National Aeronautics and Space Administration

Appendices:
Evaluation of Historic Resources Associated with the Space Shuttle Program at Ames Research Center

N-238, RCC JSC Model Testing in Ames Interaction Heating Facility

N-258, Vertical Motion Simulator in Motion

Criteria of Eligibility for Listing in The National Register of Historic Places

Code of Federal Regulations, Title 36, Part 60

www.nasa.gov

Assessment - Appendices

Final

Space Shuttle Program

NASA Ames Research Center
Moffett Field, California

February 23, 2007

Prepared for
NASA Ames Research Center
Moffett Field, California

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**National Aeronautics and Space Administration, NASA Facts:
NASA Ames Contributions to Space Exploration (March 3, 2006)**

National Aeronautics and Space Administration

NASAFacts

NASA Ames Contributions to Space Exploration

Blue-lit image of scale model of Crew Exploration Vehicle (CEV) at NASA Ames Research Center, Moffett Field, Calif., in early March 2006, where the model was tested in Ames' Unitary Wind Tunnel Complex.

NASA Ames Research Center, Moffett Field, Calif., is currently supporting the Crew Exploration Vehicle (CEV) and the Crew Launch Vehicle (CLV) directly with the several efforts including development of Thermal Protection System technology, computational modeling and wind tunnel testing, Integrated System Health Management (ISHM) expertise, crew cockpit design expertise, software validation and verification expertise and Simulation Assisted Risk Assessment (SARA) expertise. Many of these activities use unique national assets at NASA Ames such as the Arc Jet, the Unitary Wind Tunnel and the Columbia supercomputer.

Details below:

1) CEV Thermal Protection System Advanced Development Project (TPS ADP) is a NASA technology development activity led by NASA Ames with teams from NASA Johnson Space Center, Houston; Kennedy Space Center, Fla.; Langley Research Center, Hampton, Va.; and the Jet Propulsion Laboratory (JPL), Pasadena, Calif. This activity's primary objective is to show that a single heat shield design, that meets both lunar return and low-earth-orbit re-entry requirements, is able to be manufactured and is sufficiently understood by NASA to proceed with the flight development.

2) The CEV AeroSciences Project (CAP) is a NASA aerodynamic and aero thermal data base development project led by NASA Johnson with teams from NASA Ames, NASA Langley and JPL. Its primary objective is to develop and verify the aerodynamic and aerothermal database required for the design of the CEV.

3) CEV Integrated System Health Management (ISHM) project is a NASA project lead by NASA Ames with teams from NASA Johnson; JPL; and NASA Kennedy (KSC), Florida. This project's primary objective is to expedite and reduce the cost of CEV processing and refurbishment if performed at Kennedy and to define requirements and improvements to assess CEV health and status during quiescent periods.

4) NASA Ames is providing expertise and test capabilities to the NASA Johnson team designing the crew interfaces in the CEV.

5) NASA Ames is providing software validation and verification expertise and computational capabilities to the CEV software development team at NASA Johnson.

6) NASA Ames is leading a project that performs a Simulation Assisted Risk Assessment of the CLV. The objective of this work is to provide risk information through the modeling and simulation of critical failure modes of the Crew Launch Vehicle.

7) NASA Ames is providing Integrated System Health Management support to the CLV upper stage and vehicle integration projects through trade studies and requirements generation in the areas of fault detection for crew abort and ground checkout at NASA Kennedy.

Point of Contact:
George Sarver
Project Manager
CEV/CLV/HLLV Support Project (CSP)
NASA Ames Research Center, Moffett Field, Calif.

March 3, 2006

Advisory Council on Historic Preservation, "Balancing Historic Preservation Needs with the Operation of Highly Technical or Scientific Facilities" (1991)

ACHP Balancing Historic Preservation Needs with the Operation of Highly Technical or Scientific Facilities (1991)
Excerpt

Executive Summary

Context

In response to a joint request from the House Committee on Interior and Insular Affairs, Subcommittee on National Parks and Public Lands, and the House Committee on Science, Space, and Technology, the Advisory Council on Historic Preservation undertook an analysis of preservation issues concerning Federal support for highly scientific and technical facilities. The analysis considered the appropriate role of historic preservation in decision-making about the operation and management of these facilities.

When future generations reflect upon the most significant historic resources of the late 20th century, the sites associated with man's first ventures into space, the splitting of the atom, with the development of computers and artificial intelligence, and with the first successful products of genetic engineering, may well be the first examples that spring to mind. America's scientific and technical facilities stand as monuments to the Nation's supreme ability to invent and exploit new technology and to advance scientific and engineering knowledge. Some facilities and structures significant in the early history of science and technology are now inactive or have been deemed obsolete; they are in danger of being lost to future generations through lack of adequate maintenance or complete neglect.

This analysis responds to concerns on the part of the scientific community that effort to preserve or protect historic resources through compliance with Federal historic preservation law might impede efforts to stay at the forefront of international research and achievement. Many of the facilities and much of the equipment associated with scientific or engineering advancements remain in active use today, but need to be continuously upgraded and modified to stay at the cutting edge of technology. Managers and scientists fear that excessive delays, costs, or the modification or "veto" of plans for new technological facilities would inevitably result from compliance with the National Historic Preservation Act (NHPA). In addition, private institutions receiving Federal support through research grants have pointed out that such compliance would impose a burden on them to bear these monetary and other costs as a condition for receiving research funds.

Given the late-20th-century's pattern of rapid technological change, however, the protection of the physical environment that facilitated that change takes on increased importance. Federal agencies managing or assisting scientific research have a leadership role in the stewardship of historic properties under NHPA. They are obligated to present and future generations, whose tax dollars will continue to fund their operations, to consider the affects of their actions on the historic values embodied in select facilities.

The central issue discussed in this report is how organizations whose primary missions involve active research and highly technical operations can meet their obligations as stewards of the Nation's historic scientific resources, given their continuous need to modify or replace "historic" facilities and equipment. What is the appropriate balance between an agency's primary scientific and technical mission and historic preservation? How can this balance be achieved effectively and efficiently, and how can attendant costs be minimized?

The number of properties formally recognized as significant for historic scientific and technological achievements currently is fairly small. The vast majority of scientific research activities is unlikely to affect historic properties through destroying or altering their historic characteristics. Most Federal funding is used for purchasing equipment and computer time and paying staff salaries. A small minority of such activities, however, does have the potential to affect historic properties. Certainly long-term operation and management of active facilities can result in significant alterations. Further, the number of historically significant scientific properties is likely to increase in the near future as the era of World War II and its aftermath recede further into the past.

The findings and recommendations contained in this report are based on field visits to numerous affected facilities, as well as meetings with scientists, engineers, historians, facility managers, museum curators, and preservation professionals; solicitation of public comments; review of past Section 106 cases and existing agency programs; and review of National Park Service (NPS) research for the preparation of two relevant National Historic Landmark (NHL) theme studies.

Report Conclusions and Recommendations

The central theme of this analysis is the notion that a balance must be struck between the needs of active scientific and technological facilities and the need to preserve the physical evidence of America's scientific heritage. The analysis described the particular requirements of research organizations, investigating the foundations of their apprehensions about complying with Federal historic preservation law. This analysis has also discussed how the Section 106 process works to ensure consideration of historic values in Federal and federally assisted projects drawing upon past Council cases as well as discussions with past and present facility managers and research personnel. Finally, this report has explored both the criteria whereby facilities and objects are deemed "historically significant" and the problems that might arise in making such judgments.

The report has generated a number of conclusions that will be explored and justified in the following pages. Recommendations to better integrate preservation considerations into the conduct of Federal and federally assisted scientific endeavors conclude this report.

Report Conclusions

Although the current number of properties recognized as significant for historic scientific and technological achievements is fairly small, it is likely to increase as the era of World War II and its immediate aftermath continues to recede into the past.

The 1940s and the early 1950s were characterized by unprecedented scientific and technological achievement. As physical vestiges of those national achievements reach the 50-year threshold typically used to determine historic significance under NHPA, the pool of historically significant scientific and technological properties may increase dramatically. At the same time, continued advances in science and technology over the next decade and beyond into the 21st century can be expected to increase pressures on scientists, engineers, and managers to remove or alter historic facilities in order to keep those facilities up-to-date to meet changing technologies and uses.

The assumption expressed by some that the requirements of the NHPA are fine for road construction or urban redevelopment, but inappropriate for scientific research and development, must be rejected.

Scientific research and the space program are indeed important national priorities, but they are not necessarily more important than other national priorities such as National infrastructure or providing affordable housing to Americans. Federal agencies and scientific research organizations have an obligation to address the requirements of NHPA in the course of carrying out their primary missions. In the case of Federal agencies owning historically significant properties, these agencies have an important stewardship role for our collective cultural heritage that they are obligated to recognize and address.

Despite the conclusion that scientific research and high technology operations should be considered no differently from other national priorities with regard to applicability of historic preservation law, there is validity to the notion that the scientific research process requires an unusual degree of flexibility in the planning and execution of research work.

It is difficult in many cases for scientists to state explicitly what effects proposed projects might have on historic resources. Research plans evolve and change during the research process; therefore, it may be impossible to specify precisely the consequences of their work with regard to physical effects on historic equipment or facilities.

Historic preservation concerns can and should be accommodated expeditiously in a way that focuses on the extremely small percentage of Federal or federally assisted projects that might have adverse effects on highly significant and historic facilities.

Programmatic Agreements (PAs) or other mechanisms that provide for tailoring of the "normal" Section 106 process to the special needs of active, operational facilities should be pursued with relevant agencies. To the extent that the regulations and procedures implementing NHPA and the application of historic preservation concepts can be fine tuned to meet the legitimate needs of the affected agencies, this should be done. Among other things, PAs can provide for stricter time limits on review and consultation that can meet concerns about expediting agency decision-making where necessary.

The scientific community in some cases has displayed unfamiliarity with the requirements of NHPA, and appears to perceive a threat of extended delays and other problems where there is little direct supporting experience.

Despite the fact that Federal agencies have been subject to historic preservation statutes for at least 24 years, relatively few cases involving effects on highly technical properties have gone through Section 106 review. Most Federal agencies and scientific research organizations involved with historic scientific and technical facilities do not fully understand the fine points of the Federal historic preservation review process as set forth under Section 106, much less appreciate how it could be integrated more effectively into their respective programs.

Some scientists and facilities managers, unless they have had direct experience with historic preservation project review in the past, continue to assume that Federal "historic preservation laws" mandate historic preservation, i.e., the unqualified retention of historically significant properties. Section 106 mandates that historic values be considered in overall planning for a project or program; any decision concerning preservation is made only after preservation values have been weighed against other values. There is no Federal law that requires retention of any historic property.

This perception was apparent in Council negotiations with the National Aeronautics and Space Administration (NASA) about its PA. It also has been a factor in discussions with the National Science Foundation (NSF) over an agreement covering its support of observatories. A fuller understanding of the Section 106 review process and its intended outcome could make for greater appreciation on the part of some Federal agencies concerning the possible historic significance of programs they have supported. It could also institutionalize consideration for historic values in the future within those agencies.

With some notable exceptions, historic preservation is rarely seen as a mechanism for meeting other agency objectives. Too often, it tends instead to be viewed primarily as a "compliance problem."

The provisions of NHPA apply to all Federal agencies of the Executive Branch. As one piece of Federal environmental legislation, it can be compared to the National Environmental Policy Act — a Federal policy aimed at the full airing and consideration of environmental issues and, in the context of project decisions, with the result of more informed planning and decision-making. However, discussions with a variety of Federal managers for this study and direct experience by the Council staff suggests that many affected Federal agencies believe the goals of the Federal preservation program to be too nebulous to be incorporated into a coherent environmental program. Wetlands, for example, can be analyzed, assessed, and even replaced in some instances; water quality can be determined; threatened wildlife populations can be estimated. Effects on historic properties are not as easily measured. In addition, agencies often assert that the limited budget available for performing their primary "mission" automatically relegates historic preservation to a minor role in their overall program. NASA, with its visitor centers and aggressive public affairs program, is a notable exception.

This general Federal agency perception, however, coupled with the tendency to view historic facilities as simply the functional engineering structures that enabled significant events, tends to devalue the historic significance of a given facility. Practical advantages associated with historic site status may also be sacrificed. For example, it is possible that facilities formally recognized as "historic" may be better protected against the vagaries of agency budget cuts or outside development pressures, although there is conflicting evidence on this point.

The tendency to view the provisions of NHPA as merely on more hurdle in the race toward "environmental clearance" results in a loss of considerable public relations value. For example, the good that could be generated by a concerted effort to preserve in place and present to the public structures illustrative of the magnitude of the moon landing effort could help convey the message that the kinds of problems that NASA is currently experiencing with the Shuttle and the Hubble telescope are inevitable effects of scientific and engineering endeavors. Scientists rightly deplore the mediocre national standard of scientific education, yet they frequently overlook an obvious way to elevate it through historic preservation. History and science are not inherently incompatible. On the contrary, by preserving instructive physical evidence of the Apollo lunar program, among others, scientists and their agencies secure the means to memorialize heroic achievements long after generational memory has dimmed. Familiarity with this rich scientific legacy will undoubtedly encourage young people to seek careers in science and technology.

At the local level, facilities and equipment of recognized historic significance can help educate communities and their elected officials about unique concerns of sensitive, high-technology installations, such as the need for low levels of municipal lighting near a telescope, or for local zoning ordinances that could help restrict electromagnetic interference from solid waste disposal sites. These installations should be a source of pride, not the breeding grounds for local conflicts. The natural civic pride that accompanies important and historic research facilities is not typically exploited in an effective manner. Los Alamos laboratories and Kennedy Space Center are notable exceptions; they are the major employers in their locales.

Council regulations and the Section 106 review process are flexible enough to accommodate the legitimate needs of the scientific and engineering community and their activities at historic facilities.

Generally, grants for projects using existing physical plans without modifications do not take the form of undertakings within the meaning of Section 106 and, therefore, will be spared review. Similarly, work that only modifies existing equipment will have little if any effect; either no Section 106 review would be required or a summary finding of no effect would satisfy compliance requirements. Telescope improvements envisioned by institutions like the California Institute of Technology at Palomar Observatory or the University of Chicago at Yerkes Observatory, should not produce adverse effects. On the other hand, a plan affecting the integrity of the major instruments at either of these institutions could be a significant Section 106 issue. Material alterations to buildings housing scientific facilities, particularly if the structure's exterior or interior is well-known, would affect that facility; nevertheless, unless there were major changes to an important piece of scientific architecture such modifications would not be adverse.

These conclusions incorporate both the concept of materiality, i.e., the quantity of change proposed, and the concept of quality, i.e., change of character or use, as opposed to the natural, ongoing change and improvement to and in structures or equipment as they are continually subjected to minor change while they continue to function for their original purpose.

All parties involved in determining the future of America's historic scientific equipment and facilities need to have a thorough understanding of what makes them significant and why.

A clear understanding of the significance of a facility, structure, or object is vital to the discussion of preservation options. This understanding, which should be predicated on agreement about exactly what is historic, is necessary if a consensus on how best to convey that significance to future generations of Americans is to be reached.

This degree of understanding is equally important for members of the historic preservation community, scientists, and managers. The latter can and should take a more active role inasmuch as they are often in a better position to judge the historic importance of their own facilities.

The historic preservation community needs to work with the scientific and engineering communities to gain a better understanding of how best to ensure the appreciation of the historically significant objects those facilities created.

The preservation community must gain a deeper understanding of the role of various facilities and structures, e.g., the Propulsion and Structural Test Facility at Marshall Space Flight Center, or the Wilson Observatory in California, played in the advancement of scientific research, if they are to determine how best to communicate this to the public. Given the various roles these facilities played both behind the scenes and in the public eye, how can this be presented? Should every historically significant object be preserved simply because it may be a unique or rare product of science and technology, e.g., a new space suit, or a Mercury capsule? These questions need to be addressed as part of a developing consensus.

Discussions with Smithsonian Institution and other museum staff as a part of this study are instructive. These discussions indicate that scientific development of computers, cameras, and other technologically important but less prominent components of space vehicles are of greater interest to the public. However, if their impact is to be maximized, these objects must be interpreted with reference to their historic context and development and, where possible, with illustrations of how their development directly or indirectly currently affects the average person. The National Museum of

American History's new permanent exhibit, "The Information Age," illustrates this principle. Under the rubric of space exploration, people want to see and touch actual objects that have been into space — be they capsules, rockets, spacesuits, or more mundane rocks from the moon's surface. People also are interested in the everyday life of astronauts, including their routine activities. An actual sleeping hammock used in the space shuttle is the kind of object that could easily be overlooked when discussing the preservation of man-in-space efforts, but it excites the interest of a child. Detailed printed information about rocket design, NASA missions, and hardware is also valuable, and at the facilities visited for the purpose of this study, it was apparent that this material was quite popular with visitors to these sites.

Decisions about projects that may affect historic properties need to be made with as complete an understanding as possible of such effects. However, considerations of preservation options should be kept distinct from the peer review process of awarding research grants and the determination of research priorities central to the scientific research process.

Scientists fear that the impact a proposed research project may have on historic properties ultimately will be considered in determining the project's scientific value. This, in turn, suggests that non-scientists could have a major impact on what kind of research is carried out, and where. There is a real concern on the part of the scientific community that nonscientific issues will either cloud the scientific worth of a proposed activity or result in changes that will make the research less effective or comprehensive.

These two issues, the scientific value of a research activity and the considerations of effect to historic properties, should be kept separate and distinct. The Section 106 process is ideally designed to reach a consensus on accommodating historic preservation concerns as an activity proceeds; it begins with a bias toward allowing the activity to go ahead. The law states that agencies must "take into account" the effects of their undertakings on historic properties, and afford the Council a reasonable opportunity to comment on those effects. It does not mandate preservation/retention but requires only that preservation values be considered in decisions that would alter or harm historic properties. This should not be construed by the historic preservation community as a license to scrutinize and rewrite research plans and decisions much less to open them to public debate.

Federal agencies engaged in scientific research should better acknowledge their responsibilities as stewards of America's scientific heritage and strengthen their tangible commitment to preserving the Nation's scientific legacy.

Inasmuch as scientists are potentially among the best judges of the historic value of their enterprises, it may be possible to instill more interest in preservation in those scientists who work in historic facilities. Indeed, future generations may be better served through encouraging scientists to take an active preservation role than by imposing additional layers of third-party control on managers of facilities. Plans, maps, illustrative models, and other by-products of historic events are usually on hand in the immediate aftermath of an activity; the key is to ensure their preservation and accessibility beyond the activity's completion. Scientists who are conscious of their unique responsibility as interpreters of the past will ensure that important remnants of past events are not lost. To the extent that this kind of conservatorship is already done for the benefit of scholars seeking to verify or understand past research, for public information, or public relations purposes, this will not impose an additional burden on agencies' or facilities' resources.

Throughout the Federal Government, the current personnel designated to serve as Federal Preservation Officers (or the equivalent) in accordance with Section 110(c) of NHPA often have insufficient expertise or training in historic preservation. Typically they perform their preservation function in a small amount of time taken from their other duties. They have inadequate staff to assist them, and limited additional resources. As indicated in previous Council reports to Congress, including the Regulations Effectiveness Report (January 1990), this should be corrected.

The intellectual resources of the scientists and managers who have recently retired or are nearing retirement in an asset that the Federal Government should not overlook.

Whether through soliciting assistance from such individuals in developing visitor centers or displays or through more formal projects supported by the Smithsonian Institution and others designed to record the oral histories of important programs like the manned space program, the relevant agencies should capitalize on the knowledge and experience of this group while these individuals are available.

Recommendations

Policy and legislation

* The Council strongly recommends that Congress not enact legislation providing exemptions from or waivers of the administration of the national historic preservation program for the benefit of specific Federal agencies or programs. Such statutory exemptions and waivers set a dangerous precedent because they are inconsistent with sound management of our Nation's historic resources, and they discourage agencies from negotiating with the Council for flexible, mutually acceptable programmatic agreements tailored to the agencies' needs. Because of the flexibility built into the national historic preservation program, no Federal agency, and specifically no agency concerned with operating scientific institutions and facilities, has made a persuasive case for needing a legislative exemption or waiver.

These interventions in the established and flexible historic preservation processes are inconsistent with the fundamental principle of NHPA and detrimental to the sound and effective management of the Nation's historic resources.

* Future scientific achievement as well as an adequate serving of the public interest is dependent on an understanding of, and excitement for, past scientific successes and failures. Therefore, to the extent that they do not already exist in agency programs, future authorizations for major scientific and technological programs should include public education components that focus in part on the communication of the relevant history of science.

* The Advisory Council on Historic Preservation should take the lead in developing and subscribing to a statement of policy that acknowledges the sensitive relationship between the progress of scientific research and the evolving history of science and its physical manifestations. Such a statement could take the form of a policy memorandum signed by the Chairman of the Council, NPS, the National Conference of State Historic Preservation Officers (NCSHPO), and various agency heads that could lay the groundwork for future consultation on specific cases or programs.

Public interpretation and education

* In addition to the need for personnel for purposes of compliance with Federal historic preservation law, relevant agencies engaged in funding highly scientific research should provide resources to allow their resident historians and archivists to begin cataloging, or to complete the

cataloging and preservation of, various records and documentary media pertinent to their facilities, structures, projects and programs. This will ensure that the public will know where to look and who to talk to find the information they need.

* Other than NASA, which already does quite a bit in this area, Federal agencies also need to strengthen their public outreach programs, through increased direct and indirect support to internal or associated museums.

* Federal agencies and preservationists need to assess how future preservation needs can be met more effectively through public/private sector cooperation. Private corporations engaged in research and development activities have made substantial contributions to the preservation and historical documentation of their own heritage, both through funding support and active preservation of their own historic structures and equipment. Many recent exhibits at the Smithsonian Institution and other museums devoted to scientific and technological themes are largely underwritten by corporate sponsors, and/or feature historic artifacts donated by these companies. The Aerospace Industries Association, a member organization comprised of approximately 50 corporate members and their subsidiaries, maintain a Washington executive office that could help serve as a clearinghouse for such efforts.

Administrative procedures

* Over the next two years, Federal agencies, in cooperation with the Advisory Council on Historic Preservation, should evaluate their current administrative procedures for historic preservation, paying close attention to mechanisms they currently have in place for meeting their responsibilities toward not only NHLs but also properties that are eligible for or listed in the National Register of Historic Places. The Council should recommend measures to improve the effectiveness, consistency, and coordination of those procedures with the purposes of NHPA, as prescribed by Section 202(a)(6).

* The Advisory Council on Historic Preservation, in cooperation with the Smithsonian Institution and NPS, should foster better communication between the preservation and museum community and Federal agencies with the aim of establishing a consensus concerning the kinds of facilities and objects that should be physically preserved and those that could be "preserved" through documentation.

* Scientific and technological agencies need to examine whether their institutional structure is such that a programmatic approach to compliance with NHPA is in their interest and to determine whether their preservation program should be carried out through a centralized office at headquarters or at the individual installation level.

* Federal agencies should examine their existing mechanisms for public involvement to ensure that these are adequate to sufficiently include those parties with legitimate historic preservation interests in the decision-making process. Once this is done, certain questions need to be addressed. These might include: "How are such properties and the scientific and technological history behind them being presented to the public?" and "Is there a national interest in such efforts, and if so, what is it?"

* Federal agencies need to determine more precisely the management status of historic properties for which they may be responsible where questions exist. For example, some agencies have overlapping interests or jurisdictions for the care of facilities. Agencies must examine existing legal responsibilities, as well as interests among the owners, managers, and users of these properties with

regard to historic preservation. They must ensure that there are currently adequate incentives for preservation and/or public interpretation.

Staffing and training

* The Department of the Interior, in cooperation with the Smithsonian Institution, should provide technical assistance and advice to those scientific facilities around the Nation interested in identifying and evaluating the historic nature of their facilities. The information should include innovative ways in which agencies may be able to address preservation needs and responsibilities. State Historic Preservation Officer (SHPO) staff in affected States should also receive such technical assistance and advice to enhance their ability to make appropriate judgments.

* In key States that contain many potentially important historic resources of a scientific or technological nature, the Council, NPS, and NCSHPO should take the lead in working with affected agencies, private institutions, and SHPOs to facilitate interaction in workshops and other forums.

* The Advisory Council on Historic Preservation should designate one or more staff members to serve as contacts on scientific and technological programs and projects. These individuals should become thoroughly familiar with existing Federal programs and the types of historic facilities which may be affected by them.

* NASA, NSF, the United States Air Force (USAF), and the Department of Energy (DOE) should each acquire personnel with historic preservation experience for their Washington, DC, offices.

- NASA, DOE, and USAF should each designate an individual at the headquarters level to work full-time coordinating historic preservation programs and planning with facilities staff, public affairs offices, and external affairs for their respective agencies. This would include contractors and, where appropriate, visitor's centers and cooperating museums: Smithsonian Institution, Alabama Space and Rocket Center, Oak Ridge, Los Alamos, Cape Canaveral's Air Force Space Museum, etc.

* NSF should develop guidelines for NSF support that may affect historic preservation concerns. NSF should also work with recipient institutions to promote preservation of scientific and technological facilities and instruments, in conjunction with NSF's Science and Engineering Education Program. Finally, NSF should actively work with the Council, NPS, and SHPOs to address the variety of matters related to Section 106 on both a project and program-wide basis.

Funding

* Congress should consider a modest appropriation, supplemental to the NPS Fiscal Year 1992 budget, to record and document particularly vulnerable historic scientific and technical facilities and begin a systematic inventory of such resources in cooperation with agencies and SHPOs.

* Specific financial resources required to accomplish related goals should be determined, and discussions initiated toward their attainment. Specific attention should be given by all Federal agencies engaged in scientific research to the kinds of interpretive proposals and attendant costs presented in NPS's "Man in Space" study of alternatives.

* The preservation and scientific communities should discuss with Federal agencies the current and possible future preservation needs of scientific and technological properties, including, for example, whether program funds that have not normally been considered for historic preservation use, such as archival retention, cyclic maintenance, or public history, could be used to assist with physical preservation needs or onsite interpretation facilities. Money spent to advance historic preservation might well be paid back in numerous educational and other benefits.

* Existing policies restricting the use of maintenance funds for inactive or underutilized facilities should be reexamined.

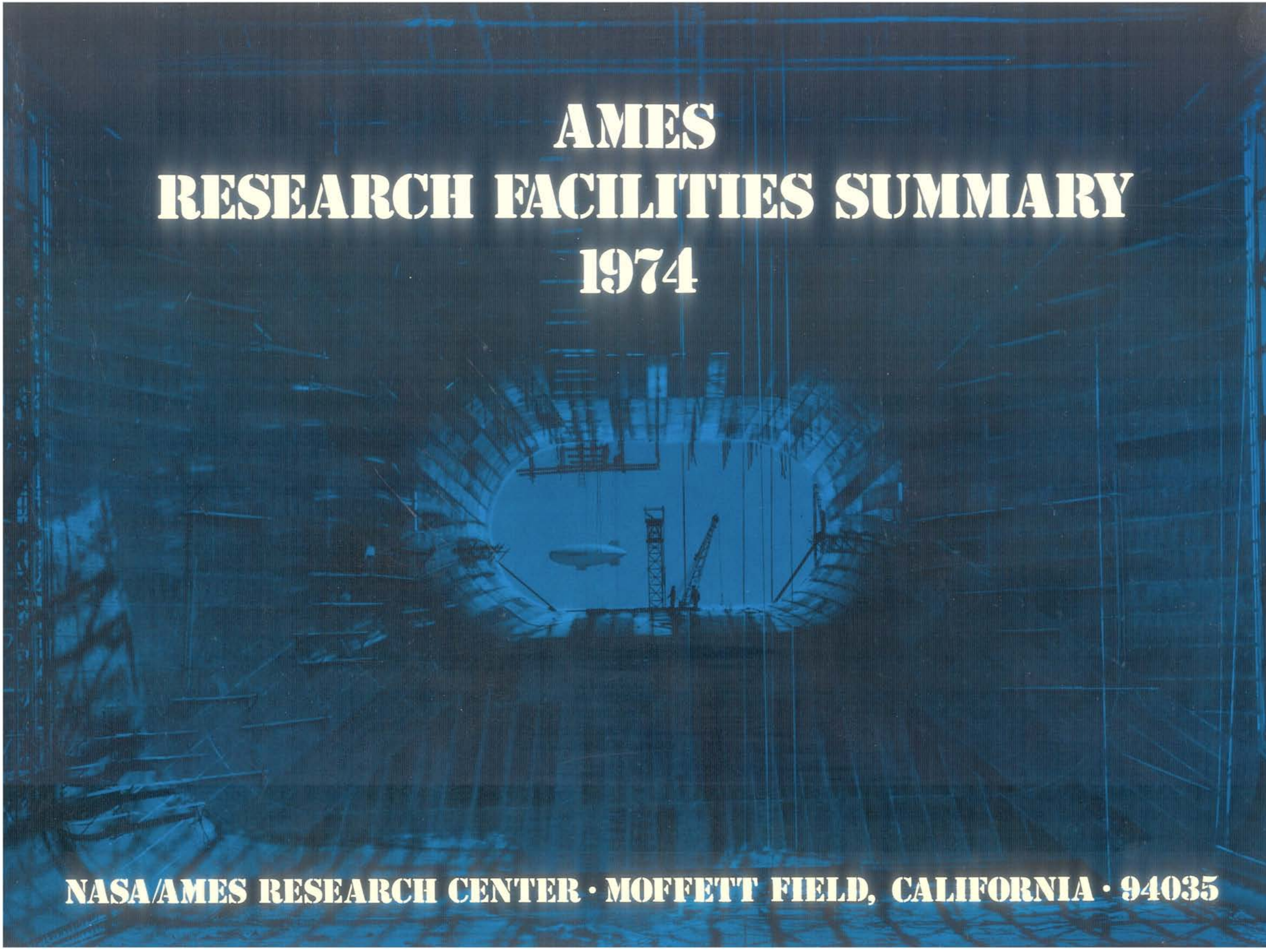
* Affected Federal agencies should examine the historic scientific and technical properties in their care to determine funding needs for preservation, including documentation where physical preservation of the facility, structure, or equipment is not realistic.

List of Acronyms Used in this Report

DOE	Department of Energy
NASA	National Aeronautics and Space Administration
NCSHPO	National Conference of State Historic Preservation Officers
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
NPS	National Park Service
NSF	National Science Foundation
PA	Programmatic Agreement
SHPO	State Historic Preservation Officer
USAF	United States Air Force

Updated June 12, 2002

Excerpts from NASA Ames Research Center, Ames Research Facilities Summary (1974)



AMES RESEARCH FACILITIES SUMMARY 1974

NASA/AMES RESEARCH CENTER · MOFFETT FIELD, CALIFORNIA · 94035

FOREWORD

Ames Research Center, a field installation of the National Aeronautics and Space Administration, was established in 1940 and is located at the southern end of San Francisco Bay on land contiguous to the U.S. Naval Air Station, Moffett Field, California. Its physical plant comprises some thirty-four major technical facilities and laboratories that are used as research tools in the aeronautical, physical, space, and life sciences. The Center occupies 365 acres of land and uses runway facilities and certain other utilities jointly with the Department of the Navy. Based on initial costs, the capital investment in the Center is approximately $270 million.

Ames' strength lies in the expertise of its staff of scientists, engineers and technicians together with the highly specialized, sometimes unique, facilities necessary to perform programs of national importance. This book is a summary of selected facilities at Ames focusing on (1) Subsonic, Transonic, and Supersonic Wind Tunnels; (2) High Enthalpy and Hypersonic Wind Tunnels, Shock Tubes and Ballistic Ranges; (3) Flight Simulators: (4) Research Aircraft; and (5) Computers.

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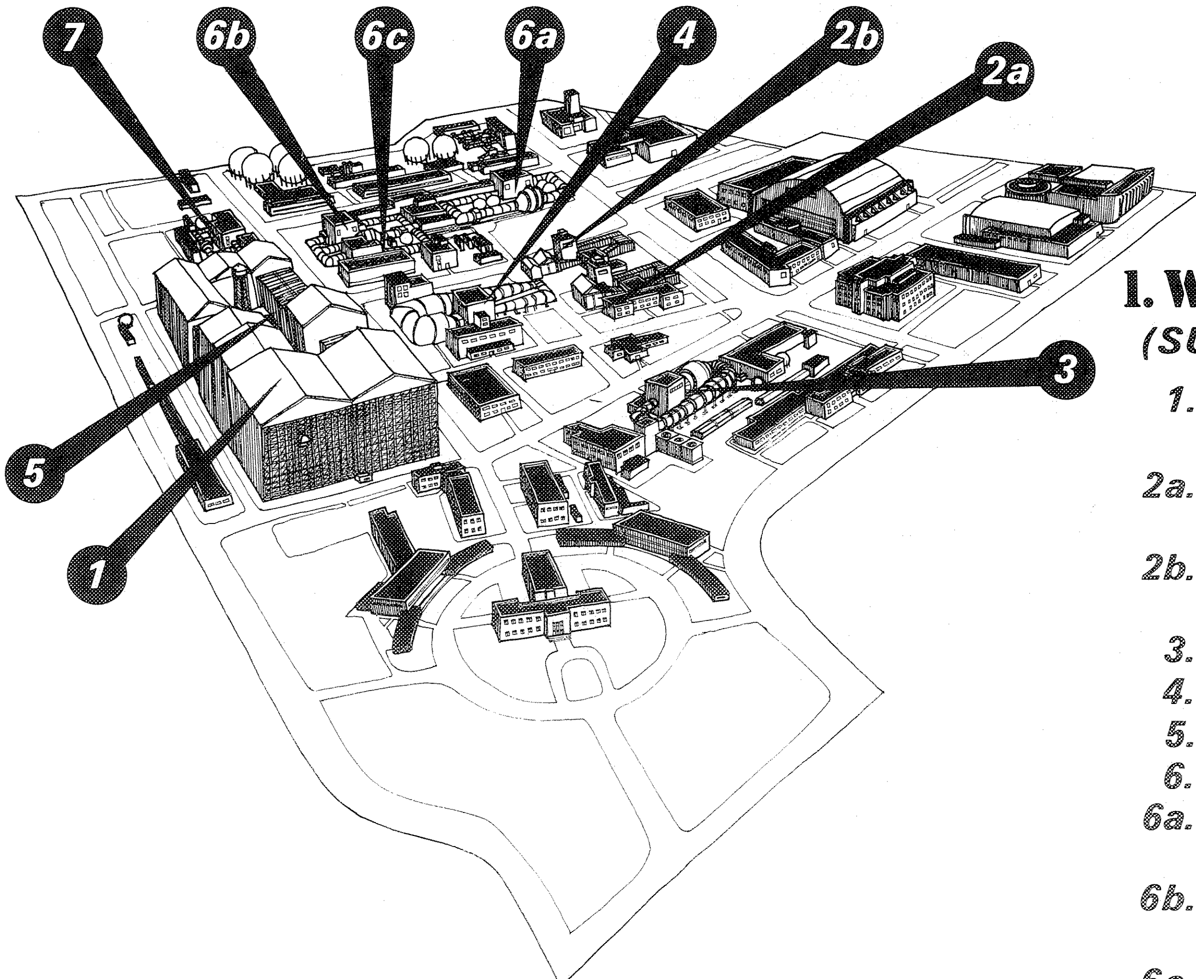


1. WIND TUNNELS

(SUBSONIC, TRANSONIC, SUPERSONIC)

1. ***FORTY-BY EIGHTY-FOOT WIND TUNNEL***

2a. ***SEVEN-BY TEN-FOOT WIND TUNNEL NO.1***

2b. ***SEVEN-BY TEN-FOOT WIND TUNNEL NO.2 (AAMRDL)***

3. ***TWELVE-FOOT WIND TUNNEL***

4. ***FOURTEEN-FOOT WIND TUNNEL***

5. ***TWO-BY TWO-FOOT WIND TUNNEL***

6. ***UNITARY PLAN WIND TUNNELS***

6a. ***ELEVEN-BY ELEVEN-FOOT WIND TUNNEL***

6b. ***NINE-BY SEVEN-FOOT WIND TUNNEL***

6c. ***EIGHT-BY SEVEN-FOOT WIND TUNNEL***

7. ***SIX-BY SIX-FOOT WIND TUNNEL***


1. WIND TUNNELS
SUBSONIC
TRANSONIC
SUPERSONIC

1. FORTY-BY EIGHTY-FOOT SUBSONIC WIND TUNNEL

DESCRIPTION:

The Forty- by Eighty-Foot Subsonic Wind Tunnel is a closed-throat, closed-circuit wind tunnel used primarily for determining the low-speed aerodynamic characteristics of high-performance aircraft and spacecraft (particularly landing and take-off and V/STOL aircraft and rotorcraft). Airflow is produced by six, variable speed, 40-foot-diameter fans, each powered by a 6,000 horsepower electric motor.

Power for operation of propellers, etc., can be obtained from either aircraft engines or electric motors. Either gasoline or JP-type fuel can be supplied for internal-combustion engines in the test section. A variety of electric motors are available for model propulsion systems (maximum electric power available for these is 3,000 horsepower).

In addition to a conventional support-strut system, a set of variable-height struts is available for ground proximity studies.

PERFORMANCE:

Speed	0 to 200 knots (continuously variable)
Stagnation Pressure	1.0 atmosphere
Reynolds Number	0 to 2.1×10^6 per foot
Temperature	ambient to 600° R

DIMENSIONS: **Test Section**

Height	40.0 feet
Width	80.0 feet
Length	80.0 feet
Access	Top doors — 49.0 X 80.0 ft

STATUS:

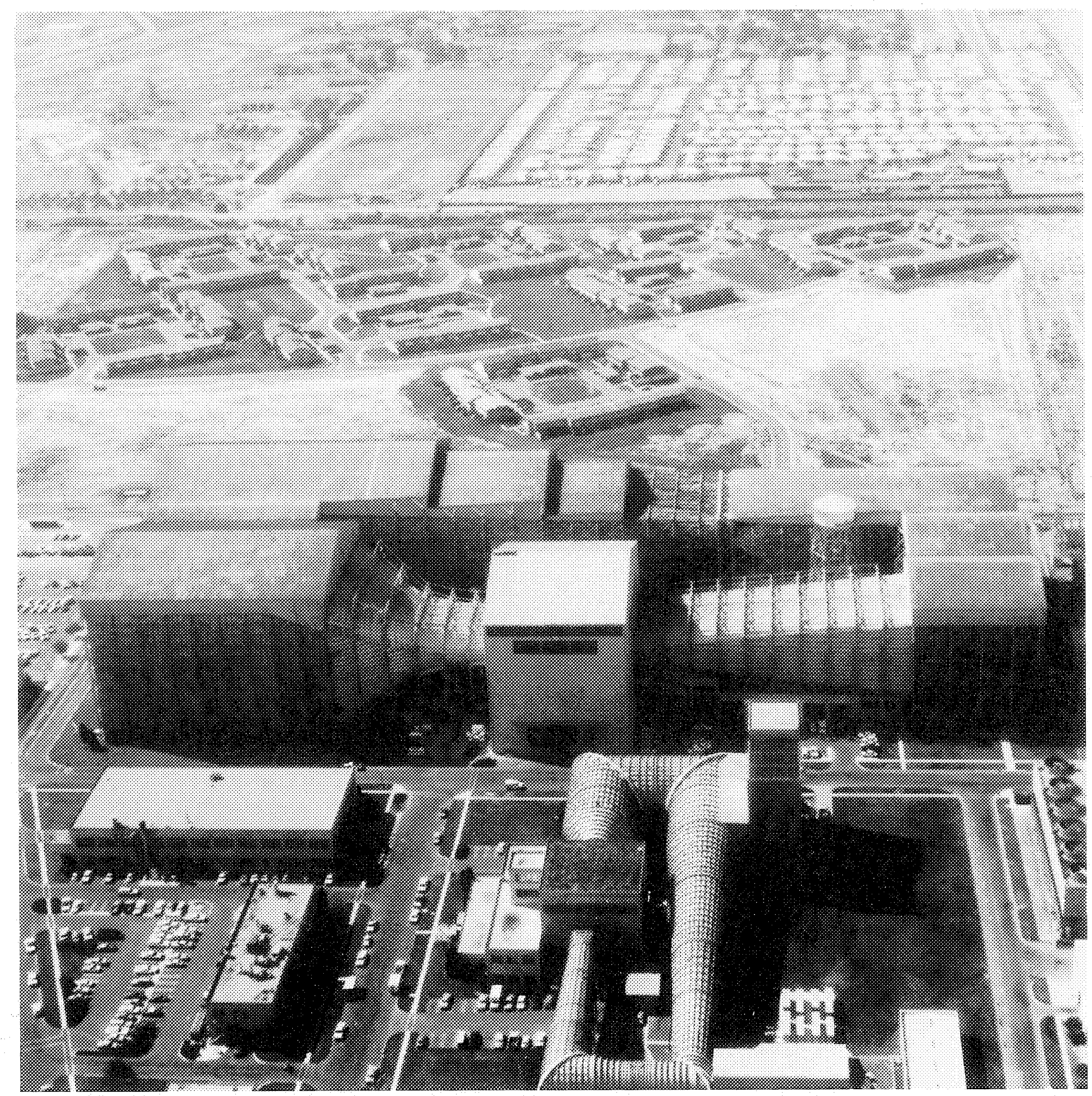
Operational since 1944

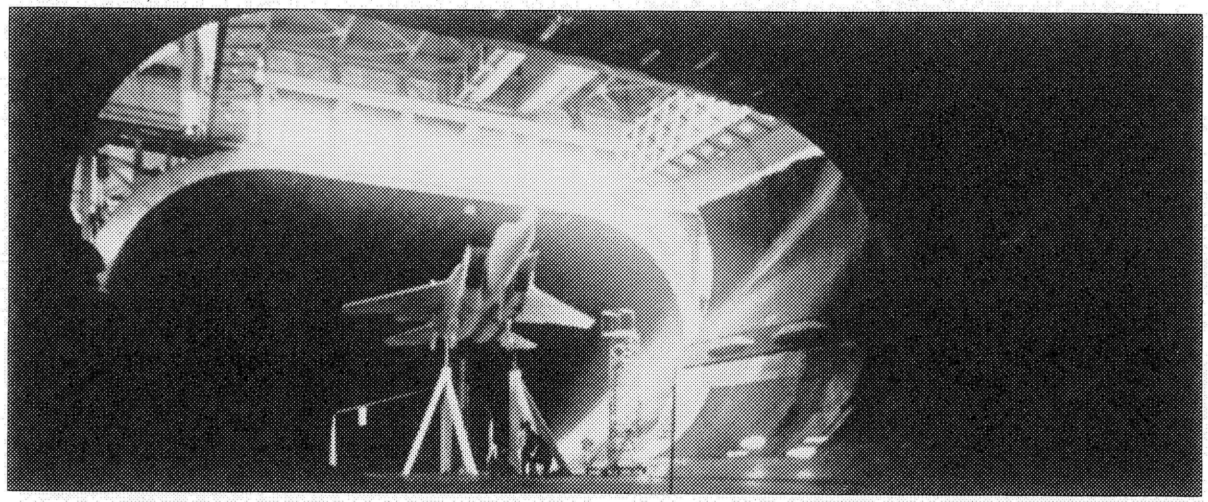
JURISDICTION:

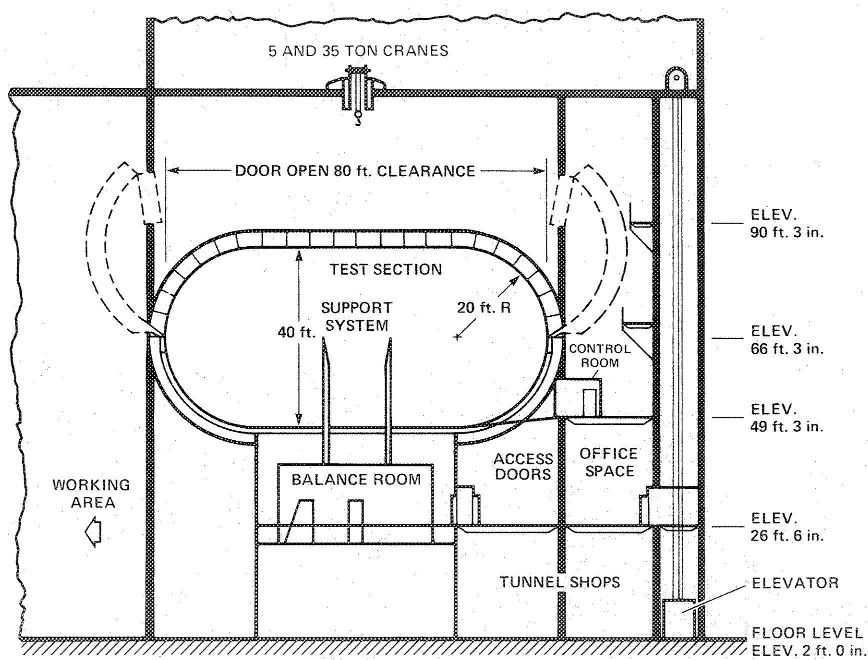
Flight Systems Research Division
Large-Scale Aerodynamics Branch
Mark W. Kelly

LOCATION:

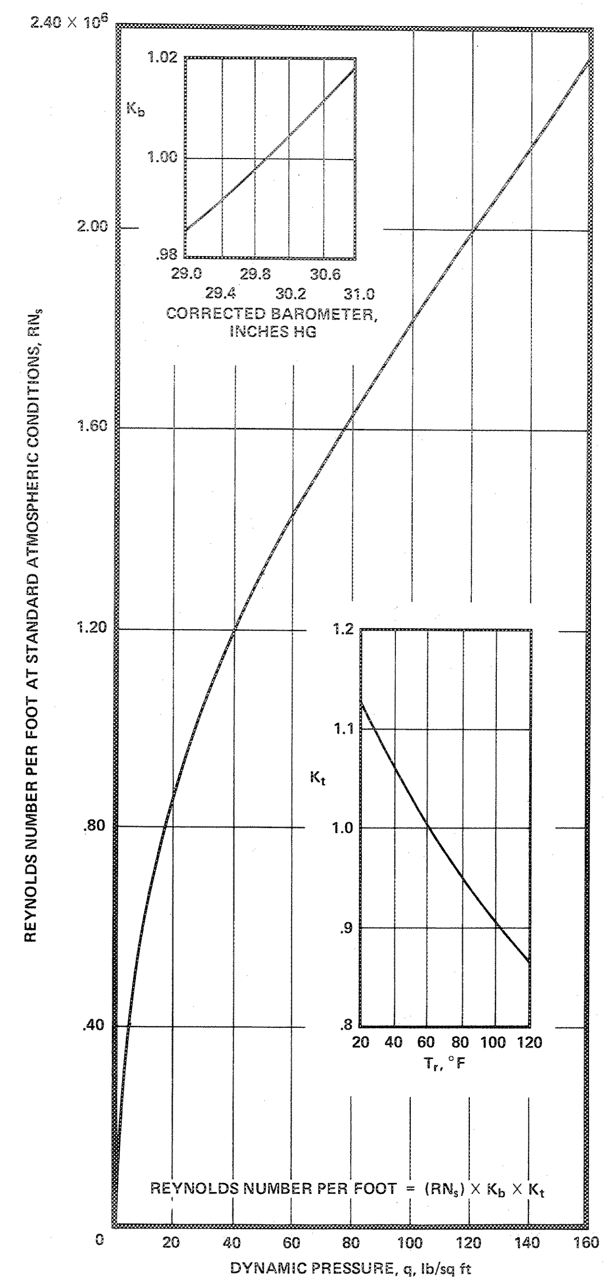
Building N-221





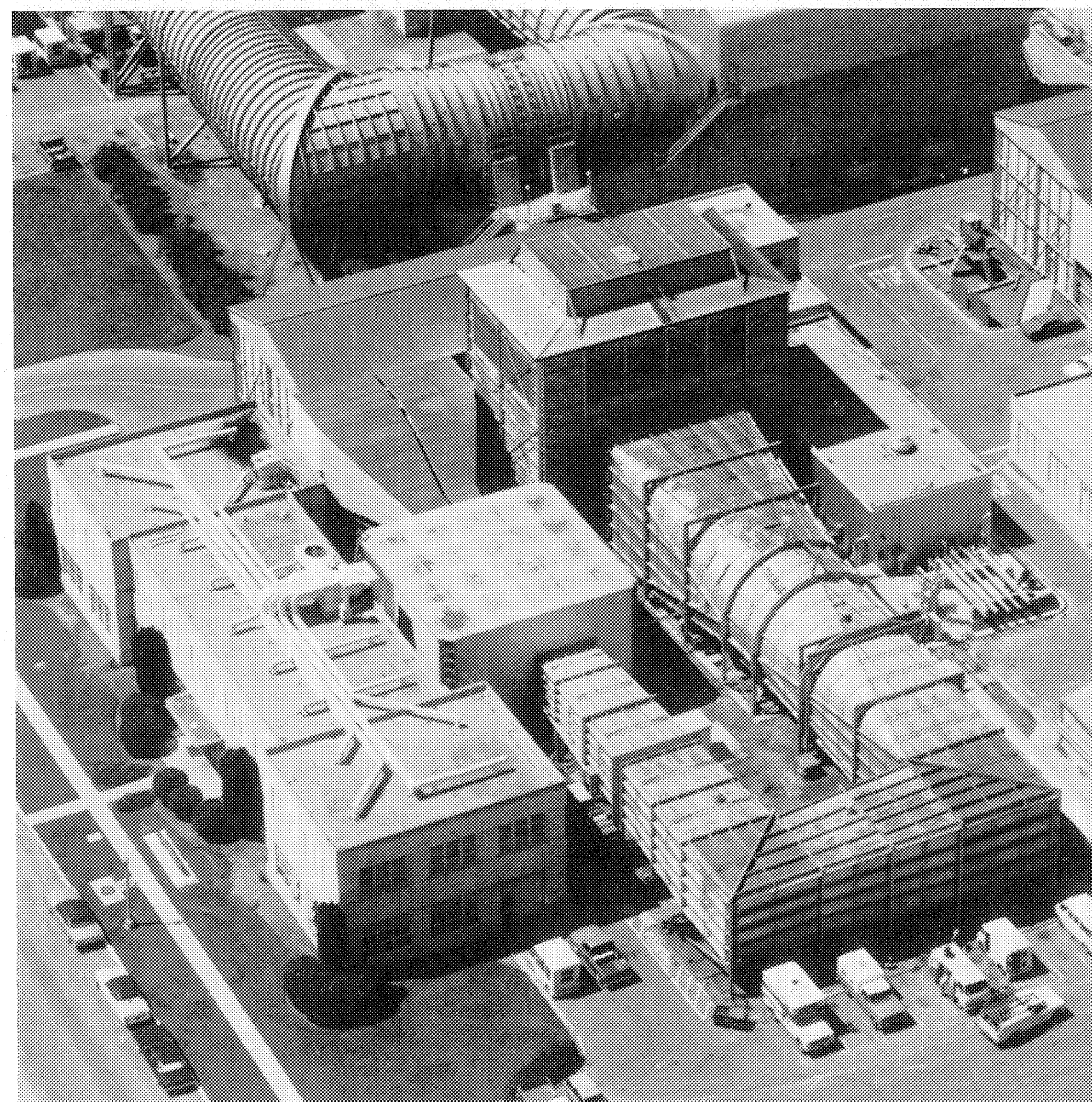


5 AND 35 TON CRANES
DOOR OPEN 80 ft. CLEARANCE
TEST SECTION
SUPPORT SYSTEM
40 ft.
20 ft. R
CONTROL ROOM
BALANCE ROOM
ACCESS DOORS
OFFICE SPACE
WORKING AREA
TUNNEL SHOPS
ELEV. 90 ft. 3 in.
ELEV. 66 ft. 3 in.
ELEV. 49 ft. 3 in.
ELEV. 26 ft. 6 in.
ELEVATOR
FLOOR LEVEL ELEV. 2 ft. 0 in.



