Department of Energy
National Nuclear Security Administration
Service Center
P. O. Box 5400
Albuquerque, NM 87185

MAR 01 2010

Mr. John Greenewald, Jr.
[redacted]

Dear Mr. Greenewald:

This letter is the final response to your June 16, 2009 Freedom of Information Act (FOIA) request for a copy of *In-Flight Participation of a B-66 Airplane*, dated October 1956.

Pursuant to Title 10, Code of Federal Regulations, Section 1004.6 (10 CFR 1004.6), the Office of Classification, Office of Health, Safety and Security, in the Department of Energy (DOE) has completed its review of the document responsive to your request. This document located in the files of the Defense Technical Information Center, contains information properly classified Formerly Restricted Data (FRD); therefore, it is provided to you with deletions.

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Pursuant to 10 CFR 1004.6(d), Dr. Andrew P. Weston-Dawkes, Director, Office of Classification, Office of Health, Safety and Security, is the official responsible for the denial of the DOE classified information.

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There are no fees chargeable to you for processing your request.

If you have questions, please contact me by e-mail at cbecknell@doeal.gov or write to the address on the first page. Please reference Control Number FOIA 10-00005-C in your communication.

Sincerely,

Carolyn A. Becknell
Freedom of Information Act Officer
Office of Public Affairs

Enclosure

MAR 0 1 2010

cc with copy of redacted document:
Wanda Peigler, SSO

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IN-FLIGHT PARTICIPATION OF A B-66 AIRPLANE (U)

Redacted Version

SANDIA NATIONAL LABS ALBUQUERQUE NM

OCT 1956

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PRELIMINARY REPORT

Operation REDWING

PACIFIC PROVING GROUNDS

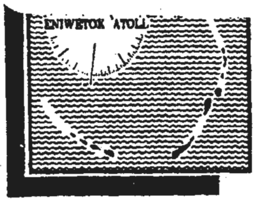
May - July 1956

Project 5.3

IN-FLIGHT PARTICIPATION OF A B-66 AIRPLANE

20

scale A



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HEADQUARTERS FIELD COMMAND, ARMED FORCES SPECIAL WEAPONS PROJECT

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This is a preliminary report based on all data available at the close of this project's participation in Operation REDWING. The contents of this report are subject to change upon completion of evaluation for the final report. This preliminary report will be superseded by the publication of the final (WT) report. Conclusions and recommendations drawn herein, if any, are therefore tentative. The work is reported at this early time to provide early test results to those concerned with the effects of nuclear weapons and to provide for an interchange of information between projects for the preparation of final reports.

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(21) Report no

OPERATION REDWING ~~- PRELIMINARY REPORT~~

PROJECT 5.3

OCTOBER 1956

(6) IN-FLIGHT PARTICIPATION OF A B-66 AIRPLANE (U)

(10) Cy

Richard W. Bachman ~~and project personnel of the Douglas Aircraft~~ Company.

Aircraft Laboratory
Wright Air Development Center
Wright-Patterson Air Force Base
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Preliminary rept (11) Oct 56, (12) 62p. (13) NA (14-15) NA

Approved: (16) Proj 5.3

L. L. Woodward

L. L. Woodward, Col., USAF
Technical Director

(17) NA

(20) SRD

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Kenneth D. Coleman

K. D. Coleman, Col., USAF
Commander, Task Unit 3

M. Dahl

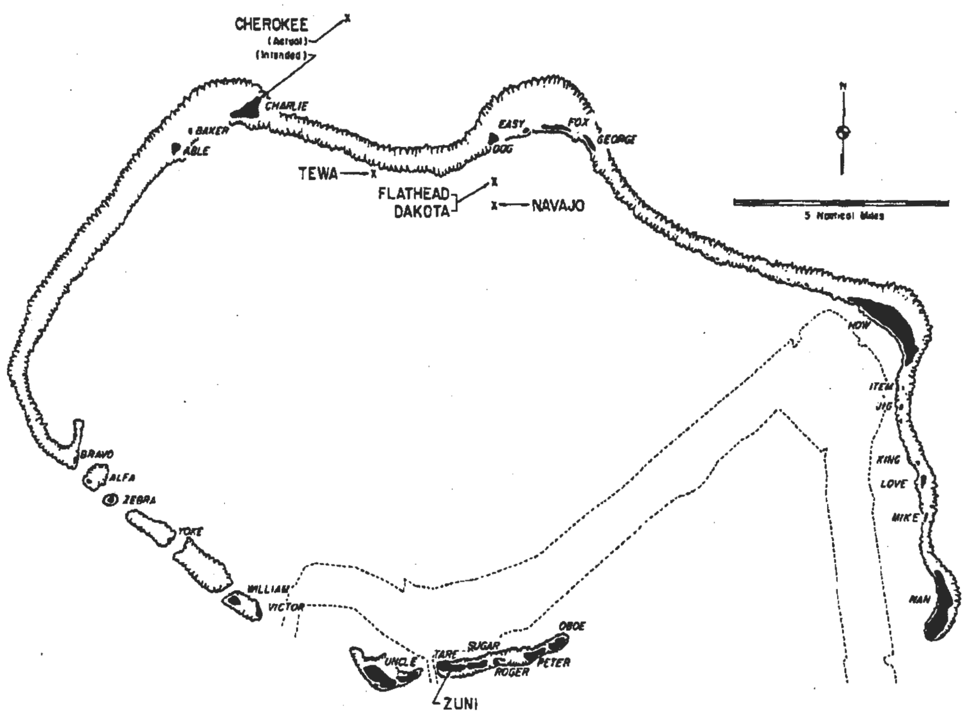
M. Dahl, CDR, USN
Director, Program 5

[redacted]

SUMMARY OF SHOT DATA, OPERATION REDWING

Shot Name (Unclassified)	Date (PPG)	Time (Approximate)	Location	Type	H&N Coordinates (Actual Ground Zero)	Geographic ° ' "
Lacrosse	5 May	0629	Eniwetok Yvonne	Surface Land	124515 E 106885 N	11 33 29 162 21 18
Cherokee	21 May	0551	Bikini Off Charlie	Air Drop (4320±150 ft) Over Water	96200 ± 100 E 185100 ± 500 N	11 43 50 165 19 46
Zuni	28 May	0556	Bikini Tare	Surface Land Water	110309 E 100154 N	11 29 48 165 22 09
Yuma	28 May	0756	Eniwetok Sally	200-ft Tower	112155 E 130604 N	11 37 24 162 19 13
Erie	31 May	0615	Eniwetok Yvonne	300-ft Tower	127930 E 102060 N	11 32 41 162 21 52
Seminole	6 June	1255	Eniwetok Irene	Surface Land[a]	75237 E 149897 N	11 40 35 162 13 02
Flathead	12 June	0626	Bikini Off Dog	Barge Water	116768 E 164094 N	11 40 22 165 23 13
Blackfoot	12 June	0626	Eniwetok Yvonne	200-ft Tower	126080 E 104435 N	11 33 04 162 21 33
Kickapoo	14 June	1126	Eniwetok Sally	300-ft Tower	114018 E 132295 N	11 37 41 162 19 32
Osage	16 June	1314	Eniwetok Yvonne	Air Drop (680±35 ft) Over Land	126647 ± 50 E 102851 ± 50 N	11 32 48 162 21 39
Inca	22 June	0956	Eniwetok Pearl	200-ft Tower	105300 E 133540 N	11 37 53 162 18 04
Dakota	26 June	0606	Bikini Off Dog	Barge Water	116767 E 164097 N	11 40 22 165 23 13
Mohawk	3 July	0606	Eniwetok Ruby	300-ft Tower	109737 E 132165 N	11 37 39 162 18 49
Apache	9 July	0606	Eniwetok Flora	Barge Water	69227 E 148063 N	11 40 17 162 12 01
Navajo	11 July	0556	Bikini Off Dog	Barge Water	116816 E 160604 N	11 39 48 165 23 14
Tewa	21 July	0546	Bikini Charlie-Dog Reef	Barge Water	99776 E 164476 N	11 40 26 165 20 22
Huron	22 July	0616	Eniwetok Flora	Barge Water	70015 E 148304 N	11 40 19 162 12 09

[a]See ITR-1344 for further details.



Airukiiji	Oboe	Bokoaetokutoku	Alfa	Eniirikku	Uncle	Rochikarai	Love
Airukiraru	Peter	Bokobyaadaa	Able	Eninman	Tare	Romurikku	Fox
Aomoen	George	Bokonejien	Baker	Enyu	Nan	Rukoji	Victor
Arriikan	Yoke	Bokonfuaaku	Rem	Ionchebi	Mike	Uorikku	Easy
Bigiren	Roger	Bokororyuru	Bravo	Namu	Charley	Yomyaran	Jig
Bikini	How	Chieerete	William	Ourukaen	Zebra	Yurochi	Dog
		Eniairo	King	Reere	Sugar		

Bikini Atoll. Locations of test detonations during Operation REDWING are indicated by large lettering and arrows. Native island names with corresponding military identifiers are given in the tabulation.

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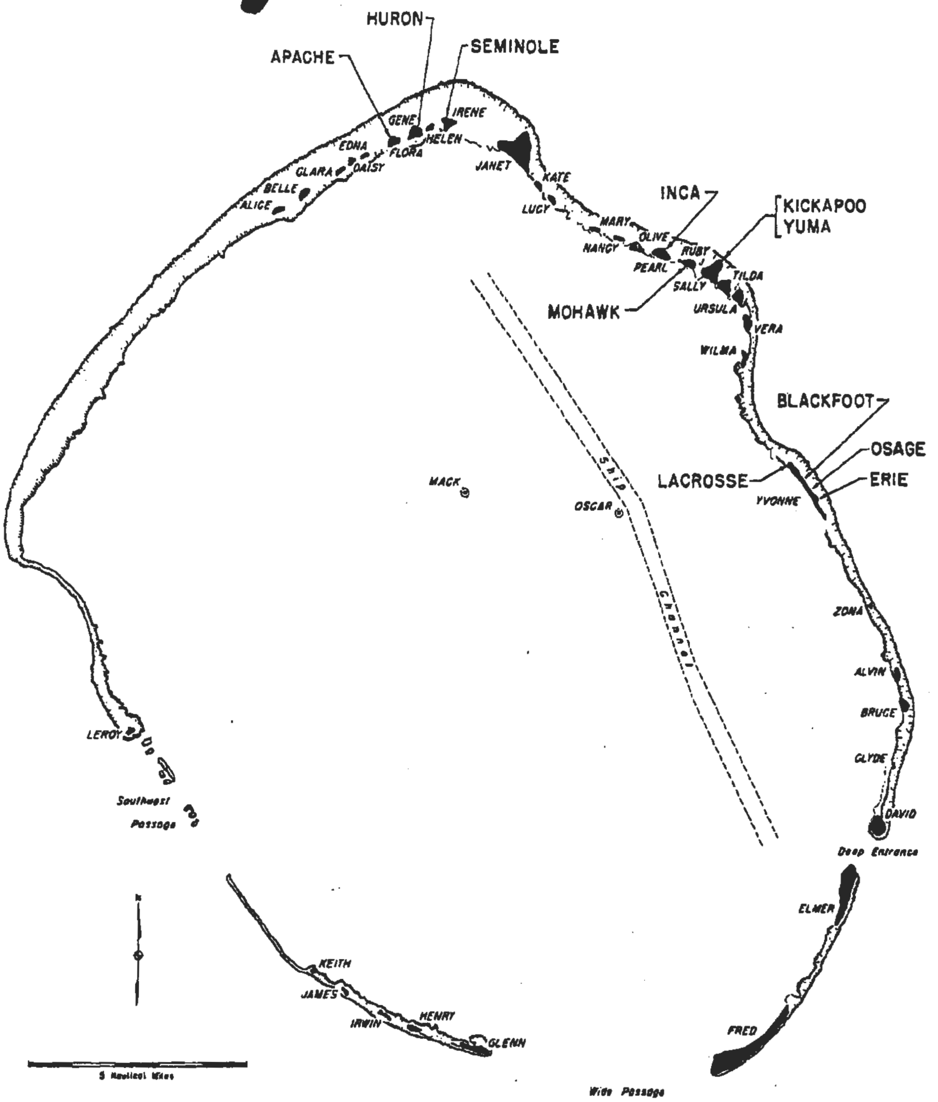

Aaraanbiru	Vera	Chinieero	Alvin	Igurin	Glenn	Ribaion	James
Aitsu	Olive	Chinimi	Clyde	Japtan	David	Rigili	Leroy
Aniyaanii	Bruce	Cochita	Daisy	Kirinian	Lucy	Rojoa	Ursula
Aomon	Sally	Coral Heads	Mack, Oscar	"M"	Zona	Ruchi	Clara
Biijiri	Tilda	Eberiru	Ruby	Mui	Henry	Rujoru	Pearl
Bogairikk	Helen	Elugelab	Flora	Muzin	Kate	Runit	Yvonne
Bogallua	Alice	Engebi	Janet	Parry	Elmer	Sandildefonso	Edna
Bogombogo	Belle	Eniwetok	Fred	Piiraai	Wilma	Teiteiripucchi	Gene
Bogon	Irene	Giriinien	Keith	Pokon	Irwin	Yeiri	Nancy
Bokonaarappu	Mary						

Eniwetok Atoll. Locations of test detonations during Operation REDWING are indicated by large lettering and arrows. Native island names with corresponding military identifiers are given in the tabulation.

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ABSTRACT

The objective of this project was to measure the overpressure, gust, and thermal effects of a nuclear detonation on a B-66 aircraft in flight to determine its delivery capability. The measured effects will be used to correct the B-66 Weapons Delivery Handbook. In addition, the project provided basic research data for the design criteria of future military aircraft.

The aircraft was instrumented by the Douglas Aircraft Company (DAC) for the Air Force to record gust load stresses, thermal stresses, temperatures, overpressures, accelerations, and other aircraft and input data. The aircraft was flown to a time-zero position which provided the maximum available load combination during each of ten nuclear detonations.

The highest temperature recorded was 444°F on an elevator of 0.016 inch thick aluminum skin painted to have an absorptivity of 0.45. The maximum thermal stress measurements indicated a local stress of 39,600 psi induced by a temperature rise of 377°F on 0.016 inch thick aluminum skin located at Station 94 of the elevator.

Maximum overpressure recorded was 1.02 psi. The maximum gust load received was 3.26 g at the center of gravity. This value is 107 percent of the gust allowable load factor. The resultant stress level at Wing Station 407 was equivalent to 110 percent of the limit allowable load on the wing. The maximum measured dynamic magnification factor was 1.59 at Wing Station 407.

Based upon preliminary data reduced under field conditions, it was concluded that the B-66 has nuclear weapon delivery capabilities equal to or in excess of those stated in the special weapon feasibility study made by DAC for the Wright Air Development Center (WADC) during 1955. No further testing of the effects of nuclear detonations on the B-66 is recommended.

[redacted]

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FOREWORD

This report presents the results of one of the 48 projects participating in the Military Effects Program of Operation REDWING, which included 17 test detonations.

For readers interested in other pertinent test information, reference is made to ITR-1344, Summary Report of the Commander, Task Unit 3. This summary report includes the following information of general interest: (1) an overall description of each detonation, including yield, height of burst, ground zero location, time of detonation, and ambient atmospheric conditions at detonation; (2) a discussion of all project results; (3) a summary of each project, including objectives and results; and (4) a complete listing of all reports covering the Military Effects Program.

PREFACE

This report presents preliminary data reduced in the test area and is subject to revision and correction following the detailed reduction and analysis of the data. However, it is believed that refinement of the measured effects will result in final figures which are near the approximate ones given in this report.

The author acknowledges the help of 2/Lt Gerald E. Holmes and 2/Lt John P. Bednar, whose work as assistant project officers materially aided in making Project 5.3 a success. The work of Walter E. Workman, project coordinator for the Douglas Aircraft Company, has been outstanding; without his constant efforts to achieve the required time schedules, the project could not have been completed. In addition, the project officer acknowledges the participating personnel of the Douglas Aircraft Company, the Wright Air Development Center flight crew and ground maintenance crew, and the many other organizations and individuals whose efforts have gone into the completion of the project. An organization chart for Project 5.3 of Operation REDWING is presented as Appendix A to this report.

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CONTENTS

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TABLES

FIGURES

CHAPTER 1

INTRODUCTION

1.1 OBJECTIVE

The objective of this project was to measure the overpressure, gust, and thermal effects of a nuclear detonation on a B-66 aircraft in flight to determine its delivery capability. The measured data can be used to correct the B-66 Weapons Delivery Handbook and to provide basic research data for the design criteria of future USAF aircraft.

