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MATERIALS EVALUATION IN THE TRI-SERVICE THERMAL RADIATION TEST FACILITY

University of Dayton
Industrial Security Super KL-505
303 College Park Avenue
Dayton, Ohio 45409

17 March 1982

Technical Report for Period 24 April 1981–24 February 1982

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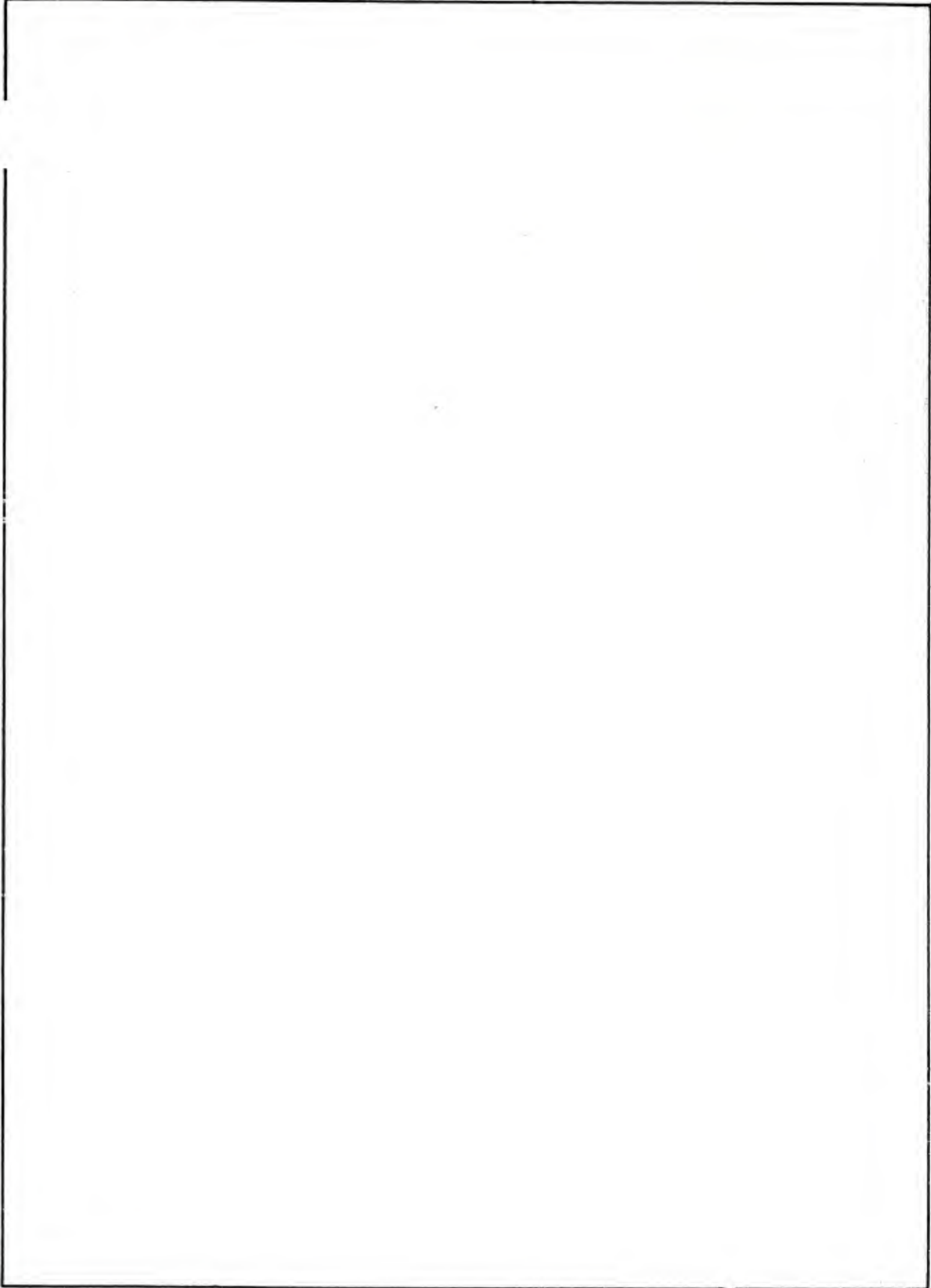
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SUMMARY

The Tri-Service Thermal Radiation Test Facility, located at Wright-Patterson Air Force Base, Ohio, has been utilized to complete over 9,600 materials tests during a five-year period under contract to the Defense Nuclear Agency. The facility has the capability to provide intense radiant heating in conjunction with either aerodynamic or mechanical tensile and bending loading.

Approximately 2,000 of the total tests were conducted during the current contract. Utilization of the facility for a similar number of materials evaluations is anticipated during a follow-on contract. Facility improvements in the area of heat flux improvement and surface phenomena data are also anticipated as scheduling allows.

PREFACE

This summary report covers work performed during the period from 24 April 1981 to 24 February 1982 under Defense Nuclear Agency Contract DNA001-81-C-0147. The work was administered under the direction of Lt. Col. R. A. Flory, Contracting Officer's Representative on this contract. The contract represents a follow-on effort to Defense Nuclear Agency Contract DNA001-80-C-0128 under which the following reports were generated:

UDRI-TR-77-28, "Tri-Service Thermal Radiation Test Facility: Test Procedures Handbook," May 1977.

DNA 4488Z, "Tri-Service Thermal Flash Test Facility," Interim Summary Report, 29 March 1978.

DNA 4757F, "Tri-Service Thermal Flash Test Facility," Final Report for Period 6 August 1976-31 October 1978, 30 November 1978.

DNA 5197F, "Tri-Service Thermal Flash Test Facility," Final Report for Period 15 December 1978-15 December 1979, 15 January 1980.

DNA 5650F, "Materials Evaluation in the Tri-Service Thermal Radiation Test Facility," Final Report for Period 25 January 1980-28 February 1981, 28 February 1981.

The work was conducted under the general supervision of Mr. Dennis Gerdeman and the Principal Investigator was Mr. Benjamin H. Wilt. Dr. Ronald A. Servais acted as consultant and the research technician was Mr. Nicholas J. Olson.

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SECTION 1
INTRODUCTION

1.1 BACKGROUND

The University of Dayton Research Institute (UDRI) has been under contract to the Defense Nuclear Agency (DNA) since 1976 to operate the Tri-Services Thermal Radiation Facility located at the Air Force Wright Aeronautical Laboratories (AFWAL), Wright-Patterson Air Force Base, Dayton, Ohio. Efforts in support of the DNA have included the development and operation of appropriate laboratory equipment to simulate thermal, aerodynamic, tensile, and bending loads and combinations of these loading conditions on materials of interest to the Tri-Service community.

The data accumulated through materials exposure to the combined thermal and aerodynamic or thermal and mechanical loads in the thermal flash facility can be utilized to match material performance with design criteria and as a data base for computer modeling.

1.2 OBJECTIVES

The primary objectives of the research activity have remained unchanged since the establishment of the test facility in 1976. These objectives have served to establish a materials data base from over 9,600 tests during that time and can be summarized as follows:

(1) To continue to provide the Tri-Service community with a quick-response intense radiation heating experimental capability, including the effects of aerodynamic and mechanical loads;

(2) To conduct tests for the Tri-Service community as required; and

(3) To maintain, improve, and modify the test facility between scheduled tests.

SECTION 2
TRI-SERVICE THERMAL FLASH TEST FACILITY

2.1 OVERVIEW

The original development of the Tri-Service Thermal Flash Test Facility is described in Reference 1. The facility has undergone numerous improvements to reflect the current needs of the Tri-Service community. There are still four basic experimental capabilities.

- (1) Irradiation of test specimens using the Mobile Quartz Lamp Bank (MQLB);
- (2) Irradiation of test specimens in aerodynamic flow using the Mobile Quartz Lamp Bank or the High Density Lamp Bank (HDLB);
- (3) Irradiation of test specimens under tensile or bending mechanical creep frame loads using the MQLB; and
- (4) Irradiation of test specimens under transient tensile/compression loads using the MQLB.

Available instrumentation include radiometers for determining heat flux, thermocouples for monitoring temperatures, a pitot tube for determining flow velocities, still and movie cameras, X-Y recorders, and various electronic control devices. Limited machining facilities are available for minor specimen modification or alteration during test programs. Figure 1 illustrates the facility layout.

2.2 NUCLEAR FLASH SIMULATION

The intense radiation needed to simulate a nuclear flash can be produced by a series or bank of tungsten filament, quartz lamps. Two banks of lamps are available in the Facility; they are designated the High Density Lamp Bank (HDLB) and the Mobile Quartz Lamp Bank (MQLB). The operational characteristics of the banks are listed in Table 1; the banks are shown in

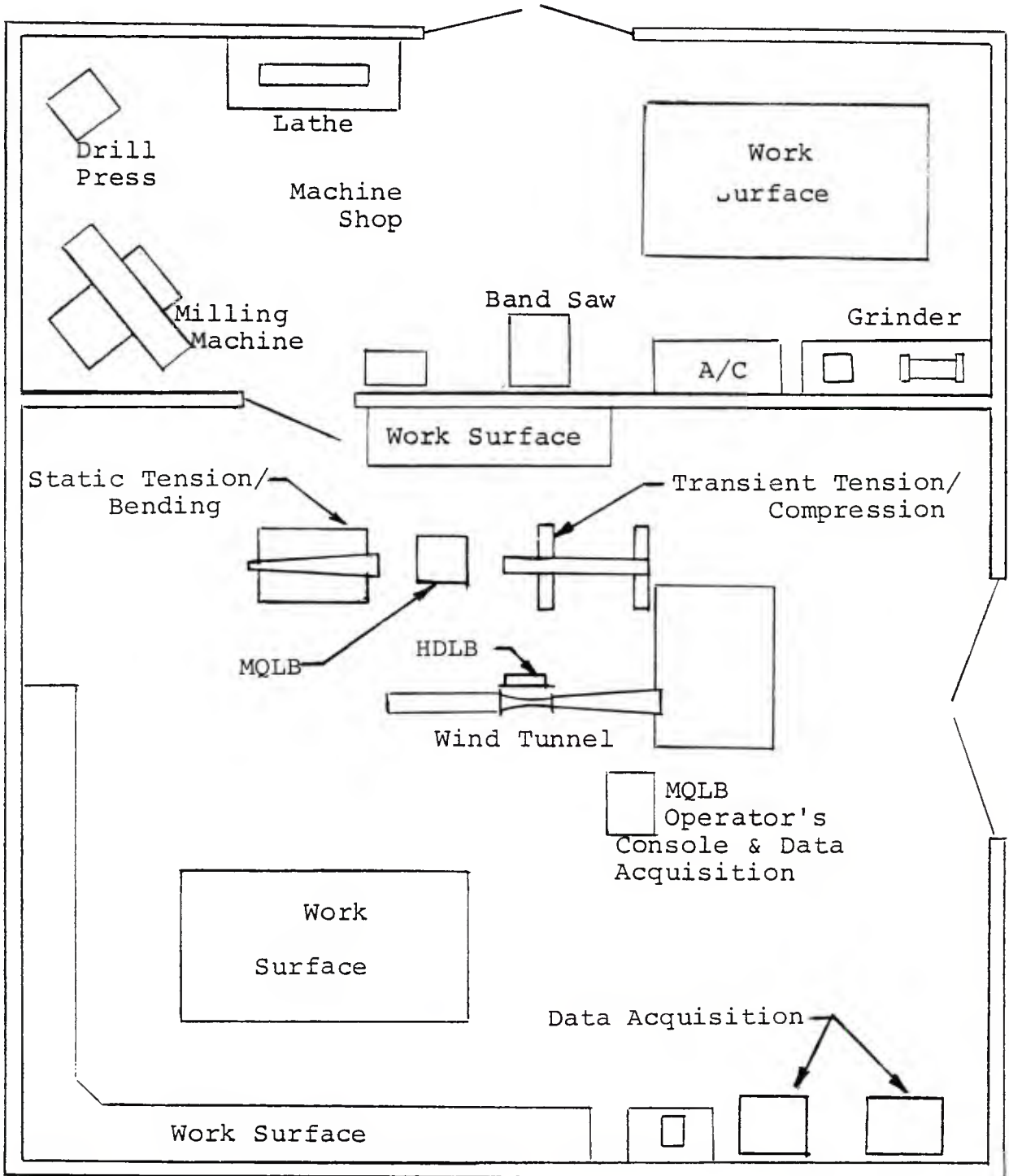


Figure .1. Tri-Service Thermal Radiation Test Facility.

