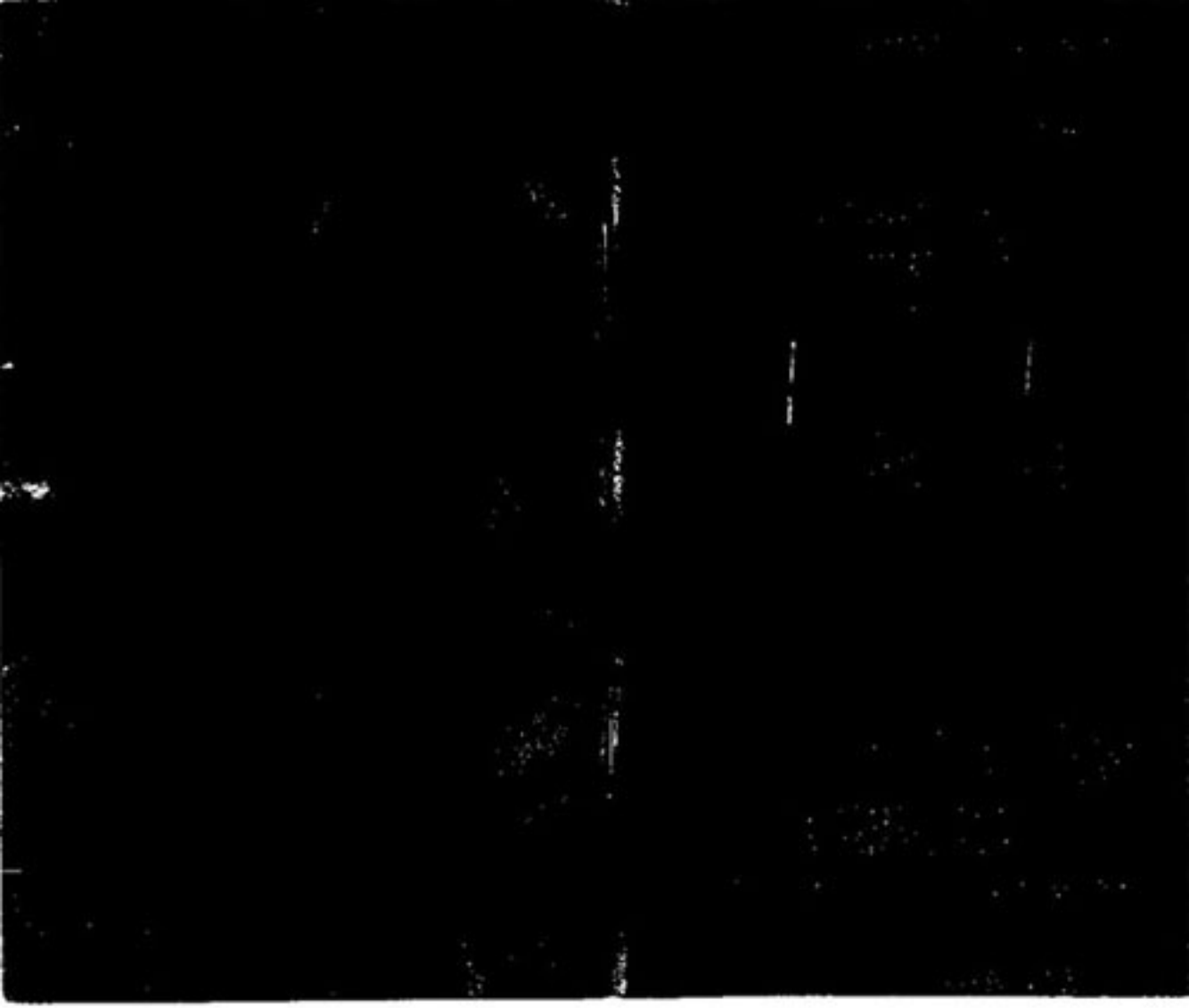


Siloi a guide Por Base Activation Personnel

General Dynamics Astronautics

PREFACE

This manual has been prepared for information of base activation personnel, to serve as a reference guide for a general description of the fundamental structural and functional items associated with a typical Atlas missile silo launching complex. The information contained within is basic only and is not to be used as contractual or authoritative data.

