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HEAVY RAIN EFFECTS ON AIRPLANE PERFORMANCE

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ABSTRACT

The objective of this activity is to determine if the aerodynamic characteristics of an airplane are altered while flying in the rain. Wind-tunnel tests conducted at the NASA Langley Research Center (LaRC) have shown losses in maximum lift, reduction in stall angle, and increases in drag when a wing is placed in a simulated rain spray. For these tests the water spray concentration used represented a very heavy rainfall. A lack of definition of the scaling laws for aerodynamic testing in a two-phase, two-component flow makes interpolation of the wind-tunnel test uncertain.

Tests of a large-scale wing are to be conducted at the LaRC. The large-scale wing is mounted on top of the Aircraft Landing Dynamics Facility (ALDF) carriage. This carriage (which is 70-foot long, 30-foot wide, and 30-foot high) is propelled with the wing model attached down a 3000-foot long test track by a water jet at speeds of up to 170 knots. A simulated rain spray system has been installed along 500 foot of the tests track and can simulate rain falls from 2 to 40 inches/hour. Operational checks are underway and the initial tests should be completed by the Fall of 1989.

HEAVY RAIN EFFECTS

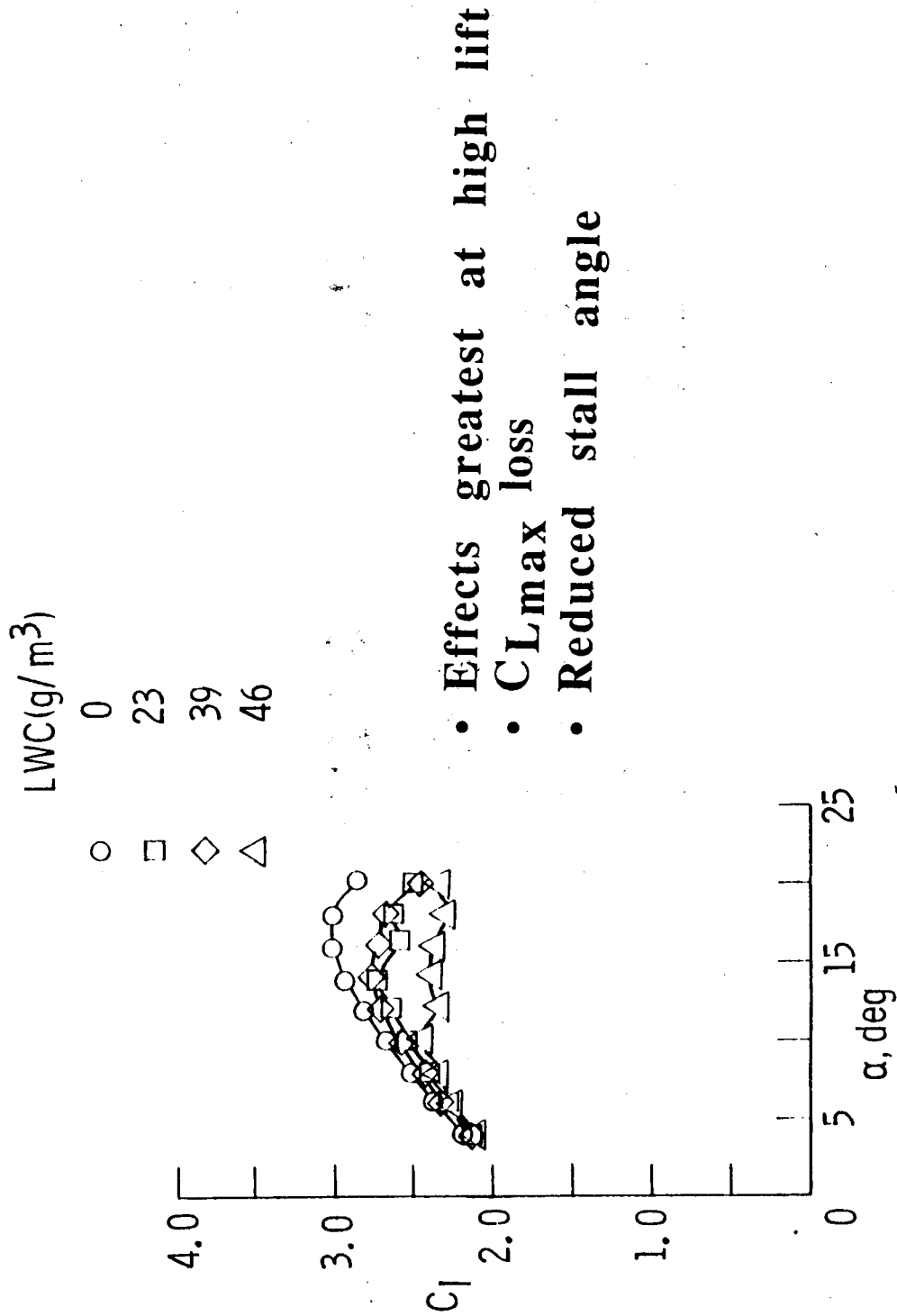
TECHNICAL ISSUE

**ARE THE AERODYNAMIC CHARACTERISTICS OF AN
AIRPLANE ALTERED WHILE FLYING IN THE RAIN?**

HEAVY RAIN EFFECTS

- **Wind Tunnel Tests**
- **Large Scale Tests**
- **Results**
- **Status and Plans**

WIND TUNNEL TESTS RESULTS



Scaling of Test Results

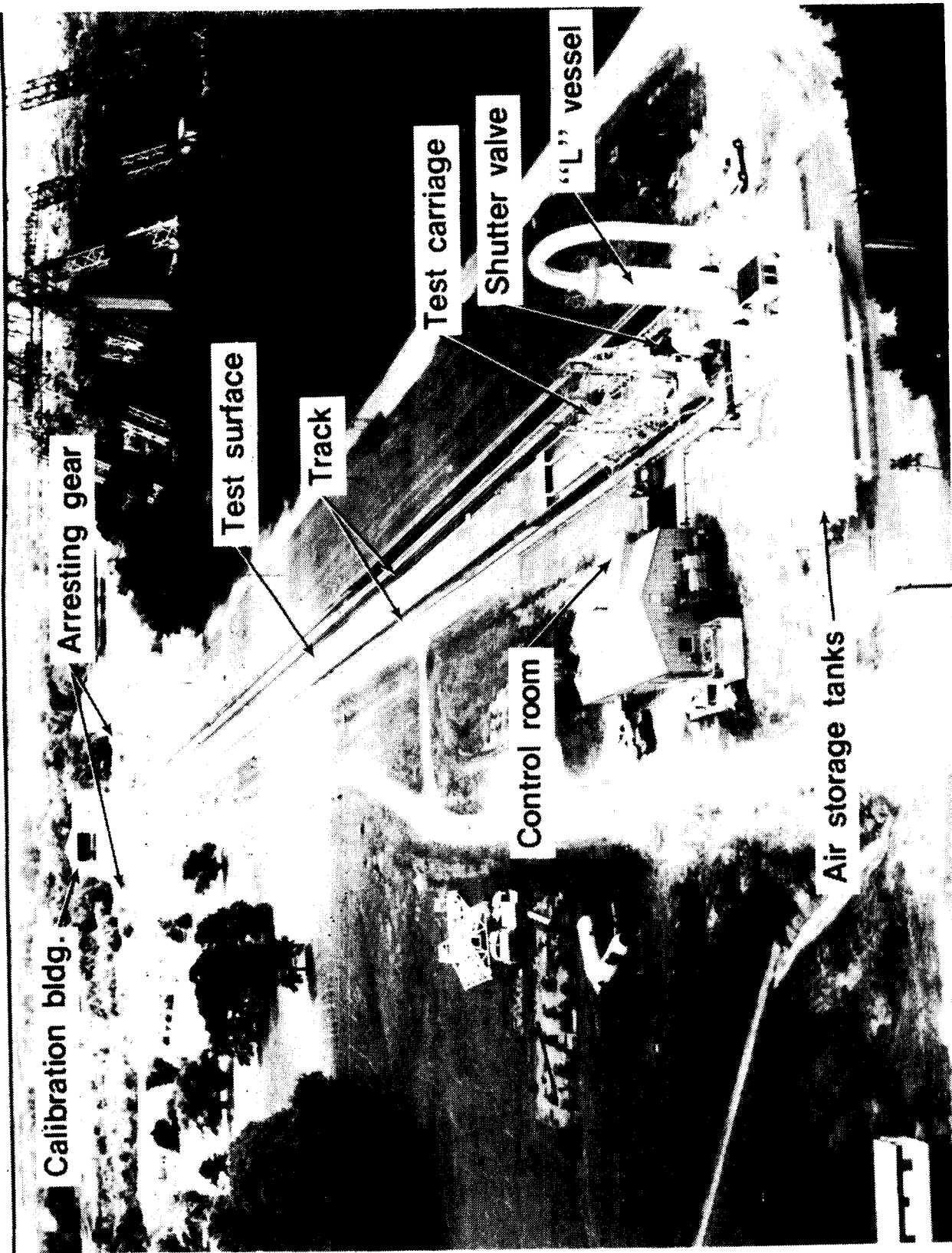
"Dry Aerodynamics"

