TITAN
WS107A-2
LAUNCHER SYSTEM

AMF

AMERICAN
MACHINE &
FOUNDRY CO.
GENERAL
ENGINEERING
LABORATORIES
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WS 107A-2 LAUNCHER SYSTEM

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FOREWORD

American Machine & Foundry Company engineers have been designing the Silo-Lift Concept TITAN Launcher System for several months. This document is published, in conjunction with the Development Engineering Inspection, to establish, illustrate and expound the salient features of the design approach being implemented to deliver a WS 107A-2 Launcher System to Cooke Air Force Base in 1959.

This Launcher System is one that has interfaces with almost every part of the weapon system, and all associate contractor designs. Requirements and information are not, in all cases, available for some requirements, especially those of the R & D nature, are still in a state of flux. Therefore, the Launcher System as illustrated is flexible to accommodate future weapon system changes.

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INTRODUCTION

The Silo-Lift Concept Launcher System has been selected by the United States Air Force to be the means for operational TITAN launching.

Major hard site launcher system requirements are . . .

- Protection against thermonuclear attack . . .
- Reaction time not in excess of 15 minutes . . .
- Reuse after initial missile launching . . .
- Operability during a ten-day isolation period . . .
- Maximum reliability in combination with minimum cost . . .
- Maximum missile and operating personnel safety . . .

The seven illustrations following are simplified schematic drawings intended to identify, define and develop the launcher subsystems and components.

1. THE MISSILE – TITAN

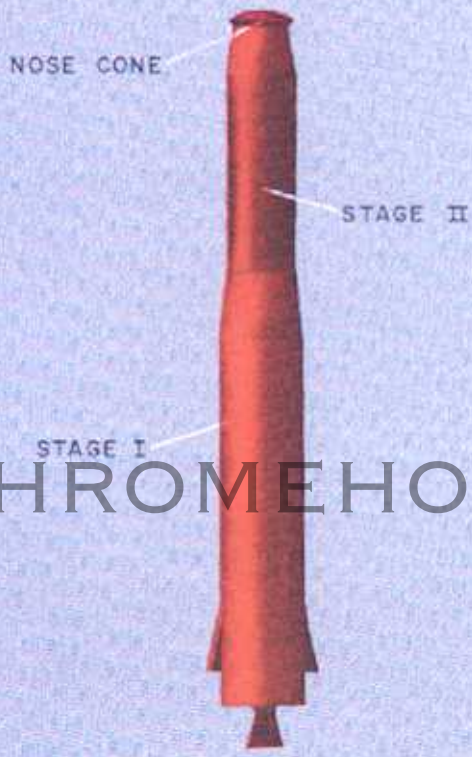
TITAN is a two-stage ballistic missile fitted with rocket engines capable of producing 300,000 pounds of thrust. The first stage is the twin-engine booster; the second stage is the single-engine sustainer. The nose cone contains the warhead and is designed for atmospheric re-entry at hypersonic speeds. TITAN is approximately 90 feet long and 10 feet in diameter. Its fully-fueled weight exceeds 220,000 pounds.

Some TITAN characteristics affecting launcher system design are . . .

- Vertical assembly in two stages plus nose cone . . .
- Use of liquid fuel and oxidizer . . .
- Fueling accomplished in vertical position . . .
- Umbilical attachments not consolidated . . . (reduces missile airborne weight) . . .
- Extreme sensitivity to g-loading . . .

The Silo-Lift Launcher System is schematically developed in the following illustrations . . .

MISSILE



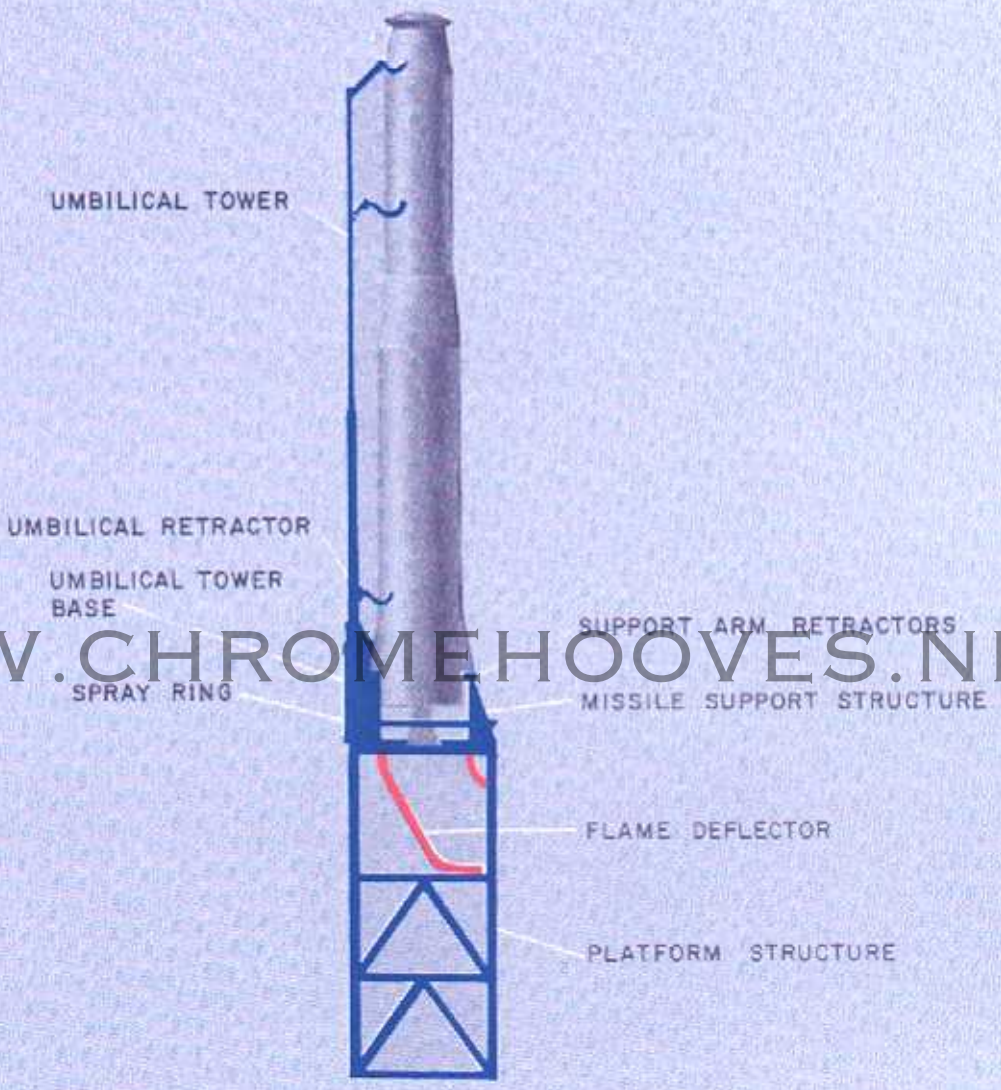
2. THE ELEVATOR PLATFORM

The missile must be supported in a vertical position. To accomplish this a platform must be provided capable of supporting the missile and raising it to the surface for launching.

