

A S T R A T O P O R T

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Study in design of ground facilities for launching  
and landing of Space-ships



T H E S I S

Presented to the Faculty of the Graduate School of the  
Massachusetts Institute of Technology in partial ful-  
fillment of the requirements for the Degree of :

M a s t e r        i n        A r c h i t e c t u r e

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Submitted for the degree of Master in Architecture in the Department of Architecture on May 13 1957.

A B S T R A C T

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### INTRODUCTION

In spite of its odd title, this thesis attempts to deal with the usual problems of the architect's profession :

- Establishment of a consistent program from unclassified data.
- Organisation of structurally articulated spaces.
- Approach to an order satisfactory for both physical and intellectual comfort.

### SPACE TRAVEL

To-morrow, man will travel to the moon; but the journey will not be a non-stop flight as described by Jules VERNE and the Science-Fiction writers.

A man-made station, erected in space with components shipped from the Earth, will orbit around our planet along a circular path, 1075 miles above the globe. Its 15,840 m.p.h. speed, balancing exactly the earth's gravitational pull will make the station our permanent satellite.

Taxi space-ships fired from a stratoport built on earth will supply regularly the space-station; in order to acquire the adequate "escape-velocity", these liners are a huge combination of two separate stages, assembled "piggy-back". The first stage, or "booster", provides the space-ship with its initial speed, then cuts off its engines and is parachuted into the ocean. A fleet of vessels, radar-tracking its descent, retrieve the booster and haul it back to the launching site. Meanwhile, the second stage, or "strato-liner" fires its own engines, reaches the space-station's orbit and unloads passengers and cargo. Then it glides back to earth, lands on the stratoport and is carefully checked.

1075 miles above, the passengers are transferred into an outer-space-bound to the moon, Mars or Venus. The space travel begins.

### THE STRATOPORT

The chosen site is the MARTINIQUE ISLAND, located in the lesser Antilles by 14 degrees 35 minutes North latitude and 61 degrees West longitude; it has been primarily selected for its relative vicinity to the equator where the

1040 mph. earth's velocity will give the space-ship, fired eastward, an additional speed. Also, the wide water area extending eastward will allow an easy recovery of the boosters discarded into the ocean 900 miles away. The very good harbor possibilities will allow the docking of the numerous tankers supplying the stratoport with the gigantic amount of propellants required for the operations. The constant summer-like climate permits an all-year-around utilisation, and the mountains neighboring the site provide on their summits areas where to build the control installations.

Once the prefabricated components of the space-ship are docked in the harbor, they are conveyed to a serie of checking-shops and test-cells before being finally assembled on top of one another, then stored in the adequate hangars.

Three huge concrete "craters", set 120 degrees apart and converging to a central control-tower, provide the space-ships with good take-off facilities. The main reason for the crater-like shape is the protection from the wind required during the crucial early seconds of the take-off. While a space-ship is launched from a crater, according to the daily schedule, the liner to take-off the next day is prepared inside an other crater. The three launching units help the continuity of the operations.

On the landing site nearby, adequate runways give the strato-liners returning to earth the convenient facilities. The landing area is also used by the conventional jet-transport connecting the stratoport with the rest of the world. The usual air-terminal welcomes the passengers.

Thanks to the efficient muffling devices suppressing all noise due to the rocket-engines, the neighborhood of the stratoport will be sufficiently calm to allow the construction of a training center and an entertainment center. In order to provide their users with the maximum comfort, all the buildings will be sound-insulated.

Built on the southwestern shore of the island, a city for the workers operating the stratoport will be connected with it by buses and helicopters.

T A B L E O F C O N T E N T S

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Cambridge, Massachusetts

May 1957

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Dear Dean BELLUSCHI,

I hereby submit the enclosed thesis entitled " A STRATOPORT " in partial fulfillment of the requirements for the degree of Master in Architecture.

Respectfully submitted .

Jacques BINOUX

A C K N O L E D G M E N T S

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The author wishes to express his gratitude to the following persons :

Professor L.B.ANDERSON and Professor H.L.BECKWITH for their approval and encouragements on the choice of the subject.

Professor Paul SANDORFF, Aeronautical Department, M.I.T., for his most precious informations, criticisms and suggestions on the space-travel techniques and on the general lay-out of the Stratoport.

Professor NEWMAN for his grat<sup>e</sup> help in the design of the accoustical installations.

A special acknowledgment is made to Mr. Ernest A. GRUNSFELD, Architect A.I.A. chairman and founder of the GRUNSFELD Fellowship, who granted the writer with the privilege to visit the United States and to attend the Graduate Class of Architecture at the Massachusetts Institute of Technology.

" When man has conquered all the depths of space, and all the mysteries of time, then will he be but still beginning ..."

H . G . W E L L S

("The shape of things to come")

I N T R O D U C T I O N

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The oddity of the title asks for an explanation ; the word "STRATOPORT" has been used by the space-travel writers during some thirty years to designate the earth facilities requested for the launching and landing of space-ships. The adequacy of the word could be argued, since the space-ship is going to travel far above the stratosphere. We only selected the word "STRATOPORT" to avoid any confusion with the "SPACEPORT", or "SPACE-STATION" which designates the man-made satellite going to be erected in space in order to facilitate space-travel.

Such will remain our attitude concerning the technical vocabulary throughout this report, and we will use only the technical words and data necessary to make clearer our explanations. We know that a fake scientific knowledge cannot fool anyone, and our sole purpose is to let the reader have his opinion about the proposed scheme.

Then may arise the question about the very choice of the subject : Why a stratoport ? Is that architectural ? And is it not too early to deal with the problem, since man has flown nowadays at the maximum altitude of 15 miles ?

We think the matter is a very actual one : The tremendous improvements made during the past years in rocket-engineering techniques have permitted Dr. Wernher von BRAUN, technical director of the U.S. Army Ordnance Guided Missiles Development Group, to declare that, technically speaking, the construction of manned-rockets capable to fly across the space frontier was possible to-day. According to his statement, a manmade satellite station

could be erected in Space within the next fifteen years. From this platform, a trip to the moon itself would be just a step, as scientists reckon distance in space.

So, one can wonder whether we are not to-day, as far as ~~space~~ space travel is concerned, in the same situation as people were in the nineties regarding air travel. Few people were foreseeing the importance commercial airplanes were to take thirty years later, and misconceptions resulted in the ~~construc-~~ construction of the early airports. By assuming to-day the reality of space travel, we are trying to show the importance of the problem, and to give a basic scheme for further discussion.