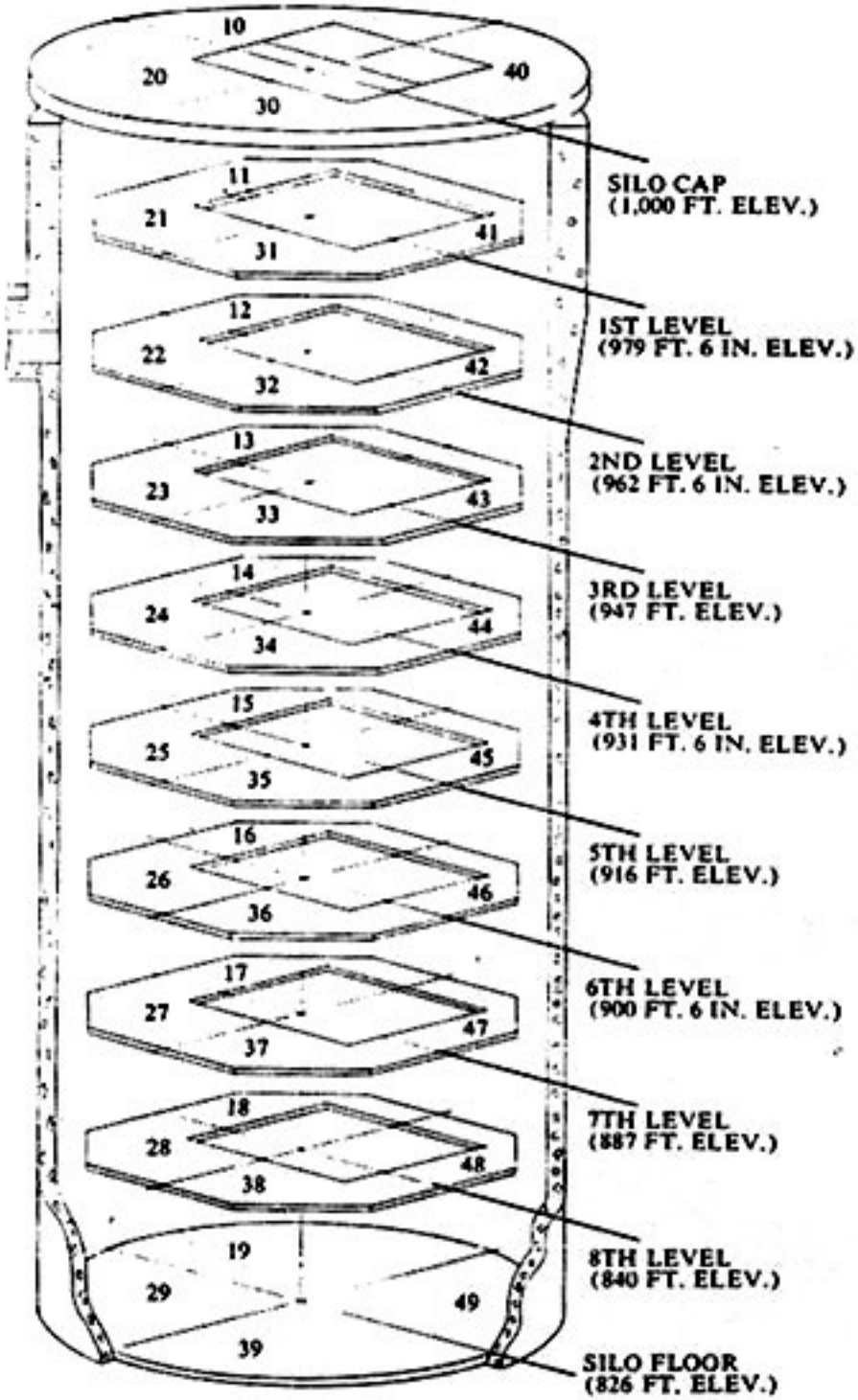
GENERAL

The silo concept of a missile launcher permits the missile to be maintained in a partially serviced condition, in the hard state while under nuclear attack, without preventing prompt execution of the mission of a strategic squadron.

The silo is a cylindrical hole, 52 ft. in diameter and 174 ft. in depth with a concrete wall varying in thickness from 2 ft. to 9 ft. Within the silo an octagonal structural steel crib divided into eight levels is suspended by a system of mechanical springs. Mounted within the crib are the numerous systems necessary to launch the missile, as well as a spiral staircase and a personnel freight elevator. The silo also contains electric generating and associated auxiliary and control equipment, heating, ventilation, and air-conditioning equipment necessary for proper functioning of the missile support system.

Located within the crib is a 21-ft. square enclosed, insulated vertical shaftway containing a launcher platform weighing approximately 270,000 lb. The launcher platform is suspended by a cable system and serves as the elevator to lift the missile to launch position. It is divided into four levels which contain the equipment to service the missile up to the rise-off period. Retractable work platforms are located within the shaftway for access to the missile. The total suspended weight of the crib and launch platform with equipment is over 1,500 tons.

Located approximately 100 ft. away, also underground, is the launch control center (LCC). The LCC is a reinforced, concrete, cylindrical-shaped room approximately 44 ft. in diameter and 33 ft. high, containing a steel crib, divided into two levels, which is supported by an air-cushioned suspension system. The LCC contains missile launch control equipment, facility control equipment, communication facilities and batteries for their operation. It also contains an operational office, ready room, storage area, heat, ventilating and air-conditioning equipment, kitchen, messing and sanitary facilities for the operating personnel. The LCC houses a normal launch crew of three and in emergen-



cies, there are provisions for support of twenty men and continuous complex operation for up to ten days after complete isolation. A tunnel with a blast resistant closure, protects the crew in the LCC from any explosions that may occur within the silo. Personnel access to the complex is through an opening at ground level to descending staircase equipped with blast door. Except for command communication, each unitary silo is operationally independent of the other silos of the squadron.

Reinforced concrete silo cap doors approximately 30 in. thick provide adequate protection for the missile and permit safe personnel access to the silo after a near miss by a nuclear weapon. Blast closures operated by a blast light sensing device located above ground, cover the air intakes, air exhausts, and theodolite sight tube, also furnishing protection. The silo complex is protected from intruders by a fence with a remote controlled gate, floodlights and surveillance TV cameras. Personnel safety during servicing and maintenance of the missile is provided by emergency showers, eyewash fountains, alarm systems and so on. The LCC is provided with a sand-filled emergency escape hatch through which escape may be made after the releasing of the sand.