Table 1
QUARTZ LAMP BANK SPECIFICATIONS

| | MQLB | HDLB |
|------------------|-----------------|-----------------|
| Lamp Designation | GE/Q6M/T3/CL/HT | GE/Q6M/T3/CL/HT |
| Number of Lamps | 24 | 24 |
| Lamp Bank Area | 22 cm x 25 cm | 15 cm x 25 cm |
| Maximum Voltage | 460 vac | 460 vac |
| Maximum Current | 300 a | 300 a |

Figures 2 and 3. The HDLB is used to produce very high heat flux levels; the MQLB is used when lower heat flux levels are required.

The HDLB mounts to the side of the wind tunnel. Use of this one-dimensional radiation source is limited to the 11 cm x 22 cm window that forms one wall of the tunnel. Incident radiation on a test specimen mounted on the opposite wall of the tunnel can only be varied by changing lamp applied voltage. Flux levels to 55 cal/cm²-sec for durations of up to 3 seconds can be achieved using a gold coated reflector that surrounds the bank, directing most of the radiant energy to the test specimen. Removal of the reflector reduces the heat flux to a level near 30 cal/cm²-sec. It also allows longer test durations of up to 5 seconds. Reducing lamp voltage for lower flux values further extends allowable test durations, as long as a maximum integrated heat fluence of 150 cal/cm² is not exceeded. Higher fluence levels can be achieved with proportionate reductions in both reliability and stability.

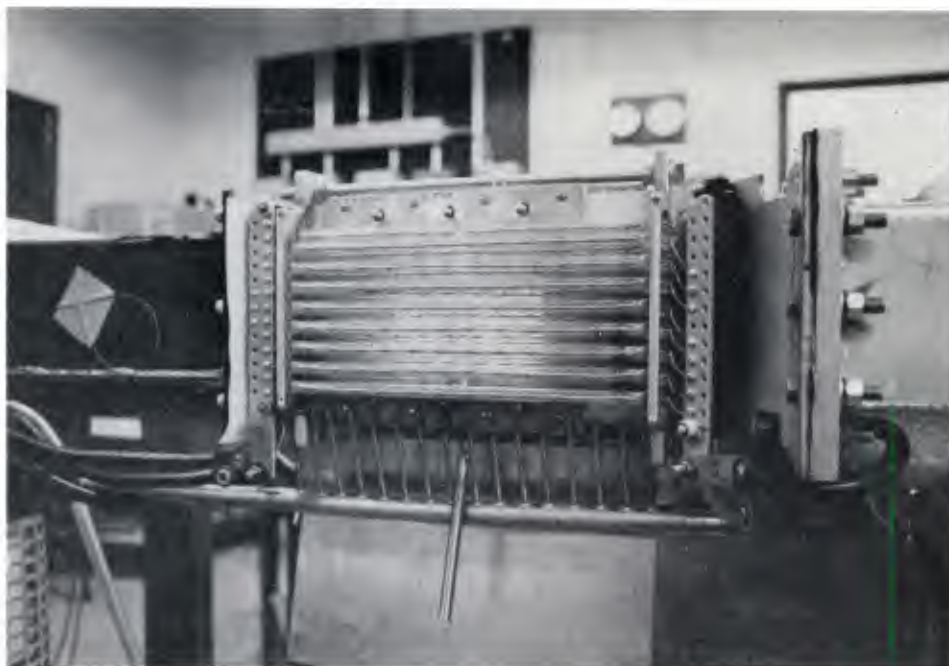


Figure 2. High Density Lamp Bank.



Figure 3. Mobile Quartz Lamp Bank.

Tunnel operation is not necessary for HDLB use but the slight air flow across the test specimens face due to flue effects prevents possible occlusion by carrying off any by-products of specimen combustion.

The MQLB with its larger area produces a one-dimensional radiation source, approximately 20 cm by 25 cm. The incident radiation on a test specimen is controlled by varying either specimen distance from the bank source or the lamp applied voltage. Certain tests require protecting the lamps; this is normally accomplished by inserting a quartz window between the lamps and the exposed specimen. The incident radiation on a test specimen as a function of the distance from the bank source is illustrated in Figure 4.

2.3 AERODYNAMIC LOAD SIMULATION

An open-circuit pull-down wind tunnel is available to simulate aerodynamic flow over specimens exposed to high intensity radiation. The wind tunnel is shown in Figure 5. A photograph of the wind tunnel test section is shown in Figure 6. The test section is 70 cm long and has a 2.38 cm x 11.43 cm cross-sectional area. The constant free-stream velocity for the section is nominally 210 m/sec with a corresponding Mach number of 0.6. The Reynolds number is 20×10^6 based on the inlet wall length. Wind tunnel exhaust gases are vented to the atmosphere through the roof of the building.

A pitot probe, manometers, and a pressure transducer are available for flow calibration, which can be supplied with each test program, as required.

The MQLB or the HDLB is used in conjunction with the wind tunnel; the beam is brought in through a quartz window which is mounted in one wall of the test section. The opposite wind tunnel test section wall holds the test specimen, which is mounted flush with the wind tunnel wall. Specimen sizes up to 22.86 cm by 10.08 cm can be accommodated. Special plates are

□ HDLB
○ MQLB

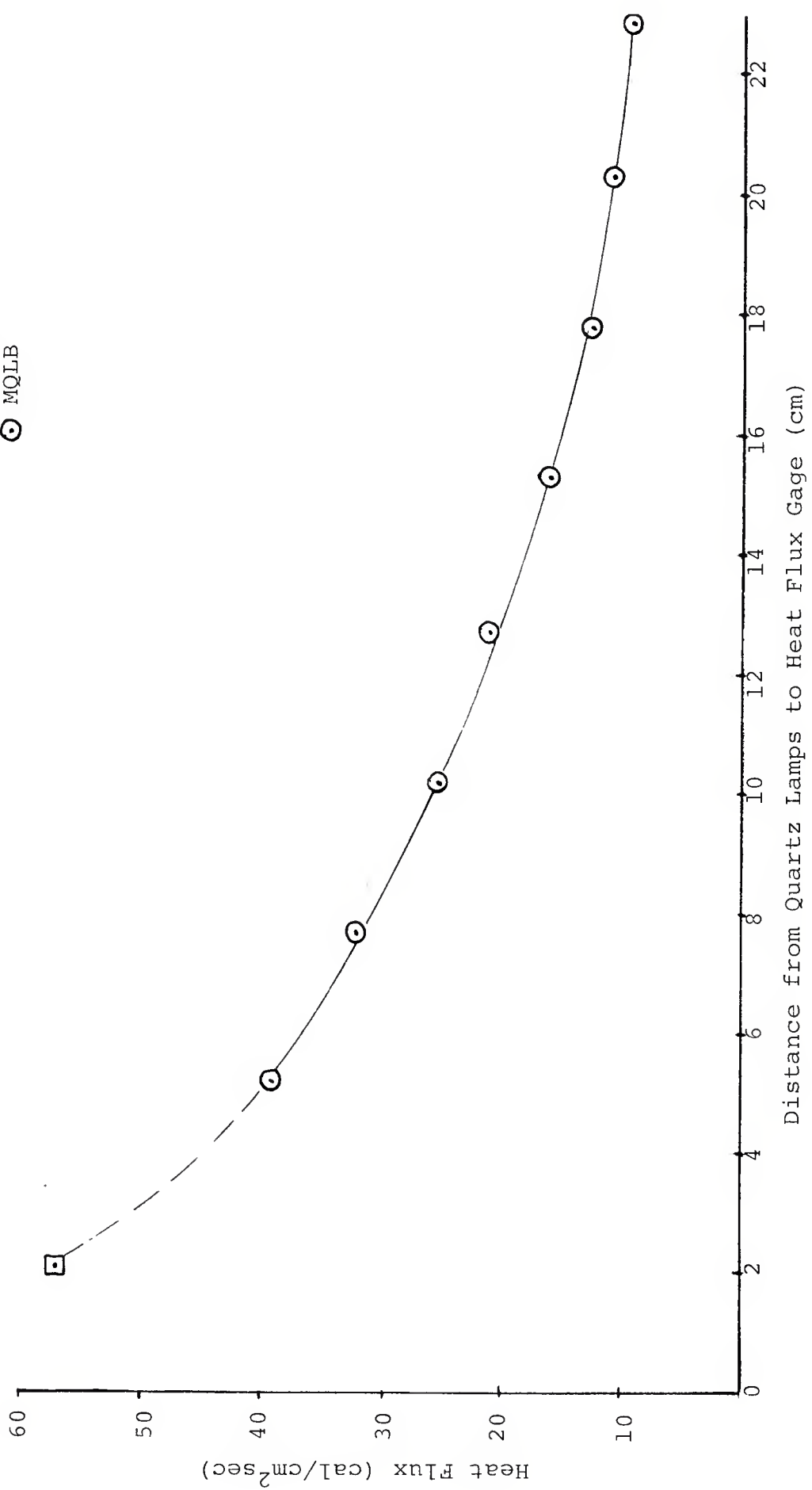


Figure 4. Radiation Heat Flux vs. Distance From Lamp Bank.

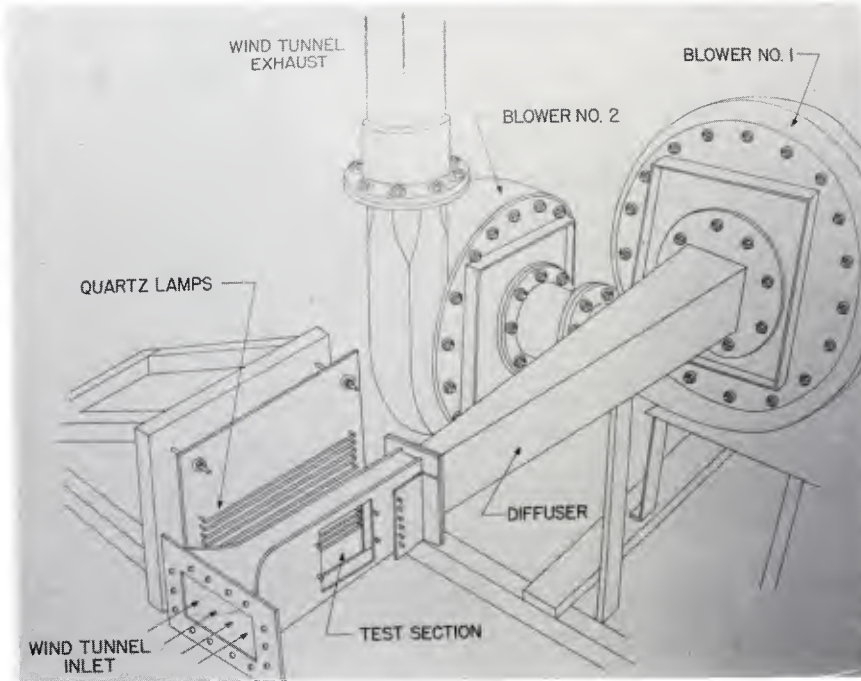


Figure 5. Wind Tunnel.

