete, concrete block (also known as concrete masonry units [CMU]), steel framing, metal cladding, and an extensive use of windows. Buildings are devoid of window and door surrounds or moldings.

Six standing buildings in this style at the NRDS express it in a very simple and generic manner. Examples are shown in Figure 24. Three more nuanced varieties of Mid-century Modern architecture were identified at the NRDS and are discussed separately below.

Figure 24. Examples of Modern architecture.
Top: Building 25-3129 (B19003), Technical Operations, facing southeast (Photo 2116_9404).
Middle: Building 25-3153 (B19004), Fire Station, facing northeast (Photo 2116_9912).
Bottom: Building 25-3123 (B19000), Technical Services Building, facing southwest (Photo 2116_9334, all DRI 2021).

MODERNE (REVIVAL)

This style is also called Art Moderne, Streamline Moderne, and for some of its variants Steamship Moderne. It is a horizontally oriented style. Walls are blank, often covered with plaster or stucco to create a uniform surface. Wall ornament, if present, is restrained, often consisting of horizontal grooves. Window orientations can be either horizontal or vertical, although round porthole-like windows are used in the Steamship variant. Metal-framed windows are often arranged in bands around the building. Glass blocks are often used. Doors and windows are installed without trim. Rounded corners are found throughout the design, ranging from a few elements such as porches or bays to the corners of the main building mass. Roofs are flat with parapets (McAlester 2013:580-585; Michael and Smith 2011:63; Whiffen 1992:241-246). As with the Contemporary style discussed below, this definition of Moderne is made up of a mixture of basic ideas of form and massing along with a specific suite of decorative details.

The style is derived from European Expressionism of the 1920s and certain other works, such as that of J. J. Oud's Hook of Holland Estate (Glancey 1998:145; Hollingsworth 1988:53). It had its peak popularity in the United States in the 1930's, to the extent that Marcus Whiffen states, "Streamline Moderne was the later 1930's style par excellence…." Moderne architecture practically disappeared during the dour years of the Second World War. Historians have placed the end point of this style sometime between 1940 and 1945. The later date is often associated with military designs, which generally made use of styles after their main popularity had waned (Michael and Smith 2011:2).

It therefore came as a tremendous shock to walk around a corner of the Control Building (25-3101, B18993) in the RCP district and be confronted by a classic Moderne building dating to 1958. The extent to which the style had disappeared, particularly from public buildings, is illustrated by the fact that in their survey of federal GSA buildings of the 1950s through 1970s, Robinson and Foell (2003) found no need to mention Moderne architecture at all. Removing all glass block windows and plugging the openings so thoroughly that they are only visible in favorable light, along with construction of a large addition, have greatly reduced the coherence of the design, which had distinctive Moderne elements on all elevations. The building is shown as it originally appeared in the reconstruction drawing in Figure 25. In this reconstruction based on original plans and surviving original elements, the asymmetrical principal façade exhibits exaggerated rounded corners on the steps, stoop, suspended rounded porch cover, and front sidewalk. All walls have large horizontally oriented glass block windows, and the flat roof has parapets.

Although this is an understated example of Moderne architecture, as originally built it displayed typical Moderne design elements throughout. In this respect it is a far more sophisticated design than that of the "Blue Box" building in Mercury (23-600), which has a folded Googie roof over a small entry foyer ludicrously attached to the huge parallelepiped, warehouse-like mass of the multiple-use building (Reno et al. 2018:57). Aside from replacement of the original pair of 3x8 foot front doors with their single large lights by smaller flush steel doors, the entry with its distinctive curved porch still looks much as it did when originally built (Figure 26). The original sidewalk with it large-radius rounded corners is also preserved in front of the north façade.

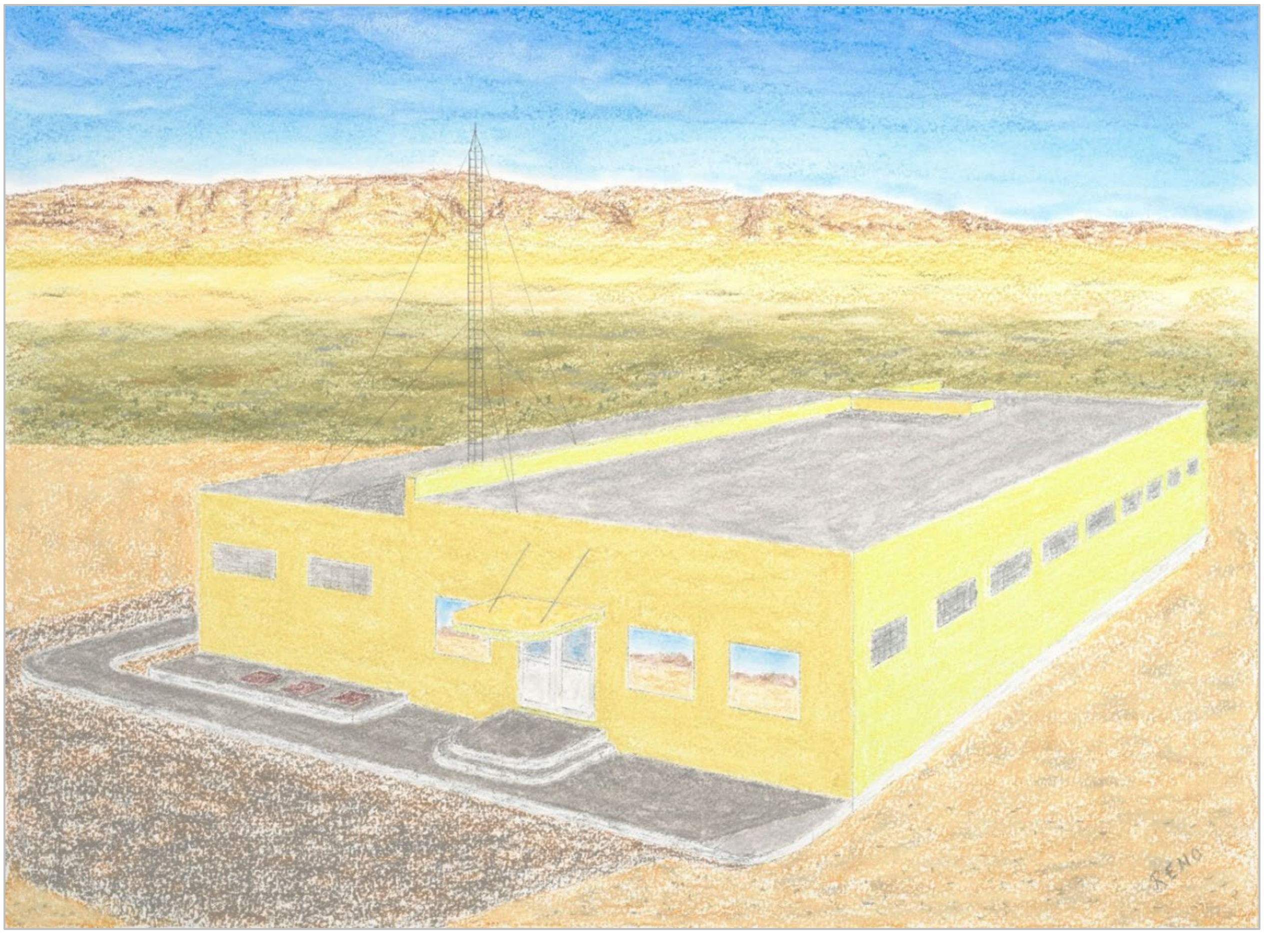


Figure 25. A reconstruction rendering of RCP Control Building 25-3101 (B18993) as it would have appeared prior to later modifications (drawing credit, Ron Reno 2022). The view is of the principal (north) façade and west elevation.

Figure 26. The main entrance to the Reactor Control Point Building, facing southwest (Photo 2116_9326, DRI 2021).

This building is representative of the many commercial buildings executed in this style. It is a common style which has received little attention or respect from mainstream architectural historians (a notable exception being members of the Society for Commercial Archaeology) and seldom succeeded in advancing the respect of their designers in eyes of other architects. This style was especially held in disregard by architects and historians such as Pevsner (1963), who preferred the purity of the angular International style archetype and viewed any hint of expressionism as deplorable.

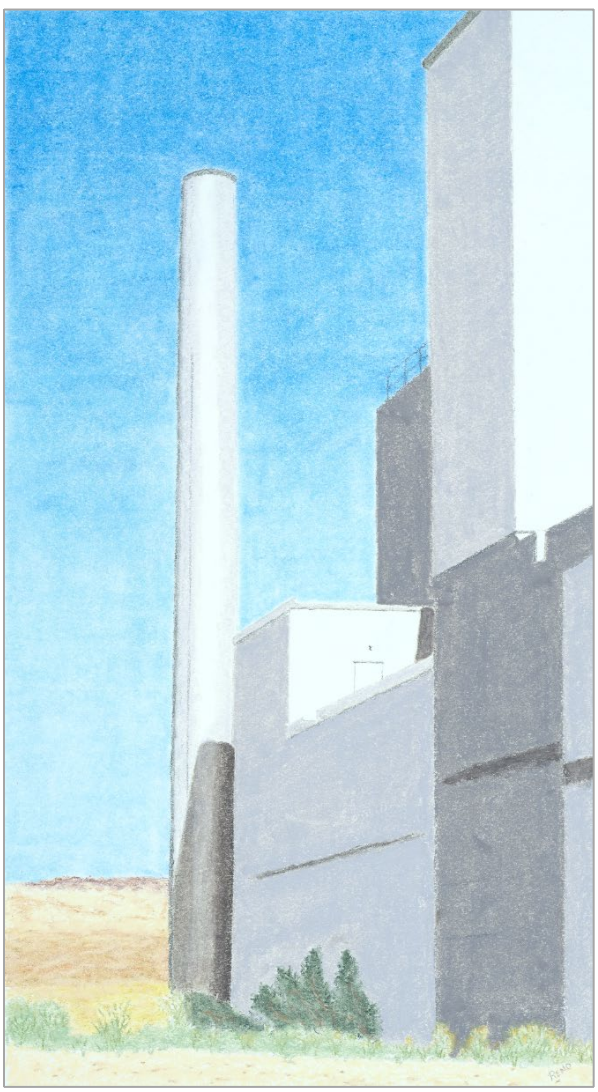
The one Streamline Moderne example touted by Whiffen (1992:243-245) and earlier by Whiffen and Koeper (1984:332-333) as a masterpiece design is Wright's late 1930s Johnson Wax Building, which is so different from the usual Moderne building as to be almost unrecognizable as sharing the type. Far more typical examples, some of which appear much like the Control Building, are the Los Angeles stores documented by Longstreth (1999:116-120, 124-125). Like most Moderne buildings, the Control Building falls into the humble category of what is perhaps best called *Common Architecture*, but after five pages of closely argued analysis of theories regarding what this kind of architecture is in relation to traditional vernacular architecture, one is inclined to agree with Upton and Vlach (1986:xv) that "A straightforward, convincing, authoritative definition has not yet been offered." Examples of these difficulties are Pevsner's only partly convincing attempt to base this distinction on *selfconscious* versus *unselfconscious* design, with only the former qualifying as serious architecture at all (Pevsner 1963: 15-17, 350-351), and Glassie's extended commentary about the concept (Glassie 2000:20-37). At any rate, the Nevada SHPO (2017) is right in discouraging use of the term *vernacular* for such buildings as this one and most others at the NNSS, despite its use by many scholars since at least the 1980s for similar unpretentious designs even when produced by architectural or engineering design firms. Such usage has expanded application of the original vernacular architecture term so widely that it has become practically meaningless.

BRUTALIST

Developed in the postwar period primarily in Great Britain and the United States, Brutalist-style buildings have a flat roof, with little or no roof overhang; cubic elements; bold recesses; often asymmetrical massing; no formal entrance; and exposed undecorated concrete or concrete masonry (Harvey 2003:2-1.21; Michael and Smith 2011; Robinson and Foell 2003:15). Nine of the standing buildings at the NRDS were identified as Brutalist, but elements of this style can easily be discerned in many of the other stylistic variations at the NRDS. Brutalism is most evident in the underlying massing of the other varieties, which are further distinguished by elaborations that are often decorative or relatively minor in nature. Because of the extreme austerity of the style's basic concept, it does not take much to de-Brutalize a building. Several of the Brutalist buildings at the NRDS, such as the J-11 Well Equipment House, portray the simplest possible concept of the style, consisting only of single cubic parallelepiped, whereas others make use of the variations of massing and other elements noted above. Examples of Brutalist Mid-century Modern architecture at the NRDS are shown in Figure 27 and Figure 28. The potential for striking sculptural effects using staggered masses is demonstrated at E-MAD in Figure 29.

Figure 27. Examples of Brutalist Mid-century Modern architecture at the NRDS.
Top: The E-MAD Building 25-3900 (B4845), north and west elevations, facing southeast (Photo 1905_1449, DRI 2019).
Bottom: The R-MAD Hot Bay, facing south (NPS 2000a).


Figure 28. Examples of minimalist Brutalist architecture at the NRDS.
Left: Communications Building 25-4101 (B19012) on the approach to Gate 500 from Mercury, facing west (Photo 2116_9612).
Right: CSA Medical Facility 25-4117 (B19013), facing northeast (Photo 2116_1070, both DRI 2021).



"THE MASTERLY, CORRECT, AND MAGNIFICENT PLAY OF MASSES BROUGHT TOGETHER IN LIGHT"

-Le Corbusier

Figure 29. Value study of E-MAD's west façade in late morning light (drawing credit, Ron Reno 2022). Additions and damage are not shown.

Although Brutalism is often out of place and dehumanizing in the wrong context (e.g., Scully 1991:352-353), it works very well in expressing at the NRDS an ethic of total concentration on mission requirements with as few distractions or elaborations as possible, an attitude taken to architectural extremes by buildings such as E-MAD (25-3900, B4845) and R-MAD (25-3110, 26NY9277). This is a style that architects used to make serious statements about the proper use of architecture and implicitly critique what had gone before. This aspect of the style was expressed by the staff of *Architectural Design* in April 1957:

> Any discussion of Brutalism will miss the point if it does not consider Brutalism's attempt to be objective about "reality"— the cultural objectives of society, its urges, its techniques and so on. Brutalism tries to face up to a mass-production society and drag a rough poetry out of the confused and powerful forces which are at work. (Quoted in Jencks 1985:257)

In this regard, it is important to remember that the style received its first extensive postwar elaboration, sometimes called New Brutalism, in Britain, which was trying to meet the need for an extensive new building program with extremely scarce resources. It is appropriate that the Brutalist buildings created at the NNSS, of which E-MAD and R-MAD are the most spectacular examples, were outgrowths of functional requirements with absolutely no attempt to make anything other than the most inexpensive building possible that would serve the immediate needs of the program.

CONTEMPORARY

Contemporary style architecture is characterized by prominent roof overhangs, a preference for flat roofs or low-pitch sheds, and the frequent use of decorative concrete masonry such as perforated or shadow-block screens and panels (McAlester 2013:629). These variegated surfaces deliberately created ever-changing shadow patterns. This was by far the most popular style of the early 1960s reconstruction of Mercury, so it is not surprising that it is represented at the NRDS as well. Only three examples of Contemporary Style architecture still stand at the NRDS. Significantly, all examples are support facilities. The Administration and Engineering Building (25-4015, B19011, Figure 30) at the Central Support Area and the New Reactor Control Point Cafeteria (25-3127, B19002, Figure 31, bottom photo) were both buildings that would have hosted important visitors. The original design of the Administration Building included some of the most elaborate landscaping, including a flagpole, constructed on the NNSS. The only other building at the NNSS where an extra effort was put into the landscape is the Mercury Cafeteria.

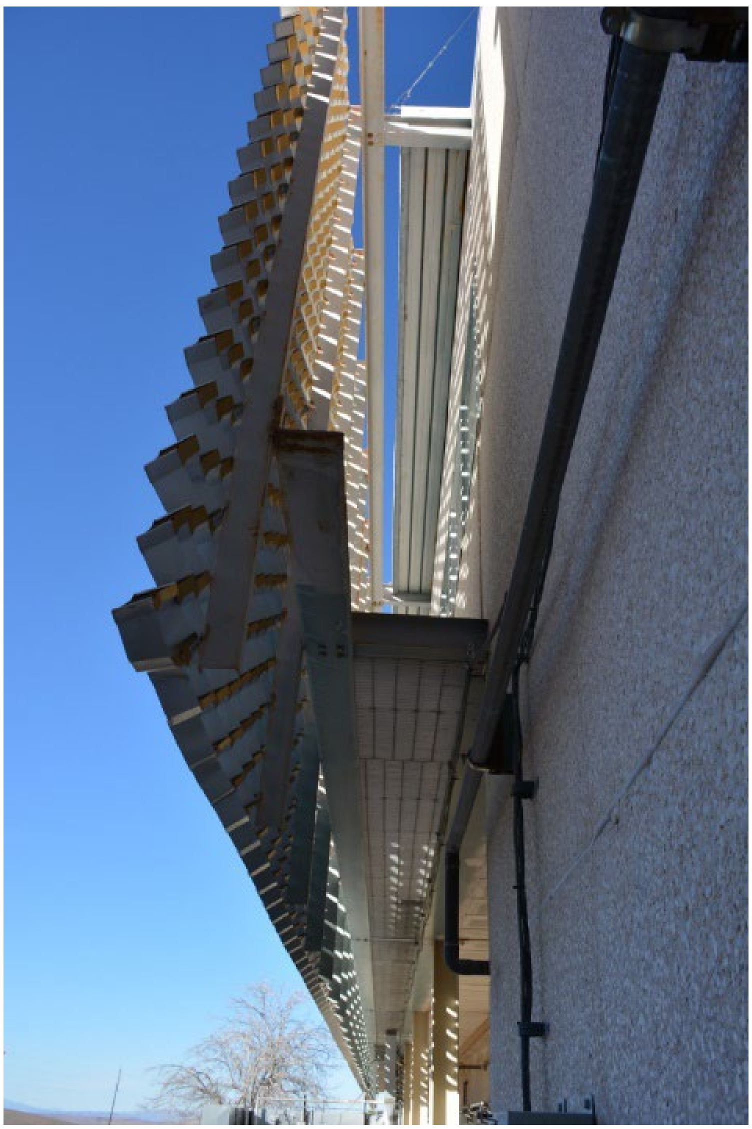


Figure 30. The best example of the Contemporary style at the NRDS.

Top: The CSA Administration and Engineering Building 25-4015, B19011, facing northeast (Photo 2116_0940).

Bottom: Detail of the aluminum brise-soleil with a precast exposed aggregate concrete wall panel in the foreground, facing upward (Photo 2116_0958, both DRI 2021).

Figure 31. Contemporary Mid-century Modern architecture at the NRDS.
Top: CSA Radiographic Facility 25-4919 (B19020) (Photo 2116_1144).
Bottom: RCP New Cafeteria 25-3127 (B19002) (Photo 2116_9476, both DRI 2021). Windows on both elevations are blocked, but their original locations are marked by protruding sills.

Architectural and Engineering Firms

Based on the research conducted for this project, 26 architectural and engineering companies contributed designs to the NRDS. Further research may reveal additional firms. Table 4 identifies the buildings or other resources designed by these companies in the NRDS. Some of the most prolific companies at the NNSS are described in more detail.

BEN BECKLER AND ASSOCIATES

Presently, the only building at the NRDS known to be designed by this prominent firm is the undistinguished addition to the RCP Control Building (25-3101, B18993).

The Los Angeles firm has the distinction of designing Warehouse 23-160, the largest building in Mercury in 1965. Other designs at Mercury include sewer improvements, a major addition to the LASL Lab 23-701 in 1967, and the LASL J-3 Division Office 23-620, which finally ended that division's need to occupy various temporary spaces throughout Mercury. Other projects at the test site included a lab and warehouse at the Area 6 Control Point complex in 1965 and a major remodel of that area's main building (CP-1) in 1971. Originally established in 1950 as Kewell, Kocher & Benedict, the firm went through a rapid series of name changes as principals came and went. Beckler joined the firm in 1953, and by approximately 1962, the firm acquired its final name of Ben Beckler and Associates.

The firm designed many Wherry and Capehart housing complexes for the Air Force and Navy in California and Hawaii, along with nonresidential base buildings at Auxiliary Air Station Mojave in 1954. Their Modern residential designs and community plans compared favorably with the best of civilian suburban development of the time. They also designed many commercial buildings and created master plans (Moore et al. 2010:49-50; Reno et al. 2016).

Table 4. Firms Involved in the Architectural Design of Buildings at the NRDS.

FIRM	LOCATION	PROJECTS*
Aerojet General Nucleonics, Aetron Division (Aerojet)	Covina, CA	**ETS-1**: Overall Design, 25-3310, 25-3312, 25-3320[B], 25-3324, 25-3330, 25-3340, 25-3350, TS5, Seismic Bracing
Air Products, Inc.	Allentown, PA	**TCC**: 25-3210, 25-3214, 25-3220, 25-3230-32
Behrent Engineering Co.	Denver, CO	**ETS-1**: TS8
Ben Beckler & Assoc. Architects & Engineers	N. Hollywood, CA	**RCP**: 25-3101 addition[B]
Bryant, Jehle & Assoc. Architects & Engineers	El Centro, CA	**TCC**: 25-3229
Burns & McDonnell Engineering Co.	Kansas City, MO	**RCP**: 25-3101[S], 25-3102 to 25-3107, 25-3108[M], 25-3122, 25-3123[M], RCP2 **R-MAD**: 25-3110[B] **TCA**: 25-3113[B], 25-3109[B], 25-3115, 25-3116, 25-3133 **Other**: 25-4101[B]
Butler Manufacturing Co. (Butler)	Kansas City, MO	**CSA**: 25-3121 AR2, 25-4224A (25-4222 AR2) **RCP**: 25-3103, 25-3105, 25-3106, 25-3107, 25-3122, 25-3128 **TCA**: 25-3115
Catalytic Construction Co. (CATCO)	Philadelphia, PA	**ETS-1**: 25-3319 **R-MAD**: Jr. Hot Cell [no remnant remains]
Chicago Bridge & Iron Co.	Chicago, IL	**ETS-1**: TS9 **TCC**: 500K-gallon dewars
Edward B. Hendricks Assoc.	Las Vegas, NV	**CSA**: 25-4226 (25-4222 AR3), 25-4838, 25-4919[C]
Flatow, Moore, Bryan & Fairburn	Albuquerque, NM	**RCP**: 25-3103 addition **R-MAD**: 25-3111, 3126 **TCC**: Camera Tower, Camera Bunker
Garland Steel Co.	Phoenix, AZ	**ETS-1**: TS9
Holmes & Narver, Inc. A.E.C. Facilities Division	Los Angeles, CA	**CSA**: 25-4014, CS6, **RCP**: 25-3128, 25-3129[M]
J.A. Blume Associates	San Francisco, CA	**ETS-1**: Seismic Bracing
Ken R. White Consulting Engineers	Denver, CO	CSA: 25-4015[C], 25-4221

(Table 4 is continued on the next page.)

(Table 4 is continued from the previous page)

FIRM	LOCATION	PROJECTS*
Los Alamos Scientific Laboratory Engineering & Construction Group (J-6) (LASL)	Los Alamos, NM	**RCP**: 25-3103 addition, RCP7 **TCA**: TCA2, TCA3 **TCC**: Overall Design, 25-3210 ARs, 25-3226, 25-3228
Norman Engineering Co.	Los Angeles, CA	**CSA**: 25-4215[C], 25-4222, 25-4226A[B] (25-4222 AR4), 25-4320, 25-4517[M]
Pan American World Airways Inc. Support Services Contractor	New York, NY, and Miami, FL	**CSA**: 25-4320 AR2, 25-4838, 25-4839 **ETS-1**: TS8 **RCP**: 25-3105 addition, RCP4, RCP5, RCP9, RCP10 **RMSF**
Reynolds Electrical and Engineering Co. (REECo)	Las Vegas, NV and others	**ETS-1**: TS1 **Gate 500 vicinity**: 25-3152[M], 25-3153[M], NRDS1 **RCP**: 25-3151, RCP1 **TCA**: TCA2, TCA3 **Other**: 25-4101, NRDS 4[B], Modifications of resources throughout district
Rogers Engineering	San Francisco, CA	**ETS-1**: Seismic Bracing
Space Nuclear Propulsion Office, NERVA Test Operations		**ETS-1**: 25-3312, 25-3330[B], 25-3331, TS5
Stran Steel Corp.	Detroit, MI	**TCC**: 25-3230 to 25-3232
T. Morrissey, Consultants	Denver, CO	**ETS-1**: TS8
Walter F. Zick – Harris P. Sharp Architects-Engineers Inc.	Las Vegas, NV	**CSA**: 25-4522, 25-4320 AR1, **RCP**: 25-3127[C]
William M. Fairhall & Assoc.	Las Vegas, NV	**CSA**: 25-4314[B]
Vitro Engineering Co.	New York, NY	**E-MAD**: 25-3900, 25-3901 **RMSF**

*Letters in brackets after the building number indicate styles if applicable: B-Brutalist, C-Contemporary, M-generic Mid-century Modern, S-Streamline Moderne.

HOLMES & NARVER, INC.

Holmes & Narver, Inc. was active from the initial construction of what is now the NNSS through the end of the Cold War. Included in this work are at least four buildings at the NRDS (see Table 3). This work was part of Contract 20, which was the longest running single contract ever administered by the U.S. government. James T. Holmes and D. Lee Narver started the firm in 1933 in Los Angeles to repair numerous earthquake-damaged buildings. The firm entered the realm of government-base architecture in 1940 with the designs of Camp Roberts and Camp Nacimiento for the Army, followed by several wartime military bases. The design of the nuclear test facility at Eniwetok in 1947 foreshadowed its role in designing the new base camp of Mercury in 1951. The firm was extremely active during the Cold War with projects including facilities at Naval Air Weapons Station China Lake, Douglas Aircraft, and overseas military bases. An example of a 1960 design at the NNSS is the Records Library

(23-310). In 1985, the DOE contract for NNSS facilities reached 400 million dollars. During this period, the firm designed the striking 23-531 to 536 series of dormitories and the Photographic Support Building 23-614 at Mercury. Much of the work, Inc. did at Mercury and at the rest of the site was the unglamorous job of perpetually altering buildings to keep pace with changing mission requirements (Reno et al. 2016). In Mercury, this kind of work also included the modifications to the Chapel (23-550), which lost some of its distinguishing original design elements because of the alterations. The firm also designed buildings at Area 12 Camp.

Although the military-related contracts were central to the work performed by Holmes & Narver, Inc., the firm also had significant civilian commissions, such as the 1958 TWA terminal at Los Angeles International Airport. The firm ceased to exist as an independent firm in 2001. It was acquired by Daniel, Mann, Johnson & Mendenhall, which in turn was acquired by AECOM (Moore et al. 2010:189-190; *NTS News* 1983).

REYNOLDS ELECTRICAL AND ENGINEERING CO. (REECO)

REECo designed all or parts of several buildings scattered about the NRDS. The firm was ubiquitous in operational maintenance at the NNSS from 1952 until the company was dissolved in 1995. It was a subsidiary of Edgerton, Germeshausen, and Grier, Inc., which separately had a research-oriented role at the NNSS. The REECo design team developed plans for an immense number of small projects throughout the site and for constant modifications of existing facilities required by changing program needs.

Construction Contractors

Construction contractors were putting in the primary roads, railroad tracks, and electrical and water distribution systems from 1957 into early 1959. The Reactor Control Point area and the R-MAD facilities were the first complexes to be built. Construction continued at a rapid pace, and the first nuclear rocket engine test, Kiwi-A, occurred on July 1, 1959.

The construction of some buildings at the NRDS required very special expertise. Aerojet had several years of experience developing rockets and other propulsion systems, which made the company a good choice for construction of the Engine Test Stand 1. The main building at Test Cell C was built by Catalytic Construction, an experienced builder of plants for a variety of industries, including the nuclear industry. A list of construction firms identified during preliminary research is below in Table 5.

The architectural type for traditional residential architecture can usually be identified by a combination of building form and plan (Carter 2015; Carter and Goss 1988; Hubka 2013; Wyatt 1987). This approach does not work for the architecture at the NNSS where nearly all buildings would be classified as "Other" from this perspective. This is particularly the case because many of the buildings were constructed in such a way as to allow free movement of interior partitions to accommodate a variety of different uses and changes through time.

Table 5. Examples of Firms Involved in the Construction of Buildings and Infrastructure at the NRDS.

FIRM	LOCATION	PROJECTS*
A.D. Schader Company	San Francisco, CA	**Railroad**: Mainline and spurs between R-MAD and TCA, Jackass and Western Extension and Spurs to E-MAD, ETS-1 and RMSF
Aerojet General Nucleonics, Aetron Division (Aerojet)	Covina, CA	**ETS-1**: 25-3310, 25-3312, 25-3320, 25-3324, 25-3330, 25-3340, 25-3350, TS5
Air Products, Inc.	Allentown, PA	**TCC**: 25-3210, 25-3214, 25-3220, 25-3230-32
Behrent Engineering Co.	Denver, CO	**ETS-1**: TS8
Ben Beckler & Assoc. Architects & Engineers	N. Hollywood, CA	**RCP**: 25-3101 addition
Bryant, Jehle & Assoc. Architects & Engineers	El Centro, CA	**TCC**: 25-3229
Burns & McDonnell Engineering Co.	Kansas City, MO	**RCP**: 25-3101, 25-3102 to 25-3107, 25-3108, 25-3122, 25-3123, RCP2 **R-MAD**: 25-3110 **TCA**: 25-3113, 25-3109, 25-3115, 25-3116, 25-3133 **Other**: 25-4101
Butler Manufacturing Co. (Butler)	Kansas City, MO	**CSA**: 25-3121 AR2, 25-4224A (25-4222 AR2) **RCP**: 25-3103, 25-3105, 25-3106, 25-3107, 25-3122, 25-3128 **TCA**: 25-3115
Catalytic Construction Co.	Philadelphia, PA	**ETS-1**: 25-3319 **R-MAD**: Jr. Hot Cell [no remnant remains] **TCC**: 25-3210
Chicago Bridge & Iron Co.	Chicago, IL	**ETS-1**: TS9 **TCC**: 500K gal Dewars
C.T. Parker Construction Co. aka Charles T. Parker	North Las Vegas, NV	**Road**: U.S. 95 at Lathrop Well to NRDS CSA
Edward B. Hendricks Assoc.	Las Vegas, NV	**CSA**: 25-4226 (25-4222 AR3), 25-4838, 25-4919
Flatow, Moore, Bryan & Fairburn	Albuquerque, NM	**RCP**: 25-3103 addition **R-MAD**: 25-3111, 3126 **TCC**: Camera Tower, Camera Bunker
Fred Galante and L.B. Wells Construction Co.	Visalia, CA	**Roads**: Jackass Flats access road (AKA Road 'A')
Garland Steel Co.	Phoenix, AZ	**ETS-1**: TS9
Hansen Plumbing and Heating Co.	Las Vegas, NV & San Bernardino, CA	**Water System**: Distribution System
Holmes & Narver, Inc. A.E.C. Facilities Division	Los Angeles, CA	**CSA**: 25-4014, CS6 **RCP**: 25-3128, 25-3129
I.L. Croft and Son, Inc.	Saugus, CA	**Roads**: secondary roads between facilities
J.A. Tiberti Construction Company	Las Vegas, NV	**RCP**: 25-3101, 25-3102, 25-3103, 25-3104, 25-3105, 25-3106, 25-3107, 25-3108

(Table 5 is continued on the next page.)

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FIRM	LOCATION	PROJECTS*
Ken R. White Consulting Engineers	Denver, CO	**CSA**: 25-4015, 25-4221
Los Alamos Scientific Laboratory Engineering & Construction Group (J-6) (LASL)	Los Alamos, NM	**RCP**: 25-3103 addition, RCP7 **TCA**: TCA2, TCA3 **TCC**: Overall Design, 25-3210 ARs, 25-3226, 25-3228
Mahout Construction Co.	CA	**ETS-1**: Test Stand
Norman Engineering Co.	Los Angeles, CA	**CSA**: 25-4215, 25-4222, 25-4226A (25-4222 AR4), 25-4320, 25-4517
Pan American World Airways Inc. Support Services Contractor		**CSA**: 25-4320 AR2, 25-4838, 25-4839 **ETS-1**: TS8 **RCP**: 25-3105 addition, RCP4, RCP5, RCP9, RCP10 **RMSF**
Perry Brothers Drilling Co.	Flagstaff, AZ	**Water System**: Water Wells J-11 and J-12
Petroleum Combustion and Engineering Co.	Los Angeles, CA	**TCA**: 25-3113, 25-3113A; Tank Farm; Moveable Shed, Tunnel Head House, Access Tunnel
Pittsburg - Des Moines Steel Co.	El Monte, CA	**RCP**: Elevated Water Tank **R-MAD**: Elevated Water Tank **TCA**: Elevated Water Tank
Reynolds Electrical and Engineering Co. (REECo)		**ETS-1**: TS1 **Gate 500 vicinity**: 25-3152, 25-3153, NRDS1 **RCP**: 25-3151, RCP1 **TCA**: TCA2, TCA3 **Other**: 25-4101, NRDS 4, Modifications of resources throughout district
Sierra Construction Company	Las Vegas, NV	**R-MAD**: 25-3
Space Nuclear Propulsion Office, NERVA Test Operations		**ETS-1**: 25-3312, 25-3330, 25-3331, TS5
Stran Steel Corp.	Detroit, MI	**TCC**: 25-3230 to 25-3232
T. Morrissey, Consultants	Denver, CO	**ETS-1**: TS8
Walter F. Zick – Harris P. Sharp Architects-Engineers Inc.	Las Vegas, NV	**CSA**: 25-4522, 25-4320 AR1, **RCP**: 25-3127
William M. Fairhall & Assoc.	Las Vegas, NV	**CSA**: 25-4314
Vitro Engineering Co.	New York, NY	**E-MAD**: 25-3900, 25-3901 **RMSF**

Functional Architectural Types

The architectural type for traditional residential architecture can usually be identified by a combination of building form and plan (Carter 2015; Carter and Goss 1988; Hubka 2013; Wyatt 1987). This approach does not work for the architecture at the NNSS where nearly all buildings would be classified as “Other” from this perspective. This is particularly the case because many of the buildings were constructed in such a way as to allow free movement of interior partitions to accommodate a variety of different uses and changes through time.

Mission-related buildings are usually constructed to meet specific technical requirements rather than to conform with any kind of general layout. For inventory purposes, it was considered more useful to develop a functional typology specific to the collection of buildings and structures at the NRDS. These types are identified at both general and specific levels in Table 6. Examples of each type at the NRDS are also presented in the table. With extensive enhancements and some changes, these types are based on those presented in *Master Plan Mercury, Nevada* (ABA 1962) as revised for the Mercury Historic District (Reno et al. 2018:48-86), Test Cell C Historic District (Reno et al. 2019b), and Area 12 Camp Historic District (Reno et al. 2021a). These types include examples of buildings, structures, and landscapes.

Table 6. Examples of Resources at the NRDS by Function Type.

General Property Type	Specific Property Type	Examples
MISSION FACILITIES		
Command & Control	RCP Control Building	25-3101
	Local Control Center	25-3110, 25-3220, 25-3310, 25-3331, 25-3900, R-MAD Test Control Building (no number)
Test Stand	Reactor Test Cell	25-3113, 25-3210
	Engine Test Stand 1	25-3350
	Camera Station	25-3226, NRDS7, TCA2, TCA3
	Camera Tower	NRDS7
	Tunnel	25-3312
	Gas Tank/Tank Farm	25-3330
	Misc. Facility/Structure	Accessory Resources
Test Support	Maintenance, Assembly, and Disassembly	25-3900, 26NY9277
	Reactor Mockup	NRDS10
	Technical Shop	25-4215
	Central Propellant Area	25-4839
Test Lab	Engine Test Laboratory	25-3124
Conventional Missile Test Facility	MX Trial Launch Facility	RM3
GENERAL SUPPORT FACILITIES		
Administration	Administration Building	25-3104, 25-3129, 25-4015
Construction	Debris Dump	Accessory Resources
	Compound	Accessory Resources
	Borrow Pit	Noted, not formally recorded
General Maintenance	Shop	25-3128, 25-3319, 25-4215, 25-4222, TS7
Motor Pool	Fuel/Lubricant Tank	Accessory Resources
	Fuel Pumps/Service Station	25-3107
	Vehicle Maintenance Building/Structure	25-4838, RCP4, RCP5
	Vehicle Scales	Accessory Resources
Radiation Control	Radiation Monitor	TCA1, TCC1
	Radiation Safety/Study	25-3152, 25-4314, 25-4919
	Radioactive Storage	RMSF, RM1
	Radiological Trailer	Accessory Resources

(Table 6 is continued on the next page.)

(Table 6 is continued from the previous page.)

General Property Type	Specific Property Type	Examples
GENERAL SUPPORT FACILITIES continued		
	Radiography Compound	25-4517
	Decontamination	TS5, Accessory Resources
	Radioactive Effluent	Accessory Resources
Science and Research	Lab/Office	25-4215
	Research Facility	25-3123, 25-4215
	Research Materials Storage	25-4221, 25-4320
	Test Plot	NRDS9
	Weather Tower	NRDS8
	Weather Station	25-3151, 25-4522
	Drill Hole	Accessory Resource
Security (and Safety)	Security Perimeter/Gate	NRDS1
	Security Training Facility	CSA, RCP, ETS 1
	Guard Hut	25-3108, 25-3108A, TS1, TS6
Surveying	Survey Office	25-4919
	Instrument Station	25-3151 AR2, CS6
	Benchmark/Survey Stake	Accessory Resources
Warehousing/Storage	Storage Building	Accessory Resources
	Storage Structure	Accessory Resources
	Storage Yard	Accessory Resources
	Warehouse Building	25-3103, 25-3106, 25-3111, 25-4014, 25-4221, 25-4320
RESIDENTIAL FACILITIES		
Housing	Trailer Park*	RCP1, RCP10
Public Services	Cafeteria	25-3105, 25-3127, CS1
	Fire Department	25-3153
	Restroom	Accessory Resources
	Industrial Hygiene	Accessory Resources
	Medical Building	25-4117, 25-3105, 25-4314
	Wash House	Accessory Resources
	Change House	Accessory Resource
Recreation	Break Patio	Accessory Resource
	Horseshoe Pit	Accessory Resource
	Park	Accessory Resource
UTILITIES**		
Electrical Utilities (Power, Communication, Lighting)	Aboveground Lines	NRDS3, NRDS13
	Communications Building	25-4101, 25-5004
	Communications Trailer	CS7
	Electrical Box	Accessory Resources
	Vault	Accessory Resources
	Light Pole	Accessory Resources
	Power Plant	25-3102, 25-3324
	Radio Aerial	25-4101 AR3, CS7 AR1
	Antenna	Accessory Resource
	Microwave Antenna	CS9
	Substation	25-3300, CS3, NRDS4, RCP6, TS3

(Table 6 is continued on the next page.)

(Table 6 is continued from the previous page.)

General Property Type	Specific Property Type	Examples
UTILITIES continued		
	Tower	CS9
	Underground Lines	NRDS3, NRDS13
Heating/Cooling	Boiler Building	25-3320
	Mechanical Building	25-3320
	Air Handler (HVAC etc.)	Accessory Resources
	Propane Tank	Accessory Resources
Sewage	Lagoon	RCP11, TCC5
	Leach Field	Accessory Resources
	Pipeline	Accessory Resources
	System	CS4, RCP11, TS4
Water	Stormwater Drainage	Accessory Resources
	Deluge System/Storm Drainage	TS5
	Storm Drainage	RM2
	Tank	NRDS3, TS9
	Pipeline	NRDS5
	Fire System	Accessory Resources
	Pump House	25-3122, TS2
	Equipment House	Accessory Resources
	Treatment	Accessory Resources
	Well	25-3121
	Reservoir	25-3121 AR5
	Water Tower	RCP2
CIRCULATION		
Vehicular Transportation	Road	NRDS2
	General Parking	Accessory Resources
	Loading Ramp/Dock	CS5
Railroad	Main Line	26NY14637
	Spur, Wye	E-MAD, ETS-1, R-MAD, RMSF, TCA, TCC
	Locomotive	E-MAD L4, L5, MCC, RMSF Accessory Resources
	Installation Car	E-MAD EIV, RMSF Accessory Resources
	Test Car	RMSF Accessory Resources
	Flatcar	E-MAD F5, F6, F7, RMSF Accessory Resources
	Switch Equipment	Accessory Resources
	Funicular	25-3214
Air Transportation	Heliport	CS2, RCP3 AR1
	Hangar	RCP3
	Windsock	Accessory Resources
OTHER		
Other	Flagpole	Accessory Resources
	Access Tunnel	25-3312
	Central Propellant Area	25-4839
	Trailer Pad/Park *	NRDS6, RCP4, RCP7, TS8

* As used at the NNSS, "trailers" also refers to single-wide portable buildings on wheels, with wheels removed, or built on skids and transported on flatbed trailers.
** Underground systems include a variety of standpipes, sweeps, cellars, and manholes to surface, along with signage.

MISSION FACILITIES

Command & Control

Two factors created a need for centralized command and control facilities. The first was the nature of the testing process itself, which had extensive and varied personnel and facilities that had to be orchestrated to create successful test outcomes rather than chaos. The second was the dangerous nature of the tests themselves, which required establishment of remote-control buildings or specialized control rooms at safe distances from the actual test locations. The Control Building 25-3101 (B18993, Figure 32) in the RCP area held the principal control room along with supporting technical control rooms in a similar manner to the arrangement at CP1 for explosive nuclear tests elsewhere on the NNSS (Reno et al. 2016). Additional local control centers were present at the test stands and assembly and disassembly buildings. These facilities are discussed in more detail below since they constitute one of the character-defining features of the NRDS Historic District.

Figure 32. The RCP Control Building 25-3101 (B18993), facing northwest (Photo 2116_9300, DRI 2021). In the foreground extending over the roof is the overhead crane for moving equipment into and out of the basement.

Test Stand

There are two types of hot test stands at the NRDS. The two earliest are Test Cell A (Figure 33) and Test Cell C (Figure 34), which are both similar in design. Engine components, pumps, and fuel are arranged horizontally in what was called a *breadboard* configuration, which allowed maximum flexibility in altering the various components as tests progressed. These components, along with a variety of other facilities, were protected behind a concrete barrier wall from the place where the reactor was installed. The reactor and nozzle were mounted upside down on a specialized railroad test car which docked onto supplemental raised rails on the ground zero concrete test slab by means of wheeled outriggers. See Chapter 5 for photographs of some of the reactors installed at the test cells.

Figure 33. The Test Cell A Building before demolition, facing northwest (Beck et al. 2000, Photo 1). The shorter structure at left is the tunnel entrance. The hydrogen flare stack is at right.

Figure 34. The Test Cell C Building before demolition, facing south (photo credit RSL c. 1967).

The last hot test stand is Engine Test Stand 1 (Figure 35). Since it was designed to test the reactor, nozzle, turbopump, and fuel tank in actual flight configuration it appears much more like a typical rocket launch stand with its tall metal support tower (see cover photo). Like the others, it has local support buildings and structures protected behind a concrete barrier. It makes far more use of underground facilities than the earlier test stands.

Figure 35. Engine Test Stand 1 and a portion of its Tank Farm, facing north-northwest (Photo 2116_9952, DRI 2021). The concrete radiation barrier wall is the pink part of the structure, mostly hidden behind the stairway and piping.

<u>Test Support</u>

The most spectacular remaining direct mission support buildings were the two looming Brutalist Maintenance, Assembly, and Disassembly Buildings. The older R-MAD building has been demolished but the larger E-MAD remains. Both buildings are the locations where test components arrived by truck, were assembled in a large cold bay, sent to the test stands by rail, and finally disassembled by remote control in elaborate shielded hot bays for post-mortem (post-test) analysis and finally packaging for long term storage of radioactive components (see Figure 27).

There were also other minor facilities directly related to technical test support. Of these the most striking visually is the Phoebus engine mockup near E-MAD (see inside cover photo).

Test Lab

Components were tested in buildings all over the district, but the principal buildings devoted largely or entirely to this purpose are the Engine Test Laboratory 25-3124 (B19001) at Test Cell A and the Technical Services Building 25-3123 (B19000) at the Reactor Control Point (Figure 36). At the latter building each laboratory opened onto a common loading dock and each also had its own office space.

Figure 36. Equipment and component test laboratories at the NRDS.
Top: Engine Test Laboratory 25-3124 (B19001) at Test Cell A, facing north-northwest (Photo 2116_1962). At the left is a low shield wall with high pressure gas tanks beyond. At the right are connections to the Test Cell A gas tank farm.
Bottom: Technical Services Building 25-3123 (B19000) at the Reactor Control Point, facing southwest (2116_9333, both DRI 2021). Each lab has double doors (several now blocked but locations are indicated by overhead lights) opening onto loading docks.

Conventional Missile Test Facility

The unique MX Trial Launch Facility was constructed at the west end of the R-MAD facility (Figure 37). Prior to its demolition, the R-MAD Building stood directly behind the towers shown in the figure, which were built on the abandoned railroad spurs leading into the older facility. Other MX launch test facilities outside the NRDS Historic District are entirely different, with the emphasis on subsurface emplacement.

Figure 37. The MX Trial Launch Facility, facing south-southeast (Photo 2116_2024, DRI 2021). The enclosed tower held the missile launch canister. The two skeletal steel towers were for photography.

Each of the general functional types had its own distinctive distribution throughout the NRDS. Mission Facilities were concentrated at the Reactor Control Point, the two maintenance, assembly, and disassembly complexes, and the three Test Stands. General Support Facilities were most heavily concentrated at the Central Support Area but were present to some extent throughout the entire district. The extremely limited Residential Facilities within the district were at the Reactor Control Point. Most housing was at Mercury or off-site. Circulation and Utilities had a distinctive spider-web-like distribution linking the eight major activity centers and several lesser activity areas at the NRDS.

GENERAL SUPPORT FACILITIES

Administration

By far the most impressive administrative building in any of the forward areas of the NNSS is the Administration and Engineering Building (25-4015, B19011) at the Central Support Area (Figure 38, see also Figure 30). Less imposing buildings are the Administration Building 25-3104 (B18995) (see Figure 21, bottom right photo) and the Technical Operations Building 25-3129 (B19003, see Figure 24, top photo) at the Reactor Control Point.

Figure 38. The CSA Administration and Engineering Building 25-4015 (B19011), facing northwest (Photo 2116_0932, DRI 2021).

Construction

Construction-related resources are still present in the district. The most obvious ones are the borrow pits scattered about the landscape, several of which have been re-used for burying contaminated waste. They are best seen on aerial photos, but a large example at the west side of the Reactor Control Point is clearly visible in the top image of Figure 39. Riprap has been installed in edges of the pit where drainages enter it to prevent downcutting into adjacent parking areas and driveways.

A compound originally created for staging construction equipment and for construction company trailers (B19026 AR2) is next to the front entrance to the Engine Test Stand 1 security perimeter. There are also piles of abandoned construction materials and concrete dumps such as the one in the maintenance yard at 25-4222 (B19015) in the Central Support Area.

A peculiar construction site is the equipment assembly area. The contractor responsible for assembling the last generation of huge spherical liquid hydrogen dewars for Test Cell C chose to build them on relatively level ground adjacent to Road H and then skid them a mile and a half uphill to the test cell. Both the construction site and skid trail are identifiable in aerial photographs. A similar disturbance pattern is on the same major road below ETS-1. Although not field verified, it is likely that another such assembly area and skid trail exist there for construction and moving of an identical dewar up to the ETS-1. In both cases, the test stands are in areas with severe topographical constraints making it easier to assemble the massive complex components elsewhere.

Figure 39. Construction-related resources.
Top: Borrow pit along the west side of the Reactor Control Point, facing east (Photo 2116_9879).
Bottom: Construction Compound B19026 AR2 at ETS-1, facing east-northeast (2116_0482, both DRI 2021).

General Maintenance

There are several general maintenance facilities throughout the district. The largest is the Maintenance Shop 25-4222 (B19015) at the Central Support Area, which had several outbuildings for specific purposes (Figure 40). The buildings and trailers that once made up the extensive maintenance area in the southwest corner of the Reactor Control Point have all been removed, although several foundations and other features, such as a Washdown Sump, remain in place.

Figure 40. The CSA Maintenance Shop 25-4222 (B19015), facing northeast (Photo 2116_1118, DRI 2021).

Motor Pool

The largest motor pool building at the NRDS is the Vehicle Maintenance Building (25-4838, B19019) and its associated fuel pumps at the Central Support Area (Figure 41). It was not necessary to be equipped for all kinds of vehicular repair here because the much larger facility at Mercury was also available. Other related resources include foundations of the tiny Service Station (25-3107, S3120) at the Reactor Control Point and Vehicle Scales for vehicles unloading gases at ETS-1 (25-3330, B19007 AR2).

Figure 41. The CSA Vehicle Maintenance Building 25-4838 (B19019, facing east-southeast (Photo 2116_1254, DRI 2021). The dark brown paint is recent.

Radiation Control

Concern over radioactive contamination of materials on site, hazards to site workers, and radioactive fallout over the NRDS and surrounding areas became more and more of a concern through time and continues to the present (Dewar 2004 Appendix C, Preston 2005:244-245). It is intimately interrelated to research concerning the behavior of contaminants over time. Evidence of radiation monitoring and controls are found throughout the NRDS. The most impressive controls are the circular radiation monitoring arrays surrounding the two test cells. The Test Cell A Array (C400) extends in four rings to 6,000 feet from the test location. The Test Cell C Array (C401) also has four rings but extends even farther, to 8,000 feet from the hot test stand. These arrays are best seen on aerial photos. A variety of low-tech fallout collectors are preserved around them (Figure 42). Collectors consisting of only metal sheets nailed to the ground were observed in the main Test Cell C complex (Reno et al. 2019b).

