A GULF COAST RESIDENCE

by

Earl S. Swensson

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APPROVED:

Dr. L. A. Pardue
Director of Graduate Studies

John W. Whittemore
Dean of Engineering and Architecture

APPROVED:

Prof. C. H. Cowgill
Head of Department

Charles S. Worley
Chief Critic

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

The presentation of this thesis is made with grateful acknowledgment to

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Photographs of the model were taken and processed by , fellow student.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

DRAWINGS:

LIST OF ILLUSTRATIONS

INTRODUCTION

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STATE YOUR PROBLEM CLEARLY AND YOU WILL SOLVE IT WITH ORIGINALITY

.....anonymous

To design a contemporary residence is a strong, creative challenge. It is in this field of architecture that originality and freshness of design is demanded. Automatically, the client presents unique design requirements. He, as an individual, has a combination of needs that must be met by a flexible approach, not by a set of rules.

Financial consideration in design is inevitable. However, in private residence design allowance is granted for non-monetary values. A client's house is more his expression than his security. Here ingenuity is encouraged to seek a satisfying solution, not a least expensive one.

The possibility for experimental design can be seen in residential work. The relatively small-scale construction involved permits variance from building customs and allows close supervision. As John Rannels, contributor to the Architectural Record magazine noted,[1] "The luxury house field serves as ... (an) experimental testing ground where problems of conflict get worked out ...".

The opportunity presented to the designer of a residence is not only a challenge, but also a responsibility. The designer must be astute in his analysis of the problem and sincere in his solution. "A house is not an abstract object--planning a house cannot be an essay in non-objective design."[2] "The truly successful house is the creative -- and practical -- resolution of a particular problem."[3] This, then, is to be a thesis of a successful house.

SUBJECT

S U B J E C T

A beach residence on an island, located on the Gulf of Mexico, is the design subject of this thesis.

The parents of the thesis author have acquired a building site on Treasure Island, located near Venice, Florida. On this site, they wish designed a residence that will serve as a winter home for themselves, as a vacation retreat for their immediate family and friends, and as an investment property that may be rented.

BACKGROUND

BACKGROUND

"...the book can be read, it's contents digested and the digested thoughts from time to time adopted ... but they must not be used, unless they are first passed through the double-procedure of both the selective and creative process ..."

Eliel Sarrinen

Climatic conditions demand special consideration in the sub-tropical house. In House Beautiful's Climate Control Project III on South Florida, the report warned,[4] "In contrast to the popular assumption that building design in tropical or sub-tropical areas is very simple, careful analysis of the actual climate points to many factors which are at least as difficult to cope with as the severities of colder climate ...".

"...The climate factors are of such positive and pervasive nature that control of climate by building design and equipment is not optional, and cannot be left to chance or to the degree of shelter and comfort provided by design and construction which are average of nationwide practice. The particular combination of climatic factors can be controlled only by maximum effort in general design to utilize the automatic actions of the natural forces themselves, supplemented by mechanical aids."

The February 1951 issue of Architectural Forum, in it's article, "A New Architecture for Tropical Florida",[5] listed the following conditions, all related to the climate, as the design problems of southern Florida: sun, rain, bugs, hot nights, rot, hurricanes, and glare. All of these conditions, the article states, "...mean living outdoors night and day most of the year with all of the comforts usually found only indoors. But, it also requires a special kind of outdoors, protected from the sun and rain

by a wide overhanging roof, protected from the insects by a screen. Above all, it means living in the breeze."

A survey of contemporary Florida architecture indicates an awareness of the peculiar climatic demands. Florida architects, such as Paul Rudolph and Igor Polevitsky, have shown imagination and practicality in solving the problems of fitting their architecture to the immediate environment with little regard for precedents or taboos.

A Venice, Florida, house[6)] designed by Paul Rudolph, one of nineteen postwar houses selected by the Museum of Modern Art for "quality and significance", was visited by the thesis author. A noteworthy feature of the house was four big sliding glass panels which, when opened, allow the prevailing breeze to be effectively captured. The house also had an open structure and thin roof line which gave a sense of airy coolness. Igor Polevitsky, in his residence for Mr. and Mrs. Roland Phillips of Miami, Florida,[7)] capitalized on the constantly warm weather by building an "atmospheric envelope" -- a screened area that is much more than a porch. This inexpensive, semi-protected living-area has proven to be usable 95% of the year. Polevitsky's directness in capturing the breeze in his Biscayne Bay house[8)] was truly imaginative; he placed a porch house between two brick walls.

The most satisfactory designs that were reviewed did a combination, or all, of the following things:

1. cross ventilated every room.
2. placed the house on the site to capture the prevailing breeze.
3. shielded the rooms from the sun.

4. provided space for outdoor, sheltered living.

5. screened living area from insects.

6. used non-deteriorating materials.

7. allowed areas for informal, yet private living.

The study of these designs emphasized that because of the climate, "a Florida house should be Florida style and no other."[9)]

THESIS OBJECTIVES

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THIS THESIS HAS THREE OBJECTIVES:

FIRST, to present the functional requirements, the technical and financial considerations, and the aesthetic needs of the thesis house.

SECOND, to examine design techniques which satisfy the particular requirements of the program.

THIRD, to present a design solution of the program through the media of drawings and photographs.

PART ONE -- PROGRAM

F U N C T I O N A L R E Q U I R E M E N T S

INTRODUCTION:

The thesis house is to be designed for three types of occupants; the clients -- a retired couple; their grown children -- three vacationing families; and renters -- visitors to Florida. Each of these occupants have separate space requirements, circulation patterns, and relations of one area to another.

THE CLIENTS' NEEDS:

General: The clients, upon their retirement in six years, expect to utilize the house as a winter home. However, because of their feeling of good health under the Florida sun, the clients believe that they eventually might desire to live in the house throughout the year. They have asked that the design be for year-around occupancy.

From their living experience in the house, the clients wish to re--ceive an overall effect of healthy restfulness.

Space Requirements: For their own private living, the clients wish the following areas:

1. An ample-size sleeping area with an adjoining bath.
2. An uncluttered kitchen containing eating facilities.
3. A living area with an adjoining lavatory room for guests.
4. Ample storage facilities, including a special room for the safe-keeping of articles and equipment when the clients are not living in the house.

Circulation Pattern: The clients request a direct connection from the kitchen, from the outdoors, and from the bath to the master bedroom because they are accustomed to making the rest-area the hub of their private living. To accommodate their guests, the clients wish a direct

access from the outside to the living area, and an easy access to the lavatory. For sea bathing, the clients desire an outside entrance to their bath.

Relation of Areas: The circulation pattern, based on the clients' wishes, dictates that the kitchen and the bath should be near the bedroom and the outdoors. To insure privacy, the main entrance should not be near the kitchen or the bedroom. The dining area should be related closely with the kitchen, the living area, and the outdoors. To give visual aid and acoustical privacy, the living area should be isolated from the bedroom area. Both sleeping and living areas should have a view of the sea.

THE VISITING OCCUPANTS' NEEDS:

General: In addition to being a private residence, the clients request that the thesis house be designed as a vacation house for their three grown children and for renters. As the grown children have, or soon will have, families, and as the renters might have families, it is necessary to consider the living needs of a large group composed of all ages.

The clients ask for a maximum of flexibility, privacy, and convenience in the design to accommodate the expected visitors and tenants.

Space Requirements: For occupants other than the clients, the following areas are listed:

1. A flexible sleeping area with an adjoining bath.
2. A large kitchen.
3. An expandable living area.

4. An expandable dining area.

5. A storage area for travel equipment.

Circulation Pattern: The sleeping area for the visiting occupants should open to a second bath and to the outside. As sea bathing will be a major activity of the visitors, a direct access to the bath from the beach is mandatory.

Relation of Areas: The clients wish to consider the house as a three zone house containing their sleeping-area, the entertaining area, and the visitors' sleeping area. As the stay of the visitors may be for extended periods, the clients desire that the sleeping areas be secluded from each other. Moreover, to make the house a more desirable rental property, the clients feel that the two sleeping quarters should be as independent as is practical. With this arrangement, the house might be rented to two families.

THE SITE

THE SITE

ISLAND DESCRIPTION:

Treasure Island, the location of the lot for the thesis house, is situated about one mile northwest of Venice, Florida. The island is separated from the mainland by a small bay known as Lyons Bay. Two wooden bridges connect the island with the mainland, and along the full length of the island runs a partially paved county road. Electrical and telephone service is available and garbage collection is made weekly.

The shape of the island resembles a small, narrow peninsular, which it once was. The island is approximately five miles long and is not wider than a quarter of a mile at any point.

The terrain is greatly varied along the length of the island. The general contours are those of a narrow, low hill. However, at several points the land is level, or nearly level. The western side of the island faces the Gulf of Mexico. A white shell sand beach slopes up gradually from the sea and dies against a low, but steep bank. From the bank eastward to the bay, the land pitch is varied throughout the length of the island.

The soil is composed of layers of white sand, and the natural vegetation appears to be limited to brush, sea-grape, vines, cabbage palm trees, and Australian firs. Grass and planted bushes are grown by some of the island residents. However, grass and other planted vegetation require constant attention.

The island is in an early stage of development and a zoning act affecting the island is only now in the process of being adopted. Though a few motels and two public beaches exist on the southern end of the island, the

majority of the developed area is devoted to winter or year-around residences. For the most part, the architecture is contemporary and the residences appear to have been designed for middle-income and upper-income groups.

Attributes of the Site: The island gives one a refreshing feeling of independence from the hot mainland. Yet, as the bay is only about three hundred yards wide, one is convenient to the outside. The attraction of the beach is it's cleanliness. There exists virtually no sea weed, crabs, or debris. The sand of the beach is composed of ground, white mussel shells and exceedingly clean sand.

The Gulf waters lap upon the beach in lazy minature swells and present little, if any, surf. Such a shore appeals to the young and the old and provides excellent swimming, fishing, and boating for all.

PHYSICAL CHARACTERISTICS OF THE LOT:

In size, the lot is approximately 100 feet wide and 200 feet deep (see figure). In addition to this area, there is a 100 foot long by 40 foot wide beach strip. As the tide does not rise or lower the water level more than two feet, the beach width remains constant.

The lot begins at the county road and slopes uniformly upward to the beach with an approximate grade of one-half foot in every ten feet. At the west edge of the lot is a ten foot sand bank that dips sharply down to the beach. Across the width of the lot the land is level.

The soil is sand for at least a depth of ten feet. The natural growth on the lot consists of groups of sea-grape vines, each of which are about seven feet in diameter; and, approximately ten scrub cabbage palm trees,

the tallest of which is about thirteen feet.

CORROSION:

The salt air and the sub-tropical conditions quickly corrode most metals and deteriorate woods. Mr. Youngberg, a contractor of the island, estimated that even treated cypress, if used on the site, would not last over five years.

INSECTS:

Mosquitoes, termites, roaches and ants are abundant on the site. Local inhabitants have found no way to rid the houses of termites, ants and roaches; and mosquitoes are a menace to outdoor living. The period when flying insect protection is needed is from April to November. However, it is considered desirable to have insect screening throughout the year.

FINANCIAL CONSIDERATIONS

The clients request a design based on an initial investment of $15,000.00, excluding the cost of the land. This estimated amount is based on Mr. Youngberg's suggestion that the construction cost be anticipated at $13.00 per square foot. From this foot-cost figure, the clients feel that they should spend $15,000.00 to obtain a suitable house. It is understood that they desire adequate facilities more than low construction cost. However, it is also understood that for immediate house erection, the cost will have to be kept within the neighborhood of the suggested investment.

To help finance the building cost, the clients wish to rent the house during the immediate years when they will not have use for the house. Mr. W. H. Wimmer, a realtor in Venice, suggested that a two bedroom, two bath house would be the best rental property.

A E S T H E T I C S

The clients have stipulated that they have no specific requirements for the appearance of the house, but they do want the design to be in harmony with the surrounding.

Though the clients wish to enjoy the outdoors, they do not wish to feel overwhelmed by it. They desire refuge from such things as the hot and glaring sun, and the cold penetrating nights.

The clients enjoy designs that are not over-ornate, that use materials to the best advantage, that indicate a high degree of skill, and that show restraint.

ACCIDENT PREVENTION

The clients have specified that safety shall be an important consideration in the design. For example, they realize that perhaps an elevated structure would better fit the climatic conditions; but at the same time, they realize that stairs and even ramps are hazards. Therefore, the clients would rather not have an elevated house. From the booklet, Planning the Home for Occupancy, the following planning fundamentals were suggested as a basis for safety:[10)]

1. The general planning for circulation within the dwelling.
2. Storage space of adequate amount and proper design. (It should be possible to store articles in frequent use without having to climb on ladders or stools.)
3. No change in level between adjacent areas.
4. Adequate clearance in front of hazardous equipment such as stoves, space heaters, and hot steam radiators.
5. Adequate provision for escape from fire, and for access for fire fighting.

A study of accidents has revealed that, "So far as the human factor is concerned, conditions in the home which cause frustration or fatigue will increase the accident susceptibility of the individual."[11)] Thus, it is important that the areas be ample in size, that the house be easy to manage, and that sound control be adequate.

Along with accident prevention, the needs of the temporarily infirmed must be considered. Some of the special requirements for the infirmed are as follows:

1. Arrangements for complete control of light and sound.
2. Ample storage space for sickroom equipment.
3. Easy accessibility to the cooking area.

4. A room area large enough for the bed, an armchair for the patient, sitting space for visitors, a sunny exposure, and an outdoor sitting place.

CLIMATE ANALYSIS

SOURCES FOR CLIMATE ANALYSIS

The discussion of weather conditions is based primarily on the article, "Regional Climate Analyses and Design Data", and the U.S. Weather Bureau's Climatological Reports on Fort Myers, Florida and Tampa, Florida.

The article, "Regional Climate Analyses", was compiled by House Beautiful and The Bulletin of the American Institute of Architects as a guide for building in southern Florida. The climatological reports are the most accurate data obtainable for the area in which the site is located. Mr. J. T. B. Beard, Acting Meteorologist in Charge, U. S. Weather Bureau, Jacksonville, Florida, wrote,[12] "We have very little weather data observed at Venice, Florida, but conditions there would not differ greatly from the mean conditions at Tampa and Fort Myers." Tampa is located approximately sixty miles north of the site, and Fort Myers, fifty miles south. Both cities are close enough to the Gulf to be affected by it.

Supplementary sources of information are employed throughout the discussion and are noted when used.

MOISTURE ANALYSIS

The site lies in a humid, sub-tropical climate zone. The annual rainfall averages about fifty-two inches per year. In cloud-bursts, which are frequent in the summer, from one to four inches of rain may be expected to fall. The heaviest rainfall for twenty-four hours in Tampa was 10.41 inches in June, 1945; and in Fort Myers, 10.85 inches in October, 1951.

There are distinct wet and dry seasons. From June through September (the wet season) the average rainfall is over eight inches per month. Some thirty inches, or about 60% of the annual precipitation occurs during

these four months. On the average, there are eighty-five days with thundershowers; more than one shower every second day. These showers, yielding heavy amounts of rain, seldom last long. They usually occur in late afternoon or early evening and aid in cooling-off the atmosphere.

It is during the rainy season that unexpected showers frequently occur during the humid night. As these showers are usually wind-driven to as much as 48°, they present a problem in controlling rain spray without shutting out the needed ventilation.

The dry season lasts from November through February. The monthly total average is less than two inches. Fort Myers has on record the following minimum monthly precipitations for the winter season:[13)]

November: a trace, "an amount too small to measure", in 1944

December: 0:01 inches in 1924

January: 0:00 inches in 1950

February: a trace in 1949

March: 0:01 inches in 1935

Thus, during the dry season, entire months may pass without rainfall. Because of this extreme dryness, artificial irrigation is necessary to grow planted vegetation.

Consideration of relative humidity (the percent of moisture in the air relative to the amount it could hold at any given temperature) is important in house furnishings, in selecting building materials, and in achieving human comfort. Generally, the relative humidity is highest in the cool of the night, and lowest in the heat of the day. It is in the summer nights that the relative humidity makes living conditions

uncomfortable. In Fort Myers for the month of June, 1952, the average relative humidity at 1:30 A.M. was 93%. During summer nights, a maximum amount of air circulation is needed.

The relative humidity varies throughout the year from a low of about 55% to 65% in the afternoons; to a high of around 90% in the evening. Sarasota, twenty miles north of the site, has the following annual average:[14)]

85% at 1:30nA.M.

84% at 7:30 A.M.