1.2 BACKGROUND

The initial work of weapon effects on aircraft consisted of approximate and hypothetical studies performed for Operations CROSSROADS and SANDSTONE. Following Operation SANDSTONE, Massachusetts Institute of Technology (MIT) was contracted by Wright Air Development Center (WADC) to develop theories for predicting the effects of nuclear explosions on aircraft structures. Thirteen aircraft were used during Operation GREENHOUSE to gather data for verification of those theoretical studies. These tests resulted in the publication of a WADC weapon effects report (Reference 1).

A B-47 (Reference 2) and a B-36 (Reference 3) participated during Operations IVY and CASTLE, and a B-50 (Reference 4) and a B-36 (Reference 5) participated during Operation UPSHOT-KNOTHOLE. The tests gathered additional data for verification, correction, and extension of existing theories developed from GREENHOUSE. The tests also determined the maximum delivery capabilities of the B-36 and B-50 aircraft and resulted in weapon-delivery handbooks for these aircraft. The capabilities of the B-47, as limited by thermal effects, were investigated for inclusion in a handbook.

Lethal volume studies were made during Operation TEAPOT by the use of drone QF-80 aircraft and telemetered data (Reference 6). Operation TEAPOT also involved two F-84F aircraft in an investigation of thermal stress phenomena and the effects of side blast loads on escort type aircraft (Reference 7).

1.3 THEORY

Eight weapon effects aircraft participated during Operation REDWING since it was not deemed feasible to establish the delivery capabilities of an aircraft by other than direct exposure to the overpressure, gust, and thermal phenomena. Analytical methods used to calculate aircraft delivery capabilities were not adequately proven, and it was considered impractical and inconclusive to reproduce these tests in the laboratory. It is likely that the massive data acquired on many types of aircraft during the operation will result in adequate and proven analytical methods of determining aircraft-delivery capabilities.

1.3.1 Capability Calculations. At the request of WADC, the Douglas Aircraft Company (DAC) made a complete investigation and report of the capability of the B-66 for the delivery of nuclear weapons (Reference 8). The report indicated the suitability of the B-66 aircraft as a carrier of nuclear weapons up to and including the multi-megaton yields. The use of a reflective white paint was recommended in the report. The pre-REDWING general limitations of the aircraft are shown in Figures 1.1 and 1.2 for the specific conditions indicated.

1.3.2 B-66 Positioning Curves. From the analysis given in Reference 8, positioning curves were drawn to indicate the locus of time zero positions of the aircraft which produce specific load responses (Figures 1.3, 1.4, and 1.5). From such curves, the best possible position of the aircraft at time zero for the measurement of effects on the aircraft can be selected. The instrumentation to measure these effects is described in Chapter 2.

The positioning of the aircraft from calculations and curves of this type has been conservative in the past. In particular, the selected position was that which would give the effects required to achieve the project objectives. This meant that in order to obtain the desired loads, a combination of actual weapon yield near that of the positioning yield and predicted atmospheric conditions was necessary. With only a minimum number of tests scheduled for an operation and an inability to predict the test yields or meteorological conditions accurately, the probabilities of obtaining the desired loads were very low. In addition, the inherent conservatisms of the prediction theories reduced the chances of achieving the desired loads.

The philosophy of positioning for Operation REDWING was developed to achieve positions at which responses were safe but, nevertheless, would provide the data required to fulfill the test objectives. It was hoped that this positioning philosophy would provide all necessary inputs during the single series of tests in order to assure early availability of accurate weapon-delivery handbooks to interested agencies and to avoid costly retesting of the same aircraft during future operations.

1.3.3 Positioning Limitations. For thermal effects the positions of the B-66 were selected so that neither the temperature rise nor total temperature would be more than 600°F in the critical aircraft section, based on the positioning yield, and not more than 400°F for the expected yield. In addition, a limit temperature of 400°F on the nose radome was established. Special panels which differed in absorbtivity because of differences in paint color were allowed to obtain temperatures up to 900°F based on the positioning yield. For gust effects the positions were selected to give no more than 95 percent of the limit allowable loads at the positioning yield and not more than 80 percent of the limit allowable loads at the expected yields. For overpressure effects the positions were selected to give not more than 100 percent of limit allowable nondamaging overpressure (2.0 psi), as based on the positioning yield. For nuclear radiation effects, the positions were selected to give not more than 1 rem per test at the positioning yield nor more than a total of 7 rem for the entire operation.

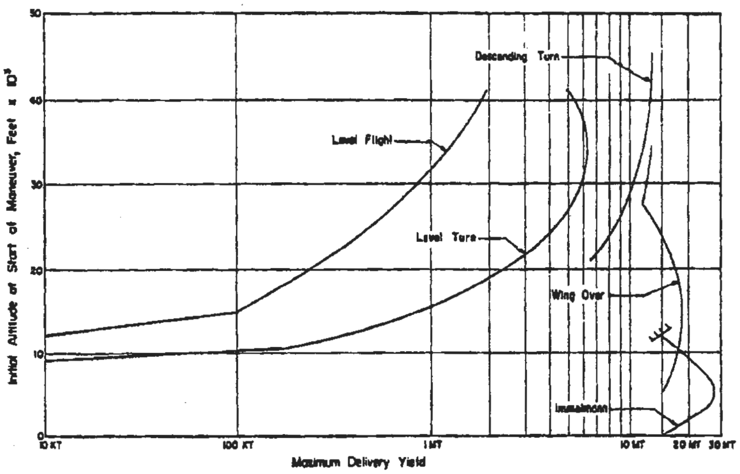


Figure 1.1 B-66 feasibility for 6,000-foot airburst and abnormal day: (1) visibility, 60 statute miles; (2) water-vapor pressure, 2 mm of mercury; (3) albedo, 0.8; (4) haze-layer height, 10,000 feet; and (5) aircraft painted white (Reference 1).

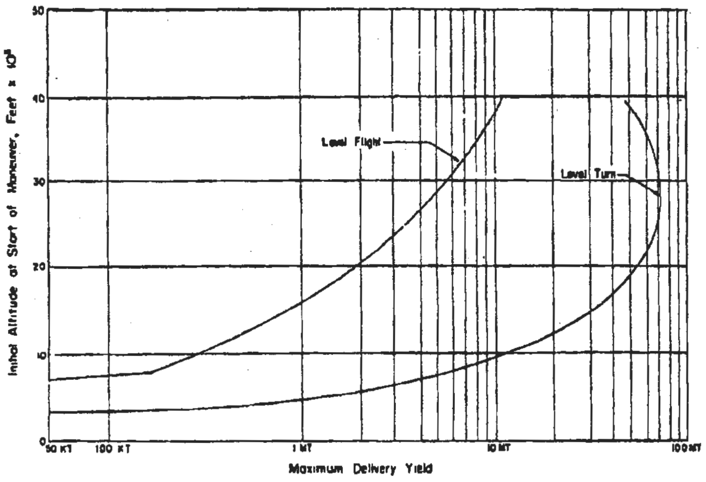
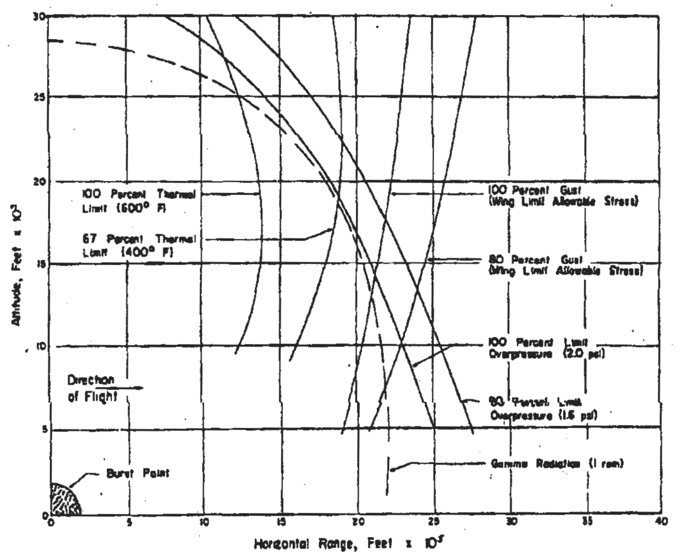


Figure 1.2 B-66 feasibility for surface burst and normal day: (1) visibility, 10 statute miles; (2) water-vapor pressure, 5 mm of mercury; (3) albedo, 0.3; (4) haze-layer height, 10,000 feet; (5) aircraft painted white (Reference 1); and (6) wing over descending turn, and Immelmann feasibility exceeds 100 MT.



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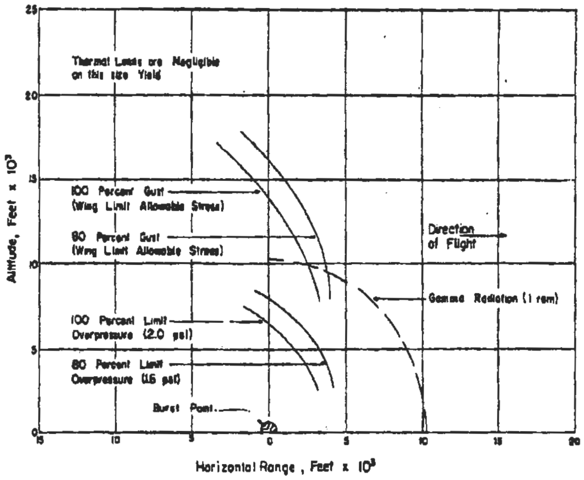
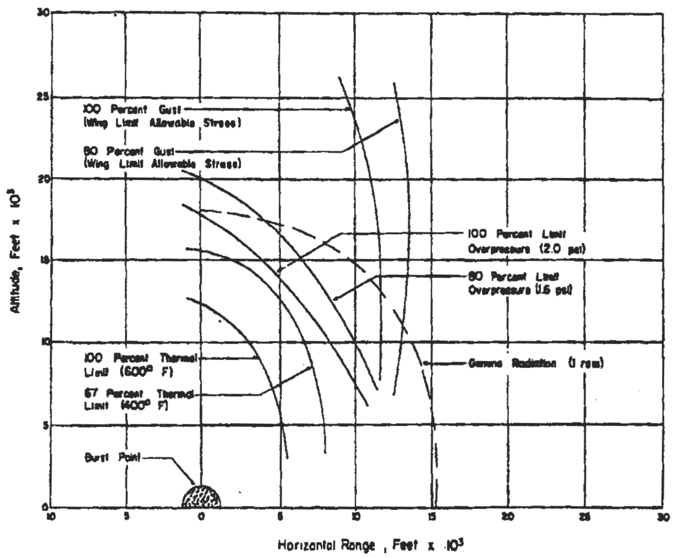

Thermal Loads are Negligible on this size Yield
100 Percent Gust (Wing Limit Allowable Stress)
80 Percent Gust (Wing Limit Allowable Stress)
Direction of Flight
Gamma Radiation (1 rem)
100 Percent Limit Overpressure (2.0 psi)
80 Percent Limit Overpressure (1.5 psi)
Burst Point
Altitude, Feet x 10^3
Horizontal Range, Feet x 10^3

(b)(3)


100 Percent Gust (Wing Limit Allowable Stress)
80 Percent Gust (Wing Limit Allowable Stress)
100 Percent Limit Overpressure (2.0 psi)
80 Percent Limit Overpressure (1.5 psi)
100 Percent Thermal Limit (600° F)
67 Percent Thermal Limit (400° F)
Gamma Radiation (1 rem)
Burst Point
Altitude, Feet x 10^3
Horizontal Range, Feet x 10^3

(b)(3)

CHAPTER 2

INSTRUMENTATION

2.1 GENERAL

The instrumentation was installed in the B-66 by DAC under the supervision of WADC project personnel. Installations were made to permit measurement of: (1) load distributions on the wing and horizontal stabilizer; (2) temperature rises of critical skin and stringer combinations; (3) thermally induced structural strains and stresses; (4) radiant exposure; (5) irradiance; (6) freestream overpressure; (7) spectral distribution of the thermal radiation; (8) dynamic response due to the gust effects; (9) radome skin-temperature rises; (10) response of the engine to the thermal and blast phenomena; and (11) additional supporting data pertinent to the extrapolation and refinement of the response measurements to other yields, test parameters, and aircraft. The instrumentation is summarized in Tables 2.1 to 2.4.

A large number of channels was installed to cover the gust and thermal measurements, either separately or combined. The selection of the channels to be recorded on any particular shot was made to obtain the measurement of the predominant effect.

2.2 TRANSDUCER TYPES AND LOCATIONS

2.2.1 Thermal Measurements. Skin temperatures were measured by means of two types of thermocouple installations. The most common thermocouple was a washer type. On some thick skin installations a hollow screw type was employed. Typical installations of both types are shown in Figure 2.1. Ice baths were used to provide a temperature reference of 32°F.

The aircraft had 65 thermocouples distributed over six stations on the left wing. The thermocouples made spanwise and chordwise skin temperature surveys, as well as panel temperature distributions. Six thermocouples located at one station on the right wing correlated the two wings. A typical wing station is shown in Figure 2.2.

The left aileron had six and the right aileron had three thermocouples to measure inner and outer skin temperatures on the surface skin and internal skin doubler.

The left stabilizer had 75 thermocouples at four spanwise stations to measure spanwise and chordwise temperature distribution. For correlation, the right stabilizer had four thermocouples at two stations. A typical stabilizer station is shown in Figure 2.3.

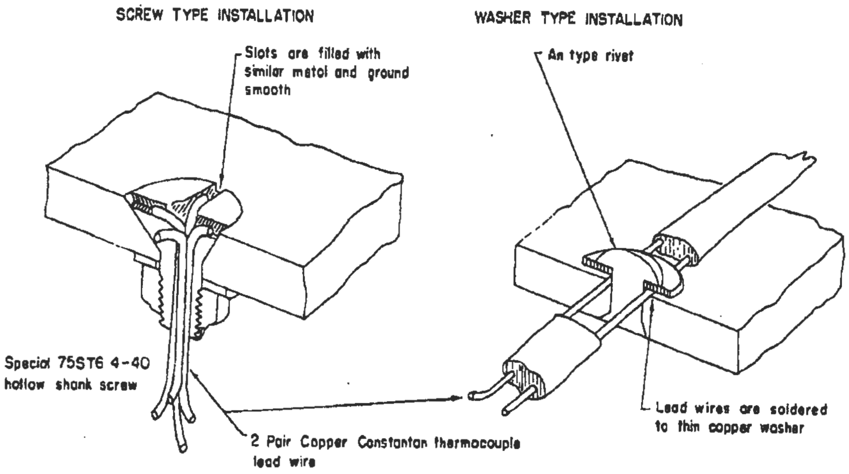


Figure 2.1 Typical thermocouple installations.

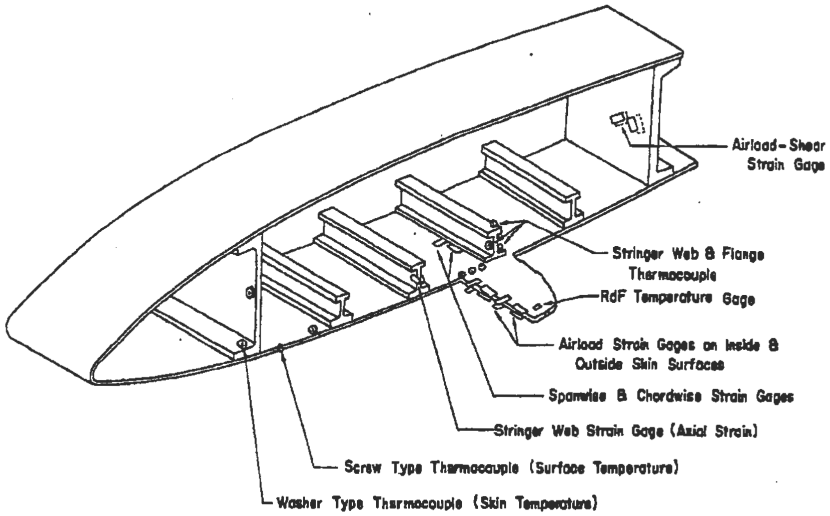


Figure 2.2 Typical wing section, showing strain gage and thermocouple installations.