It seems to us also that imagination occupies a very important place among the architect's activities. For centuries, while planning cathedrals and palaces, architects were planning utopian cities and dreaming of fantastic buildings. We most appreciate the dealing with reality, and are very conscious of the every day tasks of the architect. But we can't help believing that while still in a School of Architecture, we have the wonderful opportunity to let our dreams go.

However, the choice of the subject is not to be considered as a trick to avoid the difficulties belonging to other more realistic architectural problems : The approach to an architectural problem remains the same whatever should be the subject considered. For a stratoport, the same as for a factory or a community center, the architect has to work a program out of the multitude of requirements demanded by his client. The conception of an intelligent program is the first task of our profession.

Once its preliminary program established, the planning of a stratoport is the very province of the architect, since it deals with the organisation of structurally articulated spaces. One is amazed, indeed, when reading the nu-

merous books devoted to space travel, to notice that if the technical details of the space-ships have been carefully worked out, the indications concerning the ground installations are very vague or totally omitted. And the architect can imagine the businessmen and the engineers building the stratoport according to their ideas, then asking him to hide behind corinthian columns or window-walls an incredible mess of unorganised spaces. For a stratoport the same as for any industrial plant, the architect must not come too late. His training has provided him with the ability to organise functionally-related spaces. By working with the technicians right from the beginning, he can help them to work out a simpler solution. And lastly, while scientists and technicians are working to improve the machines, the architect keeps constantly in mind the human factor. While technical means provide the people with the physical comfort, the architect tries, by an harmonious concept of well related spaces, to give those people the feeling of beauty, that is the intellectual comfort. Obviously, this thesis, dealing with the only data available to-day, will propose a solution that will seem rather naive to the space travellers of to-morrow. We hope they will understand we had the same fun in planning the architectural lay-out of the stratoport as the scientists had in planning the to-morrow outdated space-ships.

"....Come, my friends !  
'Tis not too late to seek a newer world,  
To sail beyond the sunset, and the baths  
Of all the western stars....."

TENNYSON

("Ulysses")

S P A C E T R A V E L

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Before beginning to organize the general lay-out of the Earth Stratoport, we will try to describe the space-ships themselves, and the means by which those liners will flow their passengers in the outer space.

The matter does not belong anymore to the science-fiction province, since the tests undertaken during the past years on many different guided missiles have permitted to improve tremendously the rocket-engineering science, and we can actually foresee the major features of the space-ship. Before the end of this century, the first manned rocket will be fired above the atmosphere, and this will become man's first step in his conquest of space.

#### WHAT IS SPACE ?

The Earth is covered around by a protective envelope which provides us with life, giving oxygen and water, and also protects us against the effects of the sun's harmful ultra-violet rays.

This envelope, called ATMOSPHERE, is a mixture of 21 % oxygen, 78 % nitrogen, and about 1 % other gases. This mixture, thickest at sea level, becomes thinner and thinner as we go up, until we can say it practically disappears; the atmosphere is constituted of several different layers :

- a/ from sea level to an altitude of 8 miles : THE TROPOSPHERE
- b/ from 8 to 60 miles up : THE STRATOSPHERE
- c/ from 60 to 120 miles up : THE IONOSPHERE

-d/ from 120 miles to infinity : THE EXOSPHERE

At the boundary between ionosphere and exosphere only single air molecules may be encountered moving, just as the moon, around the earth in satellite orbits; there, a space ship can move freely, since air friction becomes negligible, and SPACE begins.

#### HOW TO GET IN SPACE?

First of all, we have to give up with the ideas exposed by Jules Verne, H. G. Wells and the other prophets of space travel : it does not seem reasonable to fly directly space ships to the moon, mars or an other planet-

To do this, we would require vehicles of such gigantic proportions that it would prove an economic impossibility- the ships would have to develop sufficient speed to penetrate the atmosphere and overcome the earth's gravity, and, having travelled all the way to the moon, they must still have enough fuel to make the return trip to the earth-

Calculations have been carefully worked out on the type of experimental ship we would need for the non stop flight to the moon; in order to give the expedition a margin of safety, we would not use a ship alone, but a minimum of three: each rocket ship would be the size of the Empire State Building ( 1250 ft) and weight about ten times the tonnage of the " Queen Mary ", or some 800.000 tons-

A much simpler approach to the problem has been first expressed by professor Oberth, and a few years ago by Dr Wehrner von Braun- The idea is to send over in space a man made satellite station, orbiting just as the moon, around the earth-

From our globe, on a regular schedule, rocket ships will be fired to the

space station and unload at the point of encounter prefixed in space ~~to~~ their passengers and their cargo- While those "taxi" rocket ships ~~will~~ will fly back to the earth, special space ships using the space station as a launching platform will fly the passengers to the moon, mars, and so on. The artificial satellite, carried into place piece by piece, will travel along a celestial route 1075 miles above the earth, completing a trip around it every two hours- A neat balance between the space station speed and the earth 's gravitational pull will keep the satellite on course, just as the moon is fixed in its orbit by the same two factors- The speed at which the 250 ft wide wheel- shaped satellite will move will be 4,4 miles per second or 15,840 miles per hour( Twenty times the speed of sound) - However, to its occupants, the space station will appear to be a perfectly steady platform.

The choice of the so called "two hours" orbit in preference to a faster one (closer to the earth) or a slower one (more remote in space) has the advantage to provide its passengers with a splendid observation post.

As one can see, the first step of the space travel organisation is to build a fleet of huge rockets capable of carrying a crew and 30 or 40 tons of cargo into the future orbit where to assemble the space station- Since those rocket ships are using reaction as a mean of propulsion, we will recall the principle of reaction.

#### PRINCIPLE OF REACTION

This principle is based on Isaac Newton 's third law of motion: "For every action, there must be a reaction of equal force, but in the opposite

direction "

To illustrate the principle, we have to use the old example of the machine-gun mounted on a light rail vehicle; if we begin firing the weapon parallel to the tracks, the recoil will set the vehicle rolling along the rails in a path opposite the firing direction- If we disregard the friction, the speed of the vehicle will steadily increase as each bullet leaves the barrel. If the vehicle were light enough and carried sufficient ammunition, its speed could eventually be greater than the speed of the bullets, since the bullets of the machine-gun are moving at a fixed speed, whereas the vehicle on the tracks is constantly increasing its speed. It is easy to see that this method of propulsion does not need air to function. Indeed, if there were no air present, the speed of both bullets and vehicle would be greater.

