REPORT DOCUMENTATION PAGE

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MEMORANDUM FOR PRS (In-House Publication)

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BJECT: Authorization for Release of Technical Information, Control Number: **AFRL-PR-ED-TP-2001-004**
Merrell, Joe, "AFRL Propulsion Directorate Test Facilities"

Presentation for Visitors/Prospective Customers to AFRL/Edwards **(Statement A)**

Air Force Research Laboratory Location

NOTE:
CHANGES FROM PREV. REVIEW ARE HI-LITED IN YELLOW.

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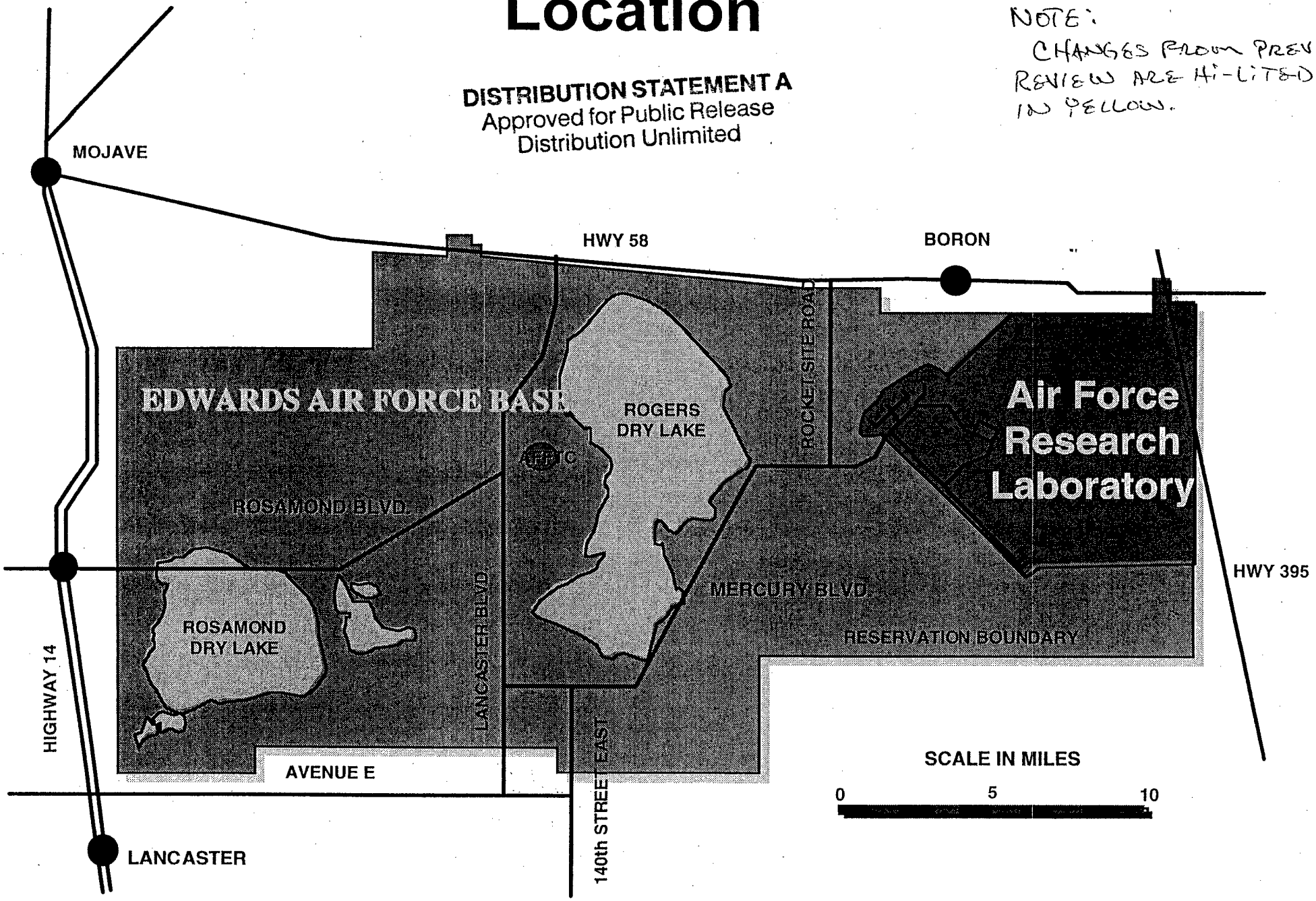

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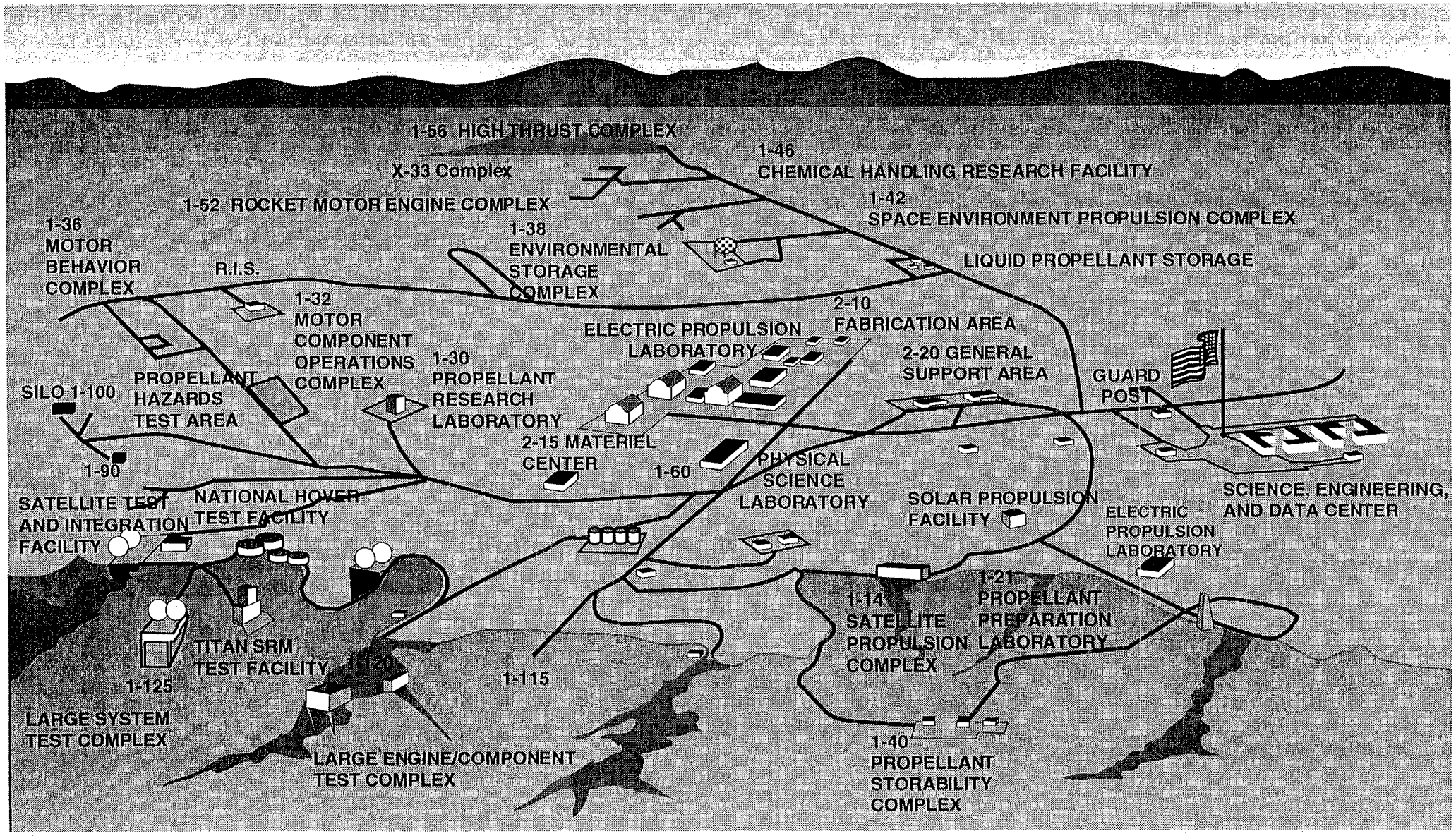
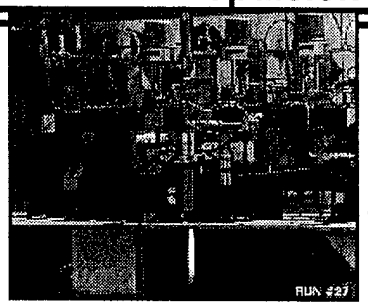
Air Force Research Laboratory Propulsion Directorate Facilities



Propulsion Directorate

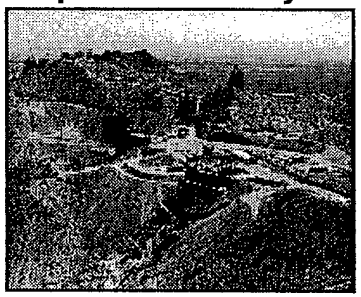
Satellite Propulsion



• HEDM

- To 5,000lb Thrust
- Horizontal Single Axis
- LOX/GOX/Hydrazine/NTO

Experimental Systems



- ATLAS
- SATURN V

- To 1,500,000lb Thrust
- Horizontal or Vertical Single Axis
- Dual Position (Expandable to Quad and 6,000,000lb Thrust)

Large Systems Complex

- SATURN V
- TITAN IVD
- TITAN 34D

- To 8,000,000lb Thrust
- Vertical Multi Axis
- Temp Conditioned 25° to 100°F
- Humidity Conditioned at 40%

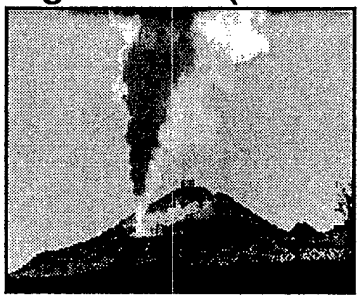
Small Solid Components

- MM I / MM III
- MX
- SICBM
- KKV

- To 36,000lb Thrust
- Horizontal Single Axis (Spin Capable)
- Temp Conditioned 30° to 120°F

TO 10,000,000 LB THRUST
FIXED OR SPIN
HORIZONTAL OR VERTICAL ORIENTATION
ENVIRONMENTAL CONDITIONING
HIGH HAZARD

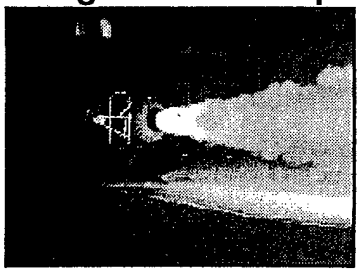
High Thrust (Solid and Liquid)



- TITAN IVD
- SUPER HIPPO
- R.R. TANK CAR

- To 10,000,000lb Thrust
- Horizontal or Vertical Multi Axis
- LOX/Hydrogen/Hydrazine/NTO

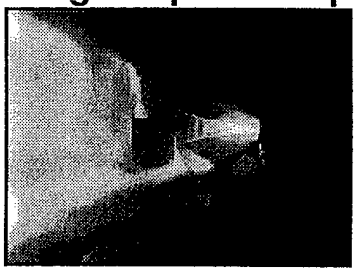
Large Solid Components



- SERGEANT
- STARBIRD
- VIPER
- F-16 LIVE FIRE
- MX
- BULL PUP

- To 300,000lb Thrust
- Horizontal and Vertical Multi Axis
- Temp Conditioned 30° to 120°F
- Spin Capable

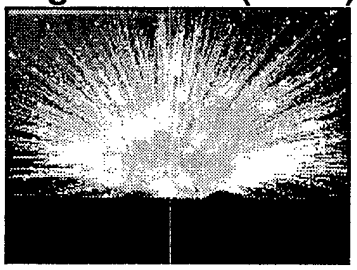
Large Liquid Components



- ABRES
- SICBM
- PEACKEEPER
- STAR TECH

- To 300,000lb Thrust
- Horizontal and Vertical Single Axis
- Temp Conditioned 30° to 120°F
- LOX/GOX/Hydrogen/Hydrazine/NTO

High Hazard (Solid)

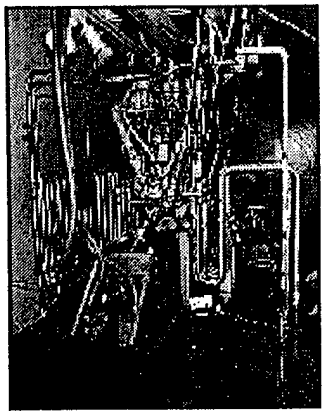


- 2.75 RAP
- MINI RPV
- MX
- F-16 HYDRAZINE TANK
- SHUTTLE STORAGE VESSELS

- To 4,000,000lb Thrust
- Horizontal Single Axis
- Temp Conditioned 30° to 120°F

Propulsion Directorate

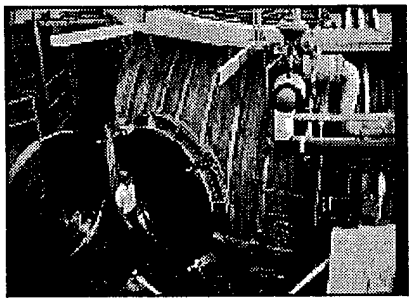
Satellite Propulsion



- MILSTAR

- 6 Hours at 125,000 Feet
- Horizontal Single Axis to 1,000lb Thrust
- LOX/GOX/Hydrogen/Hydrazine/NTO

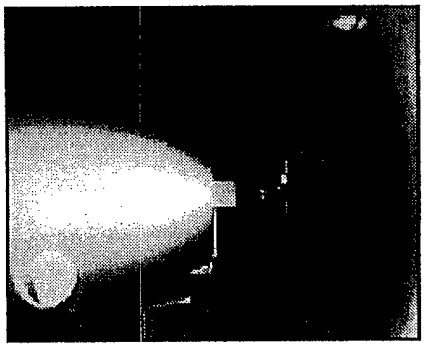
Space Experiments (SPEF)



- CENTAUR
- STM/TTM
- MSTI
- GOSSAMER TORUS

- Continuous at 650,000 Feet (Sim)
- Temp Conditioned -300 to +400
- IR/UV Solar Simulation

Electric Propulsion



- ESEX
- ELITE

- Continuous at 650,000 Feet (Sim)
- Temp Conditioned -300 to +400
- IR/UV Solar Simulation

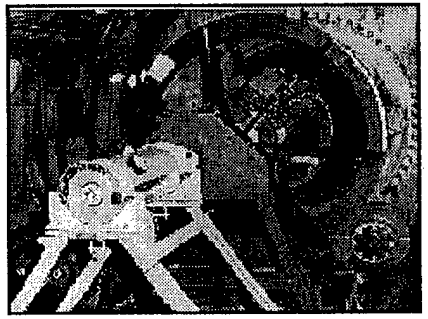
TO 650,000 FEET SIMULATION
TO 60,000 LB THRUST (FIXED OR SPIN)
HORIZONTAL OR VERTICAL ORIENTATION
ENVIRONMENTAL CONDITIONING

Space Propulsion (Liquid)

- AGENA
- JPL STORABLE PROPULSION
- STAR TECH
- XLR-132
- SKYBELT

- 20 Minutes at 110,000 Feet (Sim)
- Vertical Single Axis to 50,000lb Thrust
- LOX/Hydrazine/NTO

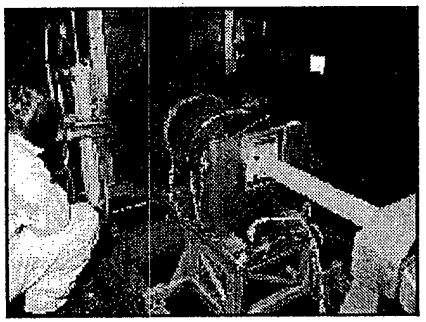
Space Propulsion (Solid)



- TRIDENT C4
- SICBM
- HAST
- PEACEKEEPER
- AIR AVG
- DELTA V

- 20 Min at 110,000 Feet (Sim)
- Horizontal Multi Axis to 60,000lb Thrust
- Fixed or Spin Capable

Space Propulsion (Solid)



- KHIT
- AIS
- VIPER
- ASAS

- To 110,000 Feet (Sim)
- Horizontal Multi Axis to 50,000lb Thrust
- Contained Exhaust

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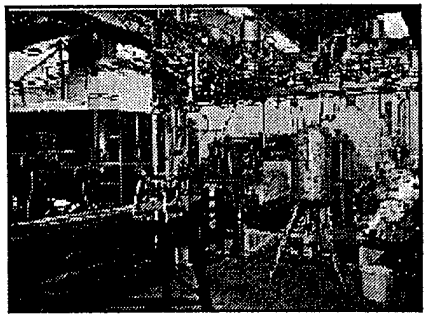
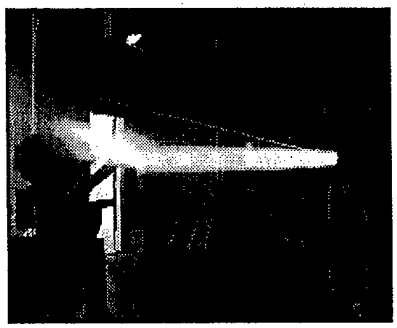
Propulsion Directorate

Flow Laboratory



- To 3,500 PSI and 16" Pipe
- 3 Isolated Water Systems
- To 32 GPM
- Flow and Mass Mixture Ratio
- Particle Sizing

Plume Studies



- SIDEWINDER
- SICBM
- SERGEANT
- VIPER

- Near IR/Visible/UV
- Horizontal or Vertical Orientation
- Temperature Mapping
- Particle Collection

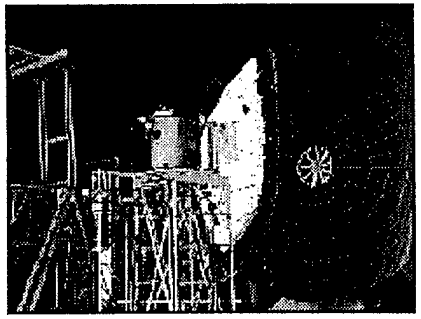
Silo

- MM

- Dual Silos
- 26 Feet Dia X 86 Feet Deep

VEHICLE FLIGHT/HOVER TESTING
REDUCED SMOKE PROPULSION STUDIES
SOLAR THRUSTER EXPERIMENTS
SATELLITE g LOAD STUDIES
TETHERED LAUNCH CAPABILITY

Solar Laboratory



- SOLAR THRUSTER

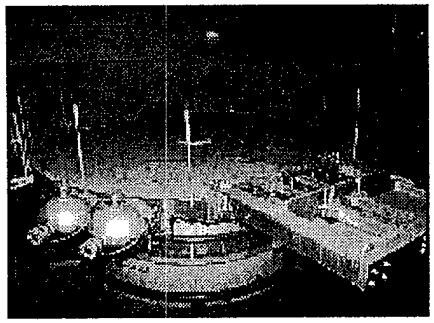
- To 5,000 F
- 24 X 32 Autotrack Heliostat
- 10,000 to 1 Concentrator
- Continuous at 0.1 PSIA

Hover Site

- KHIT
- KKV
- LEAP
- ASAT
- SCIT

- Enclosed Flight Bay (70 X 40 X 30)
- Temp Conditioned -20 to +130 F
- Static Test Stand (Pre-Flight)
- Cleanroom Integration Capability
- Optical Target 800 Meter From Bay

Centrifuge



- 2.75 RAP

- To 48 g at 21 Feet
- To 82 RPM
- To 30,000lb Test Article
- Temp Conditioned -300 to 500 F
- Humidity Conditioned to 95%

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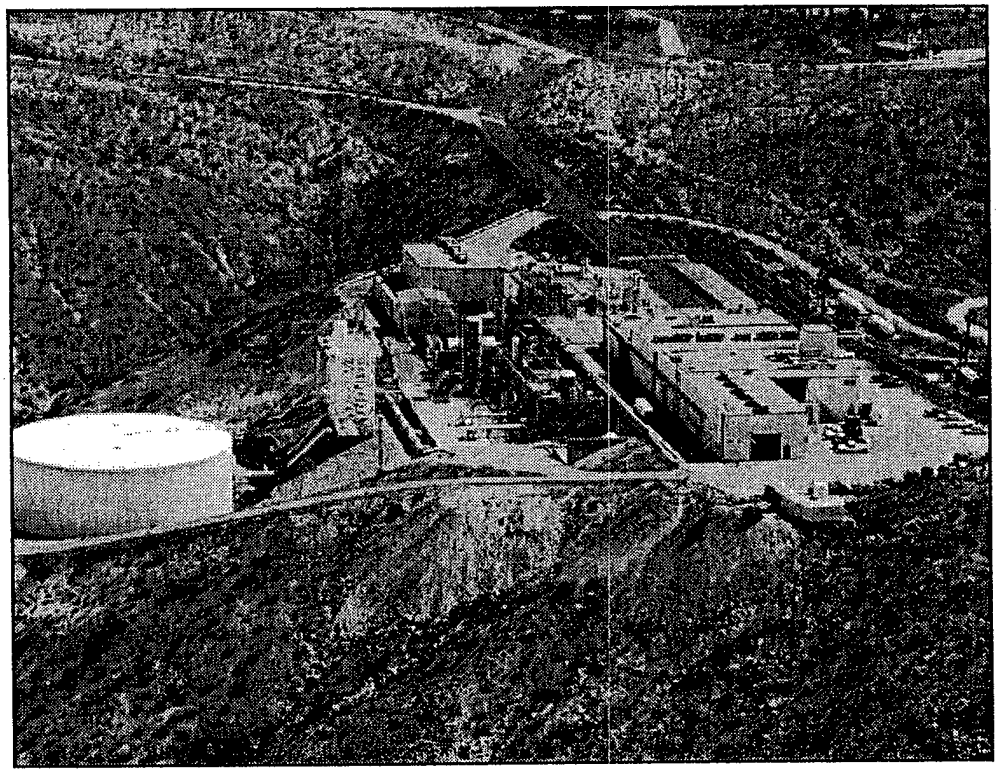
Satellite Engine Complex Area 1-14

GENERAL AREA CAPABILITIES:

- Propane-fired steam/vacuum system, up to 6 hours run time, 120 Kft simulated altitude
- Mechanical pump/diffusion system can be connected to C, D, E Chambers and Pump up to 700 Kft Simulated Altitude
- Four Data Acquisition Systems:
- 6000 psi GN2, Ample Water, LN2, LOX, GH2, Propane Tankage

CELL CAPABILITIES: (current config)

- Each Chamber / Stand Rated to 425 lb of 1.1 TNT Equivalent Liquid Propellant
- 4 Vacuum Chambers for Engine/Component Testing
  - A Cell - 1000 Lbf Thrust, 125 Kft Alt.
  - C Cell - 100 Lbf Thrust, 700 Kft Alt.
  - D Cell - No Thrust Stand, 260 Kft Alt.
  - E Cell - 300 Lbf Thrust, 260 Kft Alt.
- 3 Ambient Thrust Stands
  - A Cell - 15K Lbf Horizontal
  - B Cell - 15K Lbf Horizontal
  - D Cell - 5 Lbf HEDM Vertical



Testing History:

- Milstar Thruster
- Microcosm Low-Cost Engine
- Stoichiometric Gas Generator
- AeroAstro Low Cost Engine 1998
- X-34 Fastrack Injector 1997
- SSME Pre-Burner Injector 1997
- High Energy Density Materials Microthruster (HEDM)
- 5lb Thruster Certification
- 300lb Thruster Certification
- Atlas Vernier
- NASP 1990-91
- 100lb Thrusters Shuttle Nose Thruster
- Small Cryogenic Engine

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Satellite Engine Complex Area 1-14

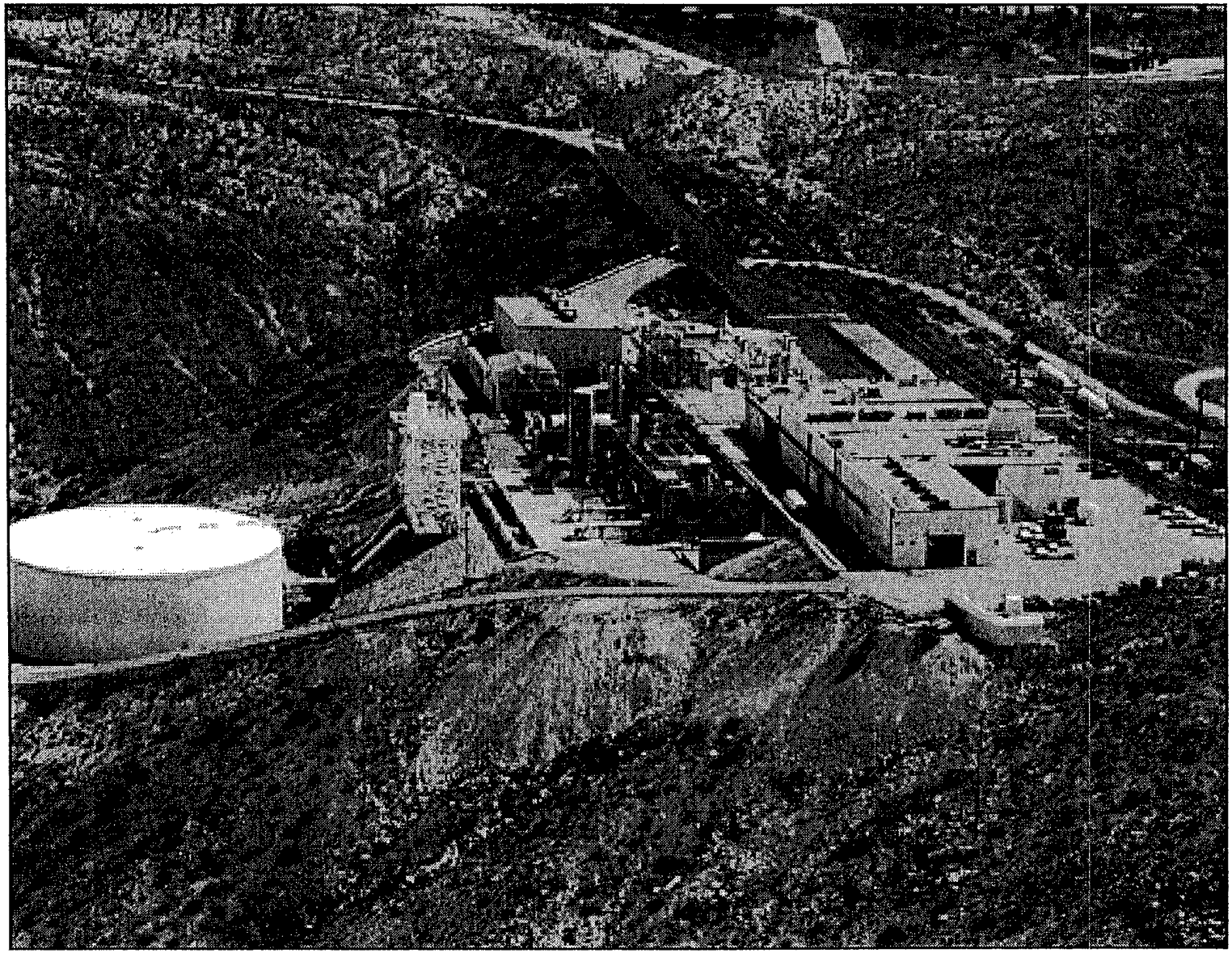
GENERAL AREA CAPABILITIES:

- Propane-fired steam/vacuum system, up to 6 hours run time, 120 Kft simulated altitude
- Mechanical pump/diffusion system can be connected to C, D, E Chambers and Pump up to 260 Kft Simulated Altitude
  - C chamber can achieve 700Kft
- Three Data Acquisition Systems
  - LABVIEW (2): 128 ch/100K Samples/Sec Throughput
  - NEFF 470: 32 Channels/10K Samples/Sec Throughput
- 6000 psi GN2, Ample Water, LN2, LOX, GH2, Propane Tankage
- Solar Laboratory
- 0 to 48 G Centrifuge
- Flow Laboratory
  - 2800 GPM @750 psi

CELL CAPABILITIES:

- Each Cell Rated to 425 lb of 1.1 TNT Equivalent Liquid Propellant
- Chamber A max thrust 5K lbf, horizontal
  - Current config - 1000 lbf thrust, 9' x 31' chamber, 120 Kft Altitude
- Chamber C max thrust 200 lbf, horizontal
  - current config - 100 lbf thrust, 7' x 12' chamber, 700 Kft Altitude
- Chamber D max thrust 5K lbf, horizontal
  - current config - No thrust stand in Chamber, 8' x 16' chamber, 260 Kft Altitude
- Chamber E maximum thrust 5K lbf, vertical
  - current config - 300 lbf thrust, 9' x 20' chamber, 260 Kft Altitude
- 3 Ambient Thrust Stands
  - A Cell - 15K lbf horizontal, thrust stand
  - B Cell - 15K lbf horizontal, thrust stand
  - D Cell - 5 lfb vertical, thrust stand

Area 1-14



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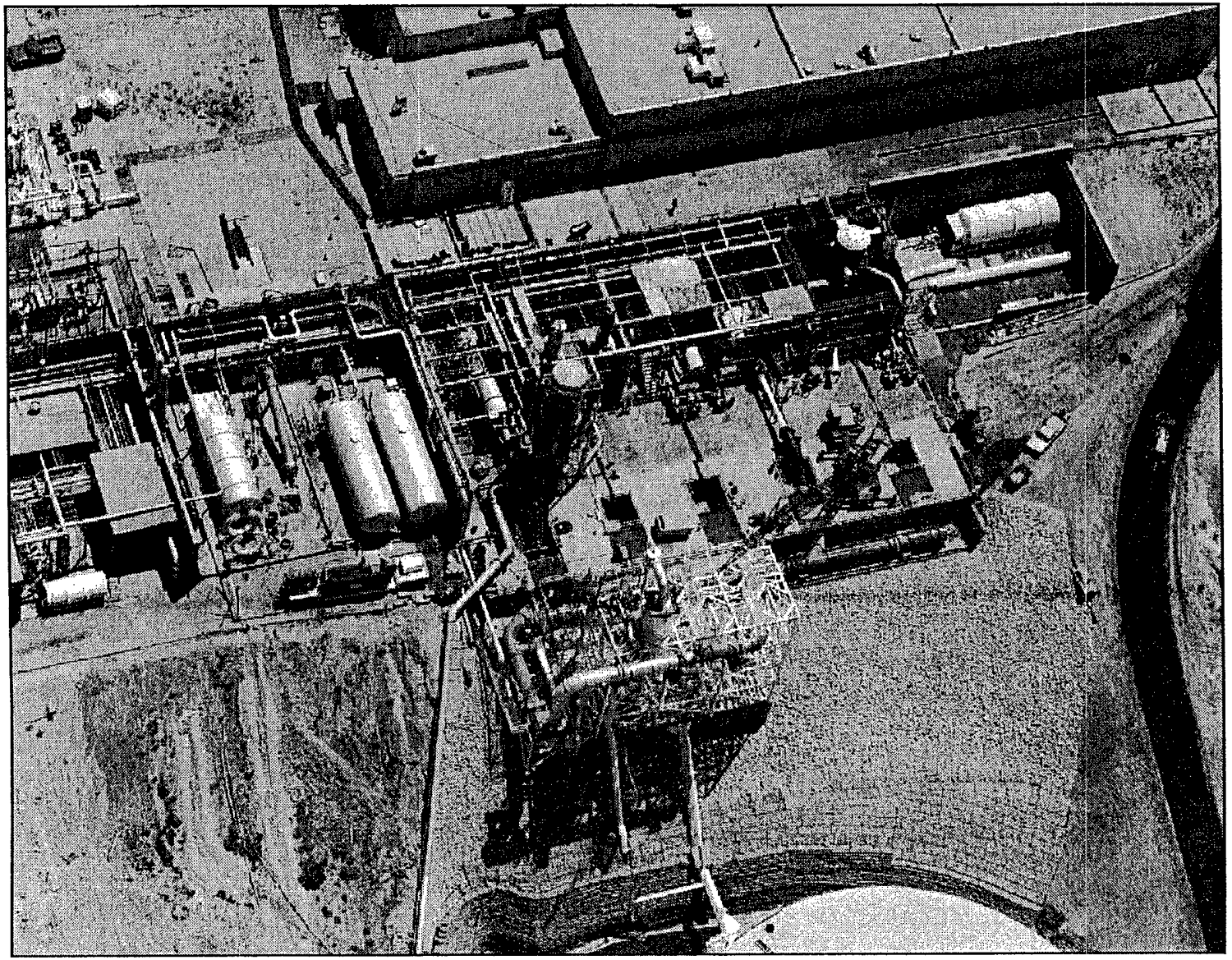
Area 1-14



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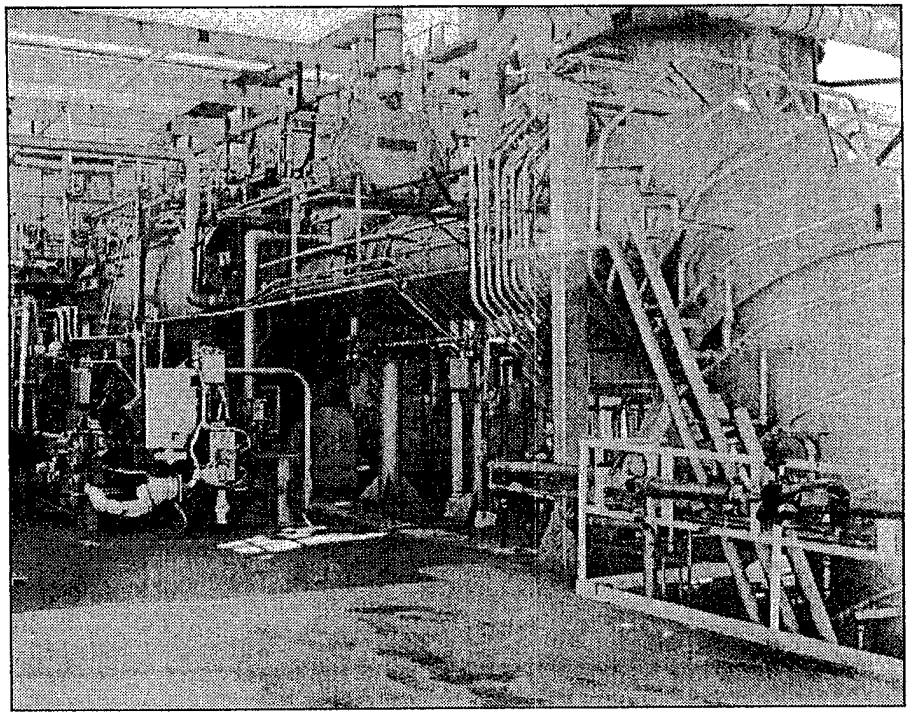
Satellite Engine Complex Test Cell A

ADDED SLIDE

CAPABILITIES:

- Ground level and altitude testing
  - Altitude simulation to 120,000 feet
  - Maximum run time; 6 hours
    - Chemical steam generator
- Maximum thrust
  - Altitude; 5,000 lbs, horizontal
  - Ground level; 15,000 lbs, horizontal
- Current thrust
  - Altitude; 1,000 lbs, horizontal
  - Ground level; 15,000 lbs, horizontal
- Cell 27 feet x 31 feet x 19 feet high
- Chamber 8.5 feet diameter x 31 feet long
- 1,000 lb overhead traveling crane
- Propellants
  - LO2; 500 gal @ 1,500 psi
  - GH2; 300 CuFt Water volume, maximum 3000 psi
- 425 lbs of TNT equivalent 1.1 class propellant



TESTING HISTORY:

- 100 lb Space Shuttle Nose Thruster 1970's
- NASP 1990 - 1991
- Stochiometeric Gas Generator 1998
- Throttling Altitude Engine 1962 - 1965
- Small Cryogenic Engine

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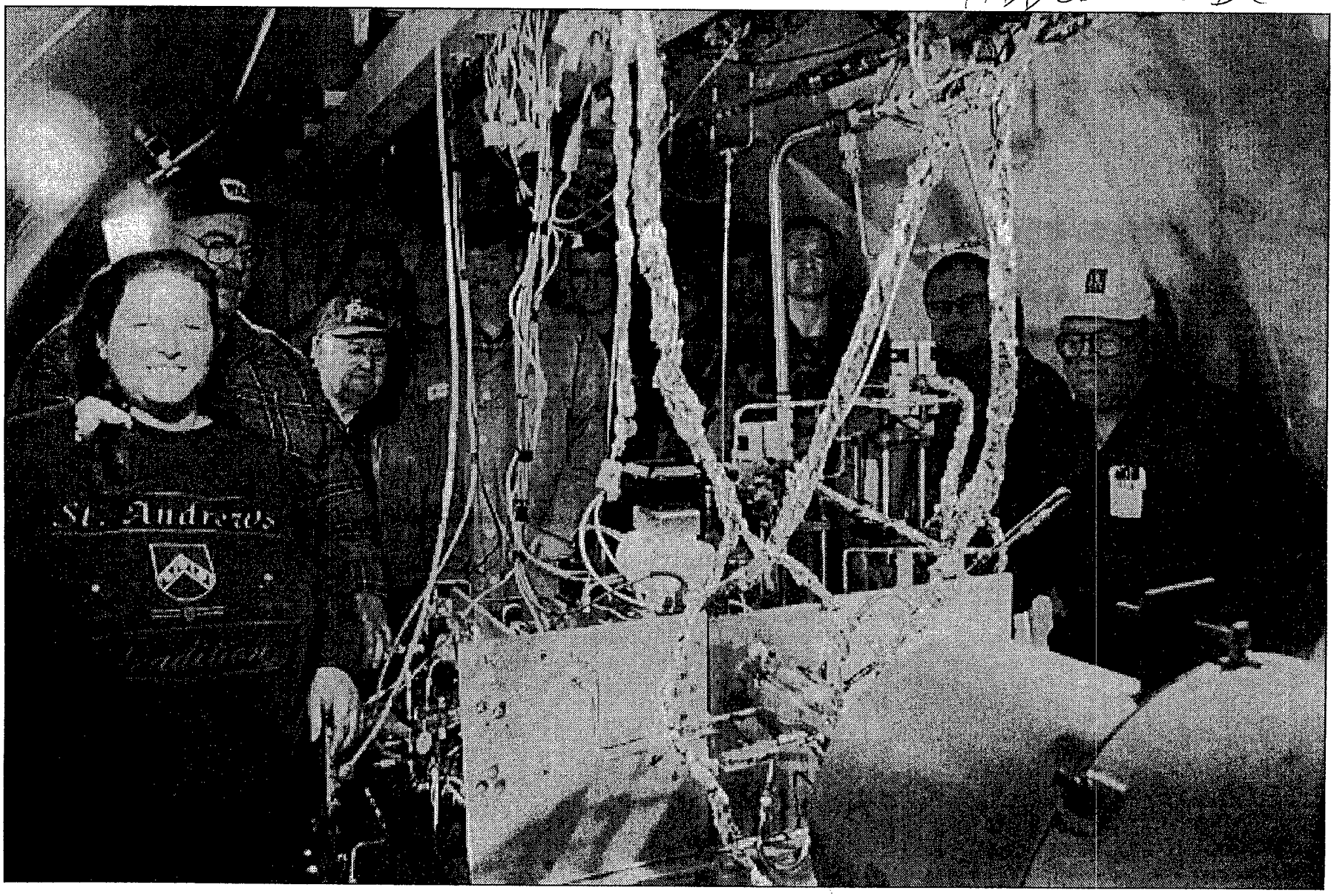
Fuel Rich Gas Generator 1-14 A Cell

ADDED SLIDE



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Satellite Engine Complex Test Cell B

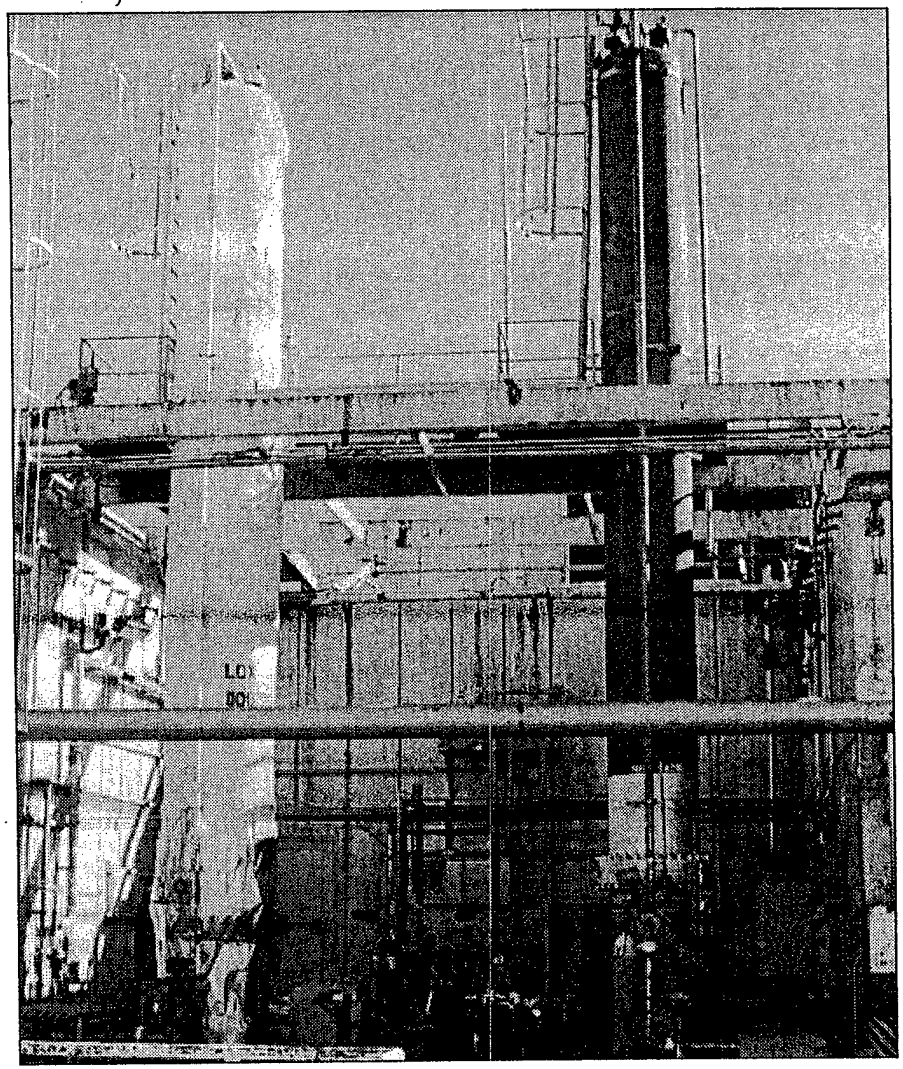
ADDED SLIDE

CAPABILITIES:

- Ground level testing
- Maximum thrust; 20,000 lbs, horizontal
  - Current configuration; 20,000 lbs, horizontal
- Cell 27 feet x 31 feet x 19 feet high
- Propellants
  - LO2; 1,400 gal @ 1,100 psi
  - RP1; 1,400 gal @ 1,100 psi
- 425 lbs of TNT equivalent 1.1 class propellant

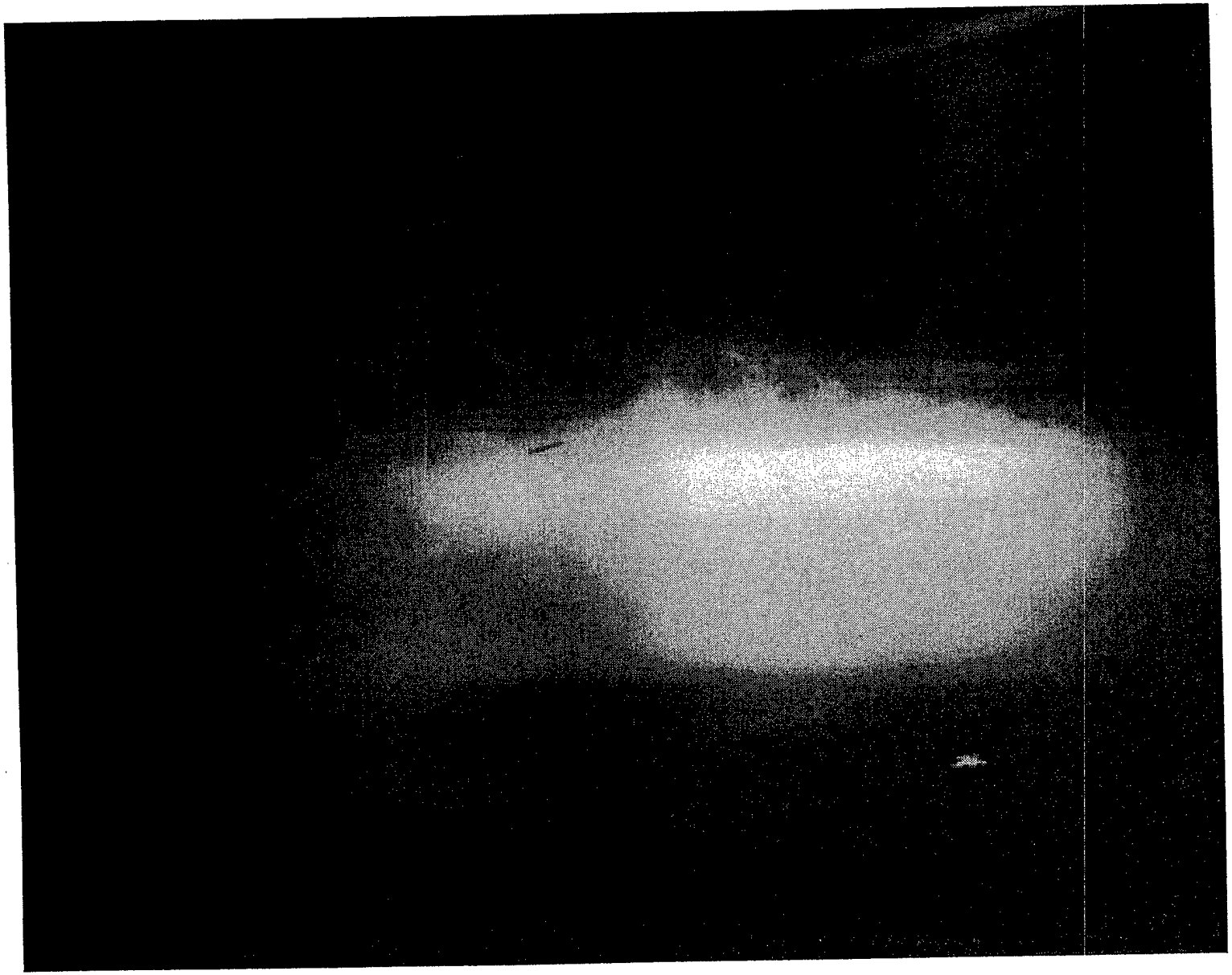
TESTING HISTORY:

- Atlas Vernier Engine 1994 - 1995
- Aero Astro Engine 1998
- Microcosm Low-Cost Engine
- High Energy Density Materials Microthruster (HEDM)



AeroAstro, 1 Mar 95
1-14 B Cell

ADDED SLIDE



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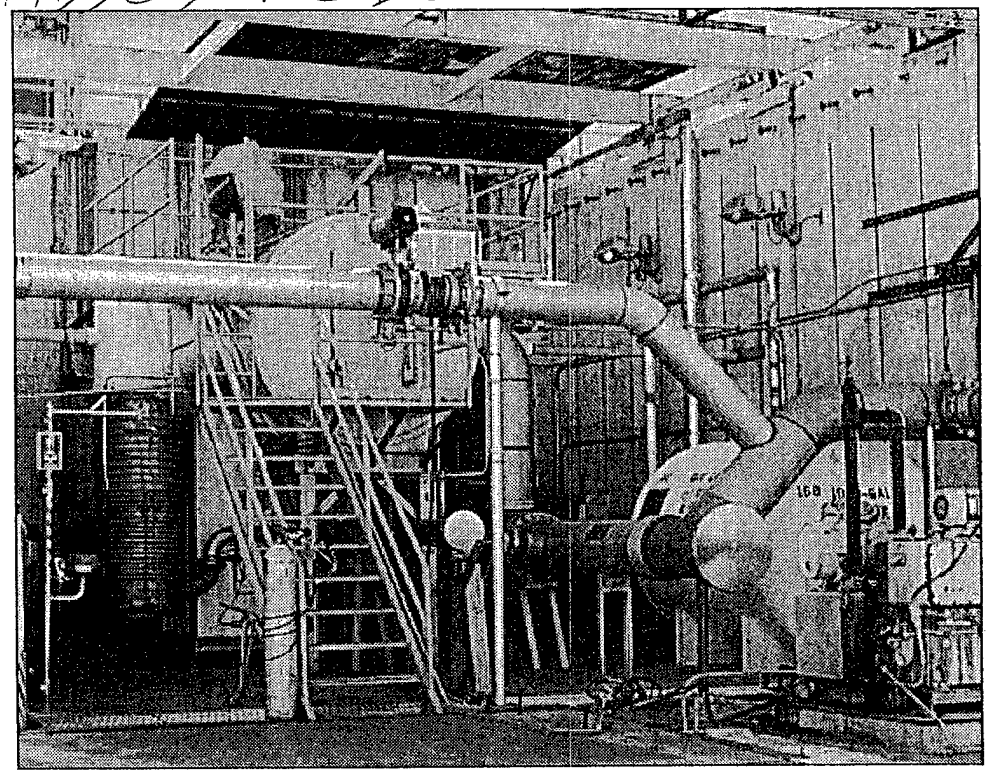
Satellite Engine Complex Test Cell C

ADDED SLIDE



CAPABILITIES:

- Altitude testing
  - Altitude simulation to 700,000 feet
  - Mechanical and diffusion pumps
- Maximum thrust; 200 lbs, horizontal
  - Current Configuration; 2 Each 10 lb thrust stands
- Cell 27 feet x 31 feet x 19 feet high
- Chamber 12 feet diameter x 7 feet long
- Propellants
- N2H4; 6 tanks, 40 gal @ 1,350 psi
- LN2; 1 tank, 1000 gal @ 125 psi
- 425 lbs of TNT equivalent 1.1 class propellant

TESTING HISTORY:

- MILSTAR 5 lb Thruster Certification, early 80's
- Teflon pulsed plasma thruster, 1970's

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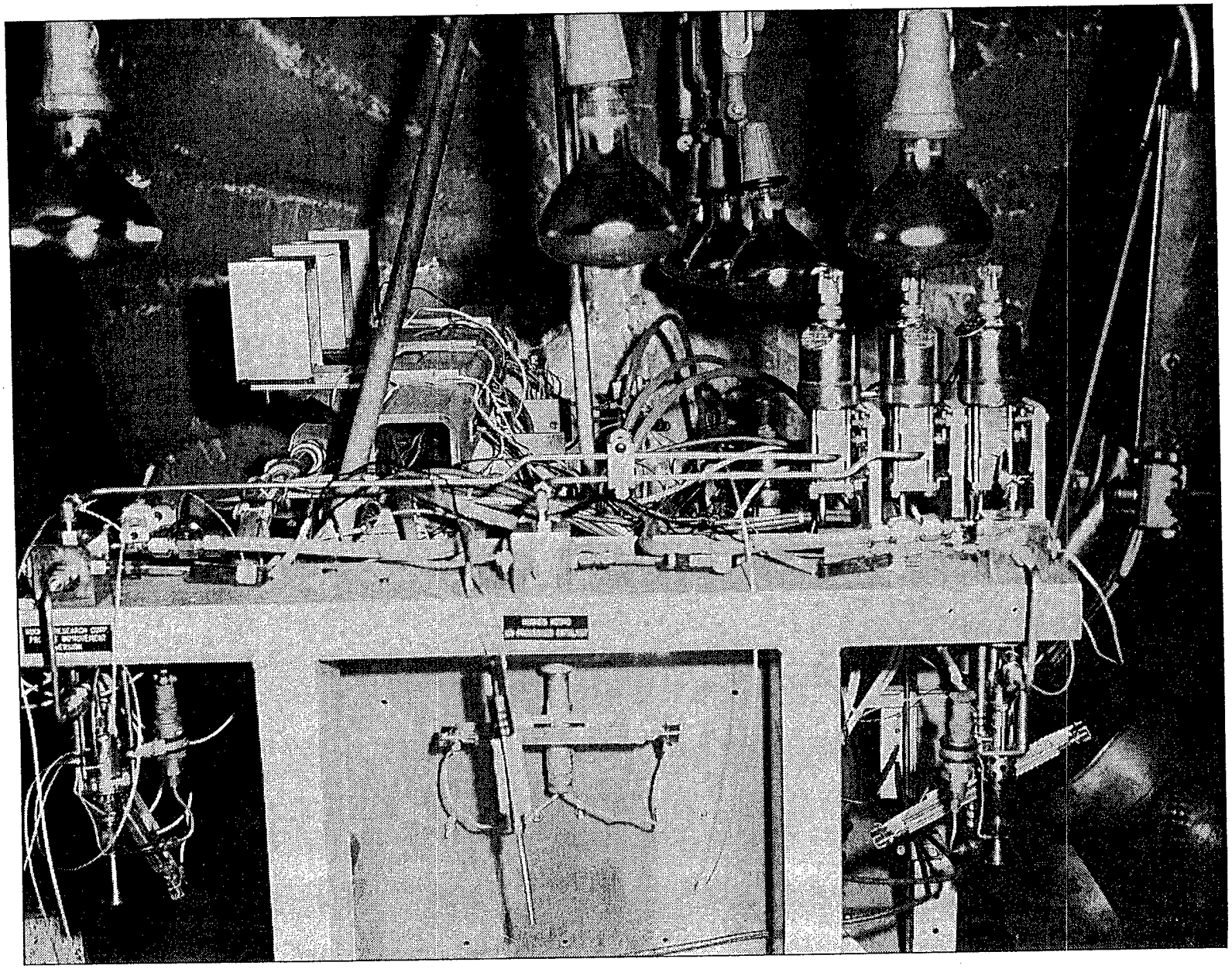
5 lb Thruster "Life Test" 1-14 C Cell

ADDED SLIDE



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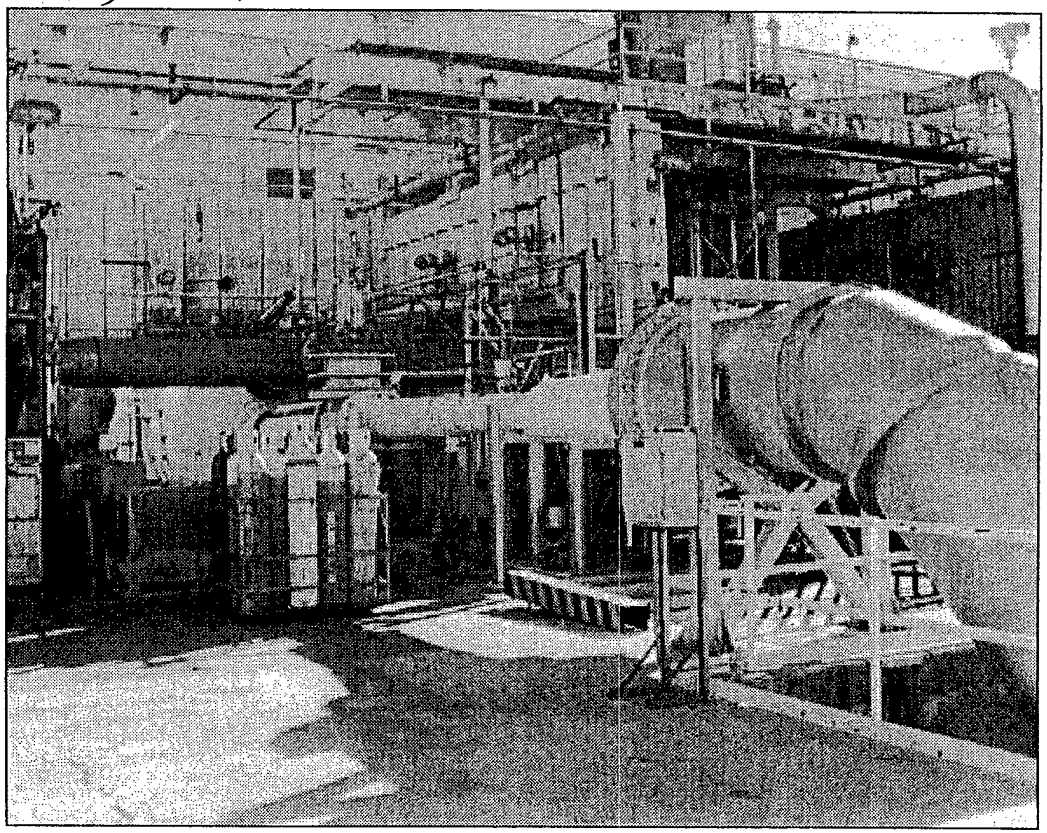
Satellite Engine Complex Test Cell D

ADDED SLIDE



CAPABILITIES:

- Altitude Testing
  - Altitude simulation to 260,000 feet
  - Mechanical and diffusion Pumps
- Maximum thrust; 1,000 lbs, horizontal
  - Current configuration; no thrust
- Cell 27 feet x 31 feet x 19 feet high
- Chamber 8 feet diameter x 16 feet long
- Propellants
  - N_2O_4; 2 tanks, 75 gal @ 1,400 psi, 2,000 psi
  - N_2H_4; 2 tanks, 75 gal @ 1,500 psi
    - Glycol Conditioning -24F To +155F
  - LN_2; 2 tanks, 1,000 gal @ 125 psi
- 425 lbs of TNT equivalent 1.1 class propellant

TESTING HISTORY:

- 300 lb Hydrazine Thruster Certification
- High Energy Density Materials (HEDM) 1991 - 1992
- Milstar Pulsiong Bipropellant Engine, early 90's

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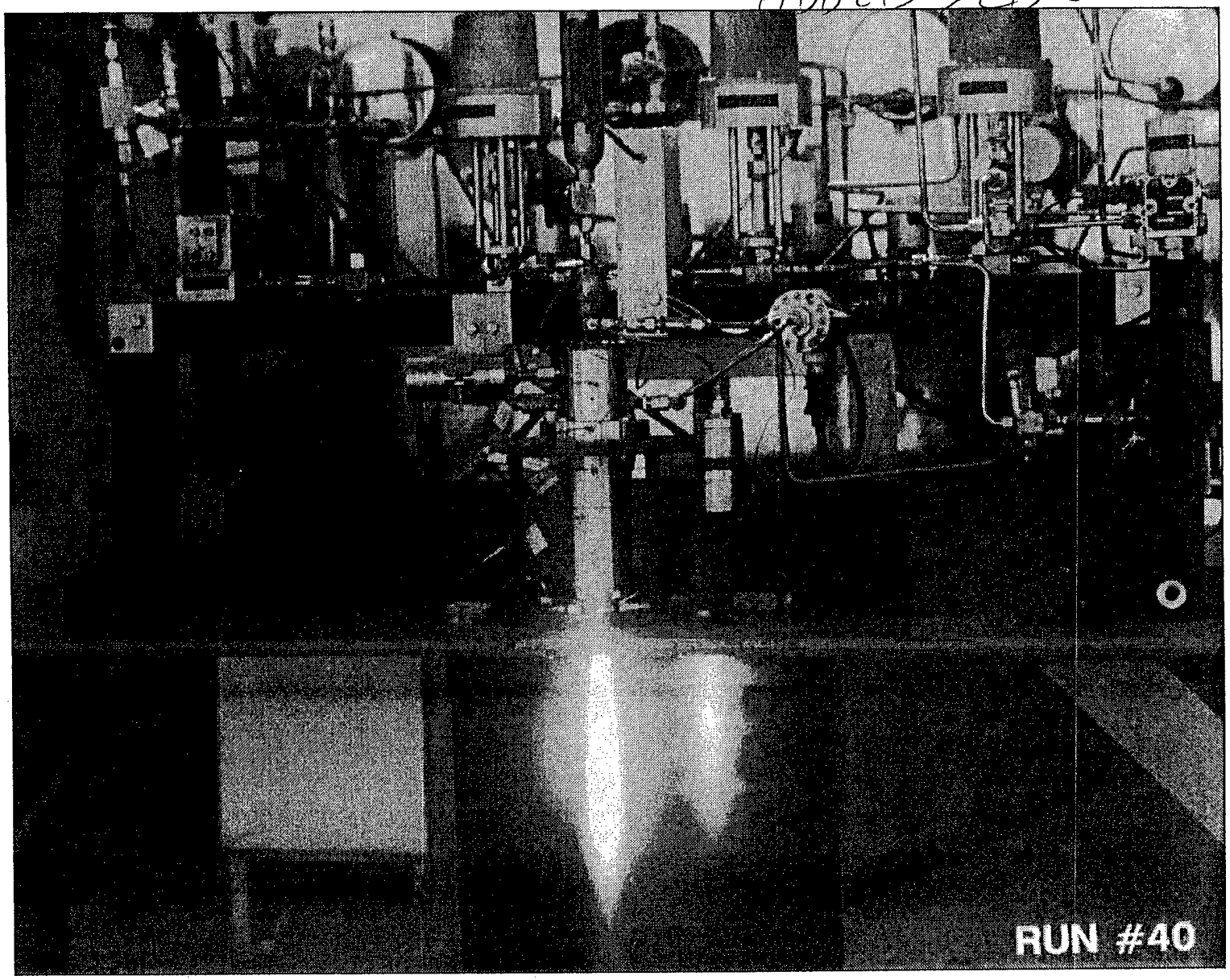
High Energy Density Materials (HEDM) 1-14 D Cell

ADDED SLIDE



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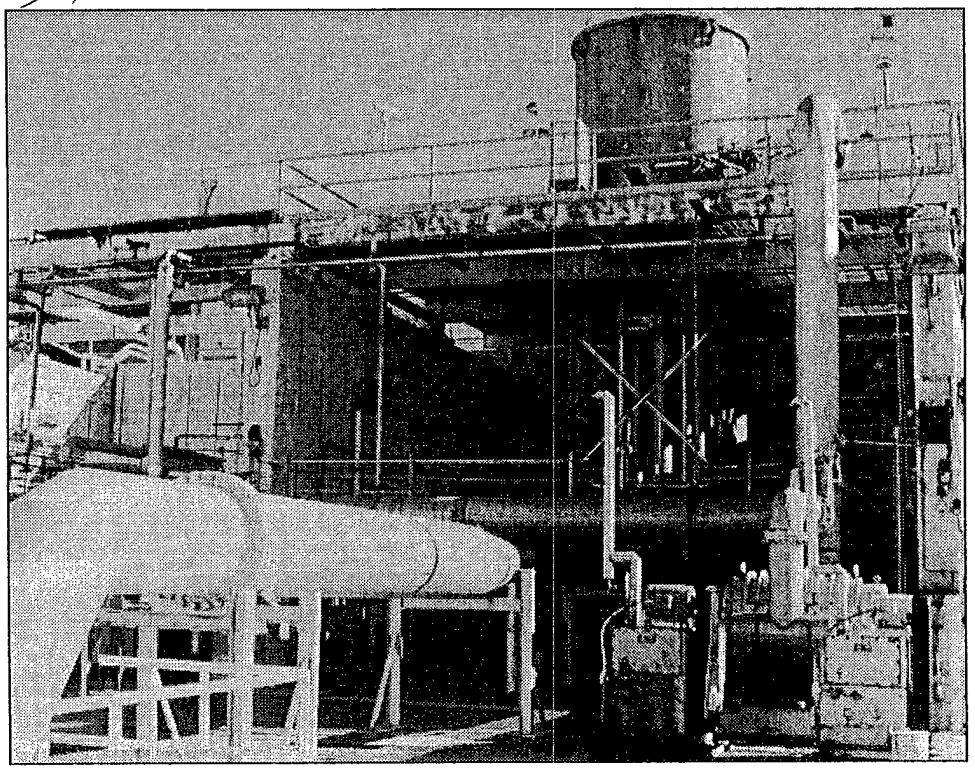
Satellite Engine Complex Test Cell E

ADDED SLIDE

CAPABILITIES:

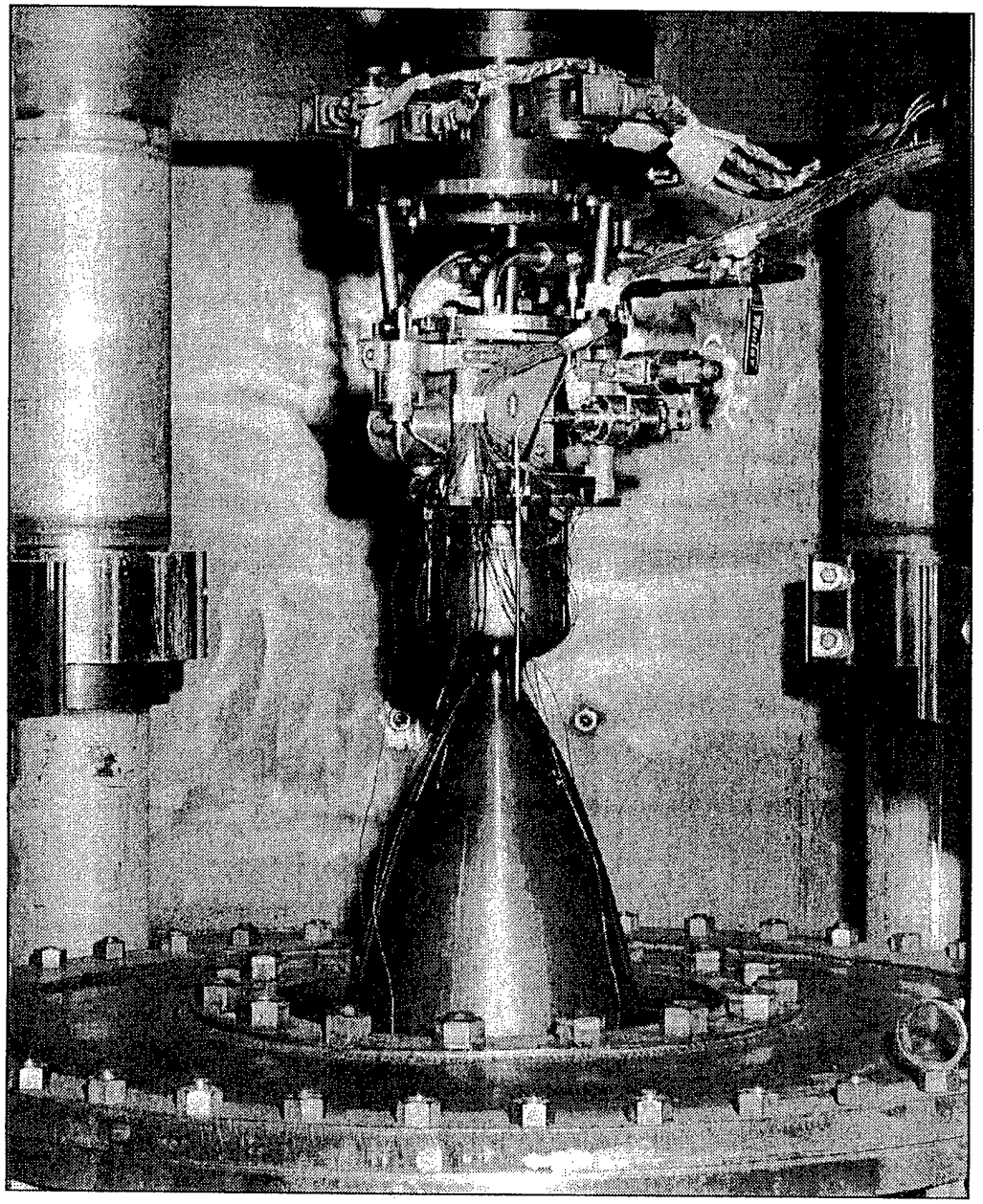
- Altitude testing
  - Altitude simulation to 260,000 feet
  - Mechanical and diffusion pumps
- Maximum thrust; 5,000 lbs, vertical
  - Current configuration; 300 lbs, vertical
- Cell 27 feet x 31 feet x 19 feet high
- Chamber 9 feet diameter x 20 feet long
- Propellants; shared with D cell
  - N_2O_4; 2 tanks, 75 gal @ 1,400 psi, 2,000 psi
  - N_2H_4; 2 tanks, 75 gal @ 1,500 psi
    - Glycol Conditioning -24F To +155F
  - LN_2; 2 tanks, 1,000 gal @ 125 psi
- 425 lbs of TNT equivalent 1.1 class propellant



TESTING HISTORY:

- **300 lb Hydrazine Thruster Certification**

300 lb Thrust N_2H_4 Orbit Adjust Engine



ADDED SLIDE

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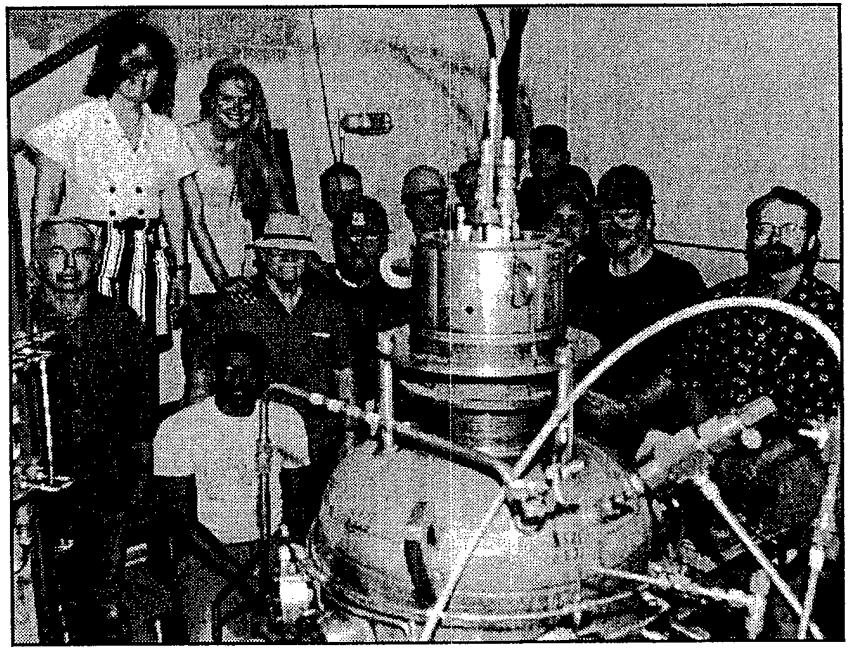
Flow Laboratory Area 1-14

CAPABILITIES:

- Multi-element injector to 1100 psi and 2800 gpm
- Single element Injector to 2000 psi and 32 gpm
  - Modern optical design
  - Flow visualization
  - Flexible changeout
  - Mass patternization
  - Simulation for liquid
- Flow checkout facility
- Modern optical diagnostics
- Flow visualization
- Flexible change-out capability to accommodate different kinds of injectors
- Mass patternization via 27 element transversable linear array
- Simulation of liquid rocket engine manifold cross flow effects
- Flow checkout facility to verify injector design prior to hot firing



PAST TESTING:

- XLR-132 Injector
- Microcosm Injector

FUTURE TESTING:

- Integrated Powerhead Pre-Burner Injector
- Rocketdyne Hybrid Injector
- Pac-Astro Injector
- Arcjet Platelet Injector
- X-34 Fastrack Injector 1997
- SSME Pre-Burner Injector 1997

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Flow Laboratory,Area 1-14 High Pressure Injector Characterization Chamber Facility

GENERAL AREA CAPABILITIES:

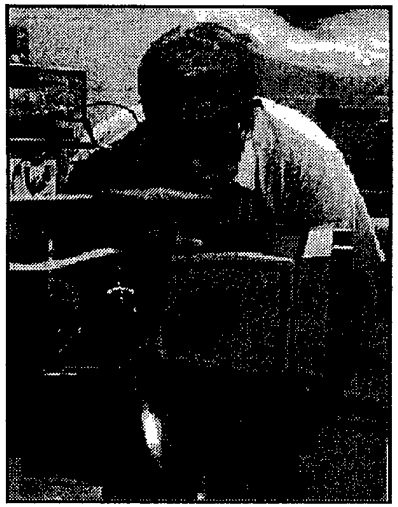
- Unique facility provides full scale, single element windowed cold flow Injector test capability up to 2000 psi
- Injector change-out capability to test most injector geometrys
- Simulate engine injector manifold cross flow effects
- Drop size and velocity measurement capability

LAB CAPABILITIES:

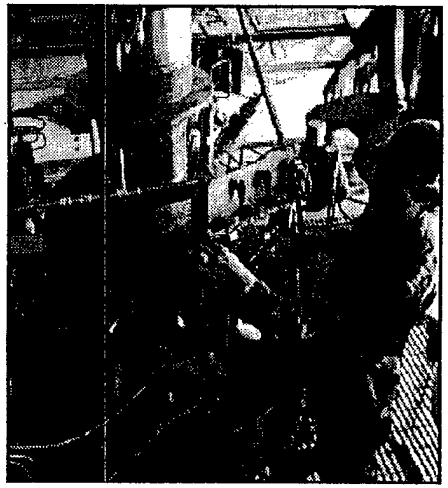
- 2000 psi, 10 ft3 chamber
- Liquid flow rates to 32 gpm
- Modern optical diagnostics
  - Malvern line-of-sight fraunhoffer diffraction instrument
  - Aerometrics phase doppler particle analyzer
  - Coaxial beam particle analyzer
  - Greefield imaging particle analyzer
- Flow visualization
- Spray mass distribution measurements with 27 element traversable array

High Pressure Injector Characterization Chamber
Injector Design Methodology

LASER DROPLET DIAGNOSTICS

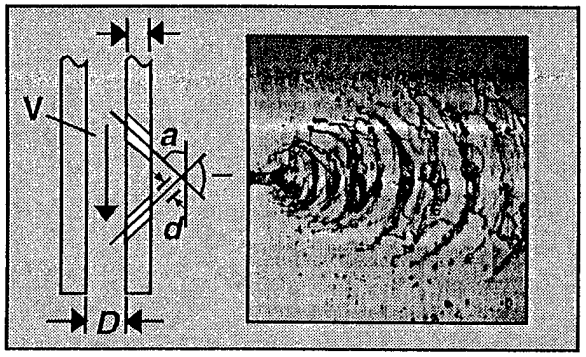


2000 psi PRESSURE VESSEL



GOALS

- Cost Effective Evaluation of Injector Designs
- Characterize the Effects of Injector Design Features on Performance and Stability



TYPICAL IMPINGING INJECTOR SPRAY

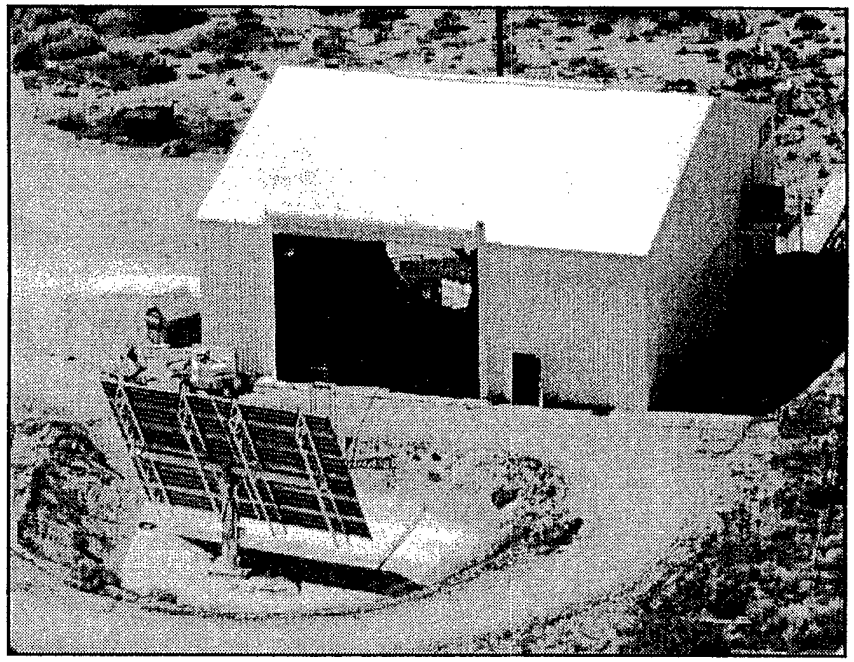
ACCOMPLISHMENTS

- In-House Testing 2000 PSI
- Atomization and Mixing Capabilities
- State of the Art Laser Measurements
- Manifold and Orifice Hydraulics

Solar Laboratory Area 1-14

CAPABILITIES:

- 10,000 : 1 Concentrator
- 32'x 2' sun tracking heliostat
- 25 kilowatt concentrator, up to 5800 degrees fahrenheit
- 2.5 gram/sec hydrogen or 5 gram/sec helium propellant flow rates
- 1lb thruster stand
- 30" x 30" chamber
- 750 Kft altitude
- 32 Channel, 10kHz, NEFF 470 data acquisition system
- 6000 psi GN2



TESTING HISTORY:

- Black Body Cavity Receivers with Secondary Concentrators Attached
- Porous Disk Test Bed
- Solar Bi-Modal Cavity Receiver
- Video Flux Mapper, Water Filled Calorimeter
- Rhenium Tube Cavity Thruster
- Reticulated Vitreous Carbon Calorimeter

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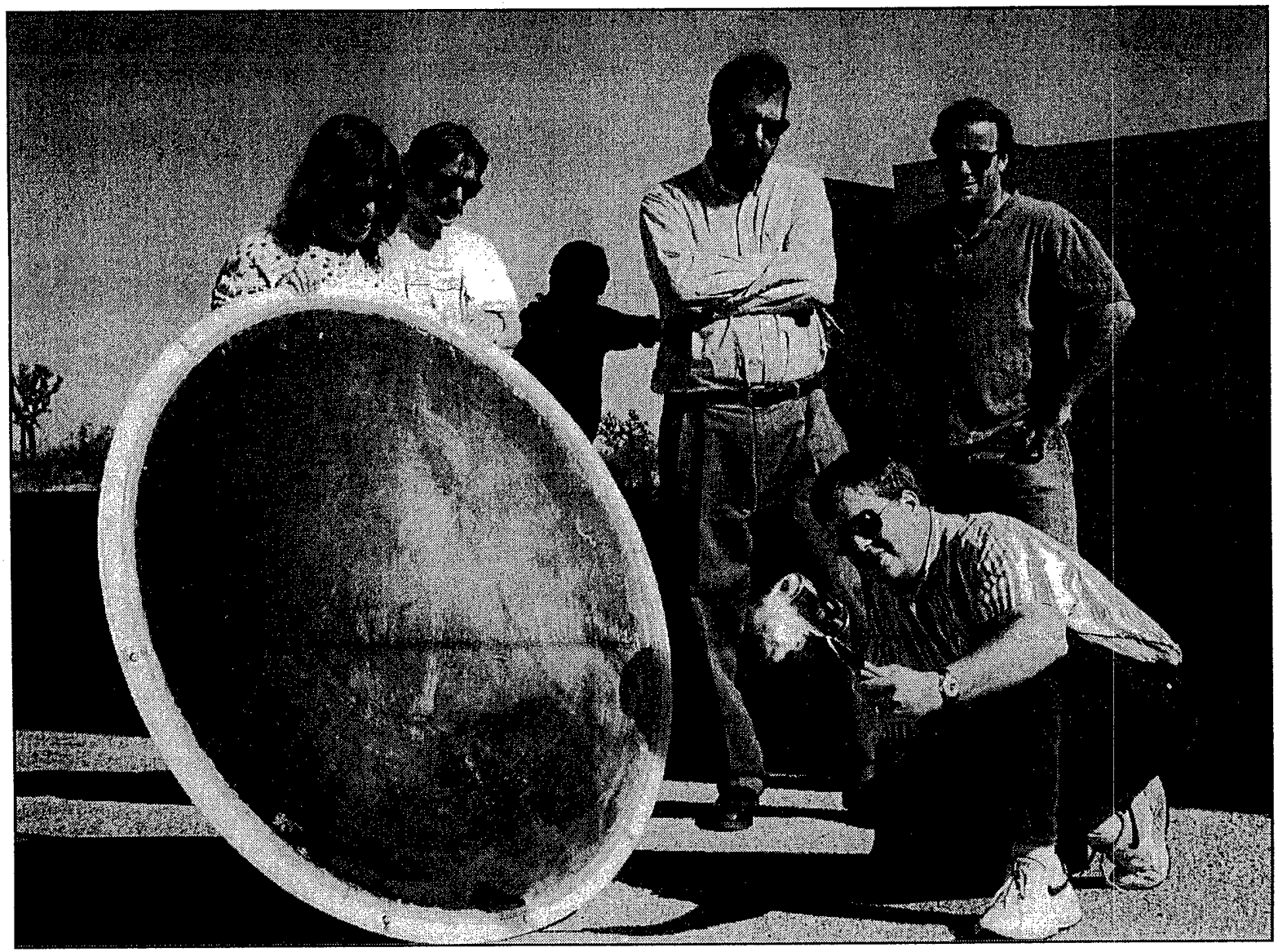
Rigidized Concentrators

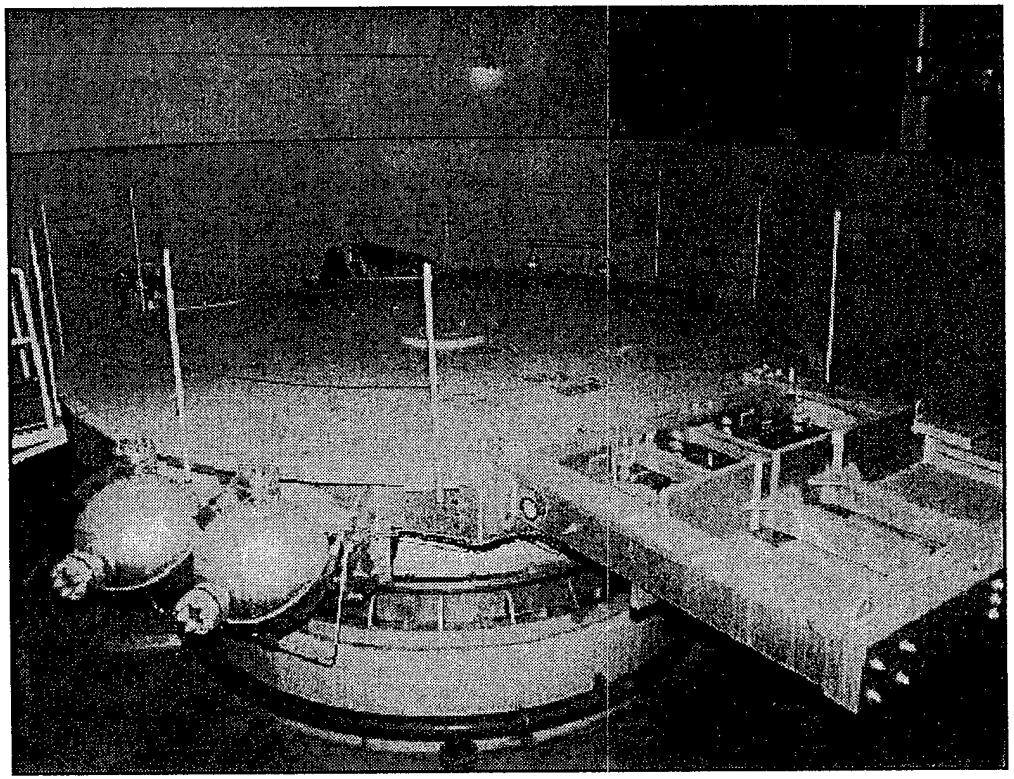


1.2 meter Rigidized

Centrifuge Facility Area 1-14

CENTRIFUGE CAPABILITIES:

- Maximum G range
  - 0 to 30 g at 13 foot radius
  - 0 to 48 g at 21 foot radius
- 0 to 82 RPM
- Acceleration to 30 g in 5 minutes
- 60,000 lb total capability
- Environmental capability
  - (-300 to +500 degree F)
  - 0 to 95 percent humidity



TESTING HISTORY:

- Solar Parabolic Dish
- 2.75 mm Rocket Assisted Projectile (RAP)

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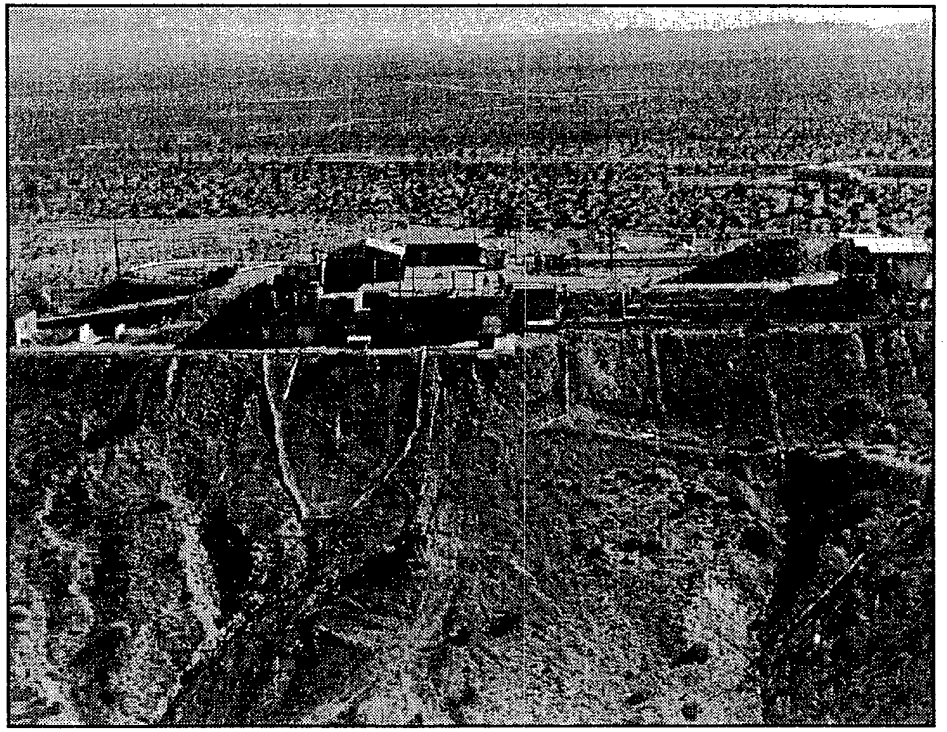
Solid Propellant Preparation Cutting and Aging Facility, Area 1-21

GENERAL AREA CAPABILITIES:

- Originally designed to test liquid rocket engines for research aircraft (X-15, X-1, X-2)
- 6,000 psi GN2 cross country line
- 14 inch water main
- 440 VAC facility power
- Mechanical shop with 2 ton crane

CELL CAPABILITIES: (current config)

- Cell 1 - 425 lbs. of 1.1 solid propellant
  - Prepare tensile test specimens
- Cell 2 - 100 lbs. of 1.1 solid propellant
  - Rough cutting large pieces of propellant
- Cell 3 - 50 lbs. of 1.1 solid propellant
  - Explosion resistant window
- Cell 4 - Office / control room for Cells 1, 2, and 3
- Cell 5 - 75 lbs. of 1.1 solid propellant
  - Initial weighing, measuring, and trimming
  - Fragmentation testing
- Cell 6 - Control room for cells 5 and 7
- Cell 7 - 425 lbs. of 1.1 solid propellant
  - 4 environmental aging chambers
- Cell 8 - 20 lbs. of 1.1 solid propellant
- Cell 12 - 100 lbs. of 1.1 solid propellant
  - Environmental propellant storage



TESTING HISTORY

- Project Showboat
- Solid propellant Aging
- Ignition Delay
- Charged Nozzle

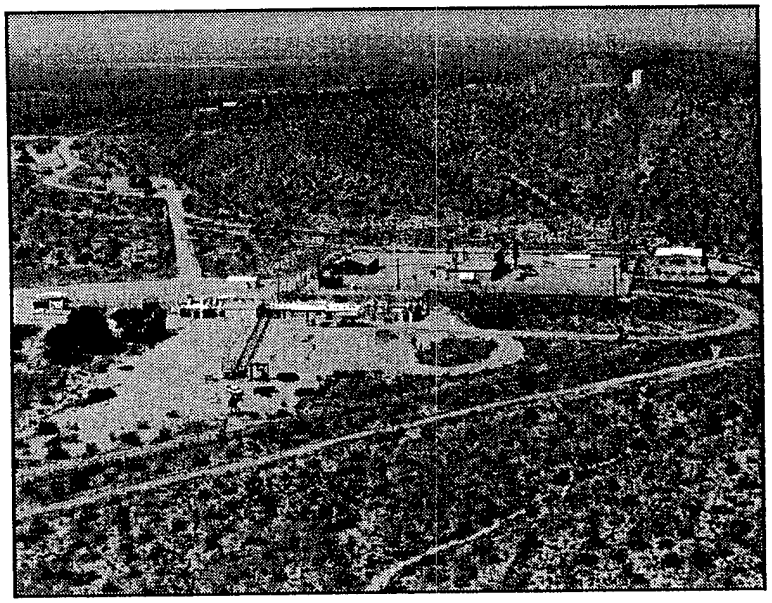
Solid Propellant Laboratory Complex Area 1-30

GENERAL AREA CAPABILITIES:

- Designed to formulate, mix, cast, cure and study, high energy propellants
- Environmental conditioning
- 6,000 psi GN2 cross country line
- 6 Inch water main
  - 50,000 gallon water storage
- 440 VAC and 28 VDC stand power
- Data acquisition and control system
- Over 30 mechanical shop buildings, preparation cells, and test stands

COMPLEX CAPABILITIES: (current configuration)

- Propellant storage bunkers, 10 each
  - Maximum 5,000 lb of 1.1 propellant
- Propellant aging cells, 12 each
  - Heat and humidity controlled
- Propellant processing cells, 11 each
  - Processing propellants, binders, and placticizers
  - Maximum of 100 lb of 1.1 propellant per cell
- Propellant evaluation facility,
  - Tensile testing
  - Strand burning
- Propellant test stands and cells



TESTING HISTORY:

- Microwave Burner 1986 - 1987
- Combustion Stability 1983 - 1987
- Sidewinder Reduced Smoke
- Maverick Reduced Smoke
- 40mm RAP 1972
- 30mm RAP 1974
- PeaceKeeper Stage I 1976
- PeaceKeeper Stage II 1976
- PeaceKeeper Stage II Failure Study 1982
- PeaceKeeper Stage III Failure Study 1985
- HMX Studies (Hardened structure Munitions) 1974
- Rotating Valve 1981
- 20mm RAP 1973
- Titan Failure Study 1986

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Solid Propellant Laboratory Complex Area 1-30

GENERAL AREA CAPABILITIES:

- Designed to formulate, mix, cast, cure and study, high energy propellants
- Environmental conditioning
- 6,000 psi GN2 cross country line
- 6 Inch water main
  - 50,000 gallon water storage
- 440 VAC and 28 VDC stand power
- Data acquisition and control system
- Over 30 mechanical shop buildings, preparation cells, and test stands

COMPLEX CAPABILITIES:

- Propellant storage bunkers, 10 each
  - Earth covered bunker
  - Above ground bunker
  - Maximum 5,000 lb of 1.1 propellant
- Propellant aging cells, 8 each
  - Heat and humidity controlled
  - From (-65 to +500) degrees F
- Propellant processing cells, 11 each
  - Processing propellants, binders, and placticizers
  - Speed and temperature controlled mixers
  - Blast proof windows or remote television monitors
  - Maximum of 100 lb of 1.1 propellant per cell
    - Some limited to 25 lb

COMPLEX CAPABILITIES (continued):

- Propellant evaluation facility
  - Tensile, friction, and drop weight testing
  - Rheometrics mechanical and stress spectrometers
  - Strand burning
- Propellant test stands and cells
  - Test cell 25
    - Pulling and twisting tensile tester
  - Test cell 26
    - Combustion bomb window
  - Test cell 27
    - 60,000 volt electrostatic discharge testing
  - Test stand 34
    - Fluid energy mill
  - Test stand 44
    - Propellant burn sensitivity

TESTING HISTORY:

- 20, 30, 40mm RAP 1972-1974
- Maverick
- Rotating Valve 1981
- Combustion Laser
- HMX Studies (Hardened Structure Munitions) 1974
- Sidewinder
- Rotating Valve
- PeaceKeeper 1976-1985
- Titan

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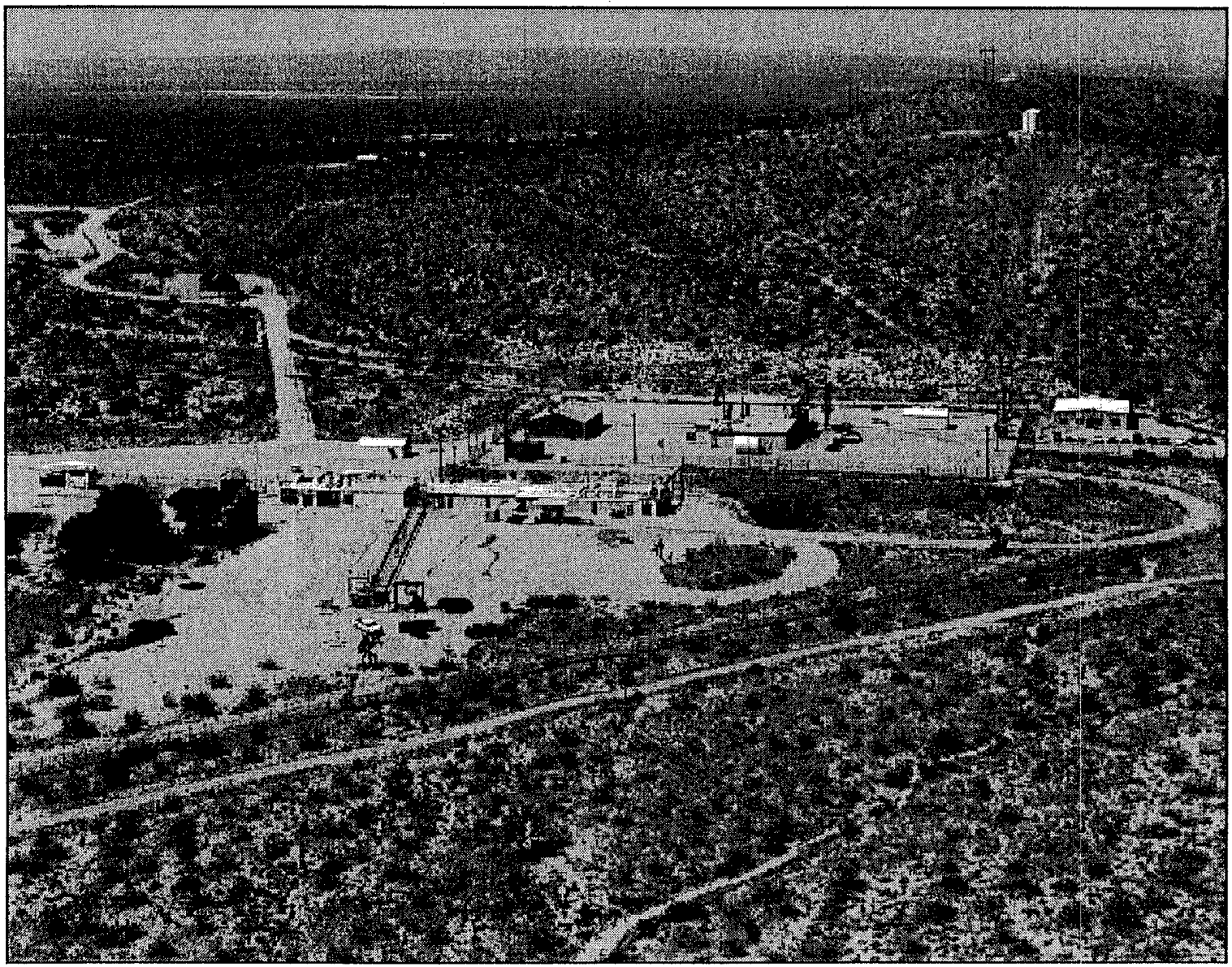
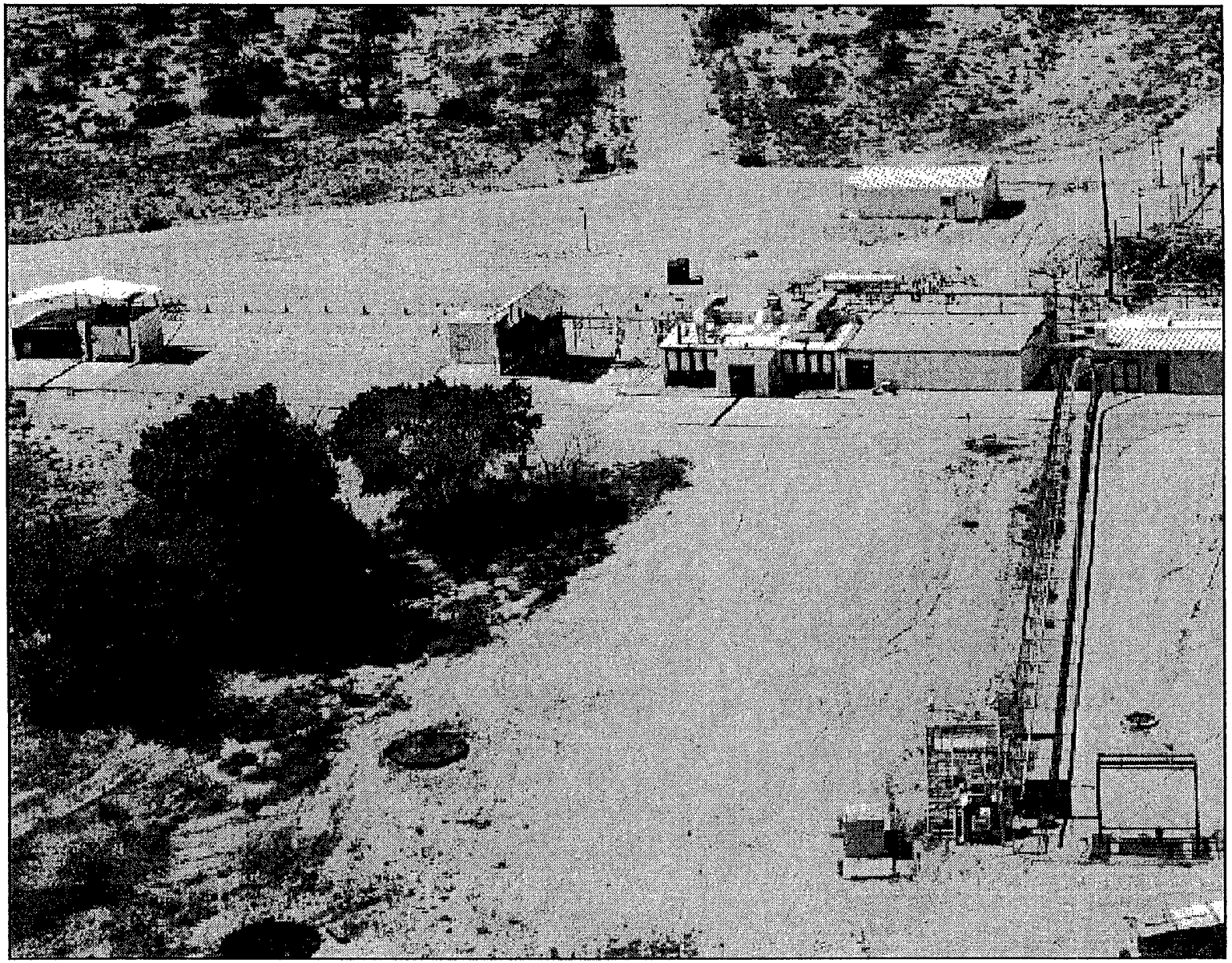
Solid Propellant Laboratory Complex Area 1-30



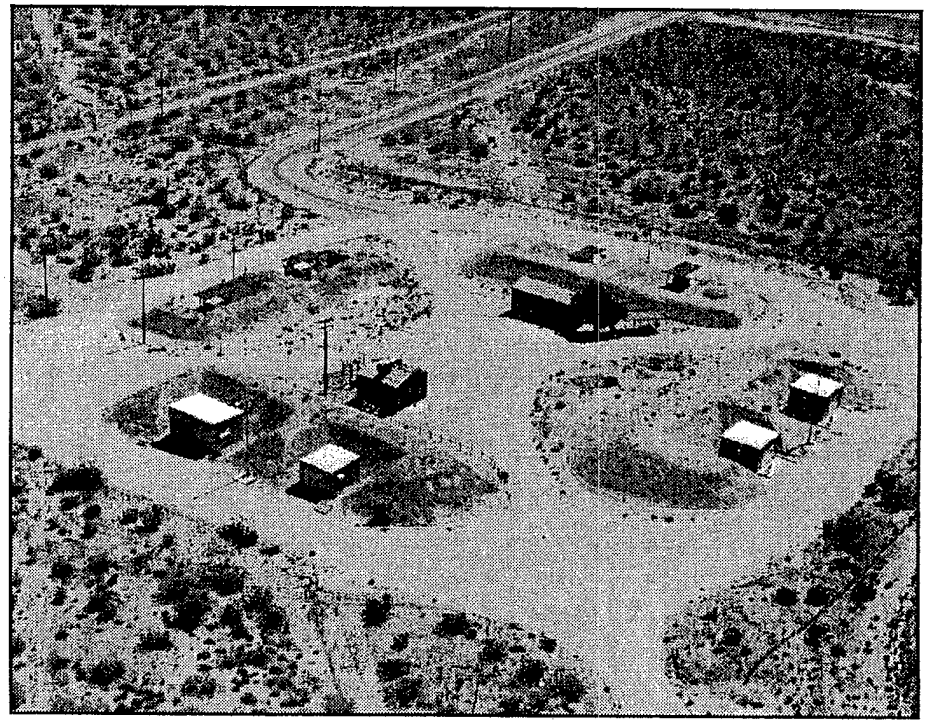
Solid Propellant Laboratory Complex Area 1-30



Propellant Aging Cells Area 1-30

CELL CAPABILITIES:

- Ground level environmental aging, 12 cells
  - Each cell is approximately 64 cubic feet
  - Temperature control From -65 to +500 degrees F.
  - Humidity control
- 2,400 lb of 1.1 TNT equivalent propellant total for 12 cells
- Remote environmental conditioning system
  - Data acquisition and health monitoring



TESTING HISTORY:

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DOCUMENT

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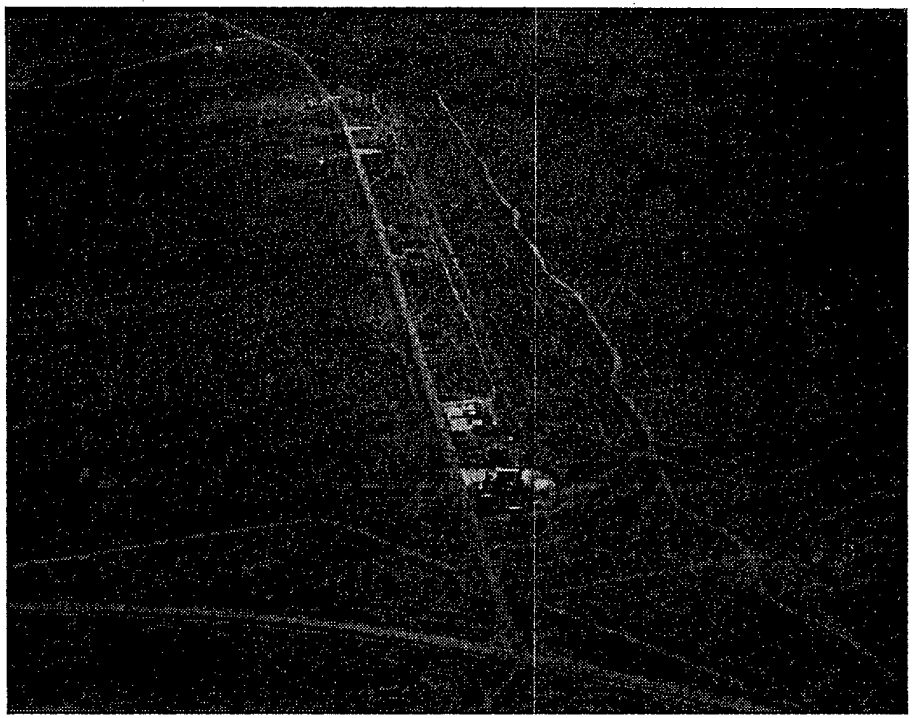
Motor Component Complex Area 1-32

GENERAL AREA CAPABILITIES:

- Plume diagnostics analysis system
- High hazard motor / propellant testing
- Hydrogen injector system
- Environmental conditioning
- 5,000 psi GN2 cross country line
- 6 inch water main
- 440 VAC and 28 VDC stand power
- Data acquisition and control system
- Mechanical shop with 2 ton crane
- Receiving and inspection station
  - — 50 ton crane
  - — Environmental conditioning



STAND CAPABILITIES: (current config)

- Pad 1 - 250,000 Lbf thrust, horizontal
- Pad 2 - 150,000 Lbf thrust, horizontal
- Pad 3 - 10,000 Lbf thrust, horizontal
- Pad 5A / 5B / 5C - 36,000 Lbf thrust, horizontal

TESTING HISTORY:

- Sidewinder
- Minuteman
- Sparrow
- Shuttle
- PeaceKeeper
- HIPPO
- Small ICBM
- Taurus
- Titan
- Hydrogen Augmented Solid Rockets
- Ammonium Perchlorate

Motor Component Complex Area 1-32

GENERAL AREA CAPABILITIES:

- 6,000 psi GN2 cross country line
- 6 inch water main
- 440 VAC and 28 VDC stand power
- Data acquisition systems
  - LabView; 64 channels, 100,000 samples/sec
- Control systems
  - Allen-Bradley; programmable logic controller
- Mechanical shop with 2 ton crane
- Receiving and inspection station
  - —50 ton crane
  - —Environmental conditioning

TEST STAND CAPABILITIES:

- Ground level testing
- Environmental conditioning
- Horizontal or vertical orientation

PAD 1 - maximum thrust 1M lbf.

- (Current configuration) 250,000 lbf. thrust
- 10 ton overhead crane, 7,000 lb of 1.1 or 50K of 1.3 solid propellant

PAD 2 - maximum thrust 1M lbf.

- (Current configuration) 150,000 lbf. thrust
- 15 ton overhead crane, 7,000 lb of 1.1 or 50K of 1.3 solid propellant

TEST STAND CAPABILITIES:

PAD 3 - maximum thrust 60,000 lbf.

- (Current configuration) no thrust,1,000 lb of 1.1 or 5K of 1.3 solid propellant
- High hazard motor / propellant / gun testing

PAD 5A / 5B / 5C - maximum thrust 36,000 lbf.

- 70 lb of 1.1 or 180 lb of 1.3 solid propellant
- Onboard automatic calibration system 99.9% accuracy
- Pad 5A (Current configuration) 12,000 lb thrust,
  - —Plume diagnostics analysis system
- Pad 5B (current configuration), 10,000 lb thrust
- Pad 5C 36,000 lbf. thrust, spin capability,
  - —Hydrogen injection system

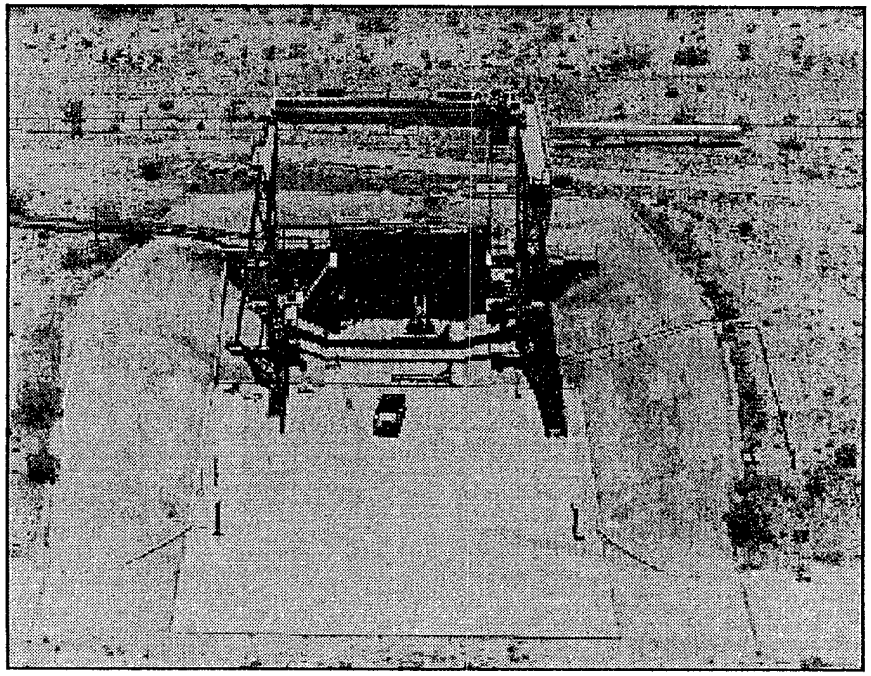
TESTING HISTORY:

- Sidewinder • Minuteman • Shuttle
- Sparrow • PeaceKeeper • Taurus
- Ammonium Perchlorate • Durandahl
- Small ICBM • Pegasus • HIPPO
- Minuteman • 30mm RAP • 20mm RAP
- Hydrogen Augmented Solid Rockets

Large Motor Test Stand
Area 1-32 Test Stand 1

CAPABILITIES:

- Ground level testing
- Maximum thrust 1,000,000 lbf. horizontal or vertical
- Current thrust
  - 250,000 lbf. horizontal, six-component, automatic calibration
  - 25,000 lbf. side force
- 30' x 45' concrete pad
- 7,000 lb of 1.1 or 50,000 lb of 1.3 solid propellant
- Environmental enclosure (temperature / humidity)
- 10 ton traveling overhead crane



TESTING HISTORY:

- Minuteman
- Titan
- PeaceKeeper
- Viper
- SuperBATES
- Trident

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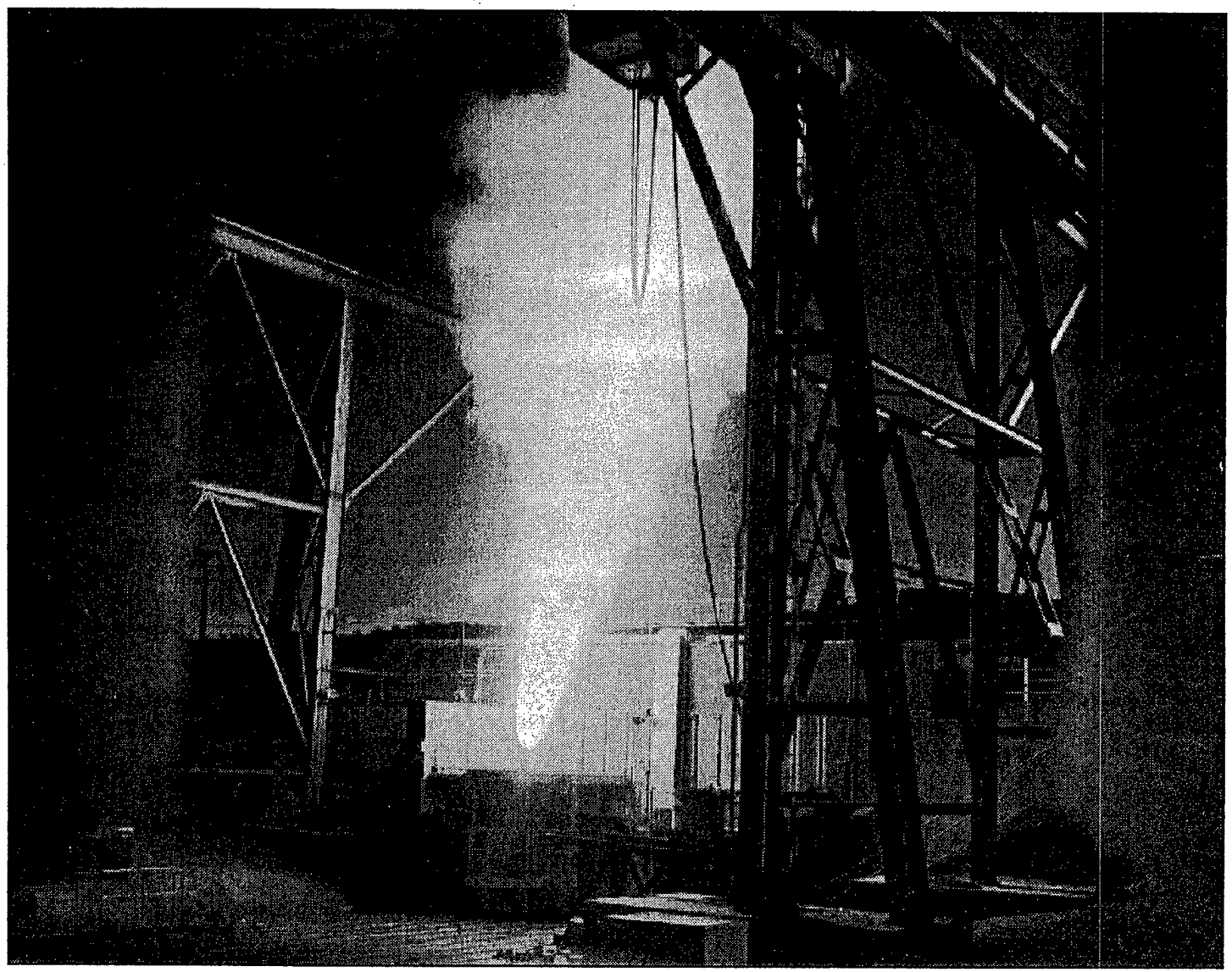
Large Motor Test Stand
Area 1-32 Test Stand 1



Thrust Vector Control (TVC) Test

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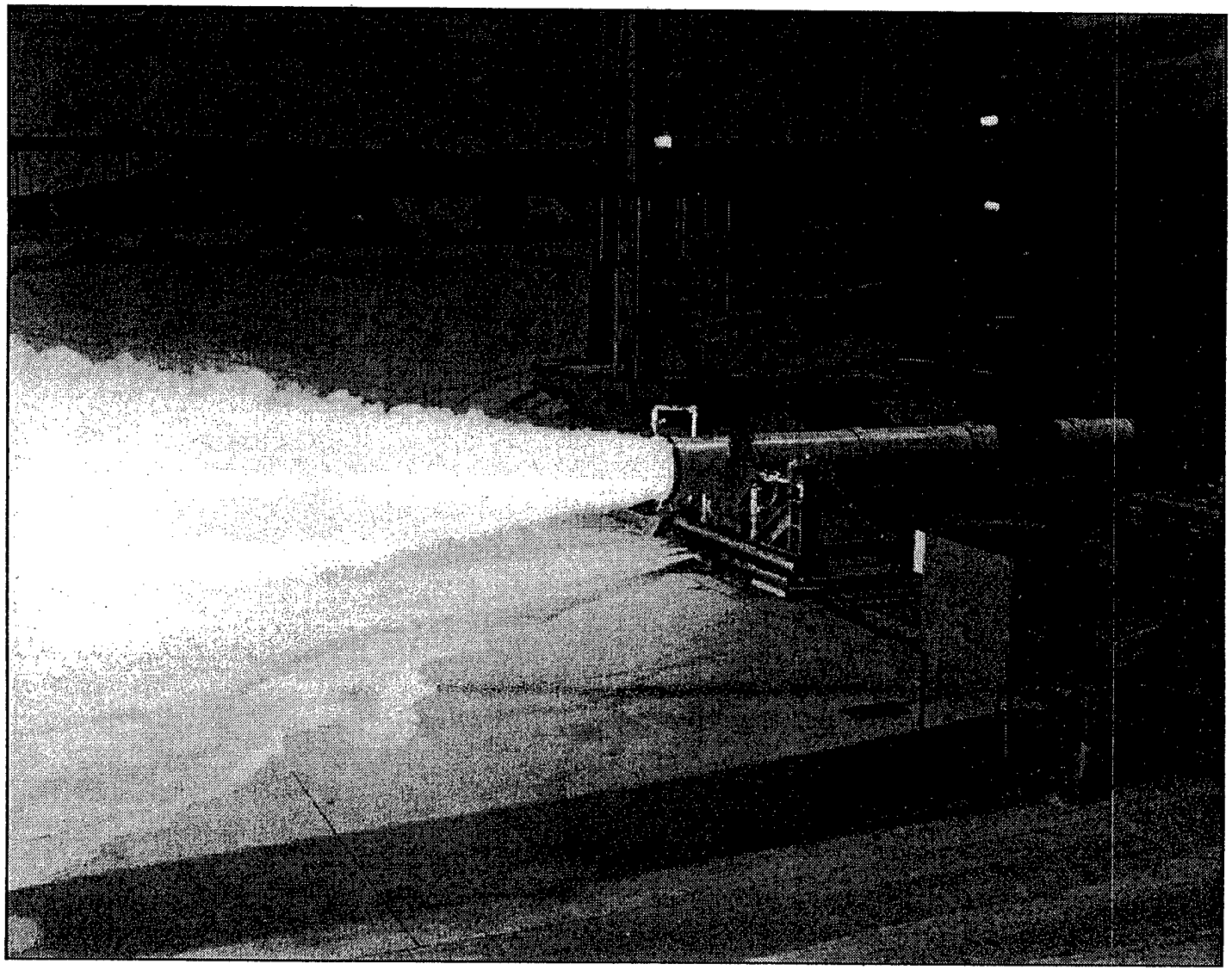
Large Motor Test Stand
Area 1-32 Test Stand 1



Nozzleless Booster 1985

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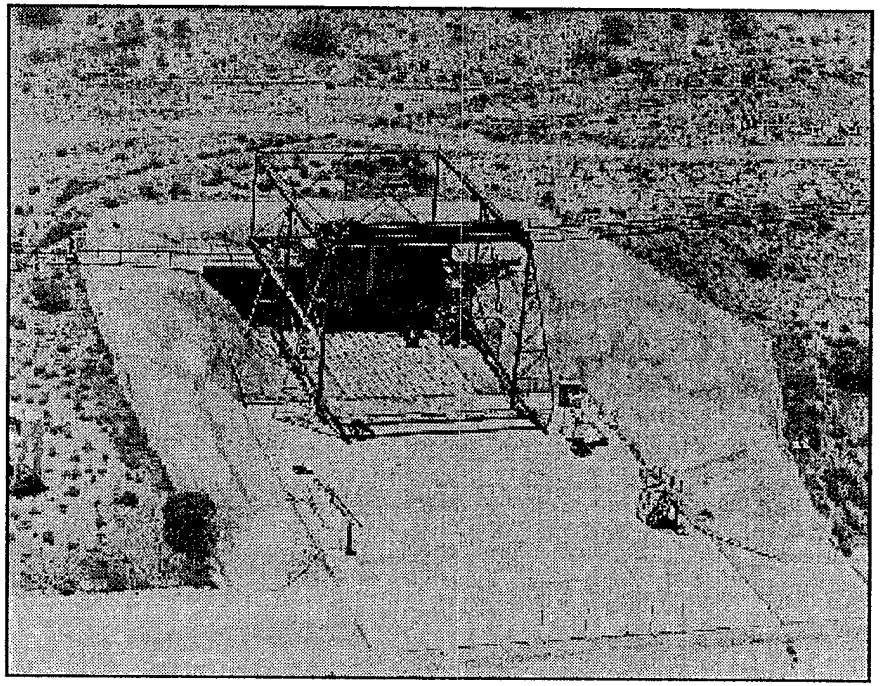
Large Motor Test Stand
Area 1-32 Test Stand 2

CAPABILITIES:

- Ground level testing
- Maximum thrust 1,000,000 lbf. horizontal or vertical
- Current thrust
  - 150,000 lbf. horizontal single axis, automatic calibration
  - 99.85 % thrust measurement accuracy
  - 1 to 4 segments, up to 34 inch diameter
- 30' x 45' concrete pad
- 7,000 lb of 1.1 or 50,000 lb of 1.3 solid propellant
- Environmental enclosure (temperature / humidity)
- 15 ton traveling overhead crane



TESTING HISTORY:

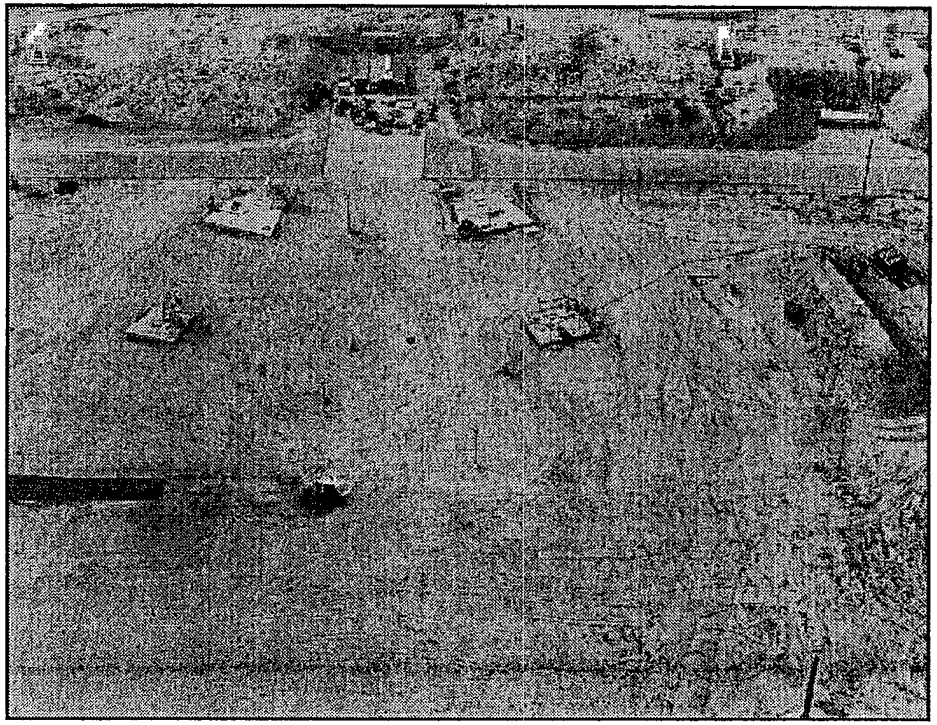
- High Internal Pressure Producing Orifice (HIPPO)
- Small ICBM (TVC Shoot Off)
- 84" Diameter, Materials Testing Motor (CHAR)
- SuperBates

High Hazards Test Stand

Area 1-32 Test Stands 3A, B, C, & D

CAPABILITIES:

- Maximum thrust 10,000 lbf, horizontal
- Current thrust
  - No thrust stand installed
- 1,000 lb of 1.1 or 5,000 lb of 1.3 solid propellant
- 2 ton traveling overhead crane
- Gun target