- $C_L = f$ (angle of attack, Reynold's Number, Mach Number)
- Scaling Laws Established

"Wet Aerodynamics"

- $C_L = f$ (angle of attack, Reynold's Number, Mach Number, Weber Number, Geometric Scaling of spray drop diameter and spacing)
- No Scaling Laws Available

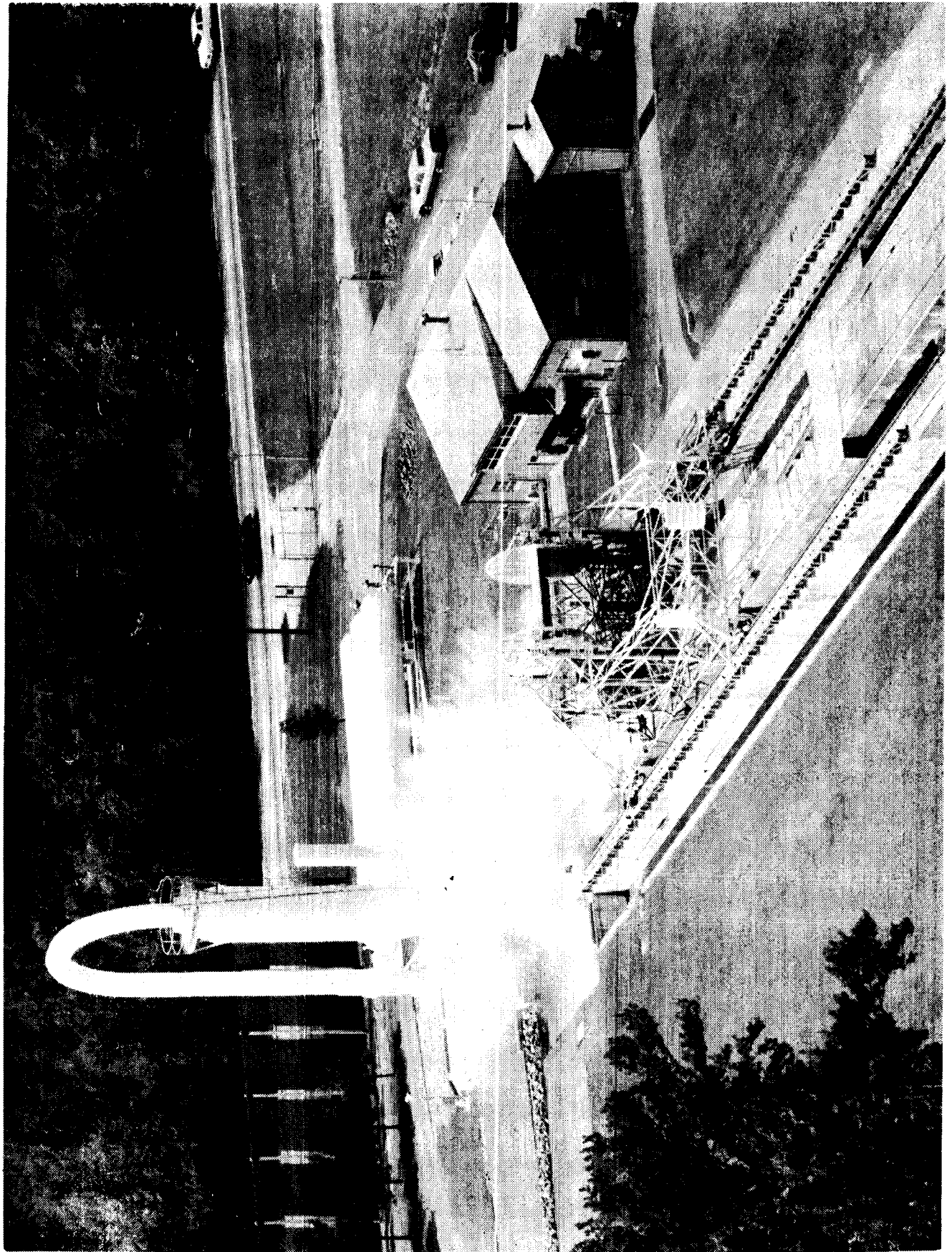
AIRCRAFT LANDING DYNAMICS FACILITY



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Hampton, Virginia 22085-0101