REYNOLDS NUMBER PER FOOT AT STANDARD ATMOSPHERIC CONDITIONS, RN_s
2.40 × 10^6
2.00
1.60
1.20
.80
.40
0
20
40
60
80
100
120
140
160
DYNAMIC PRESSURE, q, lb/sq ft
K_b
1.02
1.00
.98
29.0
29.4
29.8
30.2
30.6
31.0
CORRECTED BAROMETER, INCHES HG
K_t
1.2
1.1
1.0
.9
.8
20 40 60 80 100 120
T_r, °F
REYNOLDS NUMBER PER FOOT = $(RN_s) \times K_b \times K_t$

2a. SEVEN-BY TEN-FOOT SUBSONIC WIND TUNNEL NUMBER 1



DESCRIPTION:

The Seven-by Ten-Foot Subsonic Wind Tunnel (Number 1) is a closed-circuit, atmospheric tunnel. Airflow is produced by a fixed-pitch fan powered by a variable-speed electric motor delivering a total of 1,800 horsepower. Model mounting capabilities include single and dual strut mountings on an external balance, sting mounting using an internal balance, and two dimensional mounts across the seven-foot dimension. Automatic data acquisition equipment (576 active channels plus output of external balance and fixed digital inputs) is located in the test chamber and is linked on-line with an IBM 1800 computer, output data from which is returned to an on-line data plotter in the chamber. Six component measurements can be made for external and sting mounting, as well as three component data for two-dimensional mounting. Data systems include scanivalve and strain-gage conditioning equipment. Various model motors are available with two, 100kw, 400-cycle, variable-frequency power supplies provided, as well as a 3,000 psi air system to power pneumatic drives.

PERFORMANCE:

Speed	0 to 220 knots (continuously variable)
Stagnation Pressure	1.0 atmospheres
Reynolds Number	2.3×10^6 per foot (maximum)
Temperature	~580° R (not controlled)

DIMENSIONS: Test Section

Height	7.0 feet
Width	10.0 feet
Length	16.0 feet
Access	Top hatch – 4.6 × 5.0 feet
	Side doors – 6.3 × 10.0 feet

STATUS:

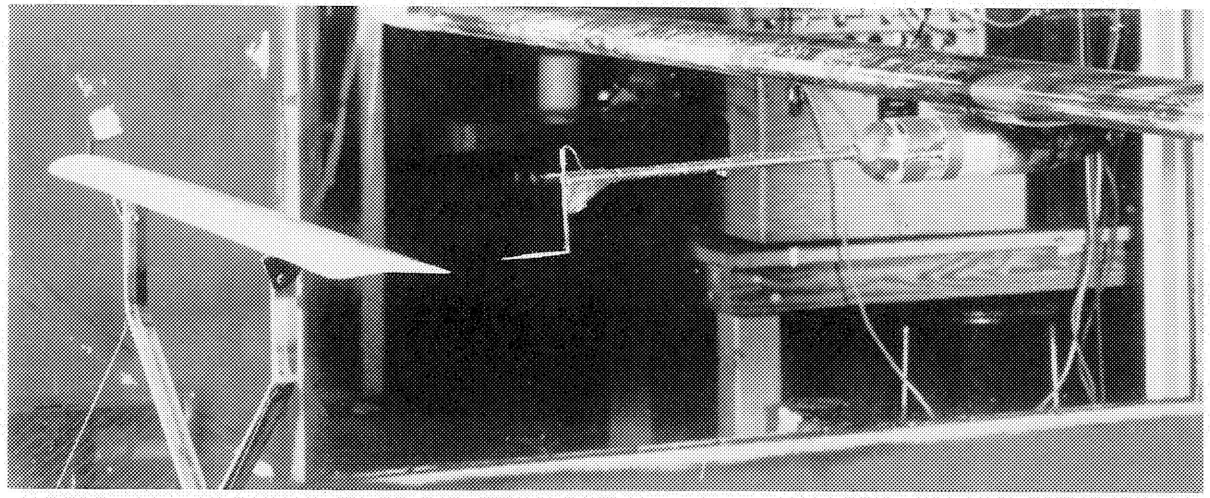
Operational since 1941

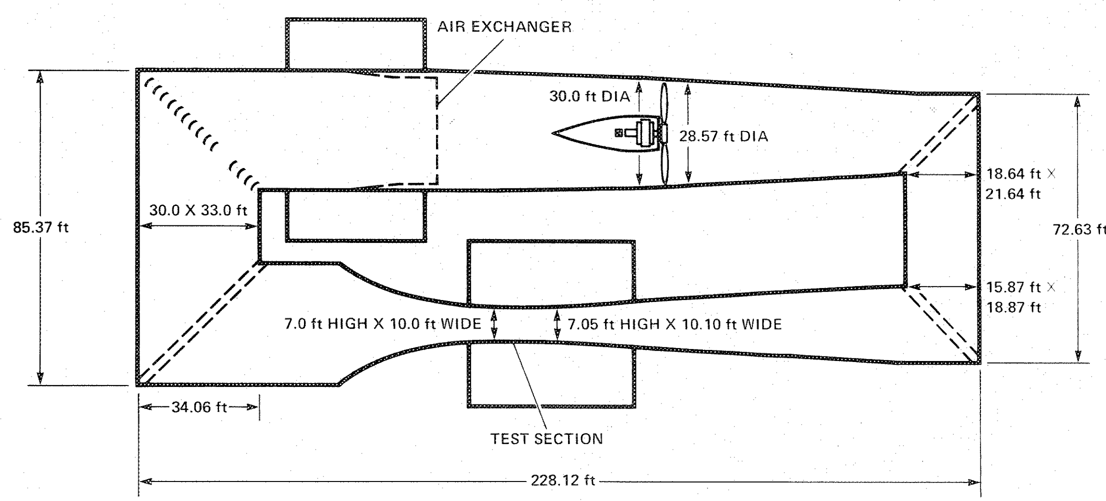
JURISDICTION:

Flight Systems Research Division
Large-Scale Aerodynamics Branch
Mark W. Kelly

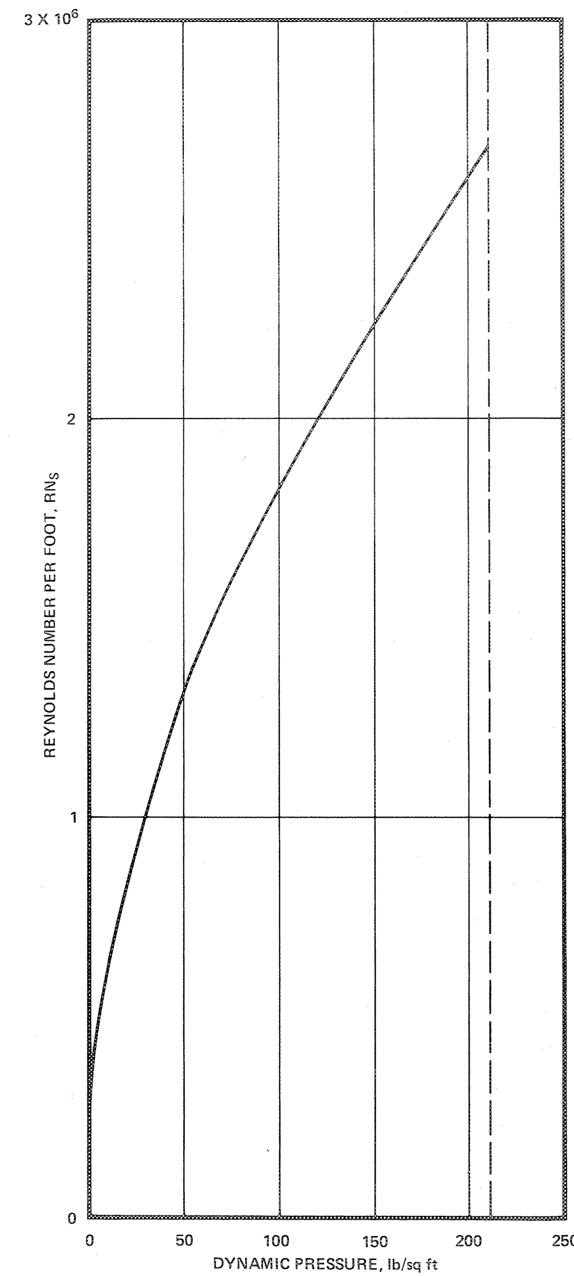
LOCATION:

Building N-215



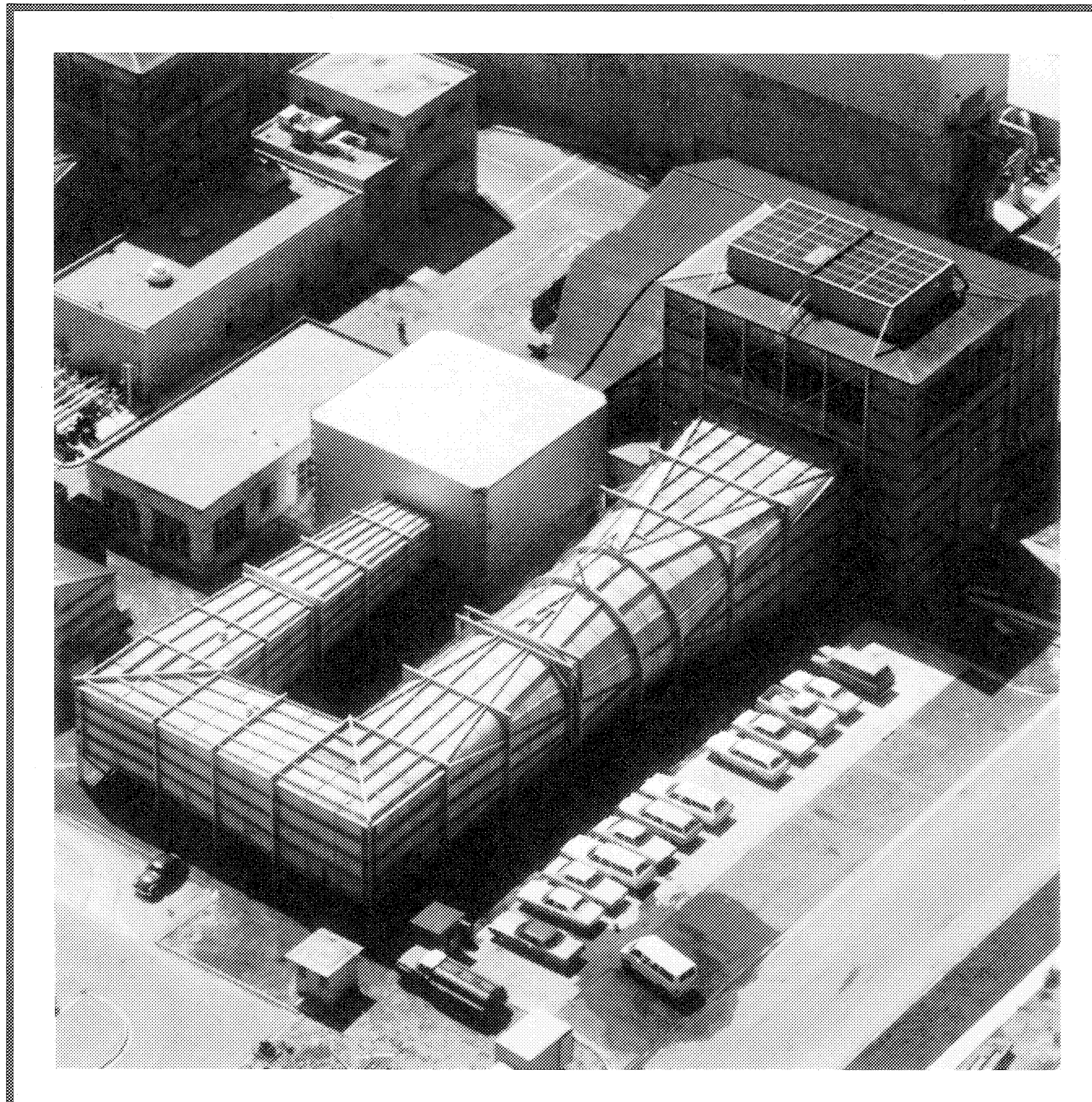


AIR EXCHANGER
30.0 ft DIA
28.57 ft DIA
18.64 ft X 21.64 ft
15.87 ft X 18.87 ft
72.63 ft
85.37 ft
30.0 X 33.0 ft
7.0 ft HIGH X 10.0 ft WIDE
7.05 ft HIGH X 10.10 ft WIDE
34.06 ft
TEST SECTION
228.12 ft



3 X 10^6
2
1
0
REYNOLDS NUMBER PER FOOT, RNs
0
50
100
150
200
250
DYNAMIC PRESSURE, lb/sq ft

2b. SEVEN-BY TEN-FOOT SUBSONIC WIND TUNNEL NUMBER 2 (AAMRDL)



DESCRIPTION:

The Seven-by Ten-Foot Subsonic Wind Tunnel (Number 2) is a closed-circuit, atmospheric tunnel. Airflow is produced by a fixed-pitch fan powered by a variable-speed electric motor delivering a total of 1,800 horsepower. Test setups are flexible to allow installation of a wide variety of two- and three-dimensional models. Two-dimensional models are installed spanwise with supports at the floor and ceiling of the tunnel; continuous angle-of-attack variation from 0° to 180° is available. Three-dimensional models are generally supported on a single or dual pair of vertical struts, each with a trailing link which provides remote pitch control. Motion in the yaw direction of 360° is available. Various model motors are available with 100kw, 400-cycle, variable-frequency power provided. An external, six-component balance system is used to measure forces and moments

PERFORMANCE:

Speed	0 to 220 knots (continuously variable)
Stagnation Pressure	1.0 atmospheres
Reynolds Number	2.3×10^6 per foot (maximum)
Temperature	~580° R (not controlled)

DIMENSIONS: Test Section

Height	7.0 feet
Width	10.0 feet
Length	16.0 feet
Access	Top hatch – 4.8 feet diameter Side door – 6.3 X 10.0 feet

STATUS:

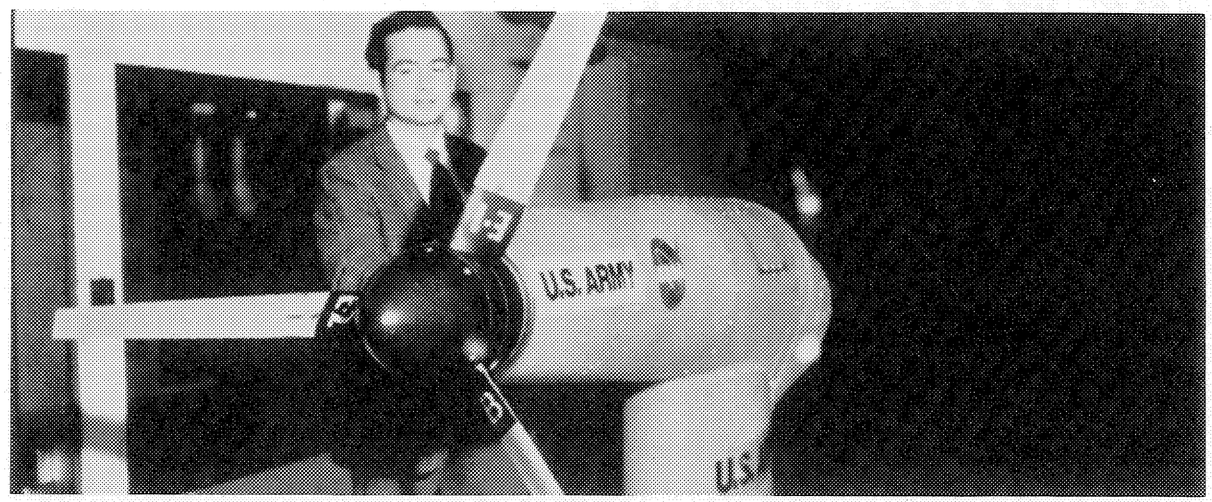
Operational since 1941

JURISDICTION:

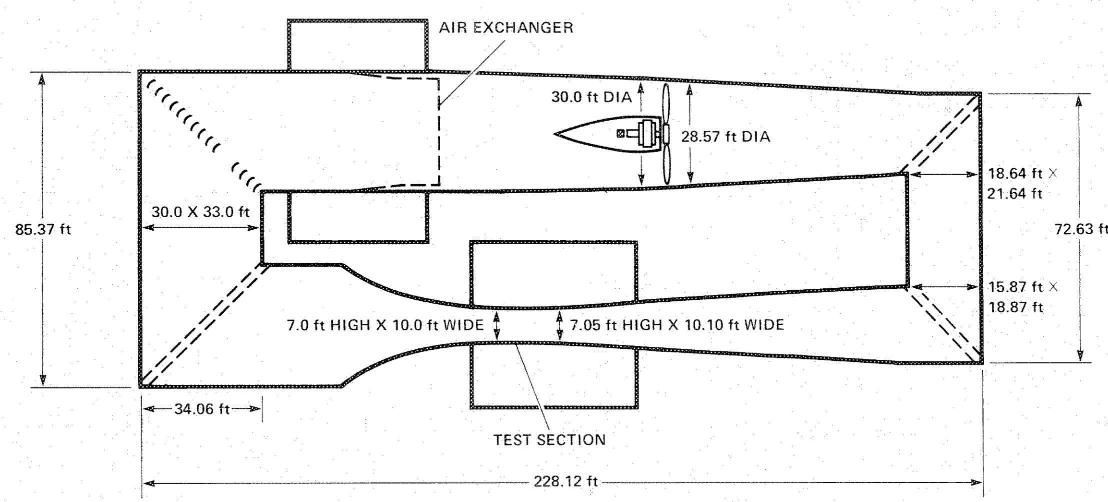
U.S. Army Air Mobility R & D Laboratory
Ames Directorate
Director: Dr. Irving C. Statler

LOCATION:

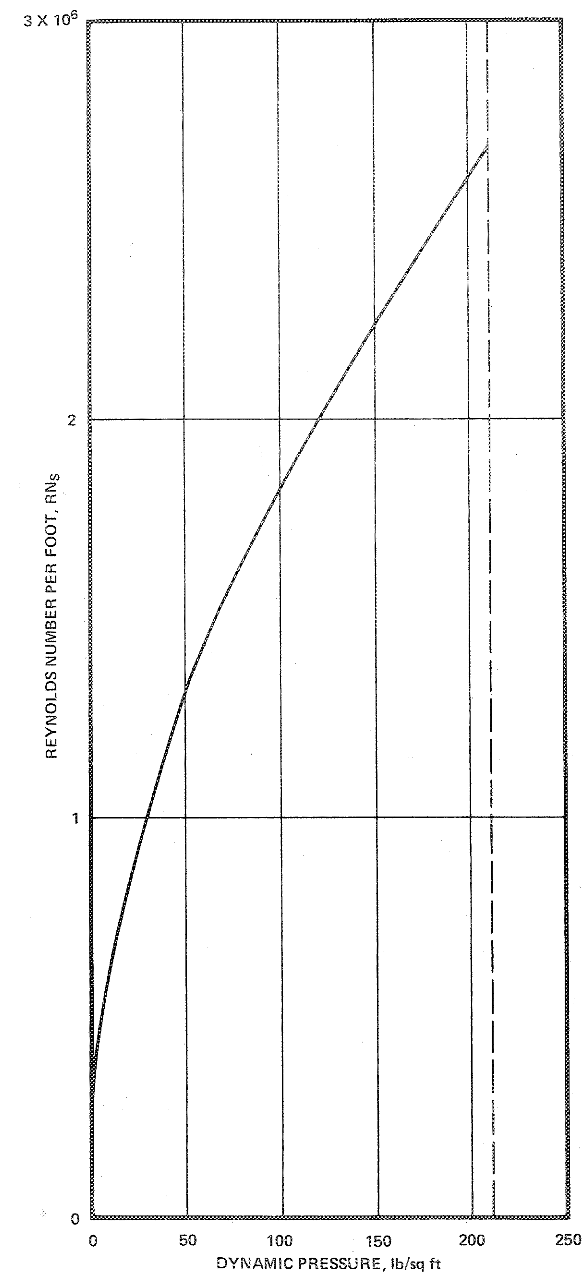
Building N-216



U.S. ARMY

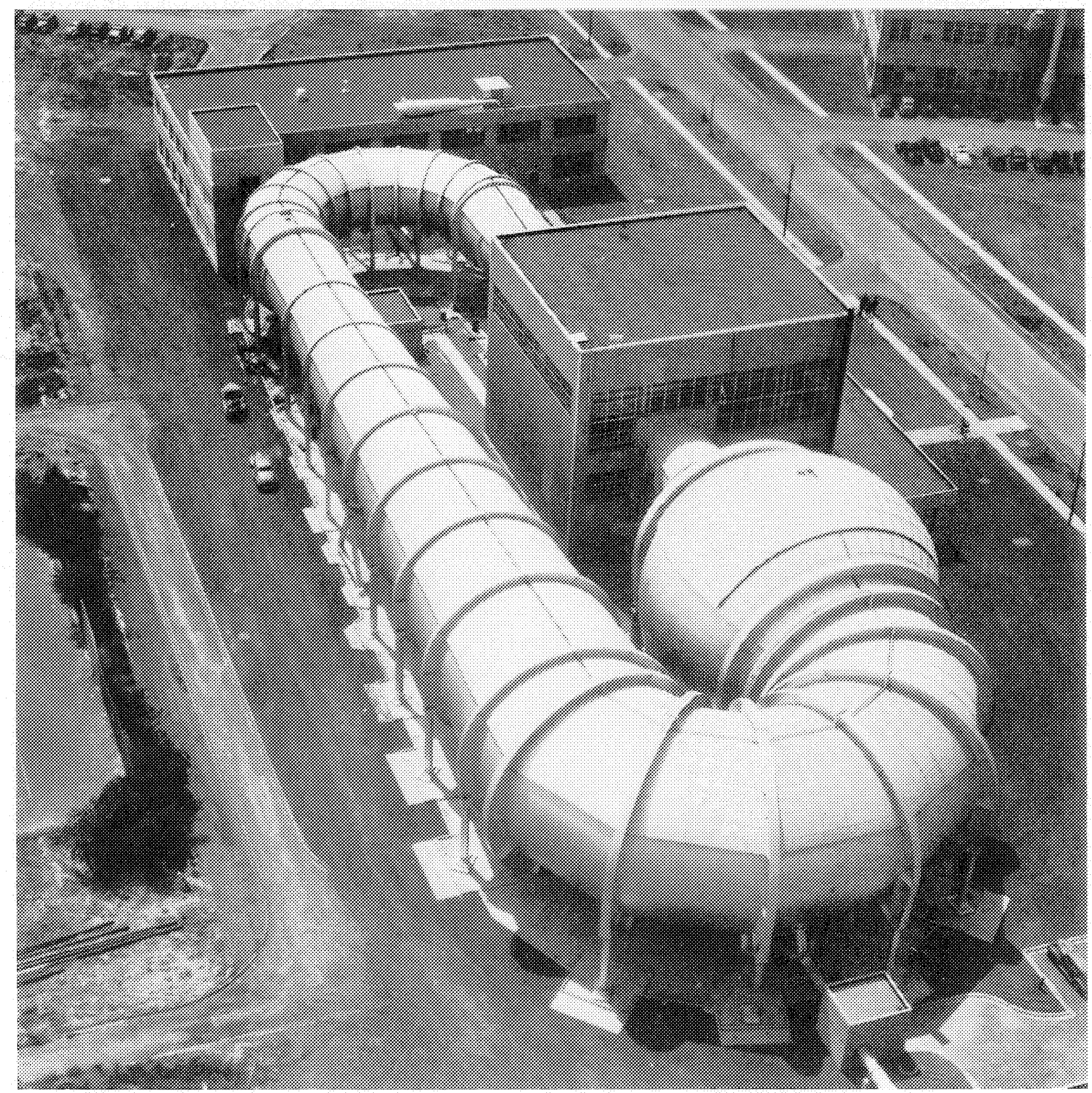


AIR EXCHANGER
30.0 ft DIA
28.57 ft DIA
18.64 ft X
21.64 ft
85.37 ft
30.0 X 33.0 ft
72.63 ft
15.87 ft X
18.87 ft
7.0 ft HIGH X 10.0 ft WIDE
7.05 ft HIGH X 10.10 ft WIDE
34.06 ft
TEST SECTION
228.12 ft



3 X 10^6
2
1
0
REYNOLDS NUMBER PER FOOT, RNs
0
50
100
150
200
250
DYNAMIC PRESSURE, lb/sq ft

3. TWELVE-FOOT PRESSURE WIND TUNNEL



DESCRIPTION:

The Twelve-Foot Pressure Wind Tunnel is a variable-density, low-turbulence tunnel that operates at subsonic speeds up to slightly less than Mach number 1.0. Airflow is produced by a two-stage, axial-flow variable-speed fan powered by electric motors delivering a total of 12,000 horsepower. Eight fine-mesh screens in the settling chamber, together with the contraction ratio of 25 to 1, provide an airstream of exceptionally low turbulence.

A variety of tests can be accomplished using various model-support systems available. These include sting, semi-span and two-dimensional-model type mountings. (A special mounting drive system is available for high angle of attack.) External and internal strain-gage balances are available.

Motion pictures of models can be taken by remotely operated cameras mounted in the balance chamber.

PERFORMANCE:

Mach Number	0. to 0.98 (continuously variable)
Stagnation Pressure	0.17 to 5.0 atmospheres
Reynolds Number	0 to 9.0×10^6 per foot
Stagnation Temperature	500 to 625° R

DIMENSIONS: Test Section

Height	11.3 feet
Width	11.3 feet
Length	18.0 feet
Access	Top hatch – 5.0×11.0 feet

STATUS:

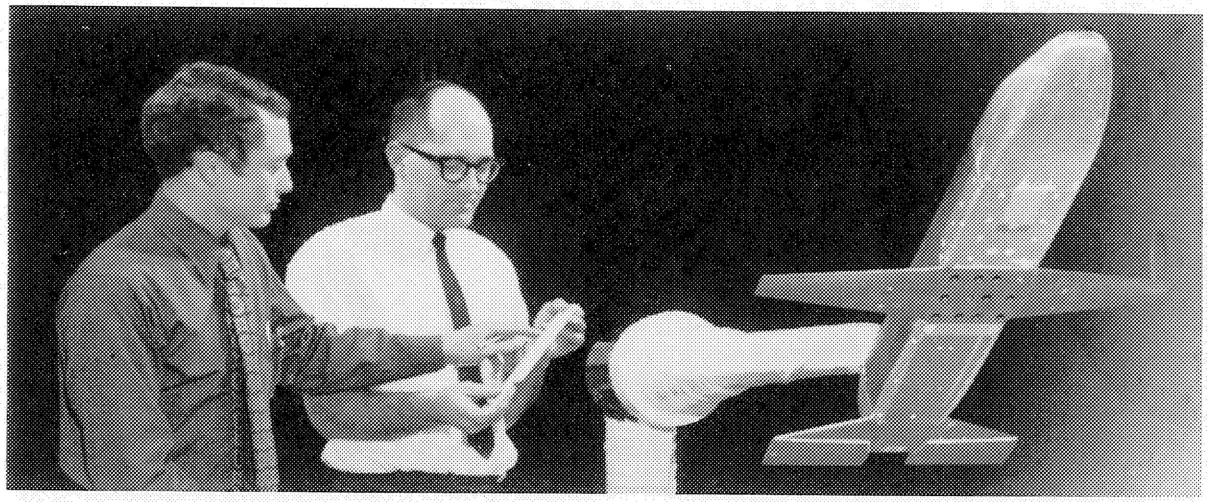
Operational since 1946

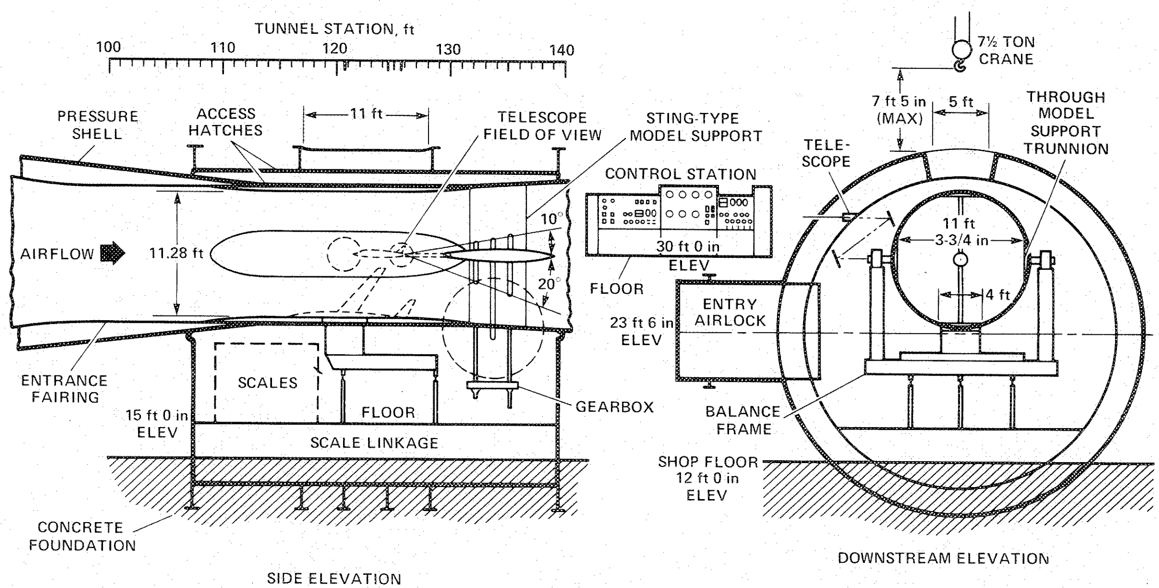
JURISDICTION:

Aeronautics Division
Experimental Investigations Branch
Stuart Treon

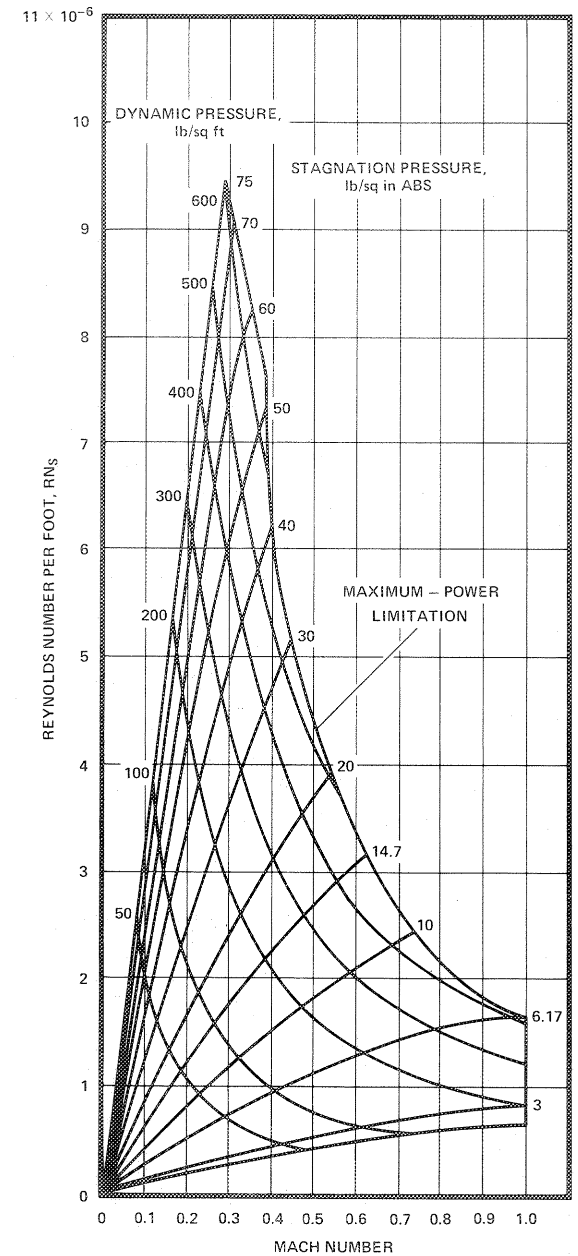
LOCATION:

Building N-206





TUNNEL STATION, ft
100
110
120
130
140
PRESSURE SHELL
ACCESS HATCHES
11 ft
TELESCOPE FIELD OF VIEW
STING-TYPE MODEL SUPPORT
CONTROL STATION
AIRFLOW
11.28 ft
10°
20°
30 ft 0 in ELEV
FLOOR
23 ft 6 in ELEV
ENTRY AIRLOCK
ENTRANCE FAIRING
15 ft 0 in ELEV
SCALES
FLOOR
SCALE LINKAGE
GEARBOX
CONCRETE FOUNDATION
SIDE ELEVATION
7½ TON CRANE
7 ft 5 in (MAX)
5 ft
THROUGH MODEL SUPPORT TRUNNION
TELE-SCOPE
11 ft 3-3/4 in
4 ft
BALANCE FRAME
SHOP FLOOR 12 ft 0 in ELEV
DOWNSTREAM ELEVATION



11 × 10^-6
REYNOLDS NUMBER PER FOOT, RNs
DYNAMIC PRESSURE, lb/sq ft
STAGNATION PRESSURE, lb/sq in ABS
600
500
400
300
200
100
50
75
70
60
50
40
30
20
14.7
10
6.17
3
MAXIMUM – POWER LIMITATION
0
1
2
3
4
5
6
7
8
9
10
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
MACH NUMBER

4. FOURTEEN-FOOT TRANSONIC WIND TUNNEL

DESCRIPTION:

The Fourteen-Foot Transonic Wind Tunnel is a closed-circuit tunnel equipped with an adjustable, flexible-wall nozzle and a test section with four slotted walls. (The air circuit is closed except for the air exchanger, in a low-speed section, which is controlled to maintain suitable air temperature.) Airflow is produced by a three-stage, axial-flow compressor powered by three variable-speed, electric motors mounted in tandem outside the tunnel, rated at 110,000 horsepower continuously or 132,000 hp for one hour.

For conventional, steady-state testing models are generally supported on an adjustable sting. Internal, strain-gage balances are used for measuring forces and moments. Additional facilities are available for measuring multiple steady or fluctuating pressures, as well as variable-speed compact model motors with a variable-frequency power source.

A schlieren system is available for flow visualization.

PERFORMANCE:

Mach Number	0.6 to 1.2 (continuously variable)
Stagnation Pressure	1.0 atmosphere
Reynolds Number	2.8×10^6 to 4.2×10^6 per foot
Stagnation Temperature	Generally 640° R

DIMENSIONS: Test Section

Height	13.5 feet
Width	13.71 feet (upstream)
	13.92 feet (downstream)
Length	33.75 feet
Access	Side doors — 6.7 X 8.0 feet

STATUS:

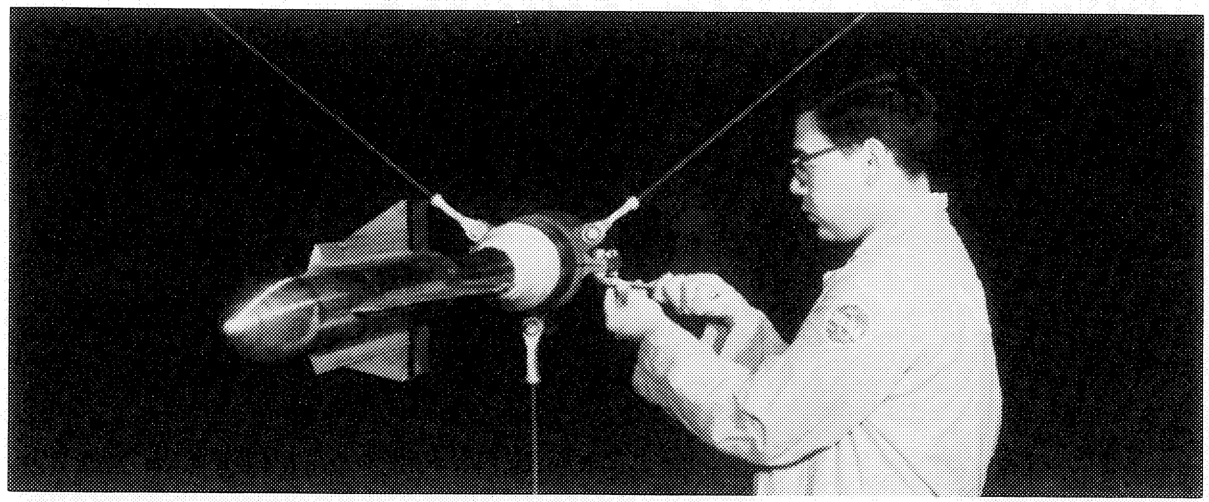
Operational since 1956

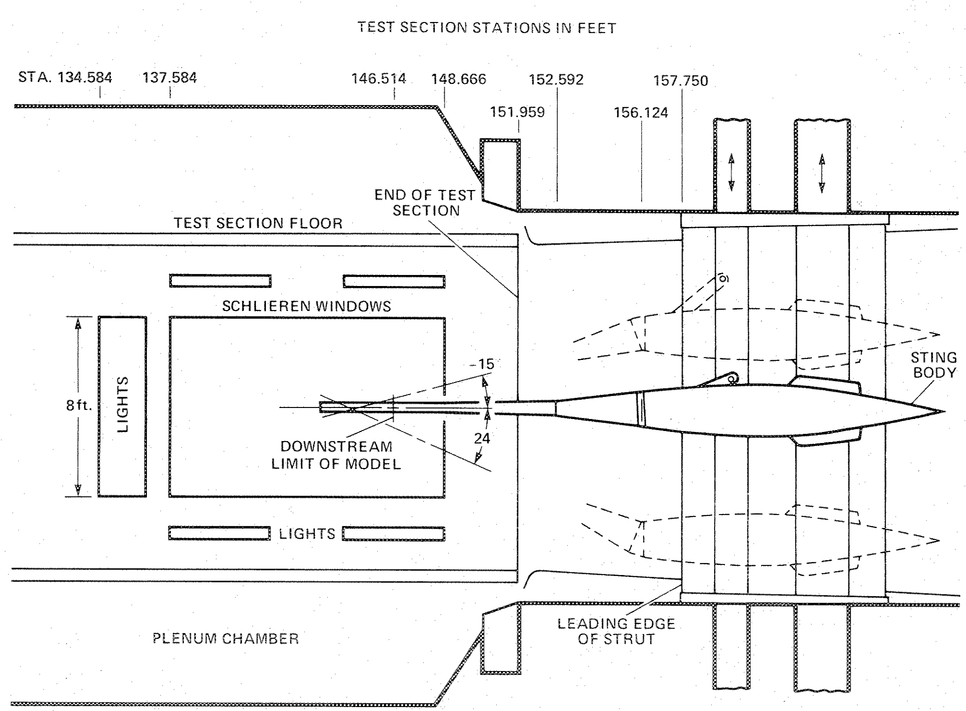
JURISDICTION:

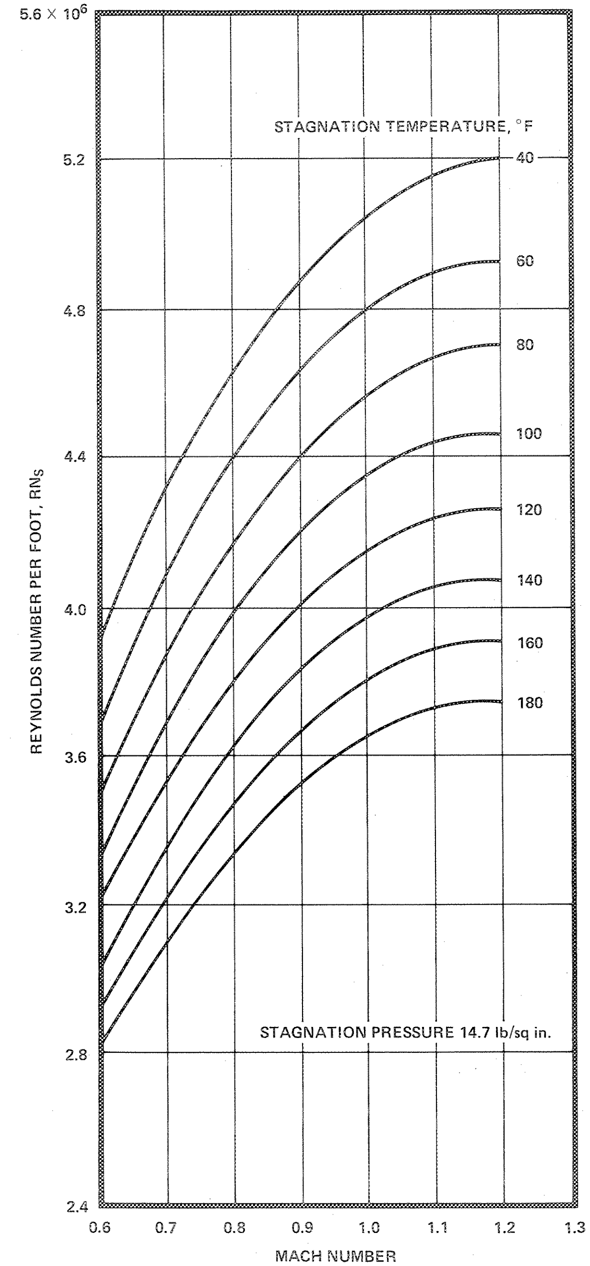
Aeronautics Division
Experimental Investigations Branch
Stuart Treon

LOCATION:

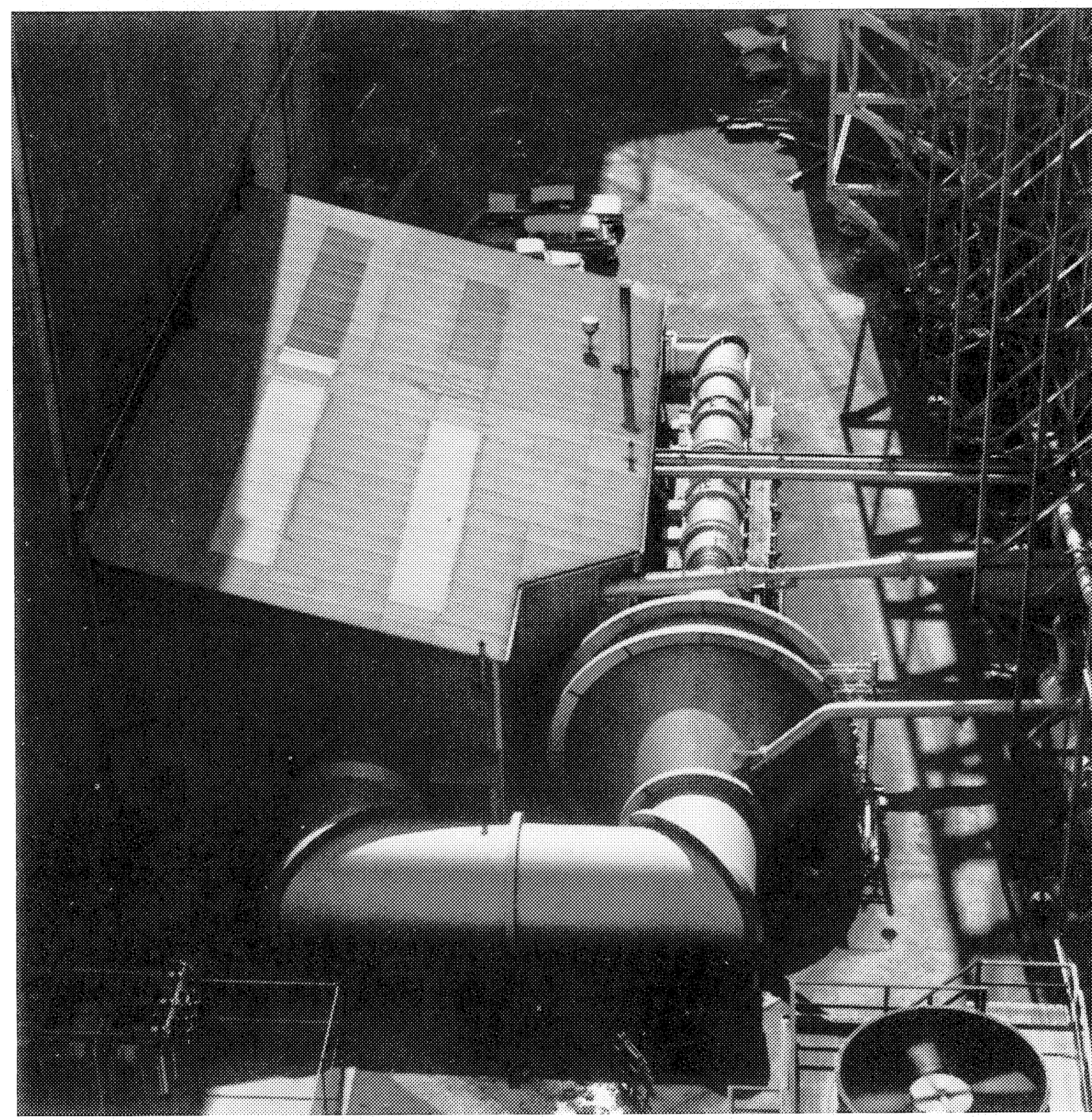
Building N-218




TEST SECTION STATIONS IN FEET
STA. 134.584
137.584
146.514
148.666
152.592
157.750
151.959
156.124
END OF TEST SECTION
TEST SECTION FLOOR
SCHLIEREN WINDOWS
LIGHTS
8 ft.
-15
24
DOWNSTREAM LIMIT OF MODEL
STING BODY
LIGHTS
PLENUM CHAMBER
LEADING EDGE OF STRUT


5.6 × 10^6
5.2
4.8
4.4
4.0
3.6
3.2
2.8
2.4
REYNOLDS NUMBER PER FOOT, RNs
STAGNATION TEMPERATURE, °F
40
60
80
100
120
140
160
180
STAGNATION PRESSURE 14.7 lb/sq in.
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
MACH NUMBER

5. TWO-BY TWO-FOOT TRANSONIC WIND TUNNEL



DESCRIPTION:

The Two- by Two-Foot Transonic Wind Tunnel is a closed-return, variable-density tunnel equipped with an adjustable, flexible-wall nozzle and a slotted test section. Airflow is produced by a two-stage, axial-flow compressor powered by four, variable-speed induction motors mounted in tandem, delivering a total of 4,000 horsepower. For conventional, steady-state testing models are generally supported on a sting. Internal, strain-gage balances are used for measuring forces and moments. (Additional facilities are available for measuring multiple steady or fluctuating pressures.)

This facility is also used for panel-flutter testing (one test-section wall is replaced with another containing the test specimen).

