They Might Be... GIANTS

A History of Project NOVA 1959-1964 Part I

NOVA

By Keith J. Scala and Glen E. Swanson

NASA'S 4-ENGINE NOVA
Originally proposed 1959

1st STAGE
ENGINE - (4) F-1
FUEL - LOX/KEROSENE
WEIGHT - 4,800,000 LBS.
THRUST - 6,000,000 LBS.

2nd STAGE
ENGINE - (1) F-1
FUEL - LOX/KEROSENE
WEIGHT - 1,300,000 LBS.
THRUST - 1,700,000 LBS.

3rd STAGE
ENGINE - (4) LH2
FUEL - LOX/HYDROGEN
WEIGHT - 370,000 LBS.
THRUST - 320,000 LBS.

4th STAGE
ENGINE - (1) LH2
FUEL - LOX/HYDROGEN
WEIGHT - 150,000 LBS.
THRUST - 80,000 LBS.

5th STAGE
STORABLE PROPELLANT

LENGTH
260 FT.

TAKEOFF THRUST
6 MILLION LBS.

PAYLOAD TO LEO
150,000 LBS.

PAYLOAD TO ESCAPE
53,000 LBS.

Drawing Courtesy NASA

Welcome to an ambitious new series. Over the next three issues, we will attempt to explore a space program that paralled and, to a greater degree, exceeded that of Apollo. A project in which its planners confidently spoke beyond routine lunar landings to that of hurling over a million pounds into orbit and beyond to manned missions to Venus, Mars and the stars–all during a time when getting a man into space and back aboard a vehicle not much bigger than a phone booth seemed almost impossible.

It isn't well known, but before the days of the mighty Saturn V and other components of the Apollo program were ever designed and built, plans for an even larger series of launch vehicles and missions were considered under the generic name of Project Nova.

Considerably more powerful—one design had 18 engines larger than the Saturn 5's F-1 for its first stage while another developed almost 50 million pounds of thrust at lift-off—this series of giant Nova-class launch vehicles, if ever built, would have made the Saturn V look like a fire cracker!

Proposed during the early 1960s, a time when NASA's dreams were as unlimited as its budget, Project Nova was as big as its name. In addition to NASA's own designs, four major aerospace companies; Boeing, McDonnell Douglas, General Dynamics and Martin Marietta, submitted dozens of detailed designs for initial review. In July 1962, General Dynamics and Martin Marietta were chosen to do additional Nova studies. Various conceptual vehicle studies were considered which included advanced engine designs, vehicle assembly and launch facilities reviews. These plans for ships that never flew seem, even today, awesome in design.

Because of the sheer magnitude of the Nova Project, a considerable amount of material remains available to research for the space flight historian. During the course of our research, we have been able to obtain numerous documents from various NASA centers which has allowed us to compile this history. Even so, gaps remain in the Nova history when certain documents were unattainable.

When we originally began researching Nova, our intent was to produce a single article on the project's history. However, as more and more information became available we quickly realized that a single article could not possibly do justice to its extensive design history and development. This was especially apparent when reviewing they many detailed vehicle drawings which we felt would be essential to include. Indeed, the drawings more accurately tell the Nova story but because they occupy more space, to include all that we chose for the initial article would have filled an entire issue alone! As a result, we agreed to write the history of Nova as a series, presenting as many of the original Nova Project drawings and diagrams as possible.

As of this writing, we hope to be able to present the story of Nova in a 3-part series beginning with Part 1 in this issue. However, as we uncover additional information and materials, the series may extend further. For example, we currently do not have any data on the proposed Boeing or McDonnell Douglas Nova designs but if something should later be found, we certainly would like to include it in the series.

In Part 1 of this series, we will introduce the Nova Project, its early history and development along with an extensive review of both NASA's and General Dynamics' proposed conceptual vehicle designs.

Part 2 will continue to explore the history of Nova along with presenting Martin Marietta's Nova designs, the engines of Nova and a comparison of Nova to the Saturn family and the Soviet built N-1 series of launch vehicles. All will be accompanied by complete and detailed original drawings.

Finally, Part 3 will present various proposed Nova assembly and launch facility designs complete with extensive original drawings. The series will conclude by examining the possible use of Nova today and how a Nova-derived heavy launch vehicle could be employed in the (now defunct) National Launch System. We would also like to include a Nova "family portrait" that would include scale drawings of all Nova designs previously shown but assembled together for comparison in one composite poster or fold-out.

We are excited about his series and hope that you will be too. As always, we appreciate any comments and especially welcome feedback from readers that may have additional information on the Nova Project.

Nova and the Apollo Program

The idea of a Nova-size vehicle appeared as early as 1951 when the German rocket pioneer Wernher von Braun published his conceptual designs for a "monster moon rocket" that would take men to the surface of the Moon and back. Still six years before the launch of Sputnik, most did not take such ideas seriously.

In 1959 when the first studies for a manned moon mission were done, America had only two large launch ve-

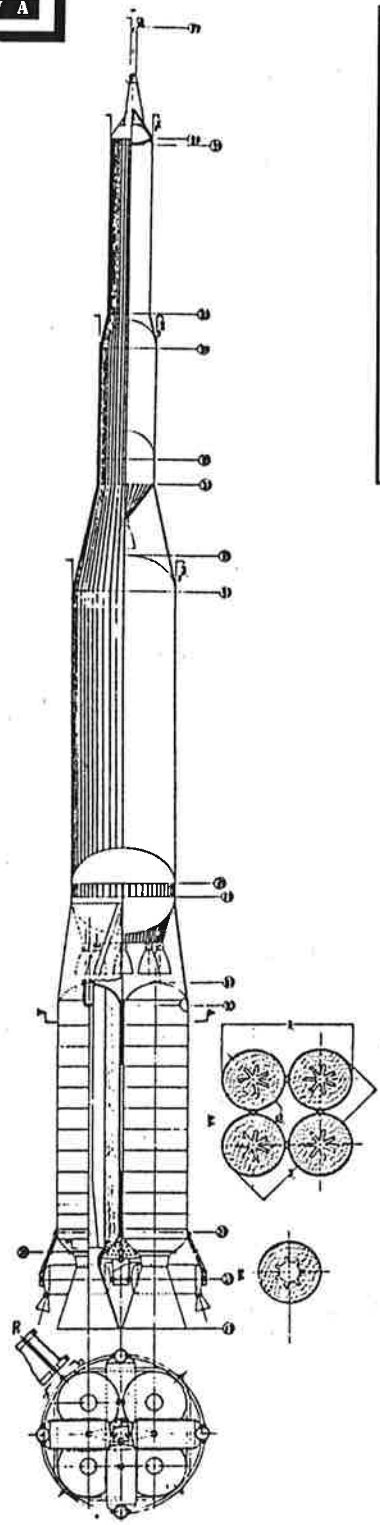
NOVA

NASA FEASIBILITY STUDY OF A SOLID

NASA'S 4-ENGINE SOLID NOVA
Originally proposed February 1962

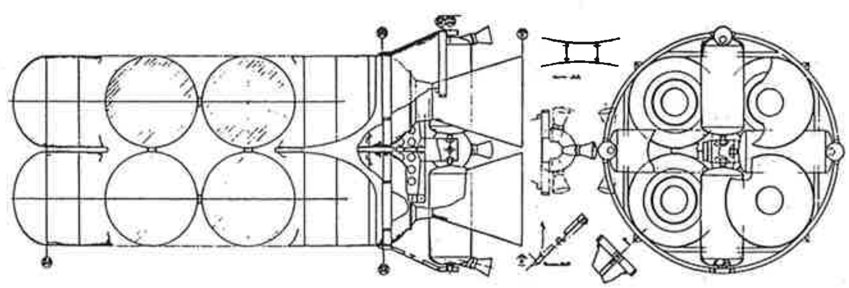
1st STAGE
FOUR 240-INCH DIAMETER SOLID ROCKET MOTORS
2nd STAGE
EIGHT J-2 ENGINES
3rd STAGE
ONE J-2 ENGINE
LENGTH
418 FT.

DIAMETER
41 FT.
TAKEOFF THRUST
20 MILLION LBS.
PAYLOAD TO LEO
435,000 LBS
PAYLOAD TO ESCAPE
166,000 LBS



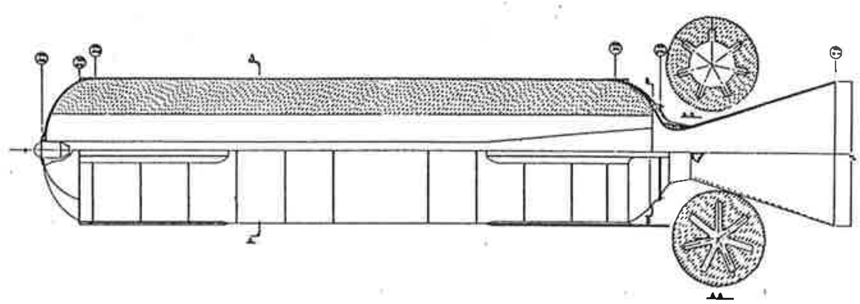
Assembly of solid NOVA first-stage 4-motor cluster design.

Drawing Courtesy NASA



Detail first-stage 4-engine solid fuel booster

Drawing Courtesy NASA



Detail 4-engine solid first-stage motor assembly

Drawing Courtesy NASA

SYMBOLS:

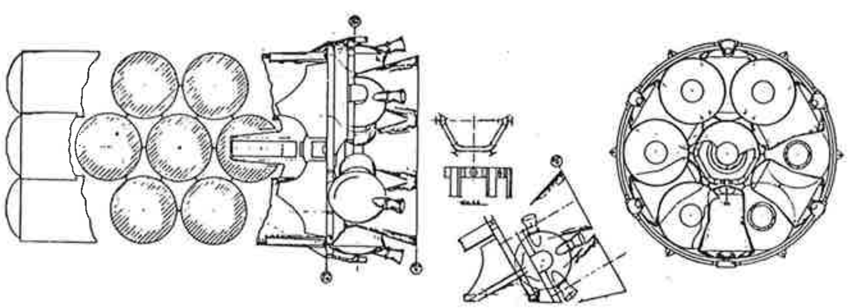
- Grain
- Buna-N-rubber
- Chopped glass - phenolic
- Graphite-cloth-phenolic
- Phenolic fiberglass
- Filament-wound glass
- Liner-fiberglass

D PROPELLANT FIRST STAGE FOR NOVA

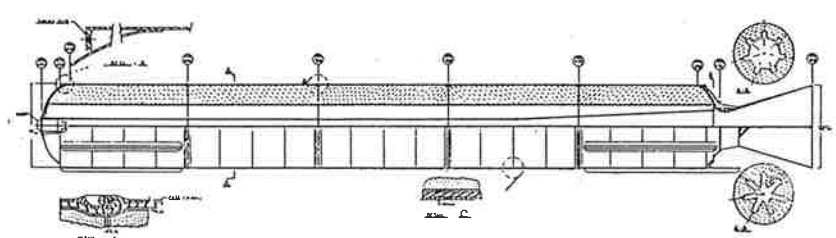
NASA'S 7-ENGINE SOLID NOVA
Originally proposed February 1962

1st STAGE
SEVEN 160-INCH DIAMETER SOLID ROCKET MOTORS
2nd STAGE
EIGHT J-2 ENGINES
3rd STAGE
ONE J-2 ENGINE
LENGTH
418 FT.

DIAMETER
42 FT.
TAKEOFF THRUST
20 MILLION LBS.
PAYLOAD TO LEO
435,000 LBS
PAYLOAD TO ESCAPE
166,000 LBS



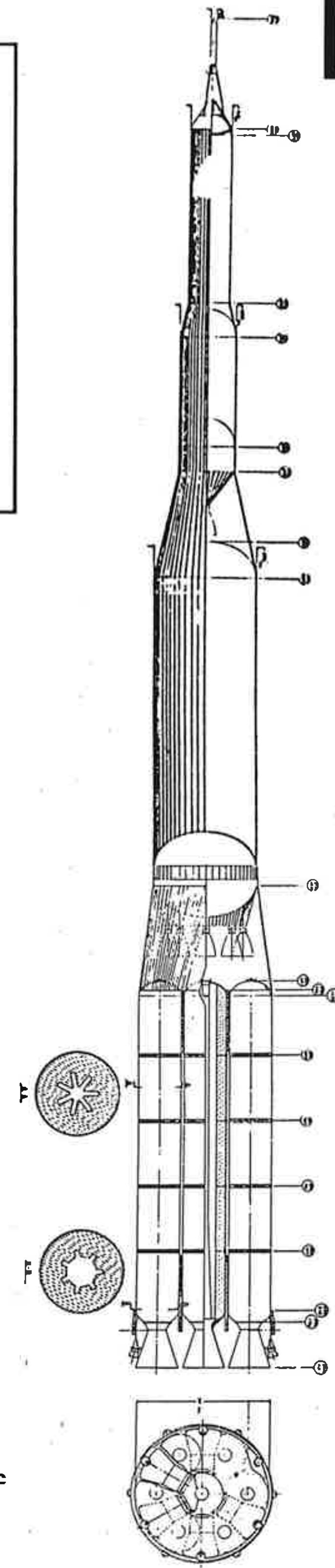
Detail first-stage 7-engine solid fuel booster
Drawing Courtesy NASA



Detail 7-engine solid first-stage motor assembly (segmented)
Drawing Courtesy NASA

SYMBOLS:

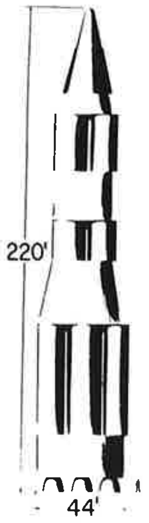
Grain
Liner
Buna-N-rubber
Phenolic fiberglass
Chopped silica rovings - phenolic
Graphite cloth - phenolic
Steel
Filament-wound fiberglass



Assembly of solid NOVA first-stage 7-motor cluster segemented design.
Drawing Courtesy NASA

NASA'S 6-ENGINE NOVA

Originally proposed 1961



1st STAGE
ENGINE - (6) F-1
FUEL - LOX/KEROSENE
WEIGHT - UNKNOWN
THRUST - 9,000,000 LBS.

2nd STAGE
ENGINE - UNKNOWN
FUEL - UNKNOWN
WEIGHT - UNKNOWN
THRUST - UNKNOWN

3rd STAGE
ENGINE - UNKNOWN
FUEL - UNKNOWN
WEIGHT - UNKNOWN
THRUST - UNKNOWN

LENGTH
220 FT.
DIAMETER
44 FT.
TAKEOFF THRUST
9 MILLION LBS.
PAYLOAD TO LEO
290,000 LBS.
PAYLOAD TO ESCAPE
100,000 LBS.

Drawing Courtesy NASA

hicles on the drawing board–the Atlas and Titan. Clearly, these vehicles did not have the lifting capacity needed for a serious manned lunar expedition. In January, a newly formed NASA proposed Nova to then President Eisenhower as a large extension to the Juno V-A and V-B (later called Saturn C-1 and C-5) family.

Nova existed prior to America's commitment to go to the Moon as a heavy-weight lifting vehicle capable of conducting such significant missions as the establishment of large space stations, the construction and logistic support of both manned and unmanned orbiting military platforms and the accomplishment of manned and unmanned interplanetary and planetary exploration. Once the space race began and President Kennedy committed our nation "to achieving the goal before before this decade is out of landing a man on the Moon and returning him safely to the Earth," NASA began to seriously consider using Nova as a means to help us fulfill this national goal.

With the advent of Project Apollo, Nova was introduced as a possible solution to the very big problem of how to get to the Moon fast, easy and cheap – and in that order of importance.

There basically evolved three schools of thought on how to get to the Moon; Direct Ascent, Earth Orbit Rendezvous and later Lunar Orbit Rendezvous. Each method had its own distinct advantages and disadvantages –all had their own devout supporters who felt that their way was the only way. Most outside of the space program realized that it was the final debate over how to go to the Moon that almost tour the whole program apart.

For many years, small boys pretending to be Buck Rogers knew exactly how to get to the Moon. First you get a big rocket that takes off from the Earth, and then when the rocket gets close enough to the Moon you turn it around and use its rocket engine as a brake. You got out and climbed down the ladder, explored for a while, climbed back up the ladder, and took off for Earth. When you got close to the Earth, you did the same thing all over again. In the parlance of Apollo, small boys pretending they were the first man on the Moon opted for the "direct ascent mode."

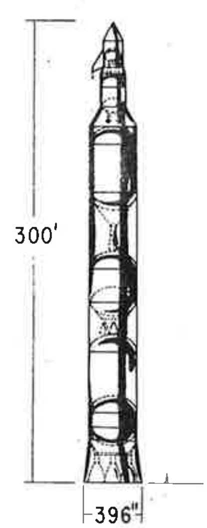
The vehicle that landed on the moon (it was assumed) had to be a large, self-contained rocket system, complete with crew quarters, on-board life-support systems, equipment for exploring the lunar surface, enough fuel to escape the Moon's gravity for the return to Earth and a heavy heat shield for surviving the 25,000 mph entry into the Earth's atmosphere. Lifting that much weight in a single launch called for a mammoth vehicle –a vehicle called Nova.

There was basically two variations considered using Earth Orbit Rendezvous, both involved the use of two Saturn V rockets. In one of them, the propellants for the lunar journey would be put into orbit by one Saturn V, then a complete but unfueled spacecraft would be launched by another Saturn V. Another variation called for the spacecraft itself to be launched in segments and assembled in space. In both scenarios, after assembly in Earth orbit the completed vehicles would then travel to the moon and back in a similar fashion to that described in the direct ascent mode.

The advantages of EOR, when NASA came to study it, was that it required a smaller launch vehicle (two Saturn Vs) that did direct ascent with one Nova. The disadvantages were considerable however. In addition to tricky orbital rendezvous, how exactly would you transfer large quantities of volatile liquids from the storage tanks to the spacecraft in the weightlessness and vacuum of space? And if instead the EOR scheme called for putting the spacecraft up in two or three segments,

NASA'S 4-ENGINE NUCLEAR NOVA

Originally proposed 1961



1st STAGE
ENGINE - (4) F-1
FUEL - LOX/RP
WEIGHT - UNKNOWN
THRUST - 6,000,000 LBS.

2nd STAGE
ENGINE - (4) J-2
FUEL - LOX/HYDROGEN
WEIGHT - UNKNOWN
THRUST - 800,000 LBS.

3rd STAGE
ENGINE - NUCLEAR
FUEL -HYDROGEN
WEIGHT - UNKNOWN
THRUST - UNKNOWN

LENGTH
300 FT.
DIAMETER
33 FT.
TAKEOFF THRUST
6 MILLION LBS.
PAYLOAD TO LEO
UNKNOWN
PAYLOAD TO ESCAPE
UNKNOWN

Drawing Courtesy NASA

NOVA VEHICLE SYSTEMS STUDY

PART I CONCEPTUAL DESIGN STUDY

March 15, 1963

REPORT NO. AE63-0096 CONTRACT NO. NAS8-5136

NOVA

NOVA MISSION STUDIES
B VEHICLE
F VEHICLE
E VEHICLE
J VEHICLE
H VEHICLE

GENERAL DYNAMICS | ASTRONAUTICS

GENERAL DYNAMICS

Planetary Missions

Mars Probe: A Voyager class vehicle with a weight of 150,000 pounds for high-resolution mapping.

Manned Mars Expedition: The Project Empire study would place 1 to 3 million pound vehicles in Earth orbit for a Mars fleet. After reaching Mars they would deploy unmanned craft to the moons of Mars and to the Surface. After which a manned landing module would be deployed for the first landing on Mars.

Martian Base: Building of a Mars base with Project Empire vehicles would continue with later missions. As much as 50 million pounds would be boosted into Earth orbit by several Nova launches to assemble a Mars base fleet.

Venus Probe: Modified Mars Voyager probe to do low-resolution radar mapping.

Manned Venus Orbiting Expedition: Using the Project Empire craft an expedition could enter Venus orbit to release a manned atmospheric entry vehicle. This vehicle would not land due to the high atmospheric pressure on Venus and then return to the orbiter. Unmanned probes could also be released to land and report back surface information.

Mercury Probe: A large unmanned lander with a surface rover. Earth orbital weight would be 800,000 pounds.

Manned Mercury Expedition: More information will be needed to determine if landing or orbital mission should be undertaken. 12 million pounds into Earth orbit would be required.

Jupiter, Saturn and Uranus Probes: Unmanned orbital missions can be accomplished to these planets with the option of landing on their moons.

Neptune & Pluto probes: A hyperbolic flyby of Jupiter and Saturn such as Voyager 1 and 2 was suggested to reach Neptune and Pluto.

Solar Probe Observatory: One Nova could place three to six solar probes inside the orbit of Mercury. This network could observe the Sun from all sides and at least one probe would be in contact with Earth while the others are blocked by the Sun. All probes could relay their information to Earth through the nearest probe to Earth. 1.2 million pounds into Earth orbit would be required for this mission.

Extraecliptic probe: A probe to explore outside the plane of the Solar System would use a hyperbolic encounter with Jupiter to change it's orbital plane. This idea is the same as the current Ulysses probe. 1 to 1.5 million pounds in Earth orbit would be Needed.

Interstellar probe: An probe to map the boundaries of the Solar System while on a escape trajectory.

Lunar Operations

Manned Lunar Orbital Base: A Lunar orbital station could be launched with a Earth orbital weight of 55,000. pounds. The orbital station with a six man crew could relay information from any place on the Moon to Earth by using ten relay communications satellites. High-resolution mapping of the Moon could also be done and support for a lunar surface base.

Lunar Exploration: A lunar surface base would support surface exploration on the Moon. Exploration could be accomplished by surface vehicles or ballistic vehicles with a range of 1,470 nautical miles.

Lunar Surface Astronomical Observatory: A optical observatory on the Moon would have no atmosphere to obstruct observations. The Lunar surface is also very stable and would serve as a steady platform to point optical instruments. A radio observatory on the far side of the Moon would be shielded from Earth's radio noise.

Exploration of Lunar resources: Lunar resources could support the construction of a Lunar base.

Lunar Weapon System: Lunar base defense system using ballistic missiles.

Lunar Transport Requirements: Nova could resupply and transport personnel to a 200 manned base or two 100 manned bases.

; MISSIONS FOR NOVA*

Unmanned Earth Orbital Operations

Reconnaissance/Surveillance System: A single Nova would lift 100 reconnaissance satellites weighing 3000 pounds each into a polar orbit. These reconnaissance satellites would take high-resolution over the entire globe.

AICBM Systems: Two different systems would intercept ballistic missiles that may be fired at the United States. The BAMBI system would launch 200 interceptor vehicles in a 1 million pound payload. 14 Novas would launch a total of 2800 interceptors in the BAMBI system. An advanced system would take 8 Nova boosters and use nuclear warheads.

Anti-Satellite Systems: 40 anti-satellite vehicles would be launched into a 1000 nautical mile orbit to intercept hostile satellites, each vehicle would weigh 6000 pounds. Two Novas would launch these vehicles into orbits 90 degrees apart.

Orbital Bombardment System: The OBS system would use three Novas to orbit platforms with nuclear re-entry warheads to destroy Earth surface targets. Another version of this system would use eight Novas to launch platforms with warheads that would be detonated at near orbital altitude above their targets.