Figure 42. Examples of radioactive fallout collectors at C400 (top) and C401 (bottom).
Top: Mortarboard (Photo 2116_1694 [*left*]), sandbox with displaced inverted hopper collectors (2116_2272 [*right*]).
Bottom: Raised bucket (2116_2509 [*left*]) and entrenched bucket collectors (2116_2489 [*right*], all DRI 2021).

In addition, monitors of radiation levels in real time were installed throughout the NRDS. Several examples remain at E-MAD and presumably at other facilities as well. An example from Engine Test Stand 1 is shown in Figure 43.

Figure 43. A radiation monitor at the Engine Test Stand 1 Tunnel entrance 25-3312 (S3124) (Photo 2116_0502, DRI 2021).

Radiation safety and study was conducted as several specially designed facilities. One aspect of these places was a heavily shielded portion of the building for radioactive samples or contaminated equipment. A good example of this is the shielded bay with double doors in Figure 44, which is part of the CSA Radiographic Facility 25-4919 (B19020). Radiography compounds were present at both Test Cells but no longer exist. They had a small heavily shielded concrete structure located in the center of a large exclusion zone. Well preserved compounds of this kind are present in Mercury and at the Area 1 Subdock Historic District (Collins et al. 2021).

Figure 44. The Radiographic Bay at Building 25-4919 (B19020) has formed concrete walls up to 1 foot and 8 inches thick, image facing southeast (Photo 2116_1148, DRI 2021).

Except for reactor cores, which were sent to another facility for reprocessing, contaminated materials generated at the NRDS remain on site in a variety of repositories (Figure 45). The largest repositories are the extensive buried radioactive waste dump at RM1 adjacent to R-MAD and the mostly aboveground Radioactive Material Storage Facility. Smaller contaminated landfills include those generated from the demolition of R-MAD and Test Cell A. In a special case, radioactive construction debris from the demolition of the main building at Test Cell C was buried in the basement of that building (Figure 46). Radioactive effluent remains in various controlled locations. The historical effluent system at E-MAD was particularly complex, involving the use of contamination holding tanks at the building prior to releasing it into the outlying tile field. There is also evidence that waste was hauled to E-MAD by rail and buried outside the compound.

Figure 45. Radioactive material repositories at the NRDS.
Top: Resource C399 at R-MAD, facing south-southeast (Photo 2116_2068).
Middle: Buried construction debris and other waste at R-MAD, facing northwest (2116_2073).
Bottom: Radioactive Material Storage Facility, facing east-northeast (2116_2295, all DRI 2021).

Figure 46. The concrete slab covering the contaminated materials pushed into the basement of the demolished Test Cell C Building 25-3210 (B2444), facing southwest (Photo 1968_0446, DRI 2019).

Several decontamination pads are present for motor vehicles and railroad rolling stock. All are concrete with provision for removing contaminated wash water underground to a nearby leach field, sump, or wash. These are located on the approaches to the test stands, Reactor Control Point, and the E-MAD and R-MAD facilities. An additional pad is at the rear of the Rad-safe Building foundation near the fire station (Figure 47). Where these facilities were away from permanent buildings, they had associated Rad-safe trailers.

Science and Research

Because the focus of activities at the NRDS was related to research designed to expand the boundaries of applied science, this function category is applied here for resources that were predominantly used for research undertakings. As noted above, the RCP Technical Services Building (25-3123, B19000) is a superbly designed research center with its row of individual laboratories, each with its own loading dock and associated office space (see Figure 36).

In addition to providing space for the rocket development program, NRDS Warehouses 1 and 2 (25-4221, B19014; 28-4320, B19017) at the Central Support Area were reused for the storage of cores collected for analyzing the subsurface geology of Yucca Mountain.

Research into local weather patterns was an essential element of NRDS operations. Weather stations and towers dating to the Cold War within the district are now represented only by foundations. A few of the stations installed during the latter part of the Cold War are still in operation.

Fenced and unfenced plots used by the Civil Effects Testing Organization (CETO) to monitor radiation effects on flora and fauna are scattered throughout the NNSS. Two such plots were identified: one (C393) near the Sandia Compound and the other adjacent to the Radsafe building foundation (25-3152, S3123) near Gate 500. Trailers were also used for research purposes, such as the one that housed the Metallography Lab. The final research facility noted is the cluster of drill holes of unknown purpose in the Central Support Area. Laboratory spaces in buildings with other primary functions included the Cryogenics Evaluation Lab in building 25-3232 (B18114) and the Oil Testing Lab, both at Test Cell C, the Neutronics Laboratory in the RCP Control Building (25-3101, B18993), and the Tracer Laboratory at the E-MAD Building (25-3900, B4845).

Figure 47. Radioactive decontamination pads.
Top: Vehicular pad adjacent to the road to Engine Test Stand 1, facing south (Photo 2116_0304, DRI 2021).
Middle: At right is the decontamination pad for the Radsafe Building 25-3152 (S3123), facing west-southwest (2116_1628, DRI 2021).
Bottom: Pad for cleaning railroad rolling stock entering E-MAD, facing north (Photo RSL 5-00208-D04_0162).

Security and Safety

The all-pervasive security system at the NRDS kept unauthorized people out to protect the sensitive equipment from damage and dangerous substances from theft for nefarious purposes. It also played an important role in keeping unwary workers from entering areas where they could suffer great harm. The mechanisms of this security system were time-tested perimeter fences and lighting, warning signs and beacons, and guard stations. Much of the post-NRDS era has seen an additional important security component – the training of security forces for coping with ever-changing threats. A sample of these components of the security system, including present use of patrol robots, is presented in Figure 48.

Figure 48. Security measures at the NRDS.
Top: Guard station at Engine Test Stand 1, facing southeast (Photo 2116_0290, DRI 2021 [*left*]); warning beacon at E-MAD (0929_0027, DRI 2009 [*middle*]), recent sign at the CSA (2116_1442, DRI 2021 [*right*]).
Bottom: Signs on the TCA perimeter fence (2116_1938, DRI 2021).

Surveying

The NRDS is a professionally designed landscape. Aside from minor and usually temporary elements, everything was built according to a formal plan. These elements were placed into precisely designated locations on a landscape that was often locally sculpted into the desired contours. These usually took the form of cut and fill terraces but also included major earthworks such as the re-routed drainage systems around Engine Test Stand 1 for sending radioactive cooling water into a holding reservoir. This surveying was normally done by Holmes & Narver, which maintained an office in the Central Support

Area (repurposed Radsafe Building 25-4919) during the 1980s. A permanent Instrument Station is near this building and survey benchmarks can be found throughout the NRDS. Another firm, Voorheis-Trindle Co. of Las Vegas, undertook a major survey of the entire NRDS as part of the 1965 Master Plan project (Figure 49).

Figure 49. Examples of land surveying resources.
Top: Benchmark disk near the northern end of the CSA (Photo 2116_1486 [*left*]) and near ETS-1 (2116_0250 [*right*] – see below left for monument).
Bottom: Benchmark monument at ETS-1 placed during mapping for the 1965 Master Plan, facing southeast (2116_0248 [*left*]); CSA instrument station with the Holmes & Narver, Inc. Office in the background, facing east (2116_1174 [*right*], all DRI 2021).

Warehousing/Storage

Warehouses at the NRDS were all rectangular plan gabled prefabricated metal buildings of various sizes. The premier warehousing and storage facilities were Warehouses 1 and 2 (25-4221, B19014; 4320, B19017) at the Central Support Area (see Figure 21). In addition to the large warehouses, there was a large storage yard with a bottled gas storage structure and another shelter for flammable gas which has mostly been dismantled (Figure 50). Although mostly removed, trailers were also used as semi-permanent storage buildings (see Figure 23).

Figure 50. Examples of minor storage structures at the main CSA Storage Yard behind Warehouses 1 and 2.
Left: Bottled gas storage facility, facing southeast (Photo 2116_1202);
Right: Flammable gas structure with roof removed, facing northwest (2116_1210, both DRI 2021).

RESIDENTIAL FACILITIES

Housing

NRDS-era housing was limited to two small trailer parks at the Reactor Control Point. Although all trailers have been removed, the improvements at the parks are largely intact (Figure 51). The Technical Operations Building (25-3129, B19003) and portions of the Technical Services Building (25-3123, B19000) at the Reactor Control Point have been modified for use as training program dormitories.

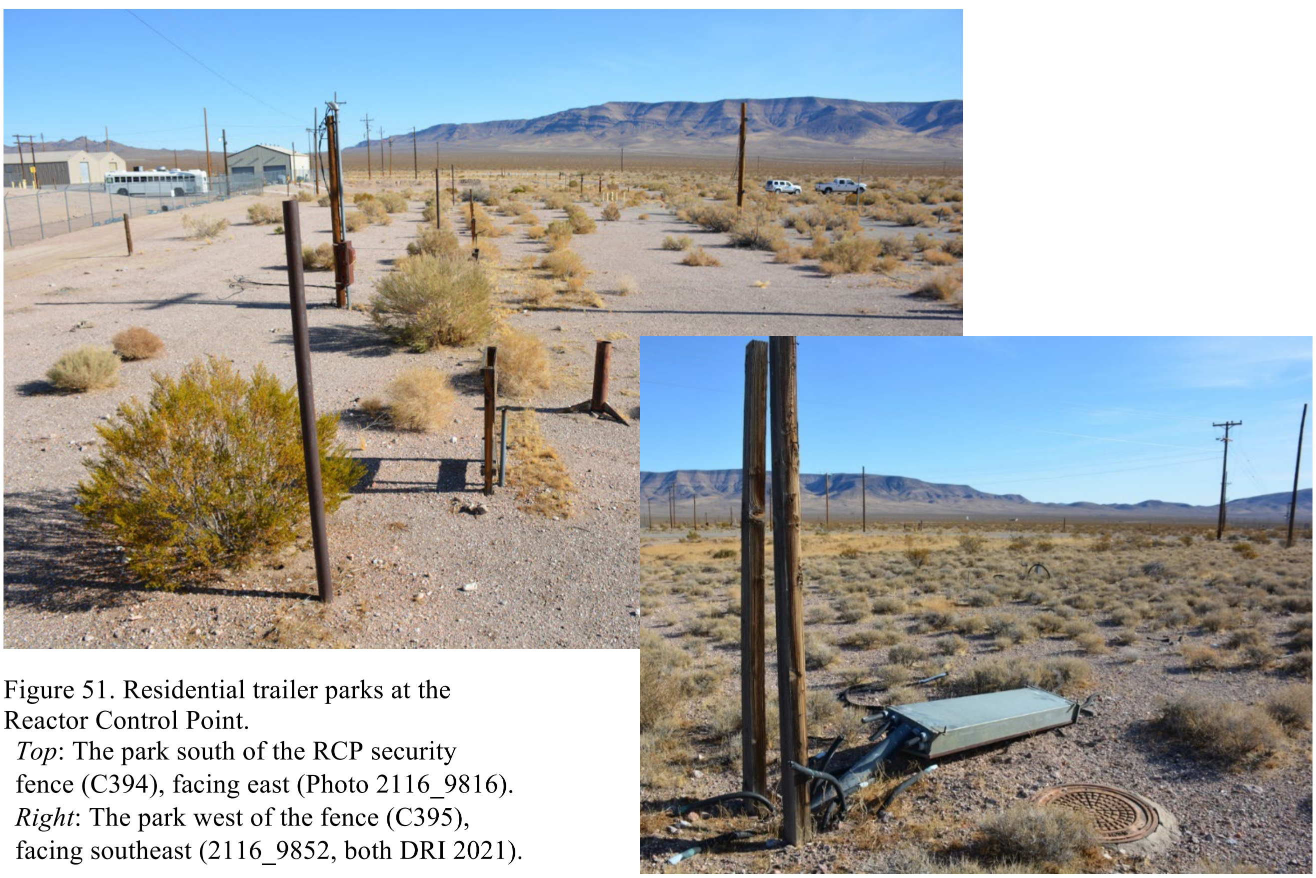

Figure 51. Residential trailer parks at the Reactor Control Point.
Top: The park south of the RCP security fence (C394), facing east (Photo 2116_9816).
Right: The park west of the fence (C395), facing southeast (2116_9852, both DRI 2021).

Public Services

Only one of the three cafeterias is still standing. It is Building 25-3127 (B19002) at the Reactor Control Point (see Figure 31, bottom photo). The other two were small temporary buildings.

The NRDS Fire Department is a prominent feature in the vicinity of Gate 500. It is a substantial four-bay concrete block facility (see Figure 24, middle photo). While the building was in use, the NRDS FIRE DEPARTMENT sign painted in white letters on the upper part of the wall of the bright red building could easily be read from Gate 500.

The principal medical building at the NRDS was the CSA Medical Facility 25-4117 (B19013, Figure 52). During the Yucca Mountain Project the building was converted to offices, and the NRDS Radiation Services Building (25-4314, B19016) was modified for medical use. Similarly, the old RCP cafeteria (25-3105, S3118), now demolished, was modified for use as a medical building, replacing a trailer which was formerly used for that purpose.

Additional public services were handled by small temporary buildings, few of which still exist.

Figure 52. CSA Medical Building 25-4117 (B19013), facing southwest (Photo 2116_1060, DRI 2021).

Recreation

The extremely limited outside recreational facilities at NRDS are almost all at the Central Support Area. These included break areas among the planted trees, a horseshoe pit, and a formerly vegetated area by the small reservoir (now dry) at Well J-11 (Figure 53). Interior recreation is outside the scope of this survey, but previous recording at E-MAD revealed a dedication to ping pong there, and darts were played at the forward control room of Test Cell C. Watching the firing of nuclear rocket engines likely served as another popular form of entertainment.

Figure 53. Recreational areas at the Central Support Area.
Top: Break area with a bench at Building 25-4215 (S3128) (Photo 2116_1371 [*left*]); horseshoe pit at Building 25-4314 (B19016) (2116_1406 [*right*]).
Bottom: Well J-11 reservoir (2116_7326, all DRI 2021).

UTILITIES

Electrical Utilities

Electrical power is generated off-site and transmitted to the Jackass Flats Terminal Substation (S3144) via aboveground transmission lines entering from two different directions and provided by two different companies. This electrical redundancy was designed to ensure that power would be available during critical operations. From the terminal substation, the power is distributed throughout the district by one, two, and three-pole aboveground lines and a maze of underground lines. Power is made available to end-users by a variety of substations, along with ground and pole-mounted transformers for individual buildings. Key NRDS facilities were equipped with their own electrical generators. Exterior generators, such as those at ETS-1, and the powerhouse at the Reactor Control Point have been removed. Equipment within buildings is outside the purview of this survey, although the previously recorded unit at E-MAD can serve as an example (Reno et al. 2019a, Room Form 106, page A-19). Examples of power-related utilities are depicted in Figure 54.

Figure 54. Examples of power utility components.
Top: Jackass Flats Substation (Photo 2116_2116).
Middle: ETS-1 Substation 25-3 (2116_0572 [*left*]); transformer at the CSA (2116_1054 [*right*]).
Bottom: Pole-mounted trailer transformers (2116_1024 [*left*]); trailer connections (2116_1351, [*middle*]); aboveground powerlines at the CSA (2116_1424 [*right*], all DRI 2021).

Communications

The main Communications Building (25-4101, B19012) is on the southern approaches to Jackass Flats. It has an importance to all projects undertaken in Jackass Flats far beyond that indicated by its modest appearance. Its commanding raised location is ideal for the radio antenna associated with the building (Figure 55). All radio communications were monitored and moderated from the Area 6 Control Point Building 1, located in a central position at the NNSS between Yucca and Frenchman Flats. This function has now moved to Mercury. A larger antenna at the CSA (B19022) was serviced by a pair of communications trailers. In addition, a variety of radio and microwave antennas are on smaller towers or attached directly to buildings and structures throughout the CSA and the rest of the NRDS (Figure 56).

The same powerline corridors are used for communication lines, but many of the most important ones for testing purposes are underground (Figure 57). Locations of major power and communications lines that appeared on engineering drawings are shown on Figure 58.

Figure 55. Communications Building 25-4101 (B19012), facing southwest (Photo 2116_9638 [left]) and associated radio antenna (2116_9628 [right], both DRI 2021).

Figure 56. Examples of communications facilities at the Central Support Area.
Left: Aerial and communications trailers near the intersection of 3rd and C Streets (Photo 2116_1178).
Middle: Communications tower at the Administration and Engineering Building (2116_0919).
Right: Microwave antenna mounted on the Medical Building 25-4117 (B19013) (2116_1062, all DRI 2021).

Figure 57. Examples of underground communications at the Reactor Control Point.
Top: Power and communications corridor to Test Cell A (Photo 2116_9705).
Bottom: Typical buried cable sign (2116_2168 [*left*]); communications junction boxes (2116_9684 [*middle*]); access hatches to main underground cableway at the Reactor Control Point Building (2116_9322 [*right*], all DRI 2021).

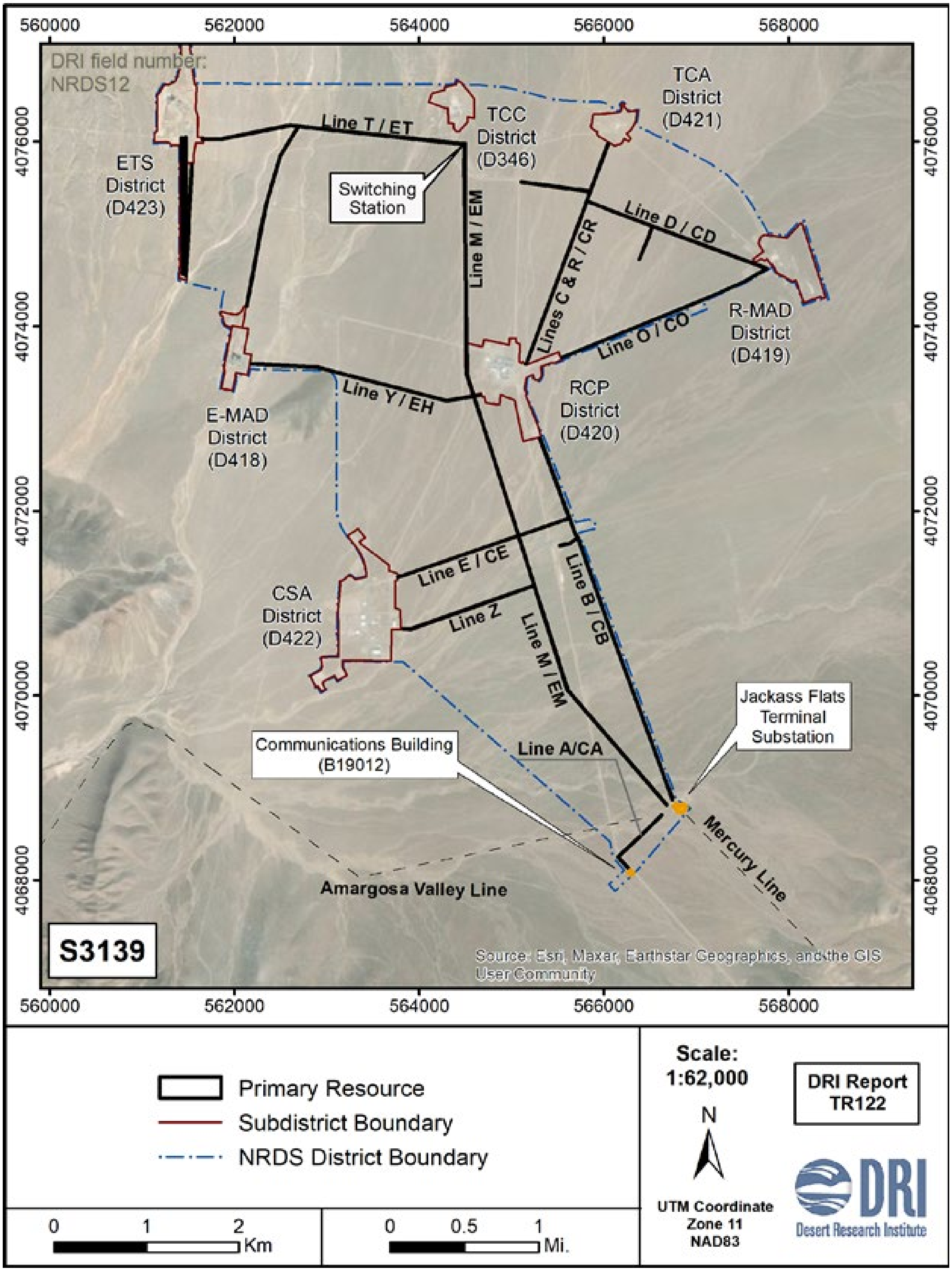

Figure 58. Power and communication lines according to various engineering drawings. Sometime after 1970, The two-letter system started to be used (Sources: Holmes & Narver Inc. 1970; Raytheon 1994).

Heating/Cooling

Heating and cooling were handled by a variety of evaporative coolers and heating, ventilation, and air conditioning (HVAC) systems attached to individual buildings. The system retrofitted at the Administration and Engineering Building to supplement the original rooftop unit (which is hidden behind parapets) at the CSA is immense and impacts portions of the Contemporary design elements on the front of the building (Figure 59). Examples of rooftop units can be seen in the top photos of Figure 21 and Figure 36. All the ubiquitous office trailers had at least one window air conditioning unit (see 23, lower right photo, for an example).

Figure 59. The retrofitted HVAC system at the CSA Administration and Engineering Building. The rear configuration is at top left (Photo 2116_1002) and the front is shown at right (2116_0956, both DRI 2021).

Sewage

Every major activity area in the district had one or more independent sewage systems. There were no central sewage treatment plants such as the one in Mercury. Instead, they were simple septic tank/leach field/lagoon systems. All extant lagoons are of similar design with a pair of interconnected unlined earthen basins of various sizes depending on usage. Many of the systems have been remediated. Septic tanks were either removed or filled with concrete and the rest of the system bladed over. Several sewage elements remain in place, however. Typical system components are illustrated in Figure 60.

Figure 60. Typical sewer system components.
Top: Septic Tank at Test Cell A (Photo 2116_1861 [*left*]); sewer manhole (2116_1036 [*right*]).
Middle: Leach Field at the CSA (2116_1546).
Bottom: Sewage Lagoons at the CSA (2116_1542, all DRI 2021).

Water

Water for the NRDS was obtained entirely from three wells with associated tanks and pumping stations. Well J-11 is at the Central Support Area. The other two wells (J-12 and J-13) are on Fortymile Wash, nearly five miles west of the NRDS Historic District boundary. This dispersion required extensive pipelines, access roads, and several intermediate pumping stations. The CSA and the rest of the facilities in the southern portion of the district relied on pumps to directly provide water pressure.

All others used pumps to move water to elevated tanks so gravity could then provide the necessary pressure. At ETS-1 the tanks were simply located on the hillside overlooking the facility. All other facilities were equipped with tall, raised water tanks, which are among the most striking features of the NRDS when seen from a distance because they are bright silver or other light colors (Figure 61). In addition to these major facilities, minor fixtures such as fire hydrants and sprinklers, standpipes, and turnoff valves are found near most of the buildings.

Figure 61. Water facilities at the NRDS.
Top left: Well J-11 is in the concrete wellhouse foundation to the right of the tank (Photo 2116_7322).
Bottom: Water tanks at ETS-1 (2116_0352 [*left*]); water tower and pumphouse at the RCP (2116_9424 [*right*], all DRI 2021).

At TCA, TCC, and ETS-1, deluge systems were added as an emergency response mechanism. These were each capable of flooding the facility almost instantaneously in case of a spill of explosive or highly flammable liquids or liquified gases. At ETS-1 it was also used to cool components during a test and to smother the exhaust plume, directing the effluent into a gunnite-sheathed drainage leading to a containment reservoir where the trapped radioactive materials could safely decompose (Figure 62).

Nearly every facility also has a stormwater diversion system. These worked quite well while the NRDS was active, but recent flash floods have inundated and damaged buildings, railroad tracks, drainage systems, and roads. Two examples of floodwater control measures are shown in Figure 63.

Figure 62. Deluge and water-cooling system at Engine Test Stand 1.
Main drainage channel (Photo 2116_0232 [*left*]); containment reservoir (2116_0336 [*right*], both DRI 2021).

Figure 63. Water diversion structures at the CSA.
Left: Drainage ditch north of the old Cane Springs-Lathrop Wells Road (Photo 2116_1510).
Right: Concrete apron at 3rd and B Streets diverting surface runoff into a natural channel and preventing undercutting into the road. Water has been contained on the road margins by concrete curbs and gutters (2116_1194, both DRI 2021).

CIRCULATION

Vehicular and Pedestrian Traffic

All materials used at the NRDS were brought in by truck. Loading docks are found at most buildings and many storage structures. Workers commuted in buses or personal vehicles. Movement within the district was almost entirely by means of government or subcontractor pool vehicles. This created a need for an extensive system of paved and bladed roads, which are discussed further in Chapter 5. It also created a typical vehicle-rich environment at the activity centers, resulting in extensive parking lots paved either with asphalt or gravel. Given the scattered placement of facility complexes, the fast-paced nature of work, and the extreme heat often experienced during the summers, there was little interest in walking more than very short distances. At the Central Support Area there are paved walkways extending a block north and south of the cafeteria. Other than these exceptions, sidewalks were limited to those surrounding individual buildings. Even in the most developed part of the CSA, the blocks lack sidewalks along the streets. Sidewalks with curbs are rare at the NNSS in general. making up only a small percentage of the walkways along the various roads within the built environments.

Railroad Transport

The railroad transportation system at the NRDS was quite complex for its size. It was primarily engineered to deliver nuclear engines from the maintenance, assembly, and disassembly buildings to the test stands and then return them, often in a highly radioactive condition. Components of the system include the grade itself and associated features, such as switches, crossings, and culverts. The longer rail segments between the facilities are recorded as the Jackass and Western Railroad. Control switches are in the remote-control rooms at the Reactor Control Point Building (and later at E-MAD), and maintenance and repair equipment are in the Train Maintenance Building in the E-MAD Historic District. Existing rolling stock is outside the E-MAD Building and at the RMSF. One engine has been transferred to the Southern Nevada Railroad Museum in Boulder City. Highly radioactive test cars were buried in radioactive waste dumps. Other components of the rail system include the numerous sidings at all facilities connected to the railroad and special features such as the turntables inside the E-MAD Building.

Air Transportation

An airstrip for the NRDS was considered near Fortymile Wash but it was never constructed. The USGS 7.5' map mistakenly identifies the peculiar road pattern at the nearby BREN Tower as an airfield. Instead, the two airstrips in the vicinity of Mercury were used. Two formal heliports are preserved in the district, however (Figure 64). The heliport at the Central Support Area (S3131) is adjacent to the Administration and Engineering Building. It is no longer in use except as a calibration target for aerial photography. The other heliport (S3149) is at the Reactor Control Point. The original heliport with its small hangar is no longer in use except for storage. Adjacent to it is a massively expanded recent addition, which is presently used for training purposes. The new heliport consists only of a paved area. It makes use of the relocated portable windsock from the original heliport.

Figure 64. Heliports at the NRDS.
Above: Heliport at the CSA (Photo 2116_0968).
Right: RCP heliport with hangar at far right (2116_9758, both DRI 2021).

OTHER

The most important resource in this category is the multitude of non-residential trailer parks and individual pads, which were used for diverse purposes, such as offices and shops. Nearly all trailers have been removed, either to be used for other purposes or disposed of as surplus. The various remnants include leveled terraces, exposed underground plumbing, power and communications boxes and lines (see Figure 54), leveling jacks, and assorted other items. Components of trailer pads are shown in Figure 65.

Figure 65. Non-residential trailer pads at the Reactor Control Point
Top: Two trailer pads and associated utilities at the LASL J-3 Trailer Park (Photo 2116_9688).
Bottom: Concrete stoop for the Laborer trailer in the maintenance area (2116_9578, both DRI 2021).

Character-defining Features

DISPERSION AND SPECIALIZED FUNCTIONAL NODES

One of the most striking aspects of the NRDS when viewed from afar is its emptiness (see Figure 2). This is due to a deliberately planned dispersion of activity areas for maximum safety. The causes of concern were the possibility of accidental explosion and/or a release of radiation. Dispersion had long been practiced at sites where nuclear accidents were a possibility. It was an essential part of the nuclear facility designs at the Oak Ridge Site in Tennessee and the Hanford Site in Washington.

Radioactive contamination from places such as the R-MAD and E-MAD facilities was relatively slight, but low levels of radiation were emitted from the hot bay exhaust stacks of both areas. Filtering was greatly enhanced at E-MAD during a later modification. By contrast, Test Cells A and C routinely emitted radioactive plumes during tests. Emissions could become much more dangerous when a reactor ejected parts of its core, which was a common occurrence, or in the case of an accidental meltdown, which fortunately never occurred. Danger to other facilities also increased if the wind unexpectedly changed direction during a test. Despite the increased costs and inconvenience, the facilities were therefore spread out over a large portion of Jackass Flats. Distances between the various facilities are given in Table 7.

Table 7. Approximate Distances in Miles Between Facilities at the NRDS.

	CSA	RCP	R-MAD	E-MAD	TCA	TCC	ETS-1
RCP	1.6						
R-MAD	3.5	1.9					
E-MAD	1.6	1.8	3.7				
TCA	3.5	1.8	1.4	3.0			
TCC	3.6	1.7	2.4	2.2	1.1		
ETS-1	3.6	2.9	3.2	1.7	3.0	1.9	
RMSF	2.5	1.4	2.9	1.0	2.0	1.0	1.1

The Central Support Area is about three and a half miles from all the hot test stands and over a mile and a half from the nearest maintenance, assembly, and disassembly facility. It and the Reactor Control Point are also positioned upwind of the test stands. The Reactor Control Point is closer to the two test cells and maintenance, assembly, and disassembly buildings but is still nearly two miles from these facilities. Engine Test Stand 1 is about three and a half miles away. The test stands themselves are also well separated from one another with about a mile between Test Cell A and Test Cell C and nearly two miles between Test Cell C and Engine Test Stand 1.

Blast and Radiation Resistance

The necessity for protection from radiation and blast damage was a major concern at the NRDS (Figure 66 and Figure 67). Control measures included designed shielding materials, such as thick concrete walls, ceilings, and floors. The thickness of this material and the composition of the concrete were calculated prior to construction with this function in mind. This kind of engineering is particularly evident at the two hot cells at R-MAD and E-MAD where remote manipulation of radioactive materials took place on equipment ranging in size from microscopic to weighing several tons. Particularly impressive is the immense concrete shield door to the hot cell at E-MAD (Figure 68).

Figure 66. Exhaust plume from the Phoebus 2A reactor at Test Cell C, June 28, 1968 (NASA/LASL).

Figure 67. The Kiwi-TNT intentional reactor explosion test near Test Cell C, January 12, 1965 (Source: https://commons.wikimedia.org/wiki/File:Kiwi_TNT_test.jpg).

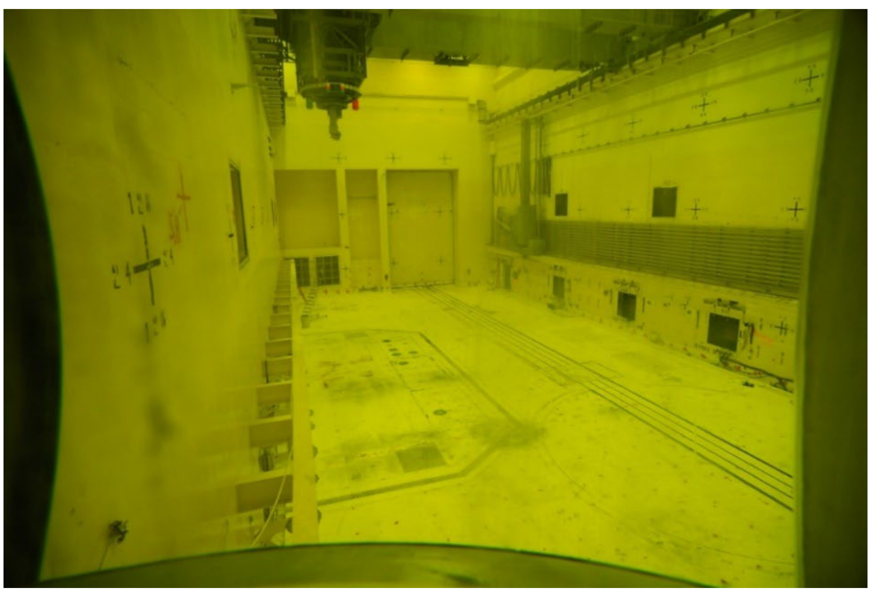

Figure 68. The Hot Bay Shield Door at E-MAD (Photo 0929_1666, DRI 2009). The door is at the far end of the Hot Bay as viewed through the shielded Control Room window. Retracted overhead and wall mounted remote manipulators are also visible.

The test stands were the facilities most prone to blast or fire damage and unanticipated radioactive contamination. Monitoring of wind direction enabled use of single linear concrete barrier walls at Test Cells A and C (Figure 69). A more cautious approach was taken at Engine Test Stand 1 where the control rooms and supporting electronics were placed in underground bunkers.

Figure 69. The protective concrete shield wall at Test Cell C is prominent in this view taken while preparing for a test (photo credit RSL c. 1997). The shield and the Test Cell Building behind it have been demolished. A portable clamshell radiation barrier surrounds the reactor in this image.

Initially the major concrete and concrete block buildings at the Reactor Control Point had numerous windows. Nearly all these windows were later sealed (Figure 70 and see Figure 24, top photo). Pending further research, it is not known whether this modification was due to increased trepidation about possible radioactive contamination or in response to an actual exposure. Windows were not removed from metal buildings, which would have been evacuated during tests. Only the special thermal pane windows near the main entrance of the Reactor Control Point Building, which served as the test viewing gallery, were retained (see Figure 26).

Figure 70. Sealed windows at the Reactor Control Point.
Left: The filled windows at the Control Point Building (25-3101, B18993) are dimly visible (Photo 2116_9320).
Right: The sealed office windows at 25-3123 (B19000) are easy to spot due to the protruding sills (Photo 2116_9350, both DRI 2021).

RADIOLOGICAL EXPERIMENTATION AND CONTROLS

Reactor tests at the three test stands deliberately released a plume of radioactive exhaust (see Figure 66). Measures for the control and monitoring of radiation were concentrated in and immediately adjacent to the reactor pads and were undertaken to a lesser extent throughout the NRDS. Test Cells A and C were surrounded by numerous radiation monitoring stations extending several thousand feet from each or the ground zeros. Farther afield, monitoring occurred in the air of moving exhaust plumes and through regional and national monitoring systems already established for weapons testing. Personnel were monitored using film badges or personal dosimeters, supplemented as needed by whole-body counts at Mercury.

Radiation monitoring also took place with a variety of portable devices. Separate fenced compounds set aside for radiography were well away from and upwind of the reactor pads at both test cells. Other specialized radiation-specific buildings are in the Central Support Area. Monitoring continues to the present day on a regular basis.

The reactors typically lost portions of their radioactive cores during tests. This problem became severe when a Phoebus 1A reactor expelled much of its core on June 24, 1965, contaminating Test Cell C to the extent that it could not be used. This created a major cleanup problem. Remote cleanup systems failed, so it was necessary to resort to manual cleanup by crews whose exposure time was carefully limited (Figure 71).

Figure 71. Manual decontamination at Test Cell C using a truck-mounted vacuum and a lead-shielded dolly (photographer: Los Alamos Scientific Laboratory, reproduced from Dewar 2004:130).

One of the most notable features still present at the NRDS is the location of the experiment involving the deliberate release of radioactive fallout – the Kiwi-TNT (Transient Nuclear Test) near Test Cell C. This unique test provoked an international controversy. Kiwi-TNT was intended to determine the effects of a runaway reactor explosion (meltdown) to safely design launch facilities for nuclear-powered rockets. The test would not create a full-scale nuclear explosion but performing it on the usual pad at Test Cell C would still result in a powerful detonation that would damage the facility and cover the area with radioactive reactor debris. Therefore, a single-purpose test stand was built on the Jackass and Western Railroad grade where it crosses Topopah Wash 630 feet from Test Cell C (Figure 72). The distance was well judged; the only damage to Test Cell C was a broken window. The blast was equivalent to 200 to 300 pounds of black powder (see Figure 67). This was enough to destroy the reactor on its railroad flatcar, but no significant damage was done to the test stand, which remains in excellent condition today. The test is described in detail by Dewar (2004:279-286) and by Reno et al. (2019b:51-52).

Figure 72. The Kiwi-TNT reactor test stand (S2287), facing northeast (Photo 1968_202, DRI 2019). The north camera bunker is in the background.

The SURF program, detailed in the historic context, is a good example of another elaborate radiation experiment carried out at the NRDS, in this case exploring methods of permanently storing high-level radioactive waste. The portion of this study done in Area 25 was confined to the E-MAD facility.

SECURITY/SAFETY

Security was initially enforced by a contractor, Federal Services, Inc., backed up by the Nye County Sheriff's office. Later, Wackenhut Security, Inc (WSI) took over this role. During the period of active use, security concerns were far less pressing than they became later in the wake of numerous incursions by protestors beginning in the 1980s and present concerns over the threat of terrorism. At the time, the security forces resembled a small-town police force (Figure 73); very different from today's elaborate security operations. With the presence of nuclear reactors on-site and records and equipment related to numerous technological innovations, security was important, but even more important was safety during ordinary operations. Principally, this involved keeping unauthorized people out of dangerous areas.

The southwest perimeter of the NNSS was merely a line on the map. The principal road from Mercury had a full-time security checkpoint at Gate 500. The road from Lathrop Wells was barricaded and staffed only part time as needed.

The Reactor Control Point, R-MAD and E-MAD facilities, RMSF, and test stand compounds were surrounded by chain-link and barbed wire perimeter fences with controlled gated access for automotive vehicles and trains. At most facilities the main gate, vehicle gates, and personnel safety exits were spaced around the perimeter. The emergency exits could only be opened from the inside. Presently, they are chained shut. The guard hut (or sometimes called a "shack") next to each main gate was the most visible security presence at most of these facilities (see the top two photos in Figure 22). The RMSF was not accessed enough to warrant a guard hut.

Figure 73. Federal Services, Inc. security guard at the original NRDS entry sign, circa 1964 (Beck et al. 2000 Figure 22).

These various measures were highly successful in terms of both site security and keeping the workers safe under often challenging conditions. Examples of security measures are shown above in Figure 48. Some examples of signs reminding employees to work safely are illustrated below in Figure 74.

Figure 74. Examples of signage at the NRDS related to safety (Photos 2116_0972 [*left*] and 0504 [*right*], both DRI 2021).

With such immense quantities of explosive gas distributed all over the facility, there was great concern of fires and explosions. There was the usual array of firefighting equipment, post indicator valves, and hydrants; and each test stand had its facility-wide emergency deluge water system. The most important safeguard was prevention, because one significant mishap could easily remove the facility from the face of the earth (hence its separation from surrounding facilities). An incident with one of the electrical boxes at Test Cell C is an example of the importance of such a preventive measure. A small explosion in one of the boxes led to the realization that the lighter-than-air hydrogen, which was so common throughout the facility, could be trapped in the tops of the boxes, and then exploded by the electronics inside. Holes were immediately drilled in the tops of all potential hydrogen traps to eliminate this problem (Benjamin McGee, *personal communication* 2019).

CONTROL ROOMS

Rooms created for the purpose of enabling efficient command and control of operations constitute a distinctive property type, which developed rapidly over the course of the twentieth century due to extreme technological changes. They were a military invention but proved to be extremely useful for other organizations as diverse as the space program, urban traffic control, and nuclear testing.

Traditionally, a military commander in tactical charge of a battle had little control over anything beyond what could be seen, supplemented by human sources of information such as runners, staff people on horseback, or couriers. Staff meetings usually could not be held once forces were engaged. Visual aids consisted of an inaccurate map at best. Decisions often had to be made instantly based on poor information. Introduction of wire telegraphy helped to provide information beyond the range of seeing and hearing, but when General Grant directed Union forces in the Battle of the Wilderness during the Civil War, he was operating no differently than he would have a thousand years previously.

In contrast, strategic command and control was likely to be centered on a conference table. Visual aids would still be maps and perhaps a globe. A good example of this kind of control center would be that of the British Lords of the Admiralty during the Napoleonic wars. An important communication advance at that time was the introduction of visual telegraph and signal flag systems to speed up the age-old methods of information gathering methods.

This setup changed rapidly in the mid-twentieth century with further expansion of communication systems using wire telegraphy, radio, and recorded video. Remote sensing, particularly by means of radar, started to come into use. Photographs became a commonplace means of conveying information, maps became far more accurate, and thematic maps for conveying information about specific problems began to be developed. During World War II. These changes came together to create the kinds of control centers we now regard as commonplace thanks to their iconic representations in newsreels, illustrations in history books, and particularly because control centers are so frequently used as principal foci of dramatic action in movies. Indeed, a problem that arises when trying to assess the significance of real control centers, such as those in the NNSS, is that they pale by comparison with their fictional counterparts. The conference table-type War Room in Dr. Strangelove occupied an entire sound stage the size of all of CP-1 with towering interior spaces. The console type control room depicted in a recent movie about a daring rescue mission to Mars accorded Chinese Mission Control with another huge room and walls covered by towering flat screens. These images work because they are firmly grounded in the way actual control rooms were designed and operated, but being the movies, everything is considerably larger than life.

"Wartime 'situation rooms' were set up for conducting operations using maps, photographs, statistics, and diagrams to create panoptic systems that made it possible to view the 'theatres' of operations from the best seats available" (Cohen 2011:322). One of the most important and successful control rooms of World War II was the Royal Air Force Fighter Command Headquarters which was the central command center for the defensive Battle of Britain (Figure 75) shows the controller and staff perched on a balcony. This position was required because a large map table was used to portray the theater of operations. The tactical situation was far too complex and fluid to keep in the mind of the controller, so a team of technicians moved markers around the display showing the positions of the various forces engaged. Other smaller displays on the balcony portrayed information such as the numbers of planes available. Each technician represented the ending point of an elaborate network of information inputs which were interpreted and condensed by analysts who then told the technicians where to move their markers via earphones. Throughout the war, the same basic pattern held in that no matter how sophisticated the means of gathering information, its portrayal usually was done in an extremely low-tech manner. A similar example can be made of the tactical control room for German U-Boat command except that the principal display was a gridded wall map on which markers were moved about by technicians on movable ladders.

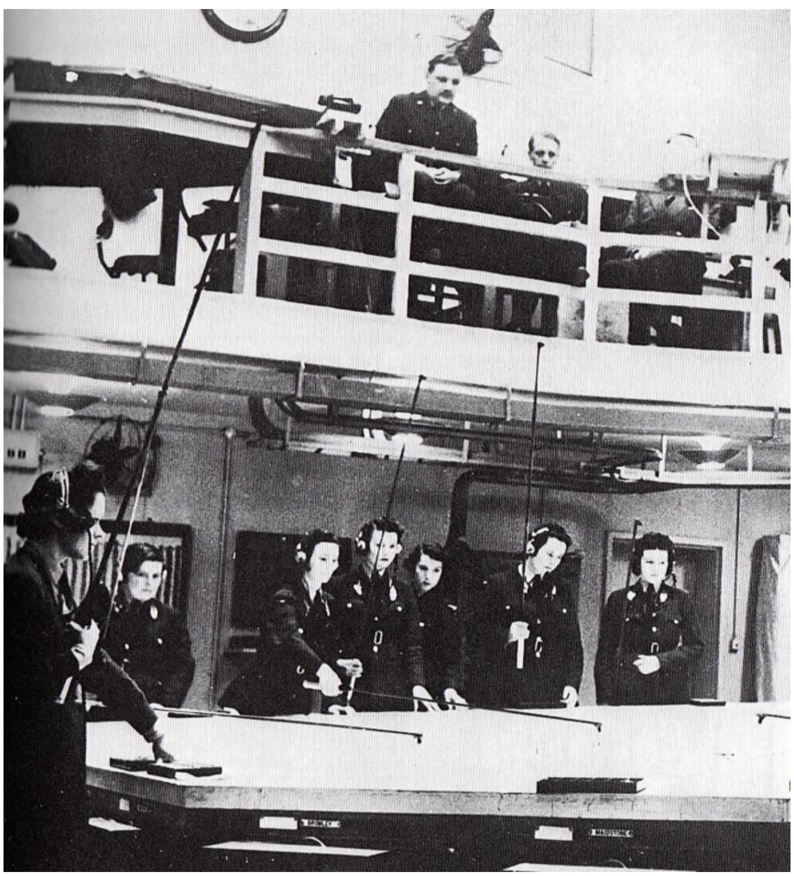

Figure 75. Royal Air Force Fighter Command Headquarters Control Room at Bentley Priory near London (British Imperial War Museum, reproduced from Mosley et al. 1977:93).

Thanks to numerous newsreel photo shoots and still publicity photographs, the conference table-based Presentation Room used by the Combined Chiefs of Staff in Washington, D.C. became widely recognized during the war. As shown in Figure 76, large wall displays were principally of a variety of maps, again kept updated by a technician on a ladder. The purpose of this room was to facilitate making strategic decisions about policies that could take months or even years to play out.

Figure 76. The Presentation Room of the Combined Chiefs of Staff, Washington, D.C. in 1942 Cohen 2011:324).

By the end of the war, great advances had been made in the electronic portrayal of information, including the use of simulations. Much of this development was under the Visual Presentation Branch (later the Presentation Division) which was created late in 1941 as part of the Office of Strategic Services. It brought a wide variety of specialists to the problem including artists, filmmakers, and architects. One of the first and perhaps the most ambitious of its projects was the design of a White House Situation Room for President Roosevelt. Henry Dreyfuss improved on the British model of control rooms by replacing the visible human display technicians with front and rear displays for images (Cohen 2011:322-323). His design, shown in Figure 77, looks remarkably like a multi-screen movie theater, and at first glance could be a photo of the CP-1 War Room. Distinctly ahead of its time and never built, it would be widely emulated after World War II.

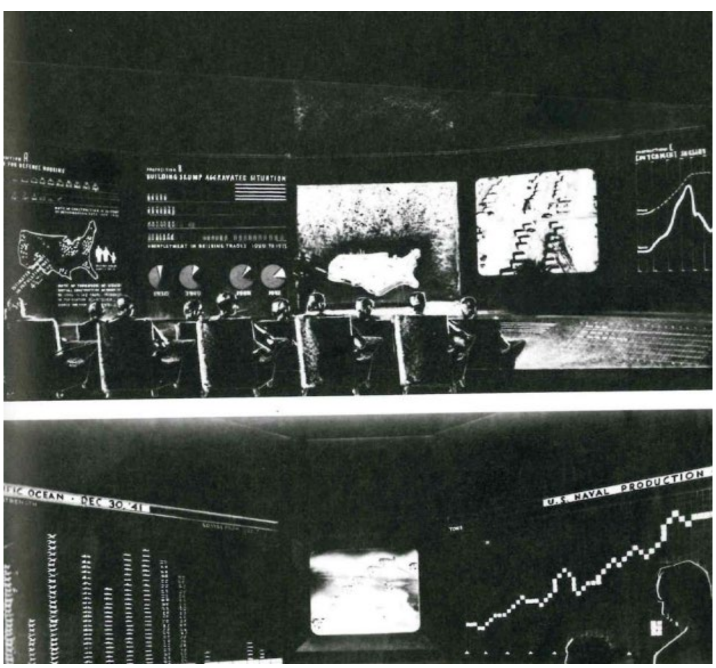

Figure 77. Henry Dreyfuss' 1941 conceptual design for a Presidential Situation Room (Cohen 2011:323).

The reality of situation room communications and graphic portrayals at the end of the war was far less impressive. Early in the Korean conflict, President Truman and his key military advisors met in the Army Teleconference Room to make some of the key decisions of the era. Their communications to Japan were typed into a teletype machine by a technician, and then they would watch a wall screen while, letter by letter, the reply would come back (Boettcher 1992:219-220).

Nuclear weapons tests at the NNSS were directed from the War Room in Building 1 of the Control Point Complex (CP-1) in Area 6, located on a ridge overlooking Frenchman and Yucca Flats. This room, constructed in 1969, represents the culmination of the conference table-type of control room (Figure 78). At the same time, the console-based Monitoring Rooms and Timing and Firing Rooms, along with several of the computer/monitoring back rooms of CP-1, represent the ultimate advancement for the time of an entirely new style of control room (Figure 79). This was a direct result of the massively increased input of information and the need to have a specialized technician interpret a small portion of it quickly and in such a way as to make it useful for the person making the command decision. This kind of console-based control room would later become standard at the National Aeronautics and Space Administration (NASA). Like the World War II tactical control rooms, those at CP-1 were created to assist the AEC/DOE Test Controller and the Test Group Director in making immediate decisions about whether a device was ready to detonate, considering both safety and technical issues. They also could address any unexpected circumstances that occurred with the assistance of the various secondary control and support rooms and similar facilities in another nearby building.

Figure 78. The nuclear test War Room in CP-1 in the 1980s (Photo D04-2216, on file at RSL).

Figure 79. Typical control and monitoring room at CP1 (Photo D10_01775, on file at RSL).