PERFORMANCE:

Mach Number	0.2 to 1.4 (continuously variable)
Stagnation Pressure	0.16 to 3.0 atmospheres
Reynolds Number	0.5×10^6 to 8.7×10^6 per foot
Stagnation Temperature	580° R

DIMENSIONS: Test Section

Height	2.0 feet
Width	2.0 feet
Length	5.0 feet
Access	Side doors – 2.0 X 5.0 feet

STATUS:

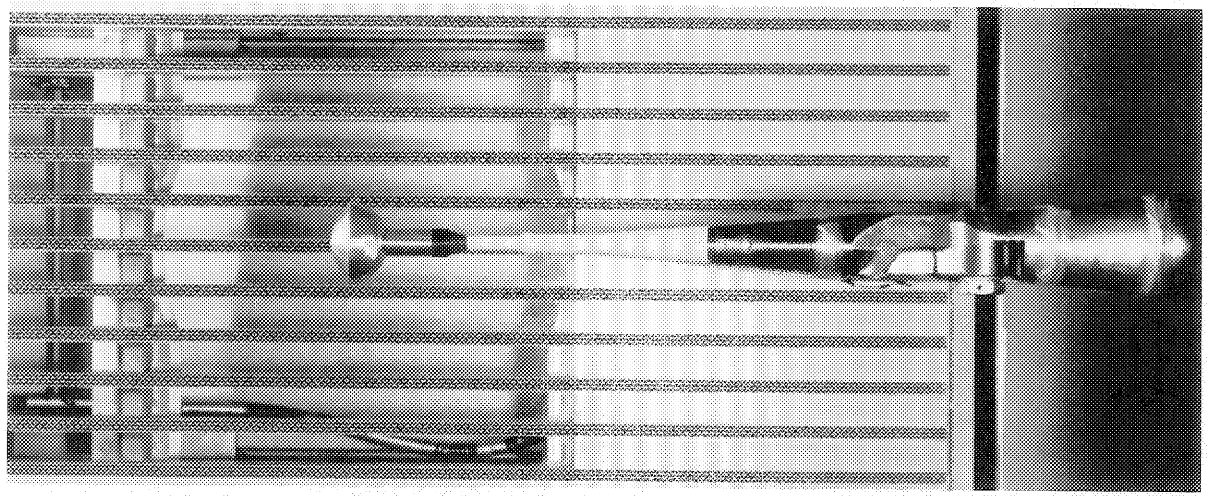
Operational since 1951

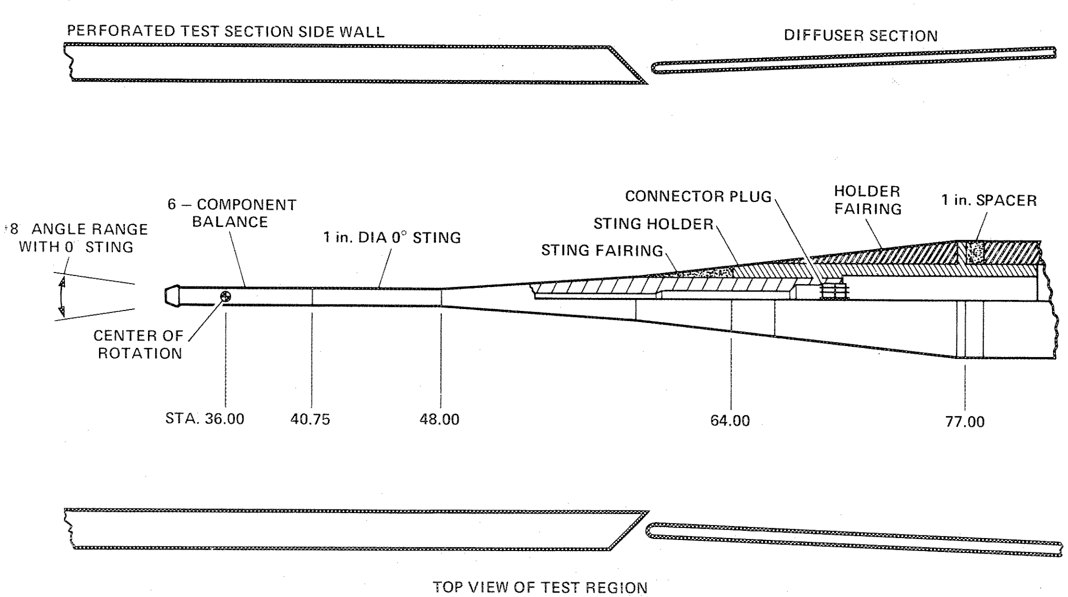
JURISDICTION:

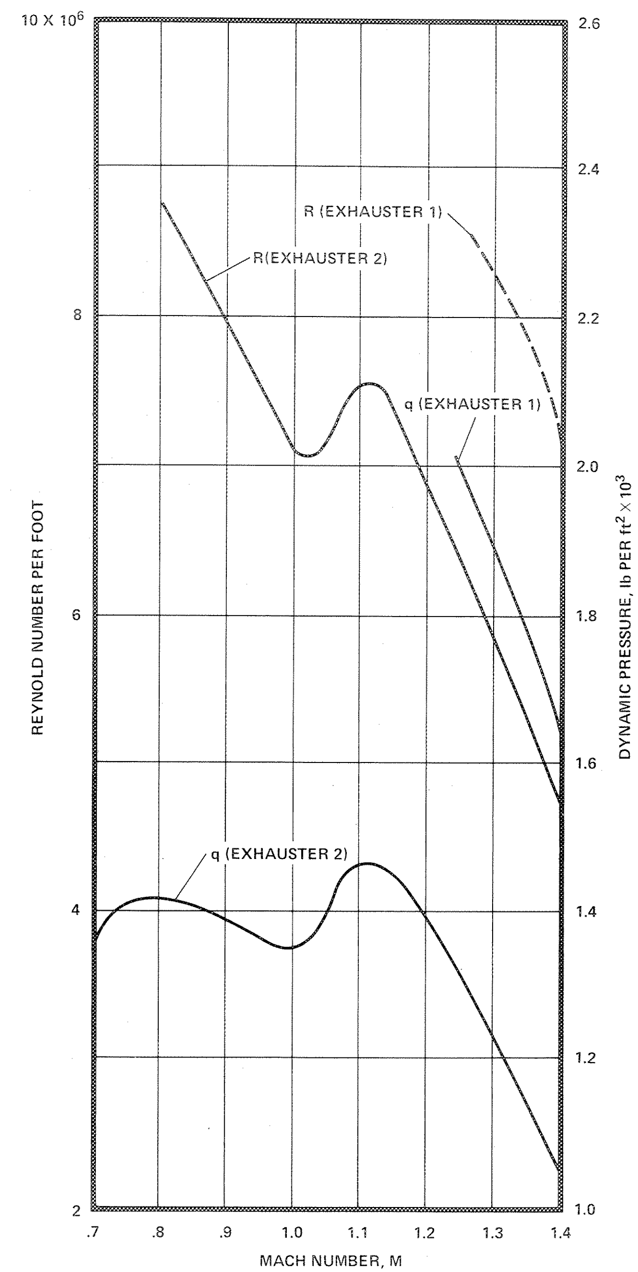
Aeronautics Division
Experimental Investigations Branch
Stuart Treon

LOCATION:

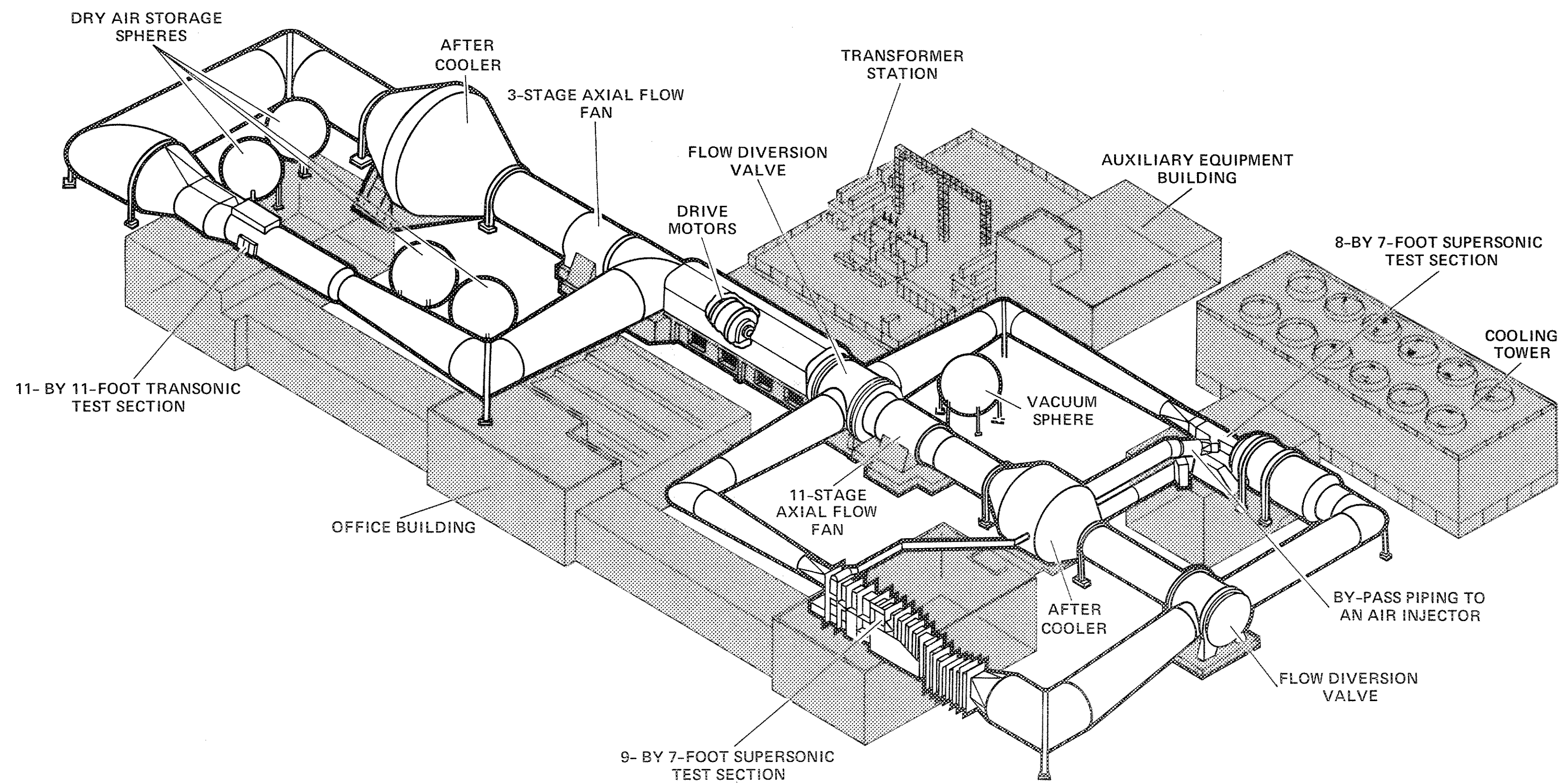
Building N-222




PERFORATED TEST SECTION SIDE WALL
DIFFUSER SECTION
±8 ANGLE RANGE WITH 0 STING
6 – COMPONENT BALANCE
1 in. DIA 0° STING
CONNECTOR PLUG
STING HOLDER
STING FAIRING
HOLDER FAIRING
1 in. SPACER
CENTER OF ROTATION
STA. 36.00
40.75
48.00
64.00
77.00
TOP VIEW OF TEST REGION

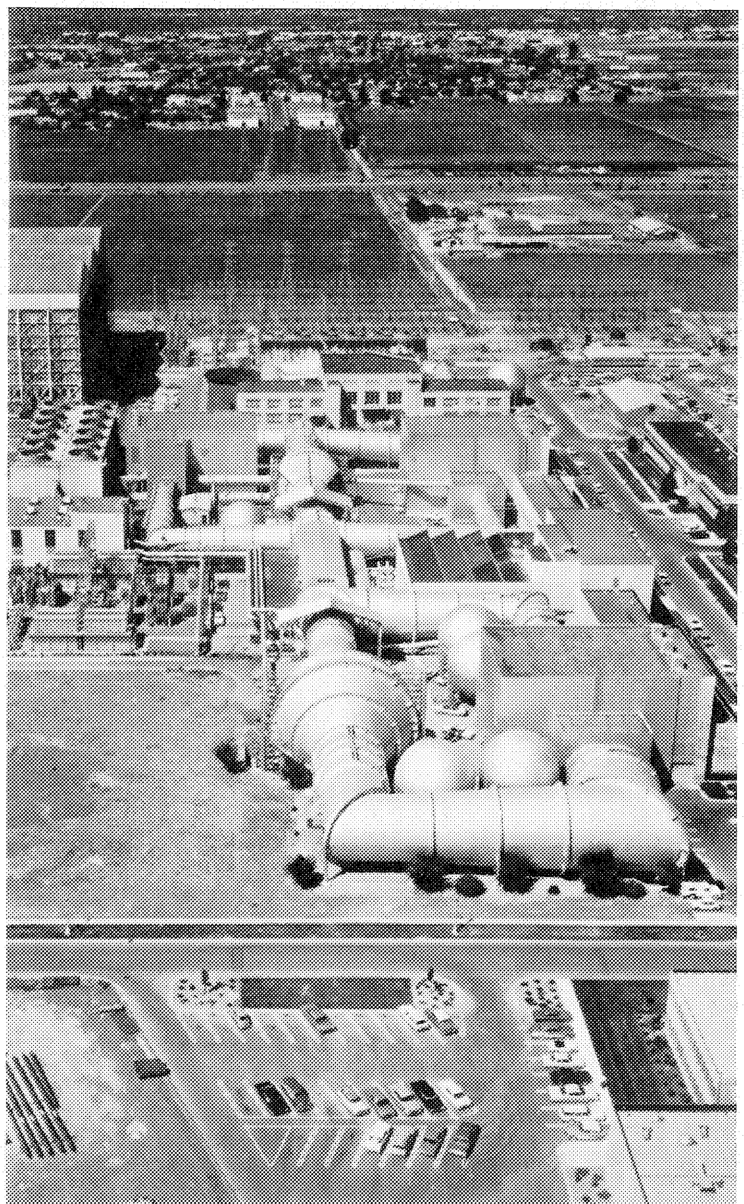

10 X 10^6
8
6
4
2
REYNOLD NUMBER PER FOOT
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
DYNAMIC PRESSURE, lb PER ft^2 × 10^3
.7
.8
.9
1.0
1.1
1.2
1.3
1.4
MACH NUMBER, M
R (EXHAUSTER 1)
R(EXHAUSTER 2)
q (EXHAUSTER 1)
q (EXHAUSTER 2)

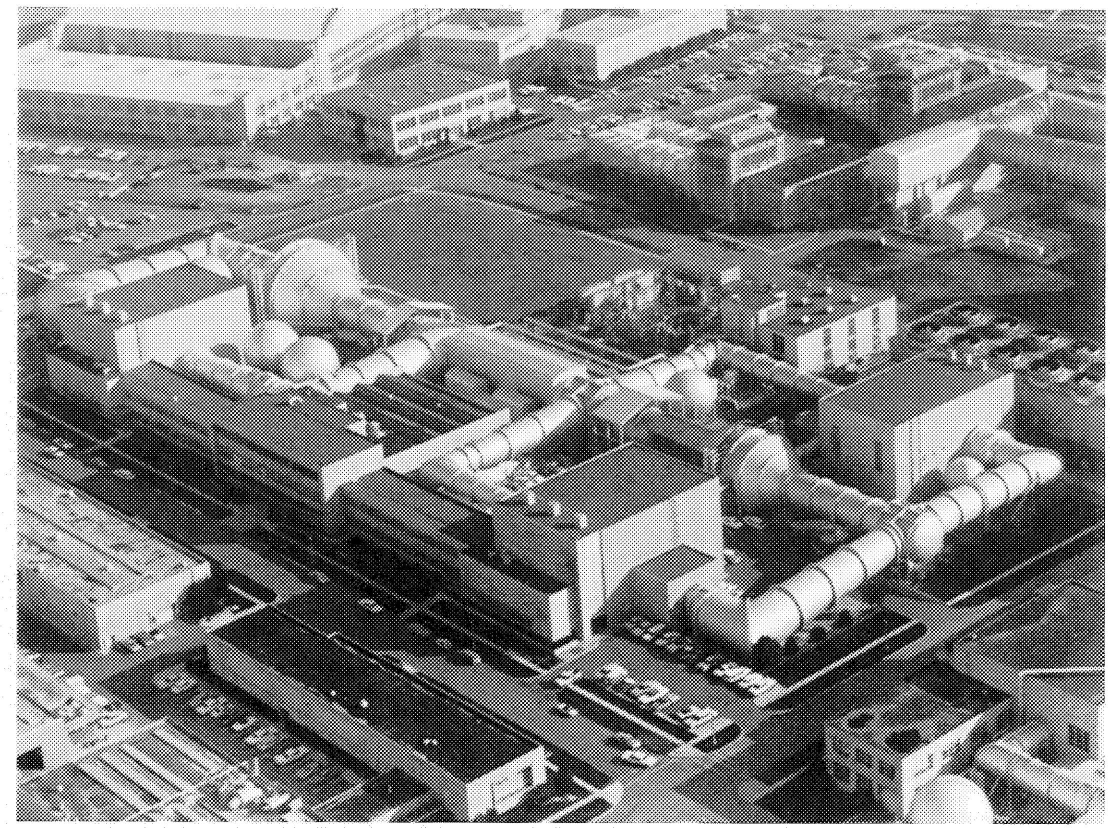
6. UNITARY PLAN WIND TUNNELS



MAJOR COMPONENTS OF THE UNITARY PLAN WIND TUNNELS

Unitary Test Sections	Height and Width, ft	Speed Range	Stagnation Press, atm	Stagnation Temp, °R	Reynolds No./ft	Dynamic Pressure, lb/ft^2	Special Features
Eleven Foot Transonic	Eleven by Eleven	0.70 to 1.4 M	0.5 to 2.25	580	1.7 to 9.4 $\times 10^6$	250 to 2000	Slotted Test Section, 4 Walls
Nine-by Seven-Foot Supersonic	Seven by Nine	1.55 to 2.5 M	0.3 to 2.0	580	1.5 to 6.5 $\times 10^6$	200 to 1450	
Eight-by Seven-Foot Supersonic	Eight by Seven	2.45 to 3.5 M	0.3 to 2.0	580	1.0 to 5.0 $\times 10^6$	200 to 1000	





Unitary Plan Wind Tunnels

The Ames Unitary Plan facility is a unique system of wind tunnels comprised of three test sections: an Eleven-by Eleven-Foot Transonic Tunnel (Mach 0.40 to 1.40), a Nine-by Seven-Foot Supersonic Tunnel (Mach 1.55 to 2.50), and an Eight-by Seven-Foot Supersonic Tunnel (Mach 2.45 to 3.45), all capable of operating at variable stagnation pressures.

The major common element of the tunnel complex is its electric powerplant consisting of four intercoupled motors capable of generating a total of 180,000 horsepower continuously. Construction of this facility began in 1951 and was fully operational by 1955. This facility is considered a landmark in the development of supersonic wind tunnels.

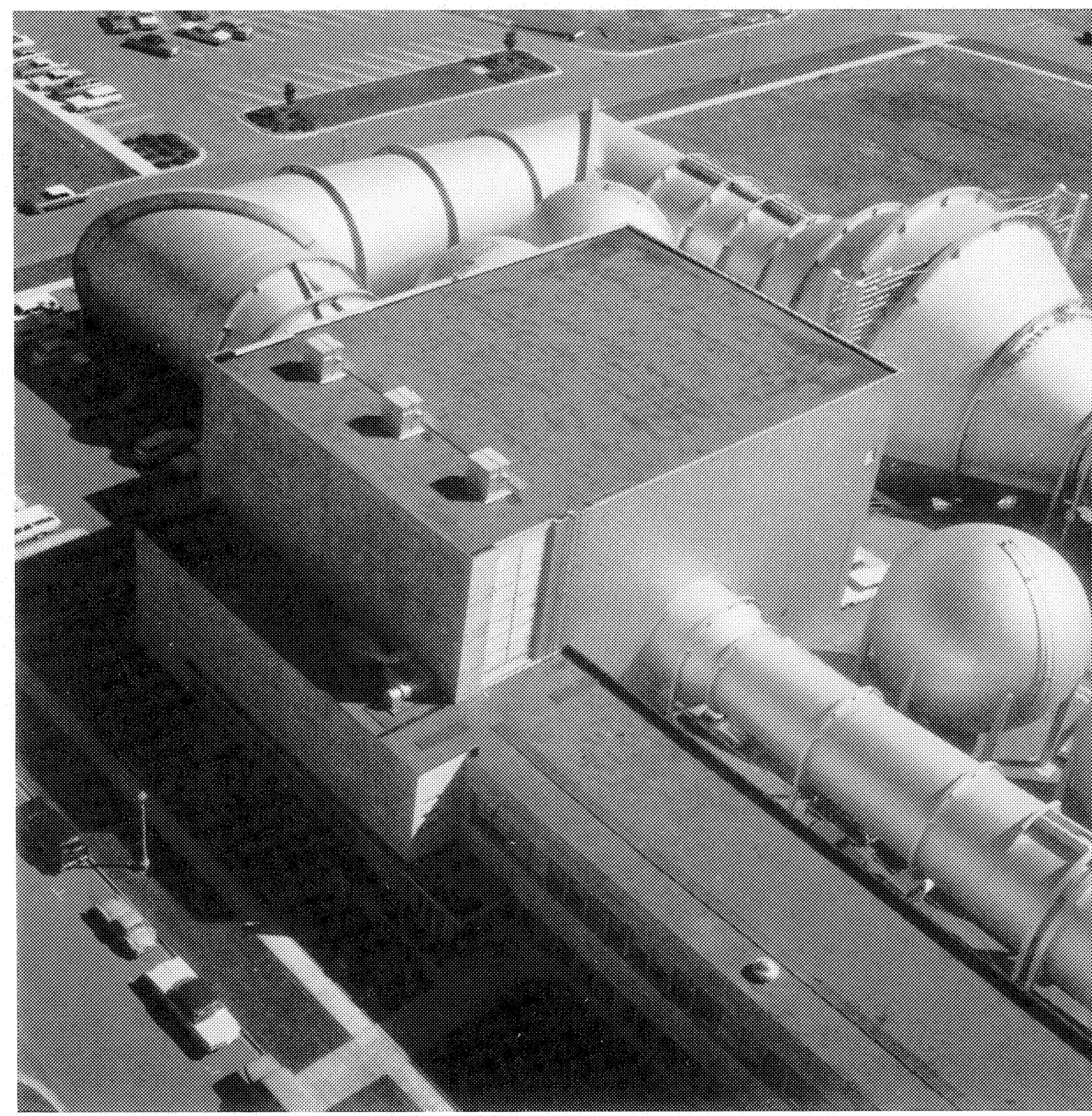
6a. ELEVEN-BY ELEVEN-FOOT WIND TUNNEL

DESCRIPTION:

The Eleven-by Eleven-Foot Transonic Wind Tunnel is a closed-return, variable density tunnel with a fixed geometry, ventilated throat and a single-jack flexible nozzle. Airflow is produced by a three-stage, axial-flow compressor powered by four wound-rotor variable-speed induction motors.

For conventional steady-state testing models are generally supported on a sting. Internal strain-gage balances are used for measuring forces and moments. (Additional facilities are available for measuring multiple steady or fluctuating pressures.)

A schlieren system is available for studying flow patterns by direct viewing or photography, as well as a system for obtaining 20-by 40-inch shadowgraph negatives.



PERFORMANCE:

Mach Number	0.4 to 1.4 (continuously variable)
Stagnation Pressure	0.5 to 2.25 atmospheres
Reynolds Number	1.7×10^6 to 9.4×10^6 per foot
Stagnation Temperature	580° R

DIMENSIONS: Test Section

Height	11.0 feet
Width	11.0 feet
Length	22.0 feet
Access	Top hatch – 7.0 X 22.0 feet

STATUS:

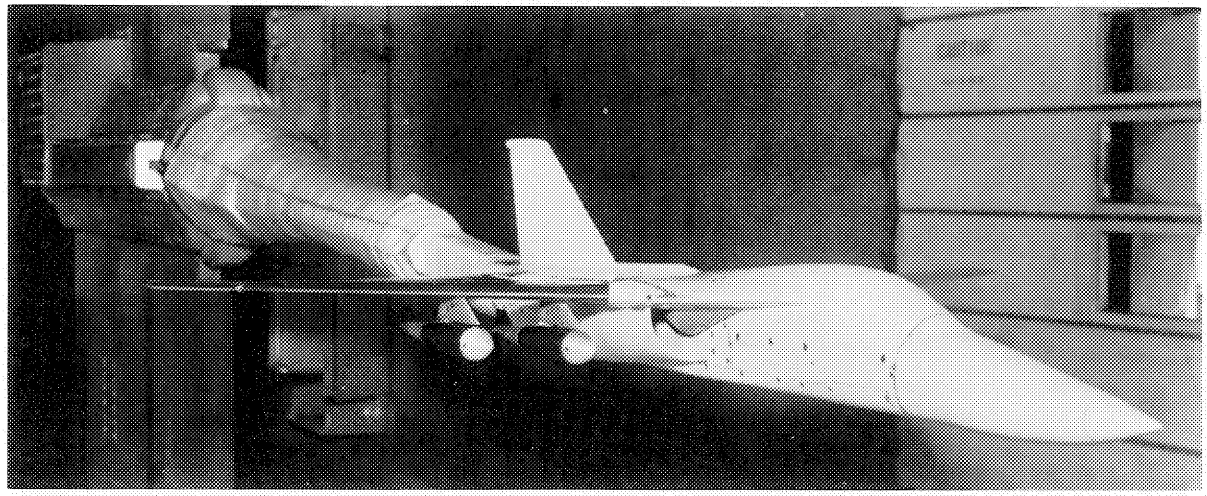
Operational since 1956

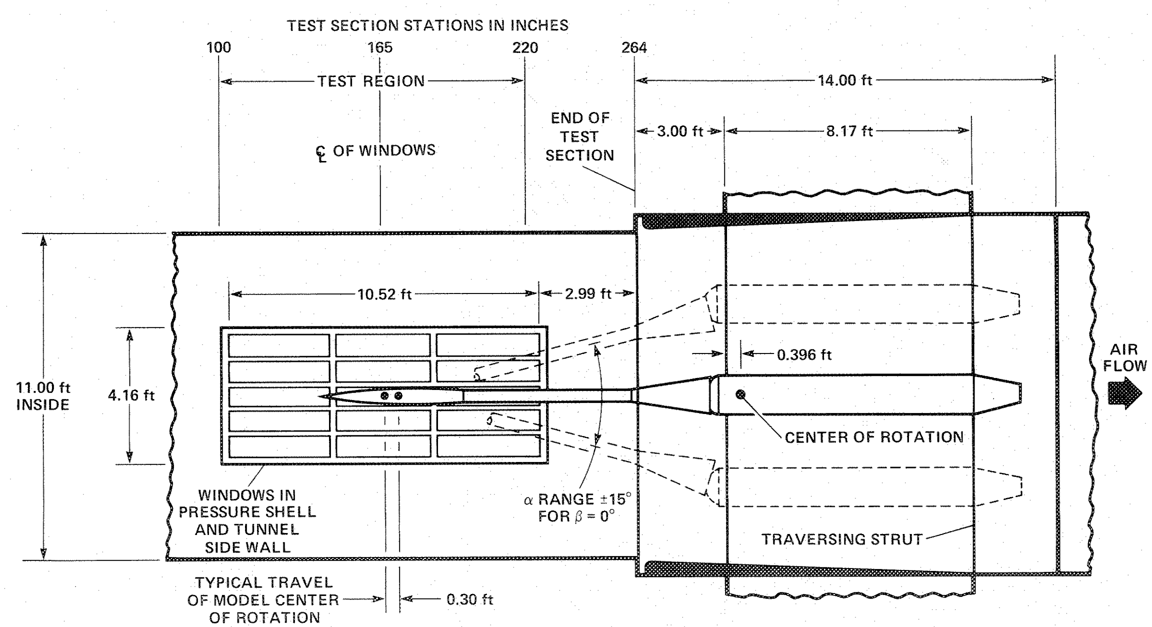
JURISDICTION:

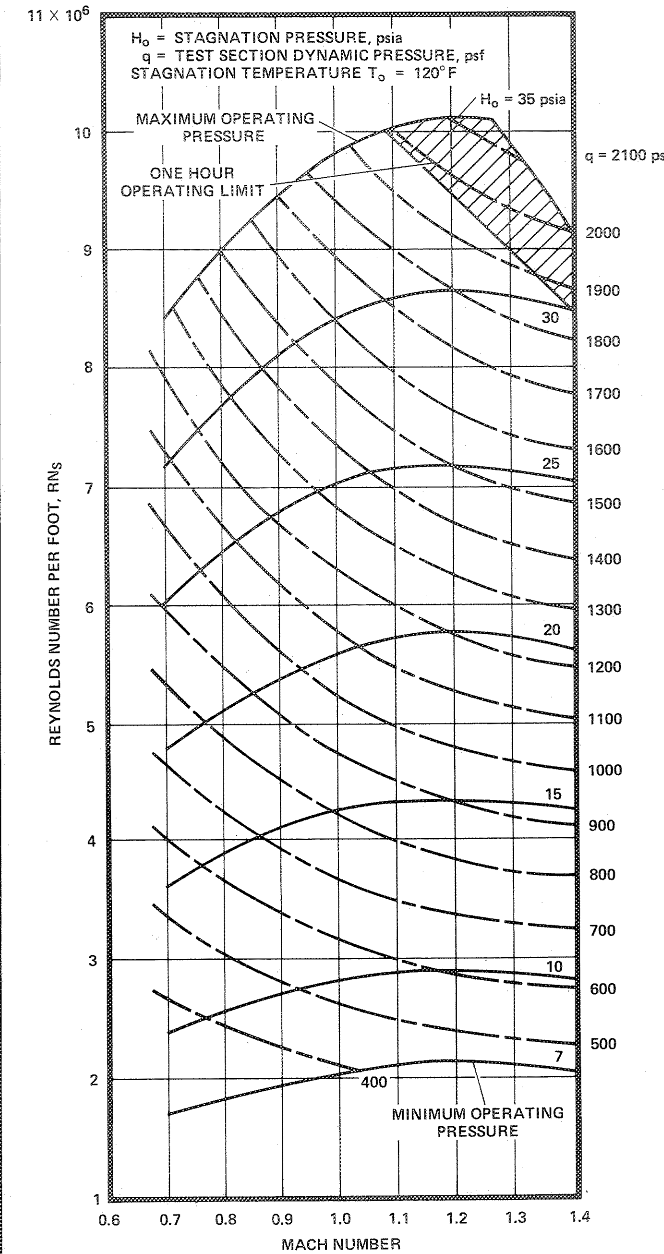
Aeronautics Division
Experimental Investigations Branch
Stuart Treon

LOCATION:

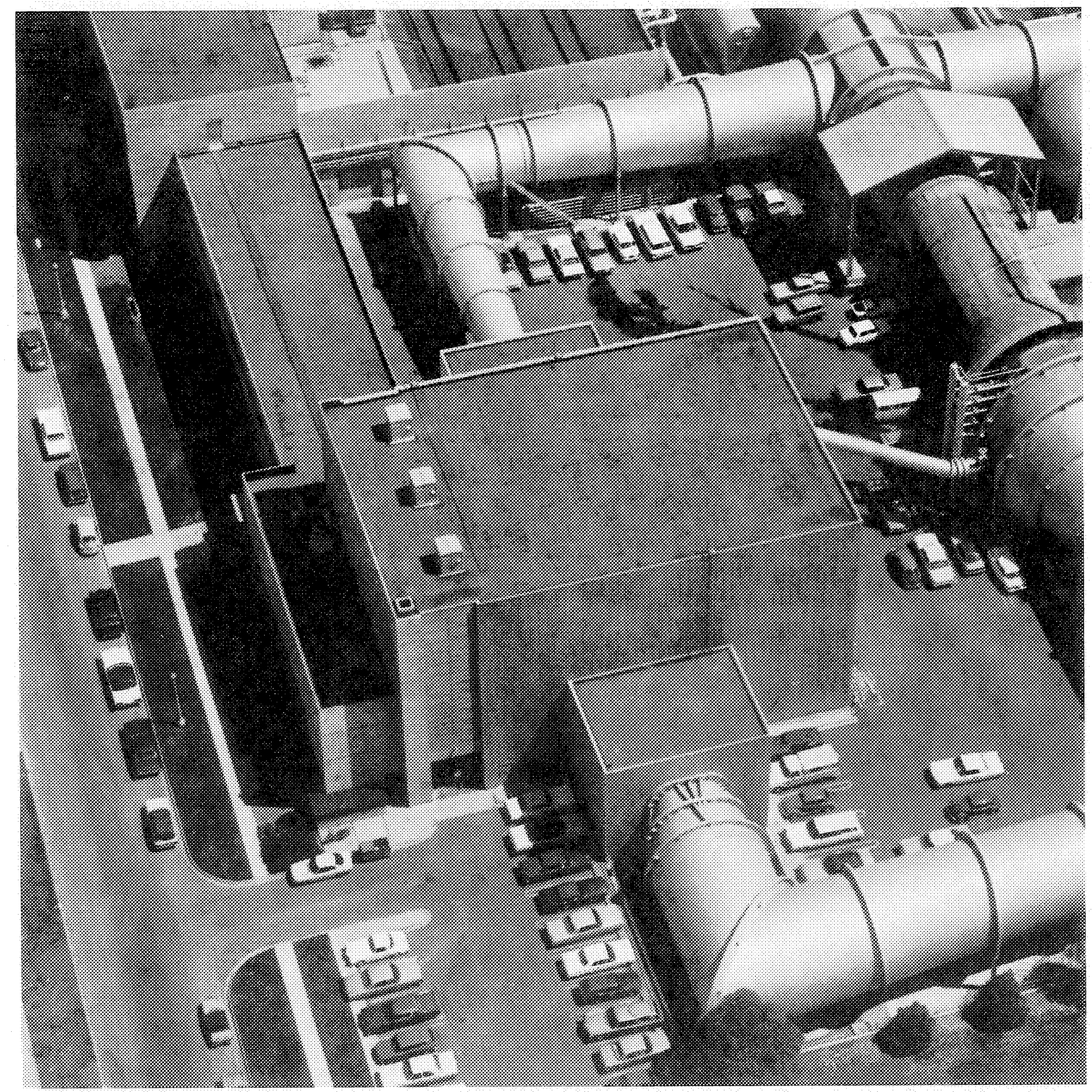
Building N-227A




TEST SECTION STATIONS IN INCHES
100
165
220
264
TEST REGION
℄ OF WINDOWS
END OF TEST SECTION
14.00 ft
3.00 ft
8.17 ft
10.52 ft
2.99 ft
0.396 ft
11.00 ft INSIDE
4.16 ft
AIR FLOW
CENTER OF ROTATION
WINDOWS IN PRESSURE SHELL AND TUNNEL SIDE WALL
α RANGE ±15° FOR β = 0°
TRAVERSING STRUT
TYPICAL TRAVEL OF MODEL CENTER OF ROTATION
0.30 ft


11 X 10^6
H_o = STAGNATION PRESSURE, psia
q = TEST SECTION DYNAMIC PRESSURE, psf
STAGNATION TEMPERATURE T_o = 120°F
H_o = 35 psia
MAXIMUM OPERATING PRESSURE
ONE HOUR OPERATING LIMIT
q = 2100 psf
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
30
25
20
15
10
7
MINIMUM OPERATING PRESSURE
REYNOLDS NUMBER PER FOOT, RN_S
10
9
8
7
6
5
4
3
2
1
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
MACH NUMBER

6b. NINE-BY SEVEN-FOOT SUPERSONIC WIND TUNNEL



DESCRIPTION:

The Nine- by Seven-Foot Supersonic Wind Tunnel is a closed-return, variable density tunnel equipped with an asymmetric, sliding-block nozzle and a flexible upper plate. Variation of the test section Mach number is achieved by translating, in the streamwise direction, the fixed contour block that forms the floor of the nozzle. Airflow is produced by an eleven-stage, axial-flow compressor powered by four variable-speed, wound-rotor induction motors.

For conventional, steady-state testing models are generally supported on a sting. Internal strain-gage balances are used for measuring forces and moments. (Additional facilities are available for measuring multiple steady or fluctuating pressures).

A schlieren system is available for studying flow patterns by direct viewing or photography, as well as a system for obtaining 20-by-20 inch shadowgraph negatives.

PERFORMANCE:

Mach Number	1.55 to 2.5 (continuously variable)
Stagnation Pressure	0.3 to 2.0 atmospheres
Reynolds Number	1.5×10^6 to 6.5×10^6 per foot
Stagnation Temperature	580° R

DIMENSIONS: **Test Section**

Height	7.0 feet
Width	9.0 feet
Length	18.0 feet
Access	Top hatch – 6.0 X 9.0 feet
	Side door – 3.0 X 6.5 feet

STATUS:

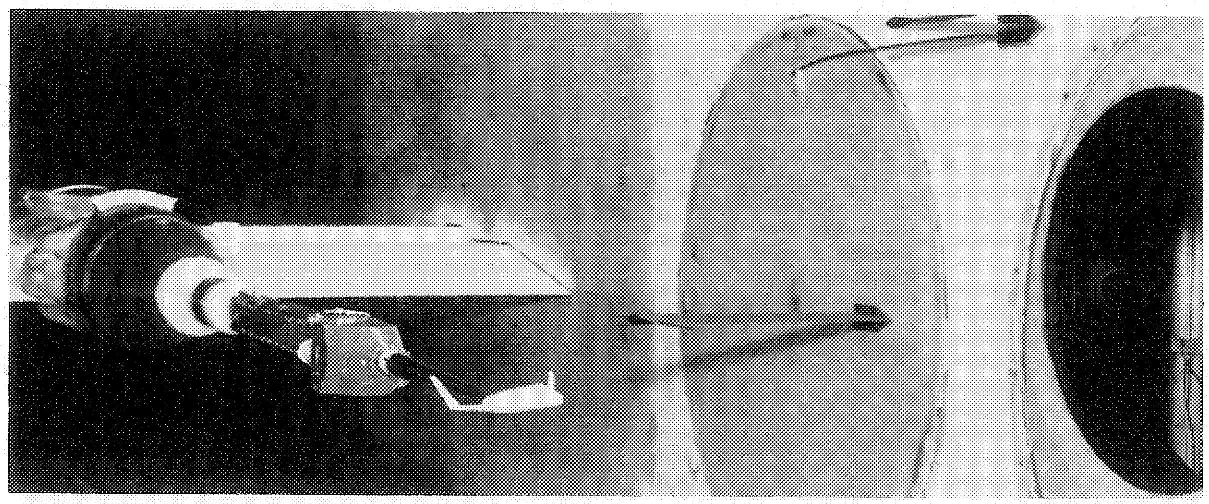
Operational since 1956

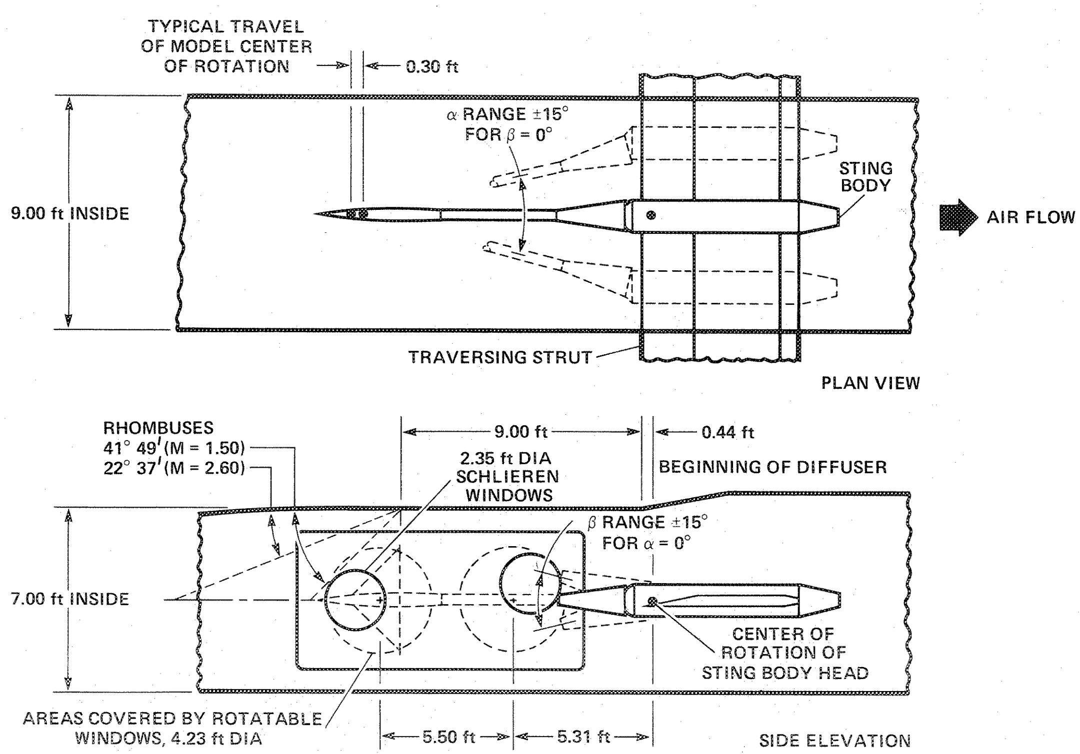
JURISDICTION:

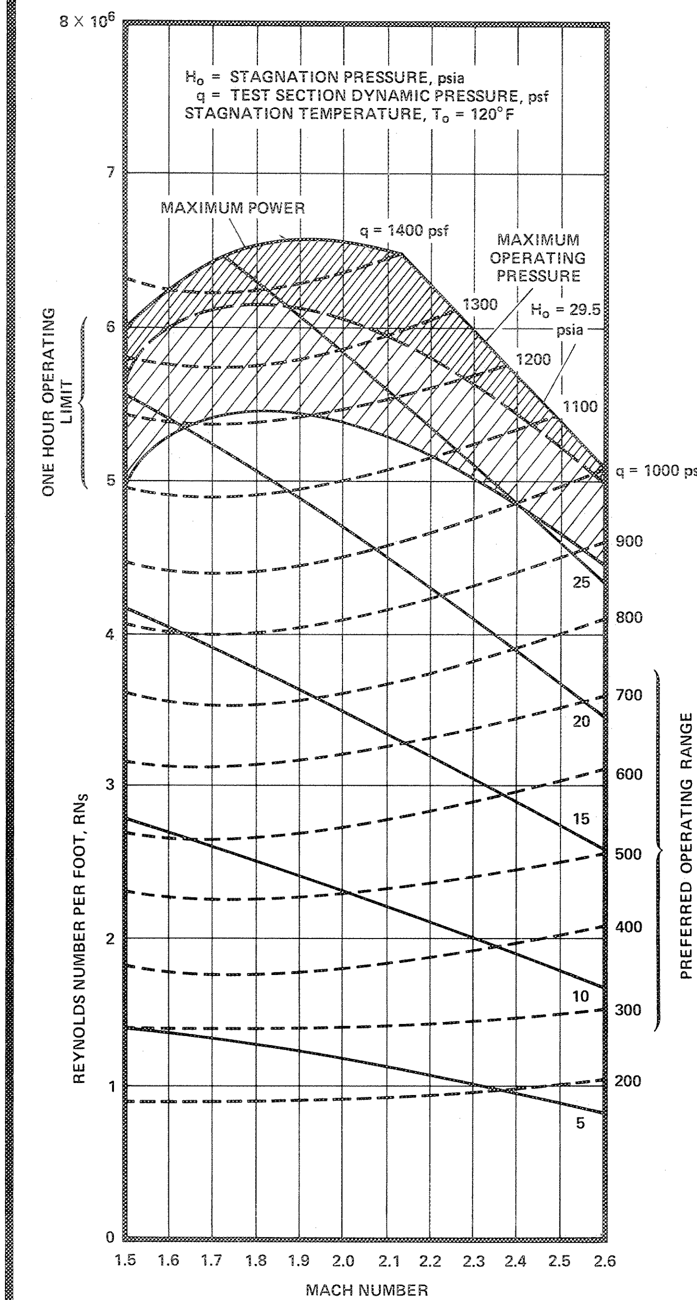
Aeronautics Division
Experimental Investigations Branch
Stuart Treon

LOCATION:

Building N-227B




TYPICAL TRAVEL
OF MODEL CENTER
OF ROTATION
0.30 ft
α RANGE ±15°
FOR β = 0°
STING
BODY
9.00 ft INSIDE
AIR FLOW
TRAVERSING STRUT
PLAN VIEW
RHOMBUSES
41° 49′ (M = 1.50)
22° 37′ (M = 2.60)
9.00 ft
0.44 ft
2.35 ft DIA
SCHLIEREN
WINDOWS
BEGINNING OF DIFFUSER
β RANGE ±15°
FOR α = 0°
7.00 ft INSIDE
CENTER OF
ROTATION OF
STING BODY HEAD
AREAS COVERED BY ROTATABLE
WINDOWS, 4.23 ft DIA
5.50 ft
5.31 ft
SIDE ELEVATION


H_o = STAGNATION PRESSURE, psia
q = TEST SECTION DYNAMIC PRESSURE, psf
STAGNATION TEMPERATURE, T_o = 120°F
MAXIMUM POWER
q = 1400 psf
MAXIMUM
OPERATING
PRESSURE
H_o = 29.5
psia
1300
1200
1100
q = 1000 psf
900
800
700
600
500
400
300
200
25
20
15
10
5
ONE HOUR OPERATING
LIMIT
PREFERRED OPERATING RANGE
REYNOLDS NUMBER PER FOOT, RN_S
8 × 10^6
7
6
5
4
3
2
1
0
1.5
1.6
1.7
1.8
1.9
2.0
2.1
2.2
2.3
2.4
2.5
2.6
MACH NUMBER

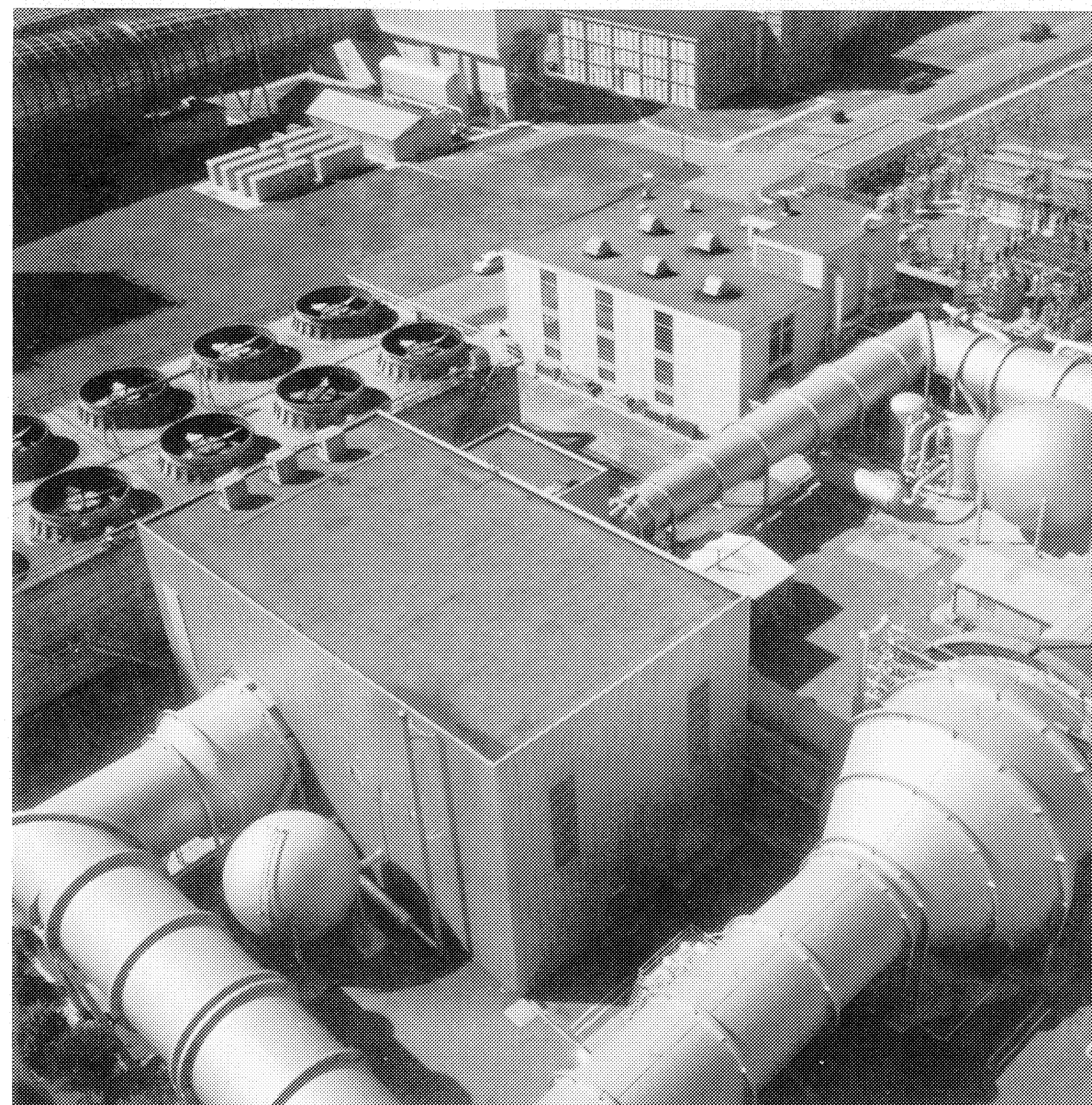
6c. EIGHT-BY SEVEN-FOOT SUPERSONIC WIND TUNNEL

DESCRIPTION:

The Eight- by Seven-Foot Supersonic Wind Tunnel is a closed-return, variable-density tunnel equipped with a symmetrical, flexible-wall throat (the sidewalls are positioned by a series of jacks operated by hydraulic motors). The upper and lower surfaces are fixed. Airflow is produced by an eleven-stage, axial-flow compressor powered by four variable-speed wound-rotor induction motors.

For conventional, steady-state testing models are generally supported on a sting. Internal, strain-gage balances are used for measuring forces and moments. (Additional facilities are available for measuring multiple steady or fluctuating pressures.)

A schlieren system is available for studying flow patterns by direct viewing or photography, as well as a system for obtaining 20-by 20-inch shadowgraph negatives.