Large Orbital Antenna: RATIO (Radio Telescope in Orbit) could have the following uses: radio astronomy, deep space communications and tracking, ICBM launch tracking, active and passive COMSAT, space surveillance, solar energy concentration, weather radar, radar mapping of Earth, battlefield reconnaissance and radiation weapon. RATIO would be 5000 feet in diameter and weigh 2.5 million pounds.

Countermeasure System: A network of satellites could jam hostile radar and communications.

Excess Payload Capability: Could be used to orbit POM (Propellant orbiting modules) for orbital fueling of spacecraft.

Orbital Retrieval Operations: Retrieval of disabled manned spacecraft, inspection of enemy satellites and orbital debris removal could be accomplished by using the Nova second stage. By adding a heat shield to the second stage the recovered satellite could be returned to Earth.

Large Orbiting Objects: Payloads that can only be lifted by a vehicle with Nova's capacity.

Secondary Orbital Missions: Some primary payloads may not completely fill Nova's capacity so secondary payloads could be added to round out a Nova launch. Three unmanned secondary payloads could be considered: Meteorological system, Navigational aid system and Communications system

Manned Earth Orbital Missions

Command and Control System: Seven manned control stations in polar orbit could command smaller maneuverable manned spacecraft and unmanned spacecraft against ICBMs or hostile satellites. The Nova booster can place 600,000 pounds in a polar orbit from Cape Canaveral using a dogleg flight path. Each station would weigh 300,000 pounds so four Novas would be needed.

Logistic Support Station: This station would provide support for the assembly and testing of lunar and interplanetary manned vehicles. Space tugs would be used by the station to perform the needed work. The station would have a complement of forty men with a total weight of 800,000 pounds.

Manned Monitoring and Maintenance Vehicles: A two manned vehicle weighing 30,000 pounds could perform up to 30-degree plane changes. This vehicle would repair an unmanned orbital system such as BAMBI. Nova could orbit ten of these vehicles with a control station using a single Nova.

Manned Space Stations: These space stations could perform the following tasks: test and development laboratory, research and development laboratory, astronomical observatory and biomedical station.

*In addition to their submitted Nova designs, General Dynamics completed this ambitious study on September 21, 1963 that identified possible mission uses for Nova. In retrospect, many of these seem ambitious for that time. However, observers should note that some suggested ideas, such as using Nova to help build a manned space station, would today be a welcome solution if such a heavy-lift vehicle existed.

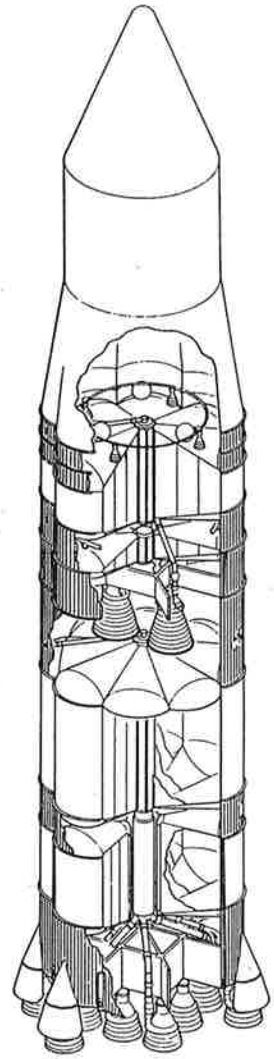
GENERAL DYNAMICS CATEGORY B VEHICLE

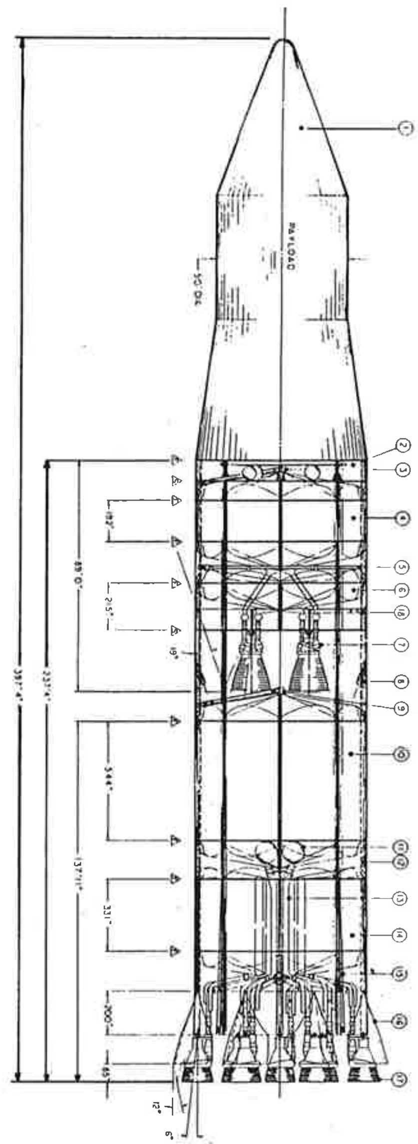
NOVA

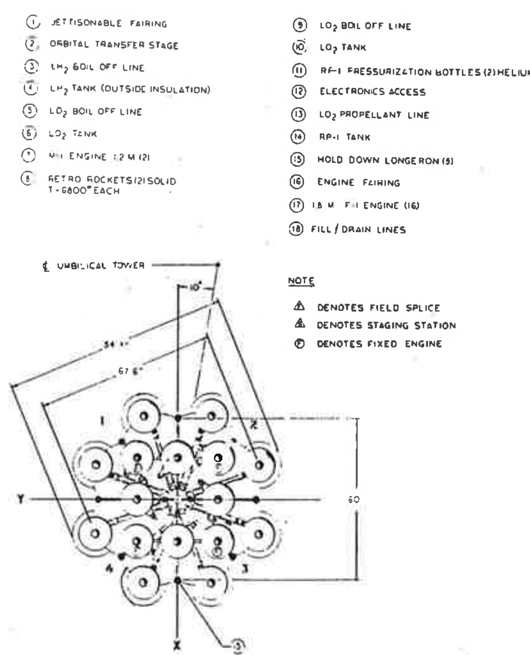
All Drawings Courtesy General Dynamics

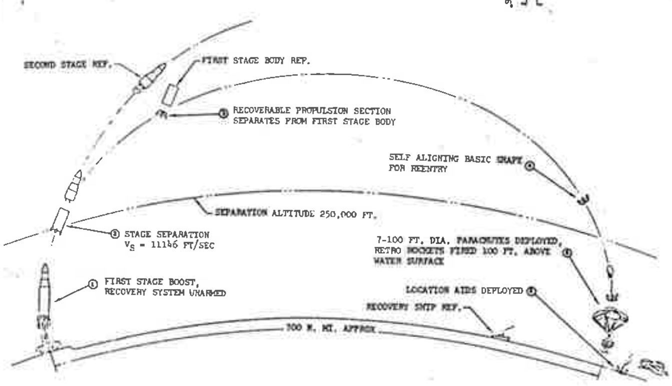
1st STAGE
(16) F-1A ENGINES
2nd STAGE
(2) M-1 ENGINES
LENGTH
397 FT.
DIAMETER
68 FT.
TAKEOFF THRUST
28 MILLION LBS.
PAYLOAD TO LEO
744,800 LBS

A unique feature of this vehicle is the capability of including recovery of the engines only, the thrust structure or an entire stage as shown in the recovery diagrams below.

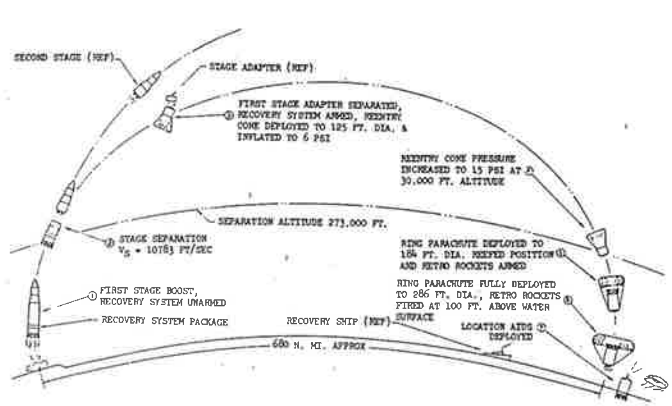








Recovery Sequence, Propulsion Section

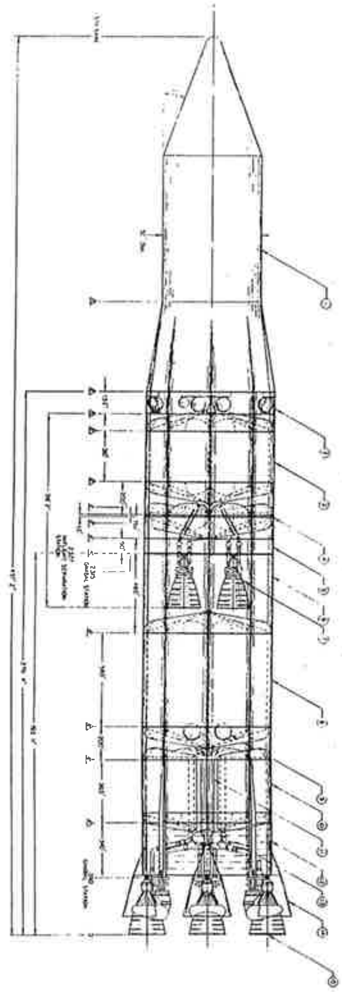


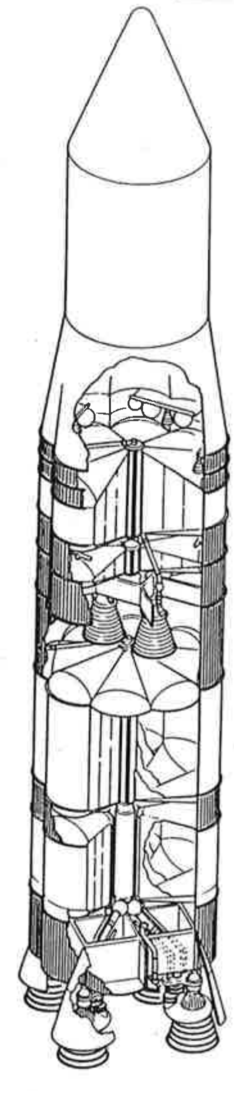
Recovery Sequence, Stage Recovery

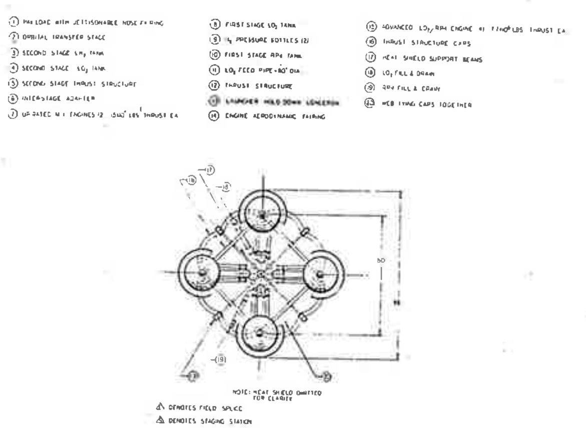
GENERAL DYNAMICS CATEGORY F VEHICLE

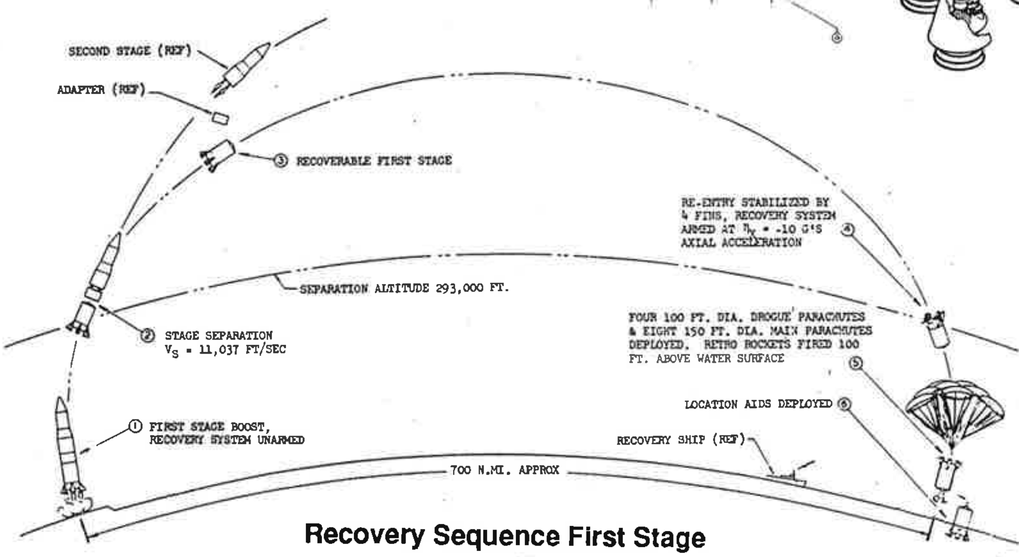
All Drawings Courtesy General Dynamics

1st STAGE
(4) ADVANCED LOX/RP-4 ENGINES
(7.7 MILLION IBS.THRUST EACH)
2nd STAGE
(2) M-1 ENGINES
LENGTH
457 FT.
DIAMETER
60 FT.
TAKEOFF THRUST
30.8 MILLION LBS.
PAYLOAD TO LEO
1,000,000 LBS





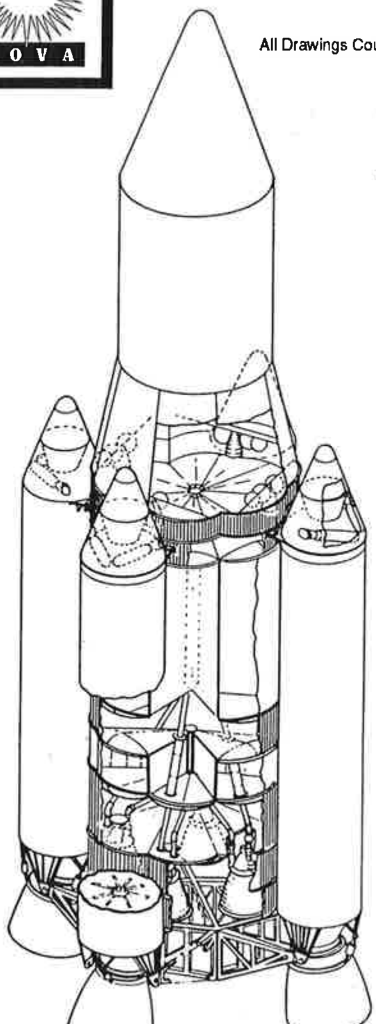


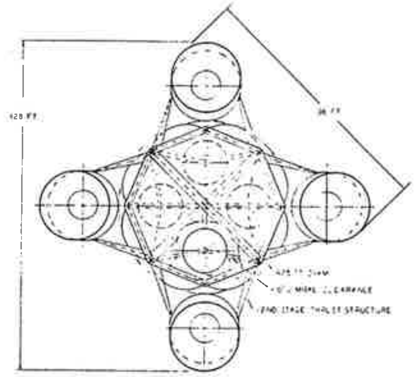


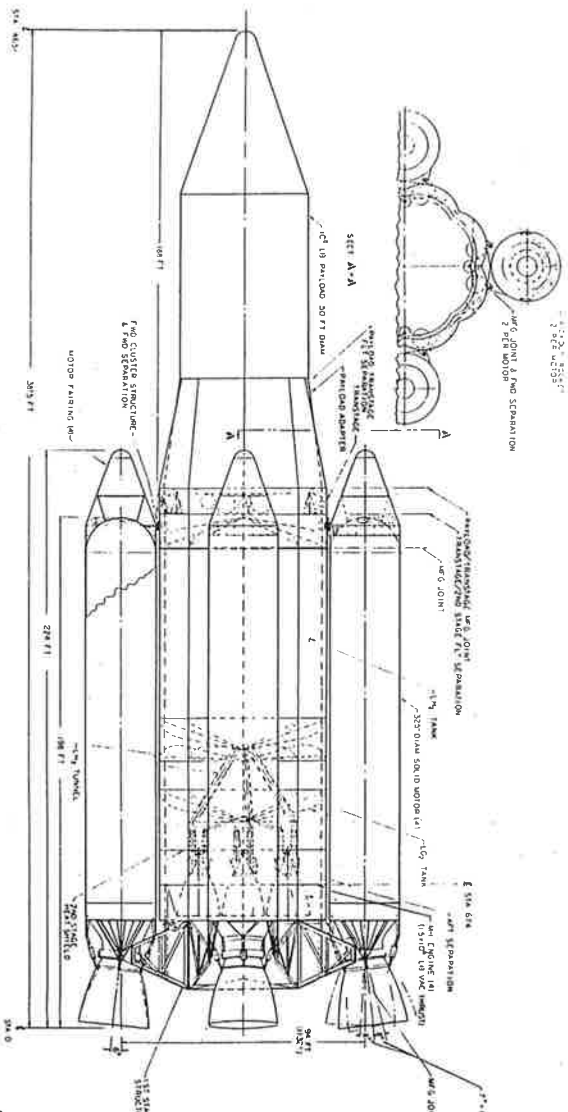
Recovery Sequence First Stage

GENERAL DYNAMICS

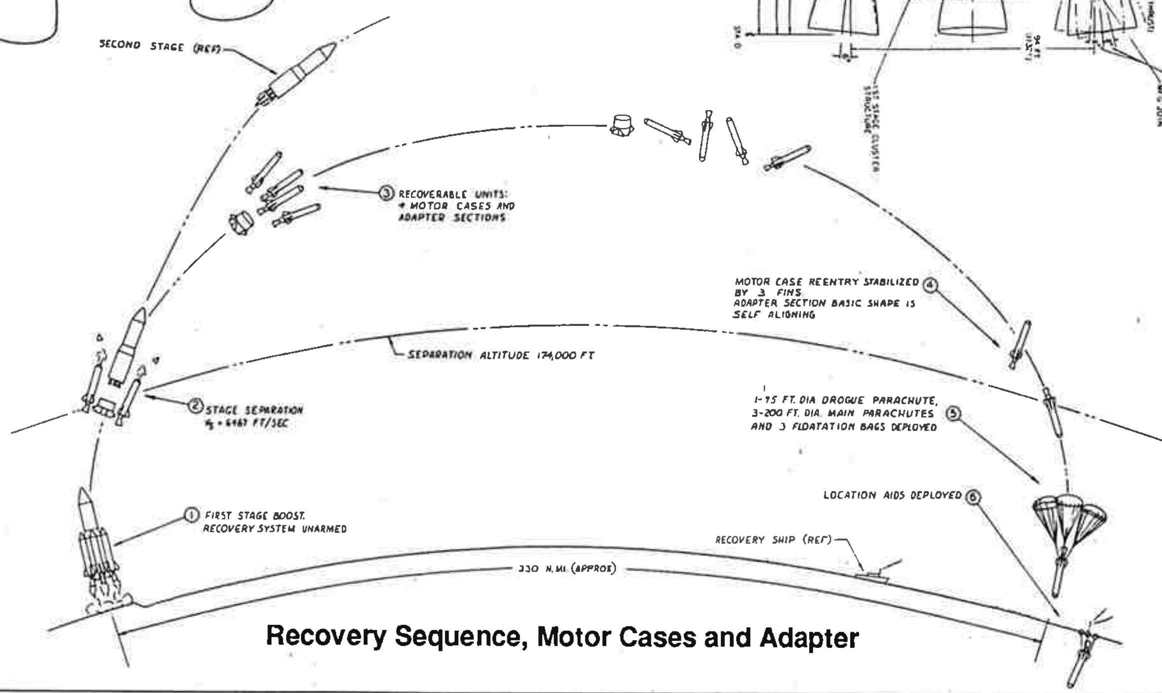
All Drawings Courtesy General Dynamics







1st STAGE
(4) 325-INCH SOLID MOTORS
2nd STAGE
(4) M-1 ENGINES
LENGTH
387 FT.
DIAMETER
67 FT.
TAKEOFF THRUST
UNKNOWN
PAYLOAD TO LEO
1,010,000 LBS

