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MATERIALS EVALUATION IN THE TRI-SERVICE THERMAL RADIATION TEST FACILITY

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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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This report outlines facility usage during the period of 24 April 1981-24 February 1982 and lists available instrumentation and projected usage.

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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

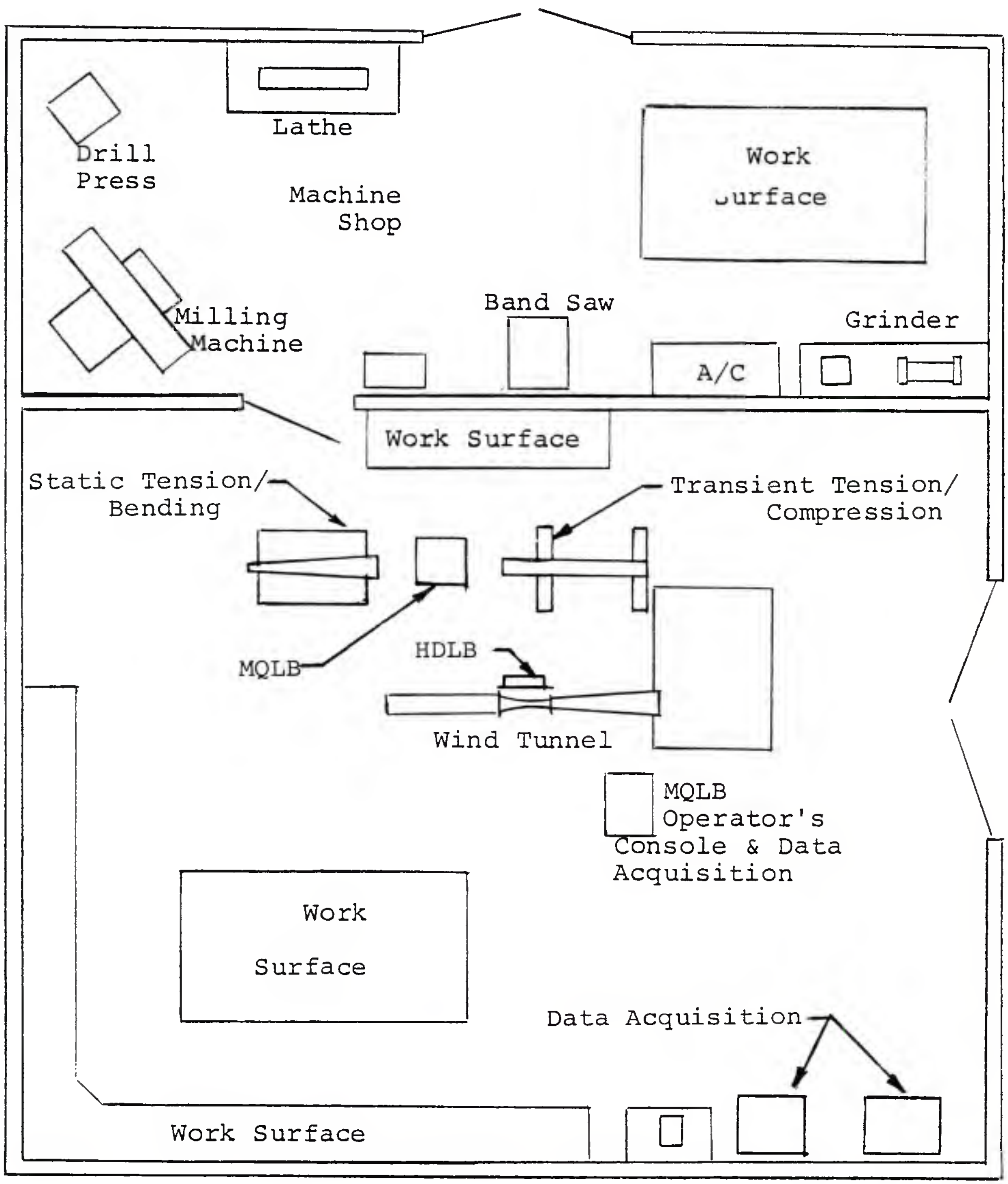

Figure .1. Tri-Service Thermal Radiation Test Facility.

