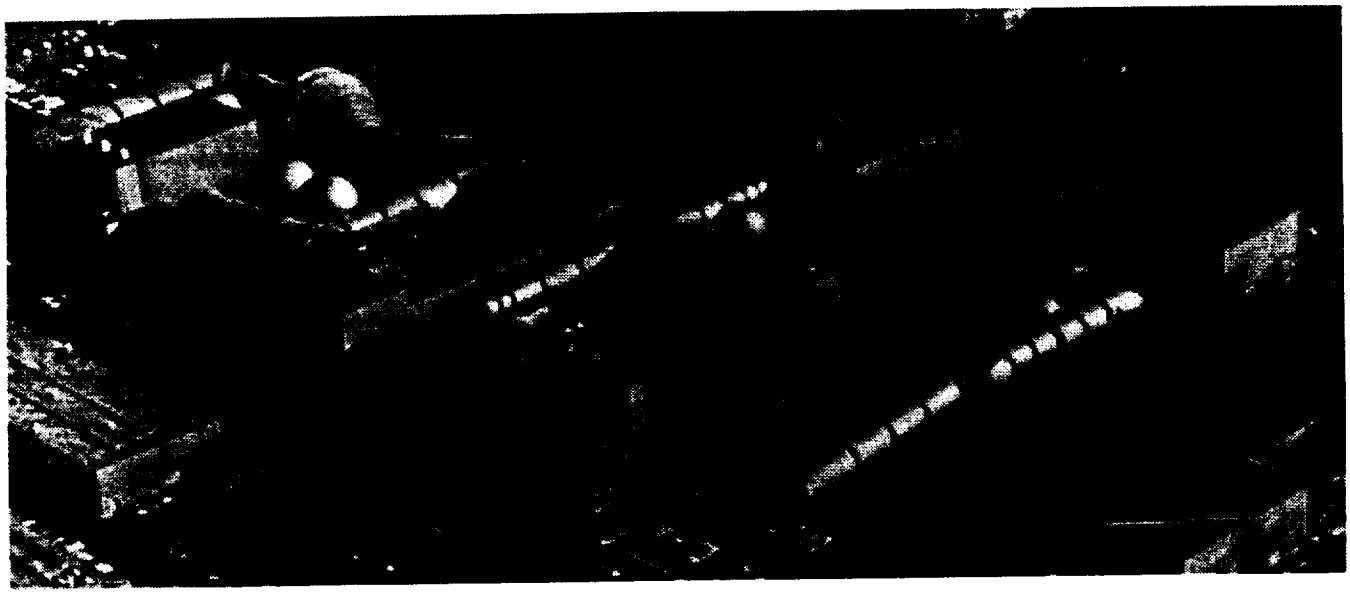
The Unitary Plan Wind Tunnels



The Unitary Plan Facility is the most heavily used wind tunnel in all of NASA. Every major commercial transport and almost every fighter built in the United States over the last 30 years has been tested in this tunnel. Also tested in this tunnel complex were models of the Space Shuttle, as well as the Mercury, Gemini, and Apollo capsules. The wind tunnel represents a unique national asset of vital importance to the nation's defense and its competitive position in the world aerospace market. In 1985, the Unitary Plan Facility was named a National Historic Landmark by the National Park Service because of "its significant associations with the development of the American Space Program."

Click here for the Applied Aerodynamics Branch (RAA) E-Mail Directory

Last updated: July 18, 1994

Comments or questions should be directed to:

Kevin Wedgworth, *wedgwort@ra-iris.arc.nasa.gov*

Alex Woo, *woo@ames.arc.nasa.gov*

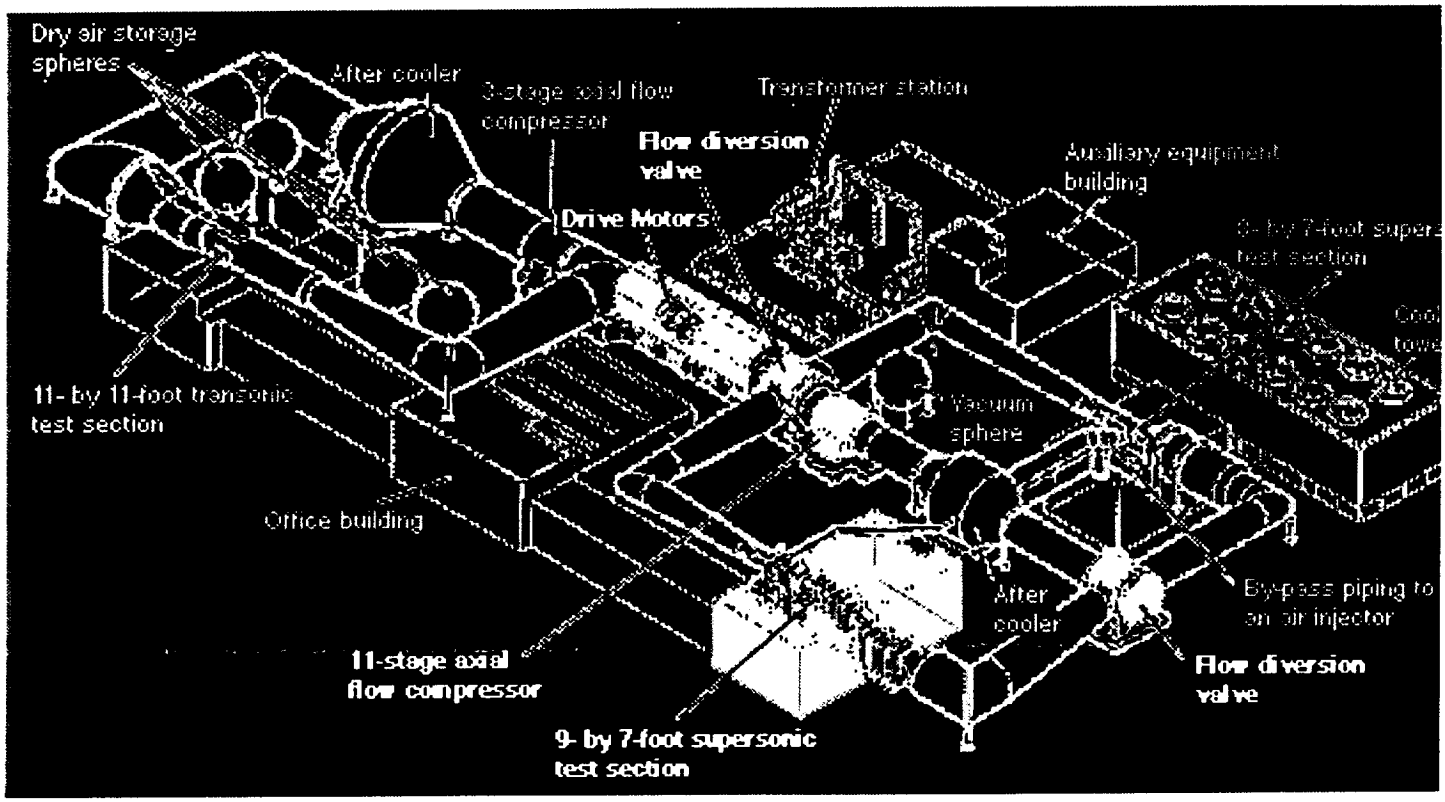
Ames Home Page

NASA's Most Heavily Used Wind Tunnels

1000+ different test programs conducted -o- 60,000 operating hours on the drive system

In 1949 Congress and the President approved the "Unitary Wind Tunnel Plan Act" which authorized construction of a group of wind tunnels ...
"which shall be available primarily to industry for testing experimental models in connection with the development of aircraft and missiles...
with proper emphasis upon the requirements of each military service and due consideration of civilian need".