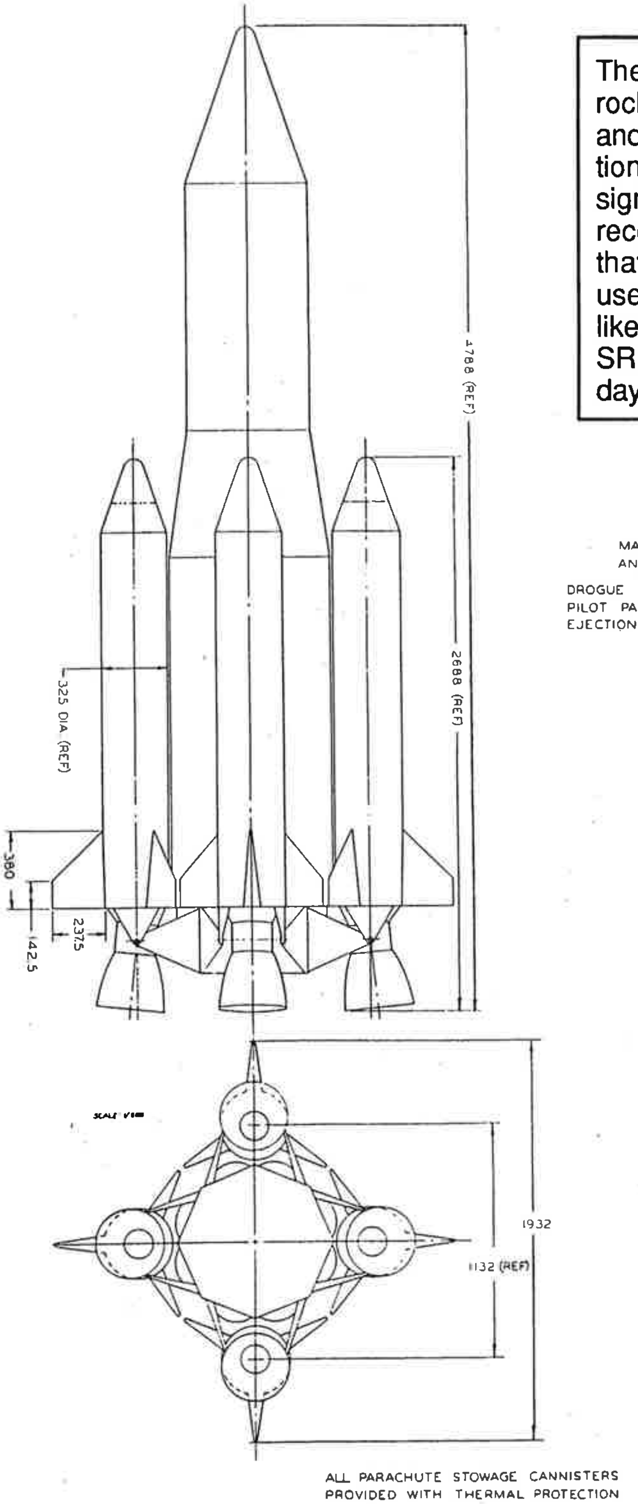


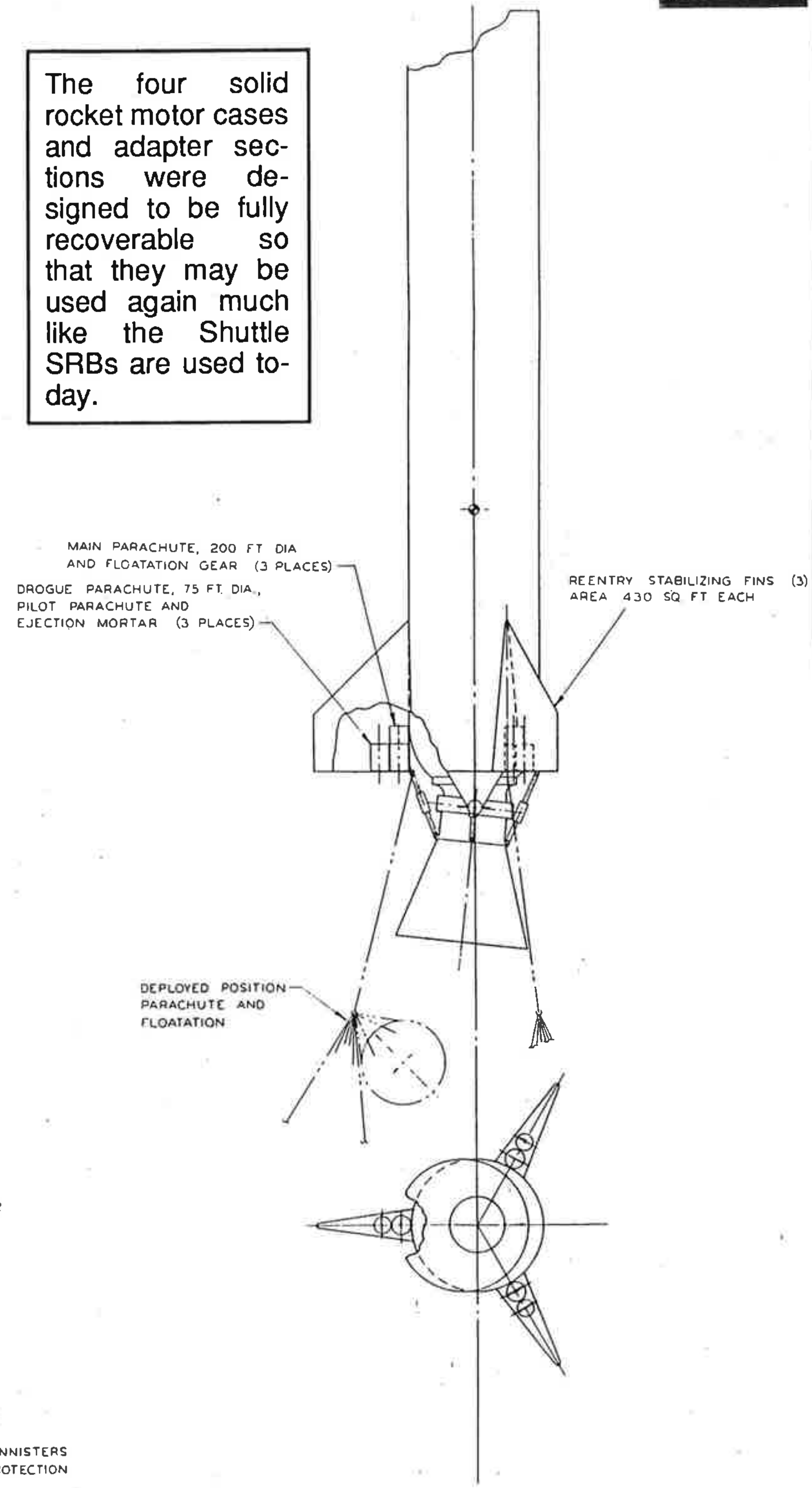
Recovery Sequence, Motor Cases and Adapter

CATEGORY E VEHICLE

All Drawings Courtesy General Dynamics

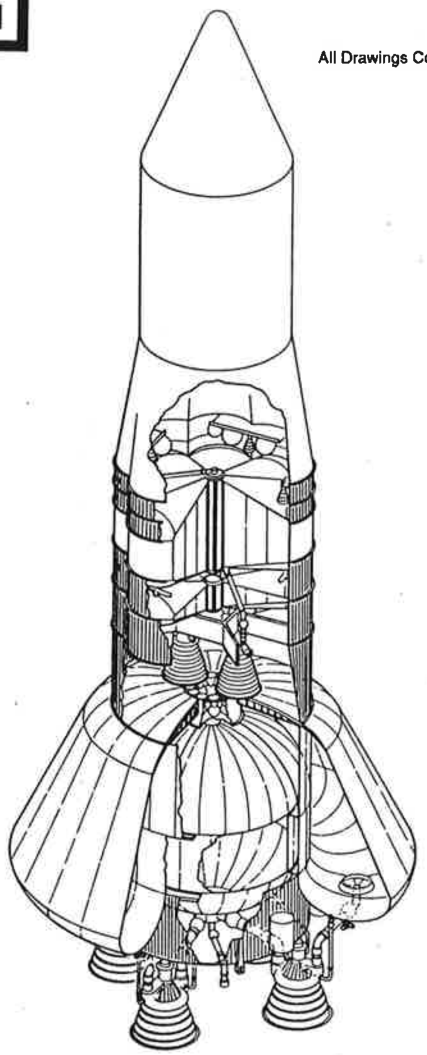
The four solid rocket motor cases and adapter sections were designed to be fully recoverable so that they may be used again much like the Shuttle SRBs are used today.

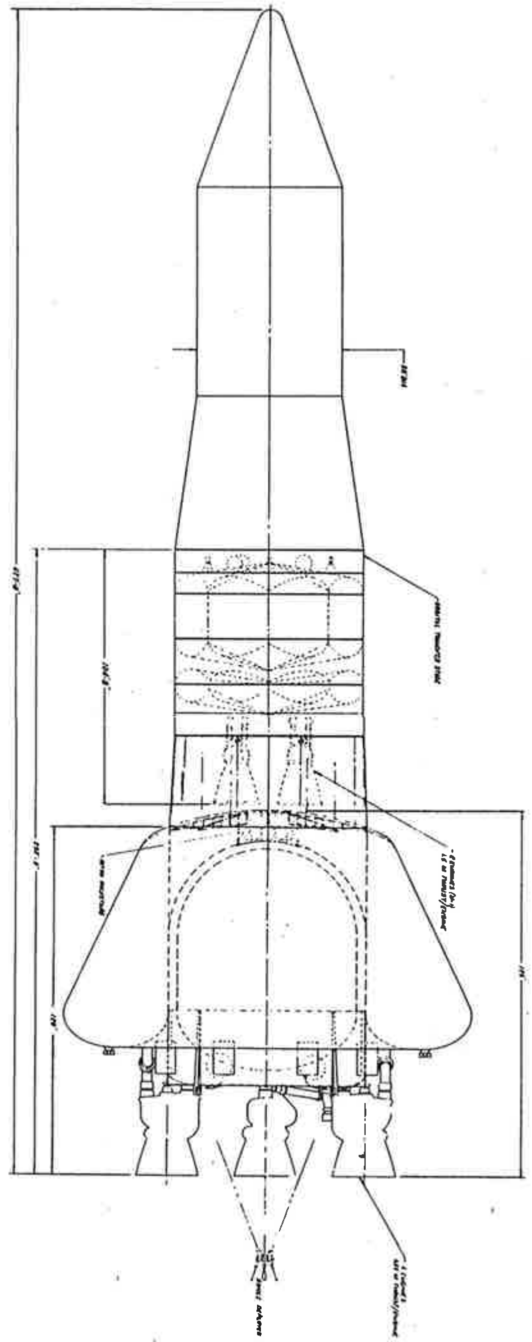


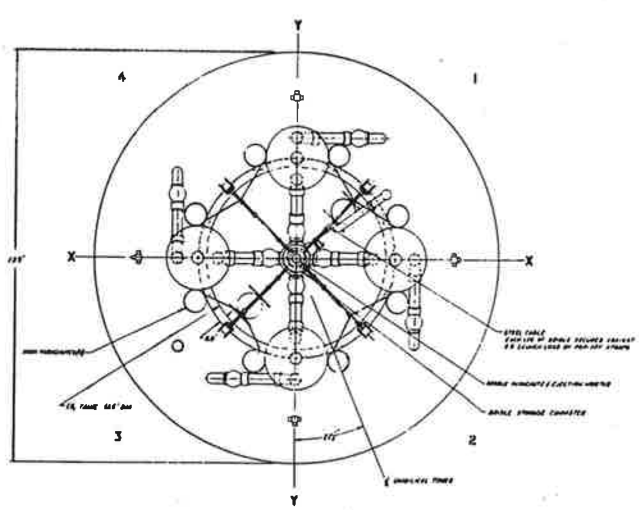


GENERAL DYNAMICS

All Drawings Courtesy General Dynamics

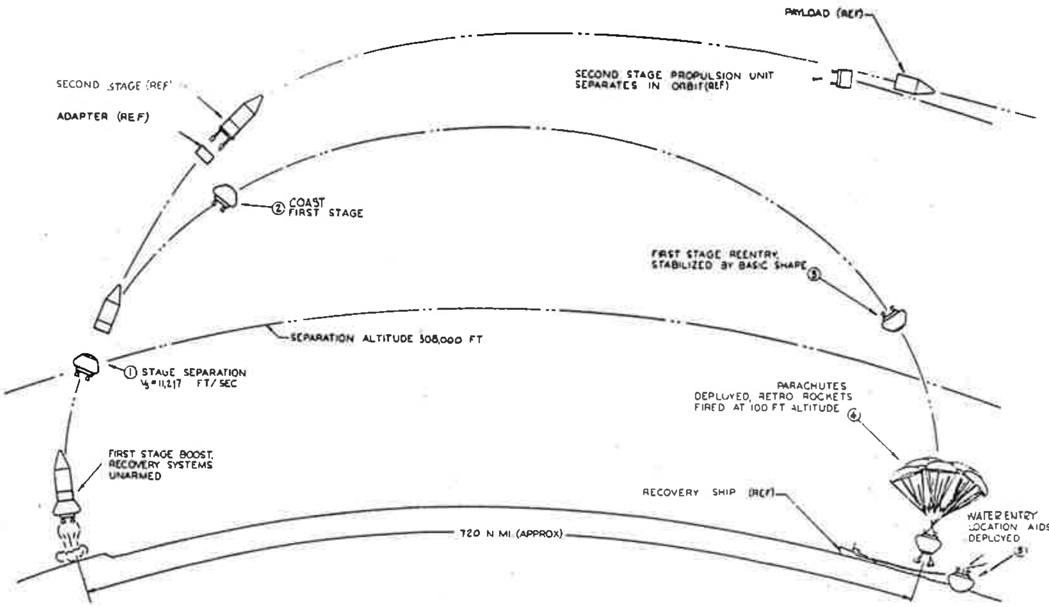




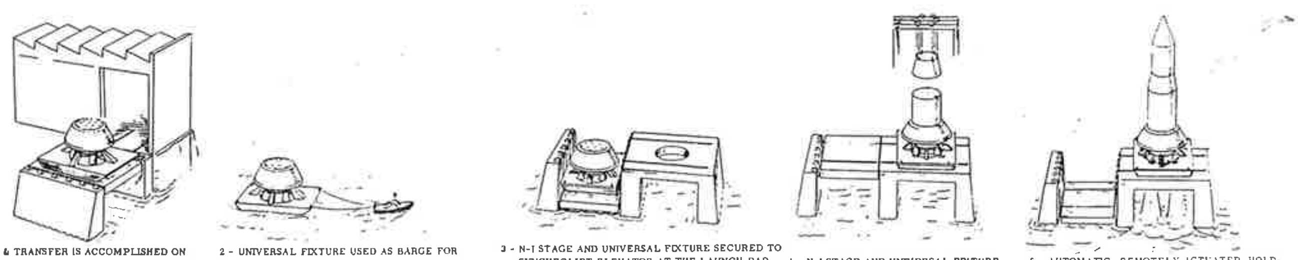


CATEGORY J VEHICLE

1st STAGE (4) 6.55 ENGINES **2nd STAGE** (2) M-1 ENGINES **LENGTH** 421 FT. **DIAMETER** 139 FT.	**TAKEOFF THRUST** 26.2 MILLION LBS. **PAYLOAD TO LEO** UNKNOWN **PAYLOAD TO ESCAPE** 443,600 MILLION LBS.



Recovery Sequence



1 - ASSEMBLY & TRANSFER IS ACCOMPLISHED ON UNIVERSAL TRANSPORTER/ASSEMBLY FIXTURE. COMBINED UNIT IS MOVED ON ROLLERS ABOARD SYNCHROLIFT ELEVATOR FOR LOWERING TO DOCK BASIN WATER SURFACE.

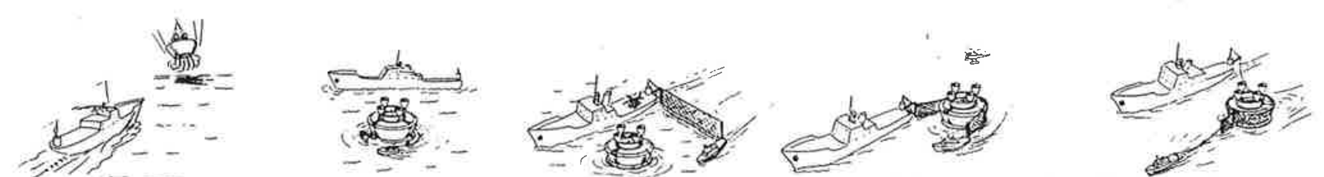
2 - UNIVERSAL FIXTURE USED AS BARGE FOR TOWING TO LAUNCH PAD.

3 - N-I STAGE AND UNIVERSAL FIXTURE SECURED TO SYNCHROLIFT ELEVATOR AT THE LAUNCH PAD.

4 - N-I STAGE AND UNIVERSAL FIXTURE MOVED TO LAUNCH POSITION AND SECURED. N-II AND PAYLOAD INSTALLED ON N-I USING MULTI-HOOK SYNCHROHOIST MECHANISM.

5 - AUTOMATIC, REMOTELY ACTUATED HOLD-DOWN MECHANISM INSTALLED. SYNCHROLIFT ELEVATOR PLATFORM RETURNED TO BOTTOM OF BASIN. VEHICLE LAUNCHED.

N-I Universal Transport/Assembly Fixture Applications



6 - PARACHUTES & RETRO ROCKETS USED TO SLOW RATE OF DESCENT. HOMING DEVICES GUIDE RECOVER TASK FORCE TO POINT OF IMPACT.

7 - SURFACE CRAFT SECURE AUXILIARY FLOATATION GEAR TO STAGE TO MAINTAIN ENGINE-UP VERTICAL POSITION.

8 - RETRIEVAL GEAR DEPLOYED.

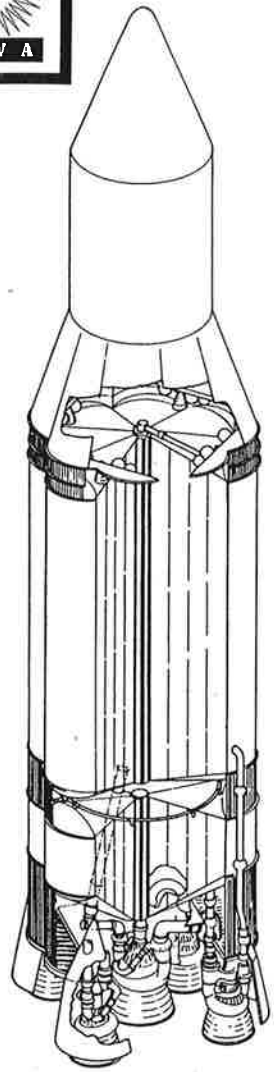
9 - RETRIEVAL & TOWING GEAR MADE SECURE FOR VOYAGE TO REFURBISHING AREA.

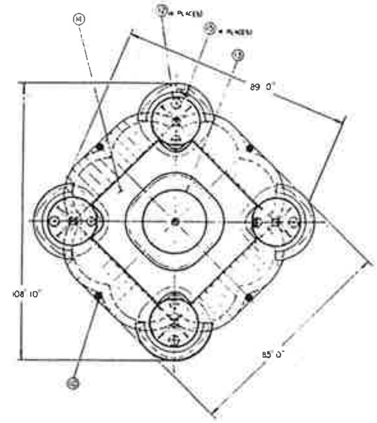
10 - N-I STAGE IN TWO. PURGE OF TANKS ACCOMPLISHED UNDERWAY. NECESSARY REPAIRS OF EMERGENCY NATURE MADE EN-ROUTE AS RESULT OF PRELIMINARY INSPECTION ACCOMPLISHED DURING STAGES 7-9.

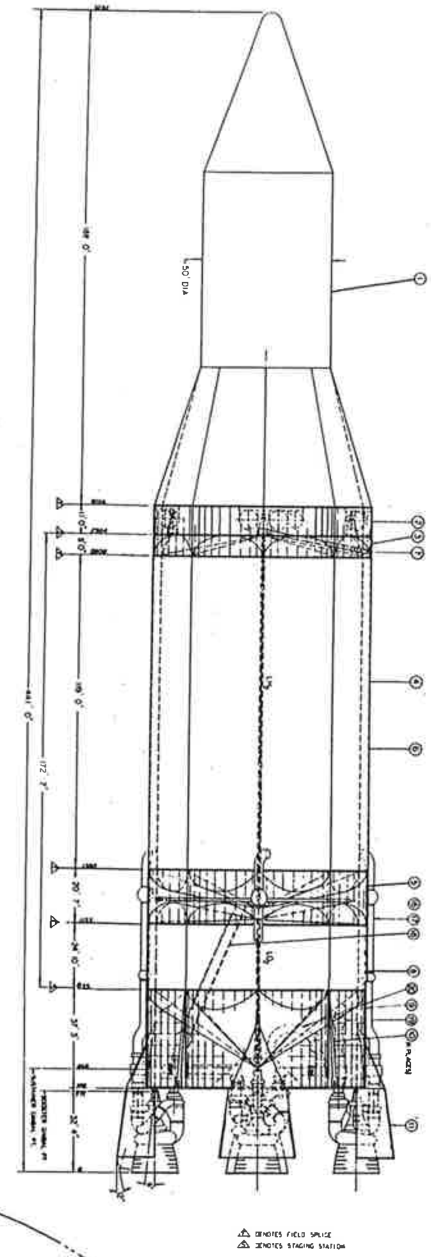
All Drawings Courtesy General Dynamics

GENERAL DYNAMICS CATEGORY H VEHICLE

NOVA



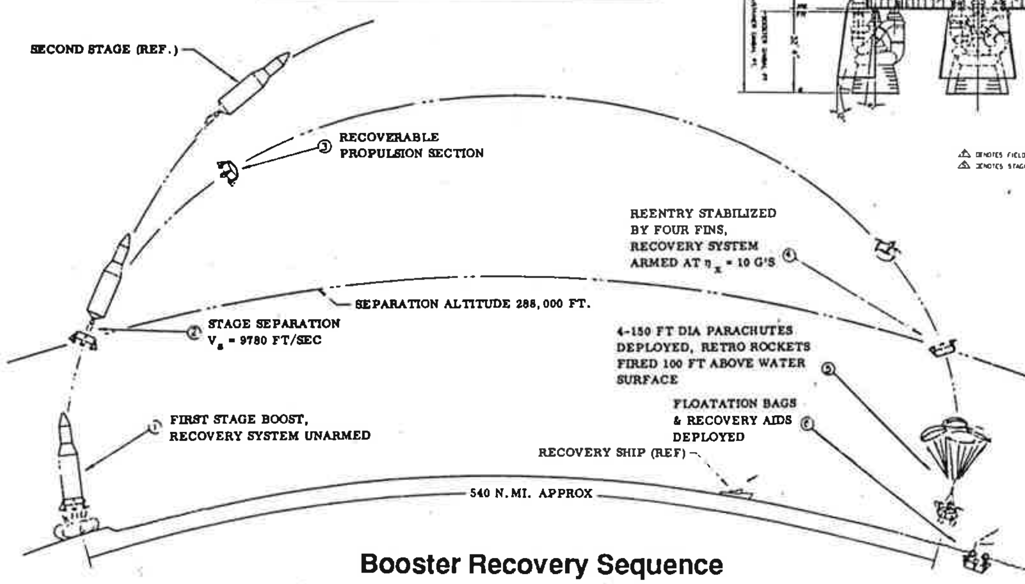




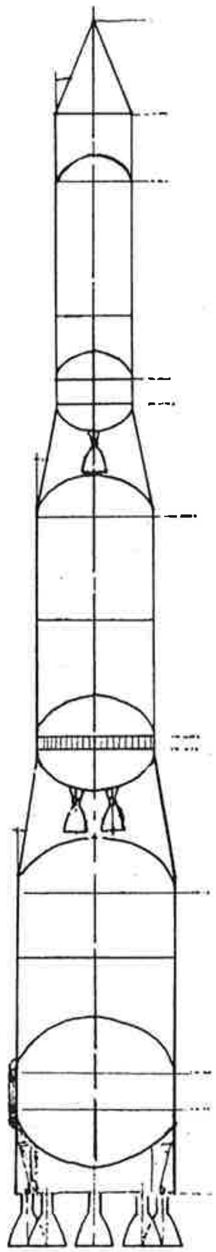
1. PAYLOAD
2. ORBITAL TRANSFER STAGE
3. INTERSTAGE ADAPTER
4. LH_2 TANK
5. LH_2-LO_2 INTERTANK ADAPTER
6. LH_2 TANK INSULATION
7. LH_2 BOIL-OFF LINE
8. LO_2 TANK
9. THRUST STRUCTURE
10. LAUNCH HOLD DOWN LONGERON
11. ENGINE FAIRING
12. L-5.25H ENGINE (E-35)
13. L-5.00H ENGINE (E-60)
14. HEAT SHIELD (HORIZ)
15. HEAT SHIELD (INSIDE FAIRING)
16. LO_2 BOIL-OFF LINE
17. LH_2 BOOSTER SUPPY LINE
18. LH_2 SUSTAINER SUPPLY LINE
19. LO_2 BOOSTER SUPPY LINE
20. LO_2 SUSTAINER SUPPLY LINE

All Drawings Courtesy General Dynamics

1st STAGE
(4) L-5.25H (L02/H2)
2nd STAGE
(1) L-5.00H (L02/LH2)
LENGTH
441 FT.
DIAMETER
89 FT.
TAKEOFF THRUST
23,500,000 LBS.
PAYLOAD TO LEO
1,000,000 LBS



Booster Recovery Sequence



NASA'S 8-ENGINE NOVA
Originally proposed June 1960
1st STAGE
(8) F-1 ENGINES
2nd STAGE
(2) M-1 ENGINES
3rd STAGE
(1) J-2 ENGINES
LENGTH
396 FT.
DIAMETER
59 FT.
TAKEOFF THRUST
12 MILLION LBS.
PAYLOAD TO LEO
400,000 LBS.
PAYLOAD TO ESCAPE
150,000 LBS.

what were the actual engineering devices whereby these segments were to be connected in outer space, ready for lunar voyage?

Finally, Lunar Orbit Rendezvous was a relatively new method of getting to the moon proposed by a group of engineers at NASA's Langley Research Center. LOR involved the use of a single Saturn V that would launch the Apollo spacecraft, including a lunar lander, into orbit around the Moon. Two men in the lunar lander would then descend to the Moon and later rendezvous with the main spacecraft in lunar orbit before returning to the Earth. This proposed mode created intense infighting within NASA but eventually became the accepted method . In Part 2 we will learn how this proposed mode helped contributed to Nova's eventual demise.

