STANLEY R. MICKELSEN SAFEGUARD COMPLEX,
MISSILE SITE CONTROL BUILDING
(STANLEY R. MICKLENSEN SAFEGUARD COMPLEX,
MISSILE SITE RADAR COMPLEX)
(BUILDING 430)
Northeast of Tactical Road; southeast of Tactical Road South
Nekoma Vicinity
Cavalier County
North Dakota

HAER No. ND-9-B

HAER
ND-9-B

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

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HISTORIC AMERICAN ENGINEERING RECORD
STANLEY R. MICKELSEN SAFEGUARD COMPLEX,
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INTRODUCTION

Location: The Missile Site Radar (MSR) site is located in Section 14 and 15, Township 159 North, Range 60 West of the Principal Meridian, Nekoma Vicinity, Cavalier County, North Dakota. The site is approximately 100 highway miles northwest of the city of Grand Forks, North Dakota, and adjacent to State Highway 1. The Missile Site Control Building (MSCB) is located northeast of the Tactical Road and southeast of Tactical Road South.

Township and Range: Listed on following page.

Date of Construction: 28 April 1970 through 3 January 1973.

Present Owner: U.S. Department of the Army.

Present Use: Caretaker Status.

Significance: It is believed that the plans for deployment and initiation of construction of this facility were instrumental in obtaining Soviet agreement to the Anti-Ballistic Missile Treaty and a subsequent decline in Cold War hostilities between the Superpowers. This structure was nuclear hardened, that is, designed to withstand a nearby nuclear blast. Both the MSR with its data processing center and its power plant were nuclear hardened. The MSR was designed to be self-contained in case of attack. The MSR was a phased array radar, its beams were steered electronically instead of using heavy moving antennas. Rather than a large dish, this radar has thousands of small antenna built into each face. The MSR had a detection range of several hundred miles. It provided more precise, close-in target data than the PAR. The MSR was to ready interceptors (Spartan and Sprint missiles) for launch and then was to guide them to intercept. The MSR had four faces allowing it to operate against attackers from any direction. A research and development version of the MSR had been built at the Kwajalein Missile Range (in the Marshall Islands.) However, that version was not built partially underground like the MSR at SRMSC.

Historian: James E. Zielinski, Environmental Specialist, December 1994.

STANLEY R. MICKELSEN SAFEGUARD COMPLEX
TOWNSHIP AND RANGE

Beginning at the Southwest corner of Section 14;

thence North 88°12'10" East along the South line of said Section 14, 3,290.09 feet;

thence North 01°34'03" West, 560.08 feet;

thence South 88°12'56" West, 250.21 feet;

thence North 01°33'24" West, 2,080.13 feet to the North line of the SE-¼ said Section 14;

thence South 88°12'00" West along said North line, 397.89 feet to the Southeast corner of the NW-¼ of said Section 14;

thence North 01°34'30" West along the East line of said NW-¼, 705.00 feet;

thence South 85°35'56" West, 1,548.79 feet;

thence South 28°24'14" West, 444.99 feet;

thence South 88°12'51" West, 872.64 feet to the East line of Section 15;

thence South 01°33'31" East along said East line, 435.48 feet; thence South 88°12'00" West, 100.00 feet;

thence South 88°50'48" West, 2,534.30 feet to the East line of the SW-¼ of said Section 15;

thence South 43°04'22" West, 682.62 feet;

thence North 46°55'38" West, 20.00 feet;

thence South 43°04'22" West, 1,466.74 feet;

thence along a 01°38'45" curve to the left, 803.78 feet;

thence South 33°18'34" East, 273.70 feet;

thence North 86°48'29" East, 1,266.36 feet;

thence South 01°35'47" East, 141.71 feet to the South line of said Section 15; thence North 88°12'29" East along said South line, 3,242.48 feet to a point of beginning.

PART I. HISTORICAL INFORMATION

A. Physical History

1. Date of Erection: Excavation for the MSCB began 6 April 1970. Structural concrete for the MSCB base slab was first poured on 18 June.[1] The Beneficial Occupancy Date (the allocated time for completion of the MSCB "shell" and installation of tactical support equipment) was established as 1 January 1973. The MSCB was released for occupancy to the SAFSCOM Site Activation Team on 3 January of that year.[2]

2. Architect(s): Design of all MSR tactical facilities including the MSCB was accomplished by the Ralph M. Parsons Company.[3] The Missile Site Radar itself was designed by the Raytheon Company.

3. Original and Subsequent Owners: In August 1972, the U.S. Army Corps of Engineers transferred site responsibility to the U.S. Army Safeguard System Command (SAFSCOM). On 3 September 1974, the U.S. Army Safeguard Command (SAFCMD) and the Ballistic Missile Defense Operations Activity (BMDOA) relieved SAFSCOM and were established as operational elements for the Safeguard system; SAFCMD soon assumed operation/maintenance responsibility.[4] The U.S. Army Air Defense Command (ARADCOM), manned by Army Surveillance Battalion, Grand Forks, was the using command.[5]

On 10 February 1976, this Safeguard facility was "abandoned in place" and put in inactive status. "Abandonment in Place" is defined as closure and seal-up of facilities to reduce potential hazards and keep care and custody to a minimum.