This principle governs the rocket's operation: the body of the rocket is like the barrel of the machine-gun.

The power of a rocket is measured in pounds or tons of recoil called " thrust "- A high speed thrust is obtained when the combustible propellants of the rockets are combined and ignited; the presence of an oxygen-containing atmosphere is not required for sustaining this combustion process because a true rocket carries its own oxygen as a part of the propellants. Therefore, the ideal field for the most efficient use of the rocket motor is the empty space outside the earth atmosphere.

#### PROPELLANTS

Which propellants shall the rocket engine use?

-a/ Solid propellants.

Solid propellants such as the cannon-powder are out of question, because

it is very ~~is~~ difficult to manufacture large charge, because of the impossibility to fasten the charge inside, <sup>because</sup> the rocket should be extremely strong (therefore heavy ) to stand high combustion pressures, and finally because once a charge of solid propellant has been ignited, there is no way of stopping its combustion.

-b/ Atomic energy.

From our actual knowledge, it does not seem possible to use atomic power as a mean of propulsion. The only known way of releasing atomic power is through its transformation ~~into~~ heat energy. This takes place in the atomic pile. We could pump water into an atomic pile, then expell the stream through an exhaust nozzle in the tail of the rocket. But this would involve a tremendous ammount of heat in order to obtain the sufficient thrust to accelerate the whole rocket-ship.

We are then limited by the melting points of the materials used in the atomic pile itself. Also we have to consider the impraticable aspect of the weight of the atomic pile, which becomes a mere dead load once energy has been drawn out of it.

-c/ The chemically propelled rocket is the only answer we have today.

Separate quantities of " fuel " and " oxidizer " will be stored in different tanks. From there, they will be pumped into a combustion chamber or " rocket motor " where their powerfull chemical combination will give the ship its propulsion. Only the pumps, the pipes and the motor need to be sufficiently thick-walled to withstand the combustion pressure.

Among the long list of liquid gases which can be used as "fuels " and chimal compounds to be used as " oxidizers " , we will chose propellants meeting the following requirements:

-High exhaust velocity and low combustion temperature.

-High specific gravity in order to be stored in small containers.

-Non corrosive~~ve~~ action on the structural materials.

All those factors taken in consideration, hydrazin ( nitrogen plus oxygen) will be used as a fuel and nitric acid as a oxidizer.

#### THE " ESCAPE VELOCITY "

In order to carry the ~~components~~ of the space-station into orbit and when the space station is built, to desserve it by regular flights, we~~l~~ will build huge rockets capable of carrying passengers and cargo in the orbit- To reach the two-hour orbit, the rockets need to be given an initial speed during a short time; then, they are carried by momentum.

The escape-velocity of the rocket must be of 17.500 miles per hour to make the coasting path of the rocket matching exactly the curvature of the earth; then its speed and the earth's ~~velocity~~ gravitational pull would balance exactly, and the rocket will become an artificial satellite.

How can we reach the desired speed?

There is a very practical method, developped from the experimentations done under the "guided missiles" program : the space-ship will be constituted of two stages, or two different rockets assembled "piggy back" the one on top of the other.

-The first "stage", or "booster" is a very large rocket destined to give the space-ship its first impulse; when its propellants are exhausted, it is discarded from the second "stage".

-The second stage or "strato-liner" is a smaller rocket carrying passengers and cargo. When the booster rockets cut off, it starts its own engines.

## THE " TAXI " - ROCKET- SHIP

Taking care of all the considerations exposed before, such could be the characteristics of the "T axi " Rocket-Ship :

-a/ Second Stage or " ~~Strato~~ liner "

Shaped as a ~~cannon~~-shell and able to glide thanks to its two " delta-wings", the strato liner will be built of stainless steel - its double walls will contain liquid coolants pumped through, to protect the passengers and the structural elements against the tremendous heat occasioned by the air resistance when the rocket- ship returns back to earth. The nose of the ship contains the instruments. Then is provided space to house the pilot and the passengers; immediately under the passengers' cabin is the cargo space. Then we find the nitric acid and hydrazine containers, the pumps and at the bottom the rocket-engines.

The following figures will give an idea of the dimensions;

Over all length from nose to tail:	75'-0"
Average diameter	: 10'-0"
Weight cargo and passengers	: 15.000 lbs
Weight struture	: 10.000 lbs
Weight propellants	: <del>50</del> .000 lbs
Total weight	: 75.000 lbs
Total thrust required	: <del>150</del> .000 lbs

( 3 engines developping each 50.000 lbs )

## -b/ First stage or " booster "

Its nose is exactly fitting the strato-liner's tail and the general shape follows aerodynamically the lines of the first stage.

Built of aluminium alloy, the booster will have the following characteristics:

Over all length from nose to tail :	125'-0"
Average diameter	: 25'-0"
Weight structure	: 58,000 lbs
Weight propellants	: 1,067,000 lbs
Total weight strato-liner and booster	: 1,200,000 lbs
Take-off thrust required	: 1,500,000 lbs
(3 engines developing each 500,000 lbs )	

#### FLIGHT TO THE SPACE STATION

Throughout the whole of its flight, the rocket is under control of an automatic pilot, due to the extremely precise maneuver required.

Fired from the launching apron, the space-ship travels less than 15 ft during the first second of the take-off. 20 seconds later, it disappears into the clouds.

84 seconds after take-off, the rocket is tilted at an angle of 20, 5 degrees by huge mounted rocket-engines, blasting sideways and causing the rocket-ship to veer.

124 seconds later, the booster has reached its maximum speed (14,500 miles per hour ) and breaks away from the first stage thanks to a separator-charge. The strato-liner starts its own engines, adding thereby its own speed to that already achieved by the booster.

THE jettisoned booster drops behind and a ring-shaped parachute made of fine steel wire-mesh is automatically released. Since the parachute must slow the booster down gradually, the proper cut-off altitude ( 40 miles up ) and a shallow angle of elevation have been carefully calculated. The boos-

ter falls at the ultimate rate of 150 ft per second. To destroy the remaining speed, small solid-fuel rockets are set-off automatically by a proximity-fuse when the first stage approaches the water.

8 minutes from the take off of the rocket-ship, and 900 miles away from the launching site, the booster reaches the ocean. Salvage ships are waiting for it, having tracked its descent by radar. Since the booster is floating like a buoy, it is hauled back to the launching site.

