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Raytheon

PATRIOT STOCKPILE RELIABILITY LIMITED LIFE COMPONENTS TEST AND EVALUATION

STORAGE/AGING TEST PLAN FOR THE TRAVELING WAVE TUBE (P/N 11448369)

BR-17319, REV B
SEPTEMBER 1990

Contract No.: DAAH01-89-G-0008/0004

92-23531

MISSILE SYSTEMS DIVISION
Bedford, Massachusetts

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Prepared by
Thomas Wein, Principal Engineer,
MSL Product Assurance
Raytheon Company

Reviewed by;

James Mills
Manager, Parts Engineering,
Patriot PMO PA
Raytheon Company

Vernon O. Chance
APM For Product Assurance
and Test
Patriot Project Office
SFAE-AD-PA-PT

Donald Fradette
Acting Manager, Patriot PMO PA
Raytheon Company

Tony A. Branyon
Chief HIMADS Branch
MICOM Product
Assurance Directorate
AMSMI-QA-RA-HM

Prepared by
RAYTHEON COMPANY
MISSILE SYSTEMS DIVISION
Bedford, Massachusetts

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

APPENDIX A
INVENTORY OF PATRIOT MISSILE TRAVELING WAVE TUBE (APN 11448369)

LIST OF ILLUSTRATIONS

LIST OF TABLES

1. INTRODUCTION

1.1 Purpose

The purpose of this storage/aging program is to determine the nonoperating storage life expectancy of the TWT when assembled into a fielded Guided Missile.

1.2 Description

The TWT power amplifier (APN 11448369, Raytheon and Litton designations QKW-1994 and L5718 respectively) is an integral part of the Patriot Missile transmitter (APN 11459538) which is located within the Terminal Guidance Section (TGS) of the missile. It is used to amplify the pulse track-via-missile (TVM) signal and to provide for transmission of missile status parameters during missile flight.

The quantities produced or to be produced by each vendor by serial number blocks and Buy number are shown in Table 1-1. Also given in the table are the major process and design changes, and what TWTs are affected.

TABLE 1-1 - QUANTITY OF TWTs MANUFACTURED SORTED BY BUY, SERIAL NUMBER AND MANUFACTURER

Buy	S/N Block	Quantity by Vendor				Process Changes by Vendor		
		Litton	Raytheon	AEG	Total	Vendor	S/N Effectivity	Description
1	590XXX	76	72	0	148	Litton	590079-590081, & 590108	Ring-loop material not blanked at Litton
						Litton	590088-590091, 590093 & 590094	Output coupler part not standard
2	600XXX	0	86	0	86			
3	610XXX	137	91	0	228			
4	620XXX	160	63	0	223	Litton	>620020	Support rods rotated 20 deg
						Raytheon	620200 & above	Helix wire changed from moly to tungsten
	625XXX	21	58	0	79	Raytheon	625050 & above	Heater wire changed from moly-nickel to tungsten-nickel
5	630XXX	130	87	0	217			
	640XXX	145	97	0	242	Raytheon	640050 & above	Window ceramic changed from beryllia to alumina.

TABLE 1-1 - QUANTITY OF TWTs MANUFACTURED SORTED BY BUY, SERIAL NUMBER AND MANUFACTURER (Continued)

Buy	S/N Block	Quantity by Vendor				Process Changes by Vendor		
		Litton	Raytheon	AEG	Total	Vendor	S/N Effectivity	Description
6	650XXX	92	166	0	258			
	660XXX	160	211	0	371	Raytheon	660020 & above	New laser welder for cathode struts (May 1986) (weld pull tests and inspections initiated November 1985)
7	670XXX	185	191	0	376			
	680XXX	141	197	0	338			
8	720XXX	243	102	70	415			
	730XXX	254	111	70	435			
9	740XXX	199	85	182	466	Raytheon	740305 & above	Cathode spray changed from CP double carbonate to non-CP triple carbonate.
	750XXX	189	81	188	458			
10	760XXX	278	123	128	529	Raytheon	760560 & above	Gun potting process changed to Dow 1200 primer and Sylgard 186/184 potting.
	770XXX	176	72	262	510			
11	780XXX/790XXX	381	163	390	934			
12	800XXX/810XXX	374	160	390	924			
	Totals	3341	2216	1680	7237			

1.3 Performance Requirements

The TWT is required to meet all its performance requirements following a 3.3 second preheat/turn-on cycle, given dormant storage was the Guided Missile's prior status. The storage temperature range is -50°F to +150°F and the operating temperature range is -30°F to 130°F. The purpose of this storage/aging program is to determine when the TWTs shall be changed out to avoid potentially unacceptable performance degradation.

2. APPLICABLE DOCUMENTS

Documents applicable to the storage/aging test program under consideration are listed below. The latest revision of each document is applicable.

2.1 Drawings

MICOM/Army

11448369	Missile Traveling Wave Tube

2.2 Specifications

MICOM/Army

MIS-23260	Signature Characteristics
MIS-28636	Purchase description for the Missile Traveling Wave Tube
T/RS-778780	Test Requirements Specification for Patriot MDAGS Downlink Transmitter
MI-CP-15035731 (Buys 1-4)	Prime Item Development Specification for Modular Digital Airborne Guidance Section
MI-CP-15035733 (Buys 5-7)	
MI-CP-15035735 (Buys 8-12)	

Part I
Military

MIL-STD-810	Environmental Test Methods
MIL-C-45662	Calibration System Requirements

3. TWT TEST ASSETS

3.1 Sources of TWT Test Assets

TWT assets are available from four sources. They are:

1) Missile Round Life Testing (MRLT)
2) Engineering Development (ED) missiles
3) TWTs purchased by the Army with each buy specifically for the storage program
4) TWTs from recertified missile rounds

3.2 Missile Round Life Testing

There are four MRLT missiles which have completed their planned environmental testing. One of these has been converted to a training missile and the TWT is with Raytheon's Microwave Power Tube Division. The tube was tested at MPTD on March 10, 1987 and found to be gaseous. It was gettered, retested and found to work satisfactorily. It was Fast Start tested again in May 1987, when it passed, and in September 1987, when it failed. Since then it has been measured for Gas Ratio along with the three ED TWTs approximately every three months. Its Gas Ratio has been increasing approximately linearly with time from 5.9 x 10-8 to 28.3 x 10-8 in March 1990. In between tests it is stored at room ambient conditions. This regime shall continue until such time that the Stockpile Reliability Working Group decides to end the testing.

The other three missiles, last tested in 1985 and passed all tests, will be stored at the Redstone Arsenal until the TWTs are 10 years old. The TWTs will be ten years old on May and September 1991. At ten years, a decision will be made by the government about either testing the TWTs at that time or to allow additional storage time to accumulate.

3.3 Engineering Development Missiles

There are three ED missiles that were stored for three years at different climatic regions (i.e., arctic, tropic, and arid). These missiles completed the storage program in 1986. They have been disassembled and the TWTs were sent to Raytheon Microwave and Power Tube Division for testing and storage. The tubes were tested for Gas Ratio and Fast Start Gain Variation during the period October through December 1986. They all met the FSGV specification. Since these initial tests the TWTs have been stored at room ambient conditions and had their Gas Ratio measured approximately every three months. To date the Gas Ratios have remained fairly constant. This regime will continue and the data reviewed until such time that the Stockpile Reliability Working Group decides otherwise.

3.4 Government Purchased Limited Life Items (Refer to Table 4-1)

The government is buying extra parts for the storage program in conjunction with the contractual buys for missile components. There are contracts to buy TWTs starting with Buy 4 through Buy 12 for a total of 255 pieces. The purchased parts will be from three vendors (Raytheon, Litton, and AEG). An effort will be made to include TWTs from each different design configuration and/or vendor in the storage/aging program.

3.5 Recertified Missiles

During fiscal year 1990, 203 transmitters are scheduled to be changed out at PMF's 1 and 2 because of limited life component expiration. Out of this group 110 transmitters shall be selected for this plan implementation. There are several conditions for selection as follows:

1) The TWTs shall be seven to eight years old as determined by the date of manufacture.
2) The selected tubes shall never have been activated since final sales testing.

3) One-half of the transmitters shall contain Raytheon TWTs and the other half Litton TWTs.

Before being removed from the forebodies at the PMFs, 80 (40 Litton and 40 Raytheon) units will have successfully undergone the standard functional PM-460 testing which includes fast start as the initial test. The remaining 30 transmitters (15 Litton and 15 Raytheon) will not be functionally PM-460 tested prior to removal from the forebody at the PMF but may undergo forebody continuity testing. These 30 transmitters will be returned to the PMSC for dormant RAC storage at Raytheon prior to testing.

4. TEST APPROACH

4.1 Two Prong Approach

This plan is composed of two separate evaluations. One for the non-deployed assets and one for the deployed tubes in transmitters. Each plan stands alone with its own schedule. Only the results of each study will be evaluated as a whole to determine the storage life of the Patriot TWT.

4.2 Government Purchased Assets (Nondeployed Tubes)

4.2.1 Test and Storage Schedule

The assets procured by the Government have been assigned to four separate Buy groupings. A portion of each grouping will be tested at 7, 12 and 17 years of age. At each test period, the previously tested tubes will be retested along with untested tubes. After testing, the tubes will be returned to their assigned environmental storage site. This approach allows a portion of each vendor's tubes to experience a dormant storage at environmental extremes of up to 17 years prior to testing. The vendor's TWT Acceptance Test Procedure (ATP) will serve as the initial test data point of reference. See Table 4-1, Planned TWT Testing Schedule for Government Furnished Assets.

The selection of the 7, 12, and 17 year time intervals reflects the revised surveillance and recertification testing intervals for the missile. Current stockpile reliability (surveillance) testing requires that approximately 34 missiles per missile category be tested during the 4 - 6 years of age timeframe. Recertification testing will be performed at approximately 10 years followed by a second stockpile reliability test during the 14 - 16 years of age timeframe.

4.2.2 Storage Sites

The two storage sites shall represent the two environmental temperature extremes at which the missile may be deployed. The cold site is the U.S. Army Cold Regions Test Center, Fort Greely, Alaska. The hot site is Dugway Proving Grounds, Utah.

The storage sites shall provide component storage either in a modified missile canister or in a temperature uncontrolled building. The temperature and relative humidity diurnal cycle for both the canister and the building will be recorded every four (4) hours at a minimum. The recorded data will be transmitted to MICOM Product Assurance Directorate on a monthly basis. The monitoring equipment will be under a calibration system per MIL-C-45662.

At a minimum, a sample of TWTs from Buys 4 - 6 will be stored in one of the modified missile canisters at each site. A listing of all currently available TWT assets, their current storage location and intended use is detailed in Appendix A.

4.3 Test Plan for Government Purchased Assets

Each Buy group of TWTs will undergo the electrical tests of Table 4-2.

The Viewing RF Output Sweep (4.3.4) and Emission Slump Measurement (4.3.12) tests are not presently part of the TWT specification but are included based on a recommendation by the Limited Life Components, Electron Tubes, Working Group, as measurements useful in detecting degradation. All testing shall be performed at room ambient conditions except the Altitude Test.

4.3.1 Prescribed Order of Testing

See Table 4-2, Prescribed Order of Testing.