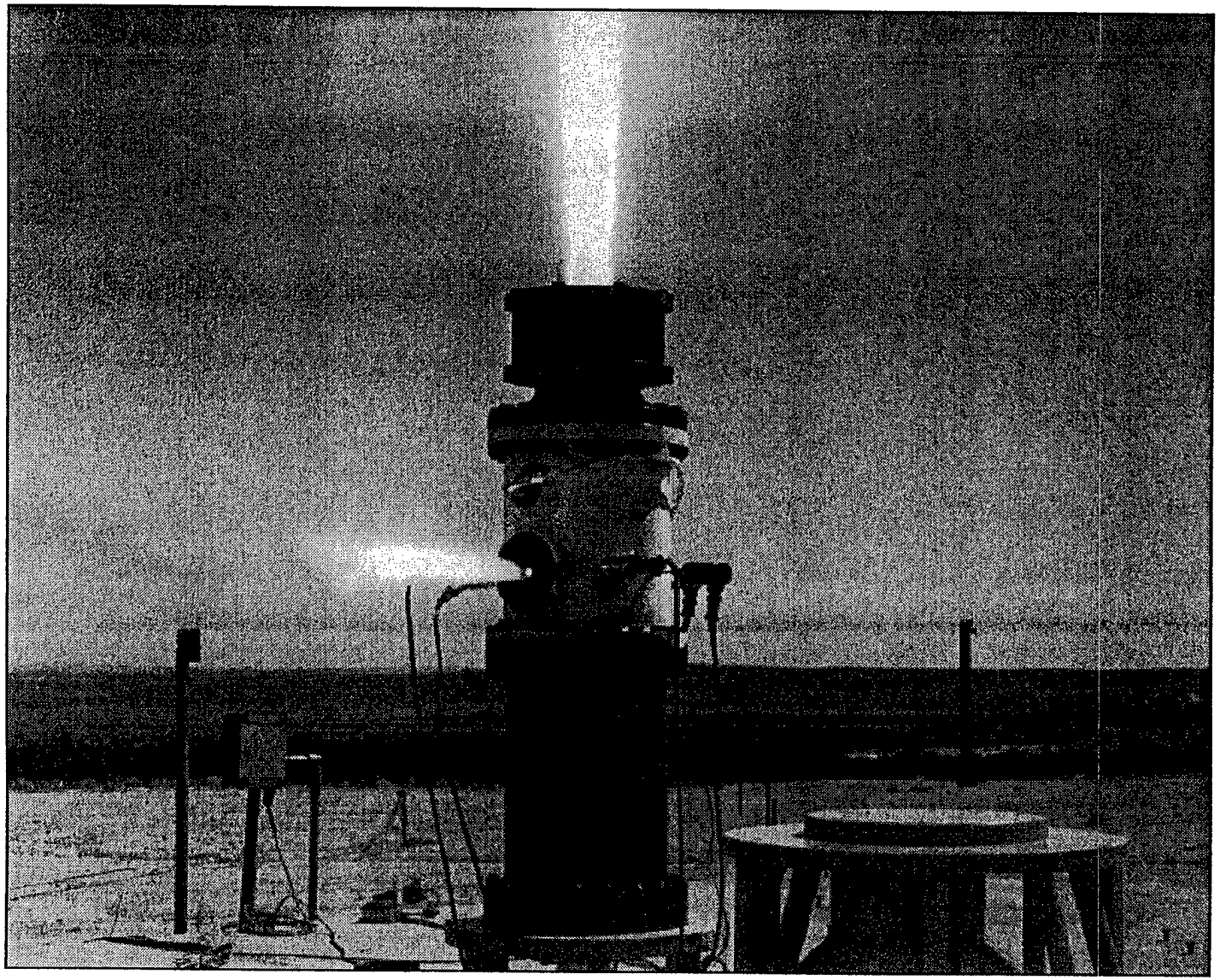


TESTING HISTORY:

- Sidewinder
- Sparrow
- 30mm RAP
- 20mm RAP
- Ammonium Perchlorate
- Hot Gas Valve• Durandahl
- F16 Emergency Hydrazine Generator
- Minuteman Critical Diameter Definition

High Hazards Test Stand

Area 1-32 Test Stand 3A



Integrated Stage Thrust Vectoring Test, 1982

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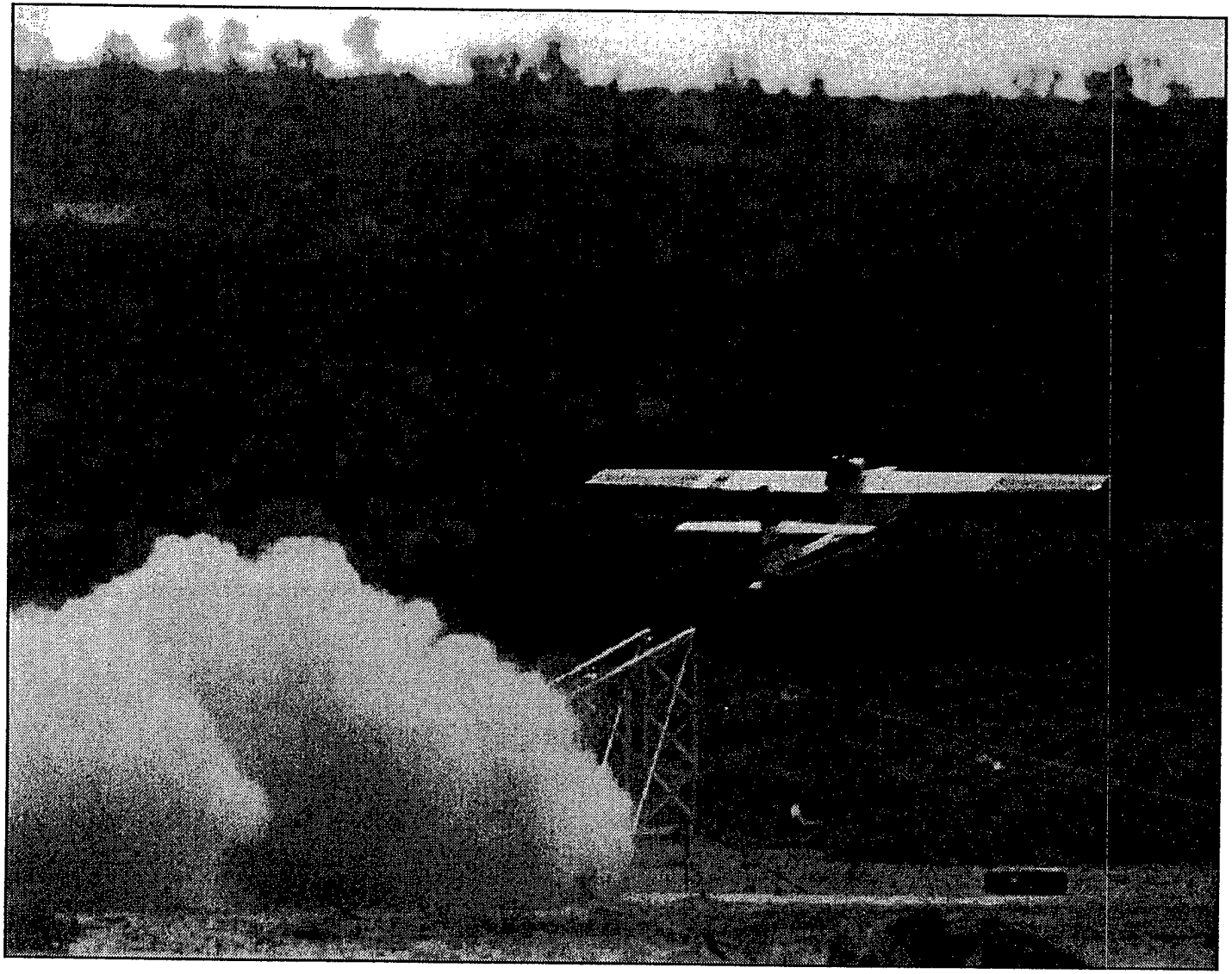
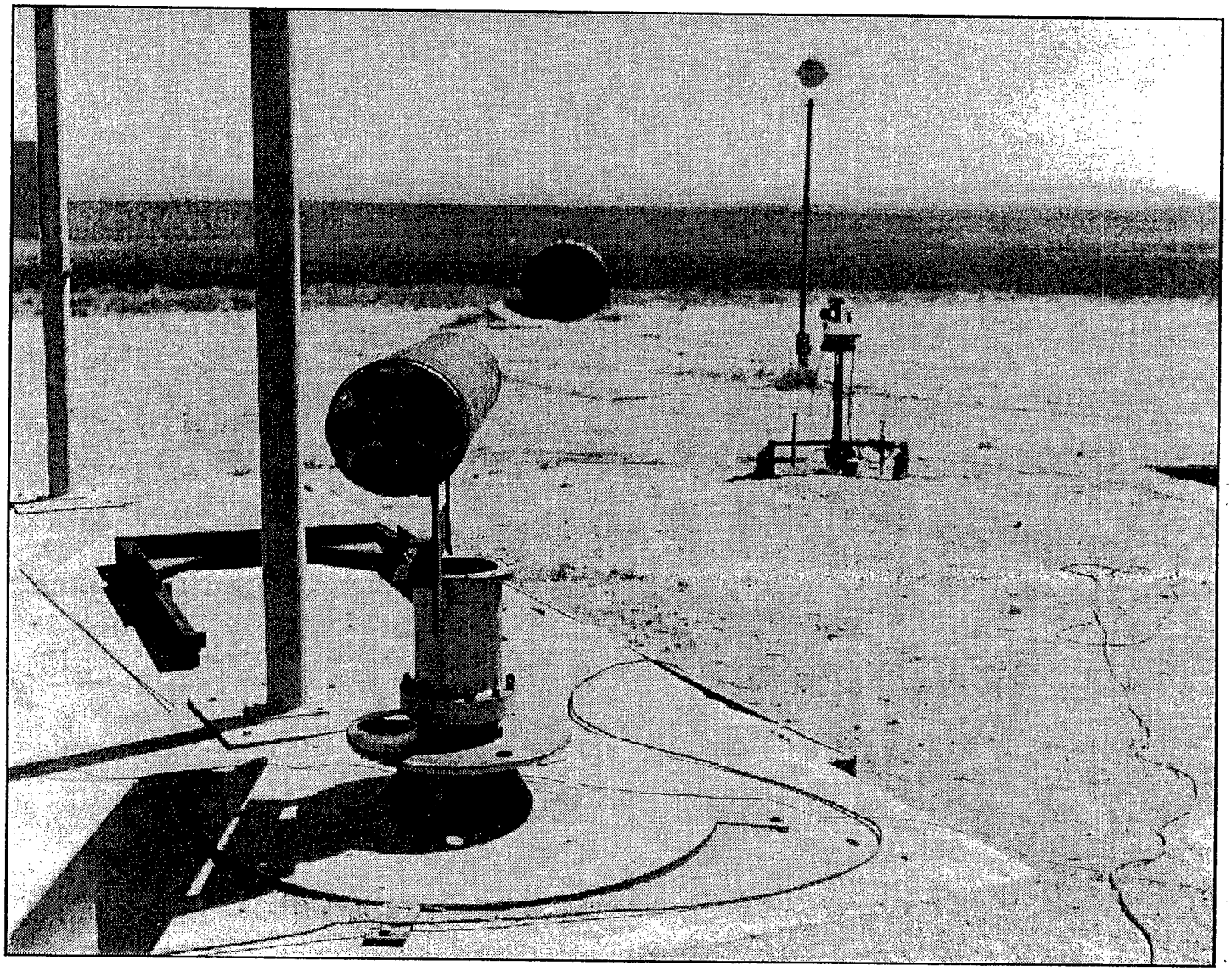
High Hazards Test Stand 3A
Test Area 1-32



Remotely Piloted Vehicle

High Hazards Test Stand 3A
Test Area 1-32

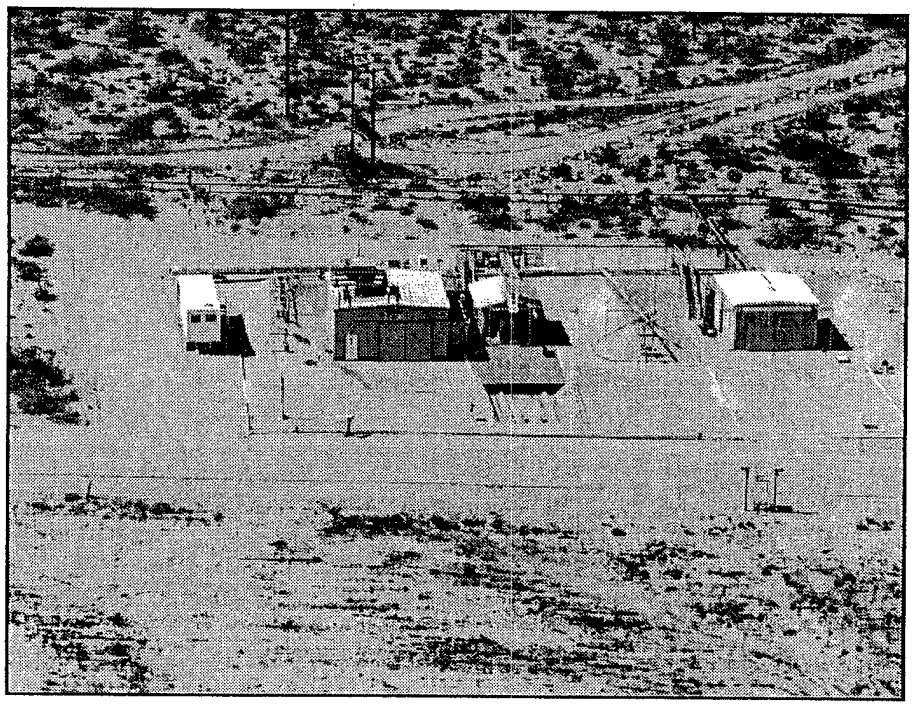


30mm Rocket Assisted Projectile (RAP)

15 & 70 lb BATES Motor Pads - Area 1-32 Pads 5A, 5B, & 5C

CAPABILITIES:

- 70 lb of 1.1 or 180 lb of 1.3 solid propellant
- Onboard automatic calibrating system 99.9% accuracy
- One to four segments, up to 14 inch diameter
- Test stand 5A
  - Maximum thrust 12,000 lbs; current thrust 12,000 lbs
  - Plume diagnostics system
    - Mean particle sizing
    - Particle capture
    - Visible UV & IR
    - Thermal image recording
    - 3 Wideband IR radiometers
    - Near IR fourier transform spectrometer
- Test stand 5B
  - Maximum thrust 10,000 lbs; current thrust 10,000 lbs
- Test stand 5C
  - Maximum thrust 36,000 lbs; current thrust 36,000 lbs
  - Motor Spinning Capability
    - Hydrogen Injection System



TESTING HISTORY:

- Sidewinder
- Sparrow
- Shuttle
- Minuteman
- Durandahl
- Titan
- PeaceKeeper
- Small ICBM
- 30mm RAP
- 20mm RAP
- Ammonium Perchlorate
- Hydrogen Augmented Solid Rockets

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BATES Motor Pad
Area 1-32, Pad 5A

15 lb Bates / Plume Test

Motor Behavior Complex Area 1-36

GENERAL AREA CAPABILITIES:

- 6,000 psi GN2 cross country line
- 16 in. water line to 100,000 gal source
- 440 VAC and 28 VDC stand power
  - Accessible for A and B pads, available for D pad
- Mechanical shop
  - With 2 ton traveling overhead crane

TEST STAND CAPABILITIES:

- Ground level testing
- Storable and solid propellant
- 1-36A Pad, maximum thrust, 4M lbf., horizontal
  - 1M Lbs TNT equivalent
- 1-36B Pad, inactive
- 1-36D Pad, explosive detonation studies
  - 1M Lbs TNT equivalent

TESTING HISTORY:

- PeaceKeeper Flight Termination Guidance

  Stage I / II / III 1980 -
- PeaceKeeper Advanced Development Program
- Titan III, 120 Inch Solid
- Ammonium Perchlorate
- Silo Fire Safety
- Solid Propellant Hazards Study (SOPHY)

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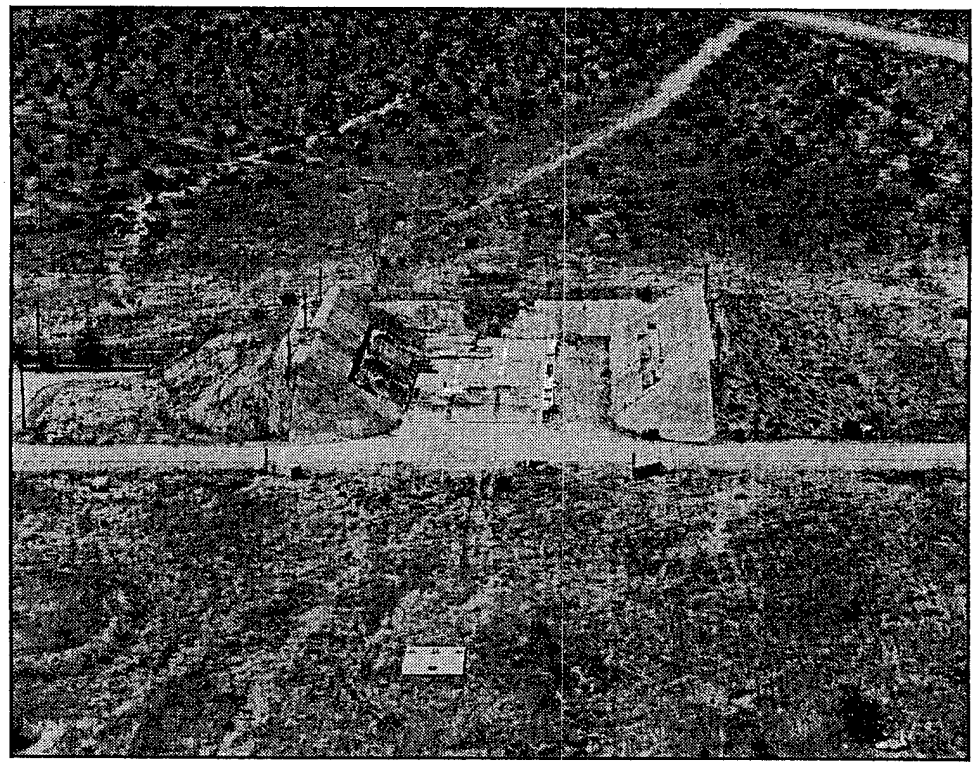
Motor Behavior Complex Area 1-36, Horizontal Test Pad A

CAPABILITIES:

- Ground level testing
- Storable and solid propellant
- Horizontal bermed bare pad
- Maximum thrust, 4M lbf.
- 1M Lbs TNT equivalent



TESTING HISTORY:

- PeaceKeeper Flight Termination Ordinance Stage I / II 1980 -
- PeaceKeeper Ordnance Advanced Development Program
- Titan III, 120 Inch Diameter, Solid Strap On
- Minuteman Stage II
- Minuteman Stage III

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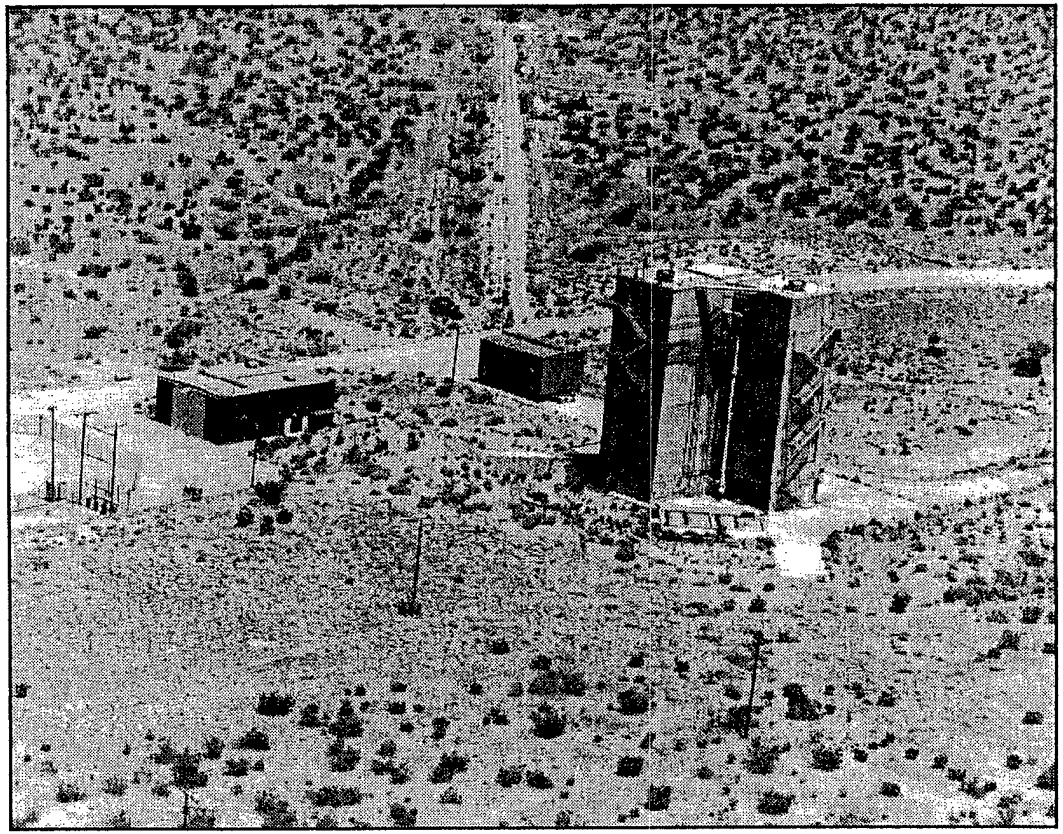
Motor Behavior Complex Area 1-36, Vertical Test Pad B

CAPABILITIES:

- Ground level testing
- 1-36B pad, inactive



TESTING HISTORY:

- Titan III, 120 Inch Diameter, Solid Strap On

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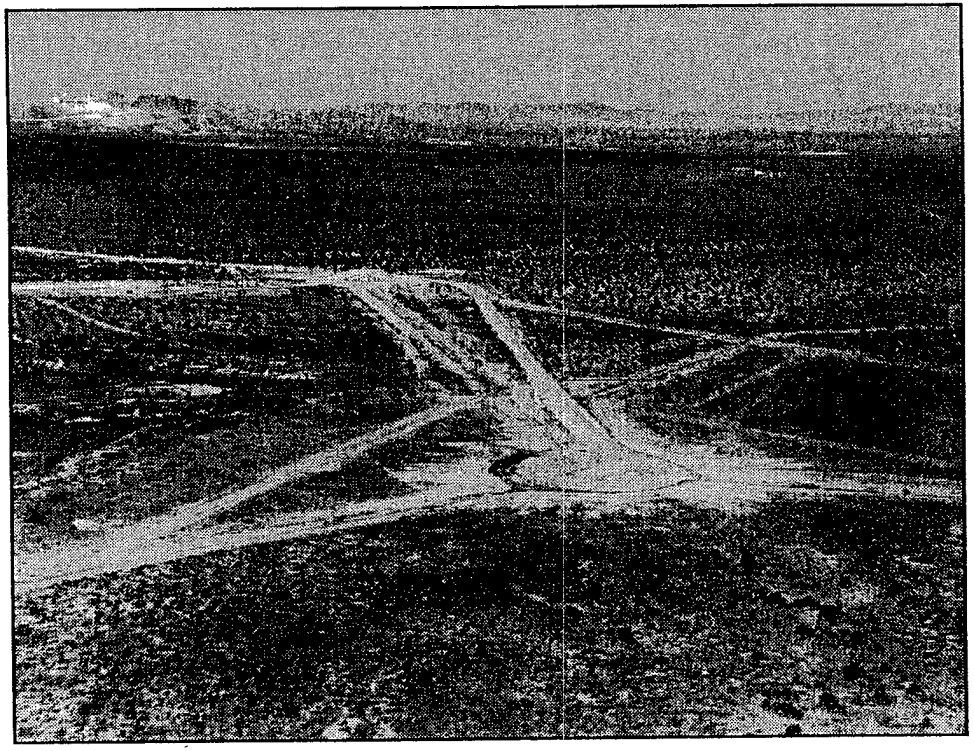
Motor Behavior Complex
Area 1-36, Detonation Test Pad D

FACILITY CAPABILITIES:

- Data acquisition and control system
  - 24 channel high-speed Le Croy digital recorder, 300mHz
  - 28 channel frequency modulated tape recorder
  - PC based LABVIEW control system

TEST STAND CAPABILITIES:

- Ground level testing
- Storable and solid propellant
- Detonation, high hazard, and explosive studies
- 150 foot diameter cleared ground pad
- 1-36D pad, maximum explosive capability
  - 1M lbs TNT equivalent
- Ignition system
  - Standard 28 VDC
  - 5,000 VDC explosive bridgewire circuit



TESTING HISTORY:

- PeaceKeeper Flight Termination Stage III
- Ammonium Percholorate
- Silo Fire Safety
- Space Launch Safety Studies
- Solid Propellant Hazards Study (SOPHY)
- Tool Drops on Minuteman Stage III

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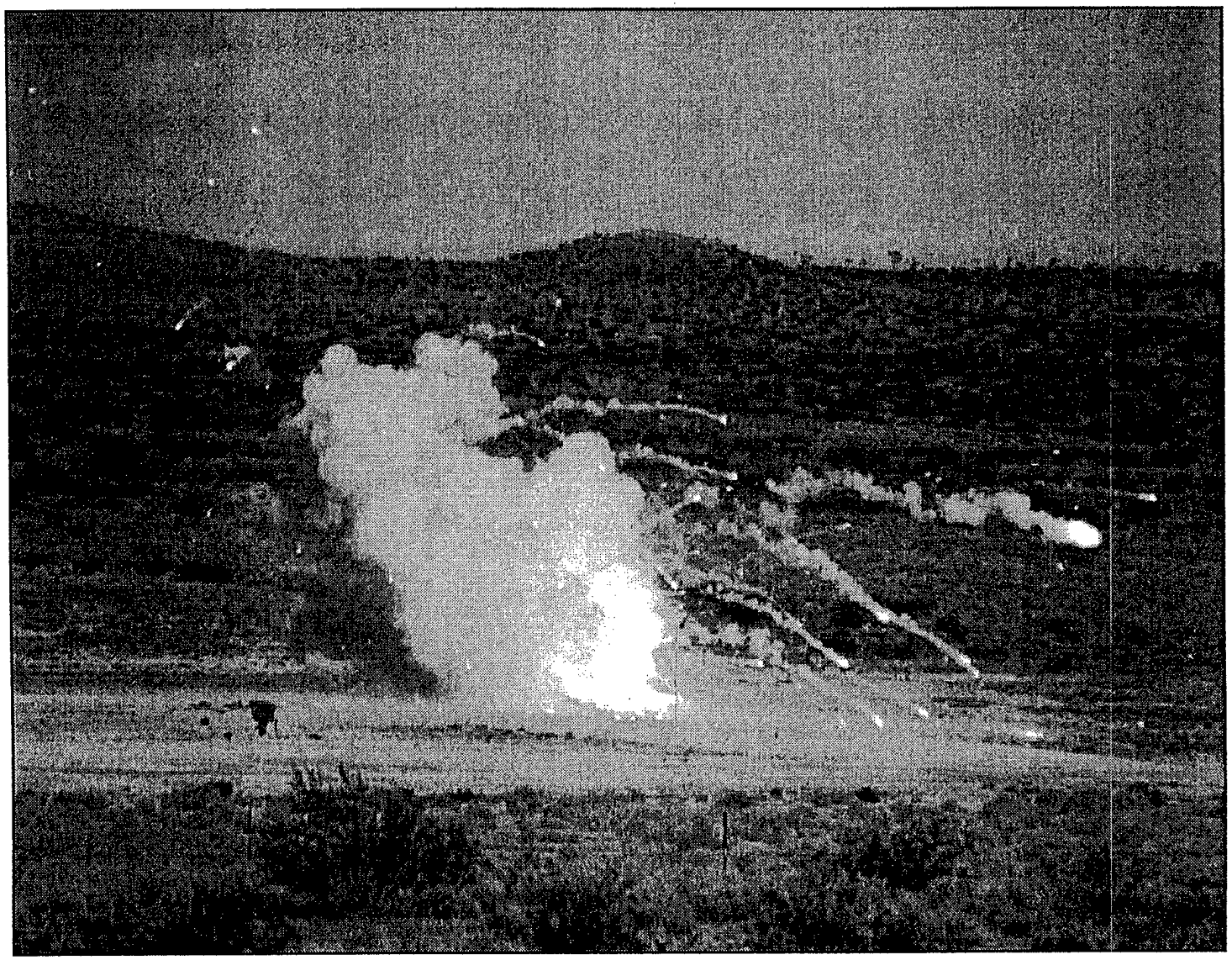
Motor Behavior Complex
Area 1-36, Detonation Test Pad D

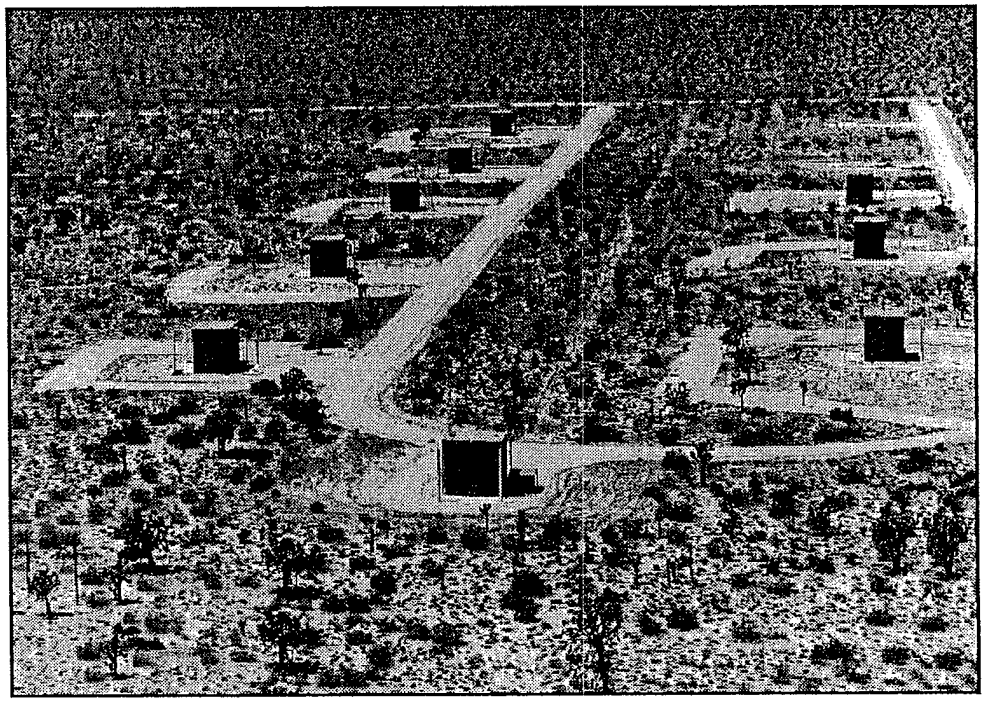


SuperHIPPO Motor Impact Studies 1992

Propellant Storage Area Area 1-38

CAPABILITIES:

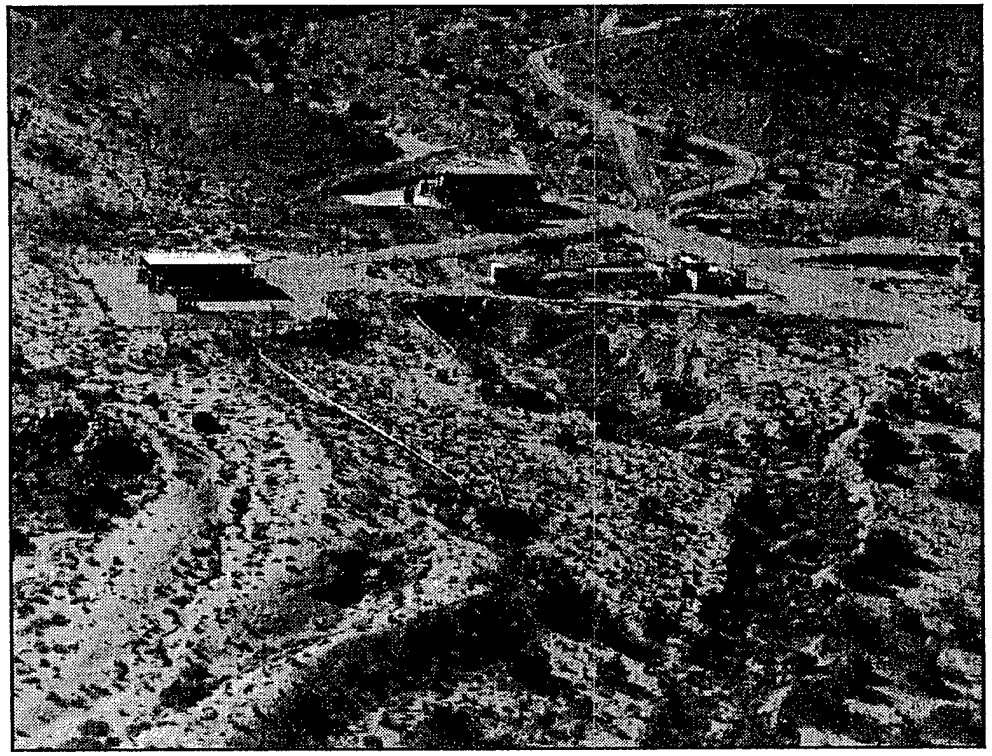
- 9 storage buildings
  - Each building 24 foot x 31 foot
  - 20 foot vertical clearance
- Sited for 50,000 lbs of 1.1 or 200,000 lbs of 1.3 TNT equivalent propellant
- Environmental capability
  - Temperature
  - Humidity



Liquid Propellant Aging Facility
Area 1-40

CAPABILITIES:
- Propellants stored since 1971
- 1,500 psi GN2 Cross country line
- 6 inch water main from area 1-14
- 440 VAC facility / stand power
- Mechanical shop

TEST STAND CAPABILITIES:
- Pad A / B - maximum thrust 5,000 lbf.
  - Current configuration; inactive
  - No thrust stand
- Pad C / D - maximum thrust 50,000 lbf.
  - Current configuration; inactive
  - No thrust stand
- Mechanical shop aging building
- Liquid propellant long term storage studies
  - CLF5 -- CLF3
  - Firex system
- Portable heating and air conditioning



TESTING HISTORY
- Bi-Propellant Oxidizer Feed System
- Tank Storability

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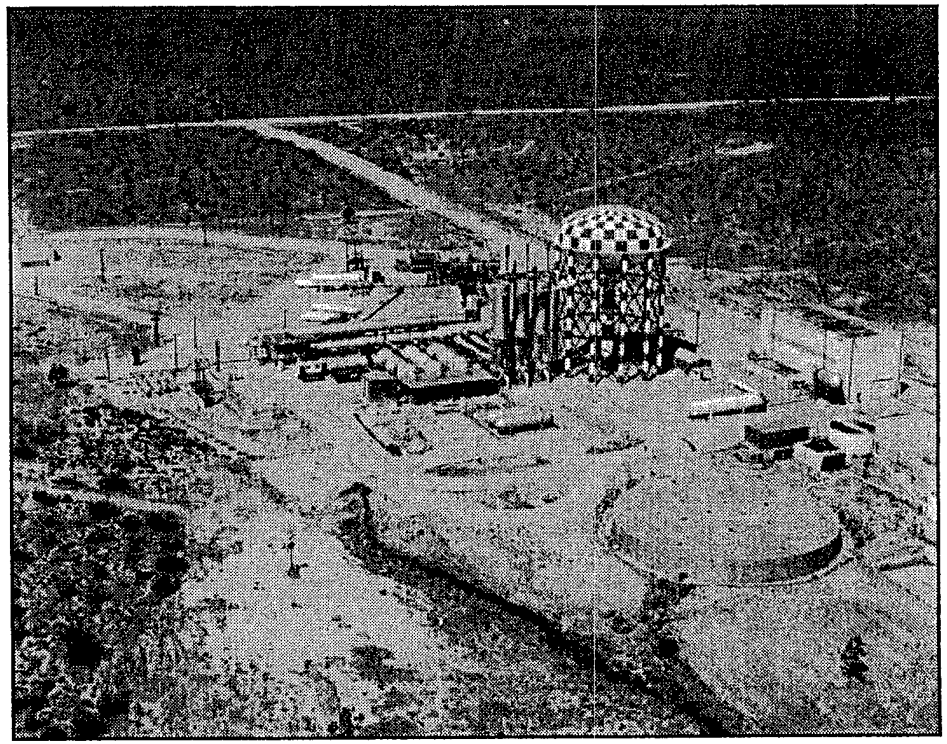
Space Environment Propulsion Complex Area 1-42

GENERAL AREA CAPABILITIES:

- Propane-fired steam / vacuum system
  - Altitude simulation to 120,000 feet (A,B,D cells)
  - 400 to 1800 seconds duration
  - Mass flow 600lb/sec EWA 70
  - 1,800,000 gallon water catch tank
- Mechanical pumped vacuum systems
  - Altitude simulation to 125,000 feet E cell
  - Altitude simulation to 650,000 feet SPEF chamber
- 6,000 psi GN2 cross country line
- 6 Inch water main
- 440 VAC and 28 VDC stand power
- Data acquisition and control system
  - 192 channel, 100,000 sample per second, data system
  - 256 channel programmable logic control system
- Mechanical shop with 2 ton crane

CELL CAPABILITIES: (current configuration)

- Altitude simulated testing
- A cell - 60,000 lbf. thrust, horizontal
- D cell - 20,000 lbf. thrust, horizontal
- B cell - 50,000 lbf. thrust, vertical
- SPEF chamber, no thrust



TESTING HISTORY

- Trident stage III • Star 30 • ASAS • Agena
- XLR-132 • Centaur • EEC • Small ICBM
- Minuteman III • Composite Polar Boss • StarTech
- MSTI I / II / III • Viper • Hughes TTM/STM
- KEW (Kinetic Energy Weapon) • Gossamer Structures
- High Altitude Supersonic Target (HAST)
- TRSM Navy Third Stage Rocket Motor 1997

Space Environment Propulsion Complex Area 1-42

GENERAL AREA CAPABILITIES:

- **Propane-fired steam / vacuum system**
  - 3 parallel stage, ejectors, 9 steam bottles
  - 120,000 feet simulated altitude (A,B,D Cells)
  - 400 to 1800 seconds duration (9 Bottles)
  - Mass flow rates approximately 600 Lb/Sec EWA 70
  - 1,800,000 gallon water catch tank
- **Mechanical pumped vacuum systems**
  - 125,000 feet simulated altitude E cell
  - 650,00 feet simulated SPEF chamber
- **6,000 psi GN2 cross country line**
- **6 Inch water main**
- **440 VAC and 28 VDC stand power**
- **Data acquisition and control system**
  - LABVIEW: 192 channel, 100,000 sample per second
  - 256 channel programmable logic control system
- **Mechanical shop with 2 ton crane**

•TEST CHAMBER CAPABILITIES

- **Altitude simulation testing**
- **Environmental conditioning**
- **A Cell - maximum thrust 60,000 lbf.**
  - (Current configuration) 60,000 lbf. thrust, horizontal
  - Chamber 12 foot diameter x 28 foot long
  - 66 Inch diffuser (77 inch maximum)
  - Solid motors up to 66 inch diameter x 18 foot long
  - 2 each 5 ton overhead cranes
  - 30K of TNT equivalent propellant

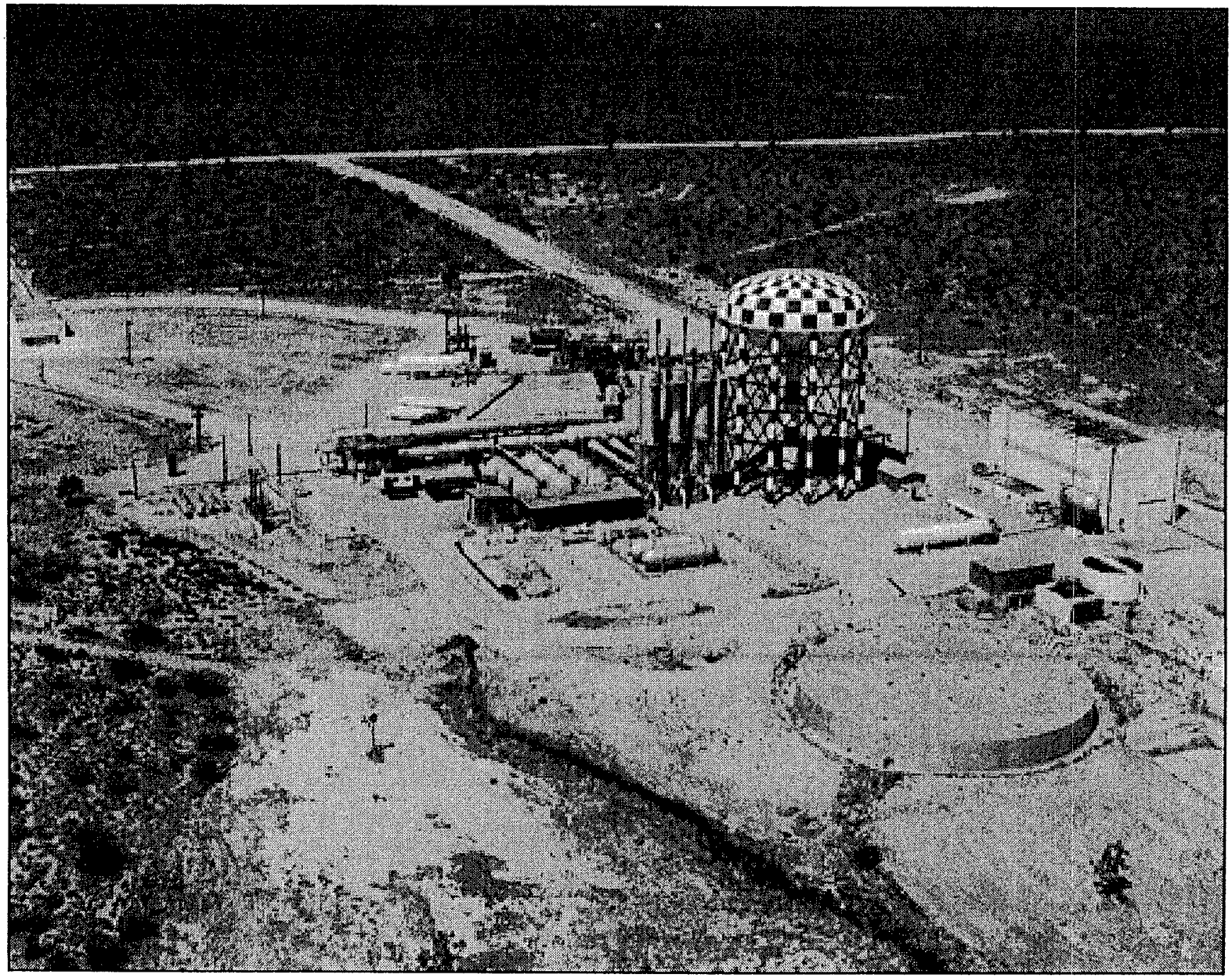
TEST CHAMBER CAPABILITIES (CONT.)