Meanwhile, the strato-liner continues its ascension. The moment when it reached the speed of 18,500 miles per hour, at an altitude of 63,3 miles up, the motors are cut-off. The ship follows its trajectory until it reaches a distance of 1,075 miles, above the earth, going up from 63,3 miles to 1,075 miles, the speed has been reduced to 14,770 miles an hour, which is not enough to maintain the ship into the orbit. In order to settle the strato-liner in the permanent orbit, one must adjust its position, thanks to an intricate system of three electrically powered flywheels, spinning at right angles to each other, and permitting to establish an artificial "horizon" from which one can determine the required angular corrections. Once the ship is facing the correct direction, the rocket-motors are turned on for a short while, and the total velocity is increased to 15,840 miles an hour, ~~the speed~~ speed required to remain in the circular orbit. The flight has taken about an hour during which the rocket has been powered for only 5 minutes.

#### RETURN TO EARTH

The control is not automatical, this time but supervised by the pilot. To leave the space station, the pilot slows down the space ship by firing its engines in a direction opposite to the path of the space station.

At the point precisely opposite the place occupied by the space-station at the moment the rocket-ship began its return trip, the strato-liner is 50 miles above sea-level, travelling at the rate of 18,468 miles per hour; the air resistance encountered by the ship in the upper layers of the atmosphere will gradually slow down the high velocity. During this supersonic glide, the outer skin will glow red hot, and this is the reason of the liquid coolants that are pumped in between the two skins of the rocket in order to protect the passengers.

At 15 miles above the earth, the speed of the rocket is about the speed of sound ( 750 m. p. h )- Then, it acts as a regular jet-plane and lands at an approximate speed of 65 m. p. h on the runways adjacent to the launching site. Since the whole flight back is a gliding, there is a need for the delta-wings provided on each side of the cabin. On the launching site, the two stages are submitted to a meticulous inspection.

#### ★ THE SPACE STATION

This ship being settled in the " two-hour " orbit, the cargo is simply dumped out the ship, since it has also become a satellite. Just as a man on the earth is not conscious of the fact that he is moving with the globe around the sun at the rate of 66, 600 miles per hour, so the men in the space ship are not aware of the fantastic speed with which they are going around the earth. At this altitude, there is no gravitational pull. Men of the crew, wearing special space-suits are propelling themselves by firing very small rocket-engines attached on their back. They converse with built-in two-ways radios. The cargo moves easily, and to push it, a crew member needs only to turn on his own rocket-engine.

To build-up the space-station, the necessary number of rockets, loaded

with cargo, will be fired according to the pre-established schedule of construction. A standard path of ascent has been selected, the motors cut-off at exactly the same time and the rockets intersect the 1075 miles orbit at the assembly point, helped to home-in by using radar.

The space station consists of 20 sections made of flexible nylon and plastic fabric, each section being assembled and sealed in a close ring. The whole wheel is therefore divided in compartments similar to those found in submarines. Once the entire wheel has been put together, it is inflated as an automobile tire.

The station is wheel-shaped to ease its rotation about its hub, the impulse being given by a small rocket-engine. The reason for this rotation is to provide the inhabitants of the station with a centrifugal force which acts as a substitute for gravity. Consequently, the inside wall of the outer rim serves as a floor.

The power is given by a solar plant, constituted of a mirror and a boiler. The mirror condenses the sun's rays on a metal pipe fed with liquid mercury. The hot vapor is driven to a turbogenerator producing the necessary electricity. The vapor is condensed back by cooling and the mercury used again.

The space station will serve as an observatory out in space, and also as a launching platform for space ships in destination of the outer-space.

#### H MOON, ROCKETSHIP AND OTHERS

Once the space station is regularly deserviced by space-ships, will begin the construction of the ships, that we will call " moon-rocketship " in order to differentiate them from the " taxi-spaceships "-

The moon-rocketship will use the engines of one of the regular taxi ships as a mean of propulsion. Attached to those engines, a lightweight skeleton-frame of aluminium girders will enclose some large spheric fuel contain-

ners, filled with propellants. The whole structure is topped with a cabin for the crew equipped with air and water recovery system, and navigation equipment. The moon-ship is the same size about as the booster, but its shape is absolutely unaerodynamic, since streamlining is not necessary in space where air pressure does not exist.

From the space station, a round trip to the moon takes about two earthly-weeks. <sup>A</sup>round trip to ~~the~~ mars about two and a half earthly years. We can assume that the first expeditions to the moon and mars will establish there permanent stations in order to organize a vast system of relays across the space. Then the strato-lines companies will take over and the tourists bound to mars will probably be mostly concerned with the quality of the meals served aboard and the physical appearance of the space-hostess.

"...L'aube enfin se leve, du jour ou la main de l' homme, ouvrant les portes de la nuit, posera a jamais le pied sur l' immense conquise."

Theodule NEGRIFFIAS

("Voyages Interstellaires")

## T H E            S T R A T O P O R T

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From the description of the space-flight, we can realize how important is the take off operation. Our aim in the planning of the stratoport will be to provide the space-ships with installations insuring the maximum safety for their launching, and good maintenance facilities.

## THE SITE

Our greatest concern is to help by all means the space-ship to reach its escape velocity. Therefore, it would be very advisable to take advantage of the earth velocity ( 1040 miles per hour at the equator ) by choosing a launching area in the vicinity of the equator.

One has calculated that one flight a day would be sufficient to supply the satellite space station. Since each space ship is to carry about 500 tons of propellants, and all its rocket-motors have to be tested before each launching, an enormous amount of fuel and oxidizers will have to supply the stratoport, in order to insure the regularity of the operations. The most economic solution is to ship the required propellants by tanker-vessels and to dock them in a harbor nearby the launching station. Therefore, a sea-cost or an island is a necessity.

Recalling the space-flight operations, we know the boosters will be discar-

ded and land 900 miles away from the stratoport. They have to be dropped into the sea, as it has been explained, in order to permit their further use. We need an area of water extending 1000 miles from the stratoport in an eastern direction. Once the boosters are floating on the ocean, the vessels who have tracked their flight by radar will retrieve them and haul them back to the launching station. This is another reason for the choice of a sea-coast.

It is highly probable that the space-ship components will not be built on the very stratoport, but prefabricated in several different plants located elsewhere. Due to their weight and huge dimensions, the two stages of the combination aircraft will be shipped more easily by sea to the launching site.

