# REPORT DOCUMENTATION PAGE

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| Thomas Hane | 5e. TASK NUMBER |
| | 5f. WORK UNIT NUMBER |

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Approved for public release; distribution is unlimited.

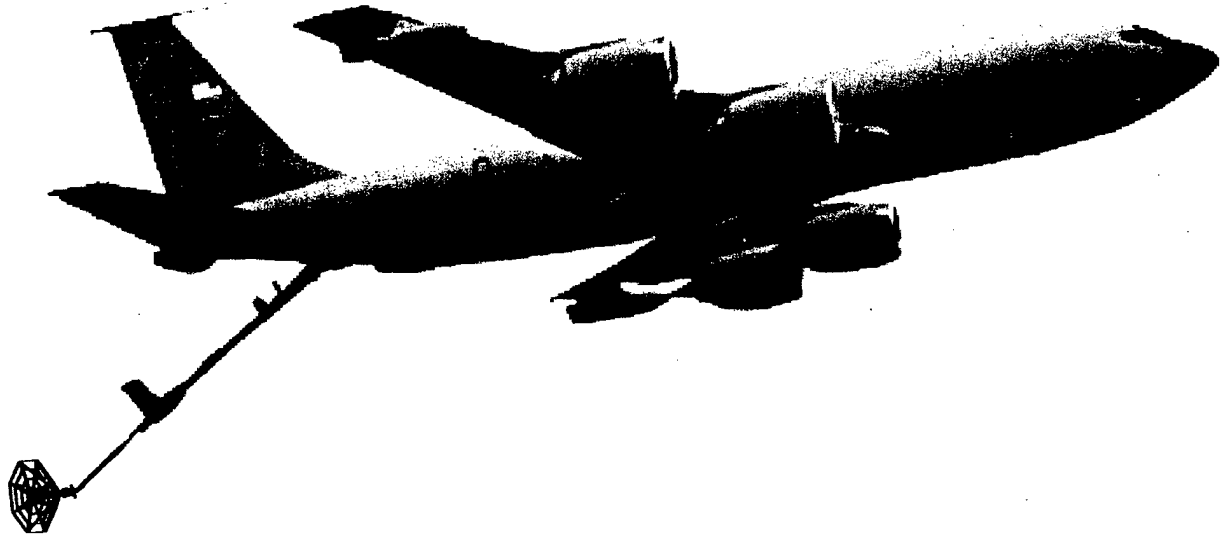
13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

| 16. SECURITY CLASSIFICATION OF: | | | 17. LIMITATION OF ABSTRACT | 18. NUMBER OF PAGES | 19a. NAME OF RESPONSIBLE PERSON |
|---|---|---|---|---|---|
| a. REPORT | b. ABSTRACT | c. THIS PAGE | | | Thomas Hane |
| Unclassified | Unclassified | Unclassified | Unclassified | 11 | 19b. TELEPHONE NUMBER (include area code)<br>(301) 342-0306 |

# AIRBORNE ICING TANKER SPRAY ARRAY



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26 Oct 1999

# AIT SYSTEM REQUIREMENTS

| | |
|---|---|
| LWC, MVD | DEFINED BY FAR PART 25 (next chart) |
| CLOUD SIZE | 8 FT DIA. (MIN.) |
| SLD | 0.1 TO 0.5 LWC, 50 TO 500 microns |