Select a shaded area of the diagram below for a more detailed view:



CONSTRUCTION

- Begun: 1950
- Operational: 1956
- Cost: $35 million
- 1,700 foundation piling 48 feet deep
- 10,000 cubic yards of concrete for foundation
- The base for the motors and two compressors was a single continuous pour requiring 69 hours and 3250 cubic yards of concrete
- 7500 tons of steel plate 1 to 2 1/2 inches thick
- 100 tons of welding rods used in fabrication

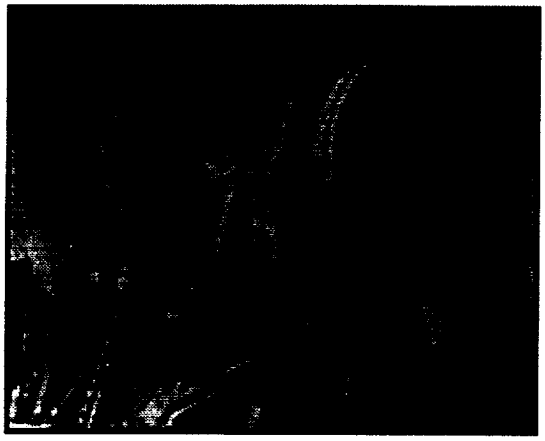
NASA's Most Heavily Used Wind Tunnels

11-Stage Axial Flow Compressor

- 1122 Rotor blades
- 1223 Stator blades
- Compressor diameter: 20.5 Ft.
- Total weight including blades and drive shaft: 445 tons
- Compression ratio: 3.5 to 1
- Flow Rate: 3,200,000 cubic ft. per min.

NASA's Most Heavily Used Wind Tunnels

Flow Diversion Valve



- Allows the 11-stage compressor to drive either the 9x7 foot or the 8x7 foot supersonic wind tunnel
- 24 ft. in diameter
- Completes rotation in 3.5 minutes
- At time of installation, the largest plug-type diversion valve ever constructed

NASA's Most Heavily Used Wind Tunnels

Main Drive Motors

- Four wound rotor induction motors
- 180,000 hp continuous rating (45,000 hp each)
- 216,000 maximum hp for one hour
- 6900 Volts
- Motors shaft length 119 feet
- Motors weigh 150 tons each

NASA's Most Heavily Used Wind Tunnels

9- By 7- Foot Supersonic Test Section

• Space Shuttle Launch Configuration being prepared for test

NASA'S Most Heavily Used Wind Tunnels

Performance Characteristics:

Tunnel	Mach No. Range	Pressure Range, PSI Absolute
11- by 11- Foot Transonic	0.3 to 1.5	5 to 35
9- by 7- Foot Supersonic	1.5 to 2.6	5 to 30
8- by 7- Foot Supersonic	2.5 to 3.5	5 to 30
Mach number is continuously variable in range		
Angle of attack range	30 degrees	
Angle of sideslip range	+/- 15 degrees	
Capable of running continuously (24 hours per day)		

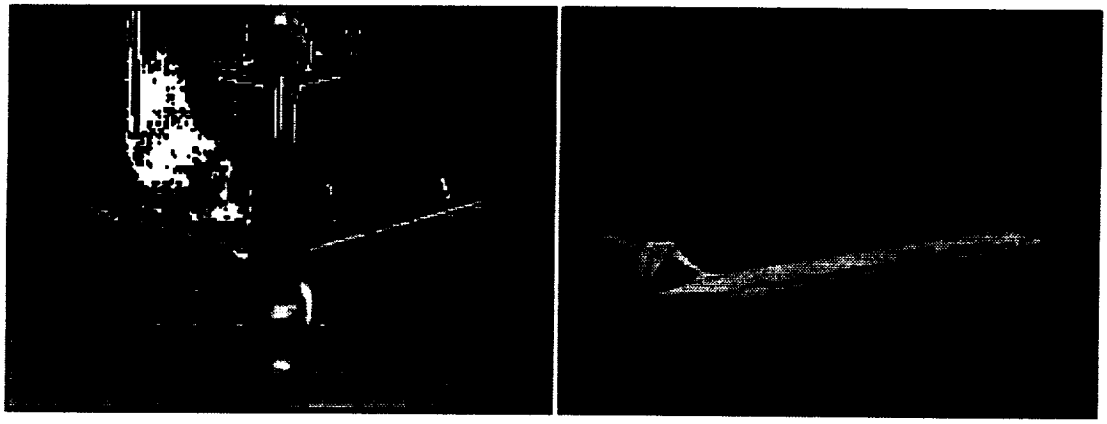
Wind Tunnel Measurements

Wind Tunnels simulate flight conditions.