The CP-1 War Room had roles beyond those directly related to test control – it was also one of the places where the Cold War was fought. It was highlighted in media presentations and shown to select visitors as the place where the United States made the 'yes and no' decisions on proceeding with tests, integrated with the countdown to detonation. It was equipped with a glass-fronted mezzanine for these visitors (Figure 80). The spontaneously generated term "War Room" is apt because tests also demonstrated nuclear capabilities to foreign opponents. CP-1 was a principal component of the Cold War battlefield, not simply a testing installation (Fehner & Gosling 2006) – and this one room was its visible command post.

Figure 80. Onlookers in the Mezzanine watching the Handley test unfold below in the War Room (Photo 3189-30, 1970, on file at the Nuclear Testing Archive, Las Vegas).

The main NRDS Control Room in the Control Building at the Reactor Control Point dates to 1958. It combined the look of one of the technical back rooms at CP-1 with the walled-off visitors' gallery of the War Room (Figure 81). It was supplemented by heavily instrumented back rooms in similar fashion to CP-1. Unfortunately, all interior fittings have been stripped from this building.

Figure 81. Engineers and technicians monitor a space nuclear propulsion reactor test from the RCP Main Control Room watched by staff and visitors from the Test Director's Office which doubled as an observation room (NASA photo).

Unlike the weapon testing program, which had all control centralized in the Control Point complex, the system used at the NRDS included one or more local control rooms at all three test stands (Figure 82, Figure 83, and Figure 84) and at the R-MAD and E-MAD buildings (Figure 85 and Figure 86).

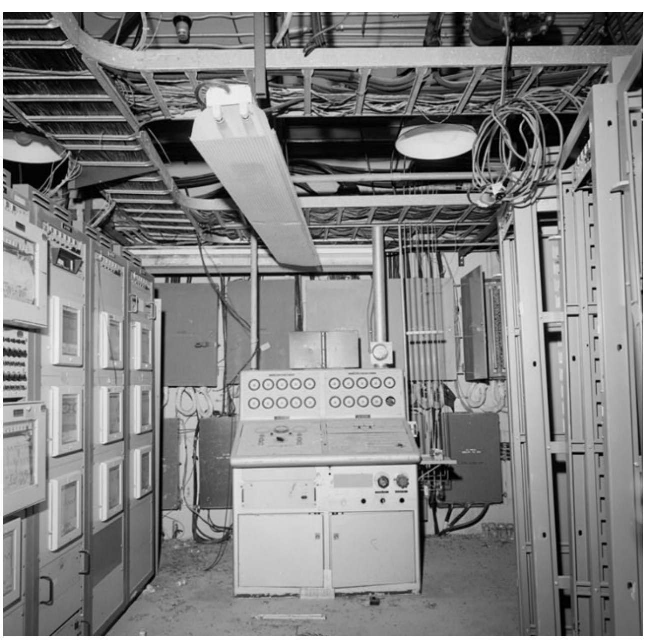

Figure 82. Interior of the Local Control Room in Building 25-3113 (Beck et al. 2000, photo 18).

Figure 83. Interior of the Local Control Room in Building 25-3220 at Test Cell C as it appears today (Photos 1968_925 and 923, DRI 2019).

Figure 84. The Local Control Room in Building 25-3310 at Engine Test Stand 1 is underground for radiation and blast resistance (Photo 2116_0494, DRI 2021).

Figure 85. R-MAD Local Control Room (National Park Service 2000a, photo 37).

Figure 86. E-MAD control rooms.
Top: Local Control Room (Photo 1905_2411, DRI 2019);
Bottom: supplementary Television Control Room (Photo 1905_2067, DRI 2019).

The buildings containing the Test Cell A and R-MAD control rooms have been demolished however the equipment at Test Cell C and E-MAD is still in place. Constructed later than the demolished control rooms, they are more refined examples of this type. Engine Test Stand 1 has two control rooms, located in separate underground bunkers connected by the main Access Tunnel. The interiors of these buildings were not accessible to the survey crew. The initial layout of the Local Control Room at ETS-1 is shown in Figure 87.

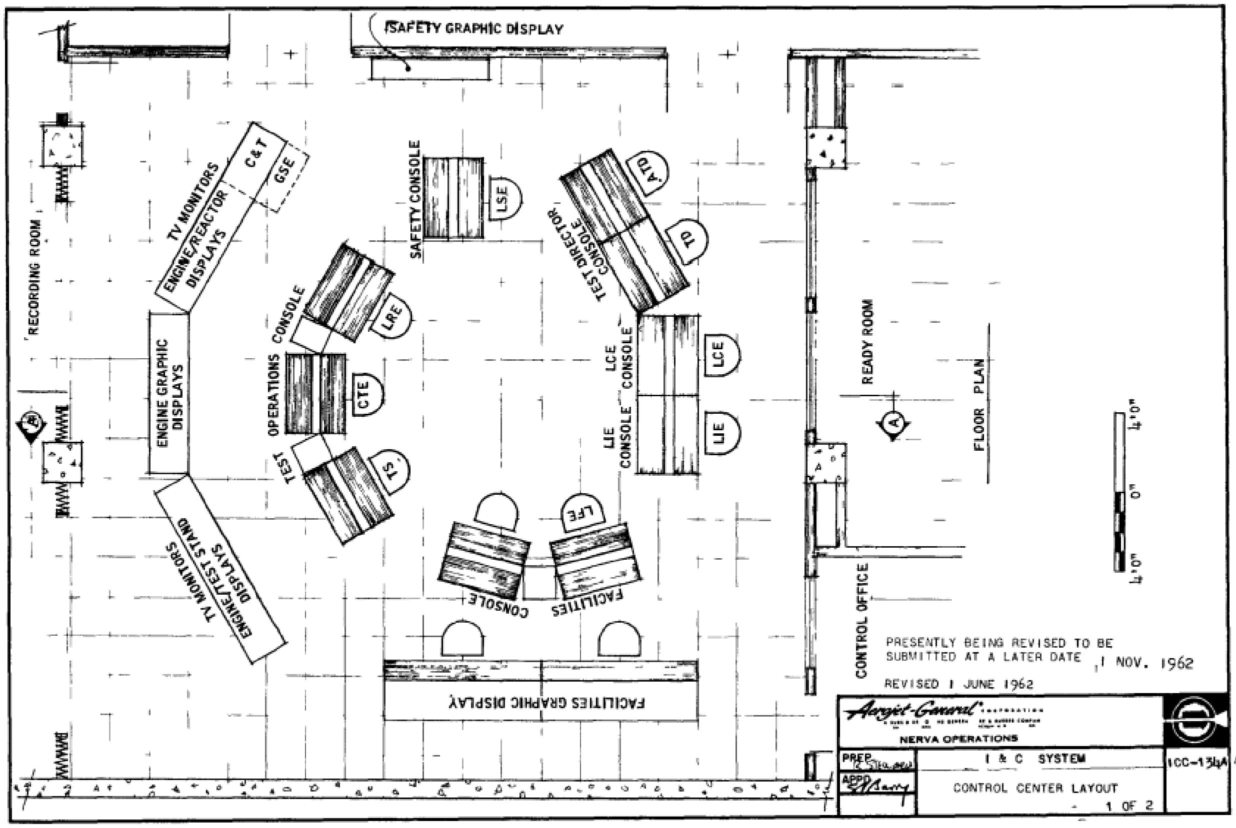

Figure 87. Planned layout of the underground Local Control Room at ETS-1 (Aerojet 1962:28).

CRYOGENICS

Moving and storing supercooled cryogenic liquid gases, particularly liquid hydrogen. Liquid oxygen, and liquid nitrogen, dominates the architectural landscape of the three test stands. Specialized features include testing laboratories, the spherical and cylindrical insulated dewars for storing the material, specialized unloading docks, and the maze of vacuum-jacketed stainless-steel pipes (Figure 88, Figure 89, Figure 90, and Figure 91). Special techniques had to be developed for field welding the exotic steel alloys used for the dewars and pipes. Constant quality control inspections were needed to locate and correct failures. Because of the temperature extremes, the piping throughout is characterized by abundant accordion or U-shaped expansion/contraction sections or were mounted on rollers to keep them from tearing themselves apart.

Figure 88. Dewar at Engine Test Stand 1 (Photo 2116_0712, DRI 2021).

Figure 89. Cryogenic pipeline at Test Cell A (Photo 2116_1910, DRI 2021) with detail of roller mount for expansion and contraction (Photo 2116_1904, DRI 2021).

Figure 90. Dewars at Test Cell C (Photos 1968_426 and 338, DRI 2019).

Figure 91. Cryogenic Pump Building and Cryogenic Lab at Test Cell C (Photos 1968_412 and 442, DRI 2019).

Moving the liquid hydrogen about the facilities required special high-pressure pumps, containment rooms, and large motors for the pumps. A specially-designed parking area for trucks hauling dangerous cryogenic liquified gases was built on the outskirts of the Reactor Control Point.

Modern Utilitarian Architecture and an Impersonal Built Environment

The NRDS exemplifies the tenet of many theorists and practitioners of modern architecture who felt, like Mies van der Rohe, that "less in more." Aside from the few Contemporary Style buildings, there was not the slightest attempt anywhere to adorn the buildings with any decoration. This same regard for functional simplicity extends to the interiors. The decision to build in this manner was partly aesthetic but largely had to do with the extremely tight budgets available for construction at the NRDS.

Horizontal Development

There was no lack of open space for development at Jackass Flats. As with other developments at the NNSS, this is a built environment composed mostly of open space punctuated by one-story buildings which are normally quite far apart with large parking areas and open spaces between them. The only multi-story support building is the intentionally impressive Administration and Engineering Building. The R-MAD and E-MAD buildings are multi-story due to the complexity of their interior activities and the extreme size of the equipment assembled and disassembled in them.

The Central Support Area is organized in a typical north-south oriented block pattern. As noted above, these blocks are not densely developed.

The three test cells all have elaborate horizontal distribution of facilities in distinctive use zones. As an example, much of Test Cell C is organized by activity throughout the compound. All these components, and the supporting equipment needed to conduct the tests, occupy discrete areas that were sometimes multiplied as the facility expanded. Use zones can be identified moving from south to north. When approaching from the south, one first reaches large parking areas with the Operations Building and the large Warehouse, which always housed various support functions and provided storage. Passing through the main gate is immediate access to propane tanks and both gas unloading docks. A generalized Support Building is immediately encountered, which provided a variety of services to the testing process, such as pumping gas from one of the gas unloading docks (the only one prior to 1966), pumping water throughout the facility, and supplying electricity. It also contained the Local Control Room. Farther north is the large Cryogenics Building, which was devoted almost entirely to providing liquefied gas to the reactor via extremely powerful pumps. To the north is the central building of the complex, 25-3210, with the Reactor Pad on its north side. The area north of the Reactor Pad facilities was dedicated almost entirely to monitoring experiments.

The organization of Engine Test Stand 1 is strikingly linear. Approaching from the south there is first a guard gate and decontamination facility, then after a long drive uphill is a support area followed by the guarded main gate. Inside are more support facilities and the tunnel entrance to shielded control buildings. Next is the elaborate tank farm and finally the test stand itself. The facility extends even farther upslope where its three water tanks are located.

Automotive Commuter Culture

Efforts to build a residential community for the NRDS failed. Two small residential trailer parks were built at the Reactor Control Point, but they could not nearly fill the need for housing. Lack of any other amenities also made living on site undesirable for most people. Thus, the NRDS was operated almost entirely by people who made a daily commute. There was some housing available in Mercury, but most made the long daily commute by bus or automobile from Las Vegas. Due to the high death rate on this two-lane highway during a period lacking speed limits, seat belts or airbags a lasting by-product of the NRDS was widening U.S. 95 to four lanes. Some workers reduced the length of the commute by purchasing houses or improving property (including filing homestead claims) in the Amargosa Valley and approaching the site via Lathrop Wells.

Once on site, abundant parking lots were developed to handle all the vehicles.

RAILROAD/AUTOMOTIVE INTERFACE

The NRDS existed to test nuclear rocket components, but it depended entirely on railroad and automotive ground transportation to function. Nearly all construction materials and equipment were transported to the site via paved roads connecting it to the national highway system and the railhead in Las Vegas. There could easily have been a direct rail connection but the Las Vegas and Tonopah Railroad, which followed the route now used by U.S. 95 and came within about 11 miles of Jackass Flats, had been dismantled.

Components of reactors and other engine components were trucked to the cold bays at R-MAD or E-MAD for assembly. From there they were mounted on specially designed railroad test cars and hauled by rail to one of the test stands. For this purpose, railroad tracks run right into the maintenance, assembly, and disassembly buildings. Following the test runs the cars were transported back for disassembly and analysis. Test cars could not be reused since they were highly radioactive. Several are still stored above-ground at the RMSF.

COLOR

Unlike Mercury which has recently acquired a uniformly brown look, most buildings in the NRDS retain their varied original colors or those applied during later use of the area prior to the early 1990s. In this regard, buildings such as the Vehicle Maintenance Shop (25-4838) at the Central Support Area or the Fire Station (25-3153) which have been repainted brown stand out as exceptional. Where painted, the usual colors usually range from pale yellow to light tan or white. Some buildings have esoteric coloring, such as the bright pink Support Building (25-3220) at Test Cell C. Concrete or concrete block buildings were often left unpainted as were many of the prefabricated metal buildings, particularly Butler buildings. Gray concrete block was used for construction with the striking exception of the small pump houses. Pink block which was left unpainted was chosen for this property type. Camera stations and the concrete shield wall at Engine Test Stand 1 are pink. The small chlorination shed at the pumping station for ETS-1 is unpainted, displaying as a result the brilliant turquoise coloring of its molded fiberglass. The fire department building was originally painted red.

SIGNAGE

The large NRDS FIRE DEPARTMENT sign is the only large sign painted directly on a building. Building and structure identification signs are limited to small metal signs (originally white with black lettering) or black lettering applied directly to the wall. Examples of signs are in Figure 92. Signage for special purposes is illustrated in figures for the various functional property types. Cold War era signage at the NNSS was nearly all produced by hand at REECo sign shops.

Figure 92. Examples of signage at the NRDS (Photos 2116_1012, 0996, 0974, and 9906; DRI 2021).

CLEANLINESS

As with the rest of the NNSS, the NRDS area is almost entirely free of litter with the rather amusing exception of the perimeter fence line downhill of Building 25-3129 at the Reactor Control Point. The building is used for training purposes and its yard serves as the storage location for empty 5-gallon plastic water bottles generated by users of the entire complex. This is an exposed location on top of a high berm and winds have tossed large numbers of the bottles downhill to accumulate behind the fence as a sort of landscape art. Historically this was not a problem at the NRDS since heavy glass bottles were used at that time. Bottled water has always been extremely important in the district since the quality of the well water was simply awful.

XERISCAPE

Xeric landscaping or no landscaping at all is the norm throughout the NNSS. It is therefore surprising how many trees and other vegetation were planted throughout the Central Support Area (Figure 93). Without their former irrigation most of these plants are either dead or severely stressed, particularly the pine and deciduous trees. Transplanted Joshua trees and yucca have fared better. Some of the juniper trees are also managing to survive.

Figure 93. Examples of plantings at the Central Support Area (Photos 2116_0940, 1060, 1106, and 1371; DRI 2021).

EXTENSIVE ABOVE AND BELOW GROUND UTILITY INFRASTRUCTURE

As was discussed in the section on linear resources, the NRDS is crisscrossed by a network of above and below ground utilities including water, power, and to some extent sewer lines. Due to the necessity of controlling tests and receiving test results at various remote locations the communications infrastructure is very highly developed.

V. National Register Eligibility

The Nuclear Rocket Development Station Historic District is eligible for inclusion in the National Register at the national level of significance under all four criteria. Its importance transcends the history of the United States to embrace one of the most revolutionary developments in the entire history of humans on this planet – our ability to leave it and to explore the outer reaches of the solar system.

The fact that the collection of closely related historic resources found in the NRDS area meet all qualifications for a highly focused National Register district of national significance has long been recognized by cultural resources professional researchers studying the area, starting with Tlachac's (1991a) contribution to the Nevada Comprehensive Preservation Plan. Specifically, she regarded the area as contributing under Criterion A (1991b:25-17).

The distances between the major facilities at the NRDS, generally ranging from approximately 1.5 to 2 miles apart, is a key aspect of the district because this separation was mandated by the special safety issues created by handling near-critical masses of radioactive materials and deliberately venting radiation to the atmosphere during reactor and engine tests, which sometimes scattered portions of radioactive cores onto the immediate surrounding landscape. The interconnectedness among all the special facilities as they interacted to perform a single overall testing function makes management of the NRDS as a single overall historic district containing several small, specialized subdistricts the most logical approach. Evaluation of the place at the district level is extremely important since so many of the resources are so individually unremarkable that they would be evaluated as non-significant. It is only in the light of the larger district context that their often small, but cumulatively important roles make them essential though to the significance of the historic district.

In the 2000 Historic Properties Inventory Form, Carey & Co. evaluated the E-MAD facility and found the resource a "contributor to NRDS District." Reno et al. (2019a) agreed with this recommendation regarding E-MAD and later made the same recommendation regarding Test Cell C (Reno et al. 2019b). Since 2019, the NRDS has been managed as an undefined National Register-eligible historic district and Test Cell C as a historic district within that larger entity.

The E-MAD Building and the Test Cell C Historic District (D346) have previously been determined eligible to the NRHP at the national level of significance under criteria A, C, and D through consultation between the SHPO and the Department of Energy (Reed 2019, Reed 2020). Several other major components of the district, including Test Cell A, R-MAD, the Jackass and Western Railroad, and the RMSF have previously been found individually significant under criteria A and C. These resources are also now recommended as contributing to the NRDS Historic District.

The purpose of the present report is to record and evaluate the proposed NRDS Historic District using the Secretary of Interior's Significance Criteria and aspects of integrity. During this project, DRI limited evaluation of the identified elements as either contributing or non-contributing to the NRDS district. The period of significance for the NRDS Historic District extends from the initial boundary survey in 1956 through the end of nuclear rocket development on January 5, 1973. Therefore, identified elements within the district boundary dating from 1956 through 1972 and retaining sufficient integrity to convey their significance were considered contributing. Elements in the NRDS Historic District that either lacked integrity or were constructed outside the period of significance were recommended as non-contributing. However, it is important to note the continuing use of facilities after 1972 (e.g., E-MAD, CSA, ETS, and the RCP) for other projects, which may be associated with important contexts unrelated to nuclear rocket development. Within the scope of this current project, DRI was not able to fully research these contexts. However, DRI anticipates further research at the subdistrict level may expand the period of significance for some facilities.

When considering landscape design, originally the National Park Service (NPS) had picturesque grounds designed entirely for aesthetic appeal either from romantic English garden or French formal garden archetypes in mind. In recent decades the concept has been expanded in practice to include designs such as the NRDS which were created for functional rather than sensory purposes. The NRDS is a rare example of what Gorman (2009) calls a *designed space landscape* that includes common elements such as remoteness, ties to ground transportation systems, and specialized structures designed specifically for rocket development. This constitutes a type of *designed historic landscape*. The NRDS exhibits elements of at least four of the types of designed historic landscapes identified by the NPS: institutional grounds; city planning or civic design; planned communities; and commercial and industrial grounds (Keller et al. 1992:2).

Areas of Significance

The NRDS is a complex creation involving at least nine of the general Areas of Significance recognized by the NPS (1991, *National Register Bulletin* 16A: 40-41). These are discussed briefly below.

Architecture

As discussed under Criterion C, the NRDS has a suite of architectural types developed specifically for the program, including the maintenance, assembly, and disassembly buildings and the three test stands. It also has a well-preserved collection of fundamental building types and styles considered appropriate for such a test facility.

Community Planning and Development

The NRDS exhibits a planned industrial community with a complete emphasis on a commuter work environment. Its elements exhibit a classic block system of development at the CSA, linear roadside development near Gate 500, semi-radial functional plans at the two test cells, and directional linear development at ETS-1.

Engineering

Nuclear Testing

The NRDS was integral to the successful development of one of the marvels of modern engineering, a nuclear rocket engine capable of reaching the outer planets at much greater speed and ultimately less cost than conventional rockets. In addition to the rocket components themselves, many specialized handling and analysis devices had to be engineered as part of the program including the anthropomorphic Beetle robot which unfortunately no longer exists. Many of the engineering developments from this program have been adapted to subsequent space exploration programs.

Exploration

MAN IN SPACE

In 1980, the 96th U.S. Congress passed legislation that, in part, would ultimately task the NPS with identifying historic sites and events emblematic of America's space program. Section 18 of Public Law 96-344 focused on the development of a new unit of the national park system commemorating the historical theme of "Man in Space." The NPS quickly responded to the legislation by initiating a reconnaissance survey of sites associated with the early space program the following year (NPS 1981).

By 1984, the NPS had produced its national historic landmark theme study and identified 13 key NASA field centers involved in the country's early space efforts (Butowsky 1984; NPS 1987). The NPS selected multiple space program resources worthy of designation as national historic landmarks at 11 of the NASA facilities. According to the report, the remaining two NASA installations "no longer existed" one of which was the Nuclear Rocket Development Station in Jackass Flats, Nevada (Butowsky 1984). That statement, however, was only partially accurate. From the start, NRDS had been a joint AEC and NASA installation and experienced all the challenges of an entity with two competing management styles. Although the nuclear-powered rocket program had indeed been terminated in January 1973, most of the NRDS buildings and infrastructure remained intact for much of the next two decades. Unfortunately, the assumption that "NRDS no longer existed" would alter its preservation trajectory, overlook the value of its scientific contributions, and delay its recognition as a significant property important to the history of America's early space program. As a matter of fact, when several components of NRDS were finally acknowledged as significant resources in the late-1990s, their initial evaluation was driven more by the 1991 Department of Defense Appropriations Act requirement to identify Cold War-era resources of national importance (Public Law 101-511, Nov. 5, 1990) than by the earlier "Man in Space" legislation.

Dynamic, complicated, and often contradictory, the story of the Nuclear Rocket Development Station is much too complex to be captured in a single compliance report. Fortunately, author James Dewar spent more than 30 years researching the U.S. nuclear rocket propulsion efforts and produced a comprehensive history of the Rover Program (Dewar 2004). His detailed account informed much of the research and helped guide the approach taken to recording the structures scheduled for decontamination, decommissioning, and dismantling.

Invention

Nearly everything about the nuclear rocket had to be invented or at least heavily modified. Existing engineering solutions to such simple matters as gaskets and sealants failed in a radioactive environment and had to be reinvented. Ways had to be found to construct huge dewars in the field. Liquid hydrogen turbopumps had to be created to operate under unprecedented pressures and volumes. Reactor elements had to be reengineered innumerable times as the tests proceeded. The list goes on and on. There were drafting facilities on site to make drawings of the many new items needed, many of which were then crafted at shops scattered all about the NRDS.

Military

The ROVER program started as a partly military venture which only became fully civilian when it was deemed that conventional missiles adequately fulfilled military requirements.

Politics/Government

FEDERAL GOVERNMENT

Although nearly all work at the NRDS was done by civilian contractors, its programs were run by numerous governmental departments and agencies, particularly the Space Nuclear Propulsion Office. The programs never run smoothly. The tangled bureaucratic and political battles are alluded to in the discussion of Clinton Anderson in the section on Criterion B and form the basis of the amazingly intricate analysis of political history of the program by James Dewar (2004). At a more local level, the strenuous efforts of Nevada Senator Howard Canon to bring federal programs such as Rover to the state and keep it here comprise a worthy subject of study, made even more interesting by his close personal and professional relationship with Anderson.

Science

Much of the NRDS is directly concerned with applied science but the one form of research that is prominent aside from the main mission is research into the still little-known behavior of radioactive materials and a variety of contaminated materials through time. Massive amounts and varieties of data on this topic have been accumulated through the years during and after the active operations of the NRDS. This database received another major enhancement from radiation monitoring throughout the region conducted as part of the Yucca Mountain Project. There are also records regarding long-term exposure levels and effects on site workers and on the biota of the area.

Transportation

The purpose of the NRDS was to create an entirely new mode of regular transportation using nuclear rocket propulsion. An additional transportation-related topic is how creation of the NRDS directly resulted in construction of one of the earliest sections of north-south running four-lane highway in the state of Nevada.

National Register Evaluation

The following section evaluates the NRDS Historic District against the Secretary of Interior's NRHP Significance Criteria.

Criterion A

To be significant under Criterion A, a property must be directly associated with events that have made a significant contribution to the broad patterns of our history. The NRDS is primarily significant for its role in the Space Program in forwarding the concept of nuclear rocket propulsion. The NRDS complex remains a touchstone for the American space program because it marks the beginning of U.S. efforts to harness the power of the atom for interplanetary travel. To visit the NRDS Historic District is to journey back in time—to stare in awe at the towering steel and concrete creations unique to the country's only field-testing area for nuclear propulsion technology. It was a bold concept, confidently pursued by hundreds of scientists, engineers, and technicians cognizant of the obstacles and challenges that lay ahead, but driven by the age-old human desire to explore and excel.

The buildings and structures of the NRDS continue to embody the hopes and aspirations of the first nuclear rocketeers and provide inspiration for their twenty-first-century counterparts with a dream of climbing aboard nuclear-propelled launch vehicles to orbit Mars, fly past Mercury and Jupiter, and travel on to the outer reaches of the solar system.

Criterion B

The critical aspect of National Register eligibility under Criterion B is that the resource be directly associated with an important aspect of the career that makes that person's achievements worthy of note (NPS 1989).During its nearly 18-year history as the proof-of-concept ground-test facility for the joint AEC/NASA Rover and NERVA nuclear propulsion development programs, Nevada's NRDS complex generated a vast amount of scientific data. Those data and the experiments conducted at the facility are a testament to the vision of a group of dedicated scientists and a handful of forward-thinking politicians that resulted in the successful completion of multiple nuclear reactor and engine tests confirming the viability of a nuclear propelled rocket. There are many individuals—scientists, technicians, administrators, and politicians—that supported this effort, including some whose professional careers are closely tied to the Rover and NERVA programs.

However, the Honorable Clinton P. Anderson, U.S. Senator for New Mexico (Figure 94) stands out for his unwavering support of the Rover Program and the NRDS ground testing facility and the critical role he played in securing the funding for both (Dewar 2004:86-87). A convincing argument can be made that his passionate backing and vigorous public advocacy for the nuclear rocket program combined with his political influence and skill in navigating the competing interests in Washington DC were key to the establishment and operation of NRDS over the course of its history. For all that he accomplished during his time in national politics, he is best remembered for the nuclear rocket program and his support for conservation issues (Anderson 1970; Baker 1985; Dewar 2004).

Figure 94. U.S. Senator Clinton P. Anderson
(U.S. Department of Agriculture).

Clinton Presba Anderson was born in 1895 in Centerville, South Dakota but migrated to New Mexico in 1917 to recover from a near fatal case of tuberculosis. He fell in love with the state and never left. Within two years of his arrival, he began a long and distinguished career in public service. Anderson cultivated diverse business and political contacts, first at the local and state level and then in Washington DC. Beginning in 1940, he was elected to three terms in the U.S. House of Representatives. Then, shortly after becoming president in 1945, Harry S. Truman appointed Anderson to serve as his Secretary of Agriculture. When U.S. Senator Carl Hatch retired in 1948, Anderson's fellow New Mexicans pressed him to run for the Senate. He did and won (Anderson 1970; Baker 1985).

Anderson entered the U.S. Senate in January 1949 with two other fellow Democrats, freshmen Senators Lyndon Johnson and Robert Kerr (founder of Kerr-McGee Energy). They formed a lifelong bond that would enhance their political fortunes and influence allowing them to make significant contributions to policy decisions affecting a wide range of issues. All three men shared an interest in science, technology, and natural resources. They gravitated towards senate committees focused on these areas (Anderson 1970; Baker 1985, Dewar 2004). While Kerr concentrated his early legislative efforts on fossil fuels, water issues, and public works, Anderson maneuvered himself onto the Joint Atomic Energy Committee (JCAE) during his freshman term—not surprising because of Los Alamos National Laboratory's preeminent role in nuclear research and weapons development. Johnson also joined the JCAE to advocate for the Pantex Plant in Amarillo, Texas which was a key component in U.S. nuclear weapons production. However, Johnson's career took a slightly different trajectory with a rapid rise through the Democratic leadership ranks ascending to Senate minority leader in 1953, Senate majority leader in January 1955, Vice President in 1961, and President in 1963. Most of his committee assignments were abandoned until the creation of the new Senate Committee on Aeronautical and Space Sciences was established in 1958. Johnson would serve as its first chair. As Majority leader, he selected Anderson and Kerr to join him knowing they would be active and influential members. Robert Kerr took over the chairmanship when Johnson became Vice President in 1961, and Anderson became the committee's third chair holding the position from 1963 until his retirement in 1973 (Senate Historical Office 2021).

A thorough review of the proceedings from the appropriation hearings for the Senate Space Committee and the JCAE as well as the AEC's Annual Report to Congress documents Senator Anderson's unrelenting support for Los Alamos' Rover Program and the nuclear rocket reactor testing site in Nevada (AEC 1956, 1957, 1958a, 1958b, 1960, 1962, 1963, 1964, 1965, 1967; U.S. Congress 1959, 1960, 1961, 1962, 1963a, 1963b, 1964, 1965, 1966, 1968, 1969, 1970). During his 15 years on the Space Committee and especially after he became the chair, he succeeded in guiding much of its agenda. Anderson also held the chair or vice chair position for the JCAE through multiple rotations beginning in the mid-1950s. His chairmanships in 1955 and 1957 were especially important for moving the Rover Program forward by getting the initial subsidy to begin reactor development and field-testing infrastructure. It was his influence that ensured LANL, his home state laboratory, would lead the project and that their preference for Nevada ground test facilities prevailed over a site in Idaho (Dewar 2004:30-31). In his leadership role, Anderson recruited experts to help him understand the science and craft sound arguments to support continued funding of the Rover program and the NRDS. He also used this knowledge to solicit public backing for the Rover program by penning opinion pieces in the popular press touting the benefits of nuclear rocket propulsion arguing it was the only way to beat the Russians in the space race (Anderson 1962).

When those tactics proved insufficient, Anderson turned to his considerable political skills and powerful allies to keep the program going (Figure 95). Not surprisingly his most successful period of influence was during the Kennedy and Johnson administrations, when Anderson's close personal relationship with Johnson provided significant dividends for the Rover Program and NRDS.

Figure 95. President Kennedy, LANL Director Norris Bradbury, and U.S. Senator Clinton Anderson during a stop in Los Alamos to view the Laboratory's progress on the development of the Rover program reactors before heading to Nevada to view the NRDS testing facilities in December 1962 (LANL).

Even after Johnson left office, the Senator's persistence and other political connections probably extended the Rover Program and NRDS funding, albeit greatly reduced, by at least three to four more years. That he persisted in the face of increasing animosity from the Nixon White House and was able to accomplish this when the Vietnam War, rising energy costs, and the new Medicare program were taking an increasingly larger share of the federal budget is remarkable. It is no coincidence that the Nixon Administration's announcement ending the program and the NRDS operations was released in January 1973, just days after Anderson retired from the U.S. Senate, finally forced out of office by his rapidly failing health (Dewar 2004).

In his autobiography, Anderson described his efforts on the space program as the most significant contribution of his political career (Anderson 1970). Others too have noted the importance of his involvement with the space program. In 1977, two years after his death, Anderson was inducted into the International Space Hall of Fame. The induction proclamation noted he had distinguished himself as a leading proponent of space exploration and one of the programs he was most closely identified with and supportive of was Project Rover (*Las Cruces Sun-News* 1977:6).

Senator Anderson's association with and advocacy for nuclear rocket propulsion, the Rover Program, and the NRDS testing facility in Nevada lasted the entire length of their operational life. He courted, cajoled, and sometimes coerced his fellow legislators, agency bureaucrats, cabinet members, and the White House to secure funding to advance the science that he was convinced would one day carry humans to distant planets. While he made no scientific or technical contributions to the program, his involvement was crucial to its existence and was a hallmark of his political career. The NRDS Historic District is a tangible reminder of the tenacity of Anderson's commitment to America's exploration of space and his belief that the power of the atom could be harnessed for peaceful purposes that would benefit all humankind.

As noted above, the critical aspect of National Register eligibility under Criterion B is that the resource be directly associated with an important aspect of the career that makes that person's achievements worthy of note. Most of the individuals important at the national level to the nation's nuclear programs or other programs that were tested or developed at what is now the NNSS had far more important ties elsewhere, such as at the Los Alamos or Lawrence Livermore National Laboratories. Although many of these individuals spent time at the test site, it was often for short visits to monitor test results. The contributions and careers of some of these individuals, such as Senator Clinton Anderson and Los

Alamos physicist George Grover, the Rover program inventor of the "heat pipe," are closely tied to the NRDS as a whole so that significance is best considered at the level of the NRDS Historic District rather than in relation to the various smaller subdistricts or individual resources within them.

The nature of complex modern research programs such as this one makes it extremely difficult to identify individual contributions in what is essentially a collaborate effort among members of an extensive team. Dewar (2004:255) emphasizes this general development as it relates to the NRDS:

> *The heart of the solid-core nuclear rocket engine, its most important and difficult part, is the fuel element, and its development was so complex and subtle that it was more of a "black art" than a materials science. Experts from all over the United States and overseas labored intensely on it, so this survey cannot emphasize their individual contributions but instead illustrates how teams worked together in modern research and development programs, a contrast to a century ago when individual scientists made the breakthroughs.*

Despite these considerations it is likely that individuals of importance to specific operations at the various subdistricts could be identified, particularly at the more local level, with further research. Some possible examples in relation to E-MAD are suggested in Reno et al. (2019a). Presently however, none have been found that compellingly indicate their individual contributions at a single facility warrant eligibility under this criterion. Anderson remains in a class by himself.

Criterion C

Properties significant under Criterion C must embody the distinctive characteristics of a type, period, or method of construction; represent the work of a master; possess high artistic values; or represent a significant and distinguishable entity whose components may lack individual distinction. The massive, iconic structures of the NRDS capture the technology of the beginnings of space travel in the last half of the twentieth century and its companions in conventional space travel, such as the launching gantries at Cape Canaveral or the Vehicle Assembly Building in Houston, which owes its great height to being designed to accommodate a nuclear-powered upper stage (McGee 2019).

As noted above, the NRDS Historic District and its contributing elements are recommended eligible to the National Register under Criterion C. Mission-related buildings and structures are significant under this criterion as representative examples of the types of architecture used for conducting research with nuclear reactors and engine components designed for space flight.

Architecture throughout the NRDS, in common with the rest of the NNSS, is characterized throughout by strict functionalism. Mission-oriented structures are designed and organized in ways mandated by the flow of critical materials, such as liquid hydrogen, to fuel the engines and to safely ensure command and control of the test along with receipt of test results to monitoring facilities.

Selection of the starker varieties of Modern architecture such as Brutalism, was mandated by lack of funds to attempt anything beyond pure function. It happens that the materials and requirements of interior room distribution and shapes essentially self-organized into a Brutalist creation with none of the inappropriate excesses in this direction for the sake of appearances that sometimes mar architect-designed buildings. Regarding the stark massing of industrial elements that comprises several entire complexes, particularly the maintenance, assembly, and disassembly buildings and test stands, Constructivism is starkly recalled. In many ways the complex is also a Futurist fantasy brought to life in the desert. The various parts of each individual test stand are tied together by bewildering amounts of pipes, all of which had to be subjected to extreme quality control measures, particularly the vacuum-jacketed cryogenic pipes.

Its functional character is largely influenced by the fact that it was largely designed by engineering firms or laboratories. For example, at Test Cell C the only building designed by an architectural firm was the Operations Building (25-3229) by Bryant, Jehle & Associates, Architects & Engineers, of which only the foundations now exist.

Two buildings that go beyond simple functionalism at the NRDS are the Contemporary style Administration and Engineering Building and New Reactor Control Point Cafeteria. Both are fine examples of their types. They are not nationally important exemplars of the style but at the more local level they were two of the finest buildings on the former Nevada Test Site. Modifications, particularly of the former building, have degraded their integrity but they remain major contributors to the NRDS Historic District and their respective subdistricts.

Selection of Moderne styling for the highly significant Control Point Building is a true curiosity. However, due to major external and internal alterations its significance is much more under Criterion A than Criterion C, but it too is a major contributor to the NRDS Historic District.

An essential consideration of the NRDS in relation to this criterion is its rarity. This is the only example of a facility for field testing nuclear reactors for the purpose of space flight in existence during this period in the United States.

Criterion D

To be significant under Criterion D, a property must have yielded or be likely to yield information important in prehistory or history. It is rare for an architectural resource to warrant eligibility for its research potential, but a strong case can be made for the NRDS. The high temperature levels and radiation levels produced by the nuclear reactions at the test stand facilities play a role in studying the behavior of materials under extreme conditions and provide information for the development of material science and environmental monitoring technologies.

The NRDS was initially designed with the intention of containing high levels of radiation while still allowing personnel to safely work near radiation sources. The success of this design has been exhaustively documented because of the intensive radiological monitoring conducted during its periods of active use. Monitoring, including personal dosimetry of all workers potentially exposed to radiation, has continued to present. Monitoring also includes radiological surveys of the surrounding areas.

The NRDS presents many decades of research findings and ongoing investigation of methods and the efficacy of such methods for decontamination. The advantage of such an extended duration study is that decontamination efforts that appear to be effective in the short term can be far from successful in the long term because deeply penetrated radiation sometimes re-contaminates surfaces that were thought to be fully decontaminated. A recent study by McGee (n.d.) exploits this research potential by using Test Cell C as a test case for using gamma-ray spectrometry to assess radioactive contamination at abandoned nuclear testing facilities. Questions regarding radioactive containment are important in relation to the various medical and industrial uses of atomic energy. Decontamination issues could become critical in the case of nuclear engineering accidents, or in this age of nuclear weapon proliferation, the intentional detonation of a nuclear device or intentional contamination with nuclear materials.

Integrity

To be eligible for listing a property must retain sufficient integrity to convey its significance. The NRHP recognizes seven aspects of integrity: setting, location, design, materials, workmanship, feeling, and association.

The NRDS amply retains all seven aspects of integrity to the extent that they convey their significance to the present observer. However, many individual resources have had their integrity reduced over time, some to the extent they no longer exist at all. In addition to the usual deterioration of buildings and structures caused by passage of time, many of which have had minimal or no maintenance for years, there are several specific natural events and human forces which have had a notable adverse effect on the integrity of these resources.

The most widespread natural impact on integrity has been periodic flash floods. The designers of the NRDS grossly underestimated the power of these floods on the normally arid landscape of Jackass Flats. As noted earlier, various flood control features were built into the facilities as needed. It was only by great good fortune that no major floods occurred during the active use of NRDS throughout the period of significance. The vulnerability of the place to flooding was dramatically demonstrated on October 18, 2015, when a major flash flood event swept through Jackass Flats. In a few hours most of the access roads, particularly unpaved ones, were rendered unusable. Some facilities such as the office trailer park at ETS-1 were obliterated. Flooding undermined or covered railroad tracts with sediment in numerous places. The boundary fence at the RMSF was so deeply undercut that it became possible to walk beneath it. E-MAD was heavily damaged as water and sediment filled the lower levels of the building and one wall was breached as is documented in Reno et al. (2019a e.g., Figures 91-96). Changes in the local landscape caused by the flood ensured that subsequent comparatively minor rainstorms would continue to flood the facility.

Since most of the temporary portable buildings and trailers were removed from the NRDS after its abandonment, wind damage is not as severe as it is at Area 12 Camp. However, there are some striking instances of wind damage. The most extreme example is Photo Tower NRDS7. This is a strongly built steel structure set in concrete foundations which has been thrown to the ground by what must have been hurricane-force winds. Less dramatic but more dangerous to the visitor are sheets of metal siding torn off the sides of unmaintained buildings and structures such as ETS-1 and E-MAD. These buildings are particularly dangerous during winds since siding is being torn off upper stories.

By far the most powerful impact on integrity at the NRDS is not natural but is instead the cumulative effect of years of removal or demolition of buildings and structures. Many buildings and structures such as the large Technical Shops Building at the CSA were removed for reuse or sale as surplus or were destroyed before active cultural resources management was gradually extended to what is now the NRDS Historic District. In most cases building foundations were left intact and continue to demonstrate the relation of the removed building with the rest of the district. Only rarely, as at the Jr. Hot Cell at R-MAD or the Access Tunnel at Test Cell A were all traces of the buildings and their foundations removed, leaving nothing more than scars on the landscape.

Similarly, many infrastructure elements such as septic systems and the MX Landfill were completely altered to the extent that they were not worth formally recording due to their treatment as Correction Action Units (CAUs). Their present appearance is simply a bladed area accompanied by CAU signage and perimeter fencing if they contain hazardous materials.

Location

All elements of the NRDS still at Jackass Flats retain fully integrity of location. Examples of elements that no longer retain location integrity are the L-3 railroad engine formerly stored inside E-MAD (moved to the Southern Nevada Railroad Museum at Boulder City) and objects relocated to the Atomic Testing Museum at Las Vegas.

Design

The case for a NRDS district is unusually compelling because practically every cultural feature in sight, except for some support buildings and structures built for the MX Project, was designed and constructed specifically for the Rover/NERVA programs, including the roads, water wells, water tanks, the Jackass and Western Railroad, the control center, the two maintenance, assembly, and disassembly buildings, the two test cells, and the Engine Test Stand 1. Later programs in the NRDS area have almost universally re-used existing buildings and structures. Thus, the district is almost entirely lacking the construction of elements post-dating the period of significance.

Setting

One only needs to recall images of tiny historic buildings dwarfed by modern skyscrapers or former farmlands awash in suburban sprawl to appreciate the immense contrast with the pristine setting of Jackass Flats. All resources retain the large buffer area of relatively undisturbed land which was integral to the design of the district. Introduction of developments within these open spaces would have severely degraded the setting but as it is, the quality of this aspect of integrity is superb. This integrity is not limited to the physical boundaries of the district but extends in all directions all the way to the visible horizon.

Materials

Due to the period when it was built, the NRDS lacks the wooden buildings characteristic of early construction at Mercury and Area 12 Camp. Instead, they are almost universally built of concrete, concrete block, or metal. A few buildings are earth-covered. Where special materials, such as exposed aggregate or scored concrete block, were utilized for special effects in the Contemporary style buildings, the original material is still exposed and not covered by stucco as was so often the case at Mercury. In most cases, metal buildings that were originally unpainted continued to survive in this state, avoiding the brown paint which has obscured original materials at Mercury. Distinctive examples showing usage of various building materials at NRDS, ETS-1 and E-MAD are shown in Figure 96.

The test stands and the maintenance, assembly, and disassembly buildings exhibit special use of exotic materials for use in a radioactive environment. Examples in the E-MAD building are the oil-filled lead-glass windows between the hot bays and surrounding operating galleries. Another example is the miles of specialized insulated stainless-steel piping needed for transporting highly corrosive materials, often under considerable pressure.

Figure 96. Examples of distinctive use of materials at the NRDS.
Top: Stainless steel pipes and aluminum structure at ETS-1 with retrofitted seismic shoring in foreground (Photo 2116_0118), pink concrete block building at Well J-11 (Photo 2116_7340), exposed aggregate at the Administration and Engineering Building (Photo 2116_0996, all DRI 2021).
Bottom: Concrete, concrete block, and metal of E-MAD south elevation (Photo 1905_1545, DRI 2019).

WORKMANSHIP

A piping photo shows the precise welds needed to secure cryogenic piping (Figure 97). Also shown is one of the accordion-style expansion joints that were essential to keep these piping systems from tearing themselves apart due to temperature fluctuations. Such welds were particularly difficult to achieve in field conditions and were subject to an extensive quality control system. Extremely demanding workmanship was required for successful field construction of the massive liquid hydrogen dewars as was noted in Chapter III. Even more demanding was construction of the rocket exhaust duct at ETS-1. This district qualifies as eligible under Criterion C, so it is worth quoting Dewar (2004:174) at length:

ETS-1's duct, however, had much higher heat fluxes that required faster rates of cooling, and it became a triumph of American blue-collar skills. The largest and most complicated stainless-steel welding project in the United States, it was 53 feet high and 56 feet long, used 120,000 pounds of stainless steel and 8,700 pounds of welding wire, and had six and a half miles of welds. To transfer the heat, 234 thin-walled tubes (0.095 inch), each with a constantly changing thickness and none with the same dimensions as the other, were welded to an interior wall so smooth that dents or scratches deeper than 0.005 inch were prohibited. Three million gallons of water had to flow through these tubes during a run, fast enough to avoid being turned into steam. If that happened they likely would rupture.

Figure 97. High-tech workmanship. Cryogenic system components provide an example of high-tech workmanship (Photo 2116_0781, DRI 2021).

At the opposite extreme are simple items such as metal radioactive fallout collectors, many of which were built on site. These, along with brock houses and the hand painted REECo signs that are shown in many of the illustrations with this report, represent the handiwork of individual artisans, but these items are the exception at NRDS and the rest of the NNSS. Here, the normal evidence of good workmanship is the complete anonymity of the workers as they erected prefabricated buildings and constructed others using systems of concrete block or formed concrete. Exceptionally, one crew of workers celebrated the anniversary of a full year on the job by signing a concrete slab at the Reactor Control Point (Figure 98).

Figure 98. Slab in the Reactor Control Point Maintenance Area signed by a crew celebrating a year on the job on 7/15/64 (Photos 2116_9534-9544, DRI 2021)

Association

Association is the *direct link* between an important historic event or person and historic property. This link must convey this relationship to the observer. Here the mission-specific elements of the district with obvious space travel or reactor technology relevance are of prime importance (Figure 99). The NRDS abounds in such linkages but the ones that make the most impact are the Phoebus Engine Mockup, the actual place where nuclear rocket engines were mounted in ETS-1, and the futuristic designs of the reactor test cars preserved at the RMSF. The sheer size and complexity of the task of handling these nuclear rocket components is dramatically shown throughout E-MAD.

Feeling

Feeling is a property's expression of the aesthetic or historic sense of a particular period. As such, it really constitutes a summation of all other aspects of integrity. As shown in Figure 100 thanks to this integrity of feeling it is easy once one has become familiar with the history of the NRDS to gaze upon Jackass Flats as a whole, or close-up at any of the facilities within it, to have a real sense of what it was like when it was alive with activity as crews raced to develop a vehicle capable of carrying humans to Mars and beyond. It is even easier to fall into a retrospective reverie about the place and the aspirations that created it when low angle evening winter light selectively illuminates the isolated other-worldly complexes of buildings and towers against the livid red – almost Martian – backdrop of the Calico Hills (Figure 101).

Another way to obtain a little more of the feeling of the place and its activities is by sampling some of the many movies made about the NRDS and later projects. Some of the more useful and easily viewed videos are listed at the end of the references.

Figure 99. Examples of places in the NRDS Historic District that overwhelm the visitor with its direct association with the nuclear rocket program.
Top: Phoebus Engine Mockup (Photo 2116_2282), The engine mount in ETS-1 (Photo 2116_0165), Radioactive contamination signage (Photo 2116_2308, all DRI 2021).
Bottom: Reactor test cars at the RMSF (Photo 2116_2332, DRI 2021); the cavernous Hot Bay at E-MAD (Photo 1905_1625, DRI 2019).

Figure 100. Remnants of NRDS/Nevada Research & Development Entry Sign (Photo 2116_1623, DRI 2021).

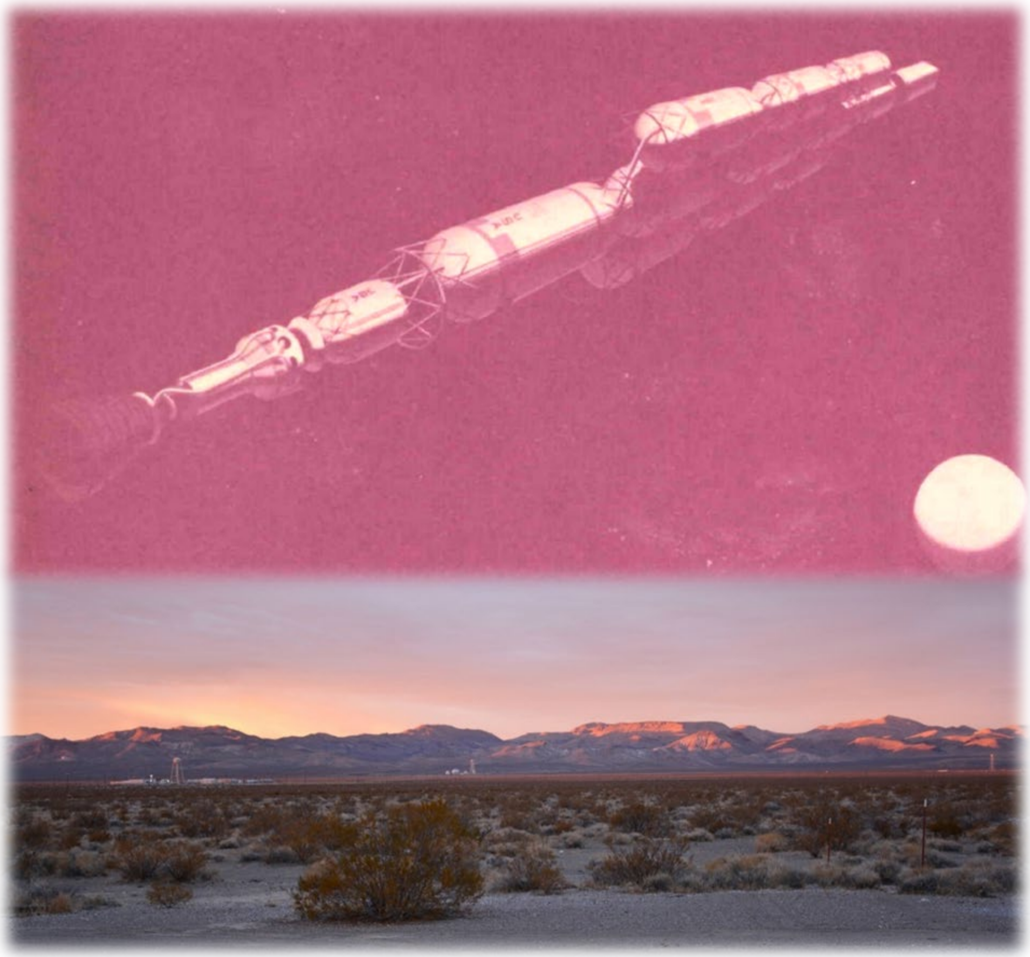

Figure 101. The NRDS and visions of travel to Mars and beyond.
Top: A nuclear NERVA engine on a routine space mission (concept drawing in Corliss and Schlenk [1971]);
Bottom: Overview of ETS-1, RCP, TCC, and TCA with the Calico Hills in the background (Photo 2116_1678, DRI 2021).