# SUBSYSTEM REQUIREMENTS

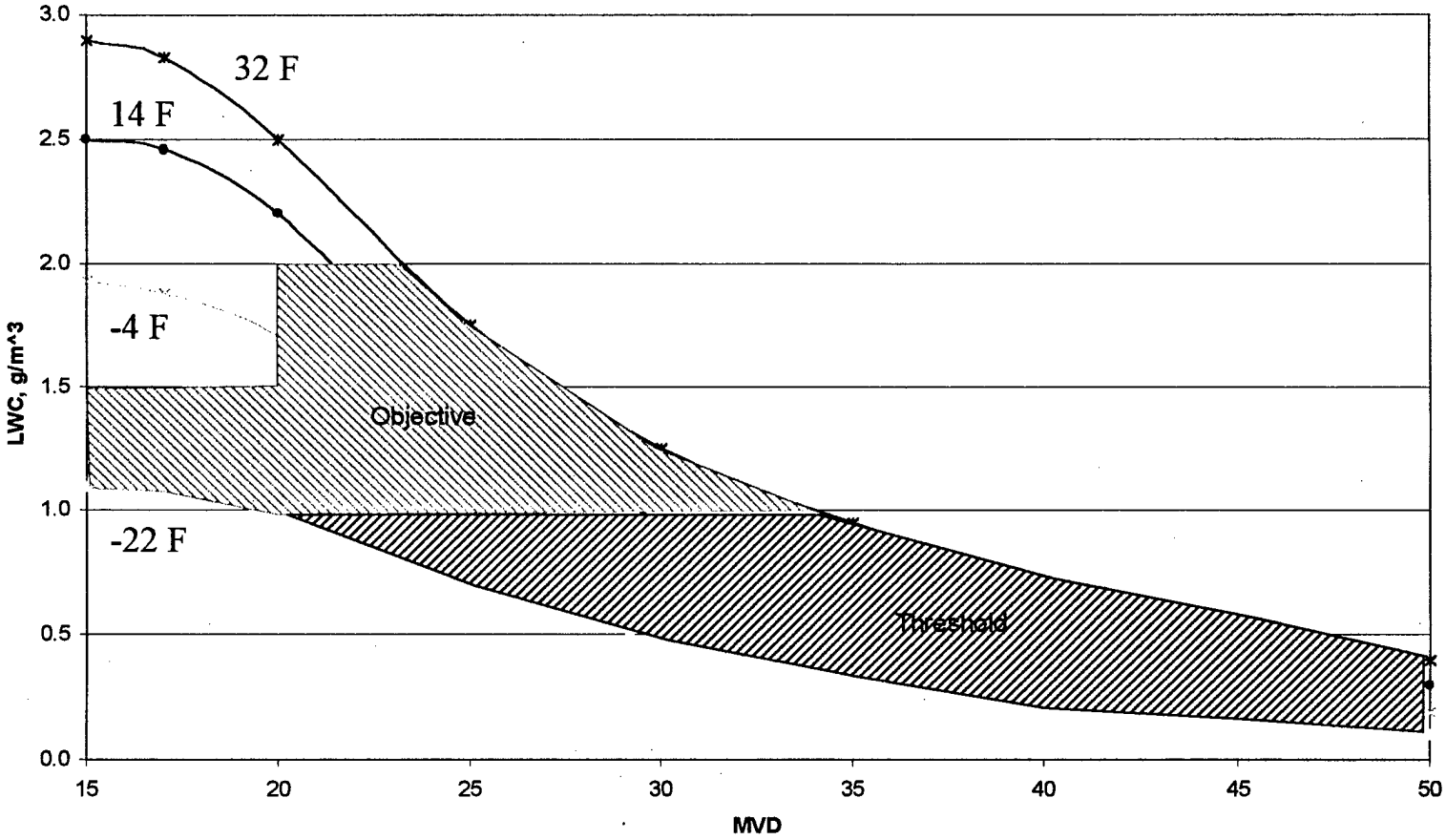
WATER:

| | |
|---|---|
| FLOW RATE | 33 gpm for 8 ft dia cloud with LWC = 2 |
| | 52 gpm for 10 ft dia cloud |

AIR:

| | |
|---|---|
| PRESSURE | 58 psig at engine - (A/C ducts + boom + array) |
| FLOW RATE | up to 105 lb/min, up to 6 scfm per nozzle |