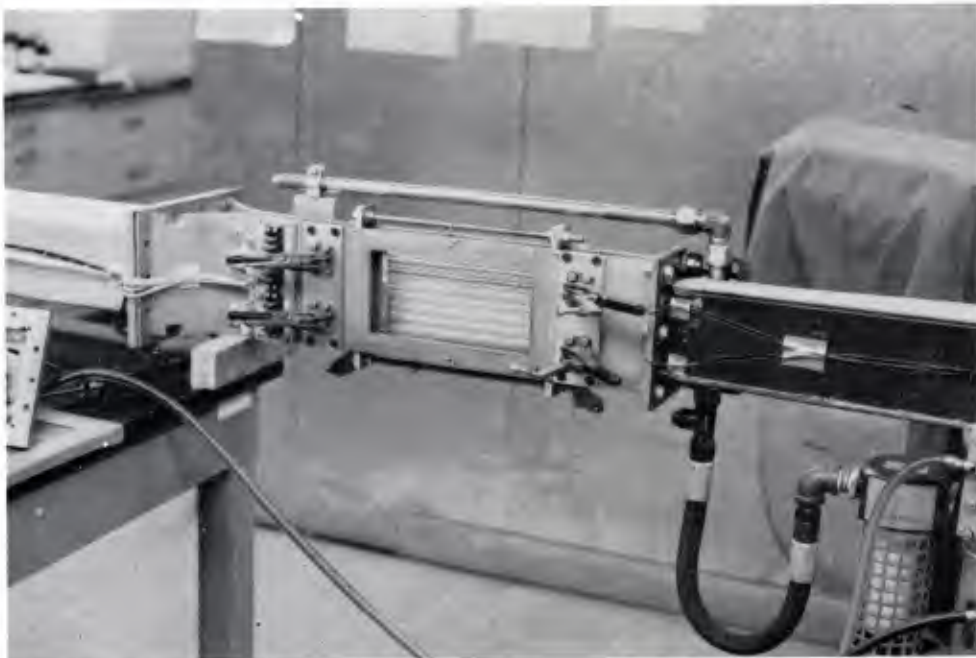


Figure 6. Wind Tunnel 70 cm Test Section.

available for the test section for mounting the various calorimeters and pitot tube for heat flux and flow calibration.

An electrically actuated shutter for the wind tunnel test configuration was designed and installed in the 70 cm test section as a first priority improvement during the previous contract effort. The shutter was installed along the centerline of the test section to take advantage of the convective cooling provided by the tunnel air flow. Lamp-to-specimen distance and, therefore, maximum heat flux available were not affected by the installation. The rapid rise and accurately controlled pulse attained with the shutter capability enhanced simulation of thermal nuclear heating. A photograph depicting shutter operation in the 70 cm test section is shown in Figure 7.

Because of recent requirements by facility users for two-level radiant heat profiles, the shutter actuating system was replaced. Materials evaluations now require long duration, low-level irradiation followed by short duration, high level heat pulses. The solenoid in the electrical system was limited to short duration use because of overheating. An air cylinder which can be operated indefinitely was installed in place of the solenoid.

2.4 DYNAMIC LOAD SIMULATION

A Materials Test System (MTS) device is available for simulating dynamic loads during exposure to radiant heating. The MTS device includes a hydraulically actuated mechanism for applying tensile or compressive loads to a specimen, as pictured in Figure 8. The loads are preset and controlled electronically; specific control components which are available are listed in Table 2. At the present time, simultaneous dynamic loads and radiant heating effects on specimens can be determined. The system is designed in order to conduct simultaneous dynamic loading in air flow while exposing the test specimen to radiant heating; this capability is tentatively scheduled for availability during 1982.

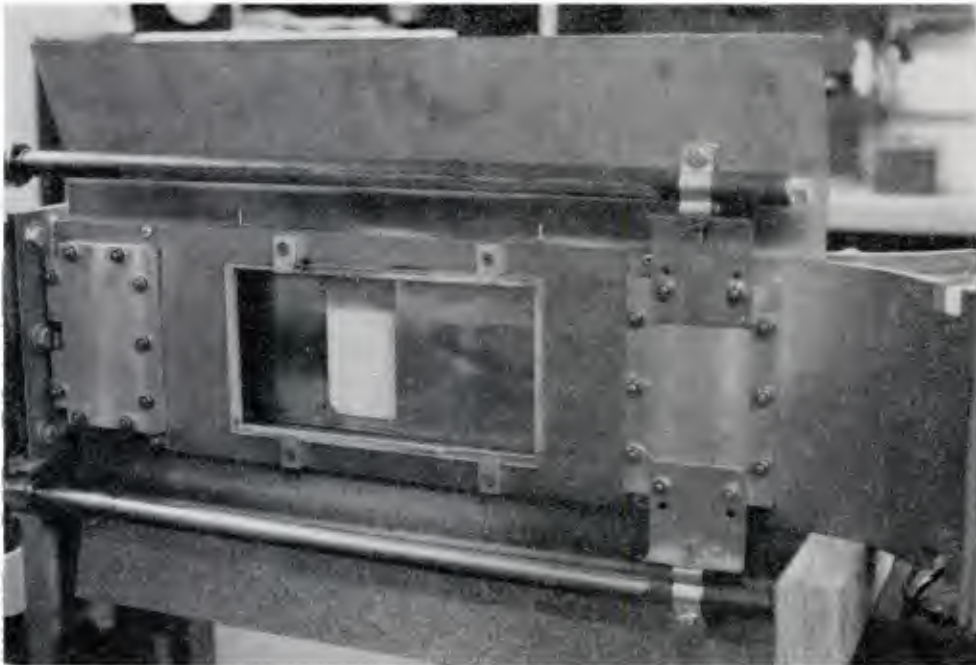


Figure 7. 70 cm Test Section Shutter.

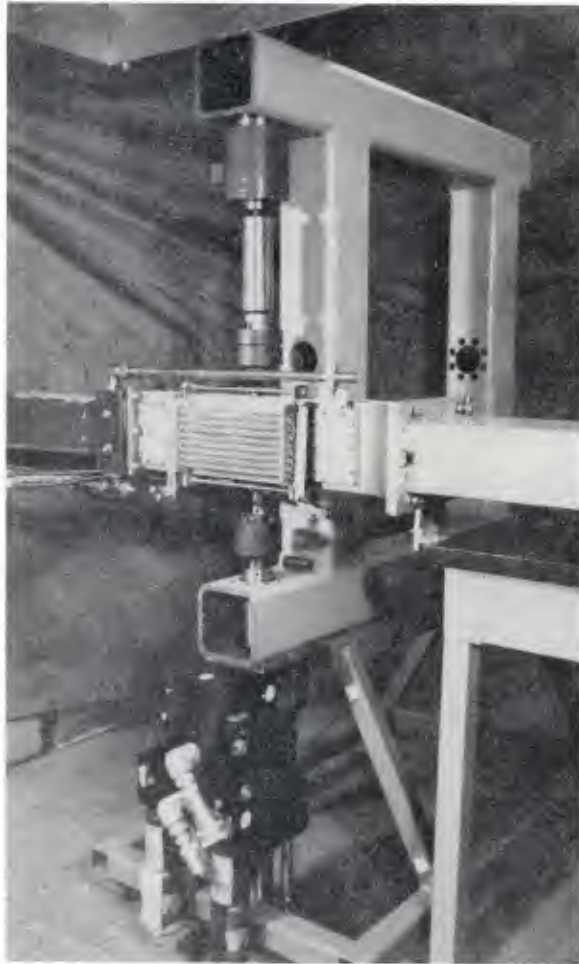


Figure 8. MTS Tensile Loading Device.

Table 2
 MTS OPERATING SYSTEM COMPONENTS

| Component | Model |
|---|--------|
| Linear Actuator | 204.51 |
| Hydraulic Manifold | 294.11 |
| Digital Function Generator | 410.31 |
| Electro-mechanical Counter | 417.01 |
| Servo Controller | 440.13 |
| DC Transducer Conditioner | 440.21 |
| AC Transducer Conditioner | 440.22 |
| Servo-controlled Closed Loop Feedback Selector | 440.31 |
| Limit Detector | 440.41 |
| Ramp Generator | 440.91 |
| Controller | 442.11 |
| Hydraulic Power Supply | 506.03 |
| Transducer Load Cell | 661.21 |

2.5 MECHANICAL LOAD SIMULATION

A creep frame is available for dead weight simulation of tensile and bending loads and is shown in Figure 9. The MQLB is used as the radiation source; the exposure procedure is similar to that used in the wind tunnel. Note that mechanical and aerodynamic loads cannot be applied simultaneously at this time. Tension and bending configurations are possible. Three and four point bending is accomplished in the mechanical load frame by the addition of a yoke and fulcrum as indicated in Figure 10. Recommended specimen sizes and maximum applied loads are specified in Table 3. Strain gages and other appropriate instrumentation are mounted on test specimens in order to monitor strain as a function of time during exposure to radiation.

Table 3
RECOMMENDED MECHANICAL LOADING
SPECIMEN INFORMATION

| | Uniaxial Tension | Bending Tension or Compression |
|---------------------|------------------|--------------------------------|
| Specimen Size (cm) | | |
| Width | 5-7.5 | 5-7.5 |
| Thickness | 0.02-1.25 | 0.6-2.5 |
| Length | 25-60 | 50-75 |
| Stress Levels (MPa) | 3.5-1700 | 7-1400 |

2.6 INSTRUMENTATION

The instrumentation required for operating the facility and which is available is summarized in Table 4. Facility users normally supply their own specimen-mounted instrumentation, such as thermocouples and strain gages. Additional details on the heat flux instrumentation and plotters which are available are given in Tables 5 and 6.

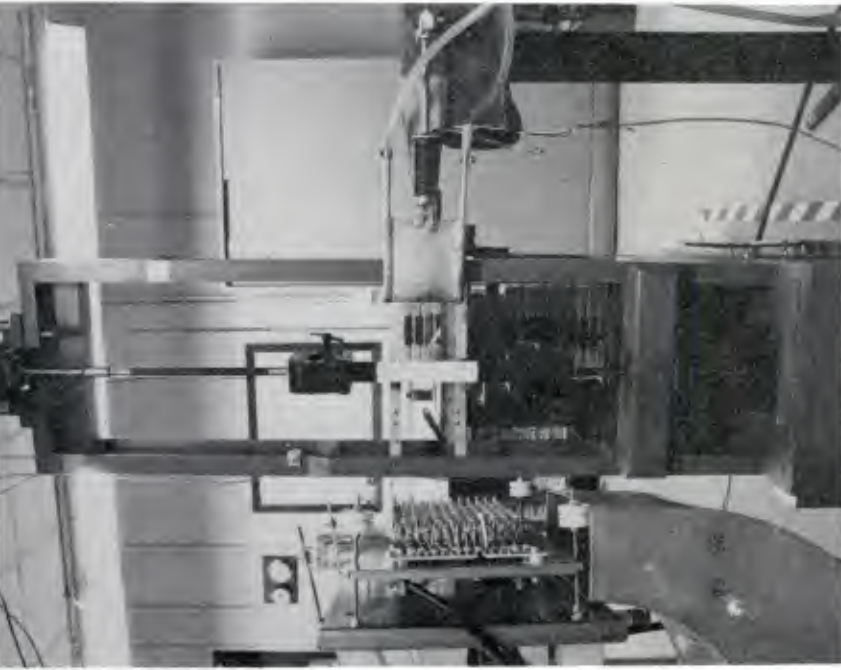


Figure 9. Mechanical Loading-Tension.