> MSR facilities were salvaged in 1977 and all tactical facilities secured; a portion of the site was briefly utilized by the General Services Administration. In 1982, the nontechnical facilities were declared excess by the Department of Defense and given to the Department of Interior for interim use. In 1984, the U.S. Army reacquired the nontechnical facilities to provide the Strategic Defense Initiative Organization (SDIO) timely support in the event a decision was made to deploy a ballistic missile defense system.[6]
> As of December 1991, the U.S. Army Strategic Defense Command obtained accountability for the property. It remains in inactive status under this organization, now known as the U.S. Army Space and Strategic Defense Command.[7]

4. Builders, Contractors, Suppliers: To help construct the facilities, consulting engineers and construction contractors, in addition to the aforementioned, were employed. These were Morrison-

Knudsen and Associates, responsible for all MSR and PAR tactical facilities construction, including the MSCB. Their contract award totaled $137,858,850 and was dated 31 March 1970.

5. Original Plans and Construction: The MSCB was to be roofed in by October 1971 and occupied by the Weapon System Contractor a few months later.

General site excavation began for the MSCB on 6 April 1970 and continued through mid-May, at which point foundation excavation and sealing commenced and forms were placed for the concrete subslab.[8] On 18 June, the first structural concrete pouring for the base slab began, and by late August, 70 percent of the MSCB first floor and south and east walls were complete.[9] The first-floor-level slabs and walls were totally complete by mid-September, and false work and steel placement began for the second-floor slab. Fear that schedule slippage and the onset of freezing temperatures would, for all purposes, halt production resulted in an acceleration to two 10-hour, 6-day shifts a week from early October to 19 November. This allowed the second-floor slab to be finished to "seal in" the building for interior winter work, and as a result, M-KA was allowed an additional 18 days to complete the building plus negotiated cost settlements of approximately $2.5 million.[10]

During design and construction of the MSCB, the primary concern regarded offsetting the effects of nuclear electromagnetic pulse (EMP); this would result from electromagnetic fields created by detonation of a nuclear warhead within a critical distance of the site(s). In some cases, extra protection was needed against radio frequency interference (RFI), a specific band in the electromagnetic wave spectrum which could result from lightning, static, and internally generated sources, as well as warhead detonation.[11] Shielding against EMP/RFI was necessary to offset adverse effects on the electrical and electronic elements of the weapon system (e.g., damage from electrical surge or from induced currents; malfunction due to spurious signals, RFI "drowning" of true signals, or spurious flux).[12]

Since some three-fifths of the MSCB required EMP/RFI shielding and neither the building's welded rebar nor its embedded wire mesh provided the required attenuation, it was decided that a metal liner-plate shielding would be utilized for the entire building.[13] The use of 11-gauge steel was preferred as it could not only be electrically welded at its seams but could also be utilized as form material when pouring the concrete walls and structures.[14]

At this juncture the decision on how to line the MSCB was between three potential scenarios: (1) an exterior steel shield, (2) steel liner plate on the inside face of the exterior walls, on the first floor slab, and under the building and turret roof, or (3) a room-by-room steel liner plating of the walls, ceilings, and floors.[15] Though more extensive, the latter option proved preferable due to its reliability, the ease of repair and testing, and cost-effectiveness.[16]

In October, cutting, placing, welding, and testing of this liner plate began, and in mid-November, fabrication, installation, and painting of conduit and heat sink cooling lines were underway. By 7 December, as temperatures dipped as low as -25°F, completion of the MSCB second floor effectively closed in the lower level. Any remaining openings were sealed off, and this, combined with gas-fired furnaces, allowed work to continue inside the building.

On 30 March 1971, outside work resumed and concrete pouring could recommence. Progress was impeded somewhat by labor disputes, precipitation, and the annual load limits placed on state highways (to protect them during spring thaw), but by the third week in August, the third-level walls and fourth-floor slab were in place.[17] Completing the fourth floor, however, would be problematic; there was a delay in shipment of the antenna support rings, which had to be emplaced to continue work.

The antenna emplacement proved to be one of the most critical construction problems encountered at the MSCB. Holes had to be left in the upper two levels to accommodate the later arrival (May 1972) of four huge, 36-segment antenna support rings; potentially a setback in schedule, the blocked-off areas were merely winterized by temporary timber and plywood boxes.[18] Once they arrived, the support rings would have to be assembled, installed, and test-aligned before the adjoining wall surfaces could be filled in with concrete.[19] The ring and the support system constitute a tremendous load (each antenna weighed approximately 455,000 pounds) and necessitated a major engineering effort to insure that the permanent structure was not overstressed.[20] In order to block out the spaces, it was necessary to transfer the loads from the ring/support system to the building itself, a problem since the ring had to be set to machine tolerances of within 0.05 in.[21] Machine alignment of the 36 shear keys, positioned with a special test fixture, proved to be the solution; the fixture checked alignment of the plane in which the ring was set to within 15 minutes of angle.[22] The antenna ring's supports were provided by the use of towers and radial framework supported on the fourth-level slab.[23]

By September's end, the fourth-level slab and walls were complete and the roof capped.[24] With the MSCB fully closed in, little winterization was required, and by 31 December 1971, 53 percent of the mechanical and 42 percent of the electrical work were completed.[25]
From May through July of 1972, the four turret rings were assembled, aligned, and set in concrete.[26] On 3 January 1973, the MSCB was transferred to the SAFSCOM Site Activation Team, and Western Electric Company employees began installation and testing of tactical equipment.[27]

Interestingly, only the northeast and northwest radar faces were ever fully completed and activated before the complex was deactivated.[28] In February 1976, activity was terminated at the MSCB. Final closure occurred on 16 September 1977. During this time, all missiles were removed from the MSR site, missile silos were sealed, and the MSCB itself was salvaged (removal of support beams, stair rails, etc.) and sealed.[29]

These salvage operations created openings which permitted rainfall, melting snow and groundwater to enter the building and flood the first two levels. In December 1989, an on-site environmental inspection found polychlorinated biphenyls (PCBs) in the MSCB.