This drawing shows . . .

- Structural steel platform and support arms with retractors . . . supports missile in ready-to-launch vertical position . . .
- Flame deflector to safely deflect and disperse engine exhaust products . . .
- Missile spray ring to prevent flash-back flames from engulfing missile in event of abort or engine shutdown . . .
- Umbilical tower . . . tower base on platform . . . hinged tower conveys umbilicals to surface . . . umbilical and other service lines provide fuel, liquids, power to missile . . .
- Umbilical retractor to separate lines from missile prior to firing . . .

ELEVATOR PLATFORM



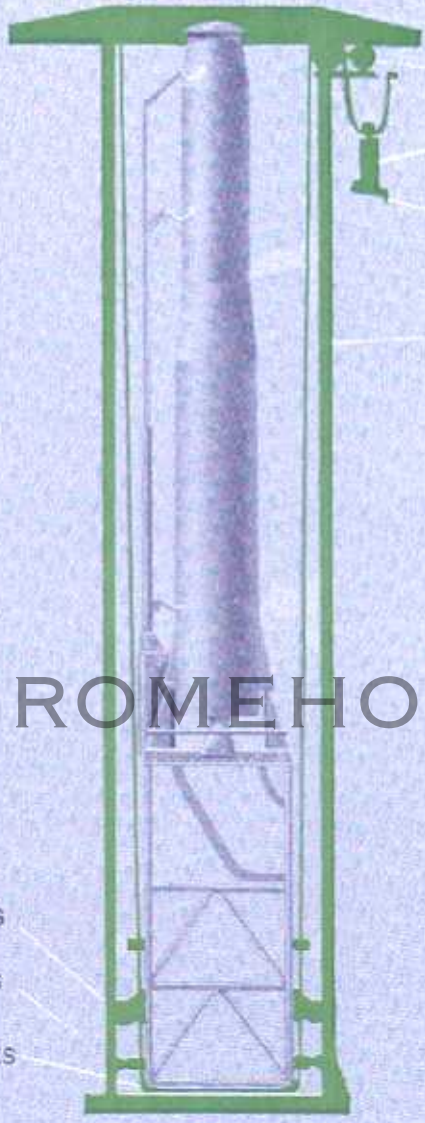
3. ELEVATOR DRIVE SYSTEM

The elevator platform must be capable of raising the assembled and serviced missile to the surface. A set of guide rails and a drive system is added to accomplish this.

The drawing illustrates . . .

- Guide rails . . . tied together to move as a unit . . . provide necessary stability for elevator platform . . . contain elevator stops and locks . . . position and restrain platform in elevated position . . .
- Elevator drive system . . . hydraulic motor drive and cable suspension . . . counterweighted to minimize power requirements . . . traction sheave arrangement . . .
- Drive located on silo wall . . . suspension cables dead-ended at counterweighted end of silo wall and other end of crib . . .
- Counterweights suspended from silo wall . . . relieve guide rails of weight in addition to elevator platform loads . . .

ELEVATOR DRIVE SYSTEM

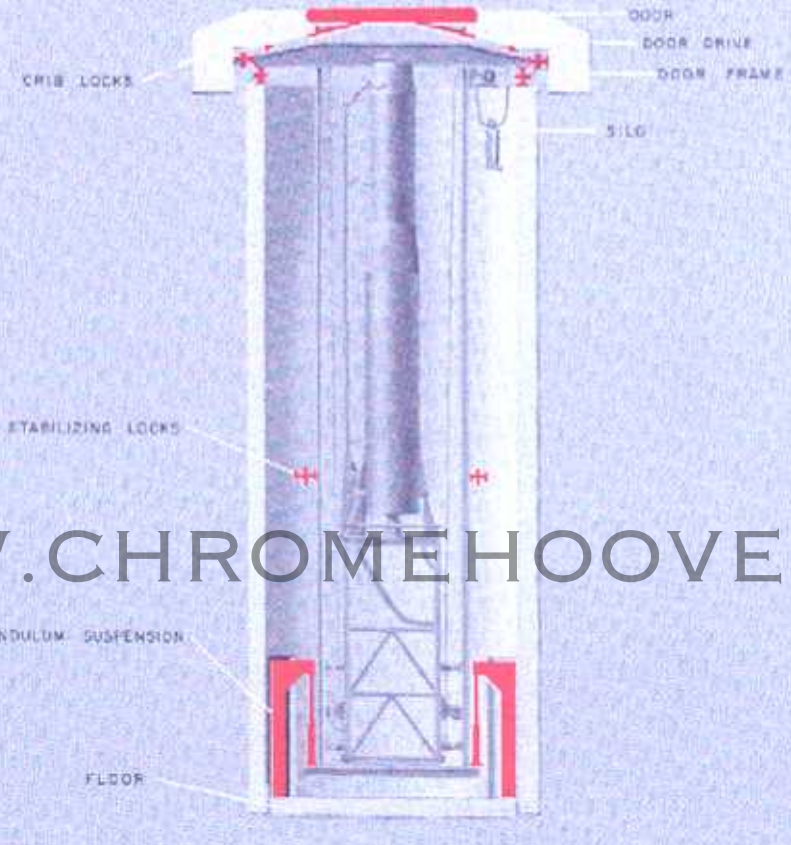


4. ISOLATION SYSTEM

The fragile missile must be protected from effects of nuclear attack. The attack is felt in form of atmospheric overpressure, plus ground shock and motion imparted through the silo.

- Elevator guide rails tied together to form crib structure . . .
- Crib . . . containing elevator platform . . . suspended from silo wall with pneumatic pendulum suspension system . . .
- Pitch control system in conjunction with pneumatic pendulum suspension . . . prevents oscillation or coupled motions from putting pitch or torsion into missile . . . built into suspension struts . . . operating medium hydraulic fluid . . . suspension cylinders also used to level crib structure within missile-imposed limitations . . .
- For stability during elevating, crib must be locked to silo before elevation . . . accomplished by crib locks shown . . . retracted while system is suspended on shock mounts . . . to provide necessary rigidity, crib locks extend to meet crib . . .
- Double pivot door provides overpressure protection . . . material re-radiation protection . . . no biological shielding . . . blast loads transmitted to door foundation . . . and directly into ground . . .
- Silo is integral reinforced concrete shell . . . designed to move as a unit . . . thus preventing lengthwise shear or cracking during nuclear attach . . .