General Dynamics Designs

General Dynamics was one of four principal contractors to submit to NASA vehicle design studies for Nova. In addition to these designs, they completed an extensive study in September 1963 which identified various possible missions for Nova beyond a direct ascent manned lunar landing (see pages 18-19).

NASA Designs

Very early NASA versions of Nova used four F-1 engines in its first stage, one F-1 engine in its second stage with four 80,000-pound thrust hydrogen engines in the third stage and one in the fourth stage. Interestingly enough, the F-1 engine was originally designated for Nova and only later used in the Saturn V design. Another version of Nova used six F-1s in the first stage with unknown types of engines in the upper stages.

By June 1960, Nova had eight F-1s in its first stage and two of the newer M-1 engines in the second stage. One J-2 would be used in the third stage in the same configuration as the Saturn V third stage. This version, basically a larger version of the Saturn 5, was most often described as that intended for use in the direct ascent mode to the Moon.

Nova grew still larger. In april 1962, one configuration showed Nova with ten F-1s on the first stage, four M-1s on the second stage and one J-2 on the third. Another showed Nova with twelve F-1s appearing in its first stage, ten J-2s in the second stage and a nuclear third stage seen in advanced versions. (Note: a more in-depth review of the engines used in Nova will be included in Part 2 of this series)

Nova was also studied by NASA using a solid fueled first stage (see pages 14-15). Designs were made consisting of a cluster of four 240-inch solid rocket motors and a cluster of seven 160-inch motors (the largest solid rocket motors in use today are the Space Shuttle's 146-inch and the Titan IV's 122-inch). A 156-inch motor was actually built and ground test fired on September 1964 by Lockheed. Some of the advantages of using solid rocket motors in Nova was their demonstrated reliability as well as the relative rapid ease in their production. No major advancement in design would be necessary other than size scaling. It was also reasoned that the limited solid propellant technology of the Russians would deter duplication. ●

Keith J. Scala is a spaceflight historian who has visited most aerospace facilities throughout North America pursuing research in the field. Keith currently lives in Bridgeport, Connecticut.

Glen E. Swanson is Editor and Publisher of "QUEST: The History of Spaceflight Magazine."

Note: A complete bibliography and listing of all references will be published in its entirety at the conclusion of this series.

Next Issue Part II:

Martin Marietta Nova Vehicle Designs
complete with over 20 drawings

Engines of Nova
including the F-1, F-1A and M-1

Compare The Giants
see how Nova stacked up to America's Saturn and Russia's N-1 –the two most powerful rockets ever built on Earth.

They Might Be... GIANTS

A History of Project NOVA 1959-1964 Part II

By Keith J. Scala and Glen E. Swanson

NOVA

This is Part 2 of a 3-part series on the history of Project Nova. The proposed vehicle designs that encompassed the Nova project from the period of 1959-1964 were proposed along a parallel path during the Apollo Program. Though never built, a variety of launch vehicle configurations were developed ranging from the then practical to the exotic. Part 1 of the series (QUEST Vol. 1 No. 3 Fall 1992) explored the beginnings of Nova when NASA was basically open to any ideas of how best to send men to the Moon. Early NASA designs were examined along with the primary Nova mission studies for five Nova-class vehicles as proposed by General Dynamics. In Part 2 we will continue to explore the historical development of the Nova program, look at 17 primary Nova designs submitted by Martin Marietta and attempt to examine the various propulsion systems that would have been used in these vehicle designs.

The idea of using a Nova-class vehicle to send men to the Moon formally ended on July 11, 1962. On this date, NASA announced during a formal press conference that the choice of Lunar Orbit Rendezvous (LOR) would be the mode used to go to the Moon.

One of the biggest debates that managed to cross all levels of management within a fledgling NASA centered upon the best way, or mode, to get to the Moon. As discussed previously in Part 1 of this series, there were three basic methods considered: Direct Ascent, Earth Orbit Rendezvous (EOR) and Lunar Orbit Rendezvous (LOR). All of these modes had their respective advantages and disadvantages. None of them however, created quite the furor as LOR.

Even though LOR was the eventual route chosen, NASA was at first reluctant to choose this method because many top level engineers and managers within the agency opposed it. Among LOR's most vehement opponents were the team at the Marshall Space Flight Center headed by Wernher von Braun.

Von Braun viewed the space program's goal of landing a man on the Moon as the fulfillment of a long dream. However, von Braun was a man of great vision. In his view, he saw the manned lunar program as a mere stepping stone toward an even greater goal –Mars. Wernher von Braun wanted to go to Mars and saw the Apollo Program as the first step in a logical progression that would eventually get us there. By advocating both the Direct Ascent and EOR modes of travel to the Moon, von Braun new that a booster more powerful than the Saturn V would be needed. A Nova-class booster could be used to achieve both the national goal of landing a man on the Moon as well as offer a means to travel beyond to Mars. Ever the visionary, von Braun was looking beyond the days of Apollo and realized that a Nova-built booster for the Moon could also be adapted as a Nova launch vehicle for Mars.

Time was his enemy however, and von Braun knew that a Nova-class vehicle could not effectively be built to achieve the decade-end goal. Eventually, von Braun conceded that, while the other leading mode alternatives were feasible, LOR offered "the highest confidence factor of successful accomplishment within this decade." *

The July decision to use LOR which could be achieved with the developed Saturn V, marked the beginning of the end of the Nova Program. Many people in NASA thought that Nova should be built (including the father of the Mercury-Apollo spacecraft, Max Faget) and as late as June 1961, when the Fleming Committee submitted the first post-speech plan for Apollo, the recommendation was for a Nova configured in three stages, capable of boosting 160,000 pounds into orbit. NASA's selection of the Lunar Orbit Rendezvous mode of operation in conjunction with the use of the Saturn V to provide a single flight capability for an Apollo mission, eliminated the use of the original Nova concept developed in the years 1959-1961 and its goal of providing a direct flight capability to the Moon and return to Earth.

In spite of the decision to use LOR, NASA did not stop its Nova studies in 1962. At this time, NASA hoped that money would still be there to fund more ambitious manned and unmanned programs that would employ Nova-class launch vehicles. As a result, NASA continued funding studies that shifted the primary requirements for Nova from early manned lunar landing missions to other areas that include; lunar support/base operations, delivery of cargo/passengers to Earth orbit, and direct escape for both manned and unmanned planetary missions.

From 1962 to the program's end in 1964, numerous studies were done to define the most desirable Nova launch vehicle system for manned Mars missions, lunar base buildups, space station and planetary probe deployment. Numerous configurations were proposed which employed both existing hardware and materials as well as those not yet developed.

In Part 1 we looked at various Nova conceptual designs developed by NASA and one of the leading Nova design study contractors, General Dynamics. These designs utilized both existing and modified hardware and were considered practical to build within a relatively short time frame. Classified as Class 1 designs, if NASA decided to develop a Nova launch vehicle, these would have been among the configurations considered.

Martin Marietta Designs

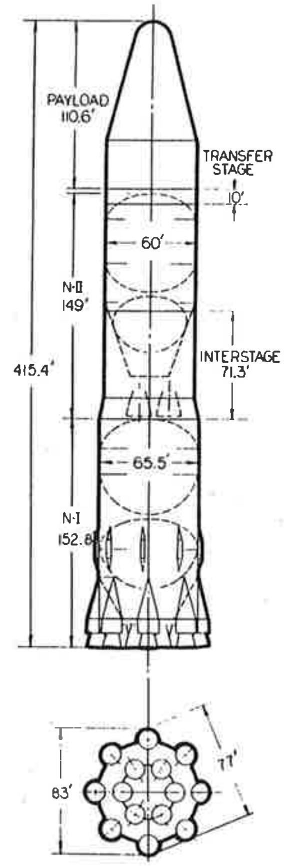
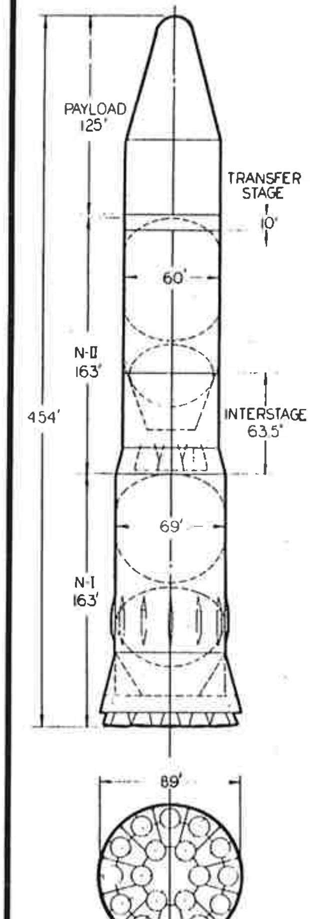
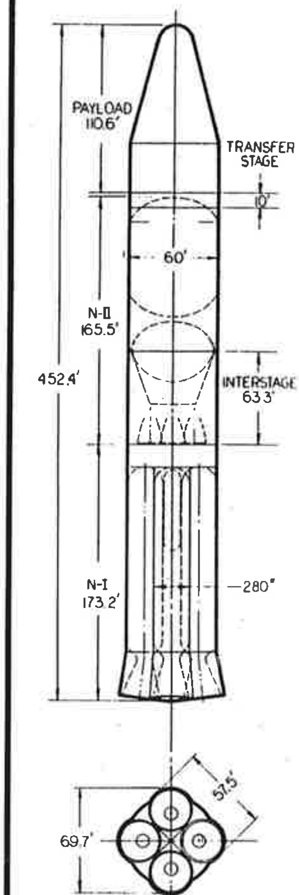
Among the four principal contractors that submitted to NASA vehicle design studies for Nova was Martin Marietta. The Martin studies were broken into two separate groups; 1.) Basic Nova Design Configurations and 2.) Advanced Nova Design Configurations.

The Basic Nova Design Configurations consisted of seven proposed vehicle designs. All of these Class I designs would exploit available and near available technology such as would evolve from F-1/M-1 propulsion. These seven versions of Nova are; 1B, 1C, 14A, 14B, 24G, 33 and 34.

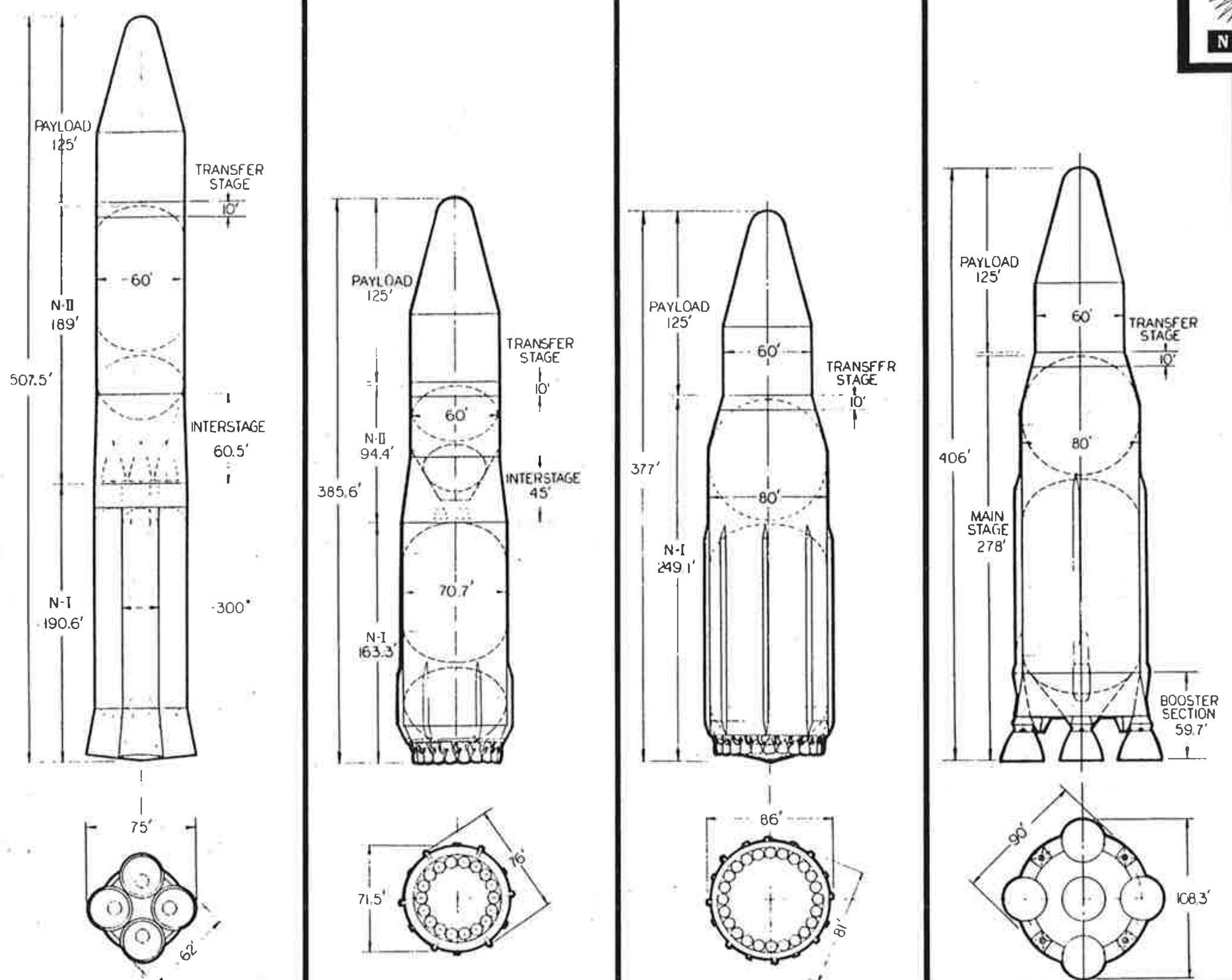
Martin Marietta's Advanced Nova Design Configurations shared no hardware with the Saturn V and utilized im-

** Oddly enough, once the Direct Ascent mode was deemed ultimately impractical, those at Marshall, including von Braun, opposed Nova and supported EOR in its place. It was argued that EOR would still require a huge booster, but Saturn-sized, perhaps with the intent that an EOR Saturn V could still be further modified (like a mini Nova) for use as a Mars-bound booster*

MARTIN MARIETTA BASIC NOVA D

Vehicle Type	1B	1C	14B
			
Number of stages	2	2	2
Total number of engines	16	21	8
Dry weight (lb x 10^6)	1.2709	1.637	2.6031
Liftoff weight (lb x 10^6)	20.1113	25.1998	26.8536
Liftoff thrust (lb x 10^6)	25.2	32.4	37.638
Overall vehicle length (ft)	415.4	454.0	452.4
Maximum vehicle diameter (ft)	77	89	69.7
Maximum payload to LEO (lbs x 10^6)	0.729	0.980	0.824
First Stage:			
Number of engines/type	(14) F-1A	(18) F-1A	(4) 280" Solid
Type of propellant	LOX/RP-1	LOX/RP-1	PBAA
Thrust per engine (lb x 10^6) –sea level	1.8	1.8	9.32 (averge)
Thrust per engine (lb x 10^6) –vacuum	2.02	2.02	10.39 (average)
Second Stage:			
Number of engines/type	(2) M-1	(3) M-1	(4) M-1
Type of propellants	LOX/LH2	LOX/LH2	LOX/LH2
Thrust per engine (lb x 10^6) –vacuum	1.5	1.5	1.5
Projected operational availability	December 1972	February 1973	February 1973

DESIGN CONFIGURATIONS 1963

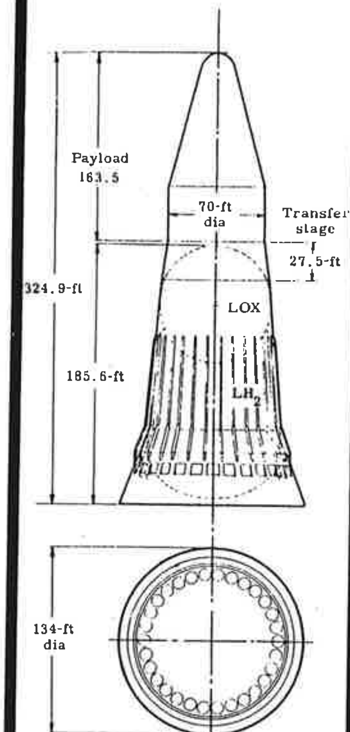


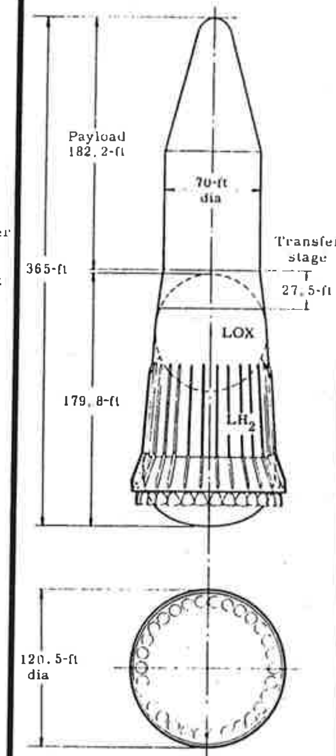
14A	24G	33	34
2	2	1	1 1/2
9	20	24	5
3.2445	1.0177	1.3809	1.656
33.672	14.4002	24.171	24.0
47.048	18.0	30.20	30.0
507.5	385.6	377.0	406.0
75.0	76.0	81.0	108.3
1.062	0.987	1.042	1.172
(4) 300" Solid	(18) HP-1	(24) HP-1	(4) L6H
PBAA	LOX/LH2	LOX/LH2	LOX/LH2
11.70 (average)	1.0	1.25	6.0
14.30 (average)	1.19	1.46	6.9
(5) M-1	(2) HP-1	—	(1) L6H*
LOX/LH2	LOX/LH2	—	LOX/LH2
1.5	1.15	—	6.9
April 1973	December 1974	April 1975	June 1976

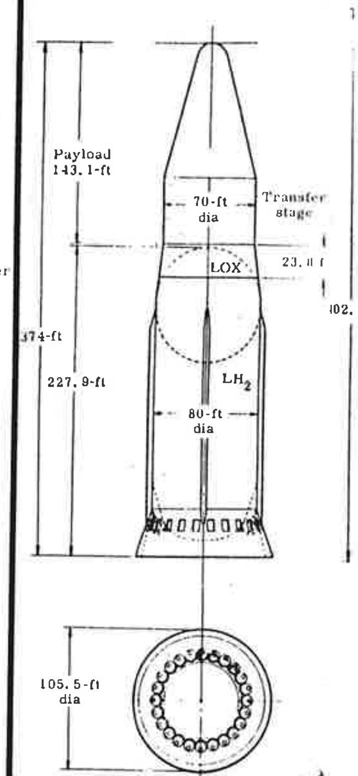
*This is a 1 1/2 stage vehicle with a central mounted sustainer engine

MARTIN MARIETTA ADVANCED NOVA

NOVA

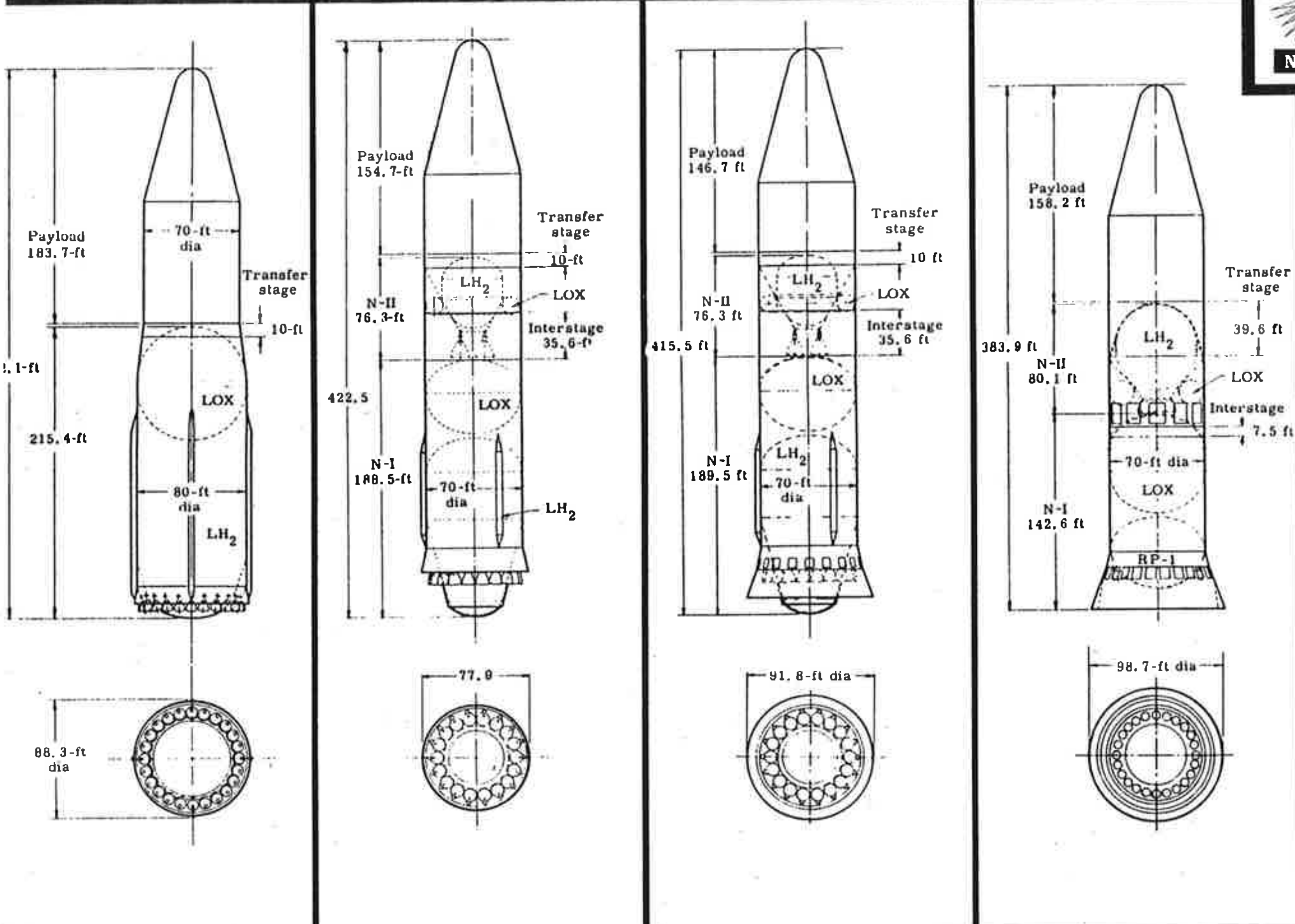






Vehicle Type	S10R-2	S10E-2	S10R-1
Vehicle Classification	Class 3	Class 2	Class 3
Number of stages	1	1	1
Type of stages	recoverable	expendable	recoverable
Total number of engines	30	30	24
Liftoff weight (lb x 10^6)	24	24	24
Liftoff thrust (lb x 10^6)	30	30	30
Maximum vehicle diameter (ft)	134	120.5	105.5
Overall vehicle length (ft)	324.9	365.0	374.0
Payload to LEO (lbs x 10^6)	0.842	1.283	0.913
First Stage:			
Number of engines/type	(30) CD module	(30) CD module	(24) CD module
Engine arrangement	Zero-length plug cluster	Zero-length plug cluster	Zero-length plug cluster
Type of propellant	LOX/LH2	LOX/LH2	LOX/LH2
Thrust per engine (lb x 10^6) –sea level	1.0	1.0	1.250
Second Stage:			
Number of engines/type	—	—	—
Engine arrangement	—	—	—
Type of propellants	—	—	—
Thrust per engine (lb x 10^6) –vacuum	—	—	—
Projected operational availability	July 1978	November 1977	June 1978

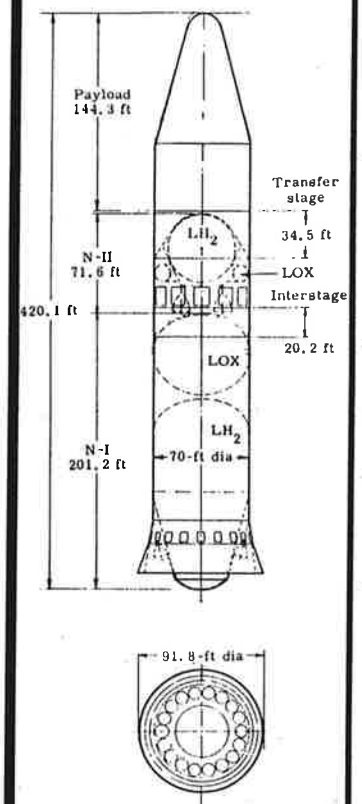
DESIGN CONFIGURATIONS 1963

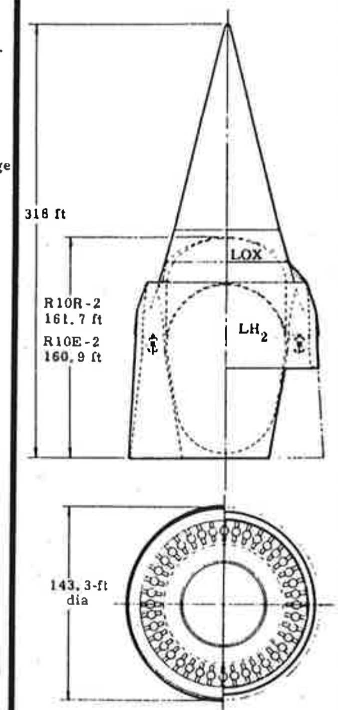


S10E-1	T10EE-1	T10RE-1	T10RR-2
Class 2	Class 2	Class 2	Class 3
1	2	2	2
expendable	expendable/expendable	recoverable/expendable	recoverable/recoverable
24	20	20	25
24	14.4	14.4	25.6
30	18	18	32
88.3	77.9	91.8	98.7
402.1	422.5	415.5	383.9
1.298	1.019	0.942	1.058
(24) CD module	(18) CD module	(18) CD module	(24) CD module
Zero-length plug cluster	10% plug cluster	10% plug cluster	Zero-length plug cluster
LOX/LH2	LOX/LH2	LOX/LH2	LOX/RP-1
1.250	1.030	1.030	1.375
—	(2) CD module	(2) CD module	(1) Toroid FD
—	side by side	side by side	single
—	LOX/LH2	LOX/LH2	LOX/LH2
—	1.240	1.240	4.5
October 1977	November 1976	January 1977	December 1976

...continued on p. 24

MARTIN MARIETTA ADVANCED NOVA DESIGN CONFIGURATIONS 1963





*Note: Vehicle R10E-2 has a larger payload capacity than vehicle R10R-2 due to increased fuel capacity that replaces recovery systems inherent in the R10R-2 design.

