Appendix 10.1

Launch Control Equipment Building and Launch Control Center Walk-Through Description

This description is for the Force Modification (circa 1968) configured Launch Control Center (LCC) with a Launch Control Equipment Building (LCEB). A description of differences for the REACT configured LCC is provided at the end. The nomenclature for the Launch Control Facility (LCF) was changed to Missile Alert Facility (MAF) which will be used in the following discussion.[1]

Approaching the Missile Alert Facility

All LCF/MAF (nomenclature change in the late 1980s) compounds sit off the main road connected by a short two- lane spur road. As you travel down this short path you will see an elevated gasoline storage tank which can be used to refuel MAF assigned vehicles and other military vehicles in the area. Shortly after passing the gasoline storage tank, you arrive at a motorized gate set in a seven-foot-high chain link fence. Normally to the west of the fence enclosure there is a small pond that serves a sewage lagoon for the facility. You temporarily stop your vehicle and one vehicle occupant exits and proceeds to a telephone box at the gate. The telephone is connected to the Flight Security Control (FSC) in the MAF security control center room. Information about the reason for entry as well as the occupants of the vehicle are passed to the FSC. During inclement weather the FSC can also be contact by VHF radio in the vehicle. The FSC checks the information against trip information he/she received from the support base. If the information matches, the gate is electrically unlatched and rolled open to allow the vehicle to enter. The FSC contacts the launch crew in the LCC to advise the crew of the trip arrival. Space permitting, the vehicle is parked adjacent to the MAF main building, typically referred to as the Ranch House. Occupants exit, enter the main door and present identification to the FSC to positively confirm identity. The FSC's office Dutch door is to the right as you enter the LCF. Any necessary materials are gathered and if below ground access is required, the FSC permits entry into the Security Control Center room. The FSC contacts the on-duty missile combat crew with a request for below ground entry. If this is a maintenance team, the team chief will usually also speak with the crew to describe where they will be working and the tasks to be performed. If the works is expected (another positive control check), the crew will allow entry. The FSC and crew pass a security code and if satisfactory, the launch crew electrically unlocks the door from the security room into the elevator room. The authorized personnel and equipment enter the elevator room and the entry door is re-secured. If this is a new crew who plans to assume the alert, they leave a new access code with the FSC.

Elevator Room

As you walk towards the elevator you pass several items on the left, the elevator lift system, a ladder to the lower level (sometimes the elevator is inoperative) and then the elevator controls and door. Immediately opposite the elevator door is a set of large, double doors that can be opened to allow entry/exit of large items. The doors are sized to accommodate the largest item in the elevator room or below grade (excluding some structural items). For example, it is large enough to pass the diesel generator set or the brine chiller equipment. If used these double doors are re-secured as soon as the large equipment movement is complete.

The elevator is a typical freight elevator. Three walls are solid with the access wall blocked with a horizontally expanding gate. If the elevator is at the lower station, the elevator upper level controls can be used to return the elevator to the upper station. A safety interlock prevents the elevator access door from being opened unless the elevator is in position to receive passengers.

The elevator is slow as it must handle two tons of load. The decent to the lower level takes a little over a minute. At the lower level, the elevator gate faces the tunnel junction blast door. The door is sized to handle the largest pieces of equipment in the LCEB or the LCC. It is hinged on the right side and held in place by a latch on the left. A hand crank, when rotated, extends or retracts lock pins along the perimeter of the door. The lock pins extend into the door frame which is set into the concrete structure. Once the lock pins are retracted, a smaller hand wheel operating a screw mechanism releases the door latch and the door can be swung out towards the elevator for entry.

In the early days of Minuteman an over or under pressure created by air handlers in the LCEB could make it almost impossible to open/close the tunnel junction blast door. An under pressure of even less than a pound created enough force given the door surface area to make it impossible to open the door in the normal manner. The solution was a crowbar and a pry point to give enough leverage to start the door to open. As soon as the door broke the seal, the under pressure neutralized. The door operator could judge when this occurred just by listening to the air flow through the door crack.