TABLE 4-1 - LIMITED LIFE COMPONENT TEST PLAN FOR PATRIOT TRAVELLING WAVE TUBE (TWT)
(AS OF: 15 AUGUST 1990)

Buys	Year of Mfg	Group #	Total Tubes	MFGR	# Tubes	Quantity Tested At Approx. Age (yrs) 7	13	17	Year of Test 1992 RSA	1992 Cold	1994 Hot	1994 Cold	1996 Hot	1996 Cold	1998 Hot	1998 Cold	2000 Hot	2000 Cold	2002 Hot	2002 Cold	2004 Hot	2004 Cold	2006 Hot	2006 Cold	2008 Hot	2008 Cold	Test Summary RSA Hot	RSA Cold	Sub Total	On Hand Test Assets RSA	Hot	Cold	Required From Previously Fielded Assets	Need To Be Shipped To Hot	Cold
4-6	84-86	I	12	MPTD	6	6	6*	6*	3	3					3	3			3	3							9	9	18	3	2	1	3	1
				Litton	6	6	6*	6*	3	3					3	3			3	3							9	9	18	3	3	0	3	0
		II	12	MPTD	6		6	6*							3	3			3	3							6	6	12	2	2	2	3	1
				Litton	6		6	6*							3	3			3	3							6	6	12	3	2	1	3	1
		III	24	MPTD	12			12											6	6							6	6	12	2	2	8	6	4
				Litton	12			12											6	6							6	6	12	2	2	8	6	4
7-8	86-88	I	12	MPTD	6	6	6*	6*			3	3					3	3			3	3					9	9	18	3	3	0	3	0
				Litton	6	6	6*	6*			3	3					3	3			3	3					9	9	18	3	3	0	3	0
		II	12	MPTD	6		6	6*									3	3			3	3					6	6	12	3	3	0	3	0
				Litton	6		6	6*									3	3			3	3					6	6	12	3	3	0	3	0
		III	24	MPTD	12			12													6	6					6	6	12		2	10	8	4
				Litton	12			12													6	6					6	6	12	1	8	3	6	2
9-10	88-90	I	18	MPTD	6	6	6*	6*					3	3					3	3			3	3			9	9	18	2	3	1	3	0
				Litton	6	6	6*	6*					3	3					3	3			3	3			9	9	18	5	1	0	3	2
				AEG	6	6	6*	6*					3	3					3	3			3	3			9	9	18	4		6	3	3
		II	18	MPTD	6		6	6*											3	3			3	3			6	6	12	2	3	6	3	0
				Litton	6		6	6*											3	3			3	3			6	6	12	6		0	3	3
				AEG	6		6	6*											3	3			3	3			6	6	12			12	3	3
		III	24	MPTD	6			6*															3	3			3	3	6			6	3	3
				Litton	6			6*															3	3			3	3	6	6		0	3	3
				AEG	12			12*															6	6			6	6	12			12	6	6
11-12	90-92	I	18	MPTD	6	6	6*	6*							3	3					3	3			3	3	9	9	18			6	3	3
				Litton	6	6	6*	6*							3	3					3	3			3	3	9	9	18			6	3	3
				AEG	6	6	6*	6*							3	3					3	3			3	3	9	9	18			6	3	3
		II	18	MPTD	6		6	6*													3	3			3	3	6	6	12			6	3	3
				Litton	6		6	6*													3	3			3	3	6	6	12			6	3	3
				AEG	6		6	6*													3	3			3	3	6	6	12			6	3	3
		III	24	MPTD	6			6*																	3	3	3	3	6			6	3	3
				Litton	6			6*																	3	3	3	3	6			6	3	3
				AEG	12			12*																	6	6	6	6	12			12	6	6
Subtotals			132	MPTD	84	24	48	84	3	3	3	3	3	3	9	9	6	6	18	18	18	18	9	9	9	9	78	78	156	17	0	20	47	42	22
				Litton	84	24	48	84	3	3	3	3	3	3	9	9	6	6	18	18	18	18	9	9	9	9	78	78	156	32	0	22	30	42	20
				AEG	48	12	12	12	0	0	0	0	3	3	3	3	0	0	6	6	6	6	12	12	12	12	42	42	84	4	0	0	44	24	24
Totals					216	60	60	96	6	6	6	6	9	9	21	21	12	12	42	42	42	42	30	30	30	30	198	198	396	53	0	42	121	108	86

Note: * Indicates That Tubes From This Group Are Being Retested at This Time Interval.

17319

FW-1qp

TABLE 4-2 - PRESCRIBED ORDER OF TESTING

Test Sequence	Test Description	Details Paragraph	MIL-28636 Paragraph	
			Requirements	Test
1	Missile-Status-Parameters Low Level Storage Life	4.3.2	3.2.1.3.2.1.a	4.3.2.4.1, 4.3.1.6
2	Track-Via-Missile Low Level Storage Life	4.3.3	3.2.1.3.2.1.b	4.3.2.4.1 4.3.1.6
3	Viewing RF Output Sweep	4.3.4	N/A	4.3.1.2
4	Pulse Amplitude Droop	4.3.5	3.2.1.3.3.6	4.3.1.2
5	Burst Droop	4.3.6	3.2.1.3.3.7	4.3.1.2
6	Intermodulation Distortion	4.3.7	3.2.1.3.3.5	4.3.1.5.b
7	Linear Gain	4.3.8	3.2.1.3.3.1	4.3.1.5.b
8	RF Output at Saturation	4.3.9	3.2.1.3.4.1	4.3.1.4.b
9	Body Current Measurements for Linear Power Mode	4.3.10	3.2.1.2.5	4.3.1.2
10	Body Current Measurements for MSP (Saturated) Power Mode	4.3.11	3.2.1.2.6	4.3.1.4.d
11	Emission Slump Measurement	4.3.12	3.2.1.2.2.2	4.3.1.5.c
12	H.V. Breakdown at Altitude	4.3.13	3.2.1.2.14	N/A
13	RF Breakdown at Altitude	4.3.14	3.2.1.3.9	4.3.1.4.c,d,e

4.3.2 Missile Status Parameters (MSP) Low Level Storage Life Test

The TWT shall be operated in its linear gain region in the MSP mode after application of its decal fast start voltages. The decal voltages and the correct RF Input to produce an RF output equal to 2.14 P_o + 0.0 dB, -2.0 dB, at a frequency of F8 + 430 at the maximum MSP duty cycle, shall be set up without any electrical connections to the tube under test. The required RF Input to produce an output of 2.14 P_o + 0.0 dB, -2.0 dB shall be obtained from the TWT's ATP (acceptance test procedure) data. See Figure 4-1 for the linear gain box. At 3.3 plus or minus 0.1 sec from initial filament voltage application, introduce the MSP burst pulse to the TWT five times at a frequency of F8 + 430 with the output power set at 1.2 P_o plus 0.0 dB minus 2.0 dB. The individual 1.5 PW2 pulse droop shall be NGT 0.5 dB by the fifth burst, and thereafter. Power gain measurements shall be made at the following times after the application of the fast start voltages:

T_o plus 3.3 ± 0.1 sec (T_o is when voltage is applied)
T_o plus 5.9 ± 0.1 sec
T_o plus 20.0 ± 1.0 sec
T_o plus 60.0 ± 1.0 sec

The tube shall be kept operating and at 180 ± 1.0 sec after the application of the fast start voltage (T_o plus 180 ± 1 sec) another gain measurement shall be made. This measurement shall be the reference gain.

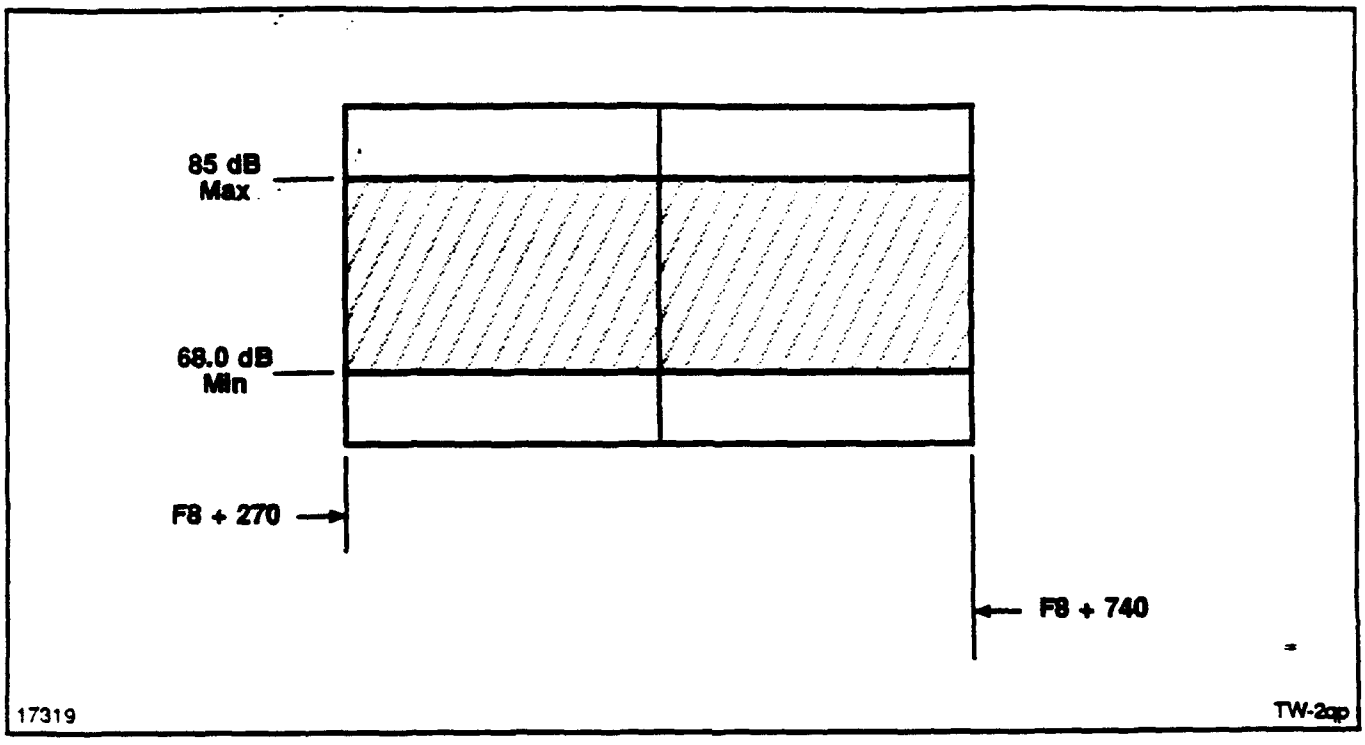


Figure 4-1 - Linear Gain Box

The difference between the first measurements and the reference shall be calculated. These deltas shall be within the following limits:

Time (sec)	Limits (dB)
T_o plus 3.3	+2, -4
T_o plus 5.9	+2, -4
T_o plus 20	+0.75, -2
T_o plus 60	+0.5, -1.2

The gain region variation box limits are shown in Figure 4-2.

4.3.3 Fast Start and Track Via Missile (TVM) Low Level Storage Life Test

The decal voltages and the correct RF Input to produce an RF Output equal to 2.14 P_o +0.0 dB, -2.0 dB at a frequency of F8 + 430 at the maximum TVM duty cycle shall be set up without any electrical connections to the tube under test. The required RF Input to produce an output of 2.14 P_o +0.0 dB, -2.0 dB shall be obtained from the TWTs ATP data.

The fast start sequence is as follows:

T_o = 0 sec. High level preheat heater voltage on.
T_o plus 2.2 + 0.1/-0.02 sec Heater voltage reduced to steady state value.
T_o plus 5.93 + 0.01/-0.1 sec Beam pulsing begins.

Power gain measurements shall be made at the following times after the application of the fast start voltages:

T_o plus 5.9 ± 0.1 sec (T_o is time voltage applied)
T_o plus 20.0 ± 1.0 sec
T_o plus 60.0 ± 1.0 sec

The tube shall be kept operating and at 180 ± 1.0 sec after the application of the fast start voltages (T_o plus 180 ± 1 sec), another gain measurement shall be made. This measurement shall be the reference gain.