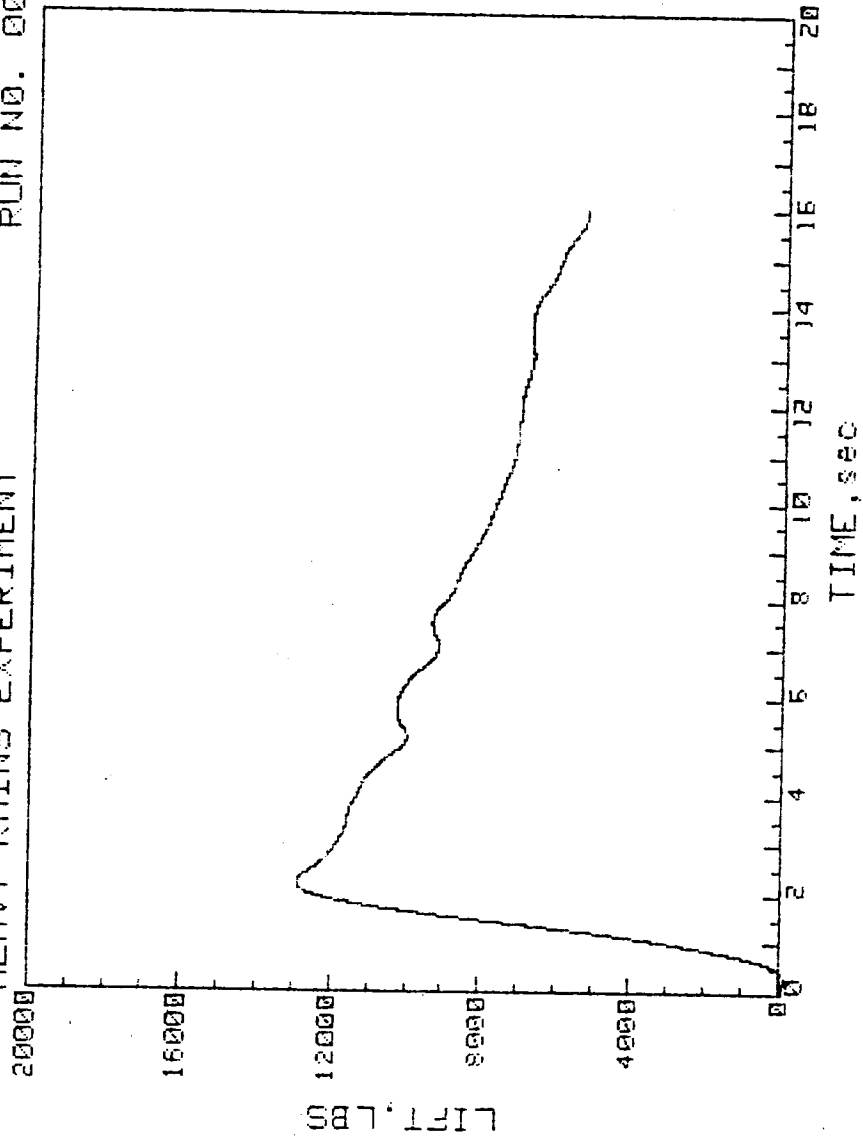
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HEAVY RAINS EXPERIMENT