ISOLATION SYSTEM

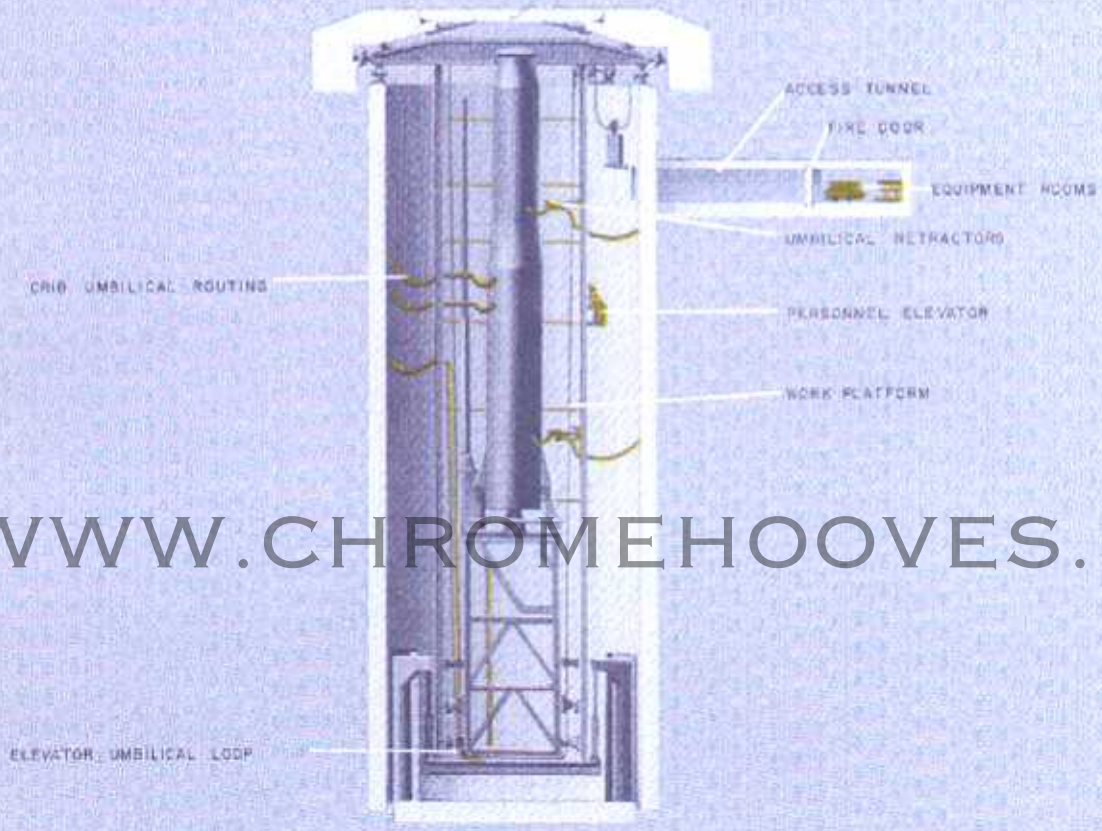


5. FACILITIES AND SERVICES

The missile has been emplaced, guided and protected. It is now necessary to proved missile and launcher services from various facilities elsewhere in the complex.

- Umbilicals routed through crib . . . looped through elevator . . . umbilical retractors . . .
- For missile maintenance . . . folding work platforms . . . at several levels . . . mounted on crib . . . permit passage of elevator platform . . .
- For work platform access . . . personnel elevator . . . runs entire length of crib . . . connects access tunnel with launcher . . .
- Access tunnel from equipment rooms to silo . . . fire door installed as safeguard against fires . . .
- Equipment rooms . . . contain power pack . . . launcher sequencing gear . . . air compressor . . . motor controller . . . various transport dollies . . .
- Hoists provided to separate Stage I from Stage II . . . within silo . . . for maintenance of Stage II engine . . .

FACILITIES & SERVICES



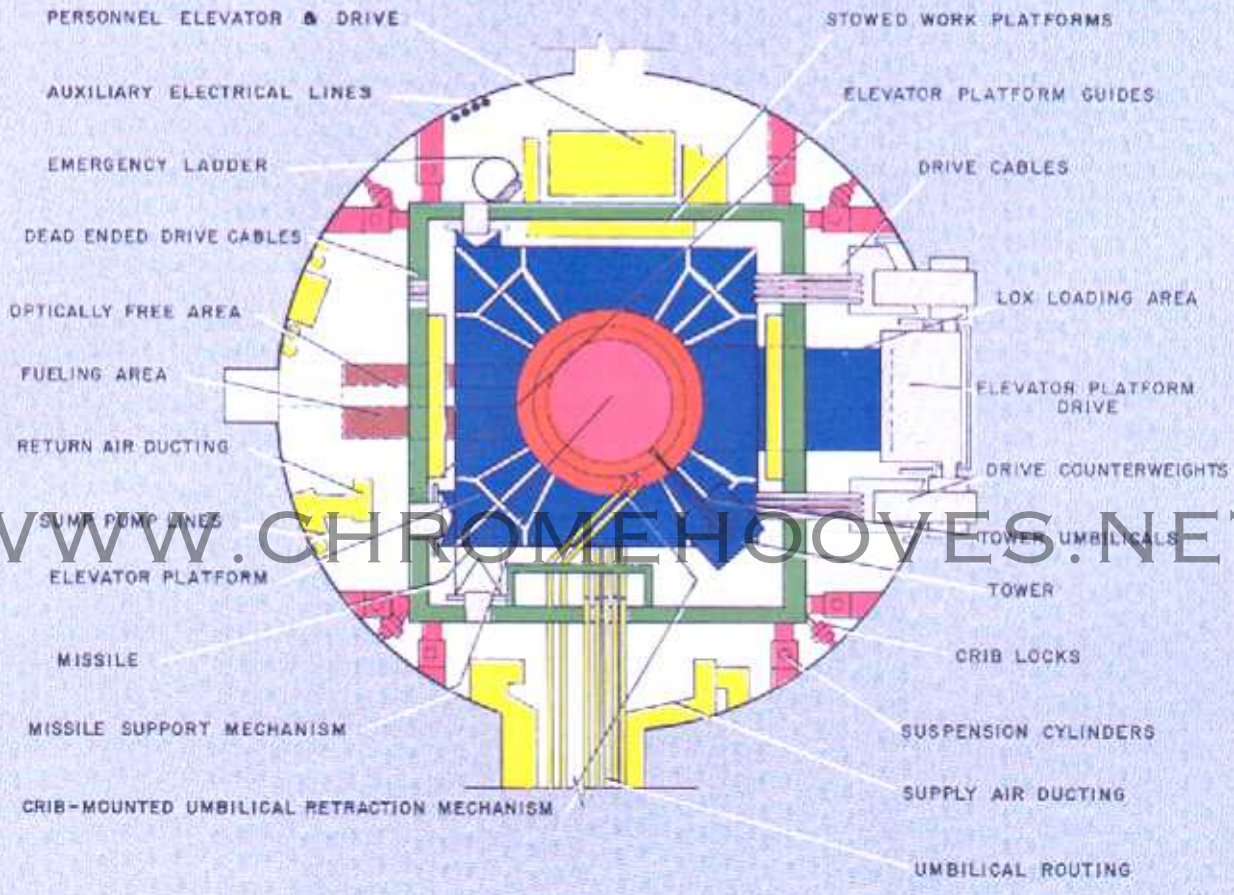
6. PLAN VIEW—LAUNCHER

A primary design objective . . . package all necessary mechanisms and components as compactly as possible . . . no one mechanism or component sizing silo diameter . . . silo diameter approximately 36.5 feet . . .

