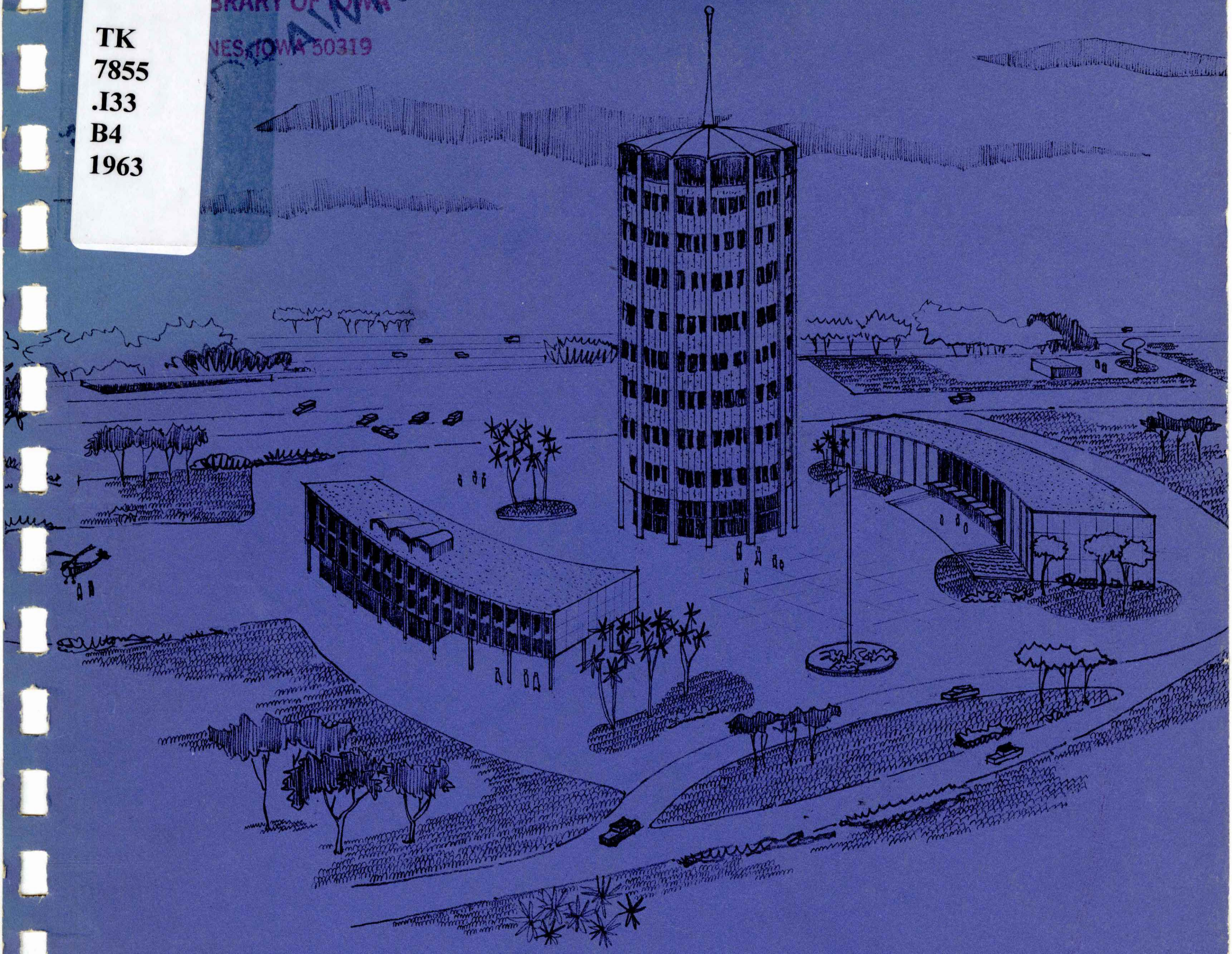

Addendum to proposal of the Iowa City Area as the site for the NASA ELECTRONICS RESEARCH CENTER

STATE UNIVERSITY OF IOWA • FOUNDED 1847 •

DECEMBER 23, 1963

FRONT COVER

An architectural sketch of the Iowa City - Cedar Rapids Executive Office building to be constructed near the proposed site. This building is offered for NASA's initial use pending construction of NASA's own facilities. Details are included in this booklet.

STATE
UNIVERSITY OF IOWA
IOWA CITY, IOWA

Office of the President

December 17, 1963

Dear Mr. Webb:

We are pleased to transmit the following information, at Dr. Simpson's request, to supplement Dr. Van Allen's presentation last week in support of the Iowa City area as a site for the proposed Electronics Research Center. For the most part it provides additional insight into the educational and industrial resources of the Mid-America region, but it also sets forth some previously undiscussed thoughts on the anticipated availability of working space and housing. We believe you will find all the material interesting, and hope it will also prove helpful.

Please call upon us for any additional information which you might think desirable as you study this question.

Sincerely yours,

Virgil M. Hancher

Virgil M. Hancher
President

Mr. James Webb
National Aeronautics and Space Administration

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3-29-68

section 1

Statistics on scientific and engineering graduates in Midwest area

SCIENTIFIC AND ENGINEERING GRADUATES IN SELECTED FIELDS
FROM 14 MAJOR UNIVERSITIES OF THE MIDWEST

YEAR *	BS	MS	PhD
1953	1,664	771	593
1954	3,886	1,150	741
1955	5,768	1,258	774
1957	5,926	1,498	658
1958	6,666	1,560	677
1959	7,361	1,792	707
1962	7,211	2,412	840

The above figures include degrees conferred in engineering, mathematics, chemistry, physics, and psychology from the following universities:

State University of Iowa (Iowa City)
Iowa State University (Ames)
University of Wisconsin
University of Illinois
Illinois Institute of Technology
Northwestern University
University of Chicago
St. Louis University
Washington University (St. Louis)
University of Missouri
University of Nebraska
Purdue University
University of Minnesota
University of Kansas

*Data for missing years not available.

DEGREES (BS, MS, PhD) CONFERRED 1956-1957
UNDER SPECIFIC CATEGORIES

	ALL ENGINEERING	EE	MATHEMATICS	CHEMISTRY	PHYSICS	PSYCHOLOGY
State Univ. of Iowa	146	34	29	27	16	47
Iowa State Univ.	493	131	13	53	24	19
Univ. of Wisconsin	548	177	72	76	50	85
Univ. of Illinois	972	260	75	153	52	85
Illinois Inst. Tech.	392	109	13	16	31	18
Northwestern Univ.	172	47	27	55	12	59
St. Louis Univ.	107	27	29	32	13	33
Washington Univ. (St. Louis)	196	51	2	22	11	36
Univ. of Missouri	557	71	16	32	23	39
Univ. of Nebraska	166	59	22	28	9	12
Purdue Univ.	1234	313	44	112	36	82
Univ. of Minnesota	446	99	65	60	26	207
Univ. of Kansas	232	39	25	54	13	41
Univ. of Chicago	-	-	43	41	66	51

DEGREES (BS, MS, PhD) CONFERRED 1961-1962
UNDER SPECIFIC CATEGORIES

	ALL ENGINEERING	EE	MATHEMATICS	CHEMISTRY	PHYSICS	PSYCHOLOGY
State Univ. of Iowa	214	45	72	38	21	73
Iowa State Univ.	508	127	80	79	21	25
Univ. of Wisconsin	661	196	140	106	89	136
Univ. of Illinois	1120	357	192	151	100	119
Illinois Inst. Tech.	450	155	39	21	34	10
Northwestern Univ.	254	63	41	57	12	51
St. Louis Univ.	145	61	35	54	22	59
Washington Univ. (St. Louis)	243	75	34	34	12	55
Univ. of Missouri	868	58	73	53	48	48
Univ. of Nebraska	226	72	41	26	13	16
Purdue Univ.	1071	388	163	90	62	86
Univ. of Minnesota	493	136	123	80	78	177
Univ. of Kansas	299	74	79	52	18	47
Univ. of Chicago	-	-	61	54	80	47

section 2

Job shop, fabrication, and special test facilities in Midwest area

An Electronics Research Center such as proposed by NASA undoubtedly will have an appropriate measure of "in-house" capability for fabrication and special testing to support research and engineering activities. The research and engineering facility of Collins Radio Company in nearby Cedar Rapids is similar in size and activity to the proposed NASA Electronics Center. Despite a large complement of machinery and test facilities, Collins finds it necessary to procure the services of specialized facilities outside its own plants.

Collins through the years has established a continuing relationship with the major sources in this area for specialized assistance. The company's experience with the sources, with respect to quality of work and quick delivery time, has been excellent.

This section provides information pertinent to the capability of this area to serve the fabrication and special testing needs of the NASA center.

Number of major fabrication job shop sources in the area

CATEGORY	CHICAGO	LOCAL	MINN. / ST. PAUL	ST. LOUIS
Air-wound coils	2		1	
Cams and cam assemblies	6		2	
Castings, machined	6		9	1
Castings, raw	3		6	
Chemically etched and milled parts	1		1	
Close tolerance ground parts	3		2	
Cold headed parts	2			
Complex machined parts	10		10	1
Detents assembly and detent wheels	4			
Differentials	2		2	
Gear and gear assemblies	10		2	
General machine parts	15		10	1
Heat exchangers	2			
Impact extrusions	1			
Jigs and fixtures	14	6	1	2
Mycalex parts - fabricated	2			
Outside services	10		6	
Precious metal contacts	2			
Printed circuits	2		3	1
Screw machine parts	15		10	1
Sheet metal parts, stamping, assemblies, weldments	17		8	2
Sintered metal parts	2			
Sprockets and splines	4		1	
Tools and dies	14	6	1	2

Record of Competence

Familiarity with stringent specifications of electronic equipment, developed from years of serving the industry.

Experienced in meeting government specifications.

Quick Reaction Time

Delivery examples:

Machine sand-castings delivered in 4 to 6 weeks.
Custom gear configurations delivered in 1 to 2 weeks.
Sheet metal work delivered in 1 week to 10 days.

Maximum delivery time on categories listed on previous page: 4 months.
Overnight part delivery courier service.

Special test facilities, major sources

COOK RESEARCH LABORATORIES; A DIVISION OF COOK ELECTRIC COMPANY, MORTON GROVE, ILLINOIS

Radar and Communications Section

Radar, microwave, space and secure communications, electronic warfare techniques and systems, advanced communications techniques and/or equipments, system instrumentation, and related surveillance and test equipment. Simulation of radar, communications, and ECM systems and signal environments, and man-made electromagnetic interference investigations.

Reconnaissance Section

Operations research, experimentation, and development of special equipment in reconnaissance, surveillance, target hunting, BW/CW warfare, and geophysics.

Instrumentation Section

Design, development, and fabrication of data acquisition and analysis systems; systems are utilized for evaluating weapons systems or commercial manufacturing systems. Capability includes choice of sensing instrumentation, packaging of instrumentation, and field operation. Experience in aerospace probes, acoustics, test aircraft instrumentation, nuclear radiation measurements, submarine, and underwater equipment.

Controls and Mechanisms Section

Analysis and experiment in control techniques and processes; research studies, design, and development of automatic control systems and devices. Applications include - air traffic control systems, navigational stabilization systems, and analog and digital data processing and computing systems.

Aerospace Technology Section

Space probes, sounding rockets, satellite recovery and landing systems, missile recovery systems, subsonic, transonic, supersonic, and hypersonic decelerator development, ground and airborne test vehicle design, development, and fabrication, missile warhead development, and wind tunnel testing.

Aerospace Mission Support Section

Designs and develops methods for communication with the remote control of atmospheric and space vehicles in flight, provides means for performing global rescue and retrieval, and provides ground support services such as launch facilities, range systems, data acquisition and processing, and graphic electronic display systems.

Telecommunications Section

Communications, tracking, and navigation systems, beacons, direction finders, spectrum serveillance, land line and earth communications, solid state amplifiers, antennas; research in reliability, intelligence, and propagation and natural interference effects.

Research Section

Fundamental studies and experimentation in the fields of: sonar, oceanography, digital logic, data recording and handling, cryptography, and bionics. Development of advanced techniques in the fields of: signal processing, target classification, microminiaturization and microlectronics, magnetic recording, and instrumentation.

INLAND TESTING LABORATORIES; A DIVISION OF COOK ELECTRIC COMPANY, MORTON GROVE, ILLINOIS

Qualification and Environmental Testing

Performed on products, components - mechanical, electrical, electronic, hydraulic, pneumatic and on materials - metals, papers, lubricants, paints. Tests include high and low temperature, humidity, altitude, sand and dust, salt spray, fungus, weatherometer, vibration, shock, and acceleration, as well as functional and materials testing. Extensive experience with military specifications, particularly MIL-E-5272, MIL-E-4970, MIL-T-5422. ASESA approval has been granted Inland Testing Laboratories facilities for performance of military qualification testing.

Reliability Testing and Engineering

Set up reliability testing program, perform sampling, conduct tests, and evaluate test results on electronic components. Reliability programs include accelerated life tests to determine expected performance over long-range utilization.

Instrument Calibration, Modification, and Repair

Authorized repair and calibration center for Weston, Texas Instruments, John Fluke, and Hughes Products. Repair and calibration is performed on measuring instruments of all types: electronic, electrical, mechanical, pressure, and acceleration sensing. All calibrations are traceable to the National Bureau of Standards and a complete parts stock is maintained for the most frequently received models of instruments.

Field Services

Field maintenance programs for electronic equipment and communications systems. Field calibration of instruments and equipment. Witnessing product testing on location.

Consulting

Consulting in environmental, design, safety engineer, field testing, and system evaluation based on extensive experience in reliability and environmental testing. Projects involve investigation and recommendation on all types of electrical, electronic, and mechanical equipment. Test procedure preparation, specification writing (procurement, design, performance), state-of-the-art surveys, and second source determination.

Plastics and Chemical

Analysis and testing of materials and fluids such as: lubricants, papers, detergents, foods, clothing. Chemical laboratory includes high level gamma irradiation facility. Pioneer research and development in manufacturing methods for use of special plastics (glass-filled epoxy, Kel-F, teflon, polycarbonate) on complex shapes and structures.

Test Equipment Design

Based on experience in designing and constructing Inland Testing Laboratories equipment, we have designed and developed electronic component testing equipment, and hydraulic shock testing machine, and numerous other pieces of equipment that are adaptable to meet specialized testing requirements; military or civilian standards can be met.

Physical Testing Facilities

Complete physical testing facilities are available for metals, wood, plastics, rubber, and paper. The Laboratories' capabilities include tension and compression testing, flexure testing, abrasion testing, surface finish determinations, microscopic and micrographic evaluations, tear and burst testing.

Testing is performed in accordance with Tappi Standards and ASTM Procedures as well as government specifications.

Radio Interference and Noise Testing

Instrumentation covers the frequency range of 14 kc to 1000 mc for radio interference and noise testing. Signal generating equipment is available for evaluation of filters.

Screen rooms meet the requirements of MIL-E-4957A over the range of 150 kc to 1000 mc and are equipped with filtered power sources.

Field intensity measurements can be made at customer's location where desired.

Fungus Testing

The Inland Testing Laboratories division of Cook Electric Company is equipped with a laboratory capable of running tests involving the resistance of various materials to both fungus and bacterial growth. In addition, work is being done involving control and identification of micro-organisms as well as studies involving the possibilities of gamma radiation as a sterilization medium.

The Laboratory equipment consists of refrigerators to properly maintain biological material, chambers capable of controlling both temperature and relative humidity to constant values, sterilization boxes employing ultraviolet light, autoclaves, and a gamma radiation source.

Petroleum Testing Facilities

The testing of petroleum products according to Federal and ASTM specifications is carried out in a completely equipped modern laboratory. Special facilities for the determination of Load Carrying Ability, Bearing Endurance, High Temperature Performance, Deposition Number, Thermal Stability of Fuels, Panel Coking, Coefficient of Friction, Gear Wear, etc., are available. The chemical laboratory that supports the mechanical evaluation laboratory is capable of performing any services called for quickly and efficiently.

Chemical Testing Facilities

A completely equipped chemical laboratory is available for analysis of paints, metals, adhesives, and plastics. The laboratory staff has access to a wide variety of equipment ranging from microscopes to visible ultraviolet and infrared spectrophotometers, spectrographs, polarographs, etc.

Wind Tunnel

One of the country's most versatile wind tunnels is now in operation at the Cook Technological Center. This tunnel is readily convertible from subsonic to supersonic velocities.

Some approximate characteristics of the wind tunnel are:

1. Supersonic Tunnel
   a. Mach Number Range: 1.25 - 2.90
   b. Test Section Size: 2 ft x 2 ft
   c. Total Pressure Available: Ambient
2. Subsonic Tunnel
   a. Velocity Range: 0 - 600 ft/sec
   b. Test Section Sizes Available: 2 ft x 2 ft, 4 ft x 4 ft, 1-1/2 ft x 1-1/2 ft, 1/2 ft x 2 ft
3. Icing Tunnel
   a. Velocity Range: 0 - 600 ft/sec
   b. Test section has a maximum size of 2 ft x 2 ft but can be modified to suit individual requirements

c. Temperature Range: Temperatures found in natural cloud formation ($-20^{o}F$ at 20 lbs/sec air flow) may be simulated to the test section. Lower temperatures may also be obtained at reduced mass flow rates.

A large air pre-conditioning chamber and refrigerator system has been installed when ambient air is present to remove moisture and reduce temperature for icing and supersonic tests. The refrigeration system is capable of dissipating 6,000,000 BTU per hour.

High Level Gamma Irradiation Facility

The Cook Electric Company high level gamma irradiation facility is operated for research and testing purposes. The 50,000 curie, Cobalt 60 source, believed to be the largest in the world, provides fluxes up to 10^{6} R/hr for research and testing purposes.

The dry cave in which irradiations are performed is a cube 16 ft x 11 ft x 16 ft. The source is raised into the cave from a 22-foot-deep well to a level in the cell of 4 feet above the floor.

Inland Expands Fluid Dynamics to Include High Temperature Testing

The Fluid Dynamics facility is capable of testing hydraulic, pneumatic, and fuel components and systems. In addition to operational tests in the fluid dynamics field, many component specification tests are undertaken on such items as servo valves, pressure switches, actuators, reducers, and flexible ducts.

High capacity equipment permits hydraulic testing at flow rates to 75 gallons per minute, temperatures from $-65^{o}F$ to $+450^{o}F$, and pressures up to 6000 pounds per square inch.

Contaminated Fuel Testing

Inland Testing Laboratories has designed, developed and built a contaminated fuel test system. Its purpose is to provide a means of accurately controlling the amount of homogeneously suspended contaminant by restricting it to one pass through the system, while at the same time circulating the test fluid continuously and recontaminating without interrupting the test.

Stress Analysis and Evaluation

The Cook Technological Center offers the following in its stress analysis services: engineering, consulting, testing, and evaluation. The complete test facilities, the necessary associated instrumentation, and experienced engineers and technicians provide a capability for complete analysis of small or large; static, dynamic, or transient strains; at low or high temperature, on stationary or rotating members.