# AIT CLOUD PHYSICS



# ARRAY DESIGN CONSTRAINTS

- AIR SUPPLY
  - –ENGINE BLEED AIR, 9TH STAGE, 58 PSIG AT STRUT
- DRAG
  - –CANNOT EXCEED EXISTING SPRAY BOOM LIMITS
  - –USE OF AIRFOILS TO MINIMIZE
- WEIGHT
  - –CANNOT EXCEED EXISTING SPRAY BOOM LIMITS
  - –LIMITS SIZE OF NEW ARRAY, COMBINED WITH DRAG
- MAINTENANCE
  - –ACCESS TO PLUMBING, REMOVEABLE NOZZLES

# ARRAY DESIGN PLAN

## FY99

- NARROW NOZZLE CHOICES, # OF NOZZLES, ARRAY CONCEPT, INTERNAL PLUMBING, DRAG PREDICTION, AERO LOADS, MANUFACTURING SELECTION, EXTERNAL LIMITS

## FY00

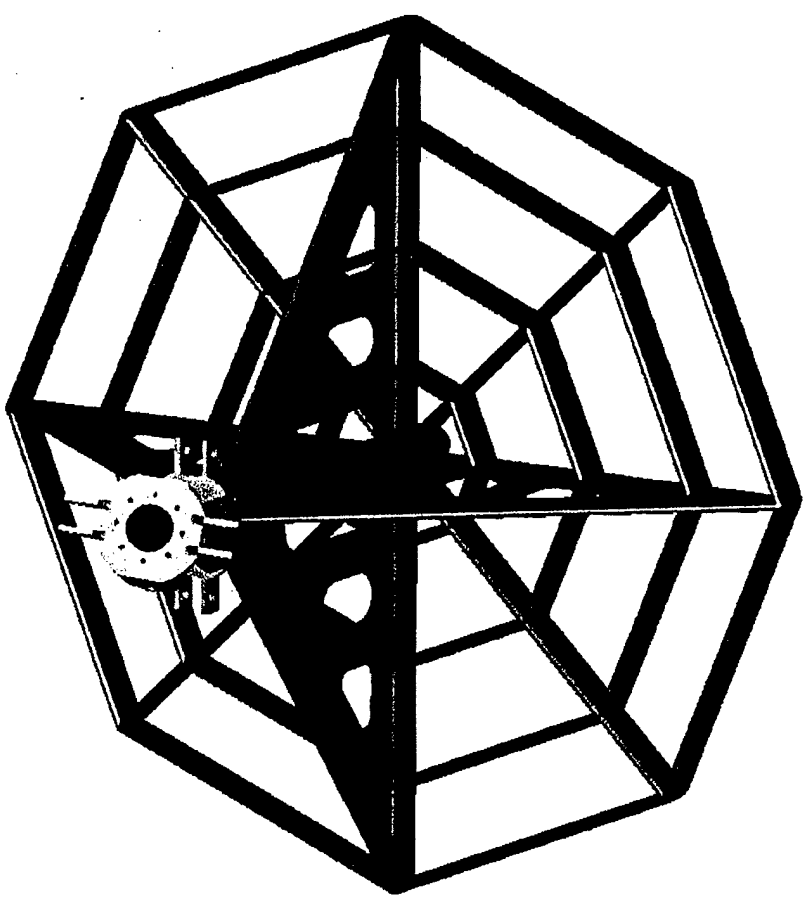
- SELECT NOZZLE, CONDUCT DRAG CFD ANALYSIS, HEAT TRANSFER CALC, DROPLET DISPERSION CFD, HYDRAULIC ANALYSIS, SCALE MODEL TESTING, DETAIL DESIGN ARRAY, ENGR DRAWINGS

