SONIC BOOM MEASUREMENT TEST PLAN

NASA-TM-85222

FOR SPACE SHUTTLE STS-1 REENTRY

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APPROVAL AUTHORITY

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TABLE OF CONTENTS

PREFACE

This document relates to an overall plan which describes the Space Shuttle STS-1 Sonic Boom Measurement Program and is supplied as a detail guide and formal documentation for measurement procedures, system specifications, and general information for others involved in the program. By way of review, the Space Shuttle STS-1 will be launched from Complex 39A at the Kennedy Space Center, Florida, into a nominal 150/150 nautical mile altitude circular orbit. Deorbit should occur to accomplish a landing at a pre-selected, primary, secondary or contingency landing site. The deorbit maneuver is initiated at 53 hours, 31 minutes, ground elapsed time during the 36th orbit, with subsequent landing on Rogers Lakebed at Edwards Air Force Base, CA. Runway 23 will be the primary runway, 17 the backup, and 04 the alternate.

In the event of deviations from the normal reentry plan, Northrup Strip at White Sands Missile Range (the designated backup to EAFB) could become the pre-selected primary landing site. Should this occur the subject sonic boom measurement test plan will not provide for the reentry sonic boom measurements.

PURPOSE OF TEST PLAN

This test plan is designed to provide information, guidance, and assignment of responsibilities for the acquisition of sonic boom and atmospheric measurements, timing correlation, communications and other necessary supporting tasks. Specifically included are details such as mobile data acquisition station locations, measurement systems calibration levels, predicted sonic boom overpressure levels, overpressure level assignment for each data acquisition station, data recording times on and off, universal coordinated time, and measurement system descriptions.

INTRODUCTION

The Space Shuttle will reenter the earth's atmosphere at near orbital velocity and will generate a sonic boom until it decelerates to subsonic speed. Sonic booms generated by aircraft flying at speeds up to Mach 4.8 and altitudes above 80,000 feet have been measured. Good agreement has been found to exist between the predicted and measured sonic booms of aircraft for a wide range of configurations, Mach numbers, altitudes, and operating conditions.

Measurements have been made of sonic booms generated at Mach numbers up to 16 during ascent and reentry of the Apollo and Skylab spacecraft. Shuttle vehicle geometric and operational characteristics differ from those of Apollo and Skylab and are significantly different from convential aircraft. Although it is believed that the existing prediction schemes for spacecraft are applicable to Shuttle, an adequate wind tunnel data base is available for the orbiter, however, no full scale flight test data yet exists.

The purpose of this program is to acquire sonic boom measurements on the STS-1 during the reentry phase to landing so that comparisons can be made between measured and predicted levels. In addition, these measurements fulfill the commitment made in the Shuttle Environmental Impact Statement to validate the preflight prediction technology.

MEASUREMENT PLAN

General Scope

This measurement plan consists of deploying eleven data acquisition stations of which ten will be mobile units (vans) and one fixed station along, under, and to the side of the STS-1 reentry flight tract into the Edwards Air Force Base area (see figure 1). These stations (see tables 1 and 2 respectively, for theoretical predictions and approximate station locations) will provide six intermediate band FM channels of Sonic Boom Data, universal time synchronization and voice annotation. They will also be supported with atmospheric measurements (rawinsonde systems) at two of the eleven positions and also at Edwards Air Force Base. All measurements will be correlated with the vehicle reentry flight track along with atmospheric and vehicle operation conditions. Program responsibilities are also identified (see figure 2).

Procedures

Stations 0 - 10

a. Two hour warm-up all instrumentation.

b. All sonic boom and meteorological measurement related activities will operate through the sonic boom coordinator console position located in building 4800 at Dryden Flight Research Center.

c. Voice communications between all measurement stations and the sonic boom coordinator console will be through commercial dedicated phone lines along with FM low band communication link.

d. Use of transceivers will be held to a minimum. There will be no communication between measurement stations unless your station is called, if, an instrumentation failure exists, call Sonic Boom Coordinator and the appropriate personnel will be notified.

e. All tape recorder data channels will be calibrated at both pre and post flight situations using a precision one volt RMS source to verify center frequency stability.

f. All microphones will be calibrated at pre and post flight conditions using 124db sound pressure level at a fixed frequency of one KHz.

g. All information pertaining to calibrations, overpressure levels, and amplifier gains will be recorded on the assigned voice annotation channel.

h. While recording data, including all calibrations, Greenwich Mean Time (GMT) will be recorded on the assigned timing channel.

i. Sonic Boom Coordinator will give "recorders on" and "recorders off" command for all sonic boom measurement stations during STS-1 reentry. However, a time delay is anticipated from the recorders on command to boom arrival.

j. All pertinent data will be recorded on data sheets; i.e., microphone number, tape channel number, calibration levels, weather conditions, aircraft in vicinity of station while calibrating instrumentation, etc.

k. Stations experiencing any problems affecting this sonic boom measurement program will notify Sonic Boom Coordinator as soon as possible.

l. There will be no radio frequency transmission during data recording.