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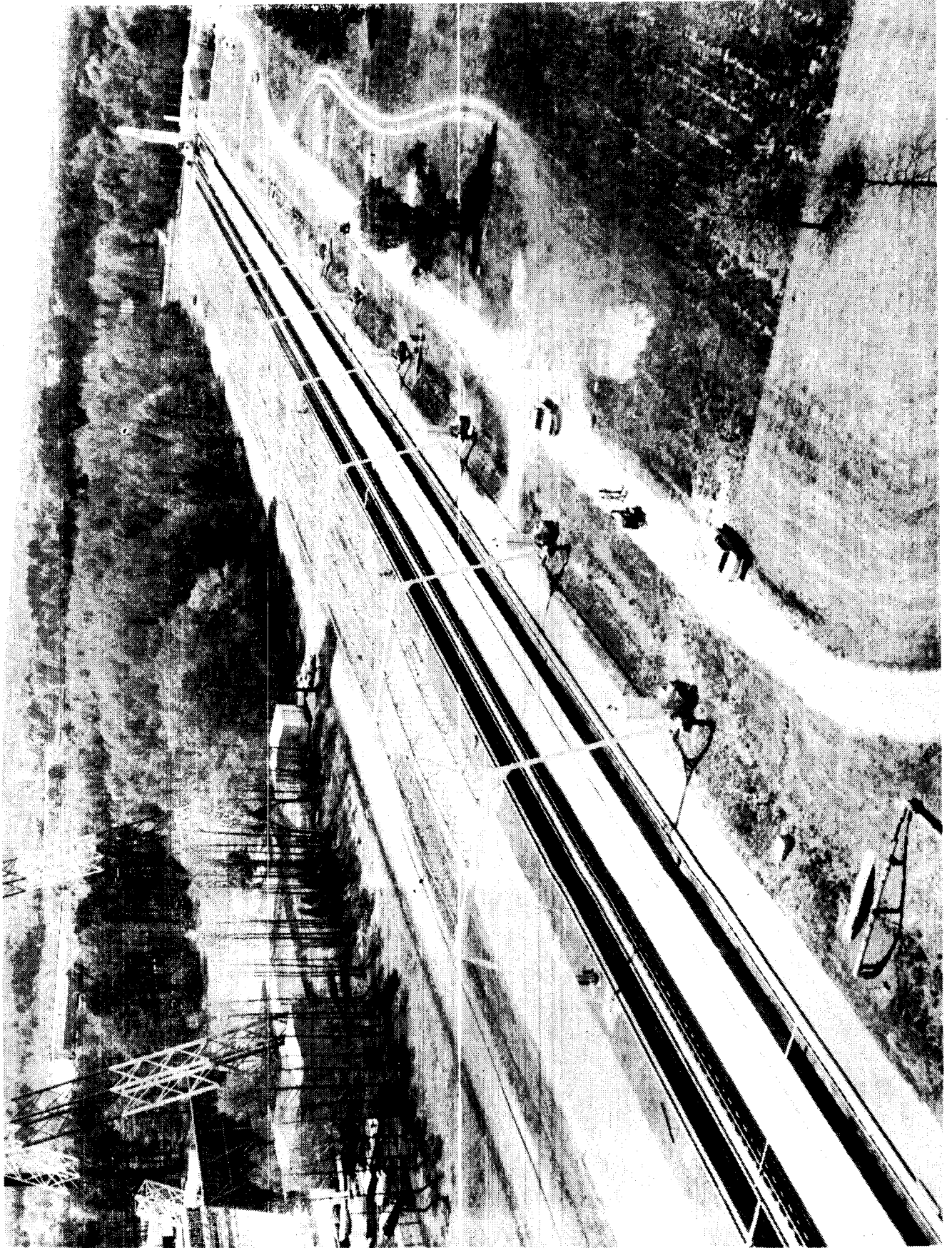