Within a year the U.S. Environmental Protection Agency (EPA) issued a Notice of Noncompliance against the SRMSC for violations of the Toxic Substances Control Act, and a major effort was undertaken to test, remove, and dispose of all PCB-containing sludge and debris and pump out many millions of gallons of water.[30] It was assumed that a number of PCB-containing equipment items might be located under the water flooding the MSCB and Missile Site Radar Power Plant (MSRPP).[31] The U.S. Army Strategic Defense Command, along with the Omaha District and the U.S. Army Corps of Engineers, Huntsville, completed the cleanup.[32] By 23 January 1992, all structures were dewatered.

Other PCB-related work included:

- Removal of approximately 150 tons of delaminated building material and debris from the MSCB lower level (Bridge Crane Rooms, Room 129, Ballast Room, Electrical Repair Shop and connected rooms) and MSRPP (Prime Mover Modules 1 & 2, Motor Generator Room)[33]

- Removal of RFI capacitors and adjacent debris and floor tiles from rooms 242/243 and 253[34]

- Removal of RFI capacitors and adjacent debris and floor tiles from rooms 129, Ballast Room, and the Electrical Repair Shop (removing the entire steel floor)[35]

- Removal of lighting ballasts from the MSCB mezzanine (100 total), second floor (1336 total), third floor (173 total), fourth floor (40 total), tunnel (873 total), and power plant tunnel (233 total)[36]

- Removal of RF filters from the MSCB mezzanine (8 total), second floor (122 total), third floor (16 total), fourth floor (14 total), MSCB tunnel (78 total), and power plant tunnel (10 total)[37]

- Removal of 1 inch of concrete from the upper portion of the MSCB unloading dock[38]

Although the extent has not been determined, some additional alteration to the building's interior may have occurred during a testing phase in 1977. On 9 November 1976, word was received from the Safeguard Project Office to retain certain items at the MSCB to support Federal Aviation Agency (FAA) and Defense Nuclear Agency (DNA) explosive testing. Requested for use were rooms 113, 114, 130, 132, and 142; a corridor; rooms 241, 242, and 243 (after all floor installed equipment had been removed); and the MSCB's utilities and elevator. It was stated that, "after testing, exterior damage to the facilities will be repaired and the facilities restored to a weathertight, secure condition," but added, "interior damage need not be repaired."[39]

The DNA performed the explosive tests for the FAA during July. They were considered successful in developing criteria for hardening baggage storage and locker areas of airport terminals to contain the explosive effects of small expedient bombs.[40] The extent of any interior damage to the MSCB has not been determined. Regardless, the corrosion and water damage caused by the later flooding would primarily have affected the two floors wherein the testing occurred and undoubtedly accelerated the room's deterioration.

PART II. ARCHITECTURAL INFORMATION

A. General Statement

Design criteria required that both the MSCB and its power plant sustain the effects of a nuclear attack with all critical systems remaining operational.[41] As a result, the MSCB was hardened and designed to contain both the MSR and all tactical operational control functions associated with surveillance, target acquisition, and Safeguard missile guidance and control.[42] Maintaining its own support facilities, the MSCB could completely seal itself up, permitting uninterrupted operation (including its air supply) during and after enemy attack, even when the outside environment became intolerable.[43] Protection was thus afforded both to personnel and the intricate machinery powering and powered by the radar faces.

The MSCB is the heart of the MSR complex; it monitored and controlled its onsite Sprint and Spartan missile fields and four Remote Sprint Launch sites and provided the terminal defense line for nearby MINUTEMAN missile fields, protecting a geographic area of approximately 600 by 900 mi.[44] It contained equipment capable of detecting and identifying multiple enemy targets, destroying them via the launch and guidance of its interceptor missiles, Spartan and Sprint. The equipment required for this task included radar, data processing equipment, control and monitoring equipment, and environmental and test support equipment.[45] The weight of the building is estimated to be 160 million pounds.

The MSCB is a massive, partially buried reinforced concrete building with five levels, and the predominant structure at the MSR site. The major portion of the building (two stories) is subterranean; the height of the exposed section is approximately 75 ft, and it contains the four phased-array radar antenna faces.[46] This above-ground area is often referred to as the "turret" of the MSCB. Its peculiar polyhedral shape resembles that of a cropped pyramid. The MSCB has 2 ft of earth cover over the high underground portion (225 ft^2 by 65 ft).[47] In order to meet established structural design criteria, rigorous dynamic analysis was accomplished. The building's configuration was also influenced by the need to optimize its radars' performance.

1. Architectural Character: The MSCB merits recording by reason of its steel-reinforced liner-plate shielded design which protects it against nuclear weapon effects and its role in early ballistic missile defense and as a pivotal figure in the SRMSC the only antiballistic site ever completed in the United States as a whole.