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/cm^2-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/cm^2-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/cm^2 is not exceeded. Higher fluence levels can be achieved with proportionate reductions in both reliability and stability.

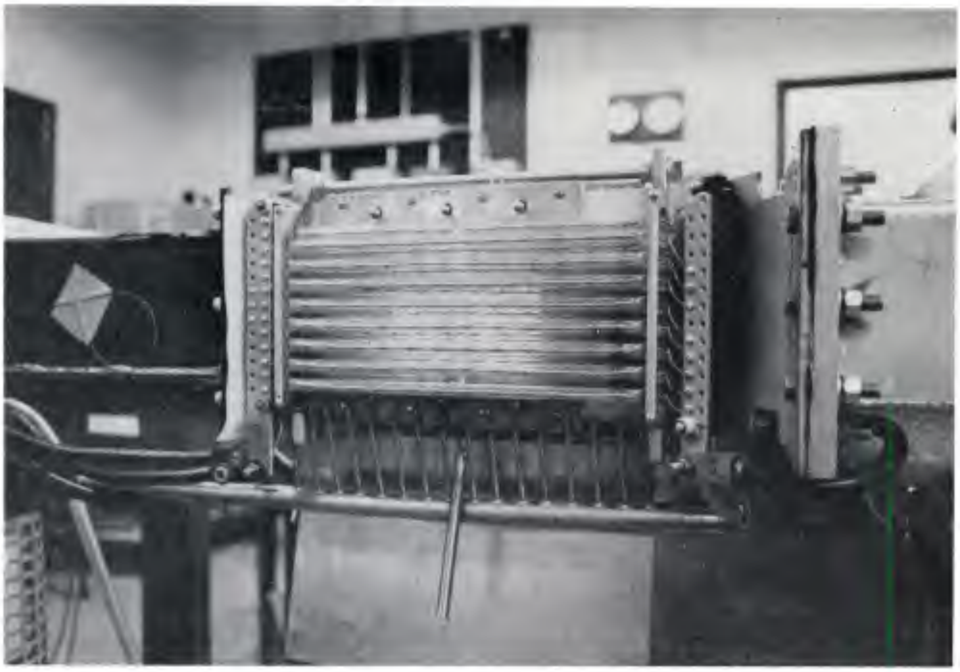

Figure 2. High Density Lamp Bank.