Test Section

To simulate flight conditions, both Mach Number and Scale Effects must be simulated.

$$Mach\ Number = \frac{Flight\ Speed}{Speed\ of\ Sound} \qquad Scale\ Effects = \frac{Air\ Inertial\ Forces}{Air\ Frictional\ Forces}$$



Measurements

Models and tunnels are instrumented to measure various physical quantities.

- Forces
- Pressures
- Model orientation
- Surface flow direction
- Moments
- Temperatures
- Model position
- Air density near model

Data

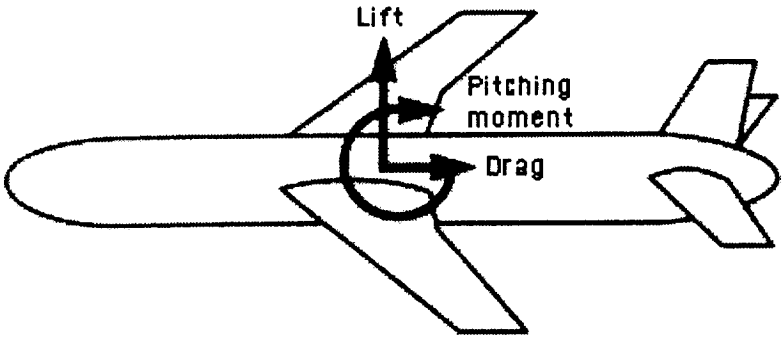
Measurements are converted to engineering data that describe the aerodynamics of the configuration.

- Structural loads
- Effects of wing bending
- Verification of predicted results
- Aircraft performance
- Inlet and nozzle performance
- Characteristics of flow near model
- Propulsion effects

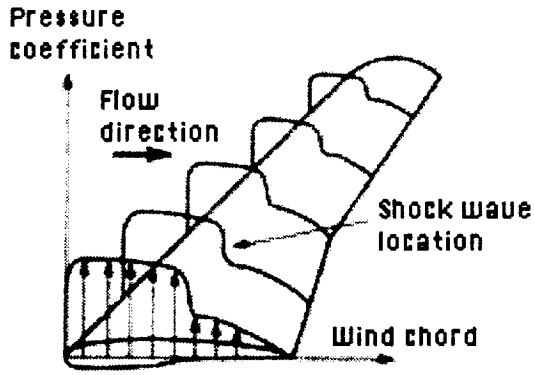
- Unsteady pressures and loads
- Stability and control characteristics

Results

Engineering data is used to assess performance, design components, and verify predictions.



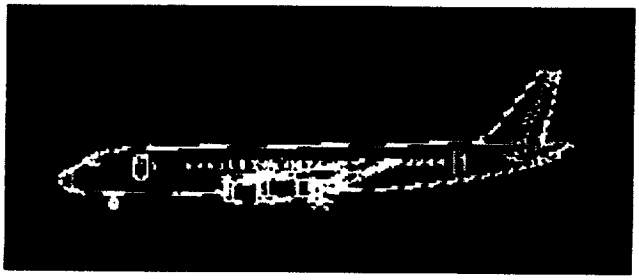
Forces on the model.



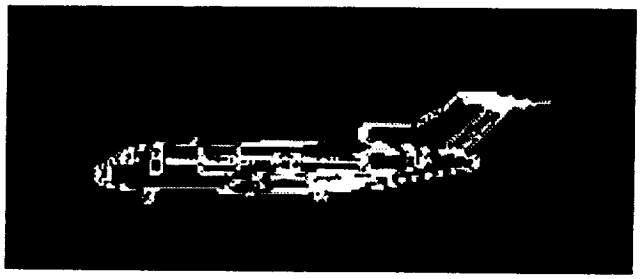
Measured surface pressure.