2. Condition: Structurally sound, the MSCB has been in inactive status since 1978. Prior to this, the building was salvaged, permitting later flood damage.[48]

B. Description of Exterior

1. Overall Dimensions: The overall dimensions of the MSCB are 127,384 ft^2, with the usable area encompassing four major floors (two subterranean and two located within the turret) and several mezzanines.

The underground building volume has dimensions of 231 ft by 231 ft by 53 ft in height, whereas the above-ground exposed antenna turret has outside base dimensions of 136 ft by 136 ft. Turret walls are sloped at an angle of 56 degrees from the vertical, and its height is 79 ft with a 39-foot square roof.[49]

2. Foundations: The MSCB foundation is a 4-foot thick slab, thickened at outer walls and at concentrations of load-bearing areas.[50] The foundation mat design employed a combination of flat slab, one-way, and two-way slab systems for vertical loads, and is designed as a diaphragm for lateral loads.[51]

3. Walls: Exterior walls (3 ft thick) were designed for vertical load bearing and as one-way or two-way slabs for dynamic lateral loads normal to the walls. In addition, they were designed as shear walls to resist dynamic loads due to nuclear weapons effects and soil pressures parallel to walls.[52] The walls, including the subterranean portion, were covered with a waterproof coating.[53]

4. Structural System, Framing: MSCB design considered an average concrete strength of 5,000 psi and reinforcement with a 60 ksi yield and included a considerable number of 18S bars.[54] The concrete was required to have a 28-day strength of 4,000 psi and a 1-year strength of 5,000 psi; MSCB design loads were developed considering the results of dynamic analysis.[55] The reinforcing steel of the MSCB shell allowed for a limited degree of EMP attenuation.[56]

Lightning protection for the MSR site was provided via installation of nine air terminals on the turret roof of the MSCB connected by down-conductors to the buried ground loop and to the MSRPP ground counterpoise grid; air terminals were also provided for each diesel air intake/exhaust stack, cooling tower, and public utility substation.[57] Not only the MSCB but the fences, lighting standards, and radar antennae were all equipped with lightning protection.[58]

Corrosion protection was provided for buried conductors such as electrical/communication conduits, utility piping, exterior steel shielding (as in the Sprint Launch Station) and the grounding counterpoise.[59]

5. Radar: Attachment for the radar antenna and antenna adaptor consists of a heavy steel antenna support ring installed in each of the four turret faces, consisting of a 30-foot inner-diameter steel ring with 36 shear keys; each was spaced equally about the perimeter to support the load, and the ring itself was embedded in concrete, leaving the inner diameter as the perimeter turret opening. The steel ring does not contribute to the strength or stiffness of the opening. The rings, fabricated of rolled steel plate, were electrically and magnetically continuous, and continuously welded to the building's steel liner plate.[60] The shear keys support the weight of the antenna (over 400,000 pounds), and were designed to resist transient loads due to wind, earthquakes, and nuclear weapons effects. The weight on the shear keys was in directions normal to the plane of the ring, tangential to the ring and radially from the ring centroid.[61]

Three equipment items were exposed directly to the potential of nuclear burst and thus were designed to withstand dynamic pressure and thermal loadings rather than building motions. They are listed as follows:

Antenna Array Support Structure Because of its importance and potential vulnerability, the array (two homogeneous plates connected by a continuum of tubes) received the most careful attention and accurate analysis of any part of the system. Vibration of the array was known to cause signal distortion and attenuation, so the array center deflection was limited to 0.5 in.

Antenna Adaptor The antenna adaptor was a donut-shaped structure which functioned as a support for the MSR array.

Q-channel Antenna The Q-channel antenna was a circular plate with a hole, supported at both the inner and the outer circumference. The "plate" was actually a sandwich of three plates, the outer plate was copper, the inner plate was steel, and the center plate was transit.[62]

For each of the four radar apertures, a RF gasket was installed to ensure shielding continuity between the antenna ring, support structure, and adaptor.[63]

6. Openings:

a. Doors Two 16-inch-thick emergency escape doors, one on the second floor (No. 278), the other on the third (No. 310), provided egress as well as protection. The door leaves were heavy, blast resistant steel plates with gas seals (to exclude radiation) and conductive gaskets (for shielding continuity).[64] Both were operated manually and pneumatically. Door No. 278 provided egress from an EMP-shielded area into an escape tunnel, and Door No. 310 was located at a third-floor EMP/RFI shielding zone.[65] Both were similar in construction and operation, providing passage openings of 3 ft by 7 ft.[66] Each door was locally operated and provided with a means to permit remote monitoring and securing from the Equipment Readiness Center.

b. Tunnels The MSCB has three tunnels: an emergency escape; the Personnel, Equipment, and Utility Tunnel (PEUT); and the Launch Area Utility Tunnel (LAUT).

