

AWT ICING DISCUSSION

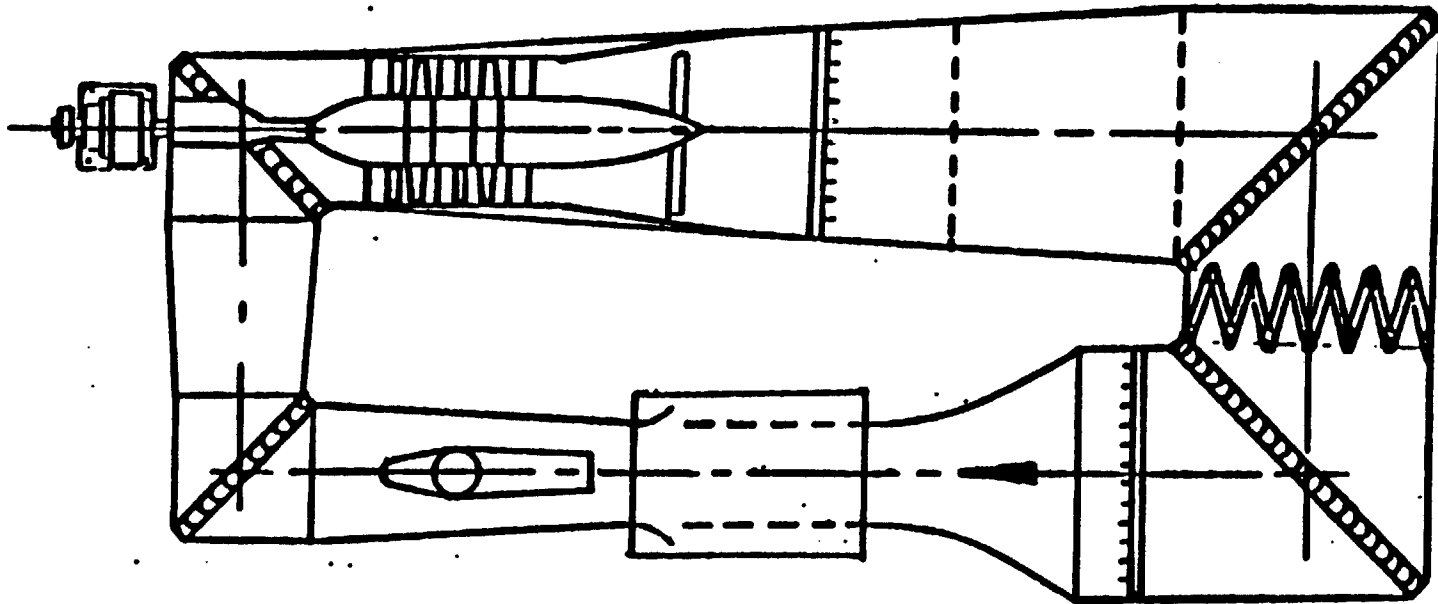
JOHN J. REINMANN
HEAD, ICING RESEARCH SECTION
NASA LEWIS RESEARCH CENTER

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AWT ICING SYSTEMS TASK TEAM



OBJECTIVES

- o PROVIDE AN ICING AND SEVERE WEATHER CAPABILITY FOR THE AWT IN BOTH THE HIGH AND LOW SPEED TEST SECTIONS
- o ENSURE THAT ALL AWT COMPONENTS ARE DESIGNED TO PERFORM IN THE SEVERE WEATHER ENVIRONMENT WITH MINIMUM IMPACT ON PERFORMANCE AND WITH HIGH RELIABILITY

ICING SYSTEMS TASK TEAM

KEY PROBLEMS TO BE ADDRESSED

NOZZLES

- o SUPERCOOLED CLOUDS
 - WIDE LWC RANGE
 - SMALL DROPLETS
 - ACCURATE CONTROL

- o HEAVY RAIN/FREEZING RAIN
 - LARGE DROPLETS
 - VERY WIDE LWC RANGE

- o SNOW
 - SNOW FLAKE GROWTH RATE VERY SLOW
 - SIMULATE WITH FROZEN DROPLETS?