59% at 1:30 P.M.

74% at 7:30 P.M.

Vapor pressure ("The force exerted by molecules of water vapor in the atmosphere as well as those escaping or accumulating in the process of evaporation or condensation")[15)] is considered to be the most useful factor in determining human comfort, due to heat exchange between atmosphere and surfaces. When vapor pressure rises above 15 milloliters of mercury at temperatures from 65° upward, there is a chance for discomfort. Above 20 milloliters, the air is almost unbearably stifling without a breeze.

Twenty-four per cent of the year the vapor pressure is in the very uncomfortable zone, whereas the next 50% is in the zone requiring ventilation. Vapor pressure is about right for human comfort in the winter, but is too high in the summer.

To summarize the discussion on moisture: The rainfall is heavy and frequent in the summer months. It usually occurs as a wind-driven thundershower in the late afternoon and at night. The winter months are too dry

for most planted vegetation since rain sometimes does not fall for more than a month. The average relative humidity is high, especially in the evenings during the summer months, and vapor pressure becomes so excessive throughout this portion that the vapor pressure must be reduced to make living conditions comfortable.

The site is located in a climate zone noted for its evenly distributed number of clear days. An average for the region throughout the year is 66% of the daylight hours filled with sunshine, and an average of 120 days clear from sunrise to sunset. The months of January and February have the largest number of clear days, which is thirteen; and, July has the least, which is two days. The sunniest part of the year is in the late winter and early spring. During this period, enough heat from the sun is received to be of value in meeting the heating requirements. In the summer there are very few cloudless days; a factor that cuts down solar heat. In Fort Myers, from July through September, the average is only 11 clear days per month. Cloud build-up in the summer is thickest during the hottest part of the day.

Dawn and twilight, each about 20 minutes long, are 5 to 10 minutes shorter than in Columbus, Ohio. The sun is at its highest in late June--88° at noon. During that month, the sun rises about 5:30 A.M.* east, 25° north. For nearly six hours the sun shines on the east wall in the morning, and for the same length of time on the west wall in the hot afternoon. The north wall receives more sunlight than does the south one. On

* Time given is apparent solar time.

the north side, the sun shines for at least two hours; whereas, on the south side, for less than an hour at angles above 80°.

The winter sun in December rises at 6:38 A.M., east, 25° south. It is within 30° of due south from 10:20 A.M. to almost 2:00 P.M. -- a period of nearly four hours with the sun at a maximum of 41°. The sun sets at 5:12 P.M. west, 25° south. During the winter months, the north wall is void of the sunlight.

TEMPERATURE

The annual average temperature for the region is 71.2°[16]. The temperature ranges about 20° from the mean of 61.3° in January to 81.9° in August.

The winters are mild and are characterized by bright, warm days and cool, calm nights. From November to March, the daily maximum temperature averages 77° and the daily minimum averages 57°. The highest temperature recorded during these months was 93° in Fort Myers in March of 1948. The lowest temperature was 19° in Tampa, December of 1894. In 71 years, the mean number of days from November to March with temperatures above 90° has been one; below 32°, none. Occasional cold snaps bring the temperatures in the thirties. Although these periods last only a day or two, a quick and ample supply of heat is needed for comfort.

In the summer (June through August), the maximum and minimum temperatures are about 20° warmer than in the winter. The temperature ranges from a mean low in the morning of 73.2° to a mean high in the afternoon of 90°. Daily maxima of 90° or more occur on about two-thirds of the days. The highest temperature ever recorded was 101° in Fort Myers, in July of 1942;

the lowest was 59° in Tampa in June of 1913. During the summer, the high temperatures are accompanied by high relative humidity, and without air movement, the living conditions are uncomfortable.

The design temperatures for southern Florida are 90° and 32°. Temperatures above 85° occur almost every afternoon from June through September, and on exceptionally sunny afternoons in March, April, May and October. The majority of the hours per year fall in the temperature range between 85° and 65°. Considered as a nocturnal condition are temperatures between 65° and 45° which occur in December through March, and on very clear, cold nights during April, May, October, and November. Temperatures below 45° occur primarily on very clear, calm nights during advent of a cold frost.

WIND

The Gulf sea breeze[17)] from the southwest washes the site daily. At night the land breeze and the constant east trade wind flows from the northeast. Thus, the major axis of wind direction is northeast - southwest. As the summer nights are humid, it is important that the easterly breeze be captured. During the winter, the wind direction may be more north than northeast. Since the wind is cold, it should be controlled during the winter.

The velocity of wind varies from 0.00 miles per hour to hurricane strength of 100.00 miles per hour or more. However, the average speed for Venice[18)] is 6.2 miles per hour. In the summer, a large part of the evening and night is calm or has very little breeze. On occasional days during late winter and early spring, the wind reaches twenty to thirty miles per

hour. High gusts occur with thunder showers, and during hurricane weather the wind becomes dangerously strong.

HURRICANES

The record of Florida hurricanes indicates that the chances of a hurricane storm in the vicinity of the site is comparatively slight.[19)] Fort Myers has one chance in twelve; and Tampa, one in twenty. Whereas, Miami has one in seven. Of the ten "great" Florida hurricanes during the past 68 years, only two passed near the site. However, all of Florida is susceptable to hurricane storms, and all building must be designed to meet the extreme stresses caused by such storms. Therefore, it is important to understand hurricane conditions.

Winds of hurricane force are defined as winds above seventy-five miles per hour. The greatest hurricanes bring winds of two hundred miles per hour or more. But, no more than once in a century may such storms be expected. The severest hurricane wind in Tampa has been seventy-five miles per hour for a five minute period in the Labor Day Hurricane of September 3 to September 5 in 1935. In Fort Myers, the strongest wind has been ninety miles per hour in the September 1947 hurricane. Though sustained velocities may be less than one hundred miles per hour, gusts may reach one hundred fifty miles per hour, and "It is these powerful gusts in the hurricane that make it so destructive"[21)]. On the ocean shore, even properly constructed buildings may be destroyed during a severe storm; not because of the winds, but because of the undermining of the foundations by storm tides. Elevation of hurricane tides varies greatly with the contour and slope of the shore. "But, as a general rule, it can be stated that major

hurricanes will produce tide elevations of ten to fifteen feet above mean low tide"[22]. The highest tide for Tampa has been 10.5 feet above mean low water during the Gulf Hurricane of October 25, 1921. Wave action reaches considerably higher than tide level. Therefore, protection from waves of more than fifteen feet above normal low tide is needed.

In conjunction with hurricanes is the question of tornadoes. Until recently, tornadoes were not considered to occur in Florida. But now, it has been found that "nearly all tropical cyclones that have visited Florida have had tornadoes associated with them"[23]. Most of the observed tornadoes have been narrow in width and have had rather short paths.

A study of hurricane protection uncovered the following observations and suggestions:

1. It is not possible to orient the building so that the strongest side will face the winds because winds of a hurricane blow in a circular path around the storm center.

2. A considerable amount of damage is caused by flying debris.

3. The real wind damage to the structure of a building is the negative pressure that may lift off the roof.

4. The probable damage to landscaping due to a hurricane should be considered.

5. Pressure differential, as much as seventy-four pounds per square foot acting outward, may cause failure in building walls, if building is air tight.

6. "The most essential precautions in structural design are: design for reversal of stresses; intelligent continuous design of the building as a unit; avoidance of accentricity in attachments and design of roofs for internal as well as external pressures."[24]

PART TWO -- DESIGN TECHNIQUES

DESIGN TECHNIQUES

In recent years much original study and design has been done in the field of climate control. It is now generally recognized that "the climate is the architect's true adversary -- as climate varies, so should the shelter". The following discussion, Design Techniques, is a review of means that have been developed in building design to combat and control existing natural conditions.

V E N T I L A T I O N

INTRODUCTION

The study of the South Florida residence is essentially a study of ventilation. Above all other climatic considerations, control of the wind is paramount in the sub-tropics. "The most common characteristic of (contemporary south Florida) houses is their openness. They are designed to catch every vagrant breeze that passes, for comfort in humid climates is most satisfactorily achieved by ventilation."[25] Wolfgang Langewiesche, in a House Beautiful article on ventilation in South Florida said,[26] "The difference between being in a breeze and not being in one, is the difference between ease and discomfort". So great is the need for ventilation in humid, sub-tropical regions, such as South Florida, that "the placing of a building will generally be governed by direction of prevailing breezes where these are dependable, rather than with relation to sun"[27].

PRINCIPLES OF AIR FLOW

How best to naturally ventilate a room recently has been reinvestigated by technical laboratories. It was once considered best for ventilation to provide "...for free entrance of cool air at the bottom and exit of warm air at the top..."[28]. But, from actual tests at the Texas Engineering Experiment Station, it has been proven that "...if the effects of the slightest breeze were super-imposed over the effects of convection currents in one-story buildings, the effects of the breeze would completely offset the effects of the convection currents." To assure that the design is based on substantiated premises, the following discussion on characteristics of air flow is made:

The characteristics here presented are derived from tests executed

by the Texas Engineering Experiment Station. In the research report, "Some General Considerations in the Natural Ventilation of Buildings",[30] these characteristics are presented as the basic ones that need be understood for building design.

1. High Pressure Areas:

   Wind, impeded by a wall, will pile up and cause a high pressure area of air. (See figure I). Inlet openings should be located in this wall, for here the pressure will push through the openings.

2. Low Pressure Areas:

   Wind flows around a building as it does over a plane's wing. The onrushing air is deflected from the surface and causes an area of low pressure. (See figure II). The shape of the structure and the direction of the wind determine the size and location of this low pressure air. Because of the pulling effect of low pressure, outlet openings should be placed in walls adjacent to such a pressure area.

3. Inertia:

   Air will strive to flow inside a building in the same direction it entered. (See figure III). This reluctance to change direction is known as inertia. Therefore, the area washed by an inlet opening will depend on the direction of the wind at the opening.

4. Pressure Differences:

   Air rushes from a high to a low pressure area in an effort to keep the pressures equalized. This basic principle of air movement can be used effectively within a structure to create a needed draft. The air flows from the inlet to the outlet openings. But, it must not be forgotten that the pattern of the air flow will be affected by the wind's inertia. (See figure IV).

5. Changes in Direction of Air Flow:

   Abrupt directional changes greatly reduce the initial speed of the air. Consequently, to achieve maximum air flow within a room it is necessary to eliminate obstacles, such as partitions and high furniture. Air needs a clean sweep from inlet

to outlet openings. (See figure V).

6. Maximum Air Changes:

Reducing the air resistance insures greatest possible air change for a given wind speed. Maximum openings, inlet and outlet openings in direct line, and few interior barriers are means to reduce the resistance. (See figure VI).

7. Maximum Speeds:

Air, flowing much as water does, may be dammed to increase its speed. Air piles up against an obstructing wall and, thus, becomes dammed. If, on the other side of the wall, a low pressure area is created, the air will squirt through an opening punctured in the wall. (See figure VII).

8. Location of Openings:

To determine the air flow pattern within a room, the location of inlet openings must be considered. Wind, striking wall areas adjacent to an opening, alters the original direction of entering winds. The air pattern within the building (see figure VIII) is in the same direction as the entering air flow.

PLANNING CONSIDERATION FOR NATURAL VENTILATION:

The following suggestions on ventilation design were made by the Texas Engineering Experiment Station[31]. These suggestions are based only on the movement due to wind-caused pressure differences and not on the movement due to temperature differences. Convection wind currents were found negligible in one-story buildings.

Considerations for Natural Ventilation:

1. The site should afford a prevailing wind and the building should receive the full sweep of the wind.

2. The maximum wall area should be perpendicular to the wind to create strong high pressure and low pressure areas.

3. Openings of proper size should be placed in both high and low pressure areas. The smaller the inlet opening, and the larger the outlet opening, the greater the speed of the interior flow.

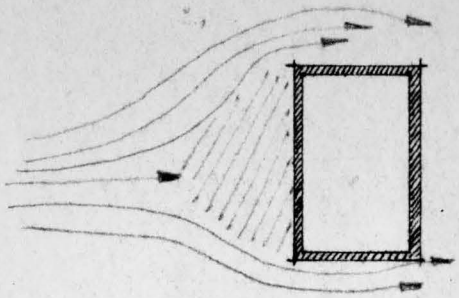


FIG.1 HIGH PRESSURE AREA

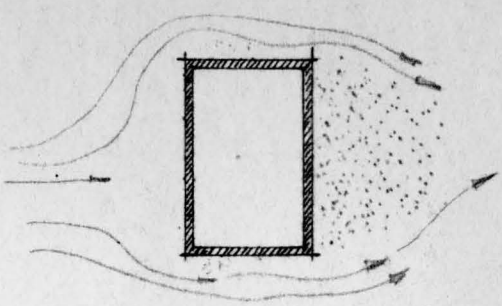


FIG.2 LOW PRESSURE AREA

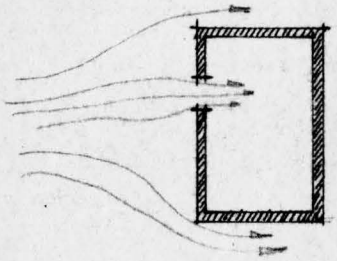


FIG.3 INERTIA

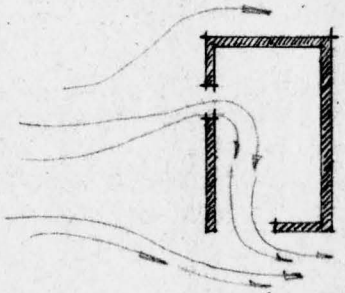


FIG.4. PRESSURE DIFFERENCE

FIG.5 CHANGES OF AIR FLOW

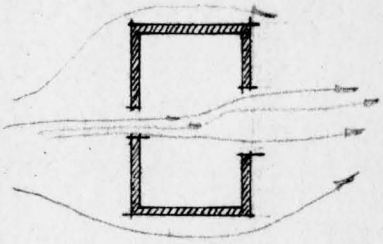


FIG.6. MAX. AIR CHANGES

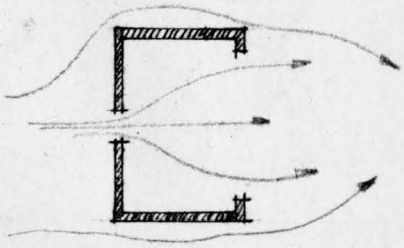


FIG.7 MAX. SPEEDS

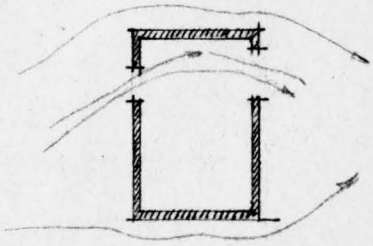


FIG.8 LOCATIONS OF OPENINGS

PRINCIPLES OF AIR FLOW

4. Interior partitions, furnishings, and landscaping should not hinder but should aid air flow.

5. The location and the design of the openings should direct the air flow into the "living zone".

6. The openings should allow for maximum air changes. Openings, as large as possible, for both inlets and outlets will provide greatest air change.

WINDOW TYPES:

The paramount concern in ventilation is that the occupants of a building become comfortable. "Moving air has an effect of cooling by increasing the rate at which perspiration evaporates. It also supplies the lungs with a continuous supply of fresh air. Both of these facts greatly add to a person's comfort."[32] The moving air has to be directed upon the body to achieve the mentioned benefits. Consequently, a study of window types becomes necessary because it is the window that directs the air flow.

There are three basic window types:[33]

1. The simple opening, which opens by sliding in a single plane.

2. The vertical vane opening, which opens by pivoting on a vertical axis.

3. The horizontal vane opening, which opens by pivoting on a horizontal axis.

Every window one sees is one or a combination of two of these types. The simple opening kind does not alter the direction of the wind and should be located directly in front of the "living zone". The vertical-vane-opening type acts much like a moving rudder in water. It can bring into the interior outside air that flows at right angles to the opening. The horizontal-vane-opening variety controls the horizontal pattern of air flow. The vertical and horizontal-vane-opening types, both, swing 100% open.

But, only the horizontal-vane window provides protection from rainfall without shutting off the air flow.

CONSTRUCTION TECHNIQUES FOR VENTILATION:

Means of controlling ventilation by adapting building construction to the natural laws of air flow have been suggested and used both by today's enlightened designers and by the early settlers of sub-tropic regions.

Many of the Gulf coast plantation houses of the early 1800's stood on stilts, with a wide covered porch and with window openings placed opposite each other. These houses caught the breeze and effectively directed it through the living zones.