Emergency Escape The 100-foot-long emergency escape tunnel was located on the second floor. Extending from the north side of the MSCB to an unloading dock and ramp, the 13-foot, 10-inch by 12-foot, 2-inch corrugated metal plate arch tunnel was equipped with handrails and had bituminous flooring; only 55 ft were subterranean.[67]

PEUT The MSCB was accessed by its power plant through the PEUT, Facility 0435. The PEUT was a hardened, reinforced concrete, buried structure which had an integrally formed two-story, separately shielded communications vault, sewage pump room, and utility entry mezzanine on one side.[68] The lower portion allowed personnel and equipment ingress and egress.[69]

The upper level was utilized for routing the MSCB electrical conduits, as well as conduits for fire alarm, security, warning and communication circuits, transmitter oil, cooling and heating water piping services, and makeup environmental air supply and return ducts between structures.[70] This tunnel also contained lift pumps for sewage and industrial waste. Electrical power for the launch area was also routed through the PEUT to the junction with the LAUT. A separately shielded two-level communication vault was provided for entry of intersite and intrasite communication cables. Out-to-out dimensions are 50 ft by 38 ft by 36 ft in height.[71] Flexible junctions (to permit differential movement) were provided for all utility connections to the MSCB and the MSRPP. A flexible liner-plate shielding connection provided EMP protection at the MSCB junction.[72] The tunnel's interior walls were also lined with 11-gauge sheet steel.
All services entering the MSCB through the PEUT were routed through steel pipe, conduits, or metal ducts which were seal-welded to the liner-plate shielding or to the steel bulkhead at the point of penetration.[73] A steel barrier (bulkhead) located near the MSRPP end served as the point of entry to the liner-plate shielding for all utilities from the MSRPP. The bulkhead was provided with a shielded personnel and equipment door. The two-level communication vault was shielded as an EMP/RFI zone. Space was provided in the communication vault for the installation of EMP filters and/or suppressors on incoming communication cables.[74] The exterior underground surface of the PEUT was provided with a waterproof coating.[75]

This hardened, underground utility tunnel housed all services between the MSCB and the Missile Site Launch Area, including circuits for 4,160 volt primary electrical power, instrumentation, communication, and monitoring and control.[76] The LAUT also provides access between the MSCB and the Missile Site Launch Area.

The LAUT was constructed of corrugated iron pipe and consisted of three basic sections: a 7-foot diameter section joined to the PEUT and the cable entry structure (CES) and attached to the MSCB at Room 201; a 8-foot diameter section between the CES and the Launch Field terminating at an underground concrete shielded structure identified as terminal structure "A" (TS-A); a 7-foot diameter section of LAUT between TS-A and a similar structure, TS-B, in the Launch Area.[77] A flexible wire cloth and copper sheet joint were provided at the MSCB and LAUT junction for electrical continuity between the tunnel walls and liner-plate shield to permit differential movement between structures.

The LAUT was designed with continuously welded seams and structural penetrations all inspected by the magnetic particle process. The tunnel provided continuity in the EMP/RFI shielding of the MSCB. All wiring other than Weapon Systems Contractor (WSC) cables were contained in electrically-continuous conduits where routed through the LAUT, whereas sensitive WSC data communication cables were equipped with RFI filters in the CES for additional protection.[78]

The WSC data communication cable was routed through the LAUT on open trays. The tunnel sections were connected to the PEUT and CES by the flexible wire mesh junctions. The exterior underground surface of the LAUT was provided with a waterproof coating.[79]

c. Security Penetrations Capped sleeves, welded to the liner plate, were provided with space allocated for installation of appropriate filters; filters were installed in the security circuits at the penetration of the EMP/RFI shielding zones.

d. Other Penetrations Numerous penetrations of the MSCB exterior (building shell) surfaces were present. They included:

- Antenna array apertures, one in each sloping wall of the turret, four total
- Antenna washdown pipes, one automatic and one manual adjacent to each aperture, eight total
- Very Low Frequency (VLF) antenna opening in the roof of the turret, one total
- Q-channel antenna opening, one in each sloping wall of the turret, four total
- Transmitter warning horn cableways, one in each of the four sloping walls of the turret

- Vent for the Inert Gas (SF6) Pressurization System in the sloping north wall of the turret, one total
- Telephone and electrical outlets, one telephone, and two electrical near the base of each sloping wall of the turret, 12 total
- Hose bibs, one near the base of each sloping wall of the turret, one total
- Waveguide entry for Weapon System Equipment (WSE) in the vertical east wall below the third-floor level, one total
- Emergency Escape Hatch in the roof of the CES, one total (This hatch was provided with a blast-hardened, EMP/RFI-shield gasketed cover to be welded shut when material handling operations were completed. Escape hatch for the LAUT (in TS-B) could be opened from the inside only.)[80]

Piping, tunnels, conduit, and sleeves were welded to ground grid fans. The interface with the tunnels and the PEUT included flexible connections as required for shock strains.[81]

7. Roof Characteristics: The turret roof was composed of concrete with elastomeric roofing.[82] It is 140 ft^2 in plan and designed both to carry vertical loads and to transfer lateral loads to the shear walls.[83] The subterranean roof is concrete with earth backfill.

C. Description of Interior

Each room, corridor, and separate enclosure was individually lined to avoid compromising the structural integrity of junctions between interior floors, walls, and columns and the exterior walls, roof, and floor slabs. Concrete columns were covered with steel liner-plate welded at the seams and at floor and ceiling junctions.[84] Only interior non-load-bearing partitions separating rooms in the same shielding zones were exceptions. Here the liner-plate shielding was permitted to penetrate partition junctions at the floor, ceiling, and walls.