- Missile
- Elevator Platform
- Tower
- Tower Umbilicals
- Umbilical Routing
- Stowed Work Platforms
- Elevator Platform Guides
- Sump Pump lines
- Supply air ducting
- Return air ducting
- Suspension cylinders
- Missile support mechanism
- Personnel elevator & drive
- Emergency ladder
- Auxiliary electrical lines
- Crib locks
- Drive cables
- Elevator platform drive
- Optically free area
- Fueling area
- LOX loading area
- Drive counterweights

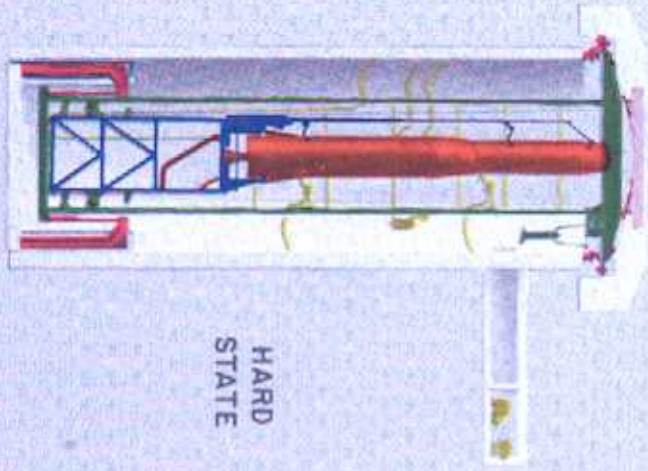
Approximately two (2) feet of clearance is required between crib and inner silo wall . . . allows for relative dynamic displacement of launcher and silo . . . due to nuclear shock . . .

PLAN VIEW – LAUNCHER

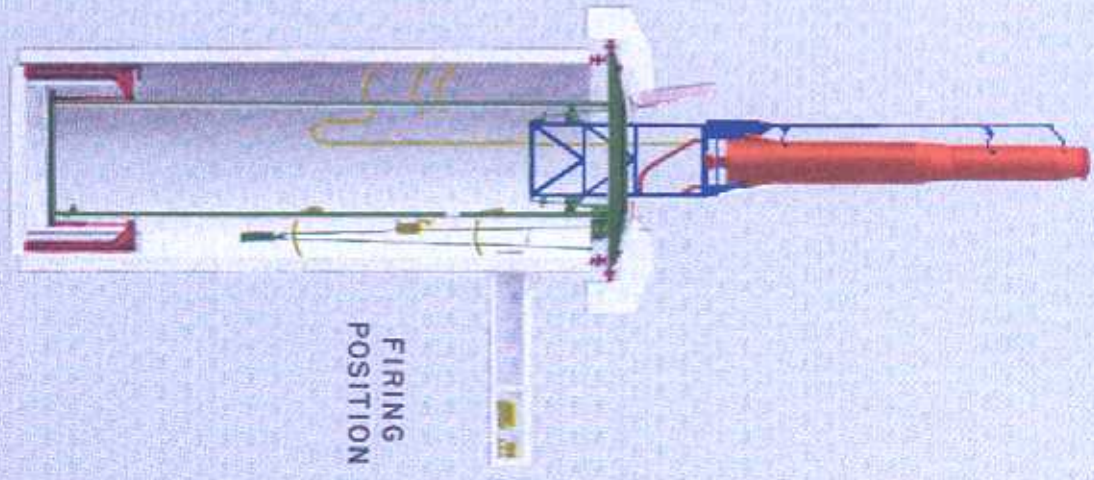


7. HARD STATE/FIRING POSITION

The complete TITAN Launcher System is shown here in the hard state and in the elevated, firing position . . . when elevated the platform is locked to top of crib . . . firing loads are transmitted directly from platform through locks to top of crib and through crib locks directly to the ground . . . unloads guide rollers and rails from huge missile blast loads . . . note umbilical loop raised with platform . . . firing seal to seal silo from missile exhaust products . . .



HARD STATE



FIRING POSITION

8. ELEVATOR PLATFORM

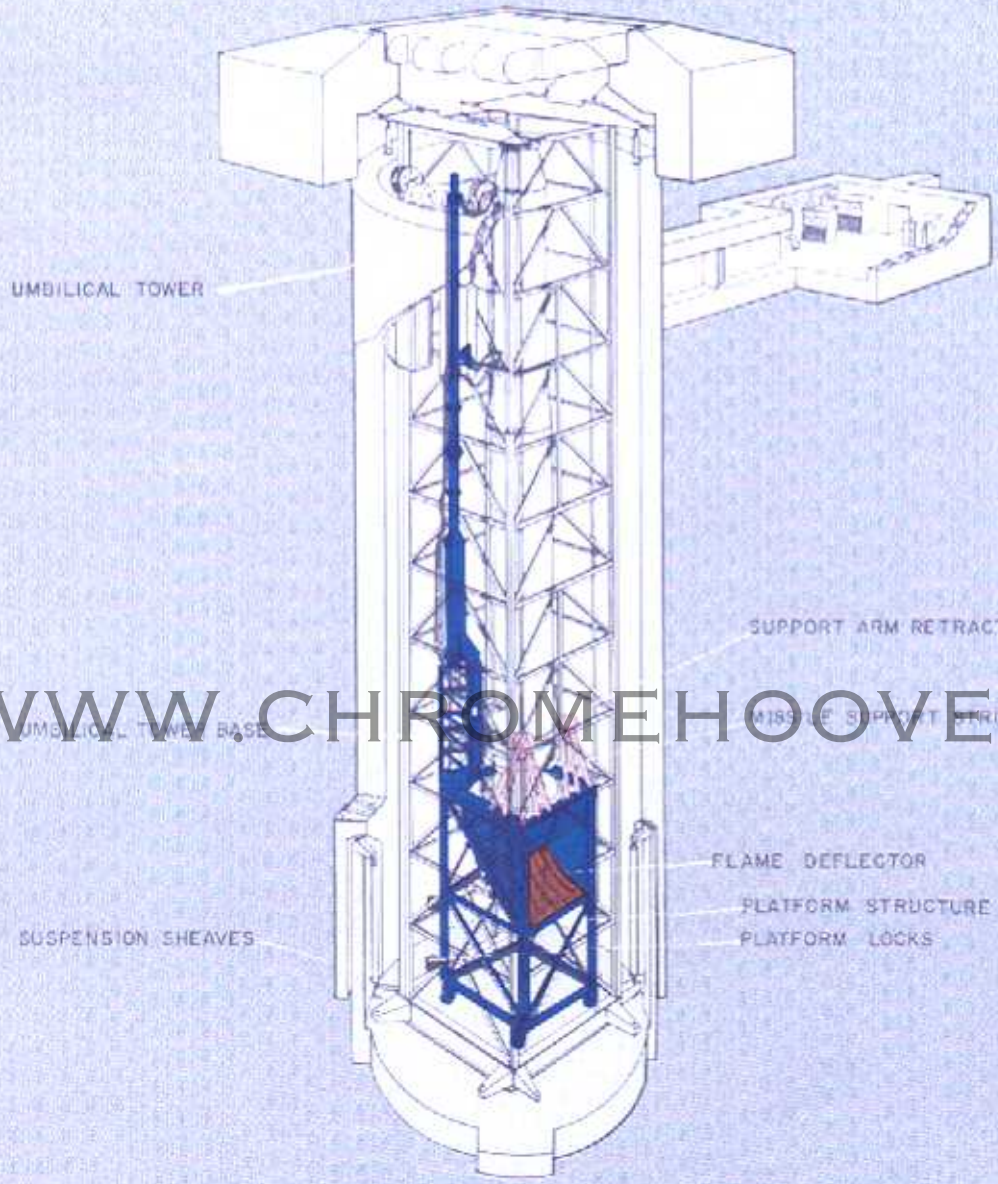
As previously shown schematically, the components illustrated are here shown in greater detail . . . Design objectives were . . .