INSTRUMENTATION

- o CALIBRATION STANDARDS NEEDED FOR LWC AND PARTICLE SIZING
- o CURRENT INSTRUMENTS LIMITED TO ONLY LOW SPEEDS

ICING SYSTEMS TASK TEAM

KEY PROBLEMS TO BE ADDRESSED (CONT'D)

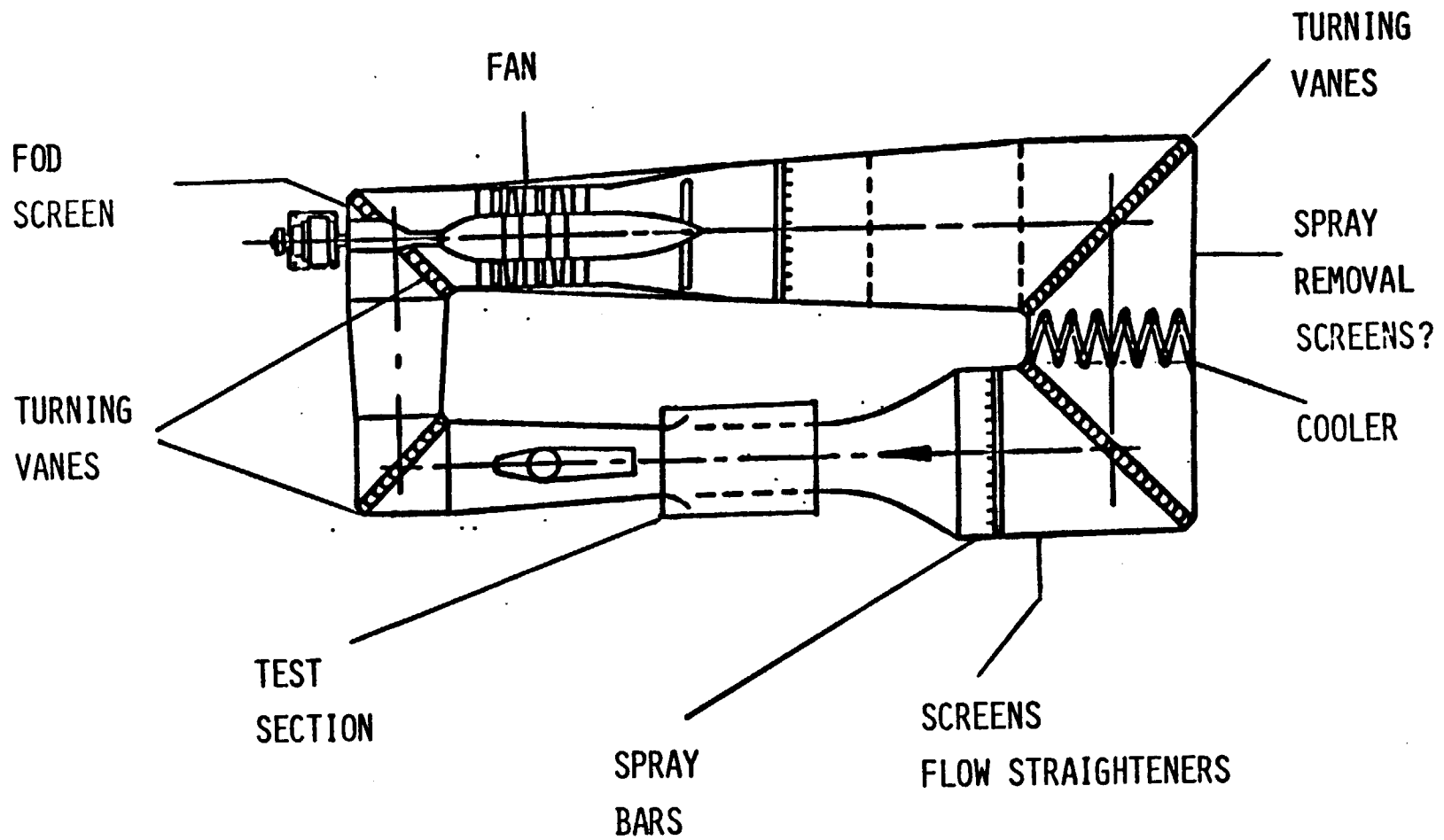
SPRAY CLOUD

- o SIZE AND UNIFORMITY
 - SCALING OF SPRAY MIXING PROCESS
 - EFFECT OF BELLMOUTH FLOW DISTORTION AND SECONDARY FLOWS
 - UNIFORM CLOUD AT LOW LWC'S
 - HIGH LWC AT HIGH SPEEDS