Atmospheric Measurements

Past experience gained on aircraft, Apollo, and Skylab Sonic Boom Measurement Programs have shown that it is necessary to have atmospheric information since temperature and wind gradients and low level turbulence can significantly affect the sonic boom ground exposure patterns.

Therefore atmospheric data at the surface and aloft will be obtained by using the rawinsonde technique. Two rawinsonde systems furnished and operated by personnel from the Atmospheric Science Division at MSFC will be located at two sonic boom measurement sites, numbers 2 and 4 which are positioned under the STS-1 reentry track.

RAWINSONDE - The RAWIN System is a transportable radio direction finder. It is designed to track a balloon-borne radiosonde automatically. A radiosonde signal containing meteorological information in the form of amplitude or frequency modulation is received, amplified and detected by this system. The detected signal is passed to separate equipment in the system where it is recorded. By reference to calibration data for the radiosonde, this recorded information is converted to values of temperature, humidity, and pressure. Recording of time versus progressive changes of the elevation and azimuth positions of the ascending balloon package, as determined by tracking of the signal from the radiosonde, are made so that they can be later converted to wind speed and direction.

The radiosonde consists of a transmitter, modulator, antenna, battery, and pressure, temperature, and humidity sensing elements. The radiosonde, parachute and train weighs about four pounds and can be carried to an altitude of about 30 KM by a helium-filled balloon.

The battery furnishes power to the modulator and transmitter. The transmitter operates in the 1660 - 1700 megahertz (MZ) band and its carrier is amplitude modulated by an audiofrequency pulse, the rate of which is determined by the pressure, temperature and humidity sensing elements.

The RAWIN set automatically tracks the balloon-borne radiosonde by continuous homing on the radiosonde signal to horizontal distances of about 125 miles and altitudes of up to 30 KM. The equipment recorder records the azimuth and elevation angles of the position of the radiosonde versus time.

Time Synchronization

In order to fully benefit from ground Sonic Boom Measurements Precision Time Synchronization is necessary. Specifically a real-time track (range time) is necessary for later data interpretation processes (ray tracing, and shock wave arrival times, etc.) which require that the time, atmospheric conditions, vehicle operating conditions and the STS-1 reentry flight track information be known relative to the time the sonic boom was received at a particular measuring station. Therefore the following time synchronization concept will be utilizied.

Precise time synchronization between 11 Sonic Boom data acquisition Stations and the STS-1 reentry trajectory will be obtained from the "GOES" satellites, (Geostationary Operational Environmental Satellite). These satellites belong to the National Oceanic and Atmospheric Administration, which calls for the positioning of one satellite of approximately 135 degrees west longitude, another at 75 degrees west longitude, and a third to be an in-orbit spare. These satellites are in orbit 36,000 kilometers above the equator, they travel at about 11,000 kilometers per hour and remain continuously above the same spot on earth, they are thus termed geostationary. Since they always have the same regions of earth in view, they can provide 24 hour, continuous service.

The sonic boom measuring stations are equipped with satellite synchronized time code clocks which have been designed to receive and decode timing information from the NOAA "GOES" satellite which transmits on a frequency of 468 MHz. The displayed time as well as the electrically outputed time will be universal coordinated time (UTC), more commonly referred to as Greenwich Mean Time (GMT). This time base will be recorded on magnetic tape using an IRIG-B format of day-of-year, hours, minutes, and seconds to an accuracy of ±1.0 milli second traceable to the National Bureau of Standards.

Communications

A voice circuit (dedicated hard line communication link) will be available from the space radiation analysis group (SRAG) console No. 386 in mission control located at the Johnson Space Center to the Sonic Boom Coordinator Console position located in building 4800 at the Dryden Flight Research Center in order that the program principal investigator may respond to possible STS-1 reentry profile anomalies.

Primary voice communications between Dryden Flight Research Center and eleven sonic boom and two meteorological measurement stations will utilize two different forms of ground-to-ground communications. Stations 0 (zero) through 3 (three) will utilize dedicated commercial phone lines and stations 4 (four) through 10 (ten) will utilize a narrow band FM system transmitting and receiving on 40.870 MHz frequency. All sonic boom related communications traffic will operate through the Sonic Boom Coordinator console position located in building 4800 at Dryden Flight Research Center.

General Flight Plan

The STS-1 will be a 54.5 hour flight launched from Kennedy Space Center on April 7, 1981, at 11:30 Greenwich Mean Time (GMT). The flight test will be achieved in a 150-n mi circular orbit with a 40.3 - degree inclination, with a 1-hour launch window (as a minimum) being provided. The nominal deorbit maneuver is thrust initiated a 53:31 GET during the 36th orbit with entry interface occuring at 400,000 feet altitude with subsequent landing on Rogers Lakebed runway 23 at Edwards Air Force Base, CA at 10:01 a.m. PST on April 9, 1981. There will be landing opportunities at EAFB on at least four orbits each day. All landings (nominal, abort, and contingency) except AOA will be no earlier than 30 minutes after sunrise and no later than 30 minutes before sunset.