- Maximum reliability . . .
- Use of readily available commercial items . . .
- Exploitation of economical component packaging . . .
- Minimum costs . . .

Components comprising the elevator platform are . . .

- Missile support structure . . .
- Platform structure . . .
- Platform locks . . .
- Flame Deflector . . .
- Umbilical tower and tower base . . .
- Suspension sheaves . . .
- Support arm retractor . . .

ELEVATOR PLATFORM

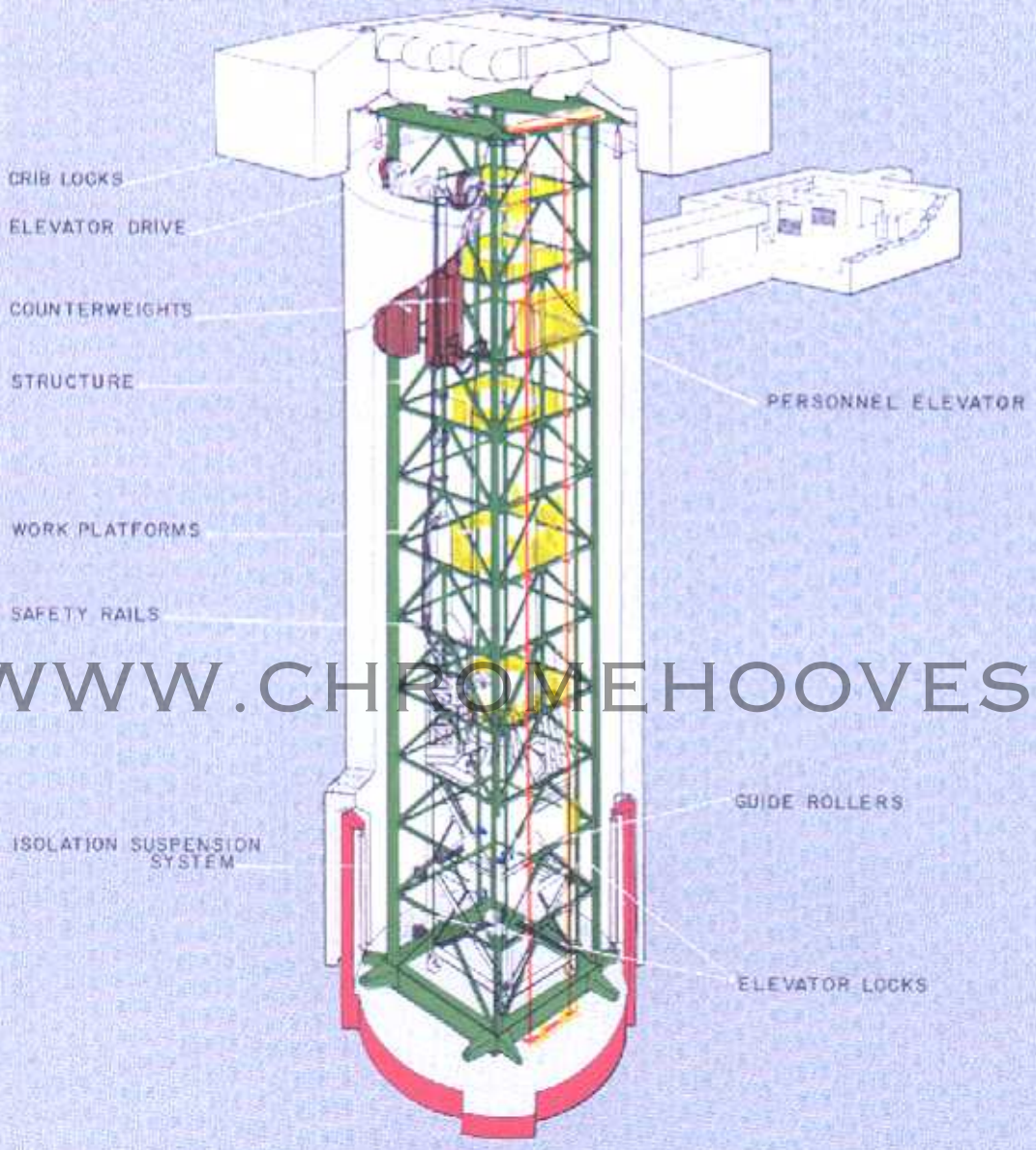


9. CRIB

Crib design characteristics and components . . .

- Composed of elevator platform guide rails . . . commercial structural steel shapes . . .
- Mounts personnel elevator, elevator platform drive mechanism and cable system with counterweights, elevator and crib locks, guide rollers, safety rails and work platforms, etc. . . .
- Supports weight of equipment above . . .
- Firing, elevator platform and counterweight loads not carried by crib . . .
- Crib locks transmit loads into ground . . .
- Personnel elevator . . . a commercial unit . . . sized by missile components dolly . . . driven by electric motor . . .
- Hoists used for separating missile stages . . .
- Pendulum suspension system . . . pneumatic . . . in conjunction with suspension system is hydraulic pitch control system . . .
- Work platforms located at necessary access levels . . . reached by personnel elevator . . . retractable by hydraulic cylinders . . . thus providing clearance for elevator platform . . .