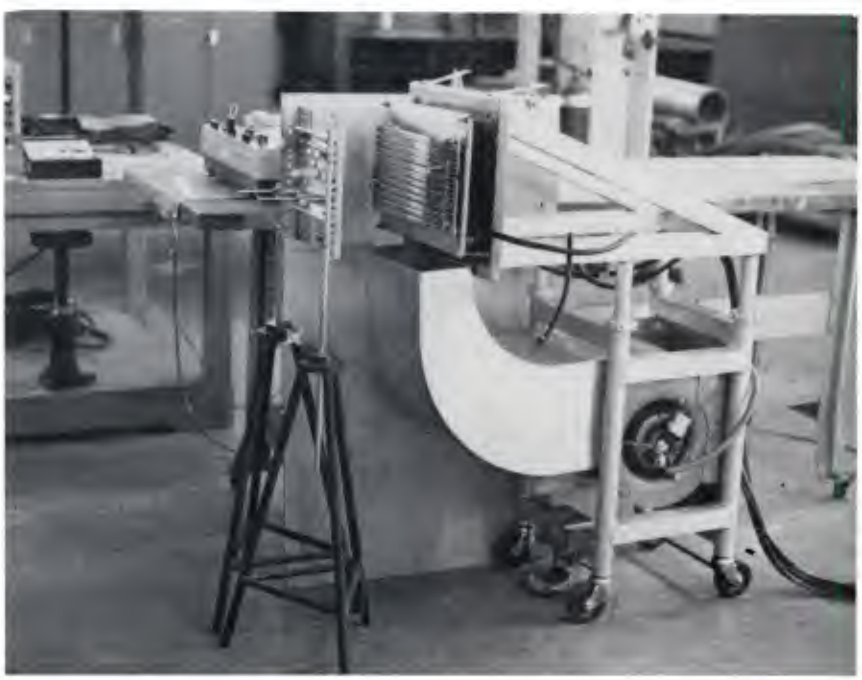

Figure 3. Mobile Quartz Lamp Bank.

