

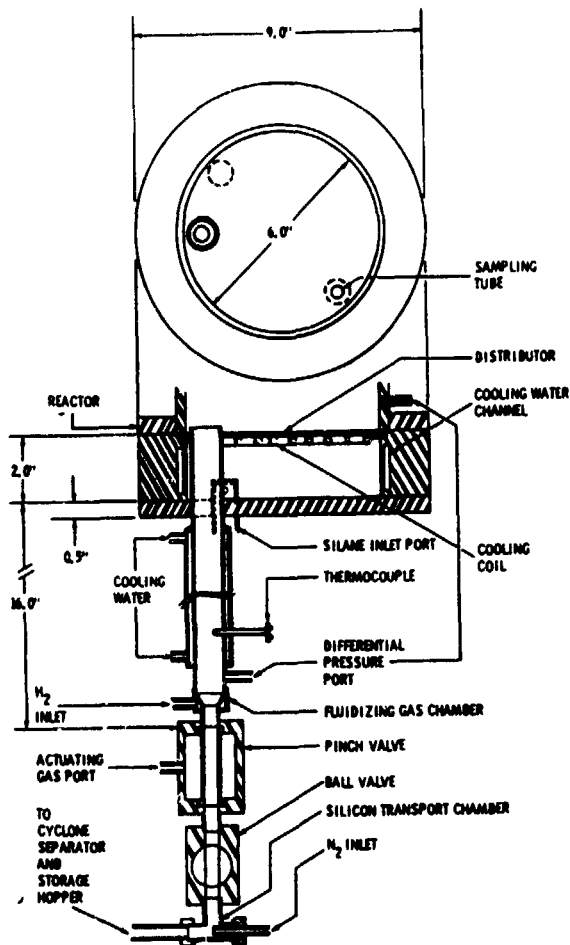
N85-32414

JPL IN-HOUSE FLUIDIZED-BED REACTOR RESEARCH

JET PROPULSION LABORATORY

N.K. Rohatgi

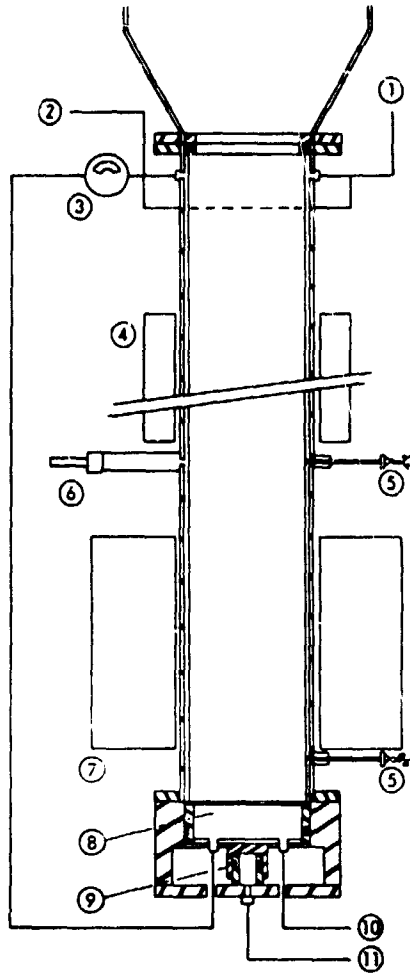
Silicon Withdrawal System



Quartz Liner System Design

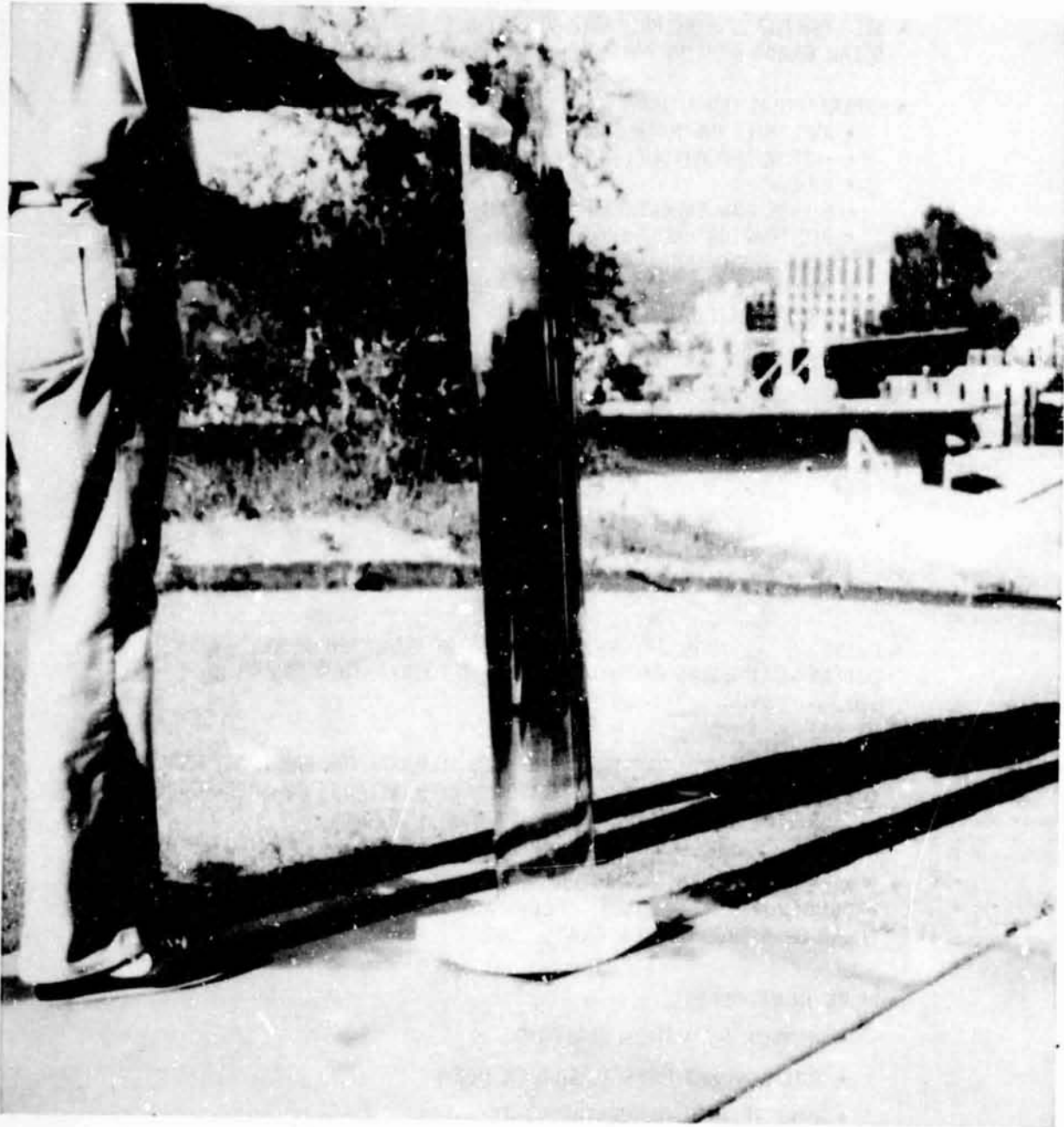
- PROBLEM
 - POSSIBLE BREAKAGE OF QUARTZ LINER DURING THERMAL CYCLE
- DESIGN CRITERION
 - NO SILANE SHOULD BE ALLOWED TO FLOW IN BETWEEN QUARTZ LINER AND STAINLESS STEEL REACTOR WALL

Quartz Liner for FBR



- ① HYDROGEN EXHAUST
- ② HYDROGEN INLET
- ③ DIFFERENTIAL PRESSURE GAGE
- ④ CLAMSHELL HEATER
- ⑤ THERMOCOUPLE
- ⑥ PYROMETER
- ⑦ SILICON CARBIDE HEATER
- ⑧ PISTON
- ⑨ PNEUMATIC CYLINDER
- ⑩ SILANE INLET
- ⑪ NITROGEN INLET

Quartz Liner After Exposure to Silane Pyrolysis



SILICON MATERIAL

Purity Experiment

- SEED PARTICLES WERE PREPARED VIA JET MILL GRINDING OF 2 TO 4 mm SIZE SOLAR GRADE SILICON PARTICLES PURCHASED FROM THE DYNAMITE NOBEL
- EXPERIMENTAL CONDITIONS
 - AVG. SEED PARTICLE SIZE: 254 μm (+106 TO -425 μm)
 - INITIAL BED WEIGHT: 9 kg (\approx 21" BED HEIGHT)
 - $U/U_{mf} = 5$
 - SILANE CONCENTRATION: 30% (IN H_2)
 - BED TEMPERATURE: 650°C
 - DURATION OF RUN: 4 hrs
 - PARTICLES WERE WITHDRAWN AT 2 hr INTERVALS EQUIVALENT TO PRODUCTION RATE
- MASS BALANCE
 - SILICON DEPOSITED ON THE PARTICLES IN BED = 90%
 - SILICON RECOVERED AS FINES = 7.2%
- PRODUCTION RATE: 1.7 kg/hr

