NPS Form 10-900
(7-81)

United States Department of the Interior
National Park Service

National Register of Historic Places Inventory—Nomination Form

For NPS use only
received
date entered

See instructions in *How to Complete National Register Forms*
Type all entries—complete applicable sections

1. Name

historic Zero Gravity Research Facility (B-2)

and/or common Zero Gravity Research Facility

2. Location

street & number Lewis Research Center ___ **not for publication**

city, town Cleveland ___ **vicinity of** **congressional district**

state Ohio **code** 39 **county** Cuyahoga **code** 035

3. Classification

Category	Ownership	Status	Present Use	
___ district	X public	___ occupied	___ agriculture	___ museum
___ building(s)	___ private	___ unoccupied	___ commercial	___ park
X structure	___ both	___ work in progress	___ educational	___ private residence
___ site	**Public Acquisition**	**Accessible**	___ entertainment	___ religious
___ object	___ in process	X yes: restricted	X government	X scientific
	___ being considered	___ yes: unrestricted	___ industrial	___ transportation
		___ no	___ military	X other: Space Exploration

4. Owner of Property

name National Aeronautics and Space Administration (NASA)

street & number

city, town Washington ___ **vicinity of** **state** D.C. 20546

5. Location of Legal Description

courthouse, registry of deeds, etc. National Aeronautics and Space Administration (NASA)

street & number Real Property Management Office Code NXG

city, town Washington **state** D.C. 20546

6. Representation in Existing Surveys

title None **has this property been determined eligible?** ___ **yes** ___ **no**

date ___ **federal** ___ **state** ___ **county** ___ **local**

depository for survey records

city, town **state**

7. Description

Condition		Check one	Check one
X excellent	___ deteriorated	X unaltered	X original site
___ good	___ ruins	___ altered	___ moved date _____
___ fair	___ unexposed		

Describe the present and original (if known) physical appearance

The Zero Gravity Research Facility is at the Lewis Research Center in Cleveland, Ohio. It is the only know facility of its size in the free world capable of performing tests in a reduced gravity environment. It has successfully supported researchers involved in the Manned Space Program (Mercury, Gemini and Apollo), and the Centaur Program. Most research tests involve behavior of components, systems, liquids, gases, and combustion when under the influence of reduced gravity or low acceleration environments.[1]

This facility consists of a concrete-lined, 28-foot diameter shaft that extends 510-feet below ground level. A steel vacuum chamber, 20-feet in diameter and 470-feet high, is contained within the concrete shaft. The pressure in this vacuum chamber is reduced to 13.3 newtons per square meter (1.3×10^{-4} atm) before use.

The ground-level service building has, as its major elements, a shop area, control room, and a clean room. Assembly, servicing, and balancing of the experiment vehicle are accomplished in the shop area. Tests are conducted from the control room, which contains controls for the "pump down" of the vacuum chamber, the experiment vehicle pre-drop checkout, release and the data retrieval system. Those components of the experiment that are in contact with the test liquid are prepared in the facility's clean room. The major elements of the clean room are an ultrasonic cleaning system and a laminar-flow work station for preparing those experiments requiring more than normal cleanliness.

Mode of Operation - The Zero-Gravity Facility has two modes of operation. One is to allow the experiment vehicle to free fall from the top of the vacuum chamber, which results in a nominal 5.15 seconds of free fall time. The second mode is to project the experiment vehicle upwards from the bottom of the vacuum chamber by a high-pressure pneumatic accelerator on the vertical axis of the chamber. The total up and down trajectory of the experiment vehicle results in a nominal 10 seconds of free fall time.

In either mode of operation, the experiment vehicle falls freely; that is, no guide wires, electrical lines, are connected to the vehicle. Therefore, the only force acting on the freely falling experiment vehicle is due to residual-air drag. This results in an equivalent gravitational acceleration acting on the experiment, which is estimated to be of the order of 10^{-5} g or better.