Sonic Boom Measurement System

Proven aircraft and large spacecraft sonic boom data acquisition systems are to be utilized for ground level sonic boom measurements during STS-1 reentry. These systems have been used in previous aircraft, Apollo, and Skylab sonic boom programs and consist of pressure transducers, Dynagages (oscillator-detector circuit), instrumentation amplifiers, FM magnetic tape recorders, and satellite time code receivers. Specifically, the pressure transducer is a commercially available condenser microphone with a high frequency response to 10 KHz ±2 dB when used with the model DG-605 Dynagage system, with the low end frequency response of approximately -5 dB at -.01 Hz. The low end frequency response is made possible by modifying the configuration of the chamber vent behind the microphone diaphram. Basically, the size of the vent was diminished thereby reducing the atmospheric pressure bleed rate. This procedure will allow adequate provisions for system balancing, temperature and, atmospheric pressure changes during field operations.

The Dynagage consists of a radio frequency oscillator coupled to a diode detector circuit whereby small changes in capacity of the pressure transducer will produce relatively large changes in the diode detector. The output of the detector is therefore proportional to the pressure applied to the tranducer diaphram. The Dynagage output is fed into an instrumentation amplifier which provides a gain of 0 to 60 dB in steps of 2 dB with a flat frequency response of D.C. to 20 KHz.

The measurement system will utilize frequency modulated magnetic tape recorders operating at 30 ips in the intermediate band with a frequency response of D.C. to 10 KHz. Electrical power will be furnished by portable gasoline generators. This instrumentation will be mounted in commercially available vehicles (vans). Each measuring station will utilize four microphones three of which will be co-located in a 4 x 4 ft ground board (necessary to obtain true ground pressures with the incident and reflected waves exactly in phase) with the fourth microphone mounted at ear level. The data from the three ground level microphones will provide information for direct comparison with predicted sonic boom overpressure levels based on measured wind tunnel data. The fourth microphone position located at the ear level height, and at the request of the MSFC co-principal investigator, will provide information of the subjective aspects of sonic booms relative to current standard measurements for aircraft flyover noise.

All microphones will be covered with wind screens consisting of two layers of cheesecloth which will minimize effects of surface winds on the microphone readings and also to provide shade from the sun and protection from blowing sand particles. The output of the microphones will be routed through the instrumentation amplifiers thus allowing for the setting of a range of over-pressure levels (a precaution necessary to allow for errors in the predictive method or anomalous overpressures caused by unusual atmospheric or focusing conditions). Each station will record 6 channels of overpressure data, time code signal, and voice annotation. All tape recorder data channels will be calibrated using a precision voltage source to verify center frequency stability, all microphones will be calibrated at both "pre" and "post" flight conditions using a fixed frequency sound pressure level calibrator which will verify an end-to-end acoustic calibration.

EVENT TIMES

STATION - 0

DAY ZERO

1. Arrival at measurement station at launch time (launch time to be announced).
2. Ready to record data, 2 hours, 30 min after launch.

DAY 1

3. Arrival at measurement station, 22 hours, 22 min after launch.
4. Ready to record data 1 day plus 50 min after launch.

Day 2

5. Arrival at measurement station 46 hours, 24 min after launch.
6. Ready to record data 2 days plus 1 hour after launch.
7. "Recorders on" command will be initiated by Sonic Boom Coodrinator.