Today, fold-in or sliding walls are used. Minimum stationary walls and maximum openings are the goal. Control over the undesirable effects of wind is achieved by overhangs, and windows. The shape and height of the ceiling and the depth of a room do not affect appreciably the air flow pattern. But, oponings should always be places opposite each other. James T. Canizaro, Architect of Jackson, Mississippi states,[34] "In residential work we have tried to make rooms one thickness so as to create direct cross ventilation".

The article, "Regional Climate Analysis, III - South Florida"[35] makes the following suggestions to aid in ventilation:

1. Avoid planting close to building and interrupting air flow.
2. Plant rooms to avoid pockets of still air.
3. Provide for reduction of high velocity breezes by reducing outlet openings with louvers or other devices.

VENTILATION

4. Prevent dead air pockets from forming below ceilings and roofs by placing air vents at ridges and ceiling lines.

5. Minimize openings and consider insulating the north wall.

6. Provide artificial ventilation, such as an attic fan, to be used on still, humid nights.

SUN CONTROL

PROBLEMS OF SUN CONTROL

For comfort in the sub-tropic regions, sun control is second only to ventilation in importance. "Nine months of the year the comfort rule in Miami is to keep out of the sun. And, to keep the sun out, particularly in the hot afternoon, becomes the rule for a comfortable Miami house."[36] Groff Conklin, in an article[37] for Progressive Architecture, breaks down the problem of sun control in the following manner:

1. Minimization of glare; particularly as the site is on the sea coast.
2. Minimization of solar heat entering rooms in summer and minimization of solar heat entering in the winter.
3. Maintenance costs versus original costs of control devices.
4. Provision of adequate exterior vision.

CONSTRUCTION TECHNIQUES FOR SUN CONTROL:

"It is a truism that complete satisfactory control of solar radiation and sunlight inside a structure with large glass areas is impossible..."[38]. Since it is necessary to provide large openings for ventilation in the thesis house, the problem of keeping out the sun is great.

There are six forms of sun control:

1. Natural devices
2. Around windows outside
3. Over windows outside
4. The window itself
5. Over windows inside
6. Interiors

To combat both heat and glare, outside-the-window devices are needed.

SUN CONTROL

Shade trees and other natural devices are employed usually for such control. But at the site, natural devices are not practical. Another device is the structural overhang. It provides rain protection and aids in ventilation, in addition to controlling the sun. Therefore, this device should be considered for the house.

"...Overhangs alone cannot do an efficient enough job of shading"[39]. An overhang that is long enough for the low summer sun rays may cut out too much illumination and too much sun-heat in the winter. Since the overhang cannot possibly cope with the low, hot, glaring western sun, a combination with exterior sunshades might be desirable.

The following is a list of exterior shades that may be used in conjunction with overhangs:

1. Awnings - "Wood or metal fixed awnings with movable slats, or metal awnings with non-adjustable surface units which can be retracted or rolled up against the wall."[40]

2. Exterior Venetian Blinds - "A retractable outside venetian blind of the awning type with adjustable slats which are held away from the window by a metal frame."[41]

3. Screening walls - Louvered or solid walls placed adjacent to the building.

Glare control is an often-overlooked, but important, aspect of sun control. In residences it is important "...to minimize glare even at the cost of full lighting efficiency"[42]. The glare intensity at the site is high because of the open sky, the water reflection, and the white sand. Non-glossy surfaces, non-reflecting floors, and cool colors are means of combating glare. Daylight should not be blocked, but should be softly

diffused. As Mr. George Thomas, Daylighting Consultant to the Truscan Steel Company, said,[43] "Daylighting is free. Get it into the room, then control it and use it wisely."

SOUND CONDITIONING

The thesis house presents a requirement of adequate sound control. The clients wish to have both sleeping areas sound isolated so that they and their guests will have maximum privacy. The following are means of obtaining the sound control desired:[44]

1. Quiet equipment.
2. Heavy non-porous walls, such as stone and brick. ("Two important factors which determine the transmission loss of a wall or floor are weight and method of construction. A homogeneous material must be relatively massive to give satisfactory sound insulation.")[45]
3. A bank of sound-absorbing clothes closets.
4. Sound-absorbing building materials ("While sound-absorbing materials may not be very efficient in preventing the transmission of sound through walls, they may be used to great advantage in reducing the reverberation of sound within a room.")[46]
5. Filled book-shelves.
6. Sound-baffle partitions.
7. Double walls, such as four-inch concrete walls; three inches apart, which gives a transmission loss more than sufficient for sound passage between noisy and quiet areas.
8. Snugly fitting, heavy doors.
9. Sound-insulated piping.
10. Double-glazed glass.
11. "...a truly impervious partition with no air leak"[47].

BUILDING METHODS

The thesis house must be constructed to suit a hot, humid climate on the sea coast. In such a locality, the interior remains damp for long periods; the roof receives severe sun and rain weathering; and unprotected exterior walls collect moisture and excessive heat. Materials, in general, greatly contract and expand, untreated woods rot and become termite infested, and metals corrode in the salty atmosphere. All openings are opportunities for insect entry. During hurricane storms, the entire building structure undergoes severe stresses.

A survey[48] of building methods suitable for the site disclosed the following means of construction:

A. For roofs:

1. Wide overhangs that protect openings during normal rains and provide shade.
2. Materials that stand sudden thermal changes and that are inorganic.
3. Gutters and downspouts that handle large amounts of drainage.
4. White roofs that reflect solar radiation.
5. Insulation that keeps out the heat.
6. Air vents.
7. Rain shields that cover the chimney stack and vents.
8. Structural framing that withstands hurricane stresses.

B. For walls:

1. Hollow walls that have interior vertical ventilation.
2. Materials that are non-absorbent.
3. Caulking that seals all jointing of materials.

4. Thin walls that do not have a thermal lag.

5. Insulation material in the north and west walls.

6. Structural columns and collar beams that give complete rigidity to the building.

C. For floor and foundation:

1. Materials that are impervious to moisture, sound and termites.

2. Elevated floor that is at least 18 inches above ground level.

3. Foundation vents.

4. Concrete-reinforced foundation that is anchored to the wall sill.

PART III -- DESIGN SOLUTION

DESIGN SOLUTION

INTRODUCTION:

The house is basically a long rectangular shelter. The end walls block off the neighbors and the unfavorable weather. The side walls open to the views and the prevailing winds. A wide butterfly roof, tied only to the structural bents, hovers over the house as though suspended. The ample porch and the slender, one-room-thick enclosure invites the outdoors to penetrate the entire house. Yet, a bank of louvered doors on one side and a row of awning-type windows on the other may completely close out any bad weather.

ACCESSES:

The requirements of the clients called for an unusual number of accesses to the outdoors -- from the bedrooms, the baths, the living room, and the kitchen. Essentially, every area has to open to either the beach side or the bay side, or both. To handle this requirement without an excess amount of door-frame construction, the bay side is conceived as a one continuous door opening which can be closed with folding louvered doors. The ocean side is punctured with only three accesses. The bathroom doors on the ocean side serve both the bathrooms and the adjoining bedrooms. The bay side doors open on to a screened porch. When the doors are folded back, the outside and inside are one. On the other hand, by keeping the ocean side relatively closed to traffic circulation, the beach activities are kept apart from the house -- a desirable feature for housekeeping.

KITCHEN:

The kitchen is located in the center of the circulation pattern. From this area there is direct access to the master bedroom, to the back entrance,

to the dining area on the porch, and to the living room. The galley shape of the kitchen enables the sea breeze to funnel through it. Moreover, the elongated shape permits more than one person to work at a time. As meals for large groups will often be needed, the consideration for ample cooking space was mandatory. The kitchen is placed across the width of the house, and opens on to both the beach and the porch. Thus, while preparing meals, the housewife may keep in touch with her playing grandchildren or her visiting weekend guests.

DINING AREA:

The conventional dining room is not found in the thesis plan. Instead, provision has been made for eating according to the occasion. For snacks and meals for two, a kitchen table is located conveniently at the end of the kitchen. During good weather, meals may be served on the cool porch. For the infrequent occasion when the weather drives activities indoors, a part of the living room may easily function as a dining area.

BATHROOMS:

The bathrooms have direct access to the beach for the convenience of bathers. The location of the two rooms allows the master bathroom to have a common wet wall with the kitchen, and gives the lavatory section of the guest bathroom a direct access to the living room. Because of the high humidity created in the bathrooms, they are mechanically ventilated through the roof, and therefore, do not need natural cross ventilation.

CABINETS:

Special consideration is given to cabinets. Floor closets are eliminated in favor of wall cabinets because of the severe termite menace. By

elevating the storage units eight inches off the floor, and by placing termite metal shields in the supporting walls, complete protection is expected from the subterranean termites. Cabinets are allocated for specific use so that there is ample, but not excessive, storage space.

UTILITY CORE:

All utility equipment, (gas furnace, water heater, soft water unit, and electrical fuse boxes), is located with the fireplace, furnace and kitchen ventilating flues in a compact utility core. Situated between the living room and the kitchen, the core is located to minimize duct and flue-runs. One chimney stack serves for all the flues.

HEATING:

Hot air, perimeter heating is used to warm the structure during infrequent cool snaps. Such a system is composed of ducts running from the furnace to a perimeter duct. This duct runs along the inside perimeter of the house. Located in this perimeter duct are registers that send an insulating blanket of warm air against the cold window and door areas. The advantages of such a system are: no time lag is in the heat response; the ducts radiate heat to the floor slab; and, the system may be readily converted into a cooling system.

STRUCTURE:

The structural system is of concrete. This material is chosen not because of economy or appearance, but because of strength and durability.

Extended overhangs over the east and the west sides of the house are needed to provide sun and rain protection. Moreover, a subtle butterfly effect is desired for the roof. Such a roof opens the house to the view

of the ocean and the bay, gives a feeling of fresh airiness, funnels the air into the structure, and captures the soft rainwater. To support the long overhangs and the tilted roof, a three-hinged bent is designed. The interior span is just twice the overhang length. Thus, the theoretical moment about the column top due to dead load is zero. The shape of the bent is dictated by the normal stress behavior of such a structure.

The exact dimensions of the bent are not determined by a stress analysis but by the minimum sizes adaptable to form-pouring and by a general understanding of sizes for given loads. The dimensions have been approved as being adequate by Harry Rietman, a graduate student in Architectural Engineering. However, it is understood that the only valid method of obtaining sufficient data for complete design of the bent is by a structural and stress analysis. Such a study is beyond the scope of this thesis.

The method of constructing the concrete structure is to be either by poured-in-place or by a combination of poured-in-place and precast. The decision as to which method would be best would depend upon the degree of anchorage obtained in the precast method, and the expense of the poured-in-place method.

The bents are placed on an eleven foot by twenty foot grid. The width is determined by the size of the windows to be placed between the bents and the length is determined by the total dimension needed for a bathroom length, a two foot deep cabinet, and a three foot passageway.

MATERIALS:

The materials used in the design: concrete block, glass, terrazzo, aluminum, treated plywood and finished wood, were selected for their

durability and appropriateness to the site. Each material was used as expressively as possible. The concrete block is used as a visual barrier material. Thus, it was brought up to a height of only 7 ft. 1 in. Glass is butted against the ceiling to indicate its plastic ability to fit the change in the ceiling slope. And, the concrete, being the structural material, is left uncovered to assure the observer that the building is securely constructed.

SAFETY:

Safety precautions are taken by eliminating all steps. The ground is only six inches below the porch and the sun deck. All the doors to the outside swing outward, and the interior doors swing against blank walls. The cabinet shelves are adjustable so that step ladders will not be needed. All the cabinets are placed back from corners or openings to be out of the way. All furnishings are to have flat surfaces to facilitate dusting and cleaning. The beds are placed on wheels that can be locked, for ease in cleaning and making of the bed, for shifting position to capture the changing breeze, and for care-taking of the temporarily infirmed.

WINDOWS:

The windows are of the aluminum awning type manufactured by the Ludman Corporation of Miami, Florida. The awning-type opening is used because it controls the breeze and the rain, provides ease in cleaning and maintenance, and gives a weatherproof closure for cold weather and for periods when the house stands vacant. The modular size window, 6 ft. 8 in. by 5 ft., is used throughout the design.

Above the lateral supporting beam is placed a 1 ft. 4 in. by 5 ft. hopper vent. The hopper vent carrys off any hot air that may accummulate

directly underneath the ceiling.

VENTILATION:

As advocated by the Texas Engineering Experiment Station,[49] a test model was constructed to observe the interior wind patterns created by the bank of awning windows. The model was built accurately at 3/4 in. to the foot scale. Upon being placed in a path of natural wind, the model was adjusted to give the maximum ventilation condition. The windows were placed at a 70° angle to the vertical. The top of each window was located six inches (in scale) below the top position when closed, and the top edge of the window was placed out to the front of the window frame. These positions closely approximated the actual position of a full-scale window.

With the model in position a smoke pattern was traced through the windows and the interior. The following observations were made:

1. With a strong wind, the air flow was changed but little by the angle of the windows.

2. With a slight breeze, the air pattern angled upward upon striking the windows and then rolled off the ceiling and back down in a boiling motion stirring the air considerably in the "living zone".

3. Under both conditions, the windows allowed air to reach all parts of the room.

The tests results are not completely accurate. There existed too many unknown factors to assure great accuracy. However, an approximation of actual conditions may be assumed, so that the awning windows seem to be desirable for the design. The house is built to capture, and capture completely, the land-sea breezes. From the study of the basic rules in

ventilation, it was learned that to direct wind, the inlet opening must be adjusted. Thus on the Gulf side, windows are used.

The desire for an uninterrupted view of the ocean from the living room, brought about a compromise with the quest for maximum ventilation. A fixed window is placed between the floor vent and the top vent, providing an unbroken clear glass for a height of about 5 ft. and a distance of about 15 ft.

PLACEMENT ON SITE:

To capture the breeze, obtain a commanding view of the Gulf, and allow for possible addition of a garage-and-utility building behind the house, the building was placed as far forward on the ridge as possible. Moreover, when located in such a position, the house is remote from the public road, and is close to the private beach.

AESTHETICS:

The appearance of the residence is designed to be in harmony with the sea coast. To achieve this, the color of the concrete blocks are left natural; the exterior and interior doors are painted in colors of the sea; the cabinets are finished in natural wood stains; the concrete bents are left a soft off-white; the aluminum gravel stop is lacquered a soft deep brown, and the fireplace hood is of a dull copper. The floors are of a light brown terrazzo, and the ceiling is roughened concrete. The basic color scheme is brown and tans to simulate the sandy beach. The accent colors are blues, to cool and bring the sea into the house.

LANDSCAPING:

Conscious landscaping is held to a minimum. The only planted areas

will be the borders where a screening for privacy is required. A very attractive appearance is achieved by raking the site clear of all underbrush and by encouraging the natural growth of cabbage palms and sea grape. To consider introducing foreign plants at the site presents a problem of irrigation during the dry season. Thus, only native vegetation is used. Small white shells found on the beach make excellent beds for paths and walks, and are utilized for this purpose on the site.

SOUND CONTROL

Special precautions are taken to achieve a great degree of sound control between certain areas. Both bathrooms are sound-insulated from the living area by hollow walls with six inch cavities. These partitions have a transmission loss greater than 50 db. Above the two partitions are placed double panes of glass that reduce sound transmission by at least 45 db. An increase in sound control is achieved by closing the bathrooms with cabinet-faced walls.

The mechanical core is sound insulated with a cabinet-covered, fireproofed, 4 in. concrete block partition to a height of about 7 ft., and above that height, two panes of glass separated by a three inch air space.

The bedrooms are sound-isolated by being located at the extreme ends of the building, and are further protected from the noisy living area by a bathroom and passage ways.

HURRICANE PROTECTION:

Protection from hurricanes, for exposed window areas, is achieved by plywood shutters which are hinged to the underside of the overhangs. These plywood shutters swing down and fasten securely over the window areas.