Summary Conclusion

The NRDS is eligible for listing in the NRHP as a Historic District under the Secretary of Interior's significance criteria A, B, C, and D. The NRDS district is eligible under Criterion A at the national level for its role in the Space Program and forwarding the concept of nuclear rocket propulsion from 1956 through 1972. It is eligible under Criteria B because it is directly associated with the career of the Honorable Clinton P. Anderson, U.S. Senator from New Mexico. Anderson stands out for his unwavering support of the Rover Program and the NRDS ground testing facility and his critical role in securing funding for both. The NRDS is also eligible under Criteria C for embodying the unique and distinctive characteristics of architectural types used for conducting research with nuclear reactors and engine components. The NRDS is a significant concentration of buildings and structures united by their role as a nuclear rocket development complex for space flight. Finally, the district is eligible under Criterion D for its research potential in studying questions regarding long-term radioactive containment and decontamination procedures. The NRDS Historic District retains all seven aspects of integrity and conveys its significance under criteria A, B, C, and D.

VI. NRDS Boundary Description

The NRDS Historic District comprises 7,115 acres in the eastern half of Jackass flats (Figure 102). It encompasses all the facilities constructed for the program and the intervening areas, containing an extensive network of roads, the railroad system, utilities, security checkpoints, minor installations, and a host of other scattered small structures. It also includes the RMSF, a facility for safely storing equipment with radioactive contamination.

The NRDS district boundary is an irregularly-shaped polygon that follows improved and unimproved roads, a railway line, utility lines, and the outside edges of the seven major NRDS facilities along the district perimeter. Chapter VII provides detailed descriptions of each subdistrict boundary.

Starting with the Communications Building (25-4101) at the southern end of the district and proceeding clockwise, the district boundary goes northwest along a communications line before turning west to encompass the Central Support Area subdistrict. From the Central Support Area, the boundary travels north, following Second Street N before turning west to trace the southern and western edges of the E-MAD Historic District. From E-MAD, the boundary continues north to the intersection with Road H where it jogs west to Road K before following Road K north to ETS-1. The boundary follows the western edge of the subdistrict before going north along a dirt road to include the water tanks high on the slopes of the Calico Hills.

After returning to the northern edge of ETS-1, the boundary follows the northern line of the Jackass and Western Railroad in an eastern direction to the Test Cell C Historic District and then the Test Cell A subdistrict. From this point, it follows a southeast bend in the rail line to the R-MAD subdistrict. From R-MAD the boundary turns west, following Road D to the rectangular Sandia Compound (C392), outlining the southern edge of the compound before continuing west along Road D to the Reactor Control Point subdistrict.

From the Reactor Control Point the boundary traces a utility line southeast to the Jackass Flats Substation, taking a slight jog to the west to include an animal shelter along the north side of Cane Springs Road. From the substation the boundary turns southwest to the Communications Building, closing the polygon.

The western half of Jackass Flats with only a few small NRDS-related resources is excluded from the recorded district. Two of the three deep wells (J-12 and J-13), which provided water for the program, are at the west edge of Jackass Flats where it meets Fortymile Canyon. The remaining well (J-11), with its suite of accessory resources, is within the district at the Central Support Area. Further to the southwest, outside the NRDS district, is the termination of the Cane-Spring-Lathrop Wells Road at Gate 510, which provides access to the NNSS.

The MOA stipulates that a district boundary be delineated based on archival research and the results of fieldwork and that the DOE will adjust the boundary, if necessary, in consultation with the SHPO. The DOE submitted a draft boundary report with supporting photographs, and the SHPO reviewed and concurred with the proposed district boundary and accompanying boundary report (Reno et al. 2021) on January 26, 2022, in fulfillment of Stipulation III.B.1 (Reed 2022a).

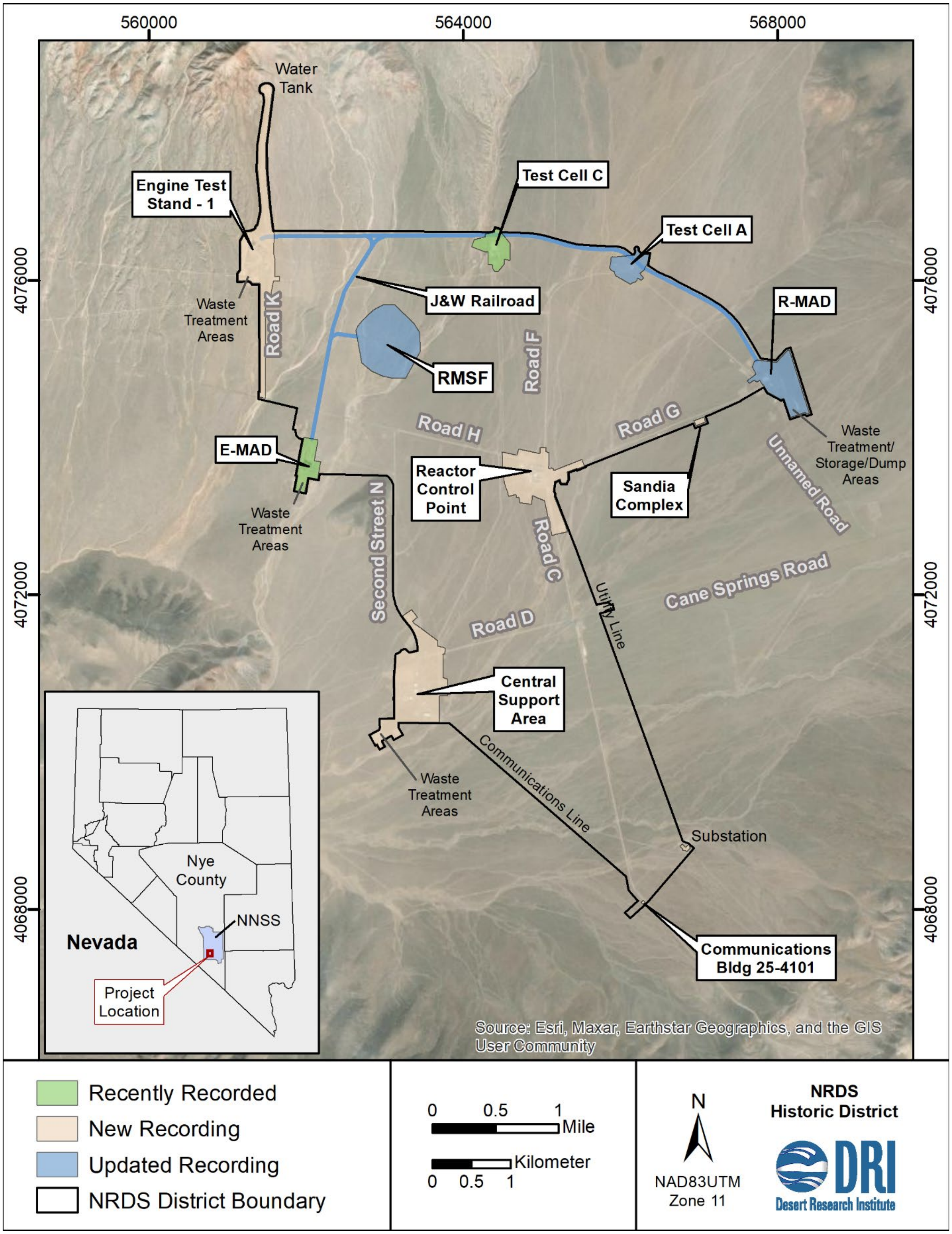

Figure 102. NRDS Historic District boundary.

VII. Contributing and Non-contributing Elements to the NRDS Historic District

The NRDS Historic District is recommended eligible for listing in the NRHP under all four criteria as the testing center for the Rover/NERVA (Nuclear Engine for Rocket Vehicle Application) program from 1956 to 1973. For the purposes of the NRDS architectural survey, resources within the boundary of the NRDS Historic District were evaluated to determine if they contribute to the significance of the district.

DRI recorded all buildings, structures, accessories, landscape features, and infrastructure within the district boundary. Resources constructed during the NRDS period of significance that retained sufficient integrity were considered contributing. Appendix A, Table A-2, provides a list of contributing and non-contributing elements of the district, including accessory resources, and provides additional information, such as the year built, architectural style, function, and property type. The ARA forms in Appendix B contain detailed information about each primary resource and its accessory resources.

The present survey only served to determine whether a resource contributes to the eligibility of the NRDS district. Resources are not evaluated individually for NRHP eligibility. Furthermore, potential historic contexts for activities post-dating NRDS, such as experiments for the disposal of radioactive waste, MX missile experiments, and training for non-conventional warfare, are not defined.

There are seven subdistricts within the larger NRDS Historic District that correspond to the major NRDS facilities (Figure 113). These provide a spatial, temporal, and functional framework for organizing the resources involved in NRDS operations. The wide separation of the seven subdistricts is a key aspect of the NRDS because distance was vital for worker safety when handling near-critical masses of radioactive materials and venting radiation to the atmosphere during reactor and engine tests.

Although the subdistricts are potential historic districts, developing historic contexts and evaluating each subdistrict for eligibility to the NRHP under the Secretary of the Interior's Significance Criteria (36 CFR 60.4) was beyond the scope of the current project. Therefore, five subdistricts are evaluated only as contributors to the NRDS district. The E-MAD facility was recently evaluated (Reno et al. 2019a) and is nearly synonymous with the subdistrict. Therefore, the E-MAD subdistrict is evaluated in this chapter and recommended eligible for the NRHP as a historic district. An additional subdistrict, Test Cell C, was previously identified and evaluated (Reno et al. 2019b) and determined eligible for listing in the NRHP as a historic district under Criteria A, C, and D in consultation with the SHPO (Reed 2020).

This chapter summarizes the resources identified within the NRDS Historic District, beginning with the subdistricts:

- Reactor Maintenance, Assembly, and Disassembly (R-MAD) subdistrict (D419),
- Engine-Maintenance, Assembly, and Disassembly (E-MAD) Historic District (D418),
- Test Cell A subdistrict (D421),
- Test Cell C Historic District (D346),
- Engine Test Stand 1 (ETS-1) subdistrict (D423),
- Reactor Control Point subdistrict (D420), and
- Central Support Area subdistrict (D422).

Each subdistrict section consists of an overview of the subdistrict context, a description of the subdistrict location and boundary, a synopsis of the resources identified within the subdistrict, and recommendations. Following the NRDS subdistrict discussion, this report turns to the results of the identification of resources not within a subdistrict in the following sections: Radioactive Material Storage Facility (RMSF), Main Gate (G500) Area and Vicinity, NRDS Miscellaneous Resources, and Linear Resources.

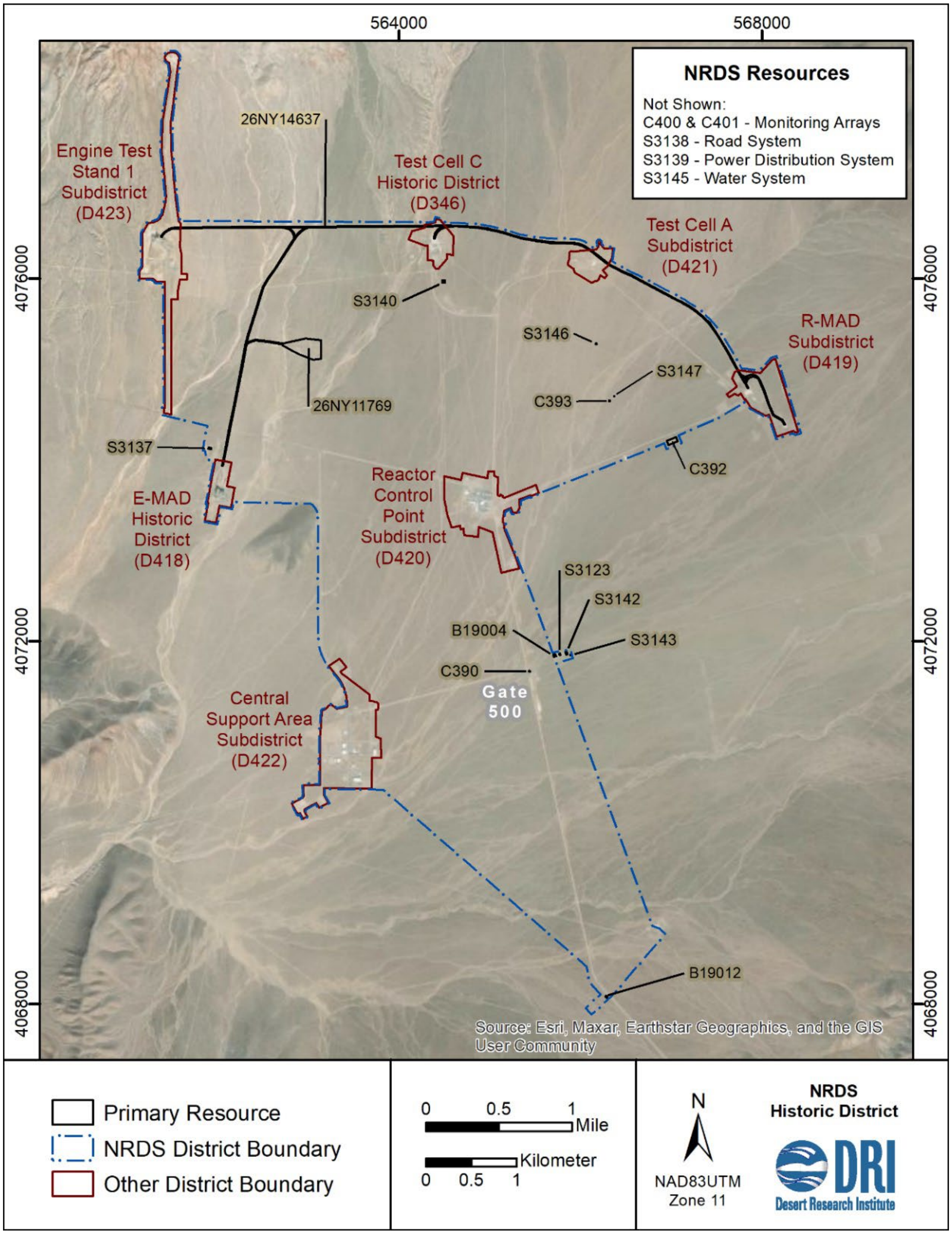

Figure 103. Resources in the NRDS Historic District.

Reactor Maintenance, Assembly, and Disassembly (R-MAD) Subdistrict (D419)

The R-MAD facility is where the early Rover program reactors used for the Kiwi and Phoebus series were developed and assembled and where the remote inspection of reactors occurred after tests. The R-MAD subdistrict possesses several interrelated resources united by their collective function of testing nuclear reactors for rocket propulsion.

Although the subdistrict was identified as a geographic area of contiguous elements, it was not evaluated as an NRHP-eligible historic district under any of the Secretary of the Interior's Significance Criteria (36 CFR 60.4).

The Jr. Hot Cell and the main R-MAD building were recorded in 1995 and 2000, respectively, as 26NY9277 (Beck et al. 1995; Drollinger et al. 2000). Constructed in 1958, Jr. Hot Cell C was used to prepare samples for radiochemical analyses following reactor tests. The main R-MAD building, also constructed in 1958, was a multi-room, concrete and metal building with approximately 61,290 square feet of floor space (see Figure 27 bottom). The "Beetle," a remote-controlled, self-propelled machine built by General Electric, was also housed at R-MAD and used for handling exposed radioactive equipment associated with the reactor tests. Operating from 1958 to 1973, the Kiwi, Phoebus, NRX (Nuclear Rocket Experimental), and Peewee test reactors were assembled and disassembled at the R-MAD facility. The Tory II-C reactor from the Pluto program was also stored here before it was transported to the E-MAD facility for disassembly. The original plan and layout of the R-MAD facility is shown in a c. 1965 aerial photo (Figure 104) and in a historic plan map (Figure 105).

Figure 104. Overview of R-MAD, c. 1965 (Drollinger et al. 2000, Figure 6).

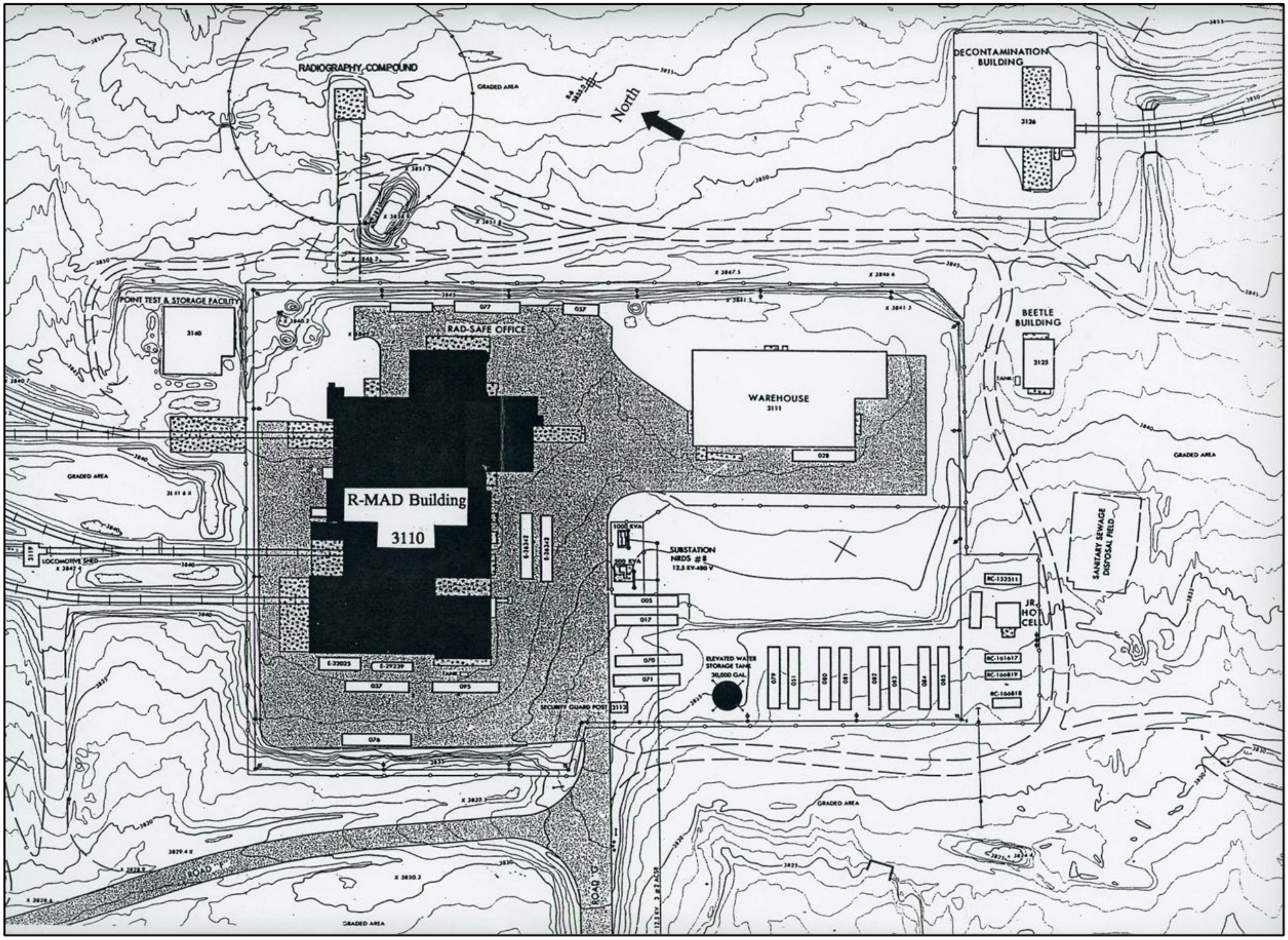

Figure 105. Historic plan map of the R-MAD facility (from Drollinger, Goldenberg, and Beck 2000b, see also Koogle and Pouls [1965]).

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Subdistrict Location and Boundary

The R-MAD subdistrict is located at the eastern edge of Jackass Flats at an elevation of 3,820 to 3,890 feet (Figure 106). It is accessed from the RCP via Road G and from Test Cell A via Road F. The Jackass and Western Railroad, which arches around the northern boundary of the NRDS district, terminates at R-MAD at its southeastern extent.

The subdistrict comprises 75.3 acres and includes the entire area within the existing perimeter fence and the adjacent fenced radioactive waste disposal facility (Figure 107). It also includes a diversion dike constructed upslope (east) of the complex to protect it from floodwaters. Sewage facilities downhill (southwest) of the facility are heavily disturbed and are not part of the district. Much of the terrain adjacent to the district boundary has been disturbed by activities in recent years, including the excavation of landfills created for previous demolitions of major buildings and structures.

Figure 106. Overview of R-MAD with the MX launch towers in the background, facing west-northwest (Photo 2116_2104, DRI 2021).

Resource Synopsis

In prior reports, the Jr. Hot Cell (26NY9277) and the R-MAD Building (25-3110, 26NY9277) were evaluated and determined individually eligible for the NRHP in consultation with the SHPO. The Jr. Hot Cell was eligible under Criterion A and the R-MAD building was determined eligible under criteria A and C (Baldrica 1995, Baldrica 2000b) (Table 8). The Jr. Test Cell and R-MAD buildings, as well as several outbuildings, were demolished as part of past deactivation and decommissioning programs. Currently, the R-MAD foundation is intact, but all traces of the Jr. Hot Cell have been removed.

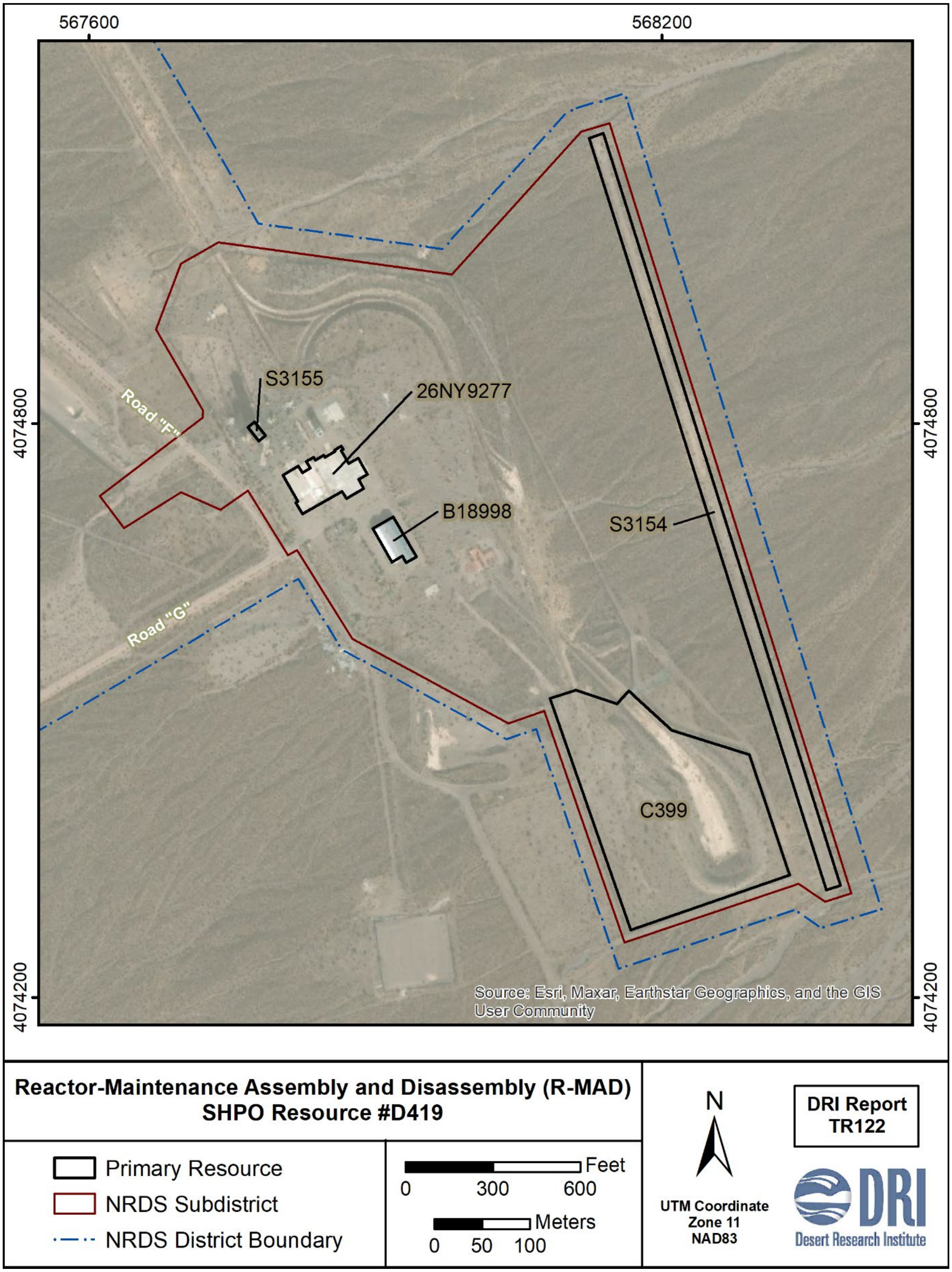

Figure 107. The R-MAD subdistrict boundary and identified primary resources.

Table 8. Previously Recorded Resources in the R-MAD Subdistrict.

Resource	Report No.	Author/Date	Purpose
R-MAD 26NY9277*	SR022900-1	Drollinger, Goldenberg, and Beck 2000b	Survey and Evaluation
R-MAD 26NY9277	HAER NV-29-A	NPS 2000a	Mitigation: Main Building. Only
Jr. Hot Cell 26NY9277*	SR032095-1	Beck et al. 1995	Survey and Evaluation

* Determined individually eligible

During this architectural survey, 5 primary resources and 11 accessory resources were identified within the R-MAD subdistrict boundary (Table 9). No remains were identified from the Jr. Hot Cell. The R-MAD Building (25-3110) exists today only as a foundation; however, two connected warehouses are still standing (25-3111, B18988). For this architectural survey, the remaining R-MAD slab foundation and three accessory resources were recorded as an update to 26NY9277. The warehouses were newly recorded as B18988. Three other newly identified resources are the Radioactive Waste Disposal Facility (C399), the floodwater diversion dike (S3154), and the MX Trial Launch Complex (S3155).

Table 9. Primary Resources in the R-MAD Subdistrict.

NNSS No. or Identifier	SHPO No.	Resource Name/ Description	Year Built	Contributing to NRDS	AR Total Count (# contributing to NRDS)*
Previously Recorded (update)					
Jr. Hot Cell	26NY9277	Jr. Hot Cell (demolished)	1958	N/A	
25-3110	26NY9277	R-MAD Building (demolished)	1958	N/A	
Newly Recorded					
25-3110	26NY9277	Foundation (formerly R-MAD building)	1958	Yes	3 (3)
25-3111	B18998	Warehouses	1958	Yes	0
RM1	C399	Radioactive Waste Disposal Facility	1958	Yes	0
RM2	S3154	Floodwater Diversion Dike	1958	Yes	0
RM3	S3155	MX Trial Launch Complex	1982	No	8 (0)

*See Table A-2 for a list and description of accessory resources and their NRDS contributing status.

Although the R-MAD Building has been removed, the presence of the building foundation and its three contributing accessory resources continue to demonstrate the relation of the removed building with the rest of the R-MAD facility. The newly recorded warehouse (B18988) provides an example of a 1950s-1960s prefabricated building and was used during the NRDS period of significance. Prior to construction of the Radioactive Material Storage Facility (26NY11769), R-MAD was the major facility for disposing of radioactive waste at the NRDS. It has a surrounding berm and perimeter fencing. A photo of how it now appears was introduced earlier (see Figure 45 top). The diversion dike for floodwater protection (S3154) is a linear feature with an adjacent ditch on the uphill side. The dike is approximately 2,100 feet long and extends upslope for the northeast end of the complex and ends just beyond the RMSF.

Today, the most impressive development at the R-MAD subdistrict is the MX Trial Launch Complex with its five-story modular launch tower (S3155) and eight accessory resources, including a missile maintenance scaffold, four photo towers, and an array of smaller structures. The facility was constructed in 1979 for use by Westinghouse, the MX contractor for the Ballistic Missile Office of the U.S. Air Force. The structure was designed for testing steam ejection technology to launch a solid-fuel ballistic missile out of a portable launch canister prior to igniting the rocket engine for flight. Five trial launches were conducted. The MX complex today looks much like it did when in operation. The Trial Launch Complex was associated with the Peacekeeper (MX) test program.

Recommendations

The R-MAD subdistrict is where the early Rover program reactors were developed and assembled, activities that were fundamental to the NRDS mission. Although the main R-MAD building has been razed down to its concrete foundations, the subdistrict retains its integrity. The fencing, lighting, rail components, electrical substation, warehouses, etc. are still present. Activities related to post-1973 operations in this area were primarily constructed to the north of the R-MAD facility and did not substantially disturb the older resources. The R-MAD subdistrict is recommended as a contributing element of the NRDS Historic District. In addition, four primary resources with three contributing accessories dating to the period of significance for NRDS contribute to the district.

The Peacekeeper (MX) Test launch complex (S3155) was constructed after the NRDS period of significance. Therefore, this resource and its eight accessories are non-contributing to the NRDS Historic District.

Previously, the Jr. Hot Cell and the main R-MAD Building were recorded as part of 26N9277 and determined individually eligible for listing in the NRHP (Baldrica 1995, 2000b). Due to demolition, these resources no longer retain sufficient integrity to convey their individual significance. This report recommends changing the determination of each demolished resource to not individually eligible.

Engine Maintenance, Assembly, and Disassembly (E-MAD) Subdistrict (D418)

In 2019, DRI produced a revised architectural survey report documenting the current condition of the E-MAD facility (Reno et al. 2019a). The DOE determined the E-MAD Building (25-3900, B4845) with its 28 contributing accessory resources was individually eligible for listing in the NRHP under Criteria A, C, and D and the Train Shed (25-3991, B17996) individually eligible for NRHP listing under Criteria A and C with SHPO concurrence (Reed 2019). Additionally, two rail cars parked on spurs within the E-MAD fenced facility, the MCC (S3058) and the EIV (S3057) were determined individually eligible for listing with SHPO concurrence on September 23, 1999 (James 1999). A recent survey documented the current condition of the rolling stock at E-MAD consisting of the L4, L5, F9, F5, F6, EIV, and MCC railcars (O'Neill and Wedding 2022), and the SHPO concurred the EIV and MCC remain individually eligible (Reed 2022b).

The E-MAD Historic District

The E-MAD Historic District possesses a significant concentration of interrelated resources with the distinctive E-MAD building serving as a focal point (Figure 108). The subdistrict is a definable geographic area, which conveys a visual sense of the overall environment of a NRDS testing center for maintenance, assembly, and disassembly of nuclear reactors for the NERVA program. Reno and others (Reno et al. 2019a) identified two periods of significance for the facility. The first extends from completion of the E-MAD building construction in 1967 to the end of nuclear rocket development program on January 5, 1973. The second is from 1977 through 1986 for the Spent Uranium Fuel (SURF) experiments. The SURF program was after the period of significance for the NRDS Historic District. Developing a potential context for spent fuel handling is beyond the scope of the NRDS survey. Therefore, the contributing status of resources associated with the SURF program are unevaluated for the spent fuel context.

The purpose of the current architectural survey is to record the NRDS district, which is recommended eligible for listing in the NRHP under all four criteria as the testing center for the Rover/NERVA program from the initial boundary survey in 1956 to the end of nuclear rocket development on January 5, 1973. Resources within the boundary of the NRDS district were evaluated to determine if they are eligible for listing in the National Register as district contributors. Subdistricts within the larger NRDS district were defined to provide a temporal, spatial, and functional framework for organizing the resources involved in the NRDS operations. Developing contexts for the individual subdistricts was beyond the scope of the NRDS survey; therefore, the potentially eligible subdistricts were not individually evaluated under any of the Secretary of Interior's Significance Criteria for eligibility to the National Register.

However, in the case of E-MAD, the E-MAD Historic District is nearly synonymous with the E-MAD facility, combining all the previously evaluated resources within the facility boundary into the subdistrict. These include the E-MAD building and its 28 accessory resources, the Train/Engine Transport System Maintenance Shed, and the rolling stock. The subdistrict boundary coincides with the perimeter fencing used to define the E-MAD facility and was only adjusted to provide a buffer along the perimeter fence line and to make a correction to the southern boundary to include an update of two previously recorded accessory resources (B4845 AR11 and AR13). In the current NRDS survey, no additional resources were newly identified.

The historic context, areas of significance, and significance criteria used to evaluate E-MAD extend to the subdistrict and are summarized below. The main context for evaluating this subdistrict is nuclear rocket development on the NNSS, and the appropriate theme within this context is the development of the E-MAD facility.

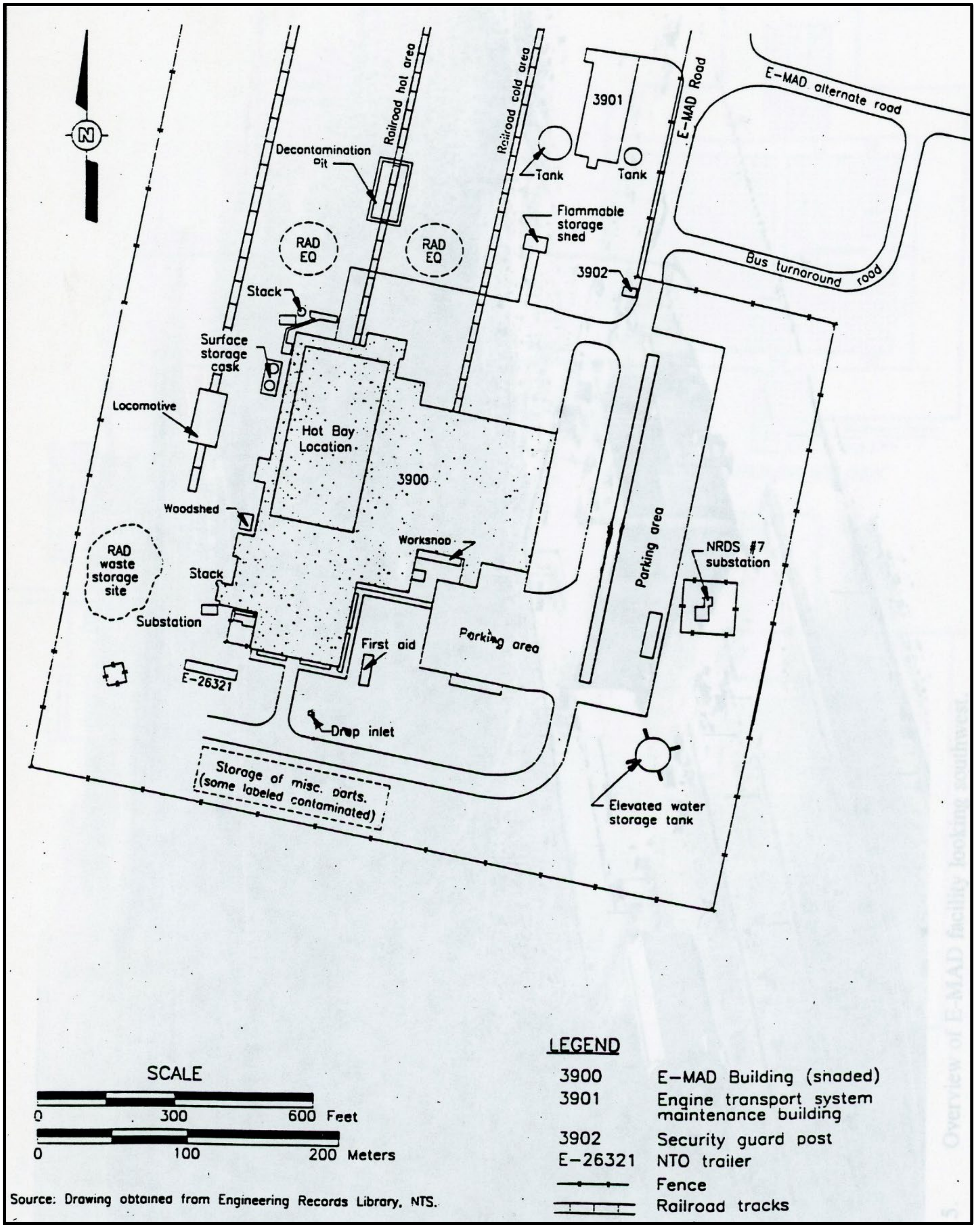

Figure 108. Plan map of the E-MAD facility (from Beck et al. 1996, Figure 4).

NUCLEAR ROCKET DEVELOPMENT AT THE NNSS

The primary mission of the NRDS at the NNSS was to support the Rover program in developing and field-testing nuclear rocket reactors and engines for the space program (AEC 1961a:69; House 1963; Miller 1984:1). The program was initially envisioned in three stages (Dyson 2002:23). The first stage involved three tasks: 1) to develop and test reactors to investigate and solve various problems in achieving a high-power density, 2) to develop and test reactor materials capable of withstanding high temperatures, and 3) to generate new concepts for converting nuclear energy into useful propulsion forms (AEC 1960:77). The second stage was to design and test a nuclear engine for actual flight, and the third stage, performed by NASA, was to incorporate the engine into a Saturn V launch vehicle for flight-testing (AEC 1964:109; Schreiber 1961:33). All these tasks were done in coordination with LASL and the private industry contractors that participated in the original Rover program and its second phase designated the Nuclear Engine for Rocket Vehicle Application (NERVA) program, which began in 1961.

DEVELOPMENT OF E-MAD

In September 1961, the AEC and NASA awarded a $6 million design and engineering contract for E-MAD to the Vitro Engineering Co., a division of Vitro Corporation of America, New York City (Missiles and Rockets (M&R) 1961a:12, 1961b:46, 1961c:47, 1961d:47, 1962:42). Once the Atomic Energy Commission and NASA accepted the initial design and engineering plans, bids were opened for the construction of E-MAD and several other facilities. The award was announced in February 1962, with the Catalytic Construction Company of Philadelphia named to build a group of structures at the NRDS in Nevada. In late 1963, the Rover program was revised, emphasizing ground-based research, engineering, and design. That left the Kiwi project unchanged, and work continued on the NERVA engine technology, but the planned RIFT stage—which was just awarded to Lockheed in 1963—was canceled (AEC 1964:110).

Aerojet, the NERVA program prime contractor, assumed full responsibility for E-MAD operations in 1966 and oversaw the gradual transfer of functions previously performed at R-MAD (*Santa Fe New Mexican* 1966:13). The E-MAD facility was built in two phases, both of which were planned from the outset. Construction of the first phase included most of the building, including the Hot Bay and Process Cells, and took place from 1962 through 1967. The E-MAD facility was first used for the NERVA XE engine assembly test in December 1967. The second phase included the construction of the Postmortem Cells and surrounding galleries. Funding was inadequate for construction of the administrative wing, so the Engine Receiving Room at the southeast corner of the Cold Bay wing was adapted into offices and continued in this use throughout the active history of the building. Drafting and other technical support office spaces were created by installing cubicle partitions along the second- and third-floor Operating Galleries. For security, wooden bulkheads separated the ad hoc office spaces from the active Operating Galleries. The Galleries had shielded windows that allowed personnel to view activities occurring in the Hot Bay. The Radiation Monitoring Room was built within the first-floor Operating Gallery. The entire expanded facility was first used in 1969. The Hot Bay, Hot Hold Tunnel, Process Cells, and Post Mortem Cells, which were connected and made up the central part of the west side of the building, as well as the two stacks and their associated components, were collectively referred to as the Hot Zone.

Successes with the nearly complete Rover test series , the ongoing NERVA engine ground tests, and good diagnostic data from the E-MAD operations underscored the technical strength of the program. Funding was secured to allow a continuation of the programs in FY1970 and FY1971 (U.S. Congress 1969, 1970). However, early in 1972, the NERVA project was canceled (AEC 1973:25). On January 5, 1973, NASA announced the end of its portion of the nuclear rocket program (Dewar 2004:192-203), and the entire NRDS program was phased out at the end of the fiscal year.

National Register of Historic Places Evaluation

Criterion A

To be eligible for the National Register under Criterion A, properties must be associated with events that have made a significant contribution to the broad patterns of our history. The E-MAD facility has previously been determined eligible for listing in the National Register under this criterion (Beck et al. 1996; Reno et al. 2019a; Reed 2019). E-MAD is significant for its role in the development of nuclear engine rocket technology during the Cold War era. The facility was responsible for maintenance, assembly, and disassembly of nuclear rocket engines to support the development of nuclear-powered rockets for space travel. The technology developed at E-MAD contributed to the advancement of the U.S. space program from 1967 (when the facility became active) to 1973 (when the NRDS program ended).

Criterion B

To be eligible under Criterion B, a property must be directly associated with the productive life of a significant person. Undoubtedly, several individuals played a crucial role in the development of nuclear reactors and engine technology. The E-MAD facility supported the work of scientists who were instrumental in the development of the NERVA program and the design of nuclear rocket engines. However, most of these individuals had far more important ties elsewhere, such as at the Los Alamos or Lawrence Livermore National Laboratories. Although many of these individuals spent time at the NNSS, it was often for short visits to monitor test results. The work conducted at E-MAD cannot be attributed to any one individual, but rather to different laboratories and contracting firms. Therefore, the E-MAD Historic District does not appear to be significant under Criterion B.

Criterion C

Properties significant under Criterion C must embody the distinctive characteristics of a type, period, or method of construction; represent the work of a master; possess high artistic values; or represent a significant and distinguishable entity whose components may lack individual distinction. The E-MAD facility has previously been determined eligible under Criterion C (Beck et al. 1966; Reno et al. 2019a) with SHPO concurrence (Reed 2019). The E-MAD facility is an example of mid-20th-century industrial architecture. The focus of the facility is the E-MAD building, a large, utilitarian building, constructed using modern and innovative building materials and techniques. The design and construction of the facility reflect the functional requirements of the NERVA program and the emphasis on safety in the handling of nuclear materials.

Criterion D

To be significant under Criterion D, a property must have yielded, or be likely to yield, information important in prehistory or history. The E-MAD facility was initially designed with the intention of containing high levels of radiation while still allowing personnel to safely work in proximity to radiation sources. The success of this design has been exhaustively documented because of the intensive radiological monitoring during its periods of active use. Monitoring, which includes personal dosimetry of all workers potentially exposed to radiation, has continued to the present and includes radiological surveys of the surrounding areas. The building was also designed with large filter plenums to restrict the release of radiation from its two exhaust stacks. The effluent was continuously monitored at the stacks, so additional buildings were constructed next to the stacks to house additional monitoring equipment.

The E-MAD facility presents many decades of research findings, as well as ongoing investigations of the methods for decontamination and the efficacy of those methods. The advantage of such a long-term study is that decontamination efforts that appear to be successful in the short term can be far from successful in the long term because deeply penetrated radiation sometimes re-contaminates surfaces that were thought to be fully decontaminated.

Questions regarding radioactive containment are important in relation to the various medical and industrial uses of atomic energy. Decontamination issues could become critical in the case of nuclear engineering accidents or, in this age of nuclear weapon proliferation, intentional nuclear device detonation or intentional contamination with nuclear materials.

The facility has significant information potential as a resource for understanding methods of decontamination, long-term studies of radioactive contamination, radioactive containment, and decontamination. The E-MAD Historic District appears to be significant under Criterion D.

Integrity

Despite some integrity issues, the resources within the E-MAD Historic District sufficiently retain all seven aspects of integrity to convey their significance. The setting in Jackass Flats is the same as during the period of significance. The location of the buildings and structures have not changed. The association of E-MAD with nuclear rocket development, a significant period in American history, is clearly established, and the sense of feeling remains. The facility is well-preserved. The only design changes since the end of the period of significance for NRDS were for the Spent Uranium Fuel experiments, and these were relatively minor. In 2015, a flash flood inundated and damaged the E-MAD building, rail spurs, drainage systems, and roads. It also deposited sediment and cut or deepened wash channels. Nonetheless, the current configuration of the E-MAD facility still closely resembles its historic plan and appearance and expresses its original materials and workmanship.

SUMMARY CONCLUSION

The E-MAD Historic District is eligible for listing in the NRHP under the Secretary of Interior's significance criteria A, C, and D. The E-MAD district is eligible under Criterion A at the national level for its role in the development of nuclear rocket technology from 1967 to 1973. It is eligible under Criterion C for embodying the unique and distinctive characteristics of an industrial architectural type used for conducting research with nuclear engine components and its role as a nuclear rocket development complex for space flight. Finally, the district is eligible under Criterion D for its research potential in studying questions regarding long-term radioactive containment and decontamination procedures. The E-MAD Historic District retains all seven aspects of integrity and conveys its significance under criteria A, C, and D.

Subdistrict Location and Boundary

Centrally located on the southwest-trending floor of the Jackass Flats, the E-MAD Historic District is on the bajada of Calico Hills to the north (Figure 109). Topopah Wash is immediately to the west. At an elevation of 3,500 to 3,560 feet, a sparse creosote-bursage plant community surrounds E-MAD. Within the subdistrict, the bajada surface is relatively flat and composed of sandy sediment with gravel and small cobbles. This sediment was easily bladed into cut-and-fill terraces for the buildings and parking areas. Access to E-MAD is from Road H by turning south on the paved E-MAD Road. Formerly the facility could also be reached via the paved E-MAD alternate road by turning west from 2nd/3rd Street; however, this road has been washed out where it crosses Topopah Wash. Railroad access to E-MAD was from the north.

The E-MAD Historic District comprises 32.8 acres. This subdistrict boundary encompasses all resources within the perimeter fence and extends southward to include the radioactive wastewater leach field (Figure 110). The subdistrict boundary coincides with the perimeter fencing previously used to define the E-MAD facility and was only adjusted to provide a buffer along the perimeter fence line and to make a correction to the southern boundary. The southern boundary was extended beyond the perimeter fence to include the extent of the sewage system and radioactive wastewater system. During the current NRDS survey, no additional resources were newly identified.

Figure 109. Aerial overview of E-MAD facing southeast (RSL 2013).

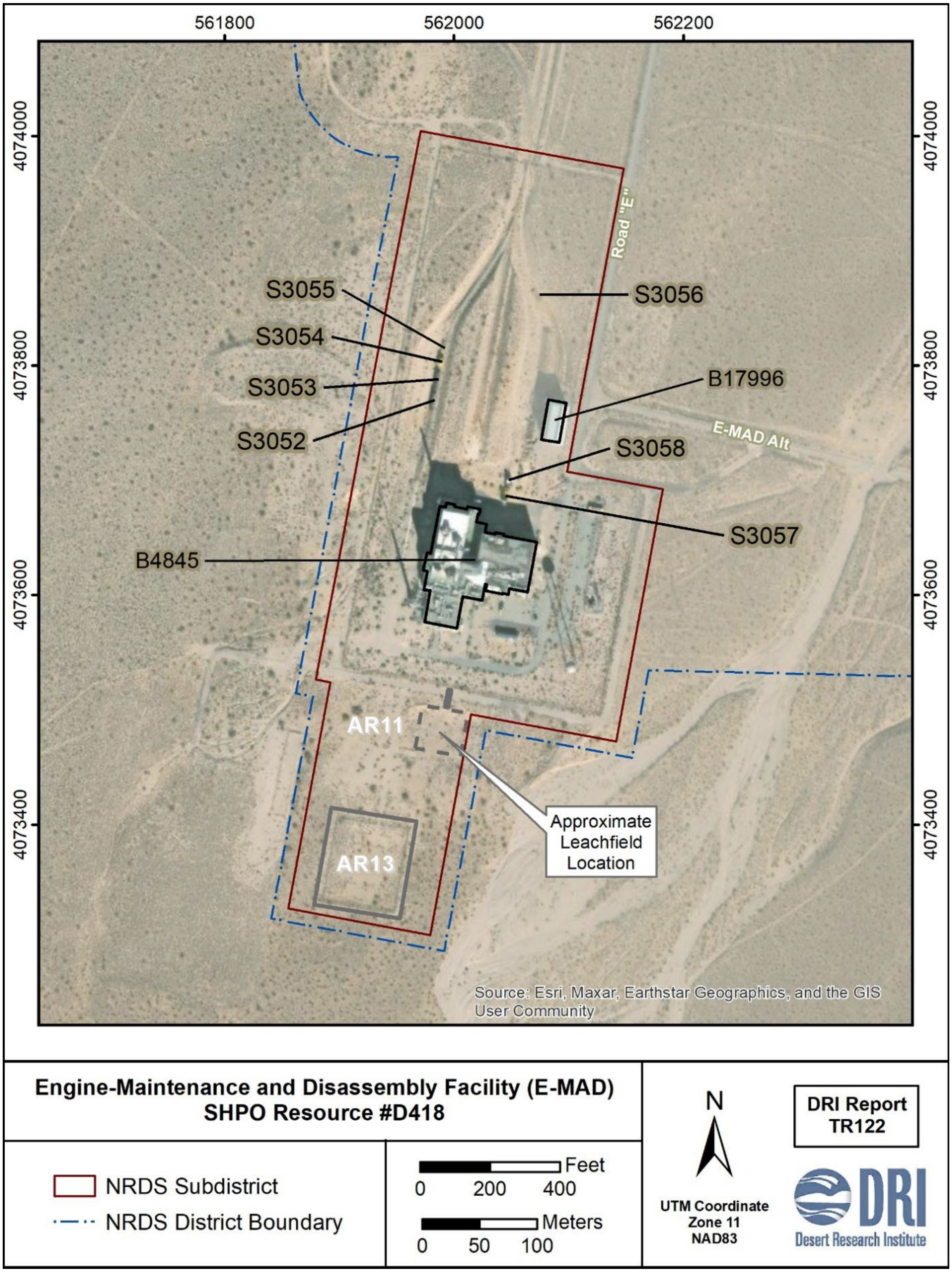

Figure 110. The E-MAD Historic District boundary and identified primary resources.