The launching site has to be very large to accommodate the gigantic installations required for the space-ship maintenance and take-off. The area must be about level, and if possible surrounded by mountains, in order to allow on their summits the construction of the radar, television and radio installations, and also the astronomical and meteorological observatories. A last requirement concerns the climate that must permit an all-year-round utilisation.

All those considerations led us to select the Martinique as the future base of operations.

One of the largest islands in the lesser Antilles, Martinique is situated halfway between Porto-Rico and Trinidad, by 14 degrees 35 minutes North latitude and 61 degrees West longitude.

Martinique " where it is always summer " has a temperature varying all year around between 75 and 80 degrees F. Its magnificent vegetation and its spectacular west coast have made this island an ideal resort for tourists.

The situation of Martini-que in relation to Latin-America will allow the vessels assigned to the boosters-retrieving to leave harbours located in Brazil, wait for the booster chute into the ocean, and haul them back to Martinique.

For our launching-site, we have selected on the West coast a 3500 acres rectangular area, about level, the long west side of which is boarded by the Cohe du Lamentin, small bay permitting good harbour facilities and enclosed by the large Fort de France bay. The three other sides of the area are surrounded by mountains. On the east side, the Trochon peak offers a good site for the observati<sup>ories</sup>~~ions~~ and radar installations. This area is the coolest of the whole island and Morne Rouge, a small hill on the sea-shore provides the ideal location for a recreation center. A part of the site is actually taken by the runways of the Fort de France airport. The city of Fort de France is located on the bay, 9 miles west of the site, from which it is separated by a chain of mountains. A highway relieves actually the site to the city.

#### HARBOR

It will provide a sufficient number of docks to house the fleet supplying the stratoport. Its numerous pier installations are defining two distinct zones.

The first one is dedicated to the unloading and reception of the prefabricated stages and the boosters retrieved in sea. There also will be unloaded from the ships the numerous supplies destined to the stratoport.

The second ~~area~~<sup>area</sup> will provide the required storage facilities for the propellants shipped to the launching site. A system of pipe-lines will connect the storage tanks with the test-cells and the take-off area.

## WAREHOUSES

Located nearby the unloading area and relied to it by mobile cranes and other means of conveying, several warehouses and hangars will be built.

- a/ Hangars for the storage of the prefabricated stages.
- b/ Hangars sheltering the retrieved boosters and the space liners after their landing. In those hangars, the rocket-motors of both stages are taken apart and conveyed to the storage warehouses.
- c/ Warehouses for the storage of the rocket-motors.

Due to the process of assembling, the engines are first stored and checked, then sent for the final testing to specially built test-cells.

After their satisfactory test, the engines are conveyed to <sup>the</sup> ~~an~~ assembly plant and fixed on the tail of both stages.

- d/ A large multistory warehouse to receive a vast amount of spare-parts of all sorts. This building will also house checking-shops for the testing of the most delicate spare-parts.

## VERIFICATION BUILDING

This huge and large one-story building will be immediately connected with the warehouses.

There are conveyed the two stages of the space-ship; along the checking chains running through the length of the building, each stage will be submitted to a ~~series~~ of checking operation as follows:

- checking of structural members
- checking of ~~containers~~ containers by air pressure
- checking of radio and radar equipment
- checking of electrical equipment
- checking of guidance and control fixtures

Most of the instruments of the space-ship have been made with a super-watchmaker's precision; during their verifications, no spect of dust can be tolerated. The whole building will therefore be air-conditionned and eventually windowless. Special devices will equip the entrances in order to maintain the dust out.

#### TEST CELLS

All the rocket-motors have been checked when stored in their wharehouse. From there, they are conveyed to test-cells where they will be submitted to a " static-firing "- Inside each test-cell, the rocket-motor lies horizontally on a special fixture; it ~~is~~ is fed with propellants and, after ignition, is kept turning on for a time sufficient to prove its perfect working-condition. Since the engines are fired at the maximum of their power, the exhaust gases are producing a terrific amount of heat and an unbearable noise. To take care of both inconveniencies, the test-cell is built of thick reinforced concrete; its roof is topped by two stacks: one for the air-intake, the other for the air exhaust. Water is sprayed continuously all around the lower part of the air-exhaust to lower the fiery gases temperature. The adequate length of water-spraying cools the gases which are driven through the upper part of the air-exhaust, lined with sound-absorbant materials. The same sound-proof lining is built in the air-intake stack. Sch test-cells have been installed at ST. Suzanna proving ground where are tested engines developping a thrust of 300.000 lbs. The sound-proofing device works so nicely that it is impossible for the people outside the test-cell to know whether the engines are firing or not. The maximum thrust developed by the engines of the space-ship being 500.000 lbs, we can assume that by increasing adequately the lenght of the sound-absorbant lining, we

will obtain as perfect a result as at Santa Suzanna.

Once the rocket-engines have been tested, they are shipped to the assembly plant.

#### ASSEMBLY PLANT

This area receives both stages of the space-ship after their checking in the verification building, and the rocket-engines from the test-cells. The main operation consists in adapting the engines to the tail of both stages. ~~the~~ <sup>the motors</sup> Once ~~the~~ in place, the two components are sent out to the mountage-hall where they will be assembled "piggy-back".

#### MOUNTAGE HALL

This building is the tallest of the whole plant. There, the booster stage, standing on its tail, is fixed on a huge mobile platform built in the form of "splash-plate". The platform ~~built on the~~ moves on adequate railroad tracks and can be hauled on request by power full locomotives. Once the booster assembled on its platform, huge cranes lift the strto-liner stage on top of the first stage. The two components are assembled one to the other, and once this operation performed, the combination aircraft moves out to its hangar.

#### SPACE\*SHIP HANGARS

Erected in the vicinity of the mountage-hall, an adequate number of hangars will shelter the space ship. Connected by rail with the launching apron, the hangars will feed on request the take-off area.

#### ADMINISTRATION BUILDING AND SERVICES

Related to the whole plant, an administration building will house the offices for the operation staff and the direction personnel. There will be provided also the canteens, lounge and general facilities for the clerks and the workers.

Driveways will connect altogether the different buildings of the plant and parking areas will be provided at the suitable places.

#### POWER PLANT

The operation of the stratoport requires a vast quantity of electric energy. In order to insure the steadiness of the launchings, the stratoport must have its own power. Since the site is coasting the ocean, it becomes the ideal emplacement for a nuclear-power station. Due to the improvements realized in the atomic energy utilisation when the stratoport begins to operate, ( between 35 and 140 nuclear power stations will be built in the United States by 1975 ), this solution, the most adequate on an island, will perfectly meet the power requirements.