The difference between the first measurements and the reference shall be calculated. These deltas shall be within the following limits.

Time (sec)	Limits (dB)
T_o plus 5.9	+2.0, -4.0
T_o plus 20.0	+0.75, -2.0
T_o plus 60.0	+0.5, -1.2

The gain region variation box limits are shown in Figure 4-2. The individual pulse and burst droop shall not exceed 0.5 dB.

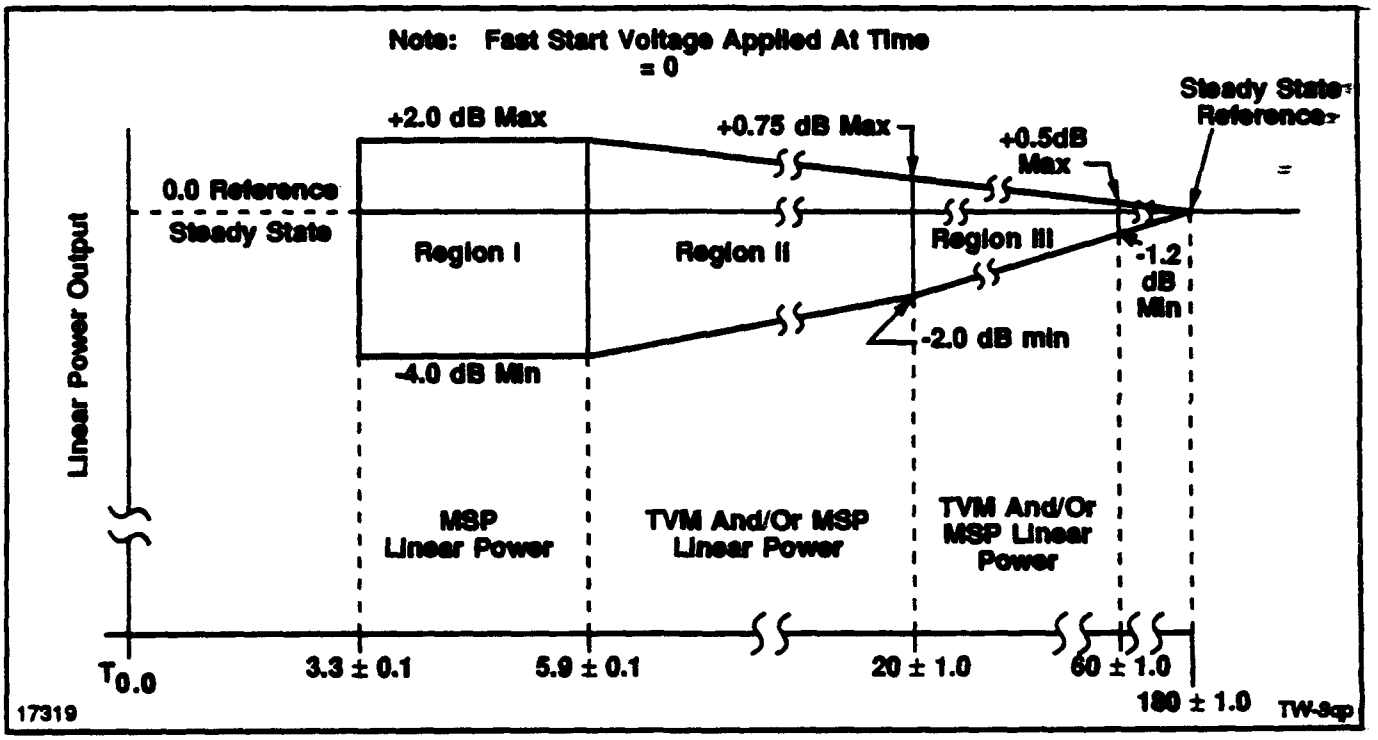


Figure 4-2 - MSP/TVM Fast Start Gain Region (Power) Variation Box

4.3.4 Viewing RF Output (Linear Mode)

Set-up the TWT to the nominal nameplate parameters and the following waveform parameters per paragraph 4.3.1.2 of MIS-28636:

Pulsewidth	6 PW1
Burstwidth	PW8
Pulse Repetition Interval	1.05 PW2
Burst Repetition Interval	10 PW7
Frequency	F8+430

A memory oscilloscope shall be attached to the RF output. The output waveform shall be viewed with the output power not less than 2.14 P_o. The output trace shall be sharp with the amount of distortion not greater than 0.5 dB.

4.3.5 Pulse Amplitude Droop (Linear Mode)

Set up the TWT to the nominal nameplate parameters and to the following waveform parameters:

Pulsewidth	6 PW1
Burstwidth	PW8
Pulse Repetition Interval	1.05 PW2
Burst Repetition Interval	10 PW7
Frequency	F8+430

The pulse amplitude droop shall be not greater than 0.5 dB over any six PW1 pulse from 0.0 P_o to 2.14 P_o. See Figure 4-3.

4.3.6 Burst Droop (Linear Mode)

Set up the TWT to the nominal nameplate parameters and to the following waveform parameters:

Pulsewidth	6 PW1
Burstwidth	PW8
Pulse Repetition Interval	1.05 PW2
Burst Repetition Interval	10 PW7
Frequency	F8+430

The individual burst amplitude droop shall not be greater than 0.5 dB over any PW8 burst at: 1) Any pulse repetition interval between 0.52 PW4 and PW2 and 2) A burst repetition interval of 50 PW7 or 70 PW7 at 2.14 P_o +0.0 dB, -2.0 dB. See Figure 4-3.

The change in droop between any bursts shall not exceed 0.2 dB over the final 0.75 x PW8 period of the burst, at 2.14 P_o +0.0 dB, -2.0 dB. See Figure 4-3.

4.3.7 Intermodulation Distortion

Apply to the TWT the decal voltages and the waveforms as defined in paragraph 4.3.1.5b of MIS-28636.

The intermodulation distortion shall not be greater than -15.5 dB for output power ranging from 0.0 P_o to 2.14 P_o minimum for all frequencies of:

f_8 + 280	f_8 + 340
f_8 + 430	f_8 + 520
f_8 + 610	f_8 + 730

For graphic definition see Figure 4-4. Run test at 2.14 P_o +0.0 dB, -2.0 dB.

4.3.8 Linear Gain

Apply to the TWT the decal voltages and the waveforms specified in the test conditions of paragraph 4.3.1.3 as modified by paragraph 4.3.1.5b of MIS-28636. Test at all the following frequencies:

f_8 + 280	f_8 + 430
f_8 + 340	f_8 + 610
f_8 + 520	f_8 + 730

Measure the linear gain at power output level of 2.14 P_o +0.0 dB, -2.0 dB. The gain limits shall be 68.0 dB to 85.0 dB. The gain box limits are shown in Figure 4-2.

4.3.9 RF Output at Saturation (MSP Mode)

Apply to the TWT the decal voltages and the waveforms of paragraph 4.3.1.4 of MIS-28636. Test at all the following frequencies:

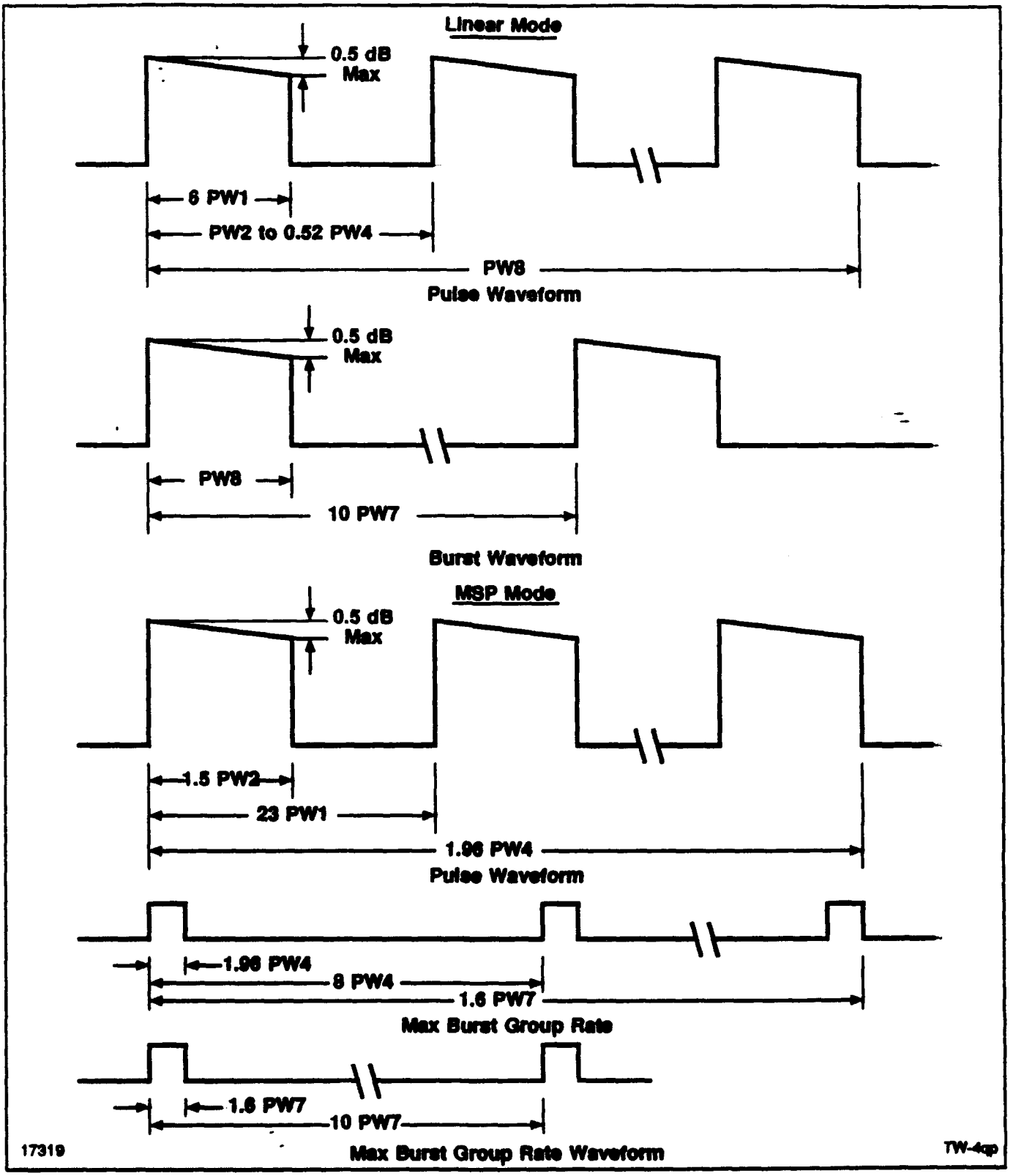


Figure 4-3 - RF Waveforms

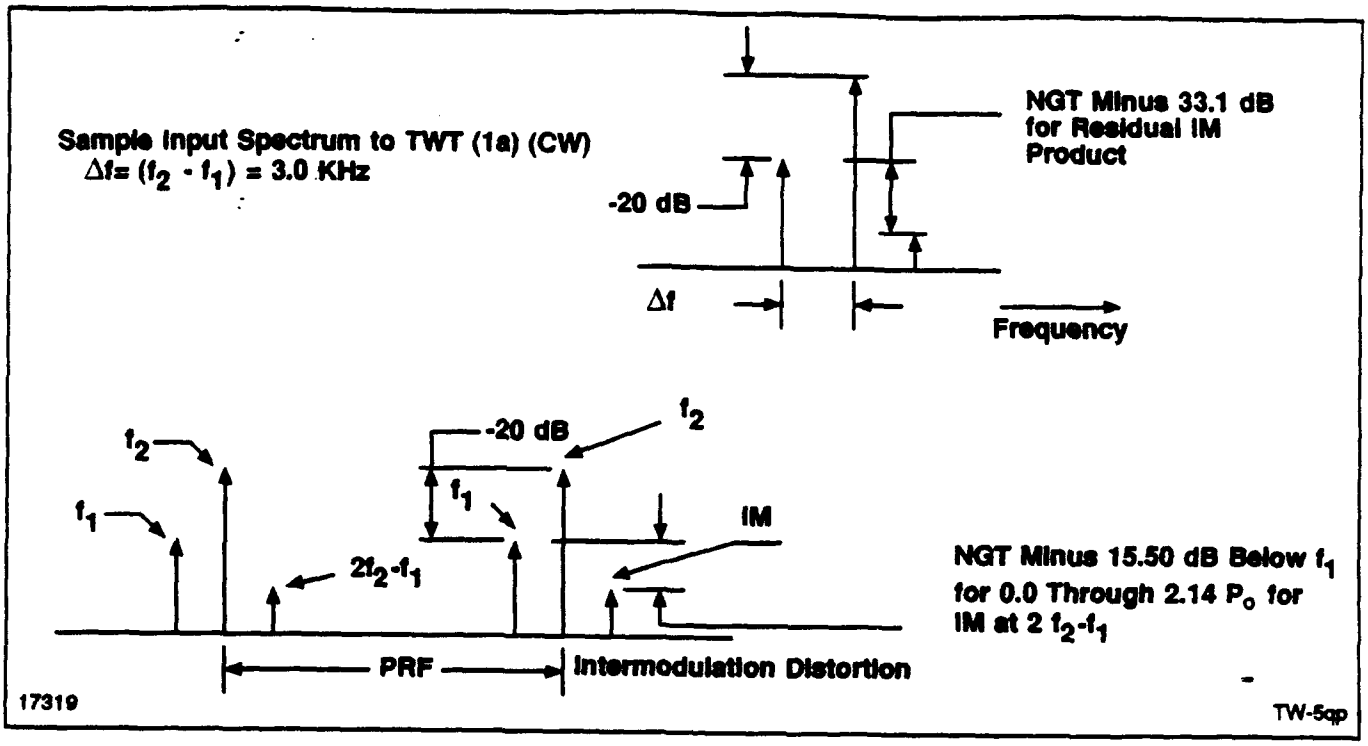


Figure 4-4 - Intermodulation Distortion Definition

$f_8 + 280$	$f_8 + 430$
$f_8 + 340$	$f_8 + 610$
$f_8 + 520$	$f_8 + 730$

The tube shall be driven until maximum full saturated output power is reached. The maximum full saturated output power shall be NLT 12 P_o and NGT 20 P_o. P_{dsl}, P_{ds}, and P_{ds2} as defined in Figure 4-5, shall be recorded.

4.3.10 Body Current Measurements for Linear Power Mode

Operate the TWT with its decal voltages and the waveforms for the linear mode as defined in paragraph 3.2.1.2.12.1 of MIS-28636. Also, see Figure 4-3, RF Waveforms. The output power shall be 4.0 P_0 ±1 percent during this measurement.

During the above conditions, i_b, peak body current, shall be greater than 190 mA. The average body current, i_{b1}, as defined in Figure 4-6, Burst Width Linear Mode, shall not be greater than 110 mA.

4.3.11 Body Currents Measurements for MSP (Saturated) Power Mode

Operate TWT with its decal voltages and the waveforms for the MSP mode as defined in paragraph 3.2.1.2.12.1 of MIS-28636. Also, see Figure 4-3, RF Waveforms. Also the collector shall be depressed to 45 percent of E_b.

During the 1.96 PW4 burst width i_b, peak body current, shall not be greater than 350 mA and i_{b2}, the average body current during a single MSP burst, shall not be greater than 266 mA.

4.3.12 Emission Slump Measurement

The TWT shall be operated at a PRF of 1 KHz in the general test mode of 3.2.1.2.12.2 of MIS-28636 except the pulse width shall be between 2.0 and 2.75 μsec. The peak collector current plus the peak body current shall not be greater than 0.95 A.

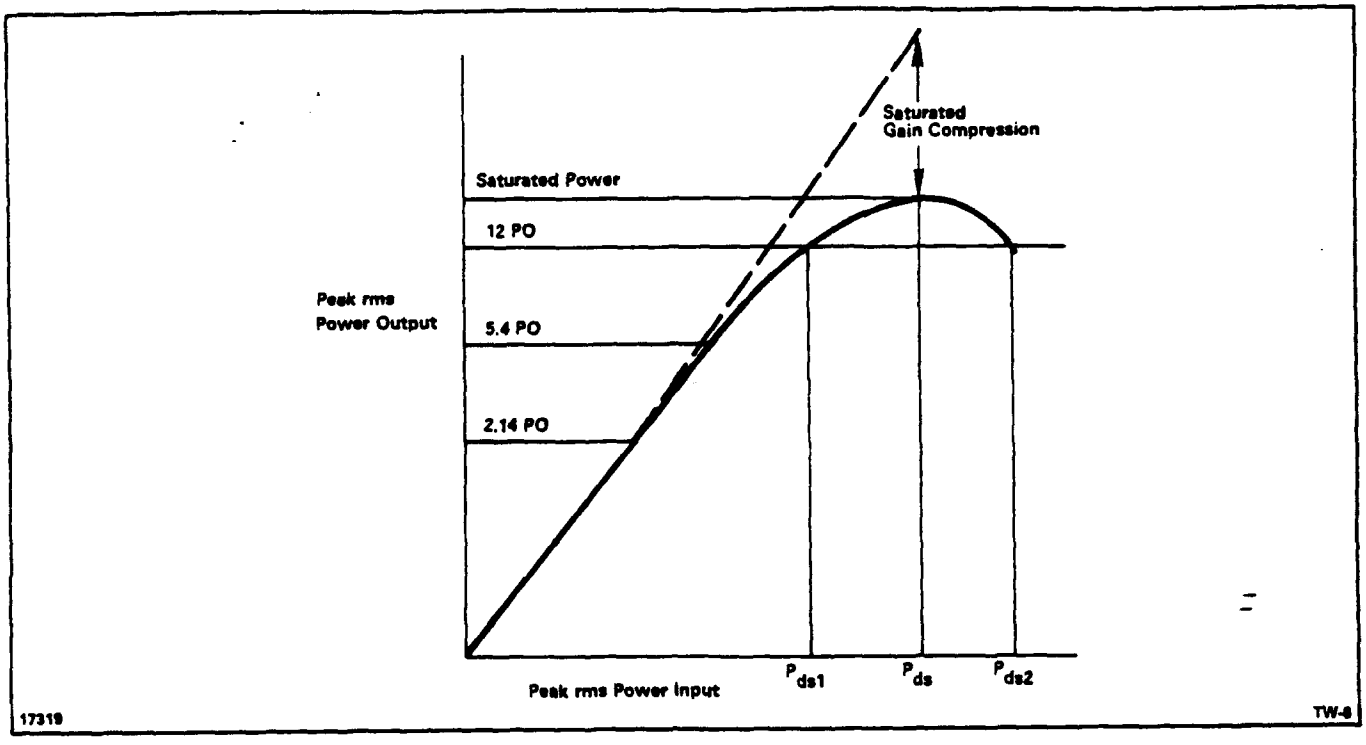


Figure 4-5 - Peak rms Output Power versus Peak rms Input Power

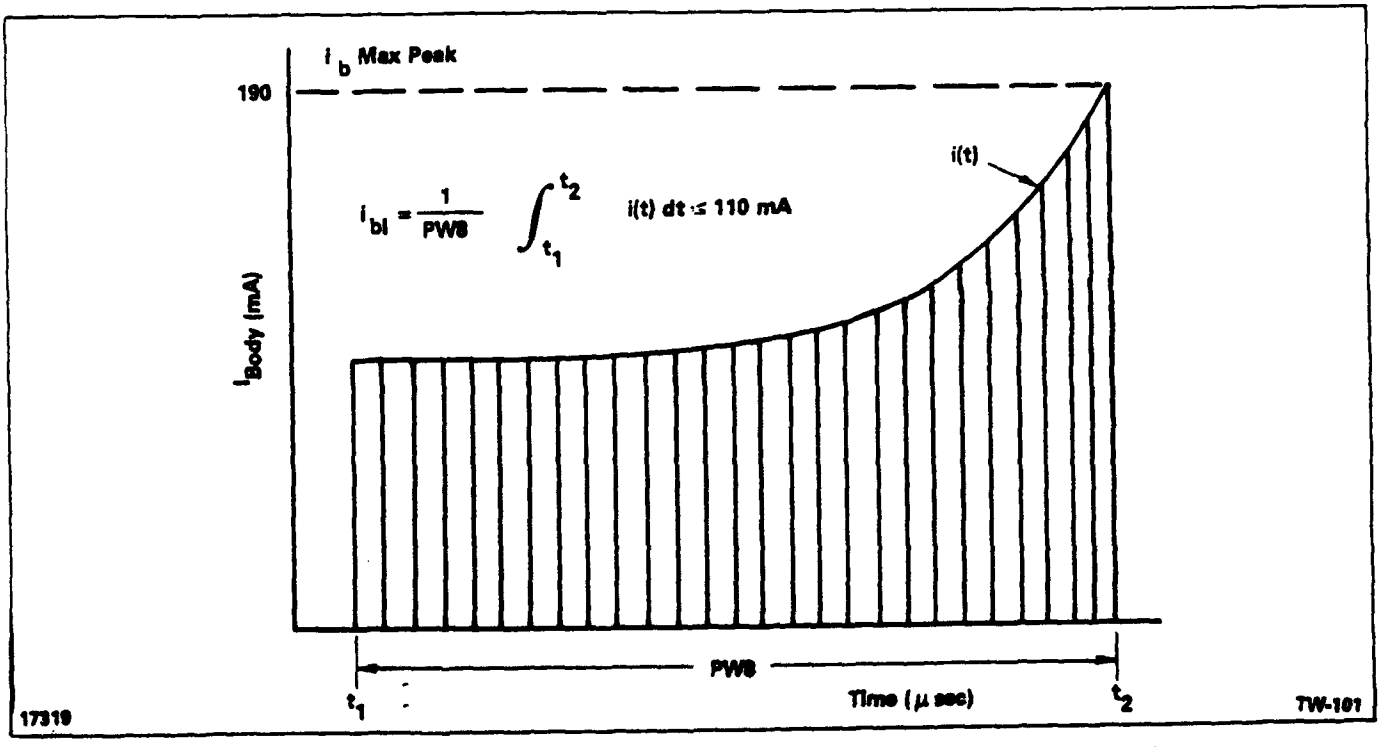


Figure 4-6 - Burst Width Linear Mode

The heater voltage, Eh, shall be set in order to 6.6 V, 6.3 V, 6.0 V, 5.5 V, 5.0 V, 4.5 V, and 4.0 V. The minimum time at each voltage shall be one minute or until a stable beam current, Ik, is obtained and recorded. Eh versus IK shall be plotted. A line shall be drawn through the first three measurements. From the last five measurements, a line shall be drawn through the two consecutive measurements with the greatest difference in Ik. The intersection of these two lines must be at an Eh not greater than 5.25 V.