8. Significance

Period	Areas of Significance—Check and justify below				
___ prehistoric	___ archeology-prehistoric	___ community planning	___ landscape architecture	___ religion	
___ 1400–1499	___ archeology-historic	___ conservation	___ law	X science	
___ 1500–1599	___ agriculture	___ economics	___ literature	___ sculpture	
___ 1600–1699	___ architecture	___ education	___ military	___ social/ humanitarian	
___ 1700–1799	___ art	X engineering	___ music	___ theater	
___ 1800–1899	___ commerce	___ exploration/settlement	___ philosophy	___ transportation	
X 1900–	___ communications	___ industry	___ politics/government	X other (specify)	
		___ invention		Space Exploration	

Specific dates 1966-Present **Builder/Architect** NASA

Statement of Significance (in one paragraph)

The Zero-Gravity Facility is significant because it is the only such facility in NASA's inventory that can study the behavior of liquids in a low gravity environment. A knowledge of the characteristics of liquids in a space vehicle is important to design engineers. Information concerning liquid sloshing which can change the center of mass of a space vehicle and thus effect vehicle stability and control is absolutely essential to the successful performance of liquid high energy space vehicles such as the Centaur and Saturn upper stages. The study of the effects of liquid sloshing on the performance of upper stage liquid rockets was therefore essential to the successful completion of the objectives of the American Space Program.

The Zero-Gravity Facility is the only such facility of its type in the world and is directly linked to the development of the Centaur and Saturn upper stage rockets, which have transported Americans to the moon and sent American space vehicles such as the Viking, Voyager, and Mariner spacecraft to the planets. Research and data developed here involving the physics of liquids in a zero-gravity environment was indispensible to the successful development of these high energy liquid fueled rockets.

9. Major Bibliographical References

See continuation sheets

10. Geographical Data

Acreage of nominated property Less than 1 acre

Quadrangle name Lakewood **Quadrangle scale** 1:24,000

UMT References

	Zone	Easting	Northing
A	17	427780	4584660
B			
C			
D			
E			
F			
G			
H			

Verbal boundary description and justification

The boundary of the Zero-Gravity Facility is shown as the green line on the accompanying map entitled "National Aeronautics and Space Administration, Lewis Research Center."

List all states and counties for properties overlapping state or county boundaries

state	code	county	code
state	code	county	code

11. Form Prepared By

name/title Harry A. Butowsky

organization National Park Service **date** May 15, 1984

street & number Division of History **telephone** (202)343-8168

city or town Washington, D.C. 20240 **state**

12. State Historic Preservation Officer Certification

The evaluated significance of this property within the state is:

___ national ___ state ___ local

As the designated State Historic Preservation Officer for the National Historic Preservation Act of 1966 (Public Law 89-665), I hereby nominate this property for inclusion in the National Register and certify that it has been evaluated according to the criteria and procedures set forth by the National Park Service.

State Historic Preservation Officer signature

title **date**

For NPS use only

I hereby certify that this property is included in the National Register

date

Keeper of the National Register

Attest: **date**

Chief of Registration

Recovery System - After the experiment vehicle has traversed the total length of the vacuum chamber, it is decelerated in a 12-foot diameter, 20-foot deep container which is centered on the vertical axis of the chamber and filled with small pellets of expanded polystyrene. The deceleration rate (averaging 32 g) is controlled by the flow of pellets through the area between the experiment vehicle and the wall of the deceleration container. This deceleration container is mounted on a cart that is retracted prior to utilizing the 10-second mode of operation. In this mode of operation, the cart is deployed after the experimental vehicle is projected upwards by the pneumatic accelerator.

This facility is in active service supporting present space shuttle experiments.

Footnotes

1. The descriptive material in this section was taken from the following source: Thomas Labus, Natural Frequency of Liquids in Annular Cylinders under Low Gravitational Conditions, NASA Technical Note D-5412, (Washington, D.C.: National Aeronautics and Space Administration, September 1969), pp. 22-4.