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

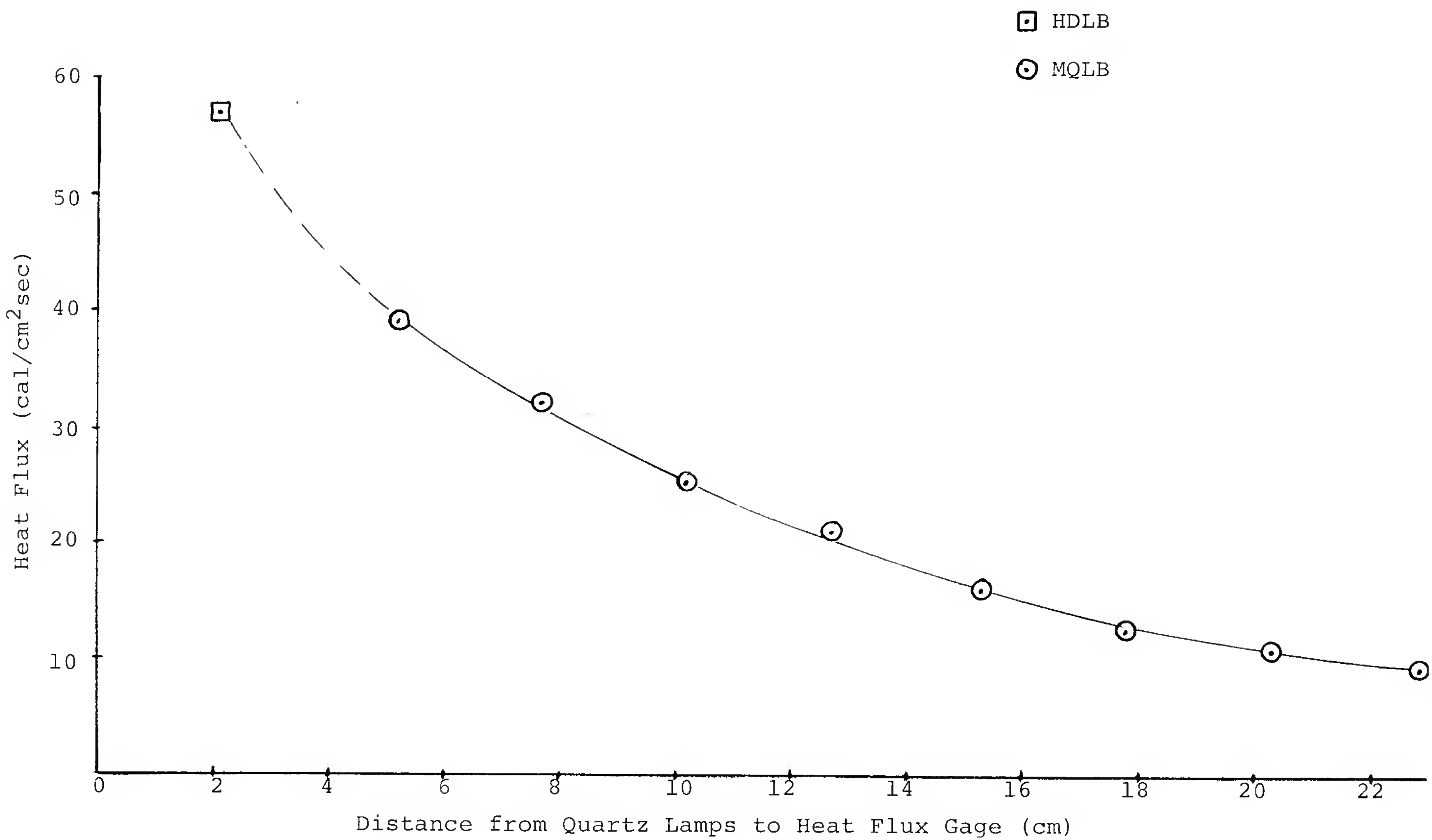

Figure 4. Radiation Heat Flux vs. Distance From Lamp Bank.

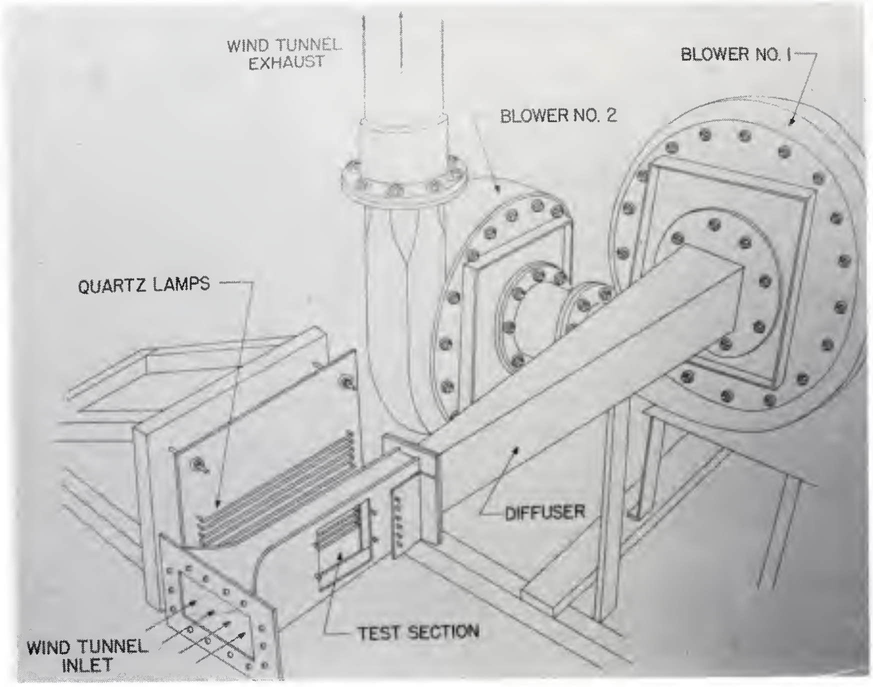

Figure 5. Wind Tunnel.