Environmental Facilities of Inland Testing Laboratories

A. Vibration

1. M. B. Manufacturing Co. Inc. Exciter - C - 25H - S/N 381 Power Supply P-25 HC S/N 350 Control Console T-25HMP S/N 321	Frequency Range: 5-2000 cps Force Output: 3500 pounds Maximum Acceleration: 45.5 g's (Peak) Maximum Total Amplitude: 0.25" 15 to 60cps 0.5" (5 to 15cps)
2. M. B. Manufacturing Co. Inc. Exciter - C 5H S/N 343 Power Supply and Control Console Model - T51D S/N 112	Frequency Range: 5-2000 cps Force Output: 620 pounds Maximum Acceleration: 27.5 g's Maximum Total Amplitude: 1"
3. All American Tool & Mfg. Co. 10 HA S/N 8431	Frequency Range: 10-60 cps Maximum Acceleration: 37 g's Maximum Total Amplitude: 0.2" Maximum Load: 10 pounds
4. M. B. Manufacturing Co. Exciter - C-5B S/N 219 Power Supply same as number 2 above	Frequency: 5-500 cps Force Output: 650 pounds Maximum Acceleration: 56.5 g's Maximum Amplitude: 1"
5. LAB Corporation RVH 30-300 S/N 386048	Frequency: 10-100 cps Cycling 10-60 cps Continuous Maximum Acceleration: 20 g's Maximum Total Amplitude: 0.125"
6. All American Tool & Mfg. Co.	Frequency Range: 10-60 cps Maximum Acceleration: 10 g's Maximum Total Amplitude: 0.25"
7. M. B. Manufacturing Co. Exciter Model C10-VB S/N 105 Power Supply Model T-666 S/N 209 Control Console Model T68-B S/N 106	Frequency Range: 5 to 5,000 cps Force Output: 1750 pounds Maximum Acceleration: 58 g's (no weight) Maximum Total Amplitude: 1 inch

8. M. B. Manufacturing Co.

Console T-51-MC S/N 343
Exciter C-10E S/N 296

Frequency Range: 5 to 3,000 cps
Force Output: 1200
Maximum Acceleration: 68.8 g's
Maximum Total Amplitude: 1 inch

B. Altitude Chambers

1. Inland Testing Laboratories

A-1019, S/N 117

Usable Dimensions: 8" diam. x 13" high
Altitude Range: Sea level to 100,000 feet

2. Inland Testing Laboratories

A-1020, S/N 118

Usable Dimensions: 14" diam. x 12" H.
Altitude Range: Sea level to 100,000 feet

C. Stratospheric Chambers

1. Inland Testing Laboratories

HAL-1003, S/N 101

Usable Dimensions: 5' diameter, 6' deep
Usable Altitude Range: Sea level to 150,000 feet
Temperature Range: -85°F to +266°F

2. Inland Testing Laboratories

HAL-1003, S/N 130, 131, 132 (Qty-3)

Usable Dimensions: 6' H. x 6' W. x 4' D.
Altitude Range: Sea level to 200,000 feet
Temperature Range: -150° to 300°F

D. Tropospheric Chambers

1. Kold-Hold

200-11-90, S/N C60

Usable Dimensions: 30" H. x 30" W. x 30"D
Temperature Range: -67°F to +200°F
Altitude Range: Sea level to 80,000 feet

E. Torarctic Chambers

1. Bowser

S-8-85, S/N 1367

Usable Dimensions: 24" H. x 24" W. x 23"D
Temperature Range: -65°F to +185°F

2. Inland Testing Laboratories

HL-1008, S/N 103

Usable Dimensions: 29" H. x 20" W. x 22"D
Temperature Range: -85°F to 212°F, ±4.0°F

3. Inland Testing Laboratories

HL-1004, S/N 104

Usable Dimensions: 33" L. x 17"W. x 19"D
Temperature Range: -100°F to +300°F, ±2°F

4. American Instrument Company
   4-3352, S/N A-7035
   Usable Dimensions: 2' H. x 2' W. x 2'D.
   Temperature Range: -99°F to $+350^{\circ}$F, $\pm 4^{\circ}$F

5. Inland Testing Laboratories
   HL-1026, S/N 122
   Usable Dimensions: 7' H. x 7' W. x 7'L
   Temperature Range: -100°F to $+200^{\circ}$F, $\pm 2^{\circ}$F

6. Inland Testing Laboratories
   HL-1005, S/N 106
   Usable Dimensions: 22" H. x 20"W. x 30"D
   Temperature Range: -85°F to $+212^{\circ}$F, $\pm 0.5^{\circ}$F

7. Inland Testing Laboratories
   HL-1006, S/N 107
   Usable Dimensions: 18"H. x 18"W. x 92"D.
   Temperature Range: -85°F to 212°F, $\pm 4.0^{\circ}$F

8. Inland Testing Laboratories
   HL-1011, S/N 105
   Usable Dimensions: 42" H. x 42" W. x 95"L.
   Temperature Range: -100°F to $+1000^{\circ}$F, $\pm 5^{\circ}$F

9. American Coil Company
   M50TC 1.A S/N 1081
   Usable Dimensions: 18" H. x 18" W. x 27" L
   Temperature Range: -67°F to $+257^{\circ}$F

10. Inland Testing Laboratories
   HL-1031, S/N 128
   Usable Dimensions: 11" W. x 12"L. x 17" Deep
   Temperature Range: -67°F to 300°F $\pm 4^{\circ}$F

F. Troparctic Chamber

1. Inland Testing Laboratories
   HH1-1002, S/N 109
   Usable Dimensions: 57"H. x 50"W. x 95"D.
   Temperature Range: -70°F to $+180^{\circ}$F
   Humidity Range: 5% to 100% RH from 34°F

2. American Coil Company (rebuilt)
   HHL-1012, S/N 108
   Usable Dimensions: 24"H. x 24"W. x 24"D
   Temperature Range: -60°F to $+180^{\circ}$F
   Humidity Range: 5% to 100% RH from 34°F

3. Inland Testing Laboratories
   HHL-1013, S/N LTI, LT 2 (Qty 2)
   Usable Dimensions: 5' H. x 4' W. x 4' D.
   Temperature Range: -76°F to $+266^{\circ}$F

4. Inland Testing Laboratories
   HHL-1015, S/N RCI, RC 2, RC 3, RC 4, (Qty 4)
   Usable Dimensions: 5' H. x 4' W. x 4' D.
   Temperature Range: 0 - 130°C
   Humidity Range: 20% to 95% RH from 34°F

G. Arctic Chamber

1. Murphy and Miller

   LT-1-90, S/N 178

   Usable Dimensions: 12" L. x 12"W. x 15"D.
   Temperature Range: Room temperature to -100°F

2. Motor Products (Inland Converted)

   Cascade 120

   Usable Dimensions: 24" diam., 30" deep
   Temperature Range: Room temperature to -100°F, ±10°F

H. Tropic Chamber

1. American Instrument Company

   4-5501, S/N P-8408

   Usable Dimensions: 24"H. x 31" W. x 20"D
   Temperature Range: +40°F to +160°F
   Humidity Range: 10% to 99% relative humidity

2. Murphy and Miller

   H-2, S/N 180

   Usable Dimensions: 11"H. x 11"W. x 12" D
   Temperature Range: +35°F to +150°F
   Humidity Range: 5% to 95%

3. Haskris (Inland Converted)

   HH-1001, S/N 110

   Usable Dimensions: 44"H. x 31"W. x 27"D
   Temperature Range: Room Temperature to 200°F, ±4°F
   Humidity Range: Room ambient to 100% RH

4. Murphy-Miller

   F-2, S/N 179

   Usable Dimensions: 18"H. x 12"W. x 12"D
   Temperature Range: Room temperature to 150°F
   Humidity Range: 5% to 95% RH

5. Inland Testing Laboratories

   HH-1014, S/N 111

   Usable Dimensions: 52"H. x 32"W. x 28"D
   Temperature Range: Room temperature to 212°F, ± 2°F
   Humidity Range: Ambient to 95% RH

6. Tenney Engr. Company

   TH-275, S/N 1707

   Usable Dimensions: 36"H. x 31"W. x 36"D
   Temperature Range: +35°F to +185°F, ±°F
   Temperature Range: +68°F to +180°F, ±2°F
   Humidity Range: 20% to 100% RH

I. Torrid Chambers

1. Inland Testing Laboratories

   H-1010, S/N 113

   Usable Dimensions: 22"H. x 31"W. x 39"D
   Temperature Range: Room temperature to 250°F, ± 2°F

2.	Inland Testing Laboratories H-1009, S/N 114 & 115 (Qty-2)	Usable Dimensions: 12"H. x 12"W. x 12"D. Temperature Range: Room temperature to 300°F, ± 2°F
3.	Hupperts MTF, S/N KH-17	Usable Dimensions: 20"H. x 18"W. x 18"D Temperature Range: Room temperature to +500°F, ± 4°F
4.	Blue "M" Electric CW20M, S/N 134	Usable Dimensions: 20" H. x 18" W. x 20"D Temperature Range: Room temperature to 550°F, ± 1.5°F.
5.	Despatch Oven CF-18, S/N 44269	Usable Dimensions: 18"H. x 18"W. x 18"D Usable Range: +100°F to +850°F
6.	Inland Testing Laboratories H-1017, S/N 1, 2, 3, 4, 5, 6 (Qty-6)	Usable Dimensions: 18"H. x 18"W. x 24"D Temperature Range: Room temperature to 225°F, ± 1°F
7.	Inland Testing Laboratories H-1022, S/N HT 1 & HT 2 (Qty-2)	Usable Dimensions: 5'H. x 4'W. x 4'D. Temperature Range: +33°F to +266°F
8.	Inland Testing Laboratories H-1023, S/N WC-1, WC-2, WC-3, WC-4, WC-5, WC-6 (Qty 6)	Usable Dimensions: 5' H. x 4'W. x 4'D. Temperature Range: +60°F to +266°F ± 2°F
9.	Blue M AHH-16, S/N 656	Usable Dimensions: 12"H. x 14"W. x 13"D. Temperature Range: +120°F to +1000°F
10.	Blue M OV-18SC, S/N RN499	Usable Dimensions: 14"H. x 19"W. x 18"D Temperature Range: Room temperature to +550°F ± 20°F
11.	J. F. Schuller H-1032, S/N 129	Usable Dimensions: 8.5"H. X 20"W. x 14"L. Temperature Range: Room ambient to 284°F Controlled ±4°F

12. Blue M. Electric Co.

OV-500 S/N 2413, 2414, 2415, 2416, 2417, 2419 (Qty-6)

Usable Dimensions: 14-7/8"W. x 18-7/8"D. x 15"H.
Temperature Range: 38^{o} to $260^{o}C$

J. Weatherometer and Sunshine

1. National Carbon Co., Inc.

X1A S/N 3524

Usable Dimensions: 6"W. x 5"D. x 12"L
Conditions: Sunshine and rain. Accelerated as per specification MIL-P-6906

2. Inland Testing Laboratories

S-1025, S/N 121

Usable Dimensions: 2'L x 2'W x 4'H
Equipped with: 4 - 100 watt GE type BL-4 Mercury Lamps; 4 - 150 watt GE type R-40 Flood Lamps

K. Salt Spray and Rain

1. Industrial Filter & Pump Company

CAHS-S/N S-2791

Temperature Range: Room ambient to $\pm$ $140^{o}F$
Humidity Range: Room conditions to 98%

2. Industrial Filter U Pump Company

CAH-1, S/N S-1645

Usable Dimensions: 48"L x 26"W x 36"D
Temperature Range: Room ambient to $+140^{o}F$
Humidity Range: Room conditions to 98%

3. Industrial Filter & Pump Company

B, S/N 3176

Usable Dimensions: 25"L x 13"W x 27"D
Equipped To: Simulate rain test as specified in MIL-E-5272A

L. Sand and Dust Chambers

1. Inland Testing Laboratories

S-1024, S/N 120

Usable Dimensions: 48"H x 48"W x 48"D
Temperature Range: $60^{o}F$ to $+ 212^{o}F$, $\pm 3^{o}F$
Humidity Range: From dew point temperature of below $-60^{o}F$ to ambient
Sand velocity variable from 100 to 3000 FPM, Density 0 to 1 gr/cu ft.

M. Shock and Impact Machines

1. Inland Testing Laboratories

SI-1027, S/N 123

Basic Type: Sand Pit Drop

Shock Durations: Variable From 6.5 to 32 milliseconds
Maximum Shock Accelerations: 77 g's at 6.5 millisecond, to 32 g at 32 milliseconds
Maximum Table Load: 400 pounds

2. Inland Testing Laboratories

SI-1028 S/N 124

Basic Type: Spring and Anvil Drop

Shock Durations: From 2.2 to 15 milliseconds
Maximum Accelerations: 500 g's at 2.2 milliseconds

3. Inland Testing Laboratories

SI-1029 S/N 125

Basic Type: Hydraulic Pendulum

N. Explosion Chambers

1. Inland Testing Laboratories

E10 30 S/N 126

Usable Dimensions: 21" Diameter 24" deep
Altitude: Sea Level to 50,000 ft

2. Inland Testing Laboratories

E 1031 S/N 127

Usable Dimensions: 12"H x 12"W x 12"D
Altitude: Sea Level to 50,000 Ft
Air Velocity: 0-700 ft/min
Temperature: -65°F to 250°F

3. Bowser (Converted by Inland Testing Laboratories)

S-8-85, S/N 1367

Usable Dimensions: 36" Dia. x 45" Length
Altitude: Sea Level to 50,000 feet
Temperature Range: Room Temperature to 71°C

O. Accelerators and Centrifuges

1. Genisco

D-50078 S/N 8

Table Dimensions: 10" x 10"
Radius of Swing: 22" to Center of Table
Accelerations: 0-100 g's
Maximum Force Rating: 1200 pounds max. with 8" cube 25 pounds

2. International

Size 1 Type SB

Usable Dimension: Two cups; 1 1/2" diam. 6" Long; 2 1/8 diam. 4 3/8 Long
Radius of Swing: 7 inches
Acceleration: 300 to 5100 g's

3. Chicago Surgical and Elec. Co.

No. 4035

Usable Dimension: 4 tubes 1-1/2 diam.
6" Long
Acceleration: 10,000 - g
Radius of Swing: 8.5 inches free Swing

Environmental Facilities

Environ Electronic Laboratories, Inc., presently has located in their plant the following facilities, all of which are owned by the company. The plant is a new building containing 14,500 square feet of space.

VIBRATION

Sine Frequency Force (M B Electronics equipment consisting of: Model T665 Power Amplifier, Model C50 Vibration Exciter, Model T68MC Control Panel)	5 to 3500 cps, 5000 g lbs.
Random (M B Electronics equipment consisting of: Model T88 Complex Wave Compensation Console, Model C50 Vibration Exciter, Model T68MC Control Panel using peak notch and multi-filter equalization networks)	4000 g lbs. rms force. 12000 g lbs. peak force.

ALTITUDE

Model A-1 Chamber, 6' dia. x 6' length	Altitudes in excess of 300,000 ft. Temperatures -100°F to +400°F.
Model A-2 Chamber, 6' dia. x 12' length	Altitudes in excess of 300,000 ft. Temperatures -100°F to +400°F.
Model A-4 Chamber, 18" x 18" x 22"	Altitudes in excess of 100,000 ft. Temperatures -85°F to +250°F.
Model E-1 Chamber, 4' dia. x 4' length	Altitudes in excess of 300,000 ft. High temperature to +400°F.

HIGH VACUUM

Model A-3 Chamber, 18" dia. x 30" high	Capable of $1x10^{-8}$mm Hg. Temperatures from -100°F to +300°F. Lower temperatures may be achieved with cryogenic cooling. Higher radiant temperatures per specification.

HIGH AND LOW TEMPERATURE

Model T1-1 Chamber, 18" dia. x 22" deep	Temperatures -100°F to +600°F.
Model T1-2 Chamber, 18" dia. x 22" deep	Temperatures -100°F to +600°F.
Model T1-3 Chamber, 20" dia. x 22" deep	Temperatures -100°F to +600°F.
Model T1-4 Chamber, 28" dia. x 34" deep	Temperatures -100°F to +600°F.
Model T2-1 Chamber, 36" x 36" x 76"	Temperatures -100°F to +300°F.
Model H-1 Chamber, 30" dia. x 34" deep	Temperatures -100°F to +250°F.
Model H-2 Chamber, 30" dia. x 64" deep	Temperatures -100°F to +250°F.
Model H-3 Chamber, 8' x 8' x 8' walk in	Temperatures -100°F to +250°F.

NOTE: Bake ovens to temperatures as high as 2,100°F are available.

SAND AND DUST

Model D-1 Chamber, 18" x 18" x 36" high working area	Dust mixtures and temperatures per requirements.

HUMIDITY

Model H-1 Chamber, 30" dia. x 34" deep	RH 15% - 100%, temperatures to +250°F
Model H-2 Chamber, 30" dia. x 64" deep	RH 15% - 100%, temperatures to +250°F
Model H-3 Chamber, 8' x 8' x 8' Walk in	RH 15% - 100%, temperatures to +250°F
Model H-4 Chamber, 42" dia. x 36" deep	RH 95% - 100%, temperatures to +200°F

SALT SPRAY/FOG

Model SS-2-16 Chamber, 30" x 30" x 33" Associated Engineering, manufacturer.	Any desired salt solution.

FUNGUS

Model F-1 Chamber, 42" dia. x 36" deep	Any desired spores.
Model F-2 Chamber, 42" dia. x 72" deep	Any desired spores.

SHOCK

Model SM-005 AVCO, manufacturer.	30 lbs. maximum to 100 g's Half-sine, sawtooth pattern to 11 m.sec. Short duration to 1500 g's.
Model S-1, mounting surface 3' x 3'	600 lbs. capacity to 100 g's

EXPLOSION

Model E-1 Chamber, 4' dia. x 4' deep	Any desired mixture.

RADIO NOISE

Model N-1, solid shielded enclosure, 8' x 16' floor area, walk in.	14 KC to 1000 MC with Empire equipment.

RAIN

Model R-1, working area 5.5' x 5.5'	Any desired requirements.

CENTRIFUGE

Model C-1	5000 lbs. force capacity at 250 lbs. or 100 g's.

NOTE: Combinations or extremes of the environments listed are generally possible. Our environmental engineers should be contacted for specific applications.

All chambers listed are ENVIRON LABORATORIES' design and manufacture unless otherwise identified with manufacturer's name.

ENVIRON ELECTRONIC LABORATORIES, INC.

INSTRUMENTATION LIST

Make	Model	Type	Range	Accuracy
STANDARDS				
Eppley	101G3	Saturated Standard Cells Group		
Sensitive Res. (Tinsley)	4363D	Precision Potentiometer d.c. w/Galvanometer	1.5 µV-1.091010V	.0015%
Physics Res. (Otto Wolff)	S442	Volt Box	1.5-1500V	.01%
Physics Res. (Otto Wolff)	MT71	Kelvin Bridge	10^{-6}-1,111,110 Ω	.01%
General Radio		Type 500 Resistor	1 Ω-100K Ω	.02%
Fluke	540A	a.c./d.c. Thermal Transfer Standard	.5-1000V	.02-.03%
Hewlett-Packard	K02-738AR	Frequency Response Test Set	0-300V d.c. 0-300V a.c. 400 cps 3V-10 meg.	.1% .25%
Fluke	803	Precision d.c./a.c. Differential Voltmeter	0-500V d.c. 0-500V a.c.	.05% .2%
Fluke	351A	Constant Current Supply, d.c.	1 µ amp-100M amp.	.05%
Fluke	407	Calibrated Power Supply	0-555V	.5%
Rubicon	2745	Precision Potentiometer	0-80.5mv	.01-.05 mv
SeKo		Precision Balance & Weights	1 Mg-200gr	1 Mg
General Radio	1001-A	RF Signal Generator	5 KC-50 Meg	1%
General Radio	1021-P2	RF Signal Generator	40-250 Meg	1%
General Radio	1021-P3	RF Signal Generator	250-920 Meg	1%
Empire	IG-115	Impulse Generator		1 db
Tektronix	180-A	Time-Mark Generator	Sine wave 50 Meg 10 Meg and 5 Meg Marker Pulse 1 micro-sec-.5 sec.	Stability 3 PP/M in 24 hours.
Endevco	2213	Accelerometer		

Make	Model	Type	Range	Accuracy
GENERAL PRECISION MEASURING EQUIPMENT & LABORATORY APPARATUS				
Honeywell	153X89	Multipoint Recorder	-100 to +250°F	.25%
Honeywell	152C15	Temperature Recorder Controller	-100 to +500°F	.25%
Honeywell	152C15	Temperature Recorder Controller	-100 to +250°F	.25%
Honeywell	152C15	Temperature Recorder Controller	0 to +250°F	.25%
Honeywell	152C15	Temperature Recorder Controller	200 to 600°F	.25%
Honeywell	R7087B	Temperature Controller	-100 to +600°F	1%
Honeywell	R7087B	Temperature Controller	-155 to +315°F	1%
Honeywell	702C	Recorder Controller, Altitude	0-80,000 ft.	1% span
Honeywell	702C	Recorder Controller, Altitude	4,700-130,000 ft.	1% span
Sanborn	296	2 Channel Recorder, d.c.		
Sanborn	350-1300	d.c. Preamplifier	0-500V d.c.	(1% cal. (.25% linear
Honeywell	1508	Visicorder Oscillograph w/Model 4550 Dynamics Amplifiers	24 channels gain 0.1 - 1000	
Steelman	18765	Portable Tape Recorder		
Hewlett-Packard	412A	d.c. Vacuum Tube Voltmeter	0-1000V d.c.	1%
Hewlett-Packard	400H	a.c. Vacuum Tube Voltmeter	0-300V a.c.	1%
Simpson	260	Multimeter	0-3000 a.c. or d.c.	3% d.c. 5% a.c.
Triplett	630	Multimeter	0-6000 a.c. or d.c.	3% d.c. 4% a.c.
Westinghouse		Voltmeter	0-350V d.c.	
Westinghouse		Voltmeter	0-150V a.c.	
Weston		Voltmeter	0-50V a.c.	
Physics Res. (Goerz)	324265/1000	a.c. Ammeter	0-1.2 amp. 0-6 amp.	.5%
Weston	432	Wattmeter	5 amp 150/300V	.5%