Examples of Aircraft and Spacecraft Tested

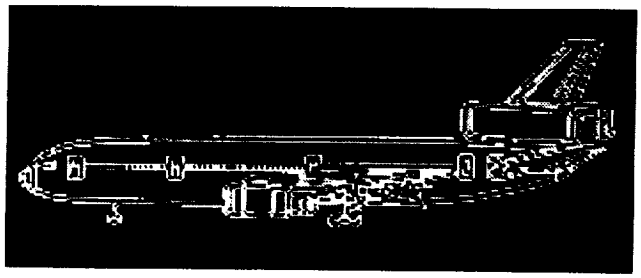
Commercial



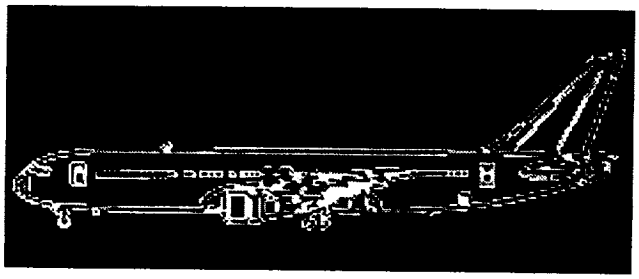
Mc Donnell-Douglas DC-8



Boeing 727

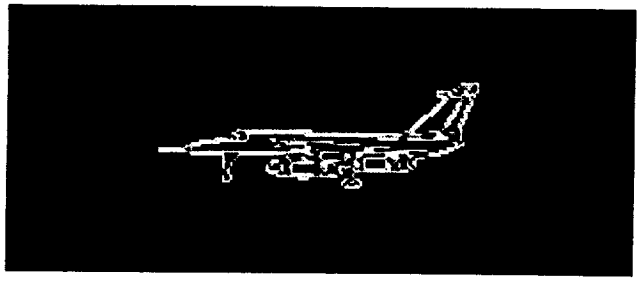


Mc Donnell-Douglas DC-10

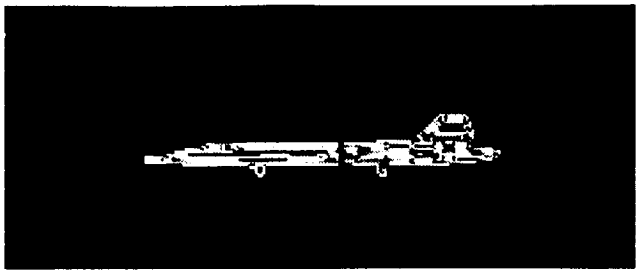


Boeing 767

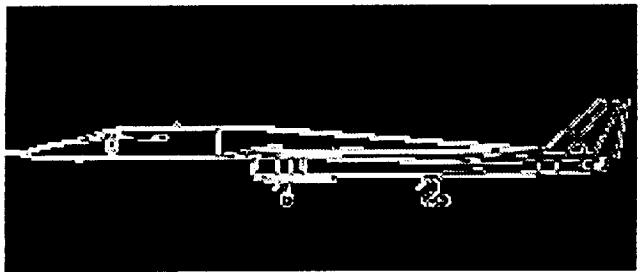
Military



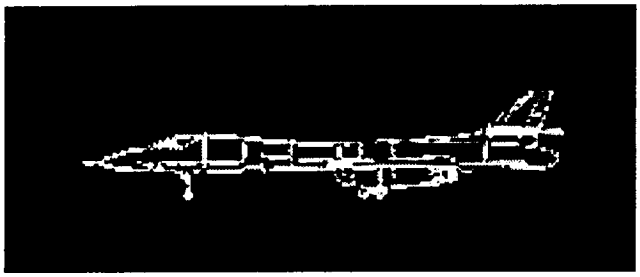
Convair B-58