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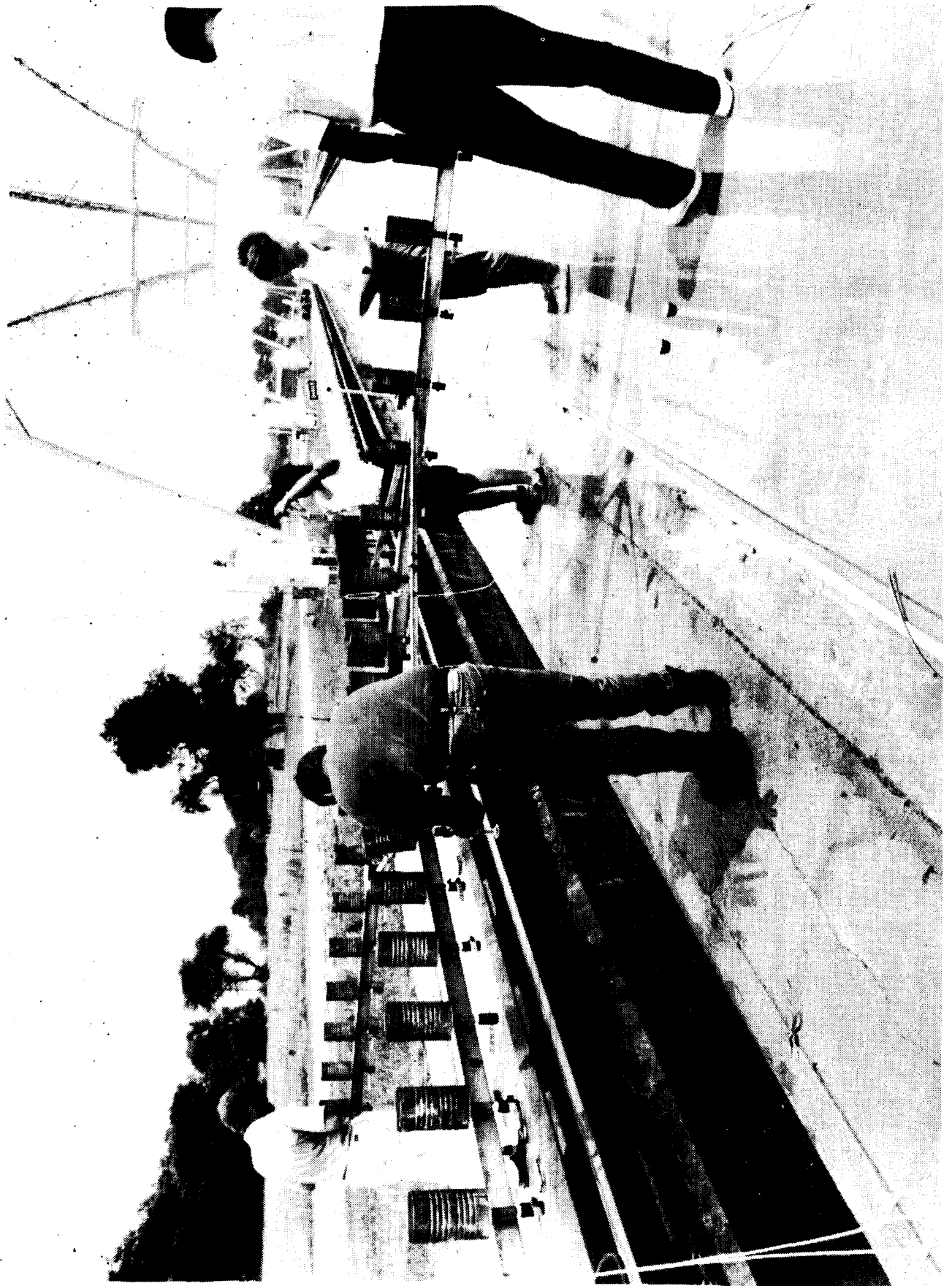
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