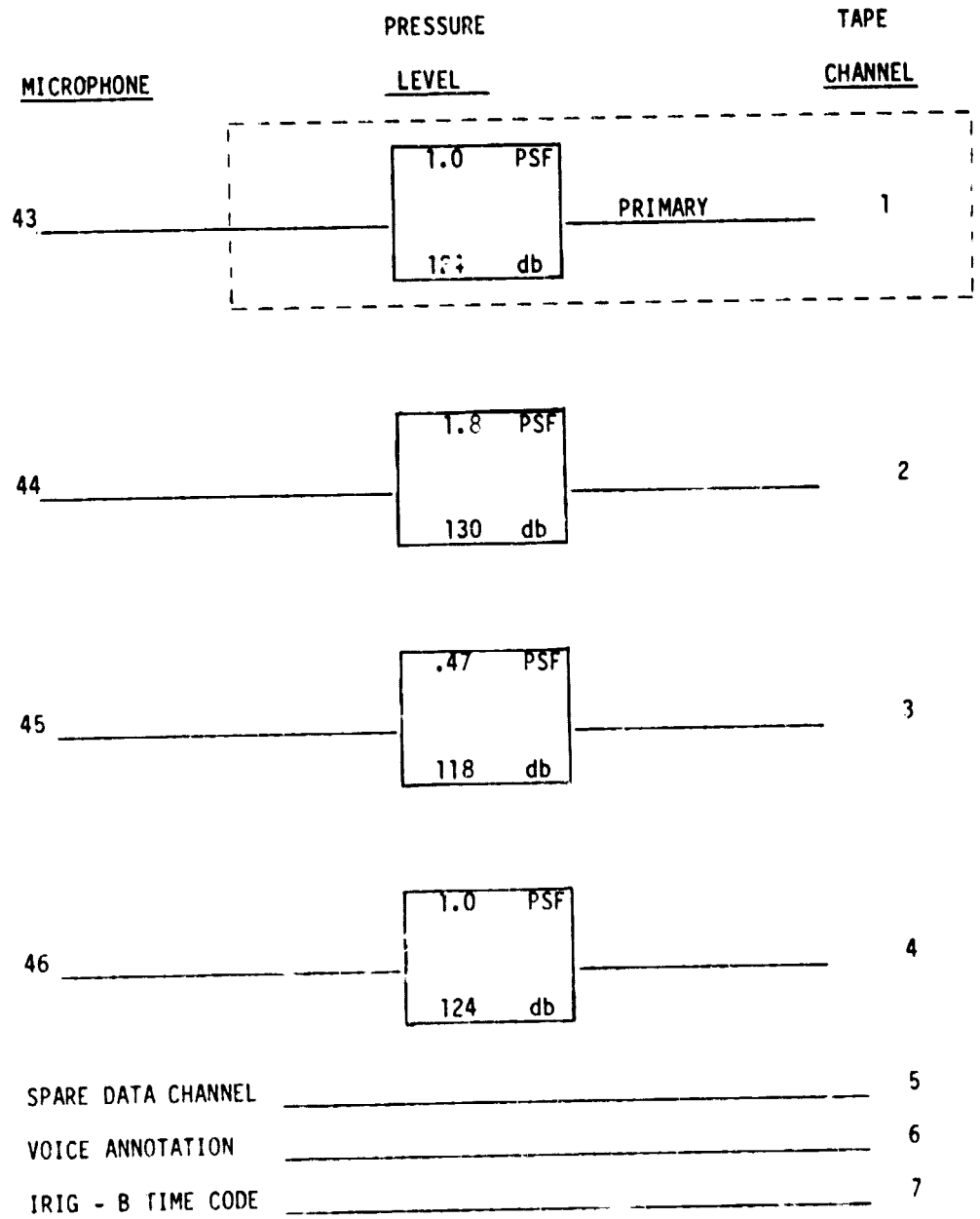
STATION RELEASE

8. Sonic Boom Coordinator will advise station release time for all situations.

Pressure Level Assignment

STATION - 0

PREDICTED OVERPRESSURE LEVEL 0.8 PSF



CALIBRATION AND OVERPRESSURE LEVEL SETTINGS

B&K SYSTEM 2631

DATE _____

OPERATOR _____

STATION 0

	CAL/SETTINGS		RUN SETTINGS	
SYSTEM NUMBER	H/P ATTENUATOR	ASSIGNED RUN LEVELS	H/P ATTENUATOR	TAPE CHANNEL
43	17 dB	124 dB	16 dB	1
44	18 db	130 dB	24 dB	2
45	16 db	118 dB	9 dB	3
46	0 db	124 dB	0 dB	4

NOTE: CALIBRATION LEVEL WILL BE 124 dB. SET SYSTEM GAIN FOR 2 VOLTS PEAK/PEAK INPUT TO TAPE RECORDER.

EVENT TIMES

STATION - 1

DAY ZERO

1. Arrival at measurement station at launch time (launch time to be announced).
2. Ready to record data 2 hours, 30 min after launch.

DAY 1

3. Arrival at measurement station, 22 hours, 22 min after launch.
4. Ready to record data 1 day, plus 50 min after launch.

DAY 2

5. Arrival at measurement station 46 hours, 24 min after launch.
6. Ready to record data, 2 days plus 1 hour after launch.
7. "Recorders on" command will be initiated by Sonic Boom Coordinator.