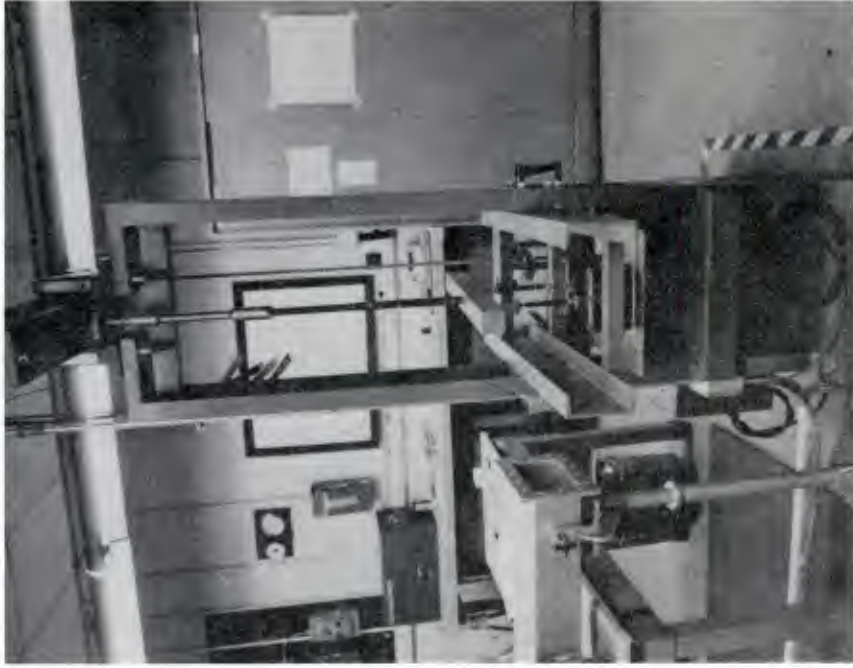


Figure 10. Mechanical Loading-Bending.

Table 4
AVAILABLE INSTRUMENTATION

| Application | Quantity | Instrumentation | Purpose |
|----------------------|----------|---|----------------------|
| Quartz Lamp Banks | 6 | Radiometers | Heat Flux |
| | 1 | Thermac Temperature Controller | Heat Flux Control |
| | 1 | Data-Trak Controller | Heat Flux Control |
| Aerodynamic Load | 1 | +10 psi Stathem Pressure Transducer | Flow Calibration |
| | 1 | Pitot Probe Assembly | Flow Calibration |
| | 1 | Manometer | Flow Calibration |
| Mechanical Load | 1 | Wheatstone Bridge | Strain Gage |
| Arc Imaging Furnaces | 2 | Radiometers | Heat Flux |
| | 1 | Calorimeter | Heat Flux |
| | 1 | Time Controller (0.1 second minimum) | Shutter Control |
| General | 3 | X-Y-Y' Recorders | Data Recording |
| | 1 | LSI-11 Micro-processor | Data Recording |
| | 1 | 35mm Nikon Still Camera | Specimen Photographs |
| | 1 | MP-4 Polaroid Still Camera | Specimen Photographs |
| | 2 | 8mm Nizo Braun Movie Cameras | Specimen Photographs |
| | --- | Various Thermocouples | Temperature |
| | 1 | L&N 8641-S Automatic Recording Pyrometer (760-6000°C) | Surface Temperature |
| | --- | Barometer, Thermometer, Hygrometer | Ambient Conditions |
| | | Tektronix Dual-Trace Memory Oscilloscope, Model 314 | |

Table 5
HEAT FLUX GAGE SPECIFICATIONS

| Mfgr | Type | Model | Range | Accuracy |
|----------|-------------|------------|--------------------------------|-------------|
| Medtherm | Gardon | 64P-20-24 | 0-5 cal/cm ² sec | <u>+3%</u> |
| Medtherm | Gardon | 64P-50-24 | 0-13 cal/cm ² sec | <u>+3%</u> |
| Medtherm | Gardon | 64P-100-24 | 0-27 cal/cm ² sec | <u>+3%</u> |
| Medtherm | Gardon | 64P-100-24 | 0-27 cal/cm ² sec | <u>+3%</u> |
| Medtherm | Gardon | 64P-200-24 | 0-54 cal/cm ² sec | <u>+3%</u> |
| Medtherm | Gardon | 64P-200-24 | 0-54 cal/cm ² sec | <u>+3%</u> |
| RdF | Gardon | CFR-1A | 0-400 cal/cm ² sec | <u>+10%</u> |
| RdF | Gardon | CFR-1A | 0-400 cal/cm ² sec | <u>+10%</u> |
| ADL | Calorimeter | --- | 50-350 cal/cm ² sec | <u>+5%</u> |

Table 6
X-Y RECORDER SPECIFICATIONS

| Mfgr | Model | Channels | Range | Response |
|-----------------|--------------|----------|-------------------|---------------|
| Hewlett-Packard | 7046A X-Y-Y' | 2 | 0.2mv/cm-4v/cm | 0.025-5cm/sec |
| Hewlett-Packard | 136 X-Y-Y' | 2 | 0.2mv/cm-20v/cm | 0.05-5cm/sec |
| Honeywell | 540 X-Y-Y' | 2 | 0.04mv/cm-0.4v/cm | 0.025-5cm/sec |
| Soltec | 3316 | 6 | 0.04mv/cm-0.4v/cm | 135cm/sec |

2.7 DATA ACQUISITION SYSTEM

The data acquisition system, including an LSI-11 micro-computer, is capable of producing conventional X-Y plots on-line or transmitting the digitized calibration or property data directly to the Wright-Patterson Air Force Base (WPAFB) Computing Facility for further data reduction. The output can be in the form of tabulated or plotted and labelled data. Figure 11 schematically illustrates the system. Table 7 lists the system components. The interface between the LSI-11 and the WPAFB Computing Facility was developed by Lt. Randy Rushe and is described in Reference 2.

2.8 CONTROL SYSTEM

The primary components of the laboratory (quartz lamp banks, wind tunnel, exhaust system) can be controlled and monitored from the operator console, which is shown in Figure 12. Only one operator is required for most tests. The console is located such that the operator can visually observe a test (if appropriate) and also monitor critical voltages and currents, etc. This allows the operator to abort a test if necessary. The console also controls the microcomputer and the other components of the data acquisition system with the exception of the data terminal. Figure 13 is an overview of the mobile quartz lamp bank, the wind tunnel, and the operating console.

2.9 COMPUTER MODELING

A two-dimensional thermal response computer program for predicting the thermal response of materials exposed to intense thermal radiation and aerodynamic cooling in the Tri-Service Thermal Flash Test Facility was developed by William N. Lee at Kaman Avidyne under contract to the Defense Nuclear Agency. The analysis and operating procedures are described in detail in Reference 3.

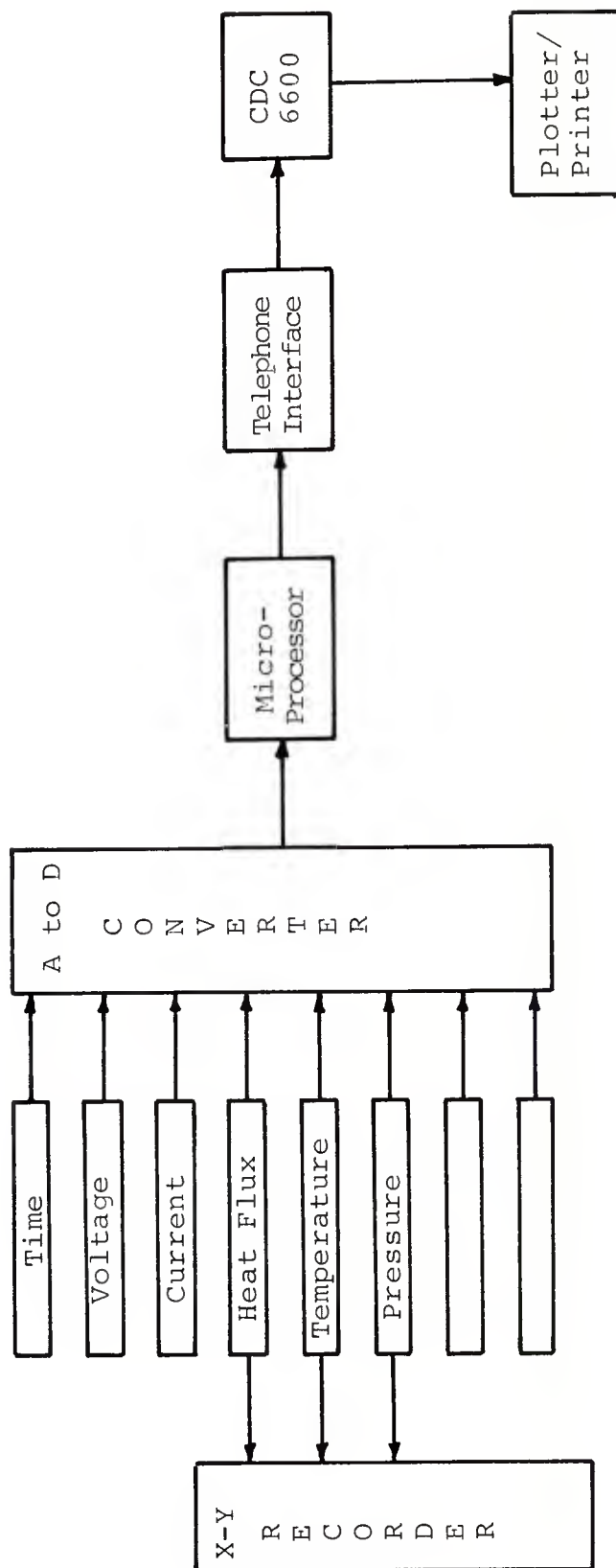


Figure 11. Data Acquisition System.

Table 7
DATA ACQUISITION SYSTEM COMPONENTS

Operating Controls

Wind tunnel operation
Quartz lamp operation
Quartz lamp cooling operation (blower & air)
Quartz lamp remote operation jack
Quartz lamp & shutter exposure time control
Computer reset, clock & hold operation
Controller set-point remote operation
Tri-phaser controller

Monitoring Controls

Quartz lamp power - voltage & current indicators
Wind tunnel pressure indicator
Peripheral equipment temperature indicator (10 pt.)
Shutter solenoid overheat indicator
Quartz lamp cumulative operating time indicator

Data Acquisition

LSI-11 microprocessor
Electron differential D.C. amplifiers (8)
Power supply
Teletype
Acoustic coupler



Figure 12. Console.

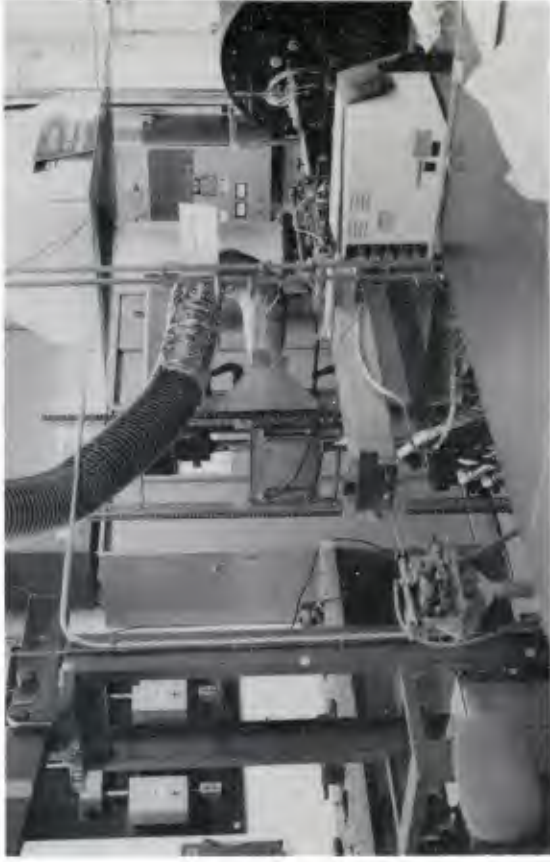


Figure 13. Thermal Flash Laboratory Overview.

SECTION 3 FACILITY UTILIZATION

3.1 TEST SCHEDULING

The Tri-Services Nuclear Flash Test Facility is available to governmental users on a no-charge basis. Test programs involving nuclear thermal flash materials performance receive priority although other tests may be accommodated; all test programs must be approved by the Defense Nuclear Agency contract monitor.