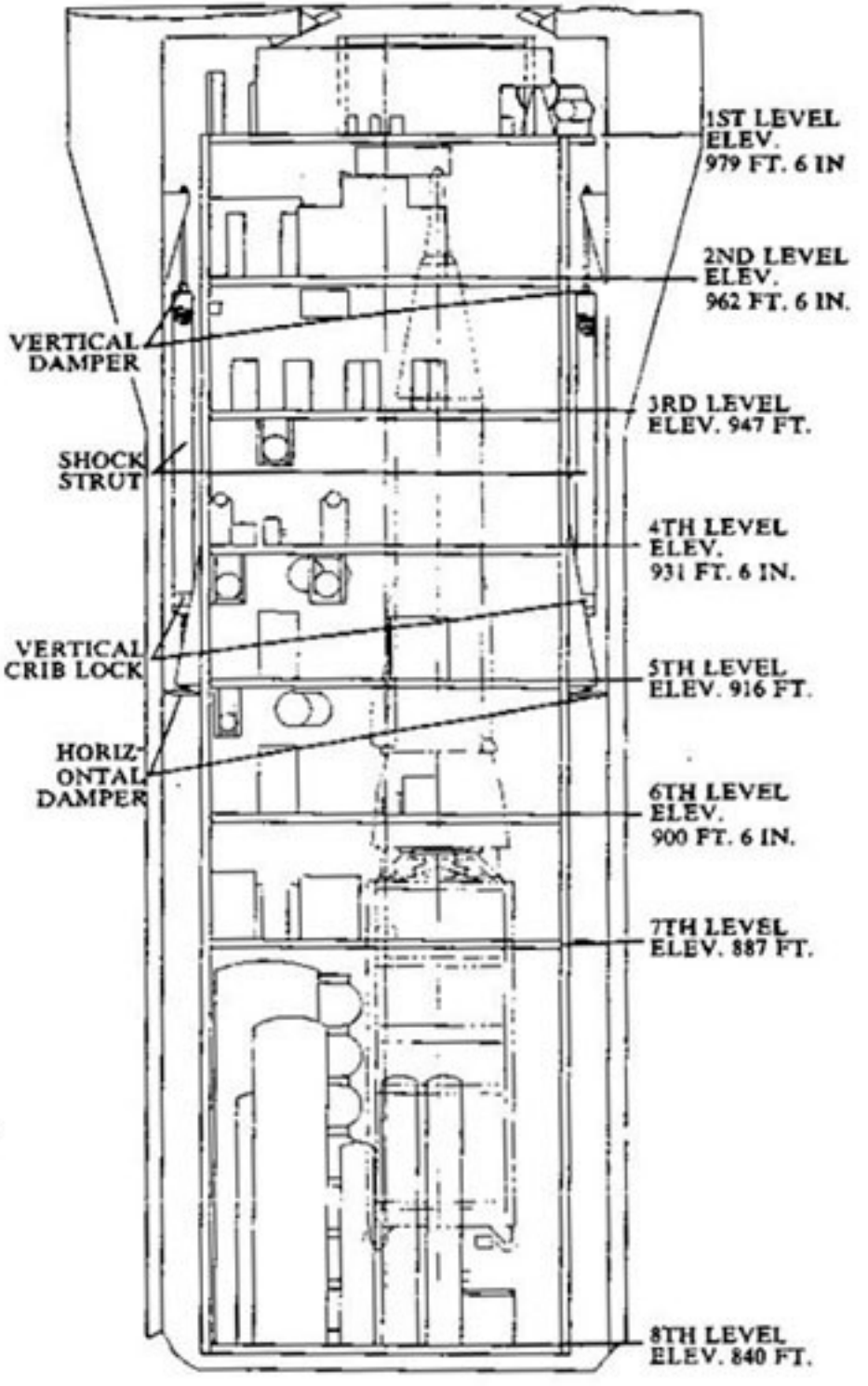
CRIB & LAUNCH PLATFORM

The crib and launch platform are designed for "stick"-type construction. Individual beams will be cut to length and predrilled before being shipped to the site. The beams will be bolted together in the silo starting with the eighth or bottom level, which is constructed upon temporary shoring. The structural members are mated and facility equipment installed before the seventh level is constructed. This procedure is followed through the construction of the fifth level after which equipment may be installed when the crib structure is completed.

The launch platform is erected in two sep-

arate sections on pads adjacent to the silo. The GSE components will be installed and the plumbing interconnects will be made before placing the launch platform into the silo. The lower half will be first lowered into the silo and set on temporary shoring. The upper section will then be lowered and the sections joined at the splice area.

To further comply with the prefabrication concept, all piping shall be detailed. In the area of tubing runs where this concept may not be the most expeditious for a particular run, production samples will be developed. These production samples will be derived from the full-scale mockup article. The mock-up is also used as an engineering check tool for details. This prefabricated plumbing as well as electrical interconnecting assembly approach, calls for the establishment of an accurate foot print and interface pattern. The facilities interface are to be designed to permit quick connection of GSE components. Because of cleaning problems, minimum working area and tight construction schedules, welding of pipe or tubing is to be kept to a minimum in the silo. Welding of brackets and other small non-critical items, is permitted. Spooling pieces are used in runs of large rigid pipes where it is mandatory to insure a proper fit. The crib is suspended within the silo shell



by a system of shock mounts attaching at the top to inserts embedded in the silo wall. The suspension system is fastened to the crib at the lower end. The system consists of four wall brackets and eight shock struts, paired into four pairs spaced around the periphery of the crib. Each strut consists of a centered spring capsule, made up of regular mechanical springs, with 5-in. dia. centered strut rod at each end. An 18 in. rattle space is provided between the crib and the silo shell, including top and bottom, to allow for the displacement of crib structure when ground shock is experienced. Horizontal and vertical dampers are provided to damp out motion between crib and silo. Prior to operation of the launch platform, it is necessary to lock the suspended crib structure to prevent its moving out of line. The locking system is remote controlled from the LCC and is a part of the countdown procedure. The launch platform is roller mounted on three vertical guide rails and is supported by a series of cables, tension equalizers, rollers and sheaves. A series of counter weights weighing approximately 565,000 lb. are installed to assist in the launch platform vertical movement. Positive locking provisions are provided for locking of the launch platform in both the fully extended and retracted positions.

SILO CRIB

This section is devoted to the listing of major GSE and facility installed equipment with a brief functional description of each.

LEVEL No. 8

LO_2 TANK (FACILITY)

Storage of missile liquid oxygen supply until tanking period, during countdown.

LO_2 TOPPING FACILITY

Supplies top off LO_2 to missile to replenish boil-off losses during extended hold periods.

LN_2HE STORAGE AND HEAT EXCHANGER (FACILITY)

Chills helium gas to missile storage bottles and supplies the helium bottle shrouds in missile with LN_2 refrigerant to maintain low helium temperature in bottles during countdown.

THRUST SECTION HEATER (FACILITY)

Supplies heated air during countdown to maintain components and small hydraulic lines at proper operating temperature in the presence of LO_2 and LN_2.

HE GROUND PRESSURIZATION TANK (FACILITY)

Pressurize missile tanks for launch (including hold period) de-tanking, etc., after an abort.

HE INFLIGHT NO. 1 (FACILITY)

One load inflight requirement, high pressure checkout to DCU, emergency pressurization system.

HE INFLIGHT NO. 2 (FACILITY)

One load inflight requirement. Checkout missile pneumatic system.

PRESSURIZATION CONTROL UNIT (GSE)

Maintains required missile tank pressures during all phases of operation, before switch over to internal pressurization at L/P rise.

PNEUMATIC DISTRIBUTION UNIT (GSE)

Controls gas flow to PCU, HCU and chilled helium fill system.

LN_2 EVAPORATOR TANK (GSE)

Evaporator tank for warmed up LN_2 already passed through the shrouds on lines and bottles.