An over pressure in the LCEB created a different problem. As the door was swung to the closed position, air flow through the door crack into the elevator shaft would tend to push the door open. The solution was to ensure the door had enough speed (momentum) to momentary overcome the air flow and seat against the door frame or at least come very close. At the moment the door was about to reverse directions, the door operator could swing the door latch into position and use the latch screw mechanism to cinch the door fully closed and extend the lock pins. Unfortunately, this technique caused excess wear on the latch mechanism resulting in a continuous repair problem. Fortunately, this situation was eventually eliminated by installation of a modification to closely regulate launch control equipment building ambient pressure eliminating the problem.

Once inside the tunnel junction, the door is normally secured to maintain facility blast hardness. The door could be left open for maintenance actions on the door or work in the equipment building or launch control center that required frequent trips in/out of the tunnel junction area.

Launch Control Equipment Building

With your back to the inside of the tunnel junction blast door, short passages lead to the LCC on the right and the LCEB on the left. Straight ahead was a covered sump pit that handles waste from the LCC and any leakage from the any of the underground structure. Waste is pumped to the ground level sewage lagoon located outside the facility security fence.

Walking into the LCEB there is a center walkway that allows access to equipment on all sides. Lighting is from overhead bulbs housed in a round bell shaped reflector. The light switch is on the right wall. Starting from the right there are several circuit breaker cabinets, the automatic switching unit panel and a ventilation changeover panel. The automatic switching unit cabinet houses power monitors and a switchgear that connects either commercial power or diesel power to primary power loads in the underground complex. When the power panel detects bad commercial power, it will disconnect that source using the switchgear and initiate the process to start the standby power diesel and connect it to facility primary power loads. Should the standby power system fail, a fault is displayed in the LCC and the facility manager will try to reset the system or do initial troubleshooting to aid technicians who will respond from the support base. While the issue is being resolved, the LCC operates on emergency power from very large lead acid batteries. Adjacent to the power panel is the diesel standby generator. The standby generator is supplied by fuel from a large day tank located to the left of the walkway. The day tank is automatically refilled from a large underground diesel storage tank.

Moving further into the room, an exhaust air handler (fan assembly) connects to the diesel radiator, diesel exhaust and the environmental control system to pull air out of the facility through the LCEB blast valves, through underground ducts to the surface. Upstream of the diesel exhaust, some air can be recirculated through ducts to conserved heated air.

To the left of the exhaust fans and at the far wall of the room is an air compressor/storage tank that generates control air pressure for some of most of the environment control system (the ECS has been undated to not require control air due to lack of spare parts). Next to the air compressor is the blast valve hydraulic pumping unit. This is an electrical motor powered pump and control valves to generate hydraulic pressure to open both the LCEB and LCC exhaust and intake blast valves. The blast valves are normally in a cocked open position. A disk/latch mechanism within the blast valve can detect an incoming overpressure, trip the latch mechanism and a very large spring forces the blast valve shut with a very large noise. The hydraulic pumping unit will be used to reopen the valves when it is safe to do so. The blast valves do not reopen automatically. If the standby diesel is running it will shut down otherwise it would rapidly consume all the oxygen while dumping exhaust gases into the facility.

Immediately left of the blast valve hydraulic pumping unit is the intake blast valve, the intake air handler and the brine chiller. Topside air enters through the intake blast valve driven by the intake air handler and flows across a Freon condenser to exhaust heat from the brine chiller high pressure side of the Freon compressor. Condensed Freon is passed through a heat exchanger where brine is cooled. The chilled brine is pumped from a heat exchanger in the Clean Room (see below).

To the left of the brine chiller is the telephone connecting and switching rack. This is a line amplification and equalization set that interfaces with all the support information lines from the LCC to the 10 launch facilities. It also connects the facility interphone system that allows technicians in the LCEB to talk to the launch crew and through patching circuits, the commercial telephone system. Patching allows technicians to talk directly to maintenance services at the support base to request parts, further support or just report status. The rack also processes VHF and EWO voice circuit signals.