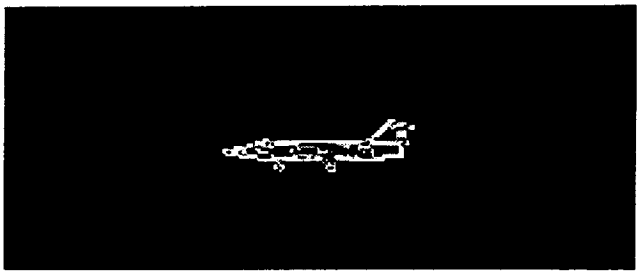
Lockheed SR-71



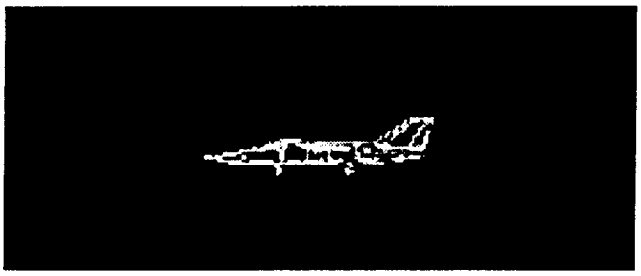
North American XB-70



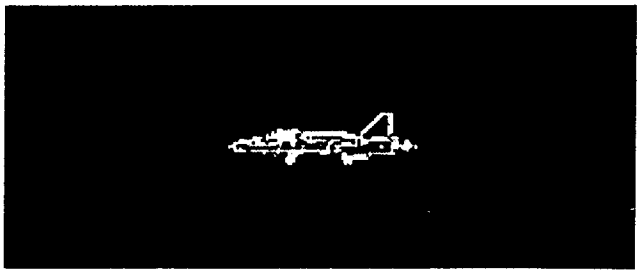
Rockwell International B-1B



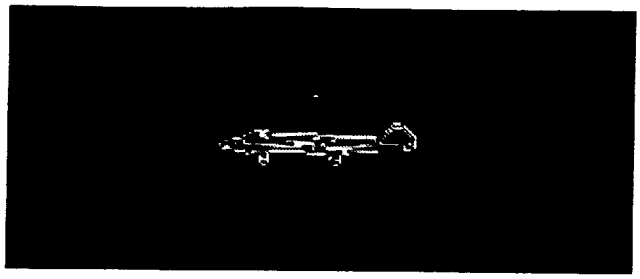
Lockheed F-104



General Dynamics F-111

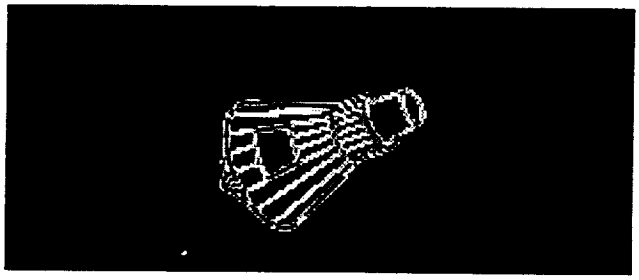


Mc Donnell-Douglas F/A-18

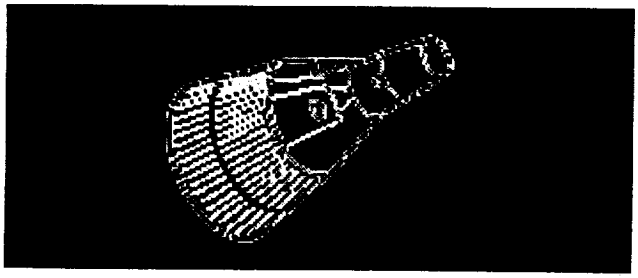


Northrop/Mc Donnell-Douglas YF-23