Resource Synopsis

In prior reports, nine primary resources within the E-MAD Historic District boundary were evaluated (Table 10). In consultation with the SHPO, the DOE determined four of these were individually eligible for listing in the NRHP and five were not individually eligible (Reed 2019; 2022). During the current survey, no new resources were identified. Seven of the nine previously recorded primary resources contribute to the significance of the NRDS Historic District. The exceptions are the two Army surplus locomotives that post-date the period of significance for the NRDS district (Table 11).

The E-MAD facility and the Rolling Stock are described in detail in previous reports (Beck et al. 1996; Reno et al. 2019a; O'Neill and Wedding 2022).

Table 10. Previously Recorded Resources in the E-MAD Historic District.

Resource	Report No.	Author/Date	Purpose
E-MAD 25-3900, B4845*	SR082696-1	Beck et al. 1996	Survey and Evaluation
E-MAD 25-3900, B4845	HAER Nv-25	NPS 1997	Mitigation: Manipulator Removal Only
E-MAD 25-3900, B4845	TR116	Reno et al. 2019a	Survey and Evaluation
E-MAD Train Shed 25-3901, B17996*	TR116	Reno et al. 2019a	Survey and Evaluation
E-MAD Rolling Stock S3052**, S3053**, S3054**, S3055**, S3056**, S3057*, S3058*	SR112221-1	O'Neill and Wedding 2022	Survey and Evaluation

*Individually eligible, **Not individually eligible

Table 11. Primary Resources in the E-MAD Historic District.

NNSS No. or Identifier	SHPO No.	Resource Name/ Description	Year Built	Contributing to E-MAD	Contributing to NRDS	AR Total Count (# contributing to NRDS and E-MAD)*
Previously Recorded (update for contributing/non-contributing to the E-MAD Historic District and the NRDS Historic District)						
25-3590**	B4845	E-MAD	1962-1967	Yes	Yes	28 (28)
25-3991**	B17996	Train Shed	1962-1967	Yes	Yes	0
L4	S3052	Army Surplus Locomotive (Engine 49)	1953	Unevaluated	No	0
L5	S3053	Army Surplus Locomotive (Engine 50)	1953	Unevaluated	No	0

(Table 11 is continued on the next page.)

(Table 11 is continued from the previous page.)

NNSS No. or Identifier	SHPO No.	Resource Name/ Description	Year Built	Contributing to E-MAD	Contributing to NRDS	AR Total Count (# contributing to NRDS and E-MAD)*
F9	S3054	Flatcar	c.1964	Yes	Yes	0
F5	S3055	Flatcar	c.1964	Yes	Yes	0
F6	S3056	Flatcar	c.1964	Yes	Yes	0
EIV**	S3057	Engine Installation Vehicle	c.1964	Yes	Yes	0
MCC**	S3058	Manned Control Car	c.1964	Yes	Yes	0

*See Table A-2 for a listing and description of accessory resources and contributing status to NRDS.
**Individually Eligible

The most important resource and the one that dominates all others is the E-MAD building (25-3900, B4845). This four-story building has a partial basement and an irregular plan (see Figure 27, top). The entire building, including its interior, is described in detail by Reno et al. (2019a). The walls of the central core of the building are unpainted, load-bearing, reinforced, and poured-in-place concrete. Other wall materials are concrete block supported by concrete and concrete block pilasters and metal. The steel walls were originally painted tan, but they are now painted a bluish gray, sometimes called battleship gray. Concrete block walls are still covered in the original faded light tan paint. Roofs are flat or nearly flat and coated with at least two generations of built-up asphalt on corrugated steel decks. Abundant mechanical equipment is on the roofs, including a large cooling tower at the very top of the building.

The E-MAD Historic District is the southwest terminus of the Jackass and Western Railroad. Many of the railroad operations, such as switching, were done from a central control room in the E-MAD Building. The large gabled metal Train Shed (25-3991, B17996) was the principal maintenance facility for the railroad, a task supplemented by the E-MAD Cold Bay when necessary.

After entering the fenced E-MAD compound, the railroad splits into four spurs. One spur ends inside the Train Shed. Two terminate inside E-MAD. Each of the E-MAD spurs is equipped with a turntable inside the building. The final spur is unique in that a series of capped core emplacement holes have been constructed along it as part of the SURF program. The switch for an additional spur was installed, but the siding was not constructed. Parked on the various sidings are the Manual Control Car (S3058), the Engine Installation Vehicle (S3057), two Army surplus locomotives (S3052 and S3053), and three flatcars (S3054, S3055, and S3056). An additional locomotive (L3) was formerly stored in the Cold Cell but was transferred to the Nevada State Railroad Museum in Boulder City, Nevada. The turntable in the E-MAD Cold Cell is no longer operable, so a portion of the east wall was removed for extraction of the locomotive. This operation was made easier by the framing of this wall, which was designed to have a train door that was never installed. The siding was replaced after removal of the engine. The remaining two engines, L1 and L2, are presently stored at the RMSF.

Recommendations

The E-MAD Historic District possesses a significant concentration of resources in a definable geographic area focused on the E-MAD building. This report recommends the E-MAD Historic District eligible for listing in the National Register of Historic Places under Criteria A, B, and C during the period of significance from completion of construction in 1967 to the end of nuclear rocket development program on January 5, 1973. A potential context for the Spent Uranium Fuel (SURF) experiments from 1977-1986 is beyond the period of significance for NRDS and was not produced for the current project. Therefore, two resources associated with the SURF experiments, the L4 and L5 locomotives, are unevaluated as contributors to the E-MAD district. All other identified resources within the district boundary are contributors to the E-MAD district.

As a major maintenance, assembly, and disassembly nuclear rocket development facility constructed for the NRDS, the E-MAD Historic District is a major element of the larger NRDS district. Despite some integrity issues, collectively the resources within the E-MAD Historic District sufficiently retain all seven aspects of integrity to convey their significance. The only design changes were for the SURF experiments, and these were relatively minor. There have been few alterations of materials or workmanship to the E-MAD exterior. The setting of the facility in Jackass Flats is the same as it was during the period of significance. The association of the E-MAD Historic District with its contributing resources is clear.

This report recommends the E-MAD Historic District as a contributing element of the NRHP-eligible NRDS Historic District. Except for the two Army surplus locomotives, all identified resources within the E-MAD Historic District contribute to the larger NRDS Historic District. The two exceptions (locomotives S3052 and S3053) were associated with military transportation prior to arriving on the NNSS and with spent fuel experiments after arrival. The Army locomotives post-date the period of significance of the NRDS district and are non-contributors.

In consultation with the SHPO, the DOE previously determined four primary resources were individually eligible for listing in the NRHP. The main E-MAD Building (25-3990, B48455) is eligible under Criteria A, C, and D and the Train Shed (25-3901, B17966) is eligible under Criteria A and C (Reed 2019). The Manned Control Car (S3058) and the Engine Installation Vehicle (S3057) were also determined eligible for listing in the NRHP under Criteria A and C (Reed 2022b). There is no recommended change to these individual eligibility determinations. With the E-MAD building and Train Shed still standing, the subdistrict and its resources have an exceptionally high level of integrity. The mass and design of the main building clearly reflects its purpose. The rail cars are also in very good condition.

Test Cell A Subdistrict (D421)

Although there has been significant modification due to building demolitions at Test Cell A, the area still possesses several interrelated resources united by their collective function to test nuclear reactors for rocket propulsion from 1958 to 1966. An aerial overview of Test Cell A prior to the 2000 recording is shown in Figure 111. In this report, the subdistrict is identified as a geographic area of contiguous elements to provide a spatial, temporal, and functional framework for organizing the facilities involved in NRDS operations. As part of the current survey, the subdistrict is not evaluated as an NRHP-eligible historic district under any of the Secretary of the Interior’s Significance Criteria (36 CFR 60.4).

Test Cell A was one of the initial facilities built at the NRDS. Construction was completed in 1958 and the facility remained active until 1966. When constructed, it was the only test stand in the United States designed to conduct hot tests of nuclear reactors for rocket propulsion. At least 90 reactor or other system tests were conducted here for the Rover program. These tests included the Kiwi and NRX series of test reactors, none of which were intended for actual flight use. For most of this period the reactors were assembled at R-MAD and transported to Test Cell A by rail for testing, and then returned there for dismantling and what was called post-mortem analysis. To ensure preservation of critical elements for analysis, tests were normally terminated well before reactors failed. This facility, in common with the later Test Cell C, had rocket components spread horizontally throughout the Test Cell A building (25-3113) and surrounding grounds rather than packed in the vertical arrangements seen later as complete engine assemblies were tested at Engine Test Stand 1.

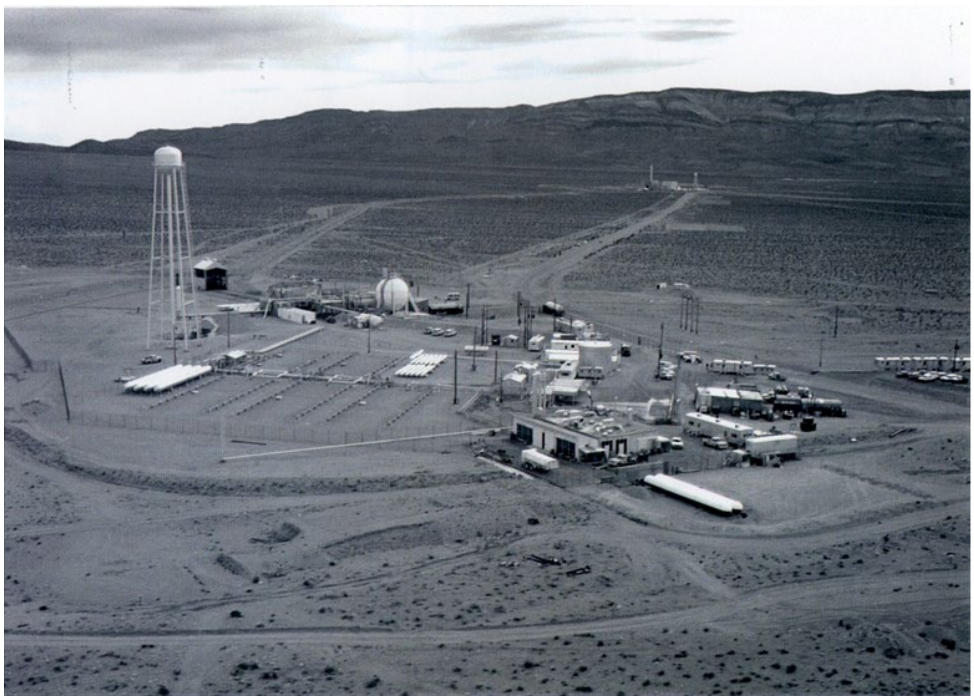

Figure 111.Test Cell A facility overview southeast prior to remediation work, date unknown (Beck et al. 2000).

In a historic plan map (Figure 112), the Engine Test Laboratory (25-3214) faces directly south. The orientation of everything else is southeast to northwest, paralleling the topography of the location.

The facility was laid out in five distinct zones according to function.

1) Mission: The core to everything at Test Cell A was the concrete slab of the test stand with the adjacent Test Cell Building (25-3113) to the west and the extended slab for the termini of the railroad spurs and the funicular railroad system for the moveable shed to the east. This zone has an additional narrow extension to the southwest where the Access Tunnel was located.
2) Mission Support: The direct mission support zone occupied the entire area inside the perimeter fence west of the Test Cell Building, which served to protect it from the reactor test stand. Most of this support area was dedicated to the unloading, storage, and movement of the various gases needed for tests. It also had tanks for treated and untreated water, including the above-ground tank, which can be seen for miles from any place on Jackass Flats. The substation is also in this area.

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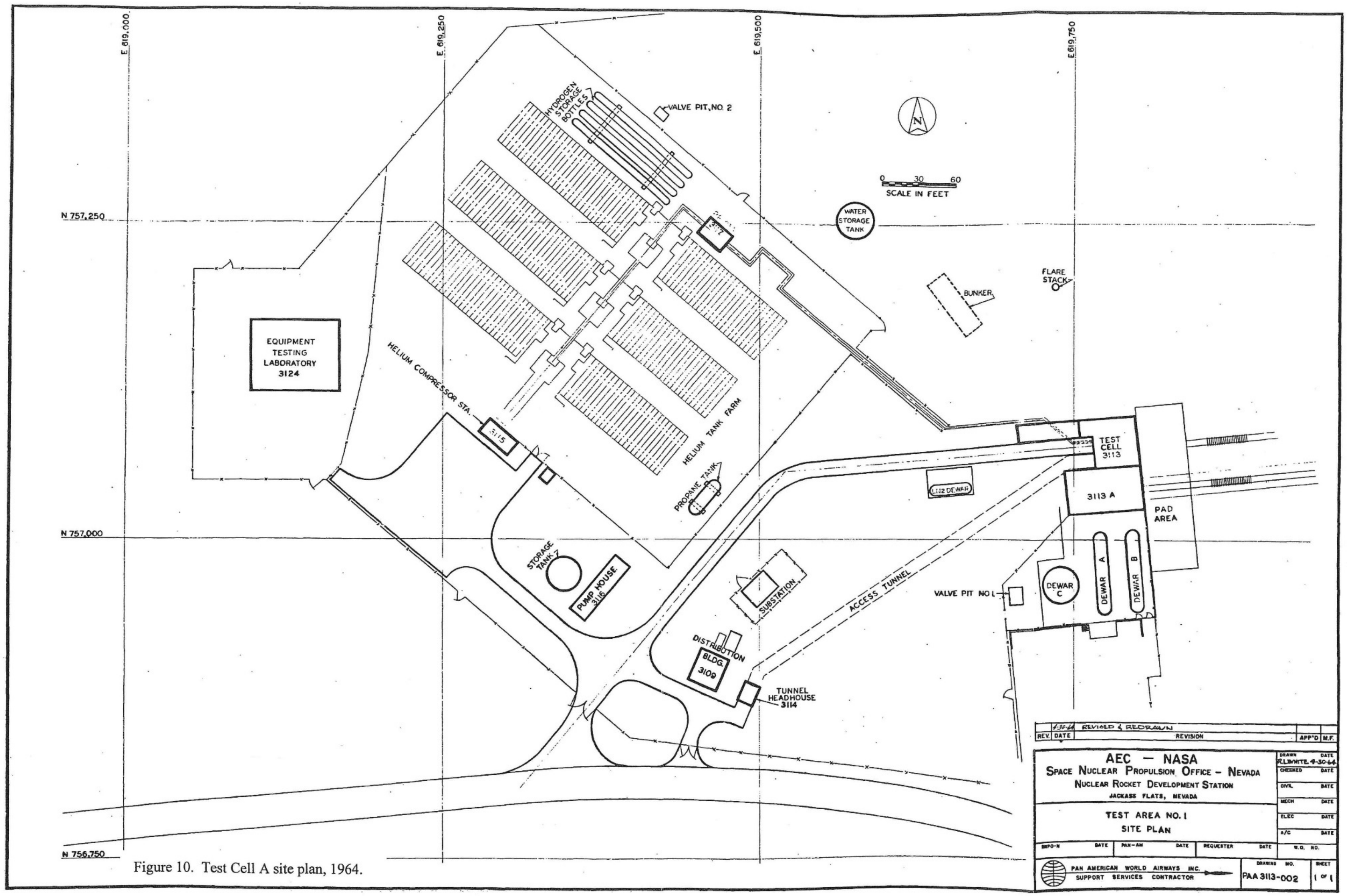

Figure 10. Test Cell A site plan, 1964.

Figure 112. Test Cell A historic plan map (Pan American 1964).

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3) General Support/Maintenance: This general support zone occupied the area outside the perimeter fence all along the southwest portion of the complex. This zone is passed through to reach the main gate into the compound. It was occupied almost entirely by trailers or portable buildings. The main septic system was also in this area. General maintenance activities were supported in this multi-purpose zone.

4) Observation and Monitoring: The area extending from the north to the northeast and continuing to south of the test stand was reserved for documenting tests with radiation monitors; including the distinctive aerial tramway, and two camera stations encased in bunkers to protect film from radiation damage, and an additional bunker for which the function is not known.

5) Equipment Test Laboratory: The Equipment Test Laboratory (25-3124) is located at the west end of the helium tank farm. It was placed as far as possible upwind of the test stand but still near the tank farm to access any gases needed for experiments in the building.

Subdistrict Location and Boundary

The Test Cell A subdistrict is located at the northern edge of Jackass Flats at an elevation of 3,800 to 3,860 feet (Figure 113). It is just south of the pass between the Calico Hills and Kiwi Mesa. Access to this subdistrict is via Road F from the Reactor Control Point to the southwest or from R-MAD to the southeast. In addition to this paved road, several unpaved roads converge on the facility. Railroad access was initially from R-MAD and later connected with E-MAD as well.

The Test Cell A subdistrict comprises 33.1 acres (Figure 114). Starting at the west end of the subdistrict and proceeding clockwise the district boundary goes north to encompass the uphill side of the water diversion dike and ditch drainage system (B2443 AR10). It then turns eastward, continuing to stay uphill of the ditch then looping north and back south again to encompass the Jet Assisted Takeoff (JATO) rocket system (B2443 AR16). At the termination of the ditch in a drainage, it turns south and southwest, staying east of the drainage, the northeast camera station (B19023), and the east end of the perimeter fence. It swerves eastward to encompass an aerial tramway (B2443 AR13) before trending southwest around the south camera station (B19024) and a raised observation platform (B2443 AR 11). From this point the boundary trends northwest to where this description started.

Figure 113. View of Test Cell A looking southwest from the railroad grade. The foundation of Building 25-3113 (B2443) and the test stand are near the center of the frame (Photo 2116_1732, DRI 2021).

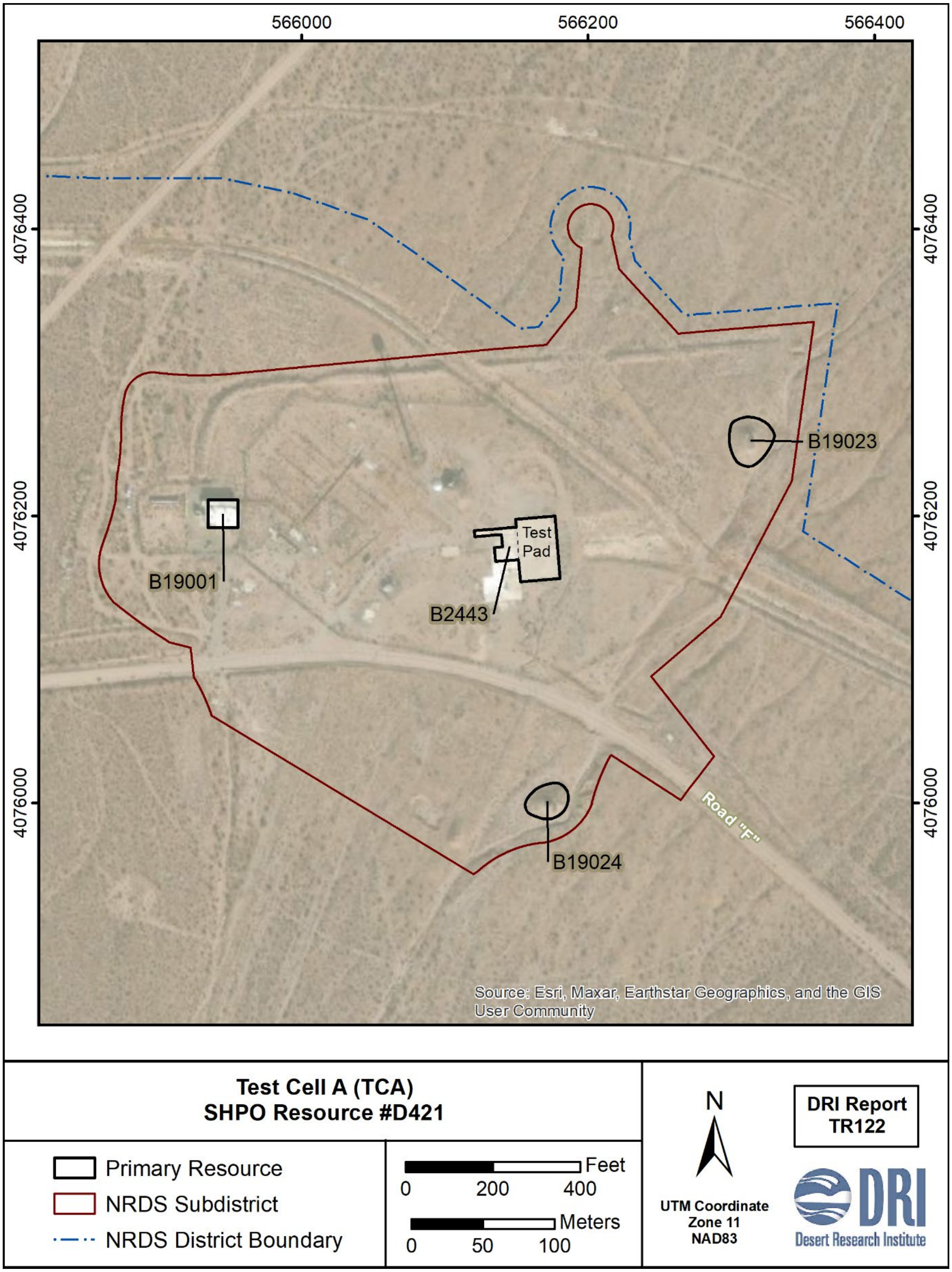

Figure 114. The Test Cell A subdistrict boundary and primary resources.

Resource Synopsis

The Test Cell A facility was initially identified and evaluated by Beck and others (2000) as a single resource (26NY11260); however, that documentation focused on the concrete slab of the test stand with the adjacent Test Cell A building (25-3113/3113A, B2443) (Table 12). The DOE determined the Test Cell A building, including the test pad, was eligible for listing in the NRHP under Criteria A and C and the SHPO concurred (Baldrica 2000c). Subsequently, a HAER document was prepared to mitigate the adverse effects from proposed demolition (NPS 2001). Demolition of 25-3113/3113A was completed in 2005.

Because the original recording of the Test Cell A facility focused on the test cell, it excluded ancillary buildings and structures. In the 2000 document and the derivative HAER report (NPS 2001), the associated resources are summarized in a single paragraph. It appears that the notion that the facility was "mitigated" was interpreted somewhat broadly since several buildings or structures were removed without formal mitigation other than some exterior photographs (see NPS 2001). These resources include the Spherical LH2 Dewar, Vaporizer Shed, 50,000 gallon "Ground Reservoir" water tank, Distribution Building (25-3109), Moveable Shed (25-3130), Shed E-28576, Shed 29830, and the Access Tunnel with its entry building (25-3114).

Table 12. Previously Recorded Primary Resources in the Test Cell A Subdistrict.

Resource	Report No.	Author/Date	Purpose
Test Cell A (Main Building) 25-3113/3113A*	SR021400-1	Beck, Drollinger, and Goldenberg 2000c	Survey and Evaluation
Test Cell A (Main Building) 25-3113/3113A	HAER NV-33	NPS 2001	Mitigation: Main Bldg. & Moveable Shed

* Individually eligible

For the current survey there was limited access to the area within the perimeter fence. Therefore, recording of the accessory resources within this area was limited to describing visible structures from the fence line. Documentation of the Test Cell A subdistrict was extended to beyond the fence to include three newly recorded primary resources, the Engine Test Laboratory (25-3124) and two camera bunkers.

For this survey, 4 primary resources and 20 accessory resources were identified in the Test Cell A subdistrict (Table 13). The concrete test stand slab together with the adjacent building foundation (25-3113/3113A, B2443) was designated the primary resource.

The five Test Cell A distinctive functional zones discussed above structure the following synopsis of the identified resources in the Test Cell A subdistrict.

MISSION

The Test Cell A test stand and adjacent test cell building supported the mission critical program of testing nuclear reactors. Although the test stand and building were removed, the remaining concrete slab and adjacent building foundation along with the 18 recorded accessory resources serve as a visual reminder of the layout of the facility.

Table 13. Primary Resources in the Test Cell A Subdistrict.

NNSS No. or Identifier	SHPO . No.	Resource Name/ Description	Year Built	Contributing to NRDS	AR Total Count (# contributing to NRDS)*
Previously Recorded (update)					
25-3113/3113A**	B2443	Concrete foundation and test pad (formerly Test Cell A and Test Stand)	1958	Yes	18 (18)
Newly Recorded					
25-3124	B19001	Equipment Test Laboratory	1963	Yes	2 (2)
TCA2	B19023	Northeast Camera Station	1961	Yes	0
TCA3	B19024	South Camera Station	1961	Yes	0

*See Table A-2 for a list and description of accessory resources.
**Due to demolition, the eligibility determination for the Test Cell A building is recommended not individually eligible.

MISSION SUPPORT

Infrastructure that supported the mission and still present includes the security fence surrounding the compound (B2443AR3), Substation 25-9 (B2443 AR5), a bunker (B2443 AR2), and a water tower (B2443 AR1). The bunker (B2443 AR2) is oriented with its entrance facing northwest (Figure 115), which provided it with maximum protection from the test stand. As noted above, an important resource in this area is the large helium tank farm area (B2443 AR8), which is best appreciated from the aerial photo (See Figure 114). Although nearly all tanks have been removed, most of the extensive piping is still in place, along with a gas delivery dock (B2443 AR7) and foundations from various buildings and tanks (B2443 AR4 and AR6) (Figure 116). The mission support area also has septic tanks for treated and untreated water (B2443 AR12).

Figure 115. Bunker at Test Cell A, facing south (Photo 2116_1784, DRI 2021).

Figure 116. Test Cell A gas unloading dock, facing east-northeast (Photo 2116_1974, DRI 2021).

General Support/Maintenance

Scattered foundations (B2443 AR18), a loading dock (B2443AR17), and remnants of a trailer park (B2443 AR15) remain in the Test Cell A multi-purpose, general support area. A raised platform (B2443 AR11) and a cryogenic pipeline (B2443 AR9) were also recorded.

Observation and Monitoring

A distinctive structure for observing and documenting tests with radiation monitors is the dosage measurement aerial tramway (B2443 AR13). The tramway remotely recovered instrumentation packages from close to the test stand during or immediately after tests when radiation levels made it hazardous for workers to enter the area (Figure 117). The same design was used at Test Cell C. The two camera stations (B19023 and B19024) used periscopes to provide the underground cameras views of the test stand (Figure 118). This station design was successful and repeated with little change at both Test Cell C and Engine Test Stand 1.

ENGINE TEST LABORATORY

The laboratory (B19001) had its own fenced compound and was built as an extension of the original Test Cell A compound (Figure 119). The building is distinguished by its direct piping to various gas connections, including cryogenics at the Test Cell A helium tank farm (B2443 AR8). It also had its own small tank farm; two large high-pressure gas cylinders are still in place (B19601 AR1). The building is made of concrete block but its small bays for testing equipment are made of concrete and are unroofed. Unlike the rest of the Test Cell A, this building continued to be used sporadically into the 1990s.

Figure 117. View northwest of the tramway showing upright steel pipes and a steel brace set in concrete at the southeast terminus (Photo 2116_1864, DRI 2021).

Figure 118. The Northeast Camera Station (B19023) at Test Cell A, facing north-northeast (Photo 2116_1716, DRI 2021). Periscopes are still present in the shelter. The worker is at the access shaft. Note earthen radiation shielding built into the roof.

Figure 119. The Engine Test Laboratory (25-3124, B19601) at Test Cell A, facing east-northeast (Photo 2116_1860, DRI 2021).

OTHER

Three other accessory resources that were recorded outside the fenced area are a galvanized tank (B2443 AR16), the JATP Rocket System (B2443 AR14) that measured the movement of the exhaust plume from a reactor test, and the stormwater drainage system (B2443 AR10).

Recommendations

Test Cell A was constructed to test nuclear reactors and was critical to the nuclear rocket development mission. Despite demolitions, it retains its integrity because there are sufficient material remains within the boundary of the Test Cell A subdistrict to convey its significance. This report recommends the Test Cell A subdistrict and the four primary resources, with 20 contributing accessories, be considered contributing elements to the NRDS Historic District.

Due to demolition of 25-3113/3113A (B2443), this resource no longer retains sufficient integrity to convey individual significance. A change in eligibility status to not individually eligible is recommended.

Test Cell C Historic District (D346)

The Test Cell C Historic District was recorded in 2019 (Reno et al. 2019b). The period of significance for this district extends from its initial construction in 1966 through the last test in 1972. The DOE determined the district was eligible for NRHP listing under Criteria A, C, and D, and the SHPO concurred (Reed 2020). Test Cell C was the second hot test stand constructed at the NRDS. So many of the tests were carried out there, it became regarded as the workhouse of the station.

The purpose of the Test Cell C complex was to test the nuclear reactors being developed for the propulsion of rockets for the United States space program. The original configuration of Test Cell C was built between 1960 and 1961. The facility was an advanced version of the Test Cell A facility and was capable of larger and more powerful tests. Unlike its earlier counterpart, which was limited to gas propellants, Test Cell C was designed to use both gaseous and liquid hydrogen (Space Nuclear Propulsion Office 1969:66-67). The facility is shown after abandonment but prior to demolitions in Figure 120.

Figure 120. Aerial overview of Test Cell C facing southeast (RSL 2000).

The first reactors tested, initially at Test Cell A and later at Test Cell C, were the Kiwi series. The Kiwi-A series tested entirely at Test Cell A was the first full-power reactor and it provided fundamental information on fuel element design and reactor control (Friesen 1995:5). Objectives of later designs in this series tested largely at Test Cell C were "to explore a somewhat different problem and incorporated advances made from the preceding ones" (AEC 1964:110). For example, Kiwi-B, 1B and B4A reactors demonstrated the use of liquid hydrogen as a coolant at power levels and temperatures for space missions (AEC 1963:169; Friesen 1995:5); the Kiwi-B4A, B4A-CF, B2A, and B4B reactors tested engineering and design changes to eliminate core damage from the flow vibrations of liquid hydrogen (AEC 1964:110; Friesen 1995:5); and the Kiwi-B4E was the first reactor fueled by uranium carbide beads (Friesen 1995:5). In 1965, a safety test known as the Kiwi Transient Nuclear Test (TNT) was conducted on a railroad trestle just west of Test Cell C. A Kiwi reactor was deliberately destroyed by subjecting it to a very fast power increase (AEC 1966:146; Friesen 1995:5; Miller 1984:5). The aim of the experiment was to determine the potential effects of a nuclear reactor explosion under launch conditions.

By 1963, a contract had been issued for architectural and engineering services to C.F. Braun of Alhambra, California, for additional modifications to Test Cell C, which focused on increasing liquid hydrogen storage capacity and cryogenic capabilities (M&R 1963a:48). Although the core 1960 to 1961 components remained, the additions were extensive, and they significantly altered the complex's visual appearance by increasing the horizontal extent and density of the footprint within the fenced area. The alteration of the facility's vertical profile was achieved principally by the installation of a pair of massive 500,000-gallon steel dewars and a labyrinth of piping to the west of the main test cell building. With a combined capacity of a million gallons, the gigantic liquid hydrogen storage tanks were the work of CB&I. The company developed a new field-welding technique specifically for the Test Cell C Hortonsphere [company trade name] tanks (M&R 1963b:37). This method, with its superior strength characteristics, allowed the rapid on-site assembly of the double-walled aluminum and carbon steel vessels, which ensured that they could withstand the exacting high-pressure and cryogenic requirements. Other enhancements at that time included the Operations Building and Warehouse. The last test at the facility was of the Nuclear Furnace in 1972. Demolitions and equipment removals occurred after testing ceased. The greatest amount of demolition work occurred between 2005 and 2011.

District Location and Boundary

The Test Cell C Historic District is near the northern edge of Jackass Flats at an elevation of 3,780 to 3,840 feet (Figure 121). It is on an alluvial bajada surface on the southeast flanks of the Calico Hills scored by numerous small ephemeral drainages. From the Reactor Control Point, the facility is accessed by following Road F northward and turning west and then north on Road J, both of which are paved. The Decontamination Facility for Test Cell C (S3141) is at this intersection. Railroad access to the test stand was via a spur from the Jackass and Western Railroad. This railroad connected Test Cell C with both the R-MAD facility to the southeast and E-MAD to the southwest

The district comprises 35.8 acres and the district boundary encompasses buildings and structures within the fenced compound, the adjoining resources around the outside of the fence line, and nearby resources such as the three camera stations, the Kiwi-TNT test stand, and the full extent of the Dosage Measurement Trolley, which runs westward across Topopah Wash (Figure 122).

Figure 121. Overview of Test Cell C looking west toward Yucca Mountain (Photo 1968_2154, DRI 2019).

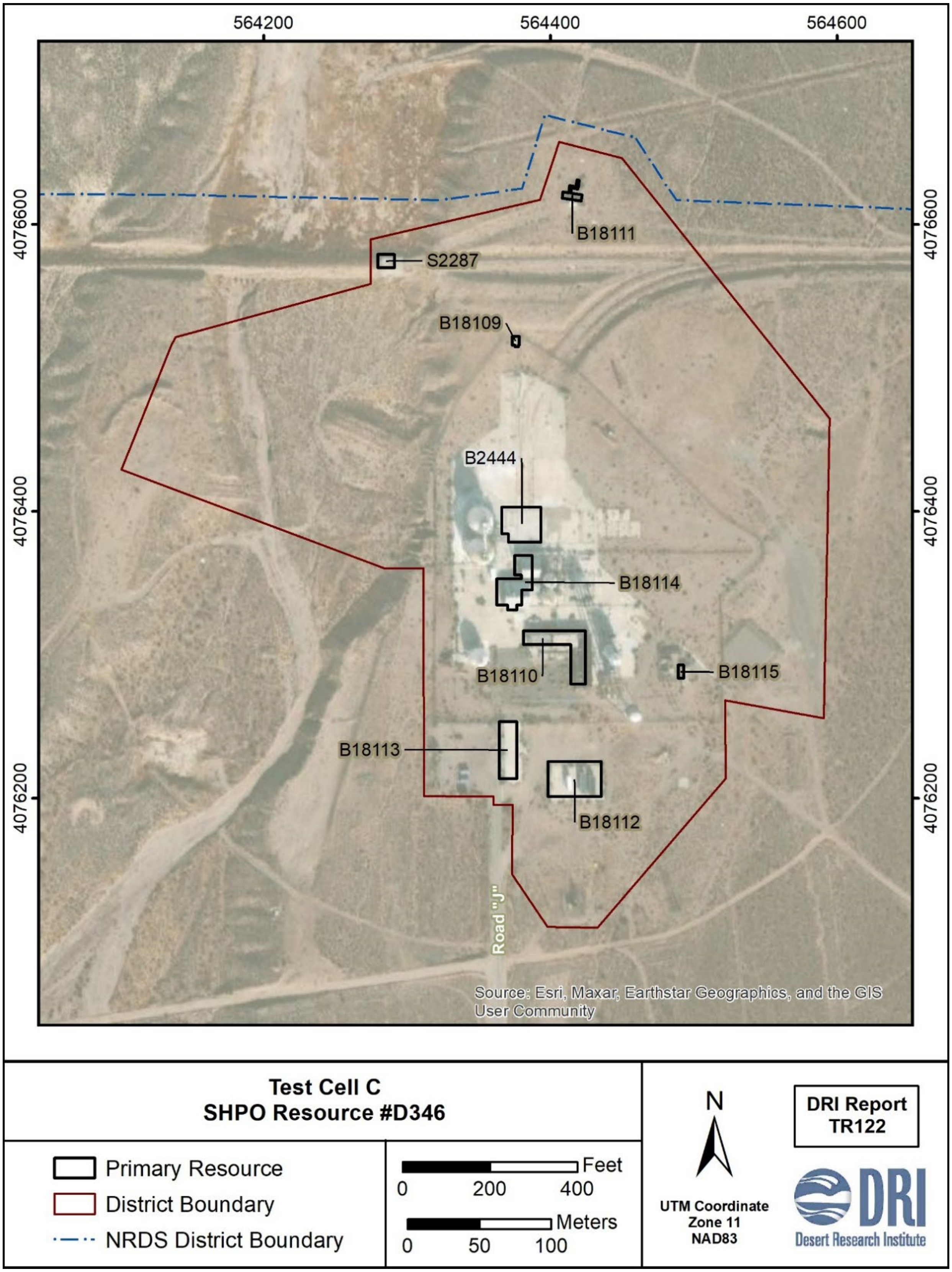

Figure 122. Test Cell C Historic District showing boundary and primary resources.

The district is bounded on the west by Topopah Wash except for the northwest terminus of the instrumentation tramway and former location of a camera bunker on its west bank. The northern boundary passes just north of the Kiwi-TNT test stand and the northern camera bunker. It extends eastward far enough to encompass the remains of the third demolished camera bunker before turning south to enclose remnants of the septic system. It then proceeds southwest around the Radiography Compound and a substation before turning northwest around the two large parking lots outside the main gate. The boundary then goes north about halfway up the perimeter fence before turning northwest to cross Topopah Wash and meet its point of origin at the demolished western camera bunker.

Resource Synopsis

The Test Cell C Building (25-3210, B2444) and the Shed Drive Funicular Railroad Building (25-3214, B18109) were initially recorded and evaluated in 2000 (Drollinger, Goldenberg, and Beck 2000a). In 2019, an architectural survey of the entire complex was completed to update the previous survey and expand the survey to include the entire Test Cell C Historic District (Reno et al 2019b). The DOE in consultation with the SHPO determined the Test Cell C Historic District eligible for listing in the NRHP under Criteria A, B, and D (Reed 2020). The SHPO also concurred the nine identified primary resources, with their 61 contributing accessory resources, contribute to the significance of the district (Table 14). Only one resource, the health physics portable building (B18114 AR6), is non-contributing.

Due to demolition, the original Test Cell C Building (25-3210) no longer retains integrity to convey its individual significance under Criteria A and C and is, therefore, no longer individually eligible. The 2019 Test Cell C architectural survey report and associated resource forms (Reno et al. 2019b) should be consulted for detailed information about Test Cell C.

During the current survey, no new resources were identified within the boundaries of the Test Cell C subdistrict. All contributing resources to the Test Cell C Historic District also contribute to the NRDS Historic District (Table 15).

Table 14. Previously Recorded Resources in the Test Cell C Historic District.

Resource	Report No.	Author/Date	Purpose
TCC 25-3210, 26NY11258*	SR021500-1	Drollinger, Goldenberg, and Beck 2000a	Survey and Evaluation
TCC 25-3210, 26NY11258	HAER NV-33-A	NPS 2000b	Mitigation
Test Cell C (TCC) Historic District D346*	TR117	Reno et al. 2019b	Survey and Evaluation
Foundation (formerly Main Building) 25-3210, B2444	TR117	Reno et al. 2019b	Survey and Evaluation
Foundation (Shed Drive Funicular Railroad) 25-3214, B18109	TR117	Reno et al. 2019b	Survey and Evaluation
Equipment Building and Local Control Center 25-3220, B18110*	TR117	Reno et al. 2019b	Survey and Evaluation
North Camera Bunker 25-3226, B18111*	TR117	Reno et al. 2019b	Survey and Evaluation

(Table 14 is continued on the next page.)

(Table 14 is continued from the previous page.)

Resource	Report No.	Author/Date	Purpose
Foundation (Maintenance/Warehouse) 25-3228, B18112	TR117	Reno et al. 2019b	Survey and Evaluation
Foundation (Operations Building) 25-3229, B18113	TR117	Reno et al. 2019b	Survey and Evaluation
Cryogenics Building 25-3230-32, B18114*	TR117	Reno et al. 2019b	Survey and Evaluation
Powerhouse 25-3233, B18155	TR117	Reno et al. 2019b	Survey and Evaluation
TCC Kiwi-TNT S2287*	TR117	Reno et al. 2019b	Survey and Evaluation

* Individually eligible

Table 15. Primary Resources in the Test Cell C Historic District.

NNSS No. or Identifier	SHPO No.	Resource Name/ Description	Year Built	Contributing to NRDS	AR Total Count (# contributing to NRDS)*
Previously Recorded (updated as contributing to NRDS Historic District)					
25-3210	B2444	Foundation (formerly the Test Cell C Building)	1960-1961	Yes	32 (32)
25-3214	B18109	Foundation (formerly the Shed Drive Building)	1960-1961	Yes	1 (1)
25-3220	B18110**	Equipment Building and Local Control Center (Support Building)	1960-1961	Yes	12 (12)
25-3226	B18111**	North Camera Bunker	1962	Yes	0
25-3228	B18112	Warehouse Foundation	1966	Yes	4 (4)
25-3229	B18113	Foundation (formerly the Operations Building)	1966	Yes	2
25-3230-32	B18114**	Cryogenics Building	1960-1961	Yes	9 (8)
25-3233	B18115	Powerhouse	c.1970	Yes	1 (1)
Kiwi-TNT	S2287**	Kiwi-TNT Reactor Test Stand	1964	Yes	1 (1)

*See Table A-2 for a list and description of accessory resources and contributing/non-contributing status.
**Individually eligible

Recommendations

The Test Cell C Historic District is a concentration of resources clustered around the test stand. The interrelationship of these resources, collectively and individually convey their function as a test cell for developing and testing nuclear reactors for the NRDS program. As mentioned above, the SHPO previously concurred that the Test Cell C Historic District is eligible for listing in the NRHP. The nine primary resources and all except one of the 62 accessory resource contribute to the significance of that district. This survey recommends the Test Cell C Historic District, and its contributing resources, are contributing elements of the NRHP-eligible NRDS Historic District.

Engine Test Stand 1 (ETS-1) Subdistrict (D423)

The significant concentration and interrelationship of resources at the newly recorded ETS-1 subdistrict are united by the theme of developing nuclear rocket technology in the United States. This test stand was designed to test nuclear rockets in their flight orientation for the Nuclear Engine for Rocket Vehicle Application (NERVA) program, which began in 1961. The ETS-1 subdistrict is a definable geographic area of contiguous elements. Although this subdistrict is an identifiable entity, development of a historic context and evaluation for significance as a potentially eligible historic district was beyond the scope of the current survey. In this report, the subdistrict is evaluated only as a contributor to the NRDS Historic District.

Aerojet Corporation began the planning for ETS-1 in 1960, and construction began the following year. ETS-1 was one of the facilities visited by President Kennedy in 1961. Figure 12 introduced in Chapter III shows the president at the base of the test stand, which was not yet operational. Unlike the two earlier test stands (Test Cell A and Test Cell C), ETS-1 was designed to test complete nuclear rocket engines mounted upright with pumps and the liquid hydrogen tank above the engine. This closely emulated their actual flight configuration while still holding everything securely in place for close observation during test firings. The XE Cold Flow engine was used to prepare ETS-1 systems for hot tests. A year of simulations took place before everything was ready for a hot test of the XE Prime engine (see Figure 11). These tests were mainly to investigate self-starting (bootstrapping), restarts, and repeated shutdowns, all of which would be essential for complex flight operations. Pulse cooling of the reactor with liquid hydrogen was also successfully tested. A series of 40 hot tests began in February 1969 and continued over eight months (Dewar 2004:173-177). The tests were highly successful, convincing project engineers that the systems were nearly ready for in-flight testing. Planning immediately began on its successor, NERVA 1. XE Prime was the only engine to be hot tested at ETS-1 because the entire NRDS was shut down on January 5, 1973. Since that time, ETS-1 has only been used as a security and military training facility.

Subdistrict Location and Boundary

ETS-1 is located at the northern edge of Jackass Flats on the flanks of the Calico Hills at an elevation of 3540 to 4240 feet (Figure 123). From the Reactor Control Point complex, the test stand is accessed by driving west on Road H. A security hut and gate (see Figure 48 top) blocked entry to Road K, which turns north and continues uphill. When approaching the ETS-1 facility, there is a security perimeter fence with a second guarded gate, and the road ends at the test stand itself. The decontamination station is also at the intersection of Roads H and K (see Figure 47 top). Railroad access from E-MAD to the test stand was from the east (Figure 124).

The ETS-1 subdistrict comprises 145.2 acres (Figure 125). Starting at the south, the boundary encompasses the guard station complex (B19026) and proceeds northward along both edges of the access road and associated ditches and underground communications lines. It broadens when approaching the main facility. To the west it encompasses the septic system (C402) before turning north again to follow the west bank of a major unnamed drainage, which has been heavily altered to handle massive amounts of water generated by the cooling and deluge water systems (C403) during tests. To the east, it encompasses the east side of the fenced ETS-1 compound. North of the test stand (S3127), the borders narrow to include the three water tanks (C405) uphill of the main facility, along with their related access road and underground utility lines.

Figure 123. Overview of the ETS-1 subdistrict from the upper water tank, facing south-southwest (Photo 2116_0372, DRI 2021).

Figure 124. The XE Prime engine being transported to ETS-1 (RSL 5_00168-D10_02754).

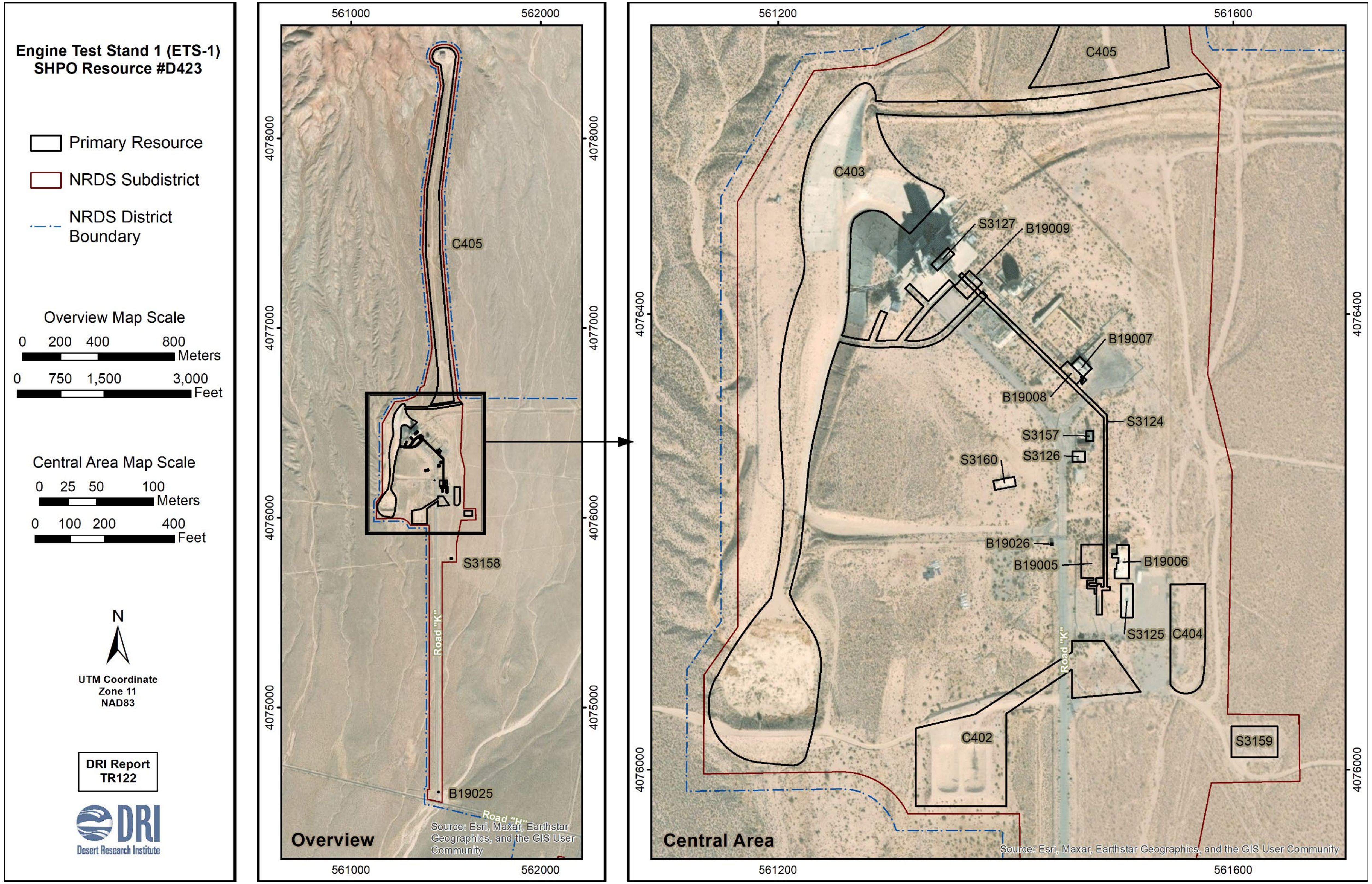

Figure 125. ETS-1 Subdistrict boundary and primary resources.