COLD DISCONNECT PANEL (GSE)

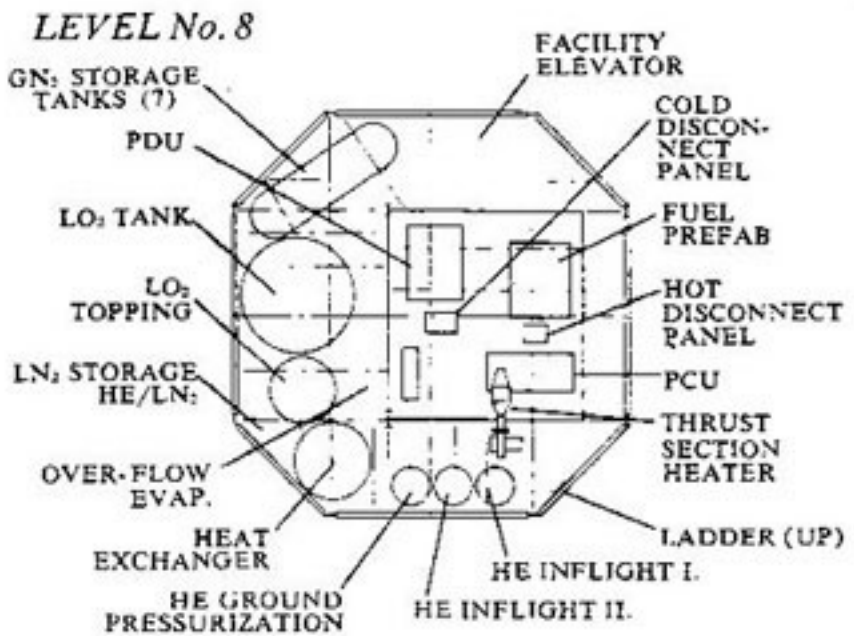
Contains fuel and LO_2 tanks, pressure lines, He charge line, GN_2 to NCU, GN_2 to slug unit, GO_2 vent from slug unit and LO_2 to slug unit disconnects.

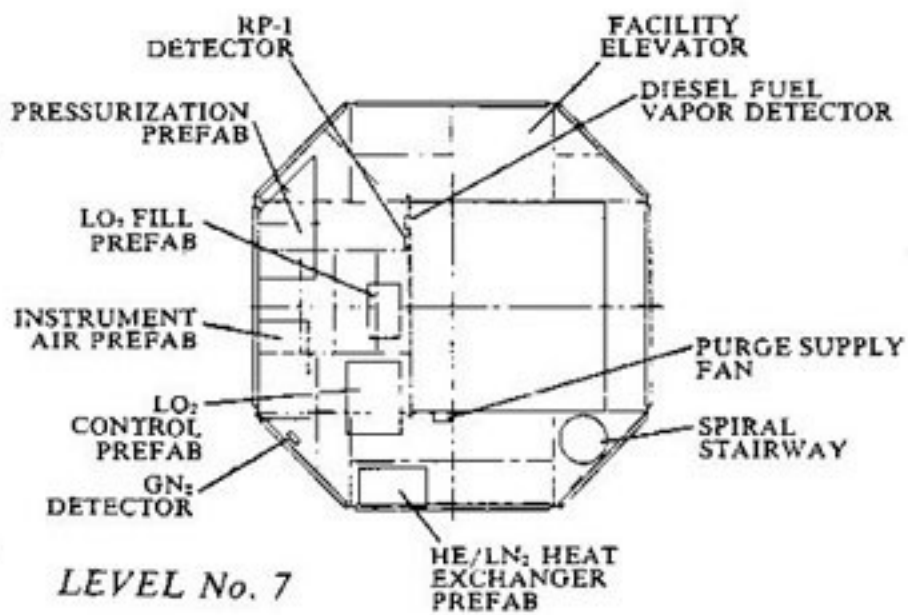
HOT DISCONNECT PANEL (GSE)

Contains thrust section heater disconnect, water inlet and return for pod cooling disconnect, and fuel fill disconnect.

FUEL LOAD PREFAB (GSE)

Unit contains necessary valves, lines, etc., for monitoring the transfer of hydrocarbon fuel to missile.





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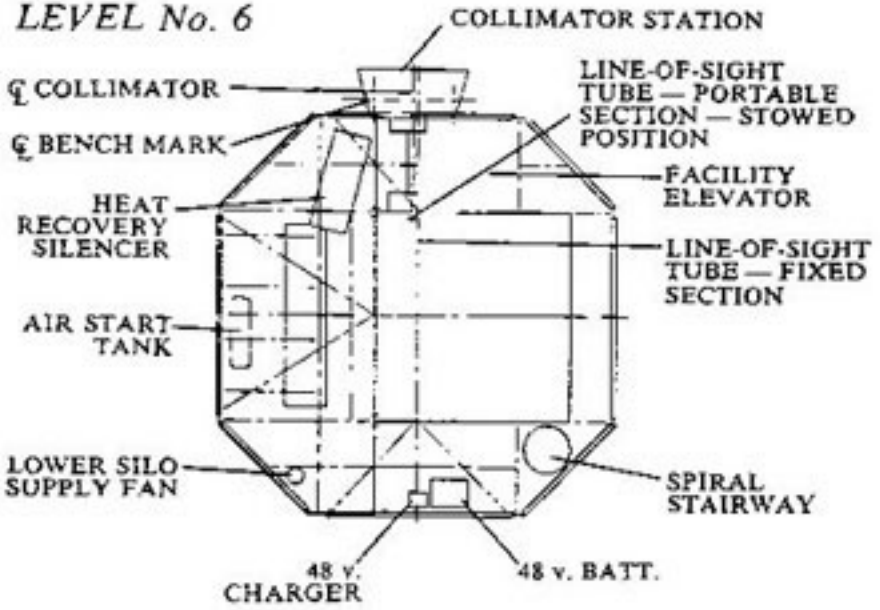

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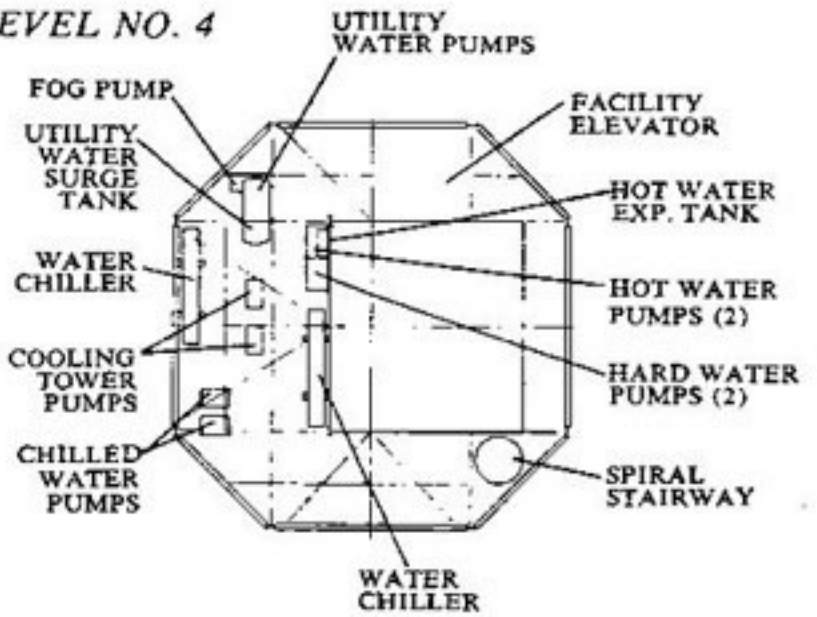