DESIGN SOLUTION

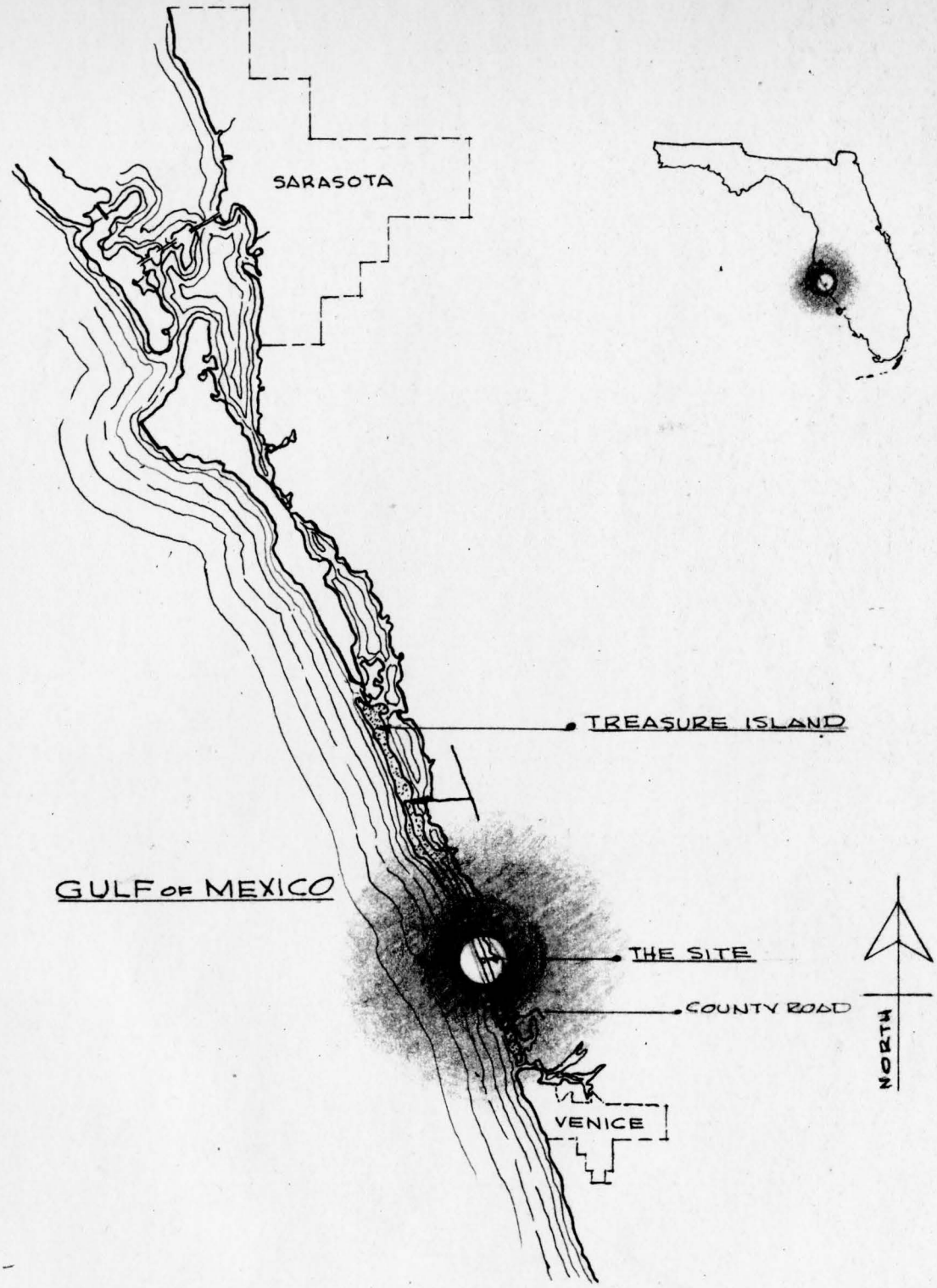
When not in use, the shutters are nestled inconspicuously against the underside of the overhangs. Thus, the shutters are located conveniently for use, and yet, are removed from view when not needed.

COST:

A cost estimate of the thesis house was made by Mr. George Youngberg, contractor of Treasure Island. His estimate was $18,000.00 -- $3,000.00 over the amount stipulated by the clients. Mr. Youngberg believes that the house may be built for the desired price without basic changes.