To the left of the telephone connecting and switching rack is the buried cable air dryer and pressure unit. The buried cable system is pressurized with dry air to limit water intrusion and also assist in detecting cable breaks. Air enters through a chemical dryer system and a compressor generates air pressure which is accumulated in a storage tank. Air from the tank is distributed to the cable system in the LCC surge arrestor vault (described in the LCC area). Although a fairly simple system (air compressor, chilling condenser, some gages and pressure regulators, the unit always seem to have problems eventually resulting in a redesign replacement. However, its reliability wasn't markedly better. Cable pressure is monitored by equipment close to the FSC office and includes alarms to indicate a cable pressure fault. Cable pressure data is also modemed to the support base for collection, long-term analysis and detailed cable pressure lead troubleshooting by the cable repair shop.

To the left of the cable pressure/dryer unit was another maintenance problem—the diesel fuel day tank (note: the day tank is located by the standby diesel in some configurations) and transfer pump. The day tank holds one hundred gallons of diesel fuel for immediate diesel use. Flow to the diesel is by gravity. A float switch monitors the fuel level and activates a transfer pump to move fuel from the external buried main diesel tank to the day tank. A hand operated switch can be used to start the pump, but the switch is normally in the automatic position letting the float switch manage fuel level in the tank. There is also a hand crank pump that can be used to transfer fuel. The float switch has ceramic floats connected by a stainless-steel cable to a multi-function switch. The switch's primary function was to activate the transfer pump, but it could also report a low-level condition to the launch crew. Both functions were not reliable. Luckily there was also a sight glass as part of the tank system and fuel level could be manually observed by opening valves at each end and observing the level directly. Checking the fuel level was part of the daily inspection. The fuel transfer pump was prone to leakage at the shaft gland seal. Small seepage leaks were noted during the daily inspections and technicians were eventually dispatched to swap out the pump. Pump seals were repaired at the support base.

Rounding the corner of the fuel day tank and heading out of the launch equipment room was the last feature—the Clean Room. The Clean Room held the air conditioning system for the LCC. It was a sealed room with a positive pressure maintained by air pumped into the room through the chemical, biological, radiological filter box. As the name implies it scrubbed bad things from the air to protect the launch crew. Room pressure was regulated by a simple weighted damper set high on the wall. As air pressure in the clean room vented through the damper it raised a weight on the damper mechanism. At some point the air flow and weight balance equalized and a set positive pressure was maintained.

Within the Clean Room was a heat exchanger that used chilled brine to cool air recirculated from the LCC where heat was generated by electronics equipment and the launch crew. Some makeup air ensured that some new air always entered into the supply. The chilled brine tended to produce very low humidity air which was a constant complaint by the launch crews and eventually resulted in the addition of a humidifier to the launch control center. This always seemed like a strange complaint. The conditions in the launch control center were often preferable to those topside. With sub-zero conditions (-30F was not unusual) humidity was almost nonexistent and it was damn cold.

Launch Control Center

Maintenance personnel and other visitors use an interphone at the entrance to the launch center equipment building to contact the launch crew and coordinate entry. Entry could be delayed by ongoing crew actions. With permission to enter, personnel approached the LCC blast door and waited behind a safety line until the door was swung outwardly to open from inside by the launch crew. The door operator would always announce "stand clear" as the door began to open. Anyone trapped between the wall and the swinging door was likely to be severely injured, large swinging mass, immovable door-stop.

The LCC blast door is hinged on the left side (facing the door from the outside) and is secured with locking pins on both the right and left of the door and a latch. The latch both secured the door and ensured the door is in the fully closed position to extend the lock pins. The open door reveals a short passageway that penetrated through the massive LCC structure. A small light is set flush in the ceiling to assist the people making the transit. The walls and floor are completely smooth without any projections. The passageway was primarily sized to accommodate equipment resulting in people having to stoop to walk through. Failure to stoop low enough could result in a very painful head crash against the blast door steel frame set into the capsule concrete. No one ever repeated that mistake.

Exiting the passageway, the interior of the LCC opened up to a large circular tube capped at each end by rounded sections. Standing just inside the LCC interior you can see the tube and end cap curvature. Directly over your head are the LCC blast valves set into the capsule wall. A flexible duct connected to the intake blast valve conducts chilled air from the clean room into ducts servicing the equipment racks and crew area. The end of the exhaust blast valve is open and part of the operating mechanism is visible. To the right is a small catwalk along the capsule wall leading to the electrical surge arrestor vault. A few metal foot rungs are set into the capsule wall allowing decent to the bottom of the capsule and a view of the underside of the LCC floor and equipment that is mounted there.