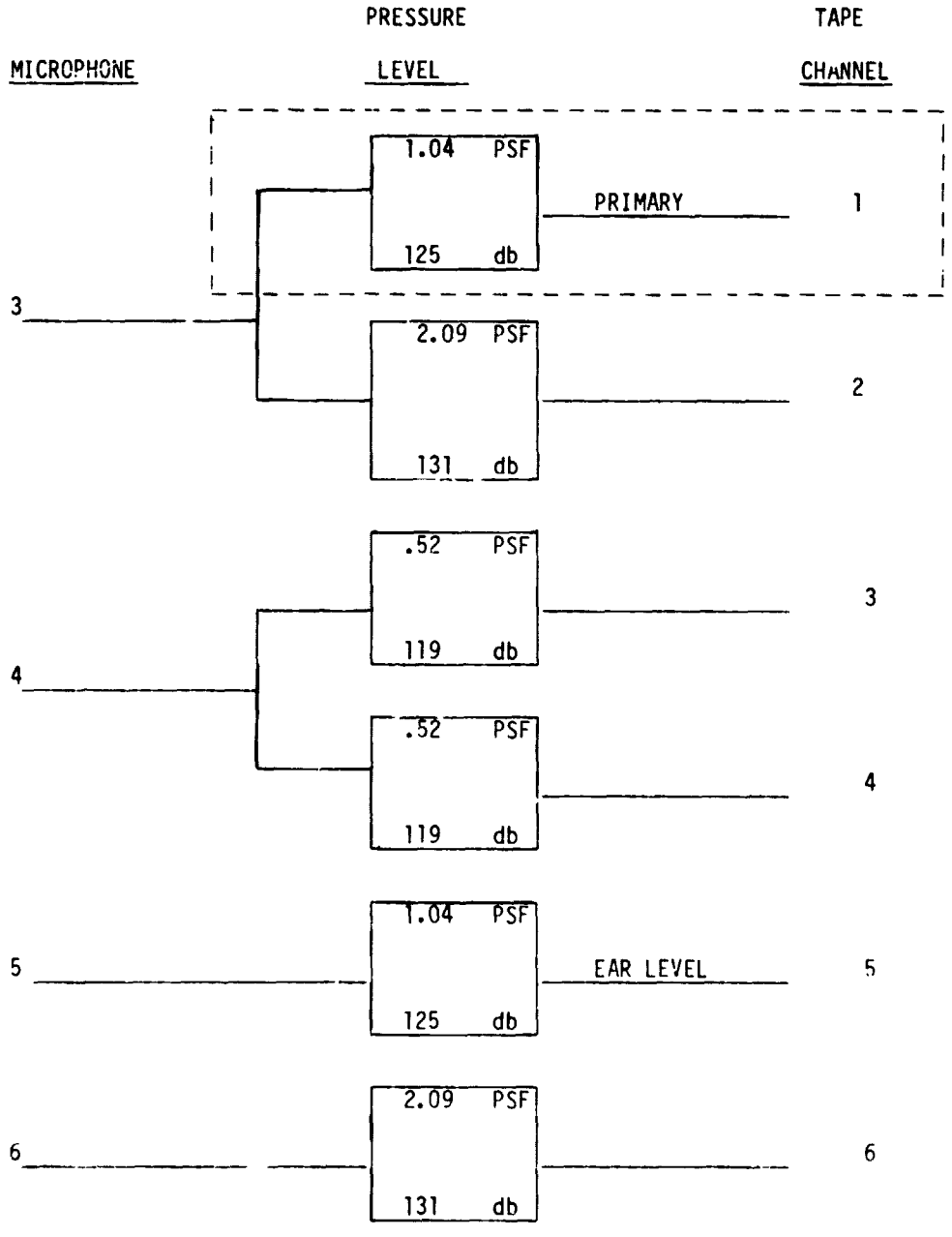
STATION RELEASE

8. Sonic Boom Coordinator will advise station release time for all situations.

Pressure Level Assignment

STATION - 1

PREDICTED OVERPRESSURE LEVEL 1.07 PSF



VOICE ANNOTATION EDGE TRACK RECORDED

CALIBRAT I AND OVERPRESSURE LEVEL SETTINGS

CONSOLE 1 DATE _____

STATION 1 OPERATOR _____

SYSTEM NUMBER	D.G TUNES	CAL. SETTINGS D.G ATTN. SETTING	CAL. SETTINGS B.B. AMP. SETTING	ASSIGNED RUN LEVELS	RUN SETTINGS D.G ATTN. SETTING	RUN SETTINGS B.B. AMP. SETTING	TAPE CH
3	4.1 at 52	18	1 8	125 db	21	1 10	1
			2 8	131 db		2 4	2
4	4.0 at 51	15	3 8	119 db	12	3 6	3
			4 8	119		4 6	4
5	4.2 at 44	21	5 12	125 db	18	5 8	5
6	3.2 at 45	6		130 db	12		6

Cal. Level 124dB, set system gain for 2 vpp input to tape recorder.

NOTE: D.G attn. setting must satisfy 2 B.B. amp settings where applicable. Avoid setting D.G attn. below 6 db if possible.

EVENT TIMES

STATION - 2

DAY ZERO

1. Arrival at measurement station at launch time (launch time to be announced).
2. Ready to record data 2 hours, 30 min after launch.

DAY 1

3. Arrival at measurement station, 22 hours, 22 min after launch.
4. Ready to record data 1 day, plus 50 min after launch.

DAY 2

5. Arrival at measurement station 46 hours, 24 min after launch.
6. Ready to record data, 2 days plus 1 hour after launch.
7. "Recorders on" command will be initiated by Sonic Boom Coordinator.