PERFORMANCE:

Mach Number	2.45 to 3.5 (continuously variable)
Stagnation Pressure	0.3 to 2.0 atmospheres
Reynolds Number	1.0×10^6 to 5.0×10^6 per foot
Stagnation Temperature	580° R

DIMENSIONS: **Test Section**

Height	8.0 feet
Width	7.0 feet
Length	16.0 feet
Access	Top hatch – 2.0×4.5 feet Side door – 8.0×10.0 feet

STATUS:

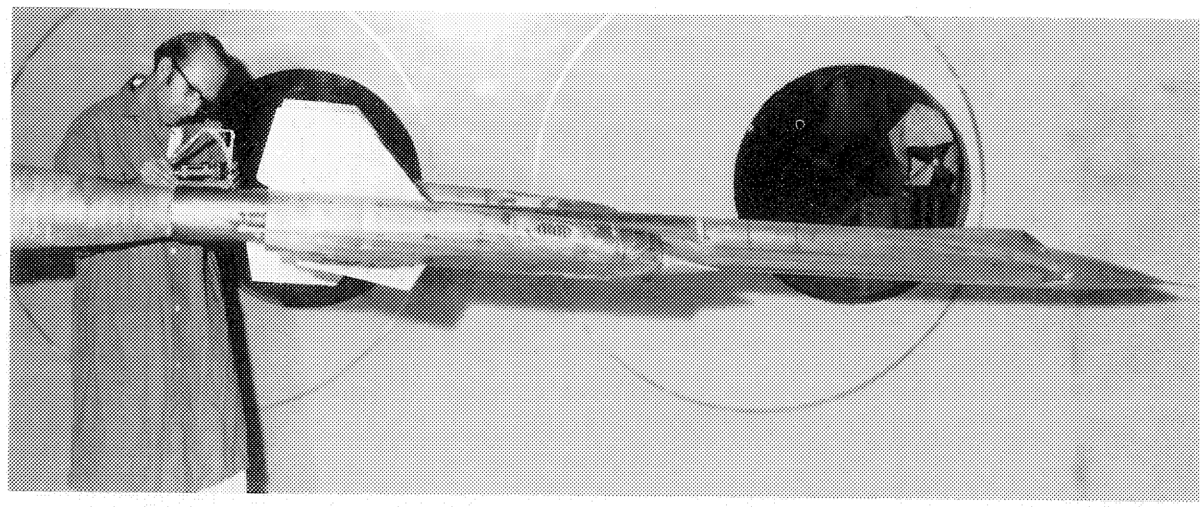
Operational since 1956

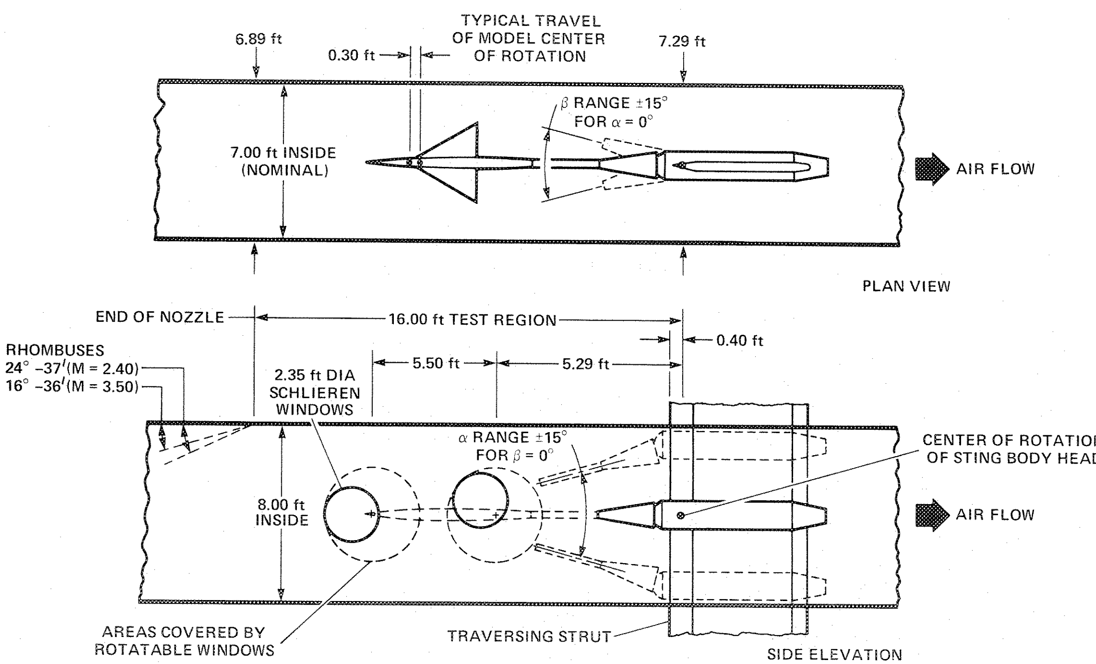
JURISDICTION:

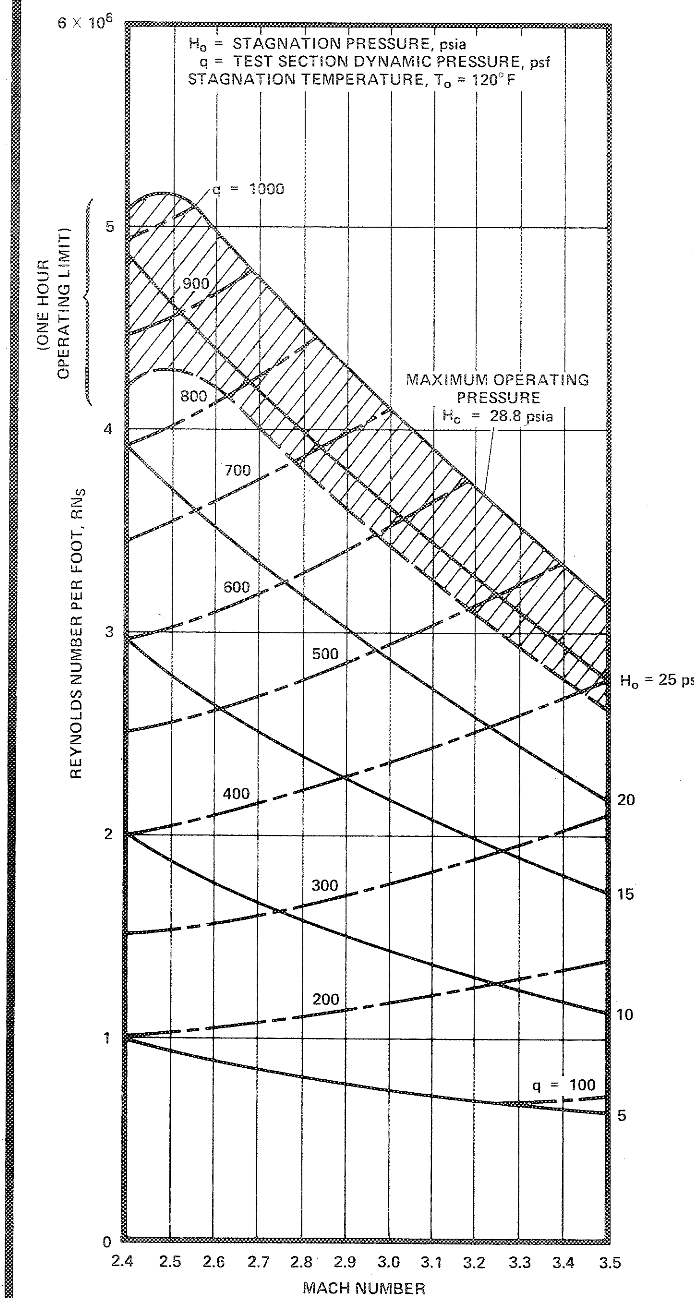
Aeronautics Division
Experimental Investigations Branch
Stuart Treon

LOCATION:

Building N-227C




TYPICAL TRAVEL OF MODEL CENTER OF ROTATION
6.89 ft
0.30 ft
7.29 ft
β RANGE ±15° FOR α = 0°
7.00 ft INSIDE (NOMINAL)
AIR FLOW
PLAN VIEW
END OF NOZZLE
16.00 ft TEST REGION
0.40 ft
5.50 ft
5.29 ft
RHOMBUSES
24° -37′(M = 2.40)
16° -36′(M = 3.50)
2.35 ft DIA SCHLIEREN WINDOWS
α RANGE ±15° FOR β = 0°
CENTER OF ROTATION OF STING BODY HEAD
8.00 ft INSIDE
AIR FLOW
AREAS COVERED BY ROTATABLE WINDOWS
TRAVERSING STRUT
SIDE ELEVATION


H_o = STAGNATION PRESSURE, psia
q = TEST SECTION DYNAMIC PRESSURE, psf
STAGNATION TEMPERATURE, T_o = 120°F
6 × 10^6
q = 1000
900
800
700
600
500
400
300
200
q = 100
MAXIMUM OPERATING PRESSURE
H_o = 28.8 psia
H_o = 25 psia
20
15
10
5
(ONE HOUR OPERATING LIMIT)
REYNOLDS NUMBER PER FOOT, RN_S
0
1
2
3
4
5
2.4
2.5
2.6
2.7
2.8
2.9
3.0
3.1
3.2
3.3
3.4
3.5
MACH NUMBER

7. SIX-BY SIX-FOOT SUPERSONIC WIND TUNNEL

DESCRIPTION:

The Six-by Six-Foot Supersonic Wind Tunnel is a closed-circuit, single-return tunnel equipped with an asymmetric sliding-block nozzle and a test section with a perforated floor and ceiling. Airflow is produced by an eight-stage, axial-flow compressor powered by two electric motors mounted in tandem outside the tunnel delivering a total of 60,000 horsepower.

For conventional, steady-state testing models are generally supported on a sting. Internal strain-gage balances are used for measuring forces and moments. (Additional facilities are available for measuring multiple steady or fluctuating pressures.)

A schlieren system is available for studying flow patterns by direct viewing or photography, as well as a system for obtaining 20-by 20-inch shadowgraph negatives.

PERFORMANCE:

Mach Number	0.25 to 2.2 (continuously variable)
Stagnation Pressure	0.3 to 1.0 atmospheres
Reynolds Number	1.0×10^6 to 5.0×10^6 per foot
Stagnation Temperature	580° R

DIMENSIONS: Test Section

Height	6.0 feet
Width	6.0 feet
Length	14.4 feet
Access	Side doors — 5.0 X 5.0 feet

STATUS:

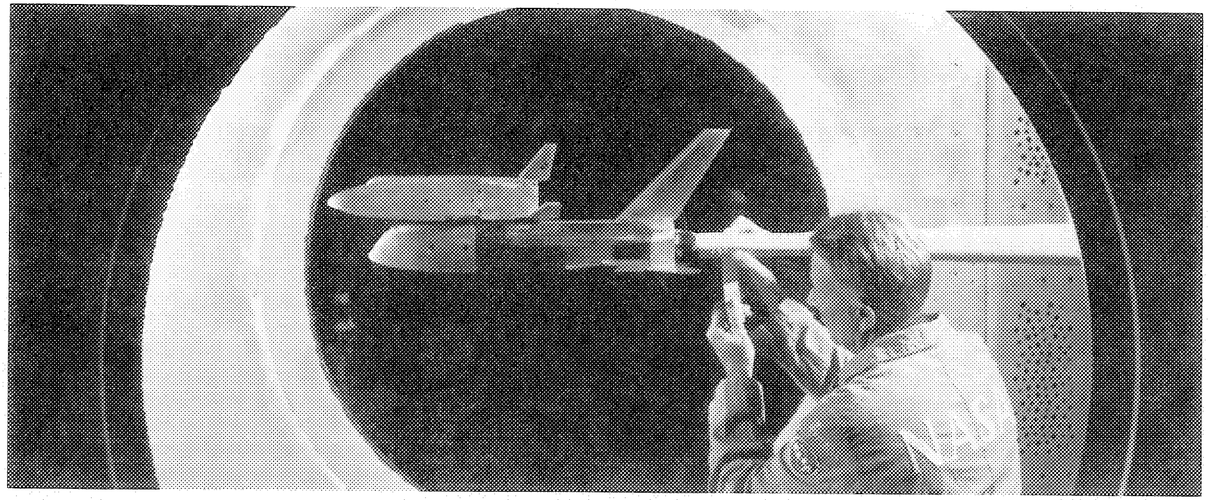
Operational since 1948

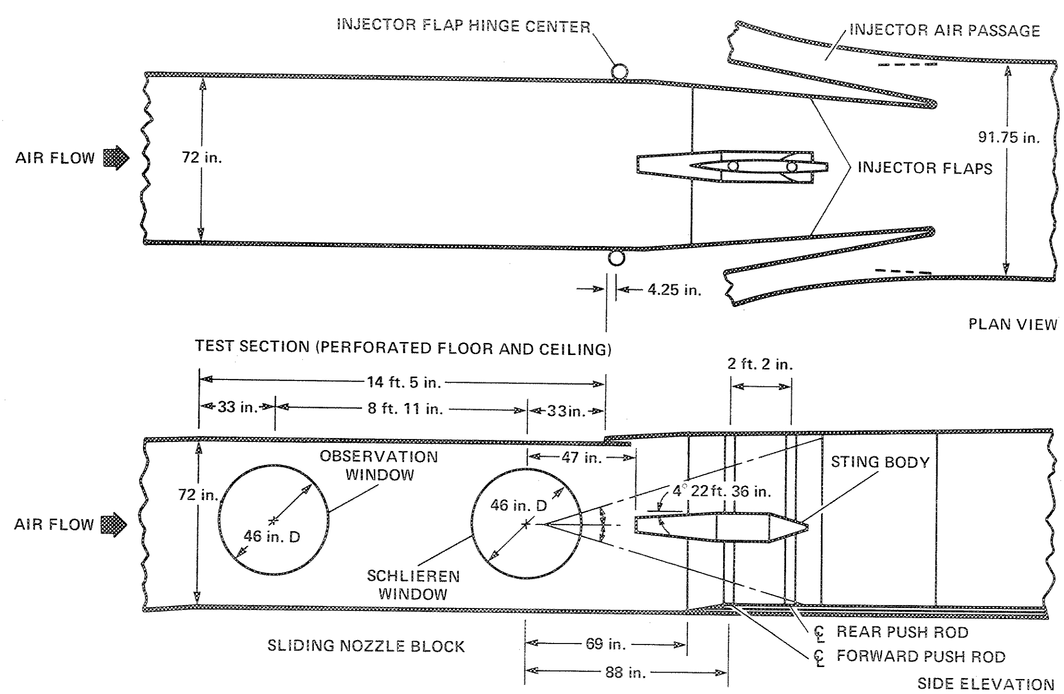
JURISDICTION:

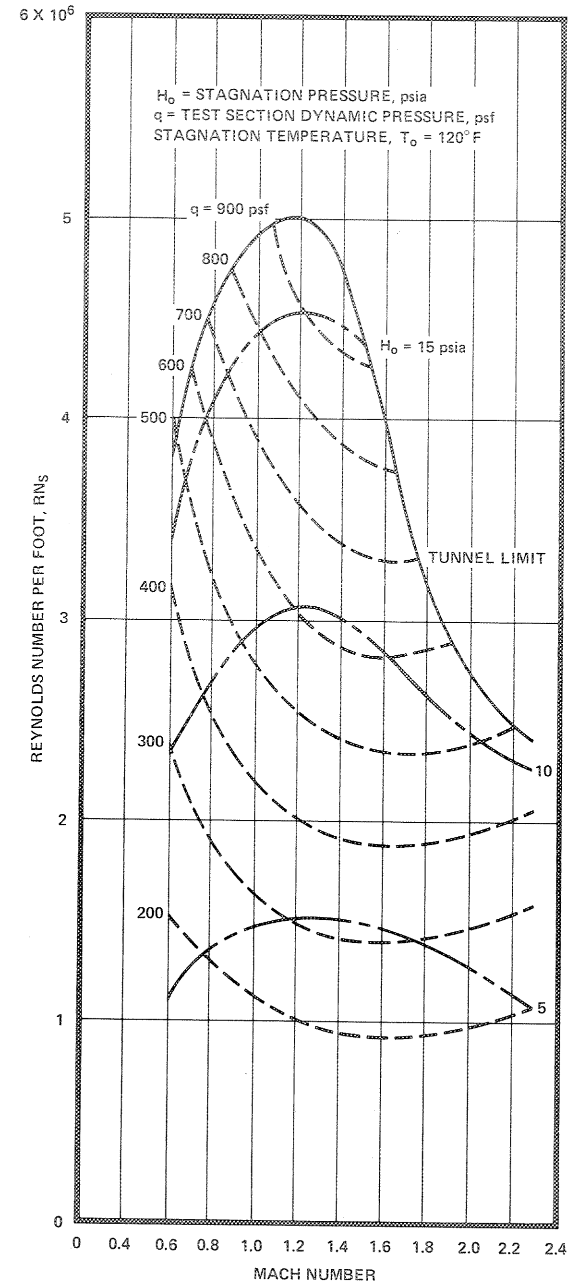
Aeronautics Division
Experimental Investigations Branch
Stuart Treon

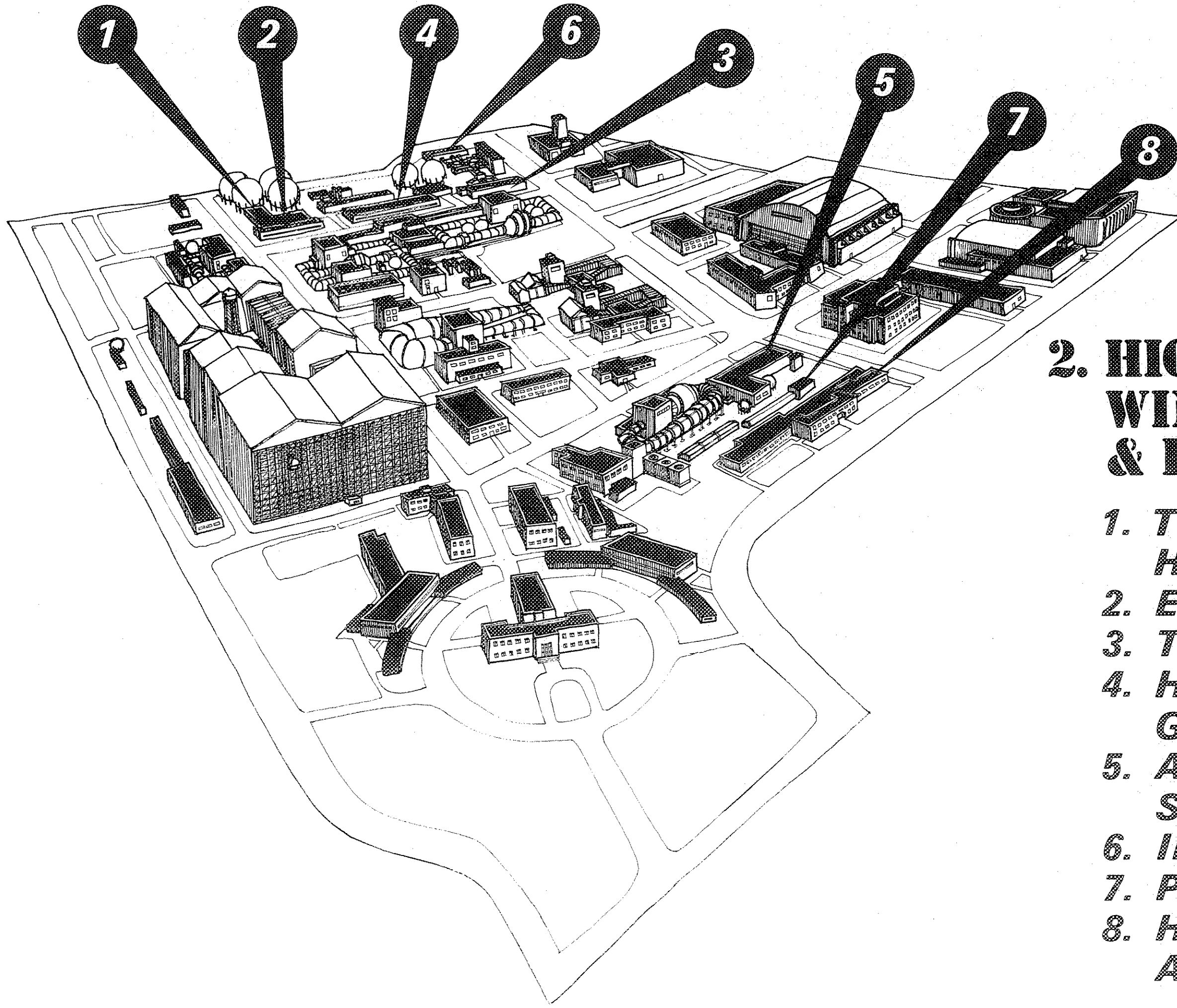
LOCATION:

Building N-226




INJECTOR FLAP HINGE CENTER
INJECTOR AIR PASSAGE
AIR FLOW
72 in.
91.75 in.
INJECTOR FLAPS
4.25 in.
PLAN VIEW
TEST SECTION (PERFORATED FLOOR AND CEILING)
14 ft. 5 in.
33 in.
8 ft. 11 in.
33in.
2 ft. 2 in.
47 in.
OBSERVATION WINDOW
72 in.
46 in. D
46 in. D
4° 22 ft. 36 in.
STING BODY
AIR FLOW
SCHLIEREN WINDOW
SLIDING NOZZLE BLOCK
69 in.
88 in.
℄ REAR PUSH ROD
℄ FORWARD PUSH ROD
SIDE ELEVATION

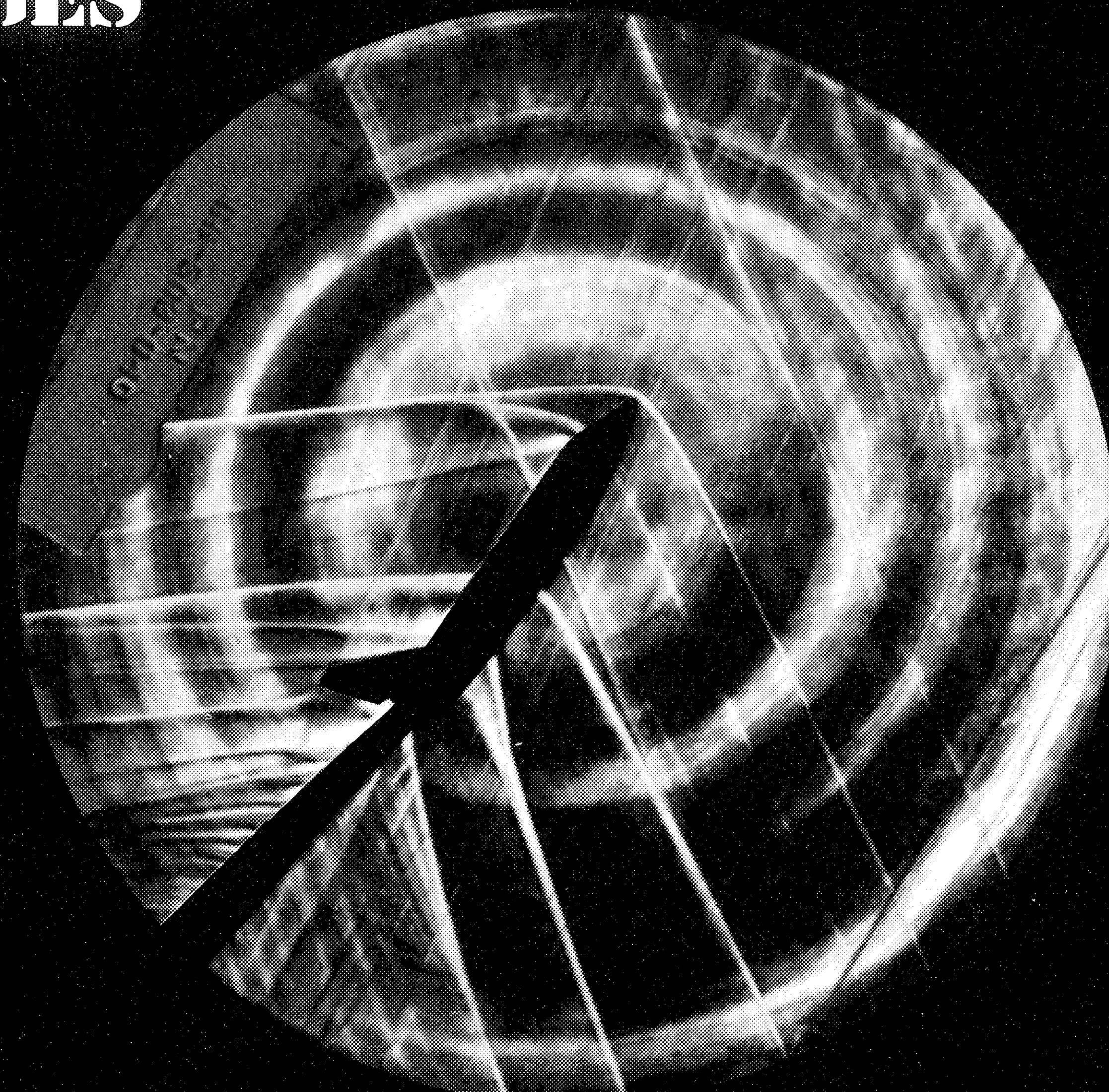

H_o = STAGNATION PRESSURE, psia
q = TEST SECTION DYNAMIC PRESSURE, psf
STAGNATION TEMPERATURE, T_o = 120° F
q = 900 psf
800
700
600
500
400
300
200
H_o = 15 psia
TUNNEL LIMIT
10
5
6 X 10^6
5
4
3
2
1
0
REYNOLDS NUMBER PER FOOT, RN_S
0
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
MACH NUMBER



2. HIGH ENTHALPY & HYPERSONIC WIND TUNNELS, SHOCK TUBES, & BALLISTIC RANGES

1. *THREE AND ONE/HALF-FOOT HYPERSONIC WIND TUNNEL*
2. *ELECTRIC ARC SHOCK TUBE*
3. *THERMAL PROTECTION LABORATORY*
4. *HIGH POWER PULSED Nd: GLASS LASER*
5. *ADVANCED ENTRY HEATING SIMULATOR*
6. *INTERACTION HEATING FACILITY*
7. *PRESSURIZED BALLISTIC RANGE*
8. *HYPERSONIC FREE-FLIGHT AERODYNAMIC FACILITY*

2. HIGH ENTHALPY & HYPERSONIC WIND TUNNELS, SHOCK TUBES, & BALLISTIC RANGES



1. THREE AND ONE/HALF - FOOT HYPERSONIC WIND TUNNEL

DESCRIPTION:

The Three and One/Half-Foot Hypersonic Wind Tunnel is a closed circuit, blow-down, wind tunnel, utilizing interchangeable contoured axisymmetric nozzles. Heat is supplied to the test gas by a storage heater containing aluminum oxide pebbles which are heated by burning natural gas during the recycle period. Usable test time, dependent upon test conditions, varies from 1/2 to 3 minutes, and the time between test runs averages 1-1/2 hours. The test region is of the open jet type. The test chamber is a cylinder 12 feet in diameter and 48 feet in length, with the axis normal to the flow direction. The effective test section core is an open jet 3.5 feet in diameter and approximately 10 feet in length. A model support inserts and retracts models from the test stream and has a remotely actuated angle of attack range from −20 to +20 degrees. Shadowgraph and cameras are contained within the test chamber. Data are normally recorded in digital form on magnetic tape at a rate of 2500 samples per second.

PERFORMANCE:

Mach numbers	5, 7, 10 and 14
Reynolds number	0.3×10^6 to 7.4×10^6/ft
Dynamic pressure	1,600 psf, maximum
Stagnation pressure	122 atmospheres, maximum
Stagnation temperature	3,460° R, maximum

DIMENSIONS: **Test Section (Core)**

Length	10 feet
Diameter	3.5 feet

STATUS:

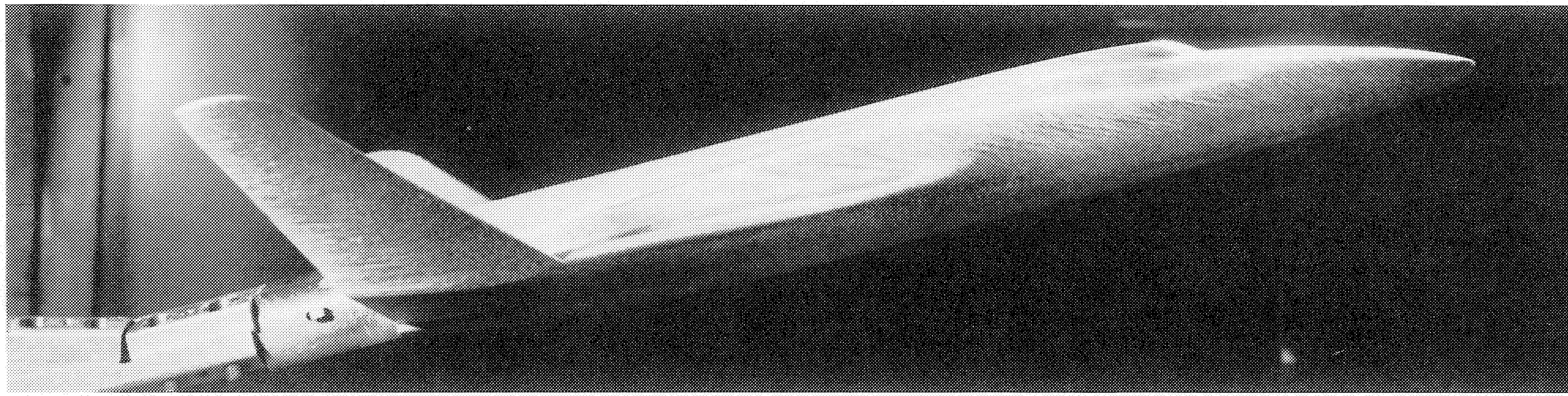
Operational since 1961, refurbished in 1972.

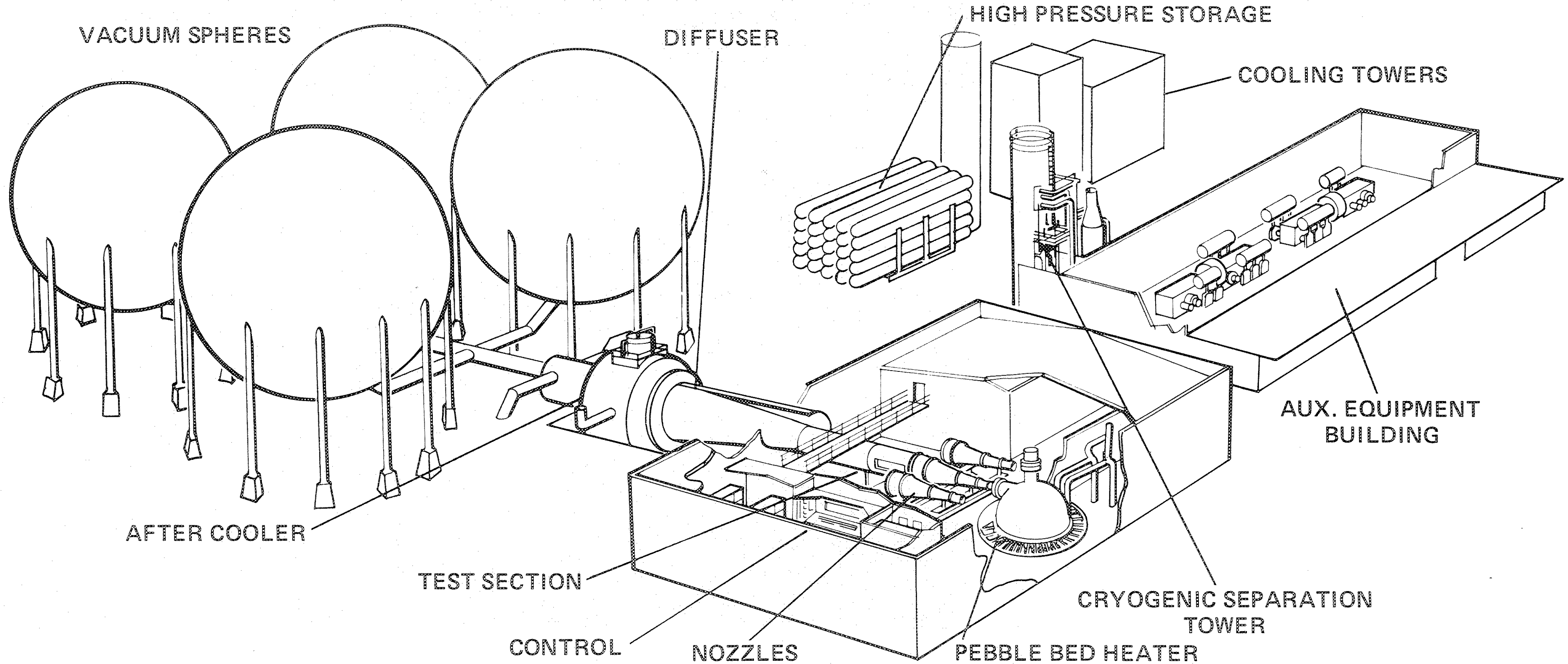
JURISDICTION:

Thermo-and Gas-Dynamics Division
Experimental Fluid Dynamics Branch
Joseph G. Marvin

LOCATION:

Building N-229

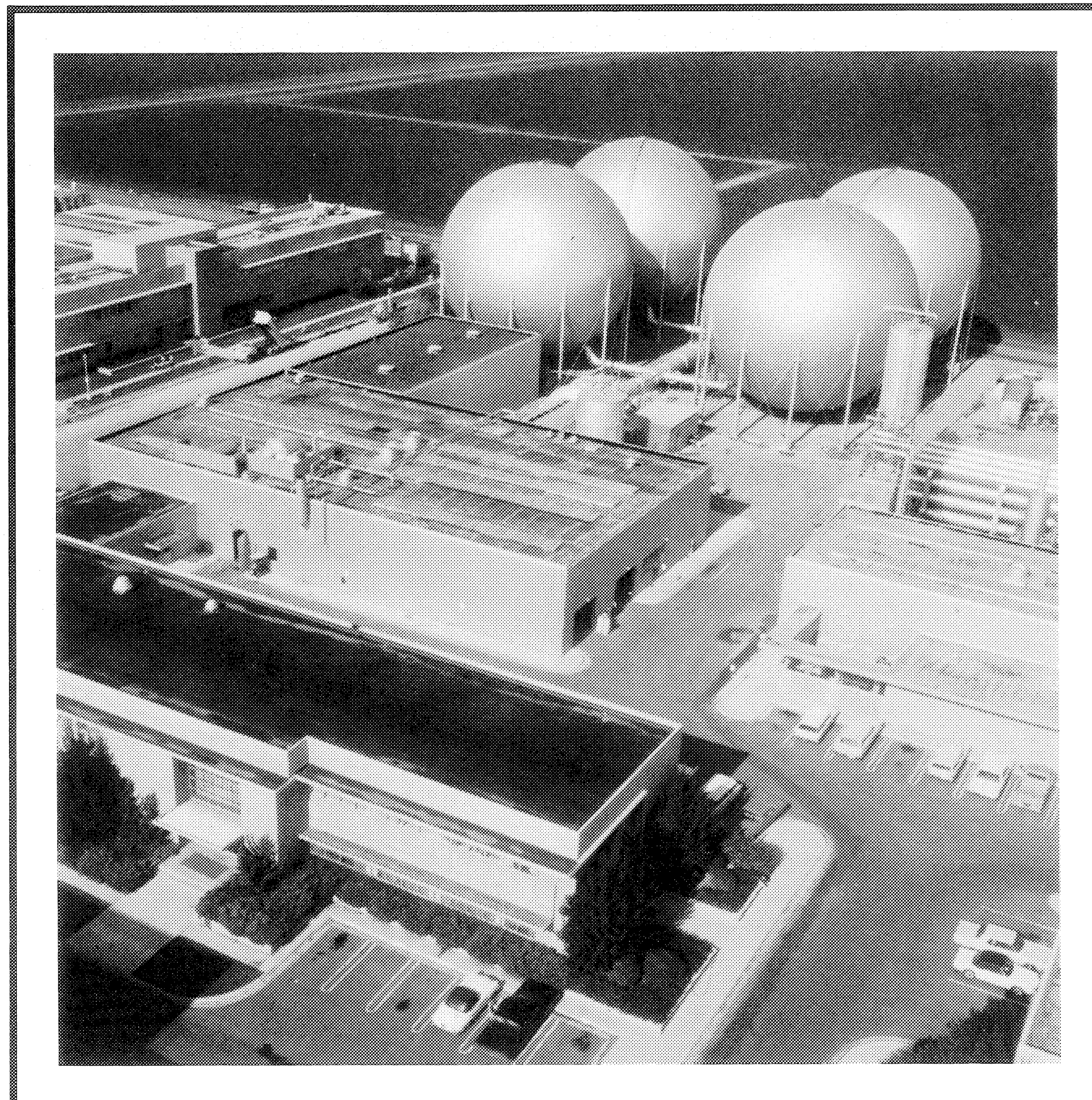



VACUUM SPHERES
DIFFUSER
HIGH PRESSURE STORAGE
COOLING TOWERS
AUX. EQUIPMENT BUILDING
AFTER COOLER
TEST SECTION
CONTROL
NOZZLES
CRYOGENIC SEPARATION TOWER
PEBBLE BED HEATER

2. ELECTRIC ARC SHOCK TUBE

DESCRIPTION:

The Electric Arc Shock Tube Facility is used for investigations such as gas laser development, radiation and ionization studies for outer planetary entries, chemical reaction rate measurements, and diagnostics in high-energy flows requiring a high-performance electric arc driven shock tube facility. Shock velocities of 30 to 40 km/sec. can be attained with quick succession operation (3-5 tests per day) utilizing the conical arc chamber. Energy for the driver is supplied by a one-megajoule capacitor storage system. It can be charged to a preset energy at either a 0 to 40 kV mode (1,250 μf) or a 0 to 20 kV mode (5,000 μf). The unique capability to change circuit capacitance for a particular energy storage permits control of the current pulse width (time constant) of the arc discharge.



DIMENSIONS:

Length	40 ft.
Diameter	4 inches

STATUS:

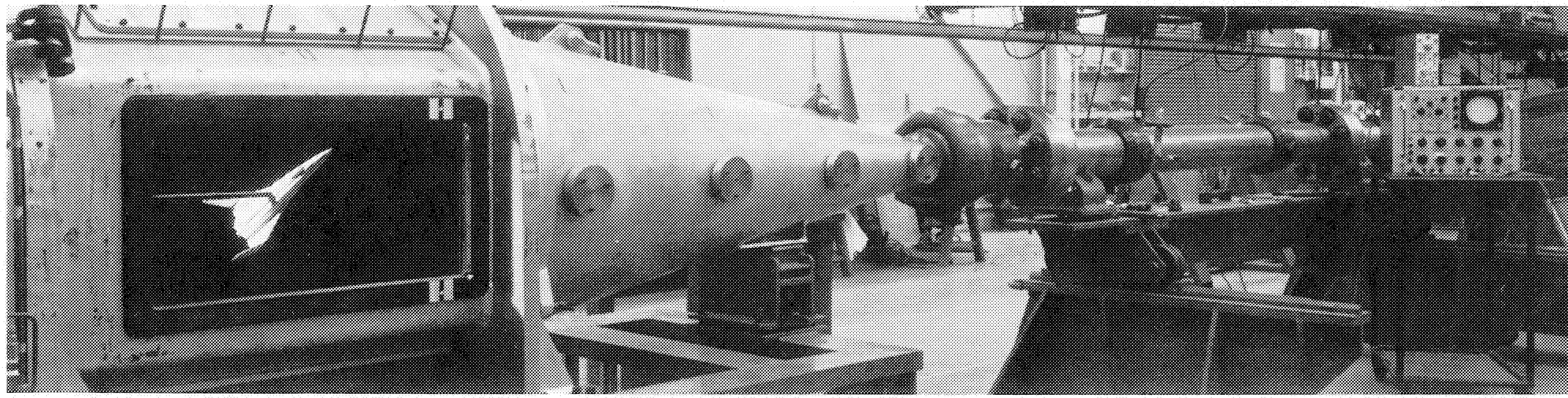
Operational since 1966

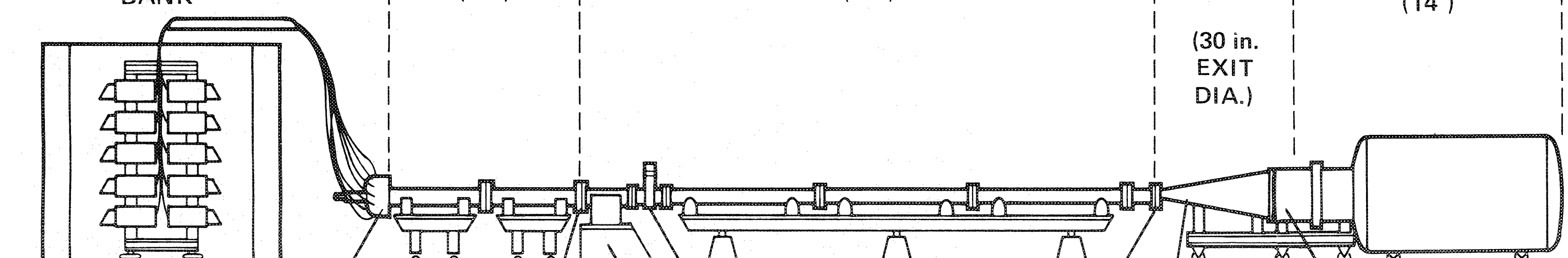
JURISDICTION:

Thermo-and Gas-Dynamics Division
Physical Gas Dynamics and Lasers Branch
C. Frederick Hansen

LOCATION:

Building N-229




CAPACITOR
BANK
DRIVER
(10′)
DRIVEN TUBE
(38′)
TEST
SECTION
(30 in.
EXIT
DIA.)
VACUUM
CHAMBER
(14′)
COLLECTOR
RING
MAIN
DIAPHRAGM
THRUST STAND
LOADING VALVE
NOZZLE
DIAPHRAGM
20°
NOZZLE
MODEL SUPPORT
SPOOL

3. THERMAL PROTECTION LABORATORY

DESCRIPTION:

The Thermal Protection Laboratory is used to research materials for heat shield applications and for aerodynamic heating and materials studies of vehicles in planetary atmospheres. This laboratory is comprised of five separate facilities: an Aerodynamic Heating Tunnel, a Heat Transfer Tunnel, two Supersonic Turbulent Ducts, and a High-Power CO_2 Gasdynamic Laser. All these facilities are driven by arc-heaters, with the exception of the large, combustion-type laser. The arc-heated facilities are powered by a 20 Megawatt DC power supply. Their effluent gas stream (test gases; Air, N_2, He, CO_2, and mixtures; flow rates from 0.05 to 5.0 lbs/sec) discharges into a five-stage steam-ejector-driven vacuum system. The vacuum system and power supply are common to the test facilities in Building N-238. All of the facilities have high pressure water available at flow rates up to 4,000 gals/min. The data obtained from these facilities are recorded on magnetic tape or oscillographs. All forms of data can be handled whether from thermocouples, pressure cells, pyrometers, or radiometers, etc. In addition, closed circuit T.V. monitors and various film cameras are available.

STATUS:

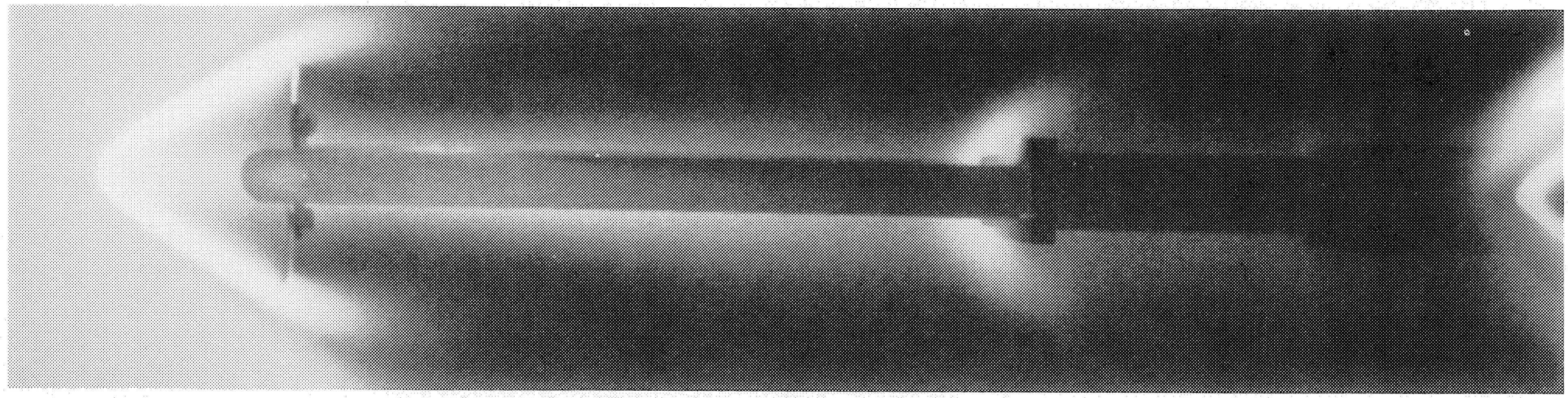
Operational since 1962

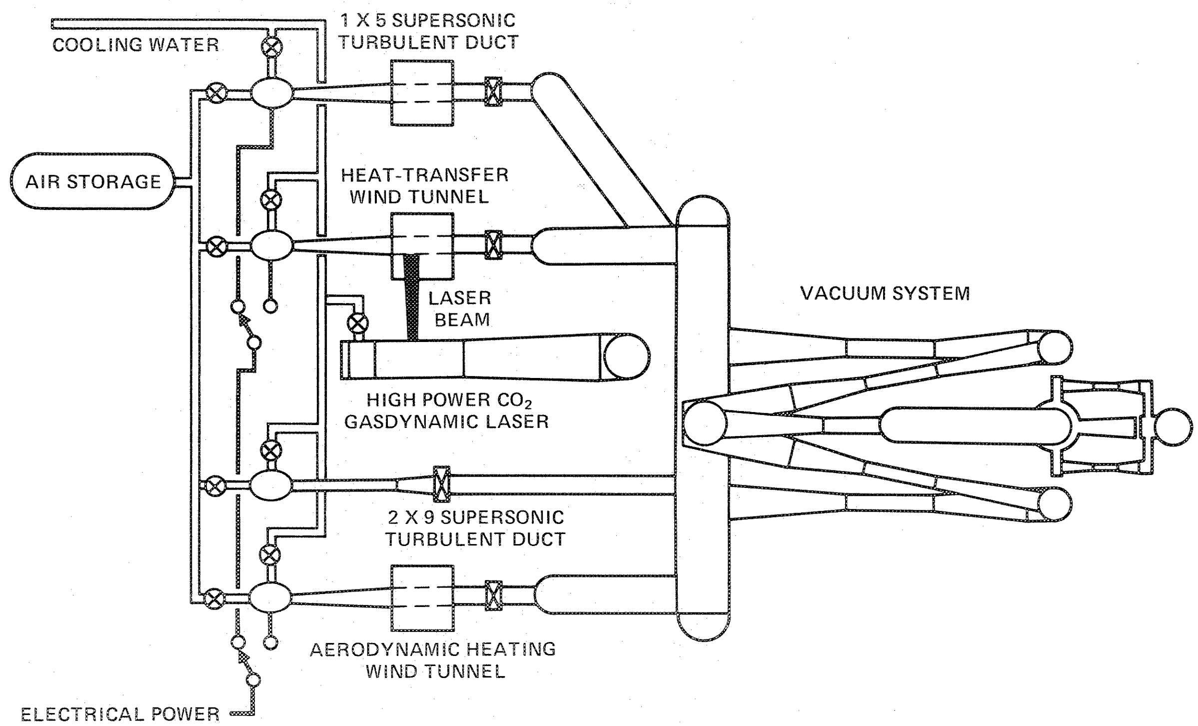
JURISDICTION:

Thermo- and Gas-Dynamics Division
Thermal Protection Branch
Howard K. Larson

LOCATION:

Building N-234





COOLING WATER
1 X 5 SUPERSONIC TURBULENT DUCT
AIR STORAGE
HEAT-TRANSFER WIND TUNNEL
LASER BEAM
VACUUM SYSTEM
HIGH POWER CO_2 GASDYNAMIC LASER
2 X 9 SUPERSONIC TURBULENT DUCT
AERODYNAMIC HEATING WIND TUNNEL
ELECTRICAL POWER

3a. AERODYNAMIC HEATING TUNNEL

DESCRIPTION:

The Aerodynamic Heating Tunnel is a hypersonic wind tunnel, driven by arc-heaters with powers up to 20 Megawatts. This tunnel has a wide range of operating characteristics, and utilizes an extensive variety of nozzle configurations. Nozzle exit diameters up to 36 inches, and throat diameters up to two inches are available. Models with specimen diameters up to ten inches can be accommodated. Two support systems are available: an angle of attack system (which is controllable through ±60 degrees), and a traversing system mounted on the test section floor (suitable for either surveying or model support). Run time is continuous.