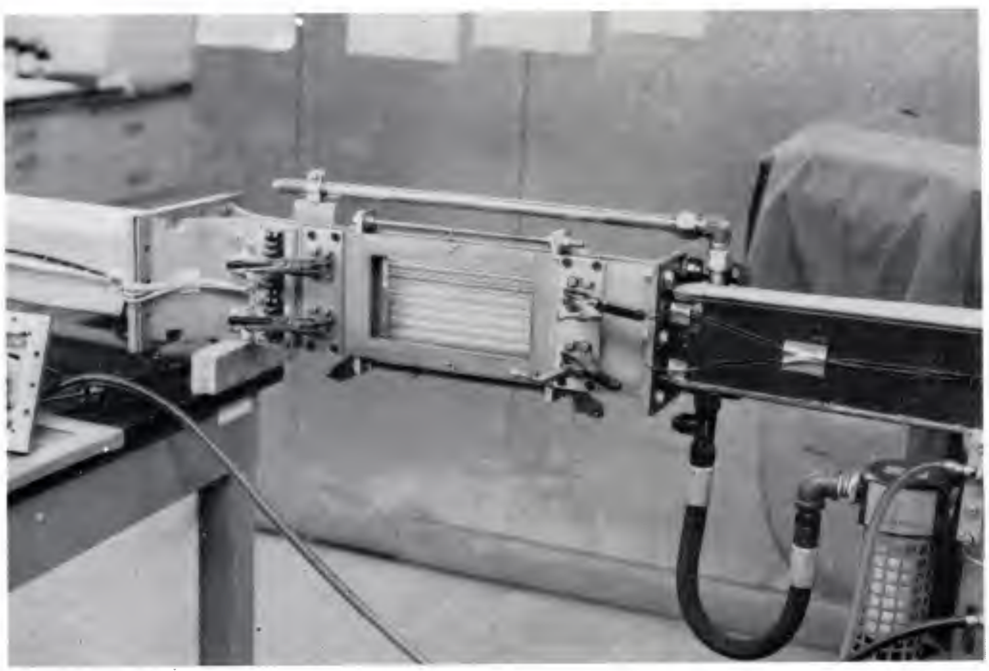

Figure 6. Wind Tunnel 70 cm Test Section.

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 radient 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.

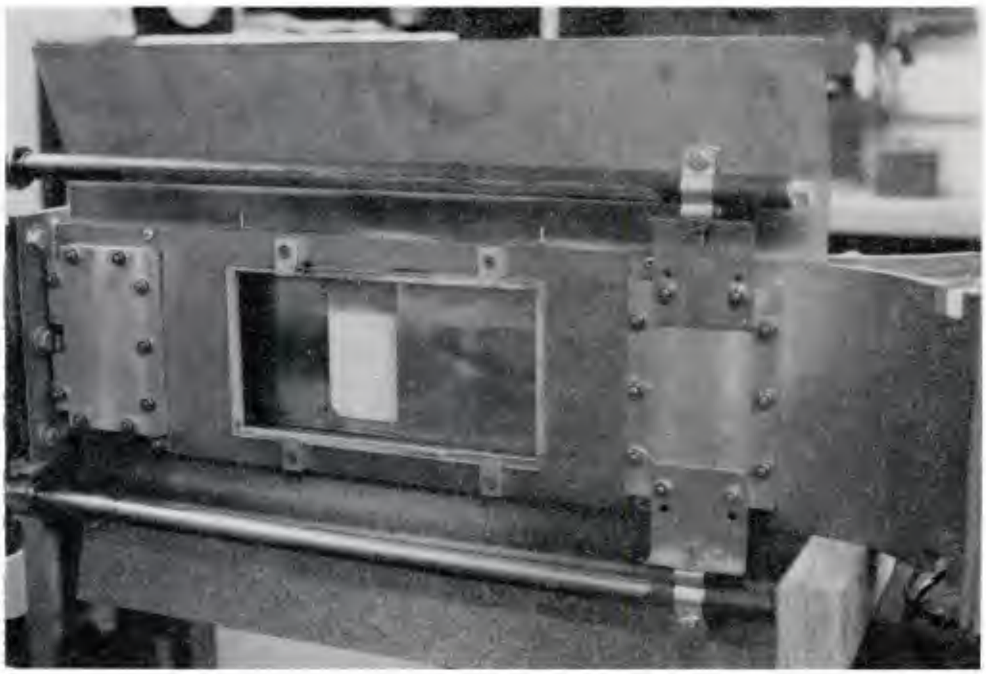

Figure 7. 70 cm Test Section Shutter.