4.3.13 High Voltage (dc) Breakdown at Altitude

The tube under test shall be brought to an altitude of 0.6 Alt ± 0.03 Alt. A voltage of 10.0 kVdc ± 0.2 kVdc shall be applied to each cathode, grid and heater lead for a minimum time of 180 sec. The leakage current shall not be greater than 10 μA for each lead.

At the same altitude, 10.0 kVdc ± 0.2 kVdc shall be applied to the collector lead for a minimum of 180 sec. The leakage current shall not be greater than 50 μA. Next 3.0 kVdc ± 0.06 kVdc shall be applied to the collector lead for a minimum of 180 sec. The leakage current shall not be greater than 10.0 μA.

4.3.14 RF Breakdown at Altitude

The tube shall be brought to an altitude of Alt 2 plus 0, minus 7 percent. It shall soak at this altitude for a period of 10 min plus or minus 0.1 min followed by heater preheat for 3 min plus or minus 0.1 min.

The tube shall then be operated at the maximum Missile System Parameters (MSP) duty cycle and saturated power levels for not less than 2 min at this altitude. Next, the tube will be operated in the above conditions while the external pressure is increased linearly within 30 sec ± 1 sec to 0.5 Alt 2 to 0.6 Alt 2. The tube will be held operating in this range for a minimum of 180 sec.

The tube shall not exhibit any breakdown or arcing.

For this test, the tube shall be operated with decal voltage applied and with drive power to achieve saturated power that is not less than 12 P_O and not greater than 20 P_O. The waveform requirements are per paragraph 3.2.1.2.12 of MIS-28636. The frequencies to be used are f_8 + 280, f_8 + 340, f_8 + 430, f_8 + 520, f_8 + 610 and f_8 + 730.

4.4 Transmitters from Recertified Missiles (Deployed Assets)

4.4.1 Disposition of Returned Transmitters

One hundred and ten transmitters returned to Raytheon from the Patriot Missile Facilities (PMFs) due to shelf life expiration, are scheduled to be tested under this test plan. The 110 transmitters have been broken down into two groups of 80 and 30 transmitters respectively.

The 80 transmitters will be identified by Raytheon as they are received at the Patriot Missile Support Center (PMSC) for recertification under the R&R program. These 80 transmitters will contain an equal number, 40 each, of Raytheon MPTD and Litton TWTs. These transmitters will immediately undergo testing per Subsection 4.4.2 of this test plan.

The remaining 30 transmitters will be identified by missile and transmitter serial numbers prior to their testing at the PMF. Raytheon shall provide the serial number information to MICOM PAD for their coordination with MLC and PMFs to ensure that the designated forebodies are not functionally PM-460 tested at the PMF prior to the transmitter's removal and return to PMSC. These 30 transmitters will contain an equal number, 15 each, of Raytheon MPTD and Litton TWTs. Upon their receipt at PMSC, the transmitters will accumulate additional RAC storage time. Ten transmitters, containing five TWTs from each vendor, will undergo testing per Subsection 4.4.2 of this test plan at time intervals corresponding to approximately eight, nine and ten years from the date of initial TWT ATP.

The returned transmitter testing sequence and schedule is summarized in Table 4-3.

TABLE 4-3 - RECERTIFICATION TRANSMITTER/TWT TESTING SCHEDULE

TWT Vendor	Quantity Transmitters	PM460 Testing	Year of LET on Transmitter	Year of ATP on TWT	Year of Tear Down on TWT
Litton	30	Yes	1990	N/A	N/A
	10	Yes	1990	1990	1990
	5	No	1991	1991	1991
	5	No	1992	1992	1992
	5	No	1993	1993	1993
Raytheon	30	Yes	1990	N/A	N/A
	10	Yes	1990	1990	1990
	5	No	1991	1991	1991
	5	No	1992	1992	1992
	5	No	1993	1993	1993

4.4.2 Test Plan for Returned Transmitters

4.4.2.1 Visual Examination

Upon receipt of the transmitters, Raytheon shall visually inspect them for any evidence of mechanical damage or physical changes such as corrosion and cracked insulation. Record and photograph all faults in color.

4.4.2.2 Functional Electrical Tests at Room Ambient Conditions

These tests shall consist of all of the Quality Conformance Inspection tests of Table III of the Transmitter Test Requirements Specification. The tests are listed in Table 4-4.

TABLE 4-4 - PRESCRIBED ORDER OF TRANSMITTER TESTING

Test Sequence		Test Description	T/RS-778780 Reference Paragraph
A	B		
1	3	Low Level Linear Gain	4.6.2
2	4	Saturated Output Power	4.6.7
3	5	Low Level MSP Mode Pulse Droop	4.6.7
4	6	Linear Mode Pulse Characteristics	4.6.3
5	7	Linear Mode Burst Droop	4.6.4
6	8	Coupled Power Level	4.6.5
7	9	Peak Limiter Power	4.6.11
8	10	Insertion Loss	4.6.12
9	1	Fast Start Gain Variation, Linear Output Power, MSP Mode	4.6.8
10	2	Fast Start Gain Variation, Linear Output Power, TVM Mode	4.6.9

The A Sequence of these test is only for the first group of 80 transmitters. The B Sequence is for the 30 transmitters held an additional one, two, and three years.

4.4.2.3 Operational Five Cycle Temperature Extreme Test

Prior to the start of the Five Cycle Test measure the low level linear gain per paragraph 4.6.2 of the T/RS at f_8 + 500.

The temperature and time profile for given operational tests is shown in Figure 4-7 for one cycle. This operational cycle is to be performed four times in sequence. The operating conditions after each turn-on during the temperature cycle are as follows:

Sequence No.	Mode	Rate Bursts/ Sec. (max.)	Operating Time Sec. (max.)
1.	MSP	20 F7	3.5
2.	MSP	2 F7	170.0
3.	TVM 3	10 F7	3.0
4.	TVM 3	2 F7	33.0
5.	TVM 3	10 F7	12.0

There are two turn-on modes as follows:

1) Fast Start Turn On per paragraph 3.2.1.1.1.a. of the T/RS
2) Preheat Turn On per paragraph 3.2.1.1.1.b. of the T/RS

The specified temperatures for the first four cycles refer to the internal temperature of the chamber containing the transmitter.

After the above four cycles are completed a fifth profile is performed per Figure 4-8. This cycle takes about 5.25 hrs. The tests performed during this cycle are the functional tests per paragraphs 4.6.2, 4.6.3, 4.6.4, 4.6.5, 4.6.6, 4.6.7, 4.6.8, and 4.6.9 of the T/RS.

The temperature referred to in this cycle is the inverter temperature. Under any operating conditions the temperature measured at the inverter sense point shall be not less than minus 37°C and not greater than 66°C.

After each operational test period the transmitter shall be turned off until the temperature stabilizes back to the preoperational test temperature which is a 5 min minimum.

At the completion of the Five Cycle Test measure the Low Level Linear Gain per paragraph 4.6.2 of the T/RS at F8 + 500. The linear gain shall not change from the initial measurement by more than ±0.5 dB.

4.4.2.4 Operation at Altitude

The transmitter shall be subjected to an altitude of Alt 2 as specified in MIS-23260, Signature Characteristics. The unit shall reach Alt 2 from sea level in not greater than 5 min. The TWT heater shall be energized simultaneously with ascent to Alt 2 for a duration of 180 ± 10 sec prior to the operational tests. During the tests the unit shall be supplied with liquid cooling. There shall be a minimum of 10 min of nonoperation (no power applied) between tests.

After the transmitter reaches Alt 2 it shall be taken to 0.33 Alt 2 at a rate of 0.50 mm Hg per sec. Simultaneously with the altitude change, the unit shall undergo a Fast Start Turn On per paragraph 3.2.1.1.1a of the T/RS. The operation shall use the waveform of paragraph 4.6.7 of the T/RS except that the quantity of bursts shall be 11 MSPs with a 10PW7 PRI. The frequency may be anywhere in the operating band. Saturated power shall not be less than 9.53 P_o.

During operation monitor the pulse amplitude fluctuations of the bursts. Variation shall not be greater than 0.8 dB peak to peak.

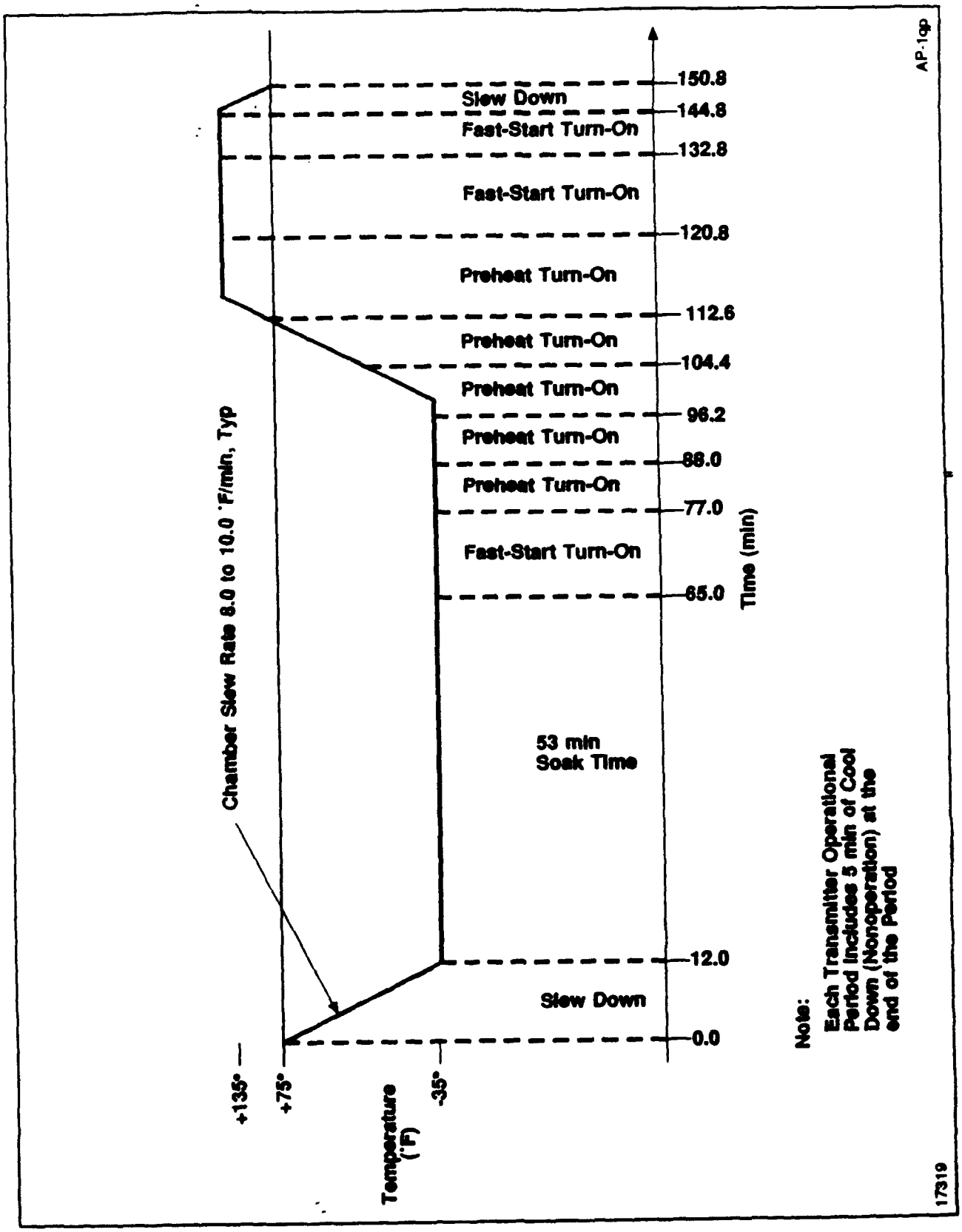


Figure 4-7 - Limited Power/Temperature Cycle Profile (Four Required)