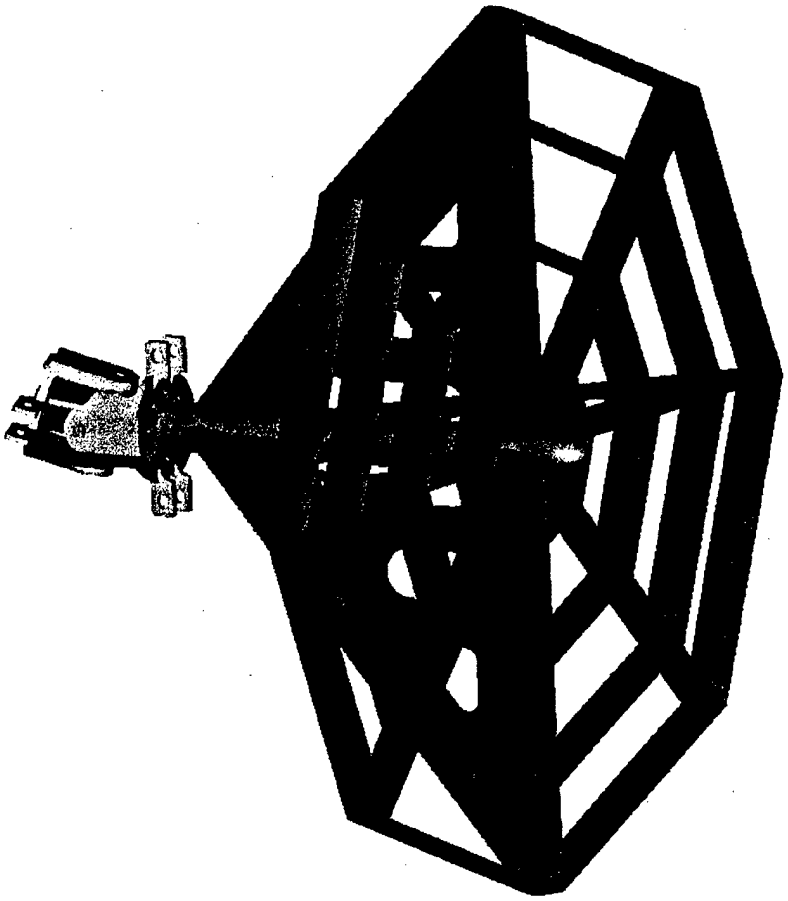
## FY01

- FABRICATE ARRAY, FULL SCALE GROUND TESTS

# AIRBORNE ICING TANKER