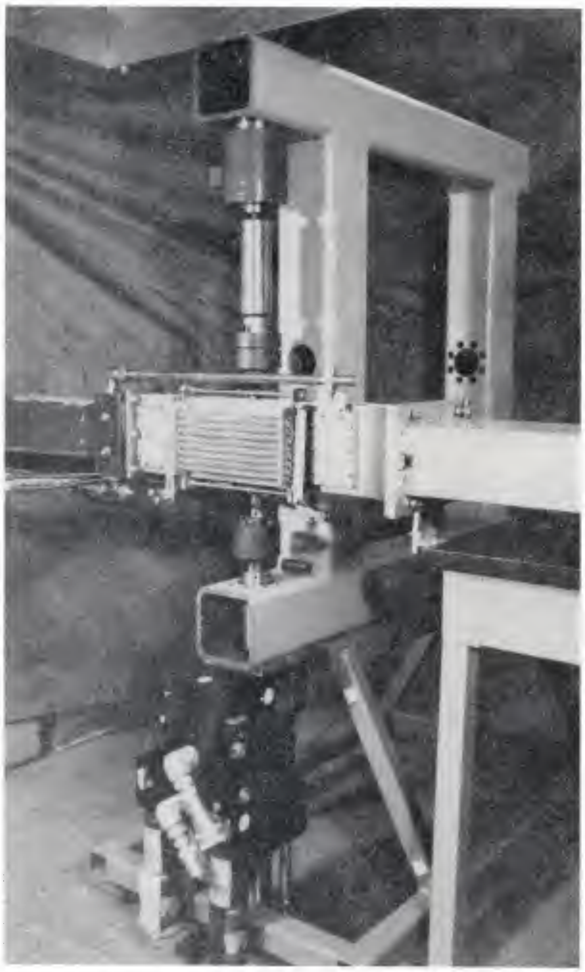

Figure 8. MTS Tensile Loading Device.

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.

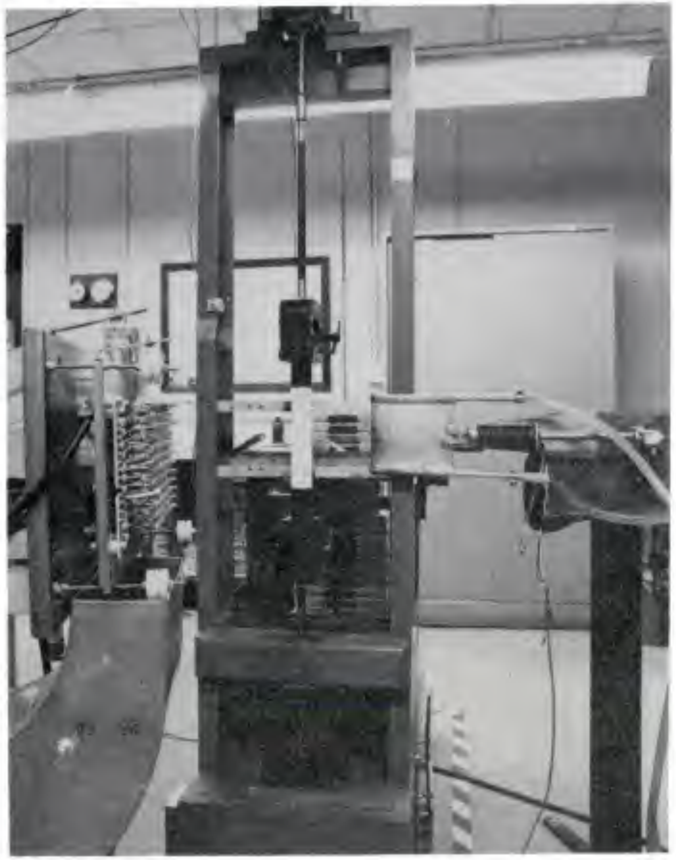

Figure 9. Mechanical Loading-Tension.