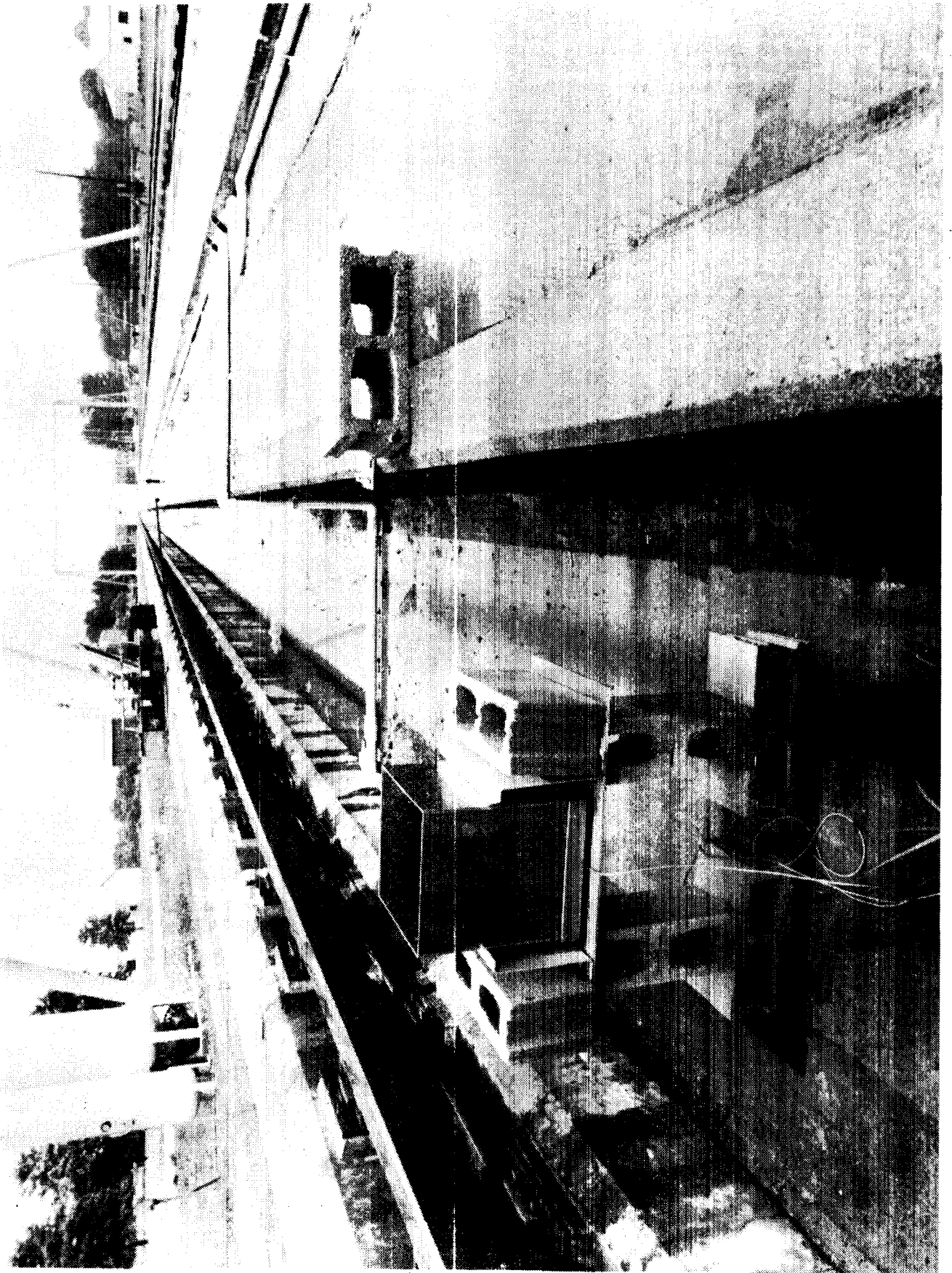
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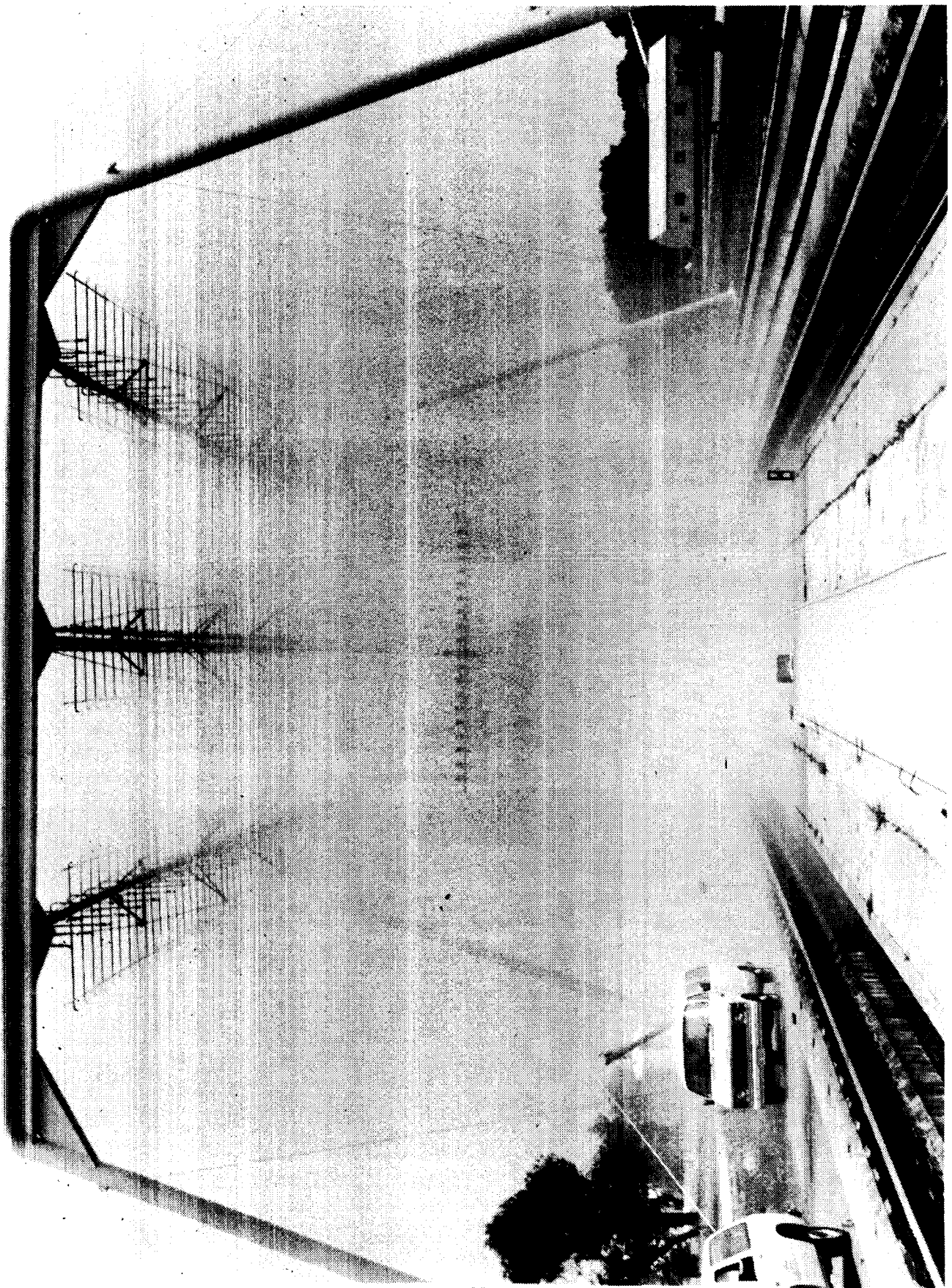