To the left of the entryway is the hydraulic pumping unit for the capsule blast valves. It provides hydraulic fluid under pressure to the capsule blast valves to force them open if a blast triggered a closing. Reopening is not automatic, but is a launch crew action when additional external blasts were not expected to reoccur. To the right of the entryway is large metal interconnect box where all non-power signals are routed the LCC equipment.

Immediately ahead is the exterior of the acoustical enclosure and an opening to allow entry. Light spilling from the LCC area is the only illumination outside the acoustical enclosure. There is no door for this opening. The acoustical enclosure is a little more than the name implies. It does attenuate noise, but it also encloses the crew and electronic rack area and keeps things and people from rolling/stepping off the edge of the floor. The floor (with acoustical enclosure) is suspended from the ceiling with a shock attenuation system. There is open space all around the edge of the floor to the capsule walls plus space under the floor to provide room for large floor movements without slamming against the capsule wall or other equipment. Crossing to the LCC proper is across a hinged plate gangway that is fixed at one end and able to slide across the floor at the other. Its unofficial name is the drawbridge. The hinged plate is only a few feet long, but there are no safety rails or chains. Some presume that if you aren't smart enough to not step off the edge, maybe you shouldn't be in control of nuclear weapons.

Stepping across the drawbridge to just inside the acoustical enclosure you can see the entire interior. There are no partitions and all the equipment is located along the walls. Prominent features are large vertical cylinders at each of the four corners and aircraft cockpit style chairs mounted to metal rails atop the gray vinyl floor tiles. The chairs can move along the floor rails to allow access to equipment while crew members are restrained in their chairs for shock protection during attack. The tiles are attached to metal floor plates that can be removed to access the motor generator, emergency power storage batteries and some storage locations for emergency rations and equipment.

The motor generator is basically an AC/DC motor attached to 60 and 400 HZ generators along a common shaft. The AC motor is supplied with primary power (commercial or standby diesel). Should primary power fail (attack or equipment failure), the DC motor immediately continues turning the generators supplied by power from the set of large lead-acid storage batteries. Large in that each one weights roughly 4,000 lbs. The motor generator ensures uninterrupted power is continually supplied to essential equipment within the LCC. Battery power operating time is sufficient to ensure missiles can properly be launched during the response period. Operating times are classified.

Just off your right shoulder is the Auxiliary Alarms Control Panel (relocated to center bay of REACT console with REACT mod). Lights and audio alarms signal problems for an LCEB fire, ECS malfunction, sewage sump pump malfunction, diesel standby power malfunction, commercial power malfunction and open status of the tunnel junction blast door. Switches control shutoff valves to various sewage pipes, LCC water normal water supply, and the toilet vent to prevent topside overpressure from reversing flow through these passages—important if being attacked. A switch can also pressurize the alternate LCC water supply tank to provide flow to the sink and toilet. There is a switch to silence audio alarms. Probably the most important switch is the pushbutton to open the elevator access door from the Security Control Center. This allows the cook to bring down food. The cook is second in importance only the relief crew and the facility manager who may inspect or troubleshoot problems (typically power) in the LCEB. The overhead fluorescent light switch is below this panel.

Immediately next to the Auxiliary Alarm panel is a vertical circular tube that is one of the four shock isolators, one mounted at each corner of suspended floor/acoustic enclosure. The shock isolator is an air cushion system that allows the LCC to survive large ground shocks. Pressurized air in the tube forces a piston down and suspends the floor. The piston is free to move up and due to ground shock. The lower ends of the shock absorber are free to swivel laterally to allow free floor movement. An air pressure control panel is adjacent to each shock absorber. Stabilizing air pressure is unique to each position due to unequal weight distribution on the support floor. A valve can shut off all air to the panel (from large high pressure air cylinder), a pressure regulator valve controls the pressure to the shock absorber, pressure gauges to monitor both supply air pressure and pressure in the shock absorber and a bleed valve to dump air out of the panel and the shock absorber. While the shock isolator system allows the LCC to survive, the floor can be expected to violently heave and swing during a ground shock. This is why crew chairs have restraint harnesses.