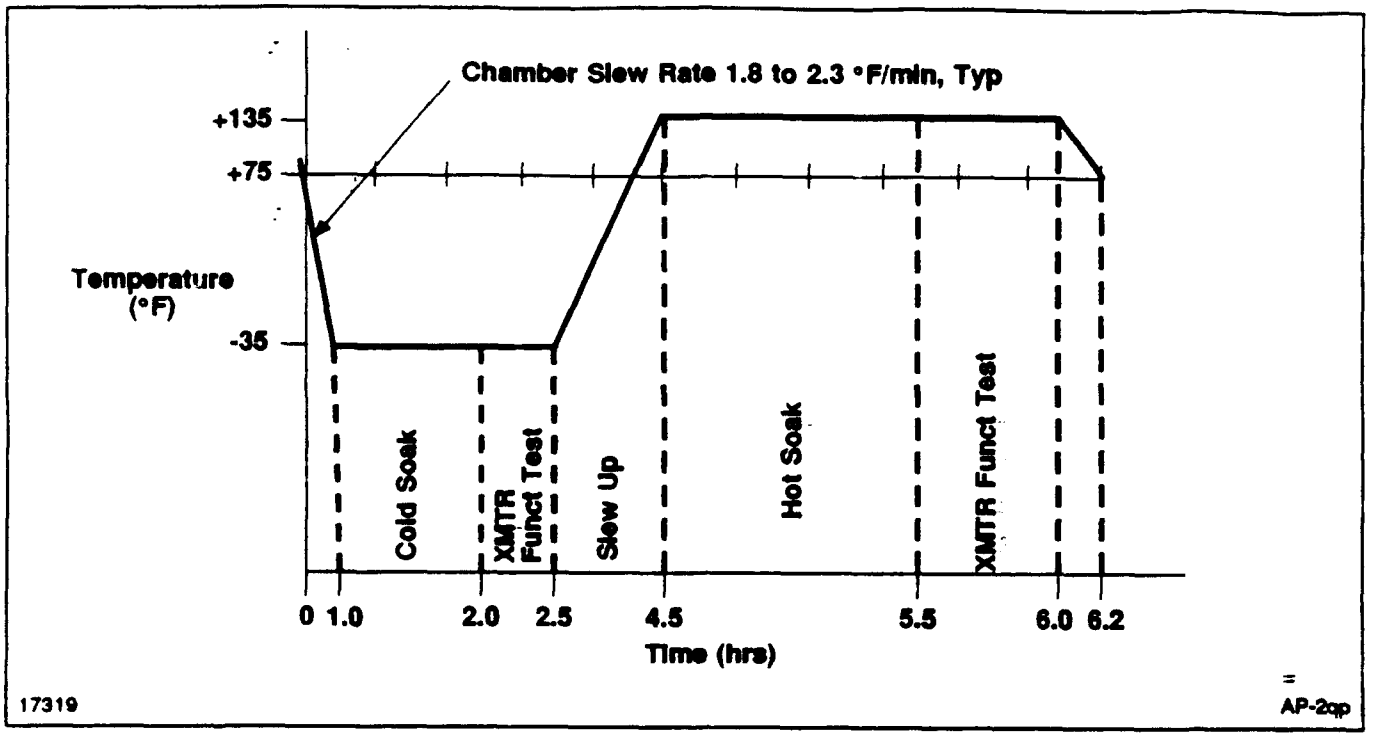


Figure 4-8 - Fifth Full Power Temperature Cycle Profile (One Required)

4.4.2.5 Vibration

Prior to starting vibration perform a Low Level Linear Gain measurement per paragraph 4. 6.2 of the T/RS at F8 + 500.

The transmitter shall first be vibrated along its vertical axis with the gun down as shown in Figure 8a of T/RS 778780. The Input Power Spectral Density Profile of Figure 4-9 with an integrated G (rms) of 3.9 g ± 0.4 g (rms) shall be used. The run time shall be 8 min maximum. During vibration the transmitter shall be operated under the conditions of paragraph 4.6.2.a of the T/RS. The microwave frequency shall be at midband and the peak RF output power set at 1.7 P_o ± 1.0 P_o. During operation the detected RF and voltage shall be monitored continuously.

Remove and remount the transmitter in the triaxial position with the TWT gun down as shown in Figure 8b of the T/RS. Vibrate the unit per the Input Power Spectral Density Profile of Figure 4-10 with an integrated g (rms) of 4.9 g ± 0.6 g (rms) for 30 min maximum. During vibration the transmitter shall be operated and monitored the same as the above vertical axis test. The total dynamic output power variation during vibration, including the effects of input power fluctuations and measurement accuracy, shall not exceed 1.0 dB.

After the completion of vibration perform the Low Level Linear Gain measurement per paragraph 4.6.2 at F8 + 500. The total Low Level Linear Gain shift as measured before and after vibration shall not exceed ±0.5 dB.

4.4.2.6 Removal of Electron Tubes

At the completion of the above testing, (paragraph 4.4. through 4.4.2.5) the TWT, Series Tube, and the Spark Gap shall be removed from the transmitter with care and in such a manner as not to damage the components. The transmitter shall be rebuilt with new components, tested per the T/RS and returned to the supply system.

For the initial group of 80 PMF returned transmitters, a minimum of ten removed TWTs will be returned to each vendor for additional testing. These tubes will be selected as follows: As

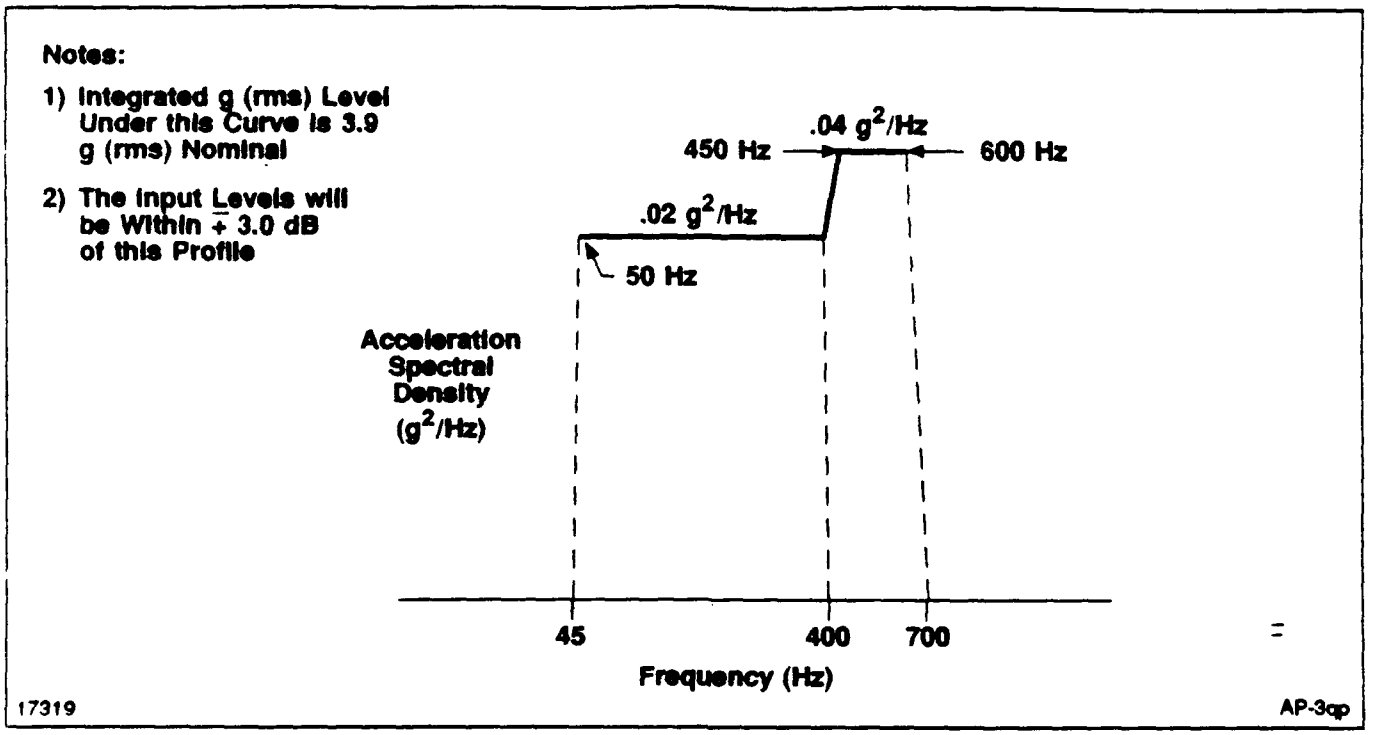


Figure 4-9 - Input Spectral Density for Limited Vibration Testing - Vertical Plane

each transmitter successfully passes the testing required by Subsections 4.4.2.1 through 4.4.2.5 of this test plan, it will be grouped by vendor in blocks of ten transmitters. Out of the first and fourth blocks, the TWTs corresponding to the transmitters demonstrating the best, average, and worst Fast Start Gain Variations will be returned to the vendor. For the second and third blocks, the TWTs corresponding to the transmitters demonstrating the best and worst Fast Start Gain Variations will be returned to the vendor.

If a transmitter fails to successfully pass the testing required by Subsections 4.4.2.1 through 4.4.2.5 of this test plan, the TWT from that transmitter shall be returned to the vendor for additional testing/failure analysis. TWTs thus returned to the vendor, are in addition to the ten previously cited. TWTs not returned to the vendor will remain at Raytheon pending disposition instructions from MICOM PAD.