Areas within the MSCB with differing shielding requirements were separated into "zones." There were 10 separate EMP/RFI zones required for Weapon System Equipment (WSE), and the remainder of the building was an EMP-only shielding zone for protection of tactical support equipment (TSE). The 10 EMP/RFI zones were designated as zones RA through RN; the remainder of the building was designated as the E-1 zone.[85]

Typically, the MSCB liner plate was supplied in 4 ft by 10 ft sheets butted together and held in place against the concrete walls and ceilings by embedded weld studs attached to the liner plate on 2-foot centers.[86] An embedded backup bar was provided behind each liner plate seam and all seams were continuously welded and inspected by the magnetic particle process to ensure no flaws or gaps would compromise the shielding continuity.[87]

1. Floor Plans: The MSCB had approximately 127,384 ft^2 of usable floor area (out of 162,522 ft^2 of total area). There are two subterranean main floors, and two above-ground turret floors which housed weapon and tactical support equipment associated with the four phased arrays. The floor system in the MSCB consisted of three elements: a structural floor, air plenum, and cable routing space. The structural floor, or main load supporting element, was reinforced concrete slab supporting all the loads between the vertical support members, walls, and columns. Above this, the air plenum was formed by a 6-inch reinforced concrete slab called the raised floor, supported by steel frames and supporting all tributary loads above itself, transmitting them to the structural floor. A removable floor, composed of 2 ft by 2 ft panels supported by steel posts, formed the cable routing space above the raised floor and air plenum.[88]

The floors were designed as either flat slabs, one-way, or two-way slabs to carry vertical loads. In addition, they were designed as diaphragms to transfer lateral loads to the shear walls.[89]

Liner-plate room shielding for each floor of the MSCB was bonded to the adjacent floor shielding by 0.125-by-2-inch steel jumpers located on 2-foot centers around the building perimeter walls.[90]

Floor space within the building is allotted on the concept that the radar has priority over other equipment. Consequently, to minimize RF and power losses and to optimize radar performance, all RF and electronic links between the antenna arrays and associated radar equipment were designed to be equal and of minimal length. To meet these requirements, the radar equipment, except for the transmitter elements, occupies the floor areas immediately below the turret.[91]

a. Basement Beneath the oil pumping room and transmitter area on the first floor was the basement oil storage area. This area contained oil storage tanks and industrial, sanitary, and oil waste sumps.[92] The underside of certain first-floor rooms can also be seen.

b. First Floor The first floor contained the life support storage and area; a corridor; transmitter cooling and control rooms; an oil pumping room; High Voltage Power Source (HVPS) rooms (nos. 1 and 2) with control rooms (nos. 1 and 2); a klystron room; tube treatment room; elevator machine room; and miscellaneous repair shops, vestibules, storage areas, and air locks.[93]

c. Mezzanine A mezzanine contained digital rack power supply rooms; a technical supply management center; parts storage; miscellaneous shafts and restrooms; and the upper level of some first floor rooms.[94]

d. Second Floor The second floor contained electronics areas (including Missile Site Data Processing [MSDP]); Equipment Readiness Center (ERC) and System Readiness Verification (SRV) rooms; Ballistic Missile Defense Center (BMDOC); Army Air Defense Operation Center (AADOC); offices; computer rooms; mechanical and electrical equipment rooms; a crypto room; data terminal room; tape handler room; calibration rooms; administration and storage rooms; microwave room; corridors; and miscellaneous repair, vestibule, and service rooms.[95]

The command and control areas and tape handler room had removable floors, permitting changes to cabling and equipment without affecting the concrete floors. Ducts constructed for air conditioning and cabling allowed them to be routed through the floor.[96]

The interior areas of both the first and second floors were shielded from any exterior EMP influence by liner plate on walls, floors, and ceilings; by RFI-gasketed, blast-hardened exterior doors; by the peripheral welding to the liner plate of all penetrations for conduits, ducts, and piping; and by waveguides in airducts.[97] Openings between rooms within the same shielding zone were lined for shielding continuity but were not equipped with shielded doors, waveguides, or electrical filters.[98]

e. Third Floor and Duplexer Platform The third floor occupies the lower portion of the turret. This floor contained mechanical and electrical equipment rooms, a telephone closet, drive amplifier racks, cable fallout equipment, control/monitor equipment, and associated cooling equipment. The third floor was removable.[99]

In the center of the third floor was an RF-shielded paramp (parameter amplifier) room, with an RF duplexer area located directly above which held microwave devices associated with the radar receivers. Access to the third floor was by stairs and the equipment elevator; personnel access above the third floor was by ladder; equipment access was by hoists.[100]

The interior areas of the third floor (and the duplexer area) were shielded from any exterior EMP influence by liner plate on walls, floors, and ceilings; by RFI-gasketed, blast-hardened exterior doors; by the peripheral welding to the liner plate of all penetrations for conduits, ducts, and piping; and by waveguides in airducts.[101] Openings between rooms within the same shielding zone were lined for shielding continuity but were not equipped with shielded doors, waveguides, or electrical filters.[102]

f. Fourth Floor The fourth floor housed and supported the four phased-array antennae, four Quality ("Q") antennae, RF chambers, feed-horn comparators, and cooling equipment.[103] A shock-isolated platform situated above the fourth floor contained the antenna support equipment; the antennae were oriented at 90 degrees from one another, with each array line-of-sight displaced 56 degrees from vertical.[104]

The interior areas of the fourth floor (and the equipment and access platforms) were shielded from any exterior EMP influence by liner plate on walls, floors, and ceilings; by RFI-gasketed, blast-hardened exterior doors; by the peripheral welding to the liner plate of all penetrations for conduits, ducts, and piping; and by waveguides in airducts.[105] Openings between rooms within the same shielding zone were lined for shielding continuity but were not equipped with shielded doors, waveguides, or electrical filters.[106]

2. Stairways: There were a total of 16 sets of stairs in the MSCB, all removed during the salvaging process. The first level stairs had a VAT finish.