Make	Model	Type	Range	Accuracy
GENERAL PRECISION MEASURING EQUIPMENT & LABORATORY APPARATUS (continued)				
Weston	461	Current Transformer	5 current	.75%
General Radio	1650A	Impedance Bridge	1 mΩ-10 MegΩ 1 mh - 1000 H 1 Pfd-1000 μfd	±1% ±1% ±1%
General Radio	544BA	Megohm Bridge	.1 meg Ω-1,000,000 meg Ω	±3% ±4%
Hewlett-Packard	522B	Electronic Counter	0-100 KC	±1 count
General Radio	1531A	Strobotac	to 250,000 rpm	1%
Rubicon	2736	Temperature Potentiometer	-100 to +600°F	.2%
TektroniX	545A	Dual Beam Scope	d.c. - 30 Meg	sweep 3%
TektroniX	C-A	Plug-in Preamplifier	d.c. - 24 Meg	3%
Hewlett-Packard	122A	Dual Trace Oscilloscope	d.c. - 200 KC	Sweeps & voltage ±5%
Hewlett-Packard	196A	Oscilloscope Camera	lens opening 16 to 1.9	
Krohn-Hite	330M	Variable Filter	.2-20,000 cps	5%
Consolidated	GTC100	Thermocouple Vacuum Gage	0-1000 micron	
Consolidated	GTC110	Ionization Vacuum Gage	10^{-4} to 10^{-8} micron	
Electro-Products	3030HTB	High Temperature Magnetic Pickup		
Cornell-Dubilier	CDB-5	Decade Capacitor	.01 - 1.1 Mfd	5%
Cornell-Dubilier	CDC-5	Decade Capacitor	1 - 10 Mfd	5%
Eico	1171	Resistance Decade Box	0 - 99,999 Ω	.5%
Power Instr.	783	In/Oz Torquemeter	1.2 - 25 in/oz.	1%
Chatillon		Push/Pull Gage	0 - 500 gms 0 - 16 oz.	
Eico	666	Tube Checker		
Seco	GCT9	Grid Circuit Tester		
		Battery Charger	6-10 V	
		Battery Cart		
Superior	116	Variac	7.5 amp	

Make	Model	Type	Range	Accuracy
POWER SOURCE				
Kato Engrg.	4VP05	350/450 cps Generator	50-300V	±1V
		Vibration Amplifier & Accelerometers		
Environ		60 cps Power Supply	110V Variable 110V & 220V 30 amp	
MECHANICAL & OPTICAL MEASURING EQUIPMENT				
Eberbach	41-536	Manometer	0-260 mm Hg	.1mm Hg
Starrett	255	Heighth Gage		
Hellige	45-960	Comparator		
Howe	H03310	Scale	0-100 lbs.	
	78-732	Stop Watch	1/5 sec. - 30 min.	
Lufkin	H32X	.0001 Dial Test Indicator	.032	
Meriam Inst.	A203	Manometer	16 inch	
Meriam Inst.	A203	Manometer	70 inch	
EQUIPMENT TO PUBLISH REPORTS & PROCEDURES				
Multilith	80	Offset Duplicator		

NOTE: Instruments are listed by type rather than quantity. The quantity of each type of instrument varies with its utilization.

ILLINOIS INSTITUTE OF TECHNOLOGY, RESEARCH INSTITUTE (CHICAGO, ILLINOIS)

Research Policies

Illinois Institute of Technology Research Institute is an independent contract research organization which engages in research, development, and experimental engineering for sponsors in government and industry. Its facilities and staff are available on a contractual basis. The scope of its work encompasses virtually all of the physical sciences and related technologies.

Research Personnel

Full-time staff of 1,650

Research Expenditures

During fiscal year 1961-62: $20,400,000

Sources of Research Support

Government and industry. During fiscal year 1961-62: $20,400,000

Primary Areas of Research:

A. Chemistry (Staff: 209)

The Chemistry Research Division conducts research in the fields of chemical engineering, solid state chemistry, physical chemistry, organic chemistry, polymer chemistry, propellants, technical information surveillance, and weapon development. Some areas in which recent experience has been gained are:

- in Chemical Engineering

  Cryogenic engineering
  Electronic computer applications
  Vacuum technology

- in Life Sciences

  Aerobiology
  Animal behavior
  Biochemistry
  Bioinstrumentation
  Space biology
  Stress physiology
  Toxicity

- in Fine Particles

  Aerosols
  Instrumentation
  Particle physics
  Weather control studies

- in Organic Chemistry

  Analytical spectroscopy
  Chromatography
  Electro-organic chemistry, organic semiconductors
  Metal organics, ziegler-type catalysts, metal hydrides
  Optically active compounds

- in Physical Chemistry

  Chemiluminescent reactions
  Emission spectrography
  High temperature chemistry
  Infrared applications
  Instrumentation
  Ion exchange
  Thin-film phenomena

- in Polymers

  Castable resins
  Coatings
  Extreme temperature applications
  Polymer kinetics
  Processing studies
  Stability studies

- in Propellants

  Combination of solid propellant systems
  Cryogenic engineering
  Exotic liquid propellants
  Solid propellant ballistic evaluation

B. Electronics (Staff: 317)

The Electronics Research Division has initiated analytical and hardware studies in bionics, microelectronics, millimeter waves, power conversion, auomata, simulation, VLF communications, solid state microwave components, computer elements, advanced recording techniques, and medical electronics. Specific areas of recent experience are:

- in Communications and Radar

  Radar system analysis
  Radar system design & development
  Analysis of communications systems
  Telemetering and digital communications
  Design & development of electronic missile guidance equipments

- in Computer Systems

  Analysis and application studies
  Logic system development
  Coding and decoding system development
  Optical computer elements and systems
  Pattern & character recognizers
  Artificial sensory and threshold nets

- in Microwaves, Antennas and Propagation

  Microwave components
  Microwave measurement techniques
  Electromagnetic theory

- in Reliability and Components

  Failure mechanisms
  Methodology
  Materials evaluation

- in Electronic Compatibility

  System compatibility analysis
  Interference control techniques
  Radio frequency instrumentation
  Low frequency field measurements
  Weather radar and satellites
  Electro-oceanography

- in Data Recording, Instrumentation and Control

  Magnetic recording
  High density and wideband techniques
  Instrumentation
    Chemical
    Meteorological
    Instrumentation & telemetry systems
    Automated inspection
  IR guidance
  Adaptive control servomechanisms
  Nonlinear analytical methods

Computer Sciences

The burgeoning field of computer science has provided many new opportunities for both practical and theoretical research. The Computer Science Division has recent experience in the following typical areas:

- Numerical analysis and approximations
- Simulation of complex systems
- Information system studies
- Mathematical linguistics
- Hybrid analog-digital simulation
- Development and use of control languages
- Linear and nonlinear programing

C. Mechanics (Staff: 200)

The Mechanics Research Division, one of the technical divisions of the IIT Research Institute, is engaged in contract research serving both industry and government agencies. In attitude and activity, the Mechanics Research Division is a problem-solving center comprising analytical, design and experimental disciplines.

The division conducts research projects from soil mechanics and oceanography to space systems and planetary studies, embracing all the classical and modern aspects of solid and fluid mechanics. The following list describes research activities in solid mechanics, systems and mechanisms, experimental mechanics, and fluid and gas dynamics, and itemizes typical projects undertaken.

- in Experimental Stress Analysis

  - Photoviscoelasticity
  - Photothermoelasticity
  - Residual and thermal stress determinations
  - Stress concentrations

- in Mechanics of Materials

  - Environmental effects on mechanical behavior
  - Hyperthermal and cryogenic studies
  - Response of materials to polyaxial loading
  - Brittle behavior

- in Materials Engineering

  - Applications of materials for extreme environment service
  - Vacuum effects on applications of materials
  - Development of evaluation procedures
  - Experimental evaluation of structures and construction techniques

- in Space Systems and Biomechanics

  - Stabilization and deceleration devices
  - Environment simulators
  - Man-machine systems
  - Cash protection and safety devices

- in Ballistics

  - Interior, exterior and terminal ballistics
  - Propulsion systems
  - Hypervelocity altitude range and impact studies
  - Explosive forming

- in Solid Mechanics-Dynamics

  - Impact studies, stress wave propagation in solids
  - Rigid body dynamics, astrodynamics
  - Sinusoidal and random vibration analysis
  - Design synthesis techniques
  - Aeroelasticity

- in Soil Mechanics

  Extraterrestrial soil mechanics
  High pressure soil mechanics
  Mechanics of granular materials
  Stress wave propagation
  Rock mechanics

- in Explosion Mechanics and Rheology

  Jet dynamics, shock flow, flow instability
  Wave propagation in compressible media, shocks in nonlinear materials
  Equation of state studies; thermomechanics; shock rheology
  Impact theory and target response
  Behavior of materials under explosive loading

- in Hydrodynamics

  Fluid rupture, mechanics of droplets, bubble dynamics
  Meteorology, turbulent diffusion, jet streams and stratified fluids.
  Climatology, cloud behavior, clear air turbulence.
  Applied gas dynamics; flutter and vortex shedding; boundary layer control; re-entry studies

- in Structures

  Prefabricated, precast, and prestressed structure
  Ultimate load analysis and design
  Tensile and compressive instability
  Structural analysis of vehicles

- in Fluid Systems and Heat Power

  Wakes and eddies, jet flow problems vortex shedding, aerodynamic noise, oscillating shocks, turbulence, supersonic flow, fluid mixing.
  Hydrodynamic lubrication, solid film lubricants
  Advanced power systems
  Ultra-high vacuum and simulated space environment studies.

D. Physics (Staff: 168)

The Physics Research Division is active over the entire spectrum of modern and classical physics. It has recently developed new fiber optical inspection devices, examined high-powered magnetostrictive acoustical generators, designed a non-cryogenic infrared detector, and investigated the gaseous plasmas of interplanetary space. Some of the recent areas explored by the Division are the following:

- in Acoustics

  Ultrasonics
  Acoustical properties of materials
  Nonlinear operation of transducers
  Propagation of sound in various media
  Vibration analysis

- in Heat and Mass Transfer

  Aerodynamics and selected ground effect machines
  Thermal instrumentation
  Heat transfer devices
  Applications of nuclear, thermoelectric and other power generation methods

- in Chemical Physics

  Radiation effects
  Molecular beams
  Electron impact phenomena
  Nuclear systematics
  Effect of recoil atoms

- in Nuclear and Radiation Physics

  Neutron physics and diffraction
  Cosmic rays
  Gamma ray and X-ray spectroscopy
  Biophysics
  Solar physics
  Shielding physics
  Reactor space power
  Lattice measurements

- in Plasma and Electron Physics

  Basic processes in gaseous discharges
  Atmospheric reactions
  Hydromagnetics
  Ion and plasma propulsion

- in Solid State Physics

  Basic research in semiconductor materials
  Microwave resonance and spectroscopy
  Semiconductor device physics
  Radiation effects in solids
  Energy conversion (thermoelectric and solar)

- in Physics of Fluids

  Viscosity and dynamic rigidity
  Cryogenics and superfluids
  Planetary atmospheres and meteorology
  Vibrational relaxation
  Molecular bond cleavage

- in Optics

  Physical optics
  Atmospheric optics
  Thin-film optics and interference filters
  Image structure and information theory
  Infrared systems and optical engineering
  Fiber optics
  Astronomical optics
  Photometry and spectrophotometry

- in Space Physics

  Solar physics
  Aeronomy
  Upper atmosphere physics
  Astronomy

E. Metals and Ceramics

Some present programs of the Metals and Ceramics Research Division cover graphite and refractory ceramics; protective metals coatings; high-strength steels; development of lead, copper, titanium, zirconium, and vanadium alloys; structural composites; and metalworking processes. Representative areas of research include:

- in Physical Metallurgy

  Fundamentals of deformation and fracture
  Surface energy and surface phenomena
  Wear and friction of metals
  Thermionic energy converter materials
  Brittle fracture
  Diffusion

- in Alloy Development

  Titanium
  Refractory metals
  Beryllium
  Vanadium

- in Ferrous Metallurgy

  Alloy development
  High alloy and tool steels
  Mechanical failure of metals

- in Reactor Materials

  Zirconium technology
  Irradiation effects

- in Powder and Fiber Metallurgy

  Powder metallurgy
  High temperature materials
  Metal-ceramic interactions
  Fiber reinforced composites
  Fiber metallurgy

- in Electrochemistry

  Electrodeposition
  Batteries
  Electroforming

- in Coating Technology

  Plasma and flame spraying
  Control of thermal properties
  Oxidation protection

- in Ceramic Technology

  Electrical ceramics
  Glass
  Super refractories
  Nozzle materials

- in Welding Research

  Joining applications
  Welding process research
  Resistance welding

- in Metallurgical Processes

  Arc melting
  Vacuum melting
  Metallography
  Creep studies

- in Foundry Work

  Sand control and formulation
  Precision molding methods
  Solidification phenomena

- in Construction Materials

  Aggregates
  Static and dynamic measurements
  RT-5000°F

- in Inorganic Technology

  Carbon and graphite
  Crystallography
  Phase diagrams
  High temperature coatings

section 3

Computation facilities in the area

Data Processing Facilities

Immediate vicinity of Iowa City and Cedar Rapids.

Hardware

Large scale - 7074/7040 class - 7
Medium scale - 1410/1401 class - 35

Distributed between

Large Computer Centers at SUI and Collins
Banks
Manufacturing establishments
Insurance Company installations

Business and Scientific Institutions in the area are extremely data processing oriented with a high level of sophistication in the use of the equipment for the following:

Heat transfer studies.

Propagation studies and analysis.

Circuit analysis.

General scientific purposes.

Control of manufacturing installations.

Budgetary control.

General business applications.

Personnel

Maintenance - more than 50 data processing maintenance engineers live and work in the area.

A large group of fully qualified scientific and business systems analysts, programers, and operators are resident and work in the area.

Training of personnel in the data processing field is extensive at all levels of education from high school through university levels.

Figure 3-1a and b. State University of Iowa Computer Facility, Including IBM 7040, Two IBM 1401 Units

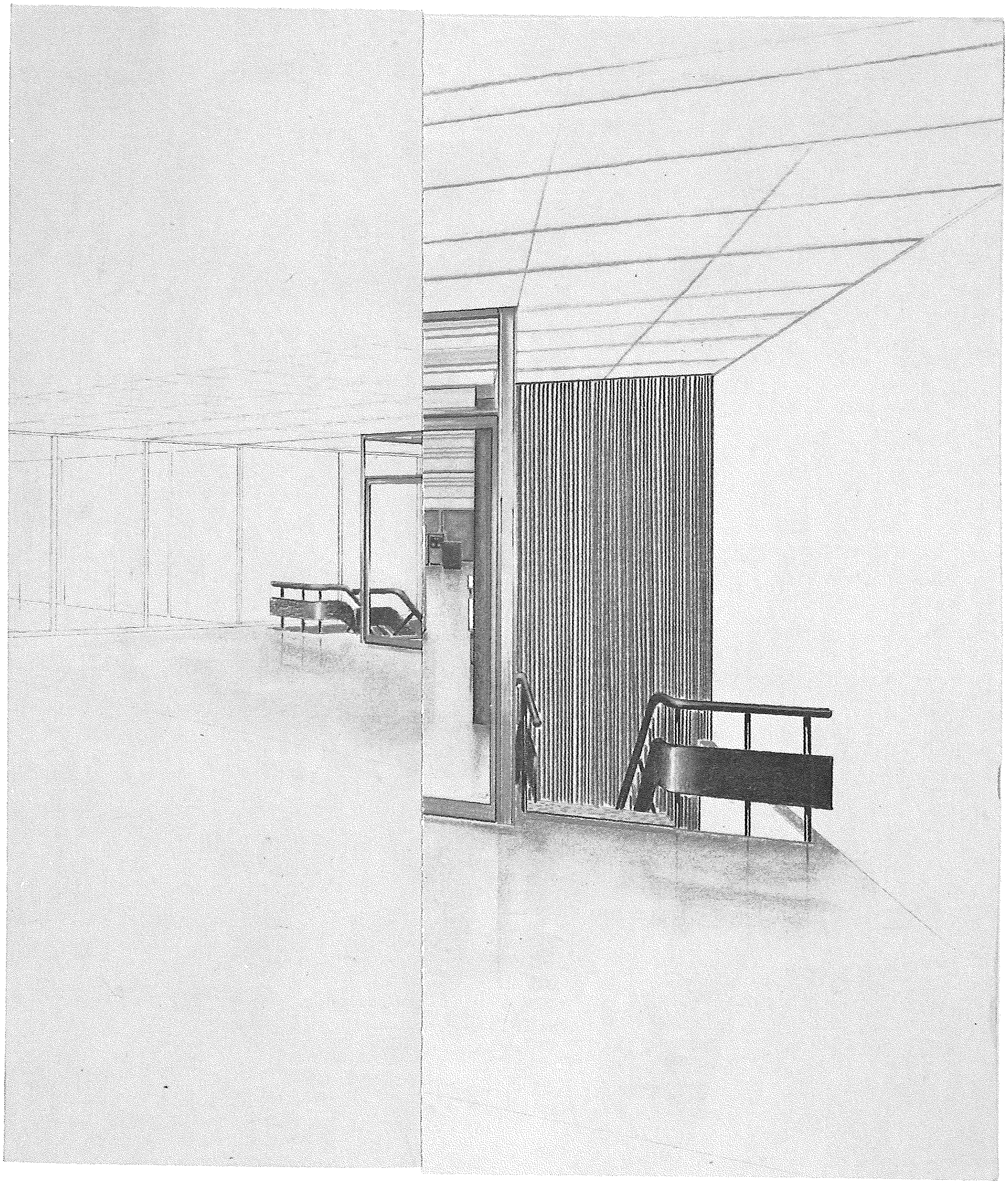


Figure 3-2. Collins CDS Division,
Computation Facility, Cedar Rapids

section **4**

Fabrication and special test facilities at Collins Radio Company which can be made available to NASA

In addition to job shop fabrication and special testing facilities available in the area, Collins Radio Company has substantial facilities of this nature in Cedar Rapids which the Collins management has assured also would be available to serve the needs of the NASA center.

Fabrication facilities

The management of Collins Radio Company has pointed out that due to the nature of its product lines the company fabrication facility is geared primarily to short-run, precision work, as opposed to mass production assembly techniques. The facility, therefore, is in reality a collection of many highly specialized job shops located under one roof.

The following is a topical outline of the facilities and capabilities available for NASA Electronics Research Center projects.

Related photographs follow the topical outline.

GENERAL

Size: Production 230,000 square feet
Model Shop 14,000 square feet

Manning: Production
Direct 862
Indirect 590

Model Shop
Direct 128
Indirect 6

FACILITIES

General Machine Shop Equipment and Capabilities

SAWING AND CUTOFF MACHINES

Operations - cutoff of rod and bar stock, sawing of thicker sheet stock
Tolerance Limits - ± .005" on rod or bar length, ± .002" on sheet size, 64 microinch finish
Types of Equipment: Hacksaw
Circular saws
Abrasive saws
Band saws
Hand mills

LATHES

Operations - Turning, Facing, Drilling, Reaming, Boring, Threading
Tolerance Limits - ± .0001" on diameter, ± .0005" on length, .0005" TIR concentricity, 8 microinch finish
Types of Equipment: Engine lathes
Ram type turret lathes
Tracer lathes
Single spindle automatic screw machines

GRINDERS

Operations - Finish grinding of flat and cylindrical parts, precision thread grinding of up to 6 start threads
Tolerance Limits - ± .0001" on diameter, ± .0005" on thickness, .0005" TIR concentricity, 6 microinch finish, class IV threads

Types of Equipment: External cylindrical grinders
Combination internal-external grinder
External centerless grinders
Disk grinders
Precision thread grinders

MILLING MACHINES

Operations - Milling, profiling, engraving, routing
Tolerance Limits - ± .0005" on width, 16 microinch finish
Types of Equipment: Hand mills
Horizontal knee type mills
Vertical knee type mills
Universal knee type mills
Rotary head mills
Horizontal bed type mills
Pantograph mills
Profiling mills
Engravers

BORING MACHINES

Operations - Precision boring and counterboring
Tolerance Limits - ± .0001" on diameter, ± .00025" on location, 8 microinch finish
Types of Equipment: Horizontal precision boring machines
Jig boring machines

DRILLING MACHINES

Operations - Drilling, Reaming, Countersinking, Counterboring, Tapping
Tolerance Limits - ± .00025" on diameter, ± .0005" on location, 16 microinch finish
Types of Equipment: Single spindle drill presses
Double spindle drill presses
Three spindle drill presses
Four spindle drill presses
Six spindle drill presses
Radial drill presses
Sensitive turret drill presses
Multiple air drill cluster
Layout machines

MISCELLANEOUS

Broaches

Operations - internal and surface broaching
Tolerance limits - ± .0001" on size, 8 microinch finish
Types of equipment - (2) vertical hydraulic broaches

Gear Hobbing Machines

Operations - generating spur or helical gears
Tolerance limits - .0007" total composite error, 16 microinch finish
Types of equipment - (3) gear hobbing machines.