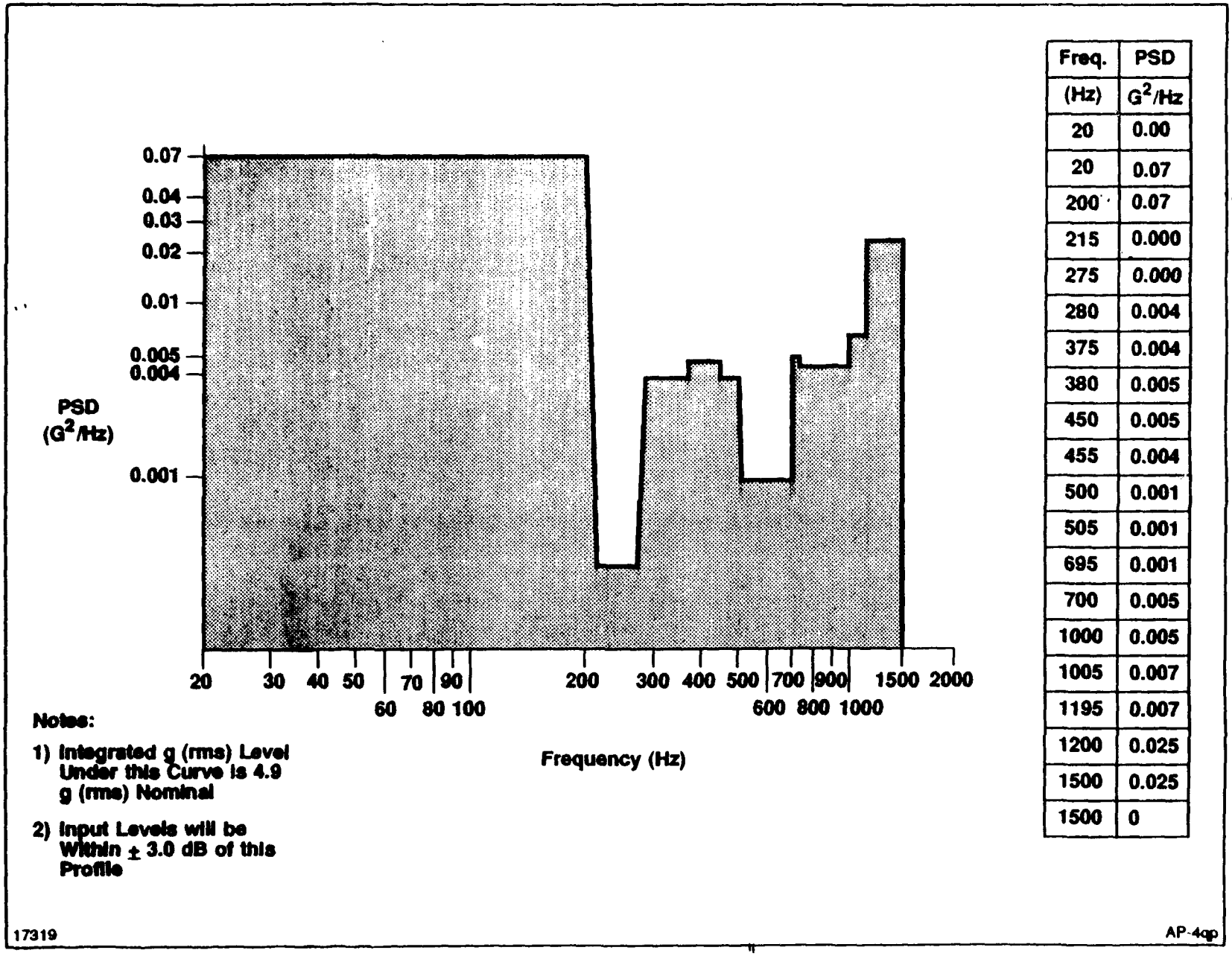
For the follow-on testing of the remaining 30 transmitters, each of the removed TWTs will be returned to the vendor regardless of test results.

Electrical transmitter test data will be provided each vendor for their correlation with and analysis of TWT electrical test data. Transmitter failure analysis information will also be provided to the vendors as it effects TWT evaluation and analysis.

4.4.3 TWT Electrical Test and Teardown

The vendor evaluation and testing of the selected TWTs shall consist of four parts as follows:

1) Incoming visual examination
2) Initial electrical tests
3) Full electrical testing
4) Teardown and inspection



Freq. (Hz)	PSD G^2/Hz
20	0.00
20	0.07
200	0.07
215	0.000
275	0.000
280	0.004
375	0.004
380	0.005
450	0.005
455	0.004
500	0.001
505	0.001
695	0.001
700	0.005
1000	0.005
1005	0.007
1195	0.007
1200	0.025
1500	0.025
1500	0

Figure 4-10 - Input Vibration Power Spectral Density for Three Axis Vibration Fixture

4.4.3.1 Incoming Visual Examination

Upon receipt of the TWTs the vendor shall perform visual examinations for signs of any physical damage or changes. The thermal strips shall also be viewed for evidence of overheating. Pictures shall be taken if any significant damage or changes are found.

4.4.3.2 Initial Electrical Tests

The first initial test is to perform a continuity test on the four cables. Next the nonoperating input and output VSWR shall be measured.

4.4.3.3 Electrical Tests

Each manufacturer shall then subject the TWTs to the tests of Subsection 4.3 of this test plan.

4.4.3.4 Teardown

After the ATP (Acceptance Test Procedures) type testing each tube shall undergo a physical teardown and material analyses according to the following sequence of procedures. Examinations shall be made at high magnification as appropriate. Pictures shall be taken any time damage, degradation or anomalies are discovered. All discovered particles shall be analyzed for chemical makeup:

1) The outer housing (heat sink) shall be inspected for degradation of the finish
2) Examine RF connectors for pin damage and plating condition
3) Remove high voltage cables and check with an ohmmeter. Inspect connectors, snouts and cables. Check insulation for evidence of degradation and separation.
4) Remove gun plate and shield (potting cover). Inspect potting for evidence of deterioration or improper cure such as brittleness.
5) Remove Heat Sink (casing) and inspect for evidence of overheating.
6) Carefully pick out potting. Inspect for evidence of arcing and verify primer was applied.
7) Remove a minimum of three magnets and examine for evidence of corrosion. The field strength of each magnet shall be measured.
8) All the weld joints and the pinchoff shall be examined for corrosion and damage.
9) The gun assembly shall be removed from the helix tube assembly by sawing through the tube between the RF input and the gun assembly.
10) The RF pin connection to the helix shall be examined.
11) The gun shall be cut open in such a way as to expose the cathode/heater, grid and anode without disturbing their position. The opened gun shall be examined for alignment of the piece parts, particles (discounting those generated by the cutting operation), evidence of arcing, and the condition of all weld and braze joints.
12) The gun piece parts shall be removed from the housing and examined individually. The cathode/heater shall be inspected for the integrity of the support structure, the condition of the surface of the cathode, and the condition of the heater potting compound (Dielectric withstanding voltage test may need to be performed.). The grid shall be examined for the condition of the support structure and its surface finish. The anode shall be examined for the condition of its surface finish.
13) The collector assembly shall be separated from the helix tube by cutting between the RF output connector and the collector assembly.
14) The RF output pin braze to the helix shall be examined.
15) The collector assembly shall be cut open in such a way as not to disturb the position of the collector and its connected lead. The exposed collector shall be examined for evidence of heat damage, cracks and deposits on the ceramic support system, and particles. The condition of all brazes shall be inspected.

16) The helix and rods shall be removed from the circuit tube. Braze joints on the tube shall be inspected for the state of condition and the amount of penetration. The rods and helix shall be examined for distortion, cracks, and thermal damage. The loss profile of the rods shall be measured.

4.4.3.5 Reporting

At a minimum of quarterly, each vendor shall prepare interim status test reports detailing the ATP test results and the results by element of the physical teardown by TWT. The final test report shall identify the electrical test parameter test changes by TWT along with its specification requirements. Failure analyses, their test data, and recommendations will be reported in a separate section within the final test report. Photographs taken of each TWT will be provided in a separate attachment to the final report. The final report shall include a trend analysis and predication based upon the original and current ATP test results. The vendor shall prepare at least three original copies of these reports for distribution to Raytheon, MICOM PAD and the PPO.

ATP test failures of TWTs that had previously passed the transmitter level testing shall immediately be reported to Raytheon via a flash report.

5. TESTING RESPONSIBILITIES

5.1 Testing Responsibilities

Raytheon will be responsible for obtaining and monitoring the electrical tests, teardown and visual examinations. All tubes shall be visually examined for any damage prior to electrical testing. Raytheon will contract out the testing and teardown to the vendor of the tube. All test results will be collected and stored by Raytheon.

Raytheon will notify MICOM PAD prior to any testing to allow them or their representative to participate in the testing.

5.2 Storage Responsibilities

The U.S. Army shall be responsible for the storage of the tubes at the arid storage site and Fort Greely, Alaska. The U.S. Army shall also be responsible for the construction and maintenance of the shelters including environmental controls and measurement systems.

The U.S. Army shall oversee the storage program to ensure that the tubes are properly stored at the environmental sites. Raytheon will notify the U.S. Army when the tubes are to be removed and shipped for testing.

6. REPORT

6.1 Failures

For any transmitter or TWT failure(s), a written flash report will be issued to MICOM PAD by Raytheon within one working week. This will be followed up by a failure analysis (F/A) and a report on the findings within six months. The F/A report will include an assessment as to the failure's impact on flight/tactical performance. As appropriate, corrective action recommendations will also be made. The F/A report shall be distributed to all appropriate parties as determined by MICOM PAD.

6.2 Report

A copy of the test data and the resulting test report will be made available to MICOM PAD within 45 days after the completion of the test. For tests that continue over a period of time, an interim test report with associated data will be provided on a three month basis.

A yearly report will be issued by Raytheon by the end of each January on the results and status of the program. Statistical analysis to include trend analyses will be provided as part of the yearly summary report.

APPENDIX A
INVENTORY OF PATRIOT MISSILE TRAVELING WAVE TUBE (APN 11448369)

INVENTORY OF PATRIOT MISSILE TRAVELLING WAVE TUBE (TWT)
PATRIOT MISSILE LIMITED LIFE COMPONENT (LLC) PROGRAM
APN: 1144838
AS OF: 15 AUGUST 1990

SORTED BY DOM, BUY AND SERIAL NUMBER

INDEX NUMBER	S/N OR ID NUMBER	MFGR	BUY	DOM	ORIGIN OF TWT COMPONENT	PLANNED USE	PROPOSED STORAGE ENVIRONMENT	CURRENT STORAGE LOCATION	YEAR EMPLACED	PREVIOUS STORAGE LOCATION(S)	TEST STATUS / RESULTS	INDEX NUMBER
1	610043	MPTD	3	12/83	PRODUCTION	GROUP I - 92	HOT - DUGWAY	RSA				1
2	610090	MPTD	3	1/84		GROUP I - 92	COLD - GREELY	FT GREELY -NON PS	3/89	RSA		2
3	610200	LITTON	3	10/83	PRODUCTION	GROUP I - 92	HOT - DUGWAY	RSA				3
4	620194	MPTD	4	1/84		GROUP II - 98	COLD - GREELY	FT GREELY -NON PS	3/89	RSA		4
5	620196	MPTD	4	1/84	PRODUCTION	GROUP II - 98	HOT - DUGWAY	RSA				5
6	620218	MPTD	4	2/84	PRODUCTION	GROUP III - 02	HOT - DUGWAY	RSA				6
7	620201-1	MPTD	4	2/84	PRODUCTION	GROUP I - 92	HOT - DUGWAY	RSA				7
8	620007	LITTON	4	1/84	PRODUCTION	GROUP II - 98	HOT - DUGWAY	RSA				8
9	610059	MPTD	3	2/84	PRODUCTION	GROUP I - 92	HOT - DUGWAY	RSA				9
10	620095	LITTON	4	6/84	PRODUCTION	GROUP III - 02	HOT - DUGWAY	RSA				10
11	630085	MPTD	5	2/85		GROUP I - 92	COLD - GREELY	FT GREELY -NON PS	3/89	RSA		11
12	630160	LITTON	5	3/85	PRODUCTION	GROUP I - 92	HOT - DUGWAY	RSA				12
13	640007	MPTD	5	3/85		GROUP II - 98	COLD - GREELY	FT GREELY -NON PS	3/89	RSA		13
14	640015	MPTD	5	3/85		GROUP III - 02	COLD - GREELY	FT GREELY -NON PS	3/89	RSA		14
15	640160	LITTON	5	8/85	PRODUCTION	GROUP II - 98	HOT - DUGWAY	RSA				15
16	640163	LITTON	5	8/85		GROUP I - 92	COLD - GREELY	FT GREELY -NON PS	3/89	RSA		16
17	610045	MPTD	5	10/85		GROUP III - 04	COLD - GREELY	FT GREELY -NON PS	3/89	RSA		17
18	640182	LITTON	5	10/85		GROUP II - 98	COLD - GREELY	FT GREELY - PS CAN	3/89	RSA		18
19	640184	LITTON	5	10/85		GROUP I - 92	COLD - GREELY	FT GREELY - PS CAN	3/89	RSA		19
20	640186	LITTON	5	10/85		GROUP II - 98	COLD - GREELY	FT GREELY -NON PS	3/89	RSA		20
21	640188	LITTON	5	10/85		GROUP III - 02	COLD - GREELY	FT GREELY -NON PS	3/89	RSA		21
22	640191	LITTON	5	10/85	PRODUCTION	GROUP III - 02	HOT - DUGWAY	RSA				22
23	640193	LITTON	5	10/85	PRODUCTION	GROUP I - 92	HOT - DUGWAY	RSA				23
24	640198	LITTON	5	10/85		GROUP III - 02	COLD - GREELY	FT GREELY -NON PS	3/89	RSA		24
25	660231	MPTD	6	11/85	PRODUCTION	GROUP II - 98	HOT - DUGWAY	RSA				25
26	660237	MPTD	6	11/85	PRODUCTION	GROUP III - 02	HOT - DUGWAY	RSA				26
27	660318	LITTON?	6	86	PRODUCTION	GROUP II - 98	HOT - DUGWAY	RSA				27
28	660208R1	LITTON	6	5/86		GROUP I - 92	COLD - GREELY	FT GREELY -NON PS	3/89	RSA		28
29	670423	LITTON	7	3/87	PRODUCTION	XTMR R&R		RAYTHEON		RSA		29
30	670425	LITTON	7	3/87	PRODUCTION	XTMR R&R		RAYTHEON		RSA		30
31	670427	LITTON	7	3/87		GROUP I - 94	COLD - GREELY	FT GREELY -NON PS	3/89	RSA		31
32	670054	MPTD	7	4/87	PRODUCTION	XTMR R&R		RAYTHEON		RSA		32
33	670065	MPTD	7	4/87	PRODUCTION	XTMR R&R		RAYTHEON		RSA		33
34	670162	MPTD	7	7/87		GROUP I - 94	COLD - GREELY	FT GREELY - PS CAN	3/89	RSA		34
35	670163	MPTD	7	7/87		GROUP II - 00	COLD - GREELY	FT GREELY -NON PS	3/89	RSA		35
36	670165	MPTD	7	7/87		GROUP III - 04	COLD - GREELY	FT GREELY -NON PS	3/89	RSA		36