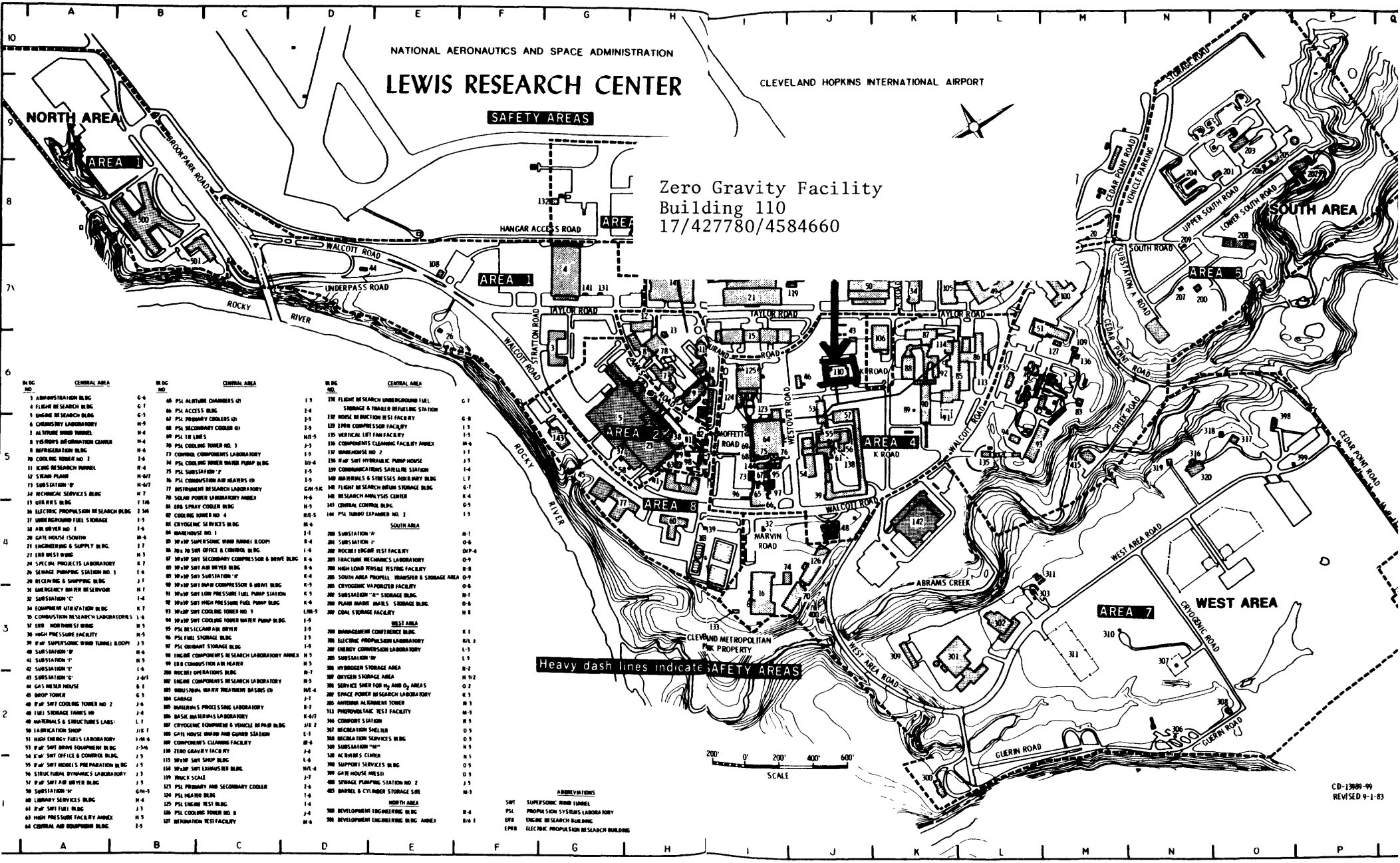
Bibliography

Labus, Thomas L. Natural Frequency of Liquids in Annular Cylinders under Low Gravitational Conditions. NASA Technical Note D-5412. Washington, D.C.: National Aeronautics and Space Administration, September 1969.

National Aeronautics and Space Administration. Technical Facilities Lewis Research Center. Cleveland, Ohio: Lewis Research Center, No Date.

National Aeronautics and Space Administration. Zero Gravity Research Facility. Cleveland, Ohio: Lewis Research Center, September 1966.

Petrash, Donald A. and Corpas, Ellias L. Zero Gravity Facility for Space Vehicle Fluid Research. Reprinted from the 1973 Proceedings of the 19th Annual Meeting of the Institute of Environmental Sciences. No place of publication, No date.