**Air-augmented cluster

***Including air augmentation

Vehicle Type	T10RR-3	R10R-2	R10E-2
Vehicle Classification	Class 3	Class 3	Class 3
Number of stages	2	1	1
Type of stages	total recovery/total recovery	total recovery	expendable
Total number of engines	20	40	40
Liftoff weight (lb x 10^6)	15.8	20.0	20.0
Liftoff thrust (lb x 10^6)	19.75	31.6	31.6
Maximum vehicle diameter (ft)	91.8	143.3	143.3
Overall vehicle length (ft)	420.1	318	318
Payload to LEO (lbs x 10^6)	0.925	0.934	1.315*
First Stage:			
Number of engines/type	(18) CD module	(40)CDmodule	(40)CDmodule
Engine arrangement	10% plug cluster	RENE**	RENE**
Type of propellant	LOX/LH2	LOX/LH2	LOX/LH2
Thrust per engine (lb x 10^6) –sea level	1.131	0.790***	0.790***
Second Stage:			
Number of engines/type	(2) CD module	—	—
Engine arrangement	side by side	—	—
Type of propellants	LOX/LH2	—	—
Thrust per engine (lb x 10^6) –vacuum	1.355	—	—
Projected operational availability	July 1977	October 1980	Sept. 1979

THE ENGINES OF NOVA

The three primary Nova vehicle designs from NASA, General Dynamics and Martin Marietta discussed in this series, all employed engines of a variety of performance levels. Some designs used the same engines as that of the Saturn V such as the F-1 in the first stage and the J-2 in the second and third stages. One Nova design contemplated the use of a cluster of twelve F-1s while another advanced version considered clustering eighteen F-1As.

The M-1 engine was an oxygen and hydrogen fueled upper stage engine developing almost as much thrust as the F-1. Had the Nova vehicle been built, the M-1 would have almost certainly been used as a second stage engine. The M-1 engine went through a complete development and test program from 1962 to 1966 with many test versions being built and test fired. The basic design developed 1.2 million pounds of thrust with later versions developing 1.5 million pounds of thrust. When the Nova program was cancelled, the M-1 was put on the shelf for lack of a vehicle that would use it.

The last Nova vehicle designs that were studied shared no hardware with that of the Saturn V. All of these vehicles utilized a totally new form of propulsion known as the aerospike or plug cluster nozzle engine. The plug nozzle consists of many small conventional nozzles that are canted inward and arranged in a ring around a central spike. This arrangement is like an inside out bell nozzle with the exhaust plume pushing outward from a central spike. A single stage vehicle takes the best advantage of this nozzle arrangement because the plug nozzle is more efficient over a wider range of atmospheric pressure variations giving better performance from sea level to the vacuum of space that that of a conventional bell nozzle. The plug nozzle also uses the lighter combination of oxygen and hydrogen for propellants. Rocketdyne did ground test a 250,000 pound-thrust version of the plug nozzle in 1971 and 1972.

The L-6H is a monstrous oxygen and hydrogen engine producing six million pounds of thrust for use in the first stage of the advanced Nova designs. The L-6H was only a paper engine since it was never built.

Summary of Liquid Fueled Engines

Type	Fuel	Thrust (lbs)	Specific Impulse (lb-sec/lb)	Weight (lbs)	Vehicle Application	Comment	Contractor
F-1	LOX/RP-1	1,522,000	265 sec. (sea level)	18,500	Saturn V 1st stage, Nova 1st stage.	Five F-1s used on Saturn V 1st stage, flown from 1967 - 1973.	Rocketdyne
F-1A	LOX/RP-1	1,8000,000	271 sec. (sea level)	17,860	Nova 1st stage.	Advanced version of the F-1, ground tested.	Rocketdyne
J-2	LOX/LH2	230,000	421 sec. (sea level)	3,621	Saturn 1B 2nd stage, Saturn V 2nd & 3rd stage, Nova 2nd & 3rd stage.	Flown from 1966 - 1975.	Rocketdyne
M-1	LOX/LH2	1,2000,000	428 sec. (vacuum)	20,000	Nova 2nd stage.	Tested in 1966 but never used.	Aerojet-General
HP Plug*	LOX/LH2	30,000,000 (this is total thrust of 24 engines)	379 sec. (sea level)	228,000	Nova 1st stage.	Smaller 250,000 lb version tested in 1971 and 1972.	Rocketdyne
CD Plug**	LOX/LH2	30,000,000 (this is total thrust of 24 engines)	377 sec. (sea level)	289,200	Nova 1st stage.	Smaller 250,000 lb. version tested in 1971 and 1972.	Rocketdyne
L-6H	LOX/LH2	6,000,000	382 sec. (sea level)	81,850	Nova 1st stage.	Never built or tested.	None

*High Pressure Aerospike **Zero Length Aerospike

USAF/NASA Solid Rocket Motor Program

Largest ever built measured a whopping 260 inches!

The largest solid-fueled rocket motors ever built were a staggering 260 inches (21.7 feet) in diameter and 80 feet long. Putting this in perspective, the largest solid rocket motors used today are the Space Shuttle's 146-inch and the Titan IV's 122-inch.

Initiated by the USAF under the code name of "Principia" and completed by NASA, Aerojet-General was the contractor that built the gigantic 260-inch segments and tested them in Dade County, Florida from 1963-1968 as part of a large solid rocket motor study project. Among the objectives of the project were to advance the technology and to demonstrate the feasibility of building and operating solid motors of greater size than those then used. Such motors were considered for use in the Nova program and were incorporated in several vehicle designs. The 260-inch program was initiated under the management of the Air Force's Space Systems Division in 1963. In mid-1964 it was transferred to NASA and management responsibility was assigned to the Lewis Research Center in Cleveland, Ohio. The Air Force retained the portion of the program related to 156-inch solid motors, considered the largest practical size for land mobility, an important aspect of defense requirements.

Three sizes of solid motors were fired under the 260-inch program. In September 1964, a 120-inch diameter motor was fired by Aerojet at its Dade Division producing about 600,000 pounds of thrust. On May 28, 1964 Lockheed test fired a 156-inch diameter monolithic maraged steel cased motor producing 1.2 million pounds with a during a burn time of two minutes and 35 seconds. A 156-inch motor was fired by Thiokol Chemical Corporation at Brunswick, Georgia on February 27, 1965 which became the first solid propellant motor to produce over 3 million pounds of thrust. Another 156-inch motor by Thiokol, incorporating the world's largest segmented fiberglass reinforced case, was test fired at their Wasatch Division near Brigham City, Utah on June 25, 1968. The motor developed a million pounds of thrust during its 120-second firing.

The first short length* 260-inch motor, designated SL-1, was successfully test fired on September 25, 1965. That two-minute firing produced a peak thrust of 3.6 million pounds and an average thrust of nearly 3 million pounds. The second firing (SL-2) occurred on February 23, 1966 at Dade County, Florida. Held in a test pit more than 160 feet deep with the nozzle protruding above ground, the nighttime firing was visible for nearly 100 miles. Its flame and smoke reached 7,500 feet into the air and produced more than 3 billion candlepower of light.

A number of material problems had to be overcome in the fabrication process of the 260-inch motors. One major problem was the case itself. Because of its huge size it was not economically sound to build a furnace large enough to heat-treat the case at 1,600 degrees F as is normal for high strength steels. To overcome this problem, a maraging steel was chosen for the case. This type of steel contains 18% nickel, 8% cobalt and 5% molybdnum, providing a minimum yield strength of 200,000 pounds per square inch with heat treatment to only 900 degrees F.

Aerojet used the tungsten inert gas (TIG) welding process to assemble the cases. The cases were fabricated for Aerojet by Sun Shipbuilding and Dry Dock Company at its Chester, Pennsylvania facility.

The nozzle for the 260-inch motor was built by TRW Incorporated of Cleveland, Ohio. It was an ablative nozzle 20 feet high with a throat diameter of about six feet and nozzle exit of about 15 feet. The structural material for the nozzle was stainless steel backed with aluminum honeycomb. The ablative material was carbon impregnated with phenolic and silica.

The ignitor motor of the 160-inch motor was another smaller solid rocket motor which fired into the throat. It developed a quarter of a million pounds of thrust itself and produced an 80-foot flame that would ignite the 500,000 square inch propellant surface area all at once. About one-half second after ignition, the ignitor would fly out of the 260-inch motor nozzle and was guided by cables to a nearby impact pond. The ignitor for the ignitor motor was a yet another smaller rocket motor weighing 100 pounds and producing 4,500 pounds of thrust. The last firing of a 260-inch motor motor (SL-3) occurred on June 17, 1967 and produced a total of 5.7 million pounds of thrust.

*These are called short-length (SL) motors because they are approximately half as long as a motor required for an actual mission. A full length motor would range from 120 feet to 200 feet and produce 5 to 8 million pounds of thrust.

proved as well as advanced concepts in hardware. These configurations includes only Class II and Class III designs. Nova Class II designs postulated improved propulsion and the inclusion of partial recovery as new technology. The aim of this class of vehicles was to provide cost effectiveness which would permit the continuation and expansion of space exploration into the 1980's and beyond. Class III designs involved very advance concepts in propulsion launch vehicles and recovery. These vehicles has as their main objective, total recovery to help meet and further develop an even broader market for launch vehicles.

Unique to the Class II and Class III vehicles was the use of a plug cluster nozzle for propulsion which is discussed further in the "Engines of NOVA" section.

Ten vehicles were included in these advanced design configurations and they are: S10R-2, S10E-2, S10R-1, S10E-1,T10EE-1, T10RE-1, T10RR-2, T10R-3, R10R-2, R10E-2. ●

Keith J. Scala is a spaceflight historian who has visited most aerospace facilities throughout North America pursuing research in the field. Keith currently lives in Bridgeport, Connecticut.

Glen E. Swanson is Editor and Publisher of "QUEST."

Note: A complete bibliography and listing of all references will be published in its entirety in Part 3 of this series.

Addition: On p. 19 of Part 1 of the Nova series under the "General Dynamics Missions for NOVA", there is mentioned an unmanned orbital system referred to only as BAMBI. Since that time, we have learned that BAMBI stands for Ballistic Missile Boost Intercept.

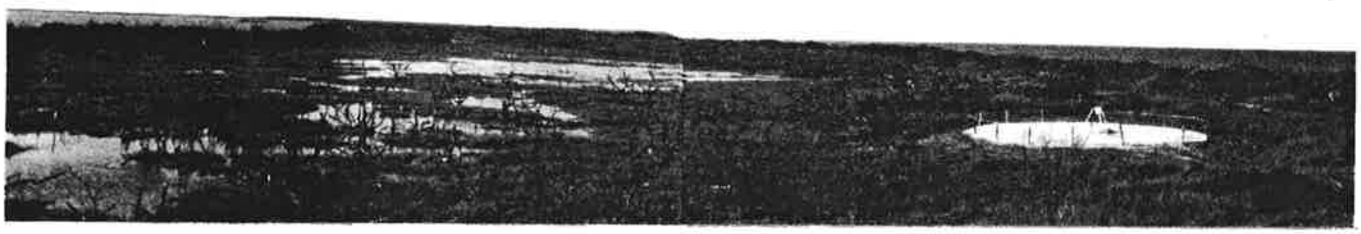
To Be Covered in Part 3:

***Nova Assembly and Launch Facilities**
***Nova and the DC-X**
***Complete Nova Reference Bibliography**

They Might Be Giants

A History of Project NOVA 1959-1964 Part III

By Keith J. Scala and Glen E. Swanson



Above: The land of the giants as viewed today. This composite photo was taken from atop a NASA tracking station located near the northern most end of Beach Road along Playalinda Beach north of NASA's Kennedy Space Center. This was the prime location from where one of three Nova launch pads would have been built. The photo was taken looking due north toward the Canaveral National Seashore with part of Florida's National Wildlife Refuge due west (left) and the Atlantic Ocean due east (right). *Photo courtesy Glen E. Swanson*

This is Part 3 and the conclusion of a 3-part series on the history of Project Nova. The proposed vehicle designs that encompassed the Nova project from the period of 1959-1964 were proposed along a parallel path during the Apollo Program. Though never built, a variety of launch vehicle configurations and related service structures were developed ranging from the practical to the exotic. Part 1 of the series (QUEST Vol. 1 No. 3 Fall 1992) explored the beginnings of Nova when NASA was open to all ideas of how best to send men to the moon. Early NASA designs were examined along with the primary Nova mission studies for five Nova-class vehicles as proposed by General Dynamics. In Part 2 (QUEST Vol. 2 No. 1 Spring 1993) the historical development of the Nova program was further explored through an examination of 17 primary Nova designs submitted by Martin Marietta along with a look at the various propulsion systems that would have been used in these vehicle designs. In this concluding installment, through text and diagrams we examine the various proposed launch facilities studied to assemble, service and launch the Nova class launch vehicles. In addition, we have included a manned lunar mission scenario which would have used the Nova booster. We have also included several data corrections and updates as well as offer a concluding retrospective overview of the program along with a complete reference bibliography.

Because of the sheer magnitude of the proposed Nova-class launch vehicles (and larger), it was thought that the proposed vehicle requirements for assembly, checkout and launch would tax the absolute limits of the then present day Cape Canaveral launch site. In addition, acoustical and blast limits of either solid or liquid type launch vehicles would severely limit the location of launch pads at the Cape. Proposed operational desirements of eight or more launches per quarter would severely tax the facilities and personnel at the Cape, disrupting other programs. For these reasons, the Launch Vehicle Operations Division of NASA sought new suggestions for both alternate launch sites as well as new launch concepts for the Nova program.

NASA considered proposals staged at a variety of different potential locations for the new Nova launch site (Figure 1). Among those locations considered and their primary reasons why they were eventually not chosen are: Brownsville, Texas -considered hazardous because faulty rockets would fall on land unless the launch azimuth was limited to between 80 and 90 degrees; Christmas Island (located in the Pacific) -facilities there would be too expensive to build and the island is owned by the United Nations; Cumberland, St. Catherine's and Sapedo Islands, Georgia -not close enough to existing space facilities; Hawaii -it would be more expensive to develop an area there than in the Cape Canaveral area. Also, Hawaii is not near existing space facilities; Mayaguana, Bahama Island - same shortcomings as Hawaii and the area is owned by Great Britain; White Sands Missile Range, New Mexico - same shortcomings as Brownsville, Texas.

Many launch facility concepts were considered by NASA for the Nova program. Because of the incredible size of the proposed Nova-class launch vehicles, engineers were faced with a multitude of challenges. Early on in the developmental phase of the program, many scientists and engineers routinely spoke of figures on a near nuclear scale. Dynamic pressures, safety zones, transport vehicles, assembly and test facilities all were characterized by gigantic figures and proportions never before realized. To routinely build, test, assemble, transport and launch vehicles two to three times the size of a Saturn 5 required everything to be big –big ideas, big hardware and big bucks. Fortunately all of these were in big supply during the peak of the Apollo program.

Among the many launch facility concepts considered, three remained the prime contenders: 1.) Hybrid – Off-pad checkout, on-pad assembly; 2.) Mobile - Off-pad assembly and checkout.*; 3.) Fixed - On-pad assembly and checkout.**

Hybrid Concept

With the hybrid concept (Figures 2, 3), activities would start with receipt of the Nova stages at the unloading dock. Stages would be delivered vertically on ocean-going barges. The barges would be positioned in slips and stabilized during the removal of the stages. Rubber-tired transporters would then hydraulically lift the liquid stages, roll them off the barge and move them to the stage checkout area. Since the solid stages would be made up of multiple solid motors with each motor weighing between 5 and 6 million pounds —too heavy for rubber-tired transporters— crawler transporters would be used for moving these motors.

Liquid stages would be positioned in one of numerous cells of a Stage Checkout Building (SCB). Operations within the SCB area begin with the receiving operations. The stage is inspected andy any modifications are incorporated. The stage is then checked out to assure that it is ready for assembly with the other stages at the pad. Checkout would include pressure tests, engine leak checks, gimbaling and equipment functional tests as necessary to avoid any delays as the pad. SCB operations include on major assembly operation -the assembly of the transtage to the top of the N-II stage (or to the top of the N-1 stage for one-stage or one-stage-and-a-half-stage Novas). Where appropriate, checkout operations would be performed after this initial assembly is completed. Solid motors for the solid propellant N-1 stages would not be delivered to the general checkout area. Instead, they would be delivered horizontally to a solid motor checkout building.

After checkout, the stages would be removed from the SCB by the transporters and taken to the launch pad area. The pad area would have a ring of instrumentation and service roads and a propellant storage system. A central enclosed launch building would completely house the vehicle during its assembly and launch operations.

The design of this enclosed launch building would include removable flame ducts and deflectors providing for internal erection and assembly of the vehicle. Umbilical arms would swing into protected areas in the walls of the building at liftoff. The roof would provide weather protection during erection, assembly and checkout but would be opened at the time of launch. The inside of the building would include an acoustic liner designed to also withstand (with a minimum of refurbishment) the temperatures expected during liftoff. The launch building would generally stand about 650 feet high with an outside diameter of about 350 feet.

Cryogenic propellants would be delivered to the area by extension of (if located at the Cape) the intercoastal waterway. These propellants would be transferred from barges to the pad stor-

Nova Size Illustrated

The relative size of the Nova class launch vehicles is often difficult to visualize. The following points, published in the July 22, 1963 issue of *Aviation Week & Space Technology* magazine, were developed in studies of Nova launch facilities to help emphasize the magnitude of the vehicles:

For an eight-hour hold on an open launch pad, the cost of liquid hydrogen boiloff would be about $1 million.

Present 2,500 gallon per minute high-speed pumping systems used to fill ICBM propellant tanks would not be able to keep up with the boiloff of a Nova booster, let alone fill its tanks. Systems capable of pumping 30,000 gallons per minute will have to be developed to fill Nova propellant tanks.

Size of rockets required for stage separation is roughly that of a Pershing guided missile (32.5 feet long and 3.3 feet in diameter).

One approach being considered for environmental control at a Nova launch complex is a launch building, enclosing the booster with a trap-door roof, which opens during launch. Such a building would stand 650 feet tall –almost 100 feet taller than the Washington monument– and cost $150 million to build. Four probably would be required.

*The sold configuration Novas were considered generally too large and had special safety problems making them impractical for consideration with the mobile concept.

**Most of these concepts were under parallel consideration for use with the Saturn C-5 (Saturn 5) program with many elements eventually used to their present form.