PERFORMANCE:

Stream Enthalpy	500 to 15,000 BTU/lb.
Mach Number	3 to 15 (variable)
Stagnation Pressure	0.005 to 5.0 atmospheres
Plenum Pressure	1,200 psi, maximum

STATUS:

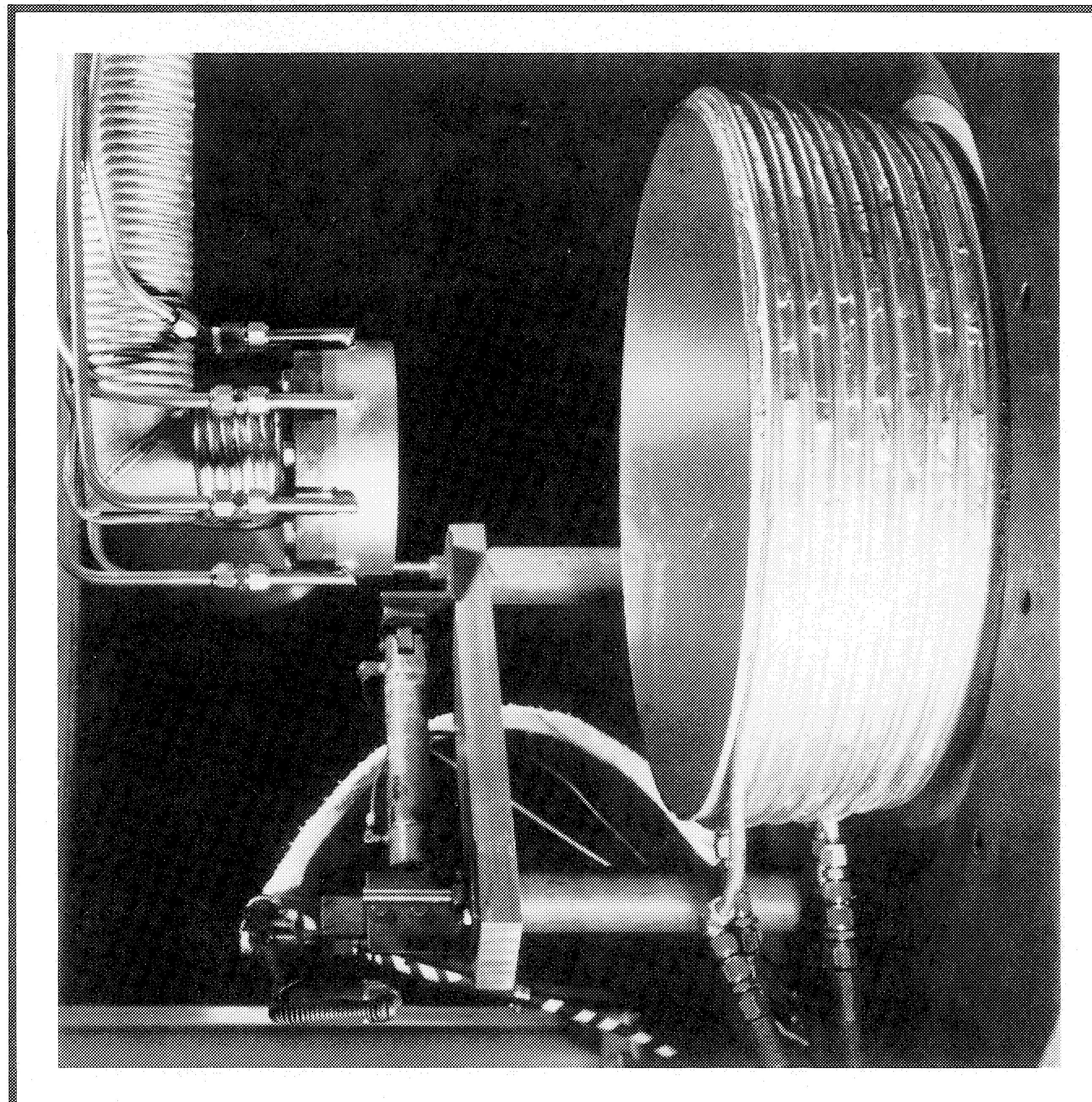
Operational since 1962

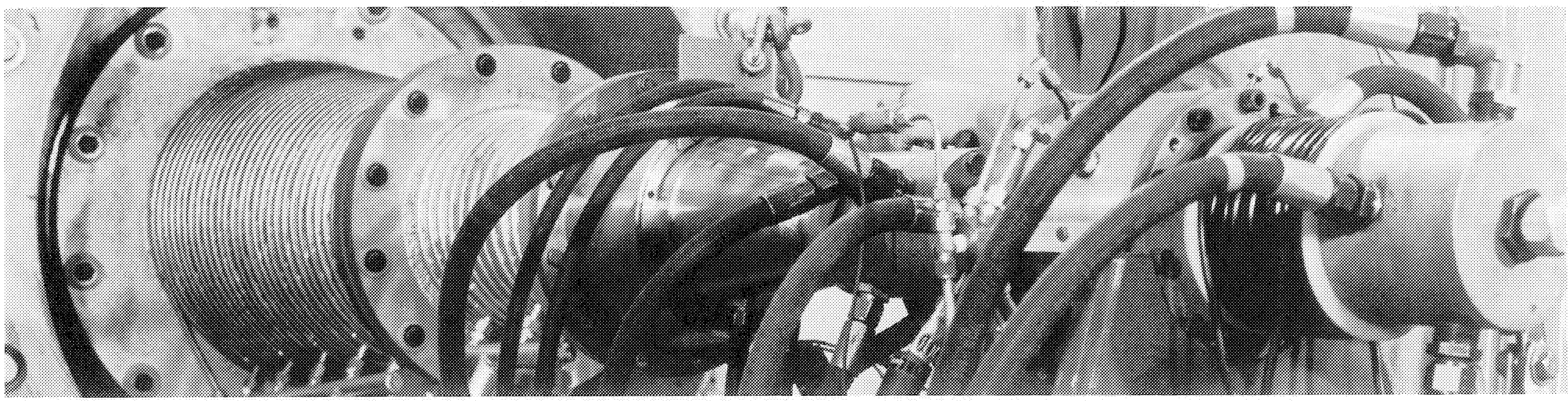
JURISDICTION:

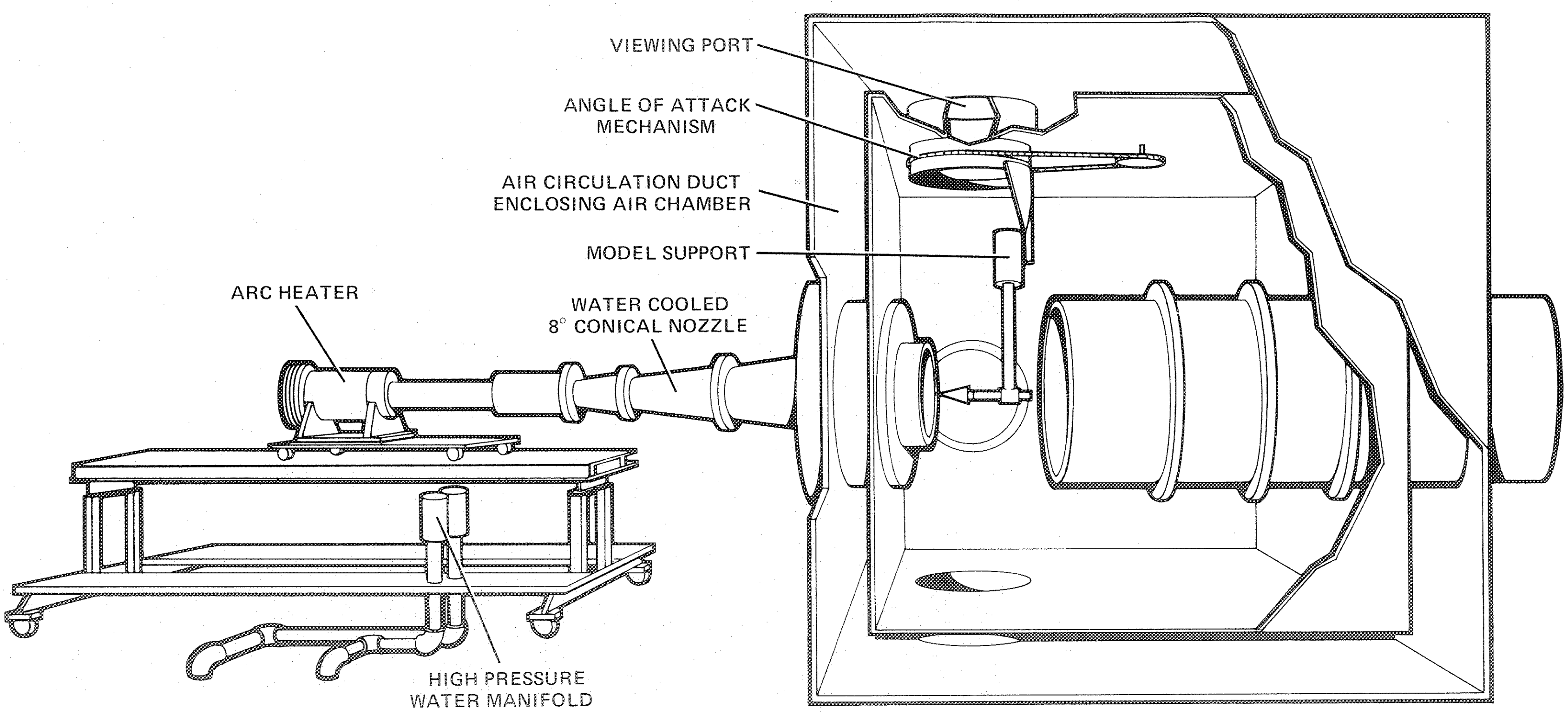
Thermo- and Gas-Dynamics Division
Thermal Protection Branch
Howard K. Larson

LOCATION:

Building N-234



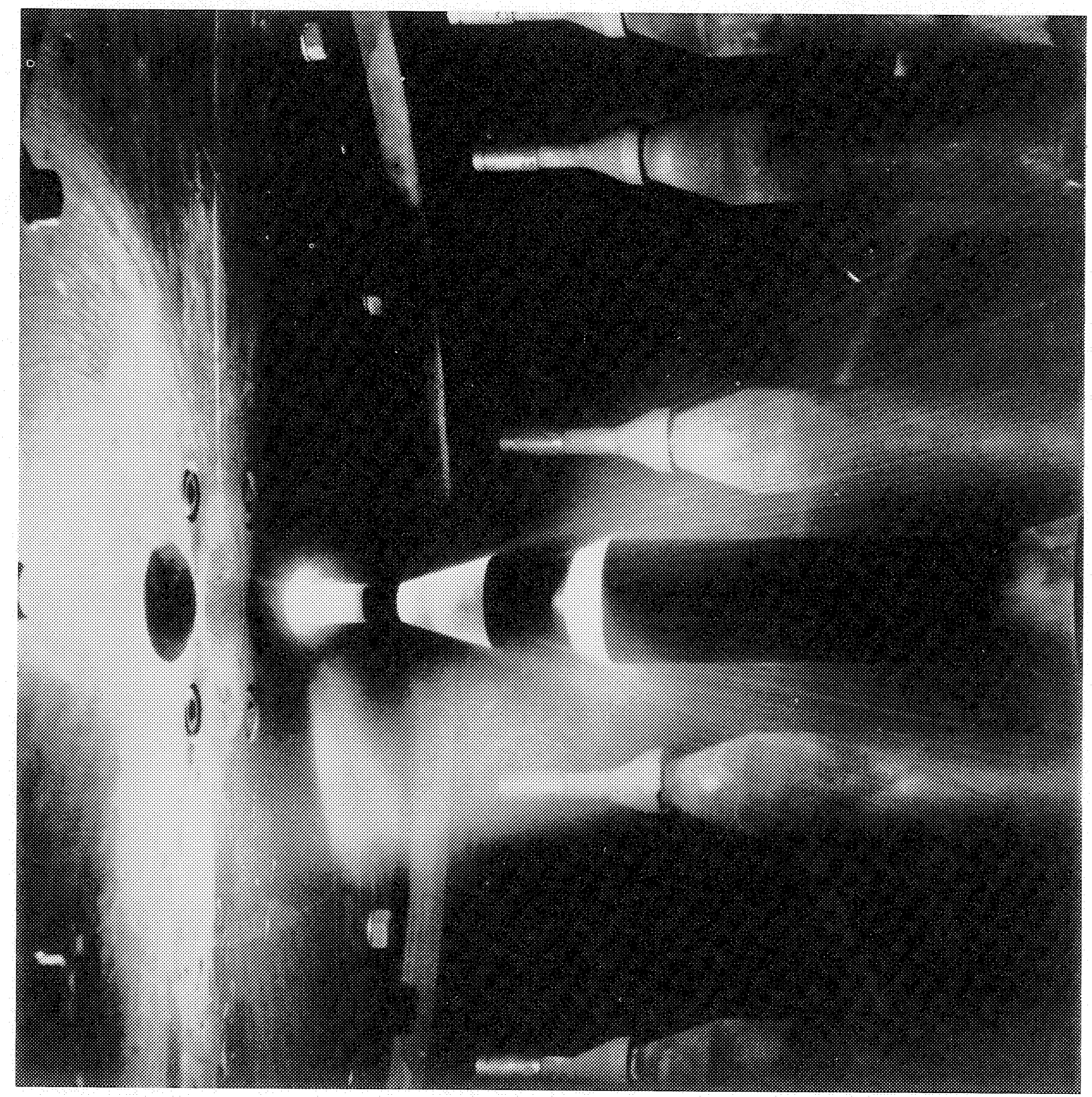



VIEWING PORT
ANGLE OF ATTACK MECHANISM
AIR CIRCULATION DUCT ENCLOSING AIR CHAMBER
MODEL SUPPORT
ARC HEATER
WATER COOLED 8° CONICAL NOZZLE
HIGH PRESSURE WATER MANIFOLD

3b. HEAT TRANSFER TUNNEL

DESCRIPTION:

The Heat Transfer Tunnel is a hypersonic wind tunnel driven by two different four megawatt arc-heaters. This tunnel has a wide range of operating characteristics, and utilizes an extensive variety of nozzle configurations. Nozzle exit diameters up to 24 inches, and throat diameters up to a diameter of one inch are available. Models with specimen diameters up to six inches can be accommodated. The model support system can handle a total of 18 models with diameters up to two inches (a lesser number of models with larger diameters can be accommodated). Support arms are arranged radially, and models are inserted into the effluent gas stream and retracted in sequence by a series of linear motion actuators. Run-time is ten minutes.



PERFORMANCE:

Stream Enthalpy	1,500 to 15,000 BTU/lb.
Mach Number	2.5 to 15 (variable)
Stagnation Pressure	0.01 to 9.0 atmospheres
Plenum Pressure	1,000 psi, maximum

STATUS:

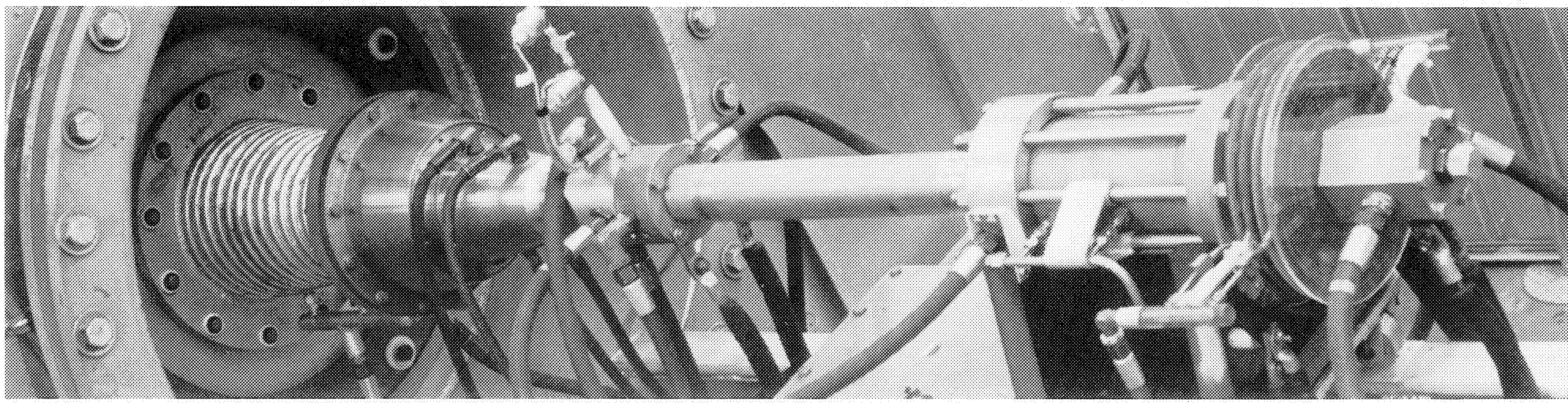
Operational since 1962

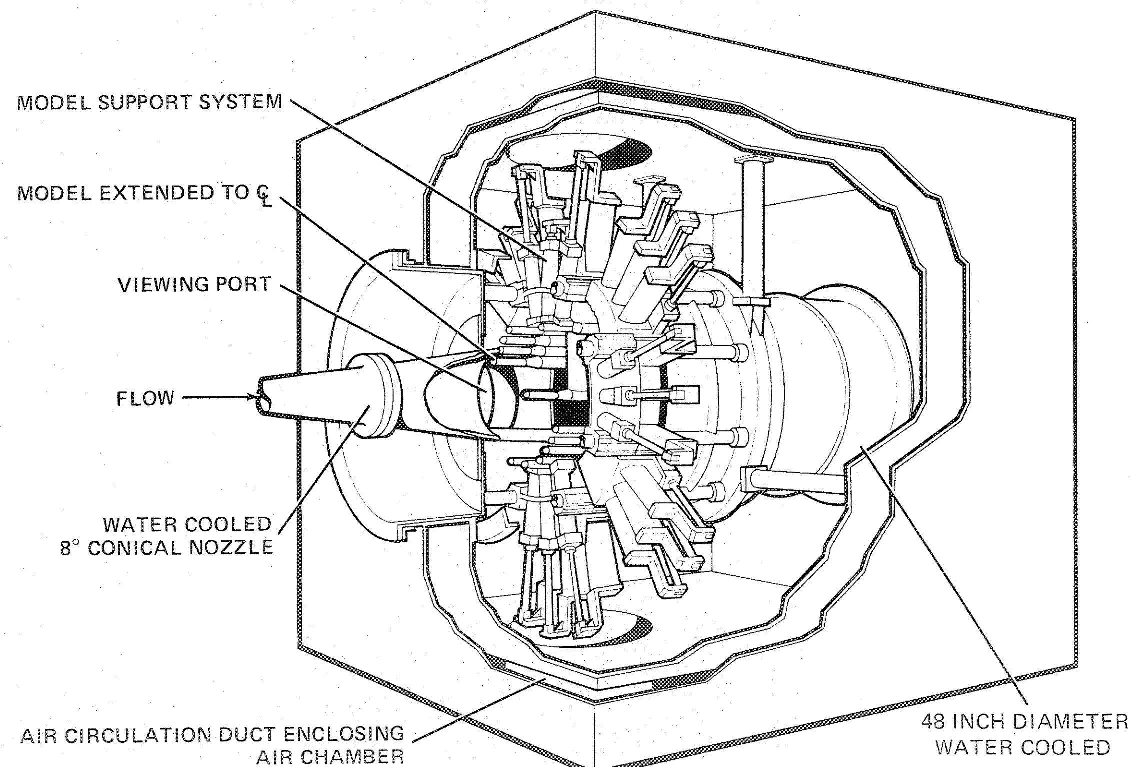
JURISDICTION:

Thermo- and Gas-Dynamics Division
Thermal Protection Branch
Howard K. Larson

LOCATION:

Building N-234

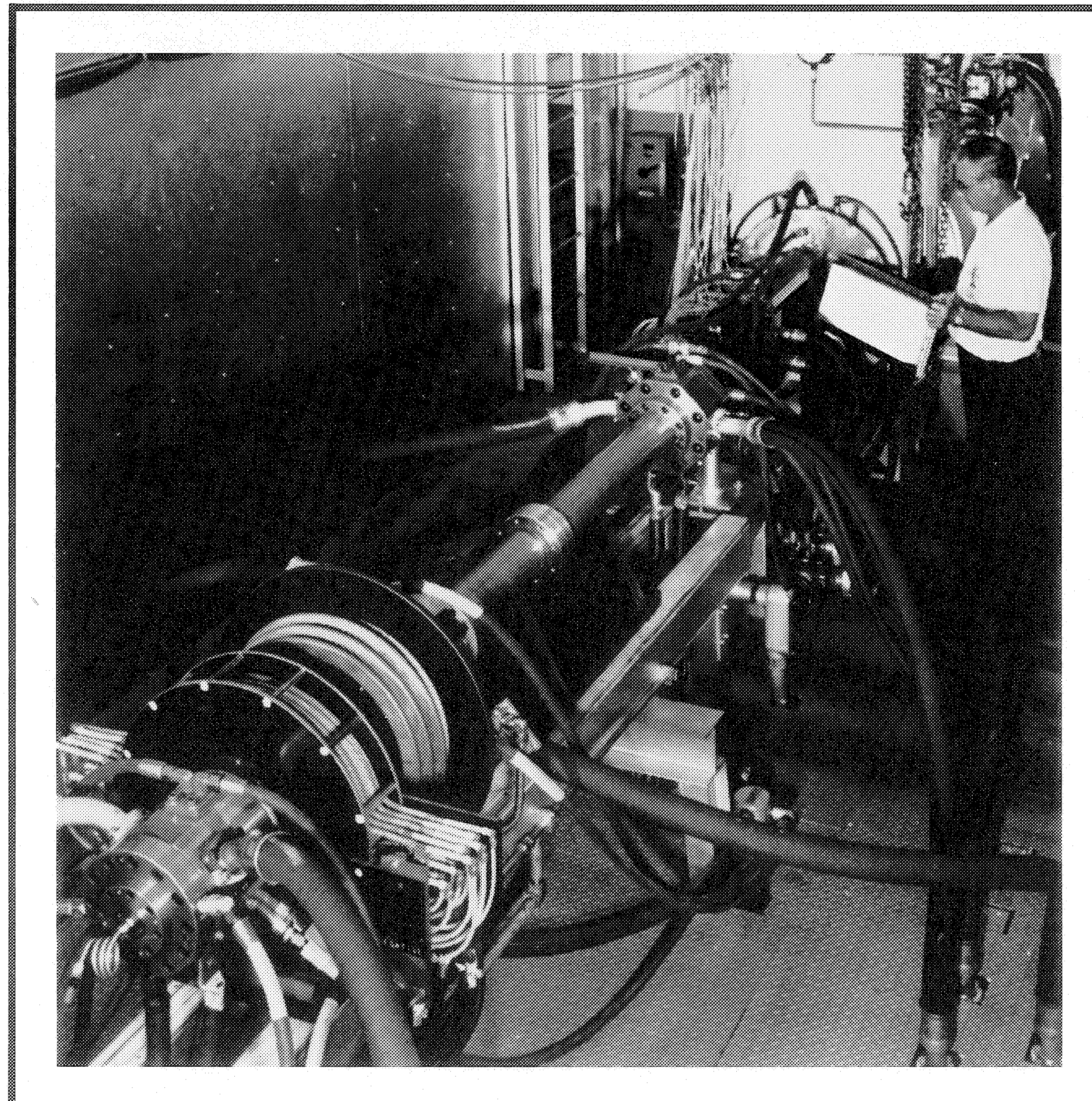



MODEL SUPPORT SYSTEM
MODEL EXTENDED TO ℄
VIEWING PORT
FLOW
WATER COOLED
8° CONICAL NOZZLE
AIR CIRCULATION DUCT ENCLOSING
AIR CHAMBER
48 INCH DIAMETER
WATER COOLED
DIFFUSER

3c. ONE-BY-FIVE INCH AND TWO-BY-NINE INCH SUPERSONIC TURBULENT FLOW DUCTS

DESCRIPTION:

The One-by-Five Inch and Two-by-Nine Inch Supersonic Turbulent Flow Ducts are used to study highly active turbulent two-dimensional fluid flows over a flat surface. Both ducts are rectangular; the One-by-Five Inch Duct can accommodate models four inches wide by six inches long, and the Two-by-Nine Inch Duct can accommodate models eight inches wide by ten and twenty inches long, and any desired depth. Wall heating rates, wall pressures, model surface temperature from thermocouples and optical pyrometers, as well as arc-heater operating data may be obtained. Run-times are continuous for both ducts.



PERFORMANCE: **One-by-Five Inch Duct**

Stream Enthalpy	700 to 5,000 BTU/lb.
Mach Number	3.4
Wall pressure	0.02 to 0.30 atmospheres
Wall heating rate	2 to 130 BTU/ft^2-sec
Plenum pressure	1 to 45 atmospheres

PERFORMANCE: **Two-by-Nine Inch Duct**

Stream Enthalpy	1,500 to 4,000 BTU/lb.
Mach Number	3.4 (nominal)
Wall pressure	0.02 to 0.15 atmospheres
Wall heating rate	2 to 60 BTU/ft^2-sec
Plenum pressure	2 to 15 atmospheres

STATUS:

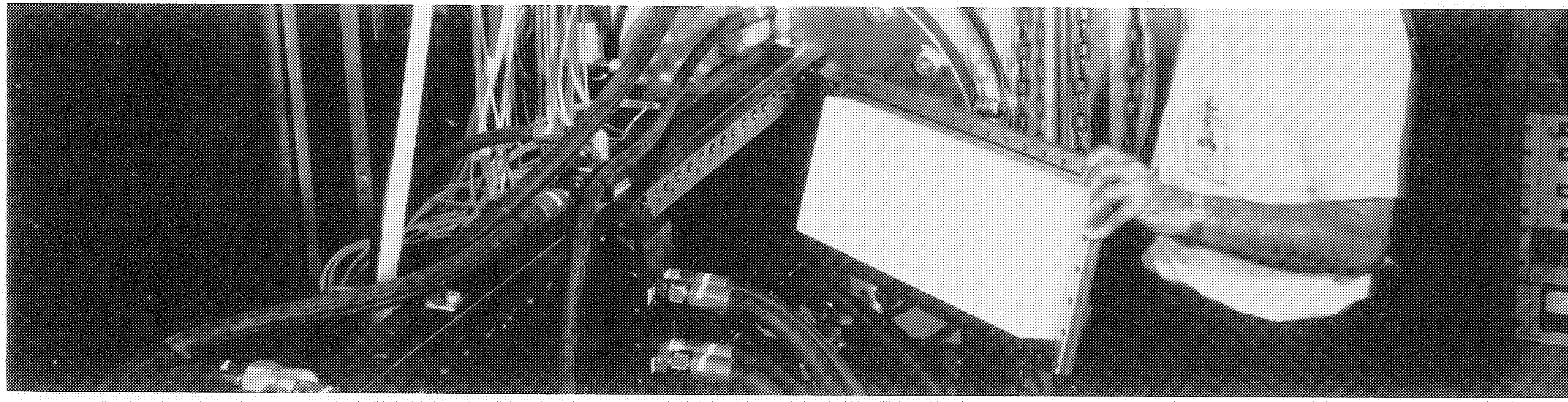
Operational since 1969 and 1972, respectively

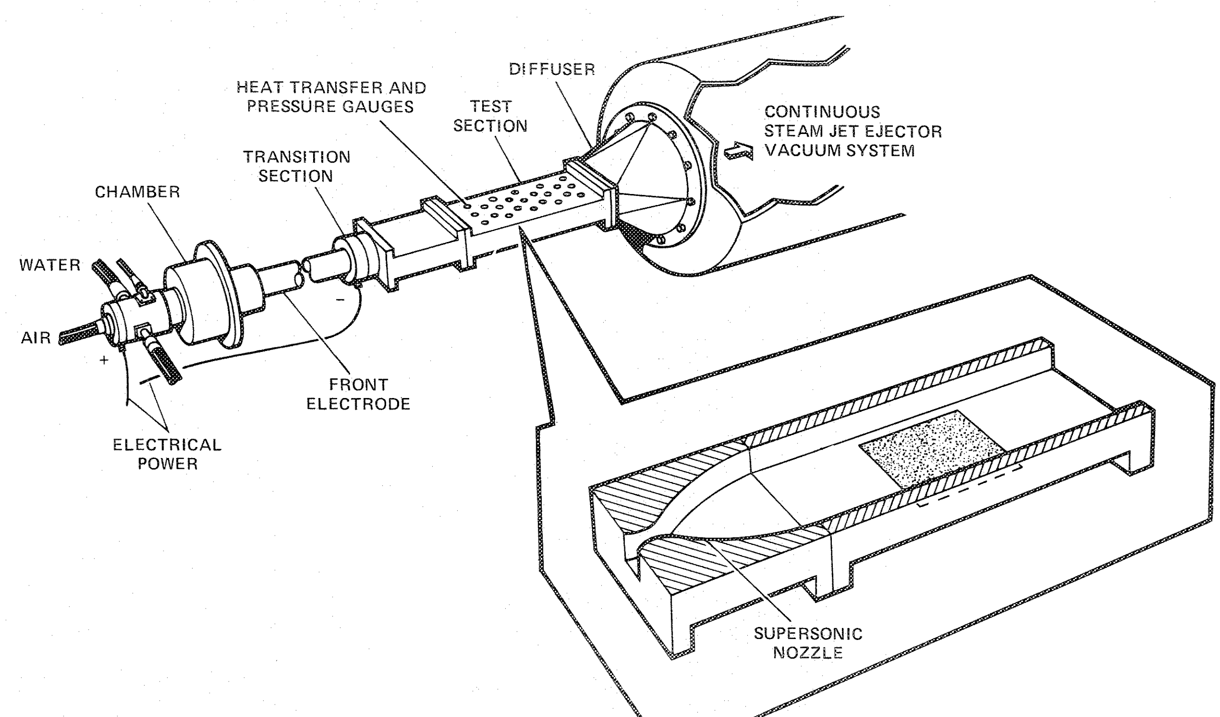
JURISDICTION:

Thermo- and Gas-Dynamics Division
Thermal Protection Branch
Howard K. Larson

LOCATION:

Building N-234

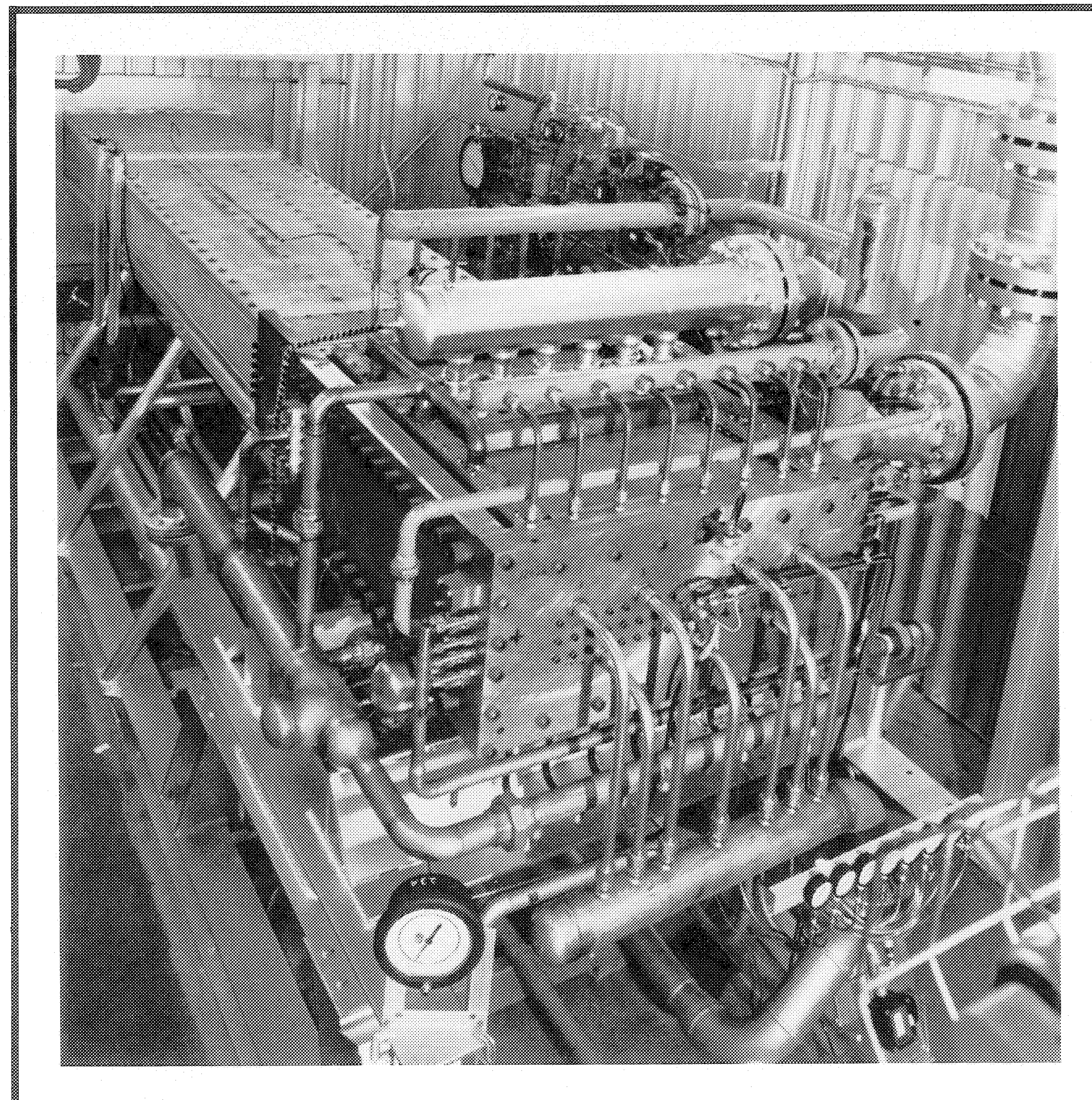



HEAT TRANSFER AND PRESSURE GAUGES
DIFFUSER
TEST SECTION
CONTINUOUS STEAM JET EJECTOR VACUUM SYSTEM
TRANSITION SECTION
CHAMBER
WATER
AIR
FRONT ELECTRODE
ELECTRICAL POWER
SUPERSONIC NOZZLE

3d. HIGH-POWER CO_2 GASDYNAMIC LASER

DESCRIPTION:

The High-Power CO_2 Gasdynamic Laser is a combustion driven laser capable of producing radiative energy at a wavelength of 10.6 microns. It can be configured in two modes; with an unstable resonator cavity, and a stable multi-mode cavity. The uniformity and power available from either configuration is variable depending on the optics used to focus and position the beam. The beam generated by the unstable resonator can be manipulated much more readily than the output beam from the multi-mode cavity. In addition, the beam generated by the unstable resonator can be transferred into the test section of the Heat Transfer Tunnel allowing a test section specimen to be exposed to both an arc-heated gas stream and a radiative beam.



PERFORMANCE:

Power available at target	
Unstable resonator	0.0 to 30.0 KW
Multi-mode resonator	0.0 to 70.0 KW
Target diameters	
Unstable resonator	0.50 to 10.0 cm
Multi-mode resonator	2.0 to 10.0 cm
Target test time	15 sec, maximum

STATUS:

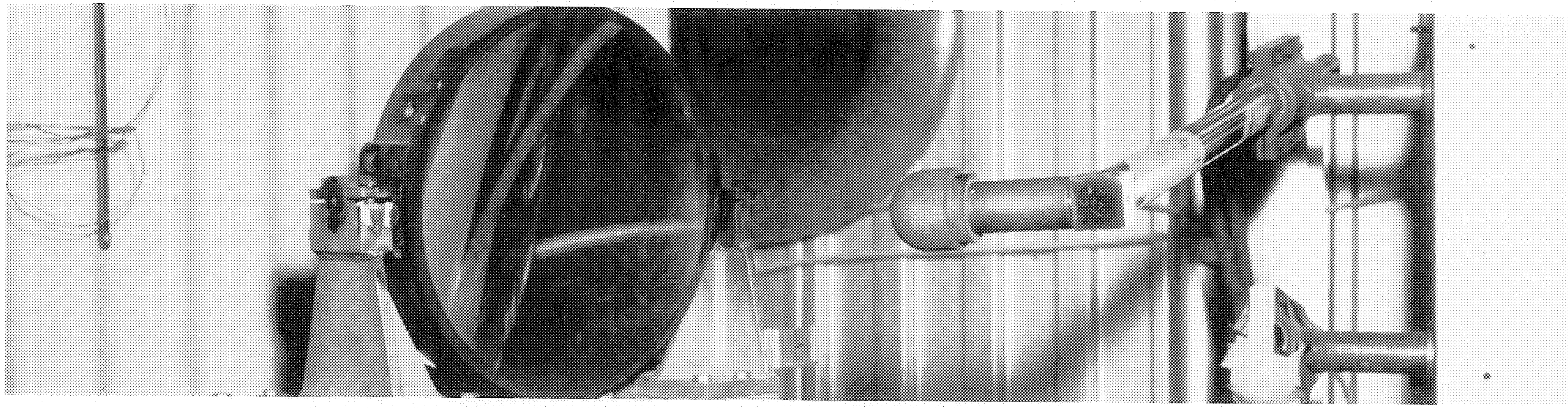
Operational since 1972

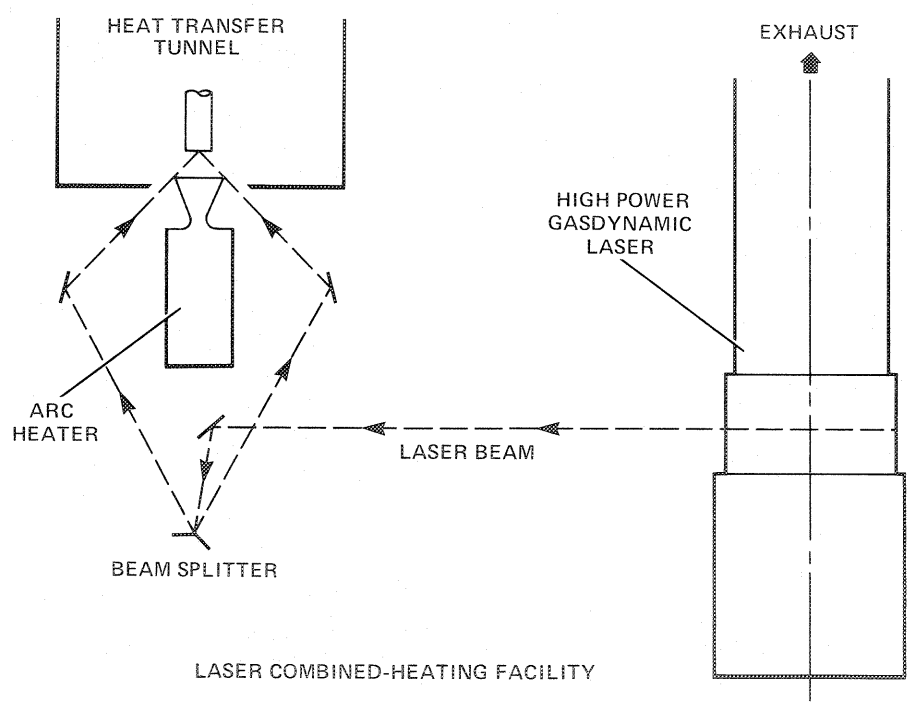
JURISDICTION:

Thermo- and Gas-Dynamics Division
Thermal Protection Branch
Howard K. Larson

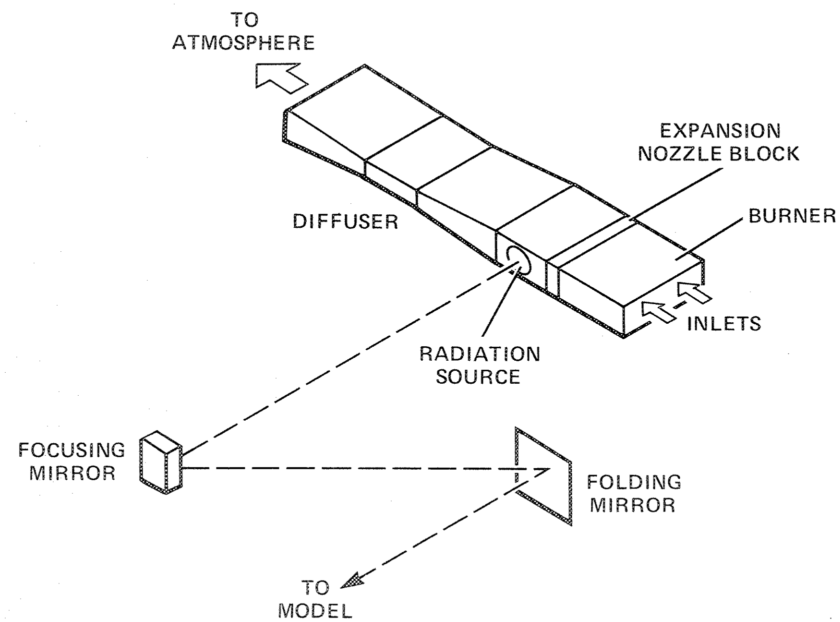
LOCATION:

Building N-234





LASER COMBINED-HEATING FACILITY



HIGH POWER CO_2 GASDYNAMIC LASER

4. HIGH POWER PULSED Nd: GLASS LASER

DESCRIPTION:

The High Power Pulsed Nd: Glass Laser is a high brightness source of coherent radiation at 1.06 μm wavelength. This radiation is emitted in a short pulse every four minutes. The pulse length is determined by the oscillator being used. A mode locked oscillator delivers a pulse whose length can be chosen between 25×10^{-12} sec to 900×10^{-12} sec. The electronic Q-switch oscillator allows pulse lengths 7.5×10^{-9} sec to 15×10^{-9} sec. A rotary prism switch oscillator gives 35 nsec pulses. The peak energy of the pulse depends upon which oscillator is used; it varies between 10 joules to 60 joules for various pulse widths. Peak power is 10^{10} watts which can be focused onto a target to give approximately 10^{15} watts/cm^2. Such intensities lead to interesting non-linear optical and heating effects. Current use is directed toward high temperature plasma production and X-ray laser development.

PERFORMANCE:

Power	10^{10} watts, maximum
Intensity	10^{15} watts/cm^2, maximum
Wavelength	1.06 μm
Pulse Length	2.5×10^{-11} sec to 3.5×10^{-8} sec
Duty Cycle	0.25 min^{-1}

STATUS:

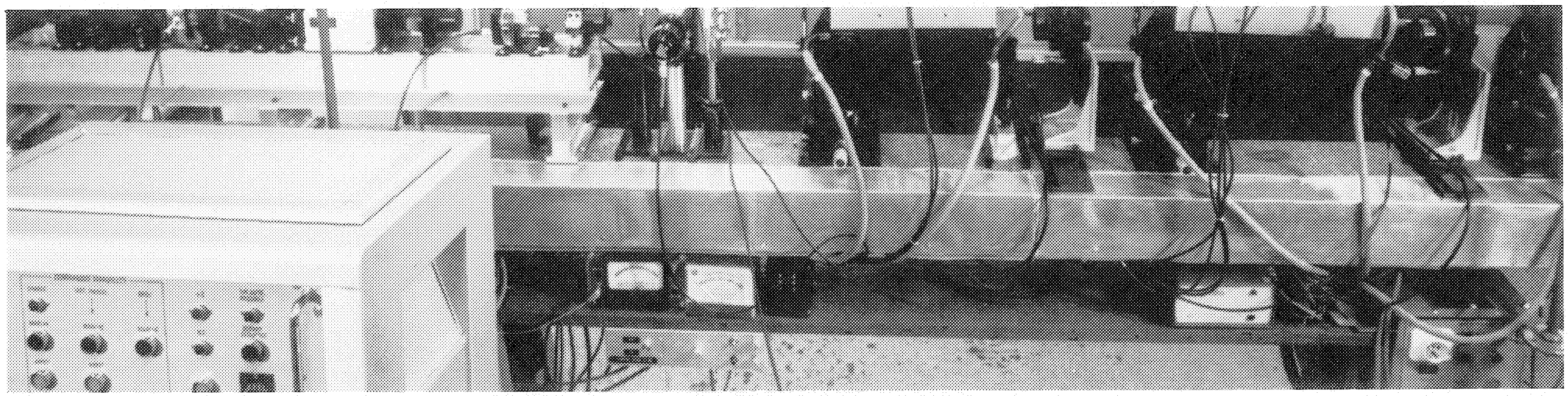
Operational; Development of short pulse oscillator continuing.

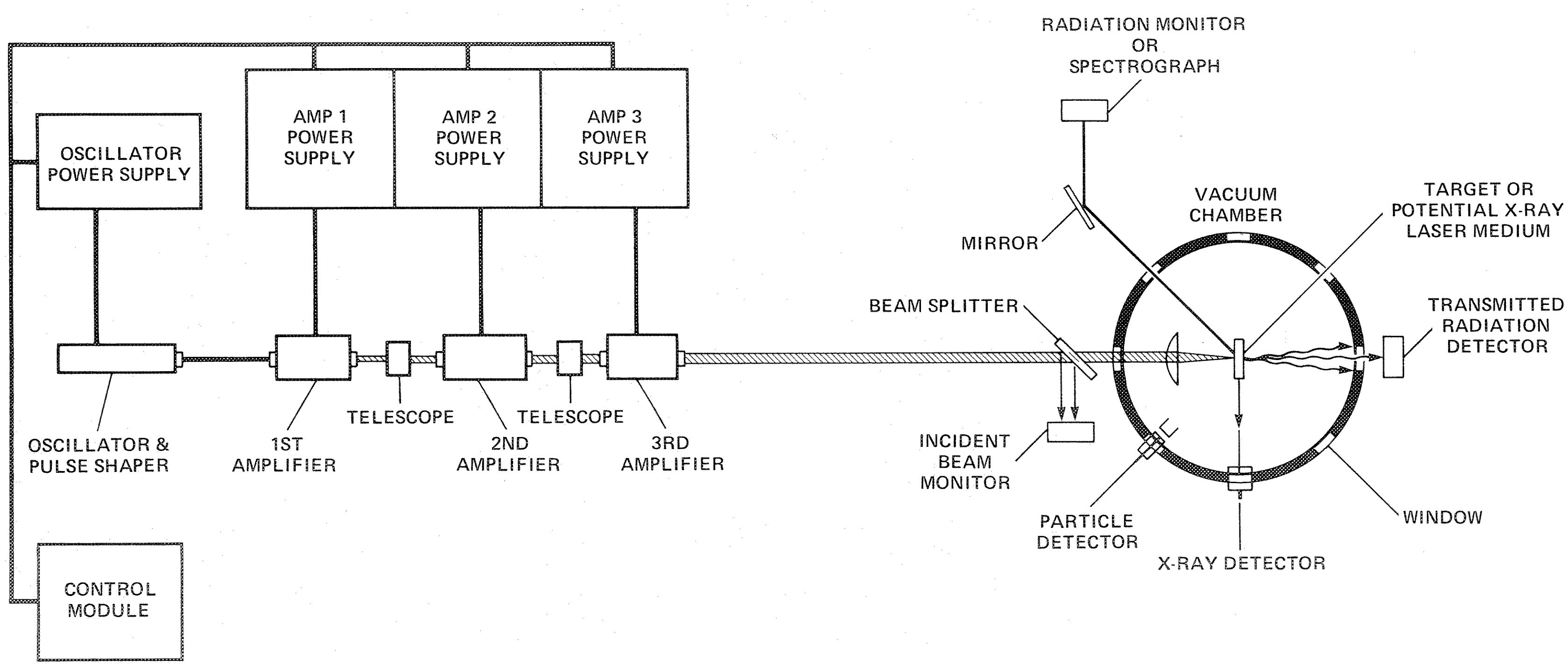
JURISDICTION:

Thermo- and Gas-Dynamics Division
Physical Gas-Dynamics and Lasers Branch
Kenneth W. Billman

LOCATION:

Building N-230



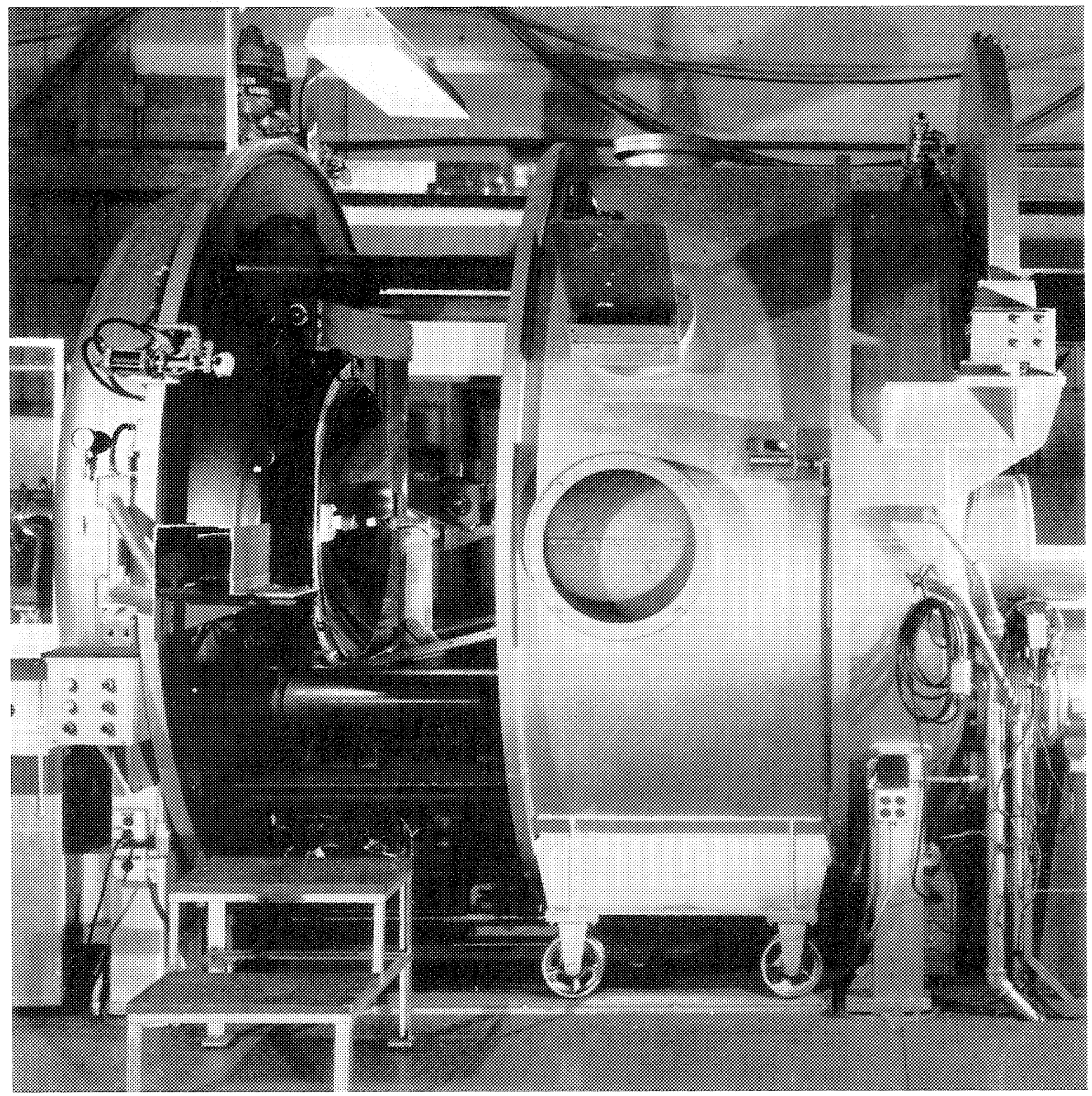


RADIATION MONITOR
OR
SPECTROGRAPH
OSCILLATOR
POWER SUPPLY
AMP 1
POWER
SUPPLY
AMP 2
POWER
SUPPLY
AMP 3
POWER
SUPPLY
VACUUM
CHAMBER
TARGET OR
POTENTIAL X-RAY
LASER MEDIUM
MIRROR
BEAM SPLITTER
TRANSMITTED
RADIATION
DETECTOR
TELESCOPE
TELESCOPE
OSCILLATOR &
PULSE SHAPER
1ST
AMPLIFIER
2ND
AMPLIFIER
3RD
AMPLIFIER
INCIDENT
BEAM
MONITOR
PARTICLE
DETECTOR
X-RAY DETECTOR
WINDOW
CONTROL
MODULE

5. ADVANCED ENTRY HEATING SIMULATOR

DESCRIPTION:

The Advanced Entry Heating Simulator is used for aerodynamic-heating and thermal-protection-materials studies of vehicles entering planetary atmospheres. It consists of a 3M.W. arc-heated supersonic wind tunnel employing vortex and magnetic field methods of arc stabilization, and operates in conjunction with a broad band radiative heating system which can furnish an additional 3,000 BTU/ft^2/sec. to 0.6-inch diameter models. Test gases include air and nitrogen with flow rates from 0.05 to 0.5 lbs/sec. Data are recorded on oscillographs or magnetic tapes utilizing calorimeters, pyrometers, and pressure cells. Models with specimen diameters from 0.5 to 2.0 inches can be accommodated. Run-time is five minutes maximum.