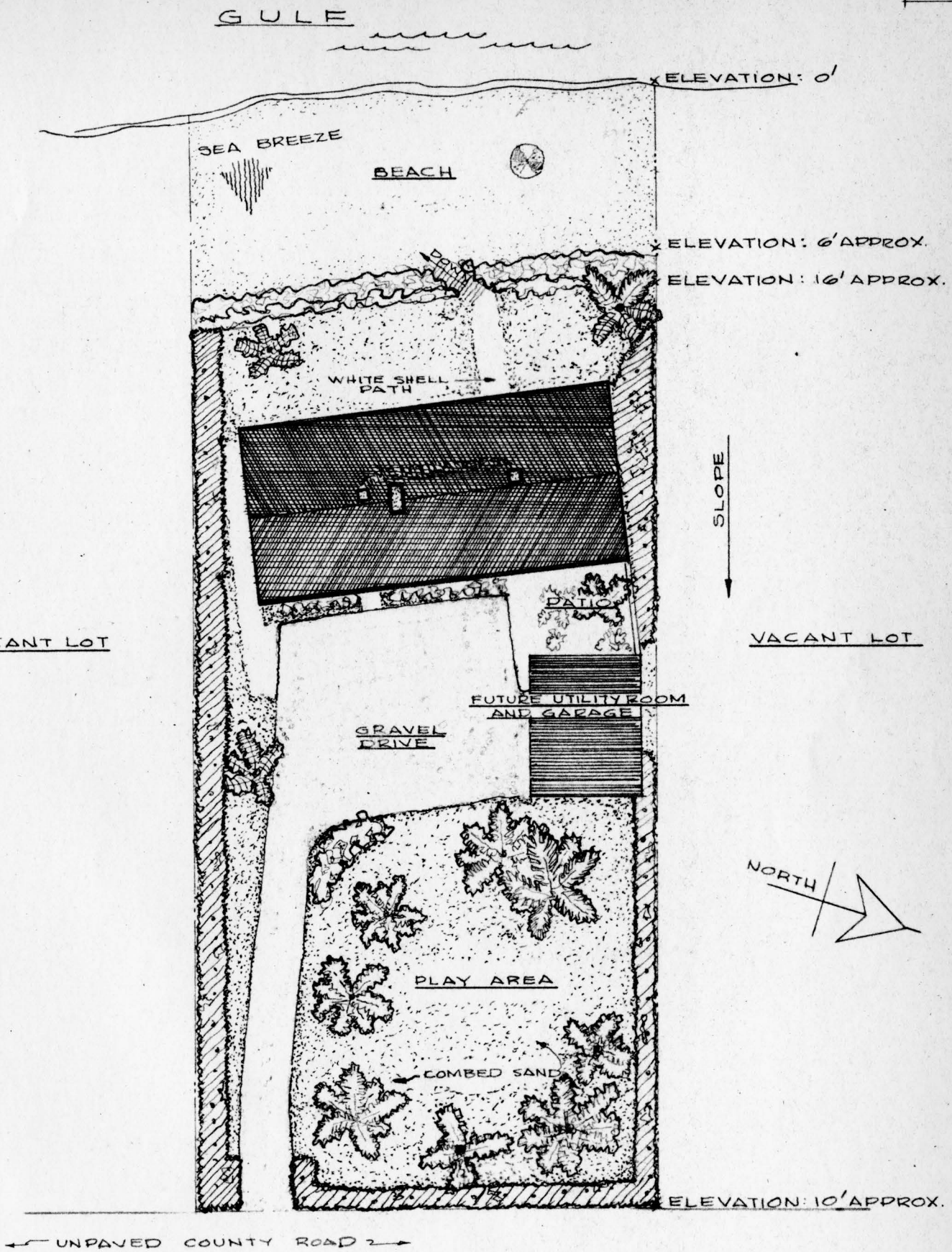
PART FOUR -- PRESENTATION

DRAWINGS



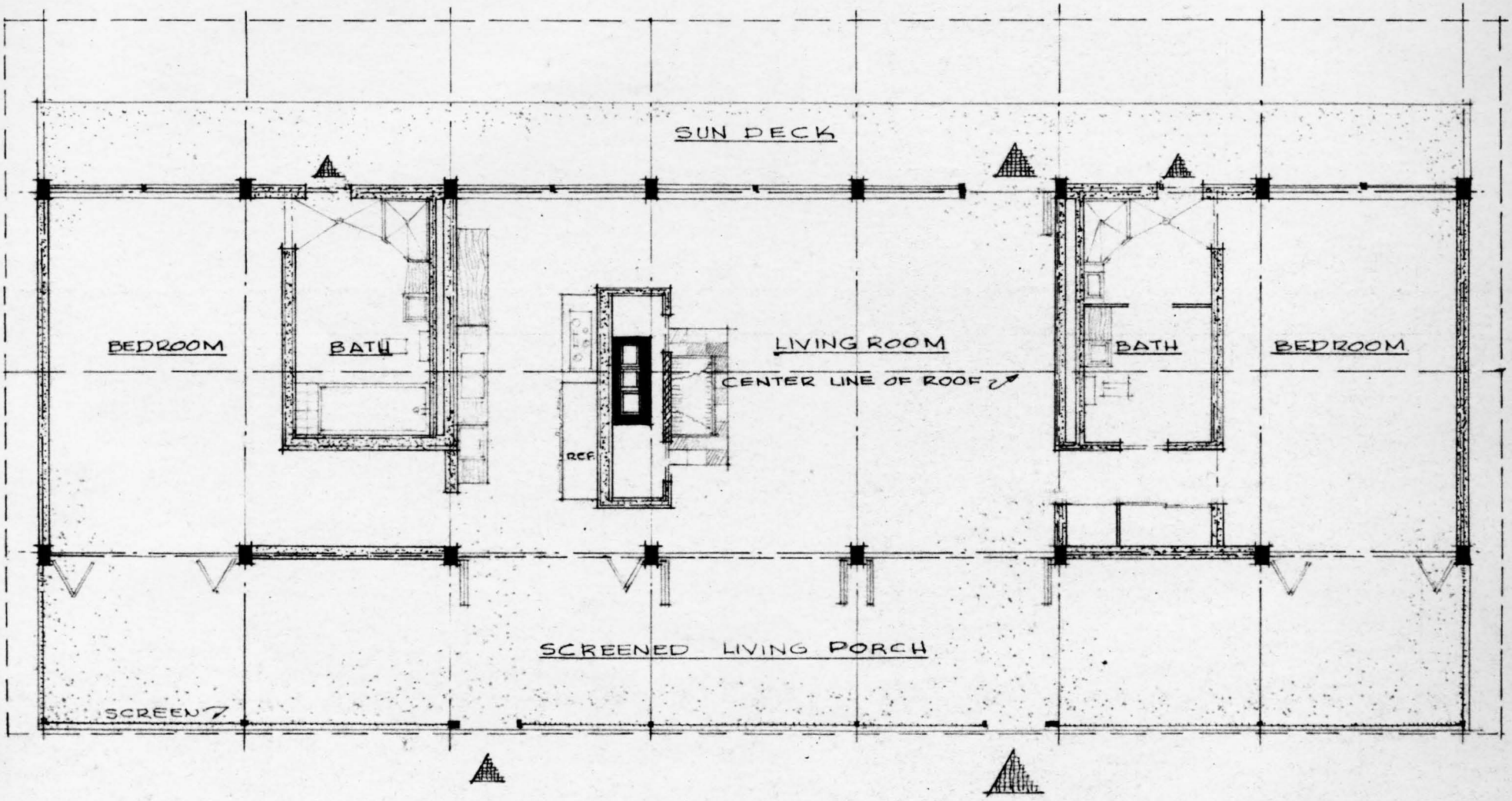
SITE LOCATION

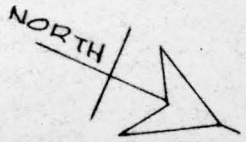
SCALE 0 1 3 MILES



PLOT PLAN

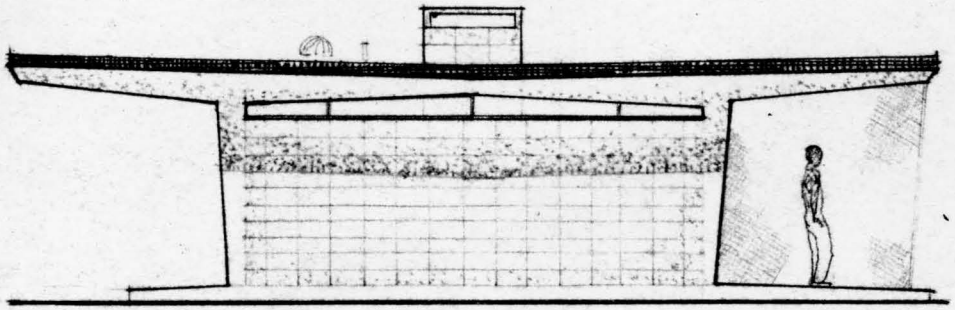
SCALE: 0 10 30 FEET



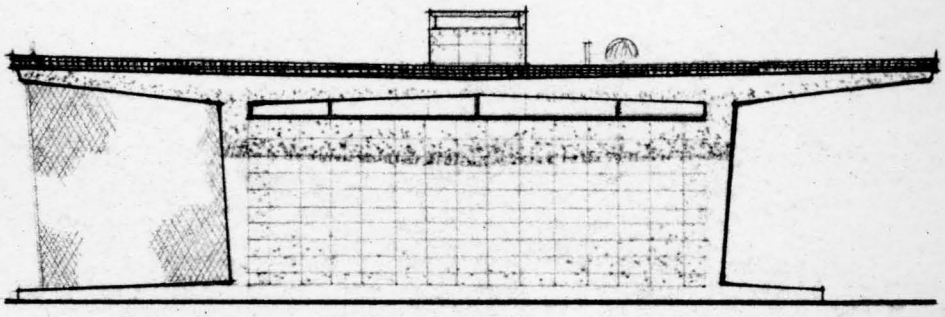


FLOOR PLAN

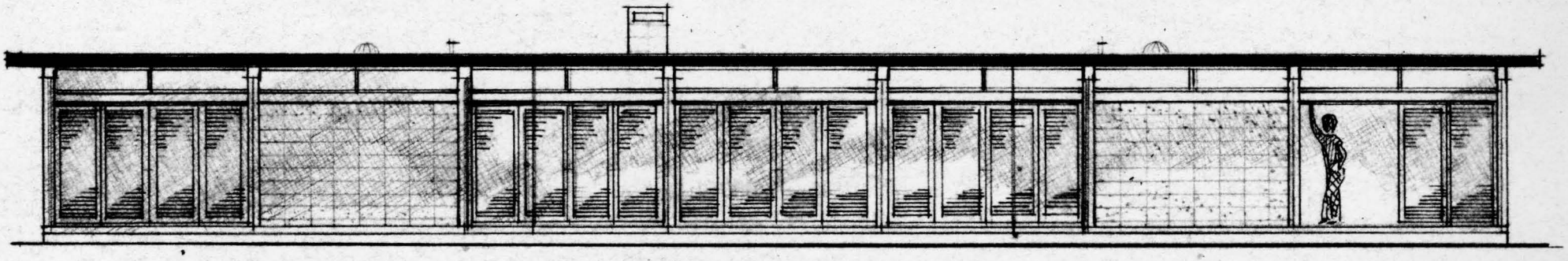
SCALE: 0 1 3 6 FEET



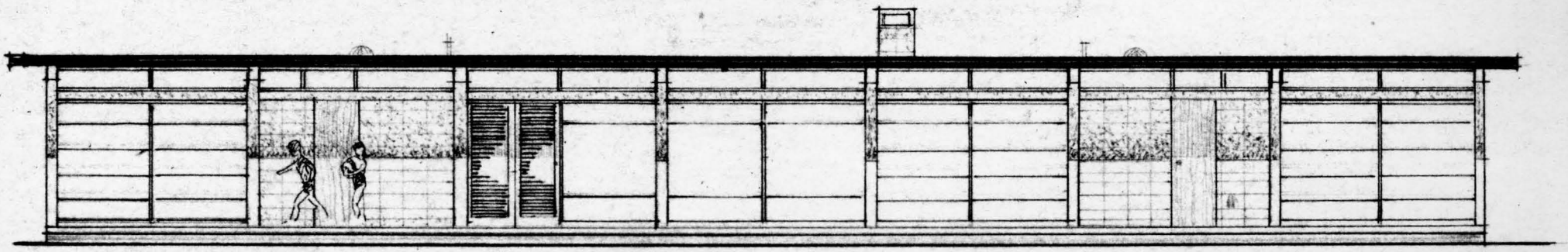
SOUTH-EAST ELEVATION



NORTH-WEST ELEVATION

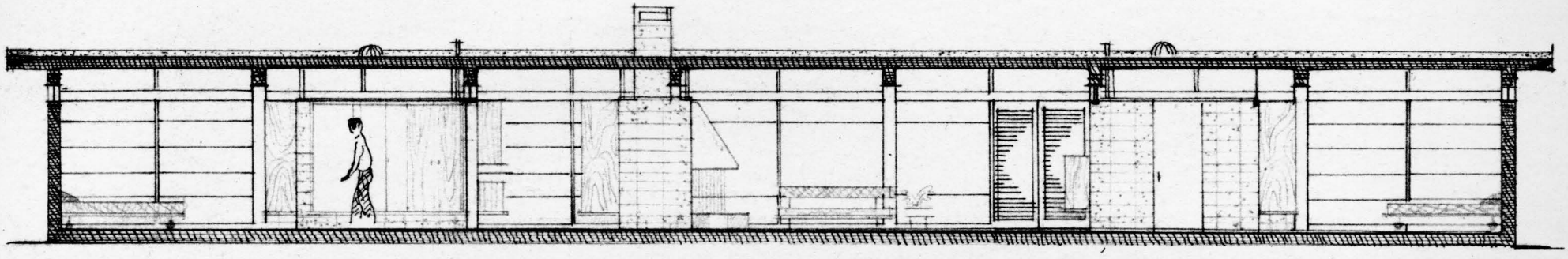


BAY SIDE ELEVATION



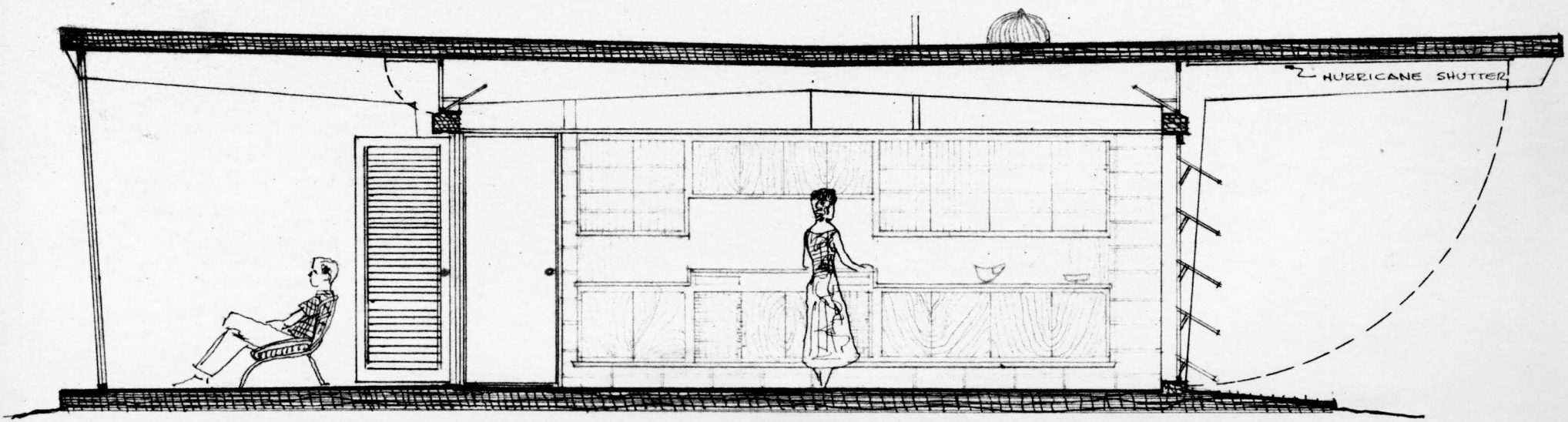
GULF SIDE ELEVATION

SCALE: 0 1 3 6 FEET



LONGITUDINAL SECTION

SCALE: 0 1 3 6 FEET



TRANSVERSE SECTION

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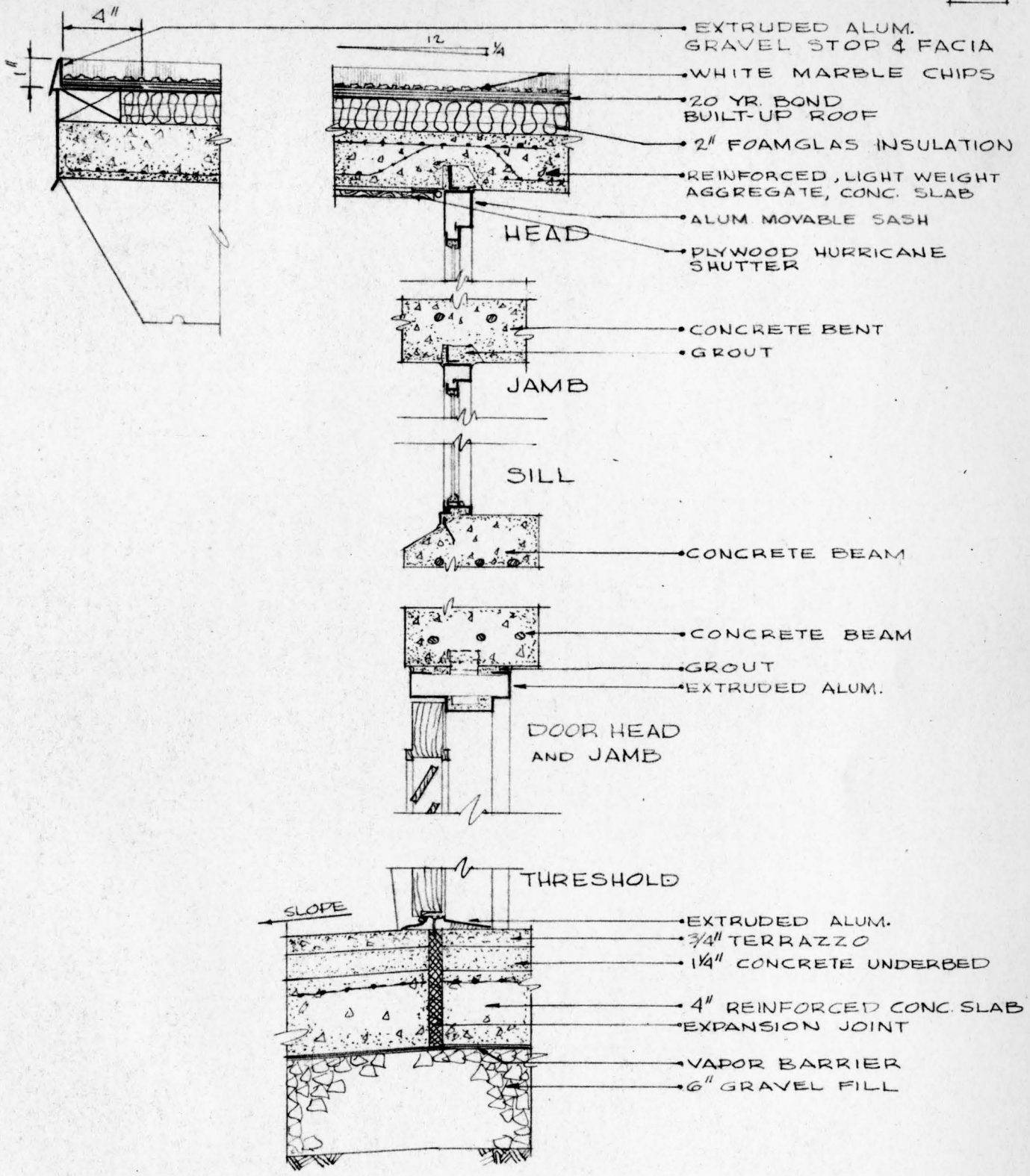
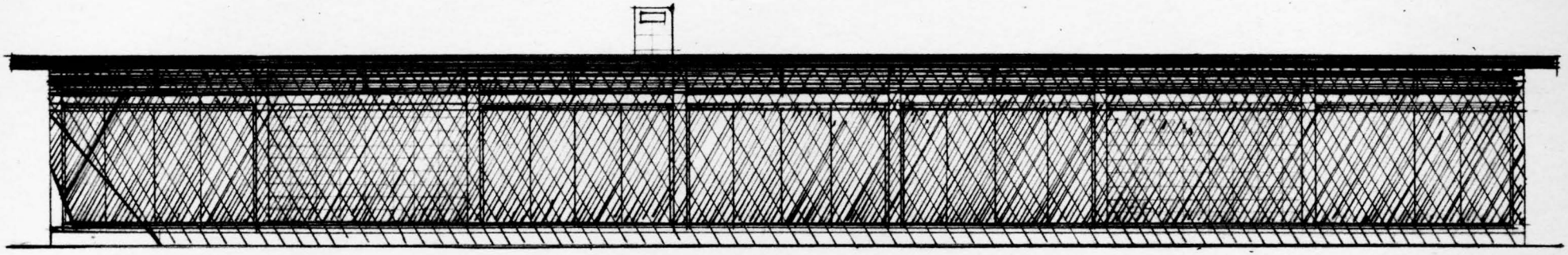


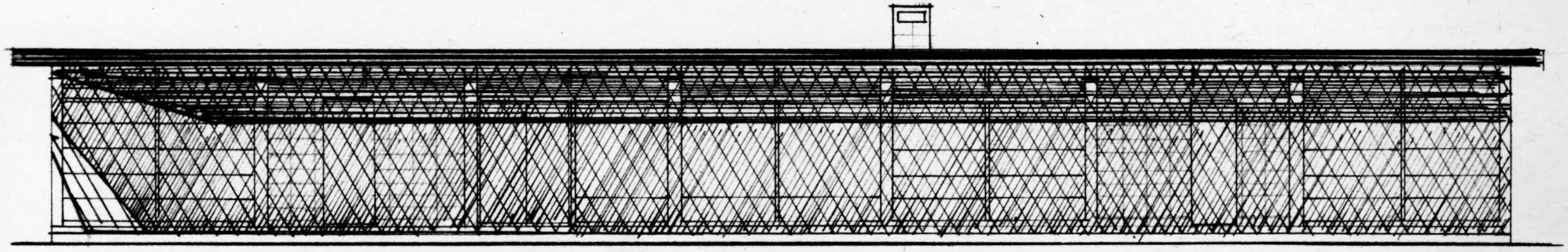
TYPICAL SECTION THRU EXTERIOR DOOR AND HIGH WINDOW

SCALE: 1 1/2" = 1'-0"



BAY SIDE ELEVATION

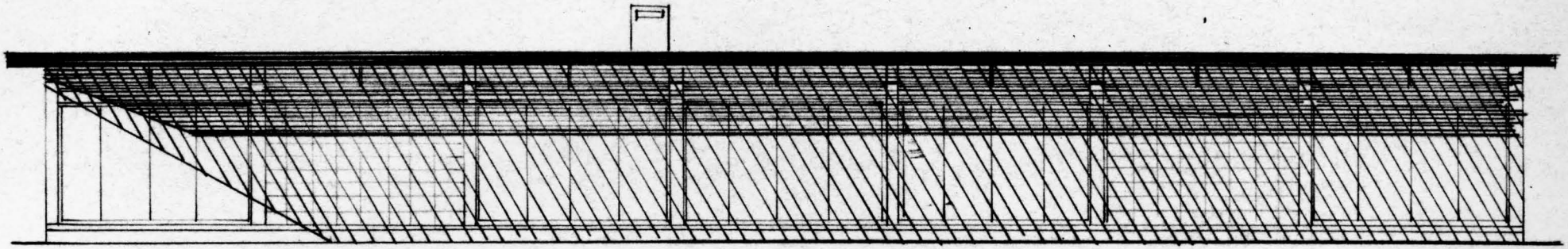
— 6 A.M. SHADOW
— 8 A.M. SHADOW
— 10 A.M. SHADOW



GULF SIDE ELEVATION

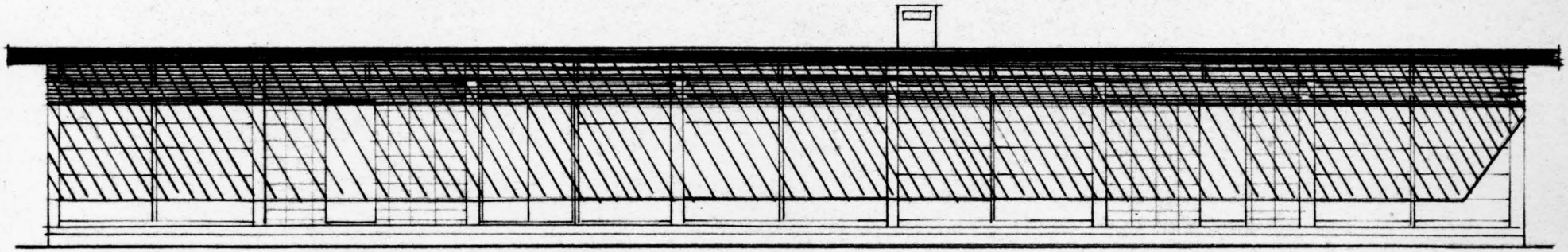
— 2 P.M. SHADOW
— 4 P.M. SHADOW
— 6 P.M SHADOW