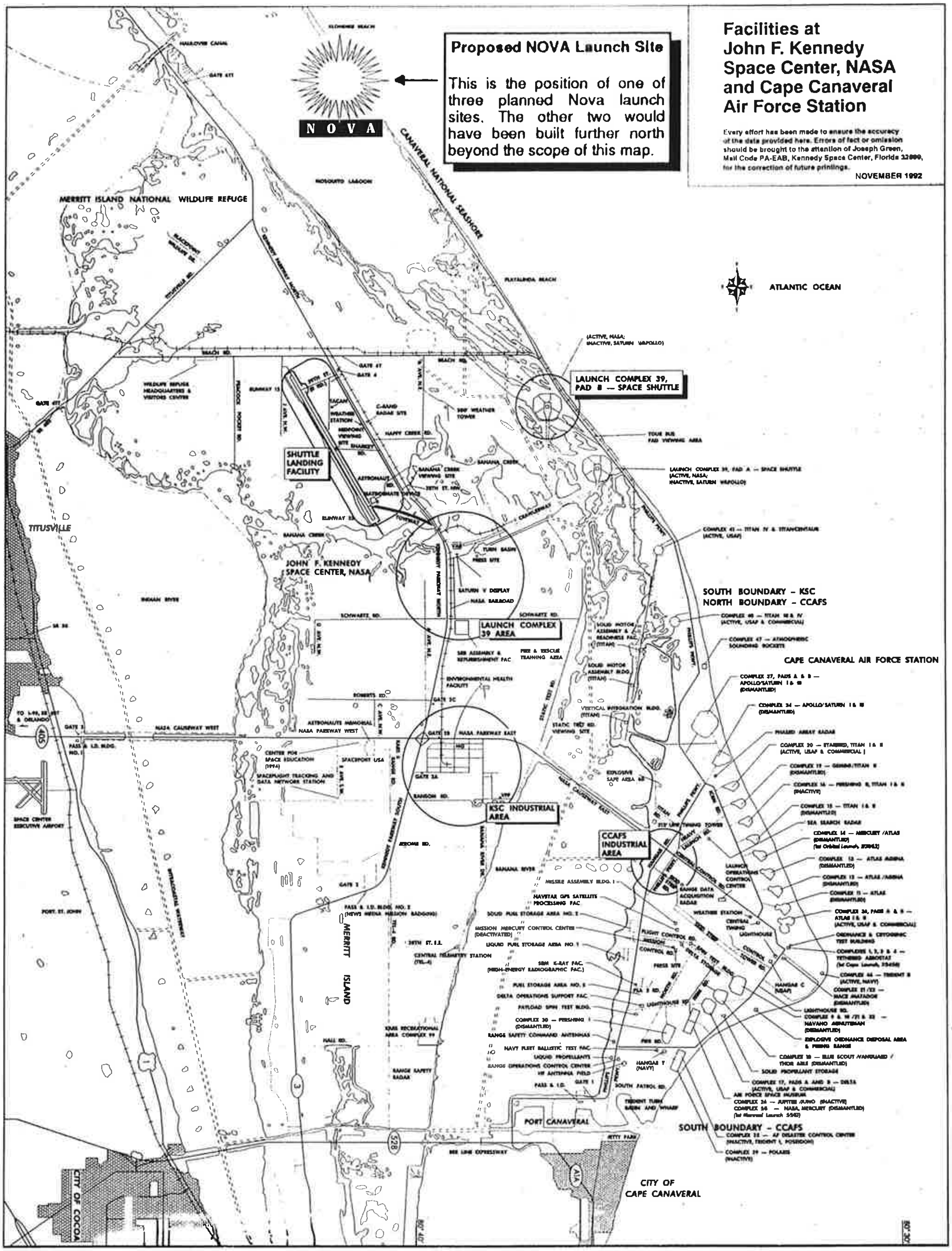


Figure 2 – Present day map of NASA Kennedy Space Center used to indicate where the NOVA launch sites would have been built (Nova site and notes added by authors). Worth noting are the three additional launch complexes that are faintly outlined northwest of Complex 39 B. The one due north of Complex 39 B would have been the third Saturn V (Complex 39 C) scheduled to have been built during Apollo. The other two are outlines for the Advanced Saturn launch facilities that were planned but never built after that program was cancelled. For some reason (perhaps in hopes that they might still be built), these three launch facilities are still included in all current maps.

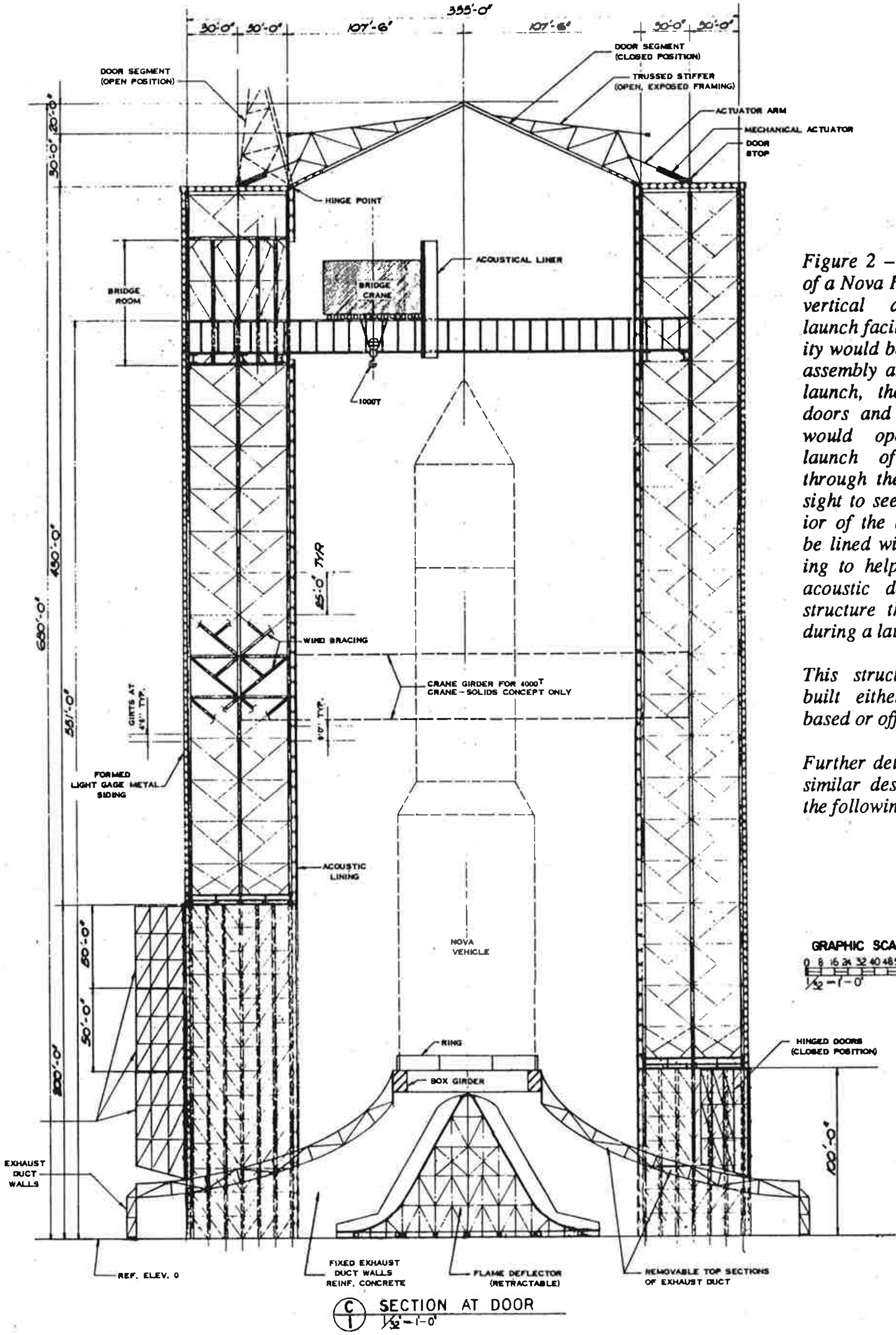


Figure 2 – Interior detail of a Nova Hybrid Concept vertical assembly and launch facility. This facility would be used for final assembly and launch. At launch, the hinged vent doors and roof structure would open permitting launch of the vehicle through the roof (what a sight to see!!). The interior of the building would be lined with acoustic tiling to help minimize any acoustic damage to the structure that may occur during a launch.

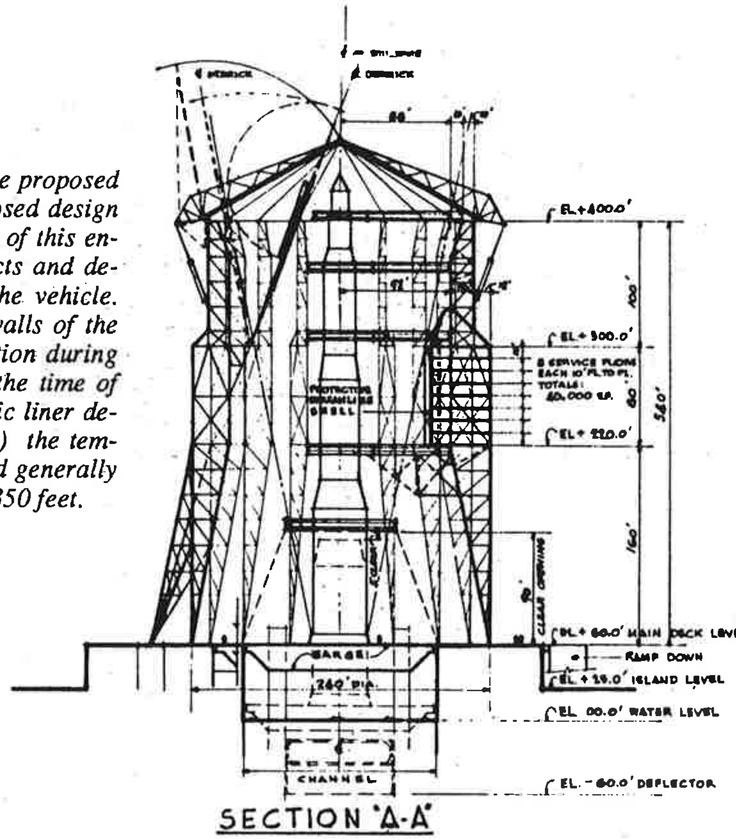
This structure could be built either as a land-based or off-shore facility.

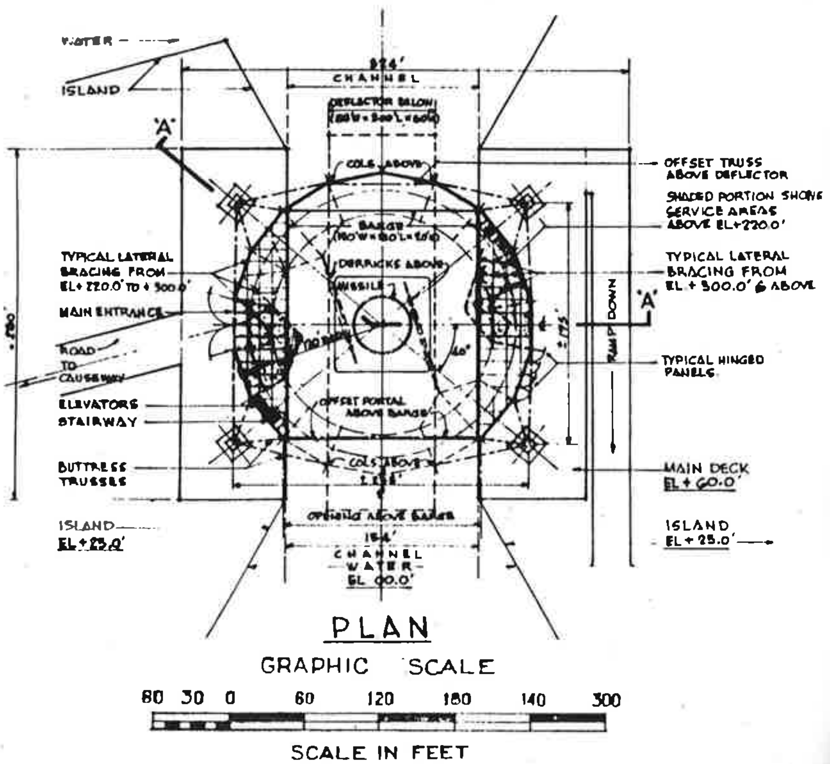
Further details of another similar design appear on the following two pages.

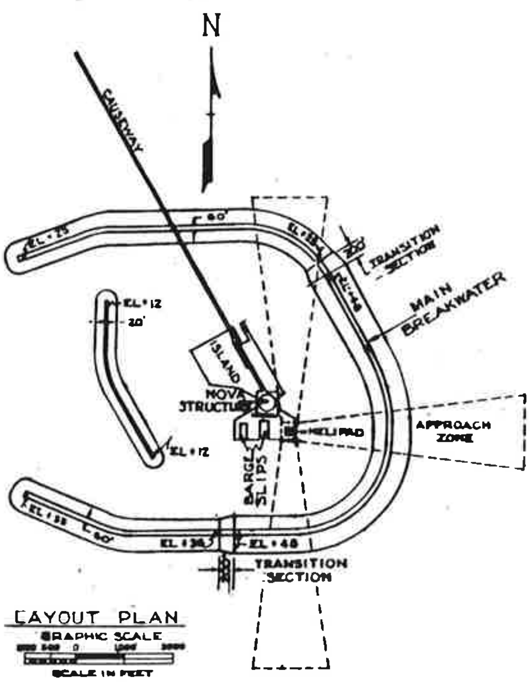
GRAPHIC SCALE
0 8 16 24 32 40 48 56 64 72 80
1/32" = 1'-0"

Figure 3 – A variety of different hybrid concept designs were proposed as a Nova launch facility. These two pages depict a proposed design for an off-shore assembly and launch building. The design of this enclosed launch building would include removable flame ducts and deflectors providing for internal erection and assembly of the vehicle. Umbilical arms would swing into protected areas in the walls of the building at liftoff. The roof would provide weather protection during erection, assembly and checkout but would be opened at the time of launch. The inside of the building would include an acoustic liner designed to also withstand (with a minimum of refurbishment) the temperatures expected during liftoff. The launch building would generally stand about 650 feet high with an outside diameter of about 350 feet.

All drawings courtesy NASA.





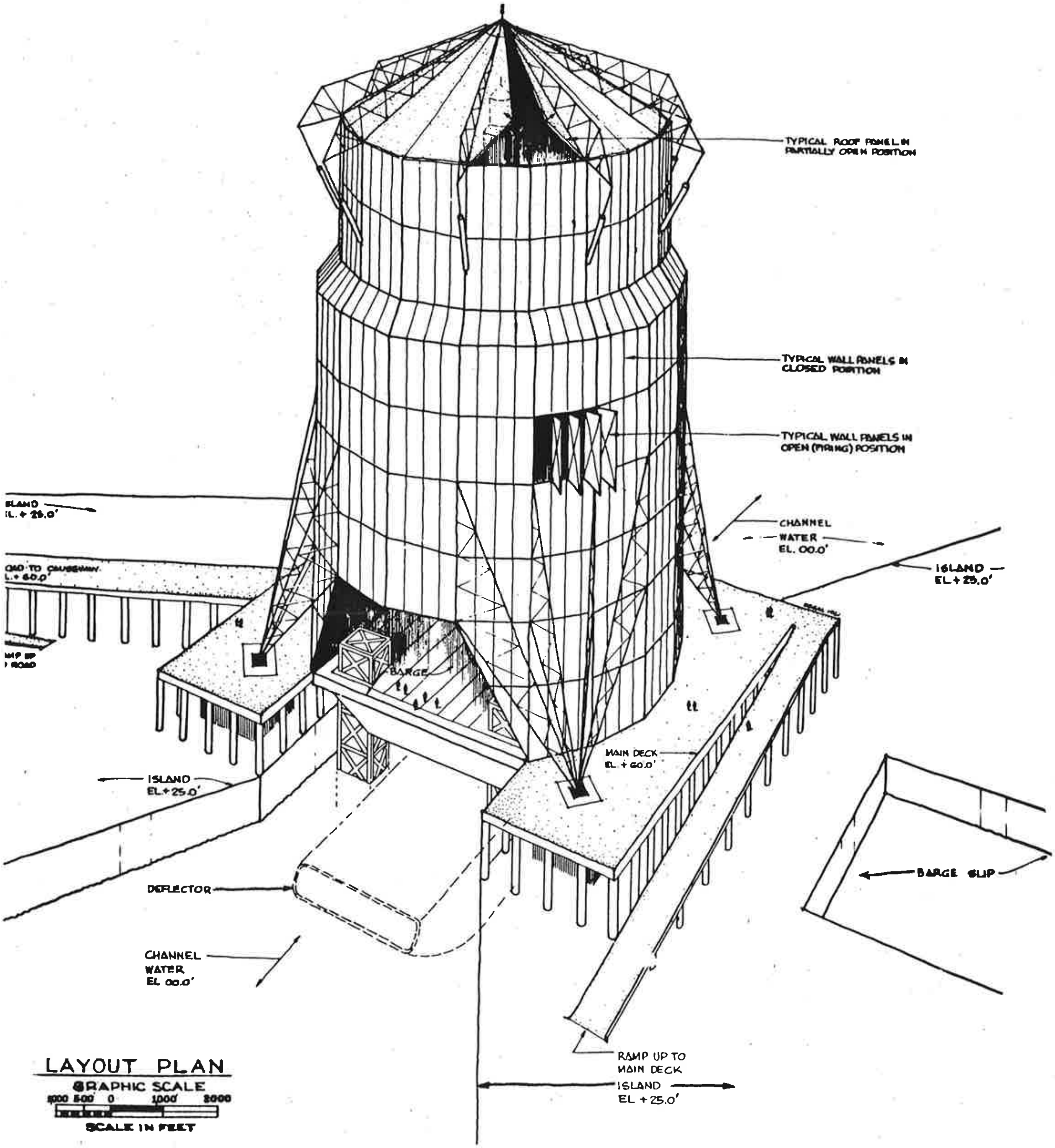


OFFICE OF
THE CHIEF OF ENGINEERS
WASHINGTON D.C.

NOVA FACILITY STUDY
ASSEMBLY & LAUNCH STRUCTURE

SCALE AS NOTED | PLATE NO: 1
DATE: 16 AUG 1961

Nova Hybrid Launch Facility Design



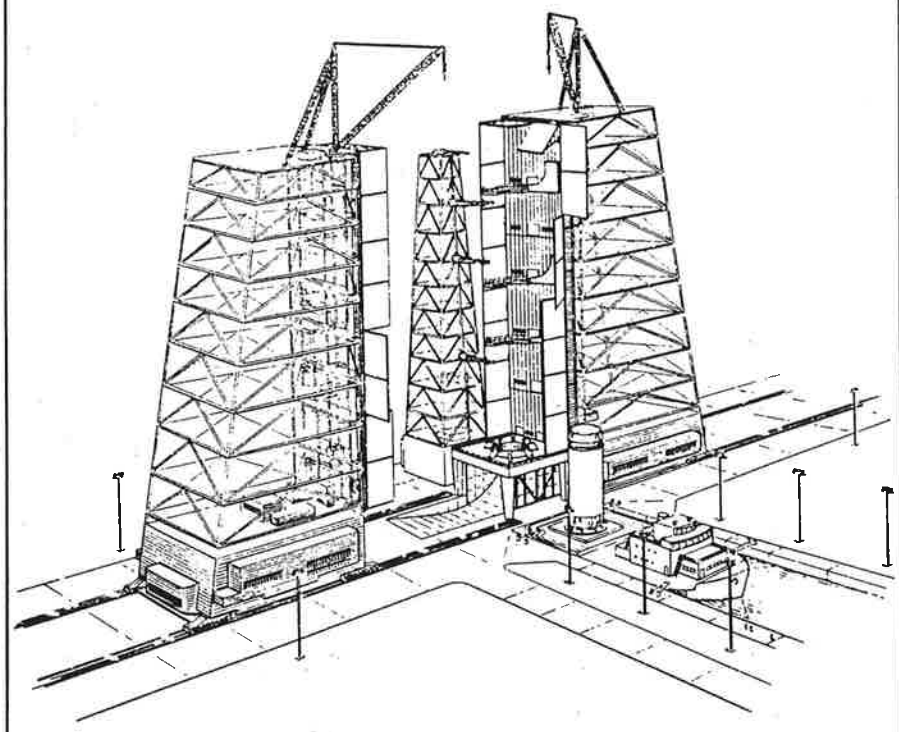


Figure 4 – A Movable Service Structure for Nova as presented in the Mobile Launch Facility Concept studies. Note the barge transport system (7/28/62). Drawing courtesy NASA

age dewars that are sized for the requirements of one launch. The dewars would be refilled as subsequent launches are scheduled at the pad. RP-1 would be delivered to a central storage tank and then trucked to the pad storage tanks as required.

A centralized launch control center (LCC) would be located in such a position so as to conveniently use microwave transmission equipment with a minimum probability of interference.

Mobile Concept

The mobile concept differs from the hybrid concept by virtue of the off-pad assembly technique. This technique requires several major additions to the facility: a building for vertical assembly (VAB) and checkout of the entire space vehicle, a transportable launch platform and umbilical system (replacing the launch building) and a very large transporter for moving vehicle and launcher to position at the pad. A crawler similar to but much larger than that used for the Saturn 5 was preferred for transporting the platform to the launch pad. In addition, a floating barge system that would travel via an inland canal was also considered (Figure 4). As the stages complete their checkout, they would be moved from the adjoining SCB into the central aisle under the VAB bridge crane. The stages would be lifted into place on the Launcher Umbilical Tower (LUT), which has previously been positioned in the assembly bay. Assembly and checkout would be completed to achieve the required confidence that the vehicle could be launched in minimum time as soon as it is positioned at the pad.

Fixed Concept

The fixed concept facility is very similar to the facility used by the hybrid concept and externally has the same appearance. However, the off-pad operations for the fixed concept are limited to receiving, visual inspection and modification. All functional testing is conducted at the pad (Figures 5, 6).

Off Shore Launch Facilities

Because of the explosive equivalent of certain Nova-class vehicles, it was determined that a sufficient number of launch pads to meet both mission requirements and safety parameters would not fit on the then exisiting Cape Canaveral land masses. One approach would have been to protect the vehicles in a hardened launch building. Another approach considered was to move some of the launch pads off shore.

The Nova off shore launch complex studies submitted on June 16, 1961 were among the more interesting studies done because of their complexity. Imagine a Texas oil rig stationed somewhere out in the Gulf coast with a launch vehicle larger than a Saturn 5 jutting from its middle and you have a basic idea of one of many designs considered. The problems associated with designing an off-shore Nova facility were magnified ten-fold from that of any land-based considerations. In addition to the problems of simply building such a facility off shore, other problems such as severe corrosion due to constant exposure to the salt sea breeze, rough weather conditions including hurricanes all had to be considered its design.

One of the primary reasons NASA considered an off-shore alternative launch site for Nova was due to safety. Their remote location (off shore) and the fact that they would be surrounded by the largest natural fire extinguisher available (the ocean), engineers felt that an off shore site would be a viable alternative.

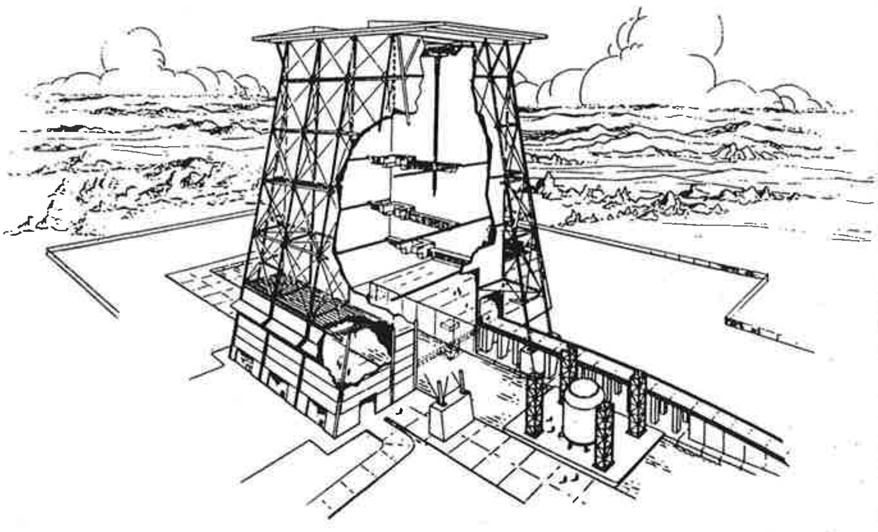
A variety of different off shore designs were considered. Among them were towable structures similar to modern day off shore oil drilling rigs, which would be assembled on land, floated and towed out to sea by means of barges then positioned and anchored (Figure 7). Primary access would be by boat, barge or helicopter. In this design, the structure would be essentially remote in that no direct physical link to the shore such as by causeway would be made.