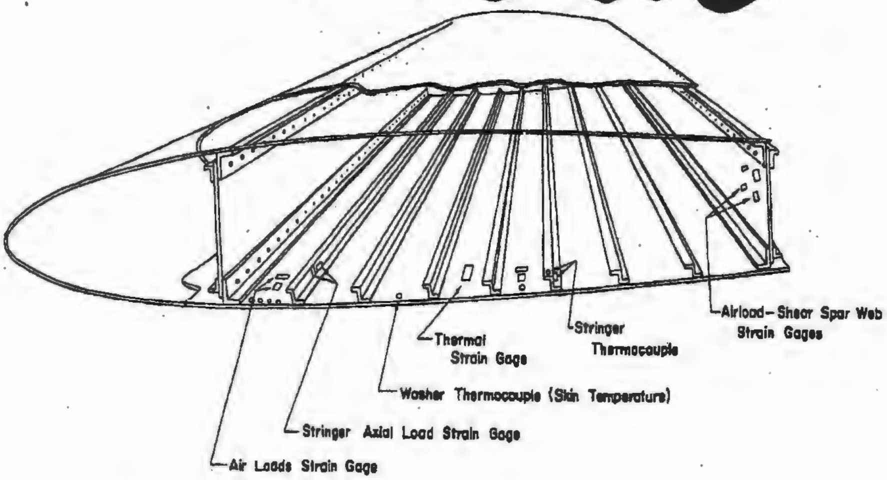


Figure 2.3 Typical horizontal stabilizer section, showing strain gage and thermocouple installations.

The left elevator had 18 thermocouples at three stations, and the right elevator had eight thermocouples at one station. These thermocouples measured skin temperatures of the upper and lower surfaces. A typical station is shown in Figure 2.4.

The nose radome had 11 thermocouples at three stations measuring radome skin temperatures beneath the full Hypolon coating and coating temperatures between the first and second coats of Hypolon.

The fuselage had 11 thermocouples at eight stations to measure a lower skin temperature distribution from nose to tail.

The vertical stabilizer had two thermocouples for the measurement of skin temperatures at the left and right fin tip.

Temperature measurements in the engine are covered in Section 2.2.4. Skin stresses occur as a result of the thermal inputs, because the external skin heats rapidly to a high temperature while the main structural components increase little in temperature and offer nearly complete resistance to thermal expansion of the skin. Baldwin Lima Hamilton Corporation (BLHC) type EBDF-13D strain gages were installed to measure these strains in the spanwise and chordwise directions. The left wing had 70 channels of thermal stress gages at four stations. The left stabilizer had 26 channels at four stations. One elevator station had six channels on the left and six on the right. BLHC Type RDF temperature gages were constructed similar to type EBDF-13D strain gages with fine wire grids imbedded between thin bakelite sheets and were installed at each thermal stress measurement area. The temperatures recorded from the gages were used to determine temperatures of the thermal stress gages, a requirement for the data reduction.

2.2.2 Gust Load Measurements. The gust loads resulting from the material velocity associated with the overpressure shock wave were measured on the wing and stabilizer by the use of BLHC type EBDF-13 strain gages. A typical gage installation is shown in Figure 2.5.

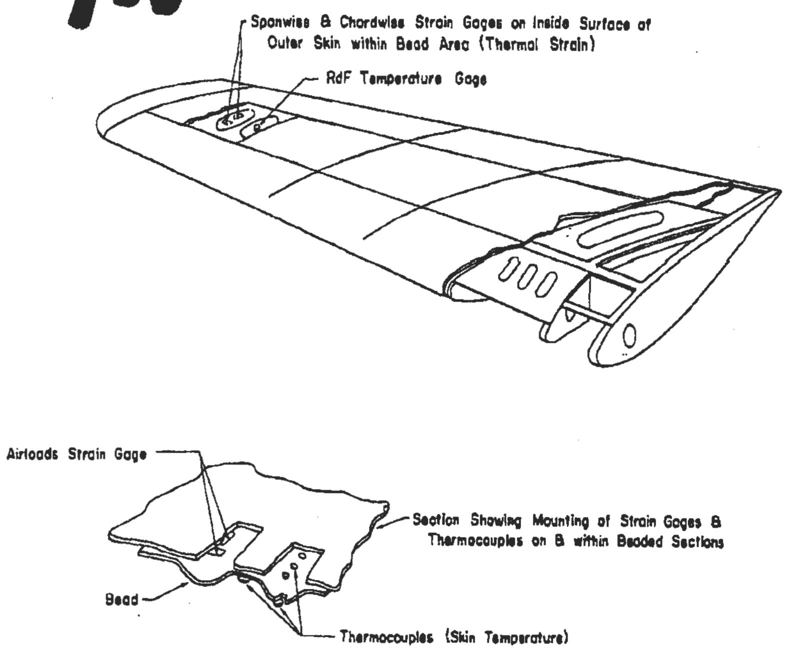


Figure 2.4 Typical elevator section, showing strain gage and thermocouple installations.

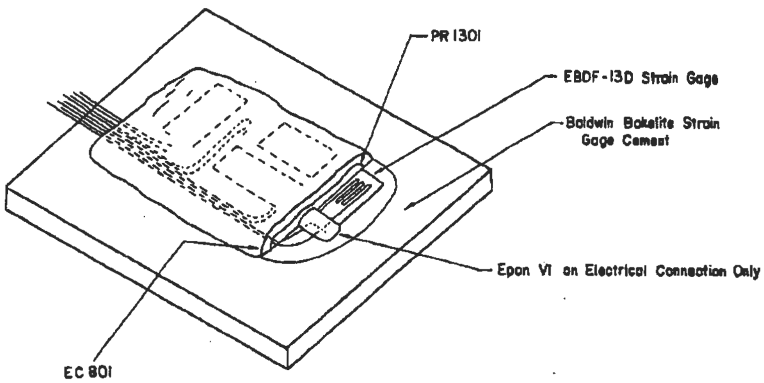
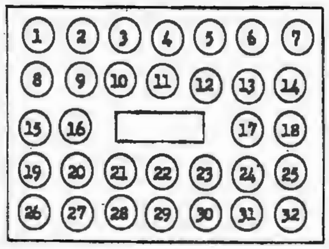


Figure 2.5 Typical strain gage installation, showing protective coatings.

TABLE 2.1 PHOTO-PANEL INSTRUMENTATION



Lights ([a]) "on" indicate

Right bomb door gap.
Left bomb door gap.
Nose gear door gap.
Right gear door gap.
Left gear door gap.
NRDL camera run.
NI-10 calib. box "on."
Correlation.

Pos.	Instrument	Measures
1	Counters	Time in seconds
2	Clock	Time of day
3	Altimeter	Reference Tank Pressure
4	Diff. Press. Gage	Angle of Attack
5	Altimeter	Aircraft's Altitude
6	Airspeed Indicator	Aircraft's Airspeed
7		
8	Dual Autosyn Indicator	Rudder (1) and Throttle (2) Position
9	Dual Autosyn Indicator	Right (1) and Left (2) Aileron Pos.
10	Autosyn Indicator	C. G. Normal Acceleration
11	Mechanical Accelerometer	Normal Acceleration
12	Altimeter	Boom Altitude
13	Airspeed Indicator	Boom Airspeed
14	Tachometer	Right Engine rpm
15	Dual Autosyn Indicator	Right (1) and Left (2) Spoiler Pos.
16	Dual Autosyn Indicator	Elevator (1) and Stabilizer (2) pos.
17	Flow Rate Indicator	Fuel Flow to Left Engine
18	Flow Rate Indicator	Fuel Flow to Right Engine
19	Autosyn Indicator	Rudder Force
20	Autosyn Indicator	Aileron Force
21	Temperature Indicator	Aircraft's OAT
22		
23		
24	Fuel Totalizer	Total Fuel to Left Engine
25	Temperature Indicator	Right Engine Tailpipe Temperature
26	NI-10 Temperature Ind.	Test OAT
27	Autosyn Indicator	Elevator Force
28	Attitude Gyro	Airplane Attitude
29	Altimeter	Bomb Bay Altitude
30		
31	Fuel Totalizer	Total Fuel to Right Engine
32	Manifold Pressure Gage	Right Engine Tailpipe Pressure

The locations of the majority of the gust gages were selected at points identical to the gage installations on the Air Force Flight Loads Survey aircraft (RB-66 52-829). This duplication enabled stress measurements to be related directly to previous airload flight test data. To accomplish the comparison and to permit postshot bending moment calculations, all locations were installed and calibrated in terms of stress at a specific point. The number and location of the strain gage bridge channels are as follows:

The left wing had 65 channels at six stations. The right wing had 16 channels at two stations.

TABLE 2.2 QUANTITY AND LOCATION OF FUSELAGE MISCELLANEOUS INSTRUMENTATION

	Fuselage: Thermocouples										
Item	Sta. 0	Sta. 40	Sta. 74	Sta. 83	Sta. 245.5	Sta. 411	Sta. 639	Sta. 641	Sta. 643	Sta. 711	Sta. 793
External (Radome)	2	2	7	1	1	1	1	1	4	1	1
	Fuselage: Accelerometers, Pressure Gages, Rate Gyros and Deflection Cameras										
	Sta. 82	Sta. 246.5	Sta. 407	Sta. 643	Sta. 710	Sta. 745	Sta. 793	Sta.	Sta.	Sta.	
Accelerometer								4	1	1	
Pressures	1	1	1	6	1		1				
Rate Gyros								3			
Defl. Cameras				2(wing)		1(tail)					
	Vertical Stabilizer: Thermocouples, Accelerometers, Pressures, and Wing Accelerometers and Pressures										
	V.S. Sta. 197	Fin Tip		L.Wing Tip	R.Wing Tip	L.Wing Up.Surf.	L.Wing Lo.Surf.	L.Wing Tank	Left Nacelle	Right Nacelle	
Thermocouples	2										
Accelerometers		1		1	1				3	3	
Pressures	2				1	1	1				
	Right Engine: Temperature, Pressure, Fuel Flow, rpm, and Nozzle Position										
	Tailpipe Rake	Inlet Duct	Fuel Control	Fuel Manifold	Fuel Pump	Turbine	Nozzle				
Thermocouples	5										
Pressures	1	12	2	1	1						
Tachometer						1					
Flow Meter				1							
Pos. Indicator							1				
	NRDL Mounts: Calorimeters, Radiometers, and Cameras										
	Tail Turret	Bottom Fuselage									
Calorimeters	16	3									
Radiometers	2										
Cameras	6	2									

The horizontal stabilizer had 16 channels to measure elevator actuator loads and 4 channels to measure elevator hinge loads.

The linear acceleration of the aircraft center of gravity and other specific structural components were measured by Statham Laboratories (SL) Types A-43 and A-46 accelerometers. For measurement of angular accelerations, SL Type AA-17 accelerometers were used. Location and type of measurements were as follows:

Measurements at the center of gravity were made of linear acceleration, in three axes, and of fuselage pitching acceleration. Fin tip lateral acceleration and left and right wing plus left stabilizer tip accelerations were also measured. Vertical linear accelerations at the nose and tail sections of the fuselage were measured to obtain the complete dynamic response of the fuselage.

Pressure measurements were made with SL Types P-128, P-131, and P-140 pressure transducers. To reduce lag in the system, all lines from the pressure intakes to the transducers were maintained at lengths of 18 inches or less. To maintain a stationary base pressure at shock arrival, all differential-pressure transducers were vented to a reference tank mounted in the fuselage. At 15 seconds prior to shock arrival the reference tank was closed to the ambient air pressure by means of a solenoid valve. One pressure measurement was made at each of five stations on the fuselage, at the fin tip, at the upper and lower surfaces of the left wing, and at the upper surface of the left stabilizer. An additional fuselage station measured overpressure at six points about the fuselage circumference.

Rates of roll, pitch, and yaw were measured at the center of gravity by Daystrom Pacific Corporation (DPC) Type R-21A rate gyros.

Left and right wing tip deflections were recorded by a 16-mm N-9 gun-sight-aiming-point motion picture (GSAP) camera for each wing. The same type of camera was used to record deflections of the left stabilizer tip.

2.2.3 Photo-Panel Instrumentation. A photo panel was used to record 27 miscellaneous items of information. These items were recorded on two Pacific Laboratories (PL) V-1 cameras and are itemized in Table 2.1.

2.2.4 Engine Instrumentation. Instrumentation was installed to record specific engine-operating parameters during the thermal and blast phenomena. Items measured were five temperatures in a tailpipe rake; 12 pressures at the inlet duct; fuel control fuel inlet pressure; fuel control air inlet pressure; tailpipe pressure; fuel manifold pressure; fuel pump pressure; fuel flow; engine speed; and nozzle position. Pressure transducers were of the types described in Section 2.2.2. Special gages and instrumentation were developed by DAC and Allison Division of General Motors (ADGM) for other measurements.

2.2.5 Thermal Inputs. Thermal inputs were measured in conjunction with Project 5.7 using GSAP cameras and various types of calorimeters and radiometers supplied by the Naval Radiological Defense Laboratories (NRDL). The instruments and cameras were mounted in two locations on the fuselage.

An NRDL mount capable of containing as many as six cameras and 21 radiometers or calorimeters was installed on the tail gun turret. The mount could be preset at an angle from 0 to 70 degrees aft from the fuselage reference line (FRL) to allow the instrumentation to be preset to aim at ground zero at time zero.

A second NRDL mount was installed in the bottom of the aft fuselage and was capable of containing as many as eight cameras and 21 calorimeters or radiometers. Part of the bottom mount was fixed to aim vertically and was capable of containing two cameras and three

TABLE 2.3 QUANTITY AND LOCATION OF HORIZONTAL-STABILIZER AND ELEVATOR INSTRUMENTATION

Left Horizontal Stabilizer

Station	Surface	Front Spar	Between Front Spar and Adj String	String No. 1	String No. 5	String No. 6	String No. 7	25-30 pct Chord	50 pct Chord	60-75 pct Chord	Between Rear Spar and Adj String	Rear Spar	Hinge Fittings
	T		1-0-2			0-2-0			1-0-2	1-0-2			
16.5	Web	0-0-2											
	B	2-0-0	5-0-2	3-0-0	3-2-0	3-0-0		1-0-0	5-4-2	5-1-2	0-0-0	2-0-2	
50	T				1-2-0				1-0-0				
	B				2-2-0				1-0-0				
86	T				1-2-0				1-0-0				
	B				2-2-0				1-0-0				
127.5	T		1-0-0		0-2-0				1-0-0		1-0-0		
	B	2-0-0	5-0-0	3-0-0	3-2-0		3-0-0	1-0-0	5-4-0	1-1-0	5-0-0	2-0-0	
Aft H													0-0-2
Actuat													0-0-2

Right Horizontal Stabilizer

Station	Surface	Front Spar	Between Front Spar and Adj String	String No. 1	String No. 5	String No. 6	String No. 7	25-30 pct Chord	50 pct Chord	60-75 pct Chord	Between Rear Spar and Adj String	Rear Spar	Hinge Fittings
	T		0-0-2						1-0-2	0-0-2			
16.5	Web	0-0-2										0-0-2	
	B		0-0-2						1-0-2	0-0-2			
127.5	T								1-0-0				
	B								1-0-0				
Aft H													0-0-2
Actuat													0-0-1

Left Elevator

Station	Surface	Upper Skin	Lower Skin
28.5			5-0
52			5-0
94			0-6
97		2-0	6-0

Right Elevator

Station	Surface	Upper Skin	Lower Skin
94			0-6
97		2-0	6-0

Note:
First digit of 3 figures indicates thermocouples.
Second digit indicates thermal strain gages.
Third digit indicates air load strain gages.

calorimeters. The remaining portion of the mount could be set at an angle from 60 to 90 degrees from the FRL. It was also preset to aim the instrument at ground zero at time zero. This portion of the mount was capable of mounting six cameras and 18 calorimeters or radiometers.

When the aircraft time zero position was at an angle of 0 to 60 degrees between the FRL and ground zero, the tail turret mount was used; when the angle was between 60 and 70 degrees, both mounts were used; and when the angle was between 70 and 90 degrees, the bottom fuselage mount was used.

The total number of instruments never exceeded 12 cameras and 21 calorimeters or radiometers for any case, even when both mounts were used simultaneously.

2.3 RECORDING EQUIPMENT

The recording equipment consisted of recording oscillographs and photo equipment with the necessary associated equipment required to control and convert the transducers' electrical signals to a recording. The associated equipment consisted of a junction panel and control units.