PERFORMANCE:

Stream Enthalpy	2,000 to 15,000 BTU/lb.
Mach numbers	2 to 5
Stagnation pressure	0.1 to 3.0 atmospheres
Arc Chamber pressure	1.0 to 15.0 atmospheres
Nozzle Exit pressure	0.0005 to 0.02 atmospheres
Nozzle Exit diameters	1.6 to 7 inches

STATUS:

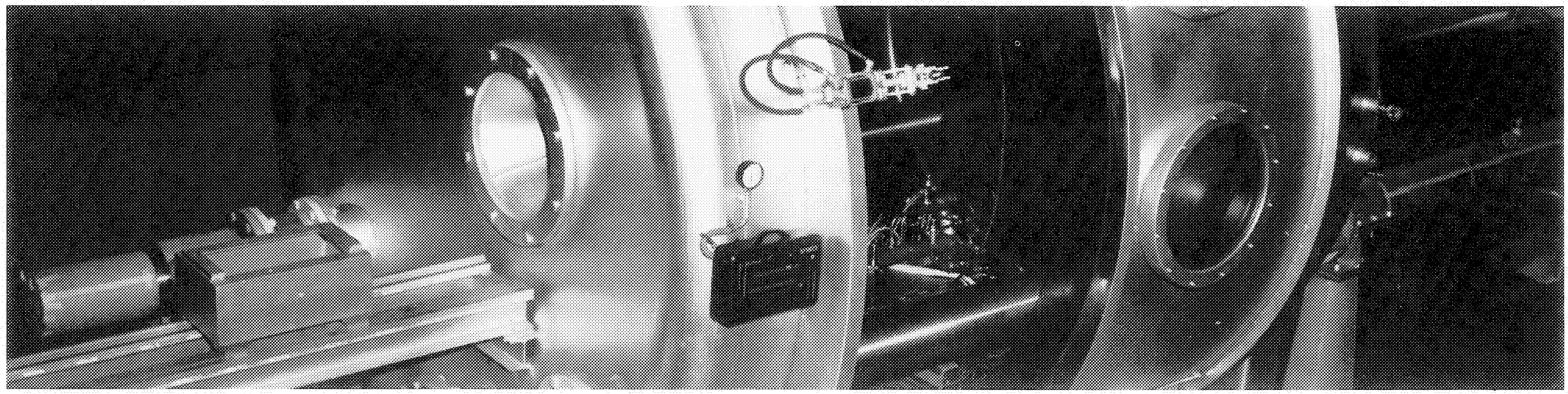
Operational since 1969

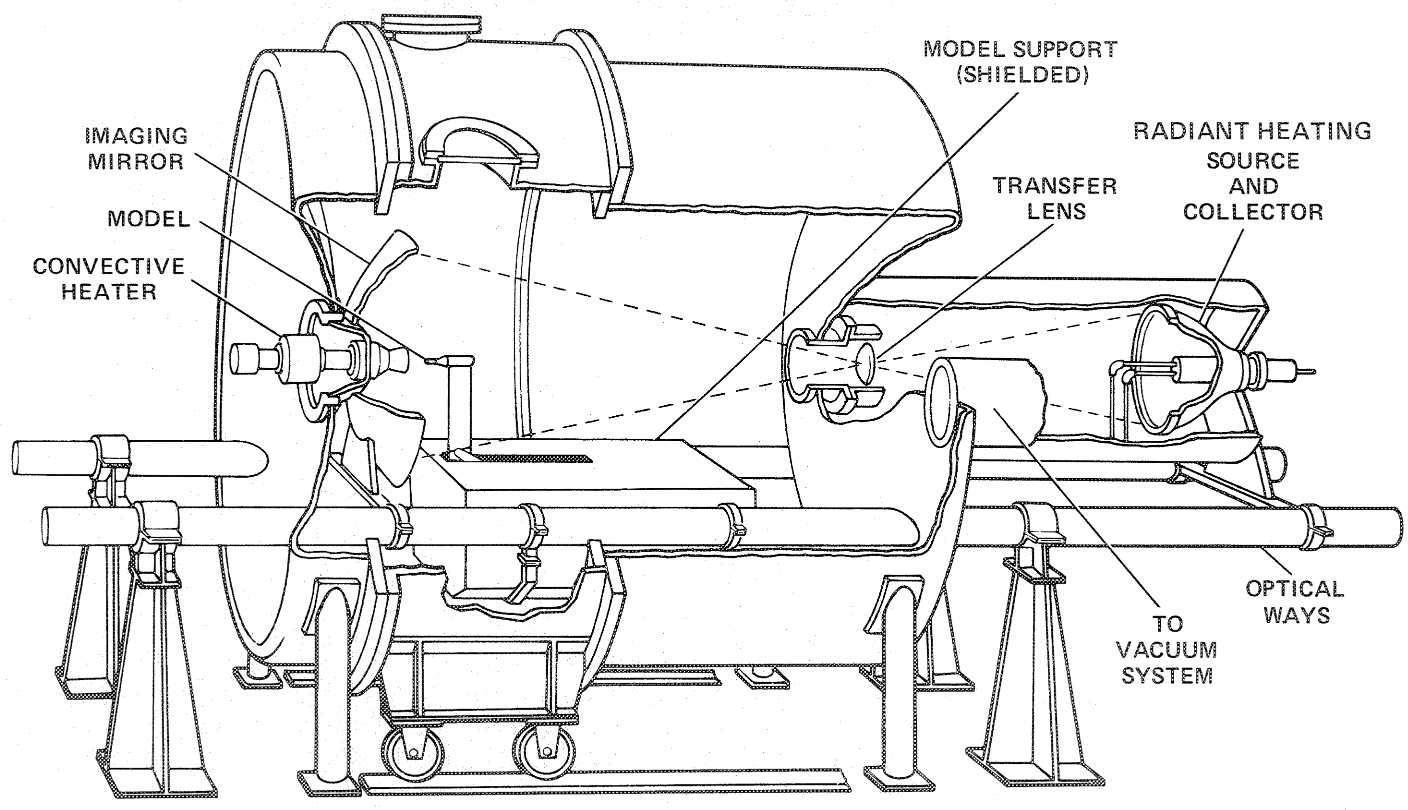
JURISDICTION:

Thermo-and Gas-Dynamics Division
Thermal Protection Branch
Howard K. Larson

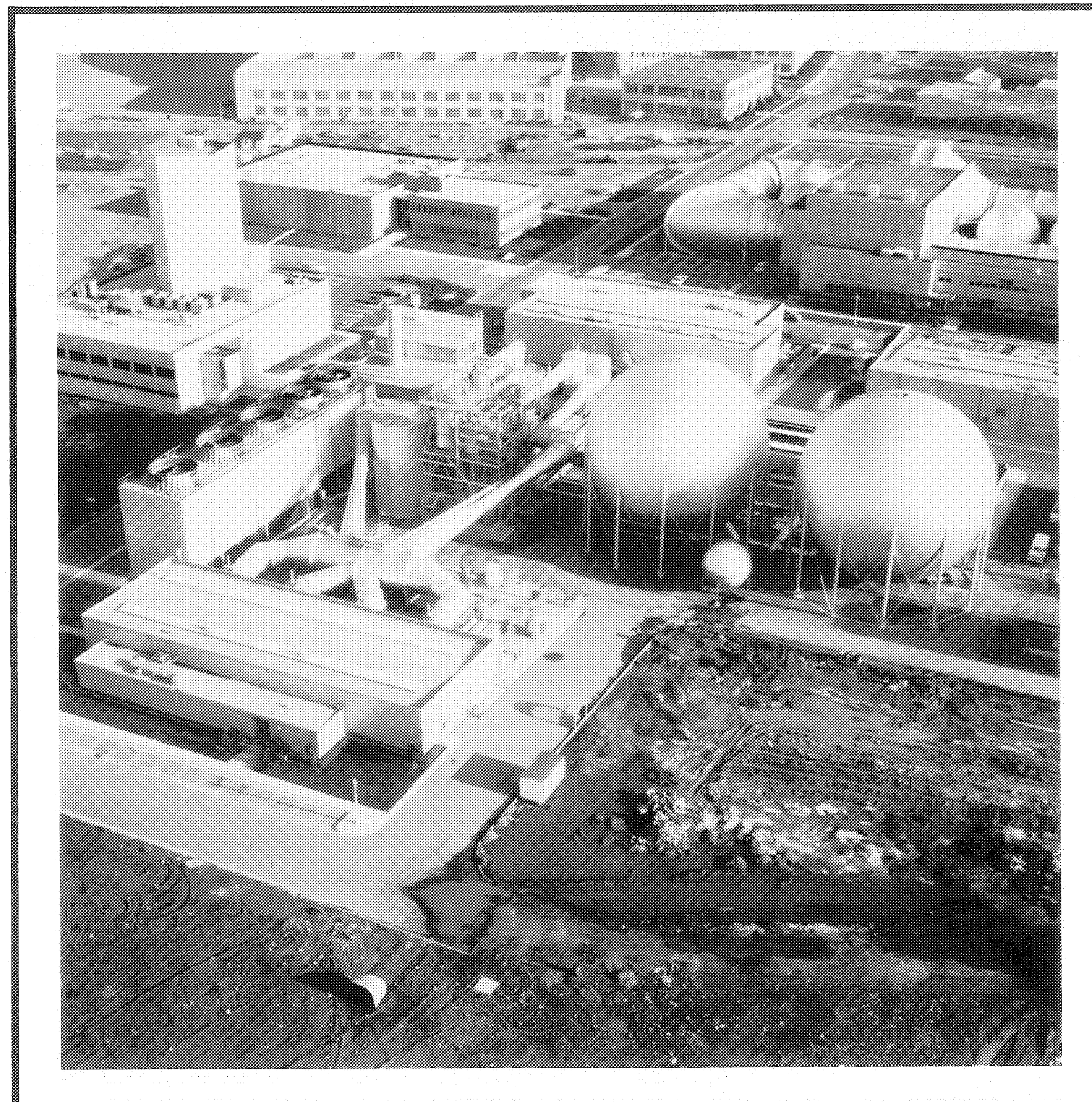
LOCATION:

Building N-207




MODEL SUPPORT (SHIELDED)
IMAGING MIRROR
MODEL
CONVECTIVE HEATER
TRANSFER LENS
RADIANT HEATING SOURCE AND COLLECTOR
OPTICAL WAYS
TO VACUUM SYSTEM

6. INTERACTION HEATING FACILITY



DESCRIPTION:

The Interaction Heating Facility and the 20 Megawatt Pilot Test Facility are used for studies of aerodynamic heating in the thermal environment resulting from the interaction of a flow field with an irregular surface. Both facilities are essentially identical, except for scale and are driven by constricted arc-heaters rated at 60MW and 20MW, respectively. Power is furnished by two DC power supplies; a 40MW power supply serving building N-238, and a 20MW power supply common to building N-234. The effluent gas stream (test gas is air with flow rates from 0.1 to 5.0 lb/sec) discharges into a five-stage steam-ejector-driven vacuum system, also common to building N-234. Two nozzles are available for each facility, a conical nozzle (Mach number ~ 5), and a semi-elliptic nozzle (Mach number ~ 3). Data are recorded by digital printout paper tape and by punched paper tape from pressure cells, calorimeters, thermocouples, and optical pyrometers. Run-time is thirty minutes for each facility.

PERFORMANCE: **20MW Pilot Test Facility**

Enthalpy	4,000 to 14,000 BTU/lb
Plenum pressure	1 to 10 atmospheres
Conical nozzle exit diameter (M ~ 5)	16 inches
Semi-elliptic width (M ~ 3)	15 inches, flat side

PERFORMANCE: **60MW Interaction Heating Facility**

Enthalpy	4,000 to 14,000 BTU/lb
Plenum pressure	1 to 10 atmospheres
Conical nozzle exit diameter (M ~ 5)	41 inches
Semi-elliptic width (M ~ 3)	30 inches, flat side

STATUS:

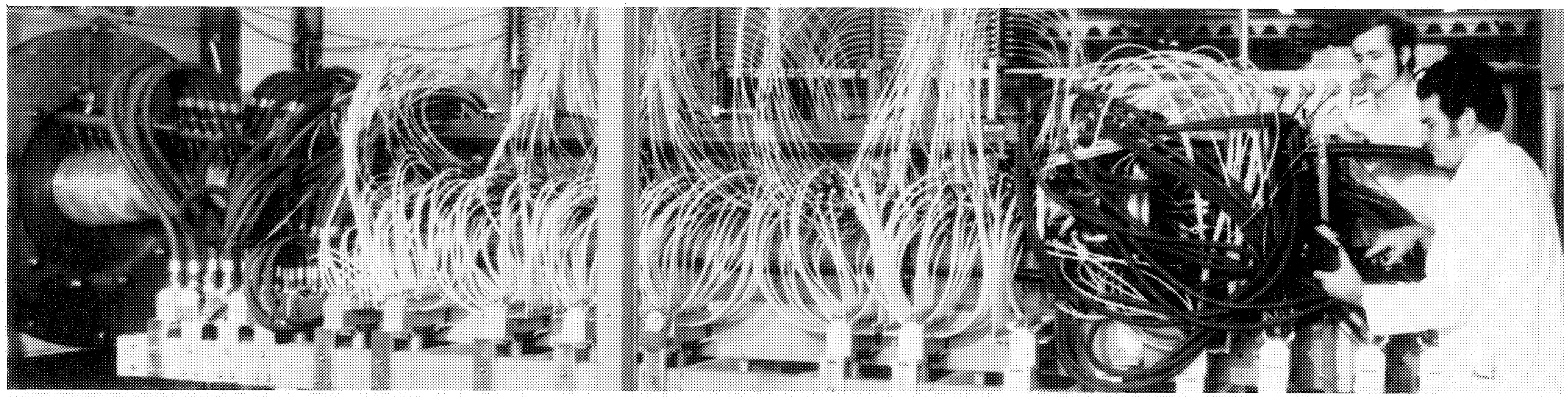
Operational since 1973 and 1974, respectively

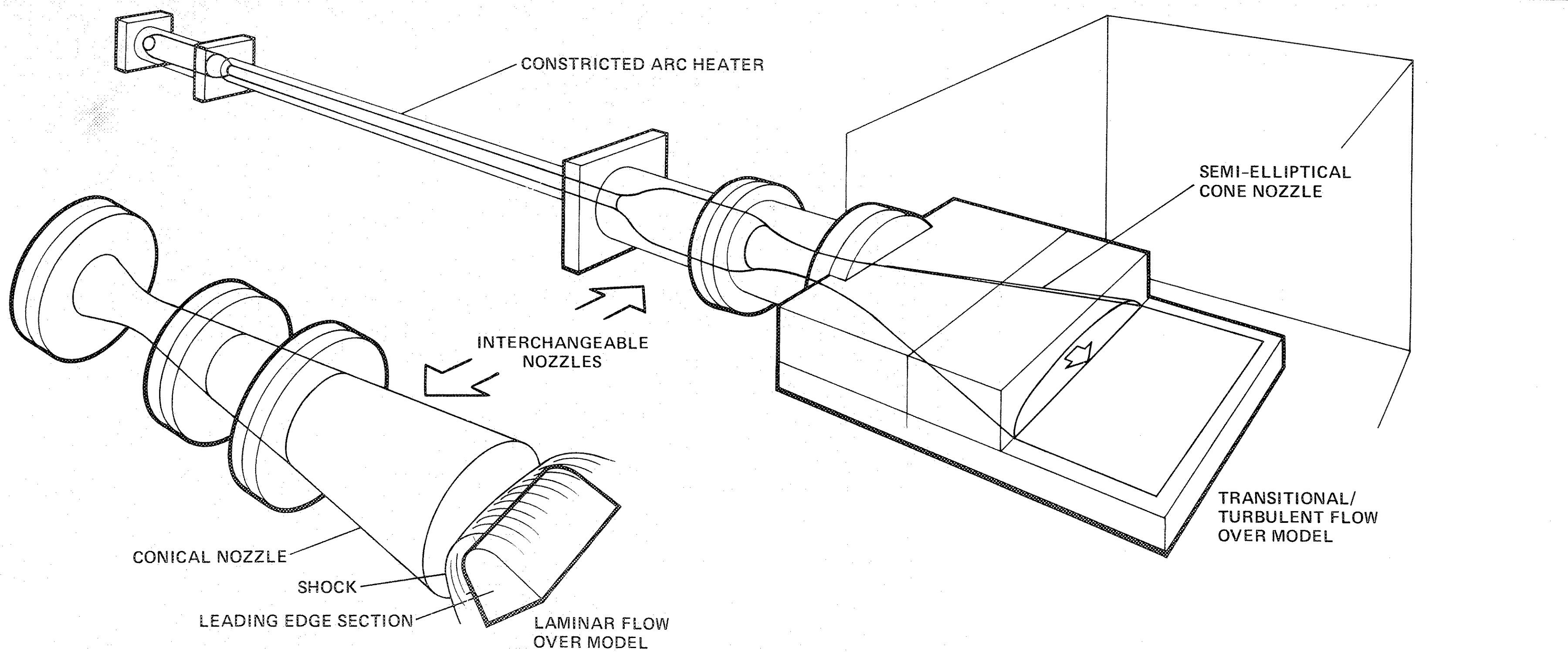
JURISDICTION:

Thermo- and Gas-Dynamics Division
Thermal Protection Branch
Howard K. Larson

LOCATION:

Building N-238

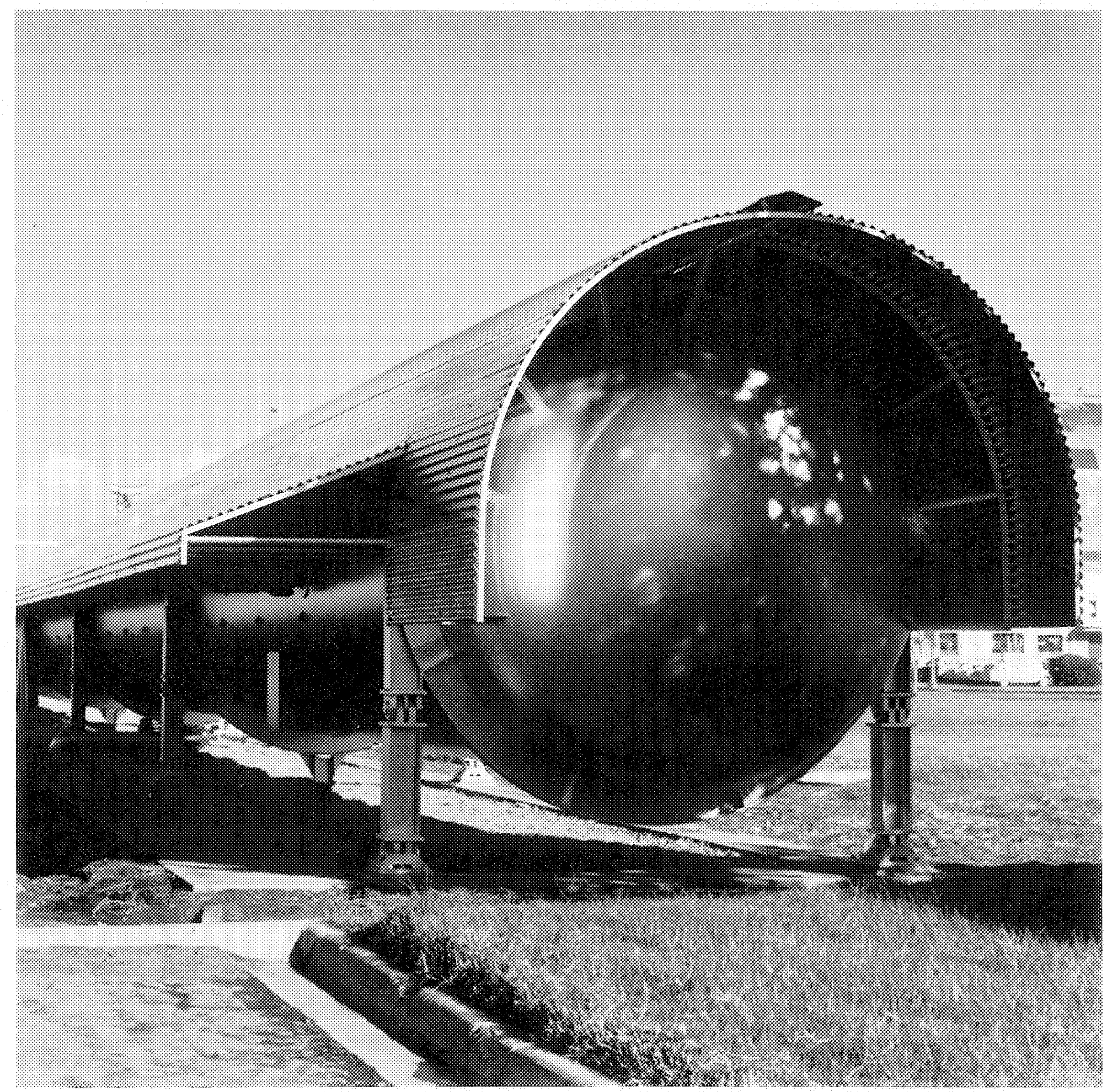



CONSTRICTED ARC HEATER
SEMI-ELLIPTICAL CONE NOZZLE
INTERCHANGEABLE NOZZLES
TRANSITIONAL/ TURBULENT FLOW OVER MODEL
CONICAL NOZZLE
SHOCK
LEADING EDGE SECTION
LAMINAR FLOW OVER MODEL

7. PRESSURIZED BALLISTIC RANGE

DESCRIPTION:

The Pressurized Ballistic Range is used to measure the aerodynamic characteristics of free-flight bodies and wing-body combinations in quiescent air at speeds from subsonic to hypersonic (11,000 ft/sec, max.) and at Reynolds numbers large enough to approach those of full-scale flight. Models up to 57 mm in diameter and weighing 170 grams maximum can be accommodated. Flights are recorded utilizing a 24-station, conical-projection shadowgraph system. Conventional numerical analysis of time-distance-attitude records is then performed to obtain aerodynamic force and moment coefficient. The range test section is large enough to accommodate diverse special equipment such as cameras, long troughs for catching aerodynamically decelerated models with minimum damage, and calorimeters for measuring the total heat input into similarly decelerated models.



PERFORMANCE:

Air pressure	0.10 to 5.0 atmospheres
Air temperature	75°F
Reynolds number	300×10^6/ft, maximum
Model speed	3.3 km/sec, maximum
Model launching acceleration	10^6g, maximum

DIMENSIONS: Test Section

Length	203 feet
Pressure Vessel diameter	10.0 feet

STATUS:

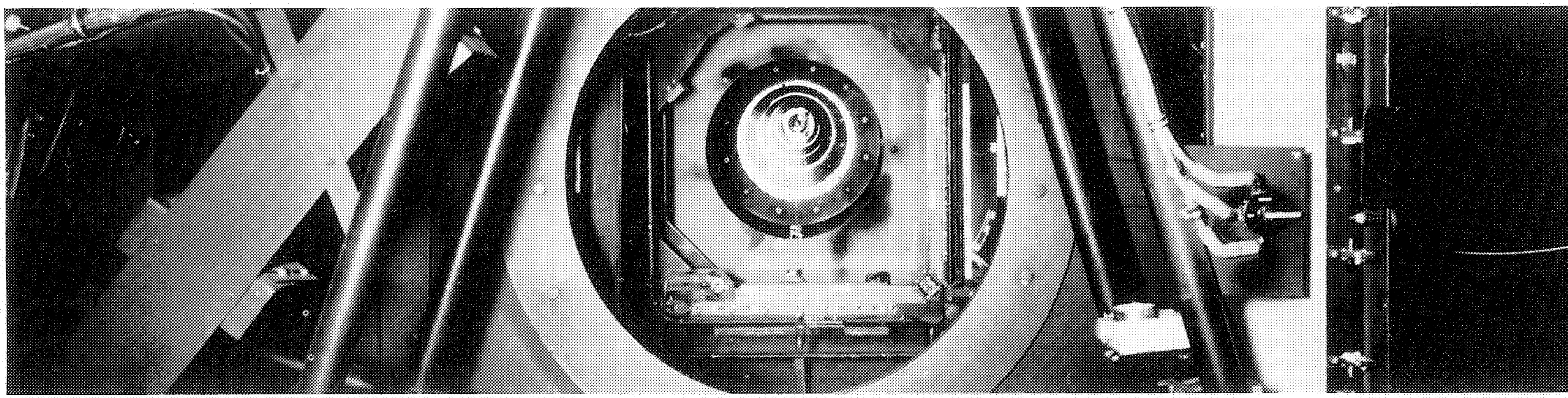
Operational since 1958

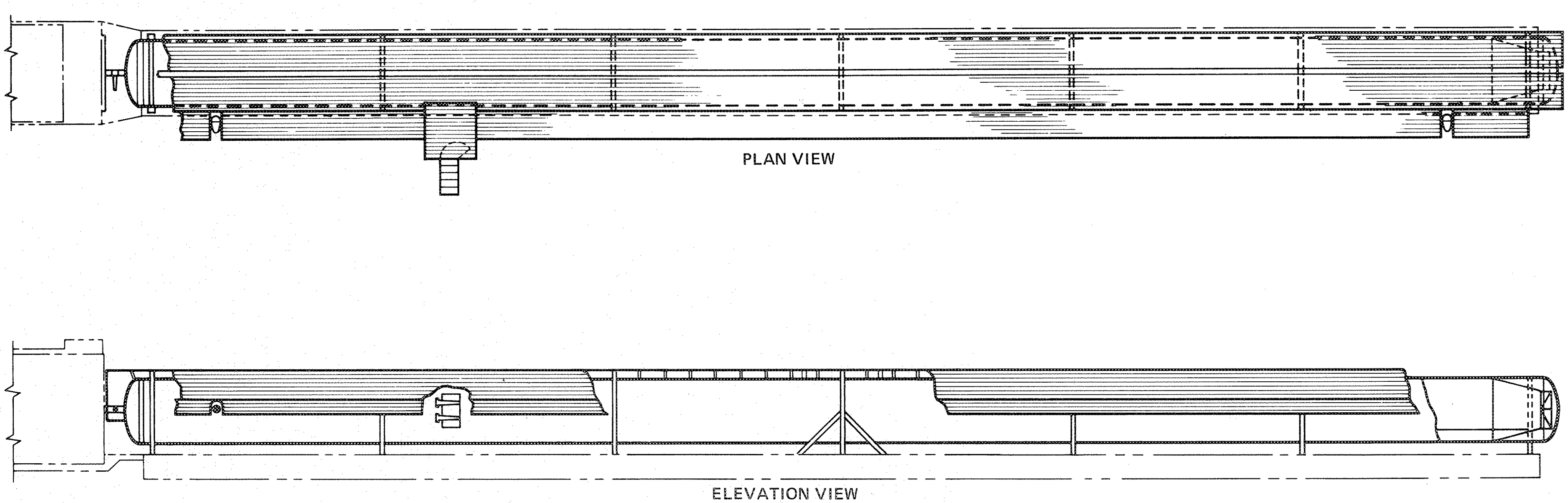
JURISDICTION:

Flight Project Development Division
Systems Development Branch
Thomas N. Canning

LOCATION:

Building N-209




PLAN VIEW
ELEVATION VIEW

8. HYPERSONIC FREE-FLIGHT AERODYNAMIC FACILITY

DESCRIPTION:

The Hypersonic Free-Flight Aerodynamic Facility is used for research on gas dynamic problems of atmospheric entry. High relative speeds are achieved by launching models (in sabots if necessary) from high-speed guns into a countercurrent hypersonic air stream (14,000 ft/sec) driven by combustion-powered shock tube. Parameters derived from observations of model flights include lift, drag, static and dynamic stability, flow characteristics (including absolute spectral emissive power of shock layers and wakes), and model ablation. Models up to 37 mm in diameter and weighing 45 grams maximum can be accommodated. Shadowgraphs can be obtained at sixteen stations spaced every five feet along the test section.

PERFORMANCE:

Stream Mach Number	7.0
Stream Enthalpy	4,000 BTU/lb., maximum
Reynolds number	80×10^6 per ft., maximum
Stream static pressure	0.005 to 0.2 atmospheres
Model speed	30,000 ft/sec maximum
Model launching acceleration	1.5×10^6 g, maximum

DIMENSIONS:

Length	75.0 feet
Diameter	3.5 feet

STATUS:

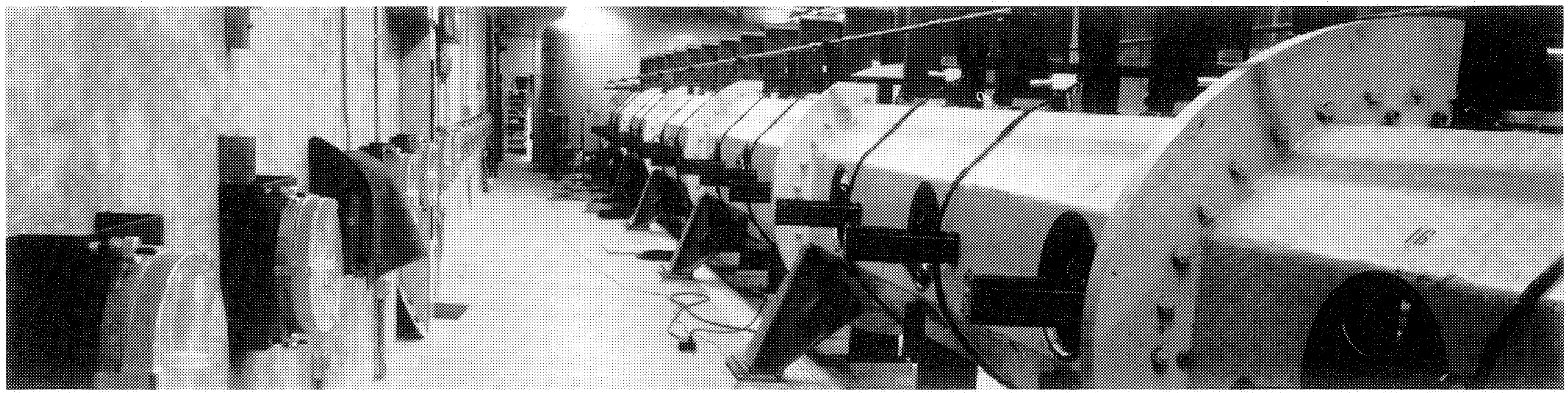
Operational since 1965

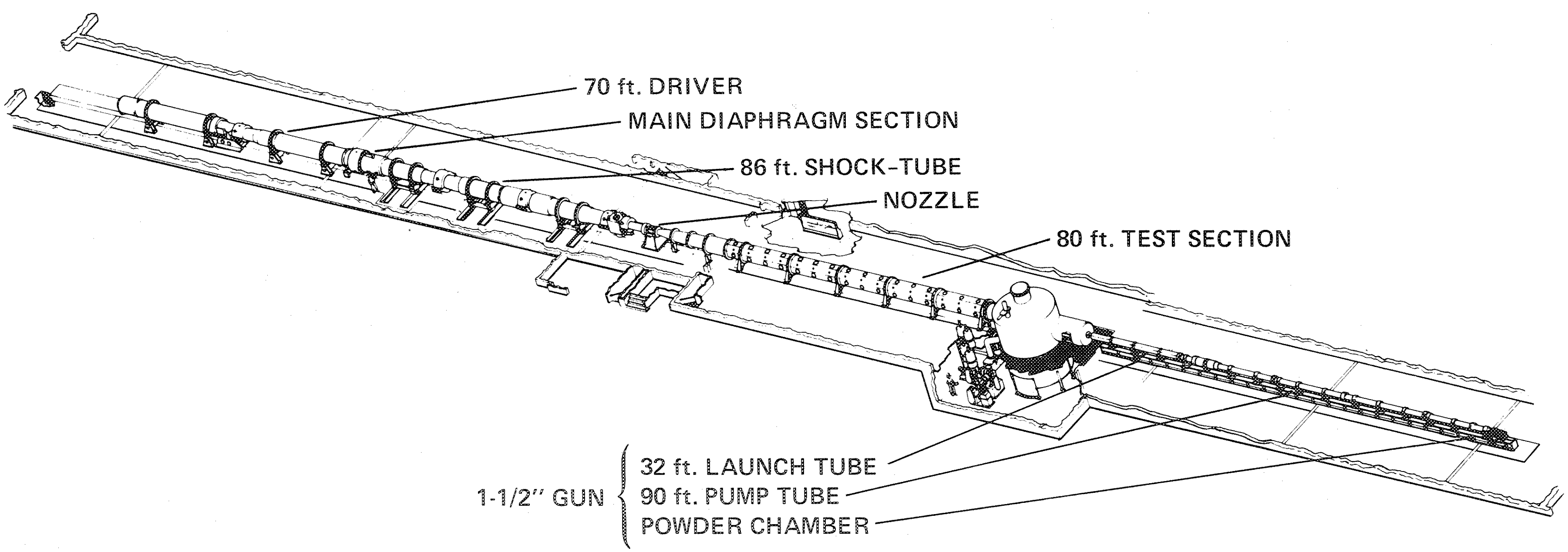
JURISDICTION:

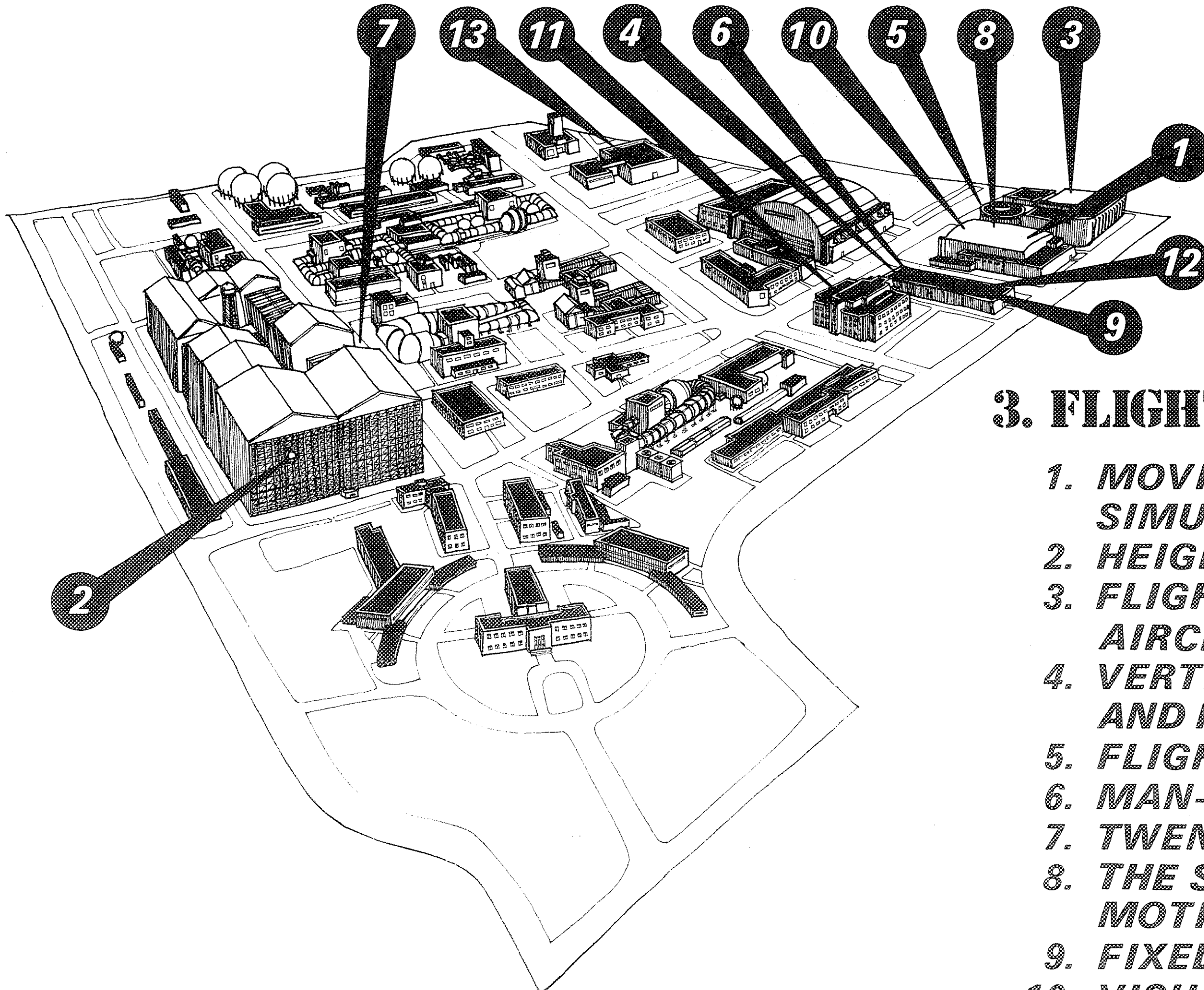
Flight Project Development Division
Systems Development Branch
Thomas N. Canning

LOCATION:

Building N-237



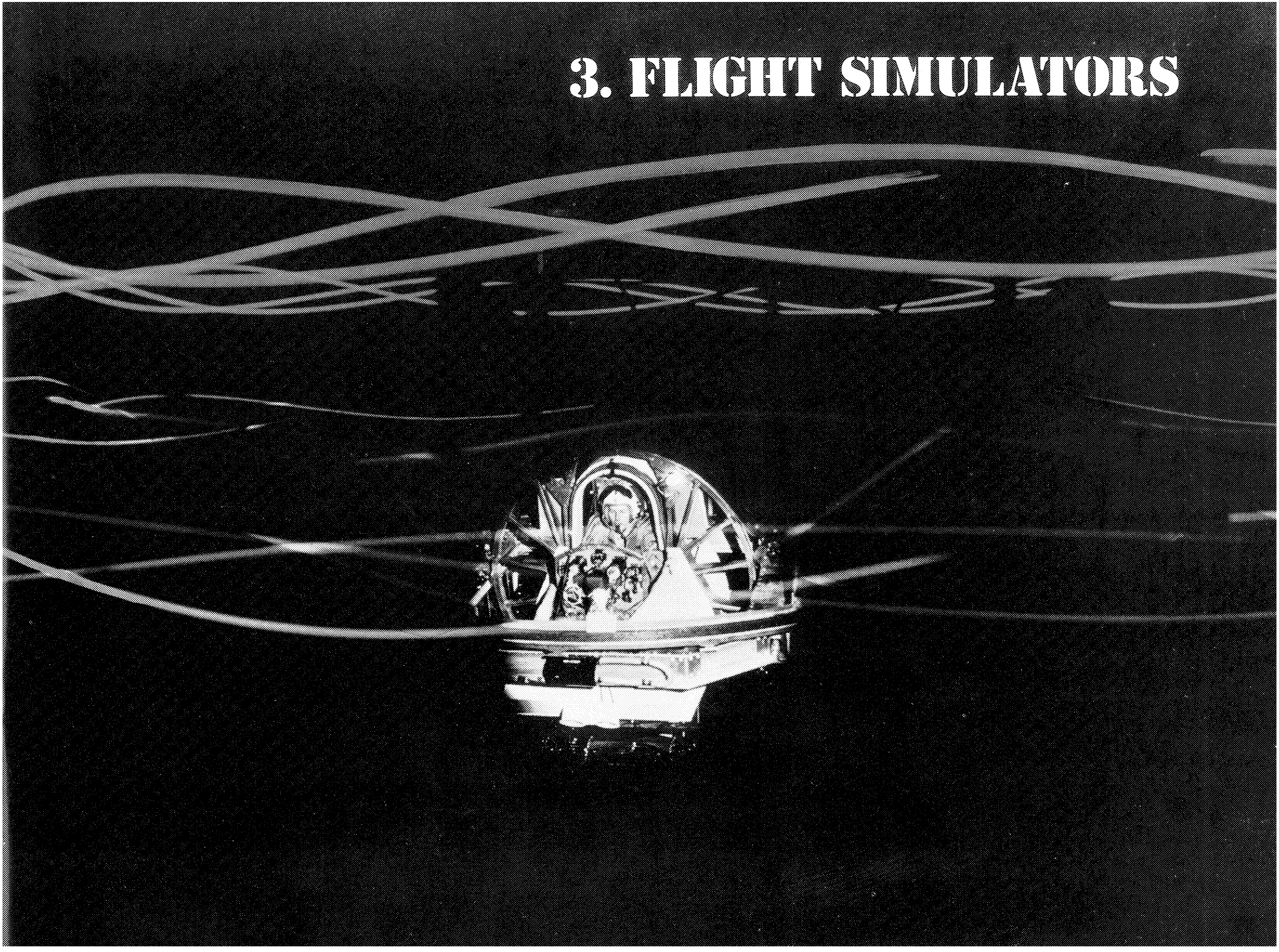

70 ft. DRIVER
MAIN DIAPHRAGM SECTION
86 ft. SHOCK-TUBE
NOZZLE
80 ft. TEST SECTION
1-1/2'' GUN
32 ft. LAUNCH TUBE
90 ft. PUMP TUBE
POWDER CHAMBER



3. FLIGHT SIMULATORS

1. *MOVING-CAB TRANSPORT SIMULATOR*
2. *HEIGHT-CONTROL TEST APPARATUS*
3. *FLIGHT SIMULATOR FOR ADVANCED AIRCRAFT*
4. *VERTICAL ACCELERATION AND ROLL DEVICE*
5. *FLIGHT AND GUIDANCE CENTRIFUGE*
6. *MAN-CARRYING ROTATION DEVICE*
7. *TWENTY-G CENTRIFUGE*
8. *THE SIX-DEGREE-OF-FREEDOM MOTION SIMULATOR*
9. *FIXED-BASE TRANSPORT SIMULATOR*
10. *VISUAL SCENE PRESENTATION SYSTEMS*
11. *COMPUTER GRAPHICS VISUAL DISPLAY SIMULATOR*
12. *ENVIRONMENTAL TEST FACILITIES*
13. *SPARCS SIMULATOR*

3. FLIGHT SIMULATORS



1. MOVING-CAB TRANSPORT SIMULATOR

DESCRIPTION:

The Moving-Cab Transport Simulator is used to evaluate a wide range of aircraft for handling qualities and control system parameters under the conditions of approach, cruise handling and taxiing. Configured as a large transport-type cab, it is equipped for side-by-side pilot/copilot operation, and is frequently used in a dual-project mode with each side outfitted as a different aircraft. The cab is provided with virtual image TV displays for each pilot; panel, center and overhead instruments; programmable hydraulic "force-feel" flight controls; auto throttles; and stereo cockpit sounds. Aircraft dynamics are provided by an EAI 8400 digital computer (32,000 word memory) and/or an EAI 231R analog computer used in the closed-loop mode.

DRIVES:

Hydraulic servo (three linear actuators operated differentially or synchronized)

STATUS:

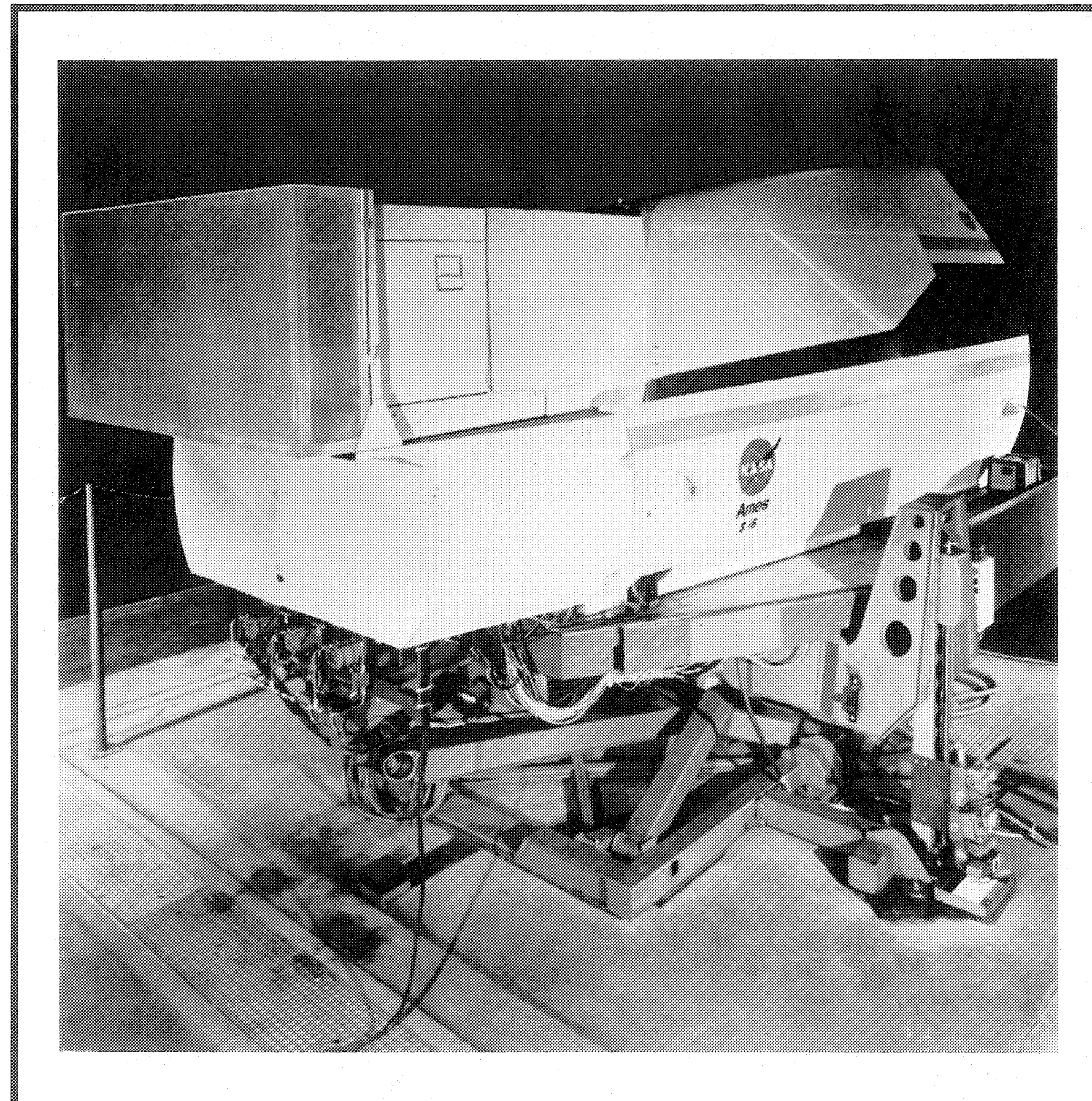
Operational since 1963

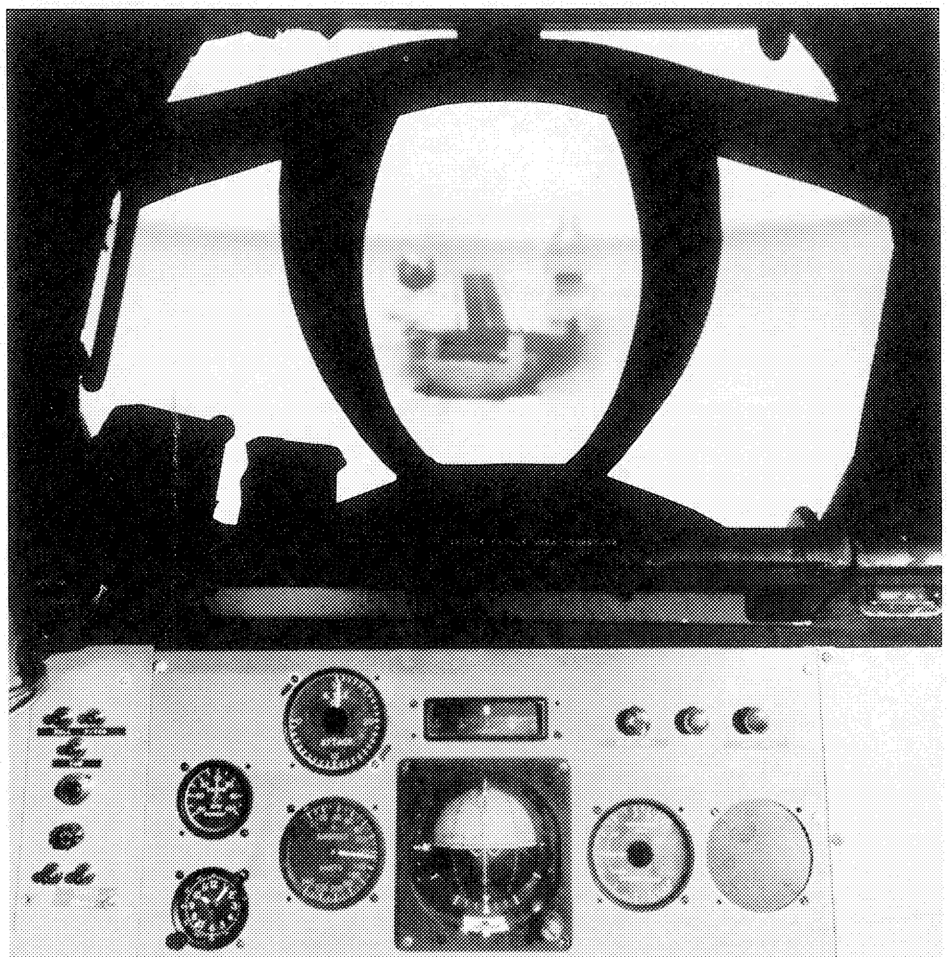
JURISDICTION:

Simulation Sciences Division
George A. Rathert, Jr.

LOCATION:

Building N-210





Motions Generated	Displacement	Acceleration	Velocity	Frequency At 30° Phase Lag
Roll	±9°	4.7 Rad/sec^2	0.22 Rad/sec	0.5 Hz
Pitch	+14° −6°	4.7 Rad/sec^2	0.22 Rad/sec	0.5 Hz
Heave (Vertical)	24 in.	±1.0 g (from ambient)		0.5 Hz

2. HEIGHT-CONTROL TEST APPARATUS

DESCRIPTION:

The Height-Control Test Apparatus is used for flight simulations requiring sustained vertical acceleration or turbulence cues. The cockpit is outfitted with control wheel and rudder pedals with an adjustable force-feel system. An instrument panel is provided for a single left seat pilot. A TV monitor is provided for out-of-the-window visual displays which are generated in the Space Flight Simulation Laboratory and transmitted by direct wire cables. Aircraft dynamics are provided by an EAI 231R analog computer used in the closed-loop mode.