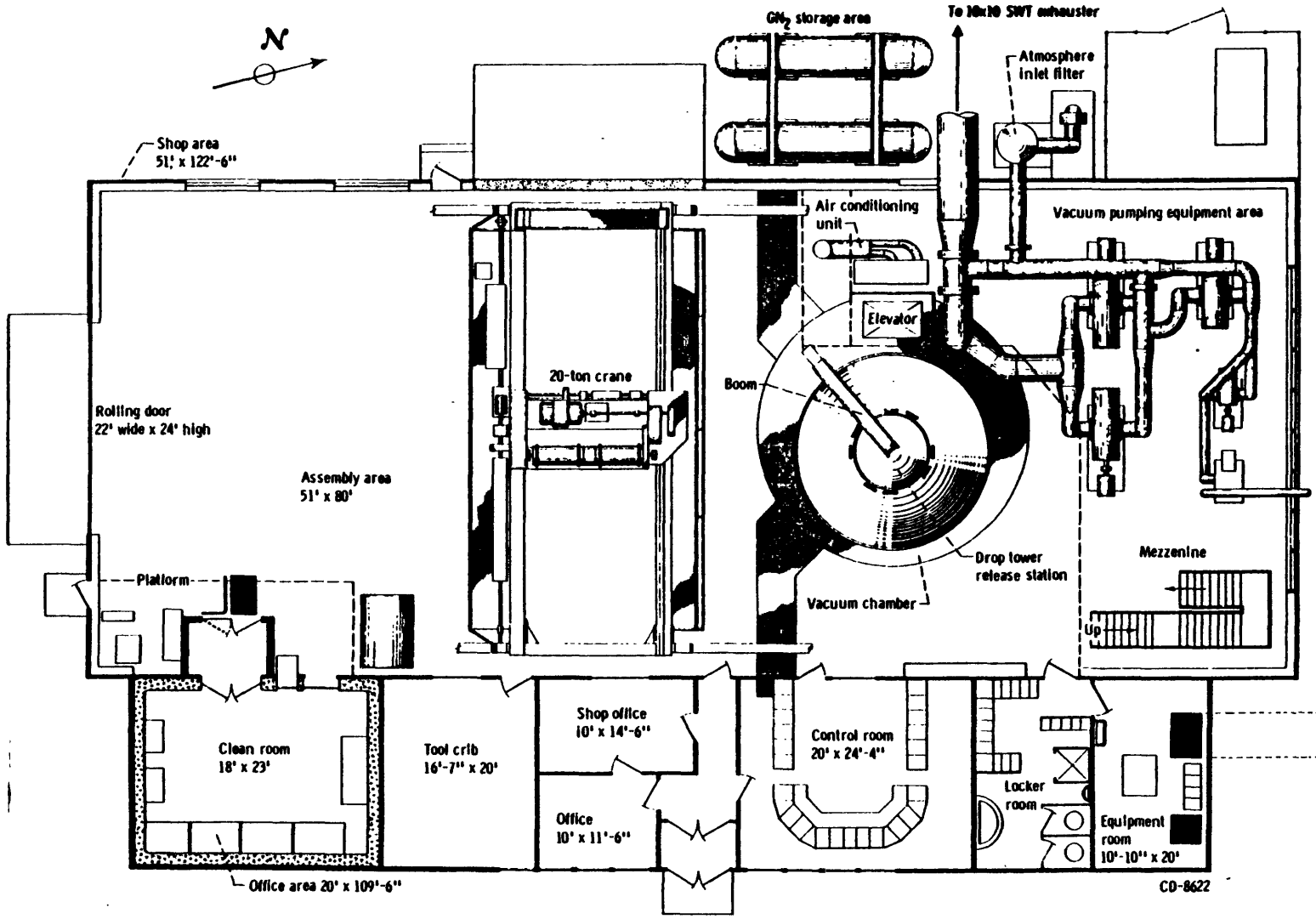


BLDG NO	CENTRAL AREA	
1	ADMINISTRATION BLDG	G-6
4	FLIGHT RESEARCH BLDG	G-7
5	ENGINE RESEARCH BLDG	G-7
6	CHEMISTRY LABORATORY	H-6
7	ALTITUDE WIND TUNNEL	H-6
8	VISITORS INFORMATION CENTER	H-6
8	REFRIGERATION BLDG	H-6
10	COOLING TOWER NO 1	I-6
11	ICING RESEARCH TUNNEL	H-6
12	STEAM PLANT	H-6/7
13	SUBSTATION 'B'	H-6/7
14	MECHANICAL SERVICES BLDG	H 7
15	UTILITIES BLDG	I 7/8
16	ELECTRIC PROPULSION RESEARCH BLDG	I 3/4
17	UNDERGROUND FUEL STORAGE	I-5
18	AIR DRYER NO 1	I-6
20	GATE HOUSE (SOUTH)	H-6
21	ENGINEERING & SUPPLY BLDG.	I 7
22	ERB WEST WING	H 5
24	SPECIAL PROJECTS LABORATORY	K 7
26	SEWAGE PUMPING STATION NO. 1	E-6
28	RECEIVING & SHIPPING BLDG	J 7
31	EMERGENCY WATER RESERVOIR	N 7
32	SUBSTATION 'C'	I-6
34	EQUIPMENT UTILIZATION BLDG	K 7
35	COMBUSTION RESEARCH LABORATORIES	L-6
37	ERB NORTHWEST WING	H 5
38	HIGH PRESSURE FACILITY	H-5
39	8' x 6' SUPERSONIC WIND TUNNEL (LOOP)	J 5
40	SUBSTATION 'D'	H-6
41	SUBSTATION 'F'	H 5
42	SUBSTATION 'E'	I-6
43	SUBSTATION 'G'	J-6/7
44	GAS METER HOUSE	G 7
45	DROP TOWER	G 5
48	8' x 6' SWT COOLING TOWER NO 2	J-6
49	FUEL STORAGE TANKS (8)	J-6
49	MATERIALS & STRUCTURES LABS	L 7
50	FABRICATION SHOP	J/K 7
51	HIGH ENERGY FUELS LABORATORY	J/M-6
53	8' x 6' SWT DRIVE EQUIPMENT BLDG	J-5/6
54	8' x 6' SWT OFFICE & CONTROL BLDG.	J 5
55	8' x 6' SWT MODELS PREPARATION BLDG	J 5
56	STRUCTURAL DYNAMICS LABORATORY	J 5
57	8' x 6' SWT AIR DRYER BLDG	J 5
58	SUBSTATION 'H'	G/H-5
60	LIBRARY SERVICES BLDG	H-6
61	8' x 6' SWT FUEL BLDG	J 5
63	HIGH PRESSURE FACILITY ANNEX	H 5
64	CENTRAL AIR EQUIPMENT BLDG.	I-5
65	PSL ALTITUDE CHAMBERS (2)	I 5
66	PSL ACCESS BLDG	J-6
67	PSL PRIMARY COOLERS (2)	J-5
68	PSL SECONDARY COOLER (1)	J-5
69	PSL TR LABS	H/I-5
70	PSL COOLING TOWER NO. 3	J-5