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Resource Synopsis

Prior to this architectural survey, the resources at ETS-1 had not been documented. During this survey, 19 primary and 59 accessory resources were recorded within the boundary of the ETS-1 subdistrict (Table 16). In this report, these resources are only evaluated as contributing or non-contributing elements to the NRDS Historic District.

Overall, the configuration of ETS-1 reflects its layout and appearance in 1973, when the nuclear rocket development program on the NNSS ended. This test cell facility is organized in a much more linear manner than the two earlier test cells. Distinctive functional areas identified on a Space Nuclear Propulsion Office (1970) plan drawing (Figure 126 and Figure 128) structure the following discussion.

Table 16. Primary Resources in the ETS-1 Subdistrict.

NNSS No. or Identifier	SHPO No.	Resource Name/ Description	Year Built	Contributing to NRDS	AR Total Count (# contributing to NRDS)*
Newly Recorded					
25-3310	B19005	Control Point Building	1964	Yes	1 (1)
25-3320	B19006	Utility Equipment Building	1964	Yes	3 (3)
25-3330	B19007	Fill Station and Tank Farm	1964	Yes	20 (20)
25-3331	B19008	Forward Control Room	1964	Yes	0
25-3340	B19009	Test Cell Building	1964	Yes	0
TS1	B19025	Road H Guard Station	c.1964	Yes	2 (2)
TS6	B19026	Guard Station Compound	c.1966	Yes	4 (4)
TS4	C402	Sewage System	c.1964	Yes	1 (1)
TS5	C403	Drainage System	c.1964	Yes	4 (4)
TS8	C404	Trailer Park	1964	No	0
TS9	C405	ETS-1 Water Tanks	1961	Yes	4 (4)
25-3312	S3124	Access Tunnel	1964	Yes	1 (1)
25-3319	S3125	Maintenance and Supply Shop (foundation)	c.1965	Yes	1 (1)
25-3324	S3126	Diesel Generator Building (foundation)	c.1966	Yes	1 (1)
25-3350	S3127	Engine Test Stand 1	1964-1967	Yes	10 (10)
TS10	S3157	Substation NRDS #3	c.1964	Yes	1 (1)
TS2	S3158	Booster Pumphouse (foundation)	1964	Yes	4 (4)
TS3	S3159	ETS Switching Station	c.1964	Yes	0
TS7	S3160	Fabrication Shop (foundation)	1964	Yes	0

*See Table A-2 for a list and description of accessory resources and contributing/non-contributing status.

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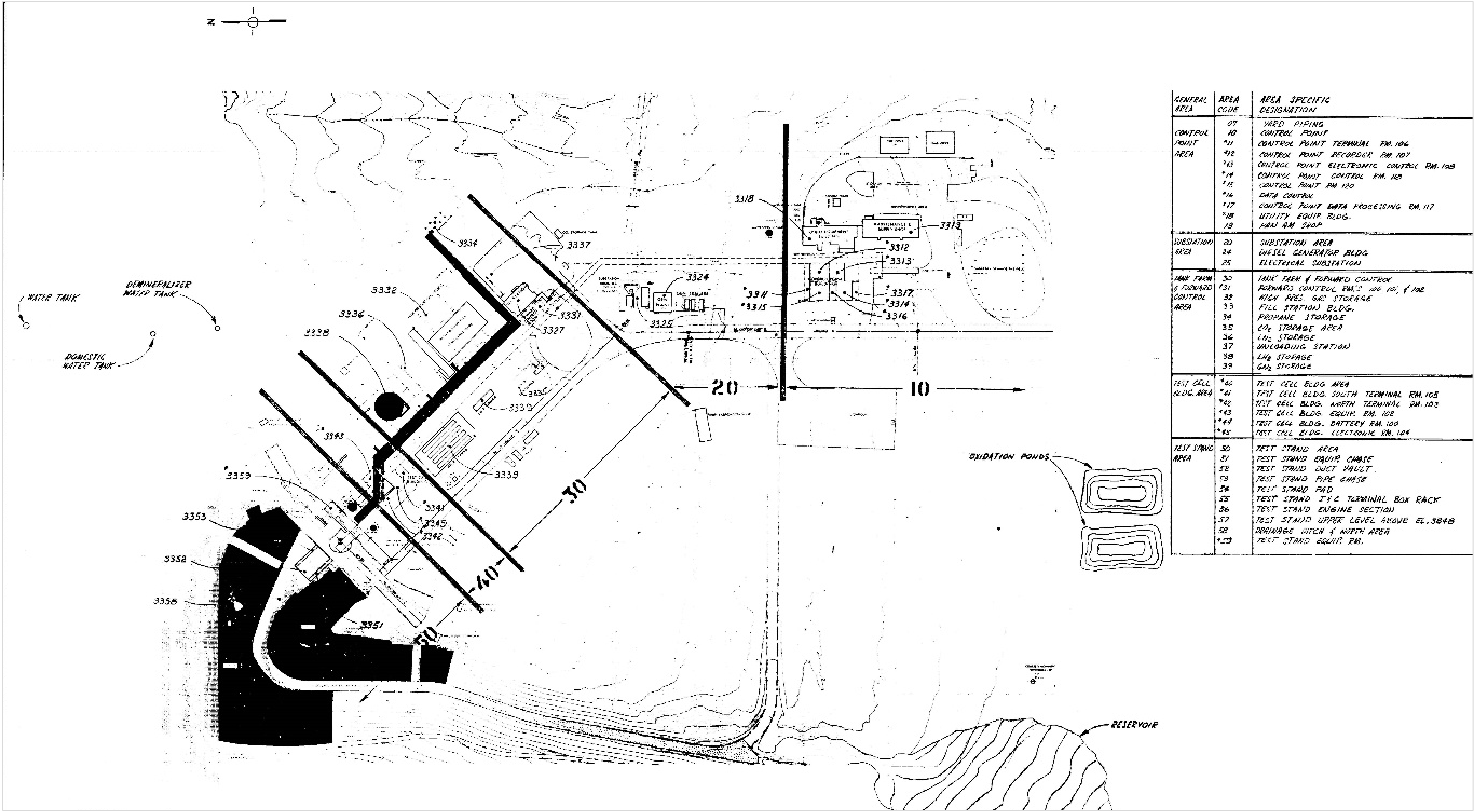

Figure 126. ETS-1 area designation drawing 010-3300-C-001 (Space Nuclear Propulsion Office 1970).

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TEST STAND AREA

The core of the complex is ETS-1 (25-3350, S3127). Made of aluminum to resist radioactive contamination, it towers over the surrounding landscape (cover photo). A railcar transported the test engine to the test stand (see Figure 124), and two portable spotlights facilitated nighttime installation. For transport to ETS-1, the test engine was clamped in place on the installation vehicle and mounted to an overhead ring, similar to an actual spacecraft, at the test stand (Figure 127). In contrast, at Test Cells A and C, the reactors were mounted on railroad test cars for transport and testing.

Figure 127. Installation of the XE Prime engine at ETS-1 (photo RSL 5-00164-D06_2098).

At Test Cell C, removeable covers called cowlings were installed around reactors to control radiation. At ETS-1, the two much larger clamshell shields (S3127 AR1) mounted on rails at ETS-1 also served this purpose, but their principal function was to create a chamber around the engine that could emulate the vacuum of space.

As shown on the cross-section in Figure 128, over a third of the test stand is below ground level to accommodate the rocket exhaust duct and the immense amount of cooling water running through the duct during a test. The height of the stand, along with the extensive modifications of the water runoff channel, is shown in Figure 129. Several camera stations (S3127 AR8 and AR9) surround the test stand.

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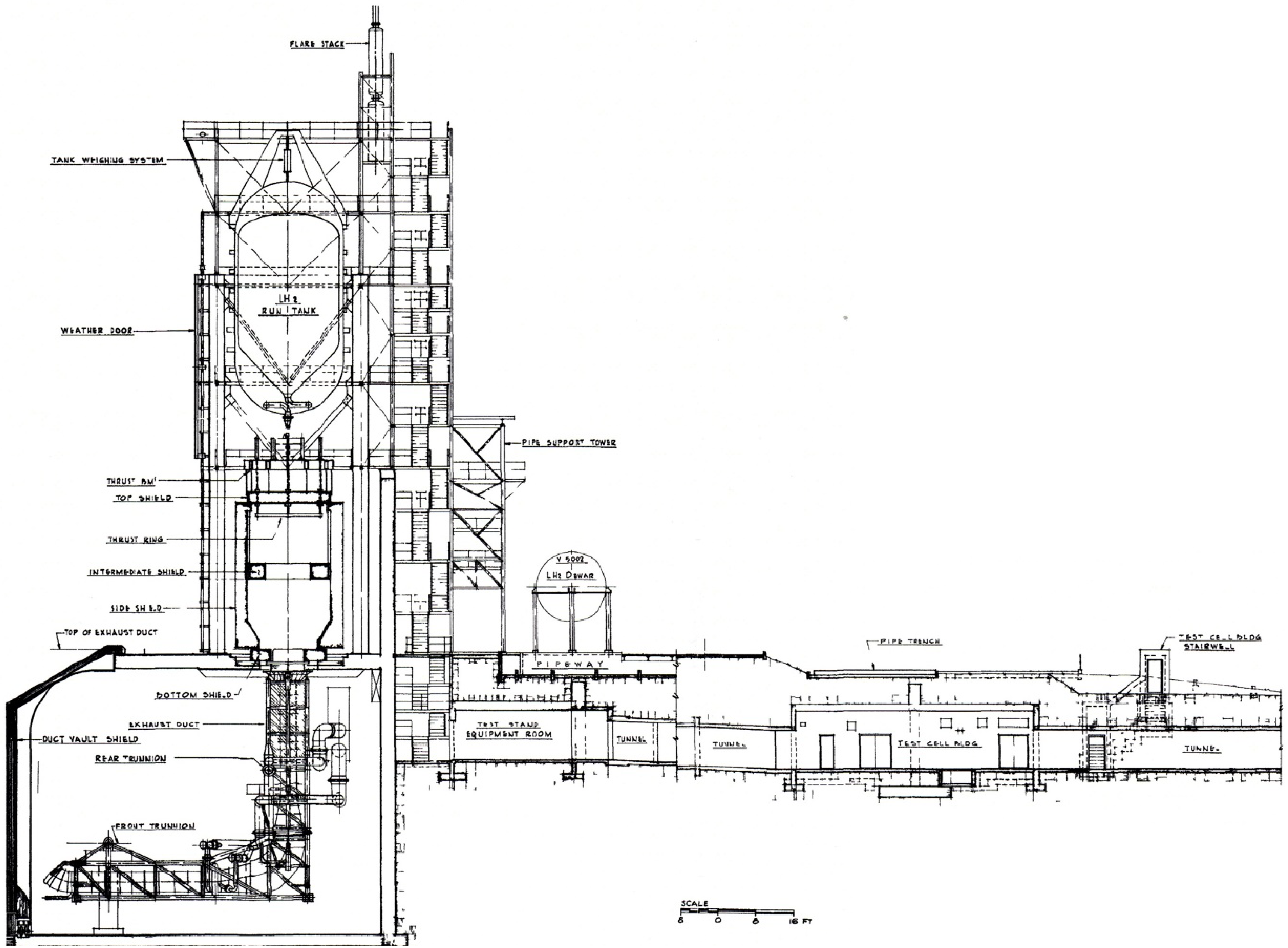

Figure 128. Sectional drawing of the ETS-1 Test Stand showing the underground Duct Vault, Equipment Room, Test Cell Building with its stairwell, and portions of the Access Tunnel (drawing on file from unknown source).

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Figure 129. View of the north elevation of ETS-1 from the channel for the exhaust duct, facing southeast (Photo 2116_0848, DRI 2021). Pipes mounted on the walls of the channel and elsewhere are for water sprays.

Test Cell Building Area

Immediately to the southeast of ETS-1 is the underground Test Cell Building (25-3340, B19009). There is nothing to see on the surface of this area other than the mass of piping leading from the Tank Farm (25-3330, B19007) to the Test Cell. Unlike Test Cells A and C, which had short and minimally used tunnels, ETS-1 has an Access Tunnel (25-3312, S3124) running nearly all the way through the complex and terminating in the basement of the Test Cell. There is an equipment room in the basement that was crammed full of electronics. From there, the tunnel proceeds to pass through the underground Test Cell Building.

Tank Farm and Forward Control Area

The Tank Farm (25-3330, B19007 AR1-AR20) retains foundations that held tanks for the many gaseous and liquified gases needed for testing. The few remaining tanks are dominated by a spherical 250,000-gallon liquid hydrogen dewar (B19007 AR20) (Figure 130). A concrete wall within the Test Stand protects this area to some extent from blast and radiation hazards. The area also includes several major concrete structures, including a gas filling dock (B19007 AR1). At the downhill (southeast) end of this area is the concrete block Fill Station (25-3330, B19007) (Figure 131). The Forward Control Room (25-3331, B19008) is underground and adjacent to the station.

Figure 130. Tank Farm at ETS-1, facing northwest (Photo 2116_0672, DRI 2021).

Figure 131. Fill Station and Gas Unloading Dock at ETS-1, facing south (Photo 2116_0623, DRI 2021).

Substation Area

This part of the complex is relatively undeveloped and includes Substation 25-3 (S3157). It also contains the foundations from the small emergency Diesel Generator Building (25-3324, S3126). The most significant aspect of this area is hidden underground — under the lot, the southeast-trending Access Tunnel (25-3312, S3124) turns to the south. The dogleg-shaped layout of ETS-1 does not match the topography. The reason for this abrupt change in axis is that the tunnel was designed to be Y-shaped. The second arm of the Y was to have led northeast to a series of facilities identical to ETS-1, named Engine Test Stand 2 (Aerojet 1962). With the termination of the project, none of these planned developments were constructed.

Control Point Area

The principal development in this area is the subterranean local Control Point Building (25-3310, B19005), and adjacent to it is the entrance to the Access Tunnel (S3124 AR1) (Figure 132). Aboveground resources in this area include parking lots, the remaining foundations (S3125) from the Maintenance and Supply Shop, and the Utility Equipment Building (25-3320, B19006).

Figure 132. ETS-1 Control Point Area, facing northwest. On the left is the Access Tunnel entrance and in the foreground is the foundation for the Maintenance and Supply Shop. The earth mound behind the foundation is over the Control Point Building; at right is the Utility Equipment Building (Photo 2116_0555, DRI 2021).

Cooling and Deluge System

All the test stands have extensive deluge systems to flood the complexes in case of fire or danger of explosion due to a gas leak. The deluge system at ETS-1 (C403) is many times more dramatic because it has all the protections of the earlier test cells, along with a need to cool the vulnerable test tower and the rocket exhaust duct. Three million gallons of water could pass through the duct during a single test, with additional water from cooling sprays adding considerably to that amount. Hence, concrete gutters and drains crisscross the entire complex. Paved areas were engineered to direct water into the drains utilizing gradients and peripheral curbs. Most impressive, however, is the re-engineered gunite-lined drainage leading to an impoundment reservoir at the southwest corner of the complex.

SUPPORT

Additional support buildings and structures or their remnants are scattered all around the edges of the main areas. Support facilities included potable water tanks north and uphill of the complex (C405), trailer parks (C404), shops (S3125, S3160), electrical substation (S3157), a switching station (S3159), a pumphouse (S3158), two guard shacks (B19025, B19026), and the sewage system (C402), among others.

Recommendations

The ETS-1 subdistrict (D243) and 18 primary with 59 accessory resources are recommended as contributing elements to the NRDS Historic District. Only one resource, the trailer park (C404), is recommended non-contributing due to extreme integrity issues from recent floods. Overall, the integrity of the complex is good. The test stand itself is in very good condition. Some buildings are still standing, and the foundations of others clearly represent the layout of the facility. The deluge system, the underground structures, and the extensive aboveground piping system that routed gases to the test stand are still in place.

As part of the current survey, the ETS-1 subdistrict was not evaluated for eligibility to the NHRP as a potential historic district under any of the Secretary of the Interior's Significance Criteria (36 CFR 60.4).

Reactor Control Point Subdistrict (D420)

The Reactor Control Point was the principal command and control center for the NRDS. Construction of this facility began in 1957 and it continued to grow into the early 1960s. The facility operated as a control point until January 5, 1973, when the NRDS programs were canceled. The functions of the buildings and structures in the Reactor Control Point subdistrict during the period of significance for NRDS were directly related to the support of the Rover and NERVA programs to develop nuclear rocket technology in the United States during the Cold War and its potential for use in space travel.

The interrelationship of resources in the Reactor Control Point subdistrict conveys an overall visual sense of the historic control point environment. It is composed of a heavily built-up central fenced and guarded compound almost completely covered by asphalt parking places and driveways (Figure 133). Around the periphery, there were large numbers of prefabricated metal buildings and trailers, most of which are portrayed on the 1965 Reactor Control Point plan map (Figure 134). Trailer pads or foundations were recorded for most of these ephemeral facilities.

Subdistrict Location, Boundary, and Layout

The Reactor Control Point subdistrict comprises 122 acres (Figure 135). It is located near the center of Jackass Flats at an elevation of 3,580 to 3,620 feet (Figure 136). It is the focal point of communications lines and the NRDS road system. Road C runs southward to Gate 500, where the three major outside connecting roads from Mercury, Lathrop Wells, and Frenchman Flat meet. Road G runs northeast to R-MAD. Road F accesses TCA and TCC to the north. Road H goes northwest to E-MAD and ETS-1. And finally, an unnamed road proceeds southwest to the Central Support Area. The subdistrict boundary extends far enough in all directions to surround the built-up central area and the periphery facilities, including the intact sewage lagoons to the south by Road C.

Figure 133. Typical paving at the RCP with the 25-3101 Reactor Control Point Building in the background (Photo 2116_9311, DRI 2021)

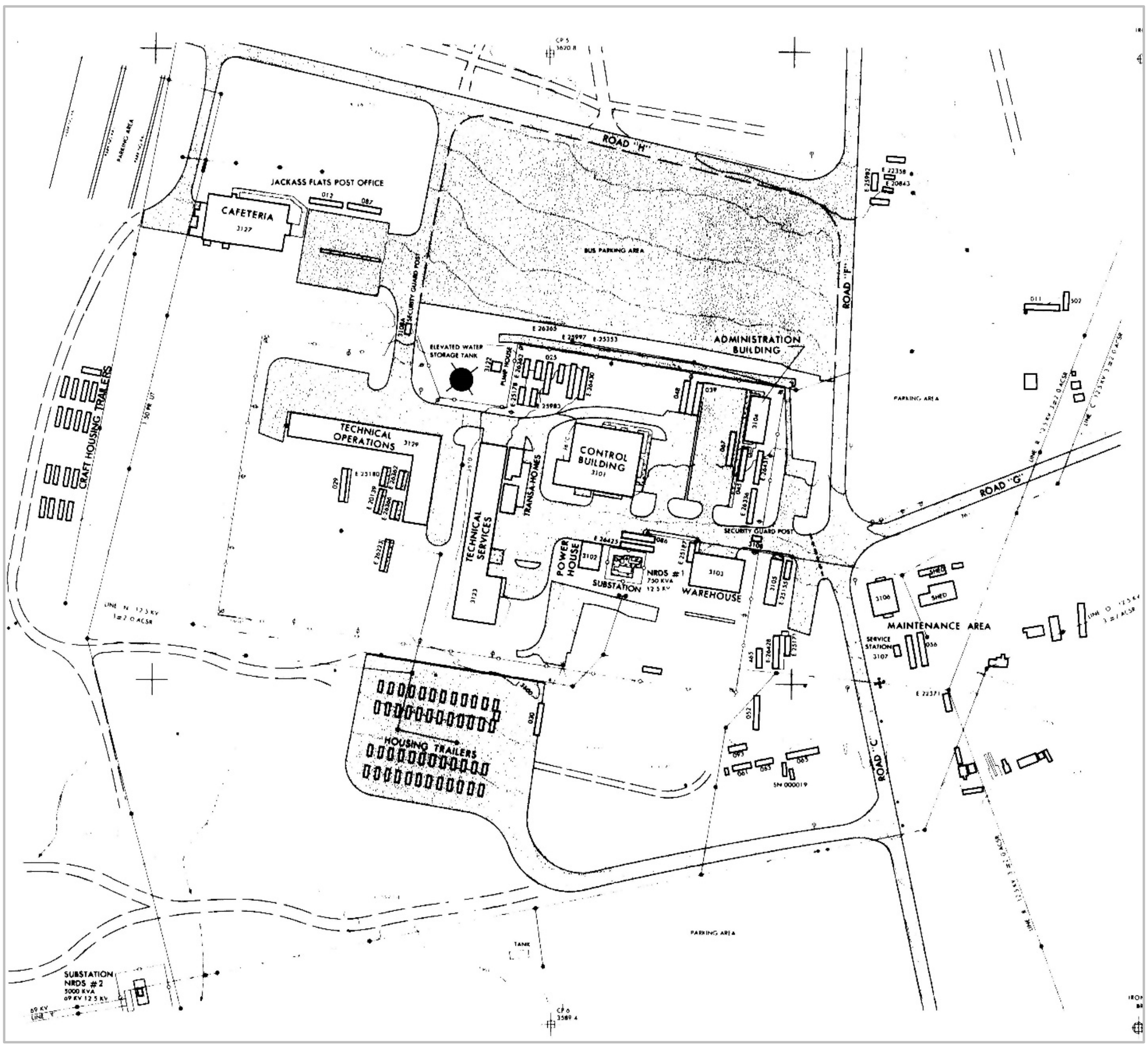

Figure 134. Reactor Control Point plan from NRDS master plan map (Koogle and Pouls Engineering, Inc. 1965).

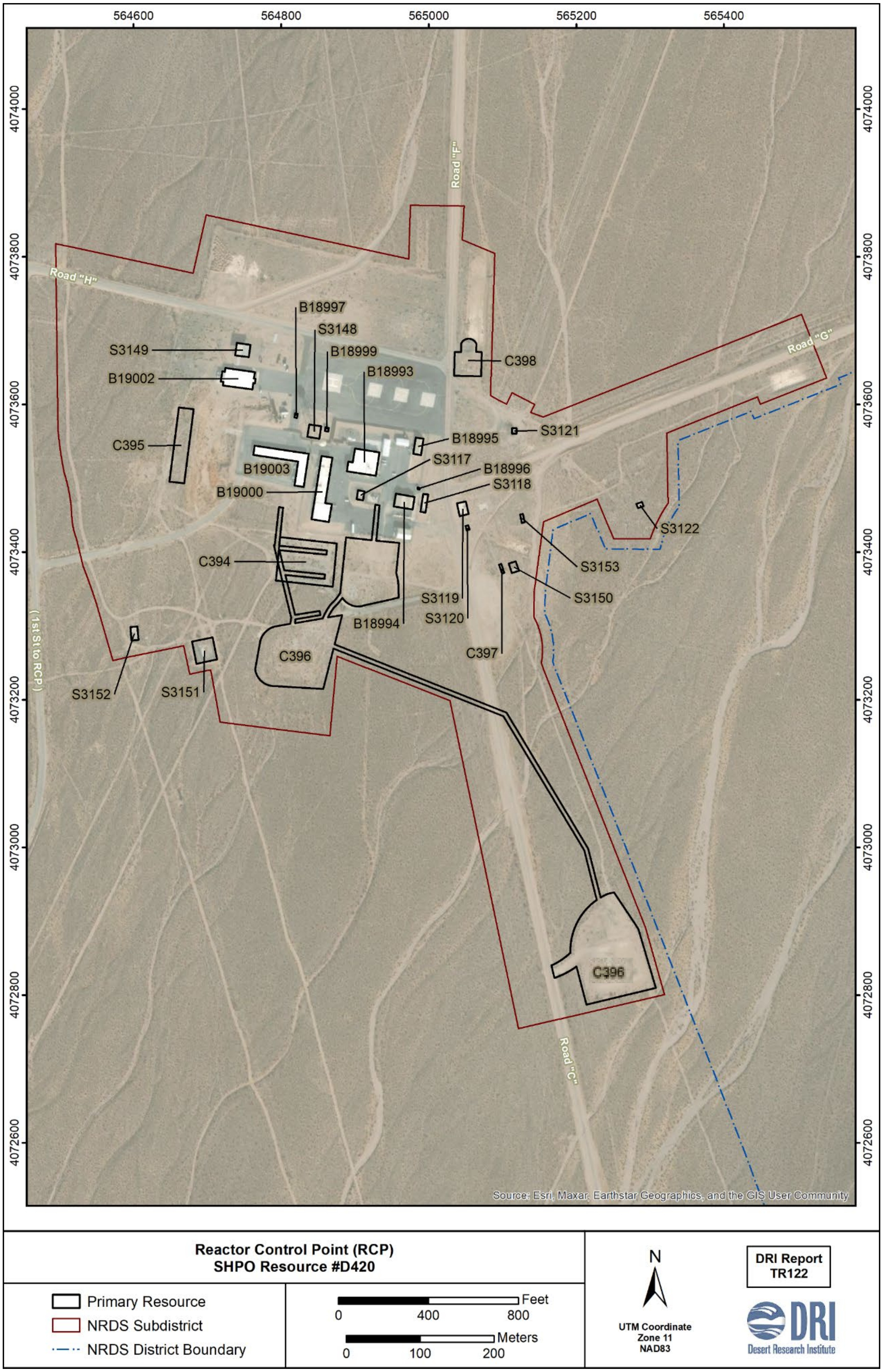

Figure 135. Reactor Control Point subdistrict boundary and primary resources.

Figure 136. Overview of the Reactor Control Point, facing northwest (Photo 2116_1682, DRI 2021).

Resource Synopsis

This architectural survey identified 26 primary and 25 accessory resources within the boundaries of the Reactor Control Point subdistrict (Table 17). All resources are newly recorded.

Table 17. Primary Resources in the Reactor Control Point Subdistrict.

NNSS No. or Identifier	SHPO No.	Resource Name/ Description	Year Built	Contributing	AR Total Count (# contributing to NRDS)*
Newly Recorded					
25-3101	B18993	Control Building	1958	Yes	0
25-3103	B18994	LASL Warehouse	1958	Yes	1 (1)
25-3104	B18995	Administration Building	1958	Yes	0
25-3108	B18996	Guard House	1958	Yes	0
25-3108A	B18997	Guard House	1962	Yes	0
25-3122	B18999	Pumphouse No. 2	1958	Yes	0
25-3123	B19000	Technical Services	1959	Yes	0
25-3127	B19002	New Cafeteria	1962	Yes	0
25-3129	B19003	Technical Operations Building	1962	Yes	0
RCP1	C394	LASL Housing Trailer Park	c.1961	Yes	0

(Table 17 is continued on the next page.)

(Table 17 is continued from the previous page.)

NNSS No. or Identifier	SHPO No.	Resource Name/ Description	Year Built	Contributing	AR Total Count (# contributing to NRDS)*
RCP10	C395	Craft Housing/CATCO Trailer Park	1964	Yes	0
RCP11	C396	Sewage System	1958	Yes	3 (3)
RCP4	C397	Vehicle Maintenance Area	1965	Yes	3 (3)
RCP7	C398	J-3 Trailer Area	c.1958	Yes	5 (5)
25-3102	S3117	Foundation (formerly the Power House)	1958	Yes	1 (1)
25-3105	S3118	Foundation (formerly the Old Cafeteria)	1958	Yes	1 (1)
25-3106	S3119	Foundation (formerly the REECo Warehouse)	1958	Yes	2 (2)
25-3107	S3120	Foundation (formerly the Service Station)	1958	Yes	0
25-3128	S3121	Foundation (formerly the Generator Trailer Service Building)	1964	Yes	3 (3)
25-3151	S3122	Foundation (formerly the Weather Station)	1959	Yes	2 (2)
RCP2	S3148	Water Tower	1958	Yes	0
RCP3	S3149	Heliport Hanger	1987	No	3
RCP5	S3150	Foundation (formerly the Vehicle Maintenance Shop)	1965	Yes	0
RCP6	S3151	Substation NRDS #2	c.1957	Yes	0
RCP8	S3152	Concrete Slab	c.1960s	Yes	1 (1)
RCP9	S3153	Shed Foundation	1965	Yes	0

*See Table A-2 for a list and description of accessory resources.

The Reactor Control Point was laid out with most permanent buildings oriented slightly to the east of true north. This orientation allowed extensive terracing for construction along natural contours. An exception was the extremely long Technical Services Building (25-3123, B19000), which was built with its long axis at a right angles to the natural contours, creating a need for the construction of an immense terrace (Figure 137). In contrast, the lower edge of the terrace for one of the warehouses (25-3103, B18994) was efficiently designed to double as a loading dock (Figure 138). Due to the shapes and placements of buildings, the pattern of driveways and parking areas was irregular. Although the main gate into the compound was to the east at the junction of Roads C, F, and G (Figure 139), the original formal entry to the Control Building (25-3101, B18993) was from the north. Due to subsequent development, that entry was rarely used.

Figure 137. The Technical Services Building 25-3123 with downhill berm of the constructed terrace, facing northeast (Photo 2116_9811, DRI 2021).

Figure 138. The rear of the warehouse area, facing northeast (Photo 2116_9284, DRI 2021). The downhill edge of the terrace for this warehouse was used as a loading dock. The framing of these steel buildings is original but exterior materials have all been replaced.

Figure 139. The guard shack at the main entry into the Reactor Control Point compound can be seen behind the trucks in this photo, facing west-northwest (Photo 2116_9564, DRI 2021). Foundations for the Old Cafeteria (25-3105, S3118) are in the foreground outside the perimeter fence.

The buildings and structures at the Reactor Control Point are discussed below by their functional areas.

MISSION

The focal point of the entire NRDS is the small control room in the Control Building (25-3101, B18993), which is the only Moderne style building ever constructed on the NNSS. This large concrete and concrete block building has one of the rare basements at the NNSS. The major underground communications chase connecting this building with the test stands emerges into this basement and connects to a mass of electronic equipment. On the main floor, extensive rooms for computers and other electronic equipment provided direct support for the team at their consoles in the control room.

A pair of long L-plan concrete block buildings (25-3123, B19000 and 25-3129, B19003) provided extensive laboratory and office space for researchers and technicians developing the nuclear rocket engine (see Figure 24 bottom). All three of these major buildings have been emptied of their NRDS-era electronics and furnishings and now serve as support buildings for training exercises in the vicinity. Their exteriors are essentially unchanged. Nearly all windows in the three buildings were filled in, most likely during the NRDS period.

SUPPORT

Support facilities at the Reactor Control Point included a small administration building (25-3104, B18995), several warehouses (25-3103, B18994; 25-3106, S3119), two generations of cafeterias (25-3105, S3118; 25-3127, B19002), two housing trailer parks (C394, C395), security stations (25-3108, B18996; 253108a, B18997), the weather station (25-3151, S3122), and a variety of maintenance facilities. The original cafeteria (25-3105) outside the main gate was reused as a medical facility before being torn down. The new cafeteria (25-3127) is presently used as a training facility.

INFRASTRUCTURE

The subdistrict is crisscrossed with above and below-ground power and communications lines, sewer lines and water lines and includes a major substation in the Area 25 power infrastructure (S3151). It still has its distinctive Water Tower (S3148) with the Butler pumphouse (25-3122) at its base; however, due to casing failures none of the wells that once provided water to the NRDS are still in operation. Buildings presently in use are easily identified by the orange portable toilets beside them.

Built in 1987, well beyond the period of significance for the NRDS Historic District, the original heliport with its steel-frame hangar (S3197) occupies the northwest corner of the subdistrict. Neither this resource nor its recent major expansion covering most of the northern edge of the subdistrict conveys the importance of nuclear rocket development from 1956 to 1973. The heliport and hanger are, therefore, non-contributing elements to the NRDS district.

Recommendations

The Reactor Control Point subdistrict is recommended as contributing to the NRDS Historic District. Except for the heliport, the configuration and layout of this subdistrict reflects its appearance at the end of the NRDS program in 1973. Although some buildings, especially prefabricated Butler buildings, have been removed or demolished, most of the foundations remain, providing a visual sense of the Reactor Control Point subdistrict's historic plan and design. There are 26 primary resources within the Reactor Control Point subdistrict boundary. Of these, 25 are recommended as contributing elements to the NRDS Historic District. One primary resource, the heliport hanger, is recommended as non-contributing because it was built many years after the NRDS Historic District's period of significance.

As part of the current survey, the Reactor Control Point subdistrict (D420) was not evaluated for eligibility to the NHRP as a potential historic district under any of the Secretary of the Interior's Significance Criteria (36 CFR 60.4).

Central Support Area Subdistrict (D422)

The Central Support Area consists of a concentration of buildings and structures that convey the interrelated functions essential for operating the NRDS. Functions included administration, warehousing and storage, technical and maintenance shops, vehicle maintenance, communications, medical services, and radiation services. The Central Support Area had no housing facilities and only a modest lunchroom.

Infrastructure construction, including Well J-11, began here in 1958 and nearly all improvements were in place by the mid to late-1960s. The Central Support Area never reached its full buildout due to cancellation of the Reactor In-flight Test (RIFT) phase of the nuclear rocket development program, but it still retains its formal street grid and a variety of buildings. The Central Support Area has one of the two formal heliports at the NRDS (see Figure 64 top).

This subdistrict, like others at the NRDS, is intentionally located three to four miles from the testing areas in a place that was normally upwind of the potential fallout but still within Jackass Flats. The Central Support Area was never a self-sufficient settlement but was, instead, a specialized satellite of the main base camp of Mercury. Other than a horseshoe pit, the only other outdoor recreation areas were benches placed among a few trees at the Administration and Engineering Building and near Well J-11. After the NRDS programs ended in 1973, the Central Support Area facilities continued to support various other programs at the NNSS, particularly if the program activities occurred in or near Area 25.

Subdistrict Location, Boundary, and Layout

The Central Support Area is at the southwest edge of Jackass Flats at an elevation of 3,360 to 3,460 feet (Figures 140 and 141). This area has enough slope to permit drainage but is flat enough that almost no terracing was required for construction of large buildings or yards. A series of ditches and dikes along the north and east sides of the main built-up area of the subdistrict protect it from floodwaters. Principal access is from Gate 500 via a Cane Springs/Lathrop Wells Road reroute that was built specifically to access the Central Support Area. The old road, which predates the NNSS, passes through the northern part of the Central Support Area. The first building encountered as the area is approached at its south end is the dramatic Administration and Engineering Building (25-4015, B19011) with its elaborate screened façade, flagpole, and strikingly out of place row of trees and other plantings (see Figure 30).

The Central Support Area subdistrict comprises 175.8 acres (Figure 142). The subdistrict boundary includes the major developments of the central area along with the central propellent area to the north, which handled the liquid hydrogen used as a propellent for nuclear rockets. . It also includes an area to the southeast occupied by the extensive sewer system. Unfortunately, local topography required putting the open sewage lagoon upwind of the Central Support Area.

Figure 140. Overview of the Central Support Area facing southeast with Little Skull Mountain in the background (RSL 2013).

Figure 141. Overview of the Central Support Area looking northeast from Lathrop Wells Road (Photo 2116_7378, DRI 2021). The road curves and passes to the right of the Administration and Engineering Building.

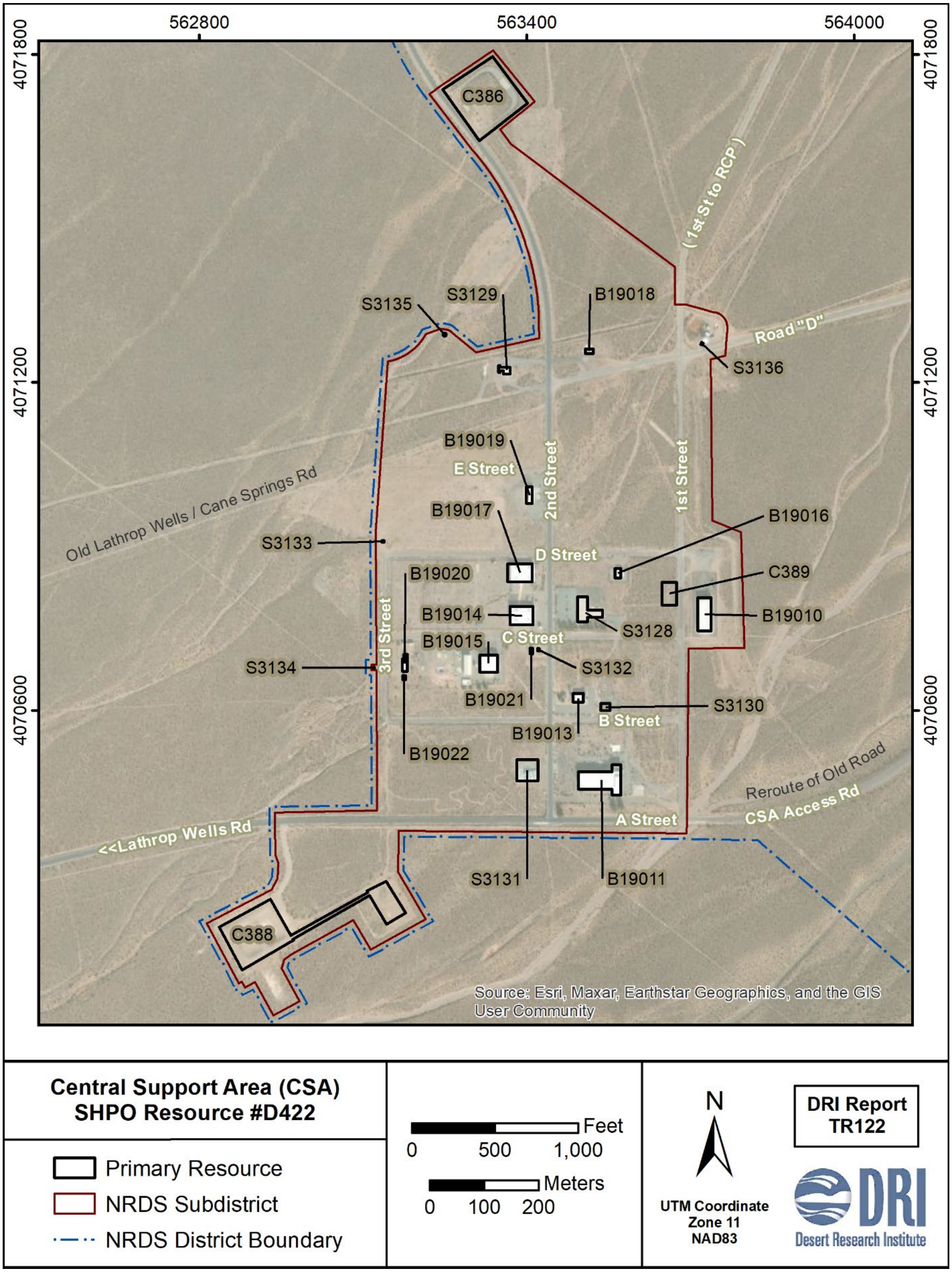

Figure 142. Central Support Area subdistrict boundary and primary resources.

The layout of the central portion of the facility north of the Lathrop Wells Road is organized as two columns of blocks. All are 500 feet north to south. The eastern column is about 800 feet wide and the western one is larger at about 1,000 feet from east to west. Streets are paved and have wide shoulders and concrete curbs and gutters (Figure 143). The north-south streets are numbered 1st through 3rd from east to west. East-west trending streets are A through E from south to north. The rerouted Lathrop Wells-Cane Spring Road is labeled on maps as an access road between the still-present part of Cane Springs Road to the east and 1st Street. The portion between 1st Street and 3rd Street is called A Street, and the road continuing to Yucca Flat is the eastern extent of Lathrop Wells Road. The array of blocks was intended to be much larger than it is due to intended expansion and long-term use of the facility. Because the program was canceled before construction was completed, the present aspect of the place is one of scattered buildings separated by large overgrown open spaces only partly improved by parking lots. This arrangement is clearly seen on the 1965 plan map of the Central Support Area (Figure 144).

During the time the Central Support Area was in use for the NRDS, the facility was bustling with activity and there were lots covered with office and storage trailers and full parking lots. Nearly every building was re-used by the Yucca Mountain Project from the early 1980s until 2011 when funding was cut for the program, and some warehouses likely still store samples collected during that project. Only a few trailers were still in use by that time. Storage yards are now nearly emptied of their former contents.

Figure 143. Typical street in the Central Support Area with minor flood sedimentation (Photo 2116_1441, DRI 2021). Warehouses 1 and 2 (25-4221, B19014 and 25-4320, B19017) are to the right. Note the absence of street lighting or sidewalks.

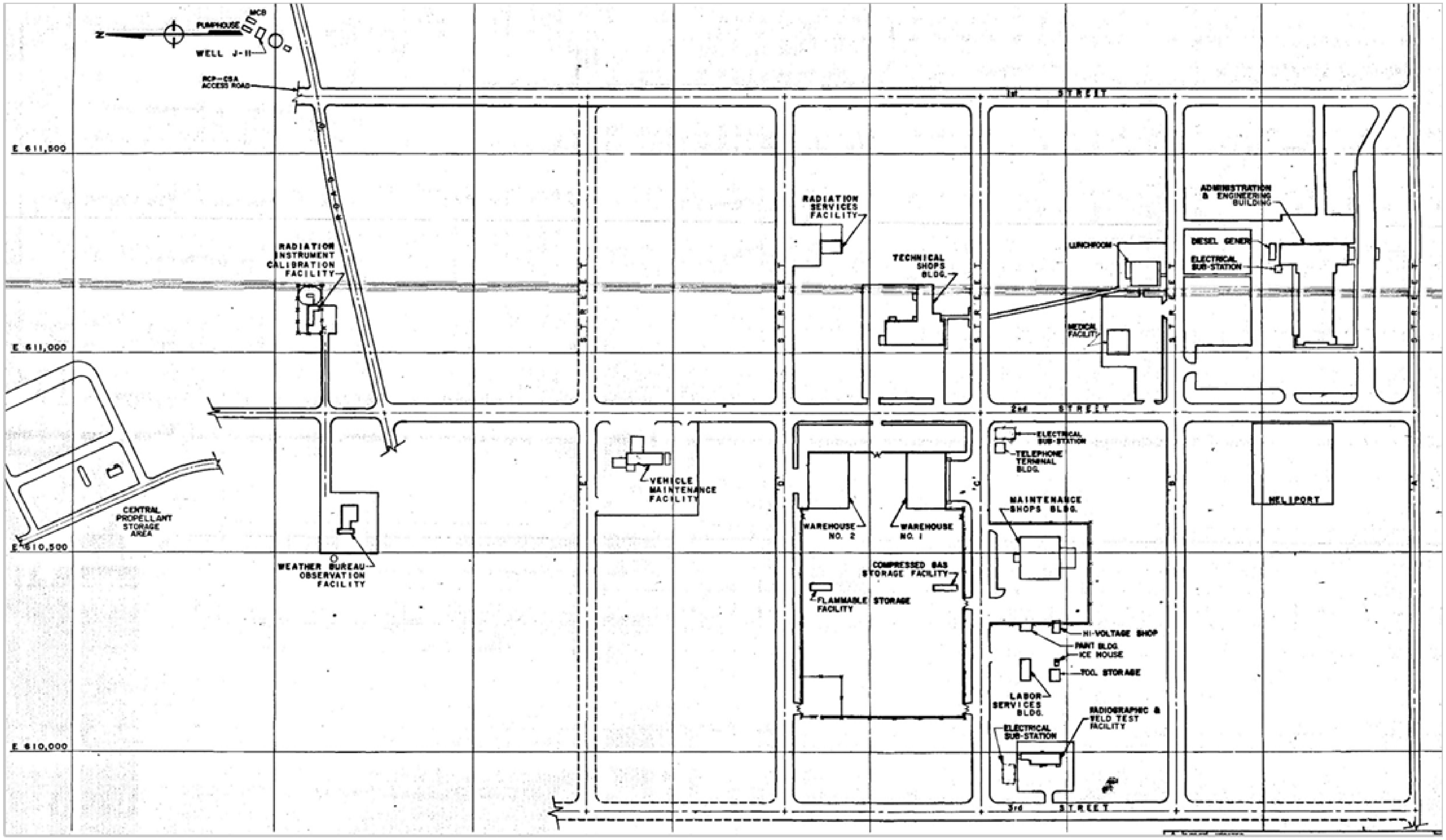

Figure 144. The Central Support Area showing buildings and streets as of 1965 (Pan American 1965).

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Resource Synopsis

During the architectural survey 24 primary resources and 76 accessory resources were identified within the boundary of the Central Support Area subdistrict (Table 18). Although the Central Support Area was repurposed after 1973, developing new historical themes that potentially have a significant place in American history was beyond the scope of the NRDS architectural survey. Only resources dating to the NRDS period of significance were evaluated during the present survey as contributors to the NRDS Historic District.

Table 18. Primary Resources in the Central Support Area Subdistrict.

NNSS No. or Identifier	SHPO No.	Resource Name/ Description	Year Built	Contributing to NRDS	AR Total Count (# contributing to NRDS)*
Newly Recorded					
25-4014	B19010	USAF Warehouse	1987	No	2
25-4015	B19011	Administrative and Engineering Building	1966	Yes	10 (7)
25-4117	B19013	Medical Building	1969	Yes	2 (2)
25-4221	B19014	Warehouse No. 1	1964	Yes	0
25-4222	B19015	Maintenance Shops	1966	Yes	6 (4)
25-4314	B19016	Radiation Services	1967	Yes	1 (1)
25-4320	B19017	Warehouse No. 2	1966	Yes	5 (5)
25-4517	B19018	Radiation Instrument Calibration Facility Foundation	1967	Yes	3 (3)
25-4838	B19019	Vehicle Maintenance Shop	1967	Yes	5 (5)
25-4919	B19020	Radiographic Facility	1967	Yes	3 (3)
25-5004	B19021	Communications Trailer	c.1960	Yes	5 (5)
CS7	B19022	Radio Communications Facility (foundation)	c.late-1960s	Yes	1 (1)
CS10	C386	Central Propellent Area	1959	Yes	10 (10)
CS4	C388	Septic System	c.1960	Yes	2 (2)
CS8	C389	Trailer Park	c.1960s	No	0
25-4215	S3128	Technical Shops (foundation)	1967	Yes	6 (6)
25-4522	S3129	Weather Bureau Observation Facility (foundation)	1966	Yes	8 (7)
CS1	S3130	Lunchroom (foundation)	c.1960	Yes	0
CS2	S3131	Heliport	c.1960	Yes	2 (2)

(Table 18 is continued on the next page.)

(Table 18 is continued from the previous page.)

NNSS No. or Identifier	SHPO No.	Resource Name/ Description	Year Built	Contributing to NRDS	AR Total Count (# contributing to NRDS)*
CS3	S3132	Substation NRDS #10	c.1964	Yes	0
CS5	S3133	Loading Ramp	c.1960	Yes	0
CS6	S3134	Survey Instrument Station	c.1980s	No	0
CS9	S3135	Microwave Tower	c.1965	Yes	0
Well J-11	S3136	Well J-11	1958	Yes	5 (5)

*See Table A-2 for a list and description of accessory resources.

Many buildings in this area are abandoned, but one older maintenance shop (25-4222, B19015) and the two large warehouses (25-4221, B19014 and 25-4320, B19017) that date to the NRDS period of significance are still in use.

Buildings with similar functions in the Central Support Area were somewhat grouped by purpose, with areas for administration, warehousing and storage; technical and maintenance shops; a vehicle shop and fuel station; communications; medicine; and radiation services. The facility was intended to operate almost entirely during normal daytime working hours, so it was equipped only with a modest lunchroom and had no housing facilities of any kind. This subdistrict also included buildings related to instrument calibration and weather observation. The function of each building can be identified by the description in Table 18.

The highly explosive Central Propellant Area was located as far as possible from the main part of the Central Support Area at the north end of the subdistrict. Well J-11, which is no longer operational, was placed at the intersection of Road "D" and 1st Street. It supplied water to many of the NRDS buildings. An adjacent pond and a few trees provided a small recreational area.

Recommendations

The Central Support Area subdistrict is recommended as contributing to the NRDS Historic District. The configuration and layout of this district reflects its appearance at the end of the NRDS program in 1973. Although some buildings have been removed, most of the foundations remain, providing a visual sense of the Central Support Area subdistrict historic plan and design. There are 24 primary resources within the Central Support Area subdistrict boundary. Of these, 21 primary resources with 68 contributing accessories are recommended as contributing elements to the NRDS Historic District. Two primary resources (B19090 and S3134) date to after the NRDS period of significance and are non-contributing. The trailer park (C389) lacks sufficient integrity to convey its significance to the NRDS district and is, therefore, also non-contributing.

As part of the current survey, the Central Support Area subdistrict was not evaluated for eligibility to the NHRP as a potential historic district under any of the Secretary of the Interior's Significance Criteria (36 CFR 60.4).

Radioactive Material Storage Facility (RMSF)

The RMSF (C399) has long been inactive. The facility was initially recorded in 2003 as site 26NY11769 (Drollinger 2003), which focused on documenting the railcars at the facility. The RMSF was constructed in 1964-1965 and is centrally located between E-MAD, Test Cell C, and ETS-1. This facility was used for the surface storage of both nuclear fuel and non-nuclear hardware from the disassembly of nuclear reactors and engines after being tested (Bond 1973:11; Miller 1984:6). In consultation with the SHPO, the DOE determined the RMSF was eligible for the NRHP under Criteria A and C (Baldrica 2000a). None of the individual railcars in the facility have been individually evaluated for NRHP eligibility as part of the earlier or current surveys.