STATUS:

Operational since 1961

DRIVES:

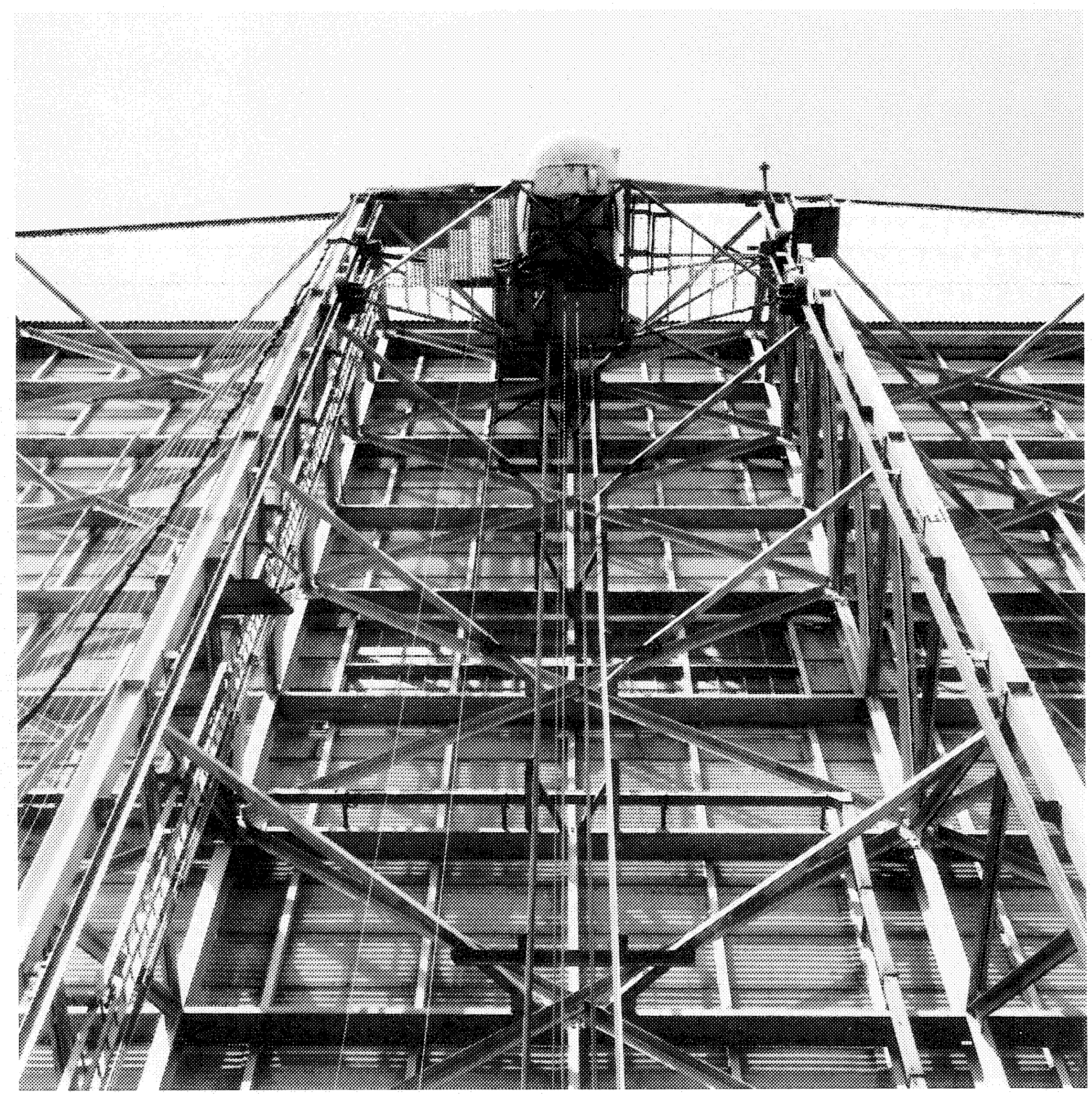
Ward-Leonard Electrical servo

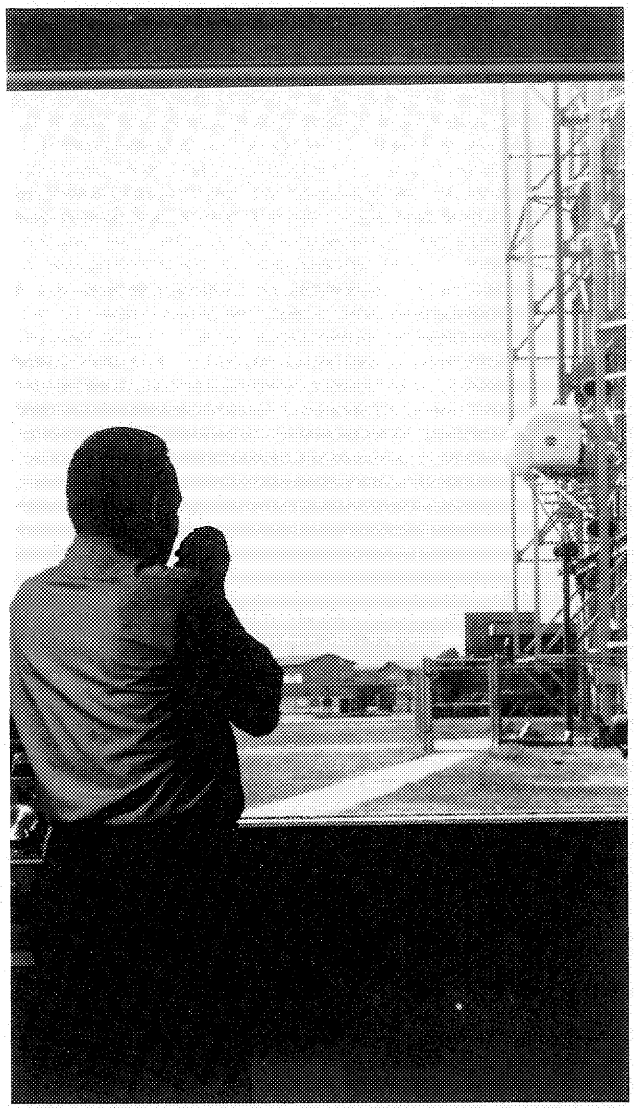
JURISDICTION:

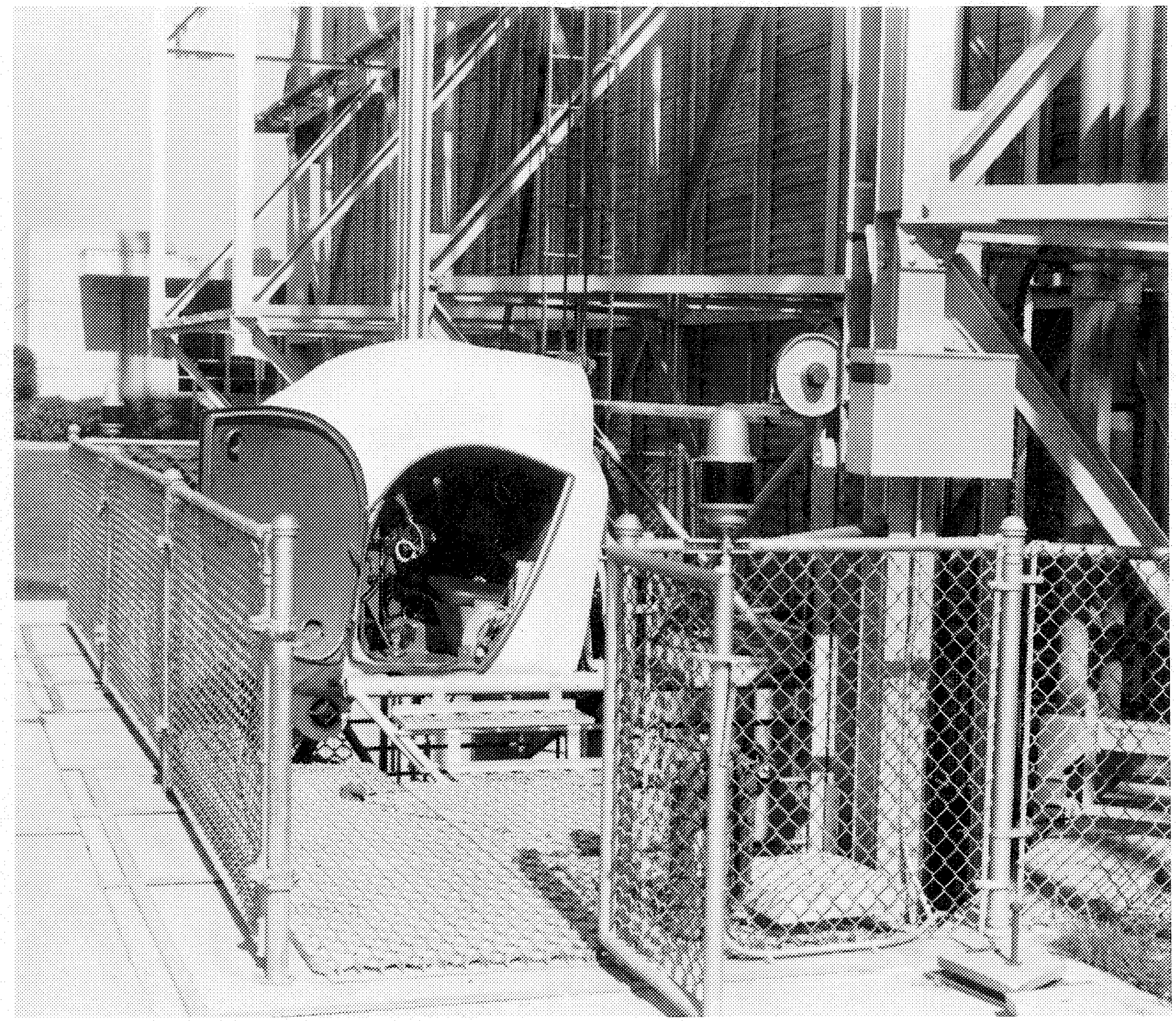
Simulation Sciences Division
George A. Rathert, Jr.

LOCATION:

Building N-221B







Motion Generated	Displacement	Acceleration	Velocity	Frequency At 30° Phase Lag
Vertical	100 ft (80 ft useable)	±0.7 g	18 ft/sec	1.5 Hz

3. FLIGHT SIMULATOR FOR ADVANCED AIRCRAFT

DESCRIPTION:

The Flight Simulator for Advanced Aircraft (FSAA) is used for investigations of landing, take-off, and general handling qualities of large aircraft as well as evaluation of crew tasks. The large lateral travel permits examination of such maneuvers as lateral side-slip during a landing approach or engine-out on take-off. Both pilot and copilot seats are available. The cab is provided with a virtual image TV display; panel, center and overhead instruments; a hydraulic control loader system; auto-throttles; and aircraft sound generator. Aircraft dynamics are provided by an XDS Sigma 8 digital computer (96,000 word memory) and an EAI 231R analog unit used in the closed-loop mode. Research operations utilizing this simulator have included investigations relating to the development of improved handling qualities and airworthiness criteria for large jets and STOL aircraft.

DRIVES:

Ward-Leonard Electric servos

STATUS:

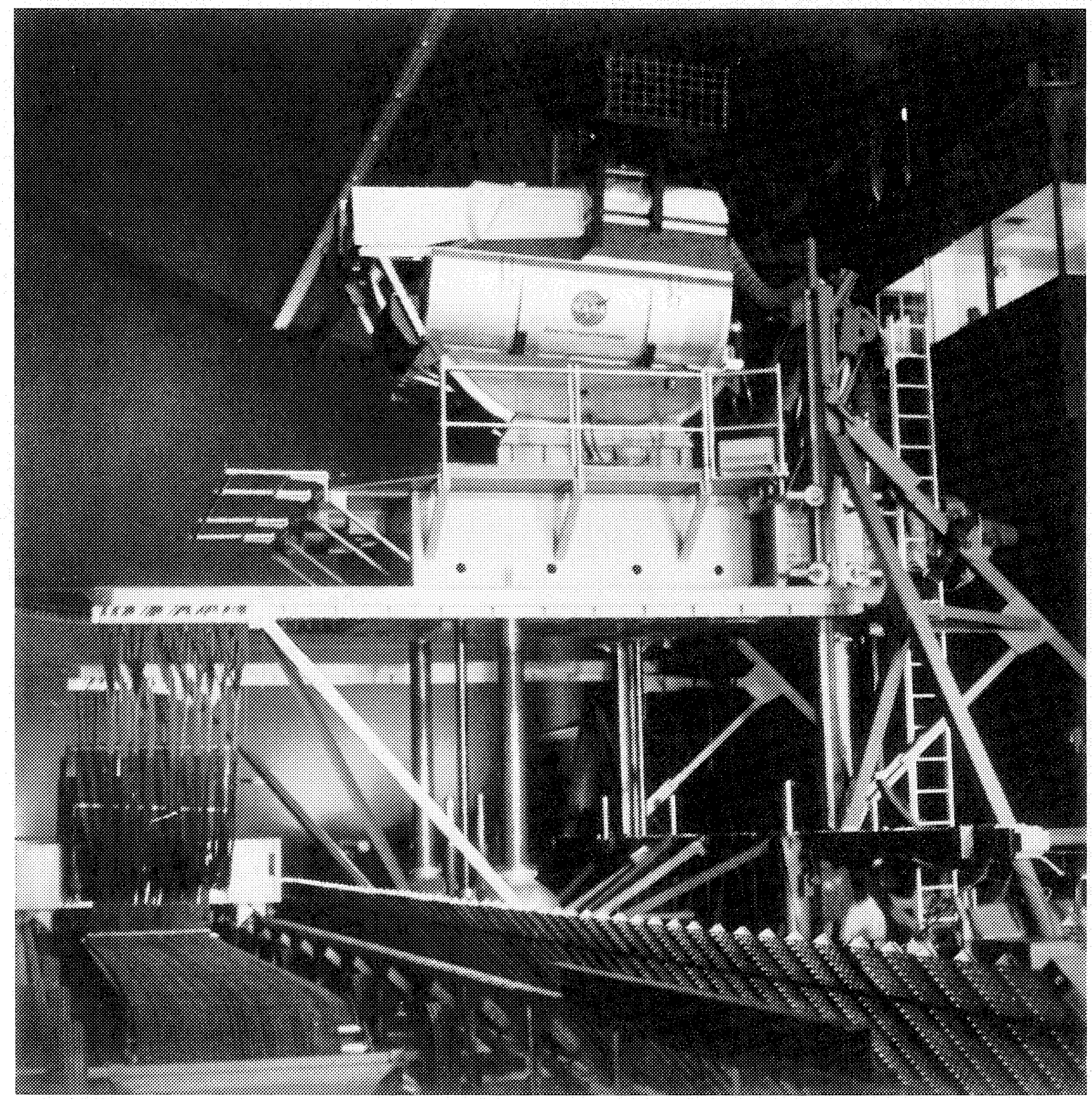
Operational since 1969

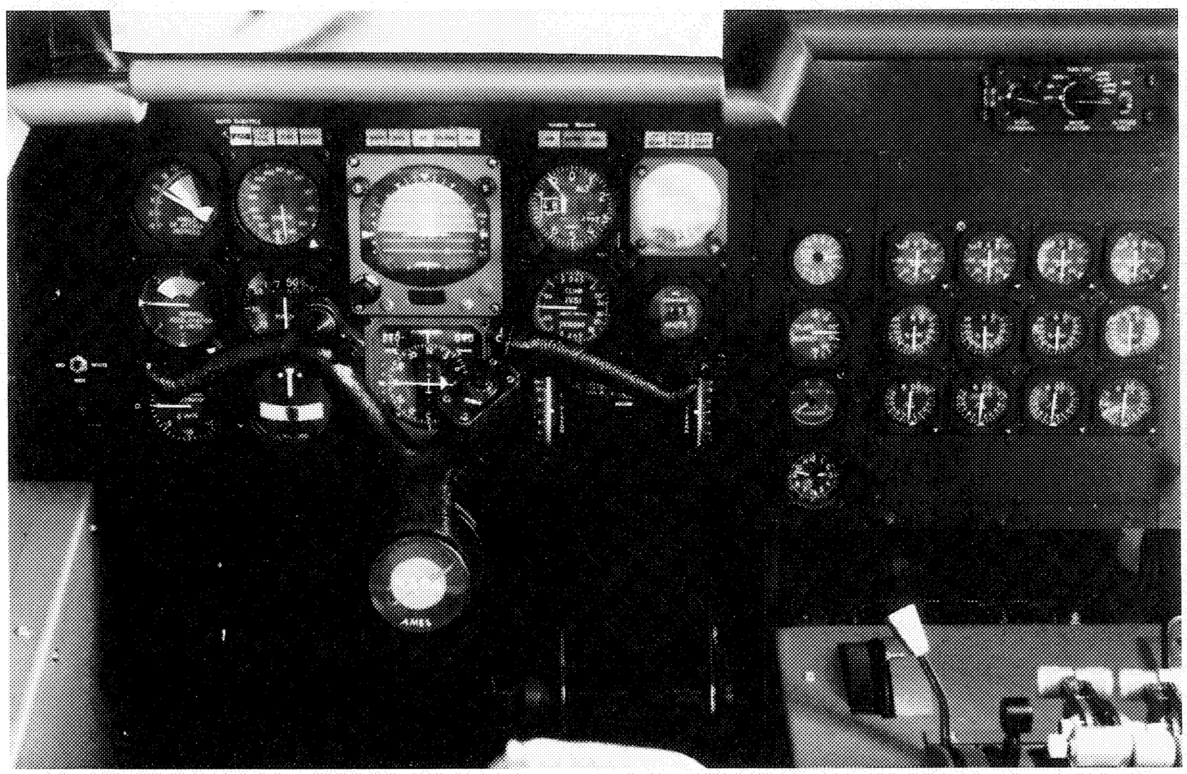
JURISDICTION:

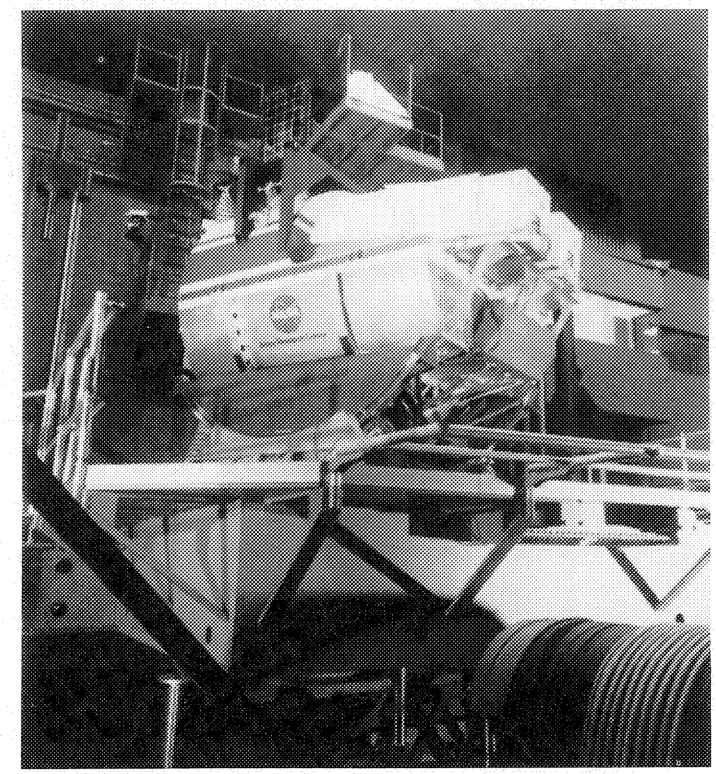
Simulation Sciences Division
George A. Rathert, Jr.

LOCATION:

Building N-243







Motions Generated	Displacement	Acceleration	Velocity	Frequency At 30° Phase Lag
Roll	±36°	1.6 Rad/sec^2	0.50 Rad/sec	3.1 Hz
Pitch	±18°	1.6 Rad/sec^2	0.50 Rad/sec	1.5 Hz
Yaw	±24°	1.6 Rad/sec^2	0.50 Rad/sec	1.7 Hz
Vertical	±4 ft	10 ft/sec^2	6.90 ft/sec	2.2 Hz
Longitudinal	±3 ft	8 ft/sec^2	5.05 ft/sec	1.8 Hz
Lateral	±40 ft	10 ft/sec^2	16.00 ft/sec	1.0 Hz

4. VERTICAL ACCELERATION AND ROLL DEVICE

DESCRIPTION:

The Vertical Acceleration and Roll Device is a dynamic flight simulator with vertical translation and roll rotation capabilities used for flight simulations requiring visual contact, as well as aircraft, spacecraft, and medical investigations requiring vertical and roll accelerations. It consists of a two-place, side-by-side cockpit supported on a vertical track. This simulator is normally operated closed-loop with flight dynamics generated on an EAI 231R analog or EAI 8400 digital computer programmed to account for vehicle dynamic response to pilot control inputs.

In the near future, a television camera will be driven closed-loop for acquiring a TV monitor view of a model runway and surrounding countryside as a visual aid in landing approach studies.

DRIVES:

Rotary hydraulic servo motors provide linear motion for the vertical excursion, controlled by an electro-hydraulic servo valve. An electrically controlled linear actuator is used for roll.

STATUS:

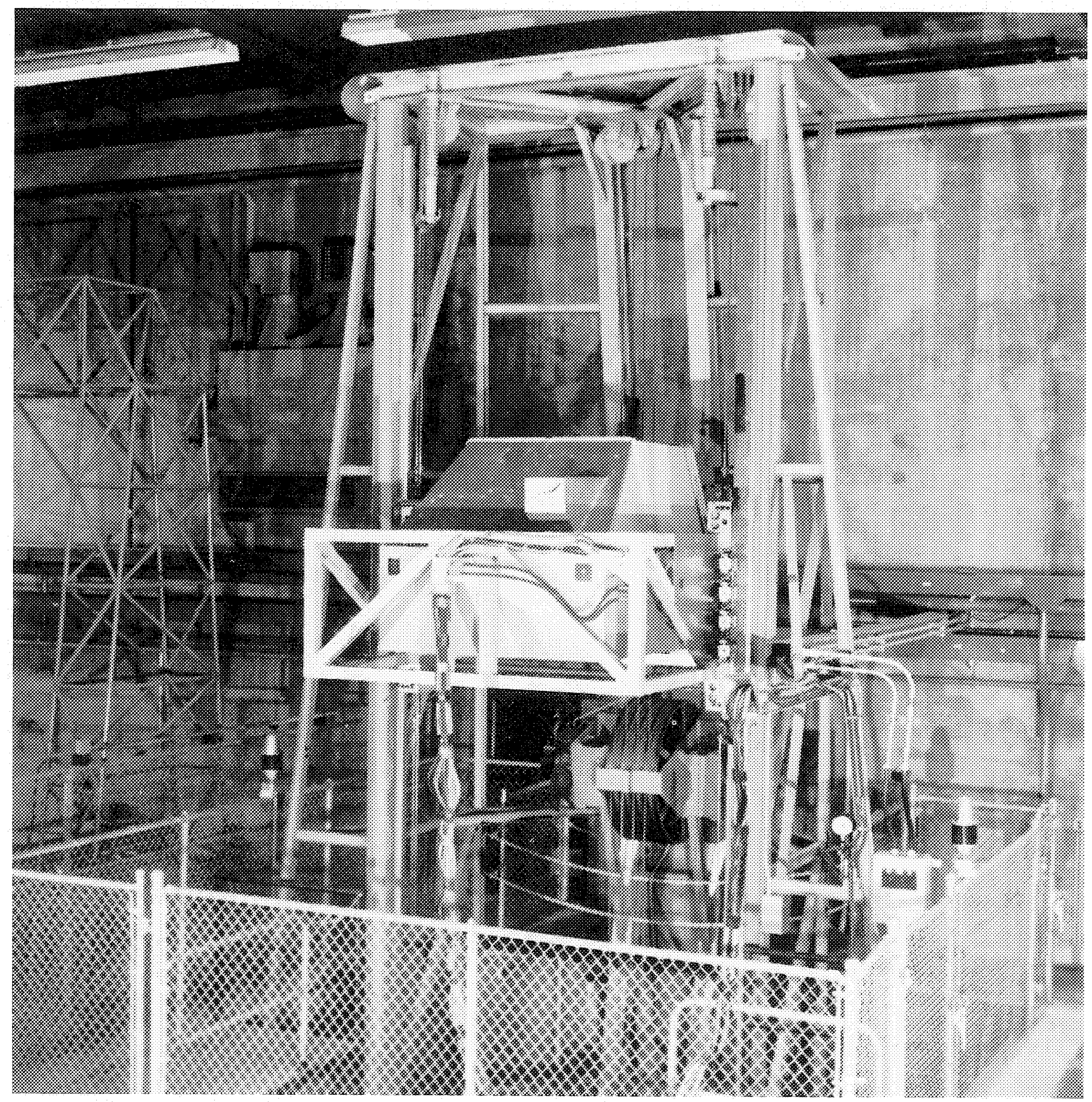
Operational since 1973

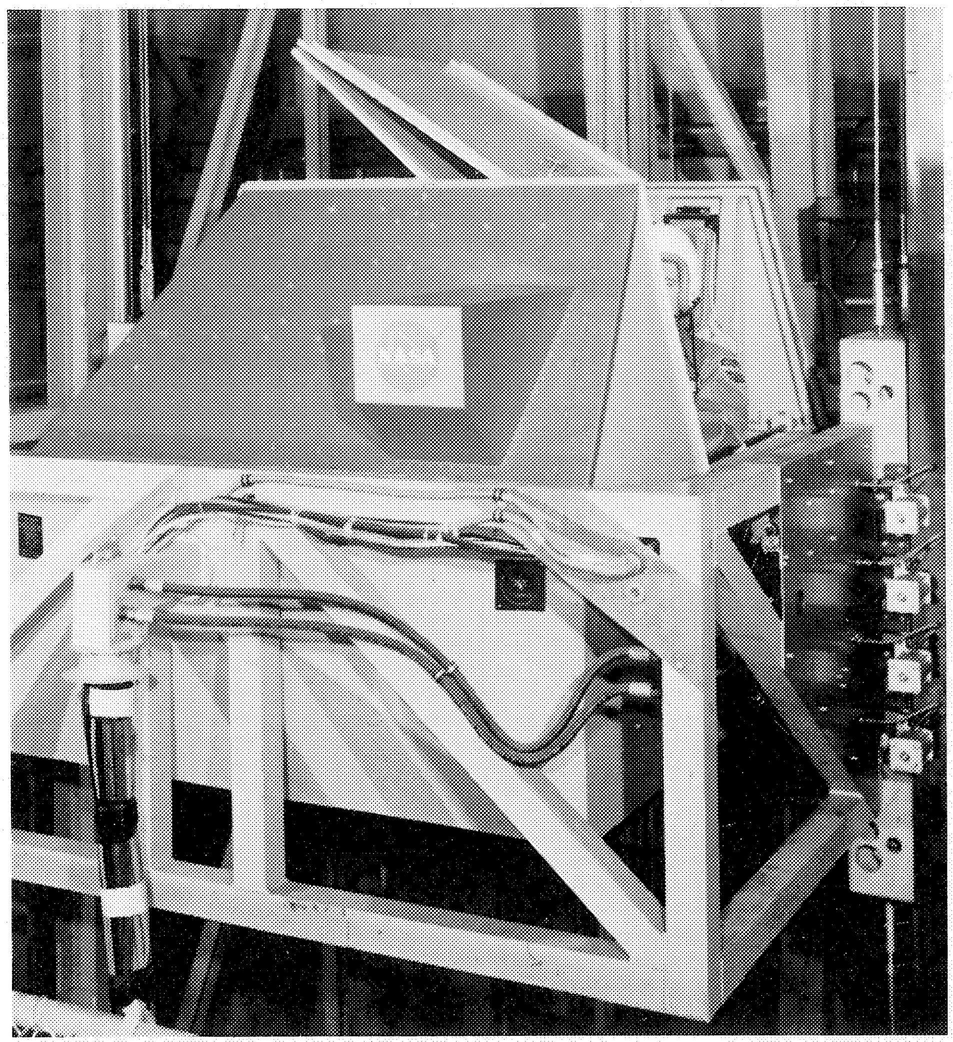
JURISDICTION:

Life Sciences Directorate
Melvin Sadoff

LOCATION:

Building N-239A





Motions Generated	Displacement	Acceleration	Velocity
Vertical	±10 ft	±2 g	±12 ft/sec
Roll (not man-rated)	±30°	±3 Rad/sec^2	±3 Rad/sec

5. FLIGHT AND GUIDANCE CENTRIFUGE

DESCRIPTION:

The Flight and Guidance Centrifuge is used for spacecraft mission simulations and is adaptable to two configurations. Configuration I: The cab will accommodate a three-man crew for space mission research. The accelerations and rates are intended to be smoothly applicable at very low value so that navigation and guidance procedures using a high-accuracy, out-the-window display may be simulated. Configuration II: The simulator can use a one-man cab for human tolerance studies and performance testing. Atmosphere and temperature can be varied as stress inducements. This simulator is operated closed-loop with digital or analog computation. It is currently man-rated for 3.5g maximum.

DRIVES:

Hydraulic servos

STATUS:

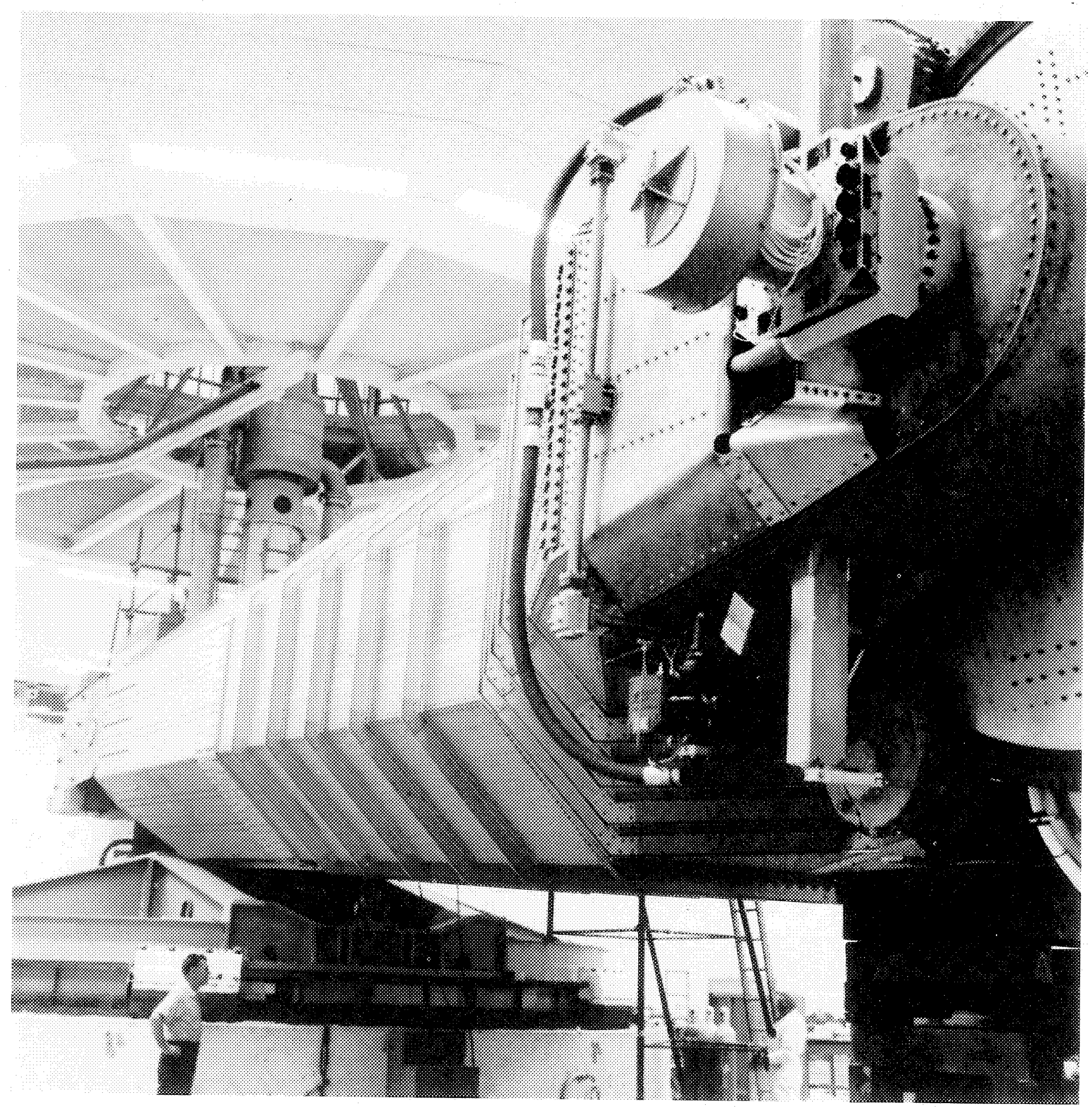
Operational since 1972

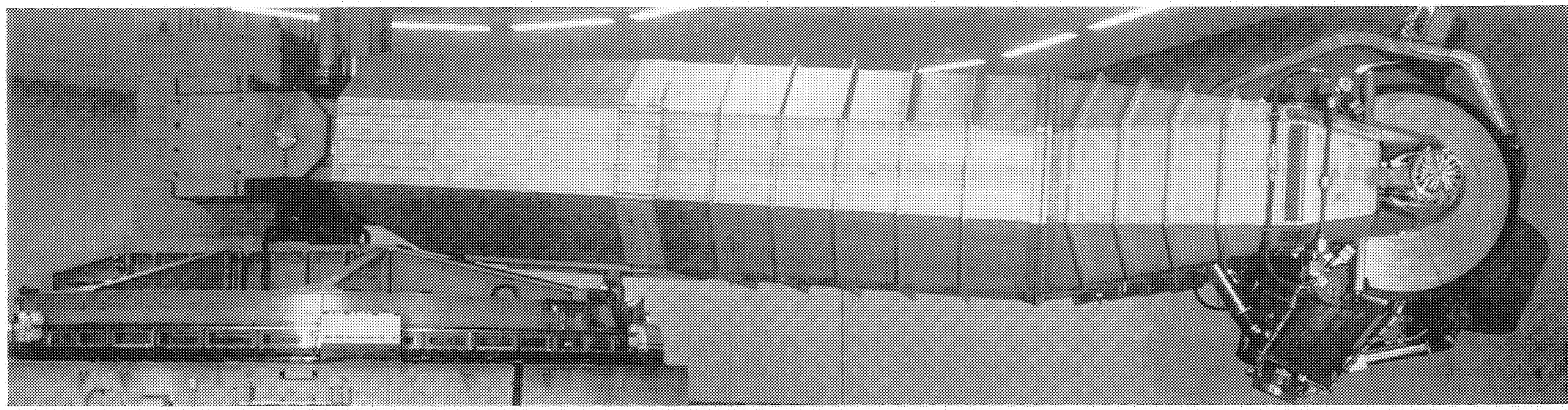
JURISDICTION:

Simulation Sciences Division
George A. Rathert, Jr.

LOCATION:

Building N-243





	Motions Generated	Displacement	Acceleration	Velocity	Frequency At 30° Phase Lag
Configuration I*	Roll	Unlimited	12 Rad/sec^2	6 Rad/sec	1.75 Hz
	Pitch	Unlimited	5 Rad/sec^2	2 Rad/sec	1.75 Hz
	Yaw	Unlimited	5 Rad/sec^2	2 Rad/sec	1.75 Hz
	Arm (Radial)	Unlimited	20 g (Angular)	3.6 Rad/sec	
	(Radial Onset)		7.5 g/sec		
Configuration II*	Roll	Unlimited	18 Rad/sec^2	6 Rad/sec	3.0 Hz
	Pitch	Unlimited	6 Rad/sec^2	2 Rad/sec	3.0 Hz
	Yaw	Unlimited	6 Rad/sec^2	2 Rad/sec	3.0 Hz
	Arm (Radial)	Unlimited	50 g (Angular)	5.7 Rad/sec	
	(Radial Onset)		7.5 g/sec		

*design specifications

6. MAN-CARRYING ROTATION DEVICE

DESCRIPTION:

The Man-Carrying Rotation Device is used for determining the physiological effects on human subjects and their ability to perform various tasks when subjected to precise angular accelerations and rates for specified periods of time. The rotation may be imposed as yaw, pitch, or roll by varying the subject's orientation. The subject's head (vestibular sensors) may be located on the rotation axis or up to four feet from the axis. This device is operated closed-loop with digital or analog computation.

A hydrostatic bearing with a diameter of four feet supports the rotating components including the armature of the 20 Hp. drive motor and a separately driven slip ring assembly, employed to reduce friction. These design features allow this device to present precisely controlled angular acceleration stimuli from 0.1 to $30^\circ/sec^2$ with a rise time of 0.1 sec. Angular vibration varies from $0.02^\circ/sec^2$ at low rates of rotation to $0.1^\circ/sec^2$ at 10 rpm.

DRIVES:

Electrical servo

STATUS:

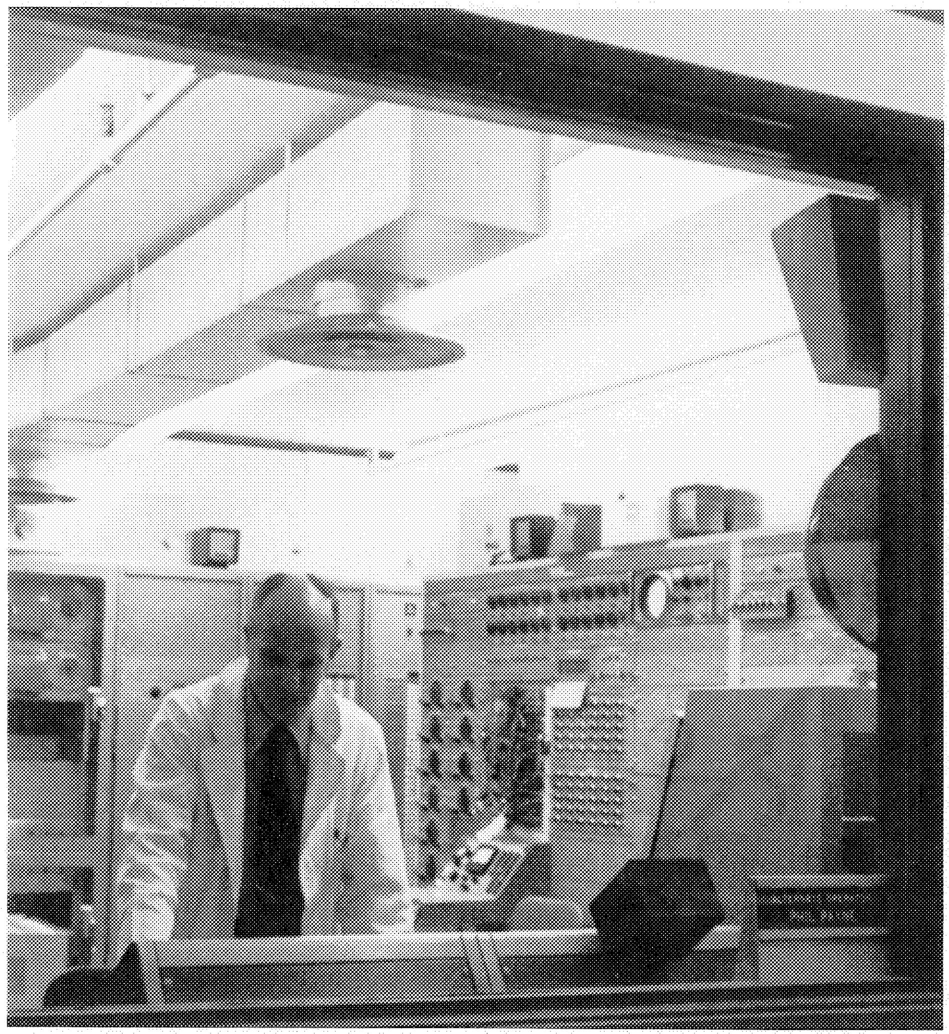
Operational since 1966

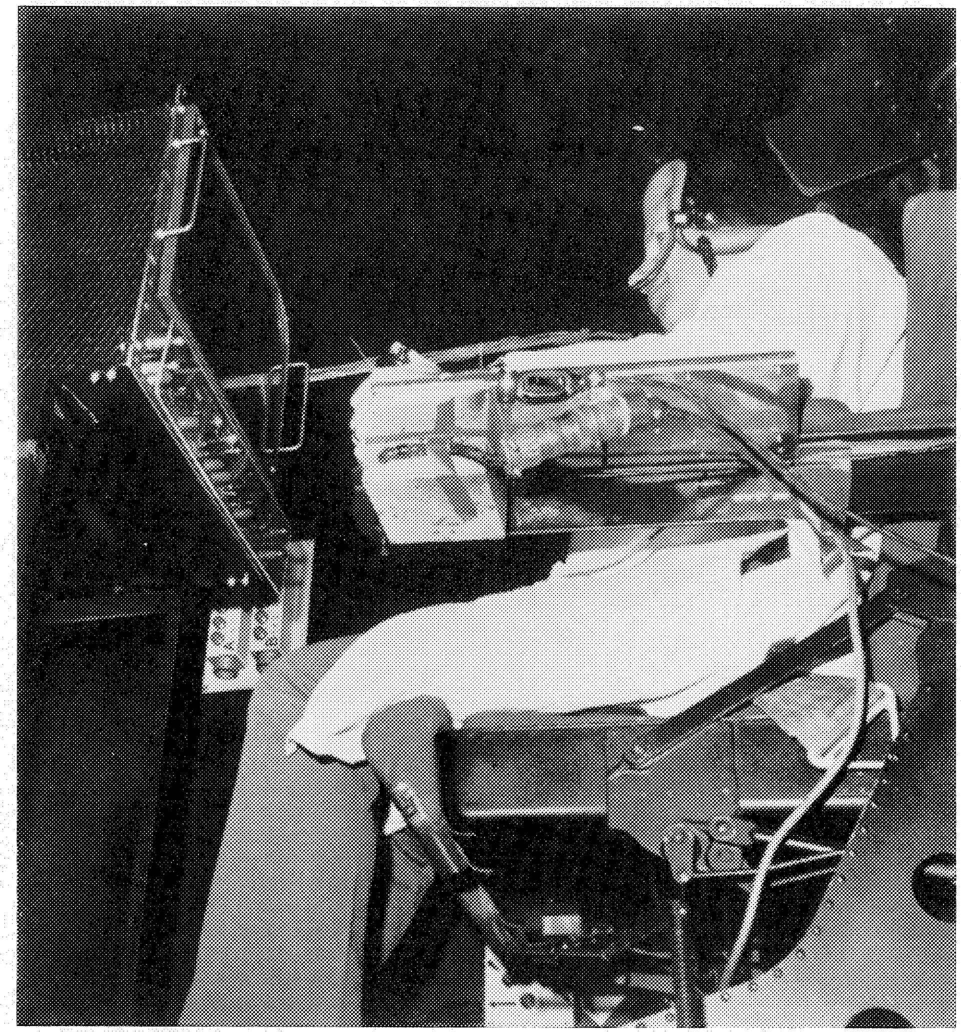
JURISDICTION:

Life Sciences Directorate
Edward M. Huff

LOCATION:

Building N-239A



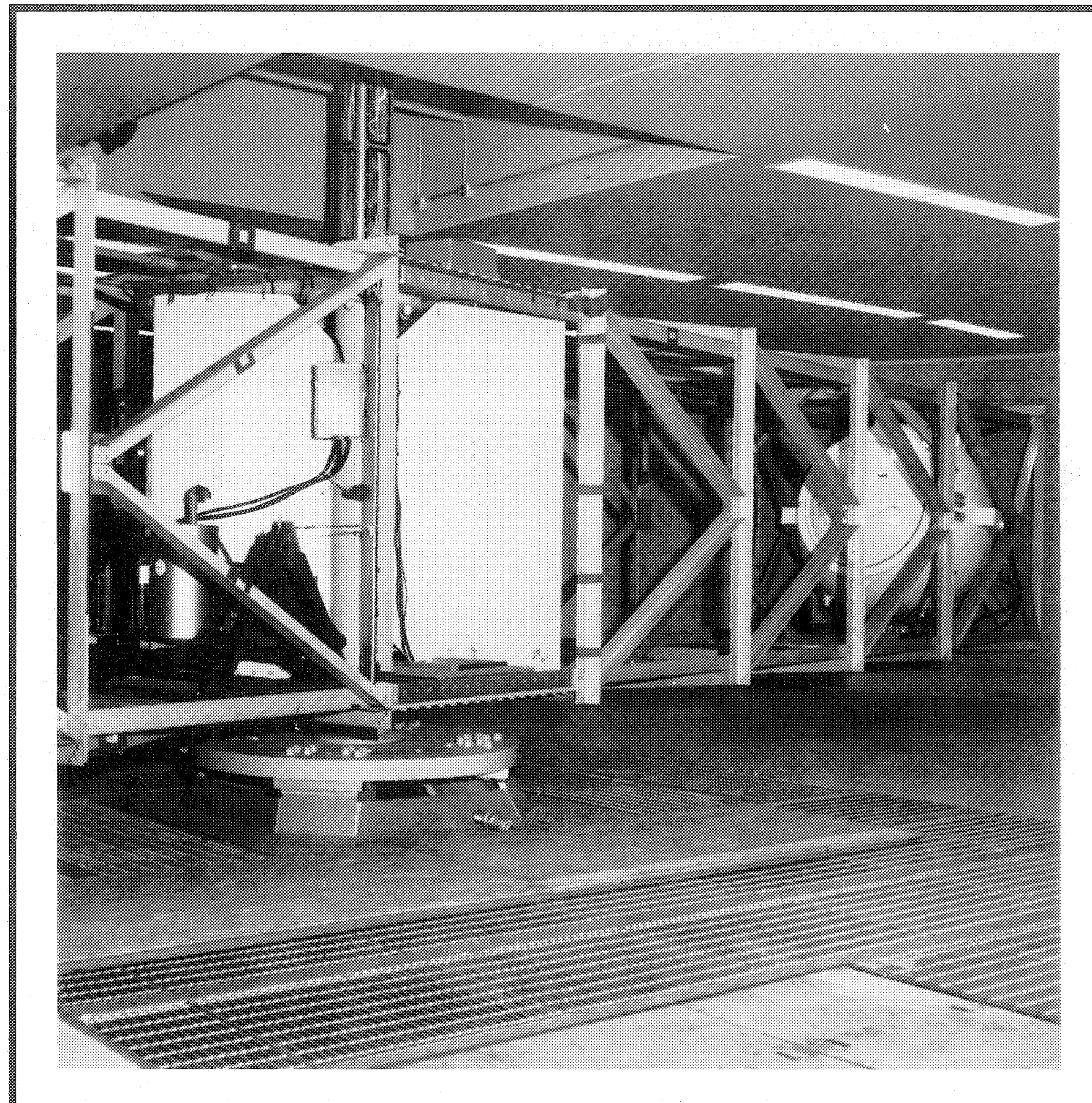


Motion Generated	Displacement	Acceleration	Velocity
About Vertical Axis	Unlimited	0.52 Rad/sec^2 (max.)	4.7 Rad/sec
	Unlimited	0.007 Rad/sec^2 (min.)	4.7 Rad/sec

7. TWENTY-G CENTRIFUGE

DESCRIPTION:

The Twenty-G Centrifuge is used to investigate the high-g tolerances of biological subjects and specimens, as well as of instrument packages and thus determine their flight qualifications. Preset velocity-time profiles, for example, have been obtained during continuous centrifugation of 27 days at 2.5g and 20-plus days at 16g. This centrifuge has a double-ended arm construction with cabs at both ends. The arm radius to the center of the cab is 25 feet. The test cab size is 6′ x 7′ x 8′, with a maximum payload at each end of 1200 pounds or 16,000 g-pounds. Additional equipment weighing up to 2000 lbs. can be mounted within four feet of the center of rotation.



DRIVES:

Electrical servos

STATUS:

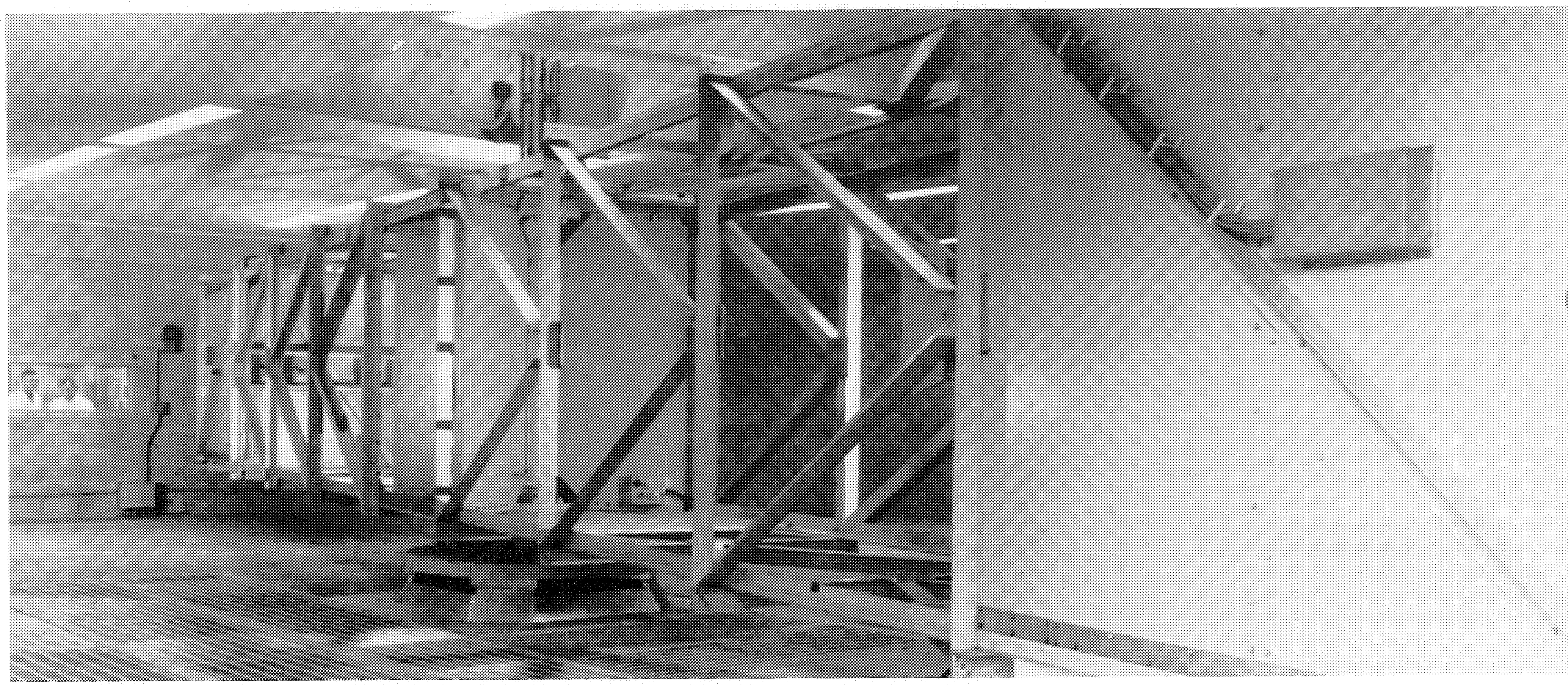
Operational since 1964

JURISDICTION:

Simulation Sciences Division
George A. Rathert, Jr.

LOCATION:

Building N-221



Motion Generated	Displacement	Acceleration	Velocity
Arm (Angular)	Unlimited		5 Rad/sec (max.)
			0.012 Rad/sec (min.)
Arm (Radial)		20 g (max.)	
		12.5 g max. (Man-Rated)	
(Radial Onset)		2 g/sec	

8. THE SIX-DEGREE-OF-FREEDOM MOTION SIMULATOR

DESCRIPTION:

The Six-Degree-of-Freedom Motion Simulator is used to investigate the handling and general flying qualities of vertical rising aircraft particularly during take-off and landing. It has a single cockpit cab outfitted with stick-type flight controls. The cab is normally closed and is provided with a TV monitor, panel instruments, "force-feel" flight controls, and stereo cockpit sounds. However, the cab may be left open to provide a one-to-one simulation using the "real" world. Aircraft dynamics are provided by an EAI 8400 digital computer (32,000 word memory) and/or an EAI 231R analog computer used in the closed-loop mode.

DRIVES:

Ward-Leonard electrical servos
Torque motors drive through silent chains to rubber-faced sectors or to cable-pulling drums.