2.3.1 Junction Panel. All inputs from the transducers were routed to a large junction panel which consisted of 540 cannon plugs mounted along the starboard side of the bomb bay and identified for simplified selections, installation, and checking. This panel permitted any channel of information to be connected to a desired oscillograph.

2.3.2 Control Panels. The Wheatstone bridge type instruments, such as strain gages, pressure transducers, and accelerometers, were routed from the junction panel to a bridge control panel. The panel provided bridge voltage control for sensitivity adjustment, bridge balance control for balancing current flow to zero in a no-load condition, and an electrical calibration by means of shunting a predetermined resistance across one arm of the bridge. The shunt resistance was selected to produce a specific, fixed, trace deflection. The control panel was set to calibrate automatically at the beginning of each oscillograph record.

Thermocouple control panels were used for all thermocouples. The panels consisted of necessary circuitry to adjust the sensitivity of the system by the application of an electrical calibration using a millivolt insertion method and were calibrated automatically at the beginning of each oscillograph record.

2.3.3 Oscillographs. Eight Consolidated Electrodynamics Corporation (CEC) Type 5-119P3-36 oscillographs were installed in the bomb bay. The galvanometers used were CEC Type 7-315, which operate on the D'Arsonal principle. Each oscillograph measured and recorded 36 channels of information.

2.3.4 Photo Recorder. The photo recorder, which was installed in

TABLE 2.4 QUANTITY AND LOCATION OF WING AND AILERON INSTRUMENTATION

Right and Left Wing

Station	Surface	Front Spar	Between Front Spar and Adj String	String No. 1	String No. 3	String No. 4	35 pct Chord	50 pct Chord	Between Rear Spar and Adj String	Rear Spar	Outb'd Trail Edge	Outb'd Trail Edge Doubler
52 L	T		0-0-2				0-0-2	0-0-2	0-0-2			
	Web											
	B		0-0-2				0-0-2	0-0-2	0-0-2			
135L	T	0-0-0	1-8-2			0-2-0		1-16-2	1-8-2			
	Web	2-0-2								0-0-2		
	B		5-8-2	3-0-0	3-2-0			6-12-3	5-8-2	0-0-0		
247L	T		0-0-2					0-0-2	0-0-2			
	Web	0-0-2								0-0-2		
	B		0-0-2		3-2-0			4-0-2	0-0-2			
368L	T											
	Web											
	B				3-2-0							
407L	T		0-0-2					0-0-2	0-0-2			
	Web	0-0-2								0-0-2		
	B	3-0-0	7-0-2	3-2-0				1-0-2	0-0-2			
518L	B				1-0-0			5-0-0			3-0-0	2-0-0
518R	B				1-0-0			5-0-0				
135R	T		0-0-2					0-0-2	0-0-2			
	Web	0-0-2								0-0-2		
	B		0-0-2					0-0-2	0-0-2			

Left Aileron: Thermocouples

Station	Surface	Outer Skin	Inner Skin	Inb'd T. E.	Inb'd T. E. Doubler
78	T				
	B			2	1
328	T				
	B	2	1		

Notes:
First digit of 3 figures indicates Thermocouples.
Second digit indicates thermal strain gages.
Third digit indicates air load strain gages.

Right Aileron: Thermocouples

Station	Surface	Outer Skin	Inner Skin
328	T		
	B	2	1

the bomb bay, used two PL Model V-1, 35-mm motion picture cameras. The instruments faced a front surface-silvered mirror, and the image of the instruments was reflected into the cameras.

2.4 INSTALLATION AND CALIBRATION

2.4.1 Strain Gage Installation. Strain gages were installed by use of BLHC bakelite strain gage cement. Surfaces were cleaned and roughened prior to gage installation with fine sandpaper and emery cloth and were washed with methyl ethyl ketone. Electrical leads were treated with Shell Oil Company (SOC) Epon VI cement. Gages were moisture proofed with a layer of Products Research Company (PRC) 1301, which was covered by a layer of Minneapolis Mining Corporation (MMC) EC 801.

2.4.2 Strain Gage Calibration. Load calibrations of the strain gages were not made on the B-66 prior to Operation REDWING, because the installation of the instrumentation and construction of the aircraft required all the time available. Plans were made to perform a load-point calibration immediately after the operation. In order to obtain approximate stress levels in the field, a gage correction factor was applied to each airload gage. This factor was obtained by comparison of identical peak tail loads and symmetrical pullup demonstration tests of the REDWING aircraft and the airload aircraft (RB-66 No. 2, AFSN 52-829).

2.4.3 Thermocouple Installation. Thermocouple leads were of two sizes, 5 and 10 mil, and were increased to 20-gage wires at an adjacent terminal strip. The washer type thermocouple, used for all measurements of thin skin temperatures, was attached to the skin with 1/16-inch rivets. Inside skin temperatures of thick skins and internal component temperatures used the washer type thermocouples attached by machine screws. Outside skin temperatures on thick skins were measured by the hollow screwtype thermocouple, which was installed in a tapped hole in the thick skin. The final installation was machined to skin level to provide a smooth surface.

2.4.4 Thermocouple Calibration. Bureau of Standard Tables of electrical potential versus temperature were used instead of a specific calibration. Laboratory calibrations were made, however, of both types of thermocouples installed on various skin thicknesses. The calibrations were performed at various heat input rates to establish time lag correction factors for the installed thermocouples.

2.4.5 Accelerometer Installation and Calibration. The accelerometers were installed on brackets rigidly attached to the structure at the point of measurement. The instruments were calibrated with a Genisco centrifuge, which subjected the accelerometers to a specific centrifugal force and the associated acceleration at a constant speed condition.

2.4.6 Pressure Transducer Installation and Calibration. The pressure transducers were mounted on brackets attached to the aircraft structure near the point of measurement. The instruments were calibrated by the use of a mercury manometer to apply a series of known fixed pressures.

CHAPTER 3

OPERATIONS

3.1 AIRCRAFT PREPARATION

In January of 1955, an addition was made to the summary B-66 production contract to have DAC install the necessary instrumentation in the B-66 for this project. Installation of the instrumentation and initial fabrication of the aircraft were started simultaneously in March 1955 and completed on 15 January 1956. Practice flights and maintenance checks were made at Wright-Patterson Air Force Base, Ohio. The aircraft was flown to Eniwetok Atoll via Travis AFB and Hickam AFB.

3.2 AIRCRAFT CONFIGURATION

The JB-66B aircraft differed from the production model B-66B in the following ways at the onset of the series of tests:

The underside of the aircraft was painted white with Vita-Var PV-100, with B-103 overcoat. All Fiberglas radomes and fairings were covered with white Hypalon (Gates Engineering XP-104). The twin 20-mm guns were removed from the tail turret, and the NRDL instrumentation was mounted on this turret. Another mount for NRDL instrumentation was placed in the bottom of the aft fuselage. Test instrumentation weighing 5,000 pounds was aboard the aircraft; 2,500 pounds of this was located in the bomb bay. Two wing deflection camera fairings were located on top of the fuselage above the wing, and protective curtains were installed in the cockpit to minimize the possibility of flash blindness.

Figure 3.3 illustrates the changes in the aircraft configuration.

3.3 SHOT PARTICIPATION

Aircraft positions were selected for each shot from positioning curves such as those shown in Figures 1.3, 1.4, and 1.5. The project participated in the following shots: Lacrosse, Cherokee, Zuni, Flathead, Inca, Dakota, Mohawk, Apache, Navajo, Tewa, and Huron. The shot schedule, location, and other associated shot data are shown in Table 3.1.

A position was selected for each shot to achieve the desired loads on the aircraft. From the selected on-time position, mission profiles were drawn to establish flight altitudes, patterns, and takeoff and landing times. Representative mission profiles are shown in Figures 3.1 and 3.2.

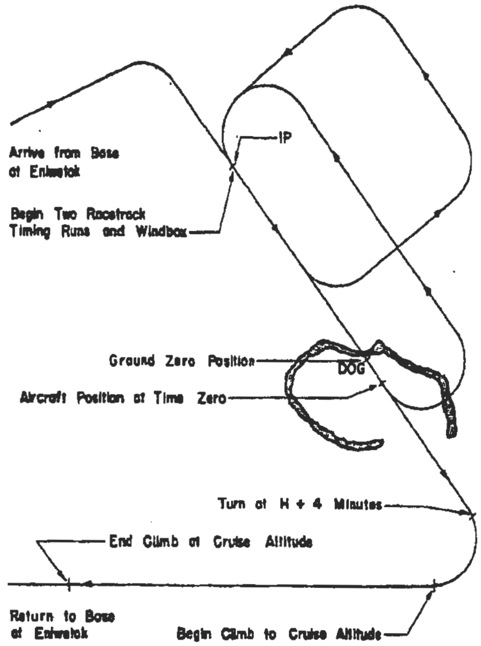


Figure 3.1 Typical mission profile at Bikini Atoll.

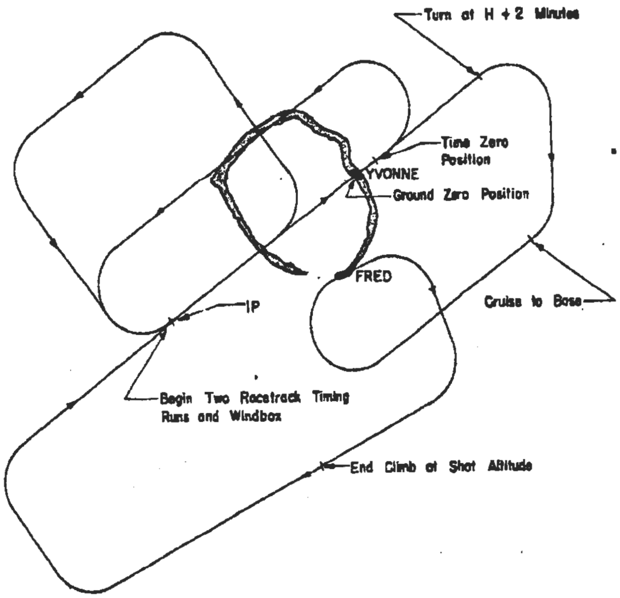


Figure 3.2 Typical mission profile at Eniwetok Atoll.

During Shots Cherokee, Lacrosse, Zuni, Flathead, Navajo, Mohawk, and Apache, the aircraft K-5 navigation and bombing radar system was used as the sole method of positioning. In order to position the aircraft correctly at the desired point in space at the precise time of detonation of the test device, a time-comparison computer and indicator were designed and manufactured by Radiation, Inc., and installed as an auxiliary aid to the pilot and navigator. The computer received a signal from the K-5 system to represent the time remaining prior to arrival of the aircraft at the desired point in space. It also received a time tone signal from the firing bunker at a known time prior to

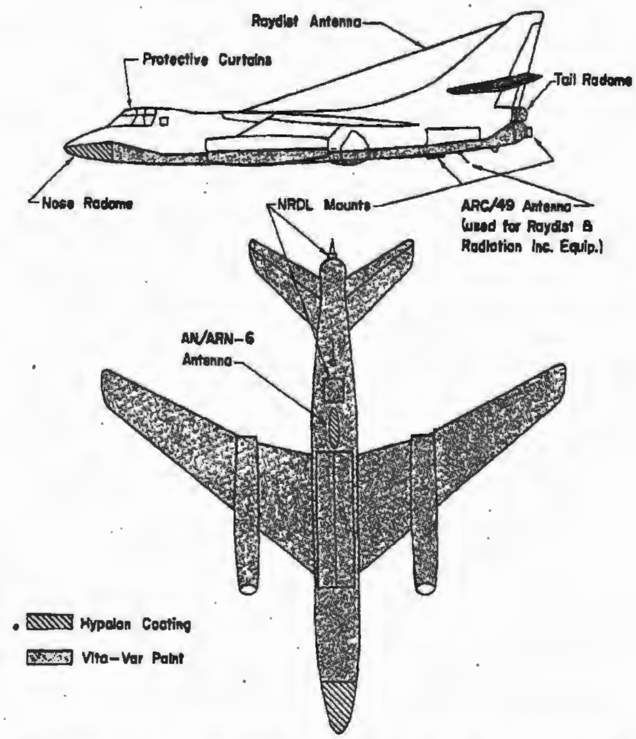


Figure 3.3 Configuration of the test aircraft.

detonation. The computer measured the difference between the two times and presented a constant indication to the pilot and navigator of the number of seconds to be gained or lost in order to be in the proper position at the proper time.

During Shot Inca, MSQ-1A ground radar was used for tracking the aircraft. It was intended as a tracking device for postshot information and was set up to be capable of assuming primary control for positioning in the event the aircraft radar malfunctioned. The mission was aborted, because the navigator could not see the target clearly until he had completed his final run-in to ground zero. The plane would have been out of position at time zero.

As a result of post-Inca discussions, it was apparent that MSQ-1A or the Raydist positioning system could serve a more useful purpose than to act only as standby for the possibility of difficulties. The MSQ-1A and Raydist systems were capable of providing considerable assistance to the crew to position the aircraft.

Following the discussions, the conversion of the B-66 to a capability for use of MSQ-1A and the Raydist positioning system was made. This was only a capability installation, since all MSQ and Raydist systems in REDWING were assigned to specific aircraft, and use of a system depended on withdrawal of an aircraft from a shot.

In order to determine the compatibility of the K-5 aircraft radar positioning methods and the flight profiles with the MSQ-1A and Raydist system, a practice mission was flown, using each system as a combined backup and auxiliary navigation system. The patterns flown were those of a K-5 mission, because the radar could not position the aircraft without the use of racetrack and wind-box flights. At the conclusion of the wind box, the airborne radar navigator and the MSQ or Raydist controller would use the information of both systems to reach the initial point on time. During the 40-mile run in from the initial point to ground zero, the pilot had a dual presentation of information, one from the ground system and one from his airborne system. In every case, these systems were alike in the presentation of position with reference to time, and the crew was able to reach the desired position on time much easier with the dual system capability working together. In addition to the compatibility, it was determined that with a malfunction of either airborne or ground positioning system, the flight could be continued by use of the remaining system to position the aircraft.

For Huron, the aircraft used the MSQ-1A system, because of the nonparticipation of a MSQ-1A controlled aircraft. All aircraft participated in Shots Apache and Navajo by using the existing MSQ and Raydist systems, and the B-66 was forced to use the K-5 aircraft radar without either of the backup systems on these tests.

During Cherokee, Flathead, Dakota, Navajo, and Tewa, the Raydist tracking system gave after-the-fact positions of the aircraft at time zero and time of shock arrival. For Zuni, Apache, and Mohawk, the aircraft position at time zero was determined from radarscope photos and in-flight recording of the pilot's comments on how early or late the aircraft was at time zero.

The recorded time of shock arrival and an integration of photopanel airspeeds during the period from time zero to shock arrival were used to determine aircraft position at shock arrival. During Huron, positions were determined by use of the methods of Zuni, Apache, and Mohawk, plus the data recorder operated by Radiation, Inc. The recorder used inputs from the MSQ-1A tracking radar.

<u>3.3.1 Shot Lacrosse.</u> For this shot, the aircraft took off at the correct time and climbed to shot altitude. After cruising to the initial point, the aircraft proceeded on course for the racetrack and wind box patterns. At 13 minutes prior to shot time the aircraft instrument power system failed, and this resulted in the loss of heading reference to the K-5 system and the loss of the flight attitude

gyro. The course to zero position was continued by use of the standby compass as a heading reference. The pilot was unable to keep the aircraft straight and level without the attitude gyro. As a result, the flight was aborted at 2 minutes prior to shot time. The aircraft was in no-effects position at time zero and at time of shock arrival and returned to base to land at the correct landing time.

3.3.2 Shot Cherokee. The aircraft took off at the correct time and climbed to shot altitude. After cruising to the initial point, the aircraft proceeded on course for the racetrack and wind box patterns. At approximately 3 minutes prior to shot time the timing calls of the drop aircraft became erroneous for the correct aircraft position. The aircraft made an abort turn of 146 degrees to the right to a heading of 251 degrees. The aircraft rolled out on a level flight heading approximately 5 seconds prior to time zero. After shock arrival the aircraft returned to base and landed at the correct time.

3.3.3 Shot Zuni. The aircraft took off at the correct time and climbed to the shot altitude. A successful mission profile was flown.

3.3.4 Shot Erie. The aircraft did not participate in this shot because of a malfunction of a relay in the left engine. The engine would not start, and the flight was cancelled.