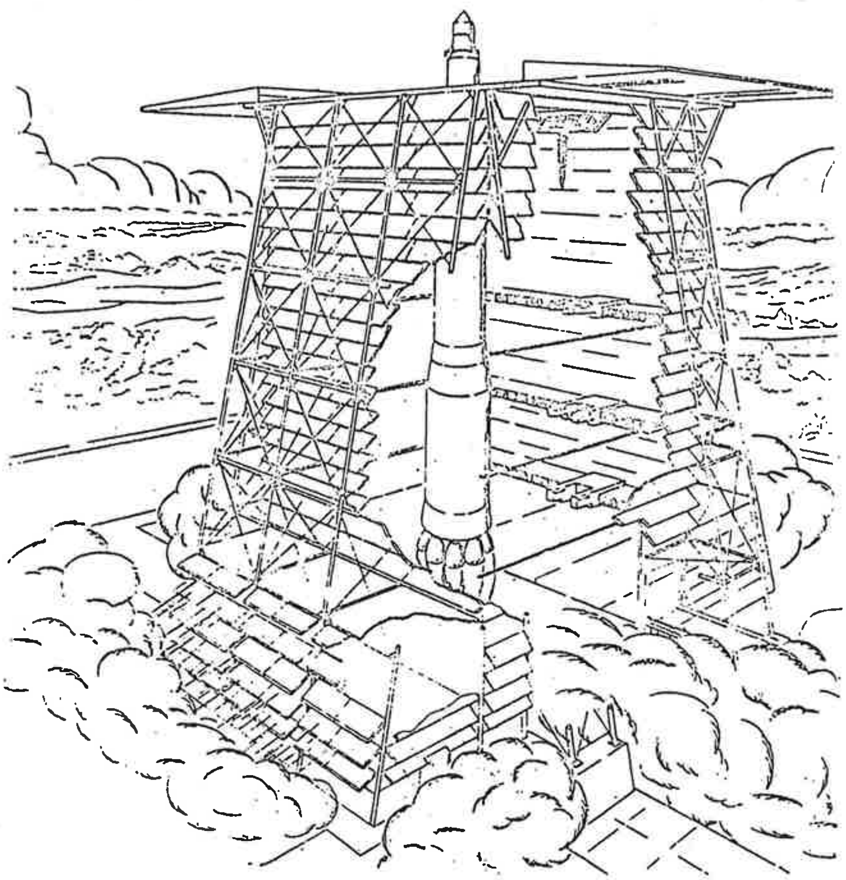
Another design similar to the above was considered with the only difference being that the facility would be connected to the shore by causeway (Figures 8). Trucks, automobiles and special vehicle transporters would all utilize this mode. If the causeway were to be built over relatively shallow water, the transfer of major Nova sections and stages would be possible.

A launch facility completely built around a massive barge (Figure 9) or dry dock was also considered. This ambitious design envisioned a portable launch facility that could be towed out to sea as needed in which all Nova stages would be assembled first while the vehicle was docked near shore. When ready to launch (and given relatively calm seas) the whole structure would be towed off shore and out to sea. The barge, equipped with retractable legs, would maneuver into position and lower its legs to the ocean floor lifting the barge above wave height, thereby providing a stable launch platform (Figure 10). Once anchored, the vehicle would be ready for launch.

Building the Nova launch facilities on off shore man-made islands was also considered. This had several distinct advantages to that of the previous off shore designs. First and foremost is that it would be cheaper to build if located in relatively shallow waters. In addition, man made islands would be more durable and stable than any off shore anchored structure. These advantages are offset by the fact that any man made island would have to be located relatively close to shore whereas an offshore anchored platform could be located a greater distance out to sea and in deeper waters. One of the more novel uses of such a off shore man made facility involved assembly of the Nova stages. With this design, the initial first and second stages would be assembled utilizing an overhead mobile service structure. These first two stages would rest upon a hydraulic platform or flotation tank submerged in a caisoon beneath the surface. Once the first two stages are assembled, water would be pumped out of the caisson and the vehicle lowered to an accommodated level where the remaining stages are then emplaced (Figure 11). Once assembled, the mobile service structure is moved away, the caisson is flooded and the whole vehicle is raised to launch position. During launch, the flotation tank could then again be drained and lowered to be used as a modified flame bucket.

Additional studies were done which would utilize a facility built upon either an anchored structure or a man made island from which the vehicle would be assembled, checked out, fueled and launched from within a large assembly-launching structure. This would have all of the features inherent in the fixed concept previously discussed except that it would be located off shore.





Figures 5, 6 – Above is pictured a Nova Vertical Assembly and Launch Facility based on the Fixed Concept. Beneath this is a depicted Nova launching from this facility. Note opened vent louvers for exhaust gases (6/15/61). Drawings Courtesy NASA

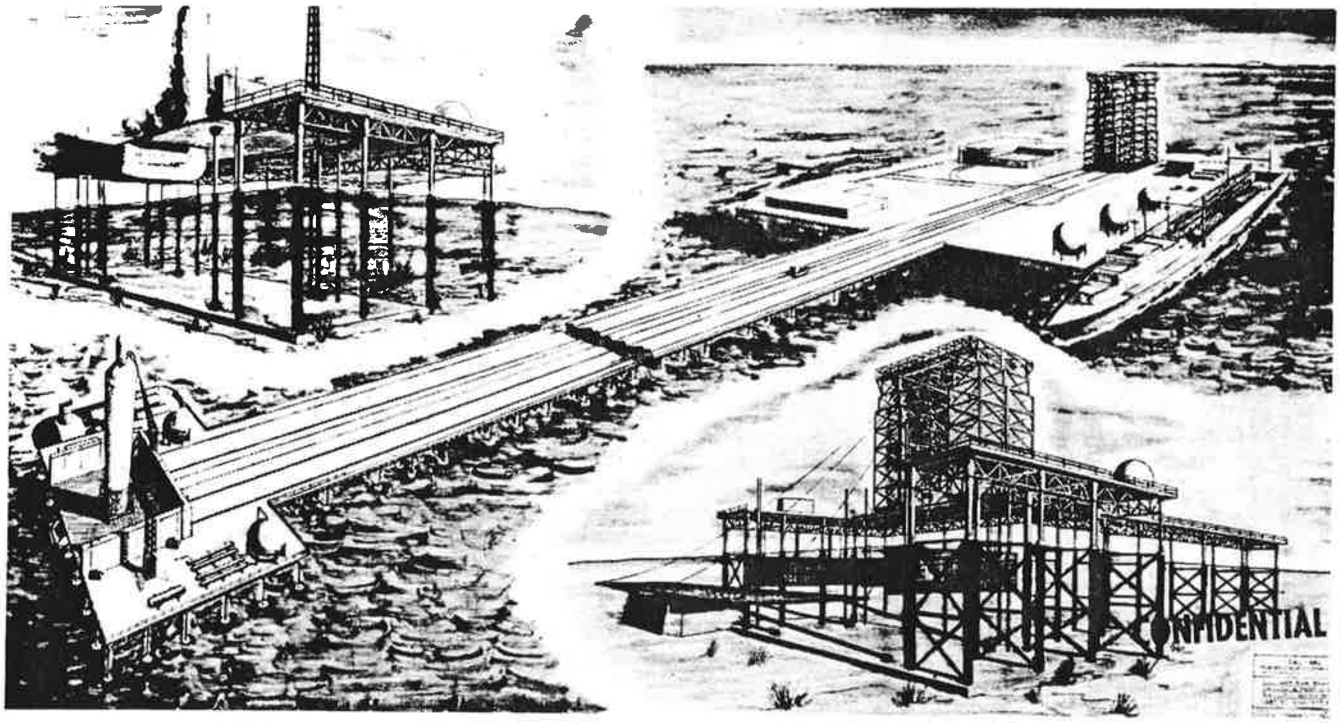


Figure 7 – Remote off shore Nova launch facility. *Drawing courtesy NASA*

Hawaii Nova Launch Site

Among the many concepts discussed for Nova launch sites, one of the more interesting would have been based on the "big island" of Hawaii. Based upon an open-silo concept of cliffside launch pads, this proposal submitted on January 10, 1963 included fixed assembly, checkout and launch towers that would be built into the hillside to take advantage of the natural barriers offered for blast protection.

The proposed Hawaii site chosen for Nova would have been located along the southeast shoreline of the main island of Hawaii. The site is near the Hawaii National Park in a sparsely inhabited section of the island approximately 40 miles from the city of Hilo.

The site would employ the use of a unique open-silo launch pad concept which utilized the naturally available high cliffs that dominate the shoreline. A series of reinforced concrete conical launch towers would be built into the sides of the hills. Because these launch pads would be completely protected from each other they could be built as close as a few hundred feet apart. Traveling cranes would then be used to remove the stages from barges which are moored at the base of the pads in a breakwater protected area. Assembly would be simple and quick. Payloads and stages would be assembled from the top of the "tower."

Lest one be concerned about one of the island's more unique natural occurrences, a valley located a few miles west of the site would provide a natural barrier for any but the heaviest lava flows which might be expected.

The total height of the proposed fixed structure would be 750 feet. The 170-foot diameter at the jack location, at 190 feet above sea level, opens out to 270 feet at the top of the conical tower. The service structure would consist of track-mounted cantilever platforms capable of varying their positions. These service structures would be moved upward and out of the silo prior to launch (Figures 12, 13).

The use of this open-silo design would channel the blast and fragmentation of a catastrophic launch pad failure out to sea. Although not shown in the diagrams, it would be expected that reinforced roof sections would be used to protect all pads from falling fragments should a failure occur in early flight. Curtains or a rigid door structure could also be used to close the silo against inclement weather and salt air.

In summary, this particular Nova launch facility design incorporated the following desirable features: Increase in maximum payload over Cape Canaveral launch, nearly unlimited launch azimuth, adapted to water transportation, launch complex is compact, pad adaptable to other vehicles, isolated site, minimum hazard problem from blast or fragments, proximity to west coast of mainland and most importantly offers a favorable climate and environmental conditions to attract support personnel. When given a choice of where to live, I am sure most Nova personnel wouldn't mind living in Hawaii.

Cumberland, St. Catherine's and Sapedo Islands Launch Sites

Another off shore island proposal considered for use as a Nova launch facility were a group of islands off the coast of Georgia. Cumberland Island, St. Catherine's Island and Sapedo Island are all located off of the coast of Georgia along the Atlantic seaboard. The largest is Cumberland Island which is about 23 miles in length with a width that varies from 1/2 mile to 2-1/2 miles. Located on the Atlantic Ocean in the southeast part of Georgia, it is about 15

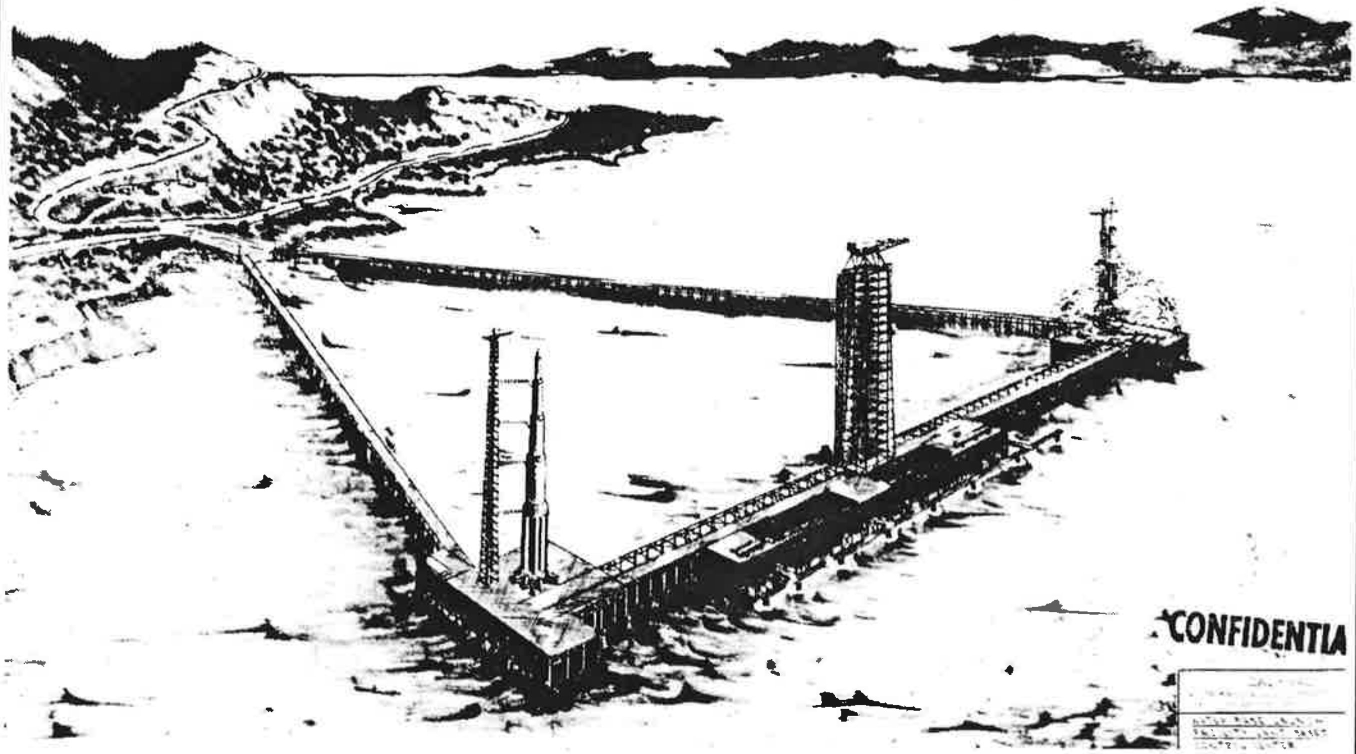


Figure 8 – Off shore Nova launch facility connected to the coast via an access causeway. *Drawing courtesy NASA*

miles south of Brunswick. The island is isolated from the mainland by the Cumberland River, which forms a part of the Intercoastal Waterway west of the island.

Among the favorable features offered by these sites were an abundance of undeveloped real estate, the Intercoastal Waterway, deep water warf and extensive rail yard.

From June 13-14, 1961 a field study was made of an area along the the Georgia coast with the center of St. Catherine's Island as the focal point. Some of the presented advantages of the site included: 1.) Sufficient land area available on mainland for industrial support build up with room for expansion; 2.) Climate very much like that at the Cape; 3.) Sparsely inhabited surrounding territory.

The Final Decision

After careful consideration of the many proposals brought before the Launch Vehicle Operations Division of NASA, the Administration's final decision was to use a mobile launch facility concept with a land-based site to be located due north of Cape Canaveral. The main reason NASA chose a land based operation was cost. It was found that it would cost approximately $590 million dollars to construct an off shore launch facility compared to $469 million for a land based system (Note: these figures are based on 1961 dollars). In addition, the cost of continual maintenance of an off shore versus land based launch facility would be considerable higher due to direct exposure to the often harsh open water environment.

In August, 1961 NASA acquired an additional 80,000 acres of land adjacent to the Atlantic Missile Range (Cape Canaveral) in Florida as the site for the new pad facilities for the Nova launch vehicle. The area met most of the major requirements set fourth in the guidelines for selection in addition to being the most economic and efficient choice.

Recalling the C-5 (Saturn 5) codevelopment that was also occurring at the same time as Nova, initial plans for development of the Nova-class series of launch vehicles included construction of two C-5 pads followed by two more C-5 pads and then three pads to handle the Nova-class vehicles. At the heart of this development would be the construction of a massive 450-foot high assembly building (the present day Vehicle Assembly Building or VAB) which was designed to assemble up to four Saturn 5 or Nova launch vehicles simultaneously. This new structure was at the heart of the decided upon mobile transfer method in which assembly and checkout would be combined in the VAB reducing pad time to a bare minimum. At that time, Launch Complex 34 from which the Saturn 1 and 1B launch vehicles were assembled and launched, could only accommodate four launches a year since two months of assembly and checkout time on the pad were required before launch with another month needed to rehabilitate the facility after launch. When NASA formally decided in July of 1962 that the Lunar Orbit Rendezvous (LOR) would be the definite mode used to go to the moon, the decision to use the much larger, more complex and expensive Nova-class booster was overlooked in favor of the Saturn 5. Up to man's first landing on the moon, NASA still had plans to build at least three Nova launch pads north of pads 39A and 39B. Lack of funds however even-

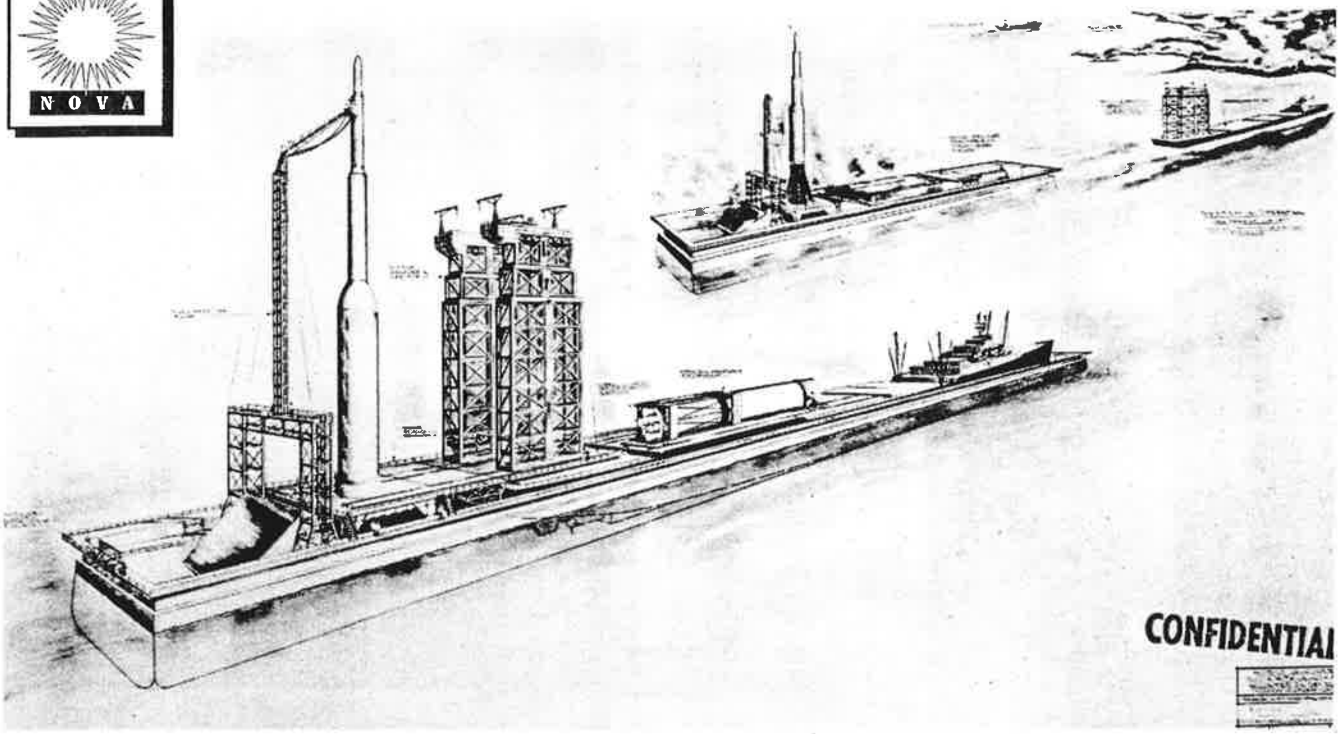


Figure 9 – Pictured above is a Nova launch facility built around a massive mobile barge. Drawing courtesy NASA

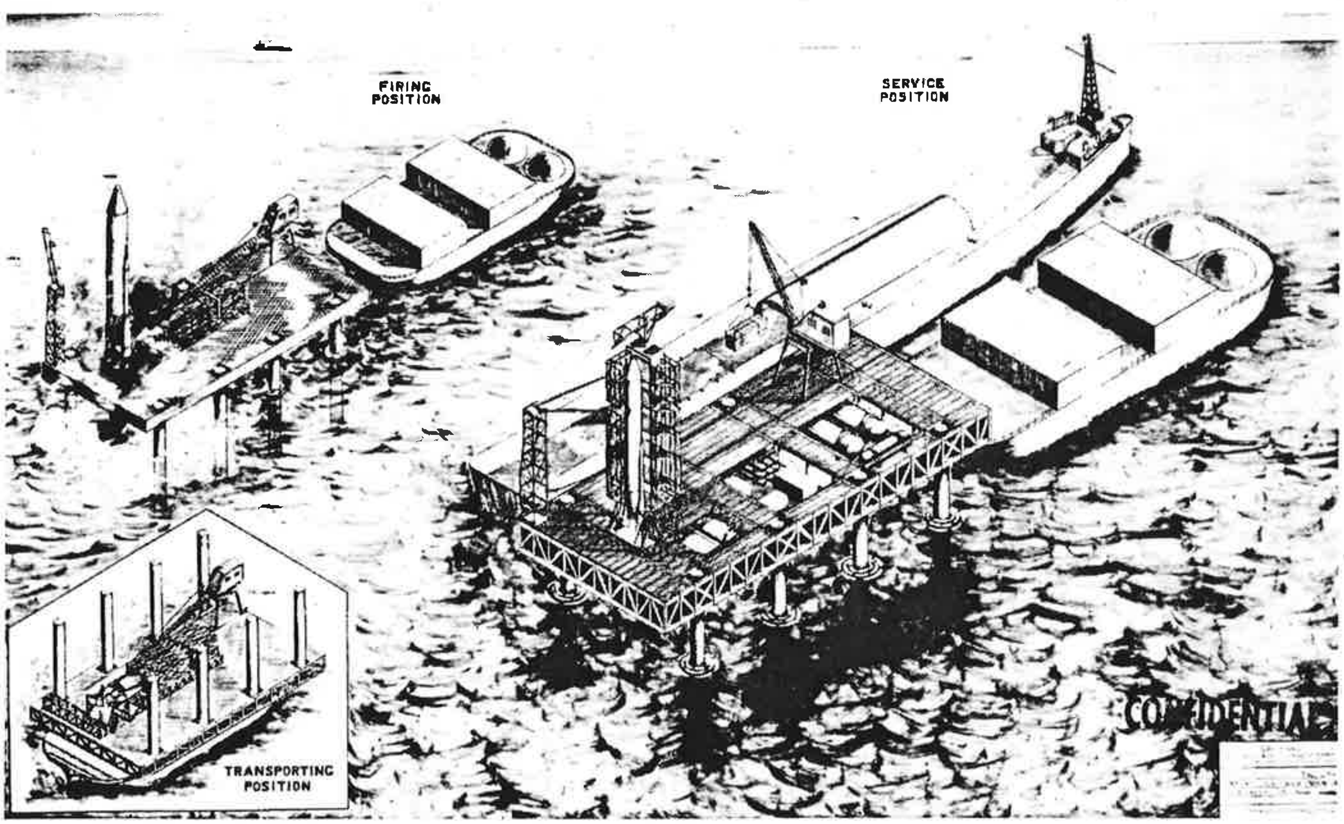


Figure 10 – Another Nova launch facility built around a barge that can be towed out to sea. Equipped with retractable legs, it would maneuver into position and lower its legs to the ocean floor lifting the barge above wave height, thereby providing a stable launch platform. *Drawing courtesy NASA*

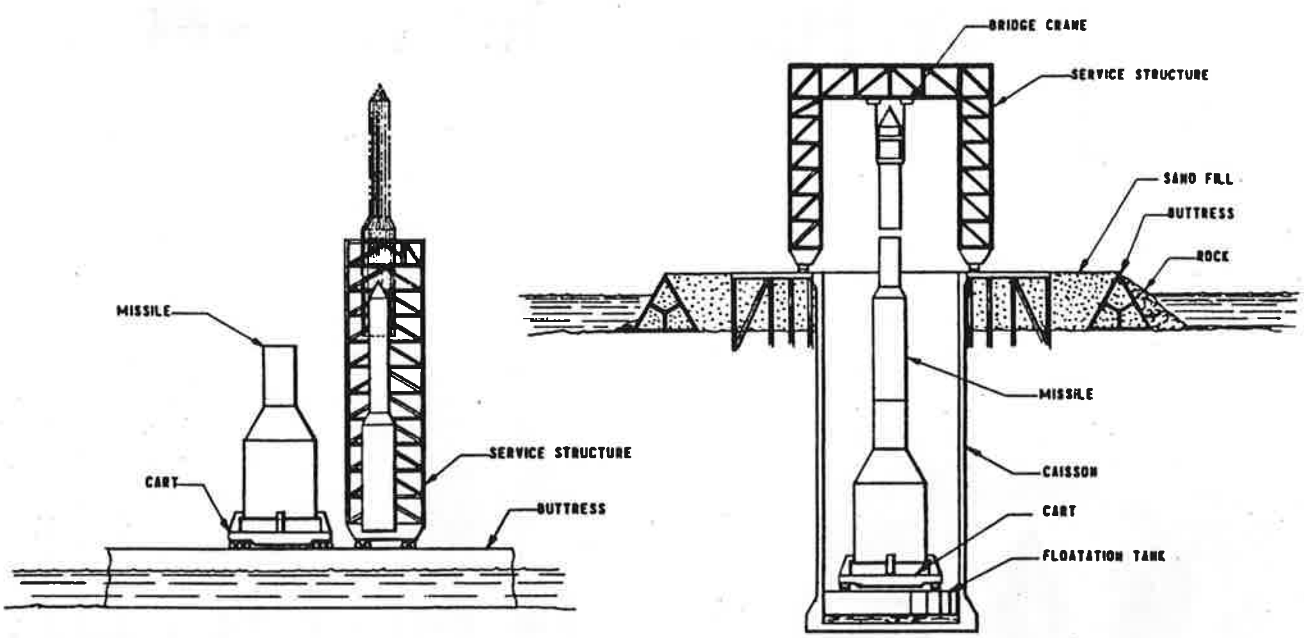


Figure 11 – This off shore facility design allowed Nova stages to be assembled using a unique flotation tank system that would lower the vehicle for easier assembly of upper stages. *Drawing courtesy NASA*

tually lead to the Nova program's final demise as did that of the Apollo program.