Internal Honing Machine

Operations - Finishing round holes to close tolerances and smooth surface finishes
Tolerance limits - ± .0001" on diameter, 4 microinch finish
Type of equipment - (1) internal honing machine

Lapping Machines

Operations - improve surface quality by reducing roughness and waviness, extremely close tolerance finishing
Tolerance limits - ± .00005" on diameter or thickness, 0.2 microinch finish
Types of equipment: Flat surface lapping machine
Cylindrical lapping machine

Sheet metal department

The Sheet Metal Department plays an important role in the production of electronic gear as most of the components are either mounted, shielded, or protected in some manner by formed sheet metal. The fabrication is performed on a job shop basis with the order quantity varying from one to several hundred.

The variation in the type of work is equally as large. Parts are fabricated for small aircraft instruments as well as large installations such as the Voice of America.

A wide selection of materials both standard and special are carried in stock to assure short lead time. The fabrication equipment has been selected with this wide variation in mind in order to permit maximum flexibility with minimum set up time. A great deal of tooling suitable for many new jobs has been accumulated through years of this type of production.

In addition to the equipment shown on the following listing, many small hand and bench tools are available for the fabrication of small orders of intricate clips, connectors, and springs.

SHEARING EQUIPMENT

The shears, six in number, range in size from small bench machines capable of cutting foil material to a large shear capable of handling 10 feet of 1/4" steel.

SHEARING TOLERANCES

The larger shears are equipped with precision micrometer back gages. Tolerances of ± .016 are common and tolerances of ± .008 to ± .005 are held on small parts for special application.

TEMPLATE LAYOUT EQUIPMENT

Part of the layout is done manually as a bench operation. A precision layout machine is available for close tolerance work.

TEMPLATE LAYOUT TOLERANCES

Layout to fractional dimensions is performed manually. The layout machine is capable of holding ± .002 between centers for template pilot holes.

PUNCH PRESS EQUIPMENT (SEE FIGURE 4-1)

The punch presses numbering 33, vary in size from small bench machines to machines of 150 to 250 ton capacity. In addition to the conventional machines for handling die sets, we have several quick tool change and turret type machines that are especially made for short run production. A nibbling machine is available for special contour work.

PUNCH PRESS TOLERANCES

Tolerances of ± .005 to ± .002 are common for die set fabrication. Tolerances of ± .005 can be held on some of our short run machines. The normal center to center tolerance on the bulk of our work is ± .016.

BENDING BRAKE EQUIPMENT (SEE FIGURE 4-2)

Seventeen of these machines are available ranging in size from small bench finger brakes to power machines with 160 ton capacity capable of bending 10 feet of 1/4" steel. A large assortment of standard and special dies are in stock to handle various types and gages of metal.

BENDING BRAKE TOLERANCES

The average part is formed to a tolerance of ± .016. Special jobs are formed to ± .008 to ± .005.

DEBURRING EQUIPMENT

The department is well equipped with a variety of tools including air operated hand tools and belt sanding machines. However, most of the precision work is processed in barrel finishing machines of the rotary or vibratory type. Thirteen of these machines are available to handle machined parts as well as sheet metal stampings.

DEBURRING TOLERANCES

As most of the precision work is handled in barrel finishing equipment, close control and uniformity are assured because the human element is eliminated.

RESISTANCE SPOT WELDING EQUIPMENT

The equipment, consisting of seventeen machines, is capable of handling miniature or large assemblies. Aluminum alloys of .010 to .125 thickness can be welded to Military Specs. Assemblies of ferrous or corrosion resistant materials can be handled over the same thickness range. Facilities are provided for material cleaning and Quality Control in the area. Precision equipment is provided for machine maintenance control.

RESISTANCE SPOT WELDING TOLERANCES

The normal assembly tolerance is $\pm$ .016. Small assemblies can be located to $\pm$ .005 by special fixtures.

SOLDERING AND BRAZING EQUIPMENT

Equipment is available for torch, furnace, or induction soldering and brazing. Dip brazing facilities are available for aluminum alloys.

SOLDERING AND BRAZING TOLERANCES

Location of $\pm$ .005 can be held by means of self-locating designs or fixtures.

ARC WELDING EQUIPMENT

Six tungsten insert gas welders are used for joining ferrous and nonferrous materials where high quality welds are required. The operators are certified.

HEAT TREATING EQUIPMENT

Heat treating equipment is available for handling both production and tool work. Special fixtures are used where necessary to meet design requirements. Control samples are run with production orders to assure the proper physical characteristics.

Tool and die shop

The Tool and Die Shop employs about 70 skilled tool and grinder men. A wide assortment of precision equipment is available for building dies, jigs, and fixtures. Grinding machines handle new work and keep cutting tools in peak condition.

The work in the Tool and Die Shop is of a diversified nature because of the wide variety of fabrication equipment and processes. Plastic molding dies, plating, welding, and heat treat fixtures are only a few of the many specialized tools made here. Tooling of both a permanent and semi-permanent nature are fabricated, the latter being more prevalent because of the normal limited order quantity.

Plating department

Number of employees - 27
Area - 9500 square feet
Number of tanks - 150 (various sizes)
Other equipment:

Blakslee indirect gas dryer
Despatch AJH 5 oven

Types of plating - tin, cadmium, nickel, copper, silver, gold, rhodium (see figure 4-3)
Other processes (see figure 4-4):

Sulphuric acid and chromic acid anodizing
Black oxide finish for stainless steel
Aluminum etching for weight reduction

Ventilation - The ventilation system is unique in that two 60-horsepower motors force 75000 cubic feet of air per minute through tiny holes in the ceiling and is later exhausted through a 14-foot-deep pit below the tanks. Also, a push-pull air flow system is used on appropriate tanks to draw off objectionable fumes through the same under-floor facility.

Painting

Number of employees - 60
Area - 21,500 square feet
Equipment:

Six water-fall type spray booths
Two dry type spray booths
One dust proof room for spraying lacquer
Two-stage overhead oven equipped with approximately 1000 feet of conveyor for curing paint.

Types of paint used - enamel, lacquer, vinyl, epoxy
Silk screening work also done in paint shop:

Equipped to make both direct process or indirect (film type) screens
Use both silk and stainless steel mesh

Printed circuits

Number of employees - 22
Area - 4000 square feet
Equipment includes following:

Edlund numerically controlled drill press (see figure 4-5)

Machine has four heads with four spindles per head. Each head can drill holes in stack of boards four high.

Tapes may be programed in office or from artwork mounted on machine.

Two Centre Circuits etching machines (see figure 4-6)

One horizontal Model 502 and one vertical Mark II.
Each machine capable of handling several different etchants.
Parts may be etched on either side or on both sides at once.

Two Millington fluorescent printers (see figure 4-7)

Printers have self-contained vacuum frames.
Parts may be exposed on one or both sides at once.

Conveyorized trichloroethylene vapor developer
Four screen presses to permit making circuits using the screen process when desired.

The chemical machining of brass, copper, and aluminum parts also carried on in this department.

Model shop

Number of employees in the shop - 128
Area - 14000 square feet
Equipment (see figure 4-8)

The model shop is a well-equipped sheet metal and machine shop consisting of approximately 160 general purpose type machine tools suitable for use with low production quantities on a wide variety of parts. These machines include horizontal, vertical, and rotary head mills, engine lathes of various sizes, cylindrical and centerless grinders, single spindle drill presses, engravers, Wales and Wiedemann punch presses, OBI punch presses, shears, press brakes, spotwelders, and tanks for cleaning, passivating and chromate dipping. At the present time one numerically controlled Pratt & Whitney drill press is used for parts which would otherwise require manual layout. Tentative plans for the near future call for the purchase of two more numerically controlled machine tools - a Wales Strippet punch press and a Pratt & Whitney boring and milling machine.

Plastics

Type of work done

Hand and semi-automatic compression and transfer molding of thermosetting resins, such as epoxy, phenolic, melamine, silicone, and diallyl phthalate resins.

Molding of high pressure, glass-cloth reinforced laminates

Epoxy resin
Polyester resin
Silicone resin

Semi-automatic and automatic injection molding of thermoplastic resins, such as Lexan, polypropylene, Delrin, nylon, polystyrene, and acrylic resins.
Form-in-place fabrication, rigid and flexible
Potting and casting of various resins, mostly epoxy
Encapsulating
Hand fiber glass layups and laminations
Adhesive bonding
Vinyl dip coating
Teflon spray coating
Spray application of solid film lubricant
Vacuum impregnation

Castings, polyester resin
Porous bronze bearings

Vacuum forming of thermoplastic sheets

Equipment

Molding presses

Semi-automatic compression and transfer molding presses

Tonnage to 300 tons
Mold size capacity to 30" x 36"

Semi-automatic or automatic injection molding press, 9" x 12" mold capacity

Tablet (preform) machine and dielectric preheaters
Vacuum forming press, 30" x 30" sheet capacity
Foam dispenser for flexible and rigid plastic foam materials
Vacuum impregnation facilities (see figure 4-9)

Autoclave, 29 3/4" dia. x 41" deep
Resin tank
Solvent tank
Vapor blast machine

Electric and gas-fired ovens with individual temperature controls
Bench and curing facilities for potting, casting, foaming, encapsulating, adhesive bonding, and dip and spray coating.

Fabrication quality control

In-process inspection

Machine shop
Sheet metal fabrication and assembly
Mechanical assembly
Finishing, plastics, and printed circuit fabrication
Model fabrication

Receiving inspection

Purchased mechanical parts
Raw materials

General purpose inspection equipment

Inspection tools, such as micrometers, depth gages, plug gages, etc.
Specialized inspection equipment, such as hardness testers, tensile testers, surface roughness gages, thread lead checker, composite-type gear checker, optical projecters, etc.

Special purpose inspection equipment

110 KVA X-ray unit

Capacity .020 - 2 inches thick, 11 1/8 x 21 7/8 inches overall dimensions.
Shows defects .032 inch and larger
Fluoroscopic accessory, or permanent film used
Darkroom facilities

Helium mass spectrometer (see figure 4-10)

Checking leak rates of hermetic-sealed instrument cases and similar parts
Minimum leak rate sensitivity .000024 micron cu. ft. per hr.

Water tank leak-test equipment

Pressure testing of cases, panel castings, and similar parts
Automatic air-pressure cycling equipment available

Sheffield-Ferranti Coordinate Measuring Machines (see figure 4-11)

Measures X and Y coordinates within .00025 inch by means of sensing probe and transistorized counting circuit; measures Z coordinates within .001 inch
Coordinates displayed on readout tubes
Automatic coordinate printout attachment
Optical viewing attachment for soft, very thin, or irregularly shaped parts.

Abawerk Coordinate Measuring Machine

Linear measurements to .000025 inch; angular measurements to 2 minutes
Utilizes electronic pick-up head
Isolated foundation to minimize external vibrations

Betascope Backscatter Thickness Gage (see figure 4-12)

Utilizes beta radiation source to measure the thickness of various electroplated coatings

Formal gage control system in operation
Formal MRB (Material Review Board) system in operation

Numerical controlled machine tools

Numerical controlled machine tools prove ideal for short run, precision jobs. Tape control eliminates need for expensive and delaying dies and tooling, shortens lead time significantly, and minimizes operator error.

Collins has fourteen numerical controlled machine tools in operation in its Fabrication Division. Programs are prepared from drawings and transferred to standard 1-inch paper tape to suit each machine's control system.
Numerical controlled machines installed and in operation are as follows:

Number of Machines	Description	Tool Capacity	Table Size	Type of Control System
4	6 spindle, 2 axis, turret type drilling machine; drilling, reaming, tapping, counter-sinking, counter-boring, and spotfacing (see figure 4-13)	3/4"	15" x 26"	Absolute
4	6 spindle, 2 axis, turret type drilling machine; drilling, reaming, tapping, countersinking, counterboring and spotfacing.	1/2"	10" x 18"	Incremental
2	8 spindle, 3 axis, turret type; all drilling operations boring and point-to-point milling. (see figure 4-14)	1-1/2"	30" x 45"	Incremental
1	Jig borer; precision boring, ± .0001 inch hole location and ± .001 hole depth	.875 max. hole dia.	11" x 24" (11" x 18" part size)	Full floating zero on machine table
1	4 head, 4 spindle per head drilling machine; drilling operations on printed circuit boards.	1/4"	14" x 20"	Absolute
2	15 ton, 30 position turret type punch press; piercing and notching of sheet metal parts (see figure 4-15)	3-1/2" dia in .074 matl.; 1-3/16"dia. in .187 matl.	30" x 72"	Absolute

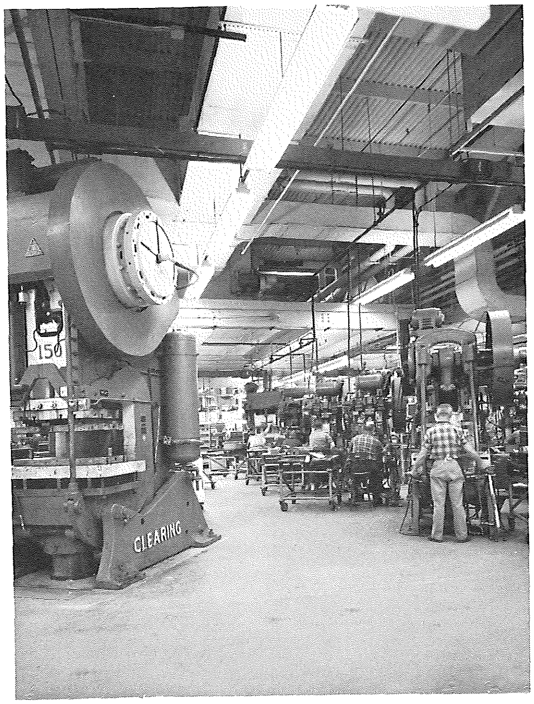
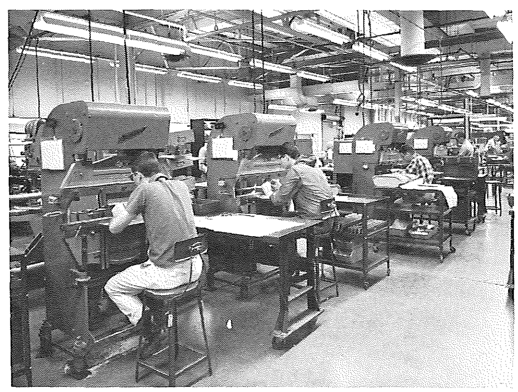


Figure 4-1. Representative Punch Press Equipment

Figure 4-2. Representative Bending Brake Equipment



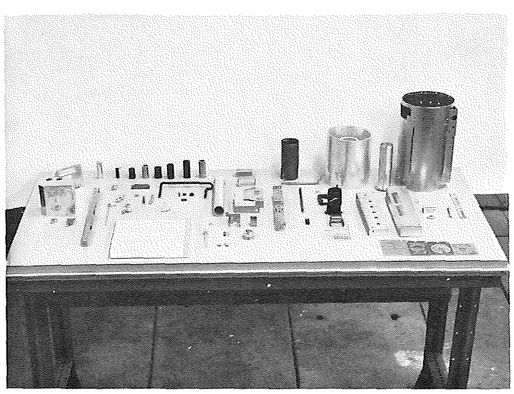


Figure 4-3. Typical Plating Jobs

Figure 4-4. Plating Area

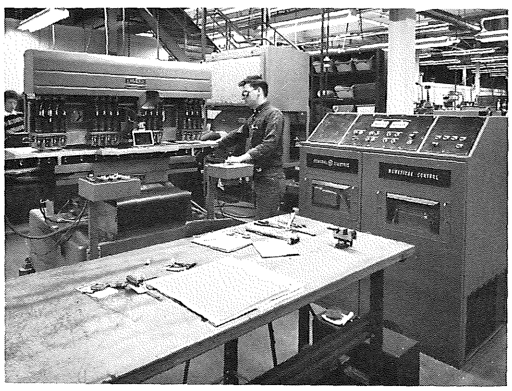


Figure 4-5. Edland Numerically Controlled Drill Press

Figure 4-6. Two Centre Circuit Etching Machines

Figure 4-7. Two Millington Fluorescent Printers

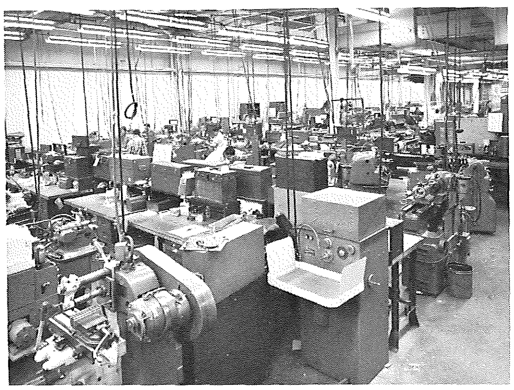
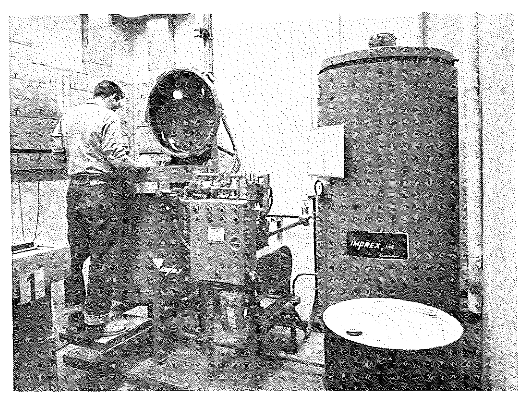


Figure 4-8. Model Shop

Figure 4-9. Vacuum Impregnation Facility for Plastics Work



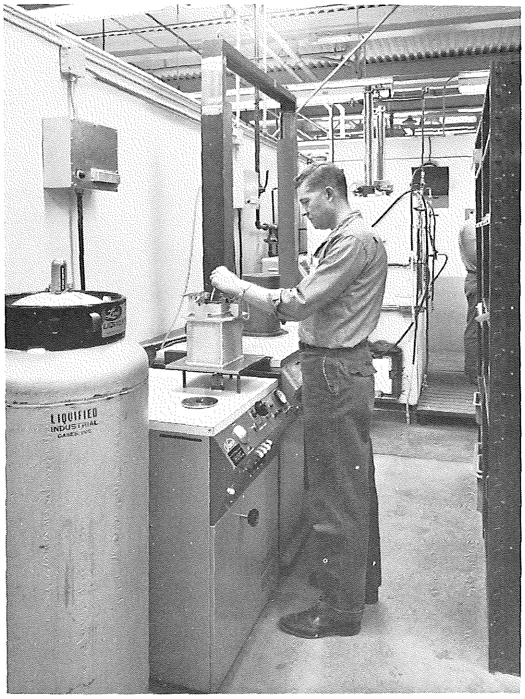


Figure 4-10. Helium Mass Spectrometer

Figure 4-11. Sheffield-Ferranti Coordinate Measuring Machines

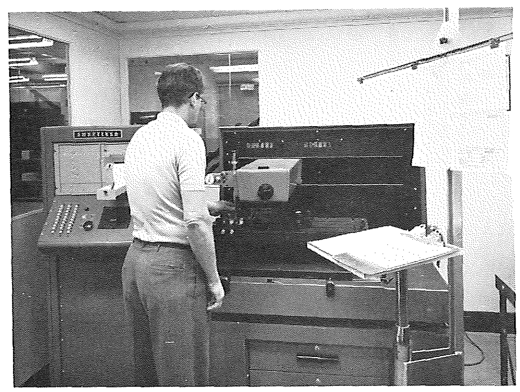


Figure 4-12. Betascope Backscatter Thickness Gauge

Figure 4-13. Six-Spindle Numerical Controlled Drilling Machine

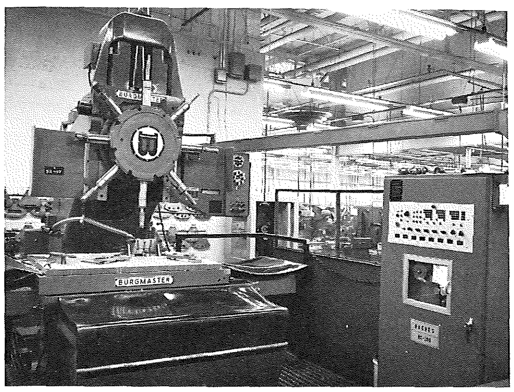


Figure 4-14. Eight-Spindle Numerical Controlled Drilling Machine

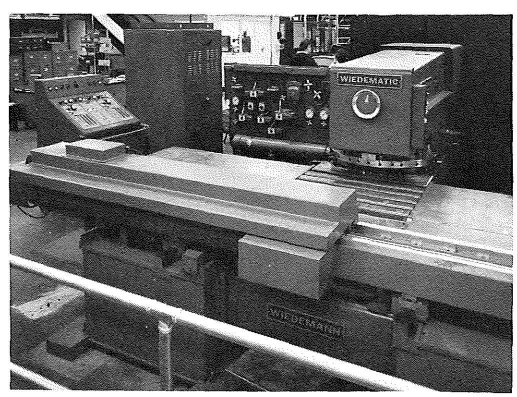


Figure 4-15. Turret Type Punch Press, Numerical Controlled

Environmental test center

The Environmental Test Center is available for component evaluation and R and D Engineering tests.