STATUS:

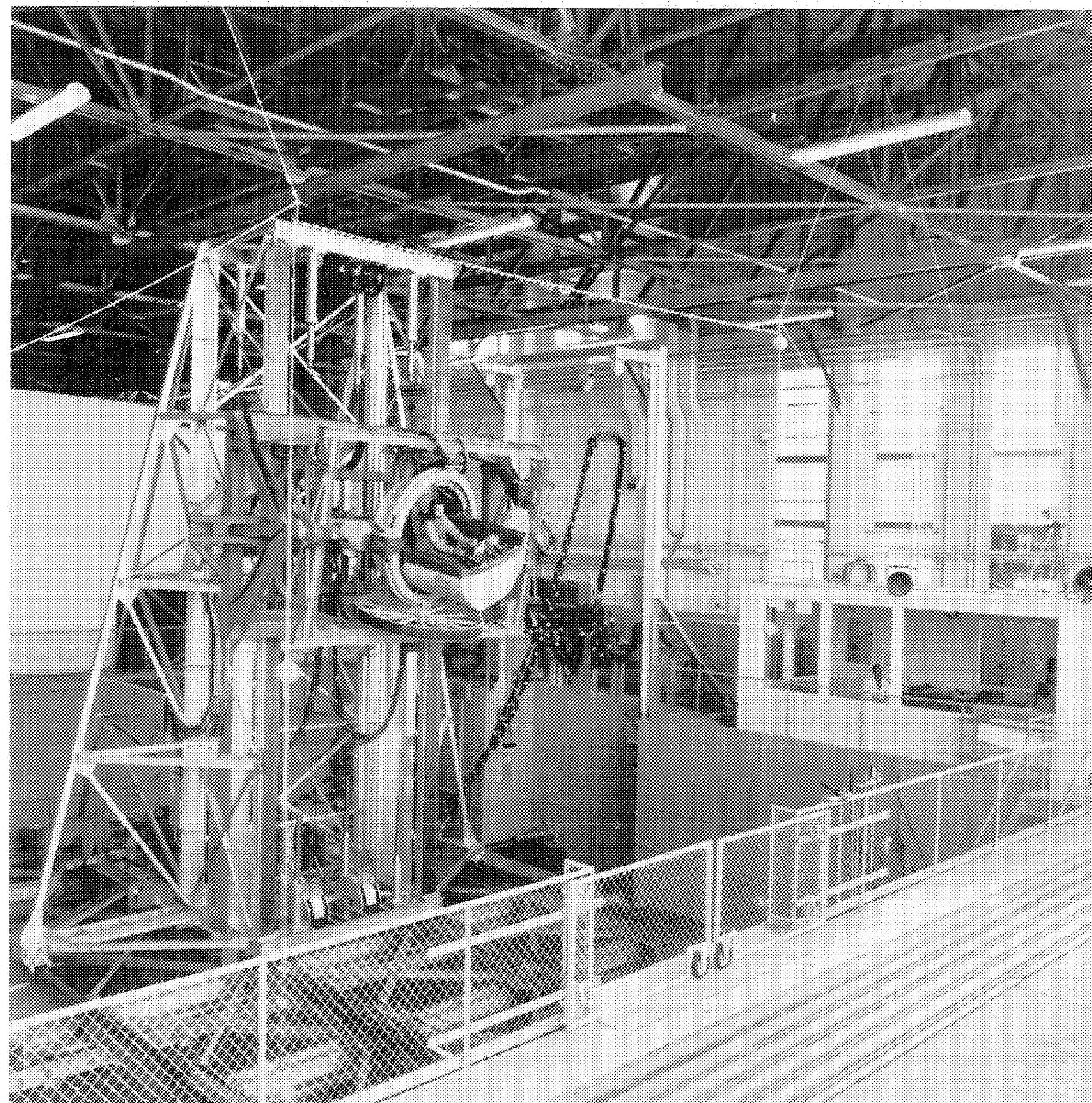
Operational since 1964

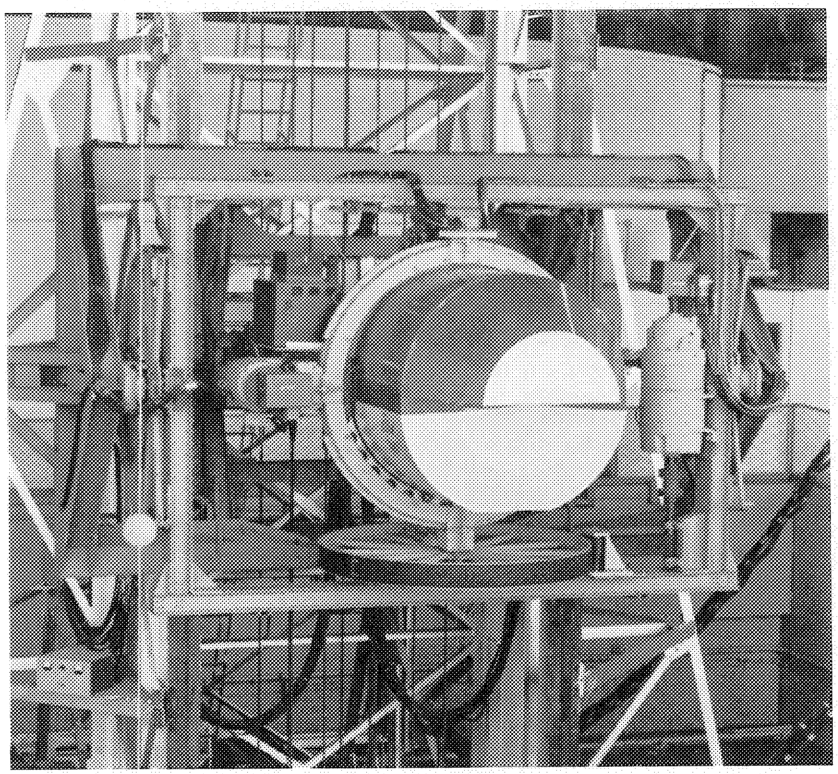
JURISDICTION:

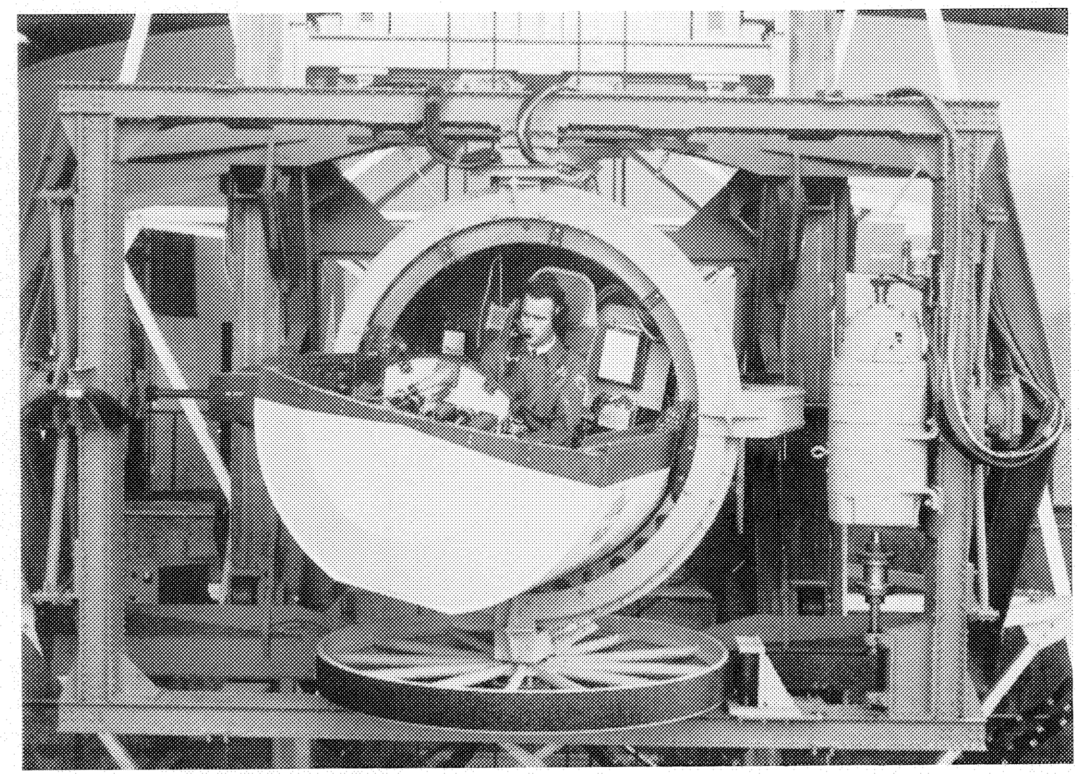
Simulation Sciences Division
George A. Rathert, Jr.

LOCATION:

Building N-210







Motions Generated	Displacement	Acceleration	Velocity	Frequency At 30° Phase Lag
Roll	±35°	10 Rad/sec^2	1.3 Rad/sec	0.63 Hz
Yaw	±35°	3.0 Rad/sec^2	3.0 Rad/sec	0.70 Hz
Pitch	±35°	4.5 Rad/sec^2	1.7 Rad/sec	0.55 Hz
Vertical	±9 ft	8.8 ft/sec^2	7.5 ft/sec	0.20 Hz
Longitudinal	±9 ft	7.5 ft/sec^2	9.0 ft/sec	0.24 Hz
Lateral	±9 ft	9.2 ft/sec^2	8.0 ft/sec	0.54 Hz

9. FIXED-BASE TRANSPORT SIMULATOR

DESCRIPTION:

The Fixed-Base Transport Simulator is primarily used to study flight management procedures and crew performance with advanced cockpit display/control configurations. The two seat cab may be used with either a virtual image TV display for day scenes, or a digitally generated collimated CRT display for night scenes. The cab is equipped with both conventional aircraft panel instruments and a general purpose, high resolution CRT display for simulating advanced avionics systems. This simulator is used in the closed-loop mode with pilot controls that are connected to hydraulic loaders for variation of control system parameters. Aircraft sounds are simulated to induce realism and to provide auditory cues for the pilot. Aircraft and wind dynamics for visual scenes and instrument displays are provided by either an SEL-840MP digital computer or an EAI 84000 computer. Representative research using this simulator includes studies of Space Shuttle energy management, STOL aircraft navigation, and elevated STOL port landing procedures.

DRIVES:

None

MOTIONS SIMULATED:

None

STATUS:

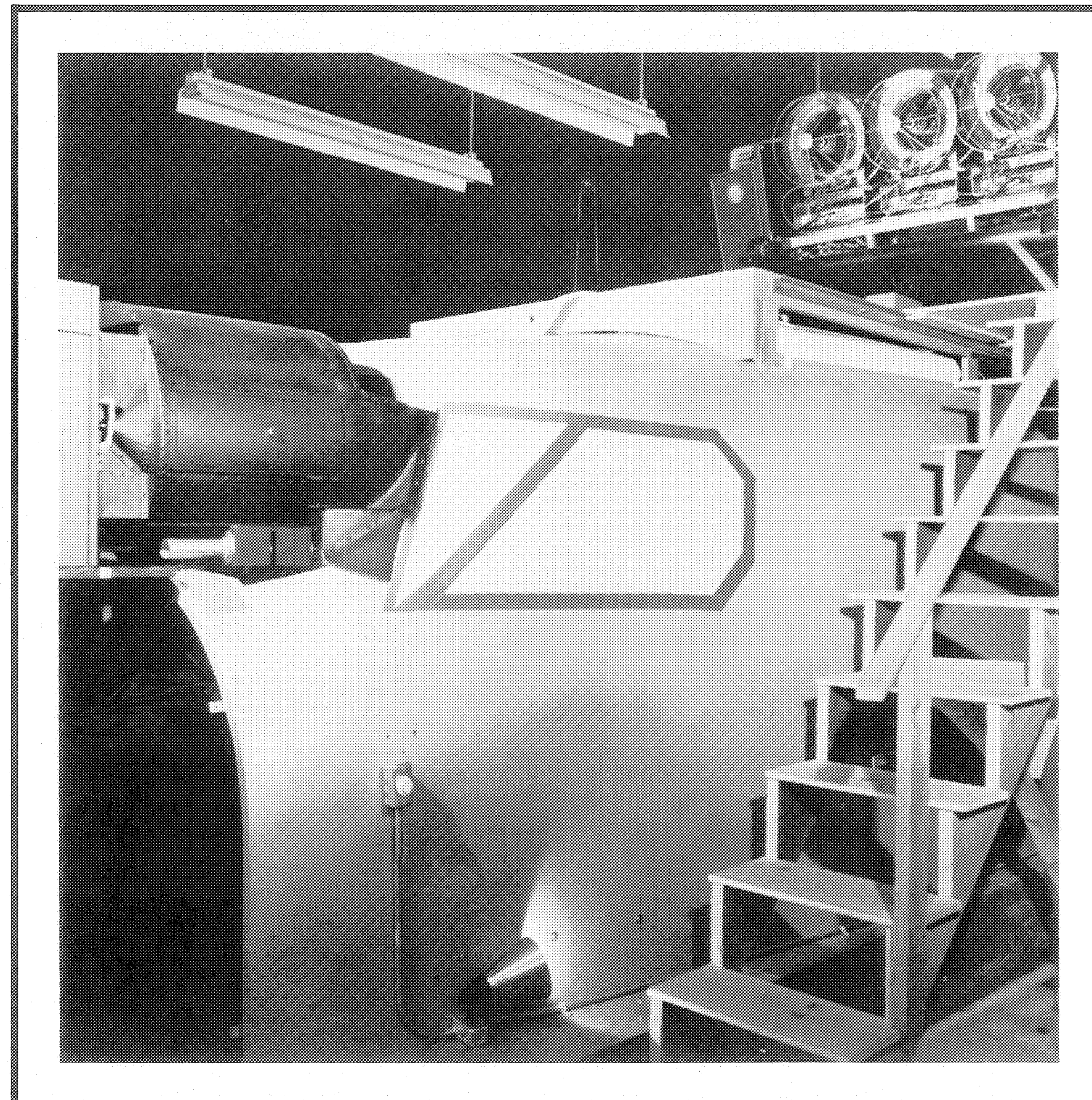
Operational since 1967

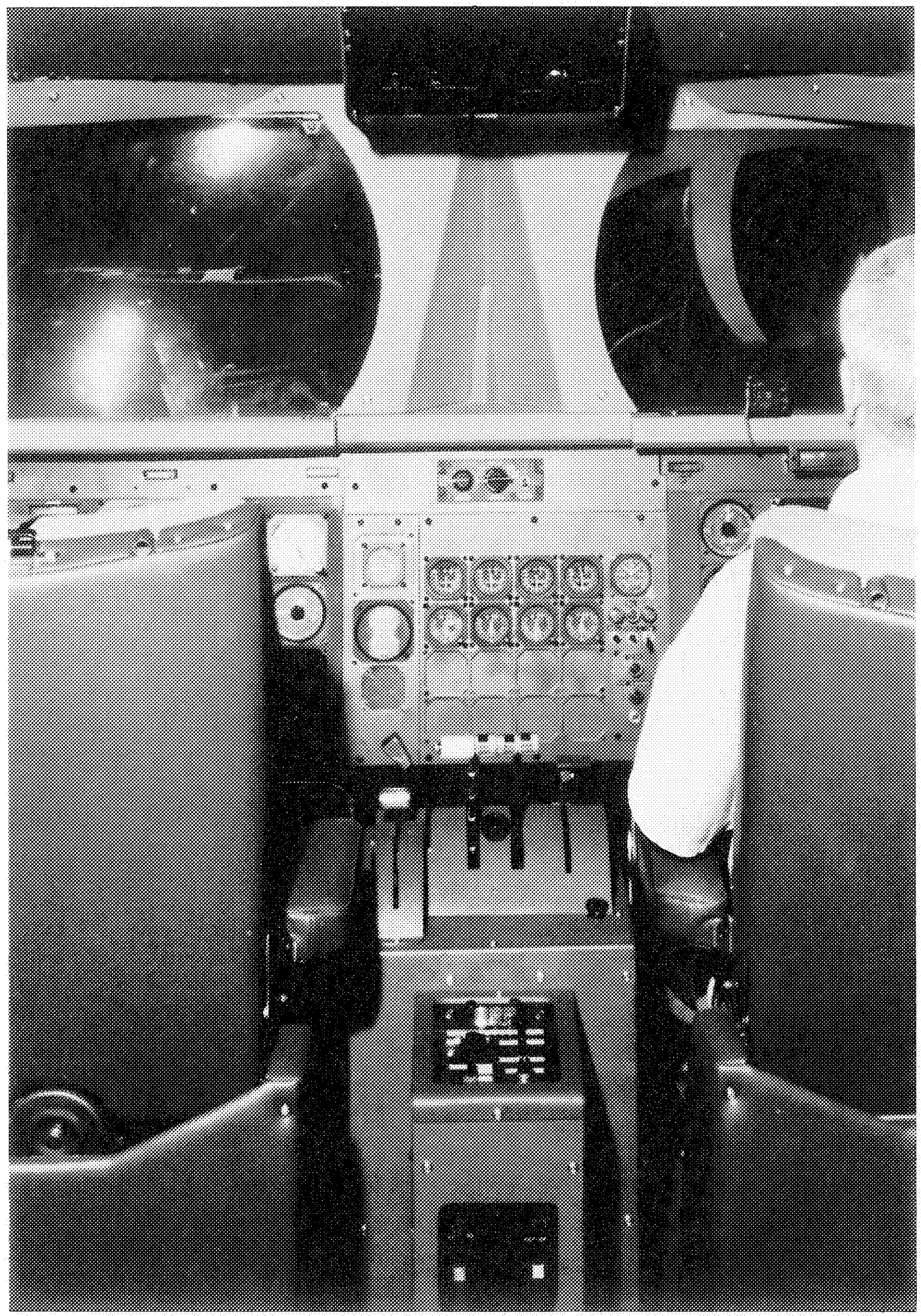
JURISDICTION:

Life Sciences Directorate
Edward M. Huff

LOCATION:

Building N-239A





10. VISUAL SCENE PRESENTATION SYSTEMS

DESCRIPTION:

Visual Scene Presentation Systems or Visual Flight Attachments are used in conjunction with the various Flight Simulators to provide the pilot with a color or black and white representation of a visual scene as would be observed during approach, landing, take-off, and taxiing exercises on conventional, STOL and V/STOL runways and on aircraft carriers under varying lighting, cloud, and visibility conditions, by means of a closed-circuit TV system. Three such attachments are described here, two manufactured by Redifon Limited, Crawley, Sussex, England, Visual Flight Attachments II and VII; one manufactured by Redifon Air Trainers Limited, Aylesbury, Bucks, England, Visual Flight Attachment IV.

DRIVES:

Visual Flight Attachments II & VII, Electrical Servo-Position
Visual Flight Attachment IV, Electrical Servo-Position (three linear drives can be driven by rate inputs)

STATUS:

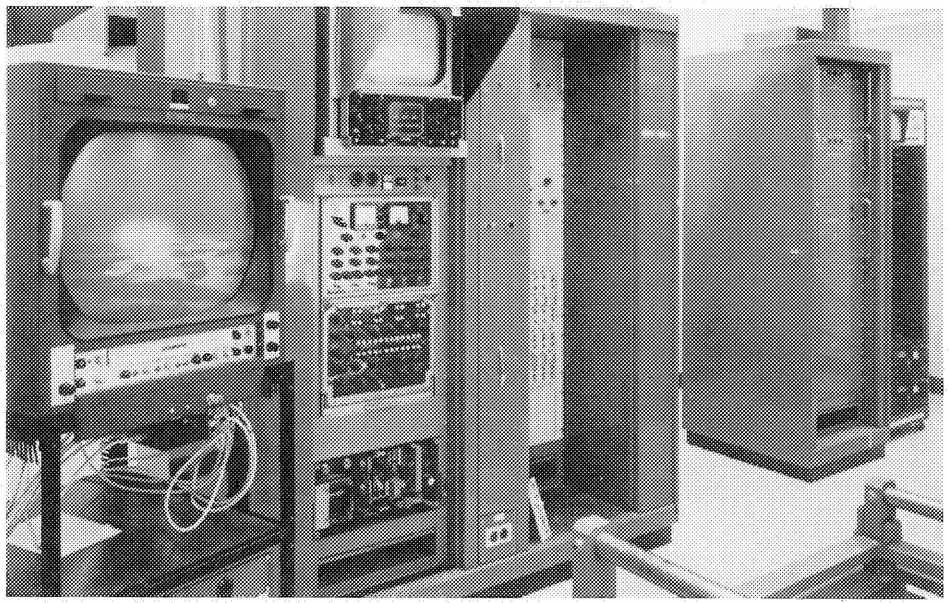
Operational since 1965 (II), 1967 (IV), 1973 (VII)

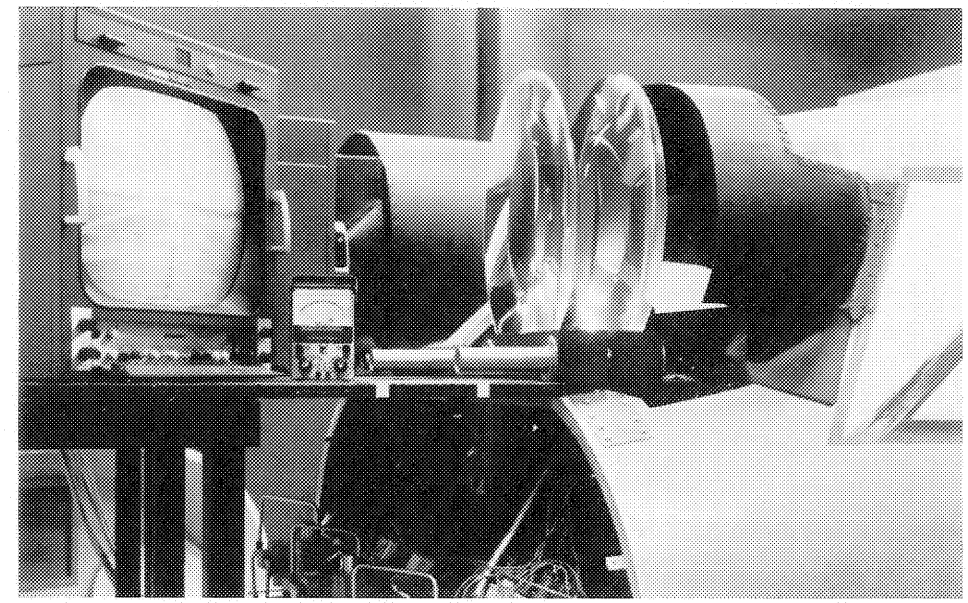
JURISDICTION:

Simulation Sciences Division
George A. Rathert, Jr.

LOCATION:

Buildings N-210, N-243, and N-239A





VISUAL FLIGHT ATTACHMENT IV

Mechanical Characteristics	Displacement	Acceleration	Velocity	Frequency At 10° Phase Lag
Roll	340°	100 Rad/sec^2	13 Rad/sec	4.2 Hz
Pitch	50°	8.75 Rad/sec^2	3.5 Rad/sec	3.5 Hz
Yaw	340°	14.8 Rad/sec^2	11.2 Rad/sec	2.9 Hz
Lateral	7 ft (1.60 miles*)	1.65 ft/sec^2 (60g*)	0.55 ft/sec (390 knots*)	0.31 Hz
Longitudinal	30 ft (6.8 miles*)	1.62 ft/sec^2 (60g*)	0.62 ft/sec (444 knots*)	0.09 Hz
Vertical (max.)	1 ft (1200 ft*)	0.5 ft/sec^2 (18.6g*)	0.233 ft/sec (16,740 ft/min*)	0.48 Hz
(min.)	0.072 in. (7.2 ft*)			
*at scale of 1:1200				

VISUAL FLIGHT ATTACHMENT II

Mechanical Characteristics	Displacement	Acceleration	Velocity	Frequency At 30° Phase Lag
Roll	±100°	90 Rad/sec^2	50 Rad/sec	2.8 Hz
Pitch	+20°, −30°	22 Rad/sec^2	3 Rad/sec	2.8 Hz
Yaw	+70°, −250°	30 Rad/sec^2	3.3 Rad/sec	2.8 Hz
Lateral	9 ft (±0.5 mile*)	0.45 ft/sec^2 (8.5g*)	0.5 ft/sec (180 knot*)	0.42 Hz
Longitudinal	35 ft (4 mile*)	0.80 ft/sec^2 (15g*)	0.53 ft/sec (185 knot*)	0.52 Hz
Vertical (max.)	1.25 ft(750 ft*)			
(min.)	0.17 in. (85 ft*)	0.24 ft/sec^2 (5.5g*)	0.093 ft/sec (3300 ft/min*)	0.75 Hz
*at scale of 1:600 (can be varied)				

VISUAL FLIGHT ATTACHMENT VII

Mechanical Characteristics	Displacement	Acceleration	Velocity	Frequency At 30° Phase Lag
Roll	±180°	90 Rad/sec^2	5.5 Rad/sec	2.8 Hz
Pitch	±25°	22 Rad/sec^2	2.5 Rad/sec	2.9 Hz
Yaw	Continuous	30 Rad/sec^2	3.3 Rad/sec	2.9 Hz
Longitudinal	64 ft. (10.9 miles*)	1.00 ft/sec^2 (28g)	0.68. ft/sec (360 knots*)	2.8 Hz
Lateral	15 ft (2.5 miles*)	1.00 ft/sec^2 (28g)	0.9 ft/sec (480 knots*)	2.9 Hz
Vertical (max.)	4 ft (3600 ft.*)	1.8 ft/sec^2 (50g)	1.4 ft/sec (75,600 ft/min*)	3.2 Hz
(min.)	0.072 in. (5.4 ft.*)			
*at scale of 1:900 (can be varied)				

11. COMPUTER GRAPHIC VISUAL DISPLAY SIMULATOR

DESCRIPTION:

The Computer Graphic Visual Display Simulator is a general purpose, high resolution graphics system manufactured by Evans & Sutherland Computer Corporation (model LDS-2). It can be used to create through-the-window night visual scenes with or without superimposed head-up display symbology, or to generate advanced cockpit display configurations including EADI, R-NAV, Datalink, collision warning, air-traffic, and system status displays. When used for generating through-the-window scenes, the pilot sees the computer symbology through a set of collimating lenses. The airport/city scene can contain up to 1800 points of light, and any type of symbology that can be represented by lines or points can be presented on the monitor, e.g., head-up display symbology, strobe lights, automobile traffic, buildings, runway markings and other aircraft. When used to simulate panel instrument displays, a sophisticated clipping capability allows the graphic system to present many subsystems simultaneously. This simulator has been used to study Head-Up displays to aid pilots during visual approaches on steep STOL landings, for two-segment noise abatement approaches by commercial transports, and for low visibility conventional approaches and landings. This simulator has also been used to study vertical and horizontal situation displays, computer interactive data entry systems and datalink message formats. In 1974 the system is scheduled to be upgraded with a full color capability for simulating day scenes and commercial type panel instruments.

STATUS:

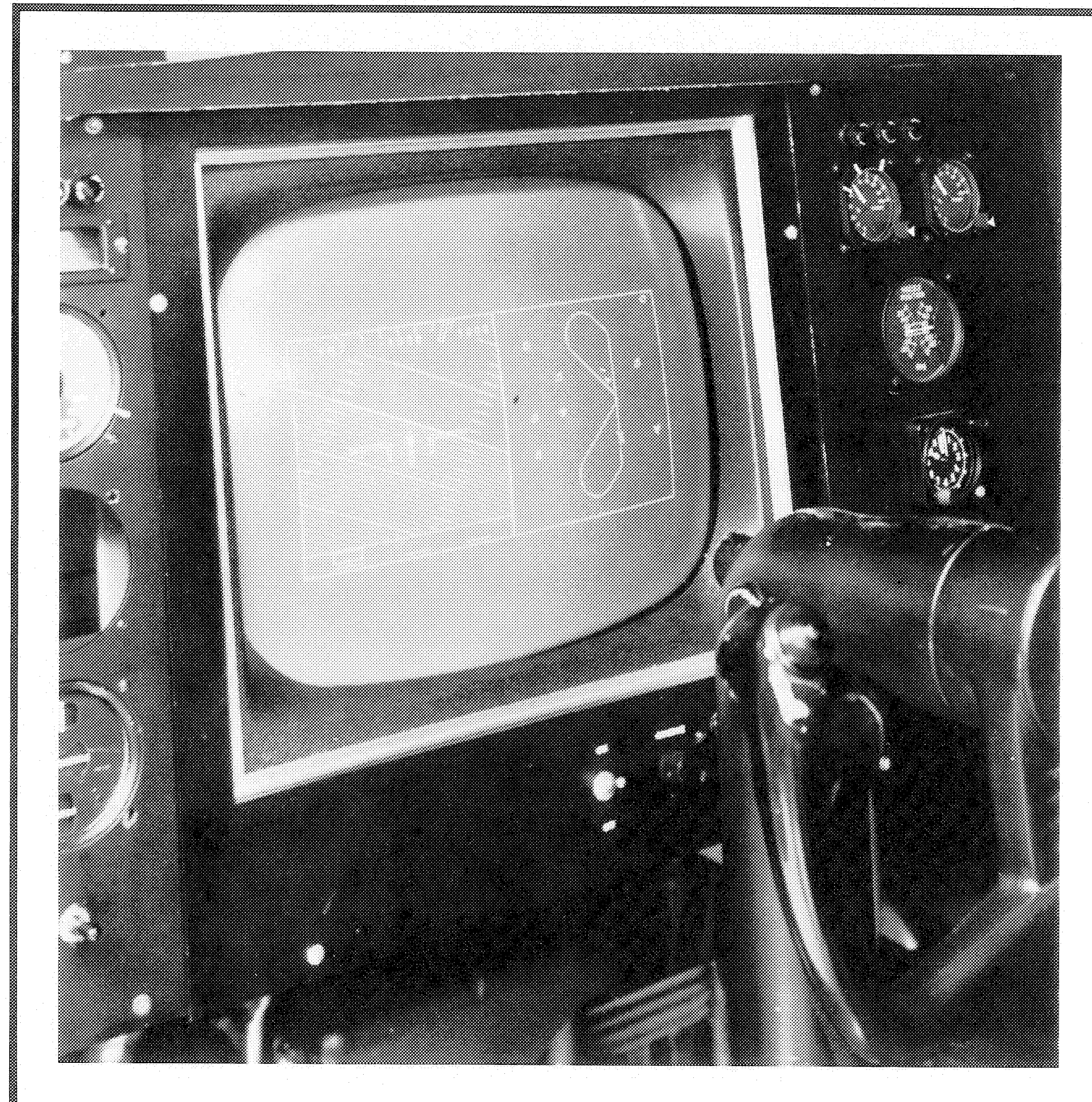
Operational since 1971.

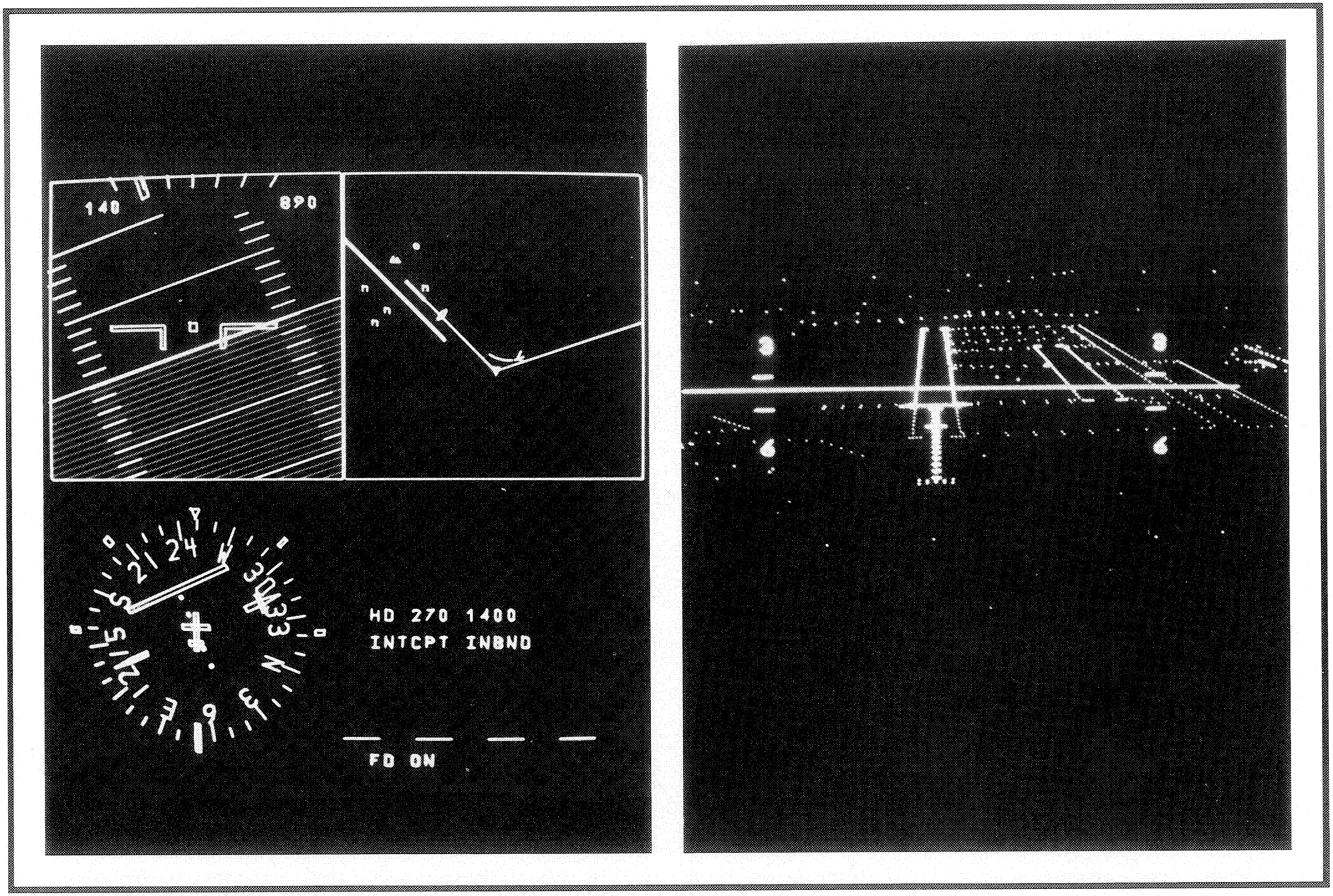
JURISDICTION:

Life Sciences Directorate
Edward M. Huff

LOCATION:

Building N-239

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12. ENVIRONMENTAL TEST FACILITIES

DESCRIPTION:

Environmental Test Facilities are used for studies involving altitude, atmospheric composition (oxygen, nitrogen, or inert gas, carbon dioxide, carbon monoxide, humidity and combustible hydrocarbons), and temperature or temperature cycling. Two facilities are described here, the Human Environmental Test Facility and the Environmental Chamber. Reduced pressure is obtained and maintained by vacuum pumps in both facilities.

The gaseous atmosphere in the Environmental Chamber is continuously recycled with CO_2 removed by a lithium hydroxide scrubber and humidity controlled by a chilled-water heat exchanger. Oxygen is added continuously to replace consumption losses. Heat may be introduced by means of heaters located in the recirculation ducting and may be removed in the heat exchanger. Fire protection consists of a hose with fog nozzle, a fixed-position fog nozzle and smoke detectors.

Temperature control in the Human Environmental Test Facility is achieved by circulating heated or chilled water through radiant panels on all wall, floor and ceiling surfaces. Since this facility was designed for studies on closed-ecological systems, gas bleeding is the only available means for eliminating humidity, carbon dioxide or other contaminants. Fire protection consists of three hoses with fog nozzles, two fixed-position fog nozzles and smoke detectors.

STATUS:

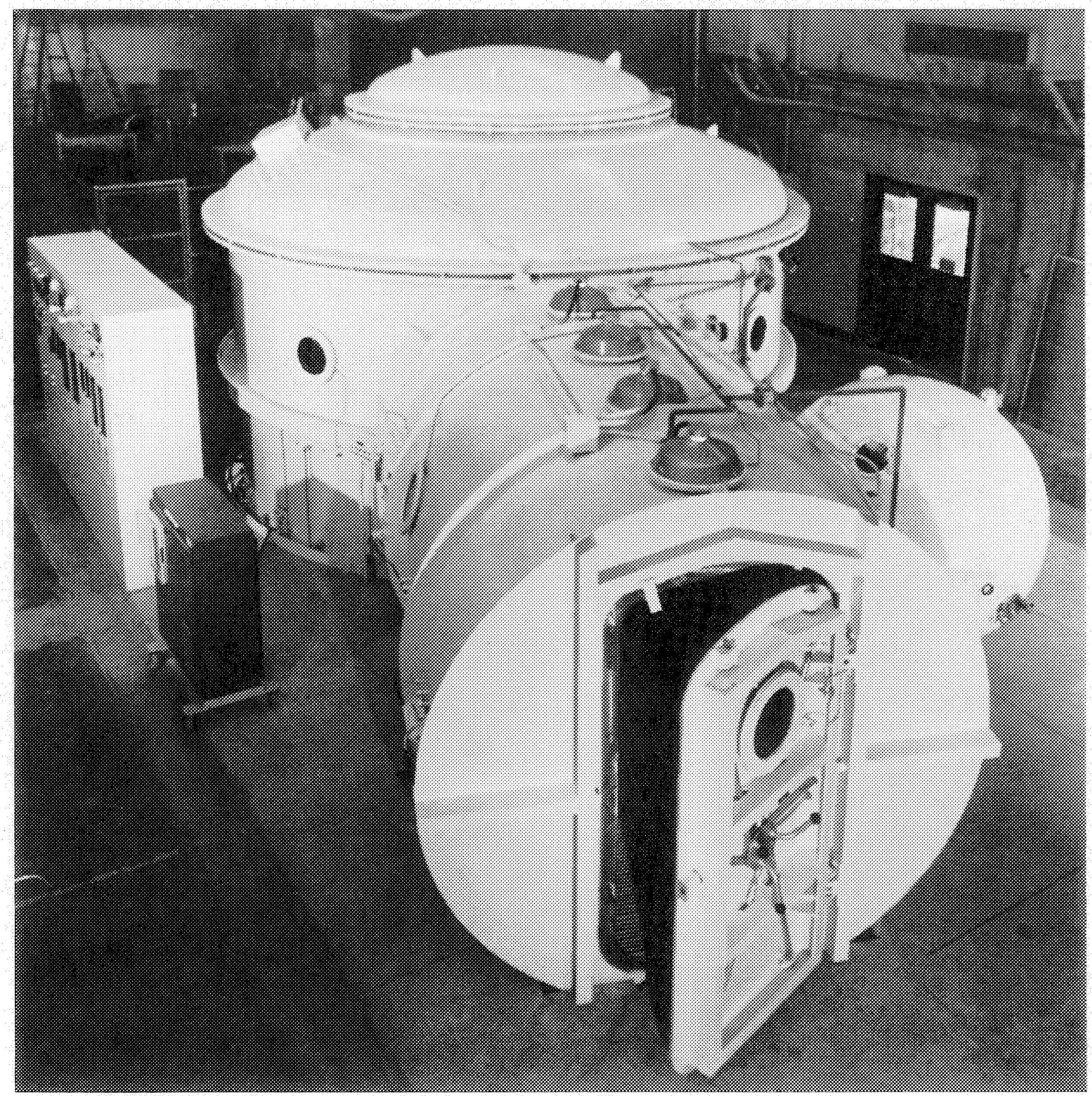
Operational since 1964, 1968

JURISDICTION:

Life Sciences Directorate
Joan V. Danellis

LOCATION:

Building N-239



HUMAN ENVIRONMENTAL TEST FACILITY

Capability	Chamber	Air Lock	Sample Air Lock
Pressure:	1 to 760 torr	1 to 760 torr	1 to 760 torr
(Altitude)	(S.L. to 150,000 ft.)	(S.L. to 150,000 ft.)	(S.L. to 150,000 ft.)
Pressure Control:	±2.5 torr, max.	±2.5 torr, max.	±2.5 torr. max.
Time to Reach Pressure:	21 min	4 min	2 min
Emergency Recompression			
from 1 torr to 250 torr:	5.25 sec	5.25 sec	
from 1 torr to 760 torr:	17 sec	17 sec	
Operating Temperature Range:	35 to 160°F, ±1°F	35 to 160°F, ±1°F	
Temperature Cycling Time:	30 min		

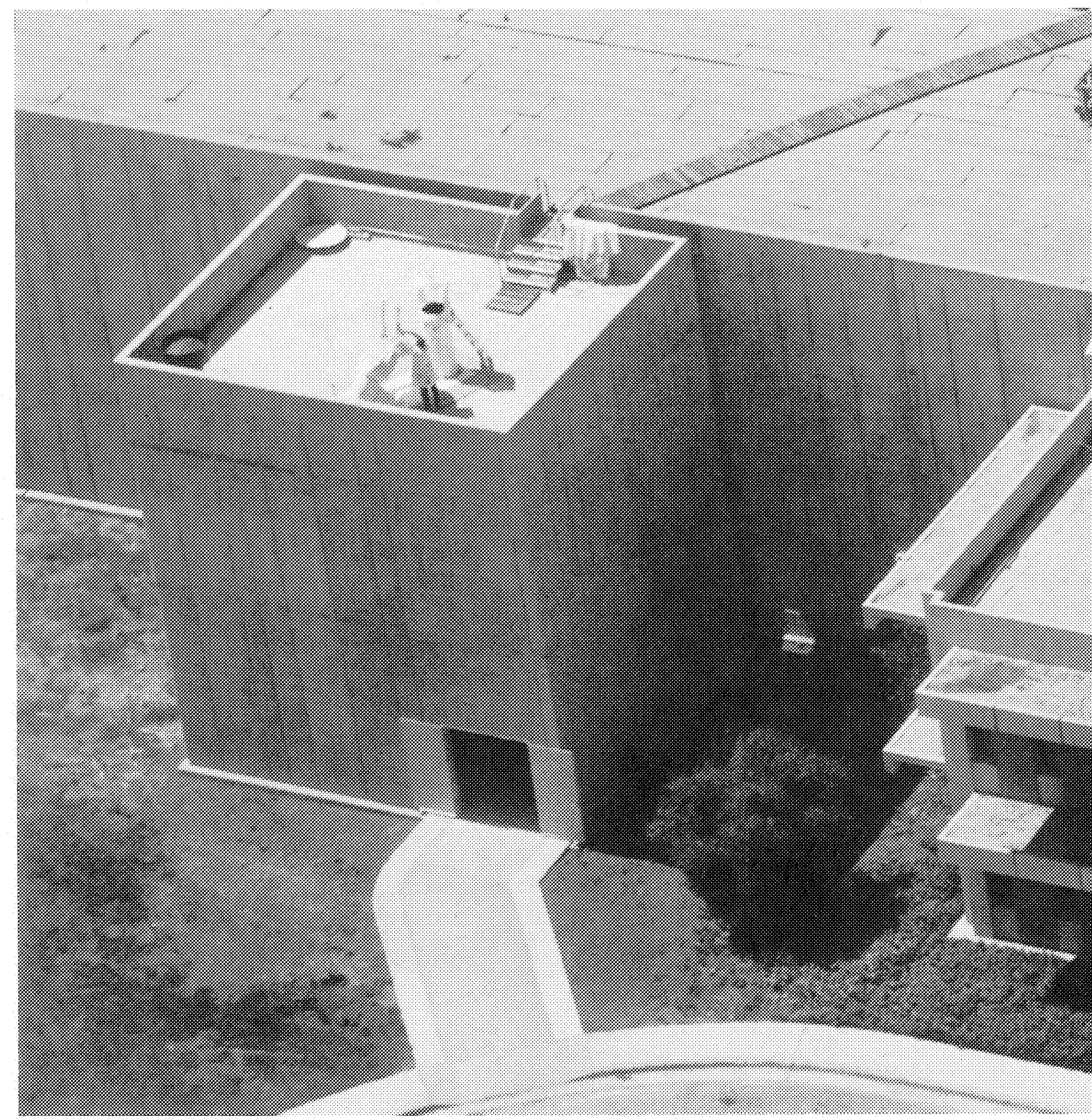
ENVIROMENTAL CHAMBER

Capability	**Chamber**	**Air Lock**
Pressure:	1 to 760 torr ±5 torr, max.	1 to 760 torr ±5 torr, max.
Pumpdown Time Sea Level to 250 torr:*	4 min	4 min
to 2.5 torr:	30 min	30 min
Recompression Time from 250 to 750 torr:*	90 sec	90 sec
Operating Temperature Range:	70 to 140°F ±2.5°F	70 to 140°F ±2.5°F
* Chamber and Air Lock Combined.		

13. SPARCS SIMULATION TEST FACILITIES

DESCRIPTION:

The Solar Pointing Aerobee Rocket Control System (SPARCS) Simulation Test Facility is used in the pre-launch preparation and testing of rocket vehicle experiment payloads. It consists of a vertical and horizontal air bearing, a ground telemetry station, a hybrid analog/digital computer simulation facility, a heliostat, and various solar simulators. The three-axis solar acquisition and the fine pointing performance of rocket payloads are simulated in the vertical and horizontal air bearings. The heliostat provides a beam of sunlight to the SPARCS system while it is mounted in the air bearings. During adverse weather conditions, solar simulators are substituted for the heliostat. The telemetry station provides the means to monitor the up and down data links of the vehicle under test. The computer facility enables the prediction of vehicle pointing and stability performance over a wide range of variables, such as payload mass and launch date and time.



STATUS:

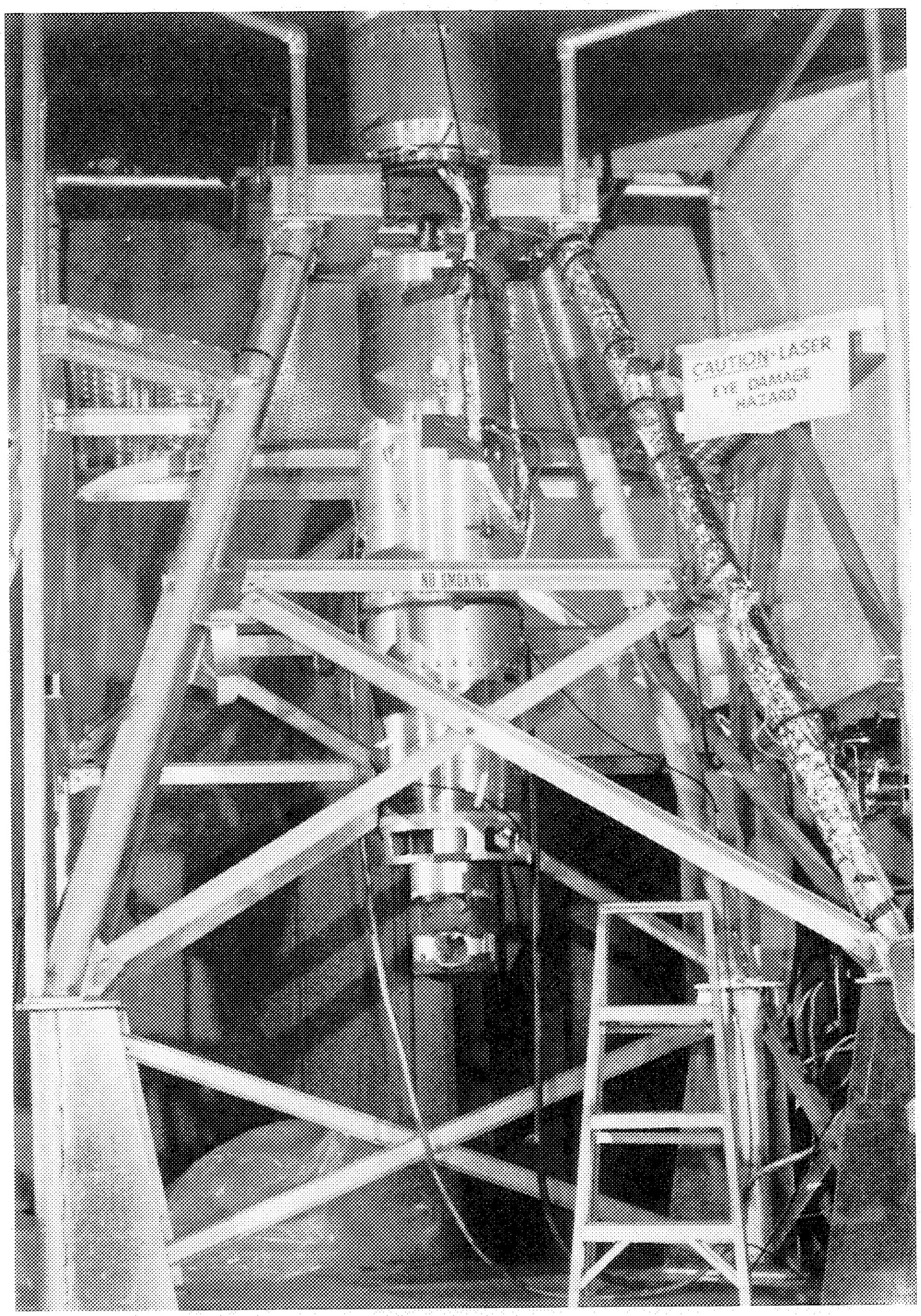
Operational since 1968

JURISDICTION:

Flight Project Development Division
Q. Marion Hansen

LOCATION:

Building N-244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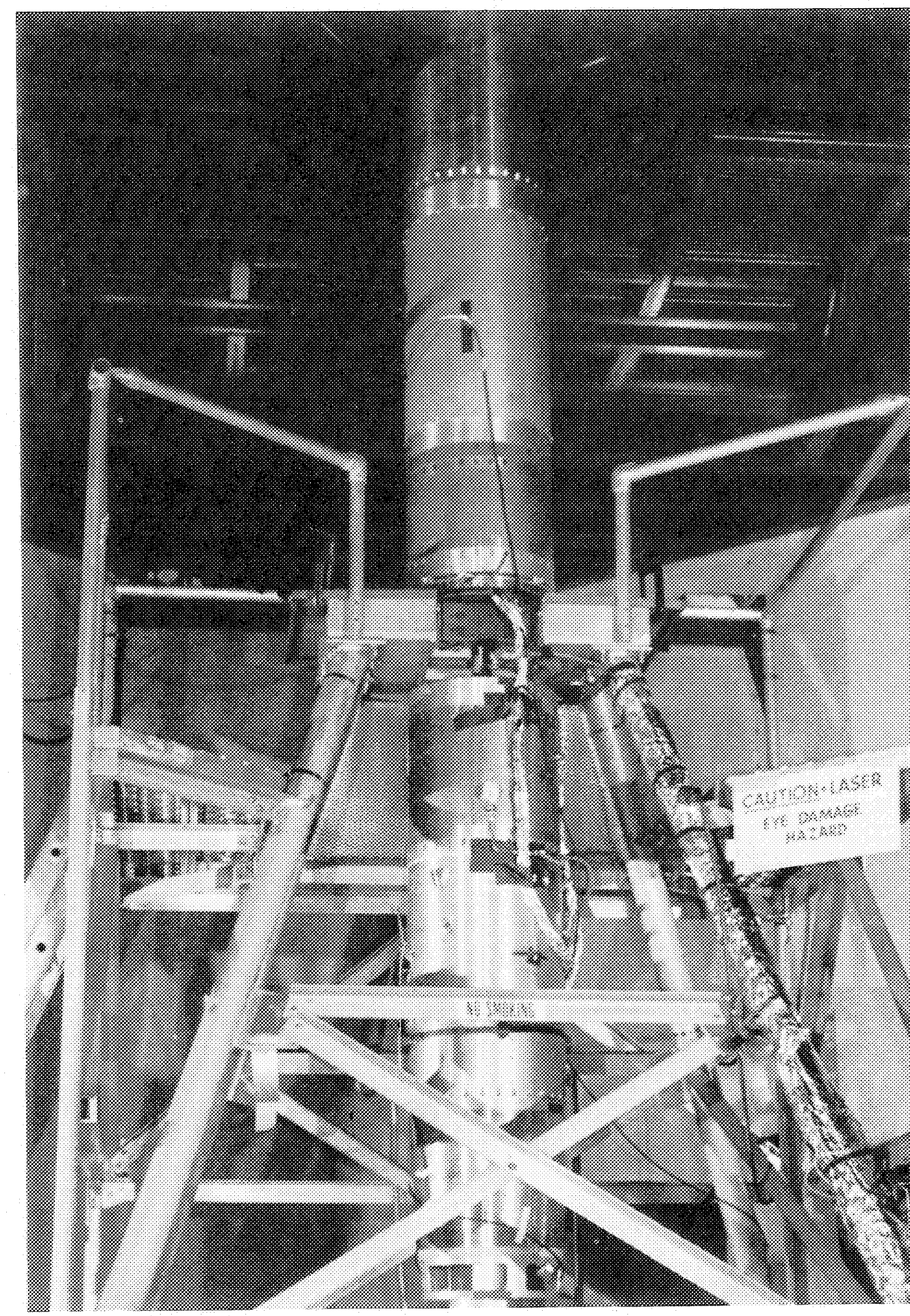
EYE DAMAGE
HAZARD
NO SMOKING


CAUTION-LASER
EYE DAMAGE
HAZARD
NO SMOKING