Specific details regarding test program procedures, scheduling, special testing requirements, specimen sizes, heat flux levels, etc., should be directed to the Principal Investigator and Test Director in charge of the Facility, Mr. Ben Wilt (513-229-2517). Note that the analysis of material performance must be conducted by the Facility user.

Material response tests for the Tri-Service community take precedence over all other activities associated with the operation of the Facility. That is, test requests have been scheduled at the test initiator's convenience if possible. Since most test programs are about one to five days in length, few conflicts in scheduling have arisen and few are anticipated. Based on experience, each new test program typically requires special planning and hardware (such as instrumentation and specimen mounting brackets); therefore, the more advance notice given for a particular test program the more efficiently the tests can be conducted. All test scheduling, special requirements, etc., have been and will be handled by the Test Director, Mr. Ben Wilt.

3.2 COMPLETED TEST PROGRAMS

The primary purpose of the Facility is to support the Tri-Service community with a quick-response, thermal nuclear flash, materials response testing capability. Tests which have

been conducted are summarized in Table 8. Additional information on these tests can be obtained by contacting Mr. Ben Wilt and References 4-8. The specific runs are listed in the Appendix.

3.3 PROJECTED TEST PROGRAMS

Table 9 identifies the known tests to be conducted during the next 12 months. Since the primary purpose of the Facility involves quick-response testing, it is not possible to establish a comprehensive list of all future tests at this time.

Table 8
COMPLETED AND CURRENT TEST PROGRAMS

| Initiator | Organization | Project | Test | |
|-----------|------------------------|------------------|---------------------|---------------------------|
| | | | Number | Date |
| Alexander | AVCO | DNA | 001-073 | March 7-10, 1977 |
| Alexander | AVCO | DNA | 074-086 | March 15, 1977 |
| Collis | Boeing | AWACS | 087-316 | March 21-24, 1977 |
| Graham | AVCO | DNA | 359-416 | June 6-16, 1977 |
| Alexander | AVCO | DNA | 419-574 | June 20-24, 1977 |
| Collis | Boeing | ALCM | 576-677 | July 19-22, 1977 |
| Alexander | AVCO | DNA | 678-772 | Oct. 5-7, 1977 |
| Grady | AFWAL | DNA | 773-870 | Oct. 12-22, 1977 |
| Litvak | AFWAL | B-1 | Documentary Film | March 13-24, 1978 |
| Collis | Boeing | ALCM | 871-1076 | July 18-20, 1978 |
| Sparling | Rockwell | DNA | 1081-2571 | July 24-Sept. 28, 1978 |
| Worscheck | GD-Convair | ALCM | 2572-2677 | Oct. 2-4, 1978 |
| Olson | UDRI | Calibra- tion | 2678-2710 | Oct. 16-20, 1978 |
| Sparling | Rockwell | DNA | 2711-5753 | Oct. 24-Dec. 5, 1978 |
| Alexander | AVCO | DNA | 5754-5809 | Dec. 11-13, 1978 |
| Baba | Harry Diamond | U.S. Army | 5810-5881 | Dec. 18-21, 1978 |
| Olson | UDRI | Calibra- tion | 5882-5890 | Jan. 22, 1979 |
| Evans | Ballistics Research | U.S. Army | 5891-5948 | Jan. 23-24, 1979 |
| Spangler | MCDAC | DNA | 5949-6032 | March 6-15, 1979 |
| Rooney | AFWAL | USAF | 6033-6036 | March 19, 1979 |
| Spanlger | MCDAC | DNA | 6037-6056 | April 2, 1979 |
| Worscheck | GD-Convair | ALCM | 6057-6074 | May 2, 1979 |
| Kimerly | LATA | DNA | 6075-6096 | May 31-June 1, 1979 |
| Alexander | AVCO | DNA | 6097-6140 | June 19-21, 1979 |
| Baba | Harry Diamond | U.S. Army | 6141-6222 | June 25-27, 1979 |
| Schmitt | AFWAL | USAF | 6223-6247 | June 28-29, 1979 |
| Kimerly | LATA | DNA | 6248-6264 | July 2-3, 1979 |
| Worscheck | GD-Convair | ALCM | 6265-6307 | July 17-19, 1979 |
| Spangler | MCDAC | DNA | 6308-6372 | July 30-Aug. 2, 1979 |
| Schmitt | AFWAL | USAF | 6373-6423 | Aug. 14-16, 1979 |
| Schmitt | AFWAL | USAF | 6424-6426 | Aug. 30, 1979 |
| Worscheck | GD-Convair | ALCM | 6427-6435 | Sept. 4, 1979 |
| Schmitt | AFWAL | USAF | 6436-6438 | Oct. 3, 1979 |
| Alexander | AVCO | DNA | 6439-6449 | Oct. 5-10, 1979 |
| Olson | UDRI | DNA | 6450-6466 | Oct. 15-19, 1979 |
| Rooney | AFWAL | USAF | 6467-6470 | Nov. 11, 1979 |
| Kimerly | LATA | DNA | 6471-6480 | Dec. 4-6, 1979 |

Table 8 (Continued)
 COMPLETED AND CURRENT TEST PROGRAMS

| Initiator | Organization | Project | Test | |
|------------|---------------------|-----------|-----------|------------------|
| | | | Number | Date |
| Etzel | Aerojet- General | DNA | 6481-6555 | Dec. 10-13, 1979 |
| Kimerly | LATA | DNA | 6556-6561 | Dec. 14, 1979 |
| Hurley | AFWAL | USAF | 6562-6598 | Dec. 17-21, 1979 |
| Sherwood | CAAPCO | USAF | 6599-6634 | Jan. 22, 1980 |
| Sherwood | CAAPCO | USAF | 6635-6639 | April 2, 1980 |
| Hurley | AFWAL | USAF | 6640-6647 | April 8, 1980 |
| Kimerly | LATA | DNA | 6648-6666 | May 8, 1980 |
| Tydings | AFWAL | USAF | 6467 | May 13, 1980 |
| Etzel | Aerojet | MX | 6468-6742 | June 4-10, 1980 |
| Henders | McDAC | MX | 6743-6755 | June 12, 1980 |
| Etzel | Aerojet | MX | 6756-6881 | July 7-10, 1980 |
| Walsh | Boeing-Wich. | B-52 | 6882-7040 | July 14-18, 1980 |
| Kimerly | LATA | DNA | 7041-7088 | Aug. 20-23, 1980 |
| Tydings | AFWAL | USAF | 7089-7090 | Aug. 27, 1980 |
| Etzel | Aerojet | MX | 7091-7206 | Sept. 22, 1980 |
| Church | Boeing-Wich. | B-52 | 7207-7211 | Oct. 1, 1980 |
| Tydings | AFWAL | USAF | 7212 | Oct. 14, 1980 |
| Kimerly | LATA | DNA | 7213-7232 | Oct. 16-18, 1980 |
| Rhodehamel | AFWAL | USAF | 7233-7258 | Nov. 4-10, 1980 |
| Olson | UDRI | DNA | 7259-7280 | Nov. 11-14, 1980 |
| Rhodehamel | AFWAL | USAF | 7281-7295 | Nov. 19-25, 1980 |
| Etzel | Aerojet | MX | 7296-7488 | Dec. 1-5, 1980 |
| Schuck | Collins Radio | USAF | 7489-7626 | Dec. 15, 1980 |
| Schuck | Collins Radio | USAF | 7627-7636 | Feb. 5, 1981 |
| Davis | Sperry-Univac | MX | 7637-7641 | Feb. 17, 1981 |
| Tydings | AFWAL | USAF | 7642-7645 | March 16, 1981 |
| Hender | Aerojet | MX | 7646-7799 | March 30, 1981 |
| Grinsberg | CAAPCO | USAF | 7800-7903 | April 7, 1981 |
| McDonnell | SAI | DNA | 7904-8057 | April 20, 1981 |
| Lane | Aerojet | MX | 8058-8150 | April 27, 1981 |
| Olson | UDRI | DNA | 8151-8157 | May 6, 1981 |
| Sparling | Rockwell | USAF | 8158-8184 | May 7, 1981 |
| Kimerly | LATA | DNA | 8185-8242 | May 15, 1981 |
| Olson | UDRI | DNA | 8243-8253 | June 1, 1981 |
| Schuck | Collins Radio | USAF | 8254-8266 | June 12, 1981 |
| Hender | Aerojet | MX | 8267-8268 | June 16, 1981 |
| Gregory | Aberdeen | U.S. Army | 8269-8294 | June 29, 1981 |
| Freeberg | LATA | DNA | 8295-8360 | July 6, 1981 |
| Griffith | Sperry-Univac | MX | 8361-8396 | July 13, 1981 |
| Davis | Sperry-Univac | MX | 8397-8405 | Aug. 26, 1981 |
| Grinsberg | CAAPCO | USAF | 8406-8443 | Aug. 27, 1981 |
| Price | LATA | DNA | 8444-8474 | Aug. 29, 1981 |
| Etzel | Aerojet | MX | 8475-8658 | Aug. 31, 1981 |

Table 8 (Concluded)
COMPLETED AND CURRENT TEST PROGRAMS

| Initiator | Organization | Project | Test | |
|-----------|-----------------|---------|-----------|----------------|
| | | | Number | Date |
| Hurley | AFWAL | USAF | 8659-8663 | Sept. 17, 1981 |
| Worscheck | GD-Convair | USAF | 8664-8708 | Sept. 22, 1981 |
| Hand | I-T-T | USAF | 8709-8719 | Oct. 1, 1981 |
| Miller | UDRI | NASA | 8720-8724 | Oct. 5, 1981 |
| Uram | Goodyear | USAF | 8725-8751 | Oct. 9, 1981 |
| Price | LATA | DNA | 8752-9246 | Oct. 19, 1981 |
| Dumus | Collins Radio | USAF | 9247-9302 | Nov. 5, 1981 |
| --- | LATA | DNA | 9303-9375 | Nov. 12, 1981 |
| --- | LATA | DNA | 9376-9389 | Nov. 18, 1981 |
| Miller | UDRI | NASA | 9390-9405 | Nov. 19, 1981 |
| Uram | Goodyear | USAF | 9406-9431 | Dec. 15, 1981 |
| Monti | Martin-Marietta | USAF | 9432-9510 | Dec. 21, 1981 |
| R. Davis | Brunswick | USAF | 9511-9538 | Dec. 28, 1981 |
| Olson | UDRI | DNA | 9539-9548 | Jan. 12, 1982 |
| Monti | Martin-Marietta | USAF | 9549-9642 | Jan. 18, 1982 |
| Miller | UDRI | NASA | 9643-9647 | Feb. 2, 1982 |

Table 9
PROJECTED TEST PROGRAMS

| Initiator | Organization | Project | Material | Date |
|------------|----------------|---------|------------------------|----------|
| Brown | AVCO | | | February |
| Miller | UDRI | NASA | Foam | February |
| Rhodehamel | AFWAL | USAF | Graphite Composites | March |
| Miller | UDRI | NASA | Foam | March |
| Olson | UDRI | DNA | Facility Upgrade | April |
| Sawdy | Boeing-Wichita | USAF | Aircraft Composites | April |
| Brettman | Boeing-Seattle | USAF | Aircraft Composites | May |
| Etzel | Aerojet | MX | Missile Protection | June |
| Rhodehamel | AFWAL | USAF | Graphite Composites | July |
| Kimerly | Rockwell | | Aircraft Composites | August |

SECTION 4
FACILITY DEVELOPMENT

4.1 FACILITY MAINTENANCE AND IMPROVEMENTS

Keeping the facility operational and current is an ongoing activity which is carried out between scheduled tests. Experience has shown that this effort requires about one week per month. During the period between March 1981 and February 1982, approximately 34 weeks were devoted to the completion of a like number of test programs for a total of over 2000 tests. The remaining time was utilized to maintain the facility.