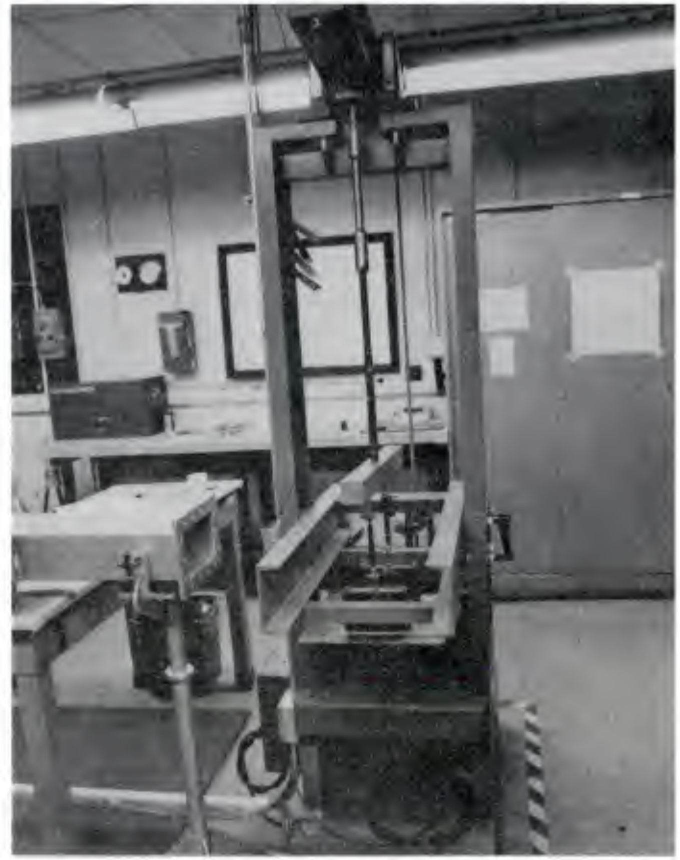

Figure 10. Mechanical Loading-Bending.

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 Microprocessor	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	±3%
Medtherm	Gardon	64P-50-24	0-13 cal/cm^{2}sec	±3%
Medtherm	Gardon	64P-100-24	0-27 cal/cm^{2}sec	±3%
Medtherm	Gardon	64P-100-24	0-27 cal/cm^{2}sec	±3%
Medtherm	Gardon	64P-200-24	0-54 cal/cm^{2}sec	±3%
Medtherm	Gardon	64P-200-24	0-54 cal/cm^{2}sec	±3%
RdF	Gardon	CFR-1A	0-400 cal/cm^{2}sec	±10%
RdF	Gardon	CFR-1A	0-400 cal/cm^{2}sec	±10%
ADL	Calorimeter	---	50-350 cal/cm^{2}sec	±5%

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 microcomputer, 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.