On the right, just left of the shock isolator is another very important piece of equipment—the toilet/sink assembly. It looks like something you would see in a prison movie, because it is. The compact shape and strength designed for prisoners, makes it well suited to fit within the LCC's limited space and survive shock. A modesty curtain (much like a shower curtain) can be pulled around it when it is occupied. This was upgraded to a walled enclosure (very small) when women were added to the crew force.

On the left is the oxygen generation unit. When normal airflow has been lost and air quality is degraded (carbon dioxide increase), a hand cranked blower can be operated to cycle LCC air through a chemical canister that removes moisture and carbon dioxide and generates oxygen to replenish the capsule air. This can become necessary when the blast valves are shut or normal ECS is inoperative.

Next to the oxygen regeneration unit is a very tall circuit breaker panel. All external power to the LCC comes through this panel. It has a sturdy door and a locking bar to keep everything in place during shock events. Immediately right of the circuit breaker panel is the LCC Emergency Air Conditioning Unit (EACU). Should the LCC loose cooling air from the clean room in the LCEB, the EACU will detect loss of air flow, cause dampers to move to redirect airflow through the EACU cabinet, across heat exchanger fins that are supplied by pre-chilled water in a protected storage tank.

Continuing along the left wall is an oven-refrigerator unit. It is often supplemented with a hot plate and coffee pot/machine (coffee was essential). A storage cabinet is mounted to the wall above the oven for storage of utensils, paper towels, extra toilet paper and reading material. All of this equipment is securely mounted to prevent movement during shock. Portions have been periodically upgraded over the years as they broke and/or technology improved. The oven to a microwave is an example.

The big section of the remaining left wall is consumed by a bed, a standard issue military cot and the radio set group rack. For command posts, communication racks fill the cot space relegating the cot to a space out into the floor. Getting sleep in this arrangement was problematic and a better bed and sleep cubical was added with REACT (described later).

At the far end of the left wall, past another shock isolator is the LCC power supply group. Power from the motor generator is routed to equipment through circuit breakers on these control panels. Power is also converted to DC to supply required circuits. The circuit breakers allow prompt removal/restoration of power to failed equipment, equipment being serviced and in very rare cases equipment fires (mainly smoke).

At the far end of the LCC is the crew commander's console. The most prominent feature is the 10 columns of colored lights, one set for each of the 10 missile launchers that are the LCCs primary responsibility. The lights provide instant status for many critical launcher functions. The color of the lights indicates importance. Red is of immediate importance, orange is prompt importance, white is just information and green, as expected, is something good. When all the launchers are "Clean and Green" it means the green Alert Ready light is illuminated for the each of the missiles and they are ready for launch actions. Direct circuits were available to each launcher, other LCCs in the squadron, the voice radios, EWO voice networks, and the squadron command post (an LCC). Voice circuits could be bridged to allow conferencing. Two telephone dial lines are available (again bridgeable). Numbers were selected using a rotary dial. A speaker with controls is included. Normally, voice communications were conducted using a common telephone handset that was mounted on the Alarm Control panel on the left side of the commander's console. The handset included a push-to-talk button.

Immediately above the commander's console is/was the High Frequency Radio Control panel. This provide controls to select transmit/receive frequencies in the HF radio spectrum. It was another voice communication source for essential communications. Specific frequencies were designated for monitoring. During slow periods during crew alert, tuning in the commercial stations were known to occur.

On the right side of the commander's Radio Control panel were switches to select external antennae for the radio system. The HF radio had a soft antenna array at all LCCs. The SCP and ACP LCCs also had a hardened, erectable HF array. While erected it was subject to blast damage. Five buried, hardened, erectable antennas were also available at primary LCCs. They were individually selectable and extended above ground with a small explosive charge. If damaged from blast another could be erected.