RESEARCH & ENGINEERING





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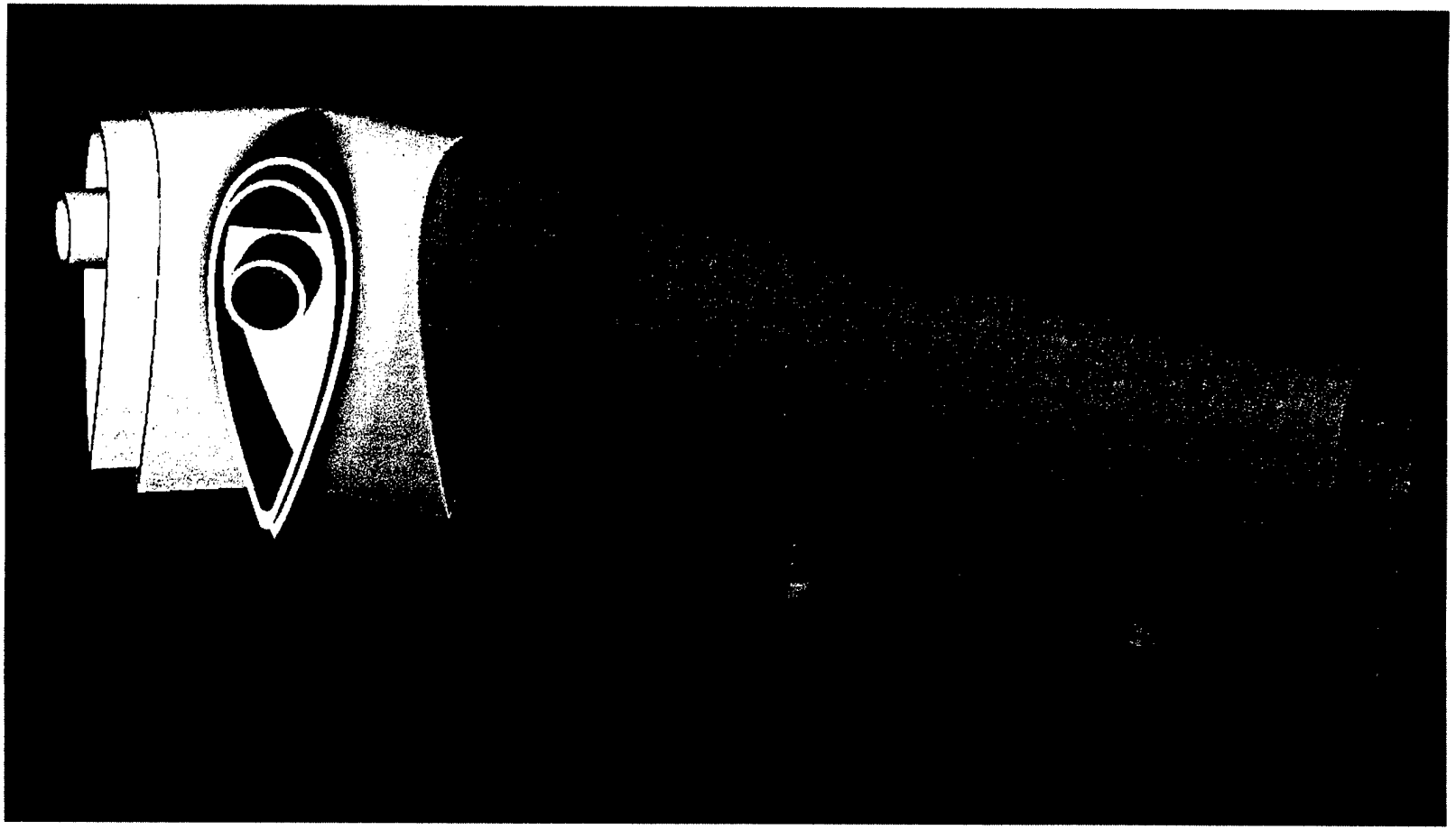