- D Cell - maximum thrust 20,000 lbf.
  - Chamber 10.5 foot diameter x 25 foot long
  - (Current configuration) 20,000 lbf.f thrust, horizontal
  - No diffuser (55 inch maximum)
  - Solid motors up to 48 inch diameter x 18 foot long
  - 5 Ton overhead crane
  - 30K of TNT equivalent propellant
- B Cell - maximum thrust 50,000 lbf.
  - Chamber 16 foot diameter x 28 foot high
  - (Current configuration) 4,500 lbf. thrust, vertical
  - 44 Inch diffuser (44 inch maximum)
  - Solid motors up to 48 inch diameter x 15 foot long
  - 30K of TNT equivalent propellant
- SPEFchamber
  - Chamber 30 foot diameter
  - Solar simulation
  - LN2 cryogenic panels

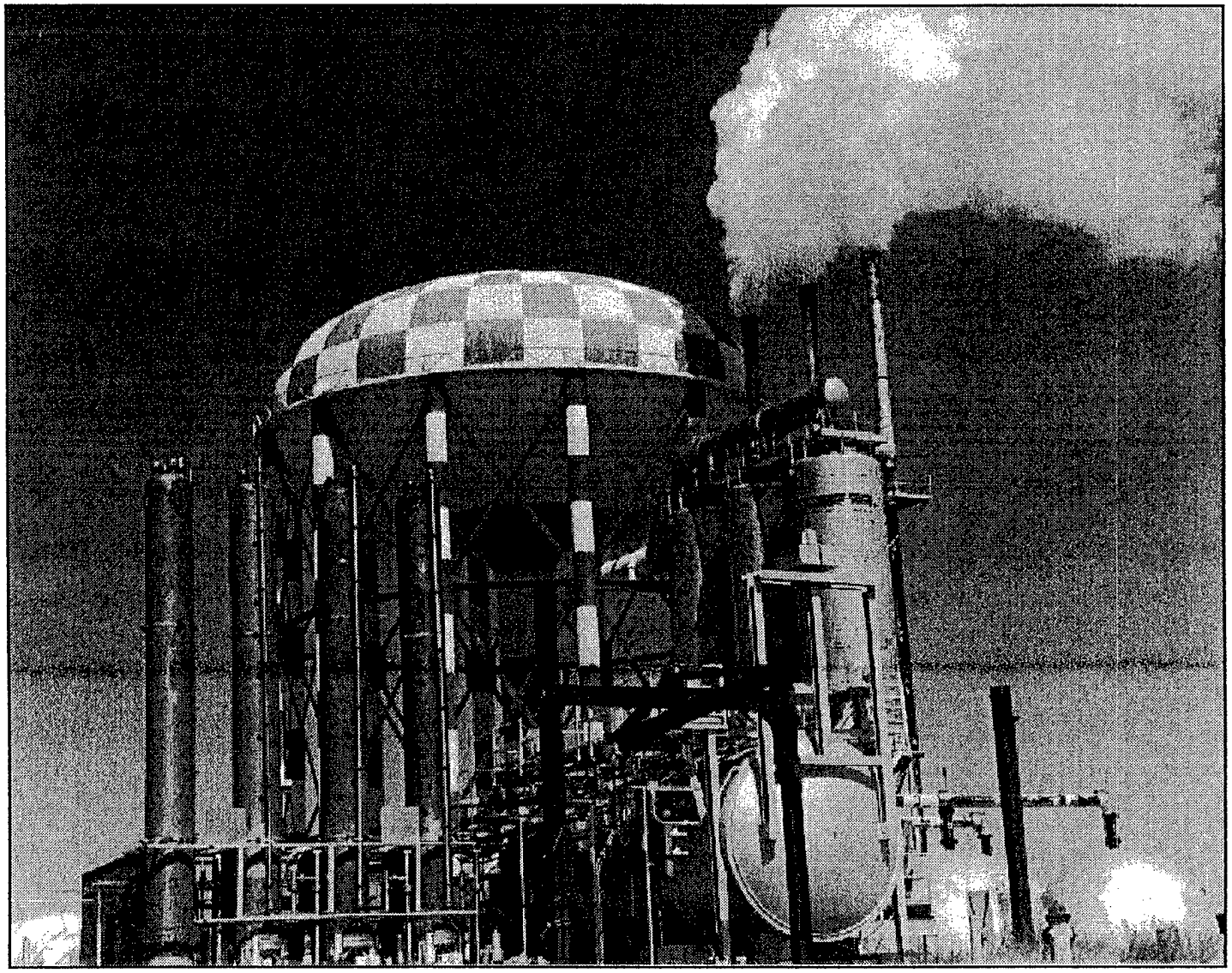
TESTING HISTORY

- Trident stage III
- Star 30
- ASAS
- Agena
- XLR-132
- Centaur
- EEC
- Small ICBM
- Minuteman III
- Composite Polar Boss
- StarTech
- MSTI I / II / III
- Viper
- Hughes TTM/STM
- KEW (Kinetic Energy Weapon)
- Gossamer Structures
- High Altitude Supersonic Target (HAST)
- TRSM Navy Third Stage Rocket Motor 1997

Space Environment Propulsion Complex Area 1-42



Space Environment Propulsion Complex
Area 1-42



Area Steam Run

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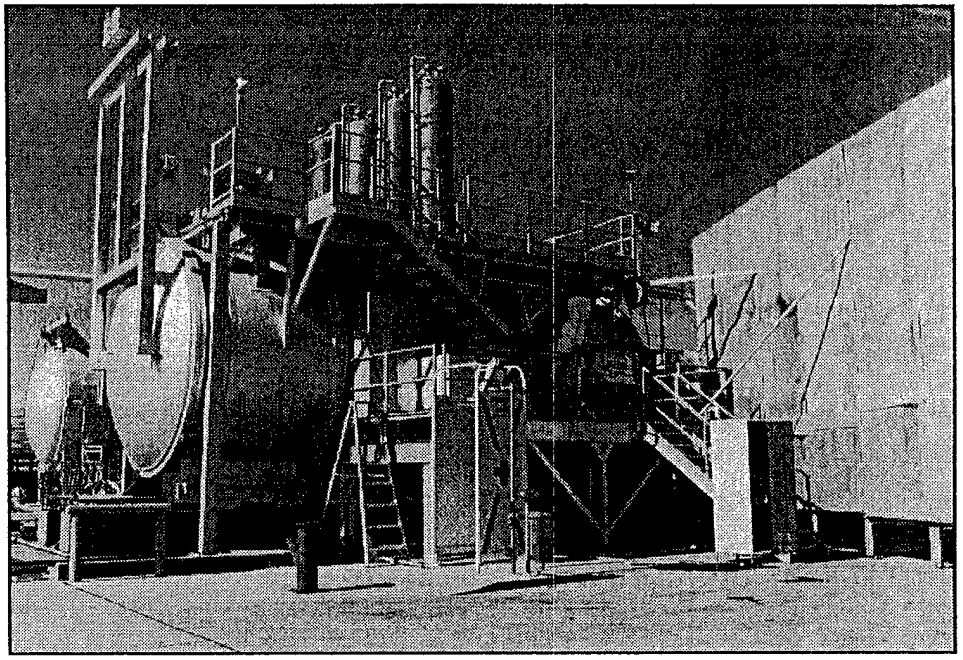
Horizontal Test Chamber Area 1-42, A Cell

CAPABILITIES:

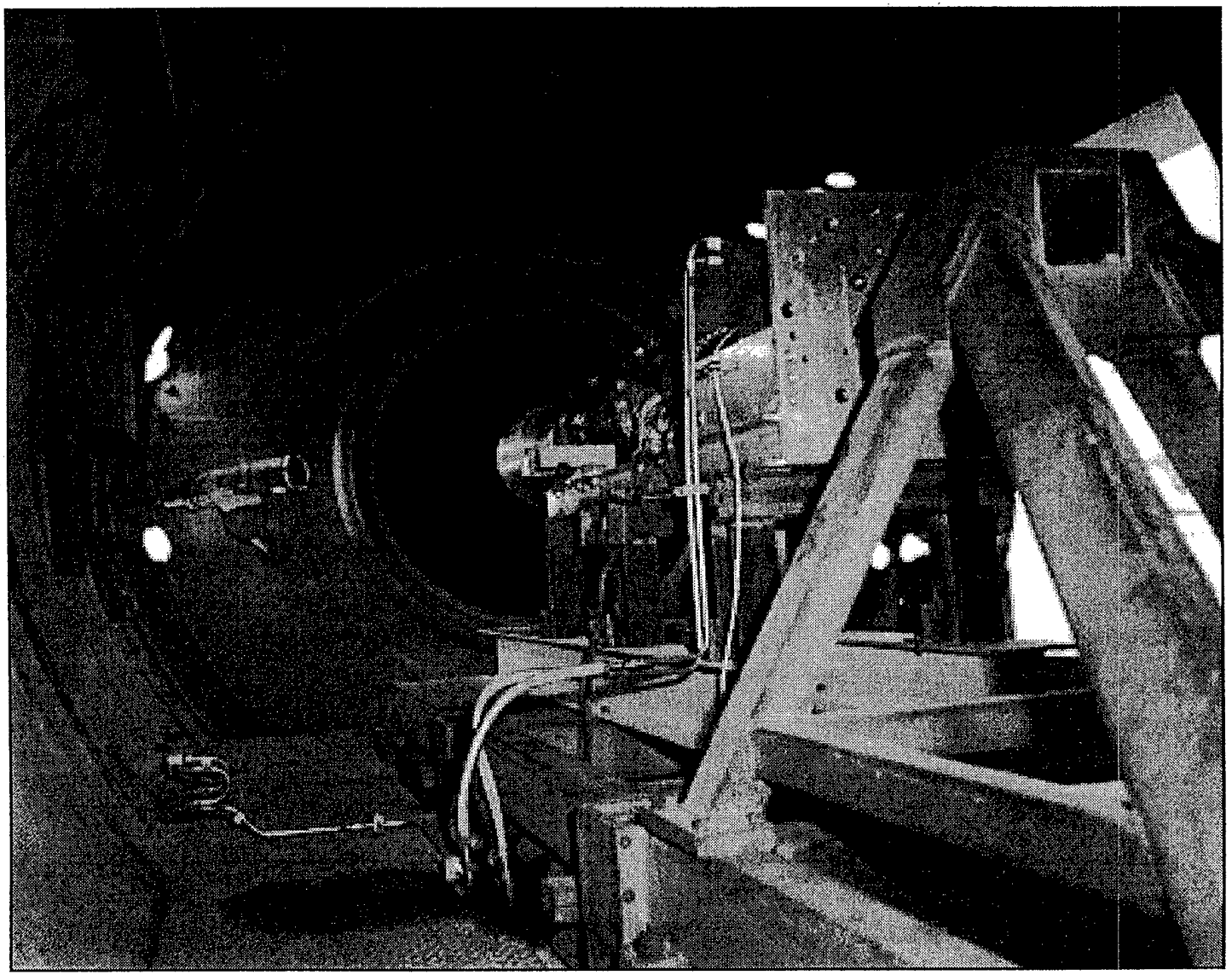
- **Altitude simulation to 120,000 feet**
- **Maximum thrust 60,000 lbf., horizontal**
  - (Current configuration) 60,000 lbf. thrust, horizontal
  - Onboard automatic calibration system 99.9% accuracy
  - Motor spin and IR measuring capability
  - Six component thrust capability
- **Chamber 12 foot diameter x 28 foot long**
  - 8 ft. diameter removable top, 12 ft. diameter clamshell door, 4 ft. x 6 ft. side access door
  - 2 each, 5 ton overhead crane
  - Film camera portholes (4), and in-chamber video (2)
  - 63 inch diffuser (77 inch maximum)
  - Solid motors Up to 32 inch diameter x 177 inch long
- **3,000 PSI test stand hydraulics**
- **Environmental conditioning**
  - (0 to + 70 degrees F)
- **30K of TNT equivalent 1.1 class propellant**



TESTING HISTORY

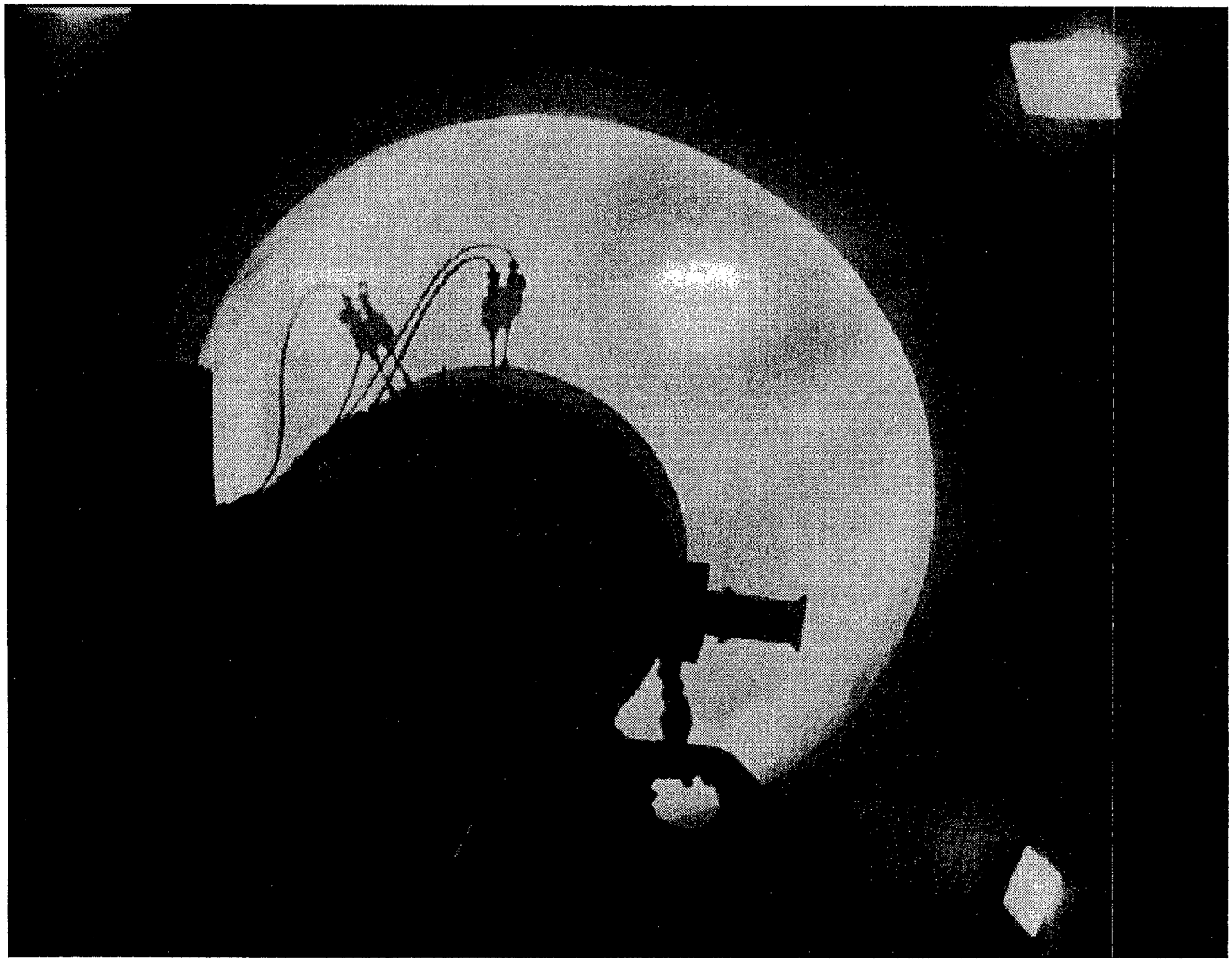
- **Trident stage III**
- **Composite Polar Boss 1990**
- **Minuteman III 1986**
- **Star 30**
- **Advanced Solid Axial Stage (ASAS)**
- **Extendible Exit Cone (EEC) 1980-1981**
- **High Altitude Supersonic Target (HAST) 1973**
- **Kinetic Energy Weapon (KEW)**
- **Advanced Integrated Stage (AIS) 1990**
- **Air Launched Space Booster 1979, 1983**

Horizontal Test Chamber Area 1-42, A Cell



70 lb. Spin BATES

Horizontal Test Chamber Area 1-42, A Cell



Minuteman III, Stage 3, 1986

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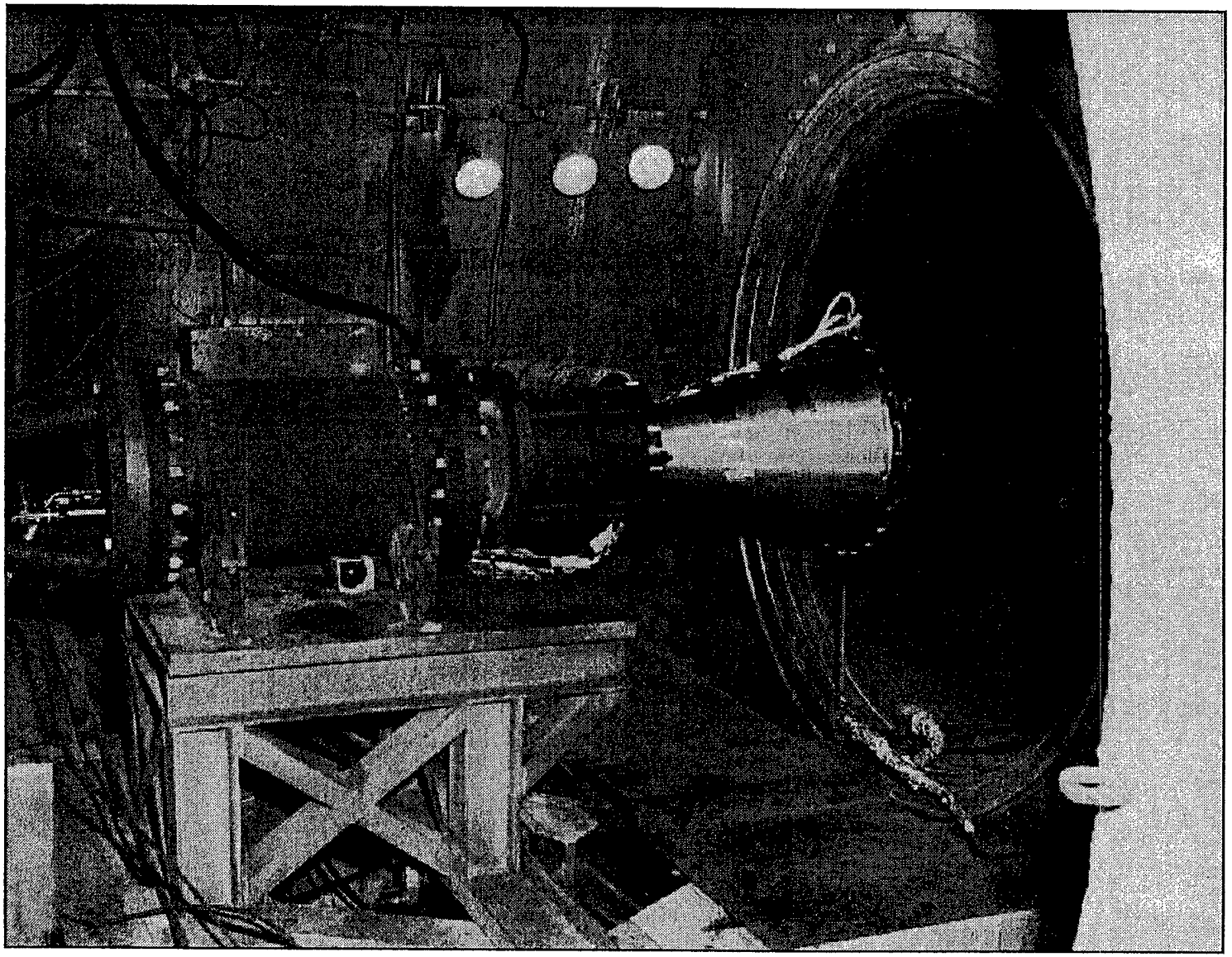
Horizontal Test Chamber Area 1-42, A Cell

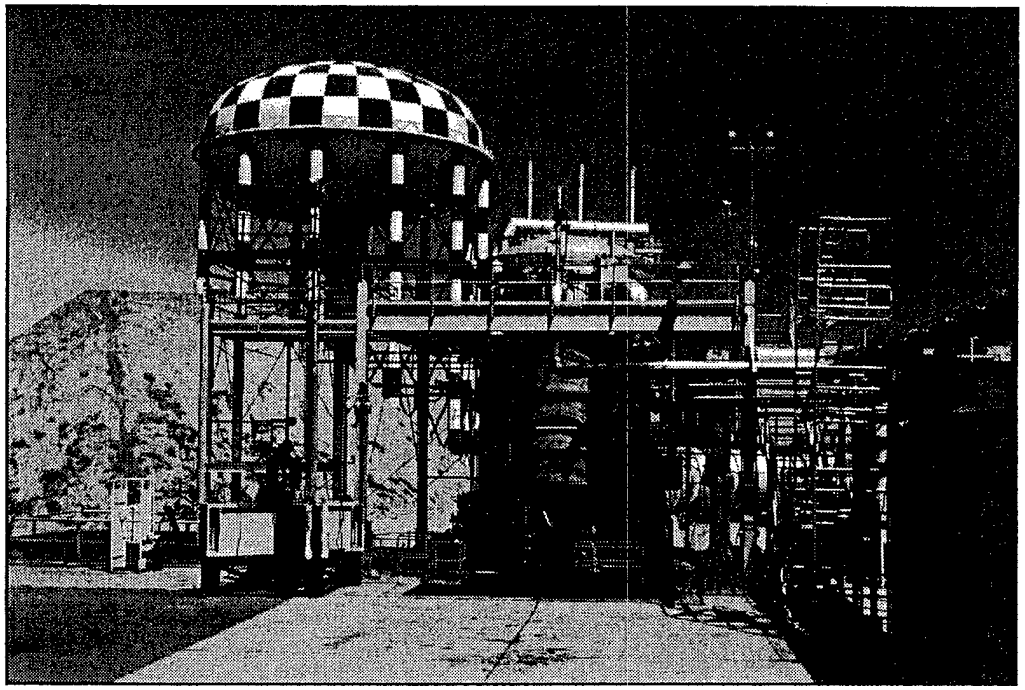


Bell Aerospace Extendible Exit Cone (EEC), 1977

Vertical Test Chamber Area 1-42, B Cell

CAPABILITIES:

- **Altitude simulation to 120,000 feet**
- **Maximum thrust 50,000 lbf., vertical, nozzle down**
  - (Current configuration) 4,500 lbf. thrust
  - Onboard automatic calibration system 99.8% accuracy
  - Motor IR measuring capability
  - Six component thrust capability
- **Chamber 16 foot diameter x 28 foot high**
  - 16 ft. diameter removable top, 4 ft. wide x 6 ft. high side door at ground level
  - Film camera portholes and in-chamber video
  - 44 inch diffuser maximum
  - Solid motors up to 48 inch diameter x 15 foot long
  - 1000 lbf hoist in cell
  - 3,000 psig Stand Hydraulics
- **Environmental conditioning**
  - (0 to 70 degrees F)
- **30K of TNT equivalent 1.1 class propellant**



TESTING HISTORY

- **StarTech 1981**
- **Trident C4 1974**
- **XLR 132 1983-1992**
- **Agena 1975-1976**
- **TRSM Navy Third Stage Rocket Motor 1997**

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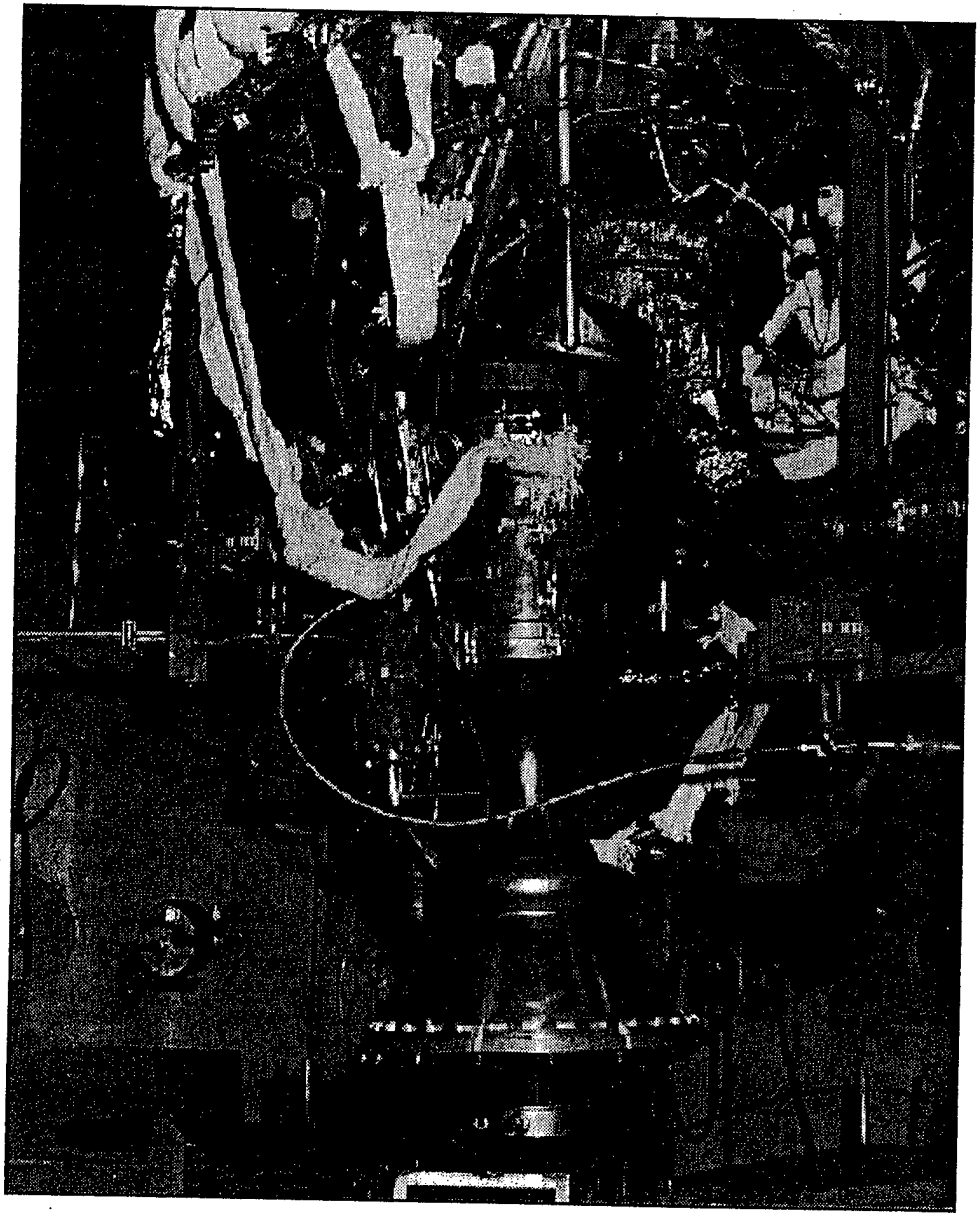
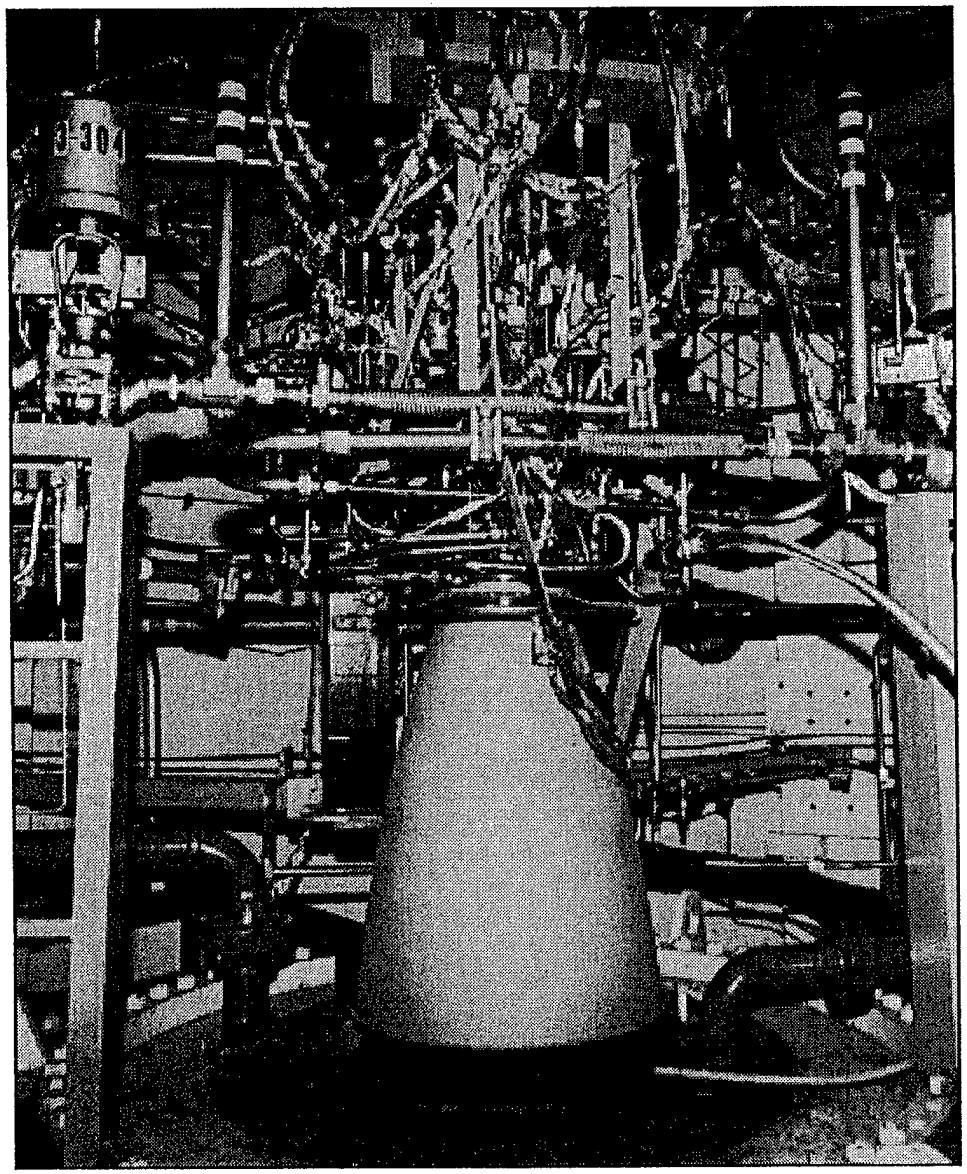
Vertical Test Chamber
Area 1-42, Chamber B



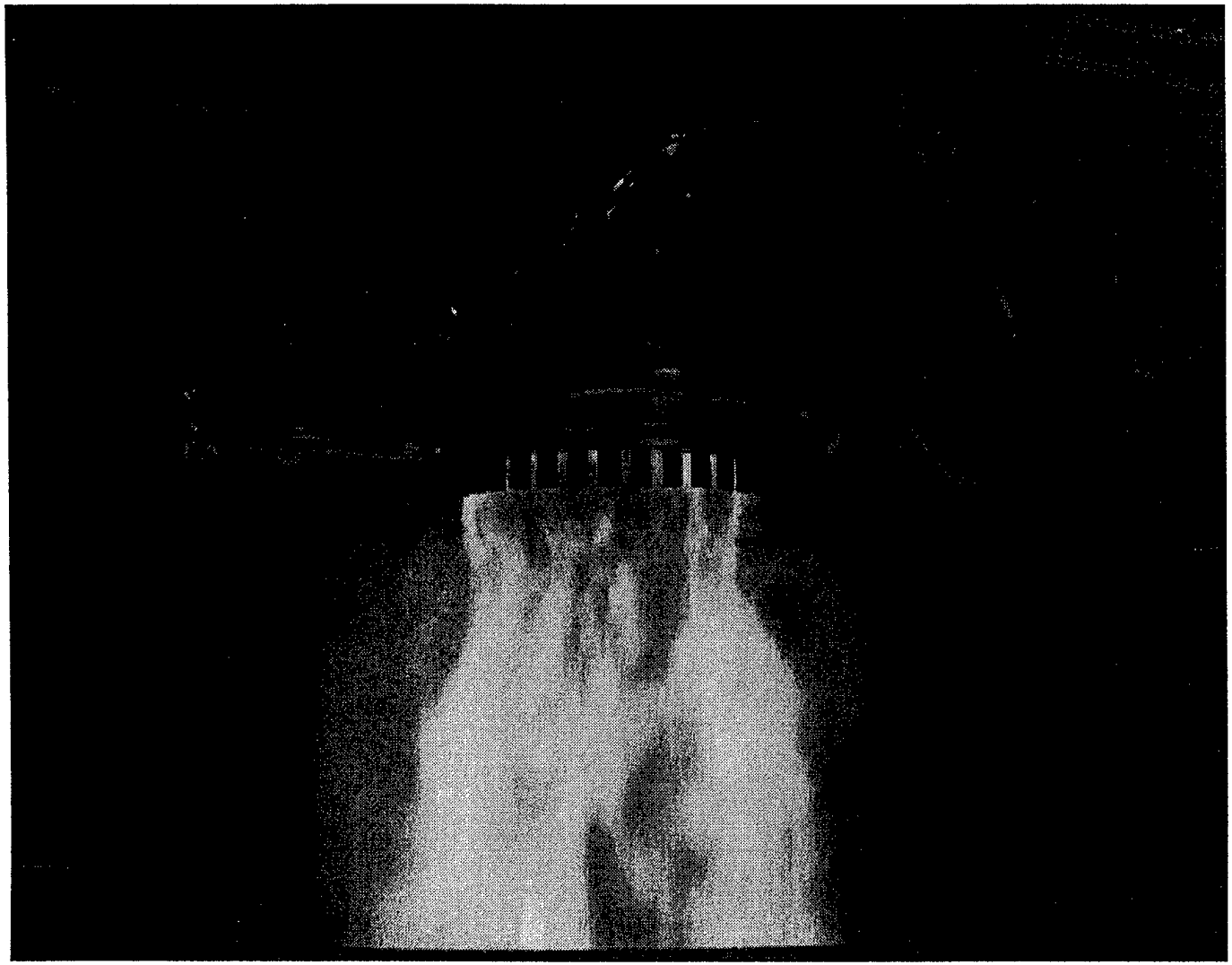
Agena Engine
1975-1976

Vertical Test Chamber
Area 1-42, Chamber B



XLR-132 Engine,
1983-1992

Vertical Test Chamber
Area 1-42, Chamber B

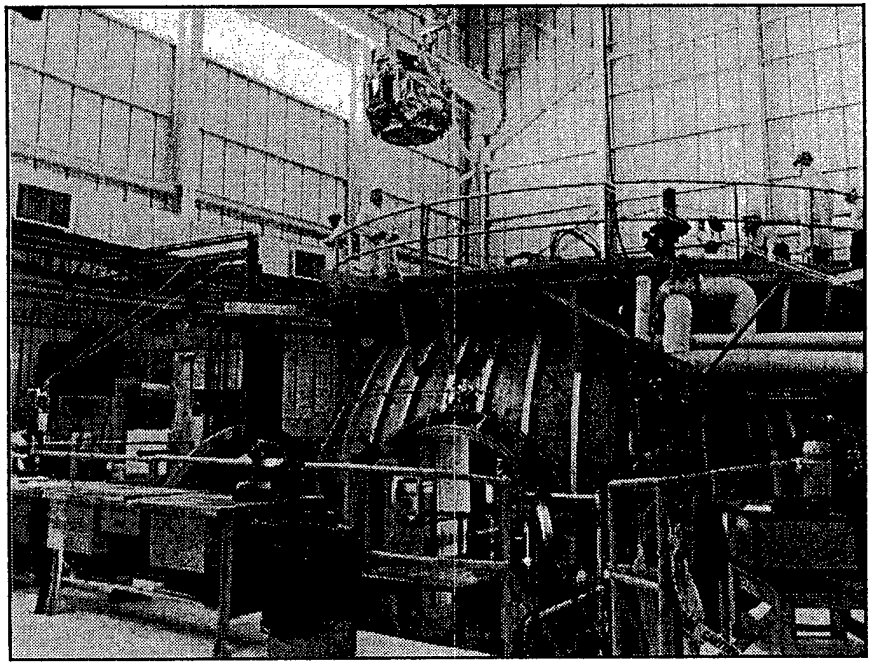


XLR-132 Engine,
1991

(SPEF) Test Sphere Area 1-42, C Cell

CAPABILITIES:

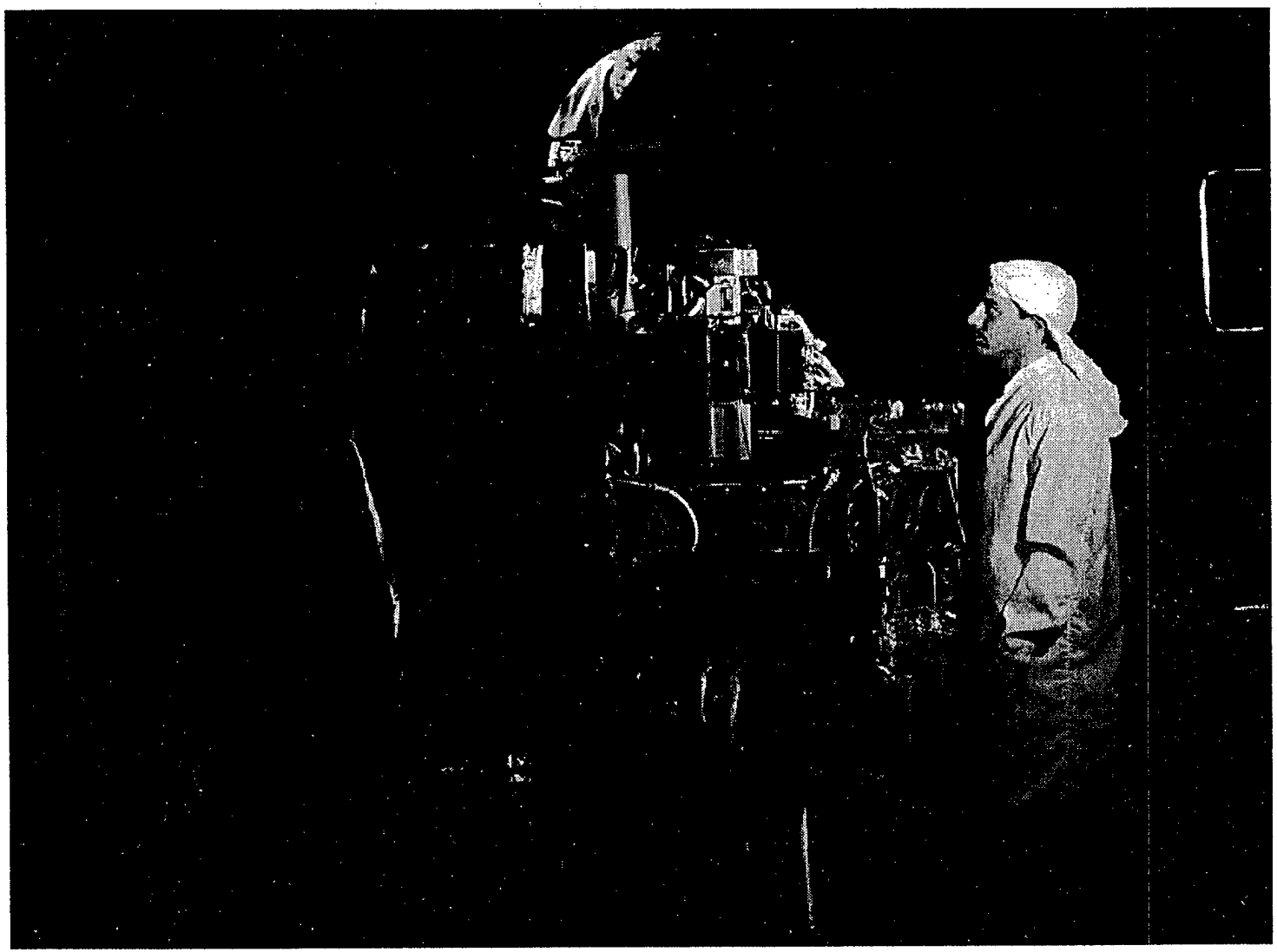
- **Mechanical pumped vacuum system**
  - Altitude simulation to 650,000 feet
  - Rotary piston pumps, roots blowers, and diffusion pumps
- **SPEF operations building**
  - Houses the test sphere and control center
  - 60 feet x 110 feet x 51 feet high
  - 60 ton and 10 ton traveling overhead cranes
- **Sphere 30 foot diameter**
  - 19 foot diameter removable top hatch
  - 8 foot diameter side access hinged door
  - LN2 cryogenic shroud to (-190 degree C)
    - 20 foot diameter x 22 foot high (with end caps)
  - Radiant heat IR simulator (200 watts/square foot)
  - Earth albedo simulator (maintain +/- 5 degree C)
    - 18 foot diameter aluminum disk with 99 heater elements
  - Film camera portholes and in-chamber video
  - Test article maximums
    - 100,000 lbs, 16 feet x 16 feet x 20 feet
  - 100K of TNT equivalent 1.1 class propellant
- **Data acquisition and control**
  - 150 channel temperature data system
  - 256 channel programmable logic control system