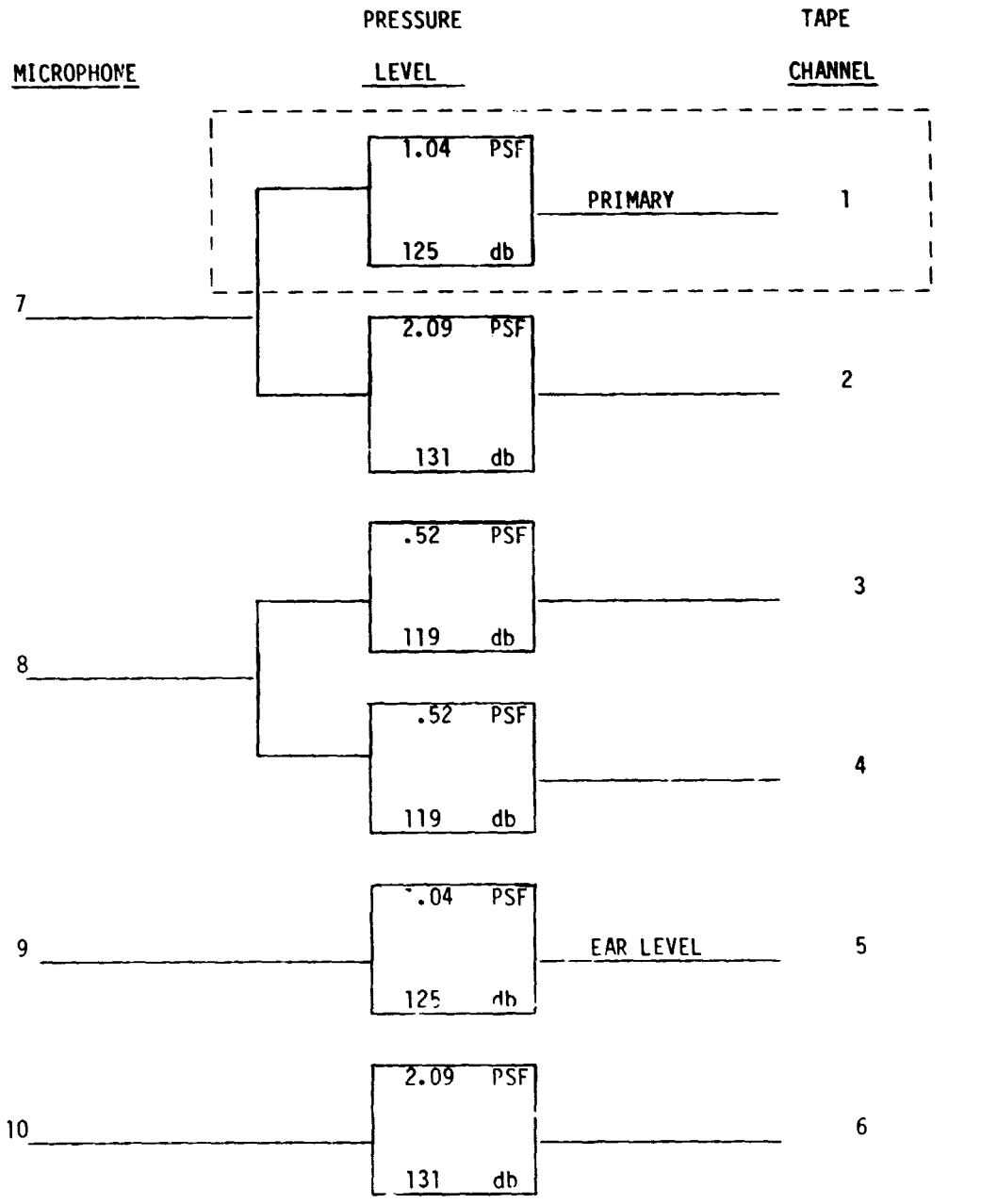
STATION RELEASE

8. Sonic Boom Coordinator will advise station release time for all situations.

Pressure Level Assignment

STATION - 2

PREDICTED OVERPRESSURE LEVEL 1.02 PSF



CALIBRATION AND OVERPRESSURE LEVEL SETTINGS

CONSOLE 2 DATE

STATION 2 OPERATOR

SYSTEM NUMBER	D.G TUNES	CAL. SETTINGS D.G ATTN. SETTING	CAL. SETTINGS B.B. AMP. SETTING	ASSIGNED RUN LEVELS	RUN SETTINGS D.G ATTN. SETTING	RUN SETTINGS B.B. AMP. SETTING	TAPE CH
7	3.3 at 56	18	1 10	125 db	21	1 12	1
			2 10	131 db		2 6	2
8	4.2 at 45	21	3 14	119 db	18	3 12	3
			4 14	119		4 12	4
9	3.3 at 46	15	5 8	125 db	18	5 4	5
10	4.2 at 47	9		130 db	15		6

Cal. Level 124dB, set system gain for 2 vpp input to tape recorder.

NOTE: D.G attn. setting must satisfy 2 B.B. amp settings where applicable.
Avoid setting D.G attn. below 6 db if possible.

EVENT TIMES

STATION - 3

DAY ZERO

1. Arrival at measurement station at launch time (launch time to be announced).
2. Ready to record data 2 hours, 30 min after launch.

DAY 1

3. Arrival at measurement station, 22 hours, 22 min after launch.
4. Ready to record data 1 day, plus 50 min after launch.

DAY 2

5. Arrival at measurement station 46 hours, 24 min after launch.
6. Ready to record data, 2 days plus 1 hour after launch.
7. "Recorders on" command will be initiated by Sonic Boom Coordinator.