The rolling stock at the RMSF consists of 19 railcars: 9 flat cars, 7 test cars, 2 engines, and 1 dump car. Test cars were rail cars modified to incorporate nuclear reactors and engines into the structure of the cars. These were assembled in cold bays at the R-MAD or E-MAD facilities and delivered to the test cells by way of the railway. They were returned to the assembly facilities, also by rail, after testing and were then disassembled in hot bays and small hot cells for further study. The flat cars were used primarily to transport material, but also served during disassembly of the reactors as stages or platforms upon which to set or stack the components. Dump cars were used to haul radioactive waste to special disposal sites at the NRDS, particularly the disposal pits near the R-MAD and E-MAD facilities. The two engines at the RMSF were used to move equipment and materials, including the transport and maneuvering of the test cars between facilities. They were also remotely controlled to ensure that workers remained at a safe distance from contaminated cars after testing. These two engines were the first employed at the NRDS and replaced later by the Railroad Transport System that had larger and more powerful engines.

A logbook for recording water pressure was found with Engine 2 during this investigation. It contains entry dates from April 25, 1963, to June 8, 1964. The latter date may indicate the last time this engine was employed. Many of the rail cars were likely still in use up through the end of the period of significance for the NRDS.

Facility Location, Boundary, and Layout

The RMSF is a 163-acre plot of land enclosed by an exterior perimeter fence surrounding an inner security fence (Figures 145 and 146). The 8-ft high chain link security fence defines the interior enclosure consisting of about 21 acres. The exterior fence is lower, about four feet in height, and consists of simple wire strands and metal posts. Penetrating the two fences are a single-track rail line and an adjacent road. A road which is still passable also circles the exterior of the inner fence. Between the two fences and encircling the interior enclosure is a series of security light poles. Access to the facility was through separate locked gates, one for ground vehicles and a second for the rail line. Due to storm damage, neither of these approaches is now passable.

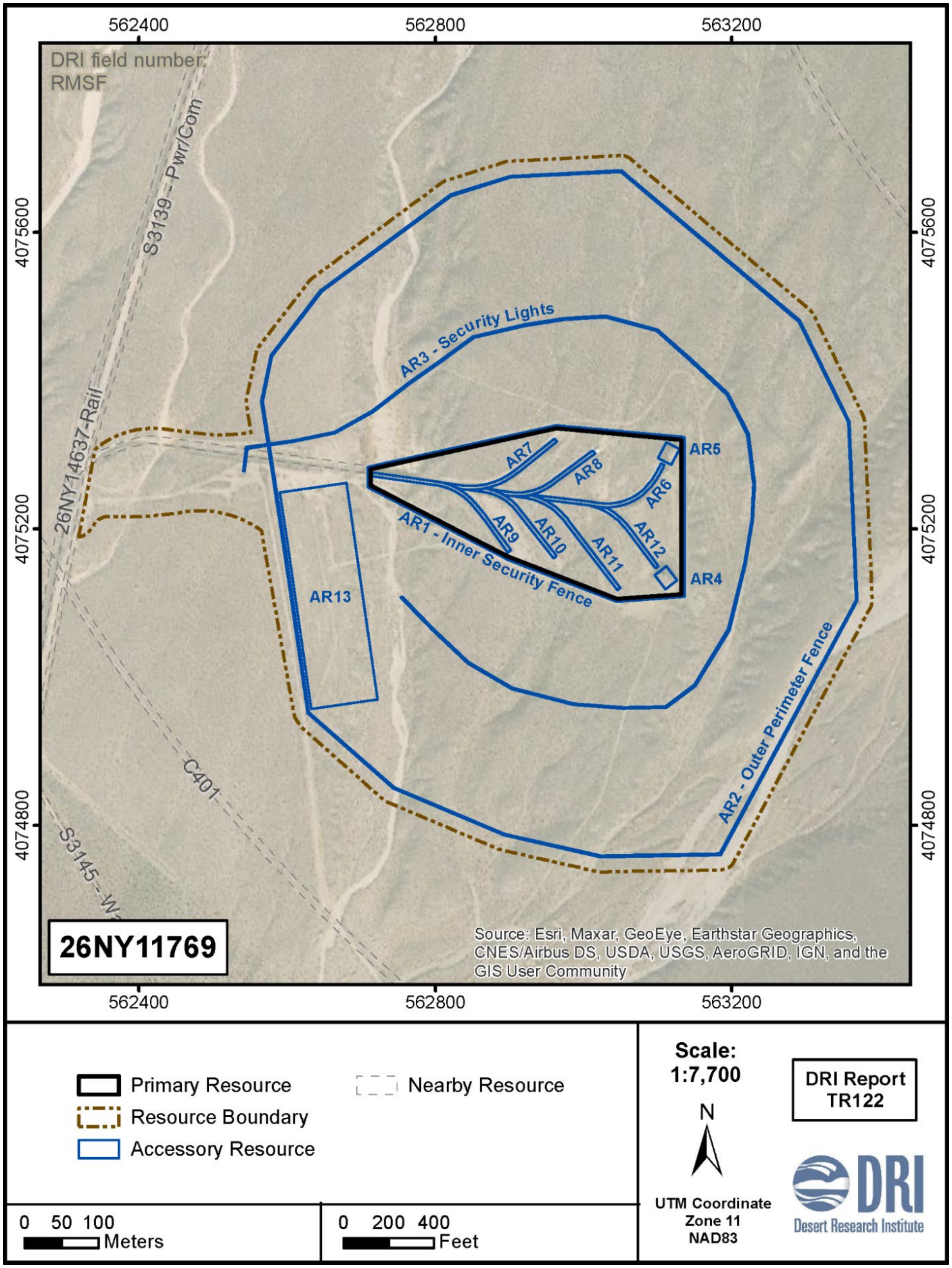

Figure 145. Map of the RMSF, as recorded in 2021 and showing the location of the 13 accessory resources.

Figure 146. Oblique aerial view of RMSF showing the rail spurs, facing south (RSL undated image taken prior to 2003).

Resource Synopsis

For this assessment of the RMSF facility, DRI did not enter the inner security fence and took a generalized approach to recording the current condition by recording each of the seven railroad spurs with associated cars as an accessory resource (AR6-12). Other accessory resources are the inner security fence (AR1), the outer perimeter fence (AR2), the perimeter security lights (AR3), the south and north bunkers (AR4 and 5), and the material storage yard (AR13). In all, 13 accessory resources to the RMSF were identified (Table 19).

Table 19. RMSF Primary Resource.

NNSS No. or Identifier	SHPO No.	Resource Name/ Description	Year Built	Contributing to NRDS	AR Total Count (# contributing to NRDS)*
Previously Recorded (update)					
RMSF**	26NY11769	Radioactive Material Storage Area	1964-1965	Yes	13 (13)

*See Table A-2 for a list and description of accessory resources and their contributing status to the NRDS district.
**Individually eligible

Within the inner fence, the rail line branches into the seven spurs, with the last two spurs leading to concrete bunkers (Figure 147). The main purpose of the spurs and bunkers were to park flat cars loaded with nuclear fuel elements in containers having neutron absorbers and reactor components (Bond 1973:11). The containers and components are covered with aluminum hoods to protect the contents from the weather. One of the spurs also provides access to a small, buried storage facility.

Figure 147. The south bunker at the RMSF, showing sidings with contaminated railroad cars, and the inner security fence, facing southeast (Photo 2116_2296, DRI 2021).

Recommendations

In 2003, the RMSF (26NY11769) was documented, recorded, and photographed in detail. Based on observations made during this survey of the NRDS Historic District, the RMSF retains sufficient integrity to remain individually eligible under Criteria A and C. Although major flash floods since 2003 have damaged the resource, this damage has not extended to the railroad cars and engines. For the most part, flooding has washed out portions of roads, fences, and the railroad subgrade (Figure 148). Beyond this, there has been minimal change to the resource.

Figure 148. Washed out railroad subgrade at the RMSF, facing north (Photo 2116_2311, DRI 2021).

This RMSF provided critical support for the NRDS mission and holds most of the surviving examples of railroad cars specially fabricated for transporting and testing nuclear reactor and rocket components.

Except for minor damage caused by stormwater, the facility is the same as it was in 2003 and retains integrity of location, design, materials, setting, feeling, workmanship, and association and conveys its significance as a contributing element to the NRDS Historic District.

Main Gate (Gate 500) Area and Vicinity

The main gate (Gate 500) was the principal entry into the NRDS. The gate guard station was south of the intersection of the road from Mercury and Cane Spring Road (Figure 149). A total of 5 primary and 12 accessory resources, consisting of the former gate location and resources in the vicinity, were recorded as part of this survey (Table 20).

The only visible remnant of Gate 500 (C390) is a wide spot in the road where a guard station once stood. The original posts and board of the large NRDS entry sign are nearby, but the sign was repurposed for the Nevada Research & Development Area. A short distance to the north-northeast of the Gate 500 area are the NRDS fire department building (25-3153, B19004) (Figure 150), the foundation of the radiation safety building (S3123), an animal shelter (S3142), and a water tank (S3143).

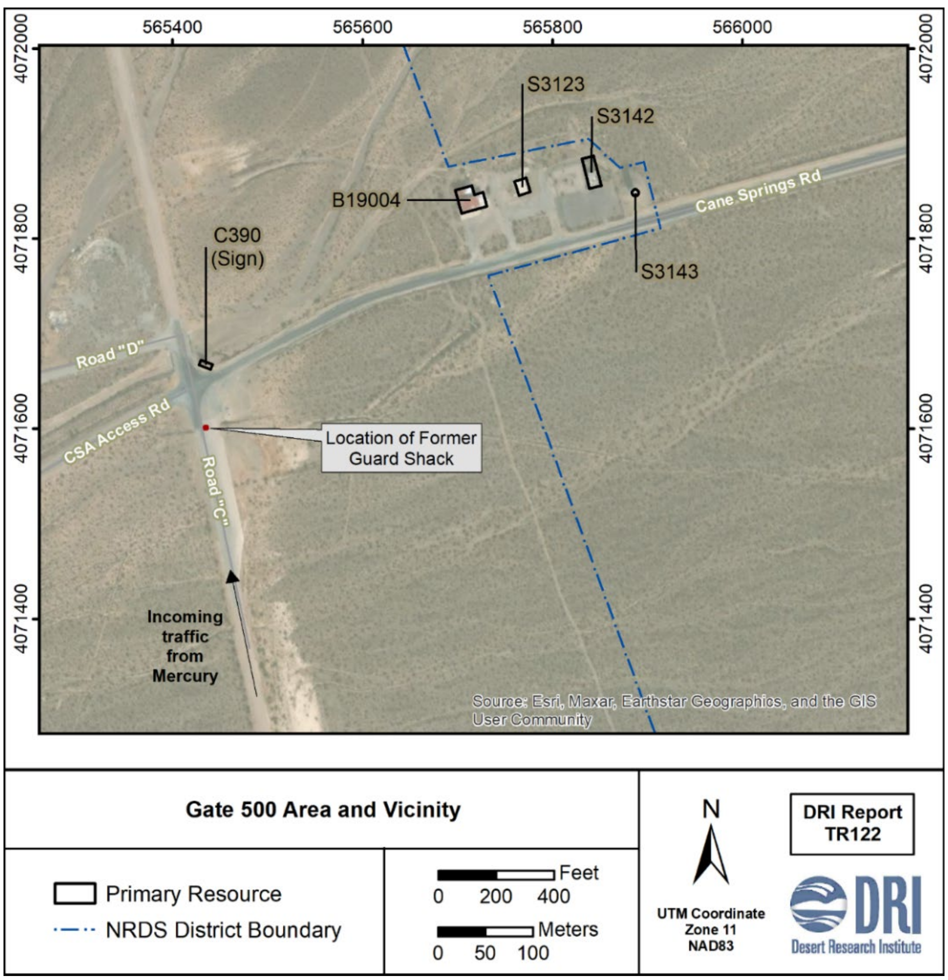

Figure 149. Primary Resources at the main gate (Gate 500) area and in the vicinity.

Table 20. Primary Resources at the Main Gate (Gate 500) Area and in the Vicinity.

NNSS No. or Identifier	SHPO No.	Resource Name/ Description	Contributing to NRDS	Year Built	AR Total Count (# contributing to NRDS)*
Newly Recorded					
25-3153	B19004	NRDS Fire Department	Yes	1961	2 (2)
NRDS1	C390	Gate 500	Yes	1959	4 (4)
25-3152	S3123	Rad-safe Building (foundation)	Yes	1961	0
NRDS2	S3142	Animal Shelter	Unevaluated	c. 1961-1962	3
NRDS3	S3143	Water Tank	Yes	1965	3 (3)

*See Table A-2 for a list and description of accessory resources.

Figure 150. NRDS fire station in the vicinity of the main gate, facing northwest (Photo 2116_9924, DRI 2021).

Recommendations

As a result of this survey, four of the primary resources at the main gate (Gate 500) and in the vicinity along with nine contributing accessories are recommended as eligible for listing in the National Register of Historic Places as contributing elements to the NRDS Historic District. The exception is the animal shelter (S3142) and its three accessory resources. An association of the shelter to the NRDS operations has not been established; therefore, pending additional research this resource is being treated as unevaluated.

NRDS Miscellaneous Resources

A variety of resources can be found in the vast areas between the major subdistricts and activity areas (Figure 151). During this survey, nine resources were recorded as NRDS miscellaneous resources (Table 21). Of these, the most important are the monitoring arrays surrounding Test Cells A and C (C400 and C401). A series of radioactive fallout monitoring stations constitute each array for its corresponding test cell. The arrays are composed of concentric circles centered on the ground zero location of each facility with maximum dimensions of approximately 2 miles (Test Cell A array, C400) and 3 miles (Test Cell C array, C401) across. The monitoring stations were placed on a strict geometrical pattern and were made up of a variety of simple fallout collectors. Although each monitoring station was only a few square feet in size, the arrays are clearly visible on satellite imagery due to the circular roads driven to access the equipment.

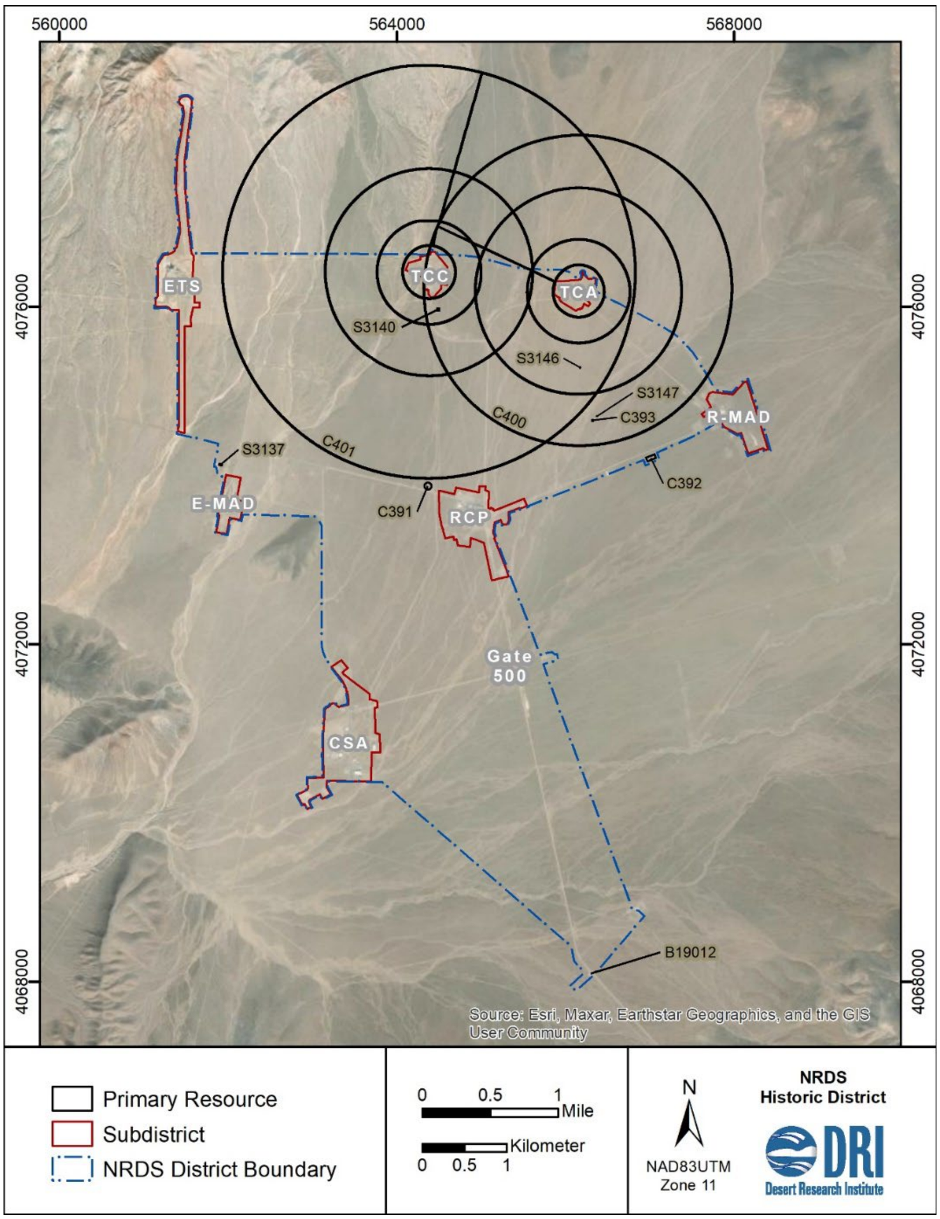

Figure 151. Locations of primary resources not within subdistrict boundaries.

Table 21. Other Primary Resources in the NRDS Historic District.

NNSS No. or Identifier	SHPO No.	Resource Name/ Description	Year Built	Contributing to NRDS	AR Total Count (# contributing to NRDS)*
Newly Recorded					
25-4101	B19012	Communications Building	1958	Yes	3(3)
NRDS6	C392	Sandia Compound	c.1958	Yes	6(6)
NRDS9	C393	Biological Study Plot	Unknown	No	0
NRDS16/TCA1	C400	TCA Radiation Monitoring Array	1958	Yes	0
NRDS17/TCC1	C401	TCC Radiation Monitoring Array	c.1961	Yes	0
NRDS10	S3137	Phoebus Mockup	c.1965	Yes	0
NRDS14	S3140	NRDS Switching Station	c.1960s	Yes	0
NRDS7	S3146	Camera Tower	c.1958	Yes	1(1)
NRDS8	S3147	Weather Tower (foundation)	c.1958	Yes	4(4)

*See Table A-2 for a full list of accessory resources.

Another notable resource is the Phoebus Mockup (S3137). This mockup was one of the most emblematic displays of the NRDS mission, representing a reactor in a test stand configuration. When driving along Road H, a spidery structure supporting a mockup of a Phoebus nuclear rocket engine suddenly comes into view, seemingly in the middle of nowhere since from this perspective E-MAD appears to be quite distant. This theatrical setting is intentional because the display was meant to impress visitors. It was built at the end of a rail turning wye near where the track enters the E-MAD security fence (Figure 152). Close inspection of the support stand reveals a control panel and a maze of stainless-steel tubing. These items would not have been necessary for a static display, which suggests that the mockup was also used to train technicians on installation procedures. The mockup engine hangs from a collar attached to the middle of the support structure, just as it would have been installed at Engine Test Stand 1.

Other resources in the NRDS miscellaneous category are the principal communications building (25-4101, B19012) and its radio aerial (see Figure 55) on the southern edge of the NRDS Historic District, the collapsed steel camera tower south of Test Cell A (S3146, Figure 153); a biological study plot (C393); the foundation for a weather tower and related nearby equipment (S3147); a switching station (S3140); and the small, fenced compound used by Sandia (C392) on Road G between the Reactor Control Point and R-MAD (Figure 154).

Recommendations

As a result of the survey, eight of the nine NRDS miscellaneous primary resources and 11 contributing accessories are recommended as eligible for listing to the National Register of Historic Places as contributing elements to the NRDS Historic District. The biological study plot contains the remnants of animal traps, but the time frame that they were in use is undetermined. Because an association to NRDS operations has not been established, the study plot is being treated as non-contributing.

Figure 152. The Phoebus Mockup, with the report author at right for scale, facing west (Photo 2117_2286, DRI 2021).

Figure 153. The collapsed photo tower previously directed toward Test Cell C, facing east (Photo 2116_2250, DRI 2021).

Figure 154. The Sandia compound on Road G, facing east (Photo 2116_2169, DRI 2021).

Linear Resources

Linear developments are identified as long, narrow structures. At the NRDS these consist of a railroad line, roads, power transmission, and the water system (Table 22).

Table 22. Primary Linear Resources at NRDS.

NNSS No. or Identifier	SHPO No.	Resource Name/ Description	Year Built	Contributing to NRDS	AR Total Count (# contributing to NRDS)*
Previously Recorded					
Railroad	26NY14637**	Jackass and Western Railroad		Yes	0
Newly Recorded					
NRDS11	S3138	NRDS Road System		Yes	0
NRDS12	S3139	NRDS Power Transmission System		Yes	0
NRDS5	S3145	NRDS Water System		Yes	0

*See Table A-2 for a list and description of accessory resources. **Individually eligible

Jackass and Western Railroad (26NY14637)

The Jackass and Western Railroad was recorded in 2012 as site 26NY1463 (Drollinger 2012) and determined individually eligible for listing in the National Register of Historic Places (NRHP) under Significance Criterion A for its role in the United States space program (Palmer 2012).

During the NRDS program, nuclear reactors and engines were shuttled on rail between facilities using specialty locomotives and cars. The Jackass and Western was a small narrow-gauge line that ran for approximately nine miles and consisted of a mainline with short spurs and wyes, connecting the NRDS testing facilities (Test Cell A, Test Cell C, and ETS-1) with the maintenance, assembly, and disassembly facilities (R-MAD and E-MAD) (Beck et al. 1996, Drollinger 2012) (Figure 155). The initial segment between the R-MAD facility and Test Cell A was designed by Burns and McDonnell Engineering Company and construction began in 1958. Additional segments were added as new facilities were built, and trackage was added between Test Cell A and Test Cell C, and between Test Cell C, E-MAD, and the ETS-1. Finally, a short line off the E-MAD line provided access to the RMSF. Holmes & Narver, Inc. and Vitro Engineering Company were involved in the later revisions to the railroad, which was completed by 1965 (Drollinger 2021).

The railroad trackage included a ballast grade, steel rails, signals, switches, wooden cross ties, and other components. Culverts and low bridge spans were included in the system design for stormwater control at major drainage crossings (O'Neill and Wedding 2021). The railroad line was decommissioned at the end of the NRDS program. However, in the late 1970s, sections of the track at E-MAD were put back into service for the spent fuel program. Apart from the reused E-MAD spurs, most rail track has not been maintained and along some segments steel rails and cross ties were removed. This has resulted in integrity issues for the line, road crossings, bridge spans, culverts, and switches. Additionally, since the original recording in 2015 segments of the railroad line were impacted by a flash flood event, which deposited flood sediment and undercut sections of the line. Most of this flooding occurred on the railroad grade between the RMSF and the E-MAD facility.

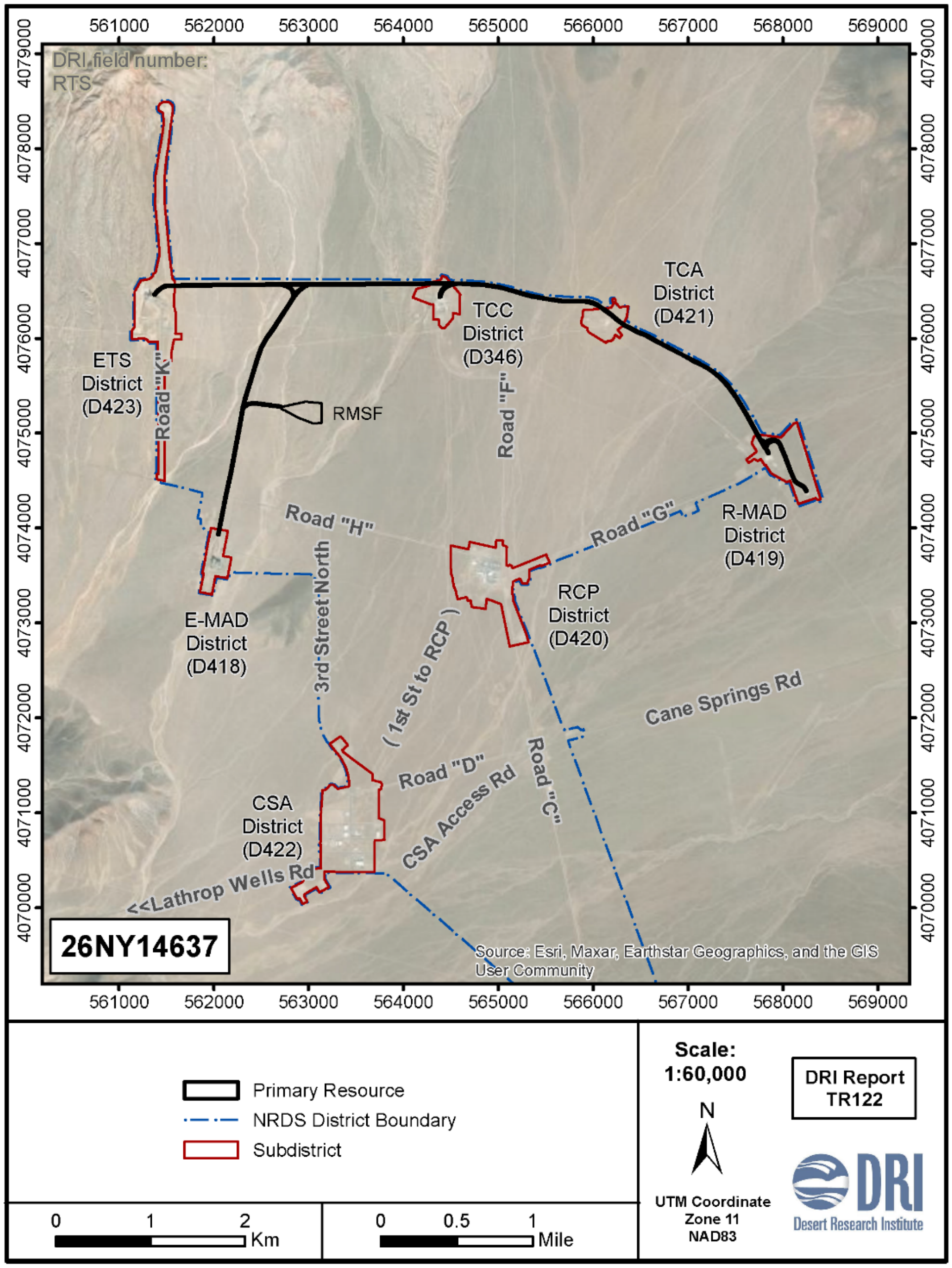

Figure 155. The Jackass and Western Railroad line (Source: Voorheis-Trindle Co. 1965; Drollinger 2012).

NRDS Road System (S3138)

The NRDS road system consists primarily of paved roads that connect the various facilities together (Figure 156). An early engineering drawing indicates planning for road construction in Jackass Flats, then called Area 400, began in 1956 (Holmes & Narver 1956). Originally referred to as Road A, the road between Mercury and the NRDS became commonly known as Jackass Flats Road. As the road approaches NRDS it becomes Road C. The road between Frenchman Flat and Gate 500 at the NRDS began as Road B before becoming Cane Springs Road. The remaining roads have largely kept their designations on updated maps throughout the use of the NRDS and into the present.

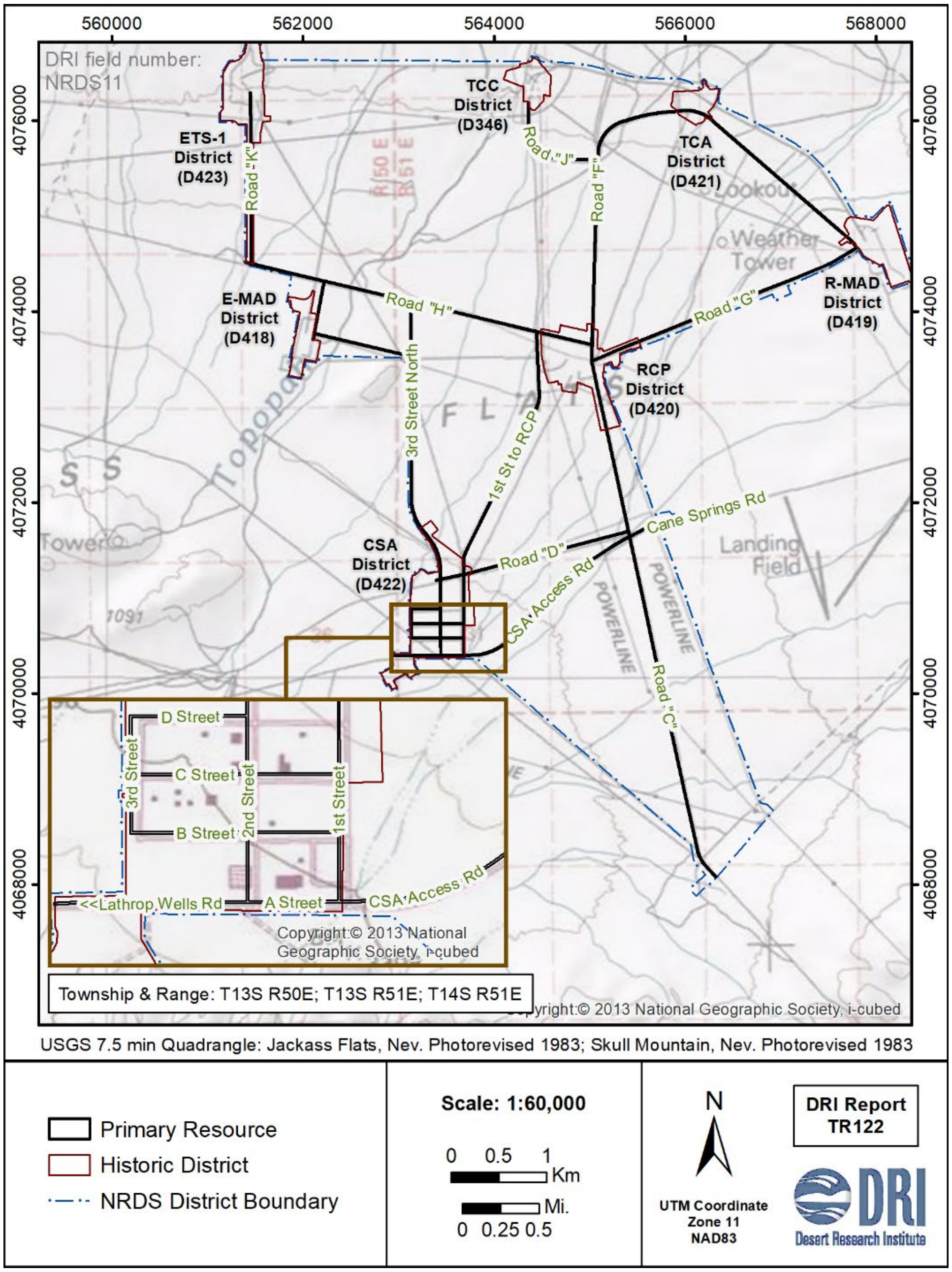

Figure 156. NRDS Road System (Sources: Holmes & Narver, Inc. 1956; Pan Am 1965, 1968).

The road system that provides access to the NRDS as well as to the individual subdistricts and other support facilities maintenance, assembly, and disassembly facilities is unremarkable from an engineering perspective (Figure 157). It consists of a graded roadbed with a simple compacted gravel base capped by asphalt laid with a slight crown to aid drainage. It was built sufficiently wide and strong to withstand the rigors of the heavy equipment and test articles that were transported to and from the various facilities. Graded shoulders (occasionally paved) and shallow drainage cuts flank all the roadways. Culverts are minimal except where the roads cross major drainages. At Engine Test Stand 1 (ETS-1), the steep slope necessitated some curbing to direct runoff into drainage channels.

The system was built in two major phases with a few more limited additions occurring as budget constraints and scheduling allowed. Phase 1 started in Spring 1957 and was meant to provide access between the initial Rover Program facilities — the Reactor Control Point, Test Cell A, and the R-MAD complex. The Phase I roads included Roads A, C, F, G, a portion of B, and part of the street grid within the CSA. Phase 2 began in 1961 and added the remaining major components of the NRDS internal road system that would join the existing Phase 1 facilities with the soon-to-be-built Phase 2 complexes — Test Cell C, E-MAD, ETS-1, and the RMSF.

The final notable improvement was made in 1964, when the unpaved portion of Road B extending from the CSA to the west boundary of Area 25 at the Lathrop Wells gate was paved (AEC 1964). This project marked the end of road development for the NRDS, although other contractors, such as Pan American Airways Support Services Group, repaired and resurfaced the road at various intervals (Pan Am 1968).

Figure 157. Overview of Road C, the Reactor Control Point is in the center and Test Cell C is in the background, facing northeast (Photo 2116_7264, DRI 2021).

NRDS Power Transmission System (S3139)

The NRDS power transmission system provided continuous and reliable power delivery to the NRDS facilities and was critical to nearly all operations at NRDS. The power source for this system was from the Jackass Flats Substation, previously recorded as part of the NNSS 138-kiloVolt (kV) power transmission line (S1725 AR1). This substation was eventually one of several substations along the NNSS redundant 138 kV distribution loop.

The installation of high voltage transmission lines to Area 25 began in late 1957, and the Jackass Flats Substation was installed ca. 1957-1958. This substation handled the transfer of incoming high-voltage electrical current to provide the NRDS power transmission system with a stepdown power supply. The system consisted of a network of distribution lines, substations, switching stations, single and multiple wood pole structures, conductors, ceramic insulators, transformers, circuit breakers, and other elements. These components were built during the period of significance for NRDS. Portions of the transmission system have been abandoned but many elements are still in place.

This resource is on the south end of Jackass Flats and covers a large area between the facilities, buildings, and structures that make up the NRDS (Figures 158 and 159). Transformers at the Jackass Flats Substation reduced the volt level first to 69 kV, then to 12.5 kV (NERVA Training Office 1964). From the substation, power was distributed northward toward the multiple NRDS facilities and west-southwest to the Communications Building. Most of the engineering and design work for initial construction was carried out by Burns & McDonnell Engineering Co., which was often referred to as "Burmac."

Several power lines were designed to handle up to 69 kV, but the line was initially powered at 12.5 kV. REECo constructed the first NRDS distribution lines labeled "A" through "E." These were completed by February of 1958 and were described by REECo as "3-phase overhead power lines using aluminum conductors and wood crossarms and poles" (REECo 1958). Construction of Lines "F" and "G" began in April of that year. The remaining lines were in place by the mid-1960s (Voorheis-Trindle 1965).

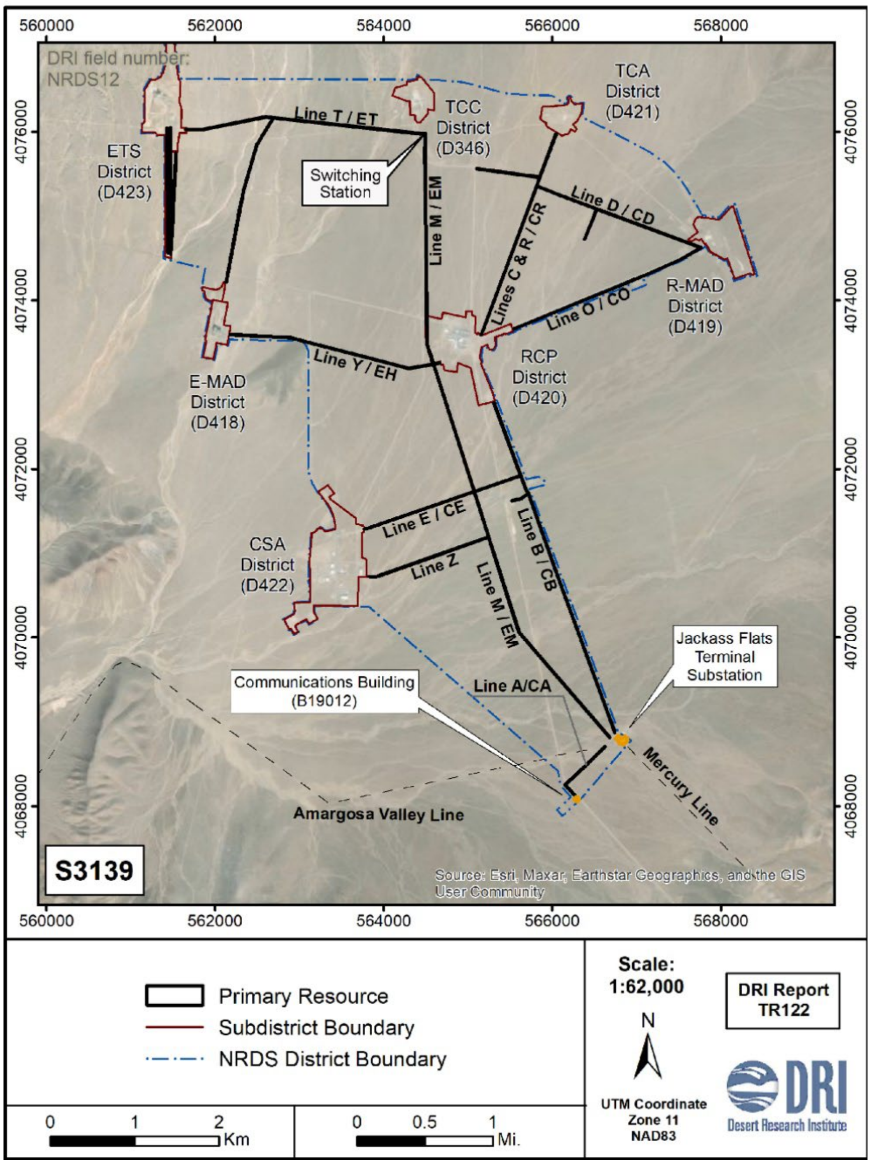

Figure 158. The NRDS power transmission system network (Sources: Holmes & Narver, Inc. 1970; Raytheon 1994).

Figure 159. Components of the NRDS power transmission system, view northwest toward Test Cell A (Photo: 2116_1894, DRI 2021).

NRDS Water System (S3145)

Many of the components of the NRDS water system, such as the water storage towers and tanks, pump houses, and water treatment facilities, have been recorded as buildings or structures within the discrete subdistricts. Therefore, this description of the water system narrowly focuses on the water distribution network linking the water wells with the various NRDS facilities (Figure 160).

The water source for NRDS primarily came from wells drilled into the welded tuff aquifer in the western portion of Jackass Flats. This aquifer supplied all the water for public use, construction, test cell coolant, exhaust cooling, thermal shielding during reactor and engine testing, and the subsequent washdown of equipment and facilities. Initially a single well was completed in July 1957. Located adjacent to what would become the Central Support Area, Well J-11 (S3136) provided water for the first phase of NRDS construction. However, as the NRDS rapidly expanded and the workforce increased, a second well was added to ensure an adequate supply for the ongoing construction tasks and for the upcoming reactor tests. Well J-12, located west of the NRDS near Fortymile Wash, came online in October 1957. Both wells were drilled by Perry Brothers Drilling Company of Flagstaff, Arizona (Young 1972).

The firm of Burns & McDonnell provided the original NRDS facilities engineering designs, including water distribution specifications. Hansen Plumbing and Heating Company won the initial bid to construct the NRDS water distribution system between the water wells and the various Phase 1 facilities (Nevada State Journal 1957). The delivery network focused on the J-11 well as the primary distribution node. Water from the J-12 well (and later the J-13 well) flowed to the J-11 well storage tank. The water of the combined well output was then distributed to the various facilities within the NRDS complex. This was accomplished via a standard network of 8-inch and 6-inch main distribution lines linked to smaller lines that fed specific buildings and structures.

While the distribution system functioned well, casing corrosion and poor water quality led to the abandonment of Well J-11 in 1962. In the interim, water was brought in by truck from existing wells in Yucca Flat to fill the J-11 storage tank. Its replacement, Well J-13 was originally drilled as USGS

Hydrologic Test Hole #6 in 1962 as part of a groundwater flow study (Thordarson 1983:1). The Western-Republic Drilling Company from Lubbock Texas was the drilling contractor for the study (Young 1972).

However, with the high-demand ETS-1 facility coming online in 1966, water truck deliveries from the Yucca Flat wells resumed to supplement the local output. In 1967, water consumption at NRDS averaged 520,000 gallons per day (Young 1972:18). Yet, there is no indication of major upgrades to the water distribution system during the existence of the NRDS testing program, although several expansions of the network occurred as new facilities were added.

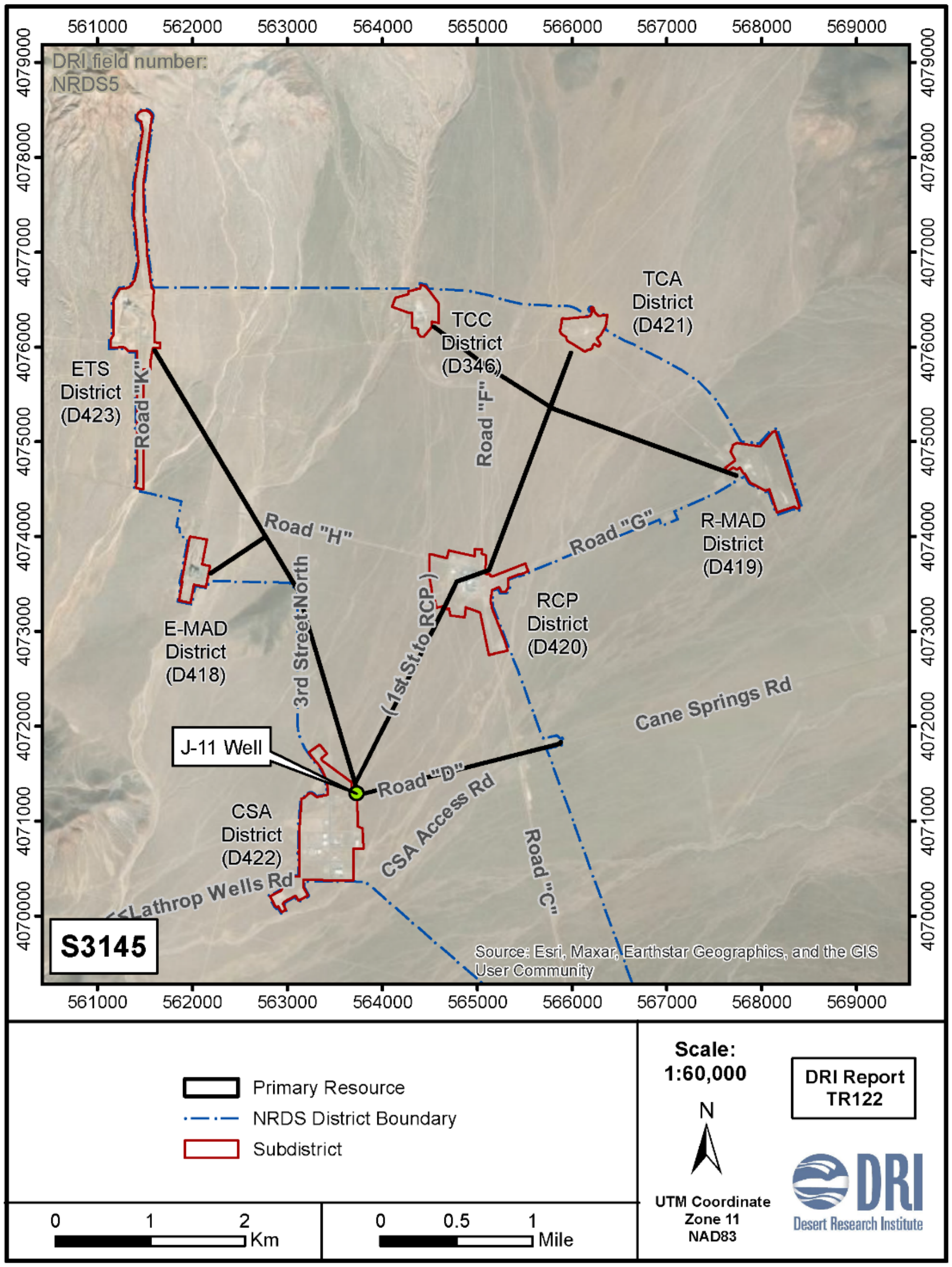

Figure 160. The NRDS water delivery system (source: Voorheis-Trindle Co. 1965).

Recommendations

Linear resources within the NRDS Historic District are long, linear developments consisting of a railroad line, roads, power transmission, and the water system. The railroad is known as the Jackass and Western Railroad, a resource recorded in 2012 as 26NY1463 (Drollinger 2012). DOE determined this resource was eligible for listing in the National Register in consultation with the SHPO under Criteria A (Palmer 2012). As part of the NRDS district survey, a condition assessment found the Jackass and Western Railroad retains significant integrity to retain its individual eligibility status. The current survey also found the railroad contributes to the NRDS Historic District. The newly identified road system (S3138), power transmission system (S3139), and water system (S3145) were recorded as structures. These highly visible infrastructure resources were constructed for the NRDS program and were essential for the NRDS mission. Each retains sufficient integrity to convey its significance. Therefore, these infrastructure systems also contribute to the significance of the NRDS Historic District.

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APPENDIX A

Resource Lists

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Table A-1. Summary Counts for Resources in the NRDS Historic District.

Subdistrict or Other	Total Primary	Contributing Primary	Non-contributing Primary	Unevaluated Primary	Total Accessory	Contributing Accessory	Non-contributing Accessory	Unevaluated Accessory	Total Primary and AR
Subdistricts									
R-MAD	5	4	1		11	3	8		16
E-MAD HD	9	7	2		28	28	0		37
Test Cell A	4	4	0		20	20	0		24
Test Cell C HD	9	9	0		62	61	1		71
ETS-1	19	18	1		59	59	0		78
RCP	26	25	1		25	22	3		51
CSA	24	21	3		76	68	8		100
Other									
RMSF	1	1	0		13	13	0		14
Gate 500	5	4	0	1	12	9	0	3	17
NRDS Other	9	8	1		14	14	0		23
Linear	4	4	0		0	0	0		4
Totals:	**115**	**105**	**9**	**1**	**320**	**297**	**20**	**3**	**435**

Historic District Resource Assessment Forms:

- ❖ NRDS Subdistrict n=7 (Note: Test Cell C was previously determined eligible as a historic district, E-MAD is evaluated in this report as an eligible historic district, five subdistricts are unevaluated for individual eligibility.)
- ❖ NRDS Historic District n=1

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Table A-2. List of Primary Resources (bold) and Accessory Resources in the NRDS Historic District (D424).

NNSS/Field Number	SHPO Number	AR Number	Name Principal Resource (left) Accessory Resource (Centered)	Year Built	Property Type	NRDS District Contributor***
REACTOR MAINTENANCE ASSEMBLY AND DISASSEMBLY (R-MAD) (26NY9277; HAER Nv-29-A); R-MAD SUBDISTRICT (D419) Contributing to the NRDS Historic District						
25-3110	**26NY9277**	**-**	**R-MAD Building Foundation**	**1958**	**Structure**	**Contributing**
		AR1	Substation NRDS #8	1958	Structure	Contributing
		AR2	Jr. Hot Cell Radioactive Storage Enclosure	c.1964	Structure	Contributing
		AR3	Perimeter Fence	1958	Structure	Contributing
25-3111	**B18998**	**-**	**Warehouse**	**1958**	**Building**	**Contributing**
RM1	**C399**	**-**	**Radioactive Waste Disposal Facility**	**1958**	**Landscape**	**Contributing**
RM2	**S3154**	**-**	**Floodwater Diversion Dike**	**1958**	**Structure**	**Contributing**
RM3	**S3155**	**-**	**MX Trial Launch Complex**	**1982**	**Structure**	**Non-contributing**
		AR1	Missile Maintenance Scaffold	1982	Structure	Non-contributing
		AR2	Pair of Tall Camera Towers	1982	Structure	Non-contributing
		AR3	Pair of Short Camera Towers	1982	Structure	Non-contributing
		AR4	Storage Pad	1962	Structure	Non-contributing
		AR5	Refurbishment Stand	1982	Structure	Non-contributing
		AR6	Crane Hoist Enclosure & Stiff-legged Crane Foundations	1982	Structure	Non-contributing
		AR7	Foundation	1982	Structure	Non-contributing
		AR8	Portable Silo	1982	Structure	Non-contributing
R-MAD subdistrict contributing/non-contributing resources to NRDS: contributing n=4 primary, n=3 accessory; non-contributing n=1 primary, n=8 accessory						

NNSS/Field Number	SHPO Number	AR Number	Name	Year Built	Property Type	NRDS District Contributor***
ENGINE MAINTENANCE AND DISASSEMBLY (E-MAD) (26NY10127; HAER NV Individually Eligible, E-MAD Historic District (D418) Contributing to the NRDS Historic District						
25-3900	**B4845**	**-**	**Engine Maintenance and Disassembly Building (E-MAD), Individually Eligible Criteria A, C, and D**	**1962-1967**	**Building**	**Individually Eligible, Contributing**
		AR1	Perimeter Fence	c.1960s	Structure	Contributing
		AR2	Access Road System	c.1960s	Structure	Contributing
		AR3	Parking	c.1960s	Structure	Contributing
		AR4	Water Tower	c.1960s	Structure	Contributing
		AR5	Substation 25-7	c.1960s	Structure	Contributing
		AR6	Radioactive Decontamination Pad	c.1960s	Structure	Contributing
		AR7	Perimeter Lighting	1966	Structure	Contributing
		AR8	Water and Fire Suppression System	c.1960s	Structure	Contributing
		AR9	South Parking Lot Fence	c.1960s	Structure	Contributing
		AR10	Camera Tower	c.1960s	Structure	Contributing
		AR11	Sewage System	c.1960s	Structure	Contributing
		AR12	Equipment Pad	c.1964-1976	Structure	Contributing
		AR13	Radioactive Wastewater Line	c.1960s	Structure	Contributing

Table A-2. List of Primary Resources (bold) and Accessory Resources in the NRDS Historic District (D424).