TESTING HISTORY

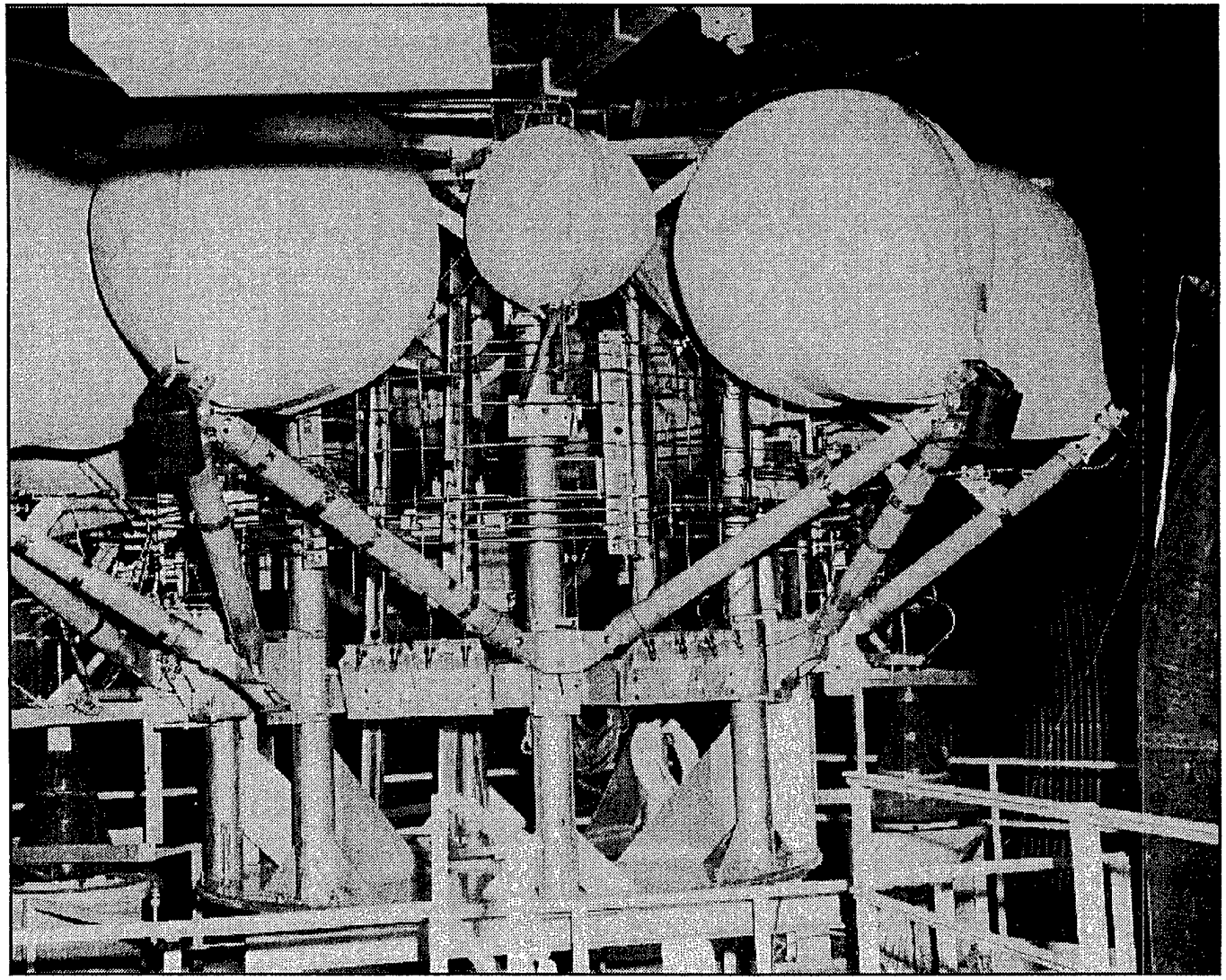
- Hughes TTM And STM
- Gossamer Structures
- Miniature Sensor Technology Integration (MSTI) Satellite I / II / III
- Centaur 1966
- Direct Chemical Laser (DCL) 1970-1974
- LASER Program (MESA) 1970-1974
- Centaur Propellant Storability

(SPEF) Test Sphere Area 1-42



MSTI II, 1995

(SPEF) Test Sphere Area 1-42, C Cell



Hughes TTM/STM 1980

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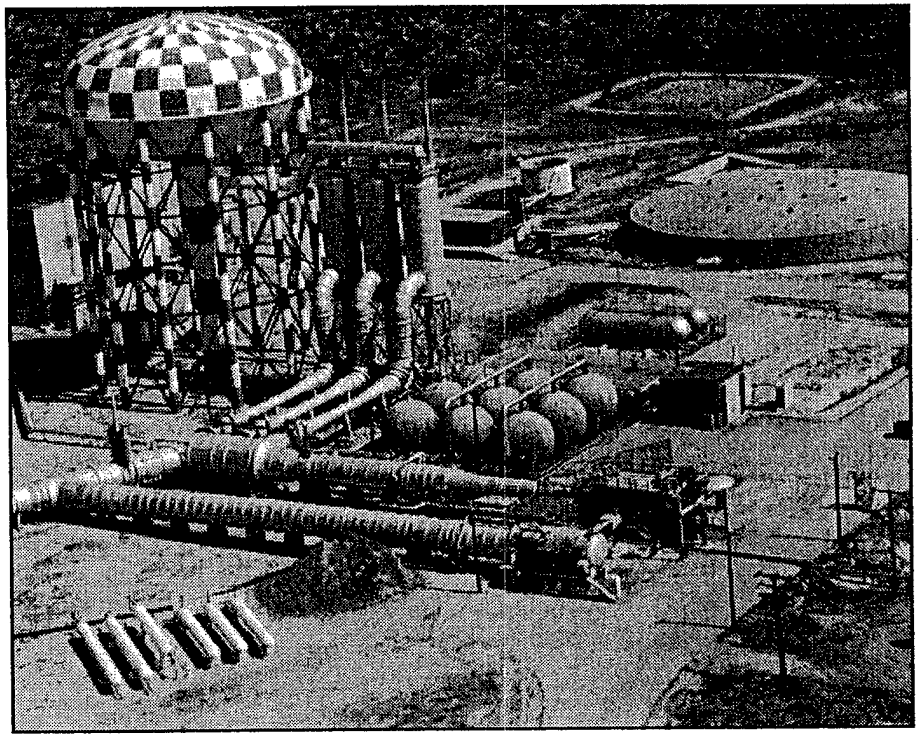
Horizontal Test Chamber Area 1-42, D Cell

CAPABILITIES:

- Altitude simulation to 125,000 feet
- Maximum thrust 20,000 lbf., horizontal
  - (Current configuration) 20,000 lbf. thrust, horizontal
  - Onboard automatic calibration system 99.9% accuracy
  - Motor spin and IR measuring capability
  - Six component thrust capability
- Chamber 10.5 foot diameter x 25 foot long
  - 10.5 ft. diameter clamshell door, 4 ft. x 8 ft. side door
  - 5 ton overhead crane
  - Film camera portholes and in-chamber video
  - No diffuser (55 inch diffuser maximum)
  - Solid motors up to 24 inch diameter x 182 inch long
- Environmental conditioning
  - (-30 to + 100 degrees F)
- 30K of TNT equivalent 1.1 class propellant



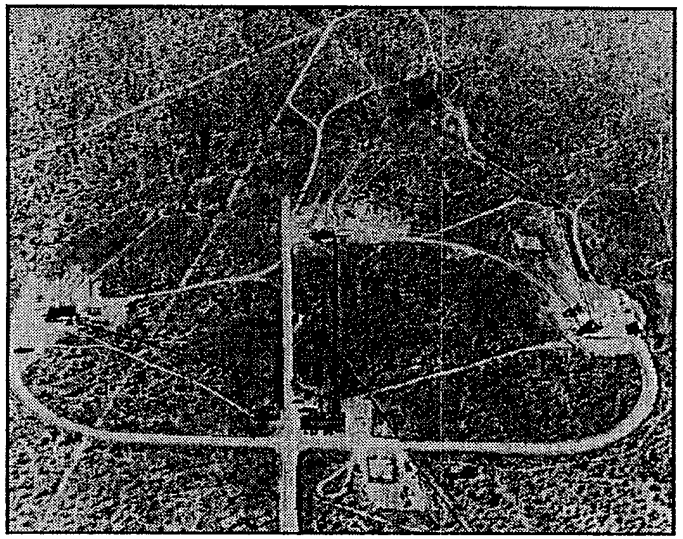
TESTING HISTORY

- Small ICBM
- Kinetic Energy Weapon (KEW)

Large Motor Operations Complex
Area 1-52

GENERAL AREA CAPABILITIES:
- 6,000 psi GN2 Cross Country Line
- 8 Inch Water Main
- 440 VAC Facility and 28 VDC Stand Power
- Data acquisition and control system
  - 192 channel, 100,000 sample per second, data system
  - 256 channel programmable logic control system
- Mechanical Shop
- 2 Assembly Buildings

TEST STAND CAPABILITIES:
(Current Configuration)
- Pad A - 50,000 lbf. Thrust
  - Horizontal or Vertical Firing
  - Liquid Engines or Solid Motors
- Pad B - No Thrust Stand
  - Horizontal or Vertical Firing
  - Solid Motors
- Pad C - 5,000 Lbf. Thrust
  - Hydrostatic Bearing Test Rig
  - Horizontal Orientation
  - Liquid Hydrogen Operations
- Pad D - No Thrust Stand
  - 250 Horsepower Commercial Air Conditioning System
  - Refrigerant Operations



TESTING HISTORY
- Liquid Fluorine Engine. 1969
- Graphite Overwrap Vessel, 1990
- Minuteman III, PAN Nozzle, 1989-1991
- Short Length SuperHIPPO, (SLSH), 1977-1983
- Minuteman III, Stage 3, Advanced Nozzle, 1983-1991
- Minuteman III, Stage 2, 1983-1989
- PeaceKeeper, Stage 3, 1982
- F-16 Hydrazine Tank Test
- STAR TEC, 1984-1985
- Bull Pup, 1982
- Titan Cook Off, 1985
- Kevlar Tank Tests, 1986
- Linear Areospike SR-71 Experiment LASRE, 1996
- Turbopump Component Technologies 1989-1996
- R134a Carrier Dual Use Technologies 1996-1997

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Large Motor Operations Complex
Area 1-52

GENERAL AREA CAPABILITIES:

- 6,000 psi GN2 Cross Country Line
- 8 Inch Water Main
- 440 VAC Facility and 28 VDC Stand Power
- Data acquisition and control system
  - 192 channel, 100,000 sample per second, data system
  - 256 channel programmable logic control system
- Mechanical Shop
- 2 Assembly Buildings

TEST STAND CAPABILITIES:

- Ground Level Testing
- Environmental Conditioning
- Pad A - Maximum Thrust 250,000 lbf.
  - (Current Configuration) 50,000 lbf. Thrust
  - Horizontal or Vertical Firing
  - Assembly Building
  - 77,000 lbs of TNT Equivalent Propellant
- Pad B - Maximum Thrust 250,000 lbf.
  - (Current Configuration) No Thrust Stand
  - Horizontal or Vertical Firing
  - 77,000 lbs of TNT Equivalent Propellant

TEST STAND CAPABILITIES (Cont):

- Pad C - Maximum Thrust 250,000 Lbf.
  - (Current Configuration) 5,000 lbs. Thrust
  - Horizontal Orientation
  - Hydrostatic Bearing Test Rig
  - 70,000 lbs of TNT Equivalent Propellant
- Pad D - Maximum Thrust 250,000 lbf.
  - (Current Configuration) No Thrust Stand
  - 250 Horsepower Commercial Air Conditioning System
  - 70,000 lbs of TNT Equivalent Propellant
  - C/D Stand Assembly Building

TESTING HISTORY

- Liquid Flourine Engine. 1969
- Minuteman III, Pan Nozzle, 1989-1991
- Short Length SuperHIPPO, (SLSH), 1977-1983
- Minuteman III, Stage 3, Advanced Nozzle, 1983-1991
- Minuteman III, Stage 2, 1983-1989
- Graphite Overwrap Vessel, 1990
- PeaceKeeper, Stage 3, 1982
- STAR TEC, 1984-1985
- F-16 Hydrazine Tank Test
- Titan Cook Off, 1985
- Bull Pup, 1982
- Kevlar Tank Tests, 1986
- Linear Areospike SR-71 Experiment LASRE, 1996
- Turbopump Component Technologies 1989-1996
- R134a Carrier Dual Use Technology 1996-1997

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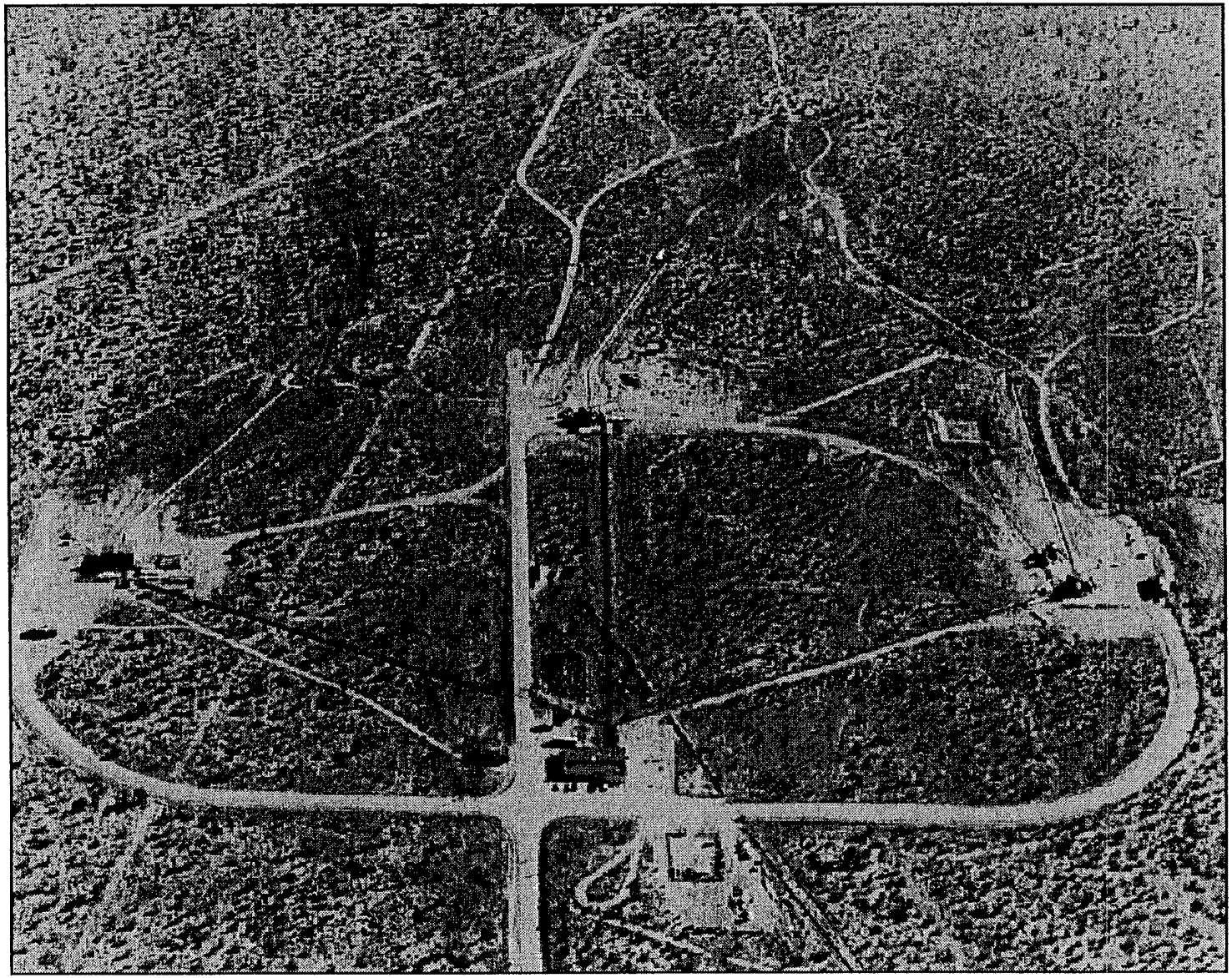
Large Motor Operations Complex
Area 1-52



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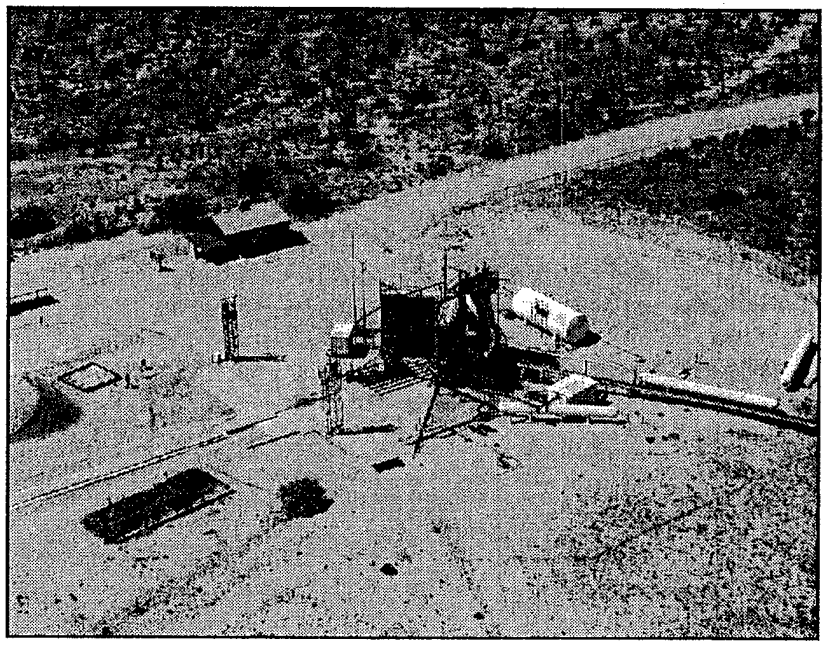
Rocket Motor Test Stand
Area 1-52, Test Stand A

CAPABILITIES:

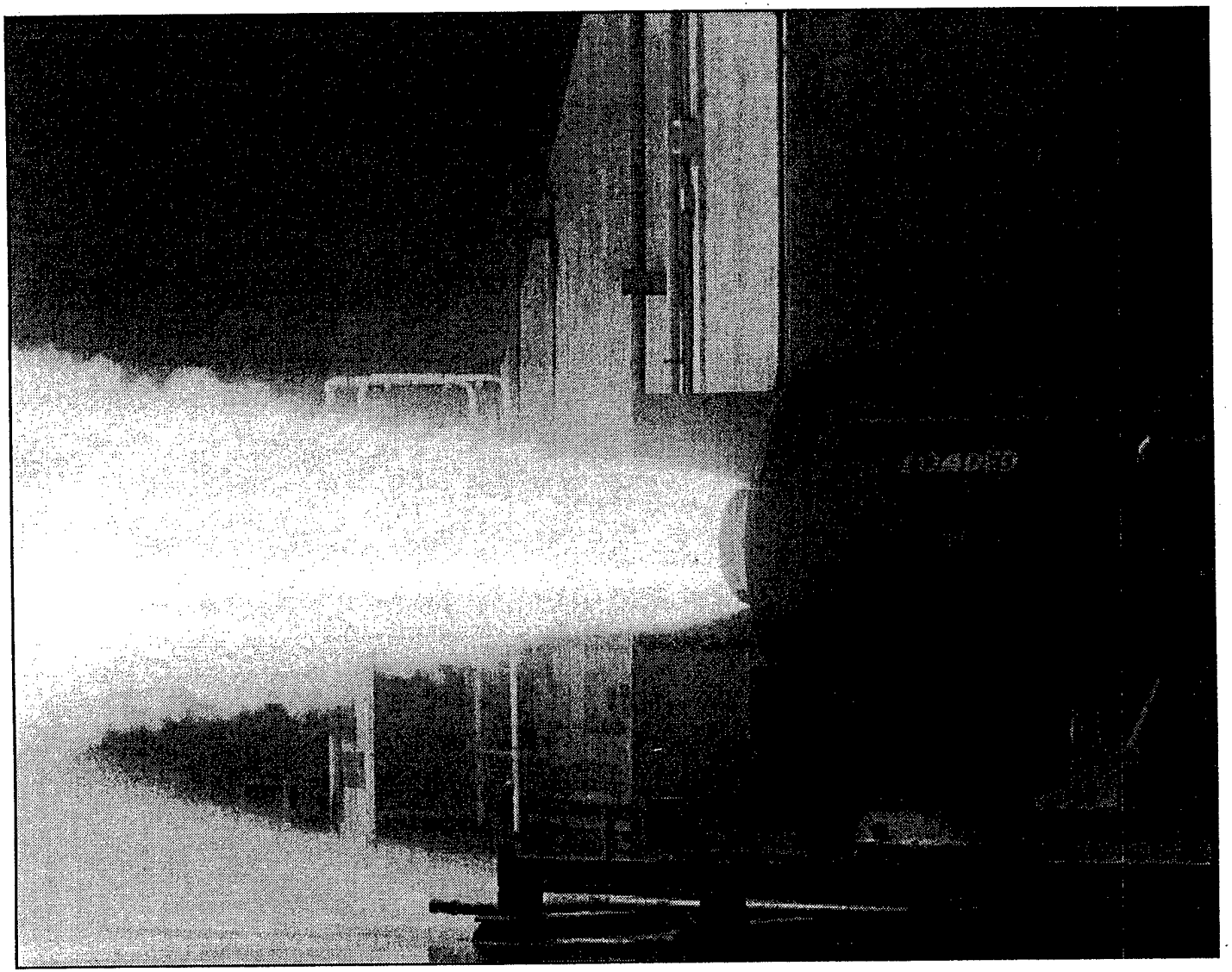
- Ground Level Testing
- Storable, Cryogenic, and Solid Propellant
- 30' x 44' x 5' Concrete Pad
- 25 ft high, 6 ft thick, vertical, reinforced concrete walls
- Horizontal or Vertical Firing
- Maximum Thrust 250,,000 lbf.
- (Current Configuration)
  - 50,000 lbf. Thrust Stand
  - Horizontal, Single Axis
- 4500 gallon DI water
- 28,000 gallon, 35 psig, LN_2 dewar
- 5000 gallon, 1500 psig, LH_2 run dewar
- 546 ACF, 6000 psig, GH_2 vessel
- 70,000 lbs of TNT Equivalent Propellant



TESTING HISTORY

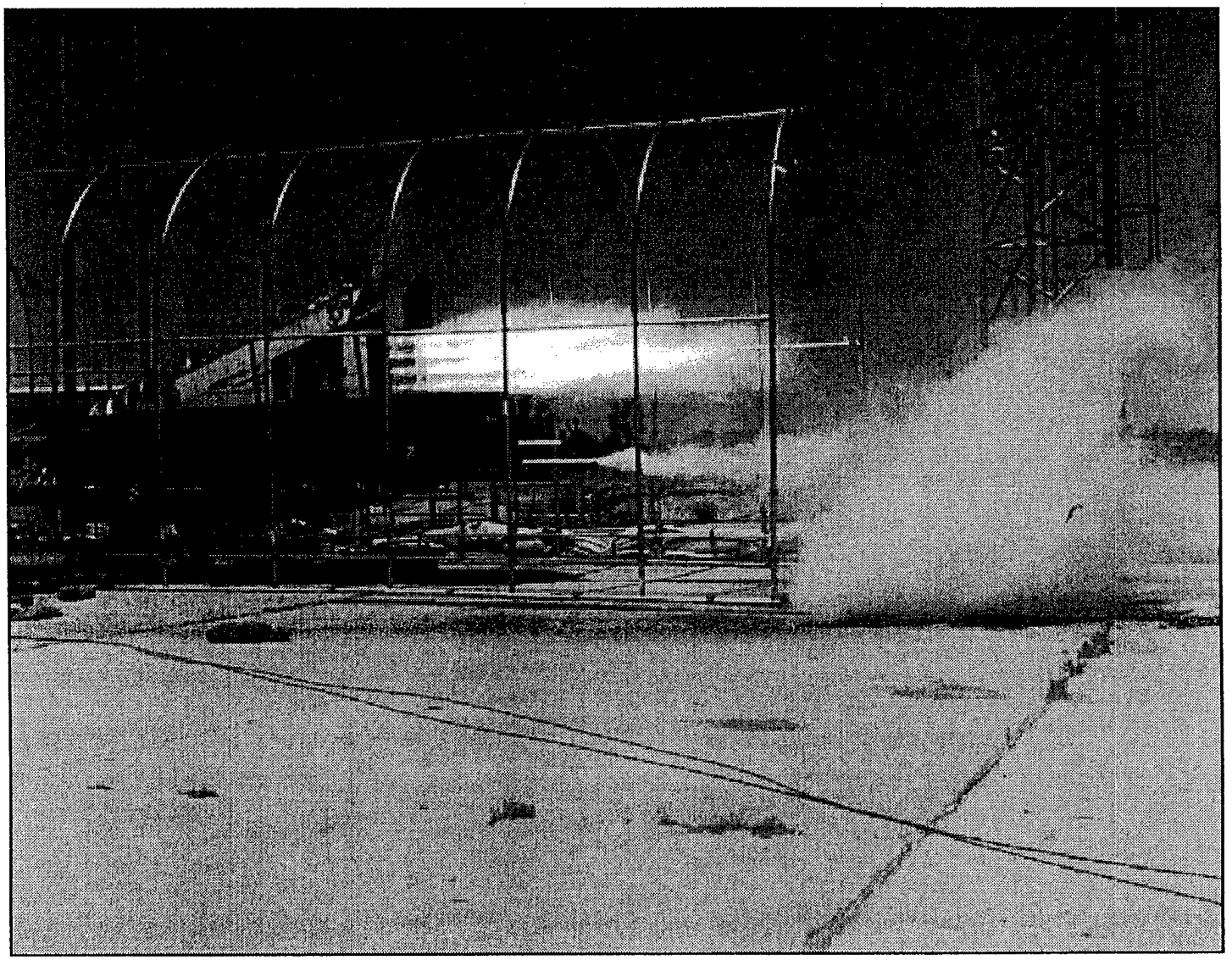
- Liquid Fluorine Engine. 1969
- Minuteman III, PAN Nozzle, 1989-1991
- Short Length SuperHIPPO, (SLSH), 1977-1983
- Zirconium Replacement Studies, 1983-1985
- Minuteman III, Stage 2, 1983-1989
- Small ICBM (SICBM) 1989
- F-16 Hydrazine Tank Test
- Motor Influence 1977
- Joint Live Fire 1986
- Linear Areospike SR-71 Experiment LASRE, 1996

Large Motor Operations Complex, Pad A



Minuteman III, Stage 3, 1985

Large Motor Operations Complex, Pad A



Linear Aerospike SR-71 Engine, 1997

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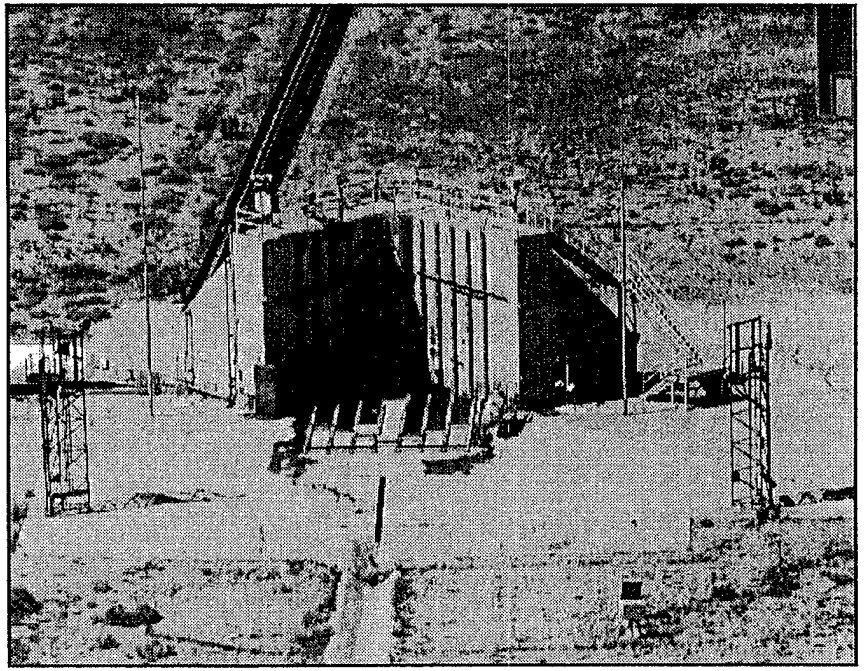
Large Motor Test Stand
Area 1-52, Test Stand B

CAPABILITIES:

- Ground Level Testing
- Storable and Solid Propellant
- 30' x 45' x 5' Concrete Pad
- Horizontal or Vertical Firing
- Maximum Thrust 250,000 lbf.
- (Current Configuration)
  - No Thrust Stand
- 70,000 lbs of TNT Equivalent Propellant



TESTING HISTORY

- Special High Performance Ignition Technology (SHIPIT). 1983
- Minuteman III, Stage 3, Advanced Nozzle, 1983-1991
- Minuteman III, Stage 2, 1983-1989
- PeaceKeeper Design Margin, 1988
- PeaceKeeper, Stage 3, 1982
- Titan Cook Off, 1985
- Bull Pup, 1982
- 84 Inch CHAR Motor, 1980-198

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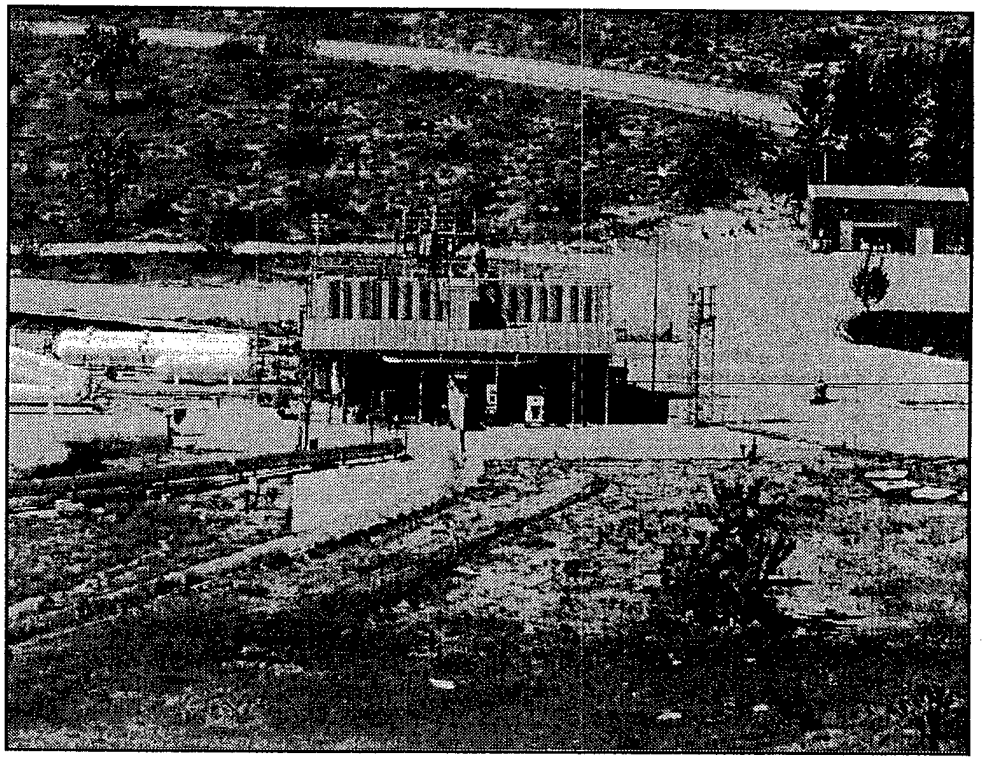
Large Motor Test Stand
Area 1-52, Test Stand C

CAPABILITIES:

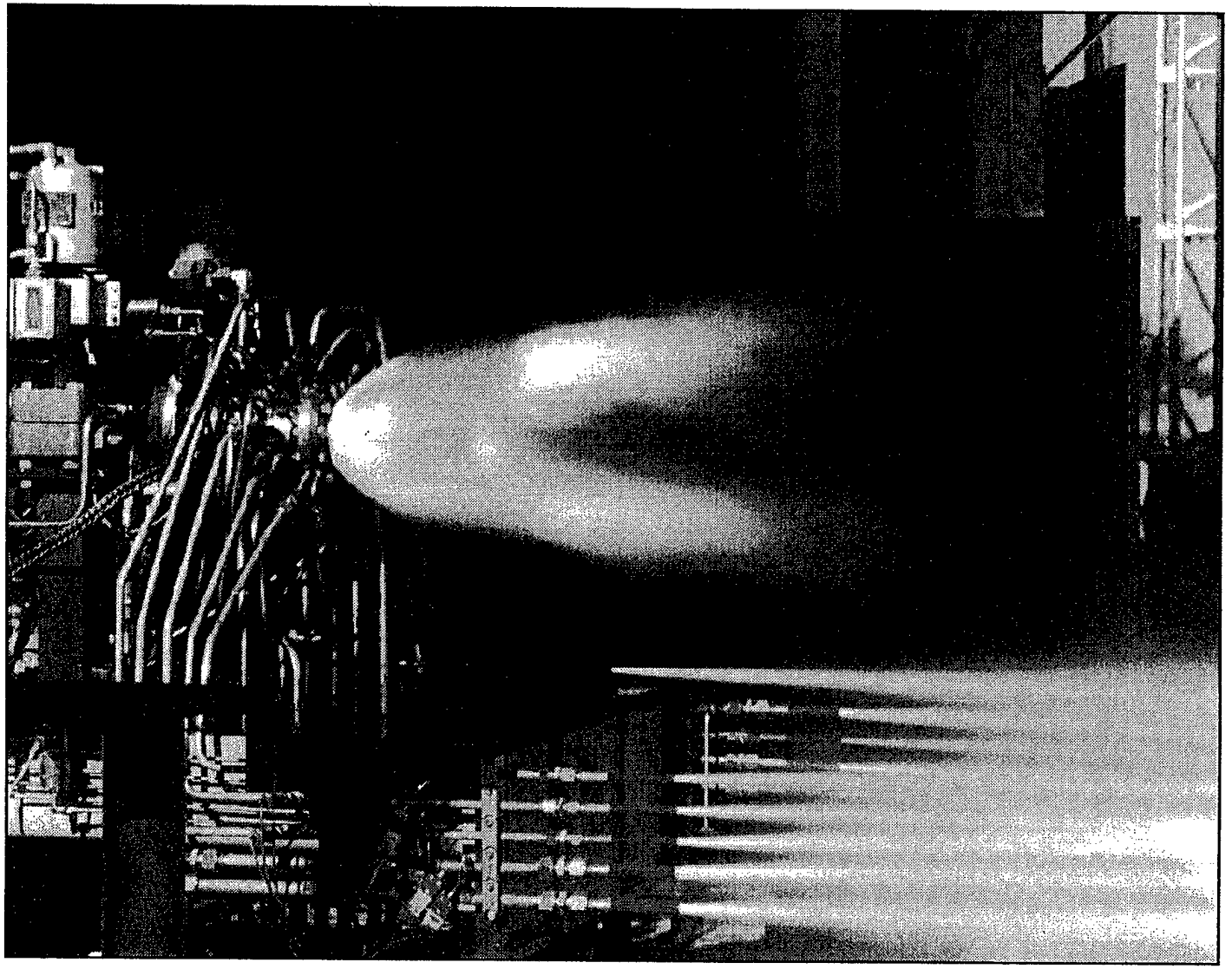
- Modified for High Pressure Cryogenic or Steel Bearing Material Testing
- Ground Level Testing
- Storable, Cryogenic, and Solid Propellant
- 28' x 30' x 5' Concrete Pad
- 2-ton monorail hoist runs throughout C/D pad
- Horizontal Orientation
- Maximum Thrust 250,000 lbf.
- (Current Configuration)
  - 5,000 Lbf Thrust Stand
  - Hydrostatic Bearing Test Rig
- 77,000 lbs of TNT Equivalent Propellant
- Hydrogen Burn Stack; 16 Lb/Mass Per Second



TESTING HISTORY

- Nose Tip Testing, 1972-1980
- Graphite Overwrap Vessel, 1990
- STAR TEC, 1984-1985
- Turbo Pump Component Technologies 1989-1996
- R134a Carrier Dual Use Technologies 1996-1997

Large Motor Operations Complex, Pad C

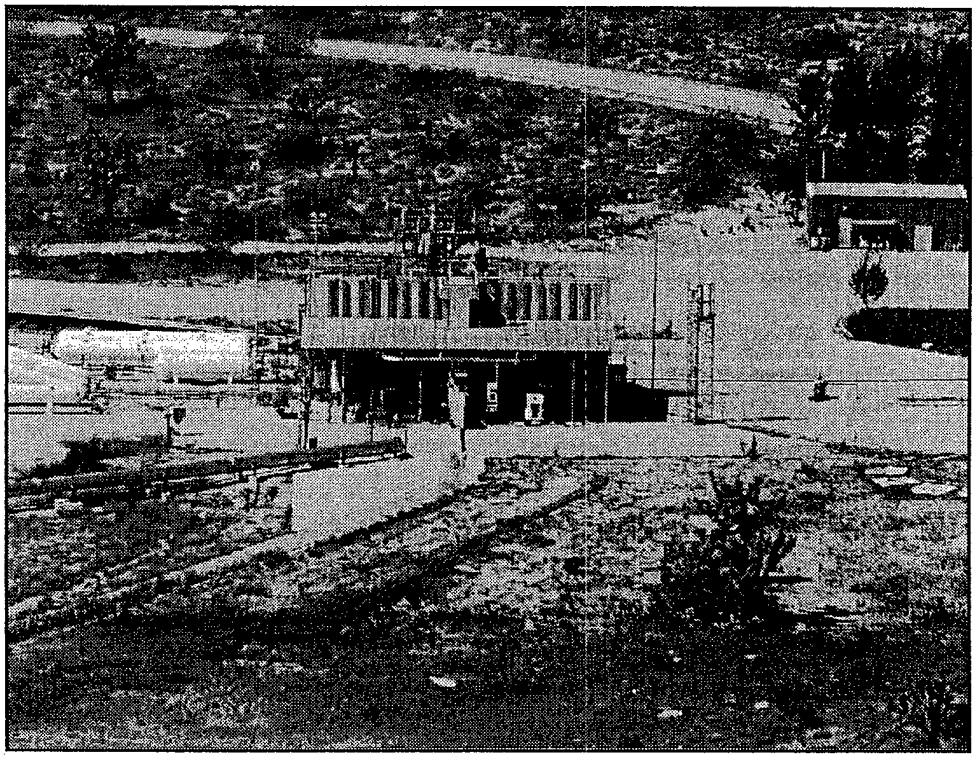


ABRES Nosetip Chamber Assembly, 1972 - 1980

Large Motor Test Stand
Area 1-52, Test Stand D

CAPABILITIES:

- Ground Level Testing
- Storable, Cryogenic, and Solid Propellant
- 28' x 30' x 5' Concrete Pad
- Horizontal Orientation
- Maximum Thrust 250,000 lbf.
- (Current Configuration)
  - No Thrust Stand
- 77,000 lbs of TNT Equivalent Propellant
- Tankage shared with C pad
  - Two 3920 gallon, 6000 psig, DI water
  - 21,850 gallon, 415 psig, LH_2 dewar
  - 1200 gallon, 6015 psig, LH_2 run dewar
  - 1000 gallon, 1000 psig, LOX run dewar
  - 500 gallon, 3700 psig, tri-wall, LF_2 run dewar
  - 299 ACF, 6000 psig, GH_2 vessel
  - 70 gallon, 3500 psig, N_2O_4 run tank
  - 25 gallon, 700 psig, N_2O_4 catch tank
  - 70 gallon, 3500 psig, MMH run tank
  - 25 gallon, 700 psig, MMH catch tank



TESTING HISTORY

- Kevlar Tank Tests, 1986
- Carrier Air Conditioner (ARPA), 1996

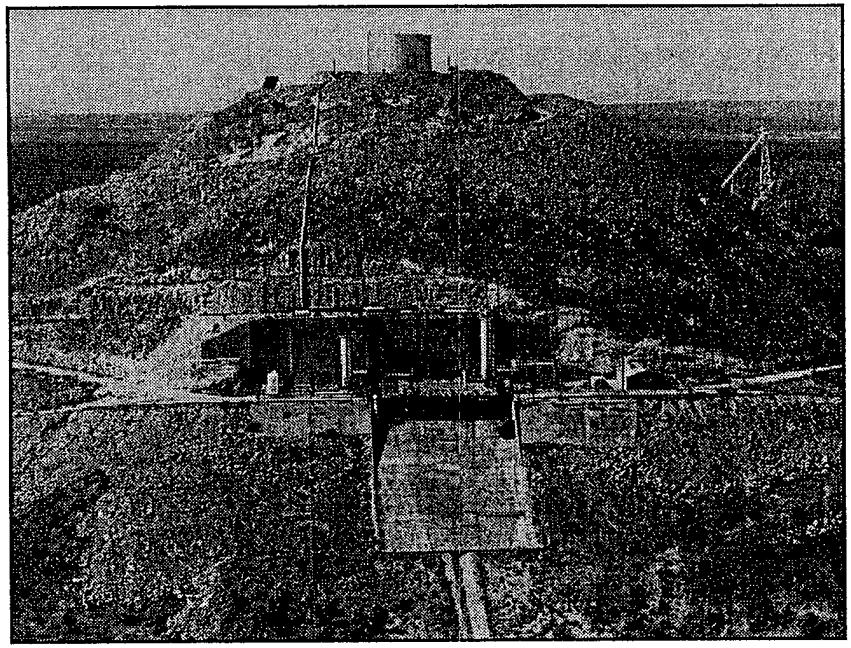
High Thrust Facility Area 1-56

GENERAL AREA CAPABILITIES:

- 6,000 psi GN2 cross country line, 6,000 psi
- 12 inch diameter water main to fill storage tank
- 1 Million gallon deluge water storage
  - 20-inch diameter water line from storage tank to pad
- 440 VAC and 28 VDC stand power
- SHOPS:
  - Control Sta., 5,000 sq. ft.
  - Mechanical, 2 ea., 5,000 sq. ft.