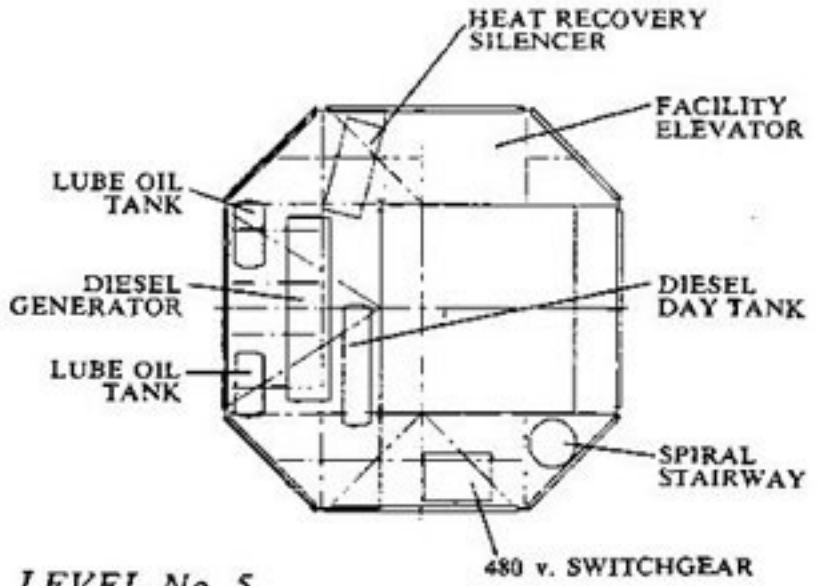

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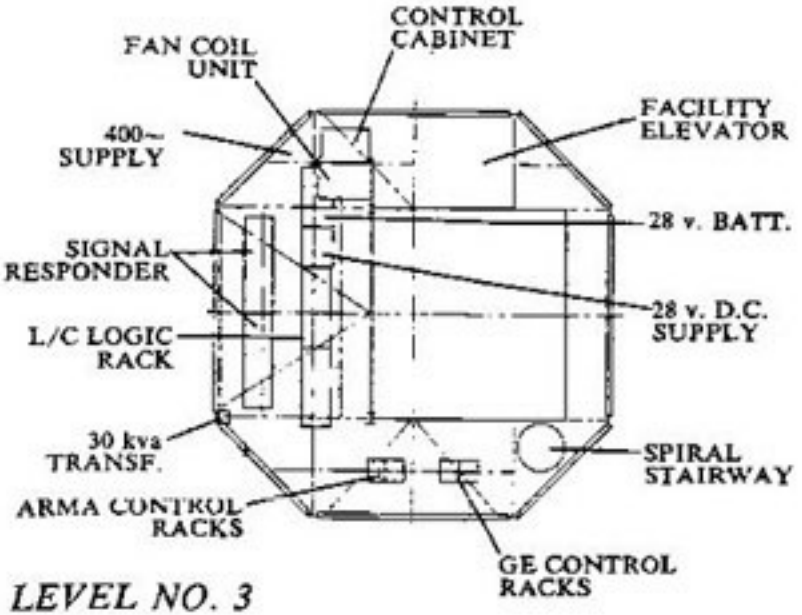
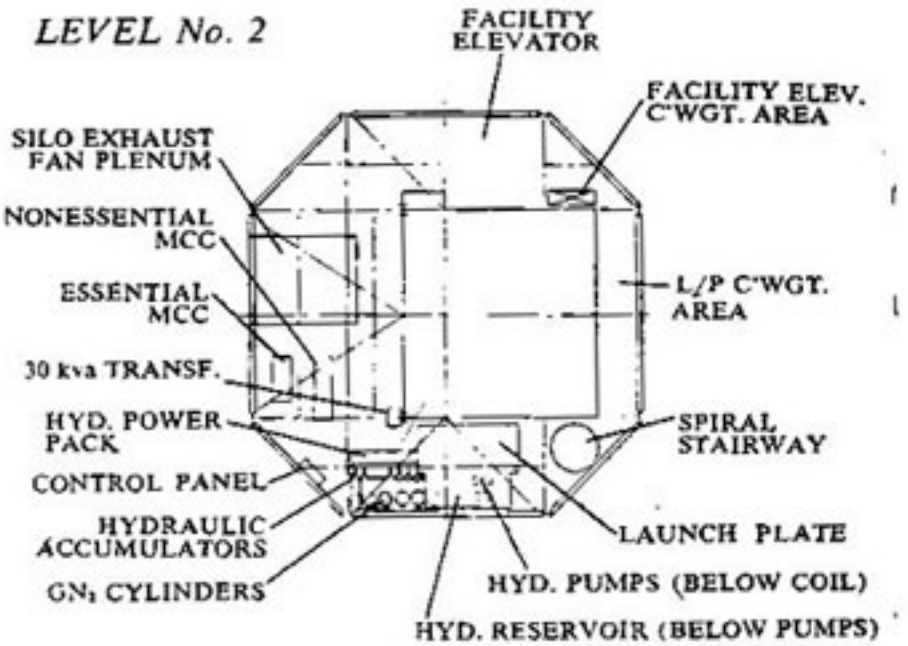
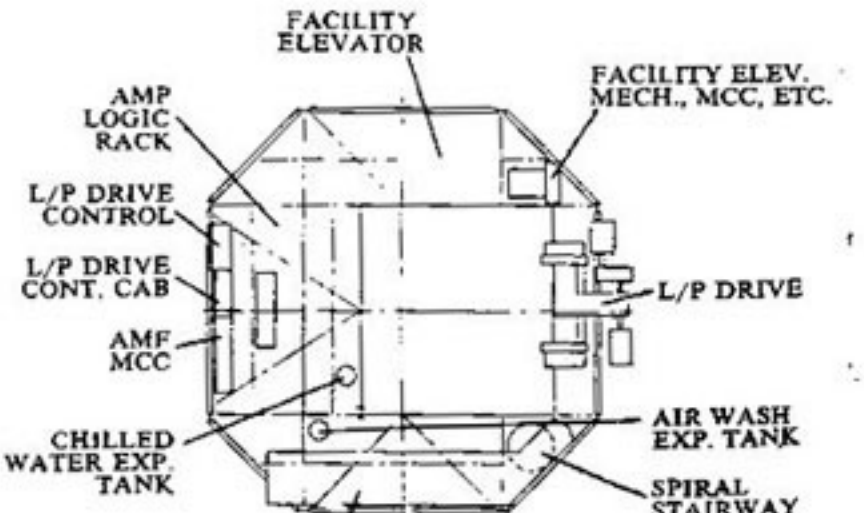