SUN PROJECTION JUNE 15TH



BAY SIDE ELEVATION

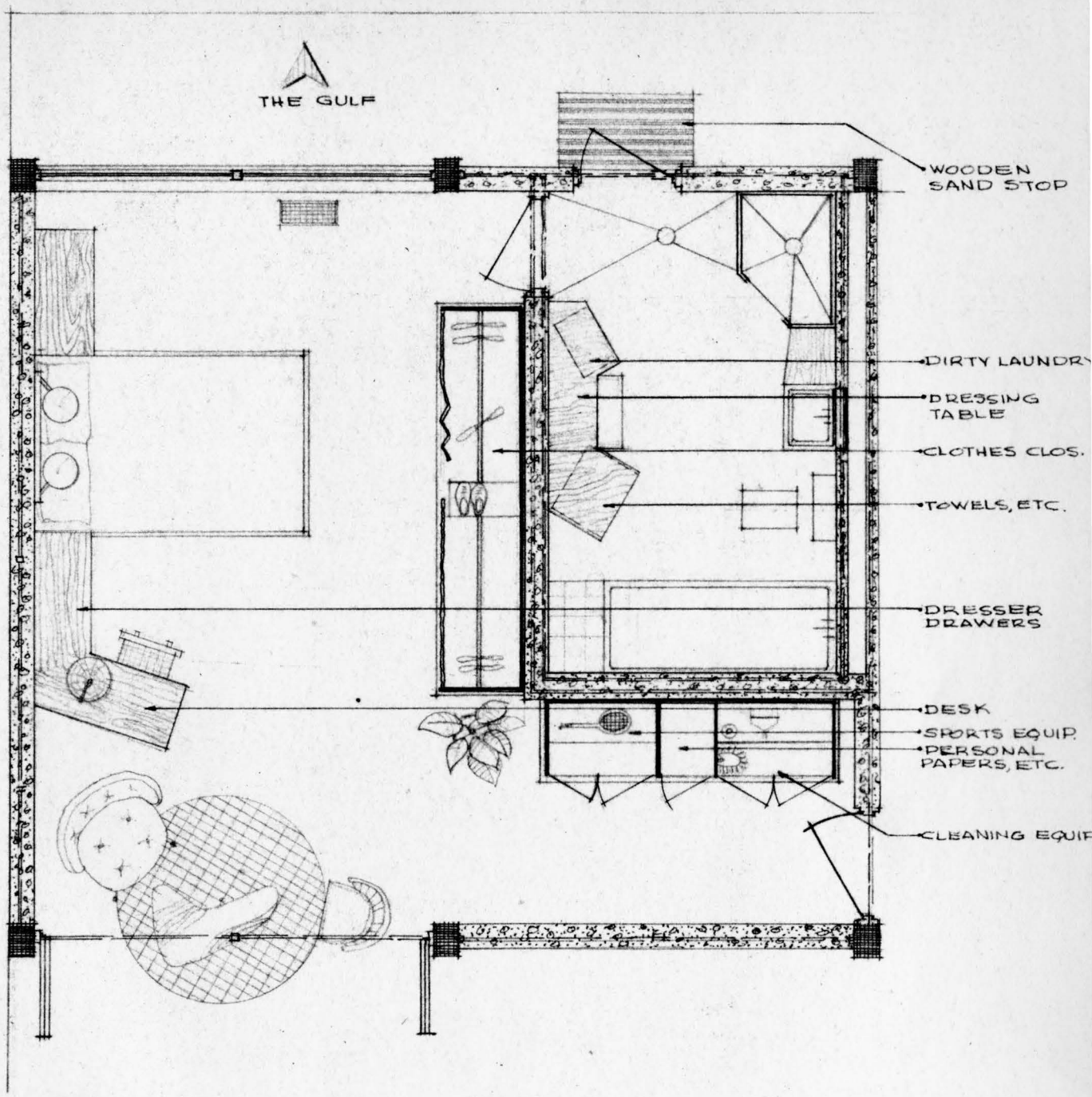
— 8 A.M. SHADOW
— 10 A.M. SHADOW



GULF SIDE ELEVATION

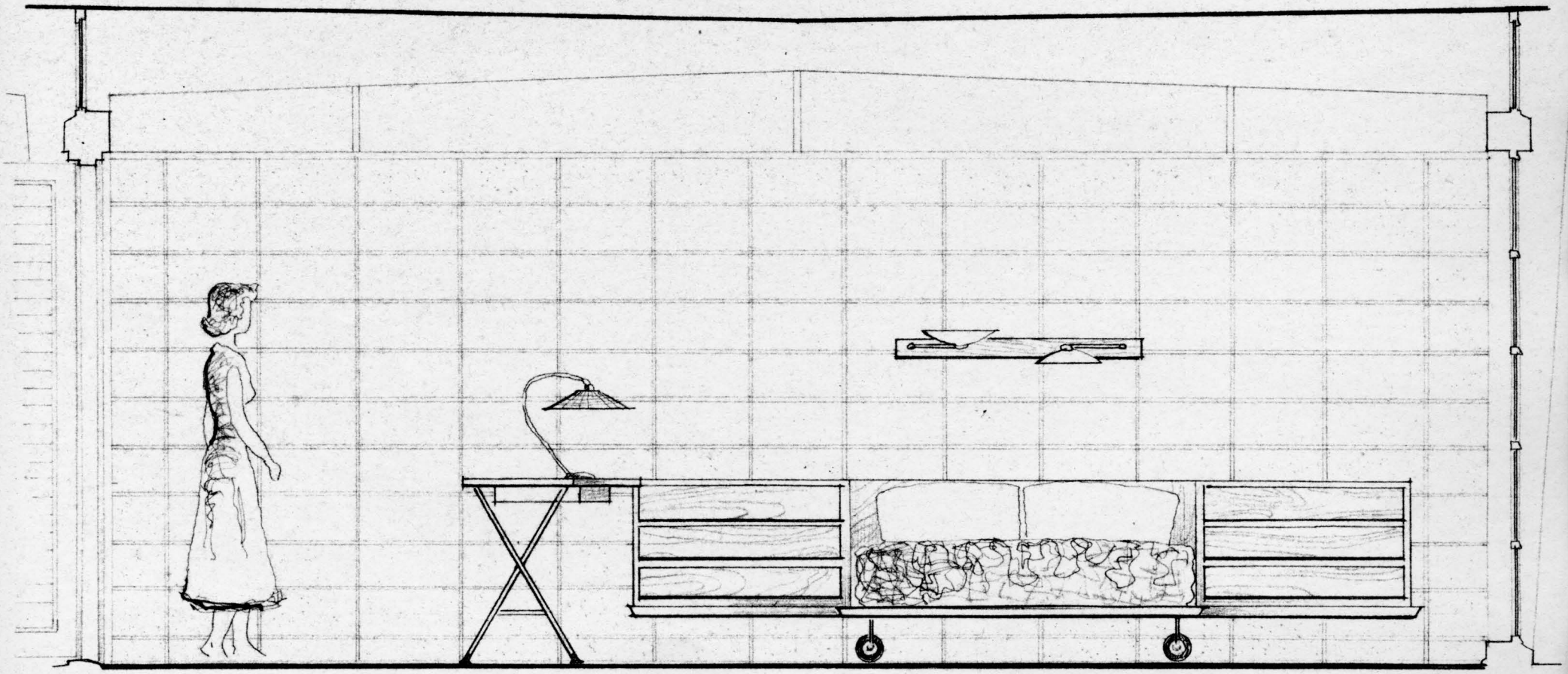
— 2 P.M. SHADOW
— 4 P.M. SHADOW

SUN PROJECTION DECEMBER 15th



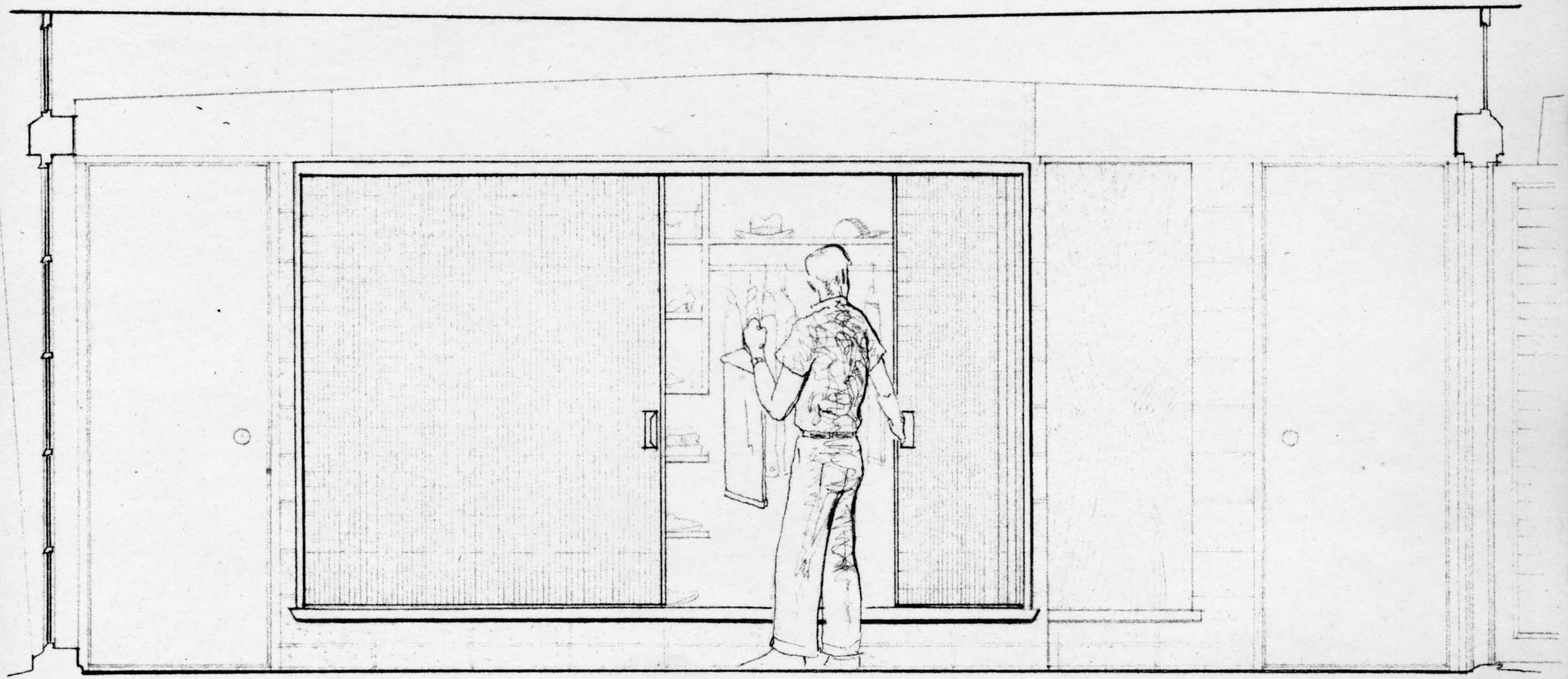
PLAN OF MASTER BEDROOM

SCALE: 0 1 3 FEET



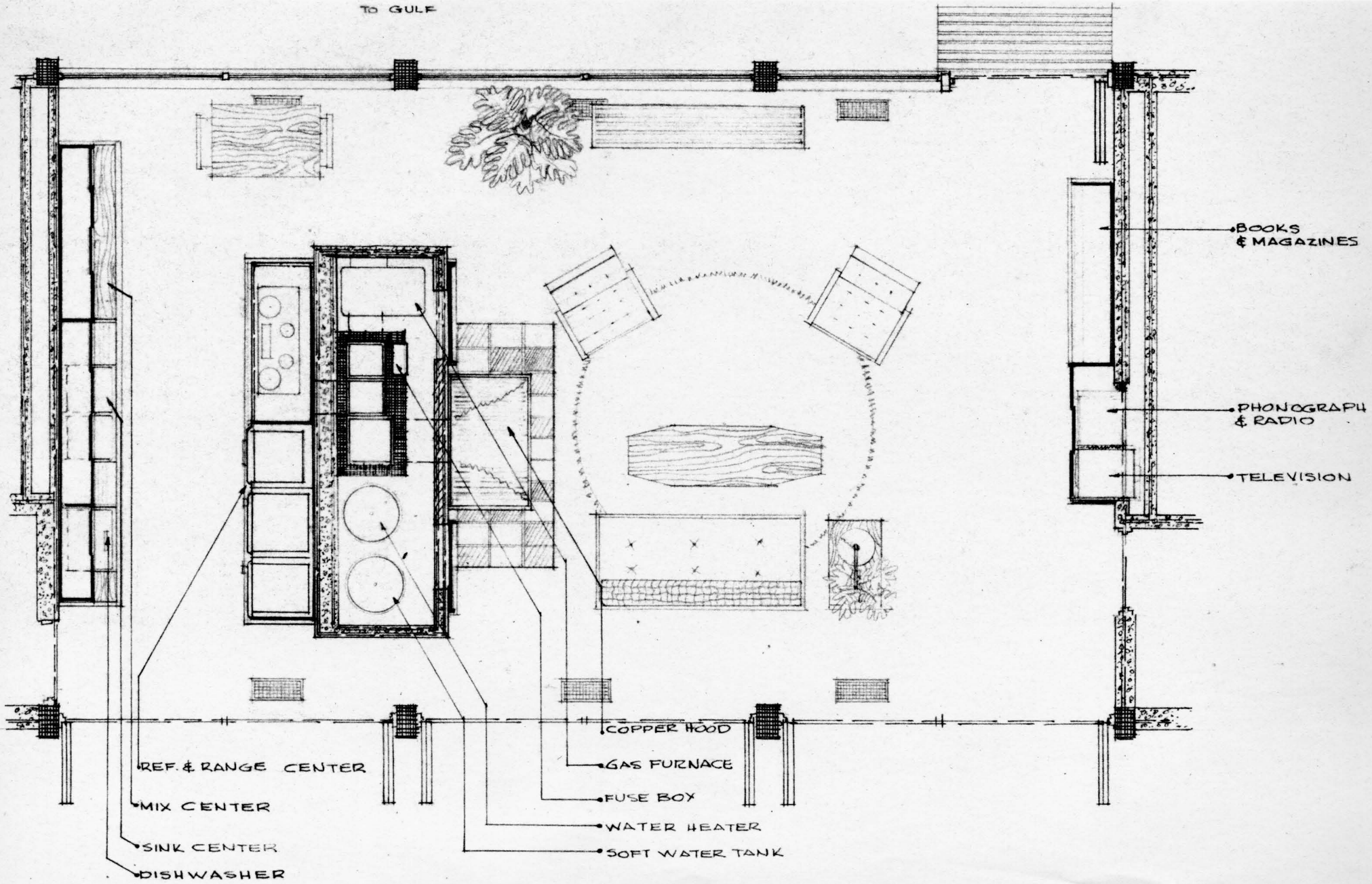
INTERIOR ELEVATION SOUTH WALL OF MASTER BEDROOM

SCALE 0' 1' 2' FEET



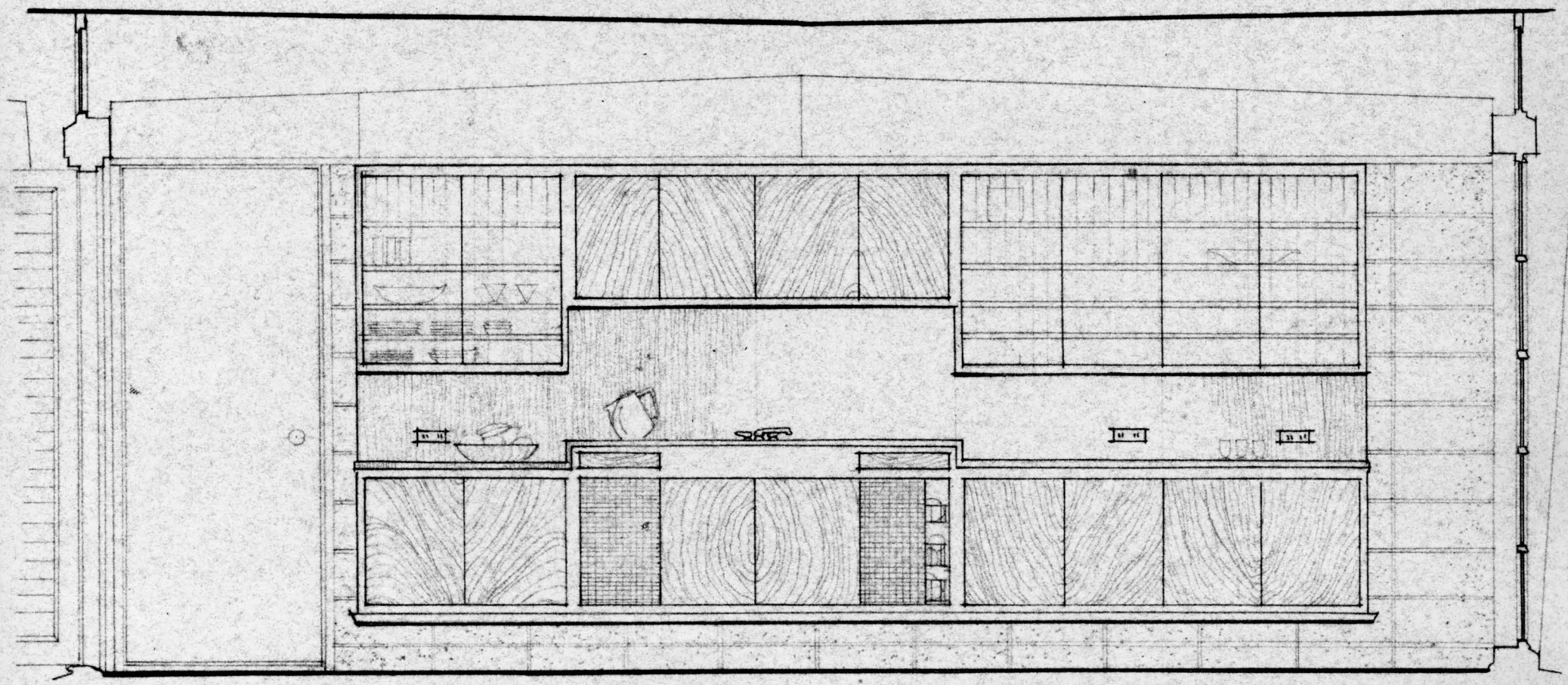
INTERIOR ELEVATION NORTH WALL OF MASTER BEDROOM

SCALE 0 1 3 FEET