TEST STAND CAPABILITIES:

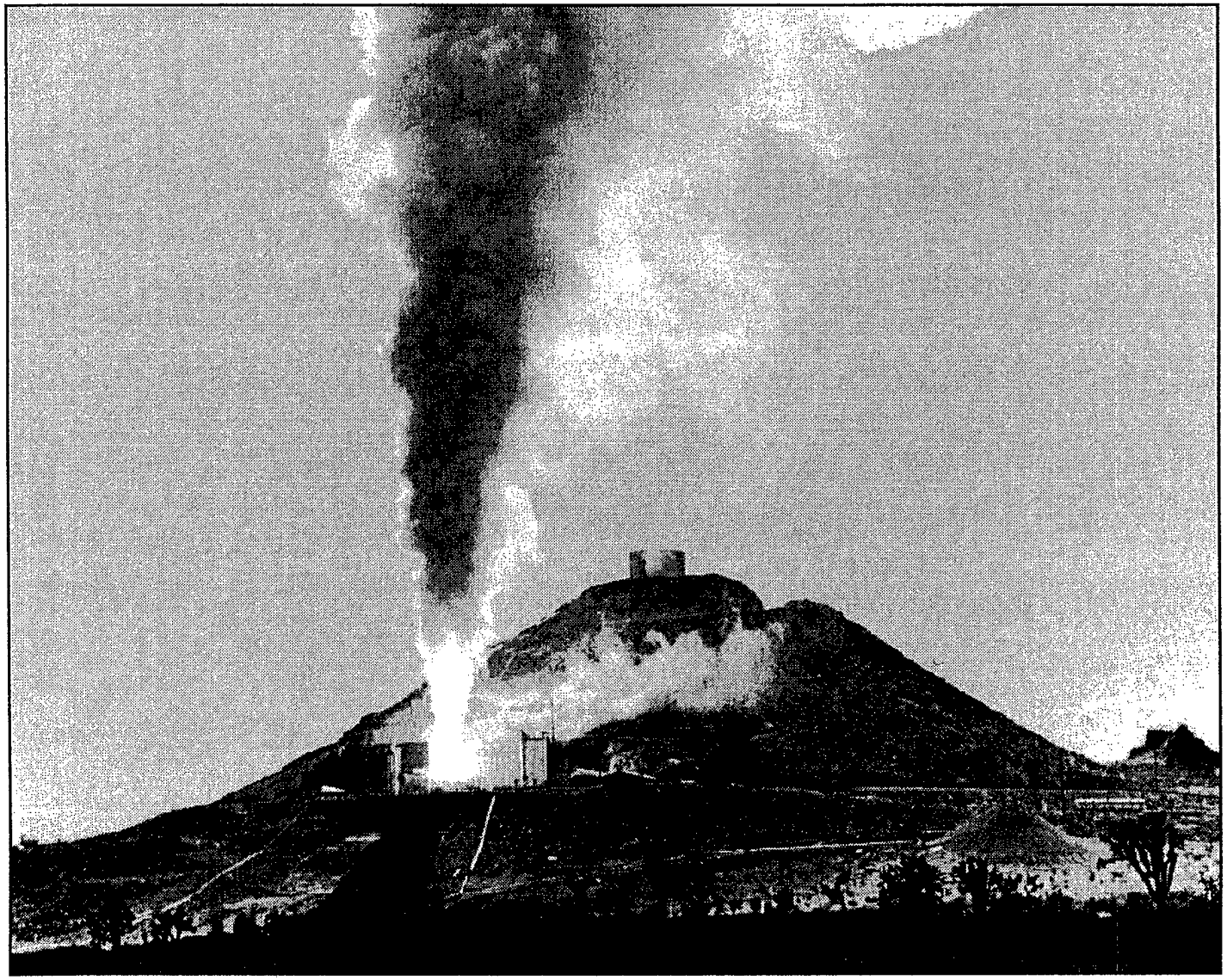
- Ground level testing
- 100 ft. deep, 120 ft. wide, 8 ft. thick, reinforced concrete pad, 50 ft. high vertical wall
- Cryogenic; storable; solid
- Maximum thrust, 10,000,000 lbs
  - Current configuration
    - 450,000 lbf thrust, vertical, nozzle up, six-component
    - 400,000 lbf thrust, horizontal, six-component
      - Maximum downward displacement 15 degrees
- 2,500,000 lbs class 1, TNT equivalent
- 1000 gallon, 400 psig LOX run tank
- GN2 Vessels, 2 ea., 270 cu. ft., 6,600 psi
- 9000 gallon, 800 psig, hydrazine run tank
- 12,000 gallon, 800 psig, nitrogen tetroxide run tank



TESTING HISTORY

- Extended Length SuperHIPPO (ELSH)
- Big Dumb Booster (Low Cost, High Thrust, Space Shuttle Alternative)
- AMROC Hybrid 1995
- Railroad Tank Car (Propane Relief Valve)
- X-33 Launch Facility 1997

High Thrust Facility



Extended Length Super HIPPO, 1985

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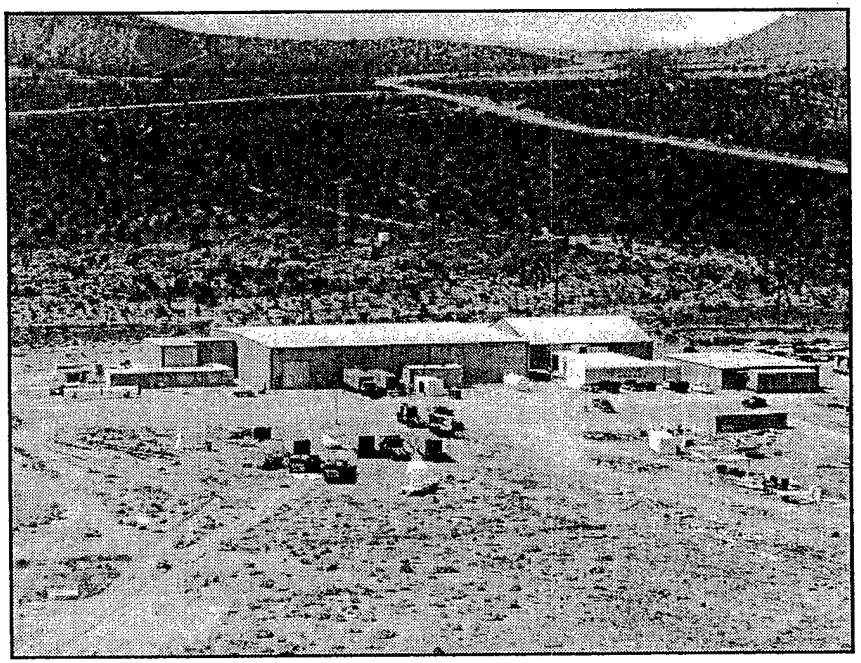
Satellite Test & Integration Facilities Area 1-90

DESIGNED CAPABILITY:

- Designed to hold three small satellites simultaneously
- 10,000 parts per million clean room capability
- Controlled temperature 70 to 78 degrees
- Relative humidity control
  - 30 to 50 Percent
- Static discharge protection
- Sealed corridors between buildings
- One-ton capacity overhead crane with load attenuating devices
- 34,900 square feet of test area
  - Altitude simulations
  - Vibration table
  - Telemetry ground station

CURRENT CAPABILITY:

- Facility inactive
- Equipment removed



TESTING HISTORY:

- Miniature Sensor Technology Integration (MSTI) - MSTI 1, MSTI 2 & MSTI 3
- Advanced Concept Architecture Test (ACAT) - ACAT Vehicle
- Summer Undergraduate Research Fellowship Satellite (SURF SAT)

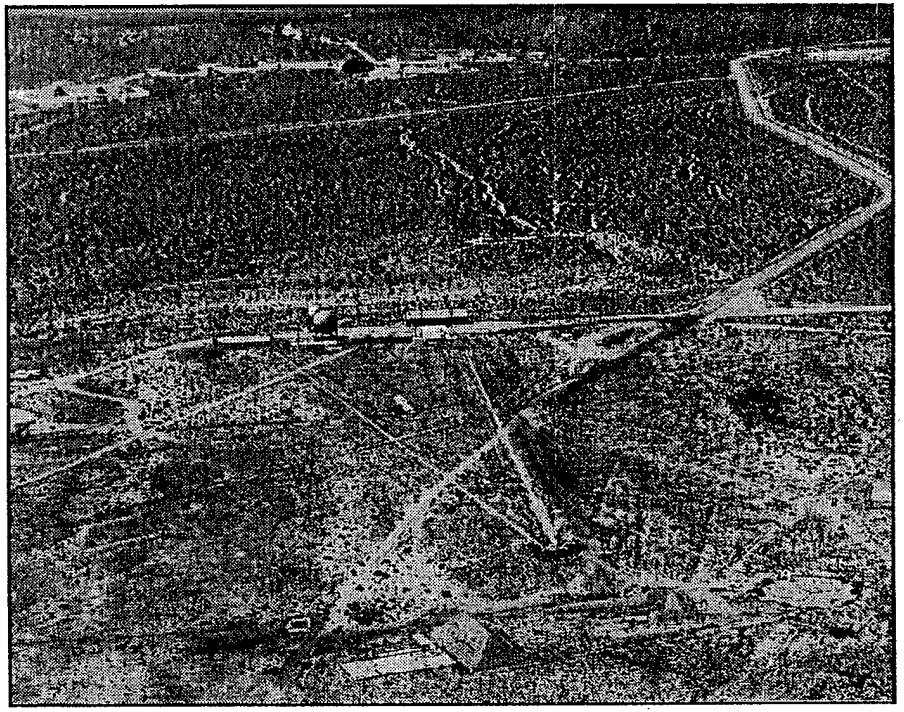
Blast Hazard Complex Area 1-90, Test Pad 1-90

FACILITIES CAPABILITIES:

- Blast hazard capability converted to satellite test and integration complexes

TEST STAND CAPABILITIES:

- Historic
  - Ground level testing
  - Liquid propellant
  - Bare pad
  - 150,000 lbs TNT equivalent



TESTING HISTORY:

- Titan I, 1st Stage
- Saturn S4B
- Blast Hazard Studies for Apollo Program

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Blast Hazard Complex Area 1-90, Test Pad 1-95

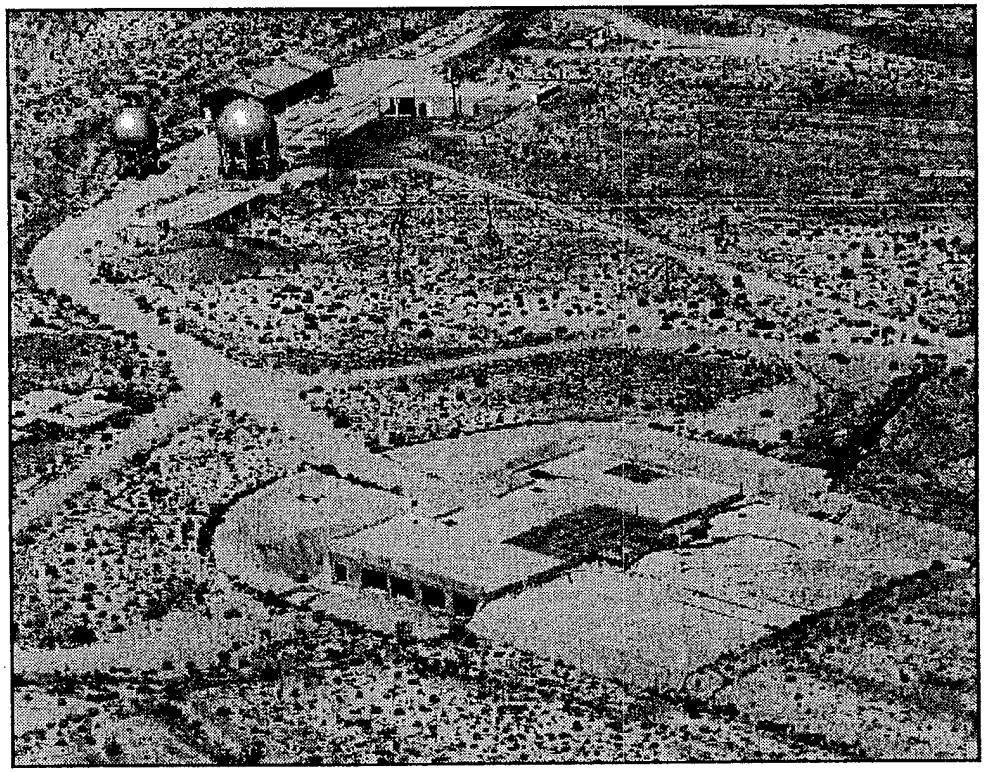
FACILITIES CAPABILITIES:

- Blast hazard capability converted to satellite test and integration complexes

TEST STAND CAPABILITIES:

HISTORIC:

- Atlas first "fast" loading of LOX and RP-1 propellants



TESTING HISTORY:

- Atlas Propellant Loading

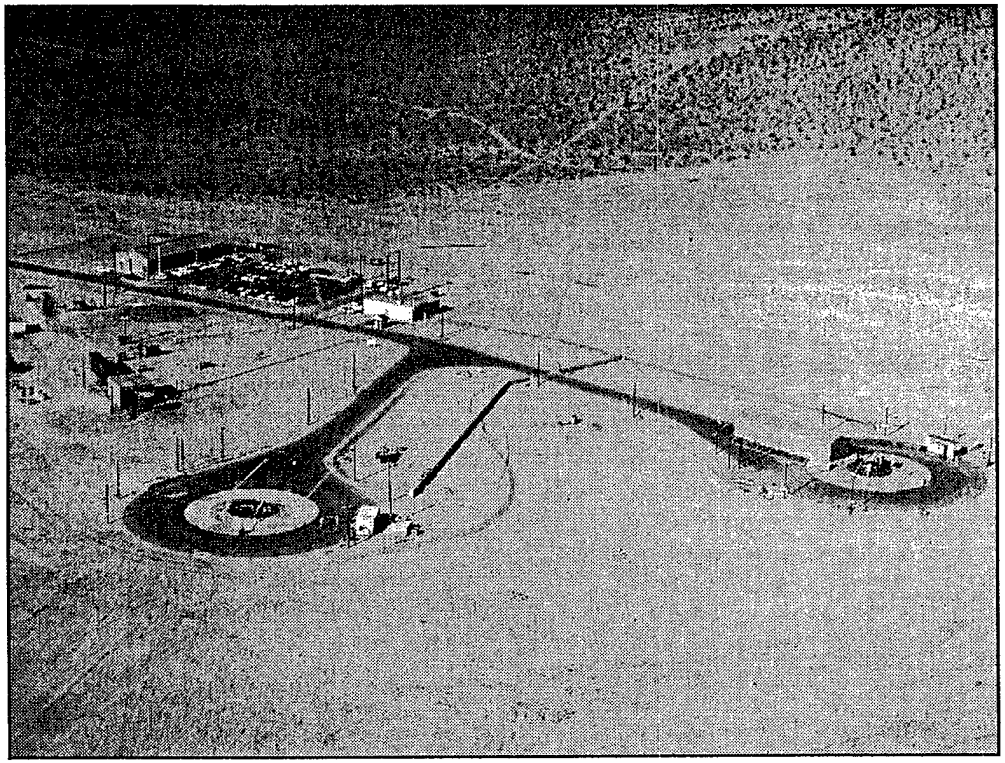
Silo Complex Area 1-100

FACILITIES CAPABILITIES:

- Facility inactive
- GN2, power available
- Mechanical shop

TEST STAND CAPABILITIES:

- Two silos, 26 feet in diameter
  - 86 feet deep
- Silos are inactive



TESTING HISTORY:

- Minuteman Tethered Launch
- PeaceKeeper Tethered Launch
- Leonid Storm 1997

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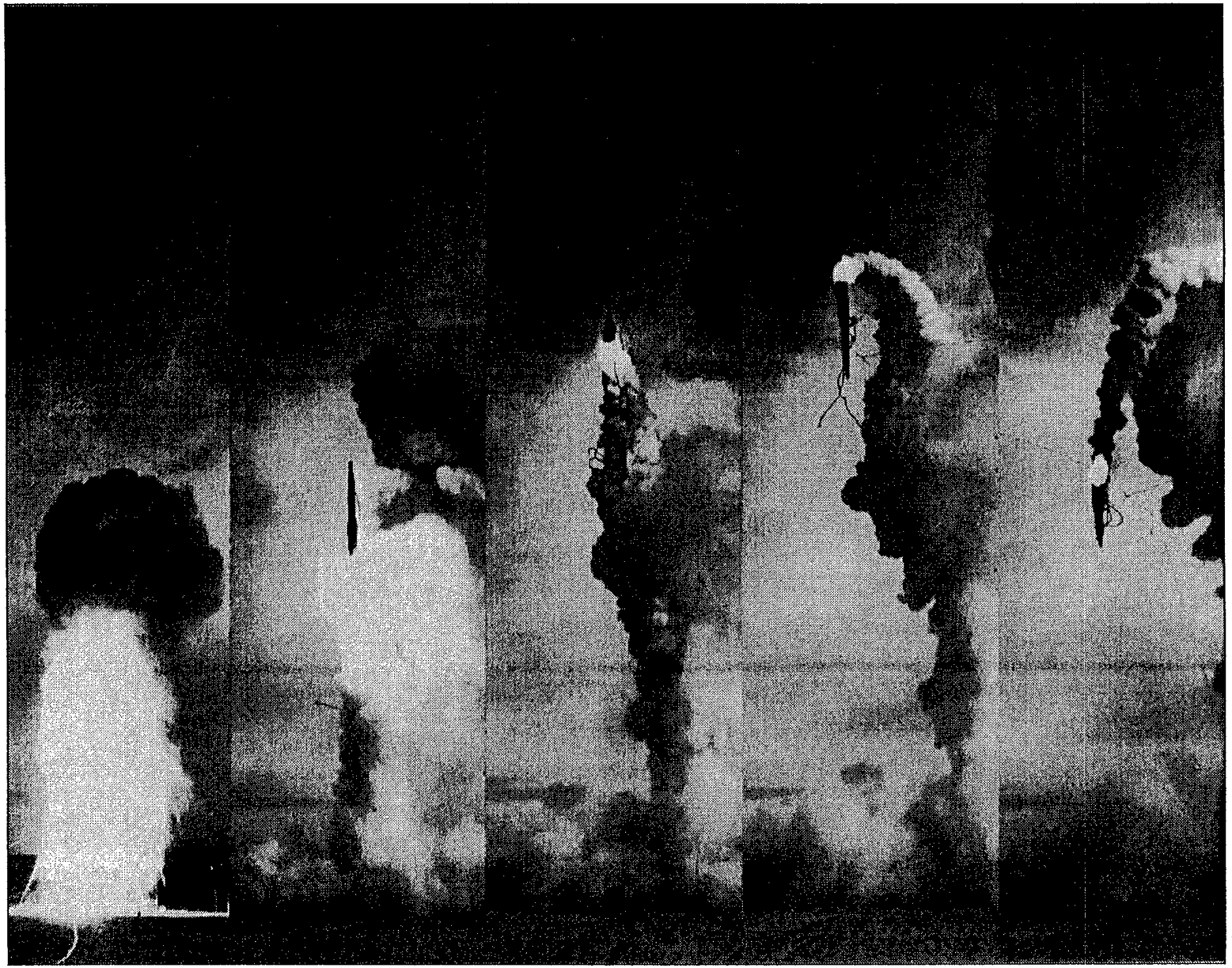
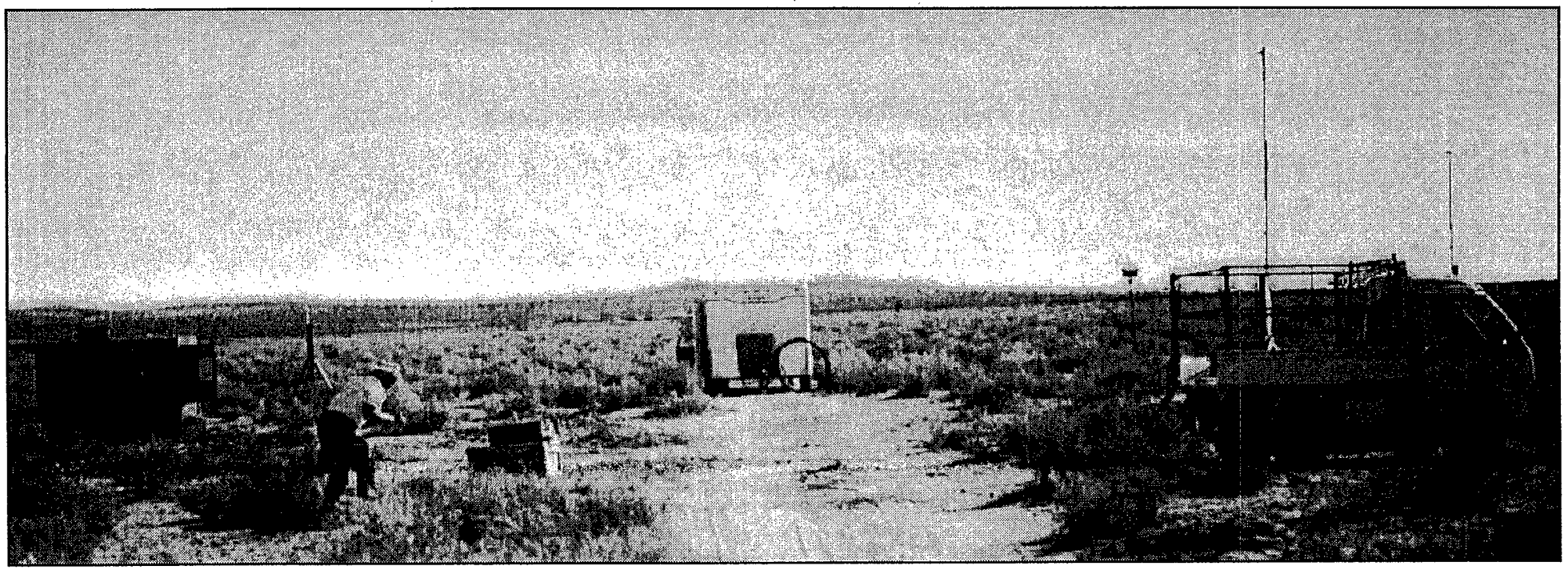
Minuteman Tethered launch Test Area 1-100



Silo Complex Area 1-100



Leonid Storm Meteorite Shower, NOV 1997

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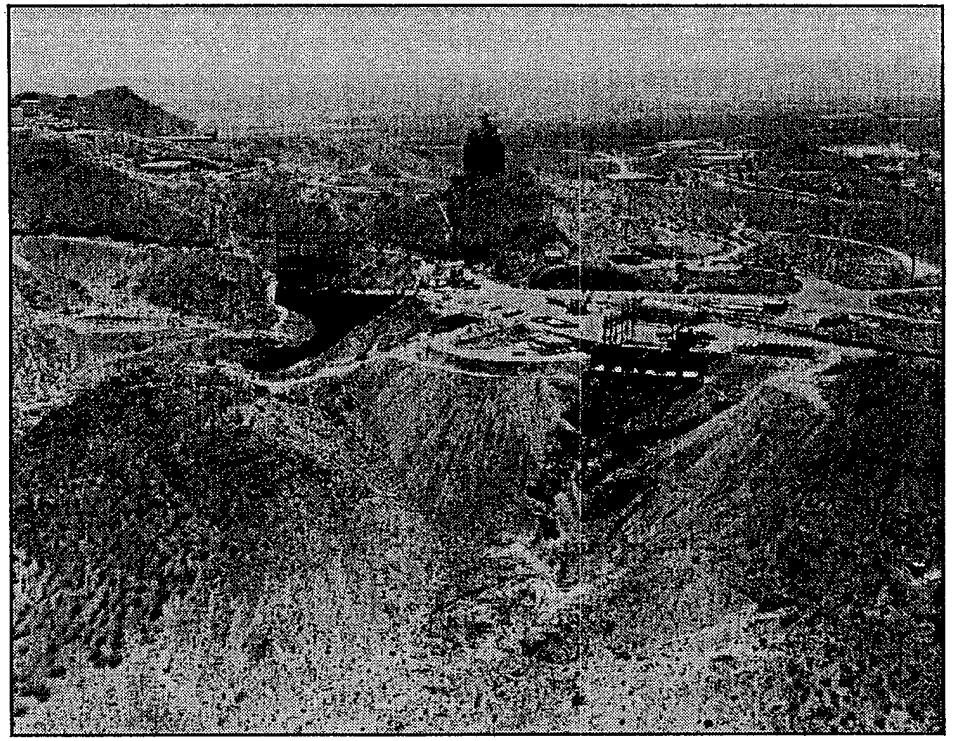
Large Engine Component/System Test Complex
Area 1-120

GENERAL AREA CAPABILITIES:

- 6,000 psi GN2 cross country line
  - Can be pumped up to 10,000 psi
- 6 Inch water main
- 440 VAC and 28 VDC Stand Power
- 3,500 psi stand hydraulics
- Ground level mechanical shop
  - With 5 to 10 ton traveling overhead cranes
- Additional mechanical shops beneath test stand
  - Small fabrication / repair
- Data acquisition and control system
  - 320 Channel, 100,000 sample per second

TEST STAND CAPABILITIES: (CURRENT CONFIGURATION)

- Ground level testing
- Test stand 2 - A, thrust abutment, 45 degree down
  - GN2 run/storage; 6,000 psi, 5010 cubic feet
  - LO2 run tank; 8,500 psi, 2,000 gallon
  - LH2 run tank; 8,500 psi, 3,800 gallon
- Test stand 1 - A, 1.6M lbf thrust, nozzle down
  - GN2 run/storage; 4,500 psi, 2850 cubic feet
  - LO2 run tank; 165 psi, 75,000 gallon
  - LH2 run tank; 165 psi, 90,000 gallon
- Test stand 1 - B, inactive, nozzle down



TESTING HISTORY

- F-1 Thrust Chamber (5,000 Firings)
- F-1 Engines, 750 firings (early 60s and 70s)
- Atlas (System) Tests (1957 - 1959)
- F-1 Engines, 980 firings (early 60s and 70s)
- RS-68 EELV 1997 -

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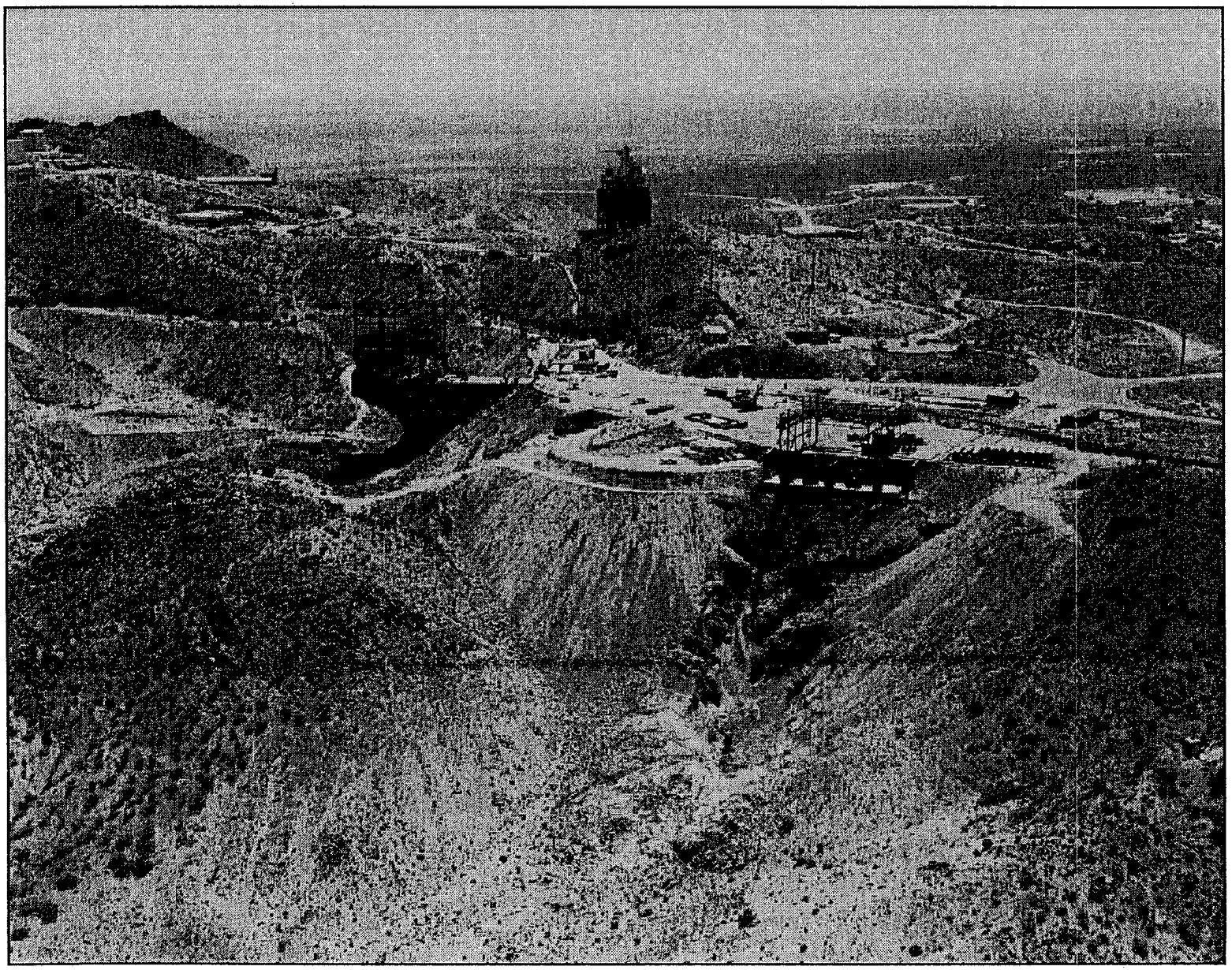
Large Engine Component/System Test Complex
Area 1-120



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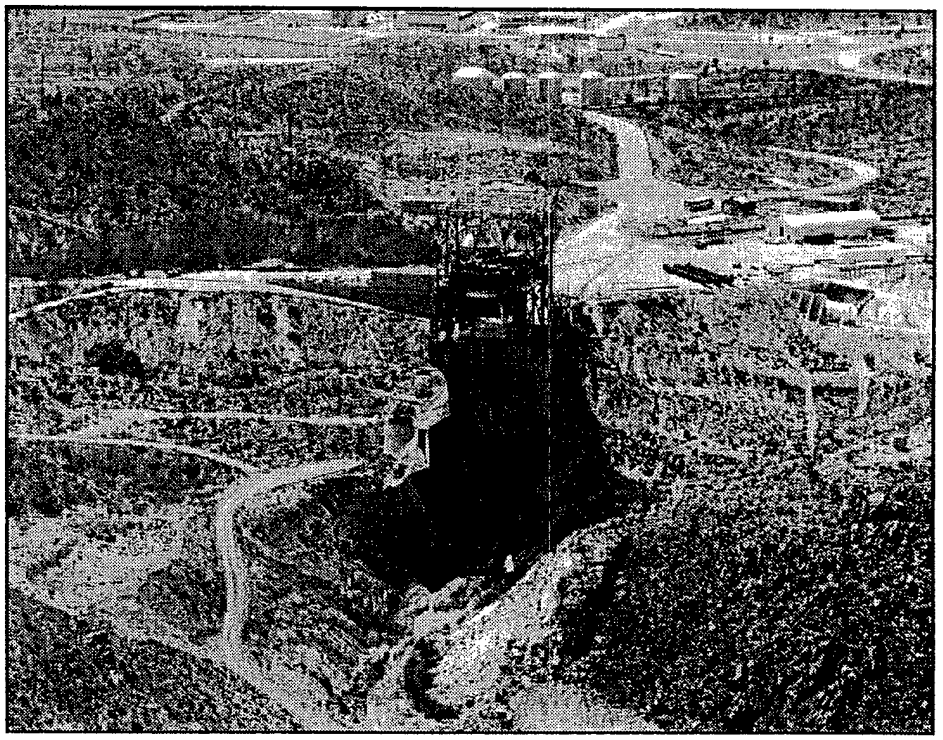
Large Engine System Test Stand, Area 1-120, Test Stand 1-A

CAPABILITIES:

- 4,500 psi GN2 line, 2850 cubic feet storage
- 14 inch water main from lake bed wells
- 440 VAC and 28 VDC stand power
- 3,000 psig, 35 gpm, hydraulic system
- Access to the 2A mechanical shop
  - With 10 ton traveling overhead cranes
- 1,000,000 gallon, gravity fed, flame deflector water storage
  - 1,200,000 gallon catch basin
- 14 inch and 12 inch diameter FIREX supply, 800,000 gallon storage
- Data acquisition and control system
  - 320 channel, 100,000 sample per second
  - 2 each, 16 channel, 3,200,000 samples per second
  - 256 Channel Programmable Logic Control
- Ground level testing
- Test Article space: 32 ft by 32 ft by 32 ft
- Maximum thrust 2,000,000 lbf, nozzle down
  - (Current configuration) thrust stand
    - 1,600,000 lbf Axial Thrust
- LO2 Run System; 75,000 Gallon, 165 psi
- Fuel Run System; LH2/RP-1, 90,000 Gallon, 165 psi
  - 60,000 hp, high pressure GH_2 system, 10,000 psig
  - 24 inch diameter hydrogen burn stack
- 20,000 lb TNT Equivalent of 1.1 Propellant



TESTING HISTORY

- Atlas (System) Tests (1957 - 1959)
- F-1 Engines, 750 firings (early 60s and 70s)
- RS-68 EELV 1997 -

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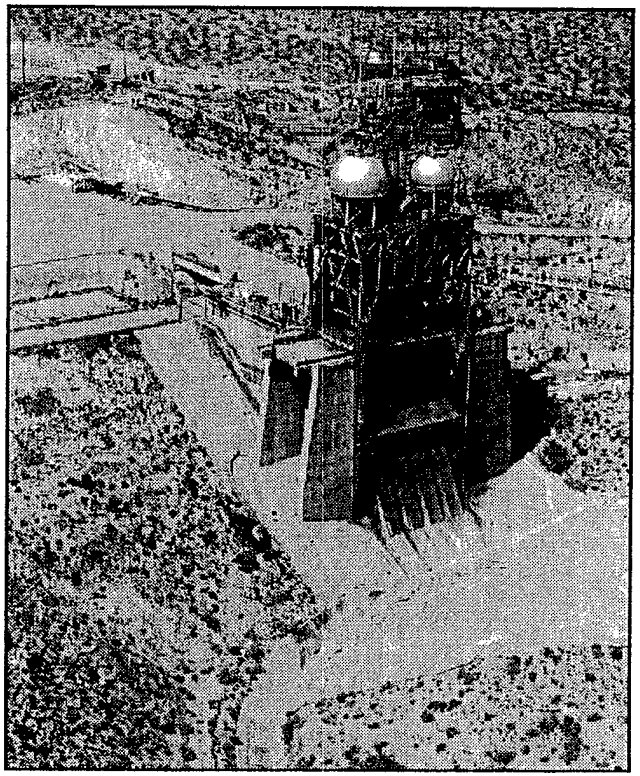
Large Engine System Test Stand, Area 1-120, Test Stand 1-B

CAPABILITIES:

- 4,500 psi GN2 line, 2850 cubic feet storage
- 14 inch water main from lake bed wells
- 440 VAC and 28 VDC stand power
- Mechanical shop
- Additional mechanical shop beneath test stand
- Flame deflector for two engines side-by-side
  - 54 inch diameter flame deflector water line from Building
- Intact, unlined, flame deflector water reclamation pond
  - 3,000,000 gallon capacity
  - 8 inch diameter return line to Building 8792
- Data acquisition and control system from test stand 1A blockhouse
- Ground level testing
- Two position, nozzle down test stand
- Room for 30 ft. by 60 ft test article
- Maximum thrust 6,000,000 lbf, 4 F1 cluster, nozzle down
  - (Current configuration) inactive, no thrust stand
- 75,670 gallon, 165 psig, LO_2 run tank
- 60,000 gallon, 150 psig, RP-1 run tank
- 10 ton traveling first story crane
- 5 ton jib crane on top of stand
- 100,000 lb TNT equivalent of 1.1 propellant



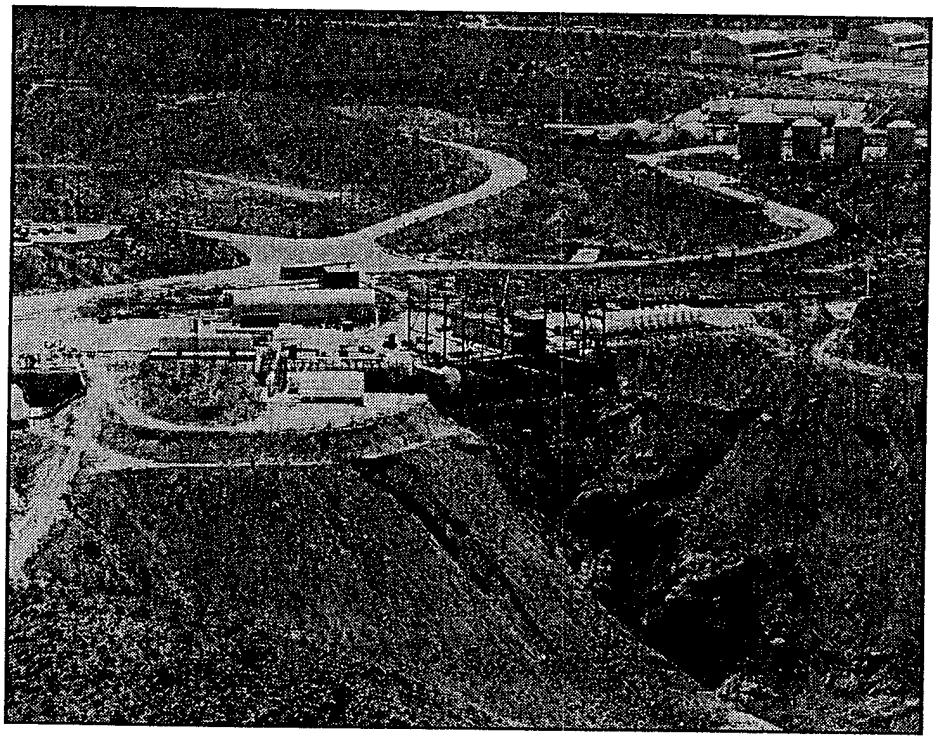
TESTING HISTORY

- F-1 Engines, 980 Tests (early 60s and 70s)

Large Engine Component Test Stand, Area 1-120, Test Stand 2-A

CAPABILITIES:

- 6,000 psi GN2 cross country line
- 14 inch water main from lake bed wells
- 440 VAC and 28 VDC stand power
- 3,500 psi stand hydraulics
- Mechanical shop with 5 ton traveling overhead crane
- Data Acquisition and control system
  - 320 channel, 100,000 sample per second
  - 2 each, 16 channel, 3,200,000 samples per second
  - 256 channel programmable logic control
- Ground level testing
- Two position component test capability
  - Test article space roughly 40 ft by 30 ft in each position
- Maximum thrust 2,000,000 lbf, 45 degree down
  - (Current Configuration) no thrust stand
  - 1,500,000 lbf thrust takeout capability
- 16 inch diameter hydrogen flare stacks
- GN2 storage; 10,000 psi, 950 ACF
- GH2 storage; 10,000 psi, 1600 ACF
- GH2 storage; 6,000 psi, 470 ACF
- GHe storage; 6,000 psi, 1,810 ACF
- LH2 storage; 248 psi, 28,000 gallon shared with 1A
- LO2 storage; 35 psi, 29,490 gallon
- LO2 run tank; 8,500 psi, 2,000 gallon
- LH2 run tank; 6,000 psi, 3,800 gallon
- RP-1 run / storage 6,600 psi, 272 gallon



CAPABILITIES (cont.)