Purity of Silicon

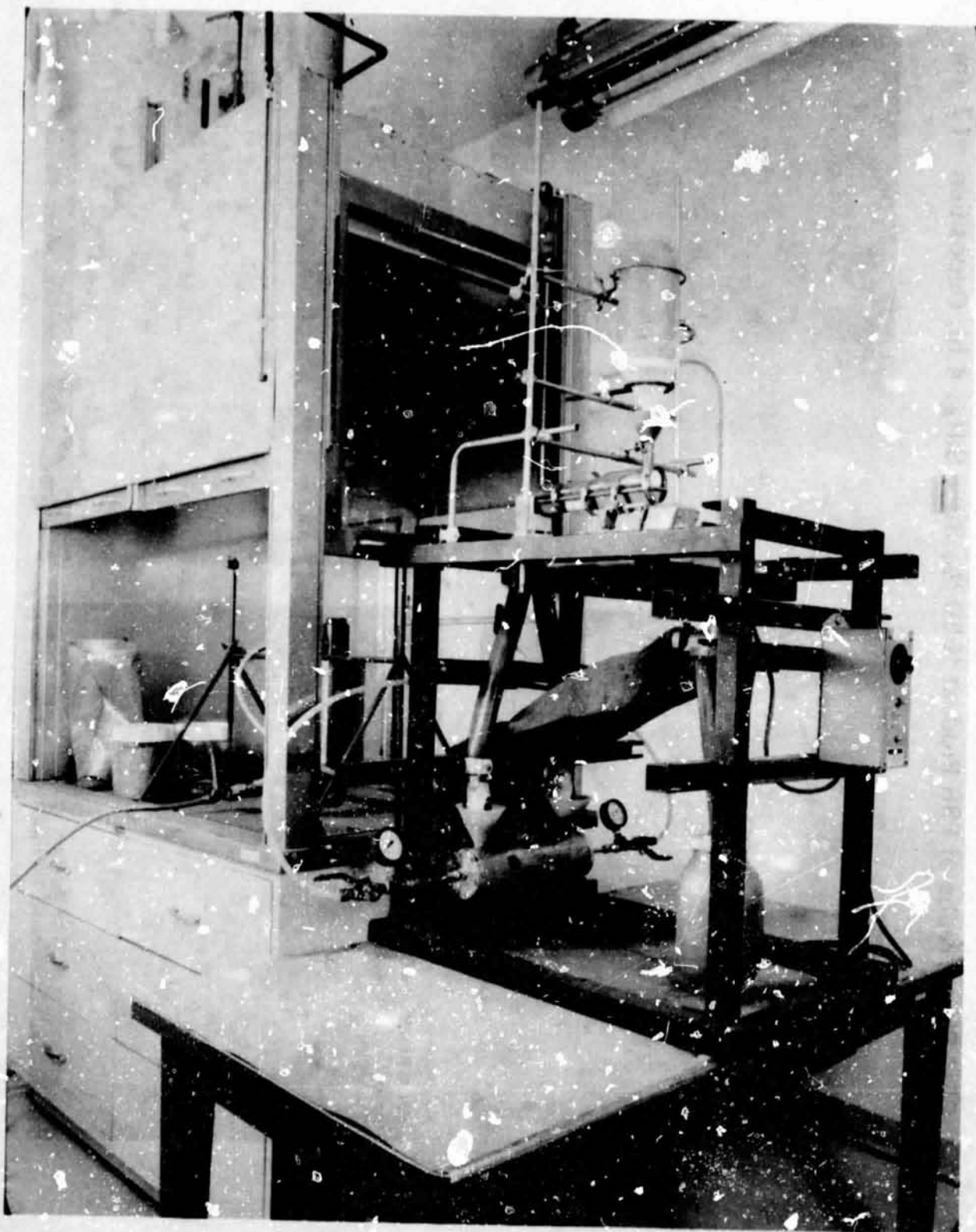
- EMISSION SPECTROSCOPY WAS USED ONLY TO ESTABLISH IF ANY GROSS CONTAMINATION WAS CAUSED DURING SEED PREPARATION AND FLUIDIZED BED PROCESSING
- PURCHASED SILICON PARTICLES AND SEED MATERIAL FOR FBR HAVE METALLIC CONTAMINATIONS BELOW THE DETECTION LIMITS OF EMISSION SPECTROSCOPY, SUCH AS Fe = 30 ppmw, CR = 8 ppmw, AND Ni = 10 ppmw
- PURITY DATA DO NOT SHOW ADDITIONAL METAL CONTAMINATIONS IN THE PRODUCT SILICON. HOWEVER, IT DOES NOT MEAN THAT FBR PRODUCT IS OF SOLAR OR SEMICONDUCTOR GRADE
- WORK IN PROGRESS
 - NEUTRON ACTIVATION ANALYSIS
 - PULL A SINGLE CRYSTAL SILICON INGOT
 - MAKE RESISTIVITY MEASUREMENTS

ORIGINAL PAGE OF
POOR QUALITYSEM Photographs of FBR Product (650 °C, 30% SiH₄, 4 h); Deposition ≈ 17 μm

SILICON MATERIAL

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OF POOR QUALITY

Jet Mill for Silicon Seed Particle Preparation



Recent Publications

- A PAPER TITLED "FINES IN FLUIDIZED BED SILANE PYROLYSIS" WAS PUBLISHED IN THE JOURNAL OF ELECTROCHEMICAL SOCIETY, MARCH 1984.
- A PAPER TITLED "FLUIDIZED BED SILICON DEPOSITION" WAS PRESENTED TO THE 17TH IEEE PV SPECIALIST CONFERENCE, FLORIDA, MAY 1-4, 1984.
- A PAPER TITLED "SILICON PARTICLE GROWTH IN A FLUIDIZED BED REACTOR," WAS SUBMITTED TO THE AIChE ANNUAL MEETING, SAN FRANCISCO, NOV. 25-30, 1984.