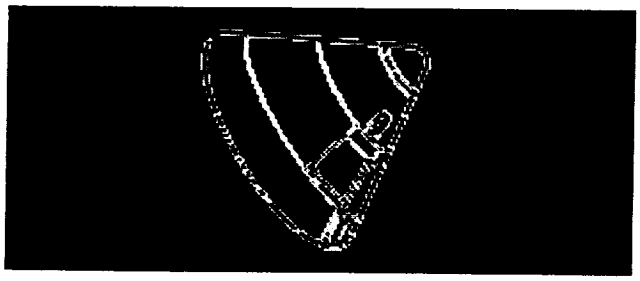
Space



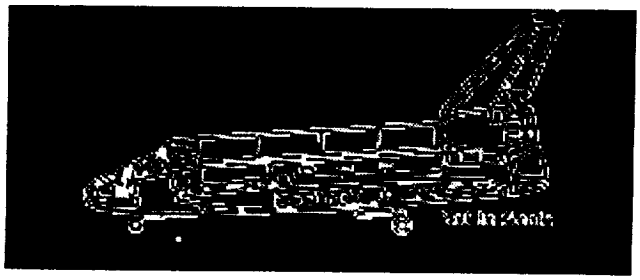
Mc Donnell-Douglas - Mercury



Mc Donnell-Douglas - Gemini



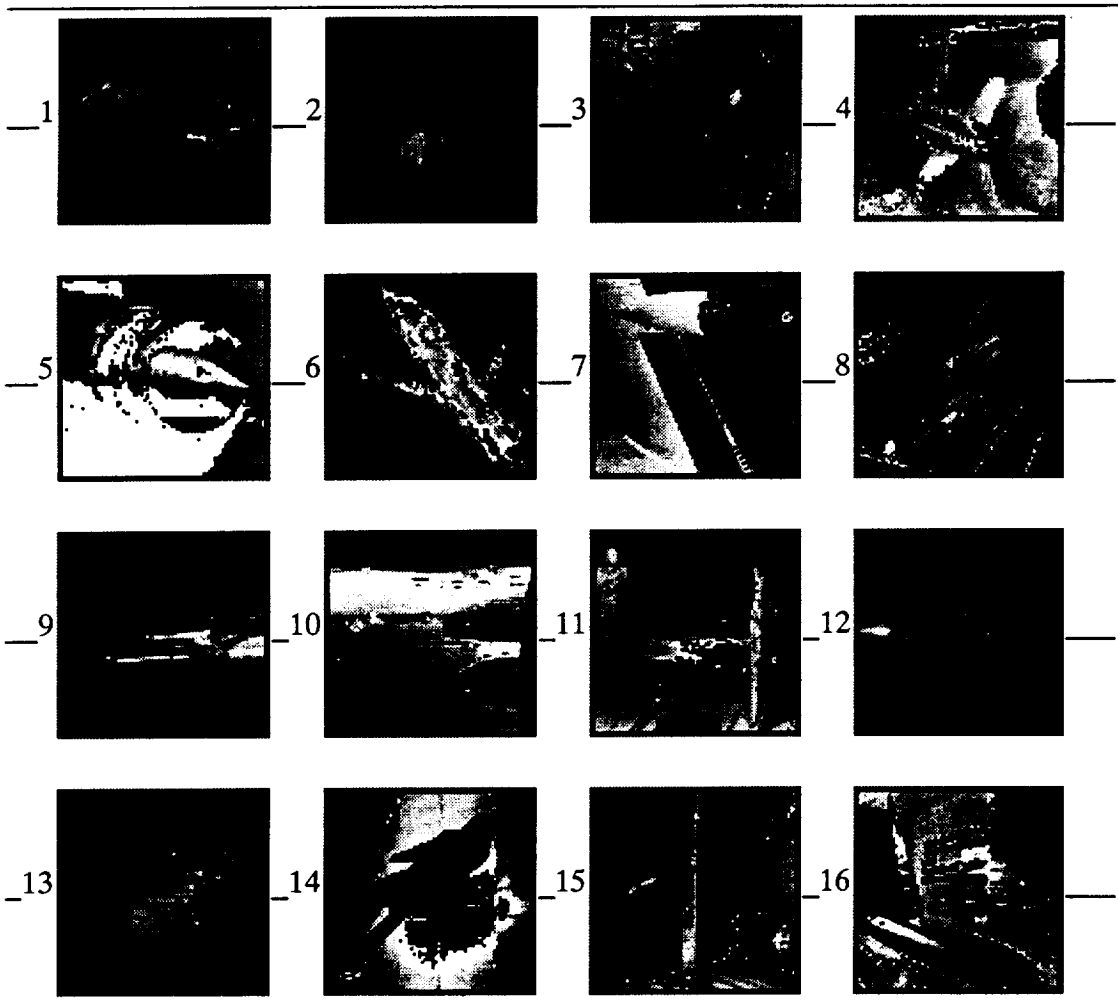
Rockwell International Apollo Command Module



Rockwell International Space Shuttle

Diversity of the Test Programs

Investigations of aerodynamic phenomena require many kinds of wind tunnel tests.