3.3.5 Shot Flathead. The aircraft took off at the correct time, climbed to the shot altitude, and successfully flew the mission profile. At the beginning of the final run in to target, approximately 5 minutes prior to shot time, the K-5 radar became erratic and was only partially effective. The aircraft was accelerated to assure arrival either on time or early without use of radar. After shock arrival, the aircraft returned to the base and landed at the correct time.

3.3.6 Shot Inca. The aircraft took off at the correct time, climbed to shot altitude, and successfully flew the mission profile. On the final run-in at 1 1/2 minutes prior to shot time, the aircraft was 5 seconds late at a point where 2 seconds late would result in destructive loading on the aircraft. Because of the high run-in speed, the aircraft could not make up the time, so an abort was made with a 90-degree right turn to roll out on a heading of 140 degrees for a no-effects position at time zero and shock arrival. The aircraft returned to base and landed at the correct time.

3.3.7 Shot Dakota. The aircraft took off at the correct time and climbed to shot altitude. A successful mission profile was flown, and after shock arrival the aircraft returned to the base to land at the correct time.

3.3.8 Shot Mohawk. The aircraft took off at the correct time and climbed to shot altitude. A mission profile was flown, and after shock arrival the aircraft returned to base and landed at the correct time. A postflight inspection revealed that the oscillograph-on and the photo-recorder-on switches were accidentally turned off prior to takeoff and remained off during the entire flight. No data were recorded, even though aircraft position was good.

3.3.9 Shot Apache. The aircraft took off at the correct time, climbed to the shot altitude, and flew a successful mission profile. After shock arrival, the aircraft returned to base and landed at the correct time.

3.3.10 Shot Navajo. The aircraft took off at the correct time and climbed to shot altitude. After cruising to the initial point, the aircraft flew the desired mission profile. It was apparent on the racetrack patterns that cloud coverage did not allow the target to be clearly distinguished until late on the timing run to ground zero. No usable wind runs were obtained as a result of the heavy cloud cover. On the final run the cover caused the aircraft to be 28 seconds late at 4 minutes prior to shot time. This was beyond the capability of the aircraft to correct, so the aircraft followed the assigned re-position plan with a turn at one minute 10 seconds prior to shot time to a heading of 241 degrees. The effects were small, as predicted for the re-position. After shock arrival, the aircraft returned to base and landed at the correct time.

3.3.11 Shot Tewa. The aircraft took off at the correct time and climbed to the shot altitude. A successful mission profile was flown.

3.3.12 Shot Huron. The aircraft took off at the correct time, climbed to shot altitude, and successfully flew the mission profile.

3.4 DATA REDUCTION

At the test site, all records were developed and peak values of the selected key channels were read. Where necessary to complete the data comparison, a few time histories were also read and plotted. The reading methods employed were by use of ruler and pencil. In special instances, where additional data were required and bulk and time were critical factors, the WADC data-reduction trailer was used. The data presented in this report are approximate and are subject to revision prior to the final report.

After all correlation data required at the proving grounds were reduced, the original records and necessary data reduction instructions were shipped to the DAC Flight Test Division, Santa Monica, California, for complete data reduction.

3.5 CORRELATION

In order to define accurately the errors and consistencies in prediction methods, the Douglas positioning criteria personnel submitted estimates of the responses expected from all key channels prior to each shot. Upon determination of an estimated actual yield and meteorological and position data, as shown in Tables 3.2, 3.3, and 3.4, the anticipated responses were re-predicted. The data were reduced for these key channels, and preliminary comparisons of the measured data to the predicted data were made. The measured data for the key channels are shown in Tables 4.1 and 4.2. Wherever the measured loads differed considerably from the predicted loads, a field analysis was made to resolve differences, and the positioning criteria were adjusted to compensate for the differences.

TABLE 3.1 SHOT DATA

For additional shot information, see Pages 2, 3, and 4.

Shot Name	Nominal Yield	Positioning Yield	Data Correlation Yield	Official Preliminary Yield
Lacrosse	(b)(3)			
Cherokee				
Zuni				
Erie				
Flathead				
Inca				
Dakota				
Mohawk				
Apache				
Navajo				
Tewa				
Huron				

TABLE 3.2 SUMMARY OF METEOROLOGICAL DATA

Shot	Ambient Air Temp. at T_o	Ambient Pressure at T_o	Visibility	Wind at A/C Altitude at T_o	Wind Direction at A/C Altitude at T_o	Sea Level Pressure	Sea Level Temperatures	Sea Level Dew Point	Sea Level Relative Humidity	Sea Level Water Vapor Pressure
	°F	psi	miles	knots	deg.	MB	°F	°F	pct	mm of Hg
Lacrosse	Flight Aborted - See Paragraph 3.3.1									
Cherokee	-47	3.63	10 +	8	250	1009	81	73	76	20.6
Zuni	20	7.325	8	10	120	1010.5	81	76	80	21.55
Flathead	28	8.225	10	9	160	1012.9	82	76	82	23
Erie	Flight not accomplished - See Paragraph 3.3.4									
Inca	Flight Aborted - See Paragraph 3.3.6									
Dakota	27	8.1	10 +	8	160	1009.1	82	75	80	23.8
Mohawk	Flight Completed. Instrumentation Off - See Paragraph 3.3.8									
Apache	48.4	11.006	10 +	19	120	1010.5	80.3	74.9	84	22.4
Navajo	2.5	6.735	10	20	80	1010.2	81.2	74	81	21.6
Huron	48.3	10.310	10	15	90	1007.8	81.4	76.2	84	22.6
Tewa	16.7	7.25	10 +	11	120	1009.3	82	77	85	23.8

TABLE 3.3 SUMMARY OF AIRCRAFT POSITION AND ATTITUDE

Shot	Estimated Yield	Test Altitude	Horizontal Range from Ground Zero at T_o	Elevator Angle with Ref. to Ground at T_o	Time of Shock Arrival	Horizontal Range from Ground Zero at T_{sa}	Aircraft Angle of Attack at T_{sa}
	(b)(3)	ft.	ft.	degree	sec.	ft.	degree
Lacrosse		Flight aborted - See Paragraph 3.3.1					
Cherokee		36,000	52,640		124.4	143,600	2
Zuni		19,000	27,000	3.6 TED	84.4	97,760	2
Flathead		16,000	17,800	3.7 TED	51.9	59,100	2
Erie		Flight not accomplished - See Paragraph 3.3.4					
Inca		Flight aborted - See Paragraph 3.3.6					
Dakota		16,000	13,100	3.6 TED	28.5	35,050	2
Mohawk		Flight completed - Instrumentation Off - See Paragraph 3.3.8					
Apache		8,000	23,500	2.0 TED	47.7	60,500	2
Navajo		21,000	71,000	4.5 TED	130	180,000	2
Huron		10,000	6,540	1.1 TED	18	22,440	2
Tewa		19,000	27,250	1.5 TED	50	65,900	2

Note: TED - Trailing Edge Down.

TABLE 3.4 SUMMARY OF PERFORMANCE DATA

Shot	Pressure Altitude at T_o	Absolute Altitude at T_o	True Airspeed at T_o	True Airspeed at T_{sa}	Gross Weight at T_{sa}	C. G. at T_{sa} pct MAC Gear up	Take off Time	Landing Time
	ft.	ft.	knots	knots	lb.		min.	min.
Lacrosse	Flight aborted - See Paragraph 3.3.1							
Cherokee	32,400	36,000	495	498	58,630	22.4	H-93	H+48
Zuni	18,060	19,000	514	491	58,720	22.4	H-83	H+35
Flathead	15,360	16,000	476	498	59,050	22.8	H-83	H+35
Erie	Flight not accomplished - See Paragraph 3.3.4							
Inca	Flight aborted - See Paragraph 3.3.6							
Dakota	15,540	16,000	458	457	60,810	23	H-83	H+35
Mohawk	Flight completed - Instrumentation Off - See Paragraph 3.3.8							
Apache	7,785	8,000	470	451	62,240	23	H-77	H+16
Navajo	19,980	21,000	532	474	59,610	22.9	H-83	H+35
Huron	a	10,000	466	466	58,630	22.7	H-77	H+16
Tewa	a	19,000	457	457	60,270	23	H-83	H+49

[a] Not available.

TABLE 3.5 COMPARISON OF DESIRED AND ACTUAL POSITIONS

Shot	Desired Heading at T.Z.	Actual Heading at T.Z.	Desired Altitude	Actual Altitude	Desired hr at T.Z.	Actual hr at T.Z.	Desired hr at sa	Actual hr at sa
	degree	degree	ft.	ft.	ft.	ft.	ft.	ft.
Lacrosse	135	090[a]	13,000	13,000	5,300	Abort	22,500	Abort
Cherokee	105	251[b]	36,000	36,000	38,000	52,640	102,000	143,609
Zuni	070	070	19,000	19,000	25,800	27,000	69,900	97,760
Erie	Cancelled		11,000		2,710		16,300	
Flathead	120	120	16,000	16,000	12,000	17,800	37,500	59,100
Inca	050	140[a]	11,000	11,000	850	Abort	11,400	Abort
Dakota	124	124	16,000	16,000	13,500	13,100	39,150	35,050
Mohawk	050	050	6,000	6,000	12,700	12,700[c]	28,450	28,450[c]
Navajo	124	241[b]	21,000	21,000	24,500	71,500	62,500	180,000
Apache	080	080	8,000	8,000	20,500	23,500	43,000	60,500
Tewa	124	124	19,000	19,000	27,100	27,250	67,000	65,900
Huron	040	040	10,000	10,000	8,700	8,450	24,000	22,400

[a] Abort [b] Reposition [c] Estimated Position

CHAPTER 4

RESULTS

The preliminary peak values of the effects on the critical portions of the aircraft at time zero and time of shock arrival are given in Tables 4.1 and 4.2.

Typical time history plots from which the tabular peak values were selected are shown in Figures 4.1, 4.2, and 4.3.

Figures 4.4 and 4.5 show detailed results of the recorded temperatures and temperature rises. During all shots, other than Cherokee, the aircraft was gust critical. Therefore, the variations in absorptivity shown on these plots were necessary to obtain data throughout a range of temperatures up to the limit used in Reference 8 calculations (423°F). These figures illustrate the completeness of data throughout the temperature range on skin thicknesses of 0.016, 0.025, and 0.040 inch and provide an indication of the temperature effects on thicknesses up to 0.070 inch.

The temperatures measured on the 0.016 inch thick elevator with a protective coat of white Vita-Var PV-100 paint (absorptivity of 0.15) compared closely with the temperatures measured on the nose radome. Since the instrumented areas were repainted prior to Shot Dakota for higher absorptivities, no measurements of the original surface condition were made during Dakota or later shots. For this reason, the nose radome temperatures from Dakota and later shots, as shown in Figures 4.6 and 4.7, may be considered as equivalent to the temperatures attained by a white-painted, 0.016 inch thick elevator panel.

The small stresses measured on the horizontal stabilizer appear to be a negligible consideration in the gust analysis.

The spanwise variations of measured percent limit stress on the wing (Figure 4.8) show the critical section of the wing to be an outboard section. The dynamic-magnification factor (DMF) is the prime factor in relating the stresses measured by an aircraft exposed to a nuclear explosion to the stresses predicted with the maneuvering rigid body gust analysis. The measured values of the DMF are shown in Figure 4.9 for the same shots and wing stations as the measured stress levels of Figure 4.8.

Some damage to secondary structural items occurred during the tests, primarily on radomes and seals. Photographs of principal damage areas are presented as Figures 4.10 and 4.11.

The measured values of radiant exposure varied from the predicted values as shown in Figure 4.12. Recorded values were less than predicted for most of the shots but were equal or greater than predicted for two shots. The data are shown for the radiant exposure measured on a receiver parallel to the ground plane (vertical radiation) and a receiver normal to the radial from the burst to the aircraft (direct radiation).

The comparison of the measured inputs and the associated incidence angles for radiant exposure, material velocity, and overpressure are shown in Figures 4.13, 4.14, and 4.15.

The positions selected were based on a critical aircraft structure component. This resulted in the collection of only a minimum amount of usable engine-response data. The critical gust overpressures for the structure and the engine are plotted in Figure 4.16. The curves show that the critical overpressure for the structure to be blast critical is considerably lower than the critical overpressure for the engine in all conditions. The relations of the power setting and overpressure to the possibility of unchoking the jet nozzle are shown in Figure 4.17. The aircraft has a limit overpressure of 2.0 psi. Delivery speeds are made at power settings on the order of 98 percent or greater. Therefore, the probability of unchoking the jet nozzle was negligible.

Of 288 oscillograph channels recording each test, an average of 96 percent operated successfully. Of 12 cameras and 27 photo-panel instruments, an average of 99 percent operated successfully.

The aircraft positions and other parameters affecting the data are shown in Tables 3.2, 3.3, and 3.4.

All values quoted are based upon observations made in the field. Approximately 20 percent of the data recorded were reduced to peak values at the test site. This reduction is estimated to be accurate within ± 10 percent for all cases in which no major error was made. Rechecks were made only when answers were obviously incorrect. An accurate value of wing stress levels received cannot be determined until after the airload calibrations are performed. These calibrations are scheduled to begin immediately following the REDWING test series.

TABLE 4.1. SUMMARY OF THERMAL RESULTS

Shot	Radiant Exposure on Receiver Normal to Line of Direct Radiation	Gray Elevator Panel Temp. Sta. 97, 0.016" Alum. Absorb. = 0.45 (66 inches from leading edge)		Gray Elevator Panel Temp. Sta. 97, 0.016" Alum. Absorb. = 0.33 (66 inches from leading edge)		White Elevator Panel Temp. Sta. 97, 0.016" Alum. Absorb. = 0.15 (66 inches from leading edge)		Nose Radome Temperature		Lower Skin Thermal Stress Station 97, Elevator
	cal/cm^2	Total Temp. °F	ΔT °F	Total Temp. °F	ΔT °F	Total Temp. °F	ΔT °F	Total Temp. °F	ΔT °F	psi
Lacrosse	Flight Aborted - See Paragraph 3.3.1									
Cherokee	18.5					45	30	60	57	
Zuni	29					114	37	127	51	1,000
Flathead	7.3					87	17	103	30	4,290
Erie	Flight Not Accomplished - See Paragraph 3.3.4									
Inca	Flight Aborted - See Paragraph 3.3.6									
Dakota	30	436	356					204	136	39,560
Mohawk	Flight Completed - Instrumentation Off - See Paragraph 3.3.8									
Apache	19	187	89	152	55			107	9	3,848
Navajo	10.6	129	56	115	46					
Huron	18	363	276	257	171			143	55	36,713[a]
Tewa	40	322	258	254	191			112	54	38,653[a]

[a]Accuracy questionable

TABLE 4.2. SUMMARY OF SHOCK ARRIVAL RESULTS

Shot	Free Overpressure	C. G. Load Factor	Percent Gust Limit Allowable Load Factor	Dynamic Magnification Factor at Wing Sta. 407	Wing Sta. 407 Stress[a]	Percent Limit Allowable Stress[a]	Gamma Radiation
	psi	(Total) g	percent		psi	percent	Roentgens
Lacrosse	Flight Aborted - See Paragraph 3.3.1						
Cherokee	0.16	1.4	45.5	1.58	6,950	52	1
Zuni	0.37	1.47	48	1.47	6,180	47	1
Flathead	0.33	1.39	46.4	1.52	6,040	45	1
Erie	Flight Not Accomplished - See Paragraph 3.3.4						
Inca	Flight Aborted - See Paragraph 3.3.6						
Dakota	0.93	2.75	94	1.39	13,300	88	1
Mohawk	Flight Completed - Instrumentation Off - See Paragraph 3.3.8						
Apache	0.85	1.7	57	1.14	4,900	48	1
Navajo	0.17	1.14	37.4	1.74	4,720	46.2	1
Huron	1.02	3.26	107	1.56	13,287	110	1
Tewa	0.84	1.68	56	1.59	8,627	65	1

[a] Stress levels are not at same gage location due to uncalibrated condition. Six channels are recorded at each station and each has a different response and limit stress. Peak value of the channel having the highest percent of limit allowable stress is indicated.