An elevator and stairway No. 1 extended from the first floor (Room 118 and 119) to the Duplexer Area.[107]

Room 126 was Stairway No. 2 and provided passage between the first floor, mezzanine, and second floor.[108]

Stairway No. 3 originated in room 108 and accessed the second floor.[109]

Stairway No. 4 originated near room 102 and accessed the mezzanine.[110]

Stairway No. 5 (from room 125) provided passage to the mezzanine (near room M2).[111]

Stairway No. 6 originated in the mezzanine and accessed room 229, the MSR electronics area.

Stairway No. 7 originated in room 239 and accessed a small mezzanine above.[112]

Stairway No. 8 originated near room 257.[113]

Stairway No. 9 exited from room 252.[114]

Stairway No. 10 exited from room 250, leading to the 3rd floor.[115]

Stairway No. 11 exited near Mechanical Equipment Area 305, allowing access to the removable third floor area.[116]

Stairway No. 12 exited from the third floor.[117]

Stairways No. 13 and 14 exited from near Mechanical Equipment Areas 306 and 304, respectively, to the removable third floor.[118]

Stairways No. 15 and 16 originated near the Duplexer Area and accessed the Cable Support Area.[119]

3. Flooring: About 60 percent of the MSCB floor area was shielded for RFI/EMP protection of sensitive WSE.[120]

The original floor finishes in the MSCB were as follows:

All basement floors were of liner plate.[121]

The first level had heavy-duty epoxy over concrete (27 rooms); vinyl asbestos tile (VAT) (vestibules and Maintenance Data System rooms 121 and 122); standard epoxy (custodian's and men's rooms); steel plate ground plane (6 rooms); and liner plate with epoxy paint (9 rooms).[122]

The mezzanine had heavy-duty epoxy (7 rooms); VAT (2 rooms); removable VAT panels (2 rooms); and standard epoxy (2 rooms).[123]

The second level had heavy-duty epoxy (30 rooms); VAT (12 rooms); removable VAT panels (15 rooms); and standard epoxy (7 rooms); liner plate with epoxy paint (crypto and cable entry rooms).[124]

The third level had heavy-duty epoxy (5 rooms); removable VAT panels (2 rooms); standard epoxy (telephone closet).[125]

The duplexer area/corridor was predominately heavy-duty epoxy flooring; metal grating (cable support area).[126]

The fourth level had all liner plate with epoxy paint.[127]

4. Wall and Ceiling Finish: The original wall finish in the MSCB was as follows:

The basement finish was liner plate, and HVPS rooms were exposed concrete underneath.[128]

The first level was liner plate (all rooms); gypboard (5 rooms); and wire partitions (4 rooms).[129]

The mezzanine had liner plate (all rooms), and gypboard (5 rooms).[130]

The second level had liner plate (58 rooms); gypboard (30 of the 58 rooms); gypboard without liner plate (7 rooms); acoustical treatment (14 rooms); exposed concrete (2 rooms); wire partitions (2 rooms); and exposed metal studs (equipment room 213).[131]

The third level had liner plate (all rooms) and exposed concrete (equipment areas).[132]

The duplexer area had all liner plate.[133]

The fourth level had all liner plate.[134]

The 1.5-foot-thick interior walls were vertical load-bearing walls, one-way slabs for dynamic lateral loads normal to the wall, and shear walls to resist dynamic lateral loads parallel to the walls.[135] All interior walls and ceilings were lined with an 11-gauge steel liner plate continuously welded at all seams.

The original ceiling finish in the MSCB was as follows:

The basement was of exposed concrete.[136]

The first level was liner plate (4 rooms), gypboard (3 rooms), and acoustical treatment (HVPS No. 2 control room).[137]

The mezzanine was liner plate (12 rooms) and gypboard (men's room and vestibule).[138]

The second level was liner plate (34 rooms); gypboard (11 rooms); acoustical treatment (10 rooms); luminous ceiling (6 rooms); and metal decking (4 rooms).[139]

The third level was liner plate (telephone closet & paramp room) and structural grid (mechanical equipment areas & antenna electronics room).[140]

The duplexer area was all liner plate.[141]

The fourth level was also entirely liner plate.[142]

The building perimeter wall shielding on each floor was interconnected with adjacent floor shielding by strap conductors through the concrete slabs separating the floors. Additional shielding was provided by the reinforcing steel embedded in structural concrete, the ground system, and the earth cover.[143]

5. Openings:

a. Doors Thirty shielded doors were present within the MSCB. Doors between rooms within the same EMP/RFI shielding zones were conventional, whereas those separating or bounding the zones had a sheet steel jacket and either conductive gaskets or metal finger stock encompassing the perimeter to ensure and electrical continuity with the door's enclosing frame or casing; the casing was seal-welded to the liner plate.[144]

The MSCB had four ventilation system fire doors which were capable of containing fire within specific areas. Two were located between the transmitter cooling room (No. 310) and the oil pumping room (No. 131); one was located between the microwave room (No. 248) and corridor No. 247.[145] The doors operated as guillotines, closing off ventilation system air flow at these critical ducting points.[146]