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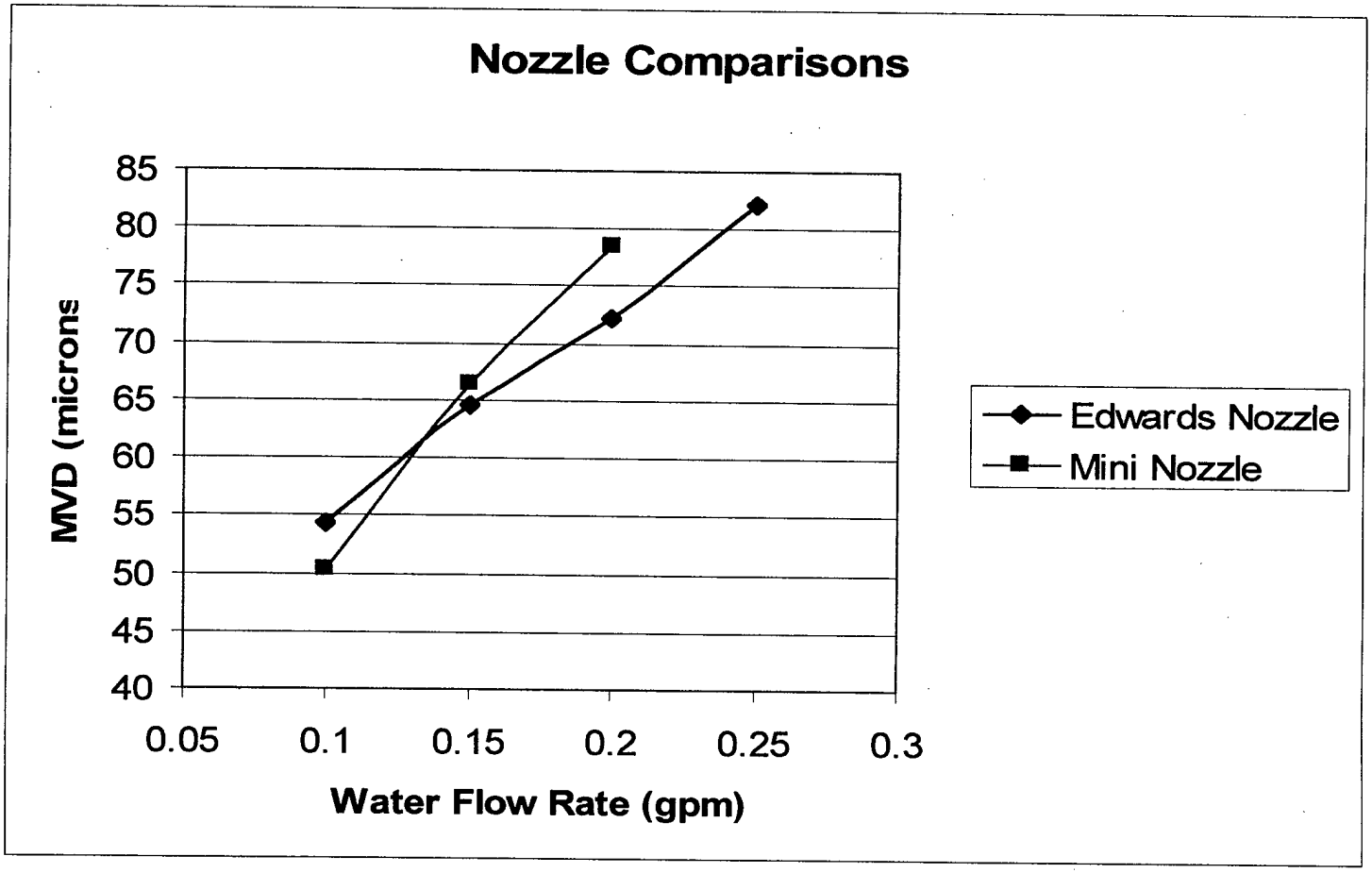