CRIB



10. UMBILICAL ROUTING

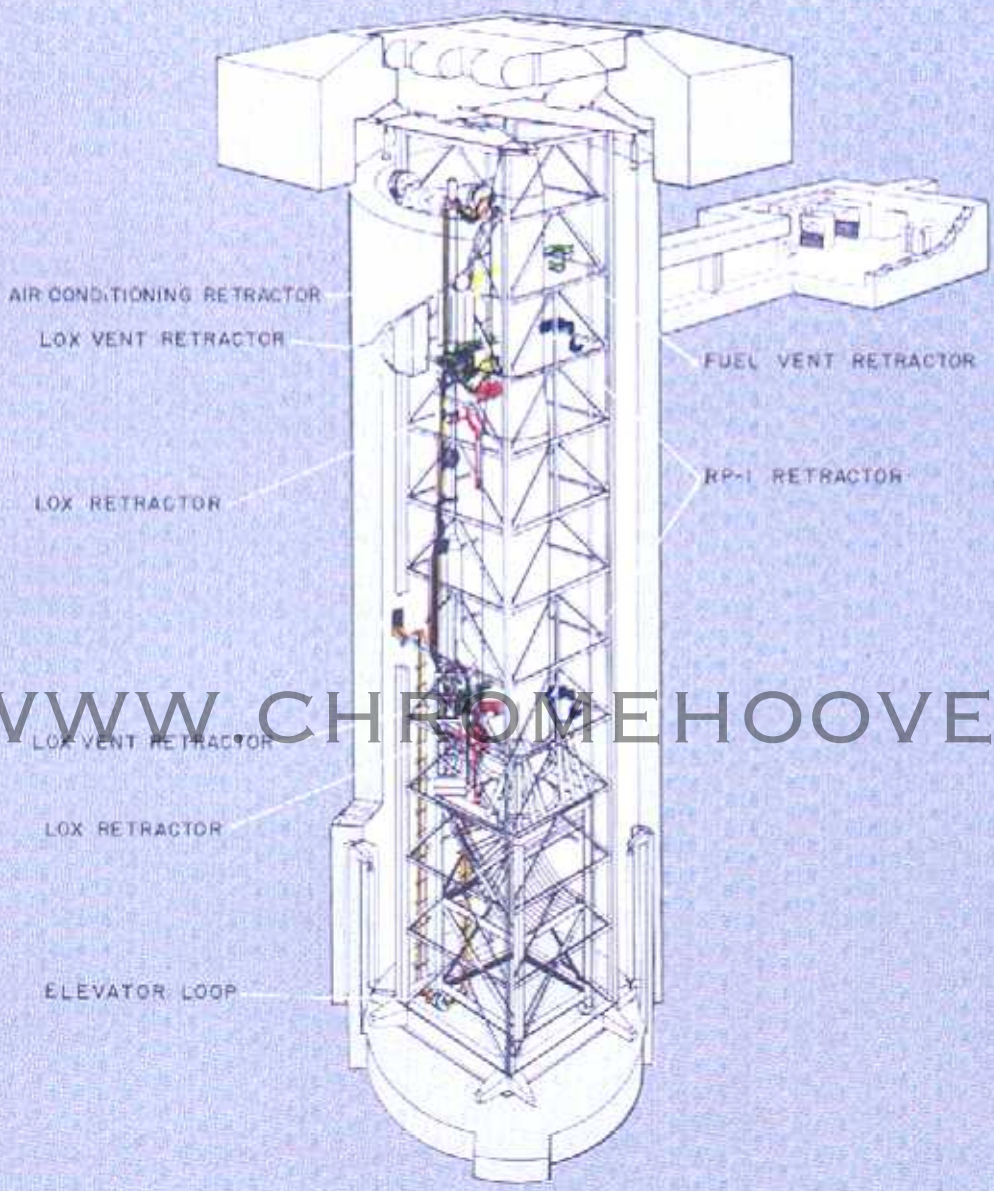
The umbilical lines provide fuel, LOX, helium, air conditioning, electrical power and other services to the missile . . . the umbilicals are . . .

- Looped from silo wall to crib . . .
- Capable of automatic reconnect in event of abort . . .
- Provided with spacers to prevent tangling . . .
- Umbilicals . . . such as propellant . . . need not elevate with missile . . . remain in-silo . . . are routed to crib-mounted retraction mechanisms . . . retracted prior to missile elevation . . . individual retractors due to large size . . .
- Umbilicals raised with elevator platform looped under platform . . . standard elevator practice . . .
- Main fuel and LOX lines . . . capable of automatic connection to missile . . . other umbilicals . . . connected by hand . . .

Shown are . . .

- Air conditioning retractor
- LOX and LOX vent retractors
- RP-1 retractors
- Umbilical loop
- Fuel vent retractor
- Spacers

UMBILICAL ROUTING



11. FACILITIES AND SERVICES

Recommended Launcher System facilities are . . .

- Silo . . . approximately 150 feet deep . . . 36.5 feet in diameter . . . built of reinforced concrete . . . an integral unit in event of ground disturbance . . . resistant to shear or cracking along length . . .

- Silo, floor of silo, door foundations . . . separate . . . loads taken by door frame not transmitted through silo shell . . . silo shell motions separate from floor . . . effectively isolates suspension system from ground shock . . .

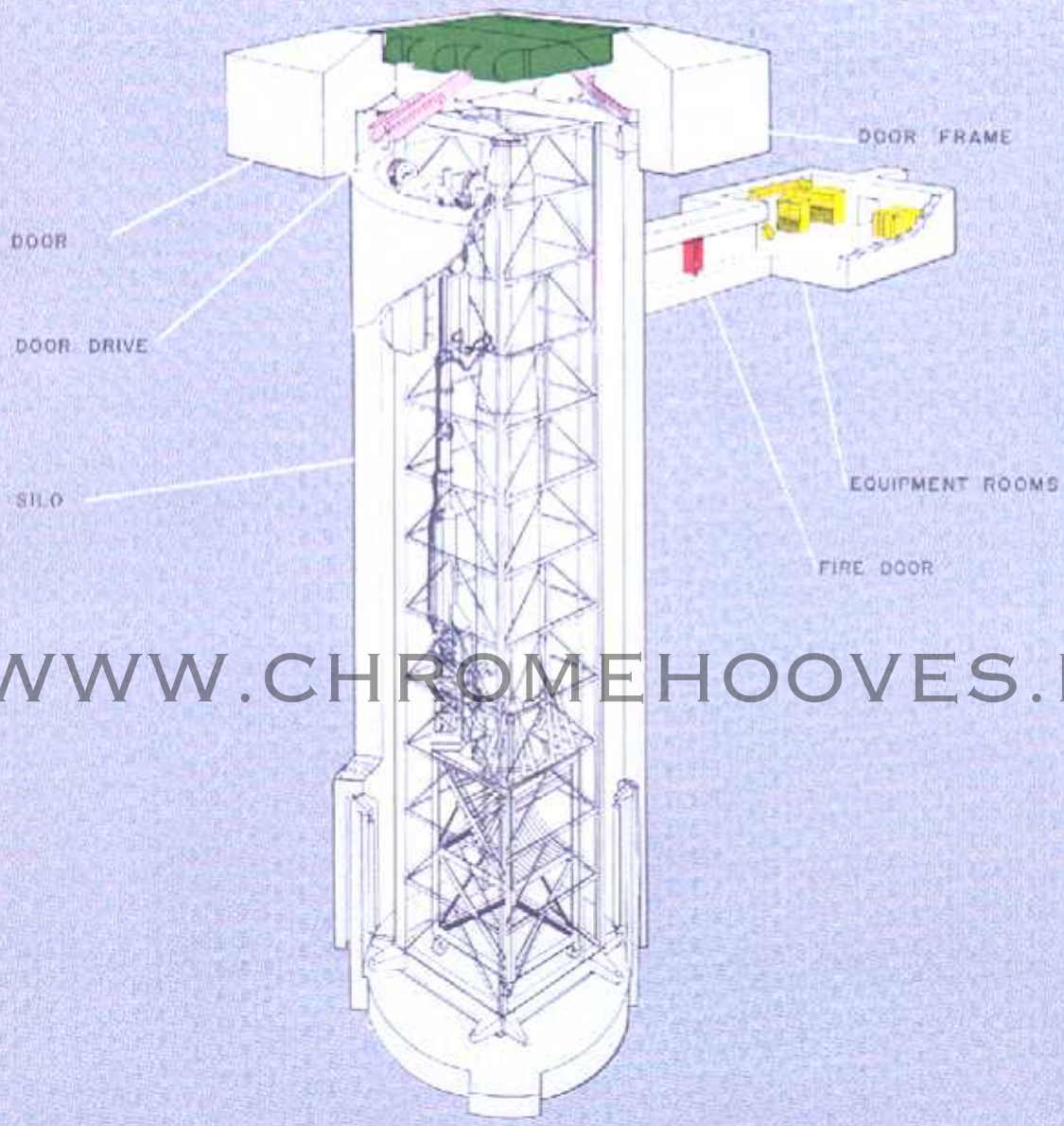
- Main closure door . . . concrete . . . double pivot type . . . hydraulically actuated . . . protects against nuclear blast effects . . . protects equipment from nuclear radiation . . . not a biological shield . . . also acts as environmental seal . . .