To the left of the radio control set was the Primary Alert System (PAS) unit. It consisted of two speakers with volume controls and power-on lights, one for Numbered Air Force and one for SAC. At the Alternate Command Post LCC, Call and Acknowledge pushbutton were available and some status/fault lights. There was a voice handset that would connect to the Numbered Air Force only. Same for the Call button. The lack of a similar capability for SAC was simple. When SAC told you something, no response was necessary. You just did it.

Below the commander's status panels is a Voice Communications panel. Using pushbuttons various voice communication circuits could be accessed. This included a direct line to each launcher, each other LCC in the squadron and the Squadron Command Post. Buttons would also access the voice radio circuits. Two standard telephone lines could be selected. Dialing was with a rotary dial. All circuits could be bridged for conferencing. Voice could be heard over an included speaker on the left side of the panel, but a telephone handset with push-to-talk switch was mostly used.

On the left side of the commander's console is the Alarm Control Panel. It is the alarm source for certain status changes. The alarm can be silenced with a push-button. There is a rotary switch which allows the operator to view status from other flights within the squadron. Each LCC monitors and stores status from all 50 launchers in the squadron, but can only actively display one flight (10 missiles) at a time. Some situations require the crew to check status of launchers outside their primary flight. Lastly, are the time slot switches/lights. All LCCs in the squadron share the same communication system. The time slot switches allow them to select a time segment in which they will use to communicate with launchers. While normally one time slot is selected, an LCC may select extra time slots to fill in for an LCC that cannot communicate with their launchers. This allows the most efficient use of the communication network and best status monitoring of missile status. Monitoring circuits check to ensure that no more than one LCC is trying to use a time slot and provides an alarm if overlay/duplication is detected. Note: time slots and the capability to view status of other flights was added during deployment of Force Modification in the late 1960s and early 1970s. Prior to Force Modification an LCC could only view status for their flight.

To the right of the commander's console is the Program Control and Launch Control panels. The Program Control panel allows tests and calibration action commands to be sent to missiles to periodically verify proper operation or, in the case of calibrations, improved targeting accuracy. Rotary switches allowed for the required function to be selected, address for the desired missile, and the dial was deep depressed to initiate the command.

Above the Program Control Panel is the Launch Control Panel. It has three two-position rotary switches each with a unique actuating handle. From left to right, these were the Launch, War Plan, and Inhibit switches. The Launch switch required a special key to be installed to operate. During normal peacetime conditions, this key is stored in a small container requiring both commander and deputy lock combinations to open. The Launch switch is rotated clockwise to initiated an Execute Launch Command, commonly referred to as a launch vote. When released (it is spring loaded), it rotates back to a code-used position to provided immediate indication of use. The War Plan switch was only used for the Minuteman I configuration. It allowed selection of a Salvo (launch everything immediately) or Ripple (launch missiles at predetermined timing intervals stored at each missile). The Preparatory Launch Command (PLC) made this function obsolete beginning with Minuteman II. A plastic cover could be closed to prevent inadvertent activation of controls, but it was normally open to provide instant access to the Inhibit Command switch—a safety requirement.

Further to the right of the commander's console is a small space where a file cabinet was installed to store a variety of crew reference documents. Behind it, through an opening in the acoustic enclosure wall is the escape tube door. The escape tube door is held in place by large bolts and covers the bottom of a tube from the capsule to just below ground level adjacent to the ranch house. When the bolts are removed the cover will swing away from the escape tube opening on chains to allow crew access. The tube is filled with sand that must be removed for crew egress. Tools are stored under the floor panels for this purpose. As the sand is removed it will fall down below the LCC floor into the space at the bottom of the capsule. Use of the tunnel was planned for a time after radiation levels had dropped. Emergency food and water supplies were stored in the LCC (under some floor panels) for use during this waiting period. Recent uncovering/inspection of one of these tunnels indicate that they have held up well over the years and appear to be useable.

Making the turn back toward the LCC there is another shock isolator and air storage cylinder followed by three electronic drawer racks. They provide connections to the command and status signal circuits to the LFs, some voice circuits, send interrogations/commands out over the signal circuits, process messages from launchers throughout the squadron and store launcher status. This is the heart of the command/control system for the weapon system.