[redacted]

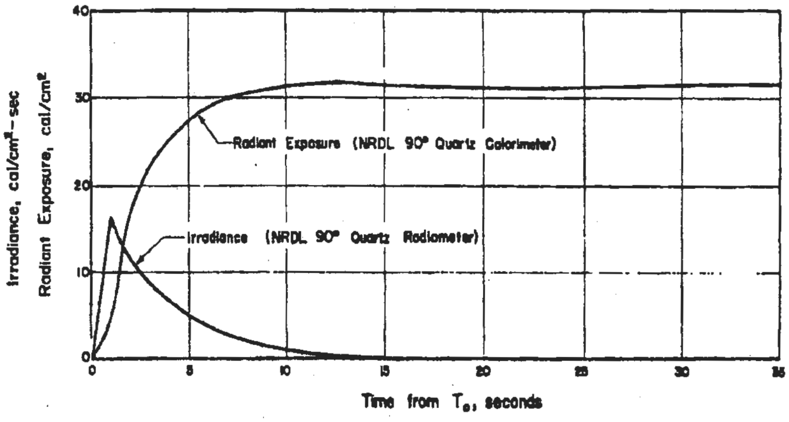


Figure 4.1. Typical plots of thermal input versus time, Shot Dakota.

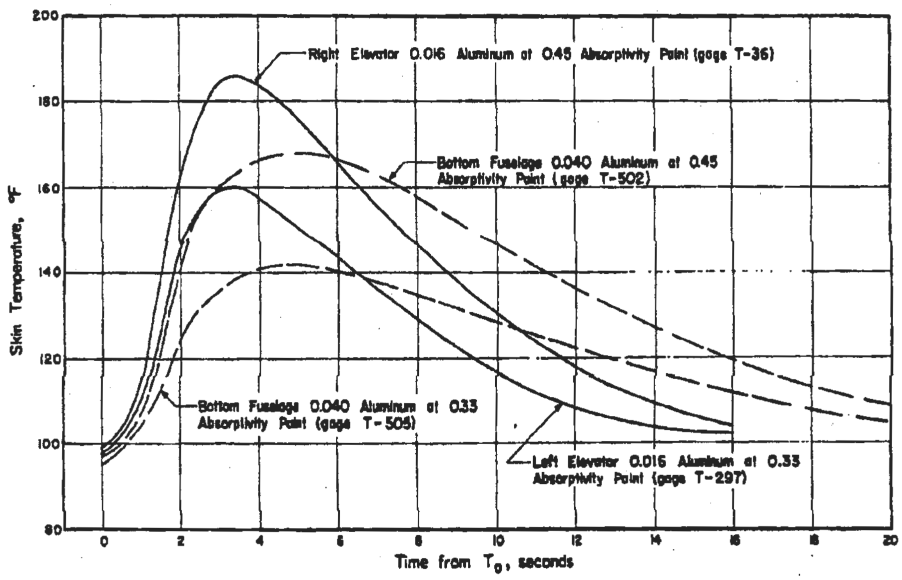


Figure 4.2. Typical plots of skin temperature from Shot Apache.

[redacted]

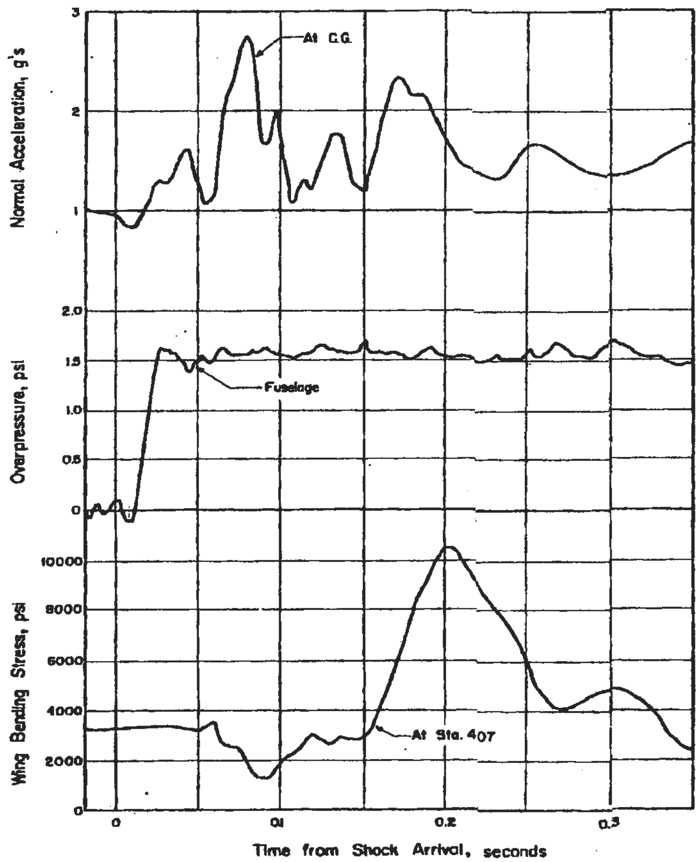


Figure 4.3. Typical histories of shock-arrival time, Shot Dakota.

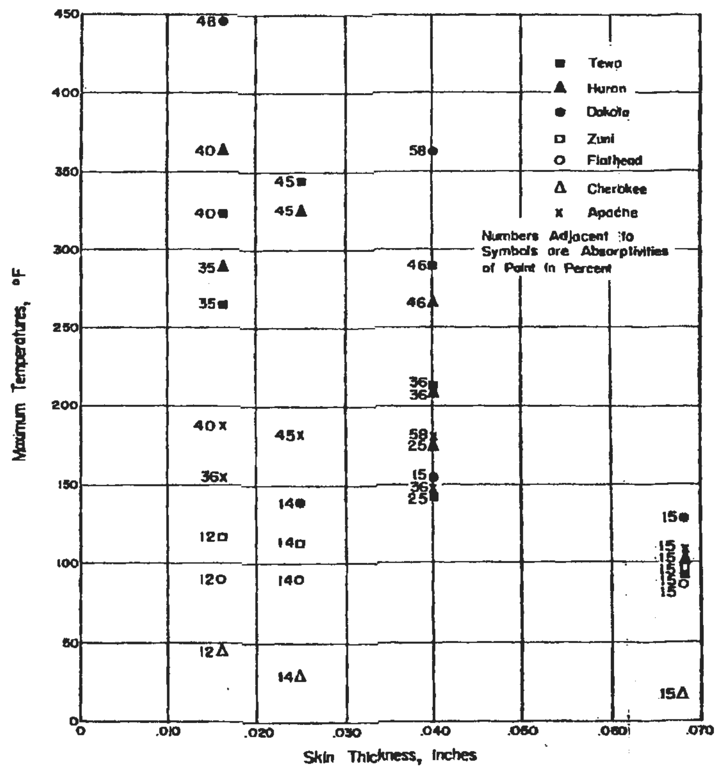


Figure 4.4. Maximum temperatures of thin skin.

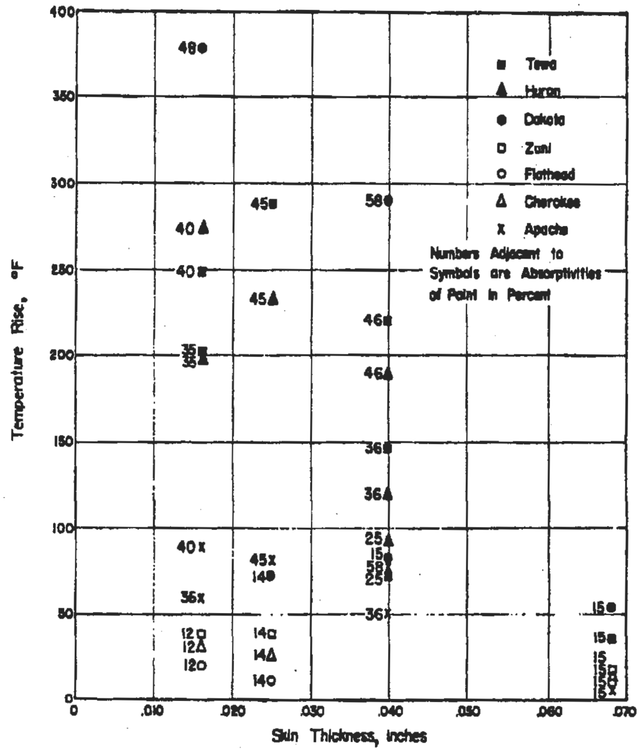


Figure 4.5 Maximum temperature rises of thin skin.

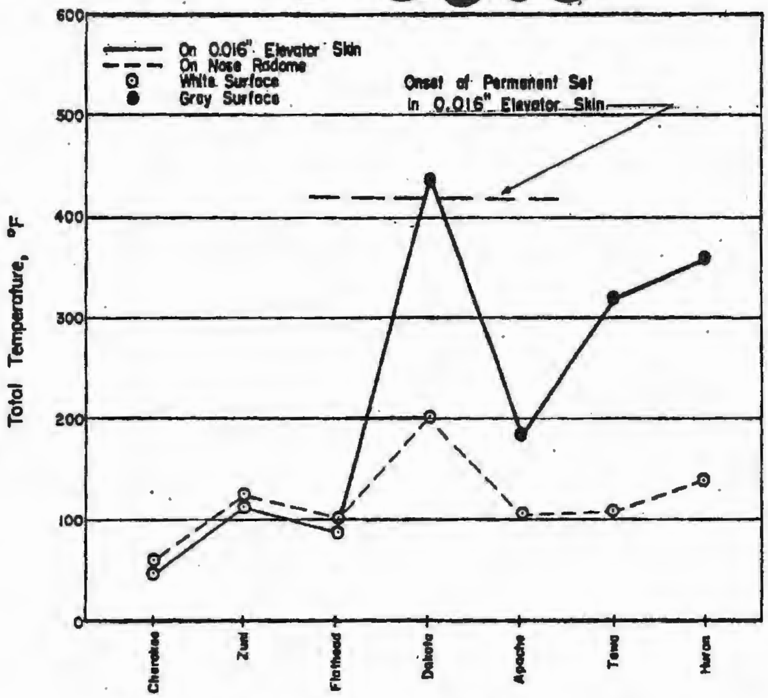


Figure 4.6 Summary of total temperatures.

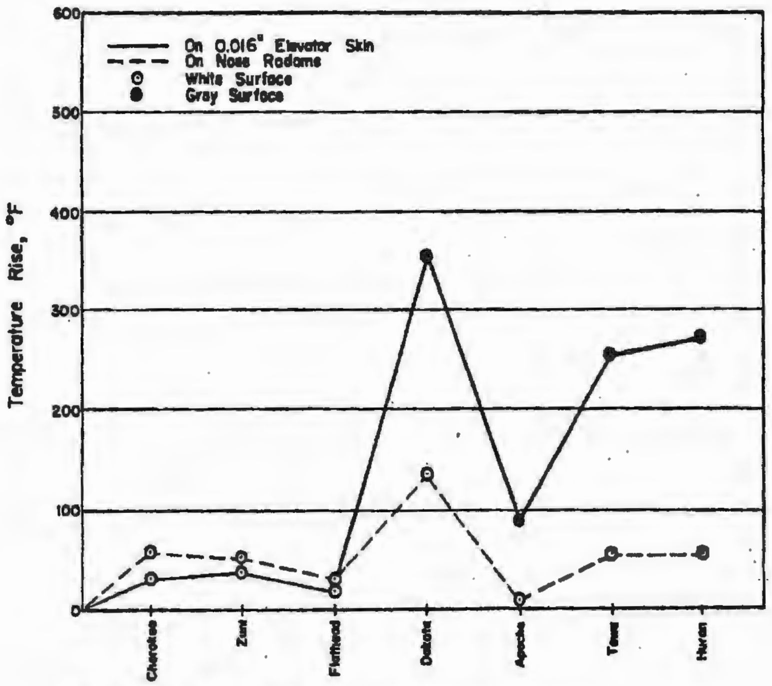


Figure 4.7 Summary of temperature rises.

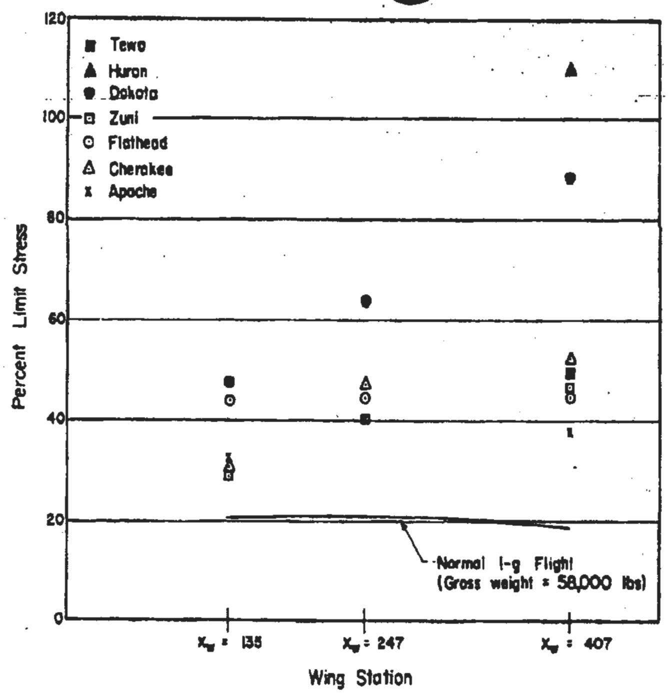


Figure 4.8 Percent of limit stress versus wing station.

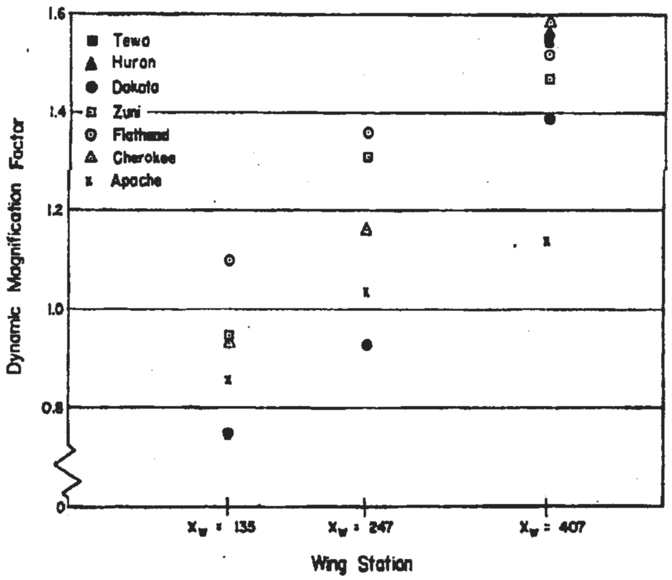


Figure 4.9 Dynamic-magnification factor versus wing station.

Figure 4.10 Radome damage; tail radome after Tewa (left) and AN/ARN-6 antenna cover after Dakota (right).