Tests simulating the environments, per specification, are made on components, subassemblies, modules, subunits, and completed items or systems to ensure high quality and reliability.

A complete environmental test program can be scheduled comprising acceleration, acoustical noise, altitude, explosion, high temperature, humidity, inclination, immersion, low temperature, pressure, radio interference, rain, salt spray, shock, spin, vacuum, vibration (sine wave and random noise), and combined environments.

Required calibrations of all measuring and recording instruments used with the environmental facilities are made on a scheduled basis to ensure accurate test results. The environmental test laboratories cover 14,580 square feet and the life and bench testing facilities cover 1,450 square feet.

The following tables list the equipment and capabilities of the test center.

Related photographs follow the tables.

ENVIRONMENTAL EQUIPMENT CAPABILITIES

I. CHAMBERS FOR TEMPERATURE/HUMIDITY/ALTITUDE/SALT SPRAY/RAIN/EXPLOSION

Unit No.	Manufacturer and Model No.	Chamber Size (Ft)			Size (Cu Ft)	Temperature Range in Degrees Fahrenheit	Altitude or Relative Humidity	Access Ports No. & Dia	Special Features
		H	W	D					
1 TH	Bowser 27	3	3	3	27	+32° to +200°	20% to 95%+ relative humidity	2 @ 5-1/2 in. 2 @ 4 in.	Program: Recorder-Controller
2 TH	Murphy and Miller H-36	3	3	4	36	+32° to +200°	20% to 98% relative humidity	3 @ 3 in.	Program to 48 hr: Recorder-Controller
3 TH	Conrad FD-32-3-3	3.2	3.3	3	32	-100° to +300° +35° to +185°	20% to 95%+ relative humidity	2 @ 8 in. in door 2 @ 4 in. 2 @ 3 in.	Program: Recorder-Controller
4 T	Conrad	3	3	3	27	-65° to +200°		2 @ 3 in.	
5 TH	Bowser HR-30	3	3	3	27	+32° to +200°	20% to 95% relative humidity	1 @ 5 in. 1 @ 3 in.	Program up to 144 hr: Recorder-Controller
6 TH	Bowser HR-30	3	3	3	27	+32° to +200°	20% to 98% relative humidity		Program: Recorder-Controller
7 TH	Conrad FD-80-3	4	5	4	80	+32° to +300° +35° to +185°	20% to 95%+	2 @ 6 in. in door. 2 @ 4 in.	Program: Recorder-Controller
8 TH	Murphy and Miller H-27	3	3	3	27	+32° to +200°	20% to 95%+ relative humidity	3 @ 3 in.	Program to 48 hr: Recorder-Controller
9 TH	Murphy and Miller H-27	3	3	3	27	+32° to +200°	20% to 95%+ relative humidity	1 @ 6 in. 2 @ 3/4 in.	Program-recorder-controller 100 volts d-c available
10 T	Conrad	3	3	3	27	-65° to +200°		2 @ 3 in.	
11 TA	Conrad FH-27-5-5 Kinney vacuum pump for bleed air cooling	3	3	3	27	-100° to +250° -100° to room ambient	to 50,000 ft to 125,000 ft up to 70,000 ft	2 @ 4 in. 2 @ 3 in.	Program-recorder-controller Recorder for altitude Up to 60 pounds per hour
12 TA	Conrad FH-80-705-705	4	5	4	80	-100° to +300° -100° to room ambient	to 50,000 ft to 120,000 ft	2 @ 4 in. 1 @ 3 in. 2 manipulator	Program-recorder-controller Recorder for altitude Extra vacuum pump
13 TA	Murphy and Miller LTA-27-120	3	3	3	27	-100° to +200° -100° to room ambient	to 50,000 ft to 100,000 ft	4 @ 3 in.	Program-recorder-controller Recorder for altitude

I. CHAMBERS FOR TEMPERATURE/HUMIDITY/ALTITUDE/SALT SPRAY/RAIN/EXPLOSION (Cont)

Unit No.	Manufacturer and Model No.	Chamber Size (Ft)			Size (Cu Ft)	Temperature Range in Degrees Fahrenheit	Altitude or Relative Humidity	Access Ports No. & Dia	Special Features
		H	W	D					
14 THR	Conrad WD-960-25-25	10	8	12	960	-100° to +300° 32° to 200°	20% to 98% relative humidity or rain	4 @ 4 in. 2 @ 6 in.	Program-recorder-controller Manipulator or hand entry. 2 access doors, 16 in. h x 20 in. w, 2.3 ft x 6.5 ft man door
15 TA	Conrad FH-36-5-5	3	3	4	36	-100° to +500° -100° to room ambient	to 50,000 ft to 150,000 ft	4 @ 2-3/4 in.	Program-recorder-controller Dual range altitude recorder
16 TA	Conrad FH10-3-3	2.2	2.2	2.1	10	-100° to +300° -100° to room ambient	to 50,000 ft to 100,000 ft	3 @ 4 in. 1 @ 3 in.	Program-recorder-controller Recorder for altitude
17 T	Conrad FB-36-5-5	3	4	3	36	-100° to +300°		2 @ 6 in. 2 @ 4 in. 1 @ 3 in.	Recorder-Controller
18 T	Conrad FB-36-5-5	3	4	3	36	-100° to +300°		2 @ 8 in. in door 2 @ 4 in. 1 @ 3 in.	Program: Recorder-Controller
19	Industrial Filter and Pump CA1	3	4	2.2	26		Salt Spray		Meets MIL-STD-5272 and MIL-STD-202 Method 101A requirements
20 TA	Collins TA27	3	3	3	27	-100° to +300° -100° to room ambient	to 50,000 ft to 80,000 ft	5 @ 4 in.	Program-recorder-controller Recorder for altitude
21 T	Guardite UTA-3-C100A	1.5	1.5	1.3	3	-100° to +425°		1 @ 6 in. 2 @ 3 in.	Portable
22 T	Guardite UTA-3-C100A	1.5	1.5	1.4	3	-100° to +425°		1 @ 6 in.	Portable
E	Tenny Engineering 3D4	3 ft dia x 4 ft			28	up to 160°	to 80,000 ft		Explosion Chamber: Pressure to 25 psia

Distilled water is used exclusively in all humidity chambers and salt spray chamber.

II. HIGH VACUUM

MANUFACTURER	TEST CHAMBER DIMENSIONS	VACUUM
NRC Equipment	18 in. dia x 30 in. high	5 x 10^{-6} mm Hg

III. SHOCK

Room 2

Unit No.	Manufacturer and Model No.	Pulse Shape*	Load Limit	Shock Time, Milliseconds	Shock Range	Max Terminal Velocity
1	AVCO SM-030-1	Half sine Saw tooth Square	1000 lb 3 ft x 4 ft x 8 ft	1.5 to 50 msec	6 g to 500 g	180 inches per second
3	Barry Corp 150-400VD		400 lb	6.5, 11,24 & 32 msec	15 g to 60 g approximately	

*Oscilloscope trigger switch for monitoring shock pulse developed at impact.

IV. VIBRATION MACHINES, ELECTRONIC — Rooms 1 and 3

Unit No.	Manufacturer and Model No.	Force Delivered (lb)	Frequency Range (cps)	Waveform	Max g *	Max Double Amplitude
1	Ling 249 System	30,000	5 to 2000	sine wave random wave tape input	75	1 inch, vert/horiz
2	Ling 182 System	10,000	5 to 2000	sine wave random wave tape input	47	.5 inch, vert/horiz
3	Ling Console and MB C-25H, System	3,500	5 to 2000	sine wave	45	.5 inch, vert/horiz
4	Ling Console and MB C25HB System	5,000	5 to 2000	sine wave random wave	70	.5 inch, vert/horiz
5	MB C25H System (no servo control)	3,500	5 to 500	sine wave	38	.5 inch, vert/horiz
6	Ling 290 System	1,200	5 to 2000	sine wave	75	1 inch, vert/horiz

Horizontal slip tables for each vibration system.

Balancing equipment for determining center of gravity before vibration.

* g's depend on weight of jig, fixture, and test specimen.

TEMPERATURE BOXES FOR VIBRATION TABLES

Dimensions	Cu Ft	Temp Range	Access Port Diameter
1. 30 in. x 30 in. x 30 in. 2. 44 in. x 44 in. x 46 in.	15.6 52	-75° to +200°F	2 @ 3 in. & 2 @ 4 in.

V. VIBRATION MACHINES, MECHANICAL

Unit No.	Manufacturer and Model No.	Maximum Capacity	Frequency Range	Maximum* Double Amplitude	Maximum g*	Special Feature	Location
7	L. A. B. Corp 27	500 lb load	5 to 60 cps	Up to .39 in.	To 10 g		Room 2
8	L. A. B. Corp Bounce Tester		Up to 500 rpm approx	.5 in.			Room 2
9	All American 25 HAD	25 lb to 10 g	5 to 55 cps	Up to .125 in.	To 10 g		Room 3
10	All American 10 HA	10 lb to 10 g	5 to 55 cps	Up to .2 in.	To 10 g	Portable	Room 3

* Maximum g depends on displacement.

VI. ACCELERATION

Manufacturer and Model No.	Speed	g Range	Weight Limit Each Arm	Test Sample Size	Centrifugal Capacity	Radius	Slip Rings
Genisco, Inc. A 1030	0-355 rpm	.1 to 150 g	100 lb	18 in. x 18 in. x 18 in.	10,000 g lb	27-45 inches	32, shielded and unshielded

VII. INTERFERENCE

Unit No.	Manufacturer and Type	Size in Feet L W H	Attenuation (db)	Frequency Range
1	Shielding Div Solid Enclosure	20 x 10 x 8	100	150 kc to 10,000 mc
2	Shielding, Inc. Solid Enclosure	20 x 10 x 10	100	14 kc to 10,000 mc
3	Shielding, Inc. Solid Enclosure	20 x 10 x 8	100	14 kc to 10,000 mc
4	Lindgren	17 x 10 x 8	100	150 kc to 1,000 mc
5	Lindgren Screen Room	17 x 10 x 8	100	150 kc to 1,000 mc
6	Lindgren Solid Enclosure	18 x 9 1/2 x 7-1/2	120	150 kc to 10,000 mc

RECEIVERS FOR USE WITH RFI ROOMS

Manufacturer and Model No.	Quantity	Frequency Range
Empire Devices NF-105	5	150 kc to 1000 mc
Empire Devices NF-112	2	1000 mc to 15,000 mc

VIII. ACOUSTICAL NOISE

Unit	Manufacturer	Frequency Range	Max Noise	Volume
1	Collins	37 to 10,000 cps	130 db in 22 cu ft chamber	180 cu ft total
2	Ling Altec	37 to 9600 cps	140 db	30 in. x 30 in. x 30 in.

IX. IMMERSION, WATER

Tank capacity: 43-1/2 in. wide x 48 in. long x 56 in. deep: 67 cu ft

X. PRESSURE, INTERNAL

Regulated, in 1/4 lb increments, up to 80 psi

Automatic cycling up to 60 lb

Safety box 3 ft x 3 ft x 3 ft for pressures over 5 psi

12-1/2 in. x 8-1/2 in. plastic window; 4 in. x 4 in. vent in top

Special odd size fittings available only from Environmental Test personnel.

XI. INCLINATION MACHINE, MOTOR DRIVEN

Maximum load: approx 250 lb

Mounting area: 29 in. x 24 in.

Meets MIL-E-16400 requirements.

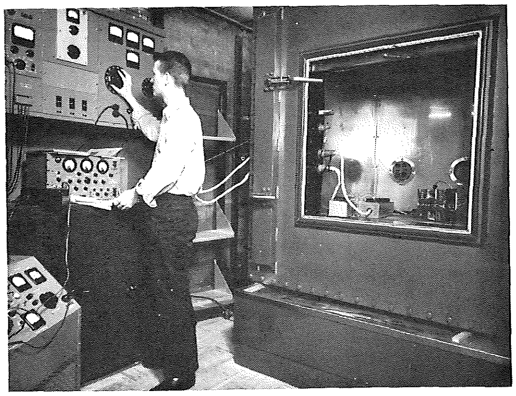
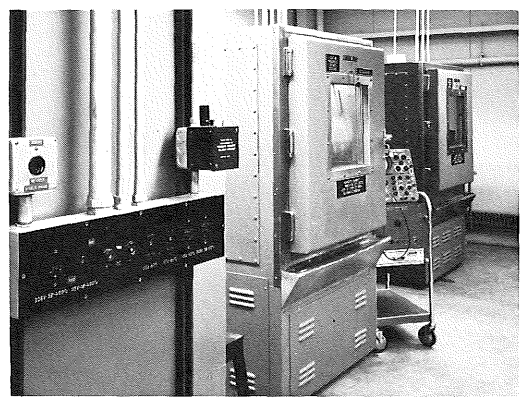


Figure 4-16. Murphy-Miller Altitude Temperature Chamber Capable of -100°F and Altitude of 100,000 Feet in 90 Seconds

Figure 4-17. Two of the Humidity Chambers Located in Collins Environmental Test Laboratory



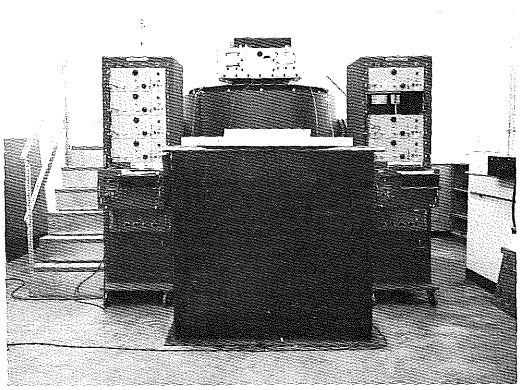
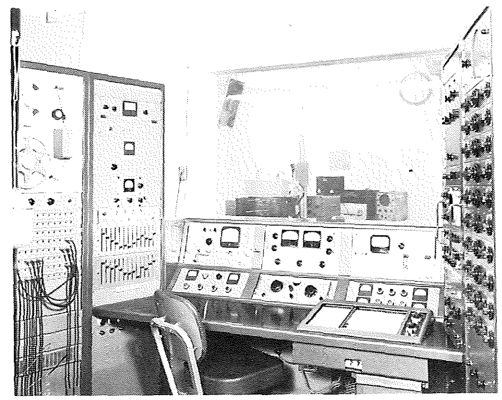


Figure 4-18. Ling Model 182 Vibration Table Capable of 15,000-Pound Thrust from 5 to 2000 CPS. Maximum Unsupported Weight Load Capability of 1900 Pounds

Figure 4-19. Console for Ling Complex Waveform Vibration System



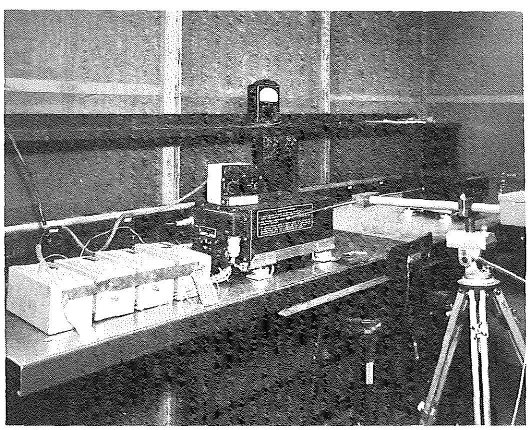


Figure 4-20. Noise and Field-Strength Screen Room Using Empire Devices NF-105 Monitoring Equipment

Figure 4-21. Tenney Explosion Chamber Designed to Meet MIL-E-5272 Specifications

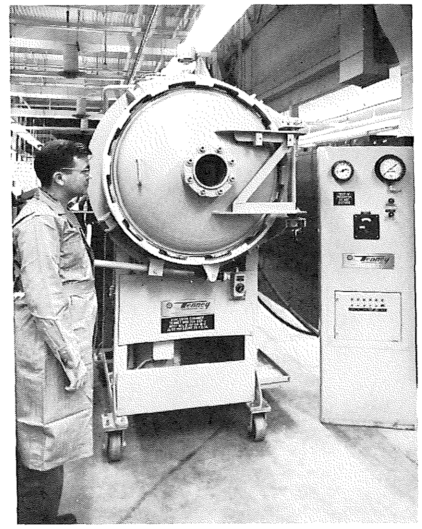


Figure 4-22. 150-g Maximum Centrifuge with Polaroid Camera Attachment for Checking Specimen Deviation During Test

Collins Communication Research Facility (CCRF)

This facility (see figure 4-23) within four miles of the research division was constructed in 1959 and 1960 entirely under company sponsorship for the purpose of making radio-propagation and communication-quality measurements using passive satellites. It was designed to work in a monostatic mode as a single station or in a bistatic mode with two or more stations.