73	CONTROL COMPONENTS LABORATORY	I-5
74	PSL COOLING TOWER WATER PUMP BLDG	I/J-6
75	PSL SUBSTATION 'J'	I-5
76	PSL COMBUSTION AIR HEATERS (3)	J-5
77	INSTRUMENT RESEARCH LABORATORY	G/H-5/6
78	SOLAR POWER LABORATORY ANNEX	H-6
81	ERB SPRAY COOLER BLDG	H-5
82	COOLING TOWER NO 4	H/I-5
86	CRYOGENIC SERVICES BLDG	M-6
88	WAREHOUSE NO. 1	I-1
89	10' x 10' SUPERSONIC WIND TUNNEL (LOOP)	H-4
90	20' x 20' SWT OFFICE & CONTROL BLDG.	I-6
91	10' x 10' SWT SECONDARY COMPRESSOR & DRIVE BLDG	K-6
93	10' x 10' SWT AIR DRYER BLDG	K-6
94	10' x 10' SWT SUBSTATION 'K'	K-4
98	10' x 10' SWT MAIN COMPRESSOR & DRIVE BLDG	K-5
99	10' x 10' SWT LOW PRESSURE FUEL PUMP STATION	K 5
102	10' x 10' SWT HIGH PRESSURE FUEL PUMP BLDG	K-6
103	10' x 10' SWT COOLING TOWER NO. 5	L/M-5
104	10' x 10' SWT COOLING TOWER WATER PUMP BLDG.	I-5
105	PSL DESICCANT AIR DRYER	I-5
106	PSL FUEL STORAGE BLDG	I-5
107	PSL OXIDANT STORAGE BLDG	I-5
108	ENGINE COMPONENTS RESEARCH LABORATORY ANNEX	H 5
109	ERB COMBUSTION AIR HEATER	H 5
200	ROCKET OPERATIONS BLDG	M-7
202	ENGINE COMPONENTS RESEARCH LABORATORY	M-5
203	WIND TUNNEL WASTE TREATMENT BASINS (3)	M/L-4
204	GARAGE	J-7
205	MATERIALS PROCESSING LABORATORY	N-7
206	BASIC MATERIALS LABORATORY	K-6/7
207	CRYOGENIC EQUIPMENT & VEHICLE REPAIR BLDG	J/K 2
208	GATE HOUSE (MAIN) AND GUARD STATION	E-1
209	COMPONENTS CLEANING FACILITY	M-6
110	ZERO GRAVITY FACILITY	J-4
113	10' x 10' SWT SHOP BLDG	L-6
114	10' x 10' SWT EXHAUSTER BLDG.	M/L-4
119	BRUCE SCALE	J-7
123	PSL PRIMARY AND SECONDARY COOLER	I-6
124	PSL HEATER BLDG	I-6
125	PSL ENGINE TEST BLDG	I-4
126	PSL COOLING TOWER NO. 8	J-4
127	REFRIGERATION TEST FACILITY	M-6
130	FLIGHT RESEARCH UNDERGROUND FUEL STORAGE & TRAILER REFUELING STATION	G 7
132	NOISE REDUCTION TEST FACILITY	G-8