UNCLASSIFIED

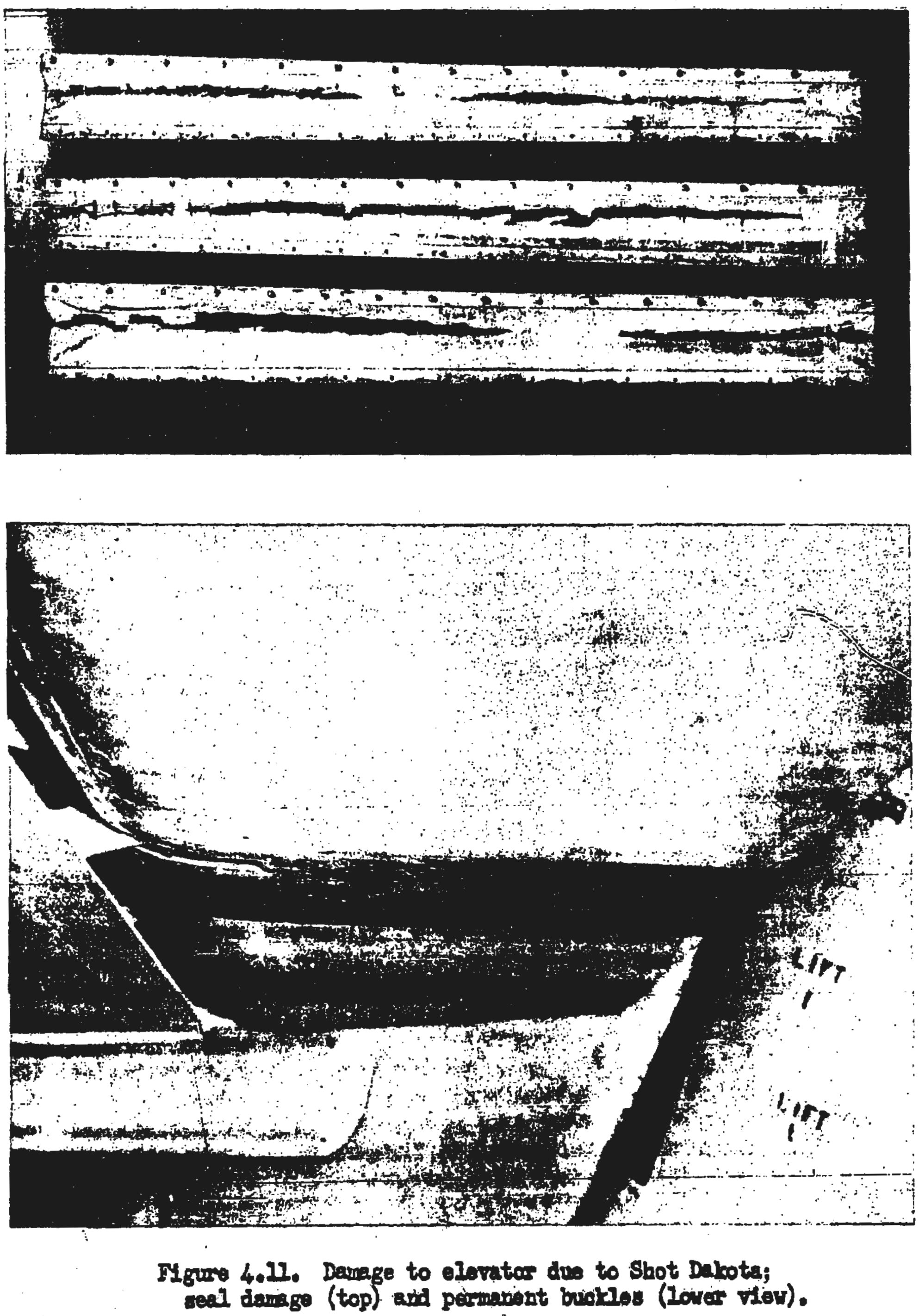
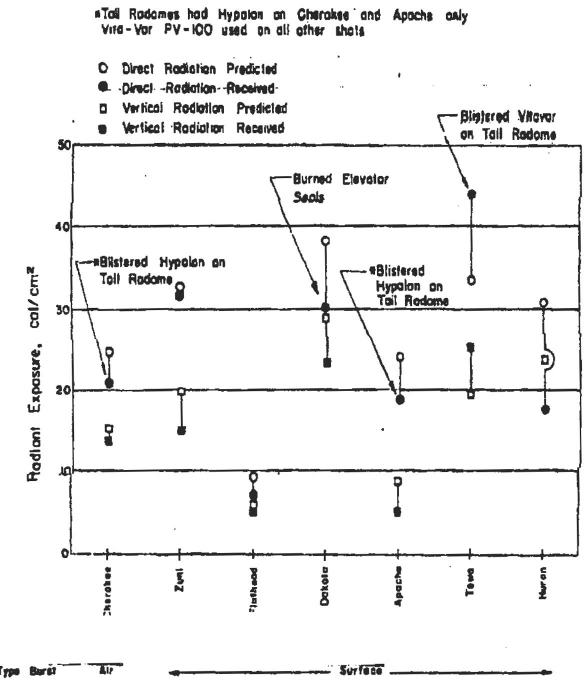


Figure 4.11. Damage to elevator due to Shot Dakota; seal damage (top) and permanent buckles (lower view).



(b)(3)

Figure 4.12. Summary of radiant exposure received and comparison to predicted values.

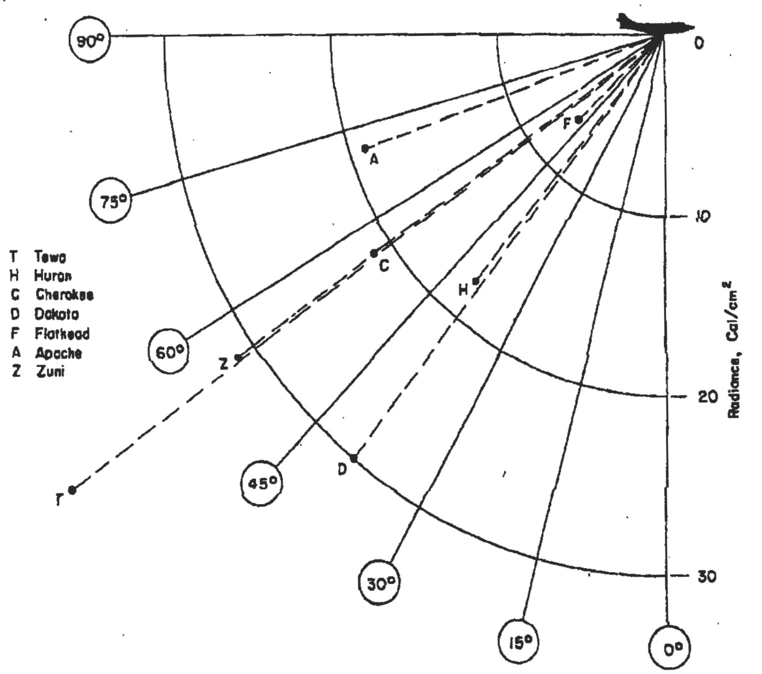


Figure 4.13. Incidence angles, thermal input.

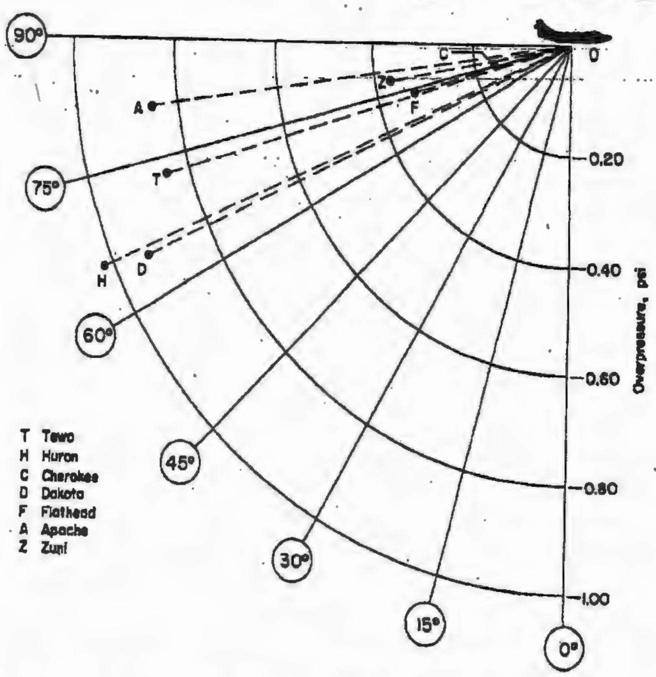


Figure 4.14. Incidence angles, overpressure.

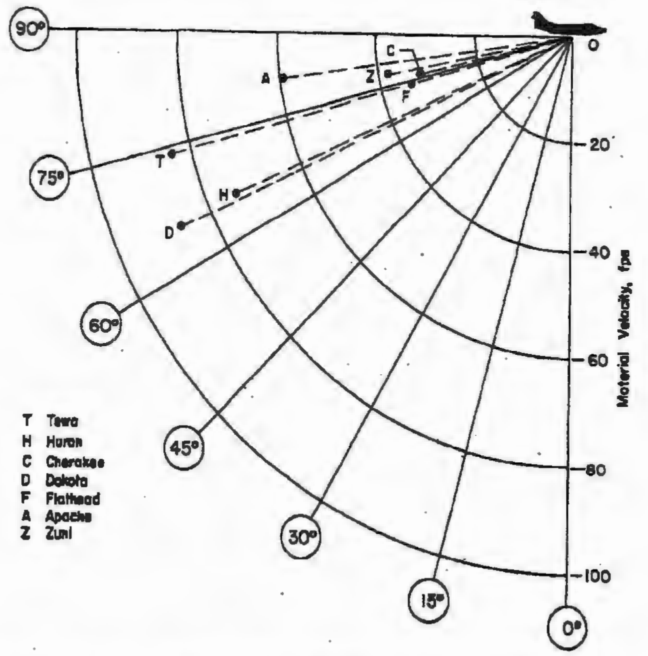


Figure 4.15. Incidence angles, material velocity.

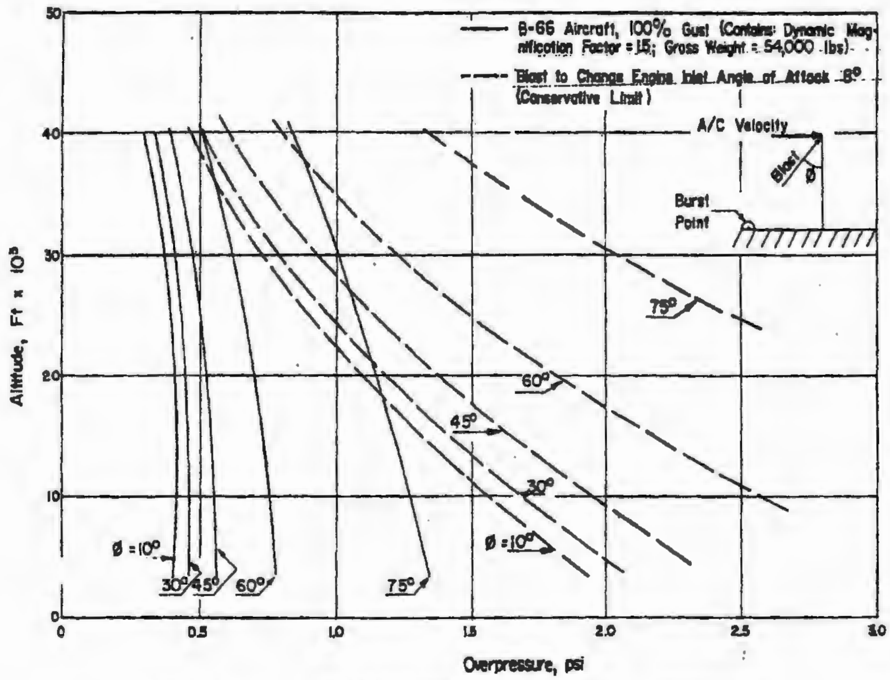


Figure 4.16. Critical values of blast. Aircraft limits are extrapolated above 30,000 feet.

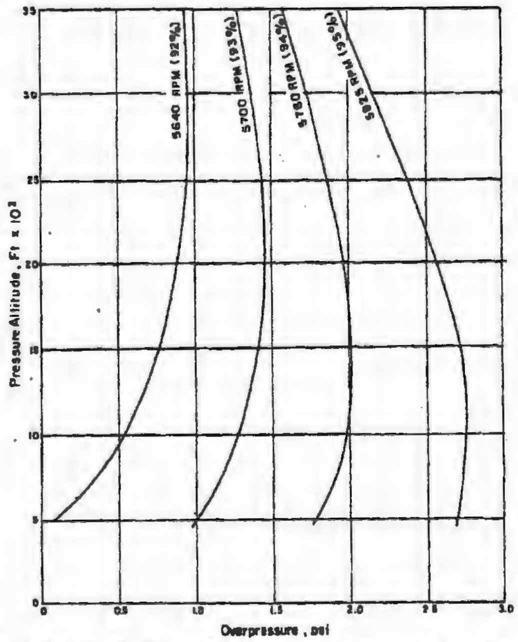


Figure 4.17. Estimated maximum overpressure to unchoke the jet nozzle. J71-A-11 engine; aircraft velocity, 0.76 Mach; these data based on Eniwetok standard day.

CHAPTER 5

DISCUSSION

The comments of this chapter are based on the preliminary results of Chapter 4, and the field observations made by the project personnel.

5.1 DESIRED EFFECTS

In order to accomplish the objectives of the B-66 participation in Operation REDWING, certain general information was required. Table 5.1 itemizes the desired effects and indicates for each shot which effect was expected. Some of these effects were used as the determining factor in the selection of a final desired position, and such influencing factors are so indicated. In order to obtain a general indication of the items accomplished, a note was made for each shot and effect to indicate the specific accomplished items.

5.1.1 Overall Considerations. The general objective of the test required the measurement of a spread of temperatures on several skin thicknesses and at several points on the aircraft having different convective cooling coefficients. It also required measurement of a spread of overpressures, accelerations, and limit-allowable stresses. In each case, the desired spread of data up to the limiting value was to be measured. It was considered adequate for satisfactory completion of the individual objectives to obtain a maximum measurement of only 70 percent of the limit effect.

Since the B-66 was designed for tactical usage and has delivery capabilities at all altitudes from sea level up to at least 40,000 feet, the positions were selected to obtain a variety of altitudes and angles of incidence of the inputs. The flight time required to perform the K-5 radar-positioning mission profiles and the range performance limitations of the aircraft were such that low altitude participations could not be made at Bikini. The low altitudes provided the best positions for the B-66 when a maximum amount of data was desired; therefore, the shots following Cherokee were flown at medium or low altitudes wherever possible. The high altitude position provided only the specific information of a high angle gust loading and no other data.

5.1.2 Effects Desired from Shot to Shot. The position selected for each shot was one which would give the maximum amounts and types of data which had not been measured up to the time of the selection. As data began to accumulate from the more successful shots and as gaps in the data occurred from aborted shots, the positions were reshuffled to obtain the missing data.

[redacted]

TABLE 5.1 SUMMARY OF PLANNED AND MEASURED EFFECTS AREAS

Symbols
* Expected Effects
# Final Position Determined by the Significance of this Desired Effect
X Accomplished Effects

DESIRED THERMAL EFFECTS	Lacrosse	Cherokee	Zuni	Erie	Flathead	Inca	Dakota	Mohawk	Apache	Navajo	Teva	Huron	TOTALS
Primary													
1. Thin-skinned control surfaces													
a. Low temperatures (0-150°F)	*	X	X	*	X	*				X			4X
b. Intermediate temperatures (150-300°F)			#		*				X		*X	*X	3X
c. Medium temperatures (300-420°F)		#					*X	*	*	*	*X	*X	3X
d. High temperatures (Permanent Set-over 420°F)							#X		#	#	#		1X
e. Realistic radiant exposure + permanent set on normal paint configuration (white)	Cannot obtain this data on a ground burst since gust considerations become critical.												
2. Nose Radome													
a. Low temperatures (0-250°F)	*	X	*X	*	X	*	X		X		X	*X	7X
b. Medium temperatures (250-350°F)		*			*		#	*	#	#	#		0X
3. Fuselage Panels													
a. Low temperatures on realistic structure	*	X	X	*	*X	*	*X		X		X	*	6X
b. Medium temperatures on realistic structure		*						*	*	*	*	X	1X
c. High temperatures on test panel only							*X		*	*	*		1X
Secondary													
1. Seals-Exposure to realistic radiant exposure		*					*X		*	*	*		1X
2. Tail Radome-Exposure to realistic radiant-exposure		*					*X		*	*	*X		2X
DESIRED BLAST WAVE EFFECTS													
1. Gust													
a. Low percentage limit allowable load factor (40-60%)		X	X		X				X	X	X		6X
b. Medium percentage limit allowable load factor (60-80%)	#	*	#	#					*				0X
c. High percentage limit allowable load factor (80-99%)					#	#	#X	#		#	#	#X	2X
2. Overpressure													
a. Low overpressure (0.1-0.75 psi)	*	*X	X	*	*X	*	*			X			4X
b. Medium overpressure (-0.75-1.5 psi)			*				X	#	X	*	*X	*X	4X
c. High overpressure (1.5-2.0 psi)									#				0X
DESIRED PROOF OF PHASE I (Reference 8)													
1. High radient exposure (expected from air-bursts)		#					*X		#	#	#X		2X
2. Low Altitude exposure (0-30 degrees from horizontal)								*	#X	X			2X
3. Intermediate angle exposure (30-45 degrees)		*X	*X		X					*	*X		4X
4. High Altitude exposure (45-80 degrees from horizontal)	*			*	*	*	*X					*X	2X
5. Long Thermal Pulse		#X	*X						*X	*X	*X		5X
6. Air Burst		#X											1X

[redacted]

5.1.3 Degree of Attainment. Shots Tewa and Huron completed nearly all the gaps in the data except for the medium temperatures on the nose radome, the medium percent of limit allowable load factor, and high overpressures. The airburst data was unfortunately compromised by the timing and bombing errors of Shot Cherokee, and only a minimum amount of data was obtained.

In view of the problems of measurement of the radome temperatures and in view of the studies now under way or proposed for increasing the strength of the nose radome on this aircraft, the lack of higher temperatures on this specific radome is not a matter of great concern.

The aircraft received two different measurements of high load factor and stress level data which were better than planned.