#### TAKE-OFF AREA

This very critical area requires the best of our attention, since the good conditions of the whole flight depend mainly upon a perfect launching. The ascent path of the ship is not a vertical one, but follows the earth's curvature. WE HAVE seen before that 84 seconds after its take-off, the space-ship is tilted to an angle of 20, 5 degrees. Even on the launching apron, the aircraft will not be fired vertically, but will be slightly aimed towards the east. The correct aiming requires an extreme accuracy and during this operation the rocket must be absolutely protected against any sudden gust

of wind. The same protection is necessary for the few early seconds of the take-off, because the ship flows only a few feet one second after ignition; the slightest deviation occurring in the aiming would ruin the whole flight.

The best answer to those problems would be to erect huge concrete "craters", taller than the space ship to insure the maximum wind protection. An other advantage of the "craters" will be to protect the surroundings from the explosion of the space ship, although this eventuality remains highly unprobable, due to the numerous tests done on the ship.

The wide structure of the craters allows us to provide all around its exterior rim a great number of water tanks that would be used as fire extinguishers in case where a fire would occur in the space ship. The actual experimentations done on rockets have proved water-spraying is the best way to fight the burning propellants.

The water tanks will be fed by a specially built pumping station.

Again, we must take care of the fiery and noisy gases blasting out of the engines after their ignition. At the center of the "crater", where the space ship is going to take-off, will be built a tunnel-like gas exhaust. This tunnel runs down vertically first, then is twice curved at an angle of 45° in order to have it running down horizontally outside the exterior wall of the "crater". As they enter the early part of the tunnels, gases are sprayed with water contained in huge tanks surrounding the tunnel; when their temperature has been cooled to normal conditions, the gases are forced through a lining of sound absorbent materials, the adequate length of which suppresses completely the noise at the end of the tunnel.

Such a device can allow the static firing of the whole motors of the space ship the day preceding its launching. Of course, when the ship takes-off

we cannot control anymore the tremendous roar of its engines. Due to the speed of the rocket, such a nuisance would last only a few seconds, and we know that only one launching will take place a day. However, all the surrounding installations will be completely sound-insulated to provide the personnel with a maximum comfort. We could even go so far with the sound proofing that a few thousand feet away, people resting in the hotel rooms would not be disturbed.

In order to ease the operations, the launching site will be provided with three identical craters, set 120° apart and converging to a central point where would stand the control tower. The craters are connected by rails with the space ships hangars. While a rocket takes off from ~~the~~ a crater, another crater receives <sup>the</sup> space ship to be launched <sup>by</sup> the next day. If some misfortune a space ship would blow-up, the stratoport would continue to operate with two craters while the ~~first~~ third one would be cleaned up.

The process of launching is accurately <sup>c</sup>sheduled:

The day before launching, a space ship is wheeled on its splash-plated platform to the interior rim of a crater. The access is closed and propellants are pumped into both stages of the aircraft. The filling completed, the space-ship moves again to the center of the crater where a special fixture is connected from the booster's tail to the exhaust-tunnell. All the engines are fired-on together. ( If there is any defect, the space ship is hauled back to the hangars and checked again ). Under regular circumstances, the space ship moves back to the inner rim after its static firing, and being fed again with propellants, waits there until the next day.

On the launching day, the passengers are lifted up to a waiting room located, as the control tower, at the point where all three craters converge. They board the strato-liner by a mobile gangway, 160 ft above the launching

apron. When all passengers are aboard, the gangway vanishes, the ship moves to the center of the crater and stands there waiting for the take-off. From the control tower a radio-contact is established with the crew in the ship; the last instructions are given, and the launching takes place.

#### LANDING AREA

The strato-liner<sup>s</sup> is able to land the same way as a regular jet-plane. An adequate number of runways shall receive the strato-liners and the regular jet-aircrafts connecting the stratoport with the rest of the world.

After their landing, the passengers disembark from the strato-liners or the jet transports and enter the air terminal built nearby; all the usual facilities are provided for the passengers reception.

An heliport will be added to the airport. Incoming passengers can fly directly to Fort de France; and, since the island is rather large and very mountainous, the helicopter is the easiest and fastest mean of communication.

The strato-liners are wheeled to their hangars to be checked according the process we described above.

The jet-transports will find in the vicinity of the landing area all the maintenance, checking and refueling facilities and can be sheltered into the adequate hangars.

#### CONTROL INSTALLATIONS

A wide network of radar-tracking, T V and radio communications will insure the contact between the control-tower of the stratoport, the air terminal, the vessels of the retrieving fleet and the space ship. It will be even possible to communicate through the space station and the orbital ships with any station established in space or on another planet; it has been calculated

that short radio waves ( length: 3,5 cm ) where quite suitable for this purpose.

This network will find its center located on the mountains surrounding the site. Their summits ( altitude 2.700-2800 ft ) will provide also the necessary meteorological and astronomical observatories with an ideal site. They will be connected with the stratoport by a driveway and a cable-car installation.

#### TRAINING CENTER

Even when the space-flights are daily scheduled and all the operations are assumed with the same safety as our actual air-transport on the to-day commercial lines, the passengers will not be able to board the ships without a special training. The pressures, for instance, to be encountered during the flight are far more severe than those which the supersonic planes pilots are exposed to; it has been demonstrated the human body can perfectly resist those high pressures, but it remains a matter of gradual training.

A building will house the training facilities, including-:

-a/ a health center. There, the passengers will be examined; all the usual installations will be provided and also a small emergency hospital giving the first care to the eventually injured people before their transfer to the hospitals in Fort de France. Also, when returning from the space-flight, the passengers will be examined in order to study the effects of travel in space.

-b/ Physical training. There, the passengers are given their initial conditioning to space flight. Among the different installations, the following will require the best of our attention:

-Several altitude simulation chambers. Their interior is looking ~~like~~ like the passengers cabin; space-travellers are secured in special chairs equi-

ped with instruments recording their reactions during the tests. Then, pressures and temperatures likely to be encountered throughout the space-flight will be artificially simulated.

-One or two huge centrifuge-simulators.

Housed in cylindrical reinforced concrete buildings, those bridge-like structures are rotating about a vertical axis. The subject is strapped into a cockpit-like chair and given "g" tests.

The forces which are generated by acceleration are expressed in units of a subject's normal weight : A person sitting in a chair is being at "1 g". Depending on the speed, the subject's weight can be increased to "2 g", "3 g", and so on. At the control board, an operator sets up all sorts of emergencies. Due to the conditions of the space-flight, the future passenger will have to experience acceleration forces up to "9 g".