A review of various methods and devices currently available to measure radiant heat flux has shown one device conforms to most requirements of the TRTF. The calorimeter, manufactured by HyCal, Inc., was purchased as the standard for facility calibration. Since the device is an asymptotic type gage, limitations regarding response time do exist. The development of a radiometric gage that can respond immediately to the energy imposed at the leading edge of a square pulse is being pursued.

Facility capabilities were significantly extended with the final incorporation of the hydraulically operated Mechanical Test System (MTS) with the Quartz Lamp Bank. The sensitivity and speed of the apparatus has greatly enhanced the combined thermal/mechanical response of materials subjected to mechanical shock during or immediately following a thermal pulse. The concept of system portability has resulted in an easily movable test frame designed to interface with both the wind tunnel and quartz lamps for simultaneous thermal, mechanical and aerodynamic effects.

The ever broadening needs of users of the TRTF has led to the design and fabrication of a number of specialized specimen holders for the testing of unique shapes and configurations. Special hardware was developed for applying uniform tensile loads to braided shields surrounding fiber optics during thermal testing. Special hardware was also developed to install cable bundles in a

repeatable location; to install short, thin specimens in a compression test mode without initiating buckling of the specimens; and for holding very thin metallic plates against the negative pressure created by the wind tunnel.

One of the more significant improvements to the facility included the fabrication of a highly polished water-cooled reflector for the Mobile Quartz Lamp Bank. The improved cooling combined with a new dual-pulse timing system with independent lamp power and pulse width control enables long-term, low-level radiant energy extending maximum fluence levels to 300 cal/cm^2 . The all solid-state timing system also incorporates the capability for long-term low level specimen pre-heat followed instantly by a high level short-term pulse. Independent and sequential programming of such test parameters as wind tunnel operation, specimen exposure time, radiance levels and, to some extent, pulse shaping is also possible.

Several improvements in data acquisition were incorporated with the installation of the six-channel Soltec recorder. The strip-chart recorder has a broad variety of ranges and provides direct plots of temperature of up to six thermocouple inputs.

The extremely short duration pulses associated with mechanical fracture of materials are now captured on the dual-trace memory screen oscilloscope incorporated in the facility during the contract period. The resulting traces are then photographed to provide a permanent record of material performance.

REFERENCES

1. Servais, R. A., Wilt, B. H., and Olson, N. J., "Tri-Service Thermal Flash Test Facility," Interim Summary Report, DNA 4488Z, 29 March 1978.
2. Rushe, R., "A Microcomputer Data Acquisition System for Materials Testing," Master of Science Thesis submitted to the Air Force Institute of Technology, March 1978.
3. Lee, W. N., "TRAP-ML-A Two Dimensional Thermal Response Code Tailored for the Defense Nuclear Agency Tri-Service Thermal Radiation Test Facility," DNA 4770F, 30 November 1978.
4. Scherer, W. R. and Collis, S. E., "Nuclear Thermal Survivability/Vulnerability of the E-4B," Boeing Aerospace Co. Rpt. No. D226-20380-1, March 1977.
5. "Skin Friction Drag Increase Due to Nuclear Thermal Damage," Boeing Aerospace Co. Final Report on Contract DNA001-77-C-0090, 30 September 1977.
6. Collis, S. E., "Simulated Nuclear Thermal Testing of AGM-86 Honeycomb Sandwich Structures," Boeing Aerospace Co. Rpt. No. D232-10599-3, November 1977.
7. Alexander, J. G., "Conductive Coatings for Composite Aircraft Surfaces," AVCO Systems Division, Rpt. No. AFML-TR-77-164, September 1977.
8. Collis, S. E., "Simulated Nuclear Thermal Testing of AGM-86 Nosecap Sandwich Structure and Fin/Elevon Graphite-Epoxy Composites," Boeing Aerospace Co. Rpt. (to be published).

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APPENDIX
THERMAL FLASH TESTS

| Run Series | Specimen Configurations | |
|------------|---------------------------------------|---|
| | Substructures | Coatings |
| 001-073 | Aluminum 6061 | WMS-0; WMS-4; WMS-7; CMS-905; WMS-0/ CMS-905; WMS-4/CMS-905; WMS-7/CMS-905; 1224-0; CMS-6231 |
| | Glass-Epoxy | WMS-0/CMS-905; WMS-7/CMS-905; CMS-905; CMS-6231 |
| | Graphite-Epoxy | WMS-0/CMS-905; WMS-4/CMS-905; WMS-7/ CMS-905; 1224-4/CMS-905; 1224-0; CMS-905 |
| 074-086 | Graphite-Epoxy | WMS-0; WMS-4; WMS-7/CMS-905; WMS-7/ CMS-6231; CMS-6231 |
| 087-316 | Glass-Epoxy Honeycomb | MIL-C-8326; MIL-L-81352; MIL-C-83281; MIL-C-83286; Astrocoat; Fluorocarbon; Polysulfide |
| | Aluminum Honeycomb | MIL-C-8326; MIL-C-83286 |
| | Graphite-Epoxy TBD Honeycomb | MIL-C-83281; MIL-C-83286 |
| | Aluminum Sheet | MIL-C-83281; MIL-C-83286 |
| | Magnesium Sheet | MIL-C-83281; MIL-C-83286 |
| 317-360 | FACILITY MODIFICATION AND CALIBRATION | |
| 361-412 | Quartz Polyimide | Uncoated |
| | Graphite-Epoxy | Uncoated |
| 419-574 | Glass-Epoxy | 1; 2; 3; 4A; 4B; 5A; 5B; 5C; 5D; 6; 7; 8A; 8B; 8C; 9; 9B; 10; 11; 12A; 12B; 13A; 13B; 15A; 15B; 16; 17 (Table 10) |
| | Graphite- Epoxy | 1; 2; 3; 4; 5; 5B; 5C; 6; 7; 8B; 9A; 9B; 10; 11; 12A; 12B; 13A; 13B; 15A; 16; 17 (Table 10) |
| | Quartz Polyimide | 1; 2; 3; 4A; 4B; 5A; 5B; 5C; 5E; 9A; 10; 12A; 15A; 15B; 16; 17 (Table 10) |
| | Aluminum 6061 | 2; 6; 7; 12; 18; 19; 20; 21 (Table 10) |

| Run Series | Specimen Configurations | |
|------------|--|--|
| | Substructures | Coatings |
| 575-677 | Glass-Epoxy Honeycomb | 25; 26; 28; 29; 30; 31; 32; 33 (Table 10) |
| | Aluminum Honeycomb | 25; 26; 27 (Table 10) |
| | Aluminum Sheet | 25; 26; 27 (Table 10) |
| 688-772 | Glass-Epoxy | 1; 2; 3; 4B; 5A; 5B; 5C; 5D; 7; 9A; 10; 10B; 15A; 24 (Table 10) |
| | Graphite- Epoxy | 4B; 6; 9A; 9C; 10; 10B; 10C; 11A; 12A; 12C; 12D; 14; 15B; 22; 23 (Table 10) |
| | Quartz Polyimide | 0; 4B; 5; 5B; 5C; 9A; 10A; 10B; 12A; 12C; 12D; 14; 15A (Table 10) |
| 773-855 | Graphite- Epoxy | White polyimide; cork silicone; un- coated (All tested in tension) |
| | Quartz Polyimide | White polyimide; cork silicone; un- coated (All tested in tension) |
| 856-870 | Aluminum | Grey polymeric bead |
| 871-1076 | Epoxy-fiberglass Foam sandwich | 34; 35; 36 (Table 10) |
| | Epoxy-fiberglass Honeycomb sandwich | 35; 37 (Table 10) |
| | Graphite-epoxy | 38; 39; 40 (Table 10) |
| | Natural poly- ethylene with honeycomb core | No coating |
| | White poly- ethylene with honeycomb core | No coating |
| | Delrin with Flex- core Honeycomb | No coating |
| | Nylon with Flex- core Honeycomb | No coating |

| Run Series | Specimen Configurations | |
|------------|--|---|
| | Substructures | Coatings |
| 1081-2571 | Honeycomb Substructure | 41; 42; 43; 44; 45; 46; 47; 48; 49; 50; 51; 52; 53; 54 (Table 10) |
| 2572-2677 | Aluminum 7075 | 55; 56; 57; 58; 59; 60; 61; 62; 63; Anodize (Table 10) |
| | Glass-Epoxy | 55; 56; 57; 58; 59; 60; 61; 62; 63; Uncoated (Table 10) |
| 2678-2710 | FACILITY MODIFICATION AND CALIBRATION | |
| 2711-5753 | Honeycomb Substructure | 41; 42; 43; 44; 45; 46; 47; 48; 49; 50; 51; 52; 53; 54 (Table 10) |
| 5754-5809 | Graphite-Epoxy | 1; 2; 3; 4A; 4B; 5A; 5B; 6; 10A; 10B; 10C; 14; 15A; 15B; 16; 17 (Table 10) |
| | Quartz Polyimide | 1; 2; 3; 4A; 4B; 5A; 5B; 6; 10A; 10B; 10C; 14; 15A; 15B; 16; 17 (Table 10) |
| 5810-5881 | Fiber Optics | 64; 65; 66; 67; 68 (Table 10) |
| | Twisted Pair and Coaxial Electrical Cables | 64; 65; 66; 67; 68 (Table 10) |
| 5882-5890 | FACILITY CALIBRATION | |
| 5891-5948 | 1060 Cold Rolled Steel | 69; 70; 71; 72; 73; 74; 75; 76; 77; 78 (Table 10) |
| 5949-6032 | Kevlar-Epoxy | 79; 80; 81; 82; 83; 84; 85; 86; 87; 88; 89; 90; 91; 92; 93; 94 (Table 10) |
| | Motorcase | 79; 80; 81; 82; 83; 84; 85; 86; 87; 88; 89; 90; 91; 92; 93; 94 (Table 10) |
| 6033-6036 | Aluminized Fabric | No coating |
| 6037-6056 | Vamac | No coating |
| | Viton | No coating |

| Run Series | Specimen Configurations | |
|------------|--|--|
| | Substructures | Coatings |
| 6057-6074 | Aluminum | 55; 56; 57; 58; 59; 60; 61; 62; 63 (Table 10) |
| | Epoxy/Fiberglass | 55; 56; 57; 58; 59; 60; 61; 62; 63 (Table 10) |
| 6075-6096 | Polypropylene | No coating |
| 6096-6140 | Graphite-Epoxy | 1; 2; 3; 4A; 4B; 5A; 5B; 6; 10A; 10B; 10C; 14; 15A; 15B; 16; 17 (Table 10) |
| | Quartz Polyimide | 1; 2; 3; 4A; 4B; 5A; 5B; 6; 10A; 10B; 10C; 14; 15A; 15B; 16; 17 (Table 10) |
| 6141-6222 | Fiber Optics | 64; 65; 66; 67; 68 (Table 10) |
| | Twisted Pair and Coaxial Electrical Cables | 64; 65; 66; 67; 68 (Table 10) |
| 6223-6247 | Aluminum | 95; 96; 97; 98; 99; 100; 101; 102; 103; 104; 105 (Table 10) |
| 6248-6264 | | 106; 107; 108; 109 (Table 10) |
| 6265-6307 | Aluminum | 55; 56; 57; 58; 59; 60; 61; 62; 63 (Table 10) |
| | Epoxy/Fiberglass | 55; 56; 57; 58; 59; 60; 61; 62; 63 (Table 10) |
| | Polycarbonate | 55; 56; 57; 58; 59; 60; 60; 62; 63 (Table 10) |
| | Quartz-Epoxy | 55; 56; 57; 58; 59; 60; 61; 62; 63 (Table 10) |
| 6308-6372 | Vamac | No coating |
| 6373-6426 | Aluminum | 110; 111; 112; 113; 114; 115; 116; 117; 118; 119; 120; 121; 122; 123; 124 (Table 10) |
| 6427-6435 | Teflon-Epoxy | 55; 56 (Table 10) |