The facility for tracking and communication utilizes a pair of steerable 28-foot parabolic reflector antennas. Automatic tracking through a system of

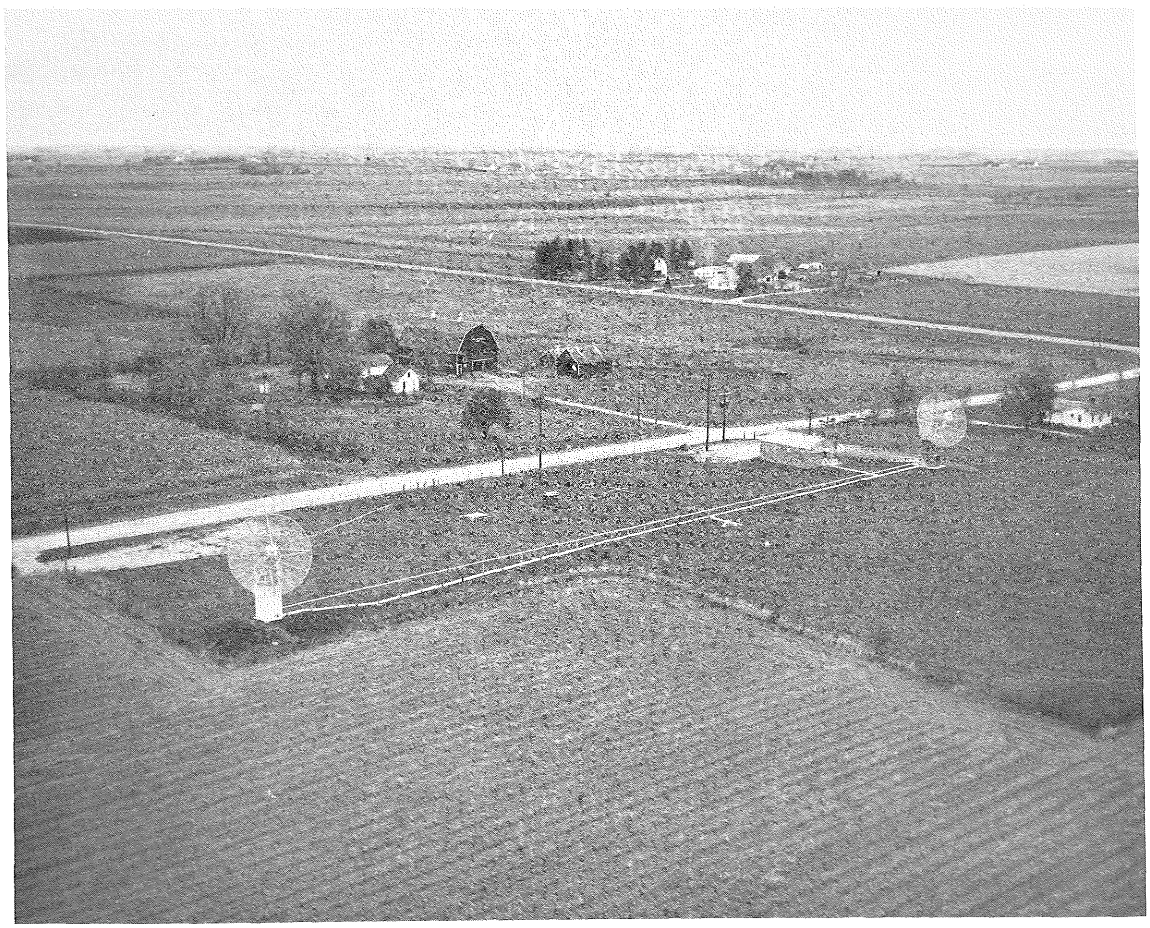


Figure 4-23. Collins Communication Research Facility (CCRF)

beam nutation is used with the system operating at approximately 810 mc, although other frequencies up to 2500 mc can be received with minor modification.

A receiver capable of detecting a carrier and two sidebands, independently, for purposes of comparison to determine spectrum coherence is used for tracking and scientific measurements. A parametric amplifier and narrow-band phase locking techniques are used for extreme sensitivity, and wide electrical tuning range is available to accommodate large doppler frequency shift. A servo system for the antenna senses the output of the receiver which varies with the nutation of the beam and positions the antenna to minimize error.

An operator's console is provided to centralize the control functions to aid in efficient operation of the station. A transmitting system consisting of a Collins 240D 12-Kw UHF Transmitter is used in conjunction with a 28-foot parabolic antenna which is slaved to the receive antenna. An optical tracker is used to aid in acquisition, and the antenna system can be slaved automatically to the tracker to provide continuous control. A time-sharing system is used to enable monostatic operation. This system has a usable range from 50 miles out to a maximum range which is limited by the returned signal level.

A precision doppler system is incorporated to provide precise measurement of doppler in the monostatic mode of operation of the station, and utilizes phase-lock circuitry to eliminate the need for measurement of the individual oscillators. Multiple terminal operation can be made available for use with various other stations with similar facilities.

A vhf-uhf phase-lock receiving system is used to monitor satellite beacon transmitters to aid in the recovery of telemetry information and as a sensor for vhf-hf propagation studies.

Data handling equipment, consisting of digital printers and magnetic recorders, is used to provide a record of the various system parameters during the data gathering phase of the operation. Data processing equipment is available within the company, consisting of IBM 7074 computers, a PACE 200 series analog computer, the Collins C-8000 series data equipment, and special correlation and harmonic wave analysis equipment. Facilities for precise calibration of the station equipment have been incorporated. These facilities consist of test transmitters, noise standards, a collimation tower, and optical sights.

Regularly scheduled tracking and measurement programs were conducted using Echo I as the reflector. From this a wealth of parameter measurements was taken and the data was reduced to provide spectrum distributions of fading, radio cross-section as a function of time, coherent bandwidth as a function of amplitude/phase, range, and orbit. Communication tests were made between Cedar Rapids and Richardson, Texas. FSK, facsimile, and voice modulation modes were utilized with excellent results. The data and analyses were made available to NASA and the scientific community.

Tropospheric forward scatter propagation studies relating to the meteorological parameters are currently being measured and analyzed in conjunction with the University of Wisconsin, Departments of Meteorology and Electrical Engineering. This experiment is the first of its kind for extreme accuracy in the measurement of path length.

The CCRF is being used in a newly formed experiment with Purdue University. This experiment will involve use of tropospheric forward scatter for adaptive communication technique research. A two-way link is planned for eventual closed loop operation.

Discussions are currently being held with SUI Physics Department personnel for determining other potential utilization for the facility. It shows excellent possibilities for tracking and data acquisition from various scientific satellites, direct tracking of passive communication satellites, tracking and communication with active communication satellites, and various propagation research measurements.

section **5**

Microelectronics facilities at Collins Radio Company

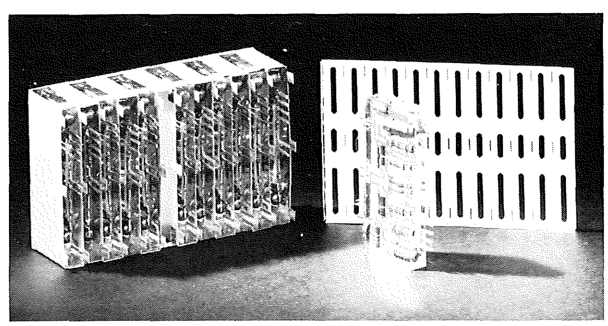
The importance of microelectronics to the development of small, lightweight, space electronics equipment could scarcely be overstated. Collins Radio Company has developed an extensive microelectronics research, development, and pilot production facility. The following section has been included to show the company's capability to serve the needs of the NASA center in this new and vital technology.

MICROELECTRONICS AT COLLINS

1. BACKGROUND AND EXPERIENCE

Microelectronics technology promises solutions to the problems of reliability, size, weight, power consumption, and system maintenance that are increasing as the requirement for system complexity in electronic design increases. Moreover, these problems weigh heaviest in the design of advanced man-pack, airborne, and space communications, airborne navigation, and data processing equipments. The concern of Collins Radio Company with the progress of microelectronics technology, therefore, is a natural extension of the company's long-standing activities in these product lines.

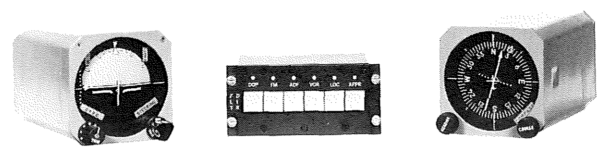
The history of microelectronics research and development at Collins is distinguished by rapidly mounting experience, with respect to both fabrication and application, in each of the recognized schools of microelectronics technology: welded discrete components, thin films, integrated semiconductor devices, and hybrid circuits. The corporate attitude toward microelectronics technology at Collins is evidenced by the recently expanded research and pilot production facilities at Cedar Rapids and the growing Solid State Division staff of experienced and highly trained scientists and laboratory personnel.



Typical IMP Module Illustrating Miniaturization Packaging Concept

One of the first programs undertaken by the company to investigate the problem of equipment density was its Instrument Miniaturization Program (IMP). Work in this program involved the development of miniaturization packaging techniques using welded discrete components. The IMP module concept, resulting from this effort, was subsequently applied to the design of airborne navigation and control equipment, yielding weight reductions of up to 50 to 1 and volume reductions of up to 100 to 1.

An entirely solid state integrated flight system intended for military applications was developed using IMP packaging techniques. All of the circuitry of the system is contained within three low-power, cockpit-mounted units, two being display instruments, and the other a switching panel/computer.



The Three Units of the FD-105C Integrated Flight System, Within Which All System Circuitry is Contained

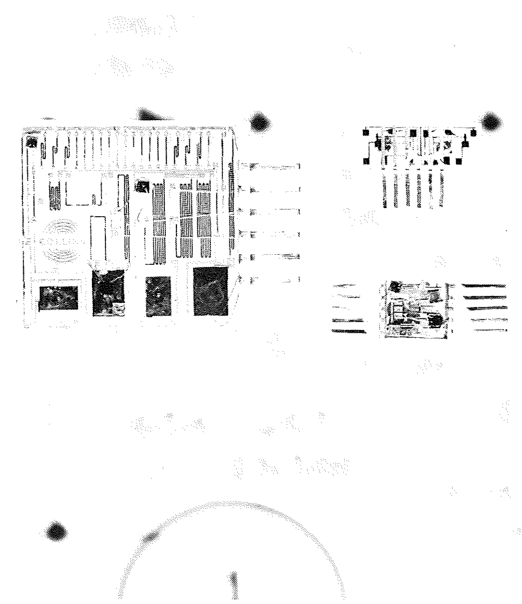
Early investigation into thin-film circuit fabrication techniques, begun by the company's chemical and materials specialists, led to the establishment of pilot assembly laboratories at plant locations in Cedar Rapids, Iowa; Dallas, Texas; and Newport Beach, California. As with the Instrument Miniaturization Program, emphasis was placed on application of the new techniques to current or projected company products. A coordinated effort thus was instituted between materials-oriented research scientists and circuit and equipment design engineers.

Thin-film circuits now are in production at the Dallas Division Thin-Film Laboratory, and contract requirements are being fulfilled for equipment containing these circuits.

Investigations conducted by the Cedar Rapids Division have included the design and application of thin-film audio oscillators, flip-flop circuits, band-pass filters, and magnetic thin-film devices for analog circuitry and computer memory applications.

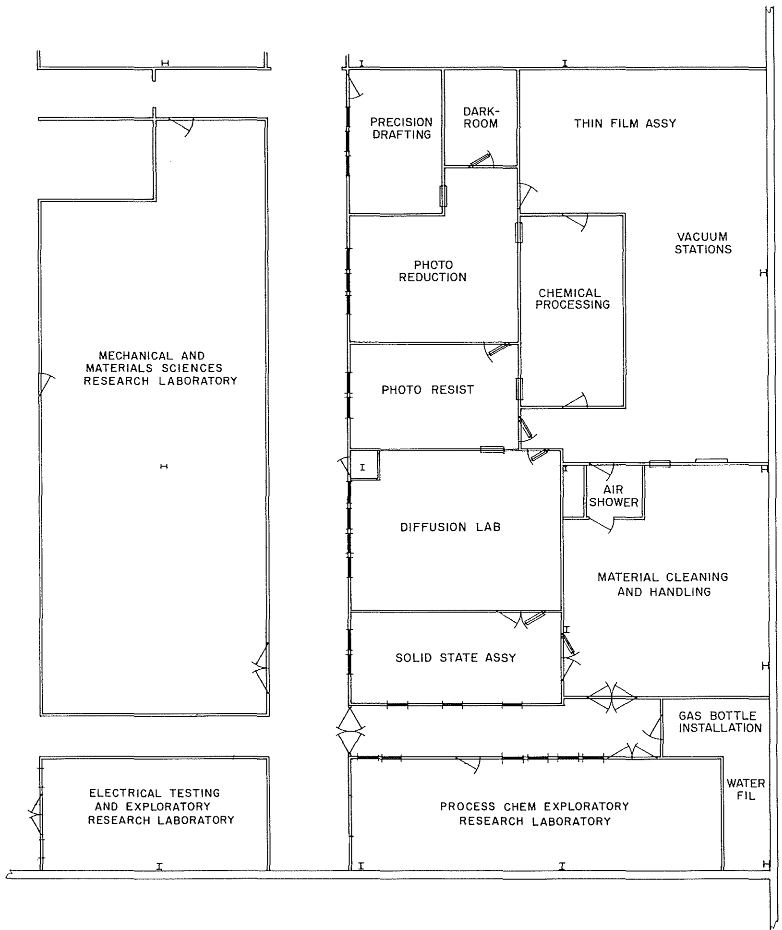
Prior to the completion of the extensive Solid State Laboratory in Cedar Rapids, integrated circuit research was added to the accelerated thin-film

Typical Thin-Film Circuit Modules, Products of the Cedar Rapids Solid State Laboratory



program. Silicon semiconductor diffusion work was initiated to develop the necessary planar technology for fabricating active and passive integrated semiconductor circuits. Work in this area currently in progress includes exploratory projects in synthesis of circuit elements in semiconductor blocks, investigation of noise effects in semiconductor devices, and the study of low temperature solid state effects.

SOLID STATE LABORATORY



The Cedar Rapids Division Solid State Laboratory, completed in June 1963, is a completely equipped, ultraclean, research and pilot production facility with approximately 7000 square feet of floor space. The facility provides complete thin-film and integrated semiconductor circuit fabrication and testing capabilities, including thin-film deposition, lead bonding, wafer bonding, registration, photo-resist, oxidation, diffusion, slicing, polishing, achemical processing, and supporting functions. Equipment in the facility, one-third of which was on hand from the previous, smaller laboratory, is valued at over $500,000.

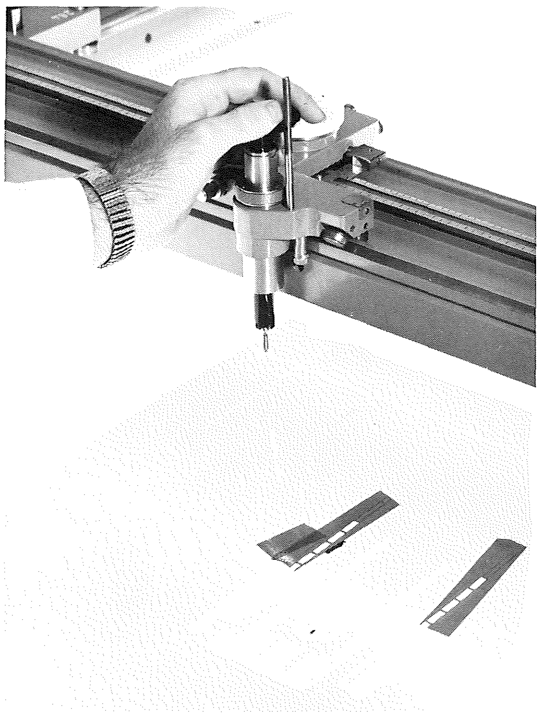
The special high filtration air-conditioning system of the laboratory consists of water wash, electronic Precipitron, carbon filter, and absolute filters. No dust-generating waxes or detergents are used in cleaning the various rooms of the laboratory, only water which is removed by vacuum sweeper. Floors, walls, ceilings, and light fixtures were designed to avoid collection of dust.

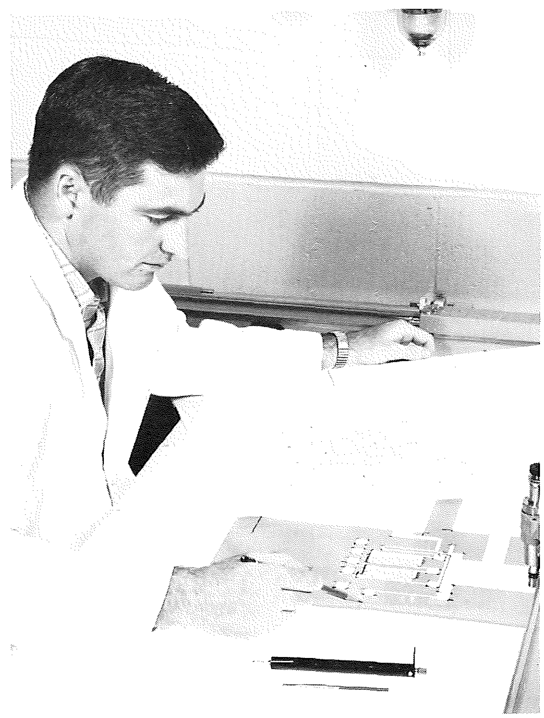
MATERIAL CLEANING AND HANDLING ROOM

All materials entering the laboratory are received first in the material cleaning and handling room, where they are cleaned thoroughly, packaged for the dust-free environment, and passed through a receiving window into the thin-film assembly room. This room is also the staging area for personnel entering the laboratory.

In keeping with the requirements of ultraclean laboratory facilities, entry into the Solid State Laboratory is made through an air shower chamber, which removes all dust and lint from clothing. In addition, personnel entering the facility are required to wear specially provided coveralls, caps, and shoe covers.

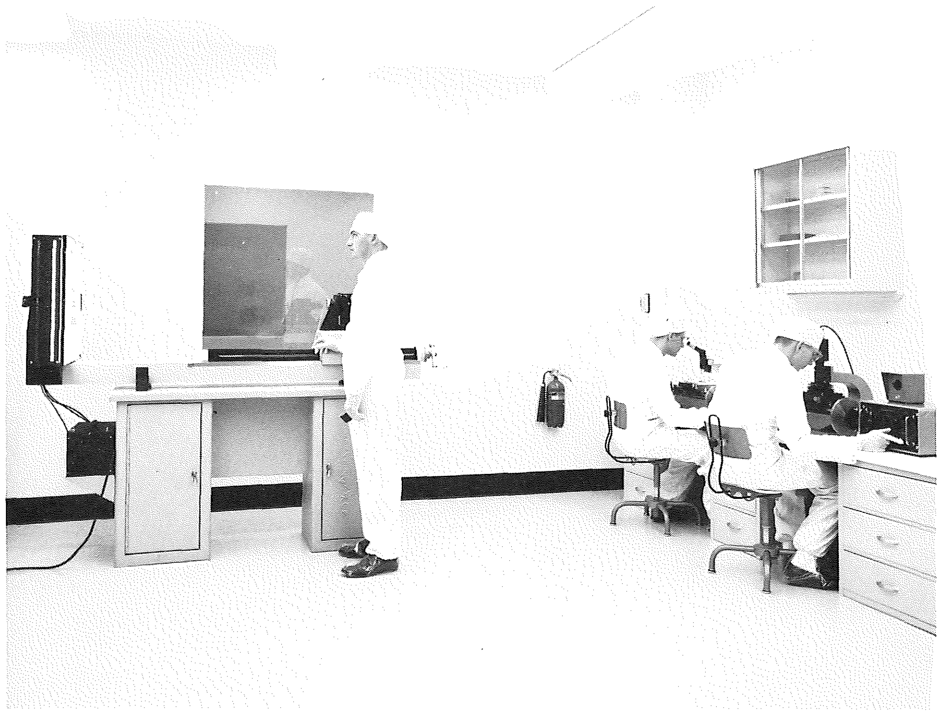
PRECISION DRAFTING ROOM





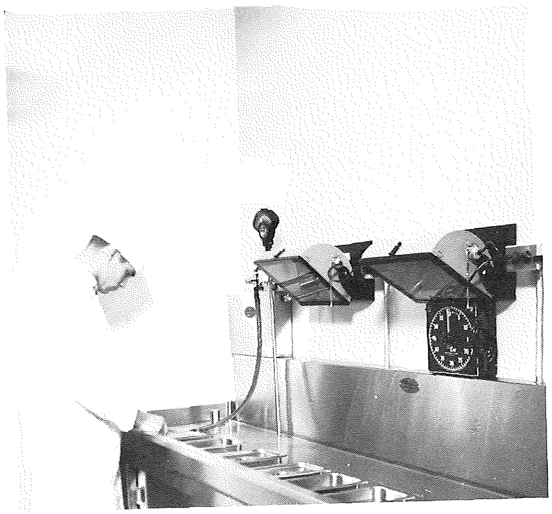
Both thin-film and integrated circuits begin as precision oversize drawings which are prepared in the Precision Drafting Room. Here, engineering sketches are converted into drawings ten to one-hundred times final circuit size using the coordinatograph drafting machine. This device is capable of spacing lines with an accuracy of .0015 inch over a four-foot span. Completed drawings are passed through a receiving window into the Photo Reduction Room.