-c/ Space travel education.

Besides the physical training, the passengers will be given as complete as possible an education concerning the new worlds they are going to visit : Lectures will be held in adequate conference rooms; films of the trip will be projected and to complete the simulation of space flight, a Planetarium will be provided nearby. A museum will house large collections of maps and models, many exhibitions of the rocks and cores taken back and, generally speaking, will give the passenger every possible information concerning the special conditions they are going to live in.

#### HOUSING FACILITIES

One can estimate a personal of 5 to 8.000 workers as sufficient to operate the base. A new city to accommodate them can be built on the southwestern shore of the island. A service of helicopters will take care of their transportation to the stratoport.

## RECREATION CENTER

When the passenger has been lectured, accelerated, shaken in all directions, or when he is back from the regions of infinite darkness, one can understand his desire to relax, at last, and forget all about rockets.

The architect appreciates the idea, and feels quite at ease to provide those infortunate people with all possible entertainment accommodations, since his accoustics consultant has promised to take care of any disturbing noise. Fortunately, the sea-shore is the most beautiful of the island, the area is the coolest and Morne Rouge, a lovely hill covered with flowers, invites the author to take advantage of its slopes and build a recreation center facing the ocean.

Luxury shops, native craftsmen's workshops, typical and snobbish restaurants, a casino, several dancing places and night clubs, including the inevitable Space-explorer Club, indoors and outdoors theaters, indoor and outdoors games will help the spaceman to appreciate the gentleness of Mother-Earth.

A 300 rooms hotel can be provided for those whose interest for take off-watching matches the gambling mania; the old alarm-clock system shall be set in the bedrooms, since the distance and the accoustical treatment will avoid the sleeper to be waken up by the daily launchings.

A swimming-pool, a marina harbour and a beach will complete the accommodations; and for those who do not like the recreation center, there are numerous helicopter flights relaying in a few minutes the station with the city of Fort de France.