| Run Series | Specimen Configurations | |
|------------|---|--|
| | Substructures | Coatings |
| 6436-6438 | Epoxy/Fiberglass | 125 (Table 10) |
| 6439-6449 | Quartz Polyimide | 4A; 4B (Table 10) |
| 6450-6466 | FACILITY CALIBRATION | |
| 6467-6470 | Aluminized Tape | No coating |
| 6471-6480 | FACILITY CALIBRATION | |
| 6481-6555 | | 126; 127; 128; 129; 130; 131; 132; 133 (Table 10) |
| 6556-6561 | FACILITY CALIBRATION | |
| 6562-6598 | Aluminum | 95; 96; 97; 98; 99; 100; 101; 102; 103; 104; 105; 110; 111; 112; 113; 114; 115; 116 (Table 10) |
| 6599-6639 | Quartz-Polyimide/ Graphite Epoxy | 134; 135; 136; 137; 138; 139; 140; 141; 142; 143 (Table 10) |
| 6640-6647 | Aluminum | 144; 145; 146; 147; 148; 149 (Table 10) |
| 6648-6666 | FACILITY CALIBRATION | |
| 6667 | Aluminized Tape | No coating |
| 6668-6742 | Aluminum | NBR/EDPM blends, Vamac |
| 6743-6755 | Wind tunnel con- vective cooling evaluation | |
| 6756-6881 | Aluminum | NBR/EDPM blends |
| 6882-7040 | Glass-Epoxy Honeycomb | 150; 151; 152 (Table 10) |
| 7041-7058 | FACILITY CALIBRATION | |

| Run Series | Specimen Configurations | |
|------------|------------------------------------|---|
| | Substructures | Coatings |
| 7059-7088 | FACILITY CALIBRATION | |
| 7089-7090 | Aluminized Tape | No coating |
| 7091-7206 | Aluminum | Ne blends; Duroid (AVCO); Cork (Thiokol); Silicone (Thiokol); Vamac 25 |
| 7207-7211 | Quartz Polyimide | No coating |
| 7212 | Aluminized Tape | No coating |
| 7213-7232 | DYNAMIC LOAD CHECKOUT | |
| 7233-7258 | Surface Temperature Determinations | |
| 7259-7280 | FACILITY CALIBRATION | |
| 7281-7295 | Quartz Polyimide | No coating |
| 7296-7488 | Aluminum | 153; 154; 155; 156; 157; 158; 159; 160; 161; 162; 163; 164; 165; 167 (Table 10) |
| 7489-7636 | Electrical Hardware | Switch faces; keyboard displays; digital panel meters; LED displays, connectors |
| 7637-7641 | Fiber-Optics | Kevlar strength shields, EDM Galite, PPP non-woven Kevlar |
| 7642-7645 | Aluminized Tape | 3M-YR-364; Y-363A-L4; Y363A-L8 |
| 7646-7799 | Aluminum | Vamac 22B; Ne blend, Kevlar; RTV560; DC93-076; DC93-104; Silastic E; Cork (Thiokol) |
| 7800-7903 | Quartz Polyimide | 168; 169; 170; 171; 172; 173; 174; 175; 176; 177; 178; 179; 180 (Table 10) |

| Run Series | Specimen Configurations | |
|------------|--------------------------|--|
| | Substructures | Coatings |
| 7904-8057 | FACILITY CALIBRATION | |
| 8058-8150 | Aluminum | 181; 182; 183; 184; 185; 186; 187; 188; 189; 190; 191 (Table 10) |
| 8151-8157 | Copper | 3M Nextel paint |
| 8158-8184 | Aluminum | Uncoated |
| | Glass-Epoxy | Aluminum screen undercoat |
| | Graphite-Epoxy | Aluminum screen undercoat |
| 8185-8242 | Thermal Print Paper | 3M Nextel paint |
| 8243-8253 | FACILITY CALIBRATION | |
| 8254-8266 | Keyboards | LCD and polyester |
| 8267-8268 | Aluminum | Vamac 22B |
| 8269-8294 | Aluminum | Medtherm optically flat black paint |
| 8295-8360 | Clear Plastic Wafers | Uncoated |
| 8361-8396 | Fiber-optics | 192; 193; 194; 195; 196; 197; 198 (Table 10) |
| 8397-8405 | Fiber-optics | 199; 200 (Table 10) |
| 8406-8443 | Quartz Polyimide | 201; 202; 203; 204; 205; 206; 207; 208; 209; 210; 211 (Table 10) |
| 8444-8474 | Styrofoam Wafers | Uncoated |
| 8475-8658 | Aluminum; Glass-Epoxy | Vamac; RTV 560; Hypalon; EPDM; Cork/Hypalon; Cork/Potting compound/ Hypalon; Silastic E; Cork; AVCO-1; AVCO-2 |
| 8659-8663 | Aluminum | Camouflage paints |

| Run Series | Specimen Configurations | |
|------------|---|--|
| | Substructures | Coatings |
| 8664-8708 | Aluminum; Lexan; Fiberglass; Fiberglass Honeycomb | CAAPCO polyurethanes |
| 8709-8719 | Fiber-optics | Polyurethane, Kevlar; Tefsel |
| 8720-8724 | Polyimide Foam | Intumescent coatings |
| 8725-8751 | Aluminum | External protection coatings |
| 8752-9246 | Glass-Epoxy; Graphite-Epoxy | Uncoated tension/compression |
| 9247-9302 | Steel; Glass-Epoxy | 169; 171; 173; 177; 179; 212; 213; 214; 215; 216; 217; 218; 219; 220; 221; 222; 223; 224; 225; 226; 227; 228 (Table 10) |
| 9303-9375 | Aluminum | Uncoated tension/compression |
| 9376-9389 | Graphite-Epoxy; Graphite-Aluminum | T-300/96% SiO ₂ |
| 9390-9405 | Aluminum | Sprayed foam insulation with polyimide and phenolic intumescent coatings |
| 9406-9431 | Aluminum; Transparencies | Uncoated and coated |
| 9432-9510 | Aluminum | 229; 230; 231; 232 (Table 10) |
| 9511-9538 | Quartz-Epoxy | CAAPCO fluoroelastomers, white and gray |
| 9539-9548 | FACILITY CALIBRATION | |
| 9549-9642 | Aluminum | 229; 230; 231; 232 (Table 10) |
| 9643-9647 | Aluminum | Sprayed on foam insulation with polyimide and phenolic intumescent coatings |

Table 10
TABLE OF MATERIALS

| | |
|-----|--|
| 1 | Two-layer anti-static white polyurethane |
| 2 | Single-layer aluminized polyurethane |
| 3 | White MIL-C-83286 over aluminized polyurethane |
| 4A | Dow 808 white silicone, 50 PVC titania |
| 4B | Dow 808 white silicone, 25 PVC titania |
| 5A | Three layer white fluorocarbon, 40 PVC titania plus fibers |
| 5B | Three layer white fluorocarbon, 25 PVC titania plus fibers |
| 5C | Three layer fluorocarbon erosion coating, 25 PVC titania plus fibers |
| 5D | Three layer fluorocarbon erosion coating, 40 PVC titania plus fibers |
| 6 | Bonded copper foil, 2 Mil |
| 7 | Flame sprayed aluminum |
| 8A | Bonded polyester film, 10 Mil |
| 8B | Bonded TFE teflon film, 10 Mil |
| 8C | Bonded UHMW polyethylene film, 10 Mil |
| 9A | Bonded cork silicone, 20 Mil |
| 9B | Bonded cork silicone, 50 Mil |
| 9C | Cork silicone, 10 Mil |
| 10A | Epoxy-polyimide white ablative paint |
| 10B | Epoxy-polyimide flexible white, 6 Mil |
| 10C | Epoxy-polyimide flexible white, 10 Mil |
| 11 | Grafoil stitched package |
| 12A | Bonded RTV 655 silicone, 20 Mil |
| 12B | Bonded RTV 655 silicone, 50 Mil |
| 12C | Modified RTV 655, white, sprayed, 10 Mil |
| 12D | Modified RTV 655, white, sprayed, 3 Mil |
| 13A | Bonded silastic 23510 white silicone, 20 Mil |
| 13B | Bonded silastic 23510 white silicone, 50 Mil |
| 14 | RTV-655, 3 Mil over cork silicone, 10 Mil |
| 15A | 134/KHDA polyurethane erosion coating, 5 PVC titania |
| 15B | 134/KHDA polyurethane erosion coating, 25 PVC titania |

Table 10
TABLE OF MATERIALS (Continued)

| | |
|-----------|--|
| 16 | Desoto 10A grey polyurethane topcoat over aluminized polyurethane |
| 17 | Bostic dark grey polyurethane over aluminized polyurethane |
| 18- 21 | Grey polyurethane |
| 22 | White RTV 655, 3 Mil over conductive RTV 3 Mil |
| 23 | Bonded aluminum foil, 2.4 Mil |
| 24 | Bonded aluminum foil with topcoat, 2.4 Mil |
| 25 | MIL-P-23377 primer plus white MIL-C-83286 enamel (Desoto) |
| 26 | Same as "25" except thicker enamel |
| 27 | Same as "25" except very thick enamel |
| 28 | Astrocoat system; primer plus white 8001 erosion coating plus white (non-yellowing) 8004 topcoat |
| 29 | Same as "28" but the 8001 coating is thicker |
| 30 | Astrocoat system; primer plus white (non-yellowing) 8004 topcoat |
| 31 | Astrocoat system; primer plus white 8001 erosion coating plus black 8003 antistatic topcoat |
| 32 | Same as "31" except thicker 8001 coating |
| 33 | Same as "25" except DEFT white enamel per MIL-C-83286 |
| 34 | 2-ply 120 fabric prepreg |
| 35 | 2-ply 181 fabric prepreg |
| 36 | 3-ply 181 fabric prepreg |
| 37 | 5-ply 120 fabric prepreg |
| 38 | 5-ply skin with chopped fiber-epoxy |
| 39 | 2-ply skin with chopped fiber-epoxy |

Table 10

TABLE OF MATERIALS (Continued)

| | |
|----|--|
| 40 | 5-ply skin with chopped graphite fiber bonded to titanium |
| 41 | MIL-C-83286 white polyurethane, MIL-P-83277 primer over 7781 glass reinforced F-161 epoxy (3, 4, 5, and 6 plies) |
| 42 | MIL-C-83286 white polyurethane, MIL-P-83277 primer over 7781 glass reinforced CE-9000 epoxy (3, 4, 5, and 6 plies) |
| 43 | MIL-C-83286 white polyurethane, MIL-P-83277 primer over 7781 glass reinforced F-178 addition polyimide (3, 4, 5, and 6 plies) |
| 44 | MIL-C-83286 white polyurethane, MIL-P-83277 primer over 7781 glass reinforced 2272 addition polyimide (3, 4, 5, and 6 plies) |
| 45 | MIL-C-83286 white polyurethane, MIL-P-83277 primer over 581 quartz reinforced F-161 epoxy (3, 4, 5, and 6 plies) |
| 46 | MIL-C-83286 white polyurethane, MIL-P-83277 primer over 581 quartz reinforced F-178 addition polyimide (3, 4, 5, and 6 plies) |
| 47 | MIL-C-83286 white polyurethane, MIL-P-83277 primer over T-300 graphite reinforced 5208 epoxy (3, 4, 5, and 6 plies) |
| 48 | MIL-C-83286 white polyurethane, MIL-P-83277 primer over AS graphite reinforced 3501-5A epoxy (3, 4, 5, and 6 plies) |
| 49 | MIL-C-83286 white polyurethane, MIL-P-83277 primer over AS graphite reinforced 934 epoxy (3, 4, 5, and 6 plies) |
| 50 | MIL-C-83286 white polyurethane, MIL-P-83277 primer over AS graphite reinforced F-178 addition polyimide (3, 4, 5, and 6 plies) |
| 51 | MIL-C-83286 white polyurethane, MIL-P-83277 primer over 181 Kevlar reinforced 5208 epoxy (3, 4, 5, and 6 plies) |
| 52 | MIL-C-83286 white polyurethane, MIL-P-83277 primer over 181 Kevlar reinforced F-161 epoxy (3, 4, 5, and 6 plies) |
| 53 | MIL-C-83286 white polyurethane, MIL-P-83277 primer over 181 Kevlar reinforced 934 epoxy (3, 4, 5, and 6 plies) |
| 54 | MIL-C-83286 white polyurethane, MIL-P-83277 primer over boron-epoxy (3, 4, 5, and 6 plies) |