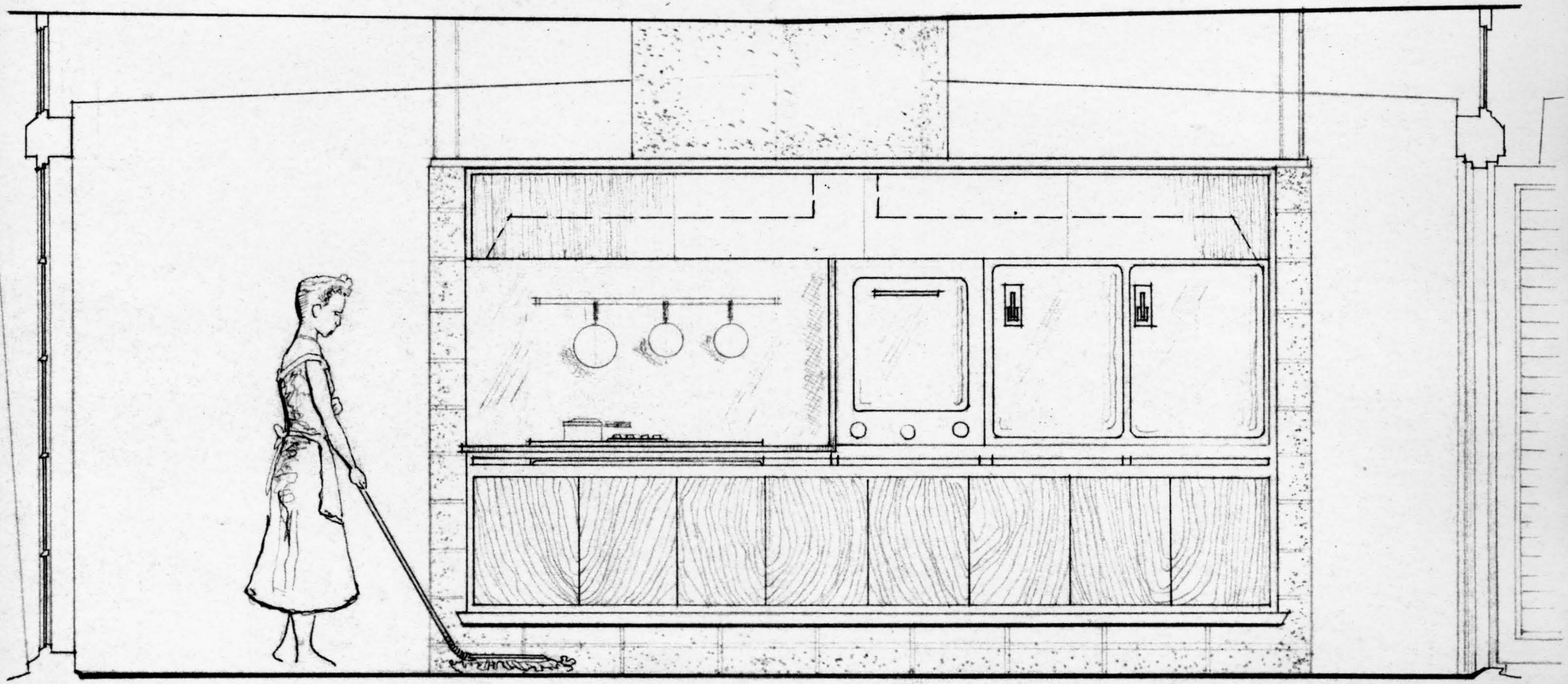
PLAN OF LIVING ROOM AND KITCHEN

SCALE 0 1 3 FEET



INTERIOR ELEVATION SOUTH WALL OF KITCHEN

SCALE 0 1 3 FEET



INTERIOR ELEVATION NORTH WALL OF KITCHEN

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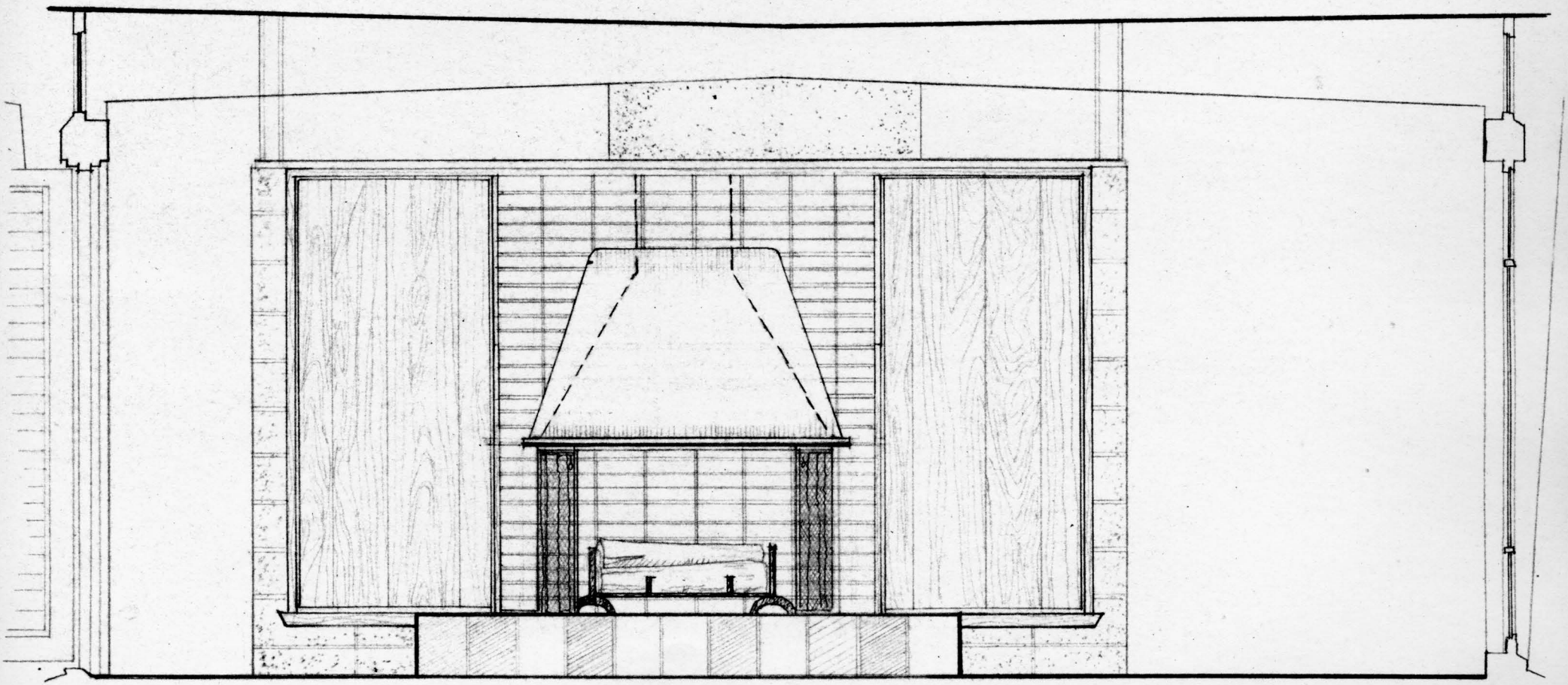

INTERIOR ELEVATION SOUTH WALL OF LIVING ROOM

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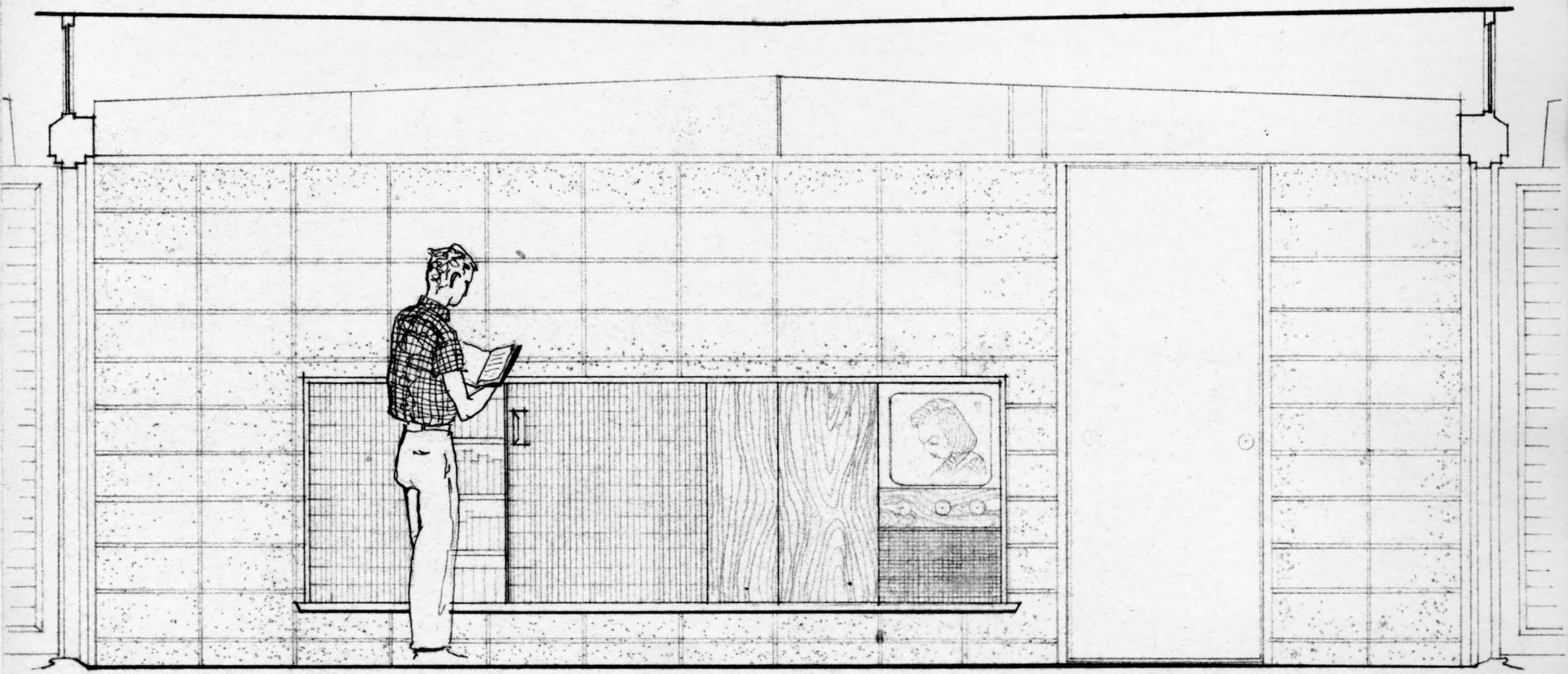
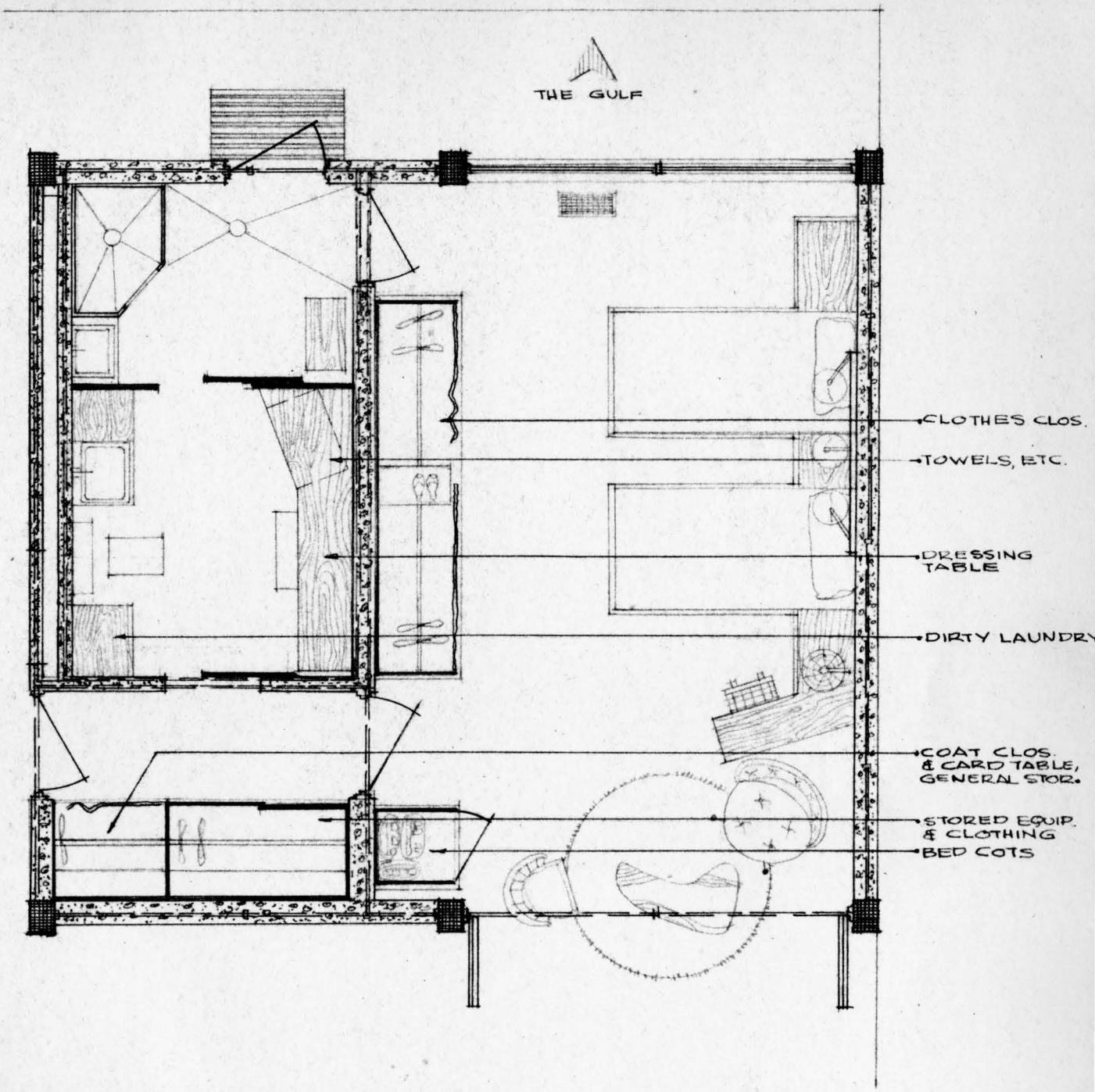


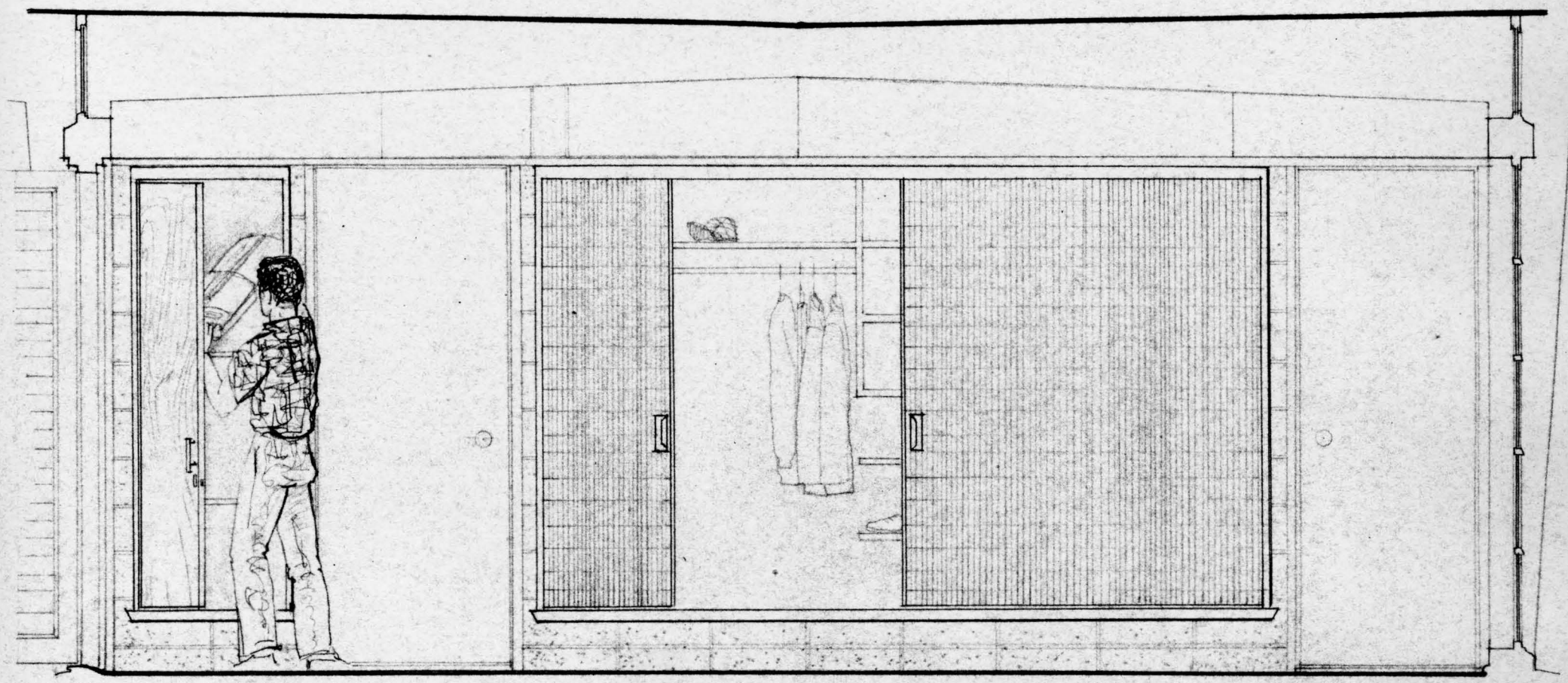
INTERIOR ELEVATION NORTH WALL OF LIVING ROOM