High overpressure data were extremely difficult to obtain during the operation, because of the other limiting criteria of the aircraft which require positioning at low altitudes. The measured overpressures were adequately large to substantiate the data correlation.

As a result of the accomplishment of all the desired effects, except the few items of minimum importance mentioned above, the project was successful in the completion of the objectives.

5.2 INPUT AND RESPONSE PREDICTIONS

During REDWING, positioning criteria were satisfactory, except for the shock-wave time of arrival and the prediction of overpressure. Gust response calculations were modified to reflect more realistic dynamic effects. Radiant exposure predictions agreed with measured inputs, and no modifications were deemed necessary for this input or associated response. More specific discussion of these items is presented below. Field reduced data evaluated for positioning and comparison of predicted and recorded inputs and responses are shown in Table 5.2.

5.2.1 Thermal Input. The method of Chapman-Seavey (Reference 11) was used with modification for the operation. The spread of the data was as expected, because of the unknowns involved regarding specific cloud and weather data required in the calculations. Conditions assumed throughout the test were: (1) albedo of 0.6; (2) water-vapor pressure of 20 mm of mercury; (3) visibility of 20 miles; (4) haze layer height of 10,000 feet.

5.2.2 Thermal Response. After Cherokee, the absorptivity of Vita-Var PV-100 assumed in the calculation of predicted responses was lowered from 0.25 to 0.18. Between Zuni and Flathead, the absorptivity was measured by use of the equipment and services of the University of Dayton. The measurements indicated an absorptivity of 0.12 to 0.15 at various areas of the PV-100. Following these measurements, 0.15 was used as the overall aircraft absorptivity.

Just prior to Shot Dakota, it was concluded that the temperature spreads desired on the thin-skinned components could not be achieved unless the instrumented areas were painted to obtain higher absorptivities. Higher absorptivities were obtained by the use of gray paint for the remainder of the shots.

[redacted]

TABLE 5.2 POSTSHOT COMPARISON OF PREDICTED[a] AND RECORDED VALUES

Shot	Radiant Exposure Normal Receiver	Radiant Exposure Horizontal Receiver	Time of Shock Arrival	Overpressure M-Problem Prediction	Overpressure Compromise Prediction	Overpressure Ledshaw & Pike Prediction	T, Elevator	T_{max}, Elevator	Total Gust Load Factor	Limit Allowable Gust
	cal/cm²	cal/cm²	seconds	psi	psi	psi	°F	°F	g	percent
Cherokee										
Predicted	24.7	13.7	125	0.21		0.17	95	104	1.38	45.5
Recorded	21	15.1	124	0.16	0.16	0.16	30	45	1.4	45
Zuni										
Predicted	32.6	19.9	76.5	0.5		0.41	72	183	1.48	48.8
Recorded	31	15	84.4	0.37	0.37	0.37	37	114	1.47	47.5
Flathead										
Predicted	9.2	6.1	51		0.40	0.33	32	116	1.51	50.3
Recorded	7	5	51.9	0.33	0.33	0.33	17	87	1.39	46.4
Dakota										
Predicted	38.1	26.8	28.2	1.13	1.04	0.95	444	524	2.74	93.5
Recorded	30	23.6	28.5	0.93	0.93	0.93	380	444	2.75	94
Apache										
Predicted	24.2	8.7	47.	0.94	0.86	0.78	115	220	1.76	59
Recorded	19	5	47.7	0.85	0.85	0.85	89	187	1.7	57
Navajo										
Predicted		Predictions for use in the field were not made								
Recorded	10.5	6	130	0.17	0.17	0.17	56	129	1.14	37
Tewa										
Predicted	33.8	19.9	51.5	0.91	0.84	0.76	227	292		
Recorded	44	25.5	50.1	0.84	0.84	0.84	258	322	1.68	56
Huron										
Predicted	31.2	24.2	19	1.3	1.2	1.09	388	485	3.10	102
Recorded	18		18	1.02	1.02	1.02	276	363	3.26	107

[a]Based on data correlation yields, Table 3.1

No correlation of the panel temperature distributions was attempted in the field.

5.2.3 Shock Wave. Initially, overpressures were based on the M-problem free air overpressure curve and the alpha altitude correction factor (Reference 9). However, since the results through Flathead did not show satisfactory comparison with measured values, it was decided to use an average overpressure computed from the M-problem and the Ledsham-Pike free overpressure curve (Reference 10) for prediction on subsequent shots. This compromise was adopted as strictly a field expedient, and a more comprehensive investigation will be accomplished during the final correlation studies. Rankine-Hugoniot relations were used with the standard Eniwetok atmosphere to calculate gust velocities and density relations.

5.2.4 Gust Response. Stresses measured on the wing resulting from the passage of the shock wave after a nuclear detonation are greater than stresses computed by a rigid body gust analysis based on the acceleration of the center of gravity. To predict the increase, WADC recommended that a dynamic magnification factor (DMF) of 1.5 be used with the rigid body gust analysis for the B-66B during REDWING.

[redacted]

The validity of 1.5 as a DMF was observed when the ratio of recorded stresses to those predicted without considering dynamics was consistently between 1.4 and 1.6 at the critical wing station (407).

5.3 SPECIAL AREAS OF CONCERN AFFECTING POSITIONING

In addition to the basic structural responses which primarily determined the positions in the operation, a number of special areas of concern existed and were considered in the final decision. Such items as the effect of low-yield participations, engine criticalness to blast, temperature rises in the nose radome, and data from airbursts were considered. The position selections were altered to include these special areas, as long as this inclusion did not compromise the structural effects desired.

5.3.1 Participation in Low-Yield Tests. The B-66 did not participate successfully in the shots having yields below 50 KT. These tests offered only one unique advantage: the opportunity to position the aircraft nearly directly over the burst at time of shock arrival. This position may have produced better response data for the instrumented engine; however, it was not representative of free fall bomb delivery.

5.3.2 Engine Criticalness. The effects of gust and overpressure on the Allison J-71-A-11 engines of the B-66 were recorded and analyzed in the field by the Allison positioning representative and are summarized in Figures 4.16 and 4.17. These figures show that, with the high power settings of a delivery condition (98 percent or larger), the engines cannot be gust critical. They also show that the structural limitations of the aircraft, as expressed in overpressure limits, are considerably more critical than the engine limitations expressed in the same terms.

5.3.3 Temperature Rises in the Nose Radome. Since thermal analyisis of Fiberglas radome materials was in the initial investigation stages, no degree of criticalness was established for the nose radome in the calculations of Reference 8. Two separate types of information had been obtained from laboratory tests by DAC, but neither were directly applicable to the REDWING tests.

With the aid of the REDWING data, an evaluation of the time lag of heat conduction through the Hypalon protective coating and resultant effect on the allowable inputs to the existing radome will be attempted by DAC. The information obtained should be directly applicable to any subsequent changes in the radome material, structure, or protective coating. The criticality of the radome has not been firmly established. After the above study is completed, an attempt will be made to determine radome criticality.

5.4 WEAPONS DELIVERY HANDBOOK

The aircraft experienced a spread of overpressures, temperatures, and stresses which should be complete enough to allow revision of the work now in progress on the B-66 Weapons Delivery Handbook. Minor thermal damage was experienced by a few secondary structural components, and field checks indicate that such items can be replaced or protected.

5.5 THERMAL PROTECTIVE PAINT

The aircraft had a coat of white Vita-Var PV-100 over the entire underside, as shown in Figure 3.3. Sufficient data have been collected to evaluate this paint under operational conditions. It was applied at WADC under the direction of the Materials Laboratory and met the required thickness criterion. It has been exposed to engine heat, engine lubricants and fuel, ATO exhaust, and deterioration of tropical heat, humidity, and salt air. It has been in use for over 40 flights of several hours each flight. During this time, the paint maintained a relatively constant absorptivity below that of Mil Spec Enamel. A coat of Vita-Var B-103 topcoat was applied to some lower surfaces. It was difficult to wash and made the aircraft harder to clean, rather than easier. The PV-100 is adversely affected by the heat and lubricants of the engine and is not a satisfactory protective coat in the engine area. All other portions of the aircraft were satisfactorily protected.

5.6 APPLICATION OF DATA TO FUTURE MILITARY AIRCRAFT

One of the secondary objectives of the project was to obtain data that could be used in the development of design criteria for future military aircraft. The data collected by this project are sufficient for this purpose.

5.7 LABORATORY TESTING

The considerable amount of data collected from REDWING by the B-66 should result in greater use of laboratory tests and more significant conclusions from them. The cooling coefficient information and thermal input rates of REDWING are applicable to such tests.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

The objectives of the project were successfully completed and adequate loads were measured to accomplish the required correlation of the B-66 Weapons Delivery Handbook.

The weather information used in the thermal input calculations of Reference 11 has an effect on the ability to obtain good correlation of predictions. Until methods are devised for field collection of all weather and cloud data required in the calculations, the data must be expected to vary on the order of ± 20 percent.

None of the methods available led to satisfactory gust and overpressure predictions, and a compromise method was required to obtain satisfactory results. In view of the higher speeds of test aircraft in this operation, the closure rates of the shock wave and the aircraft are a critical consideration in the determination of position and time of shock arrival.

The capability of the aircraft, as determined in Reference 8, is conservative in its gust limitations, because of the use of a DMF of 2.0 compared to the measured DMF of 1.5. With white paint of 0.25 absorptivity, the thermal limitations of the aircraft are approximately the same as those of Reference 8. With a lower absorptivity paint, such as the Vita-Var PV-100 used during REDWING, the thermal limitations are reduced, and the delivery capability of the aircraft is increased.

The aircraft engines are not limiting in the determination of aircraft-delivery capability.

Secondary structural items damaged during REDWING can be replaced or changed to eliminate the occurrence of such damage due to the thermal radiation.

6.2 RECOMMENDATIONS

It is recommended that the B-66 Weapons Delivery Handbook incorporate the results of REDWING in its calculations to extend the delivery capabilities of the aircraft and to modify the methods used to calculate the aircraft responses.

Secondary structure components subject to damage from thermal exposure should be replaced by components capable of withstanding values of radiant exposure which can be expected under the delivery conditions outlined in Reference 8.

Studies of the problems of the prediction of inputs and effects should be continued, and arrangements should be made to measure all known items of the calculations for any future participation of weapons-effects aircraft.

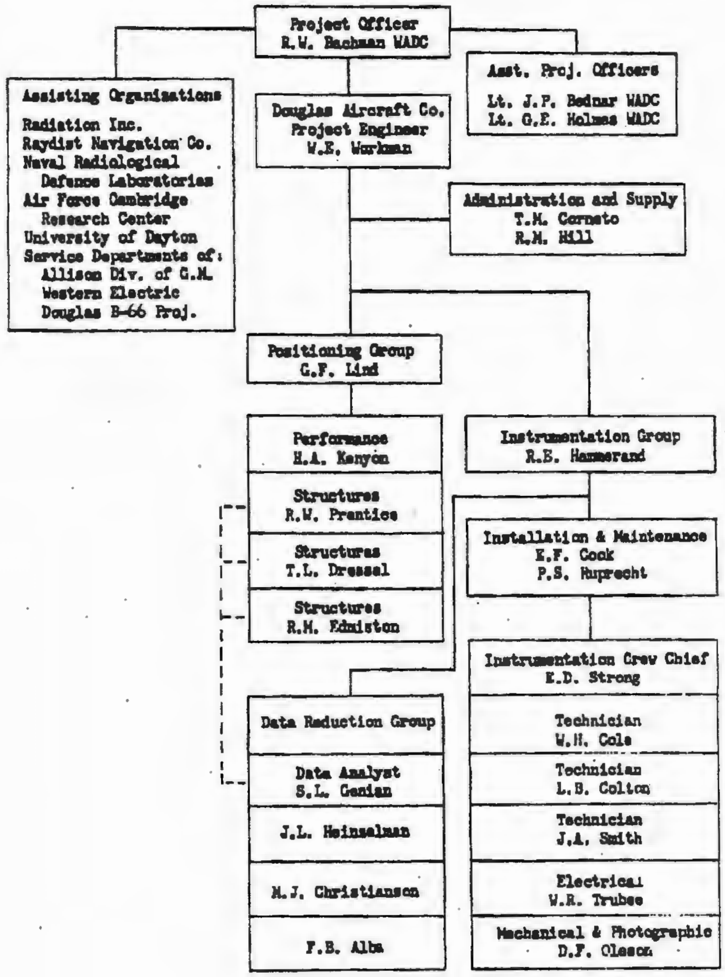
The B-66 aircraft should not participate in future tests of the nuclear-weapon-delivery capabilities of aircraft.

Specific study of the feasibility of any aircraft should begin in the design stage on future military aircraft, with specific emphasis on the elimination of secondary structure components which could limit the delivery capabilities of the aircraft.

The data collected by Project 5.3 should be utilized in the determination of design criteria of future military aircraft and in laboratory studies of aircraft structural responses to gust and thermal inputs.

APPENDIX A

PROJECT ORGANIZATION



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APPENDIX B

ERRATA

Information regarding best estimates of yield was utilized by Project 5.3 to calculate postshot inputs. Because radiometer results were readily available to the project prior to yield estimates based upon fireball photography or radio-chemical results, postshot predictions in this preliminary report were computed from average values of time to second maximum thermal irradiance records for Projects 5.1 through 5.6 aircraft. These preliminary values used by the project and the final field estimates released by Task Group 7.1 for the yields of the various devices are tabulated below.

Actual yields released by Task Group 7.1 were not incorporated in theoretical calculations because all preliminary report computations were complete and rollup operations did not permit time for extensive revisions after the firm field data on yields became available.

It may be noted that the difference in yields is not great except for Tewa and Huron. Since these were the last two shots and because only preliminary data subject to final reduction, analysis, and correlation is used in this preliminary report, yield variations will not invalidate the conclusions and recommendations as stated in Chapter 6.

SHOT	ACTUAL YIELD ESTIMATES (Based on time to second maximum thermal irradiance)	ACTUAL YIELD (Released by TG 7.1 in the forward area)
Lacrosse	(b)(3)	
Cherokee		
Zuni		
Erie		
Flathead		
Inca		
Dakota		
Mohawk		
Apache		
Navajo		
Tewa		
Huron		

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REFERENCES

1. Linnell, Richard D., et. al.; The Effects of Atomic Explosions on Aircraft, Volumes I through VII, MIT; January 1953; Wright Air Development Center Technical Report No. 52-244; SECRET-RD.

2. Blast Effects on Inflight Aircraft; November 1952; WADC; Project 6.10 Operation IVY; WT-638; SECRET-RD.

Thermal Effects On a B-47B Aircraft in Flight; March-May 1954; WADC; Project 6.2b, Operation CASTLE; WT-926; SECRET-RD.

3. Blast and Thermal Effects on a B-36 in Flight; March-May 1954; WADC; Project 6.2a, Operation CASTLE; WT-925; SECRET-RD.

4. Atomic Weapon Effects on a B-50 Type Aircraft in Flight; March-June 1953; WADC; Project 5.2, Operation UPSHOT-KNOTHOLE; WT-749; SECRET-RD.

5. Blast Effects on B-36 Type Aircraft in Flight; March-June 1953; WADC; Project 5.3, Operation UPSHOT-KNOTHOLE; WT-750; SECRET-RD.

6. Destructive Loads on Aircraft in Flight; February-May 1955; WADC; Project 5.1, Operation TEAPOT; ITR-1132; SECRET-RD.

7. Structural Response of F-84F Aircraft in Flight; February-May 1955; WADC; Project 5.2, Operation TEAPOT; ITR-1133; SECRET-RD.

8. Model B-66B Special Weapons Delivery Study, Volume I and II; 6 July 1955; DAC Report No. LB-21824; SECRET-RD.

9. Alexander, J. R.; A Modified "alpha" Method for Computation of Overpressure and Overpressure Envelopes; May 1955; WADC Technical Note WCLS-55-13; SECRET-RD.

10. Ledsham, F. C., and H. H. M. Pike; The Effect of Atmospheric Variations on the Propogation of Blast Waves to High Altitudes, British Ministry of Supply Armament Research Establishment Report 31/50; January 1951.

11. Chapman, R. M., and M. H. Seavey; Preliminary Report of the Attenuation of Thermal Radiation from Atomic or Thermonuclear Weapons; November 1955; Air Force Cambridge Research Technical Report TN-54-25; SECRET-RD.

12. Positioning Handbook for Operation REDWING; 16 March 1956; DAC Report No. LB-22382; SECRET-RD.

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