Key:

1. Evaluation of a model with an engine inlet on top
2. Supersonic speed test of Apollo capsule with launch escape rocket
3. Evaluation of an advanced concept oblique wing transport
4. Evaluation of the performance of exhaust nozzles
5. Evaluation of supersonic inlet performance
6. Evaluation of experimental aircraft before flight test
7. Simulation of the effects of a turboprop propulsion system
8. B-1 wing flutter test
9. Simulation of the effects of Space Shuttle exhaust plumes using high pressure air
10. Use of fluorescent oil showing airflow direction on Space Shuttle wing
11. Testing Space Shuttle thermal tiles at flight conditions
12. Determination of interaction between engine inlet and airframe

13. Evaluation of the aerodynamics of parachutes at supersonic speeds
14. Model with jet engine simulators powered by high pressure air
15. Evaluation of helicopter rotor blade
16. Large scale test using a half-span model

RAA Branch E-Mail Directory

- *For information on sending mail from the various platforms, click here. (Ames Users Only)*
- *an '*' in front of a name indicates that this person did not indicate a preferred e-mail address*

General Information

Chief:
Daniel Bencze
Assistant Chief:
David Banducci
Secretary:
(Vacant)
Branch Office:
Bldg.-Mail Stop: 227-6
Office Number: (415) 604-5645
Fax Number: (415) 604-4357

NASA

Dave Banducci:
Dave_Banducci@qmgate.arc.nasa.gov
Dan Bencze:
Dan_Bencze@qmgate.arc.nasa.gov
Alan Boone:
Alan_Boone@qmgate.arc.nasa.gov
Mina Cappuccio:
Mina_Cappuccio@qmgate.arc.nasa.gov
Gil Chyu:
chyu@ra-iris.arc.nasa.gov
Gary Cosentino:
cosentin@ra-iris.arc.nasa.gov
Mike Fletcher:
fletcher@ames.arc.nasa.gov
Tim Flores:
Tim_Flores@qmgate.arc.nasa.gov
*John Holmberg:
John_Holmberg@qmgate.arc.nasa.gov
Frank Kmak:
Frank_Kmak@qmgate.arc.nasa.gov
John Melton:
melton@ra-iris.arc.nasa.gov
*Steve Patterson:
Steve_Patterson@qmgate.arc.nasa.gov

*Scott Richey:
Scott_Richey@qmgate.arc.nasa.gov
*Tom Romer:
Tom_Romer@qmgate.arc.nasa.gov
Michael Schuh:
schuh@ra-iris.arc.nasa.gov
*Patti Schuhmacher:
Pat_Schumacher@qmgate.arc.nasa.gov
Ron Smith:
Ron_Smith@qmgate.arc.nasa.gov
Phil Snyder:
Phil_T_Snyder@qmgate.arc.nasa.gov
Jim Strong:
Jim_Strong@qmgate.arc.nasa.gov
Mark Won:
None
Alex Woo:
woo@ames.arc.nasa.gov

Sterling

Steve Mysko:
mysko@ra-iris.arc.nasa.gov
*David Saunders:
David_Saunders@qmgate.arc.nasa.gov
Mike Simon:
msimon@ra-iris.arc.nasa.gov
Michael Wong:
wong@ra-iris.arc.nasa.gov

VAX-to-iris:

On the VAX you will need to enter the mail utility. Type mail to get in to the utility and then you will see a mail prompt to let you know you are in. Then type send. The computer will prompt you for an address. Enter the address off the list above with the SMTP% prefix. When you are finished with your message type .

Example:
```
$ mail
mail> send
To:    SMTP%"jones@ra-iris.arc.nasa.gov"
Subj:  stuff
Enter your message below.  Press CTRL/Z when complete, or CTRL/C to quit:
```

VAX-to-Mac:

Enter the mail utility as above but at the To: prompt, enter the Macintosh address of the person you wish to send the message to.

Example:
```
To:    SMTP%"Jerry_Jones.RA_MAILCENTER@qmgate.arc.nasa.gov"
```

VAX-to-VAX:

Enter the mail utility as above but at the To: prompt, enter the VAX username of the person you wish to send the message to.

Example:
```
To:    jones
```