SUCTION CONTROL SYSTEM

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LFC DESIGN SUCTION DISTRIBUTION

RC x 10^6

CQ

LOWER SURFACE

UPPER SURFACE

x/c
SLOTTED SUCTION SURFACE METERING HOLE DESIGN CRITERIA

- Langley LFC wing-design fabrication
- Limit for single row of holes below or on one side of slot
- Limit for displaced row of holes from slot
- Reference 37
- Limit for two rows of holes opposite slot
- Viscous slot wakes; weak slot flow oscillations

\( R_{s, \text{critical}} \)

\( h/s \)
DOUGLAS STRUCTURAL CONCEPT FOR POROUS PANELS

SCHEMATIC
DOUGLAS WIND TUNNEL PANEL

POROUS SURFACE DETAIL

.0025 DIA. HOLE

METERING HOLE

ELECTRON BEAM PERFORATED TITANIUM SURFACE

FLOW

HOLE DIA. = 0.0026"
SPACING = 0.025"

.0026"D

.025"
LFC SLOTTED WING LEADING EDGE SUCTION DUCTS

(a) Airfoil leading-edge region.

Figure 24. Sketches showing features of surface and internal suction ducts.
LFC AIRFOIL SUCTION SURFACES

SKETCH OF SLOTTED SKIN-PLENUM-DUCT DESIGN

SKETCH OF POROUS SKIN-FLUTE-DUCT DESIGN
SUCTION DUCT LOCATIONS ON LFC SLOTTED WING
INSTRUMENTED SUCTION NOZZLES

Circular nozzle

Section B-B

Section C-C

Section D-D

2-D rectangular nozzle

Section A-A
INTERNAL WING DUCTING AND HOSES AT TUNNEL FLOOR

AIRFOIL MODEL SUCTION PANELS

LEADING EDGE

LINER WALL

TUNNEL WALL

SUCTION DUCT NOZZLE

LAMINAR TEST REGION

TURBULENT ZONE

COUPLING

SUCTION HOSE

TUNNEL WALL
LFC EXPERIMENT LAYOUT SCHEMATIC

- Liner (four walls)
- Two-wall choke
- Suction hoses
- Flow
- Diffuser
- LFC wing
- Screens
- Honeycomb
LFC SUCTION AIRFLOW CONTROL BOX SCHEMATIC

Electric motor

Mech. drive

Linear drive assembly

Exit pipe

To suction compressor

Acoustic liner

Contraction shell

Screen

Honeycomb

Nozzle

Airflow

Entry suction lines

Section A-A
LFC SUCTION CONTROL SONIC NOZZLE

MANIFOLD INTERFACE

SUPPORT SPIDER

DRIVE NUT

AXISYM. NOZZLE

NEEDLE

AIR CONTROL BOX INTERFACE

NEEDLE ELECTRIC DRIVE MOTOR

VIBRATION DAMPER

AIRFLOW

3°
LFC SUCTION SYSTEM SOURCE

Airflow from airfoil

Airflow control box

Collector manifold

20-in. pipe

Variable sonic nozzle

Exhaust to tunnel total pressure

To suction compression

10,000 CFM compressor
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SUCTION SYSTEM

1. Suction surface
   a) Slotted aluminum  
      0.002–0.006 in. wide, variable spacing  
   b) Perforated titanium (upper surface only)  
      0.0025 holes spaced 0.026 inch square grid through 0.030 inch thick skin, in 0.5 inch bands about 0.4 in. apart  
   c) Fiberglass collar slots  
      0.050 in. slots about 1.5 in. spacing, 6 in. long

2. Subsurface "Flute" or "Plenum"

   Slot plenum only about 0.1 inch square  
   Slot plenum continuous above laminar–turbulent region bulkhead  
   Perforated surface plenum about 0.5 inch square  
   Plenum only instrumented with perforated surface

3. Metering holes  
   0.06–0.10 in., basic suction level preset in metering hole spacing
4. Duct
   a) Laminar region
      some duct have two nozzles
      HLFC upper surface had only forward perforated panel ducts (7)
   b) Turbulent region
      short ducts with one small nozzle
   c) Collar
      one large nozzle

5. Nozzle
   a) Axisymmetric
      Calibrated Pfenninger design
   b) Two-dimensional
      Treated the same in data reduction as Pfenninger nozzle

6. Nozzle extension
   a) Original
      Same diameter as throat and 10–20 diameters long
   b) Modified
      Larger diameter for critical ducts
7. Hoses
   a) Small hoses
      0.25–0.75 inch ID, 1–2 feet long
   b) 1-inch hoses
      6–8 feet long
   c) Some adaptors instrumented for stagnation pressure
      From small hose to 1-inch hose

8. Needle valves
   All 1-inch ID

9. Flow control boxes
   Five identical
   HLFC had 2 boxes connected to special vacuum pumps (Stokes)

10. Sonic nozzles
    Only on control boxes for laminar regions
    HLFC had these two sonic nozzles for forward upper surface

11. 6 inch ID 'Dredge' hose
    Connects control boxes to suction manifold
    HLFC used same hose to connect to special vacuum pumps (Stokes)

12. Suction manifold
    About 500 cu.ft. volume, low velocity flow into 20 inch ID pipe
13. 20 inch ID pipe
   About 50 feet to compressor inlet

14. 10 000 cfm compressor
   Centrifugal, 4 to 1 compression ratio at rated flow
   About 4.5 to 1 compression ratio at LFC operating point of 5000 cfm

15. Return to circuit
    Hollow turning vanes at Ring A, end of diffuser
    HLFC Stokes pumps exhaust not returned to circuit, but 10 000 cfm
    compressor kept total pressure constant with automatic controller