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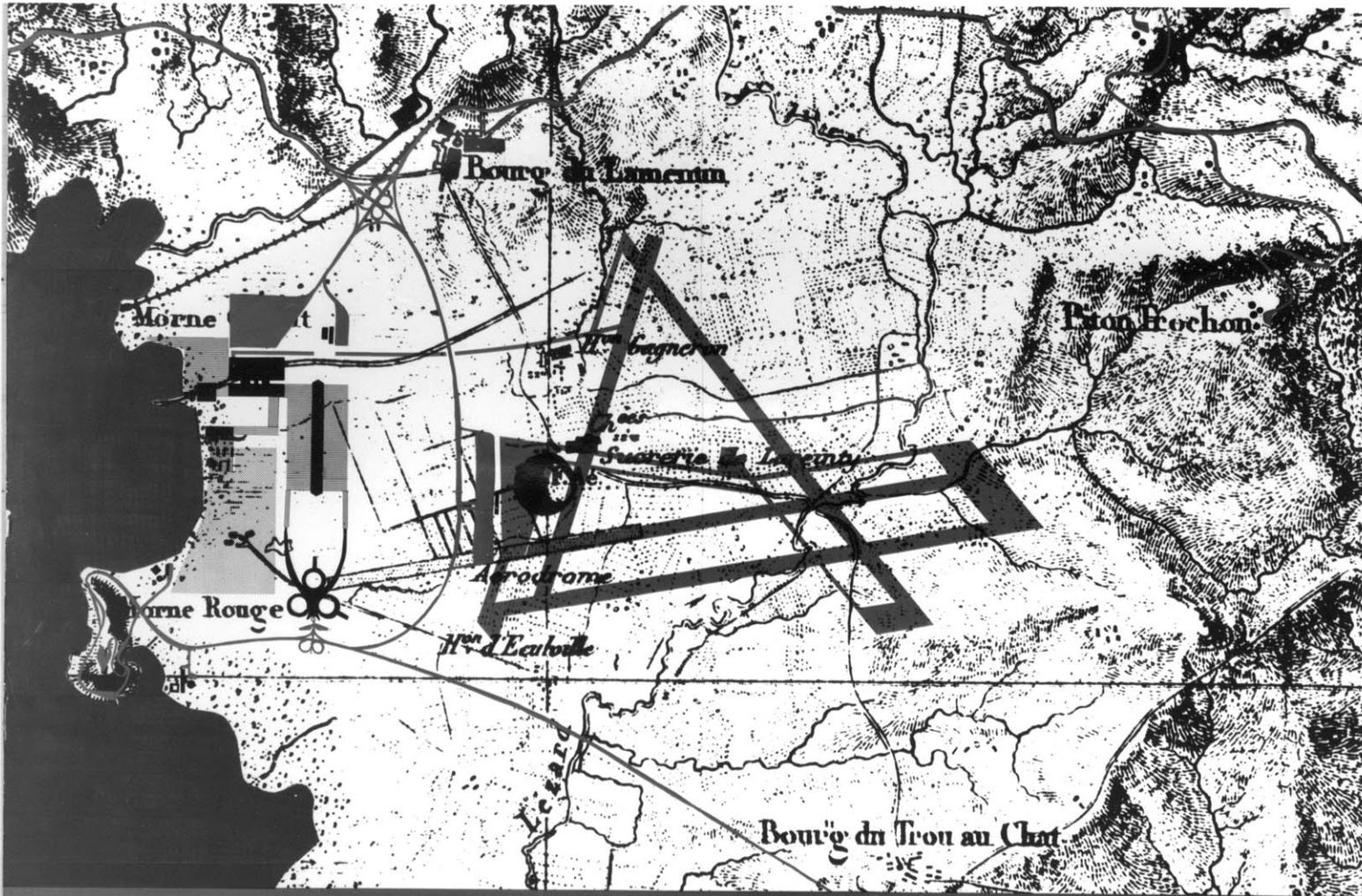
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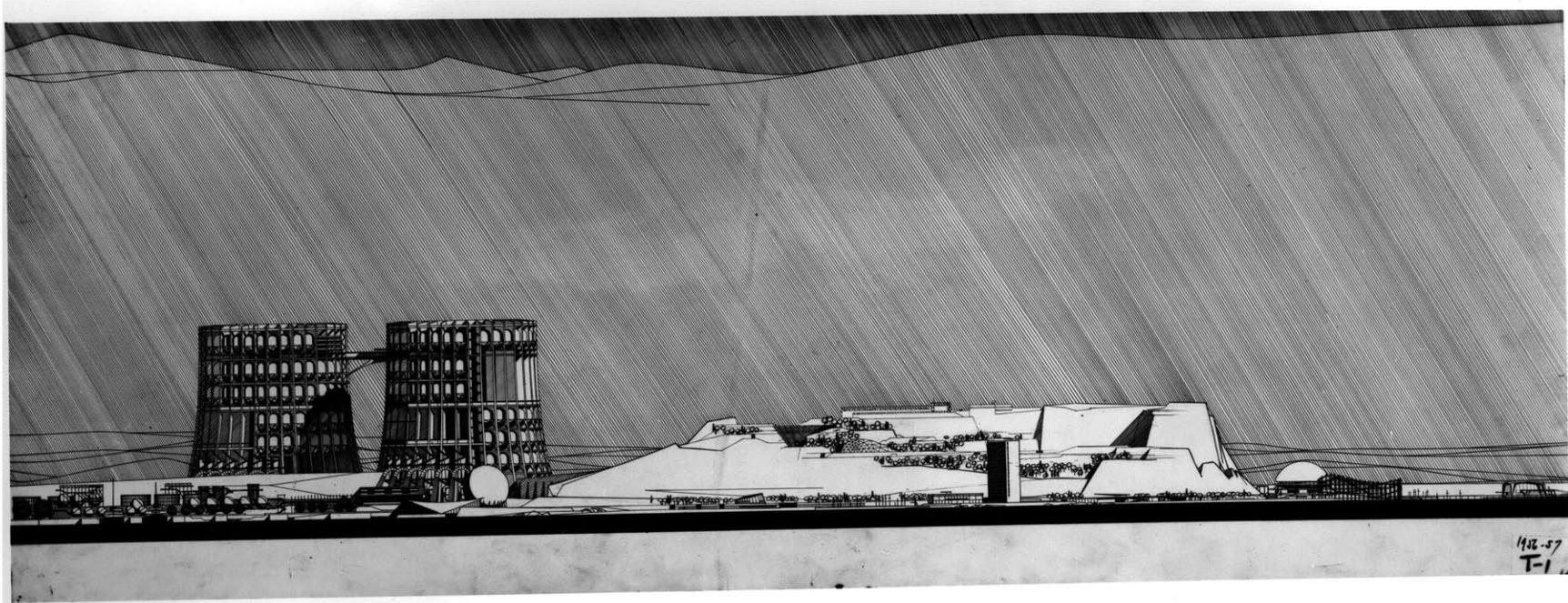
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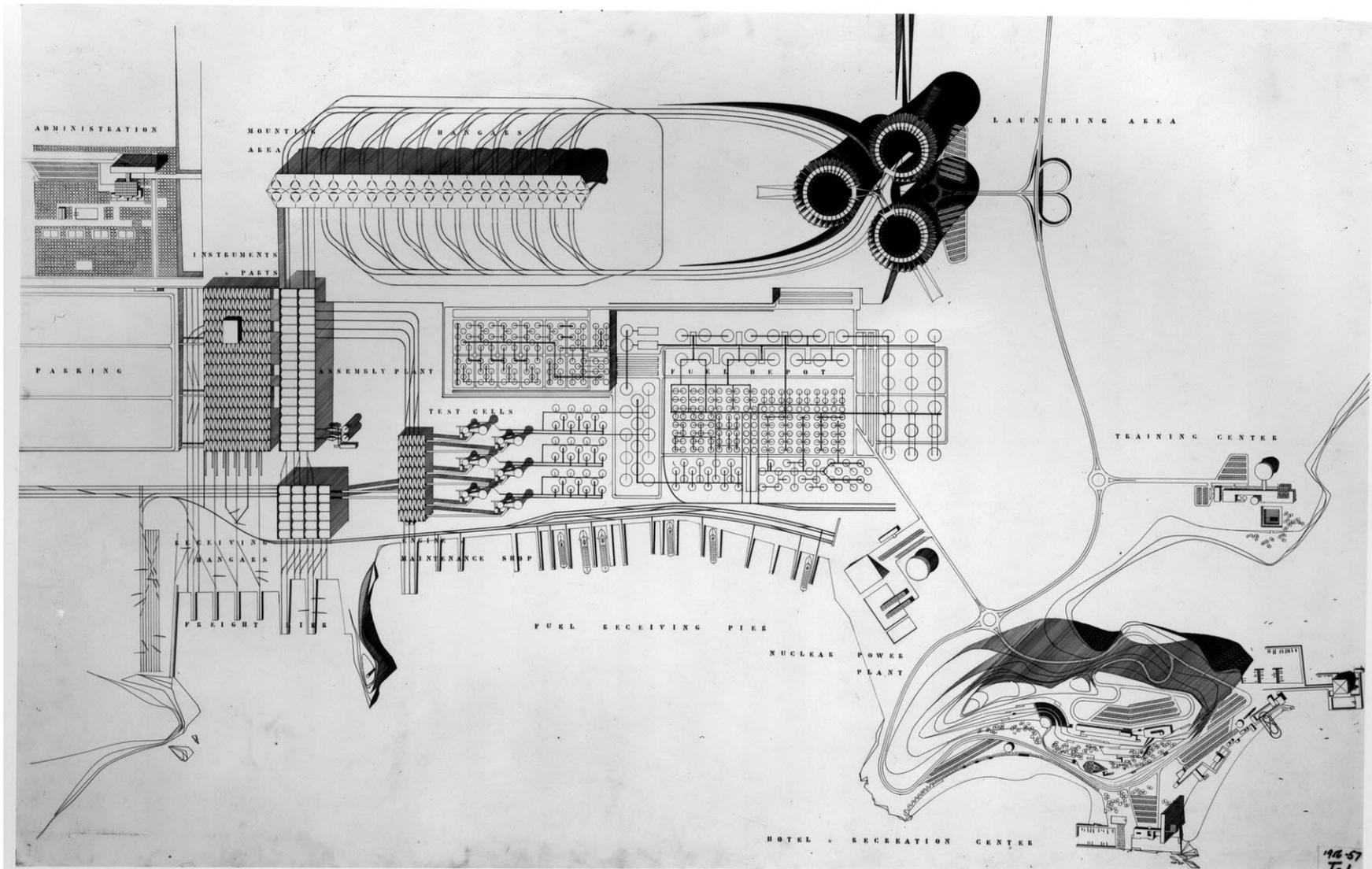
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