- Access tunnel . . . sized by silo equipment daily transporting largest missile module . . . 7 x 4 feet . . .

- Fire door in access tunnel . . . protects tunnel . . . equipment rooms, etc. . . . from fire in silo . . .

- Equipment rooms . . . contain power packages . . . hydraulic power pack . . . air compressor . . . electrical sequencing equipment . . .

FACILITIES & SERVICES

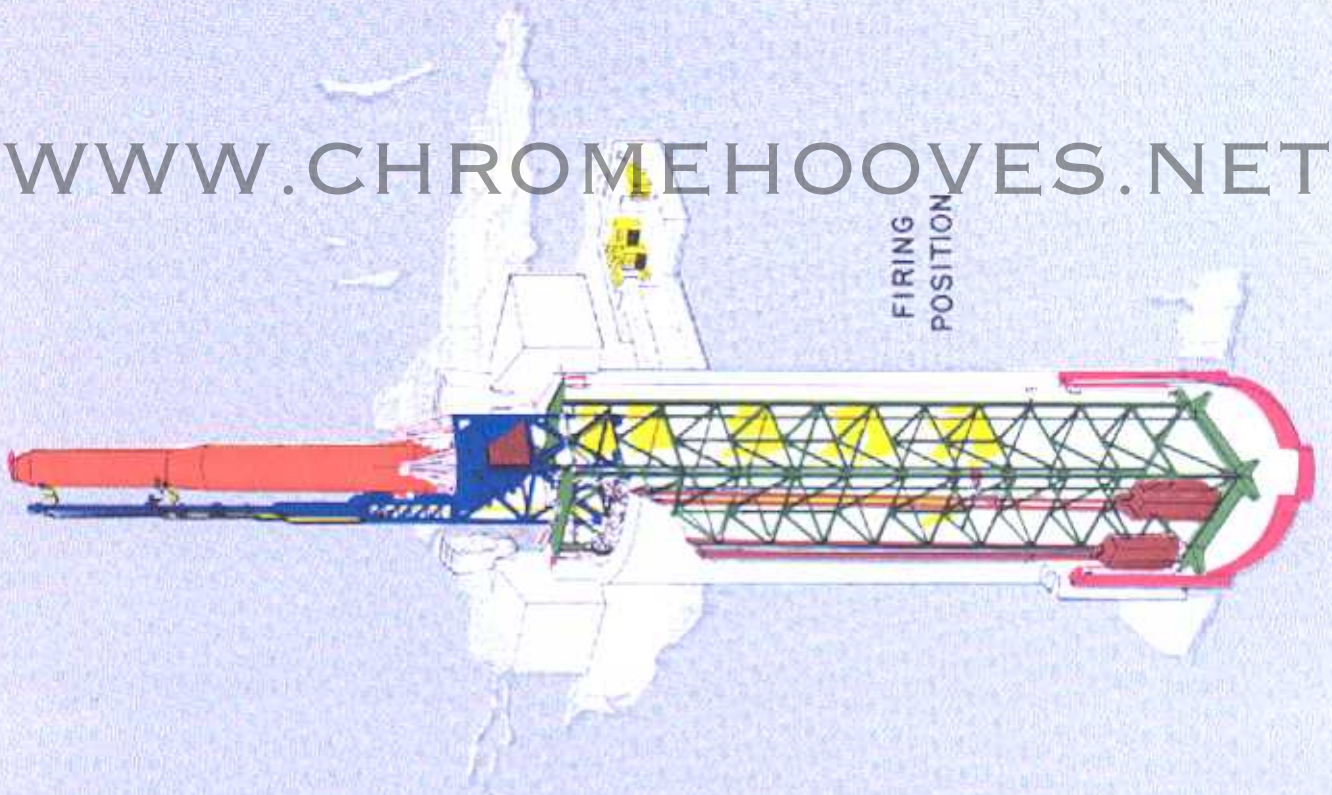


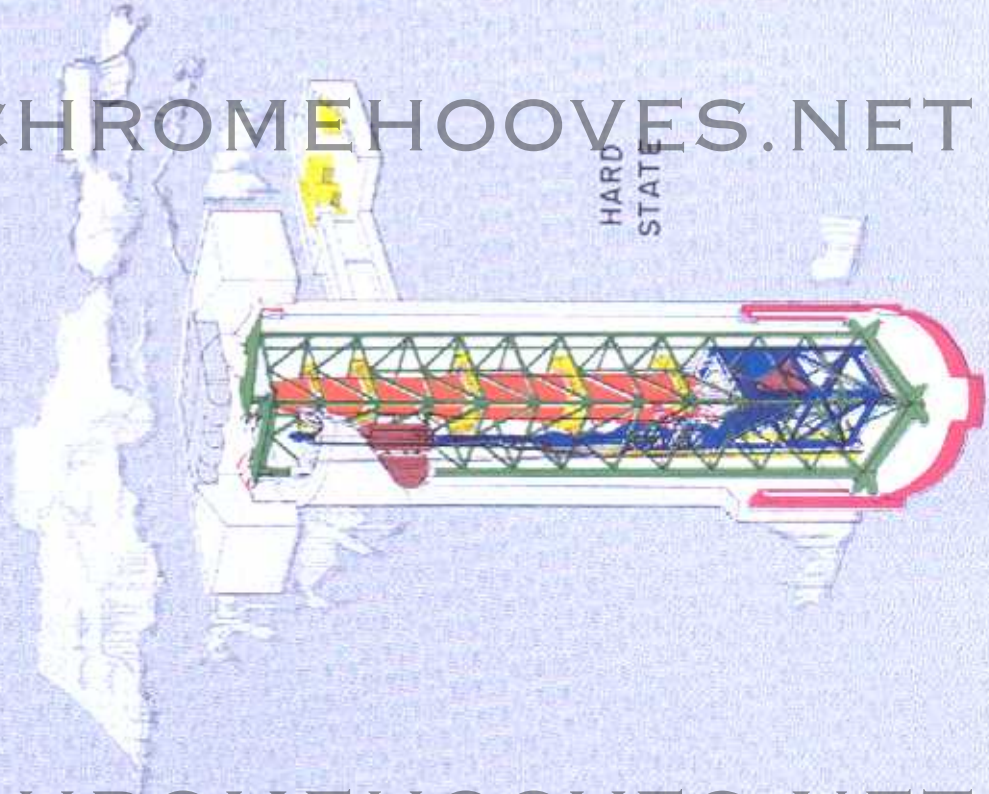
12. HARD STATE/FIRING

These artists conceptions show the Launcher System in the hard state as well as in the above ground, "ready-to-fire" state.