133	3 PHASE COMPRESSOR FACILITY	I 5
135	VERTICAL LIFT FAN FACILITY	I-5
136	COMPONENTS CLEANING FACILITY ANNEX	M-6
137	WAREHOUSE NO. 2	J 7
138	8' x 6' SWT HYDRAULIC PUMP HOUSE	J 5
139	COMMUNICATIONS SATELLITE STATION	I-4
140	MATERIALS & STRESSES ANCILLARY BLDG	L 7
141	FLIGHT RESEARCH DRUM STORAGE BLDG	G-7
142	RESEARCH ANALYSIS CENTER	K-4
143	CENTRAL CONTROL BLDG.	G-5
144	PSL TURBO EXPANDER NO. 2	I 5
	SOUTH AREA	
200	SUBSTATION 'A'	M-7
204	SUBSTATION 'I'	O-6
202	ROCKET ENGINE TEST FACILITY	D/P-4
203	FRACTURE MECHANICS LABORATORY	O-9
208	HIGH LOAD TENSILE TESTING FACILITY	N-8
205	SOUTH AREA PROPELL TRANSFER & STORAGE AREA	O-9
205	CRYOGENIC VAPORIZER FACILITY	O-6
207	SUBSTATION "A" STORAGE BLDG.	N-7
208	PLANT MAINT. MAILS STORAGE BLDG.	O-6
207	COAL STORAGE FACILITY	N 8
	WEST AREA	
200	MANAGEMENT CONFERENCE BLDG.	K 1
201	ELECTRIC PROPULSION LABORATORY	G/L 3
202	ENERGY CONVERSION LABORATORY	L-3
205	SUBSTATION 'W'	L 3
301	HYDROGEN STORAGE AREA	N-2
307	OXYGEN STORAGE AREA	N 3/2
308	SERVICE SHED FOR H_2 AND O_2 AREAS	O 2
309	SPACE POWER RESEARCH LABORATORY	K 3
305	ANTENNA ALIGNMENT TOWER	M 3
311	PHOTOVOLTAIC TEST FACILITY	M-3
306	COMFORT STATION	M 3
307	RECREATION SHELTER	O 3
308	RECREATION SERVICES BLDG	O 3
309	SUBSTATION "M"	N 3
320	ACTIVITIES CENTER	N 3
310	SUPPORT SERVICES BLDG	O 3
399	GATE HOUSE (WEST)	O 3
400	SEWAGE PUMPING STATION NO 2	J 3
405	BARREL & CYLINDER STORAGE SITE	N-3
	NORTH AREA	
500	DEVELOPMENT ENGINEERING BLDG	H-4
500	DEVELOPMENT ENGINEERING BLDG ANNEX	H/I 1

ABBREVIATIONS

SWT	SUPERSONIC WIND TUNNEL
PSL	PROPULSION SYSTEMS LABORATORY
ERB	ENGINE RESEARCH BUILDING
EPRB	ELECTRIC PROPULSION RESEARCH BUILDING

Zero Gravity Research Facility Floor Plan



Source: Zero Gravity Research Facility, op. cit., figure 5.