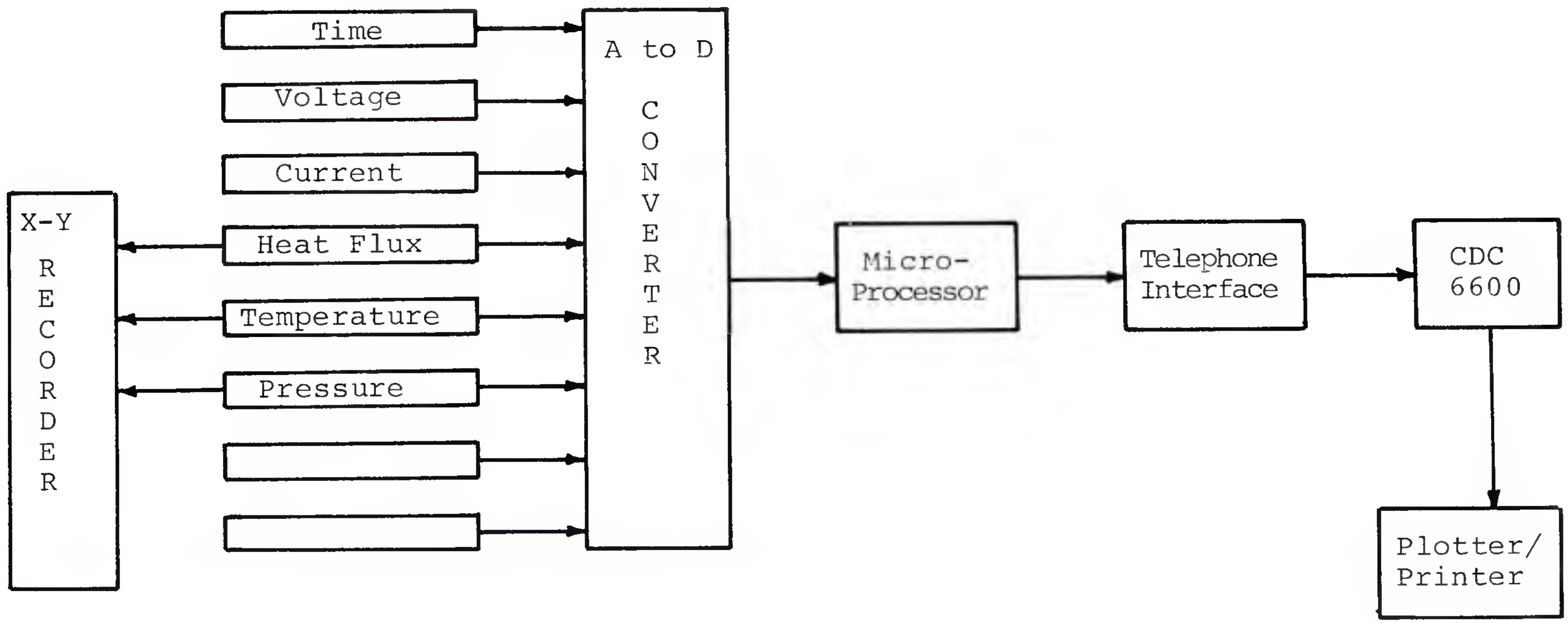

Figure 11. Data Acquisition System.

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
- Ectron differential D.C. amplifiers (8)
- Power supply
- Teletype
- Acoustic coupler

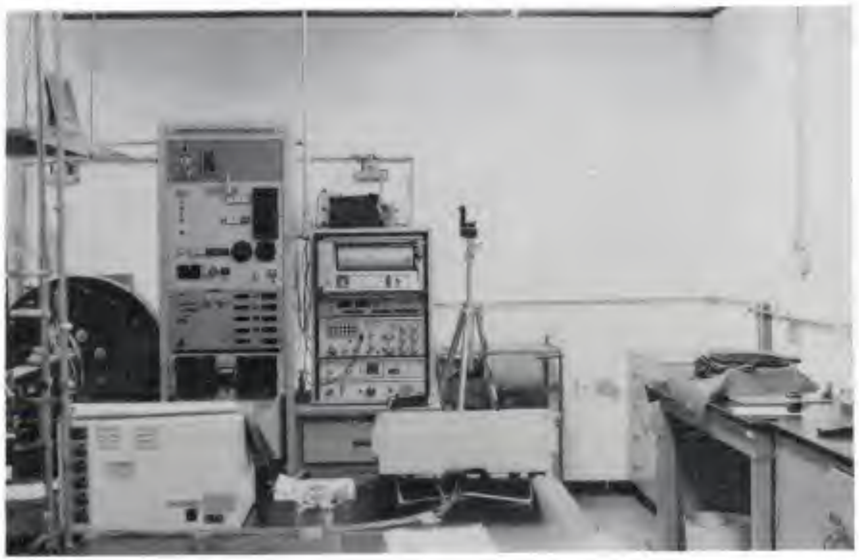

Figure 12. Console.

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	Test 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	Calibration	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	Calibration	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	Test 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	Test 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.

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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; uncoated (All tested in tension)
	Quartz Polyimide	White polyimide; cork silicone; uncoated (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 polyethylene with honeycomb core	No coating
	White polyethylene with honeycomb core	No coating
	Delrin with Flexcore Honeycomb	No coating
	Nylon with Flexcore 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; 6o; 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 convective 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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