6. Mechanical Equipment:

To survive the shock environment within the structure, equipment was either ruggedized (for example, waterlines included surge arresters to prevent equipment damage) or "shock isolated," wherein flexible connections were required between hard-mounted lines and the equipment in question to provide for the possibility of substantial blast-induced relative motion.[147]

In other words, components and subassemblies were not directly attached to the doors and walls of the MSCB. Rather, they were mounted to structures which attached to the building. For example, relays, circuit boards, and pumps were mounted typically in open frame racks, which were mounted to the building floor. Special mountings were provided for equipment considered vibration-sensitive and junctions (with flexible joints) to and between structures to allow shock-induced differential displacements without structural rupture.[148] Many items of electronic equipment and the majority of electrical and mechanical support equipment were mounted in this way. Also, partitions, suspended ceilings, raised floors, pipe runs, ducting, electrical conduits, and cable trays were designed to withstand the computed internal shock environment.

Via galvanized rigid-steel conduits to the substation transformer primaries, the main source of electrical power was distributed from shielded and grounded switchgear in the MSRPP to all electrical loads within the MSCB.[149] All conduits and ducts entering the RFI shielded areas were equipped with filters designed to attenuate RFI. All anchorage for equipment cable trays, duct work, and cabinets was attached directly to steel bearing plates which were embedded in the concrete and continuously welded to the steel liner plate to maintain shielding integrity.[150]

a. Communications Public address and television systems serviced the MSCB; also available were black, red, and maintenance telephone systems. The black telephone system was used for normal intra- and inter-building communications, as well as linking to off-site telephones. The red telephone system was employed in high-level tactical communications.[151]

Red and maintenance telephone conduits originated in the liner plate shielded area of the MSRPP, whereas television and black telephone conduits entered from a rebar shielded area.[152] Each of these steel conduits had conductive and permeable joints and were peripherally welded to the metal barrier in the PEUT and to the liner-plate shielding at each penetration.[153] At the penetrations for RFI containment/exclusion rooms, spaces were provided for the RFI filters.[154]

b. Heating, Air Conditioning, Ventilation The MSCB was provided with electrical energy, antenna cooling water, high purity water, hot water, nitrogen, ventilating air, and compressed air by the MSRPP.

The MSCB had 14 air-handling units, 13 cooling coils (ranging in capacity from 13,300 to 66,350 cubic feet per minute [CFM]), and 12 heating coils (ranging in capacity from 750 to 32,800 CFM).[155]

Thirteen supply fans (ranging in capacity from 4,400 to 27,700 CFM) serviced the heating coils and two exhaust fans (located in the mechanical equipment room) served the toilet room (7,800 CFM) and as general exhaust (2,200 CFM).[156]

All air ducts routed between adjacent shielding zones were equipped with waveguide-below-cutoff type filters at penetrations of EMP/RFI shielding zones. These waveguides were seal-welded to the air ducts and to lined openings provided in structural wall shielding. Air ducts routed between rooms in the same shielding zone were welded to the framed openings for structural support only. The number of air ducts penetrating shielding zones was minimized by ensuring mechanical and electrical rooms were included within the same zones as the WSE they served.[157]

c. Lighting Console rooms in the MSCB contained a dual lighting system, consisting of a general (50 foot-candles) system, with wall-mounted dimming controls; the latter system could override the former.[158] Illumination was generally florescent, with fixtures equipped with safety locks, diffusers, and louvers to preclude accidental dislodging of fluorescent contents.[159] In both the electronic and transmitter control rooms, the lighting design and location allowed control over illumination levels wherein observation of oscilloscopes was necessary.[160]

d. Plumbing Water for the SRMSC was provided from 10 wells through a 58-mile waterline from the Fordville Aquifer to the PAR and MSR sites. The water supply system had the capability of delivering 1,000 gallons of water per minute.[161]

All MSCB water systems originated in the MSRPP, entering via flexible pipe sections at the MSRPP-PEUT interface, were seal-welded in the PEUT at the shielding barrier, and included flexible sections at the PEUT-MSCB interface.[162] Waterlines included surge arresters to prevent equipment damage.

All piping penetrations (liquid and compressed air) between shielding zones included the use of steel pipe equipped with a flange circumferentially welded to the liner plate at the point of shielding penetration.[163] A straight section of steel pipe at each penetration was designed to function as a waveguide-below-cutoff.[164]

D. Site

1. General Setting and Orientation: The MSR site housed the comparatively short-ranged MSR and nearly half of the SRMSC defensive missiles. It was located on approximately 431.66 acres of land, 102 mi northwest of Grand Forks and 12 mi south of Langdon, close to the tiny agrarian town of Nekoma. About 25 air mi separate the MSR from the PAR. The site is 17 to 31 mi from the four Remote Sprint Launch Sites. The site was divided into a controlled area, limited area, and community center area.

2. Historic Landscape and Design: With the exception of urban and built-up areas, the entire area (83 percent) within 1.2 mi of the MSR site is agricultural. Urban and built-up areas include Nekoma, farmsteads, roads, and the Soo Line Railroad, which runs NW-SE and passes 0.5 mi to the SW of the MSR. Wooded land cover is less than 5 percent.[165]

There is little topographic relief in the area. The lowest point is 1,600 ft above mean sea level (msl), and the highest point is 1,630 ft above msl.[166]

PART III. SOURCES OF INFORMATION

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Original drawings for the MSCB were prepared by The Ralph Parsons Company, Architects-Engineers, Los Angeles, California.

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