- 14 inch diameter FIREX line
- 20,400 lb TNT equivalent of 1.1 propellant

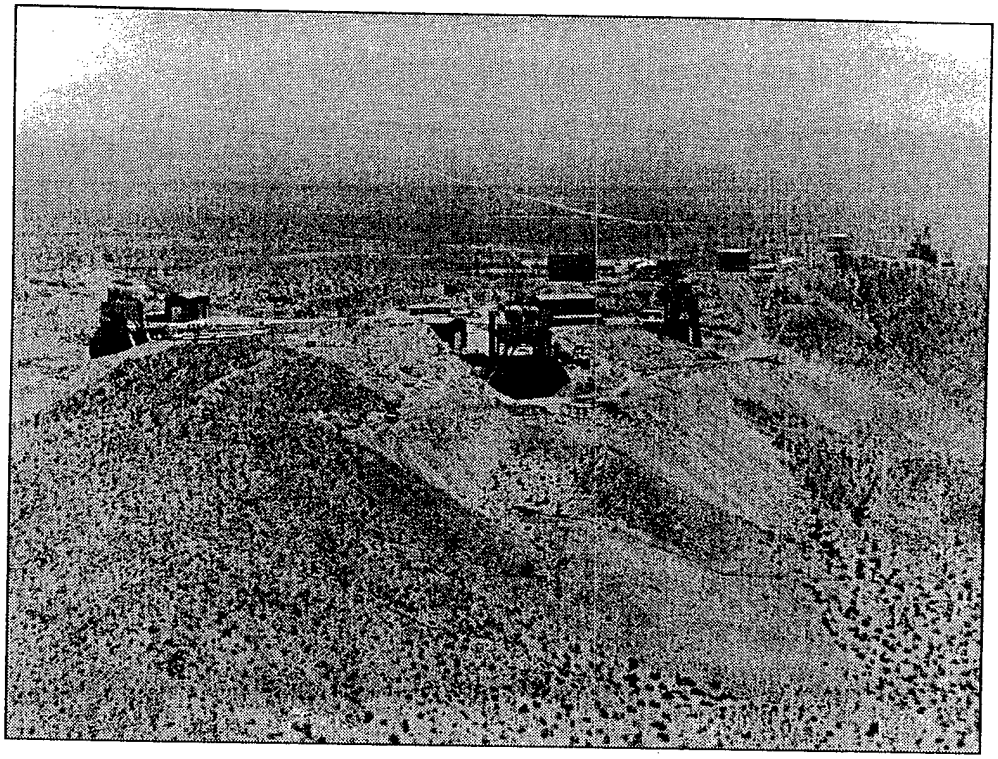
TESTING HISTORY

- F-1 Thrust Chamber (5,000 Firings)

Large Systems Complex Area 1-125

FACILITIES CAPABILITIES:

- 6,000 psi GN2 cross country line
- 14 inch water main
- 3 Mechanical shops
  - With 25 ton traveling overhead cranes
  - With environmental conditioning
- Water system
  - 3,000,000 gallon storage tank for flame deflector
  - 400,000 gallon storage tank for FIREX
  - Double lined catch basin. Water recycled back to 3,000,000 gallon storage in one shift.
  - 168,000 GPM total pumped water flow 65,000 GPM water flow by gravity feed alone



TEST STAND CAPABILITIES:

- Ground level testing
- (Current configuration)
  - Test stand 1 - C 1.6M Lbf thrust, nozzle down
  - Test stand 1 - D inactive, nozzle down
  - Test stand 1 - E inactive, nozzle down
    - Modified for hover testing requirements

TESTING HISTORY

- Titan 34D
- Titan IV
- Saturn V
- H1 Engine
- SRM Booster
- SRMU Booster
- Kinetic Kill Vehicle (KKV Prototype and Advanced)

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Large Systems Complex Area 1-125

GENERAL AREA CAPABILITIES:

- 6,000 psi GN2 Cross Country Line
- 14 Inch Water Main
- 440 VAC and 28 VDC Stand Power
- 3 Mechanical Shops (High Bay Assembly Buildings)
  - 94 Wide X 115 Tall X 50 High
  - With 25 Ton Traveling Overhead Cranes
  - With Environmental Conditioning
- Data acquisition and control system
  - NEFF 620, 512 channel, 50,000 sample per second data acquisition system
  - 256 channel programmable logic control system
- Water system
  - 3,000,000 gallon storage tank for flame deflector
  - 400,000 gallon storage tank for FIREX
  - Double lined catch basin. Water recycled back to 3,000,000 gallon storage in one shift.
  - 168,000 GPM total pumped water flow 65,000 GPM water flow by gravity feed alone

TEST STAND CAPABILITIES:

- Ground Level Testing
- Test Stand 1C - Maximum Thrust 8.0M lbf.
  - — Test Stand Idle Since 1974, Re-activated 1986
  - — Current Configuration
    - For TITAN IV Support
    - 1.6M lbf, Six-component Thrust Stand
      - —Vertical, Nozzle Down

Test Stand 1D Maximum Thrust 8.0M lbf.,

- — Test Stand Idle Since 1974
- — Vertical, Nozzle Down

- Test Stand 1E
  - — Test Stand Idle Since 1975
  - — Modified for Hover Testing Requirements
    - Added Adjacent Target Test Stand
    - Vehicle Integration Facility, With a Clean Room
    - Propellant Storage and Handling
    - Range Support for Fueling and Handling KKV's
  - — Supported KKV (Prototype and Advanced)

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Large Systems Complex Area 1-125

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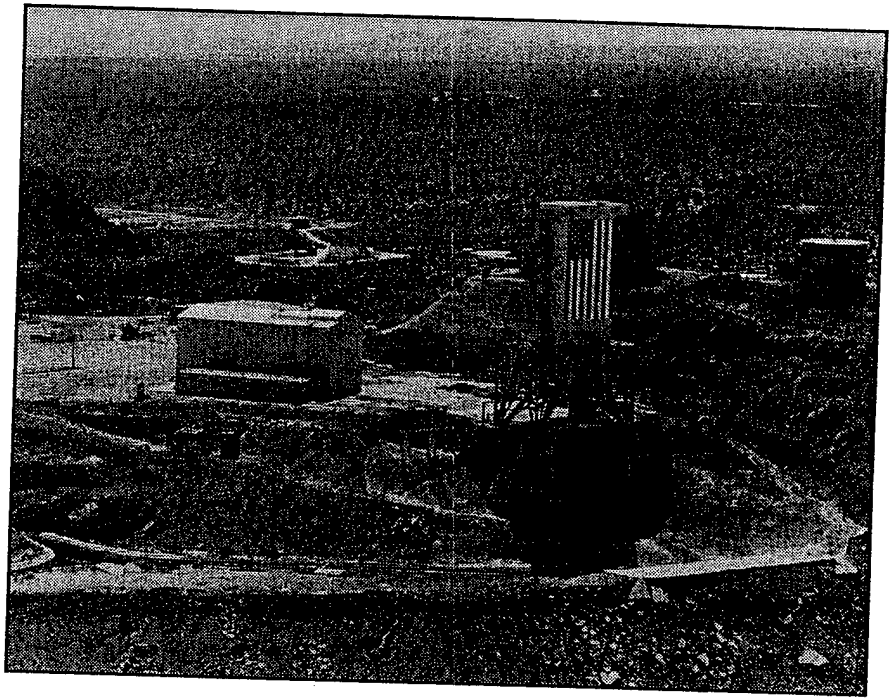
Titan SRM Test Facility
Area 1-125, Test Stand 1-C

CAPABILITIES:

- 6,000 psi GN2 cross country line
- 14 inch water main
- 440 VAC and 28 VDC stand power
- Mechanical shop
  - With 25 ton traveling overhead crane
  - With environmental conditioning
- 3,400,000 gallon deluge storage
  - Cooling water can be pumped at 168,000 gpm
  - 5,000,000 gallon catch basin
  - 400,000 gallon storage tank for FIREX
  - Modified 1988 for Titan 34D
  - Current Configuration for Titan IV

Need to collect and remove "?"



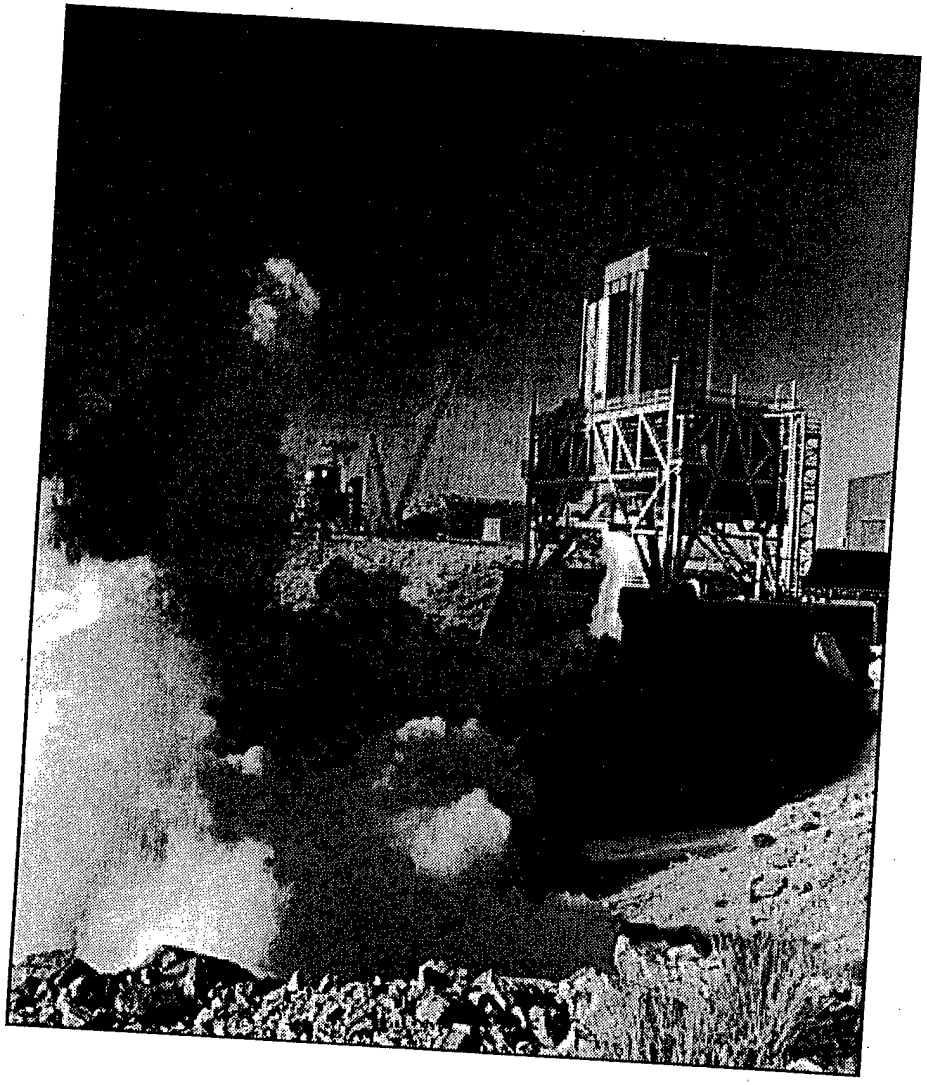
TEST STAND CAPABILITIES:

- Ground level testing
- Multi-story environmental conditioning
  - 40 to 90 degrees F, 40 percent relative humidity
- Test article volume estimated 60 by 57 by 120 ft
- Maximum thrust 8.0M lbf., nozzle down
  - Current configuration 6 component thrust stand
    - 2,500,000 lbf. thrust takeout
    - 1,600,000 lbf. axial thrust
- 690,000 lb of 1.3 class propellant

TESTING HISTORY

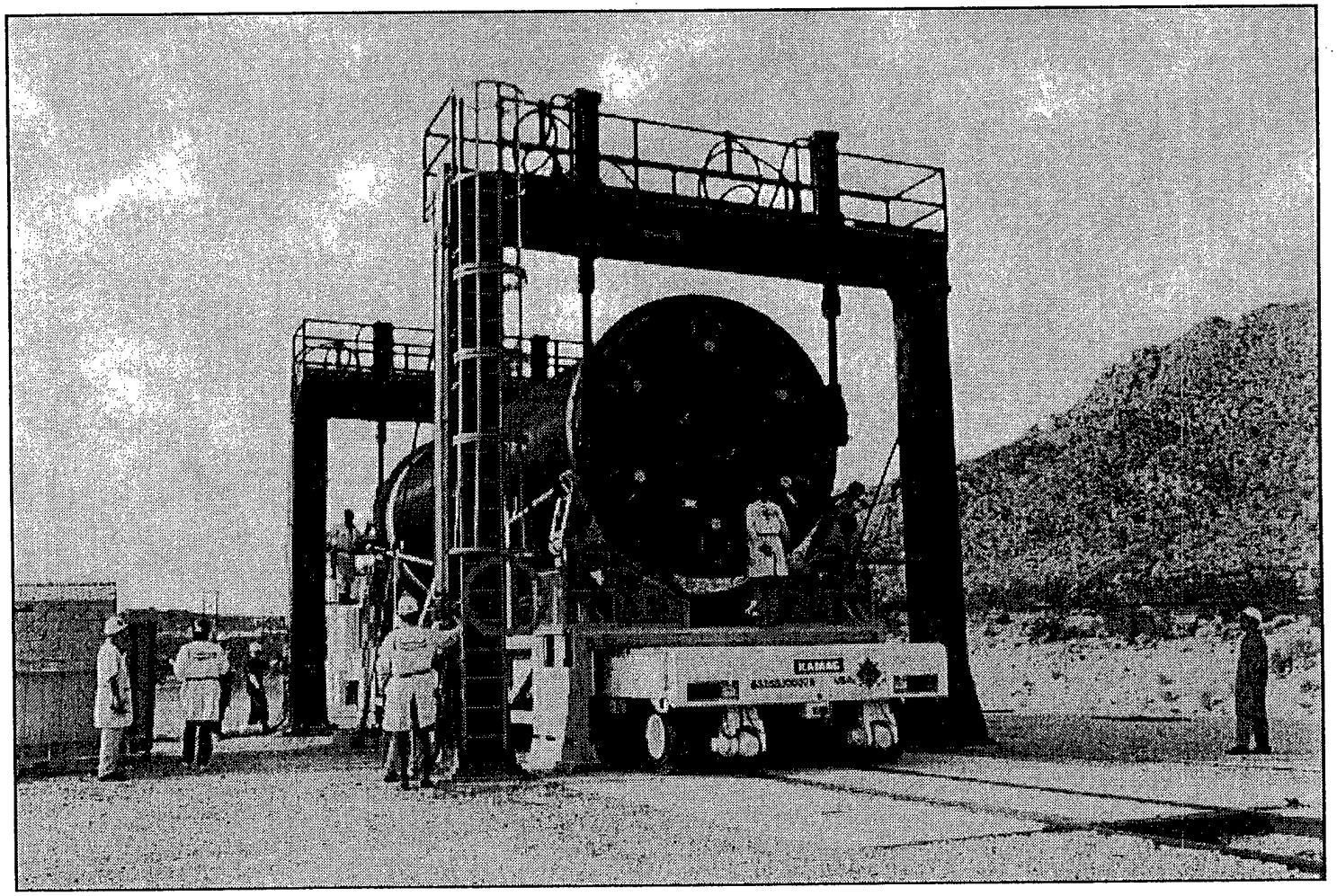
- Titan 34D, 1987
- Titan IV
- Saturn V
- SRM Booster
- SRMU Booster, 1992, 1993, 1999

Area 1-125, Test Stand 1-C



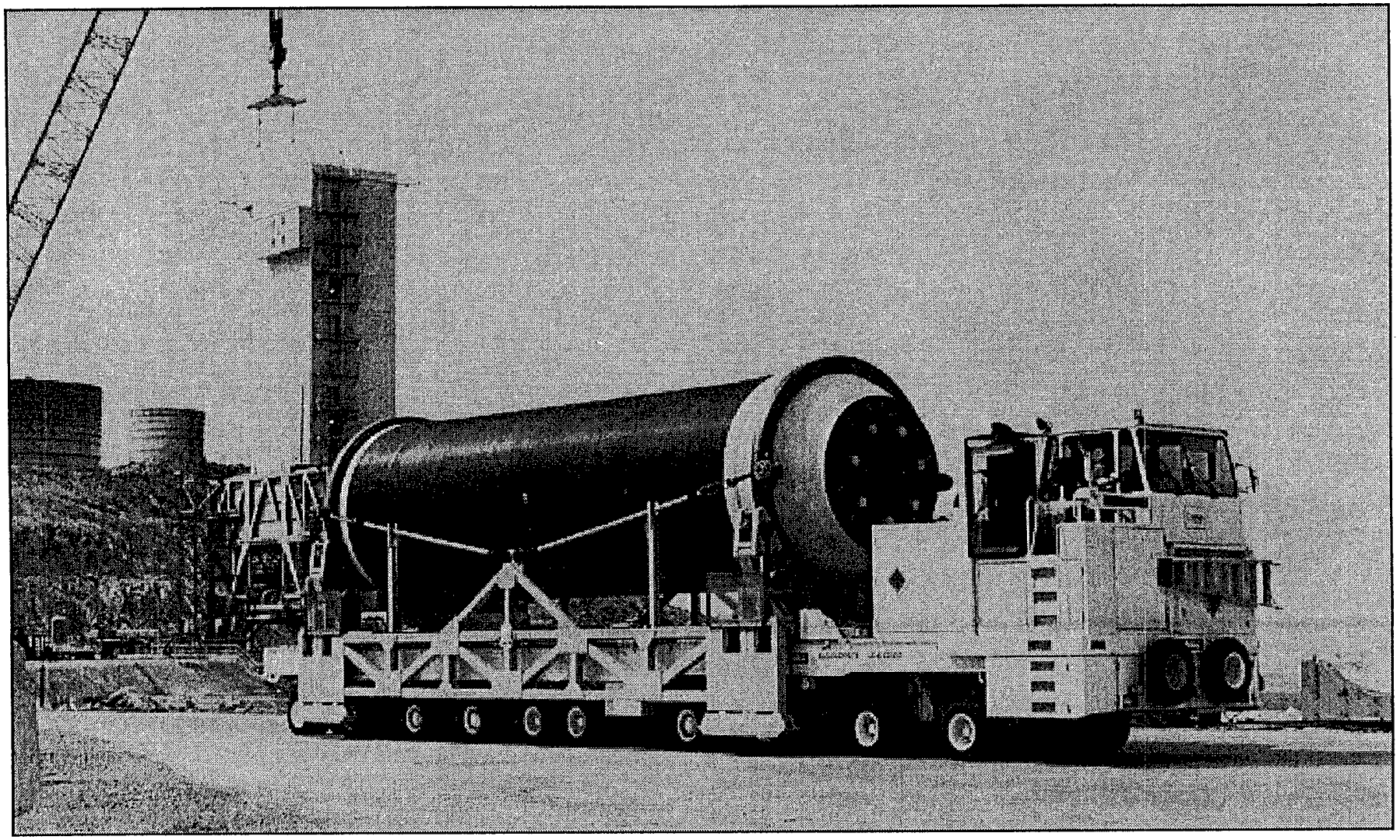
- Successfully Fired T34D SRM, 15 June 1987

Area 1-125, Test Stand 1-C



Titan IV SRMU Booster Railhead Delivery to AFRL, 1993

Area 1-125, Test Stand 1-C



Titan IV SRMU Booster Test Stand Delivery, 1993

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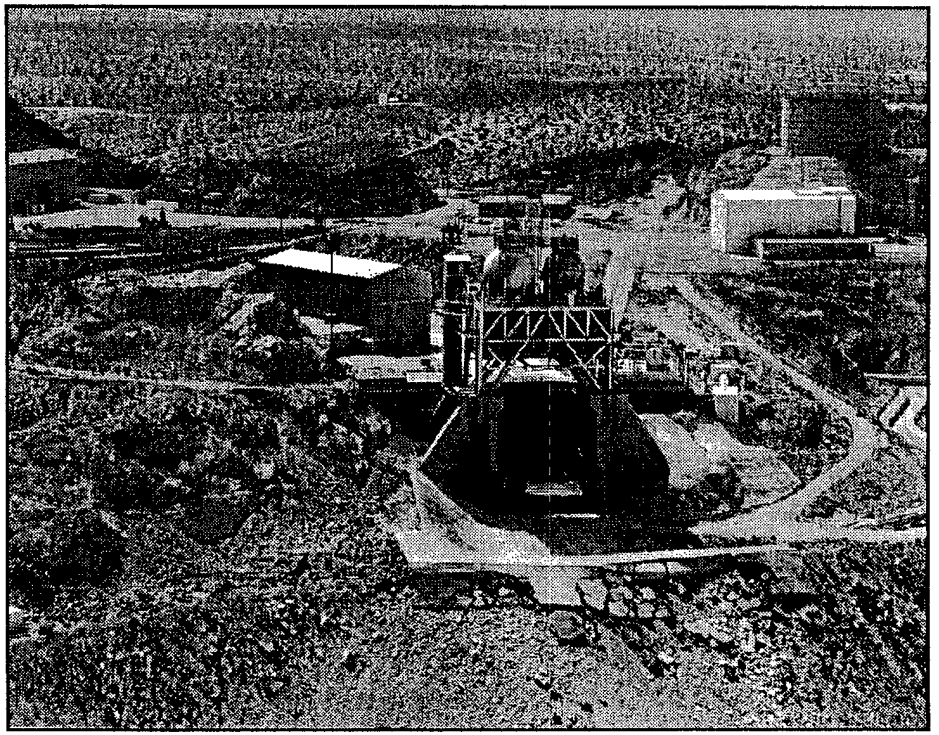
Large Systems Complex Area 1-125, Test Stand 1-D

FACILITIES CAPABILITIES:

- 6,000 psi GN2 cross country line
- 14 inch water main
- 440 VAC and 28 VDC stand power
- Mechanical shop
  - With 25 ton traveling overhead crane
  - With environmental conditioning

TEST STAND CAPABILITIES:

- Flame deflector
  - 46 ft inside width, 51.5 ft long, 56 ft deep
- Ground level testing
- Maximum thrust 8.0 M lbf., nozzle down
  - Current configuration; inactive, no thrust stand
- 90,000 gallon, vacuum jacketed, 165 psig LOX run tank
- 70,000 gallon, 165 psig, stainless steel, RP-1 run tank
- 760,000 lb of 1.3 class propellant



TESTING HISTORY

- Saturn V

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National Hover Test Facility
Area 1-125, Test Stand 1-E

FACILITIES CAPABILITIES:

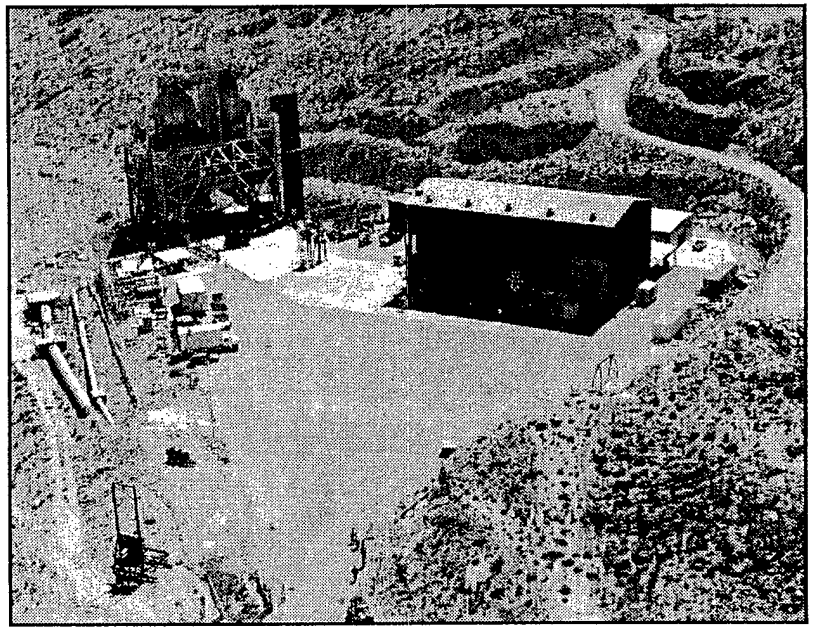
- 6,000 psi GN2 cross country line
- 14 inch water main
- 440 VAC and 28 VDC stand power

TEST STAND CAPABILITIES:

- Flame deflector
  - 46 ft inside width, 51.5 ft long, 56 ft deep
- Ground level testing
- Maximum thrust 8.0M lbf., nozzle down
  - Current configuration, inactive, no thrust stand
- 90,000 gallon, vacuum jacketed, 165 psig LOX run tank
- 70,000 gallon, 165 psig, stainless steel, RP-1 run tank
- 80,000 lb of 1.3 class propellant

HOVER FACILITY

- Mechanical shop converted to hover high bay and control room
- Kinetic kill vehicle (KKV) free flight environment
- Integrated instrumentation systems
  - Video trajectory tracking
  - Telemetry uplink and downlink
  - Precision laser velocity and position measuring system
  - Center of gravity and moment of inertia measurement
- Vehicle integration facility, with a clean room
- Range support for fueling / handling KKV's at remote locations
- External target test stand 80 meter and 800 meter distant



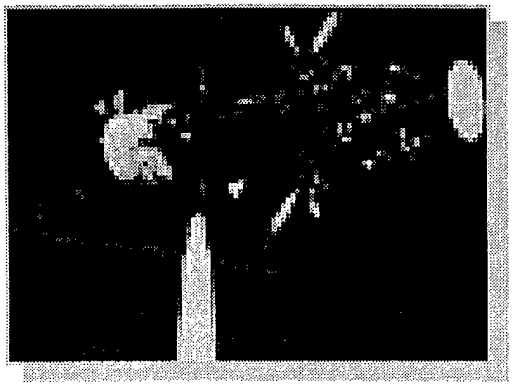
TESTING HISTORY

- 11 Different Vehicle Configurations
- Liquid and Solid Propellant Systems
- 26 Static Tests
- 16 Free Flight Tests

DRAFT 24-Nov-00

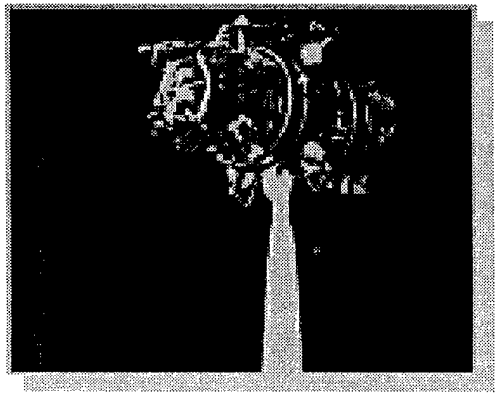
Hover Test Vehicles

ADDED SLIDE



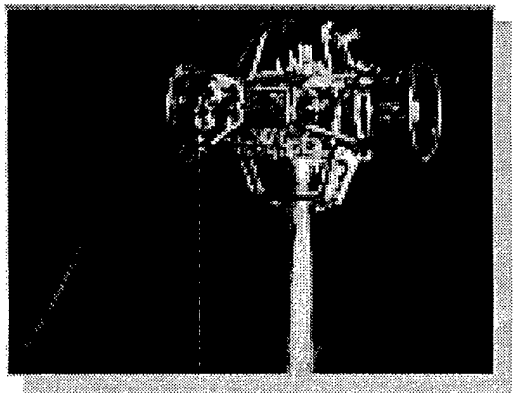
ON TARGET

DATE: 1 AUG 89
WEIGHT: 220 LB
LENGTH: 75 IN



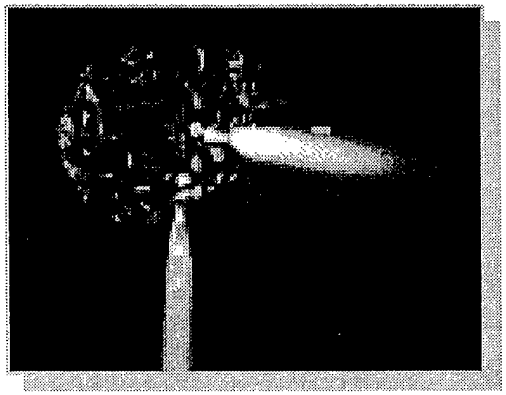
LEAP 1 PATHFINDER

DATE: 24 JUL 90
WEIGHT: 40 LB
LENGTH: 23.5 IN



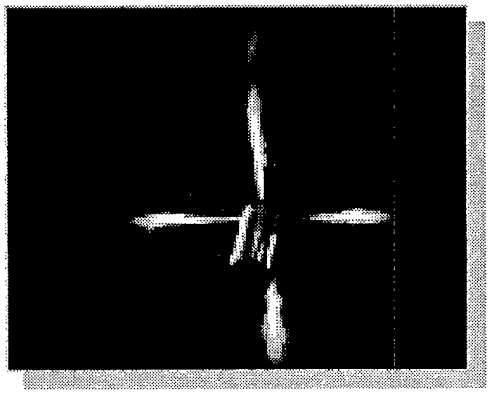
HUGHES LIQUID

DATE: 18 JUN 91
WEIGHT: 12.1 LB
LENGTH: 16 IN



ROCKWELL LIQUID

DATE: 5 AUG 92
WEIGHT: 40 LB
LENGTH: 22.9 IN



BOEING SOLID

DATE: 14 APR 93
WEIGHT: 16.5 LB
LENGTH: 25.5 IN

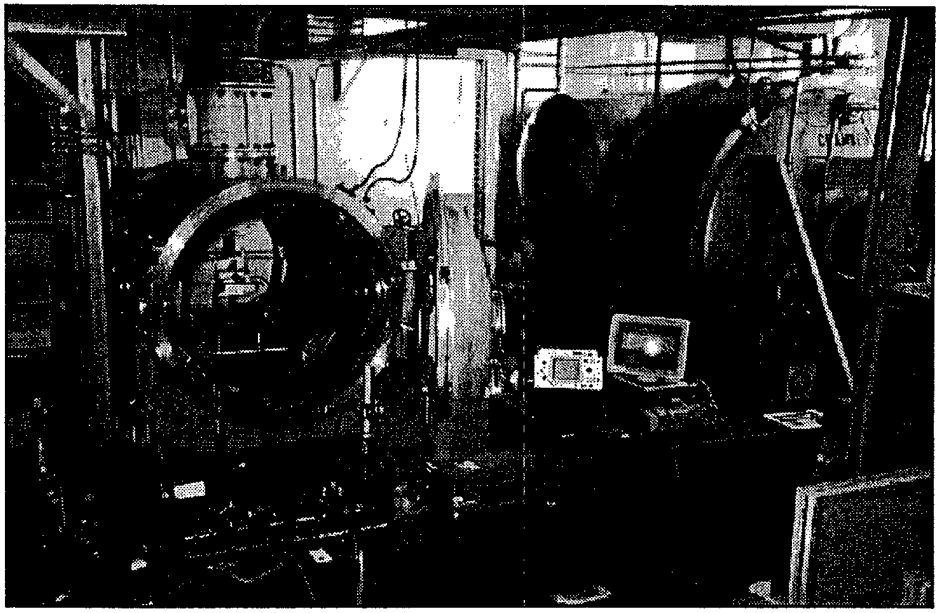
Electric Propulsion Laboratory

GENERAL AREA CAPABILITIES:

- Mechanical, Diffusion, Turbomolecular, and Cryo Pumped Vacuum Systems
- Data Acquisition and Control System

TEST CELL CAPABILITIES:

- Two 600 Cubic Foot Arcjet Chambers
  - 8 Foot Diameter x 12 Foot Long Chamber
  - 50 kWe
  - 10-2 TORR Vacuum
  - Pumps 250 mg/sec Propellant
- 200 Cubic Foot Pulsed Plasma Chamber
  - 5 Foot x 8 Foot Long Chamber
  - 20 MWe Pulsed
  - 10-5 TORR Vacuum
- 2000 Cubic Foot Chamber (Planned)
  - 10 Foot Diameter x 20 Foot Long Chamber
  - 30 kWe
  - 10-6 TORR Vacuum
  - High Power Hall Thrusters

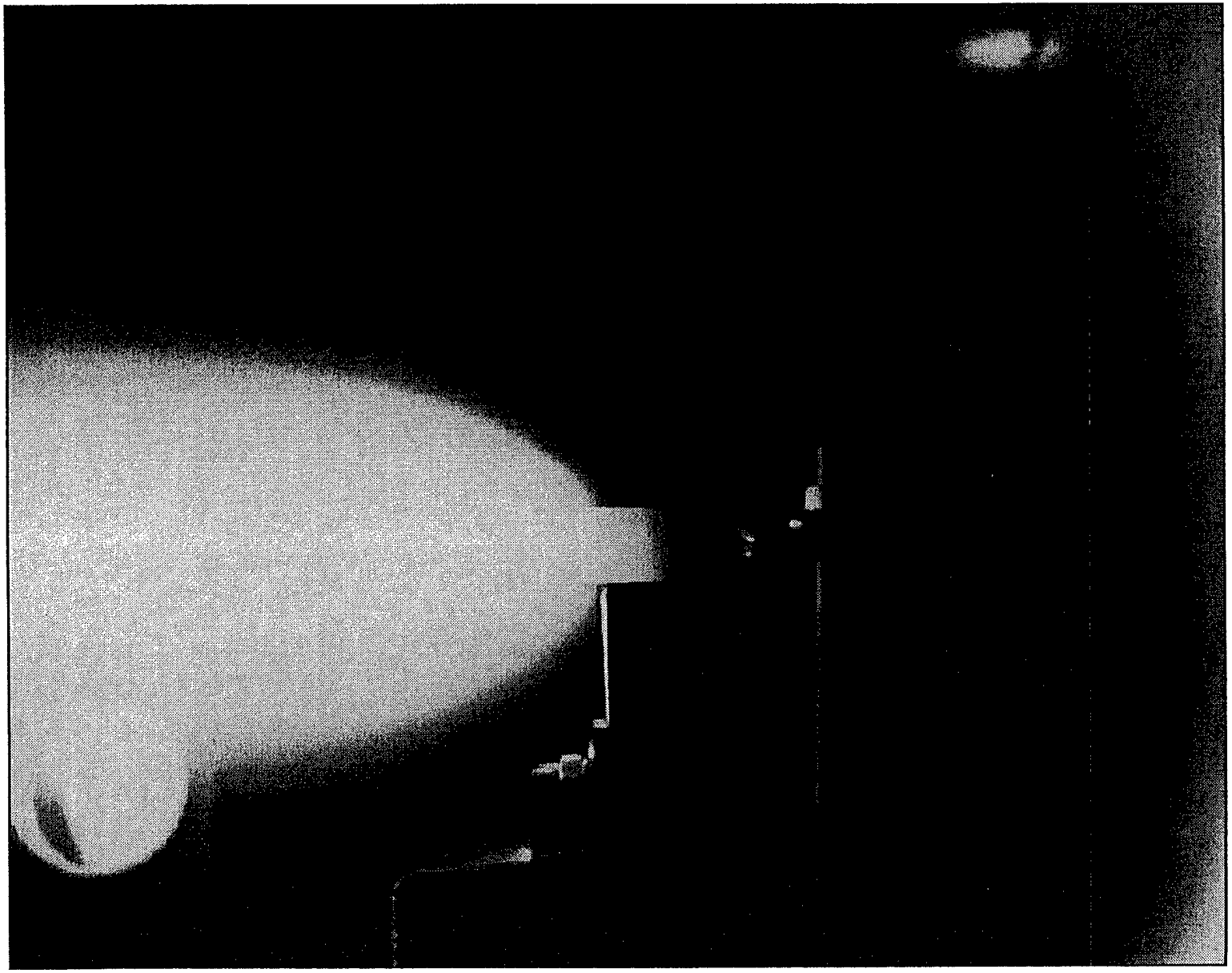


HISTORY:

- Ammonia 1995
- Teflon 1985-1996
- Hydrogen 1993-1996
- Carbon Based Propellant (Methane) 1995
- Electric Space Experiment (ESEX) 1995
- Collaborative efforts with; Loin Aerospace, NASA Lewis, and 6 Universities

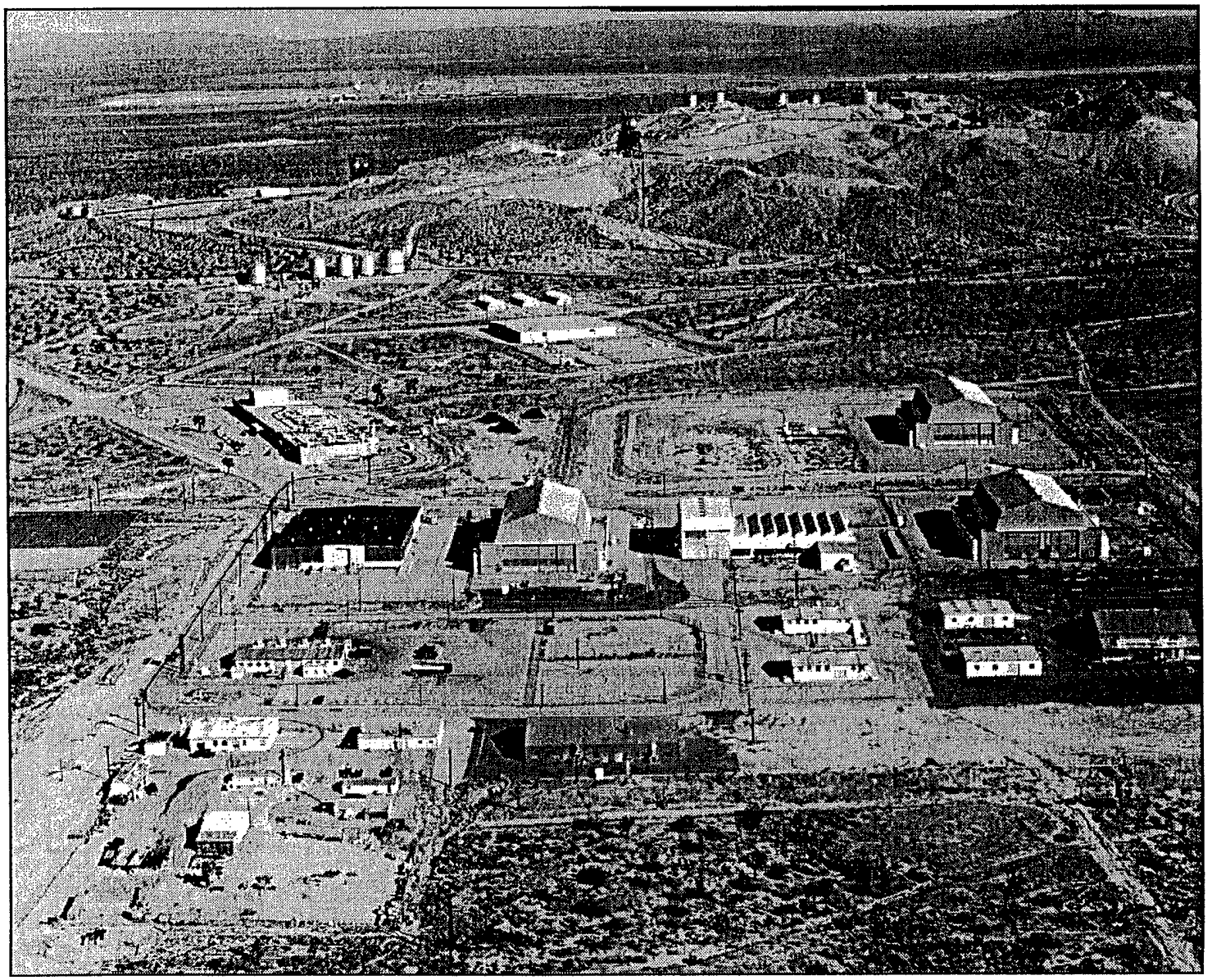
DRAFT 24-Nov-00

Electric Propulsion Laboratory

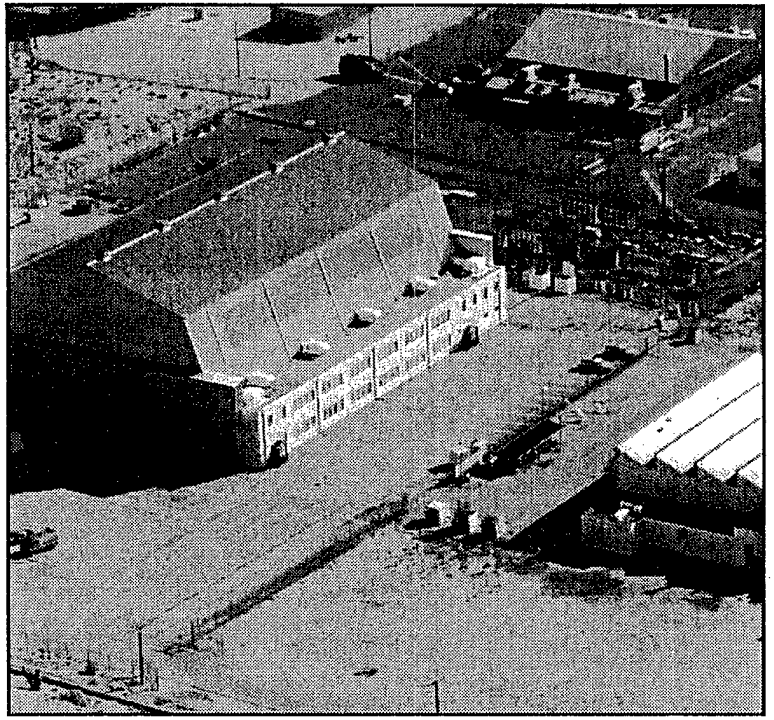


DRAFT 24-Nov-01

Air Force Research Laboratory Fabrication Area



AFRL Fabrication Area
Missile Assembly Building
Building 8419

BUILDING CAPABILITIES:

- Four 25 Ton Overhead Cranes
- 17,000 Sq Ft of Work Space Under Crane Span
- Building is 60 Ft to Peak
- 40 Ft of Vertical Work Space Under Crane
- 8,000 Sq Ft of Office Space Adjacent to Work Space
- Building Originally Built for Missile Assembly
- Full Service Machine, Weld, and Fab Shops Nearby