INVENTORY OF PATRIOT MISSILE TRAVELLING WAVE TUBE (TWT)
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SORTED BY DOM, BUY AND SERIAL NUMBER

INDEX NUMBER	S/N OR ID NUMBER	MFGR	BUY	DOM	ORIGIN OF TWT COMPONENT	PLANNED USE	PROPOSED STORAGE ENVIRONMENT	CURRENT STORAGE LOCATION	YEAR EMPLACED	PREVIOUS STORAGE LOCATION(S)	TEST STATUS / RESULTS	INDEX NUMBER
37	670168	MPTD	7	7/87	PRODUCTION	GROUP I - 94	HOT - DUGWAY	RSA				37
38	680047	MPTD	7	9/87		GROUP I - 94	COLD - GREELY	FT GREELY - PS CAN	3/89	RSA		38
39	680048	MPTD	7	9/87		GROUP III - 04	COLD - GREELY	FT GREELY -NON PS	3/89	RSA		39
40	680049	MPTD	7	9/87	PRODUCTION	GROUP II - 00	HOT - DUGWAY	RSA				40
41	680050	MPTD	7	9/87	PRODUCTION	GROUP I - 94	HOT - DUGWAY	RSA				41
42	680051	MPTD	7	9/87		GROUP II - 00	COLD - GREELY	FT GREELY -NON PS	3/89	RSA		42
43	670475	MPTD	7	10/87	PRODUCTION	GROUP II - 00	HOT - DUGWAY	RSA				43
44	670476	MPTD	7	10/87		GROUP I - 94	COLD - GREELY	FT GREELY -NON PS	3/89	RSA		44
45	680083	MPTD	7	10/87	PRODUCTION	GROUP I - 94	HOT - DUGWAY	RSA				45
46	680084	MPTD	7	10/87		GROUP II - 00	COLD - GREELY	FT GREELY - PS CAN	3/89	RSA		46
47	680085	MPTD	7	10/87	PRODUCTION	GROUP II - 00	HOT - DUGWAY	RSA				47
48	680086	MPTD	7	10/87	PRODUCTION	XTMR R&R		RAYTHEON		RSA		48
49	720084	LITTON	8	10/87	PRODUCTION	XTMR R&R		RAYTHEON		RSA		49
50	720103	LITTON	8	10/87	PRODUCTION	XTMR R&R		RAYTHEON		RSA		50
51	670182	LITTON	7	11/87		GROUP III - 04	COLD - GREELY	FT GREELY -NON PS	3/89	RSA		51
52	670183	LITTON	7	11/87		GROUP I - 94	COLD - GREELY	FT GREELY - PAD13	12/89	RSA		52
53	670184	LITTON	7	11/87		GROUP II - 00	COLD - GREELY	FT GREELY - PAD13	12/89	RSA		53
54	670185	LITTON	7	11/87		GROUP III - 04	COLD - GREELY	FT GREELY - PAD13	12/89	RSA		54
55	670189	LITTON	7	11/87		GROUP III - 04	COLD - GREELY	FT GREELY - PAD13	12/89	RSA		55
56	670190	LITTON	7	11/87	PRODUCTION	GROUP I - 94	HOT - DUGWAY	RSA				56
57	670191	LITTON	7	11/87	PRODUCTION	GROUP II - 00	HOT - DUGWAY	RSA				57
58	670192	LITTON	7	11/87	PRODUCTION	GROUP I - 94	HOT - DUGWAY	RSA				58
59	670205	LITTON	7	11/87		GROUP III - 04	COLD - GREELY	FT GREELY -NON PS	3/89	RSA		59
60	670187-1	LITTON	7	11/87		GROUP III - 04	COLD - GREELY	FT GREELY - PAD13	12/89	RSA		60
61	670219	LITTON	7	12/87	PRODUCTION	GROUP II - 00	HOT - DUGWAY	RSA				61
62	670220	LITTON	7	12/87	PRODUCTION	GROUP I - 94	HOT - DUGWAY	RSA				62
63	670226	LITTON	7	12/87	PRODUCTION	GROUP II - 00	HOT - DUGWAY	RSA				63
64	670227	LITTON	7	12/87		GROUP III - 04	COLD - GREELY	FT GREELY -NON PS	3/89	RSA		64
65	610241	LITTON	8	10/88	PRODUCTION	GROUP III - 04	HOT - DUGWAY	RSA				65
66	740017	LITTON	9	12/88		GROUP I - 94	COLD - GREELY	TESTING @ MFR	12/89	RSA		66
67	740018	LITTON	9	12/88		GROUP II - 00	COLD - GREELY	TESTING @ MFR	12/89	RSA		67
68	740022	LITTON	9	12/88		GROUP II - 00	COLD - GREELY	TESTING @ MFR	12/89	RSA		68
69	740026	LITTON	9	12/88		GROUP III - 04	COLD - GREELY	TESTING @ MFR	12/89	RSA		69
70	740028	LITTON	9	12/88		GROUP III - 04	COLD - GREELY	TESTING @ MFR	12/89	RSA		70
71	740402	AEG	9	89	PRODUCTION	GROUP I - 96	HOT - DUGWAY	RSA				71
72	740432	AEG	9	89	PRODUCTION	GROUP I - 96	COLD - GREELY	RSA				72

INVENTORY OF PATRIOT MISSILE TRAVELLING WAVE TUBE (TWT)
PATRIOT MISSILE LIMITED LIFE COMPONENT (LLC) PROGRAM
APN: 11448369
AS OF: 15 AUGUST 1990

SORTED BY DOM, BUY AND SERIAL NUMBER

INDEX NUMBER	S/N OR ID NUMBER	MFGR	BUY	DOM	ORIGIN OF TWT COMPONENT	PLANNED USE	PROPOSED STORAGE ENVIRONMENT	CURRENT STORAGE LOCATION	YEAR EMPLACED	PREVIOUS STORAGE LOCATION(S)	TEST STATUS / RESULTS	INDEX NUMBER
73	740528	AEG	9	89	PRODUCTION	GROUP I - 96	HOT - DUGWAY	RSA				73
74	750406	AEG	9	89	PRODUCTION	GROUP I - 96	COLD - GREELY	RSA				74
75	670490	LITTON	7	1/89	PRODUCTION	GROUP I - 96	COLD - GREELY	RSA				75
76	670503	LITTON	7	1/89	PRODUCTION	GROUP I - 96	HOT - DUGWAY	RSA				76
77	670504	LITTON	7	1/89	PRODUCTION	GROUP II - 02	HOT - DUGWAY	RSA				77
78	670509	LITTON	7	1/89	PRODUCTION	GROUP II - 02	COLD - GREELY	RSA				78
79	670510	LITTON	7	1/89	PRODUCTION	GROUP III - 06	HOT - DUGWAY	RSA				79
80	740044	LITTON	9	1/89		GROUP I - 96	COLD - GREELY	TESTING @ MFR	12/89	RSA		80
81	740045	LITTON	9	1/89	PRODUCTION	GROUP II - 02	COLD - GREELY	RSA				81
82	760227	MPTD	9	1/89		GROUP I - 96	COLD - GREELY	TESTING @ MFR	12/89	RSA		82
83	750230	MPTD	9	1/89		GROUP II - 02	COLD - GREELY	TESTING @ MFR	12/89	RSA		83
84	750232	MPTD	9	1/89		GROUP I - 96	COLD - GREELY	TESTING @ MFR	12/89	RSA		84
85	750238	MPTD	9	1/89		GROUP II - 02	COLD - GREELY	TESTING @ MFR	12/89	RSA		85
86	750244	MPTD	9	1/89		GROUP I - 96	COLD - GREELY	TESTING @ MFR	12/89	RSA		86
87	750024	LITTON	9	4/89	PRODUCTION	GROUP I - 96	HOT - DUGWAY	RSA				87
88	750026	LITTON	9	4/89	PRODUCTION	GROUP II - 02	HOT - DUGWAY	RSA				88
89	760274	MPTD	10	4/89		GROUP II - 02	COLD - GREELY	TESTING @ MFR	12/89	RSA		89
90	760275	MPTD	10	4/89	PRODUCTION	GROUP I - 96	HOT - DUGWAY	RSA				90
91	760276	MPTD	10	4/89	PRODUCTION	GROUP II - 02	HOT - DUGWAY	RSA				91
92	760290	MPTD	10	4/89	PRODUCTION	GROUP I - 96	HOT - DUGWAY	RSA				92
93	760291	MPTD	10	4/89	PRODUCTION	GROUP II - 02	HOT - DUGWAY	RSA				93
94	760030	LITTON	10	8/89	PRODUCTION	GROUP I - 96	COLD - GREELY	RSA				94
95	760035	LITTON	10	8/89	PRODUCTION	GROUP I - 96	HOT - DUGWAY	RSA				95
96	760037	LITTON	10	8/89	PRODUCTION	GROUP II - 02	HOT - DUGWAY	RSA				96
97	760040	LITTON	10	8/89	PRODUCTION	GROUP II - 02	COLD - GREELY	RSA				97
98	760044	LITTON	10	8/89	PRODUCTION	GROUP III - 06	HOT - DUGWAY	RSA				98
99	760046	LITTON	10	8/89	PRODUCTION	GROUP III - 06	COLD - GREELY	RSA				99
100	760048	LITTON	10	8/89	PRODUCTION	GROUP III - 06	COLD - GREELY	RSA				100
101	760050	LITTON	10	8/89	PRODUCTION	GROUP III - 06	HOT - DUGWAY	RSA				101
102	760053	LITTON	10	8/89	PRODUCTION	GROUP III - 06	COLD - GREELY	RSA				102
103												103
104												104
105												105
106												106
107												107
108												108