PHOTO REDUCTION ROOM



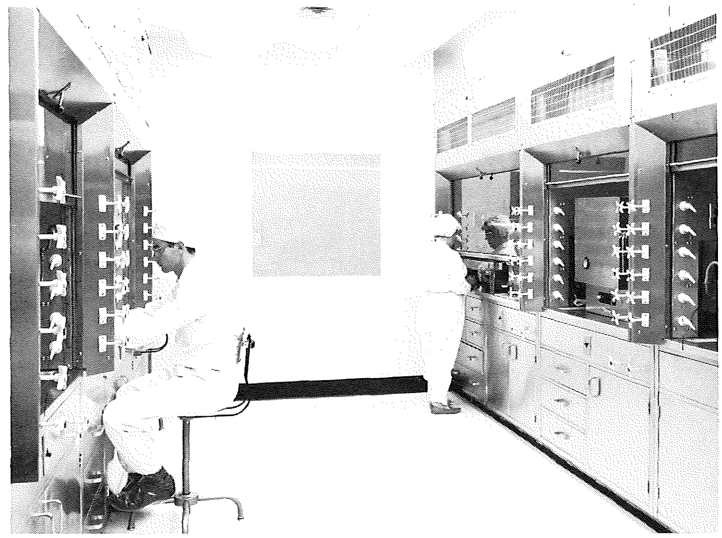
The Photo Reduction Room is equipped with a high precision camera and back-lighted easel for reducing circuit patterns photographically at a scale of 20 to 1. Also included in the room is an automatic, photo-repeater, multi-image mask instrument for final 3 to 1 reductions. Heavily constructed, the photo reduction equipment is shockmounted to minimize vibrations.

DARKROOM



Just off the Photo Reduction Room is the darkroom where photographic masks are processed. Close control of the environment and incoming materials of this room prevents imperfections in the photographic plates to be used as masks in circuit fabrication.

PHOTORESIST ROOM



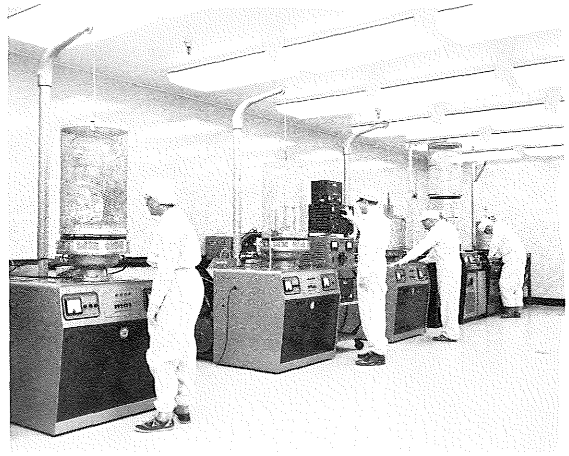
All photoresist activities, including spin-coating of substrate material, mask alignment, ultraviolet light exposure, and development are carried out in the Photoresist Room. The room is well lighted with yellow light, to which photoresist is insensitive.

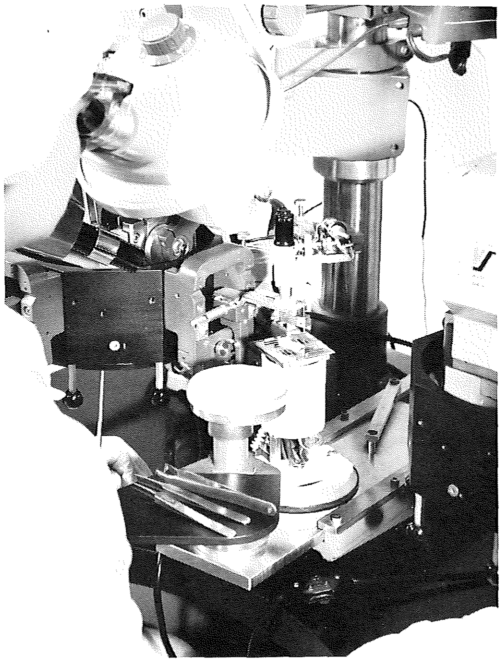
The hoods over the working areas utilize 100 percent make-up air from the air-conditioned room. Exhausting the air to the outside further prevents the introduction of dust particles. In addition to hot and cold water, demineralized water to a purity of 20 megohms is provided, as well as illuminating gas, oxygen, hydrogen, compressed air, nitrogen, and argon.

CHEMICAL PROCESSING

In the Chemical Processing Room, thin-film capacitors are fabricated on substrate material through an anodizing process. Special peripheral equipment enables capacitance to be controlled to specified values. As in other chemical areas of the facility, the hoods over the working tables utilize 100 percent make-up air from the air-conditioned room. Again, hot and cold water, demineralized water, illuminating gas, oxygen, hydrogen, compressed air, nitrogen, and argon all are available at each working area.

THIN-FILM ASSEMBLY ROOM



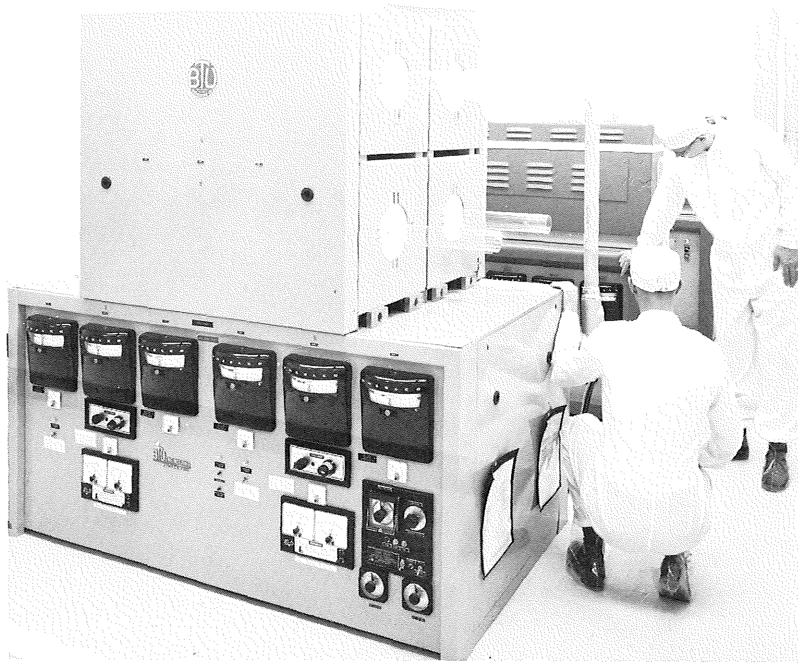


The Thin-Film Assembly Room is equipped with several vacuum stations used in depositing tantalum and gold on substrates. The vacuum systems have been adapted for the respective thin-film deposition techniques, including sputtering, vaporizing, and deposition with magnetic fields. A high vacuum station with a Vac-Ion pump is used in advanced research on thin-film deposition.

Anodizing equipment used in fabricating resistor areas of thin-film circuits is equipped with regulating devices of Collins design which automatically control resistance values to extremely close tolerances.

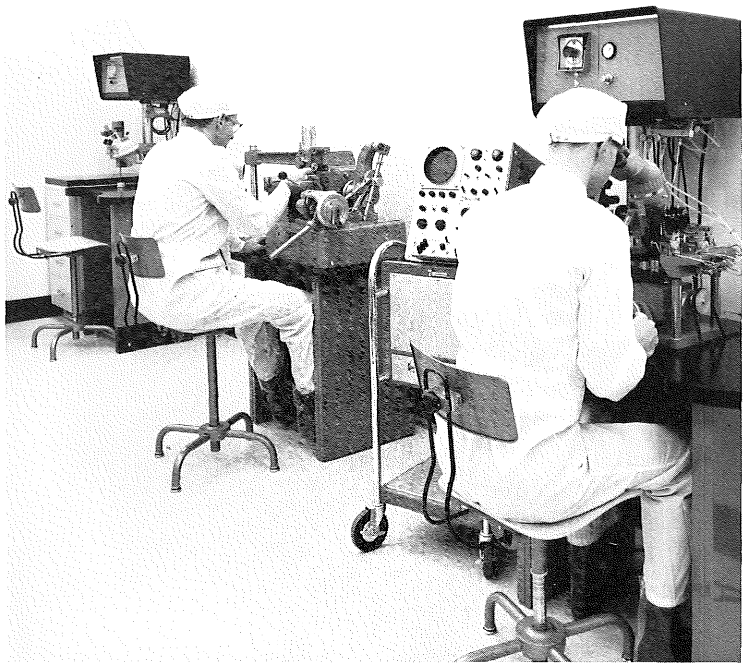
Micromanipulator machines in this room are used in the thermocompression bonding of gold wires to interconnect diodes and chip transistors with thin-film circuits.

DIFFUSION ROOM



The Diffusion Room is occupied by six precision diffusion furnaces, capable of maintaining a temperature of 1200°C to within ±1/2°C. They are used in oxidizing silicon wafers and for doping with both P and N type materials to fabricate the circuit isolation areas, diodes, transistors, resistors, and capacitors of semiconductor integrated circuits.

SOLID-STATE ASSEMBLY ROOM

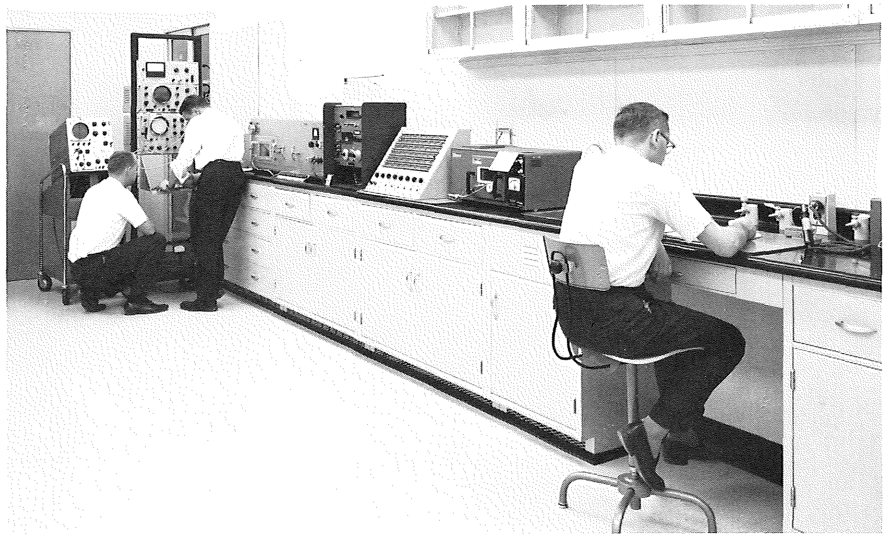


Equipment in the Solid State Assembly Room includes a precision probing machine capable of testing simultaneously nine areas of an integrated circuit; a scribing machine, used in cutting finished semiconductor circuits from silicon wafers in prescribed patterns; a wafer-bonding machine for securing finished integrated circuits in packages suitable for use in electronic equipment; and a micromanipulator lead-bonding machine, similar to the one used in the Thin-Film Assembly Room, for interconnecting semiconductor circuits with gold wires.

PROCESS CHEM EXPLORATORY RESEARCH LABORATORY

In this room, which adjoins the Solid State Laboratory, research is conducted in support of microelectronic development and pilot production. Thermochemical research is carried on in epitaxial growth of semiconductor circuit elements, deposition of dielectric thin films, metal thin-film conductors, and process improvement investigations.

ELECTRICAL TESTING AND EXPLORATORY RESEARCH LABORATORY



The Electrical Testing and Exploratory Research Laboratory is used in the electrical characterization of microcircuits and microcircuit elements for use in projecting research activity. Both environmental and electrical tests of finished microcircuits are conducted, not as a function of final checkout, which is performed at the Component Test Laboratory, but as a means of evaluating pilot production and in-process testing results. Work in new test development includes investigations of testing methods, processes, and instruments. In addition, exploratory devices being considered for use by Solid State Research personnel first are subjected to evaluation tests in this laboratory.

FACILITIES SUPPORTING CEDAR RAPIDS MICROELECTRONICS EFFORT

While the Process Chem Exploratory Research Laboratory, the Electrical Testing and Exploratory Research Laboratory, and the Microelectronics Applications Group function in direct support of the Solid State Laboratory, the microelectronics program in Cedar Rapids draws upon the aggregate knowledge and facilities of the entire Cedar Rapids Division.

Chemical, metallurgical, environmental and electrical testing, plastics fabrication, engineering measurements and standards, and mathematical computation facilities and personnel play a vital part in the continuing growth of the Cedar Rapids microelectronics effort.

The following exhibits illustrate some of the highly specialized equipment and facilities on which, to varying degrees, the microelectronics program depends.

FACILITIES SUPPORTING MICRO-
ELECTRONICS EFFORT

1. SUPPORTING LABORATORY FACILITIES

Figure 5-1. The Chemical Laboratory Contains Equipment for New Product Development Studies and Chemical Analysis Work

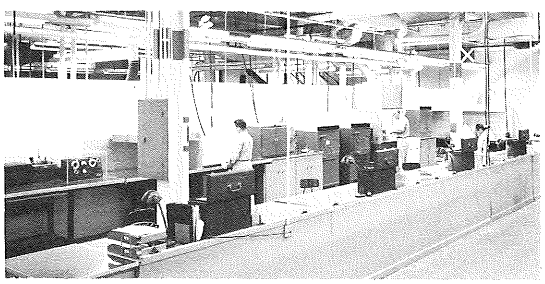


Figure 5-2. The Main Plastics Laboratory, Available for New Product Development Work As Well As for Special Research Assistance, Contains the Injection Molding Machinery and Special Equipment Required for Material and Processing Engineering

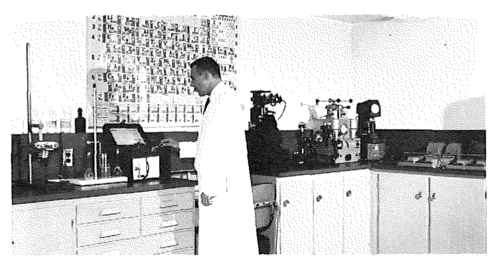
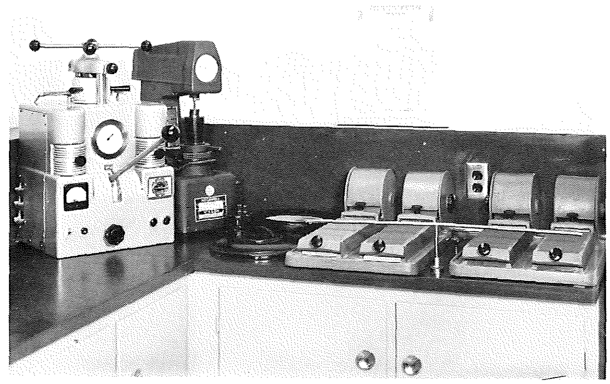


Figure 5-3. The Metallurgical Laboratory Is Equipped to Prepare Samples, Make Photomicrographs, and Conduct Studies to Determine Metallurgical Structure

Figure 5-4. Metallurgical Sample Preparation and Test Equipment



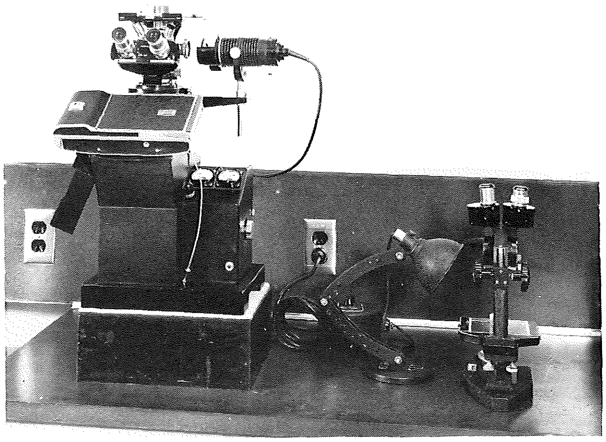
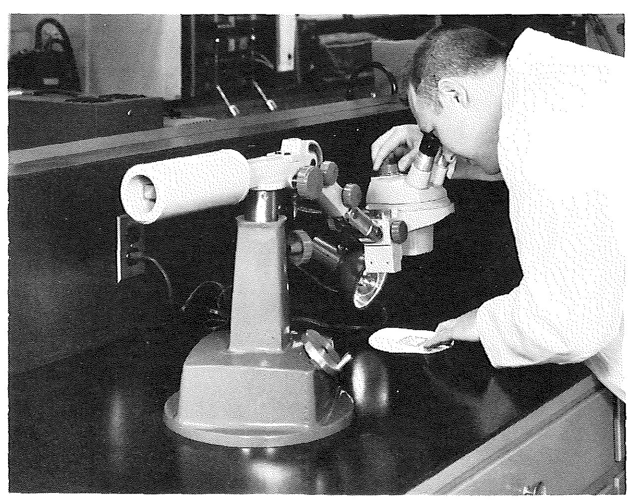


Figure 5-5. Metallurgical Microscope Equipment for Catching Structural Studies and Photomicrographs

Figure 5-6. Bausch & Lomb Stereo-Zoom Microscope for Rapid Visual Examination of Structures



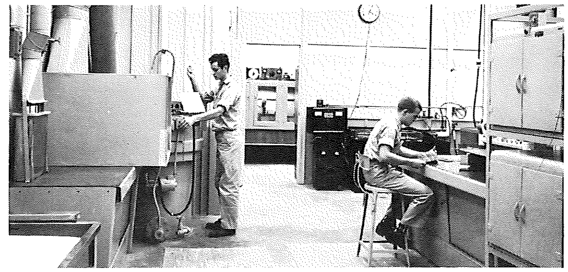


Figure 5-7. In the Chemical Fabrication Laboratory, Quantities of Intricate Metal Parts Are Produced by Chemical Processes

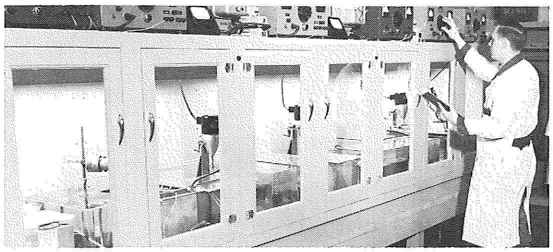


Figure 5-8. Experimental Electrochemical Plating Baths, Located in the Chemical Fabrication Laboratory, Are Used in New Process Studies

This special laboratory contains four temperature chambers with independently controlled heated walls, simulating high temperature, free convection, operational environments. Facilities are available for metering and controlling the flow rate and temperature of component cooling air. Multipoint temperature recorders, with a capacity for 144 thermocouples each, are used to monitor and record various surface and air temperatures during thermal evaluation.