SCALE 0 1 3 FEET



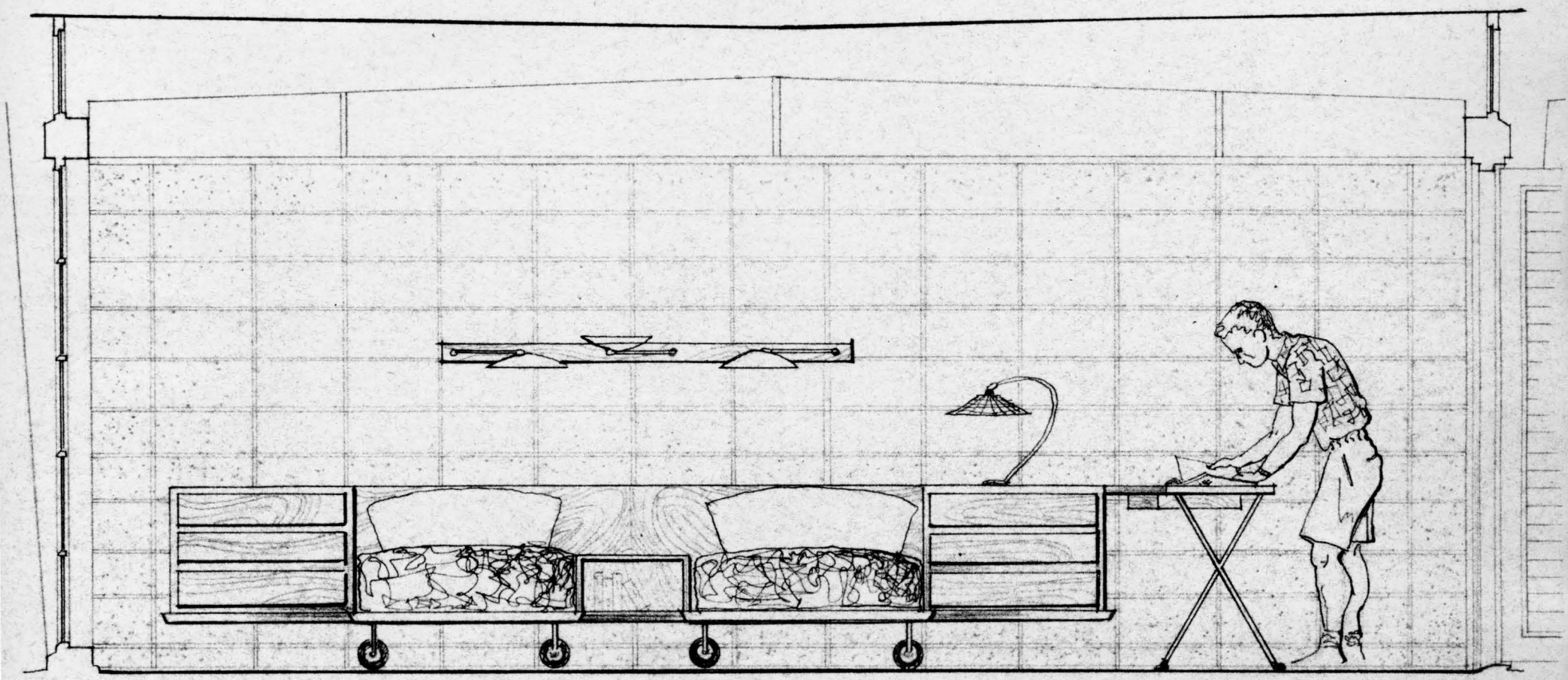
PLAN OF GUEST BEDROOM

SCALE: 0 1 3 FEET



INTERIOR ELEVATION SOUTH WALL OF GUEST BEDROOM

SCALE 0 1 3 FEET



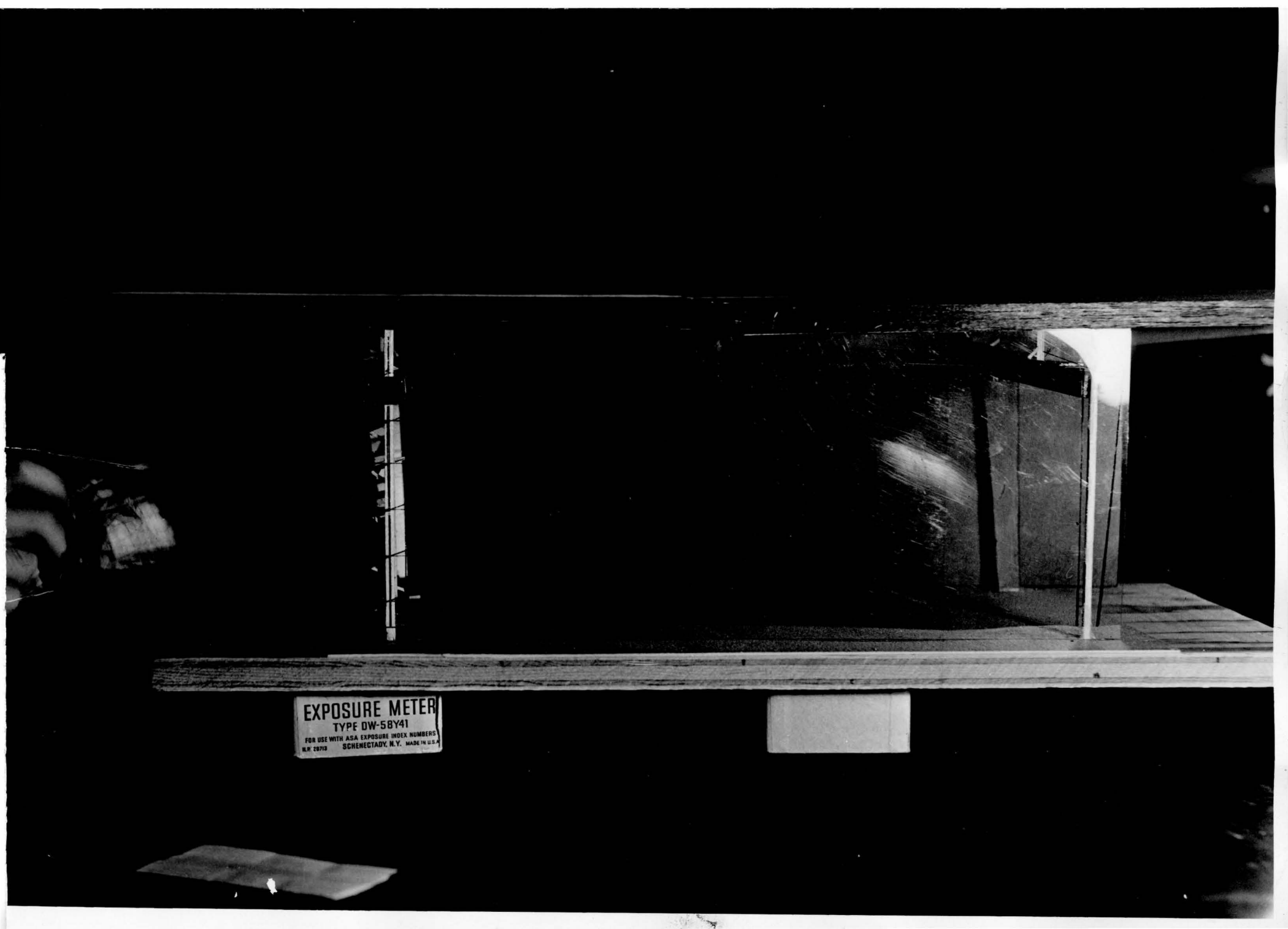
INTERIOR ELEVATION NORTH WALL OF GUEST BEDROOM

SCALE 0 1 2 FEET

PHOTOGRAPHS OF TEST MODEL AND SCALE MODEL

TEST MODEL: SIDE VIEW OF TEST MODEL SHOWING

SMOKE PATTERN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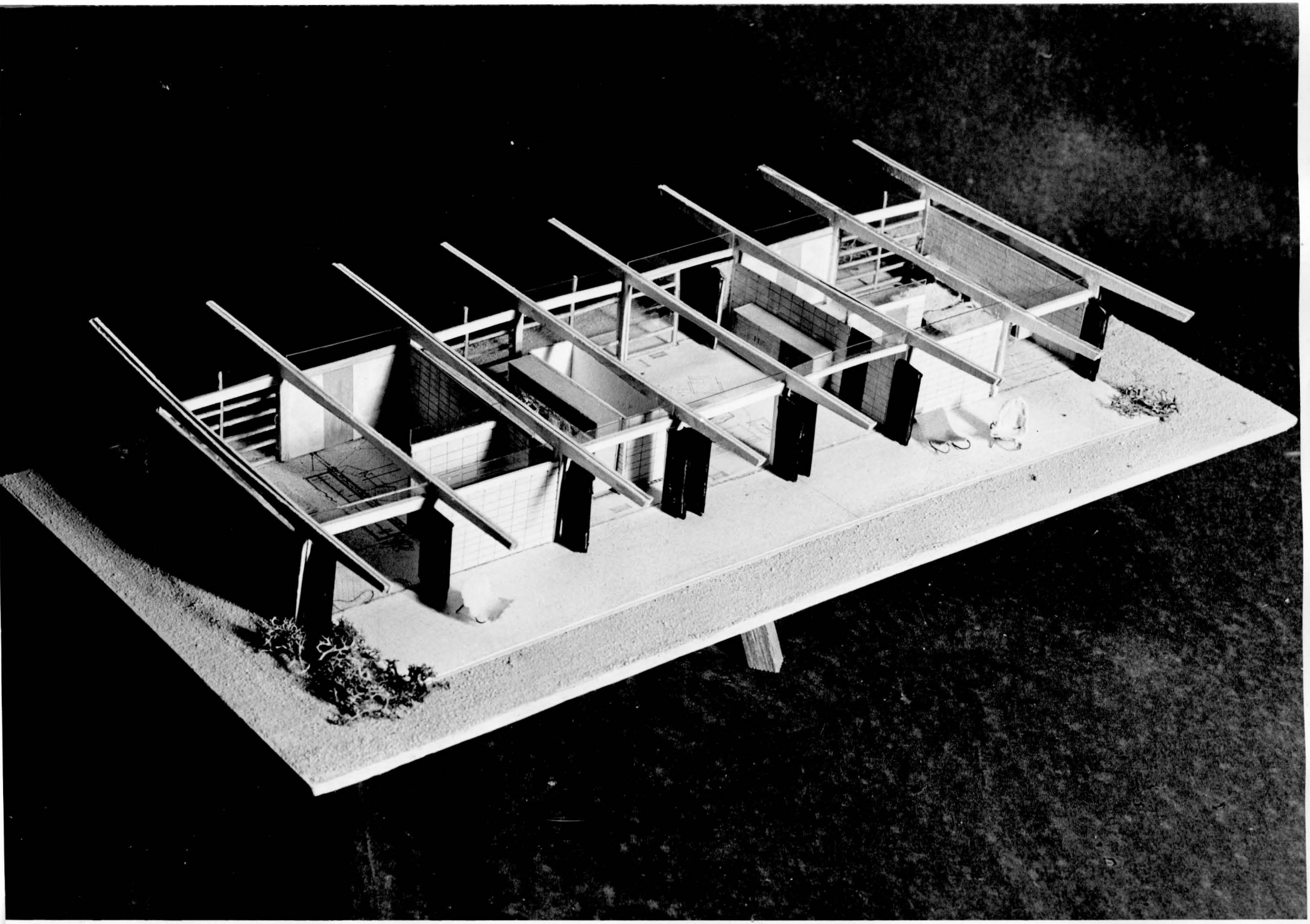
TYPE DW-58Y41
FOR USE WITH ASA EXPOSURE INDEX NUMBERS
N.R. 28713
SCHENECTADY, N.Y.
MADE IN U.S.A.

TEST MODEL: SIDE VIEW OF TEST MODEL SHOWING

SMOKE PATTERN

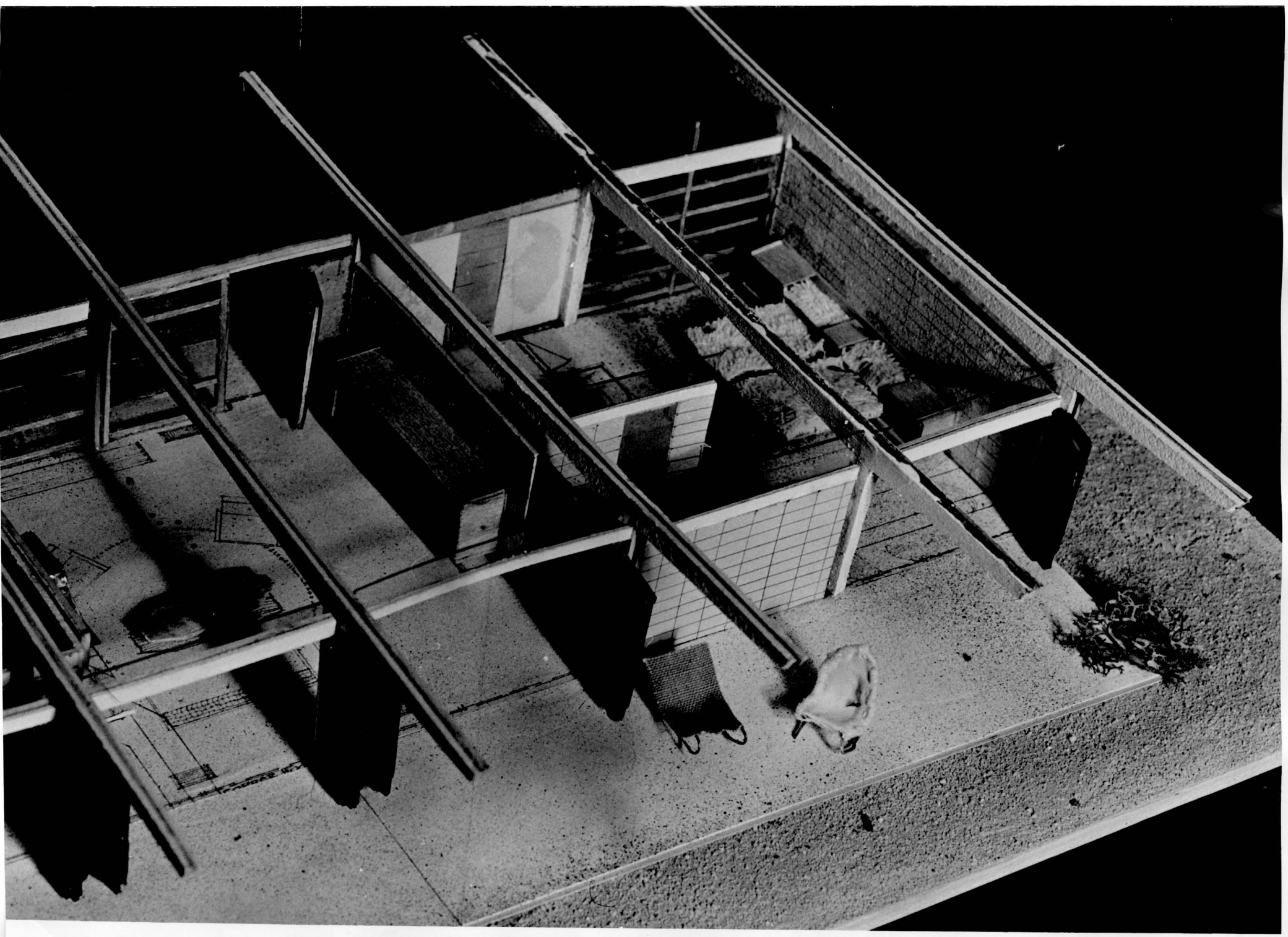

EXPOSURE METER
TYPE DW-58Y41
FOR USE WITH ASA EXPOSURE INDEX NUMBERS
N.P. 28713 SCHENECTADY, N.Y. MADE IN U.S.A.

SCALE MODEL: VIEW OF HOUSE WITHOUT ROOF



SCALE MODEL: VIEW FROM WEST

SCALE MODEL: BIRD'S-EYE VIEW OF GUEST SLEEPING AREA



CONCLUSION

C O N C L U S I O N

The purpose of this thesis was to design a "successful house" - one that gave a creative and practical solution to a particular problem.

It is hoped that the house design will soon become a reality. Then, and only then, should the conclusion of this thesis be given.

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VITA

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