The hardware previously described is shown in greater detail . . .

- Silo
- Crib
- Elevator platform
- Missile support structure
- Suspension system
- Counterweights
- Umbilical tower
- Double pivot door
- Flame deflector
- Extended & retracted work platforms
- Umbilicals
- Equipment rooms





13. HANDLING EQUIPMENT

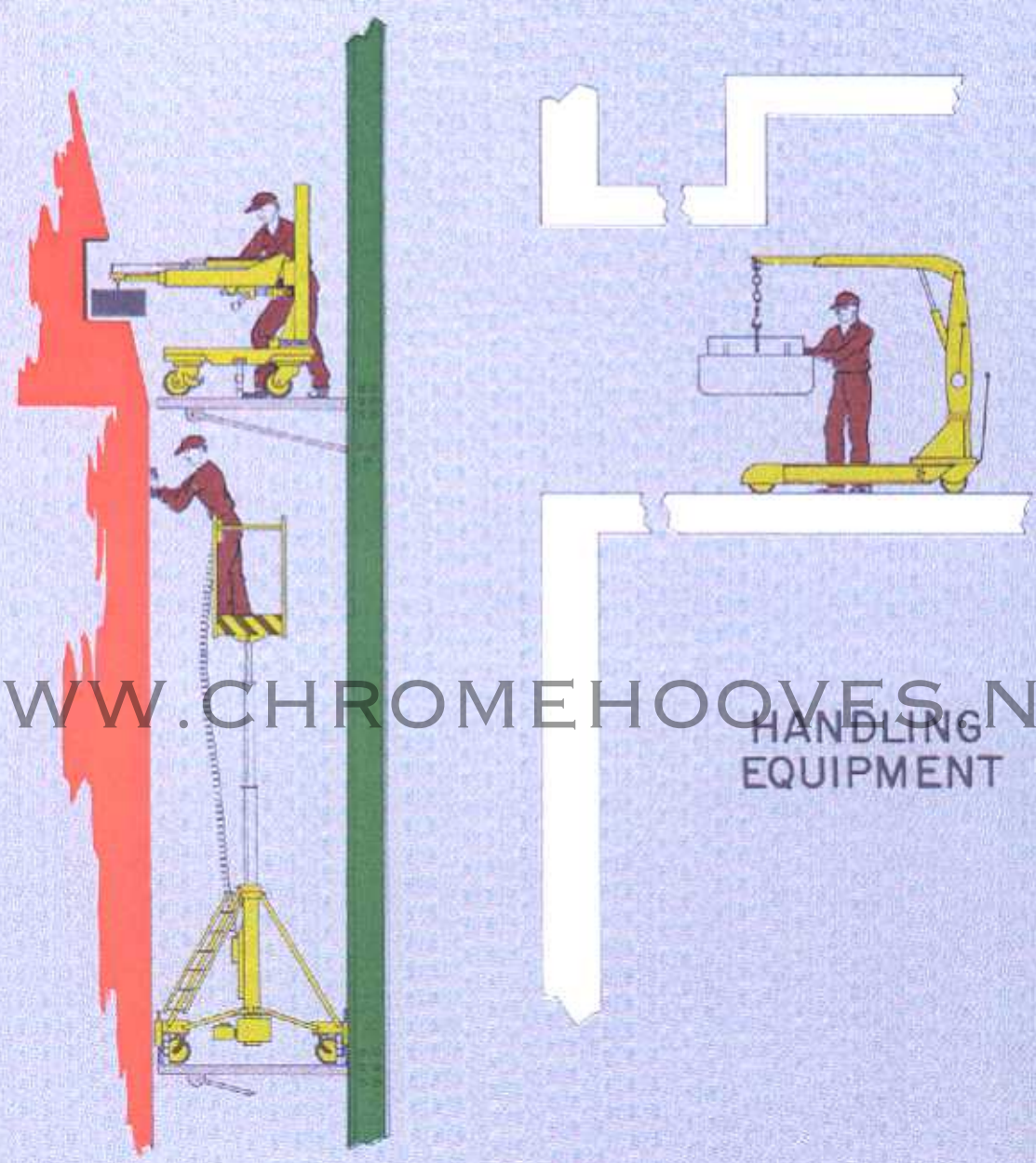
Handling equipment of various types supplements the missile launcher system . . .

- Truck crane . . . standard military vehicle . . . lifts individual stages from transtainers . . . erects stages to vertical position . . . deposits them on elevator platform . . . jacks provided for firm footing . . . guarding against vehicle sway . . . a tag line restraint system provides stability in winds for large, light missile stages . . .
- Auxiliary crane . . . standard military vehicle . . . equipped with extremely accurate vernier control device . . . nose cone lifted from transport vehicle in cradle . . . deposited on Stage II . . . provided with jacks for firm footing . . . guards against vehicle sway . . .
- Missile components dolly . . . transports various missile modular components . . . black boxes . . . a commercially available unit . . . modified for confined space operation . . . rolls on work platforms . . . in personnel elevator . . . through access tunnel . . .
- The shop crane . . . a commercial vehicle . . . is used to emplace modular components in the missile . . .

Other equipment consists of . . .

- Various transtainers . . .
- Portable work platform . . . for access to areas between permanent work platforms . . . commercial unit . . . modified for work in confined quarters . . . uses telescoping stand . . .
- Slings . . . adapters . . .
- Temporary platform structures . . . such as used at silo mouth . . . provided better communication among personnel . . . convenient single work level during important mating operations . . .

Many of these equipments are illustrated in use in the stage erection sequence following . . .



HANDLING EQUIPMENT

14. LOADING CYCLE—SILO MOUTH

To load the TITAN missile the transtainers containing the missile stages are brought out to the silo from the storage area . . . truck and auxiliary cranes arrive at silo . . . 15 minutes elapse . . . after the door is opened . . . to emplace the temporary silo mouth work platform . . . the auxiliary crane is used to accomplish this operation . . . meanwhile truck crane is utilized to remove protective coverings from the missile stages on their transtainers . . .