2. SPECIAL EQUIPMENT

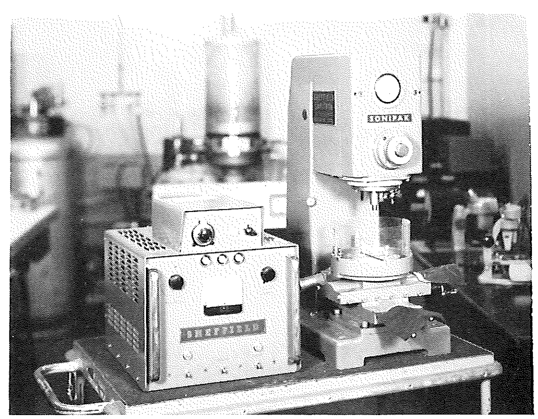


Figure 5-9. Cavitron Ultrasonic Machine for Cutting Hard-to-Machine Materials in Intricate Shapes

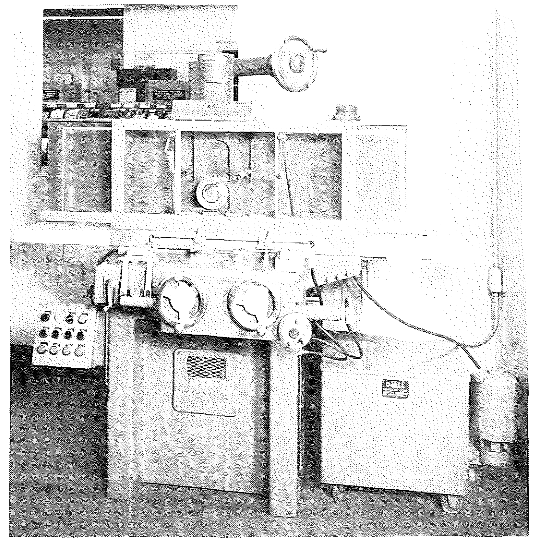


Figure 5-10. Slicing Machine Used in Cutting Semiconductor Wafers

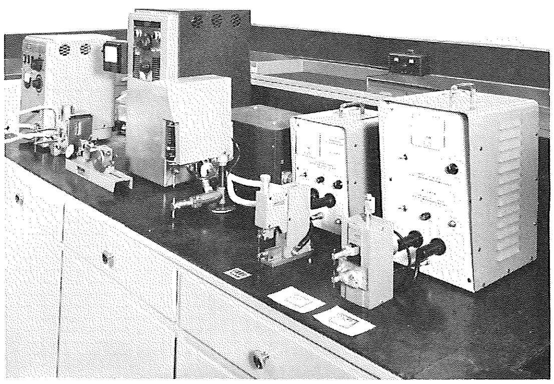


Figure 5-11. Welding Equipment Facility for Miniature Module Construction

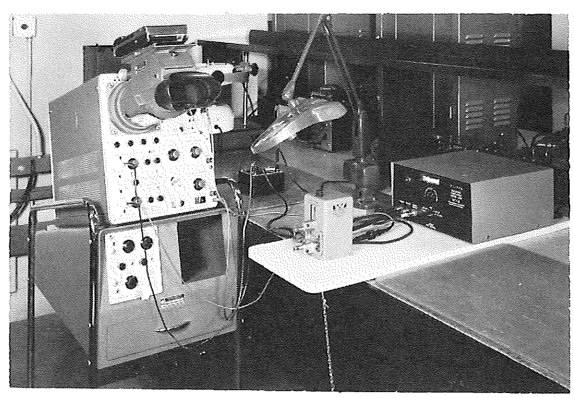


Figure 5-12. Welding Equipment with Oscilloscope to Record Weld Pulse Characteristics

section 6

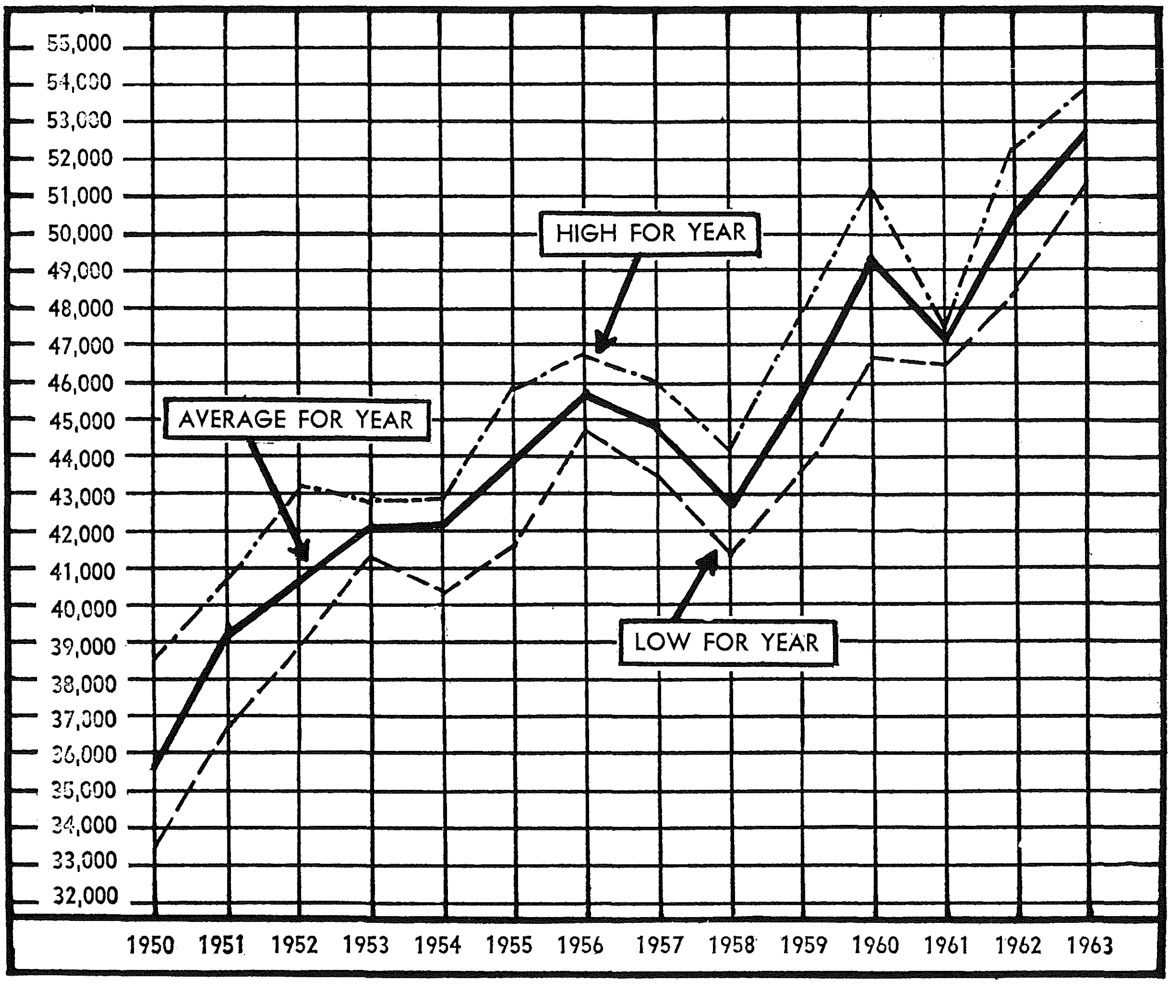
Industrial growth of Iowa City and Cedar Rapids Community

The Iowa City area, proposed as the site for the NASA Electronics Research Center, is located in the center of a rapidly growing industrial region.

The largest population center in the area is Cedar Rapids. The growth in Cedar Rapids for the last 12 years is shown in the following chart prepared from data compiled by the Iowa State Employment Service.

This growth has brought with it expansion in homebuilding, shopping centers, schools, and churches. Development is continuing, but past growth figures alone furnish ample proof that the area could easily assimilate the 2000 employees planned to carry out the programs of the NASA Electronics Research Center.

Since World War II, the industrial expansion of the Cedar Rapids and Iowa City area has amounted to several millions of dollars representing both newly located industry and growth of existing firms. As a result, this area has been considered to have more nationally and internationally known manufacturing firms per capita than any other in the United States. Such well known names as Collins Radio Company, Quaker Oats Company, Penick and Ford, Ltd., Inc.,



NON-AGRICULTURAL EMPLOYMENT in the Cedar Rapids labor market area (all of Linn county) has risen substantially in the last 14 years. The average for this year stands more than 48% higher than that of 1950, according to Iowa State Employment Service figures, compiled by the Cedar Rapids Chamber of Commerce.

Wilson & Co., Inc., Amana Refrigeration, Inc., Proctor & Gamble Mfg. Co., Link Belt Speeder Company, W. R. Grace & Co., and the Square D Company are among many located in this area.

In selecting locations, the managements of these industries have been carefully analytical. They have conducted extensive investigations before locating their new facilities in this area or expanding existing facilities. This represents a significant endorsement of the business environment in this area.

Through studies conducted by the Bureau of Business and Economic Research in the College of Business Administration, State University of Iowa, it is learned that for the past 60 years the greatest growth of Iowa has taken place in an area extending from Des Moines to Keokuk in the southeast portion of the state and to Waukon in the northeast. Since the Cedar Rapids-Iowa City area is in the heart of this section, it has enjoyed a major share of this expansion. Further, the same source advises that this present trend will continue for the next 50 years.

The proposed site between Iowa City and Cedar Rapids would be roughly in the center of this industrially dynamic area, which at present includes a total community of approximately 150,000 people.

section 7

Availability of immediate office, laboratory space, and housing for initial NASA operations

Should NASA choose the Iowa City-Cedar Rapids area, initial facilities would be available for the start of operations pending the construction of the proposed NASA installations. National journals report a projected professional staff of 100 men for 1964. Assuming that supporting personnel, such as technicians, draftsmen, clerical, etc., will be needed at a ratio of about 3 to 1, a total force of approximately 400 people might be expected during the first year.

Collins Radio Company, judging from its experience, has suggested that about 150 square feet of office and laboratory space will be required per man. This would mean a total requirement of 60,000 square feet of space. Housing requirements for the professional people and supporting staff imported from other areas might represent 75 percent of the total staff and require about 300 homes. The following data present information on this subject.

Office and laboratory facilities for initial NASA use

THE IOWA CITY-CEDAR RAPIDS EXECUTIVE CENTER

The development of the Iowa City-Cedar Rapids Executive Center is described briefly in the following clipping from the Iowa City Press Citizen edition of 17 December 1963.

Plans for $10 Million Coralville Project Told

CORALVILLE — Tentative plans for a $10-million commercial and residential development at the intersection of Highways 6, 218 and Interstate 80 west of Coralville have been outlined for the Coralville Chamber of Commerce by William Hoover, manager of Holiday Inn.

Hoover said the project, to be known as the Iowa City-Cedar Rapids Executive center, will include industry, housing (both single and multiple-unit dwellings), an office building and shopping center, as well as the Holiday Inn, already in operation, and a Shell Oil Co. service station, just completed.

Present plans call for construction of the four-story office building and Corondolet apartments to begin as soon as weather permits in the spring, Hoover added. He said the apartment project will include 112 two- and three-bedroom units, a swimming pool and community building.

* * *

AS FOR THE shopping center, its size will be determined by the number of leases accepted, Hoover continued, the aim being a "well-rounded, one-stop center" catering to all the shopper's needs.

According to Hoover, the entire project will encompass approximately a 300-acre area, mostly on the east side of Highway 218, where the Holiday Inn is located.

The development is backed by C. H. Laundre and Associates of Memphis, Tenn., owner of the Holiday Inn.

In a letter included at the end of this section, Mr. Trent Laundre, the developer of the Iowa City-Cedar Rapids Executive Center, indicates both willingness and ability to adapt his plans to any reasonable requirement for office space or for temporary or permanent housing. Additional motel units, for example, could provide attractive and highly functional initial office and laboratory space; the apartment buildings also could be used for this purpose. Design of the office building facilitates expansion to provide virtually any amount of space that might be required.

Sketches on the following pages show the present plans of Mr. Laundre and his associates and reflect their imaginative approach to site development - imagination which will be put at NASA's service immediately upon request.

This office center is in the immediate area of the proposed Iowa City site for the NASA Electronics Research Center.

In addition to the Iowa City-Cedar Rapids Executive Center, conventional office space of substantial size is available at several locations in Cedar Rapids. The LeFebure building alone has 98,000 square feet and will be available in mid-1964.

T. H. LAUNDRE AND ASSOCIATES, INC.
1261 EAST RAINES ROAD—TEL. 397-3359—MEMPHIS 16, TENNESSEE

December 17, 1963

Mr. James Webb, Administrator
National Aeronautics and Space Administration
Washington, D. C.

Dear Mr. Webb:

As the developer of the Iowa City-Cedar Rapids Executive Center described on the preceding pages, I am writing to advise that I would be pleased to consider leasing the entire office facility, or as much of it as you might desire, to your agency for as long as might be required for NASA to construct its own buildings for the site of the Electronics Research Center.

As you will note from the following material, this development will include apartment and shopping facilities in addition to the office structure. These buildings will be located on Interstate 80 at the intersection of the main highway to Cedar Rapids (U.S. 218), approximately 10 minutes west of Iowa City. We have just completed a 105-unit Holiday Inn motel at this location, the initial structure in the planned development of this site. We own or have contracted for a total of 256 acres in the immediate area, to provide sufficient room for almost any expansion which we can contemplate.

It is our intention to begin construction of the remaining buildings for the Executive Center in the early spring. The initial office structure is planned to provide 60,000 square feet, but we are prepared to build additional space in whatever quantity required. Actually, by a minimum conversion of part of our new motel space, we could make up to 15,000 square feet of space available at any time from this moment forward.

Please be assured that our present plans are sufficiently flexible to allow us to adapt to any of NASA's anticipated needs at any time in the Iowa City-Cedar Rapids area. We shall be most happy to discuss any aspect of this matter further at your pleasure and convenience.

Sincerely,

T. H. Laundre

T. H. Laundre

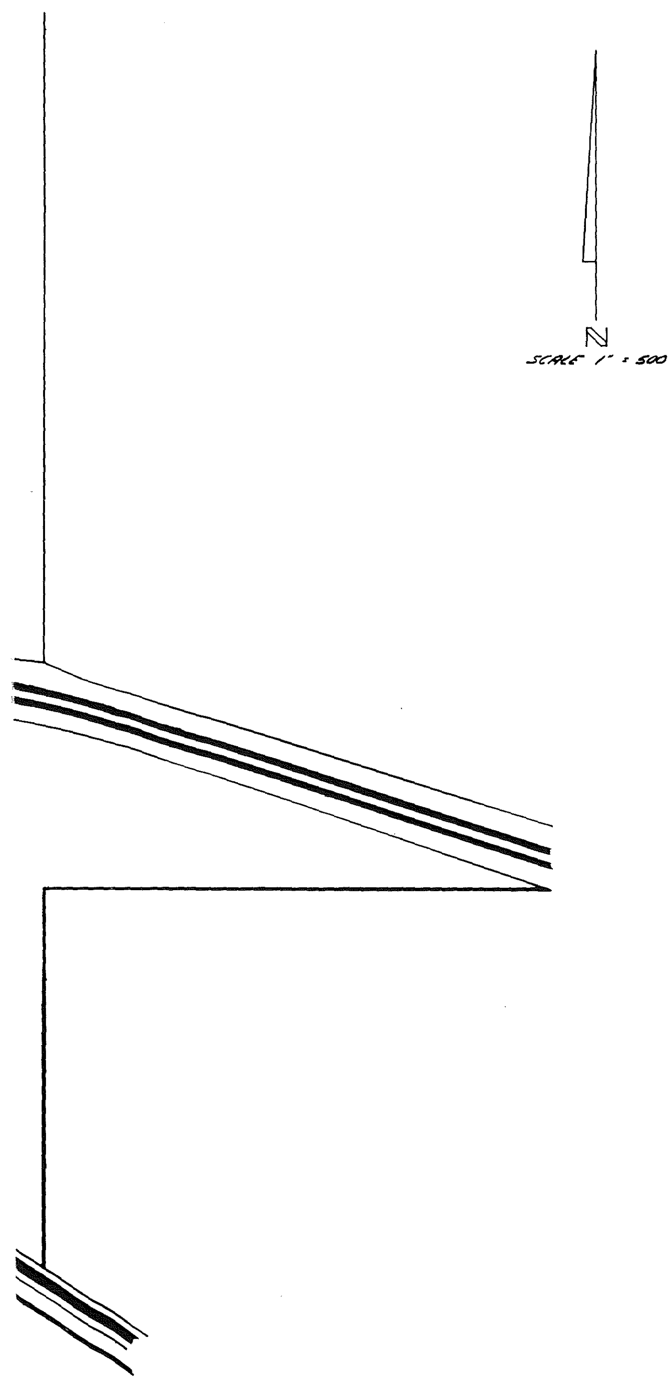


Figure 7-1. Executive Center Adjacent to Proposed Site

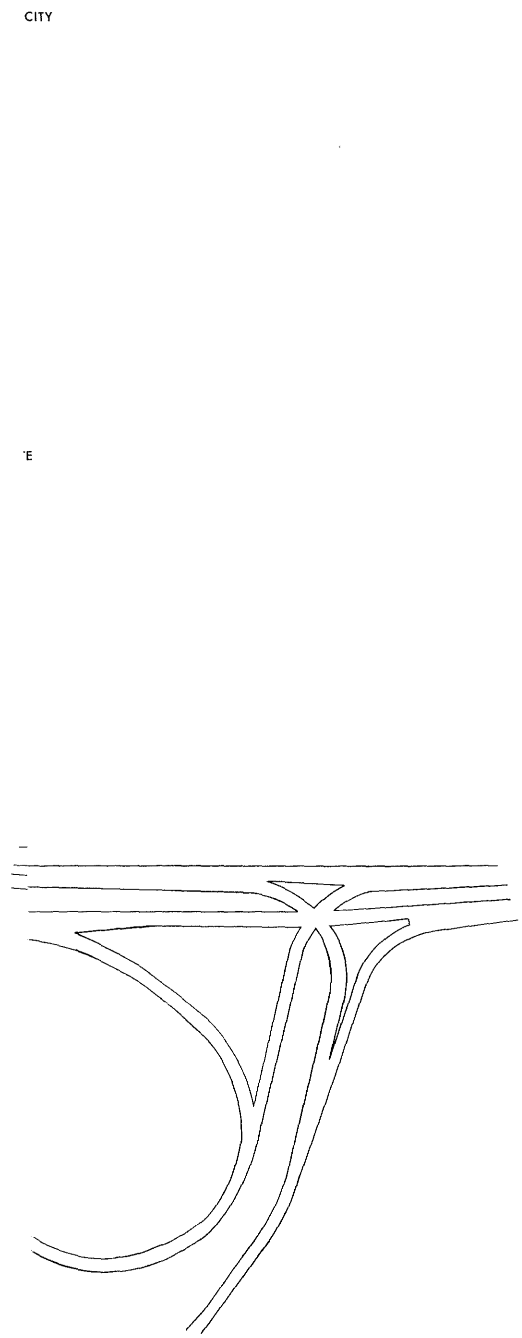


Figure 7-2. Detail View of Executive Center

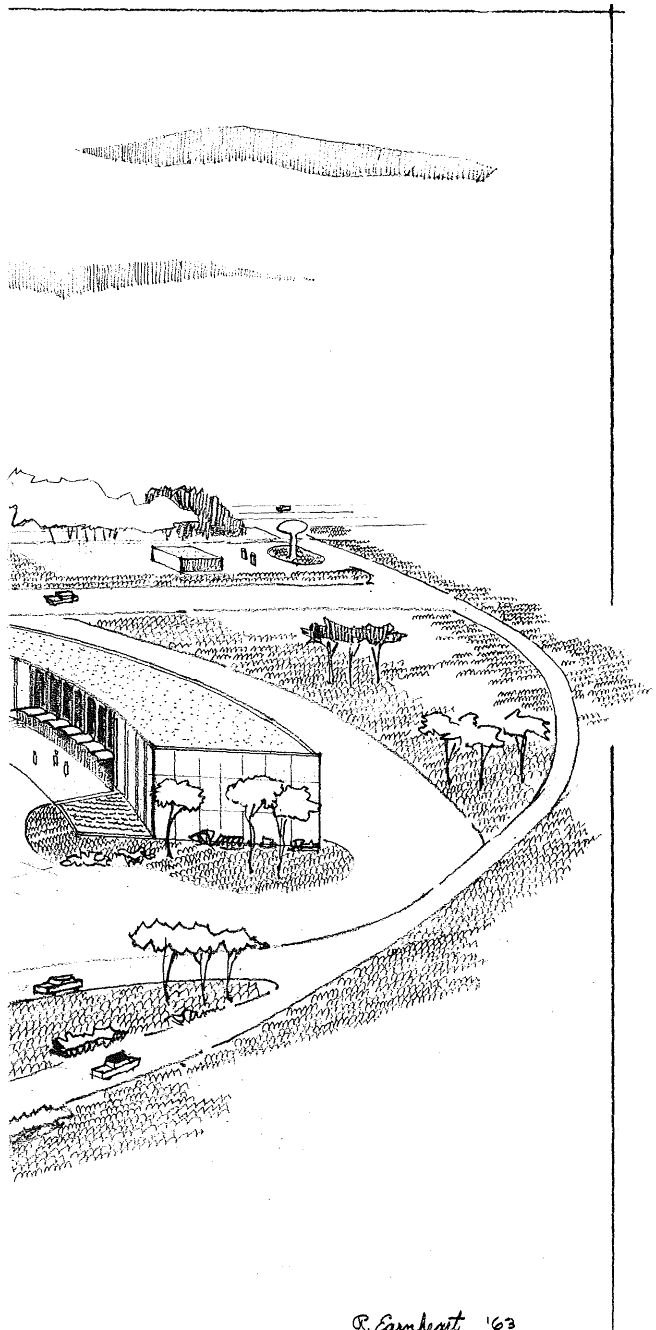


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Figure 7-3. Iowa City-Cedar Rapids Executive Center Office Building, Proposed for Initial NASA Operations

Housing

New home construction has been proceeding at a record pace in the Iowa City and Cedar Rapids areas for the past several years. Several high quality residential areas are developing in the pleasant countryside immediately adjacent to the two cities. Most recently, several substantial apartment developments have taken shape, and more are planned for the next year.

It can be said without reservation that quality housing can be available in whatever quantity required by the time it is needed to serve staff members and families connected with the proposed Electronics Research Center.

The Iowa City-Cedar Rapids Executive Center development, previously cited, will include more than 120 high quality two- and three-bedroom apartment units.