NNSS/Field Number	SHPO Number	AR Number	Name Principal Resource (left) Accessory Resource (Centered)	Year Built	Property Type	NRDS District Contributor***
		AR14	Soil Temperature Test Drywell	1977	Structure	Contributing
		AR15	Weather Station	c.1960s	Structure	Contributing
		AR16	Enclosure	c.1960s-80s	Structure	Contributing
		AR17	Pipeline	c.1960s-80s	Structure	Contributing
		AR18	Surface Spent Fuel Storage Casks	1978	Structure	Contributing
		AR19	Stack Monitor System Equipment Enclosure Foundations	1982	Structure	Contributing
		AR20	Radioactive Effluent Tanks (Holdup Tanks)	c.1960s	Structure	Contributing
		AR21	Equipment Cellar	c.1960s	Structure	Contributing
		AR22	Storm Drain Cellar	c.1960s	Structure	Contributing
		AR23	Railroad Spur A	c.1960s	Structure	Contributing
		AR24	Railroad Spur B	c.1960s	Structure	Contributing
		AR25	Railroad Spur C	c.1960s	Structure	Contributing
		AR26	Railroad Spur D	c.1960s	Structure	Contributing
25-3902		AR3902	Security Hut Foundation	c.1960s	Structure	Contributing
25-3903		AR3903	Flammable Materials Storage Shed Foundation	c.1960s	Structure	Contributing
25-3901	**B17996**	**-**	**ETSMB Building (Train Shed), Individually Eligible Criteria, A, C**	**1962-1967**	**Building**	**Contributing**
L4	**S3052**	**-**	**L4 Locomotive, Not Individually Eligible**		**Structure**	**Non-Contributing**
L5	**S3053**	**-**	**L5 Locomotive, Not Individually Eligible**		**Structure**	**Non-Contributing**
F9	**S3054**	**-**	**F9 Flatcar, Not Individually Eligible**		**Structure**	**Contributing**
F5	**S3055**	**-**	**F5 Flatcar, Not Individually Eligible**		**Structure**	**Contributing**
F6	**S3056**	**-**	**F6 Flatcar, Not Individually Eligible,**		**Structure**	**Contributing**
EIV	**S3057**	**-**	**Engine Installation Vehicle (EIV), Individually Eligible Criteria A, C**		**Structure**	**Contributing**
MCC	**S3058**	**-**	**Manned Control Car (MCC), Individually Eligible Criteria A, C**		**Structure**	**Contributing**
E-MAD Historic District contributing/non-contributing resources to NRDS: contributing n=7 primary, n=28 accessory; non-contributing: n=2 primary						

Table A-2. List of Primary Resources (bold) and Accessory Resources in the NRDS Historic District (D424).

NNSS/Field Number	SHPO Number	AR Number	Name Principal Resource (left) Accessory Resource (Centered)	Year Built	Property Type	NRDS District Contributor***
TEST CELL A (TCA) (26NY11260; HAER Nv-33z Individually Eligible; TCA Subdistrict (D421) Contributing to the NRDS Historic District						
25-3113/3113A	**B2443**	**-**	**Test Cell Building Foundation and Test Stand Concrete Pad**	**1958**	**Structure**	**Contributing**
		AR1	Water Tower	1958	Structure	Contributing
		AR2	Bunker	1958	Building	Contributing
		AR3	Perimeter Fence	1958	Structure	Contributing
		AR4	Valve Pit #2	1958	Structure	Contributing
		AR5	Substation NRDS #9	1958	Structure	Contributing
		AR6	Propane Tank	1958	Structure	Contributing
		AR7	Gas Delivery Dock	1958	Structure	Contributing
		AR8	Helium Tank Farm	1958	Structure	Contributing
		AR9	Cryogenic Pipeline	c.1962	Structure	Contributing
		AR10	Stormwater Drainage System	1958	Landscape	Contributing
		AR11	Raised Platform	1958	Structure	Contributing
		AR12	Non-Process Septic System	1963	Structure	Contributing
		AR13	Dosage Measurement Aerial Trolley	c. early 1960s	Structure	Contributing
		AR14	JATO Rocket System	c.1958-1960s	Structure	Contributing
		AR15	Trailer Park (Trailers 43, 539, 505)	c. early 1960s	Landscape	Contributing
		AR16	Tank	c.1958-1960s	Structure	Contributing
		AR17	Maintenance Trailer (47) and Loading Dock	1958	Structure	Contributing
		AR18	Maintenance Building Foundations (E-29380)	1958	Structure	Contributing
25-3124	**B19001**	-	**Equipment Test Laboratory**	**1963**	**Building**	**Contributing**
		AR1	High Pressure Gas Tanks	c. 1966	Structure	Contributing
		AR2	Cryogenic Pipeline	1963	Structure	Contributing
TCA2	**B19023**	-	**Northeast Camera Station**	**1961**	**Building**	**Contributing**
TCA3	**B19024**	-	**South Camera Station**	**1961**	**Building**	**Contributing**
Test Cell A subdistrict contributing/non-contributing resources to NRDS: contributing=4 primary, n=20 accessory						
TEST CELL C HISTORIC DISTRICT (D346), Individually Eligible Criteria A, C, and D; Contributing to the NRDS Historic District)						
25-3210	**B2444**	-	**Test Cell C Building Foundation**	**1960-1961**	**Structure**	**Contributing**
25-3205		AR3205	Air Intake Building Foundation	1960	Structure	Contributing
25-3206		AR3206	Reactor Pad	1960	Structure	Contributing
25-3212		AR3212	High Pressure Gas Tank Farm Foundations	1961	Structure	Contributing
25-3218		AR3218 A&B	Liquid Hydrogen Dewars 1 and 2	1965	Structure	Contributing

Table A-2. List of Primary Resources (bold) and Accessory Resources in the NRDS Historic District (D424).

NNSS/Field Number	SHPO Number	AR Number	Name Principal Resource (left) Accessory Resource (Centered)	Year Built	Property Type	NRDS District Contributor***
25-3218		AR3218 C	Turbine Energy Source/Exchanger	1965	Structure	Contributing
		AR1	Concrete Standpipe	1965	Structure	Contributing
		AR2	Drain (to Topopah Wash)	1966	Structure	Contributing
		AR3	Concrete Pad	c.1960s	Structure	Contributing
		AR4	Liquid Hydrogen Unloading Ramp	1966	Structure	Contributing
		AR5	Deluge Pit #3	1960-1961	Structure	Contributing
		AR6	Dosage Measurement Aerial Trolley	1962-1963	Structure	Contributing
		AR7	Camera Station Pedestal	1962	Structure	Contributing
		AR8	Vault	1965	Structure	Contributing
		AR9	Nuclear Furnace Cleanup System	1972	Structure	Contributing
		AR10	Camera Station Pedestal	1962	Structure	Contributing
		AR11	Railroad Spurs	1960	Structure	Contributing
		AR12	Metal Ground Panels (Fallout Samplers)	c.1960s	Structure	Contributing
		AR13	Runoff Channel	1966-1967	Structure	Contributing
		AR14	Tile Field	1962	Structure	Contributing
		AR15	Radioactive Wastewater Vault	c.1960s	Structure	Contributing
		AR16	Radioactive Wastewater Vault	c.1960s	Structure	Contributing
		AR17	Electrical Vault	1961	Structure	Contributing
		AR18	Deluge Pit #1	1961	Structure	Contributing
		AR19	Flare Stack and Flume	1960-1961	Structure	Contributing
		AR20	Tank Farm Extension Foundations	c.1960s	Structure	Contributing
		AR21	Meteorological Station	c.1960s	Structure	Contributing
		AR22	Tower Foundation	c.1960s	Structure	Contributing
		AR23	Jet-Assisted Takeoff (JATO) Area	1966	Structure	Contributing
		AR24	Relocated (High-pressure) Tank	Unknown	Structure	Contributing
		AR25	Perimeter Fence and Gates	1961	Structure	Contributing
		AR26	Exterior Lighting System	1960-1966	Structure	Contributing
		AR27	Water and Fire Suppression System	c.1960s	Structure	Contributing
25-3214	**B18109**	-	**Shed Drive Funicular Railroad Foundation**	**1960-1961**	**Structure**	**Contributing**
		AR1	Track and Drive Cable	1960-1961	Structure	Contributing
25-3220	**B18110**	-	**Equipment Support Building (Individually Eligible)**	**1960-1961**	**Building**	**Contributing**
25-3203		AR3203	Cooling Tower	1960	Structure	Contributing
25-3207		AR3207	Borated Water System	1960-1966	Structure	Contributing
25-3208		AR3208	Conditioned Water System	1960	Structure	Contributing
25-3209		AR3209	Moderated/Processed Water Tank	1965	Structure	Contributing
25-3217		AR3217	Substation NRDS #6	1960	Structure	Contributing
25-3219		AR3219	Gas Unloading Area	1960	Structure	Contributing
		AR1	Process Water Heater	1964-1968	Structure	Contributing

Table A-2. List of Primary Resources (bold) and Accessory Resources in the NRDS Historic District (D424).

NNSS/Field Number	SHPO Number	AR Number	Name Principal Resource (left) Accessory Resource (Centered)	Year Built	Property Type	NRDS District Contributor***
		AR2	Water Conditioner	1971	Structure	Contributing
		AR3	Propane Storage Area	1965-1966	Structure	Contributing
		AR4	Telephone Vault	1961	Structure	Contributing
		AR5	Electrical Vault	c.1960s	Structure	Contributing
		AR6	Rest Room Foundation	c.1960s	Structure	Contributing
25-3226	**B18111**	-	**North Camera Bunker (Individually Eligible)**	**1962**	**Building**	**Contributing**
25-3228	**B18112**	-	**Warehouse Foundation**	**1966**	**Structure**	**Contributing**
25-3216		AR3216	Substation NRDS #5	1960	Structure	Contributing
		AR1	Southern Fence and Parking Area	1960-1961	Structure	Contributing
		AR2	Radiography Compound	1961-1965	Structure	Contributing
		AR3	Southeastern Fence	1961-1965	Structure	Contributing
25-3229	**B18113**	-	**Operations Building Foundation**	**1966**	**Structure**	**Contributing**
		AR1	Southwest Parking Lot	1966-1967	Structure	Contributing
		AR2	Main Entrance Road (Road J)	1960	Structure	Contributing
25-3230-32	**B18114**	-	**Cryogenics Building (incorporates 25-3230, 3231, 3232) (Individually Eligible)**	**1960-1961**	**Building**	**Contributing**
25-3213 A & B		AR3213 A & B	Liquid Hydrogen Dewars 4 & 5	1960	Structure	Contributing
25-3223		AR3223	Liquid Nitrogen Dewars 6, 7, and 8 Foundations	1965-1966	Structure	Contributing
25-3224		AR3224	Rest Room Foundation	1966	Structure	Contributing
		AR1	Deluge Pit #2	1960	Structure	Contributing
		AR2	Southern Liquid Hydrogen Vaporizer Foundation	1965	Structure	Contributing
		AR3	Utility Gantry	1961	Structure	Contributing
		AR4	Northern Liquid Hydrogen Vaporizer Foundation	1960	Structure	Contributing
		AR5	Concrete Pad	c.1960s	Structure	Contributing
		AR6	Health Physics Portable Building	c.1970s	Building	Non-contributing
25-3233	**B18115**	-	**Powerhouse**	**c.1970**	**Building**	**Contributing**
25-3215		AR3215	Substation NRDS #4	1960	Structure	Contributing
Kiwi-TNT	**S2287**	-	**Kiwi-TNT Reactor Test Stand (Individually Eligible)**	**1964**	**Structure**	**Contributing**
		AR1	Railroad Track Alteration	1964	Structure	Contributing
Test Cell C Historic District contributing/non-contributing resources to NRDS: contributing n= 9 primary, n=61 accessory; non-contributing n=1 accessory						

Table A-2. List of Primary Resources (bold) and Accessory Resources in the NRDS Historic District (D424).

NNSS/Field Number	SHPO Number	AR Number	Name Principal Resource (left) Accessory Resource (Centered)	Year Built	Property Type	NRDS District Contributor***
ENGINE TEST STAND 1 (ETS-1) SUBISTRICT (D423) Contributing to the NRDS Historic District						
25-3310	**B19005**	-	**Control Point Building**	**1964**	**Building**	**Contributing**
		AR1	Meteorological Tower	1964	Structure	Contributing
25-3320	**B19006**	-	**Utility Equipment Building**	**1964**	**Building**	**Contributing**
		AR1	Water or Diesel Storage Tank Pad	c.1964	Structure	Contributing
		AR2	Acid and Caustic Tanks Pad	1963	Structure	Contributing
		AR3	Cooling Tower	c.1964	Structure	Contributing
25-3330	**B19007**	-	**Fill Station and Tank Farm**	**1964**	**Building**	**Contributing**
		AR1	Filling Dock	c.1964-1966	Structure	Contributing
		AR2	Truck Scales	c. 1964-1966	Structure	Contributing
		AR3	Cooling Tower Foundation	c. 1964-1966	Structure	Contributing
		AR4	Gas Tank Foundations	c. 1964-1966	Structure	Contributing
		AR5	Concrete Equipment Pad	c. 1964-1966	Structure	Contributing
		AR6	Survey Monument	c. 1964-1966	Structure	Contributing
		AR7	Central Pipe and Conduit Chase	c. 1964-1966	Structure	Contributing
		AR8	Propane Tank Foundation	c. 1964-1966	Structure	Contributing
		AR9	Valve Pit #3	c. 1964-1966	Structure	Contributing
		AR10	High-Pressure Gas Enclosure	c. 1964-1966	Structure	Contributing
		AR11	Liquid Oxygen Fill Station	c. 1964-1966	Structure	Contributing
		AR12	Liquid Oxygen Dewar Foundations	c. 1964-1966	Structure	Contributing
25-3336		AR13	Liquid Nitrogen Dewar Foundations	c. 1964-1966	Structure	Contributing
		AR14	Gaseous Nitrogen Foundations	c. 1964-1966	Structure	Contributing
		AR15	Hose Cart Shed	c. 1964-1966	Structure	Contributing
		AR16	Gas System Emergency Panel	c. 1964-1966	Structure	Contributing
		AR17	Liquid Nitrogen Dewar	c. 1964-1966	Structure	Contributing
		AR18	Flare Stack	c. 1964-1966	Structure	Contributing
		AR19	Valve Pit #2	c. 1964-1966	Structure	Contributing
25-3338		AR20	Liquid Hydrogen Dewar	c. 1964-1966	Structure	Contributing
25-3331	**B19008**	-	**Forward Control Room**	**1964**	**Building**	**Contributing**
25-3340	**B19009**	-	**Test Cell Building**	**1964**	**Building**	**Contributing**
TS1	**B19025**	-	**Road H Guard Station**	**c.1964**	**Building**	**Contributing**
		AR1	RAD-SAFE Trailer Area	c.1964-1965	Landscape	Contributing
		AR2	Decontamination Pad	c.1964-1965	Structure	Contributing
TS6	**B19026**	-	**Guard Station Compound**	**c.1966**	**Building**	**Contributing**
		AR1	Hose Cart Shed	1964	Structure	Contributing
		AR2	Construction Compound	1964	Structure	Contributing
		AR3	Storage Yard	1964	Structure	Contributing

Table A-2. List of Primary Resources (bold) and Accessory Resources in the NRDS Historic District (D424).

NNSS/Field Number	SHPO Number	AR Number	Name Principal Resource (left) Accessory Resource (Centered)	Year Built	Property Type	NRDS District Contributor***
		AR4	Main Gate and Security Fence	c.1966	Structure	Contributing
TS4	**C402**	-	**Sewage System**	**c.1964**	**Landscape**	**Contributing**
		AR1	Sewage Lagoons	c.1964	Structure	Contributing
		AR2	Leach Field	c.1964	Structure	Contributing
		AR3	Exposed Sewer Line	c.1964	Structure	Contributing
TS5	**C403**	-	**Stormwater/Cooling Water/Deluge Drainage System**	**c.1964**	**Landscape**	**Contributing**
		AR1	Main Channel	c.1964	Structure	Contributing
		AR2	Dam and Reservoir	c.1964	Structure	Contributing
		AR3	Deluge and Stormwater Drain System	c.1964	Structure	Contributing
		AR4	Ditch and Dike	c.1964	Structure	Contributing
TS8	**C404**	-	**Trailer Park**	**1964**	**Landscape**	**Non-contributing**
TS9	**C405**	-	**ETS-1 Water Tanks**	**1961**	**Landscape**	**Contributing**
		AR1	Utility Water Tank T-3301	1961	Structure	Contributing
		AR2	Process Water Tank T-3302	1962	Structure	Contributing
		AR3	Utility Water Tank T-3303	1967	Structure	Contributing
		AR4	Pump House Foundation	1967	Structure	Contributing
25-3312	**S3124**	-	**Access Tunnel**	**1964**	**Structure**	**Contributing**
		AR1	Tunnel Entry near Test Cell Building	1964	Structure	Contributing
25-3319	**S3125**	-	**Maintenance and Supply Shop Foundation**	**c.1965**	**Structure**	**Contributing**
		AR1	Trailer Park	c.1965-1967	Landscape	Contributing
25-3324	**S3126**	-	**Diesel Generator Building Foundation**	**c.1966**	**Structure**	**Contributing**
		AR1	Generator Trailers Pad	c.1966	Structure	Contributing
25-3350	**S3127**	-	**Engine Test Stand 1**	**1964-1967**	**Structure**	**Contributing**
		AR1	Moveable Clamshell Shields (2)	1966	Structure	Contributing
		AR2	Moveable Engine Installation Tower	c.1966	Structure	Contributing
		AR3	NE Liquid Oxygen Dewar Foundation	1964	Structure	Contributing
		AR4	SW Liquid Oxygen Dewar Foundation	1964	Structure	Contributing
		AR5	Radiation Shield Drive Foundations (2)	1964	Structure	Contributing
		AR6	Exhaust Cover Drive Foundation	1964	Structure	Contributing
		AR7	Valve Pit #1	c.1964	Structure	Contributing
		AR8	Camera Station Vaults (7)	c.1964	Structure	Contributing
		AR9	Periscope Camera Station	c.1967	Structure	Contributing
		AR10	Flare Stack	c.1964	Structure	Contributing
TS10	**S3157**	-	**Substation NRDS #3**	**c.1964**	**Structure**	**Contributing**
25-3300		AR1	Equipment Building	c.1964	Building	Contributing
TS2	**S3158**	-	**Booster Pumphouse Foundation**	**1964**	**Structure**	**Contributing**

Table A-2. List of Primary Resources (bold) and Accessory Resources in the NRDS Historic District (D424).

NNSS/Field Number	SHPO Number	AR Number	Name Principal Resource (left) Accessory Resource (Centered)	Year Built	Property Type	NRDS District Contributor***
		AR1	Chlorination Shed	1964	Building	Contributing
		AR2	Valve Vault	1964	Structure	Contributing
		AR3	Valve Vault	1964	Structure	Contributing
		AR4	Valve Vault	1964	Structure	Contributing
TS3	**S3159**	-	**ETS Switching Station**	**c.1964**	**Structure**	**Contributing**
TS7	**S3160**	-	**Fabrication Shop Foundation**	**1964**	**Structure**	**Contributing**
			ETS-1 subdistrict contributing/non-contributing resources to NRDS: contributing n=18 primary, n=59 accessory; non-contributing: n=1 primary			
			REACTOR CONTROL POINT (RCP) SUBDISTRICT (D420) Contributing to the NRDS Historic District			
25-3101	**B18993**	-	**Control Building**	**1958**	**Building**	**Contributing**
25-3103	**B18994**	-	**LASL Warehouse**	**1958**	**Building**	**Contributing**
25-3104	**B18995**	-	**Administration Building**	**1958**	**Building**	**Contributing**
25-3108	**B18996**	-	**Guard Hut (407999)**	**1958**	**Building**	**Contributing**
25-3108A	**B18997**	-	**Guard Station (408153)**	**1962**	**Building**	**Contributing**
25-3122	**B18999**	-	**Pump House No. 2**	**1958**	**Building**	**Contributing**
25-3123	**B19000**	-	**Technical Services Building**	**1959**	**Building**	**Contributing**
25-3127	**B19002**	-	**New Cafeteria**	**1962**	**Building**	**Contributing**
25-3129	**B19003**	-	**Technical Operations Building**	**1962**	**Building**	**Contributing**
RCP1	**C394**	-	**LASL Housing Trailer Park (Boyerville)**	**c.1961**	**Landscape**	**Contributing**
RCP10	**C395**	-	**Craft Housing/CATCO Trailer Park Area**	**1964**	**Landscape**	**Contributing**
RCP11	**C396**	-	**Sewage System**	**1958**	**Landscape**	**Contributing**
		AR1	Sewage Lagoons	1958	Structure	Contributing
		AR2	Leach Field	1958	Structure	Contributing
		AR3	Leach Field	1958	Structure	Contributing
RCP4	**C397**	-	**Vehicle Maintenance Area**	**1965**	**Landscape**	**Contributing**
		AR1	Electrical Boxes	1965	Structure	Contributing
		AR2	Concrete Slab	1965	Structure	Contributing
		AR3	Washdown Sump	1965	Structure	Contributing
RCP7	**C398**	-	**J-3 Trailer Area**	**c.1958**	**Landscape**	**Contributing**
		AR1	Trailer/Portable Building Pad	c.1966-1972	Structure	Contributing
		AR2	Communications Trailer/Portable Building Pad	c.1966-1972	Structure	Contributing
		AR3	Communications Boxes	c.1966-1972	Structure	Contributing
		AR4	Water Spigots	1961	Structure	Contributing
		AR5	Decontamination Sump	1961	Structure	Contributing
25-3102	**S3117**	-	**Power House Foundation**	**1958**	**Structure**	**Contributing**
		AR1	Substation NRDS #1	1958	Structure	Contributing

Table A-2. List of Primary Resources (bold) and Accessory Resources in the NRDS Historic District (D424).

NNSS/Field Number	SHPO Number	AR Number	Name Principal Resource (left) Accessory Resource (Centered)	Year Built	Property Type	NRDS District Contributor***
		AR2	Loading Dock	c.1962	Structure	Contributing
25-3105	**S3118**	-	**Cafeteria/Medical Facility Foundation**	**1958**	**Structure**	**Contributing**
		AR1	Trailer Park	c.1960s	Structure	Contributing
25-3106	**S3119**	-	**REECo Warehouse Foundation**	**1958**	**Structure**	**Contributing**
		AR1	Shed Foundation	1964	Structure	Contributing
		AR2	Above-Ground Power Pole	1964	Structure	Contributing
25-3107	**S3120**	-	**Service Station Foundation**	**1958**	**Structure**	**Contributing**
25-3128	**S3121**	-	**Generator Trailer Service Building Foundation**	**1964**	**Structure**	**Contributing**
		AR1	Trailer Pad	c.1964-1980s	Structure	Contributing
		AR2	Concrete Equipment Pad	c.1964-1980s	Structure	Contributing
		AR3	Water Hydrant	c.1964-1980s	Structure	Contributing
25-3151	**S3122**	-	**Weather Station Foundation**	**1959**	**Structure**	**Contributing**
		AR1	Concrete Equipment Pads	c.1959	Structure	Contributing
		AR2	U.S.W.B. Theodolite Station No. 1	1959	Structure	Contributing
RCP2	**S3148**	-	**Water Tower**	**1958**	**Structure**	**Contributing**
RCP3	**S3149**	-	**Heliport Hangar**	**1987**	**Structure**	**Non-contributing**
		AR1	Landing Pad	1987	Structure	Non-contributing
		AR2	Wind Sock	1987	Structure	Non-contributing
		AR3	Parking Area and Cargo Dolly	1987	Structure	Non-contributing
RCP5	**S3150**	-	**Vehicle Maintenance Shop Foundation**	**1965**	**Structure**	**Contributing**
RCP6	**S3151**	-	**Substation NRDS #2**	**c.1957**	**Structure**	**Contributing**
RCP8	**S3152**	-	**Concrete Slab**	**c.1960s**	**Structure**	**Contributing**
		AR1	Concrete Slab	c.1960s	Structure	Contributing
RCP9	**S3153**	-	**Shed Foundation**	**1965**	**Structure**	**Contributing**
RCP subdistrict contributing/non-contributing resources to NRDS: contributing n=25 primary, n=22 accessory; non-contributing n=1 primary, n=3 accessory						
CENTRAL SUPPORT AREA (CSA) SUBDISTRICT (D422) Contributing to the NRDS Historic District						
25-4014	**B19010**	-	**USAF Warehouse (Block C1)**	**1987**	**Building**	**Non-contributing**
		AR1	Stormwater Diversion Ditch	1987	Structure	Non-contributing
		AR2	Guard Rail	1987	Structure	Non-contributing
25-4015	**B19011**	-	**Administration and Engineering Bldg. (Block A2)**	**1966**	**Building**	**Contributing**
		AR1	Concrete Slab	c.1980s	Structure	Contributing
		AR2	Communications Tower	c.1966	Structure	Contributing
		AR3	Generator Pad	1966	Structure	Contributing
25-4001		AR4	Change House Foundation	1971	Structure	Contributing
		AR5	Trailer Park	1966	Landscape	Contributing

Table A-2. List of Primary Resources (bold) and Accessory Resources in the NRDS Historic District (D424).

NNSS/Field Number	SHPO Number	AR Number	Name Principal Resource (left) Accessory Resource (Centered)	Year Built	Property Type	NRDS District Contributor***
		AR6	Substation NRDS #11	1966	Structure	Contributing
		AR7	Plumbing Vaults	1966	Structure	Contributing
		AR8	Air Handler	1966	Structure	Non-contributing
		AR9	Flagpole	1966	Structure	Contributing
		AR10	Portable Building Pad	c.1966-1980s	Structure	Non-contributing
25-4117	**B19013**	-	**Medical Building (Block B2)**	**1969**	**Building**	**Contributing**
		AR1	Trailer Park	c.1970s	Landscape	Contributing
		AR2	Substation	c.1969	Structure	Contributing
25-4221	**B19014**	-	**Warehouse #1 (Block C3)**	**1964**	**Building**	**Contributing**
25-4222	**B19015**	-	**Maintenance Shops (Block B3)**	**1966**	**Building**	**Contributing**
25-4224		AR1	Paint Building Foundation	1967	Structure	Contributing
25-4224A		AR2	High Voltage Shop Foundation	1967	Structure	Contributing
25-4226		AR3	Labor Services Building Foundation	1967	Structure	Contributing
25-4226A		AR4	Tool Storage Building Foundation	1967	Structure	Contributing
		AR5	Storage Trailer	c.1970s-1980s	Structure	Non-contributing
		AR6	Two Brock Houses	c.1970s-1980s	Building	Non-contributing
25-4314	**B19016**	-	**Radiation Services (Block C2)**	**1967**	**Building**	**Contributing**
		AR1	Horseshoe Pit	c.1967-1980s	Structure	Contributing
25-4320	**B19017**	-	**Warehouse #2 (Block C3)**	**1966**	**Building**	**Contributing**
		AR1	Compressed Gas Storage Dock	1966	Building	Contributing
		AR2	Flammable Materials Storage Structure (408309)	1966	Structure	Contributing
		AR3	Parking/Storage Yard	Post-2004	Structure	Non-contributing
		AR4	Side Storage Yard	1964	Structure	Contributing
		AR5	Main Storage Yard	1966	Structure	Contributing
25-4517	**B19018**	-	**Radiation Instrument Calibration Facility Foundation (Block F2)**	**1967**	**Building**	**Contributing**
		AR1	Shielding Berm (Remnants)	1967	Structure	Contributing
		AR2	Stormwater Ditch and Dike	1966	Structure	Contributing
		AR3	Drain	1967	Structure	Contributing
25-4838	**B19019**	-	**Vehicle Maintenance Shop (Block D3)**	**1967**	**Building**	**Contributing**
		AR1	Fuel Island	1967	Structure	Contributing
		AR2	Above-Ground Tank Foundation	1967	Structure	Contributing
		AR3	Propane Tank Foundation	c.1967	Structure	Contributing
		AR4	Flagpole	c.1967-1980s	Structure	Contributing
		AR5	Concrete Slab	c.1967-1980s	Structure	Contributing
25-4919	**B19020**	-	**Radiographic Facility (Block B3)**	**1967**	**Building**	**Contributing**
		AR1	Substation 25-10	1967	Structure	Contributing
		AR2	Storage Trailer #582	c.1960s-1980s	Building	Contributing

Table A-2. List of Primary Resources (bold) and Accessory Resources in the NRDS Historic District (D424).

NNSS/Field Number	SHPO Number	AR Number	Name Principal Resource (left) Accessory Resource (Centered)	Year Built	Property Type	NRDS District Contributor***
		AR3	Storage Trailer #E-24286	c.1960s-1980s	Building	Contributing
25-5004	**B19021**	-	**Communications Trailer (Block B3) 202168**	**c.late-1960s**	**Building**	**Contributing**
		AR1	Portable Microwave Antenna	c.late-1960s	Structure	Contributing
		AR2	Concrete Communications Vault	c.1964	Structure	Contributing
		AR3	Communications Building #109	c.late-1960s	Building	Contributing
		AR4	Antenna	c.late-1960s	Structure	Contributing
		AR5	Microwave Antenna	c.late-1960s	Structure	Contributing
CS7	**B19022**	-	**Radio Communications Facility (Block B3)**	**c.late-1960s**	**Building**	**Contributing**
		AR1	Radio Aerial	c.late-1960s	Structure	Contributing
CS10	**C386**	-	**Central Propellant Area**	**1959**	**Landscape**	**Contributing**
25-4839		AR1	25-4839 Building Foundation	1968	Structure	Contributing
		AR2	Gas Tank Area	1959	Structure	Contributing
		AR3	Concrete Slab	c.1968	Structure	Contributing
		AR4	Entry Sign	1959	Structure	Contributing
		AR5	Gate	1959	Structure	Contributing
		AR6	Main Gas Handling Facility	1959	Structure	Contributing
		AR7	Gas Cylinder Racks	c.1965-1972	Structure	Contributing
		AR8	Gate	1959	Structure	Contributing
		AR9	Valve Cellar	1959	Structure	Contributing
		AR10	Entry Sign	1959	Structure	Contributing
CS4	**C388**	-	**CSA Septic System**	**c.1960**	**Landscape**	**Contributing**
		AR1	Leach Field	c.1960s	Structure	Contributing
		AR2	Sewage Lagoons	c.1960	Structure	Contributing
CS8	**C389**	-	**Trailer Park (Block C2)**	**c.1960s**	**Landscape**	**Non-contributing**
25-4215	**S3128**	-	**Technical Shops Foundation (Block C2)**	**1967**	**Structure**	**Contributing**
		AR1	Trailer Power Supply	c.1967-1980s	Structure	Contributing
		AR2	East Trailer Area	c.1967-1980s	Landscape	Contributing
		AR3	Underground Fuel Tank/Foundation	c.1967-1980s	Structure	Contributing
		AR4	Drill Holes UE-25 HRF UZP 1, 2a, and 3a	c.1967-1980s	Structure	Contributing
		AR5	Steel Structure	c.1967-1980s	Structure	Contributing
		AR6	Communications Box	c.1967-1980s	Structure	Contributing
25-4522	**S3129**	-	**Weather Bureau Observation Facility Foundation (Block F3)**	**1966**	**Structure**	**Contributing**
		AR1	Office Trailer Foundation	c.1966-1972	Structure	Contributing
		AR2	Radome Foundation	1966	Structure	Contributing
		AR3	Diversion Ditch and Dike	1966	Structure	Contributing
		AR4	Concrete Slab	c.1966-1972	Structure	Contributing
		AR5	Concrete Slab	c.1966-1972	Structure	Contributing

Table A-2. List of Primary Resources (bold) and Accessory Resources in the NRDS Historic District (D424).

NNSS/Field Number	SHPO Number	AR Number	Name Principal Resource (left) Accessory Resource (Centered)	Year Built	Property Type	NRDS District Contributor***
		AR6	Building Foundation	c.1966-1972	Structure	Contributing
		AR7	Observation Equipment Frame	1966	Structure	Contributing
		AR8	Meteorological Tower and Rain Gauge	c.2010s	Structure	Non-contributing
CS1	**S3130**	**-**	**Lunchroom Foundation (Block B2)**	**c.1960**	**Structure**	**Contributing**
CS2	**S3131**	**-**	**Helicopter Pad (Block A3)**	**c.1960**	**Structure**	**Contributing**
		AR1	Windsock Poles	c.1960	Structure	Contributing
		AR2	Safety Sign	c.1960	Structure	Contributing
CS3	**S3132**	**-**	**Substation NRDS #10 (Block B3)**	**c.1964**	**Structure**	**Contributing**
CS5	**S3133**	**-**	**Loading Ramp (Block D3)**	**c.1960s**	**Structure**	**Contributing**
CS6	**S3134**	**-**	**Survey Instrument Station**	**c.1980s**	**Structure**	**Non-contributing**
CS9	**S3135**	**-**	**Microwave Tower (Block F3)**	**c.1965**	**Structure**	**Contributing**
Well J-11	**S3136**	**-**	**Well J-11 (Block F1)**	**1958**	**Structure**	**Contributing**
		AR1	150,000 Gallon Water Tank (408040)	1958	Structure	Contributing
25-3121		AR2	Pump House (408043)	1958	Building	Contributing
		AR3	Equipment House (408540)	1958	Building	Contributing
		AR4	Equipment House Foundation (408541)	1958	Structure	Contributing
		AR5	Reservoir (Wilson's Pond)	1958	Structure	Contributing
CSA subdistrict contributing/non-contributing resources to NRDS: contributing n=21 primary, n=68 accessory; non-contributing: n=3 primary, n=8 accessory						

RADIOACTIVE MATERIAL STORAGE FACILITY (RMSF) (26NY11769, INDIVIDUALLY ELIGIBLE, Criteria A and C)						
RMSF	**26NY11769**	**-**	**Radioactive Material Storage Facility – RMSF, Individually Eligible Criteria A and C**	**1964-1965**	**Landscape**	**Contributing**
		AR1	Inner Security Fence	1964-1965	Structure	Contributing
		AR2	Outer Perimeter Fence	1964-1965	Structure	Contributing
		AR3	Perimeter Security Lights	1964-1965	Structure	Contributing
		AR4	South Bunker	1964-1965	Building	Contributing
		AR5	North Bunker	1964-1965	Building	Contributing
		AR6	Railroad Spur S	1964-1965	Structure	Contributing
		AR7	Railroad Spur K	1964-1965	Structure	Contributing
		AR8	Railroad Spur L	1964-1965	Structure	Contributing
		AR9	Railroad Spur M	1964-1965	Structure	Contributing
		AR10	Railroad Spur N	1964-1965	Structure	Contributing
		AR11	Railroad Spur O	1964-1965	Structure	Contributing
		AR12	Railroad Spur P	1964-1965	Structure	Contributing
		AR13	Southwest Material Storage Yard	1964-1965	Structure	Contributing

Table A-2. List of Primary Resources (bold) and Accessory Resources in the NRDS Historic District (D424).

NNSS/Field Number	SHPO Number	AR Number	Name Principal Resource (left) Accessory Resource (Centered)	Year Built	Property Type	NRDS District Contributor***
MAIN GATE (GATE 500) AND VICINITY						
25-3153	**B19004**	**-**	**NRDS Fire Station**	**1961**	**Building**	**Contributing**
		AR1	Retaining Walls and Terraces	c.1960s	Structure	Contributing
		AR2	Transformer Pad	1961	Structure	Contributing
NRDS1	**C390**	**-**	**Gate 500**	**1959**	**Landscape**	**Contributing**
		AR1	Security Fence	1959	Structure	Contributing
		AR2	Enlarged Highway and Guard Shack Location	1959	Structure	Contributing
		AR3	Leach Field	c.1959	Structure	Contributing
		AR4	Fuel Oil Storage	c.1959	Structure	Contributing
25-3152	**S3123**	**-**	**Rad-safe Building Foundation**	**1961**	**Structure**	**Contributing**
NRDS2	**S3142**	**-**	**Animal Shelter**	**c.1961-1962**	**Structure**	**Unevaluated**
		AR1	Light Pole	c.1961-1962	Structure	Unevaluated
		AR2	Light Pole	c.1961-1962	Structure	Unevaluated
		AR3	Storage Yard	c.1961-1962	Structure	Unevaluated
NRDS3	**S3143**	**-**	**Water Tank**	**1965**	**Structure**	**Contributing**
		AR1	Cellar	1965	Structure	Contributing
		AR2	Outlet Pipe	1965	Structure	Contributing
		AR3	Electrical Boxes	1965	Structure	Contributing
NRDS MISCELLANEOUS RESOURCES						
25-4101	**B19012**	**-**	**Communications Building**	**1958**	**Building**	**Contributing**
		AR1	Trailer Pad	c.1960s	Structure	Contributing
		AR2	Signage Dump	c.1960s	Landscape	Contributing
		AR3	Radio Aerial	c.1958	Structure	Contributing
NRDS6	**C392**	**-**	**Sandia Compound**	**c.1958**	**Landscape**	**Contributing**
		AR1	Radiation Monitor	c. 1958	Structure	Contributing
		AR2	Concrete Pad	c. 1958	Structure	Contributing
		AR3	Power Transmission Pole	c. 1958	Structure	Contributing
		AR4	Electrical Box and Sweep	c. 1958	Structure	Contributing
		AR5	Entrance Sign Post	c. 1958	Structure	Contributing
		AR6	Signposts	c. 1958	Structure	Contributing
NRDS9	**C393**	**-**	**Biological Study Plot**	**Unknown**	**Landscape**	**Non-contributing**
NRDS16	**C400**	**-**	**Radiation Monitoring Array (Test Cell A)**	**1958**	**Landscape**	**Contributing**
TCC1	**C401**	**-**	**Radiation Monitoring Array (Test Cell C)**	**c.1964**	**Landscape**	**Contributing**

Table A-2. List of Primary Resources (bold) and Accessory Resources in the NRDS Historic District (D424).

NNSS/Field Number	SHPO Number	AR Number	Name Principal Resource (left) Accessory Resource (Centered)	Year Built	Property Type	NRDS District Contributor***
NRDS10	**S3137**	**-**	**Phoebus Mock-up**	**c.1965**	**Structure**	**Contributing**
NRDS14	**S3140**		**NRDS Switching Station**	**c.1960**	**Structure**	**Contributing**
NRDS7	**S3146**	**-**	**Camera Tower**	**c. 1958**	**Structure**	**Contributing**
		AR1	Equipment Lifting Cage	c. 1958	Structure	Contributing
NRDS8	**S3147**	**-**	**Weather Tower Foundation**	**c. 1958**	**Structure**	**Contributing**
		AR1	Meteorological Instrument Stand	c. 1958	Structure	Contributing
		AR2	Instrument Foundation	c. 1958	Structure	Contributing
		AR3	Post	c. 1958	Structure	Contributing
		AR4	Utility Line	c. 1958	Structure	Contributing
LINEAR RESOURCES						
RTS	**26NY14637**	**N/A-**	**Jackass & Western Railroad (Individually Eligible Criteria A)**	**1958-1965**	**Landscape**	**Contributing**
NRDS11	**S3138**	**N/A**	**NRDS Road System**	**1957**	**Structure**	**Contributing**
NRDS12	**S3139**	**N/A**	**NRDS Power System**	**1957**	**Structure**	**Contributing**
NRDS5	**S3145**	**N/A**	**NRDS Water System**	**1957**	**Structure**	**Contributing**

Table A-3. Primary Resources in the NRDS Historic District with Previous Individual NRHP Eligibility Determinations and Current Recommendations.

NNSS No. or Other Designation	SHPO No	Previous Determination	Current Recommendation	NRDS District Contributor
R-MAD Subdistrict				
Jr. Hot Cell	26NY9277	Eligible: Criterion A	Not Individually Eligible, Demolished	No
25-3110	26NY9277	Eligible: Criteria A and C	Not Individually Eligible, Demolished	Yes
E-MAD Historic District				
25-3900	B4845	Eligible: Criteria A, C, and D	No Change	Yes
25-3901	B17966	Eligible: Criteria A and C	No Change	Yes
EIV	S3057	Eligible: Criteria A and C	No Change	Yes
MCC	S3058	Eligible: Criteria A and C	No Change	Yes
Test Cell A Subdistrict				
25-3113/3113A	B2443	Eligible: Criteria A and C	Not Individually Eligible, Demolished	Yes
Test Cell C Historic District				
Test Cell C	D346	Eligible: Criteria A, C, and D	No Change	Yes
25-3220	B18110	Eligible: Criteria A and C	No Change	Yes
25-3226	B18111	Eligible: Criteria A and C	No Change	Yes
25-3230-32	B18114	Eligible: Criteria A and C	No Change	Yes
Kiwi-TNT	S2287	Eligible: Criteria A, C, and D	No Change	Yes
25-3210	B2444	Eligible: Criteria A and C	Not Individually Eligible, Demolished	Yes
Radioactive Material Storage Facility				
RMSF	26NY11769	Eligible: Criteria A and C	No Change	Yes
NRDS Miscellaneous Resources				
Jackass and Western Railroad	26NY14637	Eligible: Criterion A	No Change	Yes

Table A-4. Concordance of Primary Resource Number.

NNSS/Field Number to SHPO Number

NNSS/Field No.	SHPO No.	Report Section
25-3101	B18993	RCP
25-3102	S3117	RCP
25-3103	B18994	RCP
25-3104	B18995	RCP
25-3105	S3118	RCP
25-3106	S3119	RCP
25-3107	S3120	RCP
25-3108	B18996	RCP
25-3108A	B18997	RCP
25-3110	26NY9277	R-MAD
25-3111	B18998	R-MAD
25-3113/3113A	B2443	TCA
25-3122	B18999	RCP
25-3123	B19000	RCP
25-3124	B19001	TCA
25-3127	B19002	RCP
25-3128	S3121	RCP
25-3129	B19003	RCP
25-3151	S3122	RCP
25-3152	S3123	Gate 500
25-3153	B19004	Gate 500
25-3210	B2444	TCC
25-3214	B18109	TCC
25-3220	B18110	TCC
25-3226	B18111	TCC
25-3228	B18112	TCC
25-3229	B18113	TCC
25-3230-32	B18114	TCC
25-3233	B18115	TCC
25-3310	B19005	ETS-1
25-3312	S3124	ETS-1
25-3319	S3125	ETS-1
25-3320	B19006	ETS-1
25-3324	S3126	ETS-1
25-3330	B19007	ETS-1
25-3331	B19008	ETS-1
25-3340	B19009	ETS-1
25-3350	S3127	ETS-1
25-3900	B4845	E-MAD

NNSS/Field No.	SHPO No.	Report Section
25-3901	B17996	E-MAD
25-4014	B19010	CSA
25-4015	B19011	CSA
25-4101	B19012	NRDS
25-4117	B19013	CSA
25-4215	S3128	CSA
25-4221	B19014	CSA
25-4222	B19015	CSA
25-4314	B19016	CSA
25-4320	B19017	CSA
25-4517	B19018	CSA
25-4522	S3129	CSA
25-4838	B19019	CSA
25-4919	B19020	CSA
25-5004	B19021	CSA
CS1	S3130	CSA
CS2	S3131	CSA
CS3	S3132	CSA
CS4	C388	CSA
CS5	S3133	CSA
CS6	S3134	CSA
CS7	B19022	CSA
CS8	C389	CSA
CS9	S3135	CSA
CS10	C386	CSA
EIV	S3057	E-MAD
F5	S3055	E-MAD
F6	S3056	E-MAD
F9	S3054	E-MAD
Kiwi-TNT	S2287	TCC
L4	S3052	E-MAD
L5	S3053	E-MAD
MCC	S3058	E-MAD
NRDS1	C390	Gate 500
NRDS2	S3142	Gate 500
NRDS3	S3143	Gate 500
NRDS5	S3145	Linear
NRDS6	C392	NRDS
NRDS7	S3146	NRDS

NNSS/Field No.	SHPO No.	Report Section
NRDS8	S3147	NRDS
NRDS9	C393	NRDS
NRDS10	S3137	E-MAD
NRDS11	S3138	Linear
NRDS12	S3139	Linear
NRDS14	S3140	NRDS
NRDS16 (TCA1)	C400	NRDS
RCP1	C394	RCP
RCP2	S3148	RCP
RCP3	S3149	RCP
RCP4	C397	RCP
RCP5	S3150	RCP
RCP6	S3151	RCP
RCP7	C398	RCP
RCP8	S3152	RCP
RCP9	S3153	RCP
RCP10	C395	RCP
RCP11	C396	RCP
RM1	C399	R-MAD
RM2	S3154	R-MAD
RM3	S3155	R-MAD
RMSF	26NY11769	RMSF
RTS	26NY14637	Linear
TCA2	B19023	TCA
TCA3	B19024	TCA
TCC1	C401	NRDS
TS1	B19025	ETS-1
TS2	S3158	ETS-1
TS3	S3159	ETS-1
TS4	C402	ETS-1
TS5	C403	ETS-1
TS6	B19026	ETS-1
TS7	S3160	ETS-1
TS8	C404	ETS-1
TS9	C405	ETS-1
TS10	S3157	ETS-1
Well J-11	S3136	CSA

SHPO Number to NNSS/Field Number

SHPO No.	NNSS/Field No.	Report Section
26NY11769	RMSF	RMSF
26NY14637	RTS	Linear
26NY9277	25-3110	R-MAD
B17996	25-3901	E-MAD
B18109	25-3214	TCC
B18110	25-3220	TCC
B18111	25-3226	TCC
B18112	25-3228	TCC
B18113	25-3229	TCC
B18114	25-3230-32	TCC
B18115	25-3233	TCC
B18993	25-3101	RCP
B18994	25-3103	RCP
B18995	25-3104	RCP
B18996	25-3108	RCP
B18997	25-3108A	RCP
B18998	25-3111	R-MAD
B18999	25-3122	RCP
B19000	25-3123	RCP
B19001	25-3124	TCA
B19002	25-3127	RCP
B19003	25-3129	RCP
B19004	25-3153	Gate 500
B19005	25-3310	ETS-1
B19006	25-3320	ETS-1
B19007	25-3330	ETS-1
B19008	25-3331	ETS-1
B19009	25-3340	ETS-1
B19010	25-4014	CSA
B19011	25-4015	CSA
B19012	25-4101	NRDS
B19013	25-4117	CSA
B19014	25-4221	CSA
B19015	25-4222	CSA
B19016	25-4314	CSA
B19017	25-4320	CSA
B19018	25-4517	CSA
B19019	25-4838	CSA

SHPO No.	NNSS/Field No.	Report Section
B19020	25-4919	CSA
B19021	25-5004	CSA
B19022	CS7	CSA
B19023	TCA2	TCA
B19024	TCA3	TCA
B19025	TS1	ETS-1
B19026	TS6	ETS-1
B2443	25-3113	TCA
B2444	25-3210	TCC
B4845	25-3900	E-MAD
C386	CS10	CSA
C388	CS4	CSA
C389	CS8	CSA
C390	NRDS1	Gate 500
C392	NRDS6	NRDS
C393	NRDS9	NRDS
C394	RCP1	RCP
C395	RCP10	RCP
C396	RCP11	RCP
C397	RCP4	RCP
C398	RCP7	RCP
C399	RM1	R-MAD
C401	C401	NRDS
C402	TS4	ETS-1
C403	TS5	ETS-1
C404	TS8	ETS-1
C405	TS9	ETS-1
S2287	Kiwi-TNT	TCC
S3052	L4	E-MAD
S3053	L5	E-MAD
S3054	F9	E-MAD
S3055	F5	E-MAD
S3056	F6	E-MAD
S3057	EIV	E-MAD
S3058	MCC	E-MAD
S3117	25-3102	RCP
S3118	25-3105	RCP
S3119	25-3106	RCP

SHPO No.	NNSS/Field No.	Report Section
S3120	25-3107	RCP
S3121	25-3128	RCP
S3122	25-3151	RCP
S3123	25-3152	Gate 500
S3124	25-3312	ETS-1
S3125	25-3319	ETS-1
S3126	25-3324	ETS-1
S3127	25-3350	ETS-1
S3128	25-4215	CSA
S3129	25-4522	CSA
S3130	CS1	CSA
S3131	CS2	CSA
S3132	CS3	CSA
S3133	CS5	CSA
S3134	CS6	CSA
S3135	CS9	CSA
S3136	Well J-11	CSA
S3137	NRDS10	E-MAD
S3138	NRDS11	Linear
S3139	NRDS12	Linear
S3140	NRDS14	NRDS
S3142	NRDS2	Gate 500
S3143	NRDS3	Gate 500
S3145	NRDS5	Linear
S3146	NRDS7	NRDS
S3147	NRDS8	NRDS
S3148	RCP2	RCP
S3149	RCP3	RCP
S3150	RCP5	RCP
S3151	RCP6	RCP
S3152	RCP8	RCP
S3153	RCP9	RCP
S3154	RM2	R-MAD
S3155	RM3	R-MAD
S3157	TS10	ETS-1
S3158	TS2	ETS-1
S3159	TS3	ETS-1

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