- o CLOUD CHARACTERISTICS
 - DROPLET SIZE CHANGE DUE TO EVAPORATION
 - SUPERCOOLING/FREEZE-OUT

- o RAIN
 - DROPLET BREAK-UP AT HIGH SPEEDS
 - DROPLET TRAJECTORY/SPRAY BAR PLACEMENT

AWT ICING SYSTEMS TASK TEAM
KEY COMPONENTS AFFECTED BY ICING



ICING SYSTEM TASK TEAM

APPROACH

NOZZLES

- o TEST CURRENT DESIGNS
- o DESIGN AND EVALUATE NEW DESIGNS
- o CANDIDATE FACILITIES
 - IN-HOUSE SINGLE NOZZLE RIGS
 - AEDC

CLOUD INSTRUMENTATION

- o USE IN-HOUSE INSTRUMENTATION WHERE AVAILABLE
- o PURCHASE EXISTING INSTRUMENTATION AND MODIFY AS NEEDED
- o DEVELOP CALIBRATION PROCEDURES AND STANDARDS
- o CONTRACT FOR HIGH SPEED INSTRUMENTATION

SPRAY CLOUD

- o ANALYTICAL MODELING
 - SPRAY MIXING PROCESS
 - FLOW FIELDS AND PARTICLE TRAJECTORIES
- o EXPERIMENTAL MODELING CANIDATE FACILITIES
 - PSL 3/4 (10 TO 15% SCALE)
 - AWT PILOT WIND TUNNEL (~15% SCALE)
 - ICING RESEARCH TUNNEL (6 FT. X 9 FT.)

SINGLE NOZZLE TEST RIG

NOZZLE SERVICES:

WATER:

FLOW RATE 0 TO 0.5 GPM (FREEZING RAIN, HEAVY RAIN--MUCH HIGHER)

PRESSURE 10 TO 500 PSIG

TEMPERATURE 70 TO 200 F

AIR:

FLOW RATE 0 TO 0.4 LB/SEC

PRESSURE 10 TO 400 PSIG

TEMPERATURE 70 TO 200 F

PRESSURE MEASUREMENT ACCURACY: $\pm 1\%$ OF READING FOR AIR PRESSURE AND
DIFFERENTIAL PRESSURE ($P_{\text{WATER}} - P_{\text{AIR}}$)

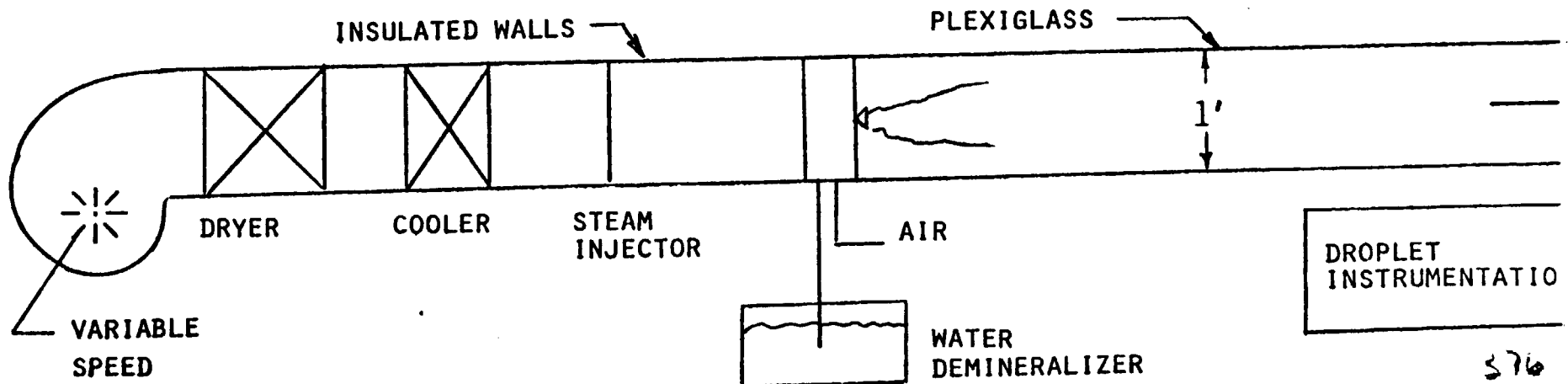
SECONDARY AIR:

PRESSURE 1 ATM

SPEED 0 TO 75 MPH

TEMP -20 TO 70°F

HUMIDITY 20 TO 100%



HIGH SPEED/HIGH ALTITUDE ICING TEST FACILITY

TUNNEL

MACH NO 0 TO 0.8
ALTITUDE S.L. TO 22,000 FT
TOTAL TEMP -20 TO 70°F
FLOW RATE 0 TO 140 LB/SEC
RELATIVE HUMIDITY 20 TO 100%

STEAM 85 PSIG, 2 INCH LINE

INSTRUMENTATION

DROPLET SIZING SYSTEM
HEATED WAKE SURVEY PROBE
WALL PRESSURE TAPS
VIDEO CAMERA AND LIGHTING

SUPERCOOLED CLOUD SPRAY BARS

WATER:

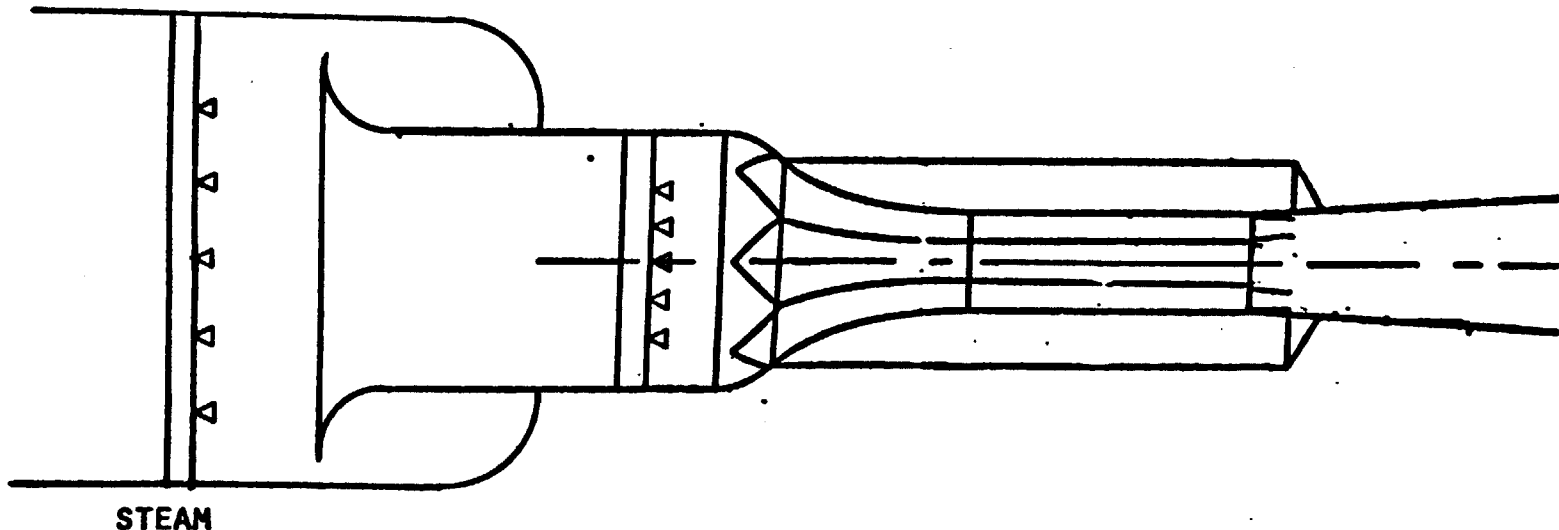
FLOW RATE 0 TO 20 GPM
TEMP 70 TO 200°F
PRESS 10 TO 500 PSIG
DEMINERALIZED

AIR:

FLOW RATE 0 TO 12 LB/SEC
TEMP 70 TO 200°F
PRESS 10 TO 400 PSIG

FREEZING & HEAVY RAIN SPRAY BARS

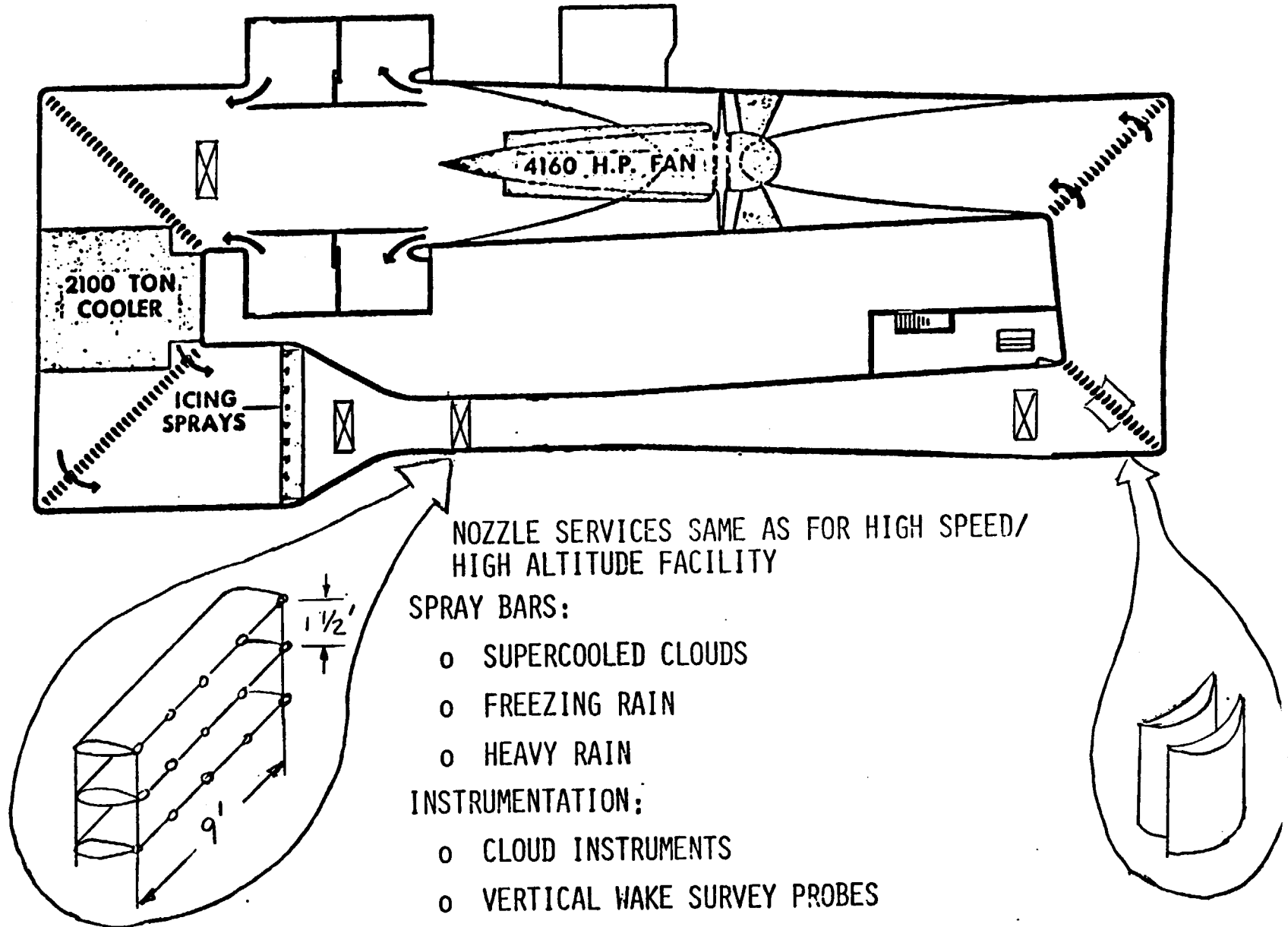
WATER:



1/10 SCALE MODEL OF HIGH SPEED TEST CELL ENGINE TEST CELL

IRT TEST SUPPORT FOR AWT

ICING RESEARCH TUNNEL



NOZZLE SERVICES SAME AS FOR HIGH SPEED/
HIGH ALTITUDE FACILITY

SPRAY BARS:

- o SUPERCOOLED CLOUDS
- o FREEZING RAIN
- o HEAVY RAIN

INSTRUMENTATION:

- o CLOUD INSTRUMENTS
- o VERTICAL WAKE SURVEY PROBES
- o HOT WIRE SYSTEM

PORTABLE AWT SPRAY BAR ASSEMBLY

AWT TURNING VANES