The third rack, the Status Message Processing Group (SMPG) also has a drawer where the deputy can use switches to select and enter commands to addressed launchers. It also included the deputy's Co-op Launch Switch used to provide a method of requiring both the commander and deputy to compete a simultaneous key turn to issue a launch command (vote) from the LCC.

To the right of the SMPG is the deputy commander's console. It consists of a Voice Communications panel the same as at the commander's console, above it the Voice Reporting

Status Assembly (VRSA) and above it the Enable Control Group. In drawers below the work surface the deputy's Co-op launch switch.

A drawer immediately below and to the left of the deputy's writing surface is a simple printer drawer. It uses a paper tape similar to what was found on cash registers to print out information for the crew. The scope of information was quite large and will not be covered in detail, but the important parts were used to monitor/confirm settings at the missiles. It also provided a paper copy with time stamps for record keeping and troubleshooting faults.

Below the printer drawer was the Electrical Frequency Detector drawer. The drawer monitored for Electro-magnetic Pulse (EMP) events generated by nuclear explosions. The external antenna and sensing electronics would sound an audible alarm for the crew upon detection.

The VRSA panel accessed a voice fault monitoring/reporting equipment at each launcher. When activated the launcher would provide a voice report of all active faults at the selected launcher. Faults were latched until reset. Using a rotary switch, a specific LF could be selected, a query (report) tone sent with an adjacent pushbutton and the report heard over an included speaker or by attaching a voice handset. The Minuteman I Enable switches across the top of the panel (10 toggle switches, one for each launcher in the flight) could be lifted and returned to the down position to reset inactive fault reports at the launcher. In practice, the deputy selected a launcher, queried, recorded reported faults, reset and queried again to check remaining faults or that all faults had cleared. Faults were relayed to the support base where appropriate maintenance teams would be dispatched for troubleshooting/repair to include sometimes just resetting equipment. Note: the VRSA panel was a reuse of the pre-Force Modification Enable panel (Minuteman I configuration). The Enable panel produced a tone sent over a cable voice circuit individually to each LF in the Flight. Presence of the tone kept the LF in a Safe condition, Removal of the tone by activating switches on the Enable panel was the first step in the early launch process. Removal of tone to check LF detection and processing was performed each time a maintenance team was about to depart the LF interior. Loss of the SAFE tone was displayed by the Safety Control Switch indication moving from S (safe) to A (armed). The S indication was restored upon reapplying the Safe tone at the Enable panel. These actions were performed by the Deputy Missile Crew Commander (DMCCC) and monitored by both crew members by voice contact with the maintenance team in the LF.

The voice reporting approach was a Boeing innovation first used on the B-52. It allowed a large number of faults to be reported over a simple reporting and reset circuit. Some reports claim that a female voice was used on the B-52 to allow immediate recognition of the source (the voice circuit was common to the entire aircraft. A male voice was used for Minuteman. The VRSA was eliminated during the CDB/ILCS modification.

Above the deputy's console was the Survivable Low Frequency Communication System (SLFCS) printer and alarm panel. Communication System racks (three total) were located to the right. These were primarily digital message system provided printouts of received data. These systems provide EWO and other priority communications in addition the direct voice circuits from SAC Headquarters.

Last, but not least, the crew operator chairs. The seats could be moved along a floor mounted rail and locked into various positions along the rail to provide a solid position to perform tasks. Seat height could be adjusted. The seat would tilt back fairly far and had a movable head rest. Both left and right armrests could be completely lowered or locked in a comfortable, height. The chair had problems. To start, the crew spent a lot of time in them which contributed to wear and tear. When not lowered, the armrests unfortunately could strike the console work surfaces sometimes breaking their support arms. The rail locking control had a latch to hold it in the open position, but the rivets securing it would often fail. This would force the operator (usually the deputy) to have to manually retract the position lock every time they move the chair (which was a lot given their duties). Then there were spills and rips on the cushions. Basically, anything that could go wrong did. Most of the problems were not a maintenance priority so between getting parts and getting a team to the LCC to make repairs, it was a constant crew complaint. After decades, a new chair was installed, but now it is just a fresh set of problems.

Endnotes

1. Contributed by Mitch Cannon, CMSgt., USAF (ret.) April 2018.