LEVEL NO. 3

LEVEL No. 2





LEVEL No. 1

LEVEL No. 7

LO_2 CONTROL PREFAB (FACILITY)

Monitors, controls servicing of missile with LO_2. Controls venting of LO_2 storage tank.

LO_2 FILL PREFAB (FACILITY)

Monitors, controls filling of LO_2 storage vessels; controls venting of topping tank during standby.

PRESSURIZATION PREFAB (FACILITY)

Controls filling of gaseous nitrogen storage, distribution of gaseous nitrogen to the LO_2 storage, topping and slug tanks, to the fuel prefab, NDU and various other components as required.

LN_2 PREFAB (FACILITY)

Monitors, controls the fill and transfer operations in the LN_2 units.

INSTRUMENT AIR PREFAB (FACILITY)

Compressed air system for complex instrument air, diesel engine starting air, and operating of blast closure mechanism.

RP-1 DETECTOR (FACILITY)

System shall be capable of sampling, analyzing and actuating the specified alarms when concentrations of RP-1 excess vapors are present in the areas serviced by the sampling stations.

DIESEL FUEL VAPOR DETECTOR (FACILITY)

Same function as RP-1 detector, for diesel vapors.

OXYGEN DETECTOR (FACILITY)
Same function as RP-1 detector, for excessive oxygen.

LEVEL No. 6

DIESEL GENERATOR (FACILITY)
Facility a-c power requirement is provided by diesel driven synchronous generators (one is located on Level 5). Only one will be operating during ready condition. The standby generator is remotely controlled from the LCC as required, by failure of the operating generator or for periodic maintenance. Both will be operating during countdown.

AIR START TANK (FACILITY)
Compressed air storage tank for engine starting air.

48 V BATTERY (FACILITY)
Used with constantly operated electrical equipment, switch gear, LCC control, etc. Also supplies current for emergency light if generators fail.

48 V CHARGER (FACILITY)
Charger provides for normal current drain, plus a rapid recharge after use.

HEAT RECOVERY SILENCER (FACILITY)
Engine cooling and waste heat recovery system for space heating of launcher, silo and LCC.

AIG SYSTEM COLLIMATOR AND BENCH MARKS
Optical alignment equipment utilized in orienting the sensing platform to the selected target azimuth. The bench mark supports, collimator support platform and collimator is housed in a special room, attached to the silo wall between the sixth and seventh levels. The self closing light tight door to the room is located approximately eight feet above crib level and is reached by a special ladder.

LEVEL No. 5

DIESEL GENERATOR (FACILITY)
Explained with Level No. 6.

HEAT RECOVERY SILENCER (FACILITY)
Explained with Level No. 6.

LUBE OIL TANK (FACILITY)
Lube oil storage tanks, one for clean oil and one for dirty oil transferred from the sump.

FUEL OIL DAY TANK (FACILITY)
Tank capacity is sufficient for 24 hr. and is maintained by a continuous topping operation from underground storage.

480 V SWITCH GEAR (FACILITY)
Contains synchronization and control equipment for diesel generator sets, as well as main circuit breakers for the 480 v bus power from switch gear supports 480 v motor control center of silo and LCC.

LEVEL No. 4

UTILITY WATER PUMP (FACILITY)

The utility water supply system consists of a turbine type utility water pump, a centrifugal fog spray pump and a hydropneumatic tank with necessary valves, fittings, etc. Used for fire protection etc.

UTILITY WATER TANK (FACILITY)

Hydropneumatic tank for above system.

WATER CHILLER UNIT (FACILITY)

Reciprocating type water chiller, consisting of hermetic reciprocating compressors and motors, control system, and other necessary equipment to furnish chilled air to the air wash in the air-conditioning system and pod air cooler.

HOT WATER EXPANSION TANK AND PUMPS (FACILITY)

Hot water in a closed loop is pumped to the heat recovery silencers where it is re-heated and circulated to thrust section heater, launch platform heat coil, and the LCC.

CHILLED WATER PUMP (FACILITY)

Electrically driven, single stage, enclosed impeller type water pumps, for circulating the chilled water.

COOLING TOWER PUMP (FACILITY)

Condenser water pumps circulate cooling water from cooling tower to the diesel generators, condenser units and instrument air prefab and returns to cooling tower.

FOG PUMP (FACILITY)

Supplements the utility water pump when large demand drops the pressure in the hydropneumatic tank.

LEVEL NO. 3

400 A-C MOTOR GENERATOR SET (GSE)

Supplies 400 cps, 120/208v 3 phase power to launch control GSE.

28V D-C BATTERY (GSE)

Emergency 28v d-c in the event of 20v d-c power supply unit failure.

28V D-C SUPPLY (GSE)

Supplies 28v d-c to launch control GSE.

L/C LOGIC RACKS (GSE)

The relay logic units contain the relays, comparators, delay devices, and wiring to perform operations required for a missile launching.

SIGNAL RESPONDER (GSE)

The responders contain the relays, simulators, delay devices, and wiring to simulate the circuitry of the missile and associated GSE.

ARMA CONTROL RACK (GSE)

Guidance system checkout equipment to test the inertial guidance system.

GE LAUNCH MONITOR (GSE)

Re-entry vehicle, pre-launch monitor and control group.

30 KVA TRANSFORMER (FACILITY)
(ALSO ON LEVEL NO. 2)
One transformer supplies 120/208 v, 3 phase power to energize 120/208v distribution panel which supports the launch control 60 cps power supply panel.