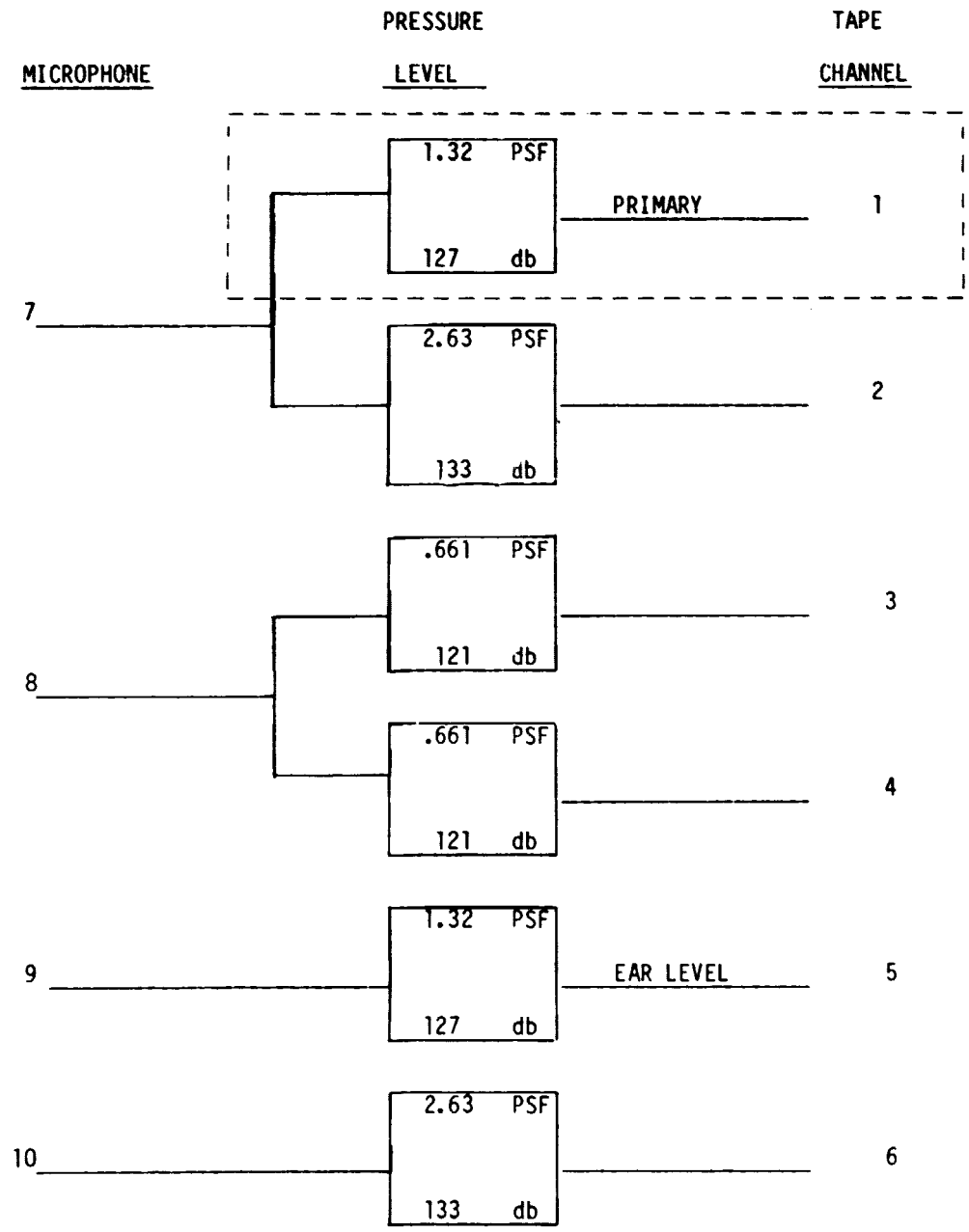
STATION RELEASE

8. Sonic Boom Coordinator will advise station release time for all situations.

Pressure Level Assignment

STATION - 3

PREDICTED OVERPRESSURE LEVEL 1.34 PSF



CALIBRATION AND OVERPRESSURE LEVEL SETTINGS

CONSOLE 3 DATE _____

STATION 3 OPERATOR _____

SYSTEM NUMBER	D.G TUNES	CAL. SETTINGS D.G ATTN. SETTING	CAL. SETTINGS B.B. AMP. SETTING	ASSIGNED RUN LEVELS	RUN SETTINGS D.G ATTN. SETTING	RUN SETTINGS B.B. AMP. SETTING	TAPE CH
11	4.0 at 51	18	1 8	127 db	21	1 8	1
			2 8	133 db		2 2	2
12	4.2 at 46	18	3 8	121 db	15	3 8	3
			4 8	121		4 8	4
13	3.3 at 51	18	5 10	127 db	21	5 10	5
14	4.3 at 46	9		133 db	18		6

Cal. Level 124dB, set system gain for 2 vpp input to tape recorder.

NOTE: D.G attn. setting must satisfy 2 B.B. amp settings where applicable. Avoid setting D.G attn. below 6 db if possible.

EVENT TIMES

STATION - 4

DAY ZERO

1. Arrival at measurement station at launch time (launch time to be announced).
2. Ready to record data 2 hours, 30 min after launch.

DAY 1

3. Arrival at measurement station, 22 hours, 22 min after launch.
4. Ready to record data 1 day, plus 50 min after launch.

DAY 2

5. Arrival at measurement station 46 hours, 24 min after launch.
6. Ready to record data, 2 days plus 1 hour after launch.
7. "Recorders on" command will be initiated by Sonic Boom Coordinator.