Today, you can walk among the would be "land of the giants" by taking Beach Road, located north of the Kennedy Space Center, through to the Merritt Island Wildlife Refuge. Travelling on this road due east and heading toward the Atlantic Ocean you will eventually have to turn left (you can't go straight because the ocean is in the way and you can't turn right because of a restricted access road to KSC). Waving at the elevated ranger station as you turn (they are watching you because you are driving through not only a National Park but, more importantly, you are driving less than three miles from an active launch facility), you are now travelling north along Playalinda Beach. Part of the Canaveral National Seashore, this area is actually a beautiful place to stop and soak up some sun and surf since it is rarely crowded with plenty of parking and access to the beach. You will want to take this road as far north as it will go. The end of the road is marked by a tracking station that is still in use for shuttle launches. Get out of your car and walk up to the slight mound where this tracking station is built. While you are enjoying the view looking northwest across the marsh or perhaps due south toward Launch Complex 39B, it is at this point where one of the Nova launch sites would have been built.

Series Conclusion

With its ambitious goals of not only landing men on the moon via direct ascent, but of also sending manned expeditions to Mars and beyond, Nova captured the public's imagination beyond the routine missions of Apollo.

If Nova had been used in place of the Saturn 5 to land a man on the moon what then? What of future projects leading up to the development of the space shuttle and the present plans for a manned space station? How would Nova fit into these program? Would the goals of the manned space program have changed? In retrospect, it is doubtful that much would have been different.

The Nova series of launch vehicles would have been three to four times more expensive to build and operate on a regular basis that that of the Saturn 5. Recall the reasons for the eventual demise of the Saturn 5, mainly politics and cost, and these same reasons would have lead to the fall of Nova as well. Indeed, because of the considerable costs involved for each Nova flight, chances are there would have been fewer missions to the moon if Nova were used instead of the Saturn 5 as the principle launch vehicle.

Nova could have been developed after the Lunar Orbit Rendezvous (LOR) decision had selected the Saturn 5 if Congress would have backed a manned Mars mission or a large space station development project after the Apollo program. These projects would have required the payload capacity of a Nova-class launch vehicle, perhaps even an advanced version with single stage to orbit capability.

Looking at the launch vehicle requirements of today, NASA could surely use a Nova class vehicle to help launch segments of the planned space station into the projected higher orbital inclination of 52 degrees chosen for the new international space station. Since funding has not been forthcoming for advanced launch systems such as "Spacelifter" or "Delta Clipper," one cannot help but wonder what the United States will use to launch large payloads of the immediate future. It is not practical to continue using the Space Shuttle until the current fleet wears out nor is it wise to rely on the costly and outdated Delta, Atlas and Titan vehicles.

It is always interesting to ponder what would have been, especially in retrospect to the events that have since happened. We hope that this three part series on one of the more ambitious and somewhat obscure manned space program projects has been as much a pleasure for our readers to follow as it has been our pleasure in producing. Project Nova, like that of Apollo, was a program ahead of its time and it has been our goal through this series to make its history known for those generations to come. ●

***Editor's Note:** Additional Nova drawings, text and bibliography continue through page 20.*

Hawaii Nova

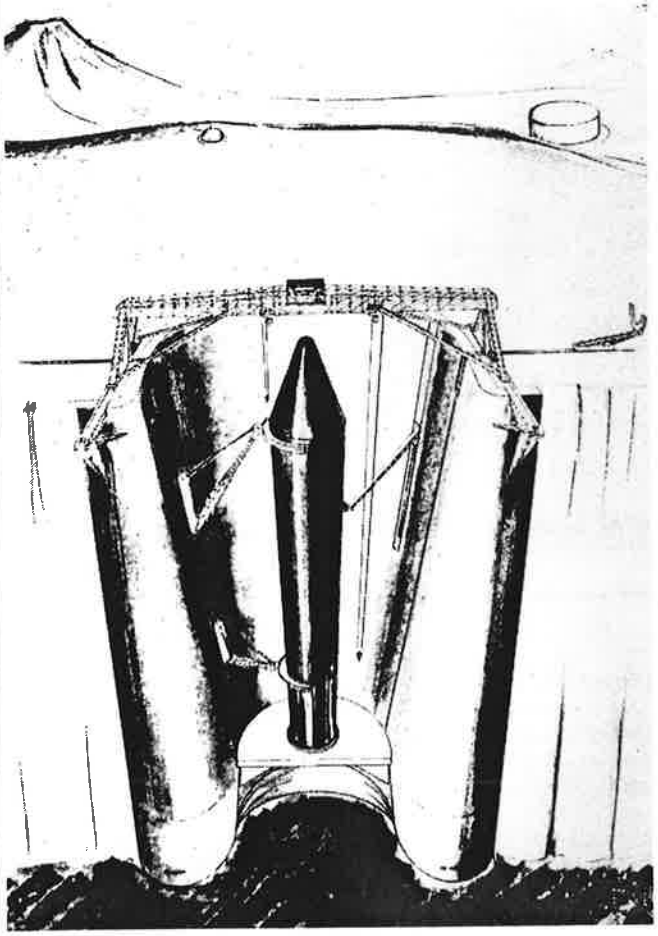


Figure 12

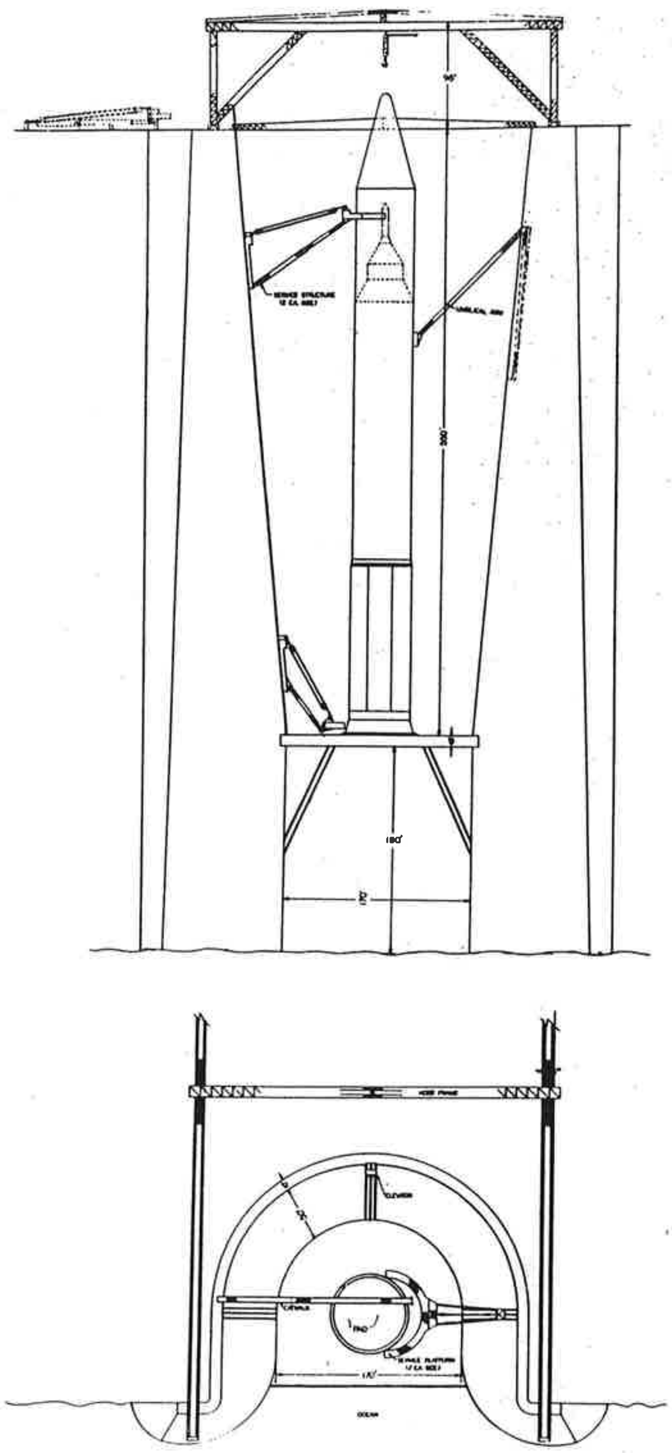
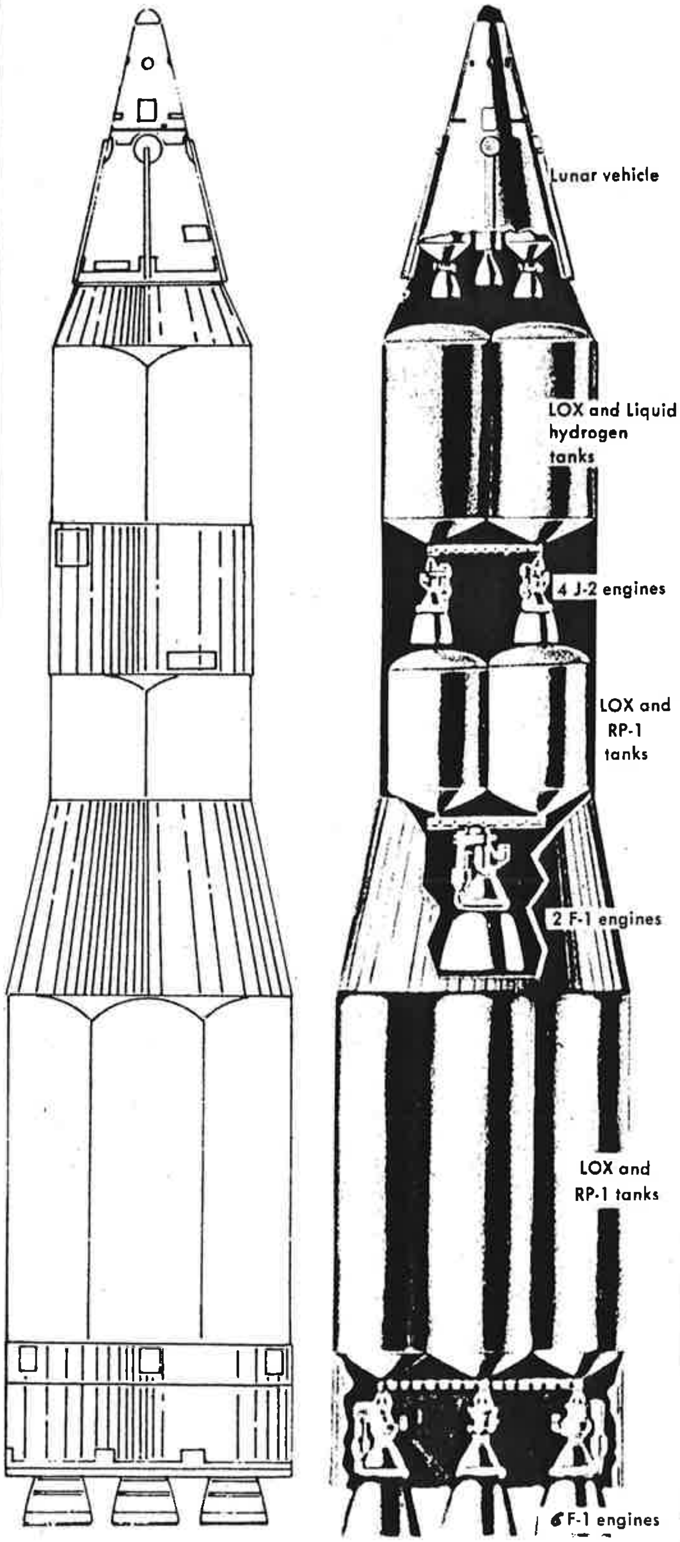


Figure 13

Among the many concepts discussed for Nova launch sites, one of the more interesting would have been based on the "big island" of Hawaii. Based upon an open-silo concept of cliffside launch pads, this proposal submitted on January 10, 1963 included fixed assembly, checkout and launch towers that would be built into the hillside (Figure 12) to take advantage of the natural barriers offered for blast protection. (Figure 13) The total height of the proposed fixed structure would be 750 feet. The 170-foot diameter at the jack location, at 190 feet above sea level, opens out to 270 feet at the top of the conical tower. The service structure would consist of track-mounted cantilever platforms capable of varying their positions. These service structures would be moved upward and out of the silo prior to launch.

NOVA Corrections



During the continued course of our research, we have uncovered several pieces of new information relating to the Nova program. This new information has revised some of our initial data which we would like to share with our readers.

The first correction refers to the Fall 1992 issue of *QUEST*. On page 22, the Nova Category "E" General Dynamics Vehicle was listed as having an unknown takeoff thrust. Since then we have found a source that stated that the takeoff thrust for this category vehicle was determined to be 56.2 million pounds.

The second correction again refers to the Fall 1992 issue of *QUEST*. On page 16 we had listed unknown data for the second and third stage portions of the NASA six-engine Nova. Since then, we now have additional data on this particular vehicle (listed in the box below) as well as more detailed drawings (at left).

NASA'S 6-ENGINE NOVA
Originally proposed 1959

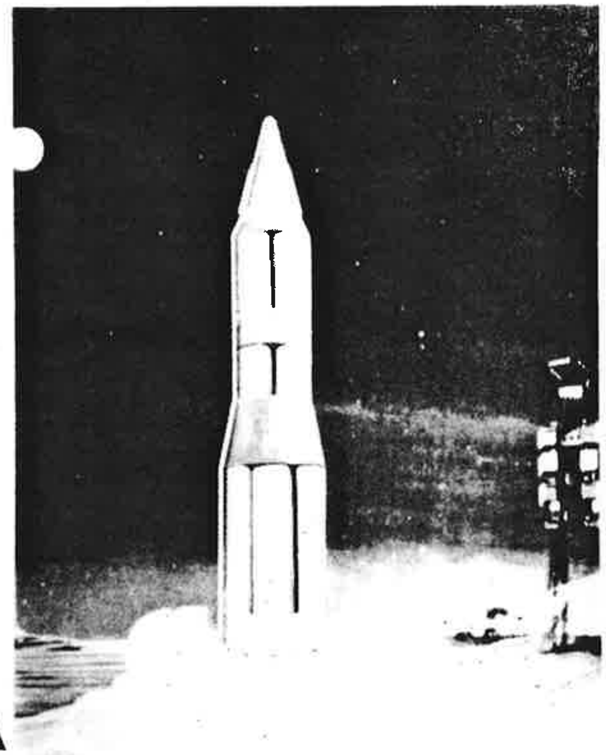
1st STAGE
ENGINE - (6) F-1
FUEL - LOX/KEROSENE
WEIGHT - UNKNOWN
THRUST - 9,000,000 LBS.
2nd STAGE
ENGINE - (2) F-1
FUEL - LOX/KEROSENE
WEIGHT - UNKNOWN
THRUST - 3,000,000 LBS.
3rd STAGE
ENGINE - (4) J-2
FUEL - LOX/HYDROGEN
WEIGHT - UNKNOWN
THRUST - 800,000 LBS.

LENGTH
220 FT.
DIAMETER
44 FT.
TAKEOFF THRUST
9 MILLION LBS.
PAYLOAD TO LEO
290,000 LBS.
PAYLOAD TO ESCAPE
100,000 LBS.

Source for the above revised figures and accompanying drawings to the left: "America's Space Vehicles: A Pictorial Review" by Will Eisner, Sterling Publishing Co., Inc., New York, 1962; pages 44, 45, 106-113.

NOVA

What Might Have Been: A



A

Imagine if you will...

With these words let us go back in time to the early1960s when world tension has reached its peak. The "space race" takes a new turn as intelligence reports indicate that the Soviets have had remarkable success with their new lunar "super booster" N-1 launch vehicle. Experts predict that the Russians may beat the United States in first landing a man on the moon. With this news, Congress has ordered NASA to get to the moon at all costs. No expense is to be spared as the Apollo program's goal is revised to not only land a man on the surface of the moon before the end of the decade but more importantly, to do it before the Russians.

Of the several techniques capable of performing such a mission, it has been agreed to go with the direct ascent mode as the most feasible to meet this challenge. A direct flight to the moon, while requiring a larger booster, has the clearer advantage of saving time. The Nova booster is given the final go ahead for development as the main launch vehicle for the Apollo program.

It is now July 1969 and the final day has come when men will travel to the moon and walk on its surface for the very first time. On an island near the equator, the new giant Nova rocket sets waiting as millions of people all over the world listen to the final seconds of countdown.

(A) At "zero", six F-1 engines thunder in unison and the world shakes as nine million pounds of thrust struggles to break free from earth's cradle. Man now turns an expectant eye toward the heavens.

(B) Rising in a vertical path for 10 seconds, the mighty Nova booster veers slightly to the east and in 135 seconds, reaches an altitude of about 35 miles. At this point, the first stage cuts off, parachuting back to earth for recovery by the waiting vessels below. The two F-1 second stage engines then ignite to continue the vehicle's lunar journey.

(C) In 177 seconds (traveling now at about 15,600 feet per second) the second stage cuts off and the four J-2 engines of the third stage fire with 800,000 pounds of thrust, sending the rocket along a near parallel path to the earth at approximately 150 miles altitude.

(D) For 60 hours after the third stage burns out and is dropped, the cone-shaped lunar vehicle coasts through the darkness of cislunar space — the area between the earth and the moon. As it approaches the moon, its control jets slowly position it for descent to the surface.

(E) At this point, four braking rockets of the fourth stage begin to fire and the vehicle is maneuvered toward its preselected landing area.

(F) The landing struts extend in a 40-foot span from the vehicle's sides, bracing the cone as it slowly comes to rest on the moon's surface.

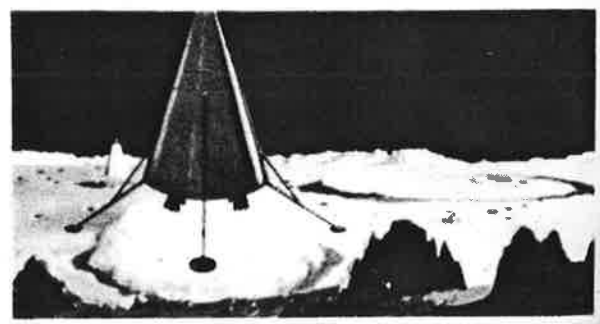
(G) Two astronauts emerge while a third stays on board. Not far from where they land is a duplicate of their vehicle, which was landed without a pilot. The second vehicle, which was also launched using a Nova booster, acts as a return ship should their own vehicle be damaged. Nearby is a beacon which was used as a reference point to direct their landing.

(H) Twelve days of exploration pass. The astronauts have spent their time making notes, collecting rock samples, recording temperatures and radiation and performing a thousand-odd tasks. They have loaded the ship with their valuable cargo of information and are ready to return. The vehicle fires its fifth-stage rockets, using the fourth stage as a launching stand. While on the moon, the spent fourth stage served as a meteor bumper and shielding against thermal radiations which would have affected the operation of the fifth stage.

(I) After 220 seconds of thrust, the fifth and final stage burns out and is discarded. The capsule, after a few corrective blasts from its stabilization rockets, begins its 60-hour journey back to earth.

(J) At the edge of the earth's atmosphere, the capsule starts down its entry "corridor." The surface begins to glow from heat caused by the friction of reentry.

(K) At 30,000 feet a parachute is unfurled. The capsule falls slowly to the sea where tracking and rescue ships await it.



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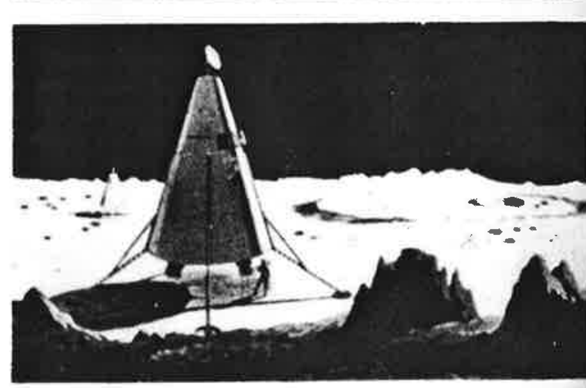

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The primary source used for the above mission description and accompanying drawings was the book "America's Space Vehicles: A Pictorial Review" by Will Eisner, Sterling Publishing Co., Inc., New York, 1962; pages 44, 45, 106-113. In addition, these six artist's concepts (sketched about February 1959) were originally used in a presentation by M. W. Rosen and F.C. Schwenk at the Tenth International Astronautical Congress held in London on August 31, 1959. (Source: "Chariots for Apollo: A History of Manned Spacecraft" by Courtney G. Brooks, James M. Grimwood, Loyd S. Swensen, Jr., NASA SP-4205, published 1979, p. 2)

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