LEVEL No. 2

HYDRAULIC POWER PACK (GSE)
Hydraulic system consists of reservoir, pump assembly, accumulators, GN_2 bottles, and control panel and is source of power to operate door closures, platforms, locks, etc.

COUNTER WEIGHT (GSE)
Series of counter weights contributing to launch platform vertical movement.

AIR HANDLING UNIT (FACILITY)
Silo exhaust fan and plenum for controlling the ventilation within the silo structure.

ESSENTIAL MOTOR CONTROL CENTER (GSE)
Electrical power from the 440v MCC essential bus is necessary to support the instrument air system, air compressor, 30 kva transformers, d-c power supply unit, missile pod refrigeration equipment, thrust section heater, HPU, 400 cps motor generator and distribution system, 48v d-c battery rectifier (charger) water chiller unit and chilled water pumps, gas detectors and emergency water pump.

NON-ESSENTIAL MOTOR CONTROL CENTER (GSE)
Non-essential power is necessary to support main air and silo supply fans, hot water heater, main exhaust fan, exhaust vent blast closures, sump pump, spray pumps, LO_2 vacuum pumps, and so on.

LEVEL No. 1

L/P DRIVE MECHANISM (GSE)
Mechanism consists of two identical 125 hp electric motors. One motor is used for high-speed hoisting; the other for low-speed hoisting. With the necessary gearing, clutch assembly, brace assembly, sheaves, etc., to perform their required function.

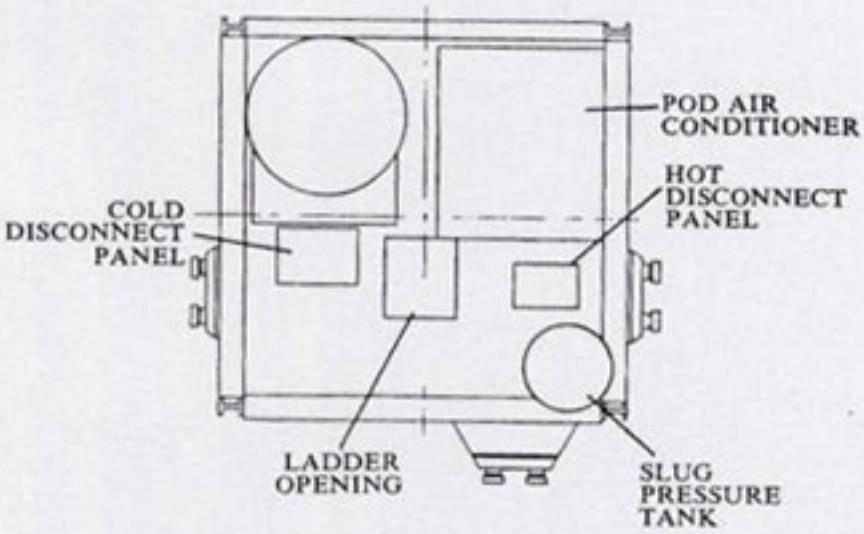
L/P DRIVE CONTROL CABINET (GSE)
Cabinets containing control circuitry amplifiers, transformer, reactors and resistors for controlling the drive mechanism.

AMF LOGIC RACK (GSE)
Contains relays, comparators, delay devices and circuitry to control and sequence; the launch platform locks, launch platform rise, and silo doors, prior to launching.

AIR WASH DUST COLLECTOR UNIT (FACILITY)
Supply air entering the silo is passed through an air washer and wet impingement type dust collector.

FACILITY ELEVATOR DRIVE MECHANISM (FACILITY)
Contains controls, cables, sheaves, etc., for operating the freight and personnel elevator.

LAUNCH PLATFORM



L/P LEVEL NO. 4

POD AIR-CONDITIONER (GSE)

Provides cooling air to missile equipment pod while in the silo. To dissipate heat buildup due to electronic equipment operation.

LO_2 SLUG TANK (GSE)

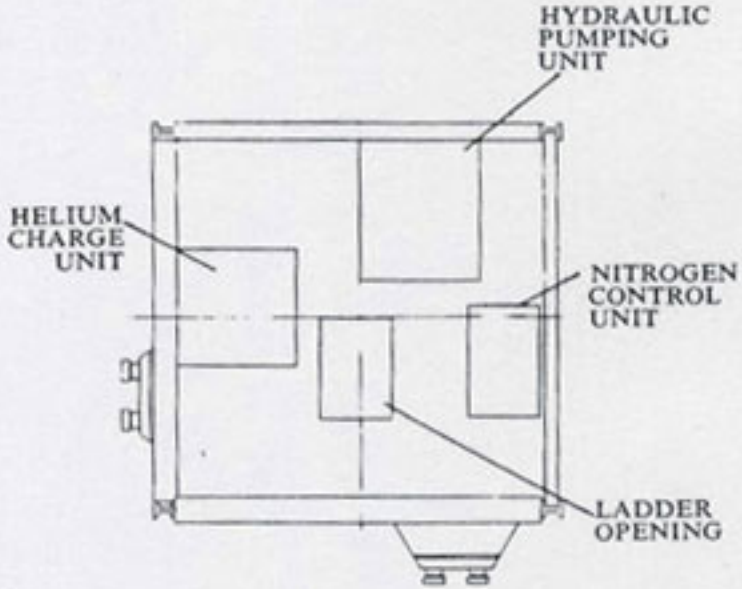
Provides final slug of subcooled LO_2 to propulsion system to prevent pump cavitation at engine start and maintain full LO_2 supply in missile during elevator rise.

SLUG PRESSURE TANK (GSE)

Supports the slug tank with pressure.

DISCONNECT PANELS (GSE)

Missileborne hydraulic, pneumatic, liquid oxygen and nitrogen supply disconnects.