Table 10

TABLE OF MATERIALS (Continued)

| | |
|----|---|
| 55 | MIL-P-23377 primer |
| 56 | MIL-C-81773 coating 37875 over MIL-P-23377 primer |
| 57 | MIL-C-81773 coating 36622 over MIL-P-23377 primer |
| 58 | MIL-C-81773 coating 36314 over MIL-P-23377 primer |
| 59 | MIL-C-81773 coating 17875 over MIL-P-23377 primer |
| 60 | MIL-C-83286 coating 30140 over MIL-P-23377 primer |
| 61 | Mask 10A over MIL-P-23377 primer |
| 62 | Mask 10A over MIL-C-81773 coating 17875 over MIL-P-23377 primer |
| 63 | Mask 10A over MIL-C-81773 coating 37875 over MIL-P-23377 primer |
| 64 | Polyethylene |
| 65 | Polyurethane |
| 66 | Teflon |
| 67 | Polyvinylchloride |
| 68 | Rubber |
| 69 | Army Systems Camouflage MIL-E-52798A over TTP-636 primer |
| 70 | Army Systems Camouflage MIL-E-52835A over TTP-636 primer |
| 71 | Army Systems Camouflage MIL-E-52929 over TTP-636 primer |
| 72 | Army Systems Camouflage MIL-E-52909 over TTP-636 primer |
| 73 | Army Systems Camouflage MIL-E-52926 over TTP-636 primer |
| 74 | Army Systems Camouflage MIL-E-52798A over TTP-664 primer |
| 75 | Army Systems Camouflage MIL-E-52835A over TTP-664 primer |
| 76 | Army Systems Camouflage MIL-E-52929 over TTP-664 primer |
| 77 | Army Systems Camouflage MIL-E-52909 over TTP-664 primer |
| 78 | Army Systems Camouflage MIL-E-52926 over TTP-664 primer |

Table 10

TABLE OF MATERIALS (Continued)

| | |
|-----|---|
| 79 | Vamac 25-1.5, 2.5, and 3.5 mm thick |
| 80 | Viton 2B12-1.5, 2.5, and 3.5 mm thick |
| 81 | Vamac, 0.635 mm over Vamac-Silica, 2.865 mm |
| 82 | Vamac-Silica, 3.5 mm thick |
| 83 | NBR, 3.5 mm thick |
| 84 | Motorcase, 4.2 mm over motorcase, 7.7 mm |
| 85 | Vamac, 2.5 mm over Vamac Foam, 1.0 mm |
| 86 | Vamac, 2.5 mm over Light Vamac Foam, 1.0 mm |
| 87 | Vamac, 1.5 mm over Vamac Foam, 2.0 mm |
| 88 | Viton, 2.5 mm over Viton Foam, 1.0 mm |
| 89 | Viton, 1.5 mm over Viton Foam, 2.0 mm |
| 90 | Viton, 2.5 mm over Light Viton Foam, 1.0 mm |
| 91 | Low carbon Vamac, 3.5 mm |
| 92 | Low resistivity Vamac, 3.5 mm |
| 93 | KPN |
| 94 | White Viton over Viton, 2.0 mm |
| 95 | IR Silicone Camouflage, Black, F1 |
| 96 | IR Silicone Camouflage, Green, F2 |
| 97 | IR Silicone Camouflage, White, F3 |
| 98 | IR Silicone Camouflage, Yellow, F4 |
| 99 | IR Silicone Camouflage, Blue, F5 |
| 100 | IR Silicone Camouflage, White, F6 |
| 101 | IR Silicone Camouflage, Yellow, F7 |
| 102 | IR Silicone Camouflage, Red, F8 |

Table 10

TABLE OF MATERIALS (Continued)

| | |
|-----|---|
| 103 | IR Silicone Camouflage, Black, F9 |
| 104 | IR Silicone Camouflage, Yellow, F10 |
| 105 | IR Silicone Camouflage, Yellow, F11 |
| 106 | Vamac 25 |
| 107 | Vamac 1 and 2 |
| 108 | Vamac (GD 151) |
| 109 | Royacril 1 |
| 110 | IR Silicone Camouflage, White, F12-F15 |
| 111 | IR Silicone Camouflage, Green, F16 |
| 112 | IR Silicone Camouflage, Black, F17 |
| 113 | IR Silicone Camouflage, Green, F18 |
| 114 | IR Silicone Camouflage, Green, F19 |
| 115 | IR Silicone Camouflage, Blue, F20 |
| 116 | IR Silicone Camouflage, Blue, F21 |
| 117 | IR Silicone Camouflage, Grey, F22-F25 |
| 118 | IR Silicone Camouflage, Green, F26 |
| 119 | IR Silicone Camouflage, Lt. Green, F27 |
| 120 | IR Silicone Camouflage, Tan, F28 |
| 121 | IR Silicone Camouflage, Grey, F29 |
| 122 | IR Silicone Camouflage, Tan, F30 |
| 123 | IR Silicone Camouflage, Black, F31 |
| 124 | IR Silicone Camouflage, Dk. Green, F32-33 |

Table 10
TABLE OF MATERIALS (Continued)

| | |
|-----|--|
| 125 | Polyurethane, CAAP |
| 126 | Vamac 25, Lab |
| 127 | Vamac 25, PP2-B |
| 128 | Vamac 25, PP2-E |
| 129 | Vamac 25, PP2-B/Sp |
| 130 | Vamac 25, PP2-E/Sp |
| 131 | Vamac 25, Lab/Sp |
| 132 | Vamac 32, Lab |
| 133 | Vamac 32, PP2-B |
| 134 | White fluoroelastomer, Type II lusterless |
| 135 | White fluoroelastomer, over A10 primer |
| 136 | White fluoroelastomer, over black anti-static primer, Type III |
| 137 | White fluoroelastomer, with Cd/Se gray fluoroelastomer No. 36622 |
| 138 | White fluoroelastomer, with No. 36270 Cd/Se fluoroelastomer (gray) |
| 139 | White fluoroelastomer, with No. 30219 Pb/Cr fluoroelastomer (brown) |
| 140 | White fluoroelastomer, with No. 30219 Cd fluoroelastomer (brown) |
| 141 | White fluoroelastomer, with No. 34154 Cd fluoroelastomer (green) |
| 142 | Tungsten oxide fluoroelastomer - 5 PVC |
| 143 | Tungsten oxide fluoroelastomer - 10 PVC |
| 144 | IR silicone camouflage, Green, F47-3A |
| 144 | IR silicone camouflage, Green, F47-3B |

Table 10
TABLE OF MATERIALS (Continued)

| | |
|-----|---|
| 146 | IR silicone camouflage, Green, F48-3A |
| 147 | IR silicone camouflage, Green, F48-3B |
| 148 | IR silicone camouflage, Red, F51-3A |
| 149 | IR silicone camouflage, Red, F51-3B |
| 150 | MIL-C-83286 white polyurethane (5 mil), MIL-P-23377 primer |
| 151 | MIL-C-83286 white polyurethane (10 mil), MIL-P-23377 primer |
| 152 | MIL-C-83286 white polyurethane (2 mil) over MIL-C-84445 white rain erosion Astrocoat (10 mil), Chem-glaze No. 9922 primer |
| 153 | External protection materials, NE 36-A |
| 154 | External protection materials, 370-9966A |
| 155 | External protection materials, 370-9966A (single-ply) |
| 156 | External protection materials, 11 NE |
| 157 | External protection materials, V34Y |
| 158 | External protection materials, V22A |
| 159 | External protection materials, V25 |
| 160 | Carbon felt |
| 161 | RTV 560 |
| 162 | RTV 560 - 50 percent porosity |
| 163 | RTV 560 - maximum porosity |
| 164 | RS 1305 |
| 165 | RS 1305 - 50 percent porosity |
| 166 | RS 1305 - maximum porosity |
| 167 | RS 1305 loaded - 90 percent porosity |

Table 10
TABLE OF MATERIALS (Continued)

| | |
|-----|----------------------------------|
| 168 | Fluoroelastomer, No. 36622 Gray |
| 169 | Fluoroelastomer, No. 36270 Gray |
| 170 | White fluoroelastomer Type II |
| 171 | Fluoroelastomer, No. 30219 Brown |
| 172 | Fluoroelastomer, No. 34159 Green |
| 173 | Fluoroelastomer, No. 26320 Gray |
| 174 | Fluoroelastomer, No. 26492 Gray |
| 175 | Fluoroelastomer, No. 27880 White |
| 176 | Fluoroelastomer, No. 37880 White |
| 177 | Fluoroelastomer, No. 30400 Tan |
| 178 | Fluoroelastomer, No. 20400 Tan |
| 179 | Fluoroelastomer, No. 34102 Green |
| 180 | Fluoroelastomer, No. 24201 Green |
| 181 | Grafoil/fiber foam |
| 182 | Cork |
| 183 | ESM |
| 184 | PD200-16 |
| 185 | PD200-32 |
| 186 | Vamac 22B |
| 187 | Vamac 22C |
| 188 | Vamac 36A |
| 189 | Vamac 34Y |
| 190 | NE-270-9969A |
| 191 | NE-36A |
| 192 | Siecor "Orange" |

Table 10
TABLE OF MATERIALS (Continued)

| | |
|-----|-----------------------------------|
| 193 | ITT 040881-15-1A |
| 194 | Raychem FEP |
| 195 | Raychem Arnitch |
| 196 | Galite 545-21713 ARD |
| 197 | Raychem Tefzel |
| 198 | Galite 5020 |
| 199 | Sperry Univac 545-21713C |
| 200 | Raychem EFTE Fluorocarbon |
| 201 | Camouflage White |
| 202 | Camouflage Yellow |
| 203 | Camouflage Light Yellow |
| 204 | Camouflage Bright Yellow |
| 205 | Camouflage Orange |
| 206 | Camouflage Red |
| 207 | Camouflage Brown |
| 208 | Camouflage Green |
| 209 | Camouflage Dark Green |
| 210 | Camouflage Blue |
| 211 | Camouflage Dark Blue |
| 212 | Polyurethane Gloss White |
| 213 | Polyurethane Flatted White |
| 214 | Polyurethane No. 34092 Green |
| 215 | Polyurethane No. 36081 Dark Gray |
| 216 | Polyurethane No. 36492 Light Gray |

Table 10
TABLE OF MATERIALS (Concluded)

| | |
|-----|--|
| 217 | Polyurethane Black |
| 218 | Fluoroelastomer V-8830 Red |
| 219 | Fluoroelastomer X-2825 Yellow |
| 220 | Fluoroelastomer A3R Blue |
| 221 | Fluoroelastomer X-3367 Monarch Blue |
| 222 | Fluoroelastomer F-6279 Dark Red Blue |
| 223 | Fluoroelastomer BT-383-D Monastral Blue |
| 224 | Fluoroelastomer X-2285 C.P.A.R. Blue |
| 225 | Fluoroelastomer EG-35-E Blue |
| 226 | Fluoroelastomer ZnO White |
| 227 | Fluoroelastomer R-900 White |
| 228 | Fluoroelastomer White Type II |
| 229 | CS3810 per MMS K438 |
| 230 | MA255 per STM K736 |
| 231 | "Flamemaster" S886 per STM K798 |
| 232 | STM K431 Epoxy Primer; STM K789 Polyurethane Paint |

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