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SPACE SHUTTLE
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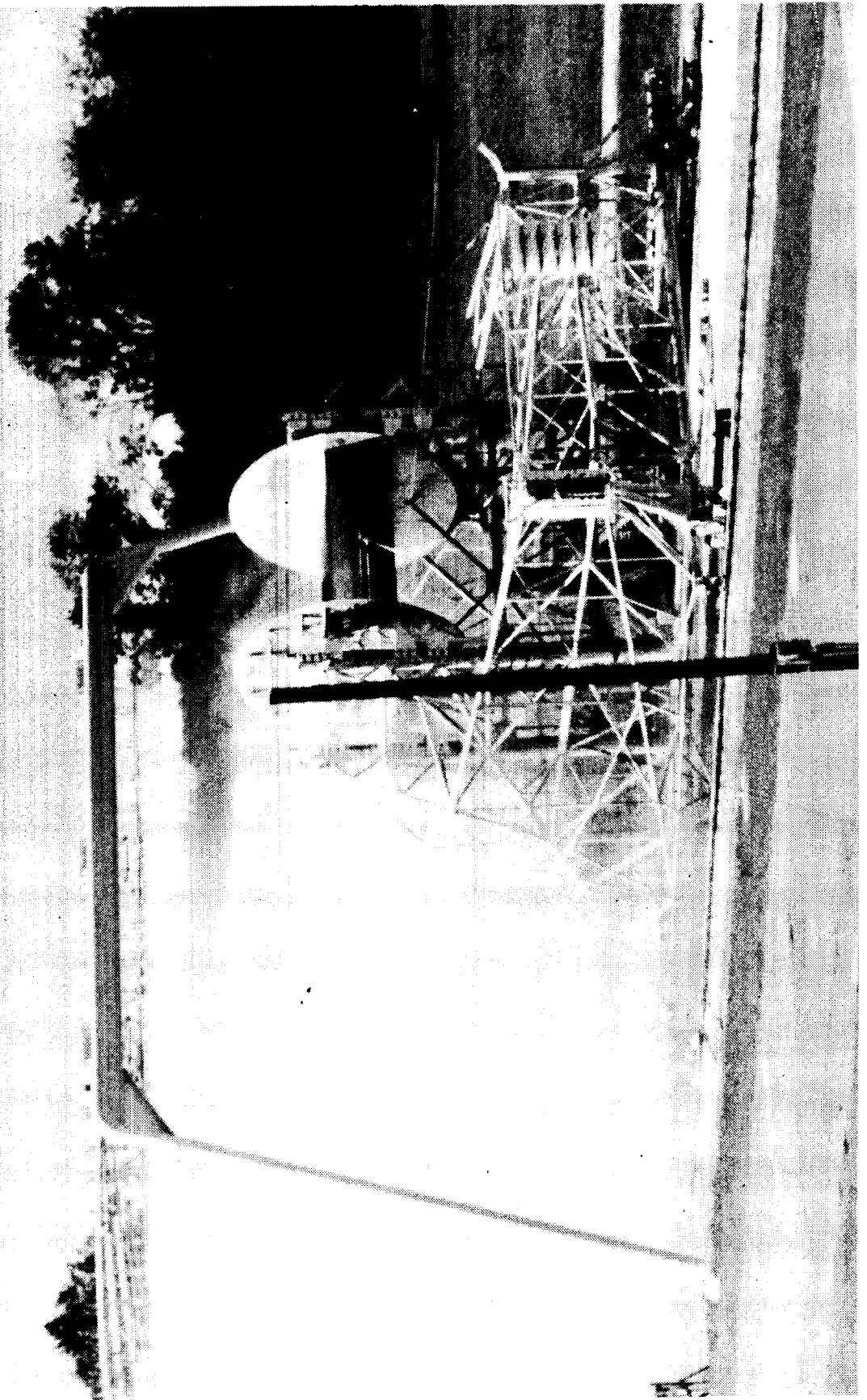
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Large Scale Tests

- Spray system operational
- Wing/carriage Engineering checkout in progress
- Preliminary results indicate system capable of providing good aerodynamic data
- Majority of tests matrix to be completed by Fall 1989