Testing w/ 45 psi air, PDPA at 3 ft standoff, 10 runs at each point

Edwards: Spray Systems Nozzle 1/4J 60100-140-1110SS

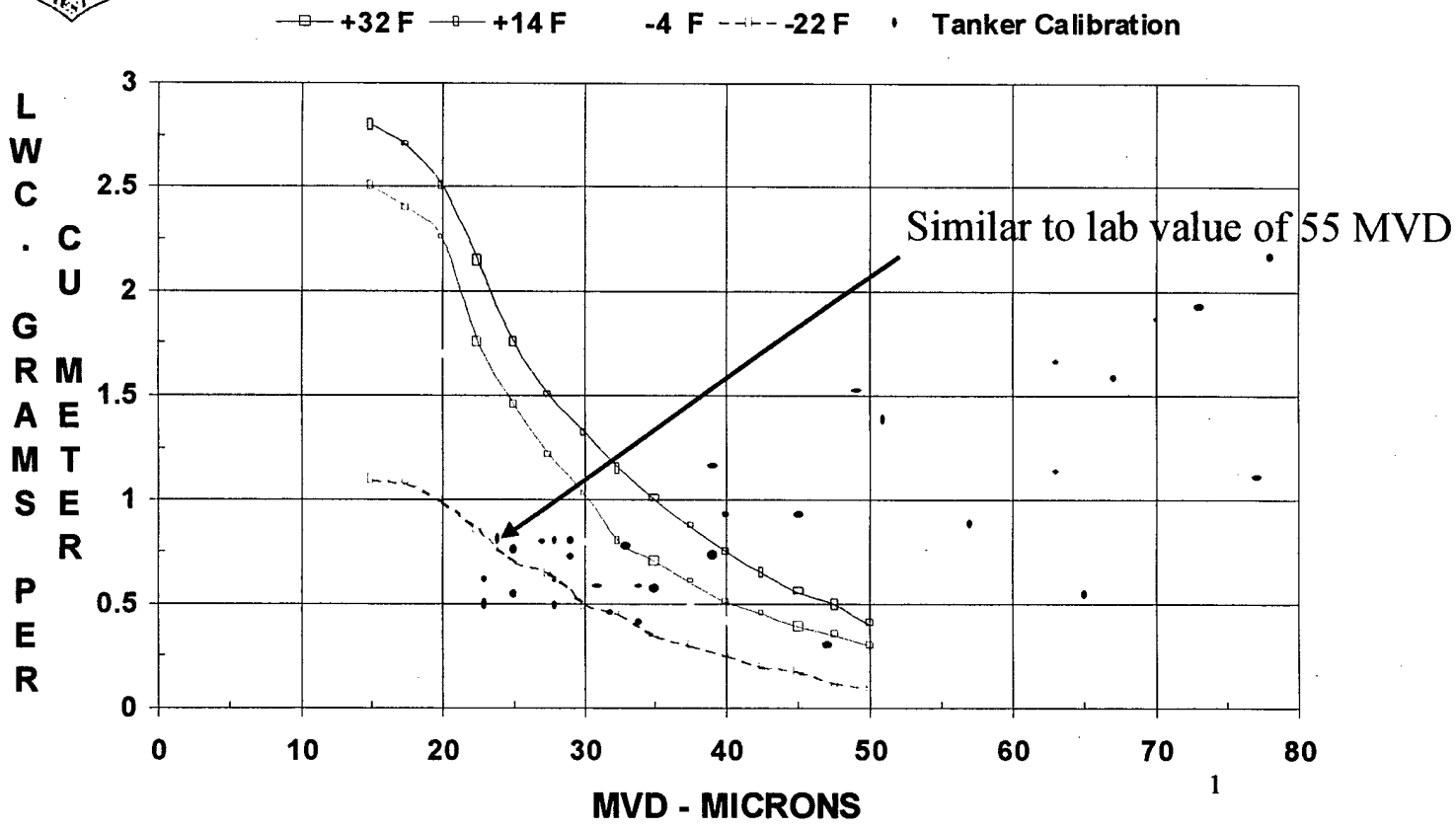
Mini: Spray Systems Nozzle 1/8PAJSS 140-6-37-70 (no fluid cap)

# Back-ups

# AIRBORNE ICING TANKER

RESEARCH & ENGINEERING

**INTERMITTENT MAXIMUM (CUMULIFORM CLOUDS)**
**FAR PART 25 Vs ARTIFICIAL CONDITIONS**
**LWC Vs MVD**




## AIR FORCE KC-135A PAST TEST DATA

# SYSTEM REQUIREMENTS

| System Capabilities and Characteristics | Thresholds | Objectives |
|---|---|---|
| Icing Cloud Liquid Water Content (LWC), Median Volumetric Diameter (MVD), and Temperature | those portions of FAR Part 25 Continuous and Intermittent Maximum conditions shown in Appendix A | threshold + those additional portions of FAR Part 25 Continuous & Intermittent Maximum conditions shown in Appendix A |
| Icing Cloud Size at 50 ft behind array | 8 ft diameter | 15 ft diameter |
| Supercooled Large Drop Liquid Water Content | 0.10 to 0.50 gram per cubic meter | - |
| Supercooled Large Drop Diameter | 50 to 500 microns | - |
| Supercooled Large Drop Distribution | N/A | IAW with Table 2 below |
| Supercooled Large Drop Temperature Range | 0° to –15° Celsius | - |
| Supercooled Large Drop Cloud Size at 50 ft behind array | 8 ft diameter | 15 ft diameter |
| Rain Cloud Rainfall Rate | 5.0 inches per hour | 7.0 inches per hour |
| Rain Cloud Median Volumetric Drop Diameter | 1 mm | 2 mm |
| Rain Cloud Size at 50 to 75 ft behind array | 5 ft | - |