L/P LEVEL No. 3

HELIUM CHARGE UNIT (GSE)

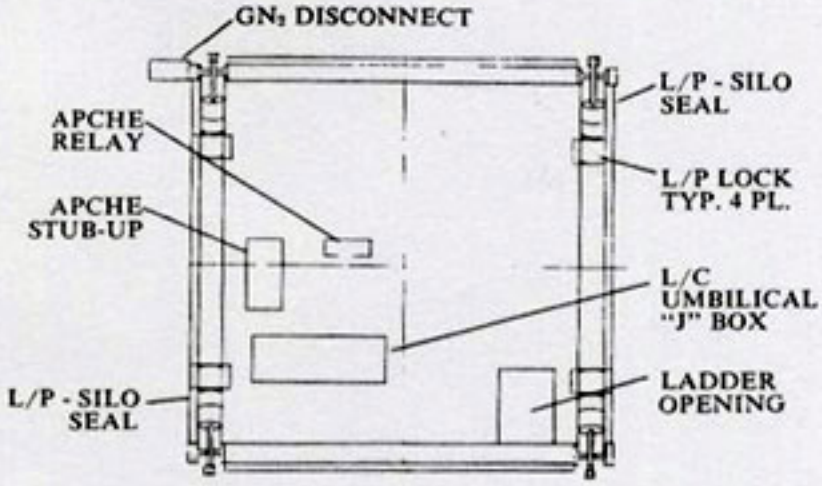
Controls helium source to missile spheres during platform rise.

NITROGEN CONTROL UNIT (GSE)

Regulates and controls nitrogen for charging, testing and purging operation.

HYDRAULIC PUMPING UNIT (GSE)

Provides an oil supply for filling and bleeding hydraulic system and provides hydraulic power for missile hydraulic system or autopilot system C/O and for missile requirements during active countdown, until the time airborne equipment over-rides and takes over.



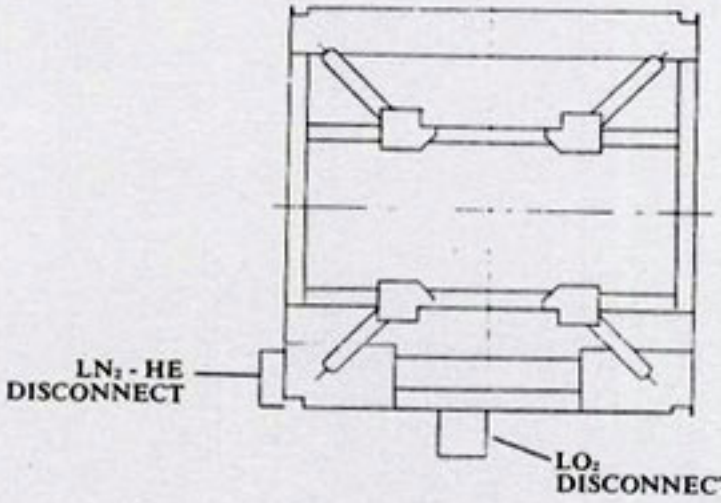
L/P LEVEL No. 2

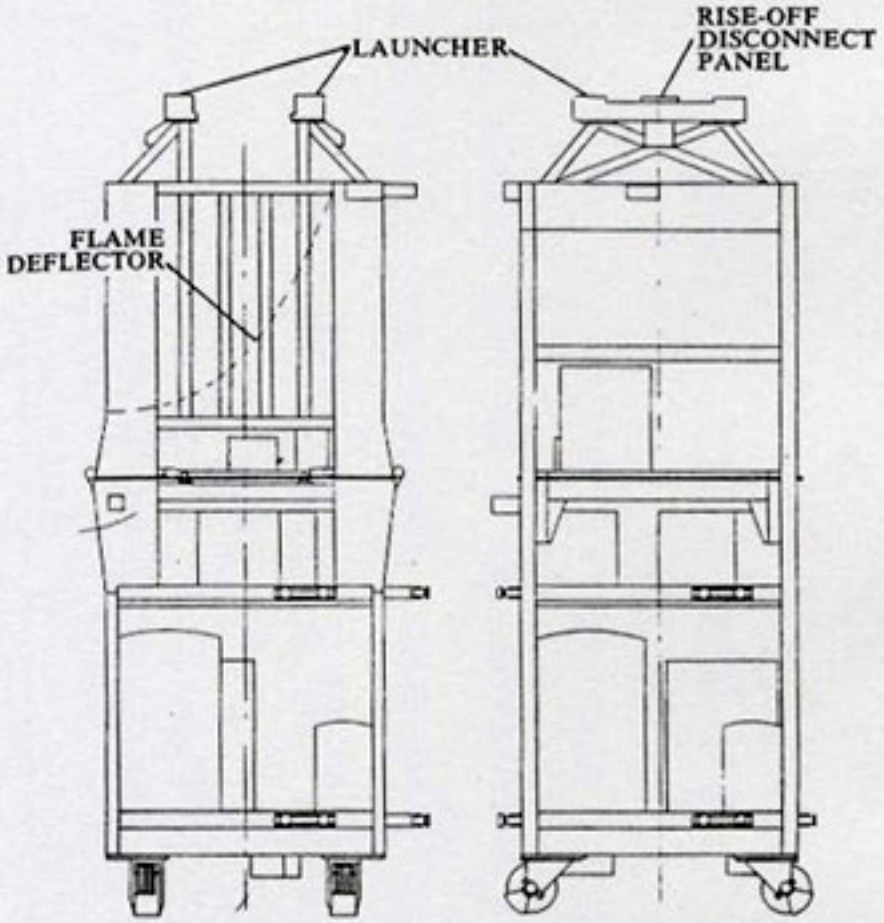
UMBILICAL JUNCTION BOX (GSE)

Serves as the junction point for missile umbilical cables and launch control checkout cables.

FLAME DEFLECTOR

A dry-type flame deflector is located between first and second floor.





Elevation looking at quadrants II & III diagonal structural members deleted for clarity

Elevation looking at quadrants III & IV diagonal structural members deleted for clarity

← *L/P LEVEL No. 1*

LAUNCH PEDESTAL (GSE)

Launch pedestal and missile support assembly.

SQUADRON MAINTENANCE AREA

The SMA provides the necessary facilities for support maintenance requirements of the missile squadron. The SMA is composed of three separate buildings supporting the various operations.

A missile assembly building (MAB) with missile maintenance area and adjacent shop areas for system and component checkout and repair. These areas include: engine maintenance area, inertial guidance system area, hydraulic - pneumatic area, electrical - electronic area, instrument area, component area, power room and supplementary work shops and tool cribs.

A munition section strategic missile squadron (MSSMS), provides facilities for maintenance, repair and checkout of re-entry vehicles, hypergols, explosives, etc., required to support the weapon system.

An administration and storage building (ASB) will be located adjacent to the MAB. The squadron command headquarters housed in the ASB has the capability to activate the launch capability of any or all of the launchers, (alternate command post is also established in one of the complex LCC). The ASB also provides storage facilities for administration and space for weapon system maintenance and service supplies.