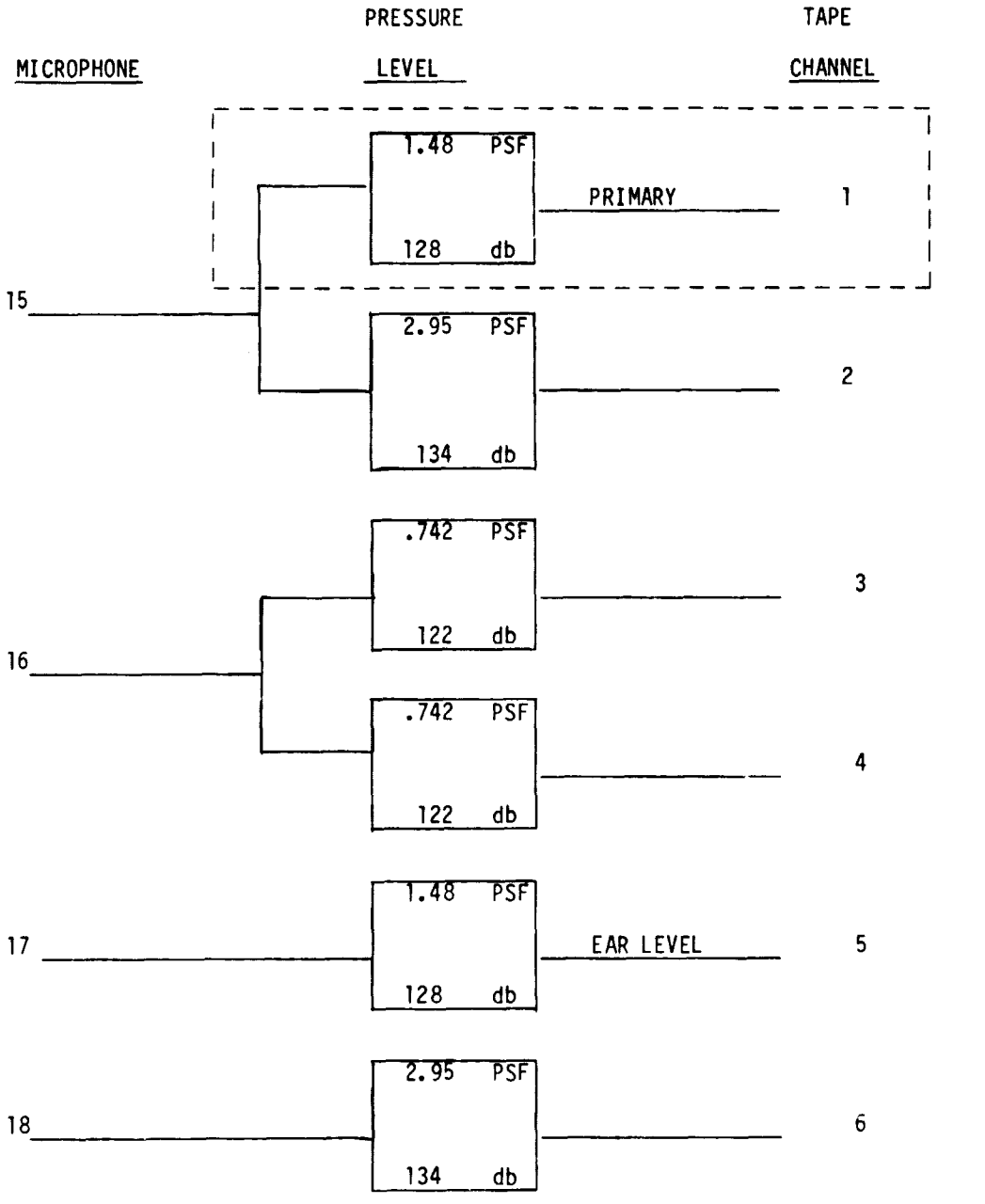
STATION RELEASE

8. Sonic Boom Coordinator will advise station release time for all situations.

Pressure Level Assignment

STATION - 4

PREDICTED OVERPRESSURE LEVEL 1.54 PSF



CALIBRATION AND OVERPRESSURE LEVEL SETTINGS

CONSOLE 4 DATE _____

STATION 4 OPERATOR _____

SYSTEM NUMBER	D.G TUNES	CAL. SETTINGS D.G ATTN. SETTING	CAL. SETTINGS B.B. AMP. SETTING	ASSIGNED RUN LEVELS	RUN SETTINGS D.G ATTN. SETTING	RUN SETTINGS B.B. AMP. SETTING	TAPE CH
15	4.0 at 52	18	1 8	128 db	24	1 10	1
			2 8	134 db		2 4	2
16	4.0 at 47	21	3 12	122 db	15	3 8	3
			4 12	122		4 8	4
17	4.4 at 47	18	5 8	128 db	18	5 4	5
18	3.1 at 51	9		133 db	18		6

Cal. Level 124dB, set system gain for 2 vpp input to tape recorder.

NOTE: D.G attn. setting must satisfy 2 B.B. amp settings where applicable.
Avoid setting D.G attn. below 6 db if possible.

EVENT TIMES

STATION - 5

DAY ZERO

1. Arrival at measurement station at launch time (launch time to be announced).
2. Ready to record data 2 hours, 22 min after launch.

DAY 1

3. Arrival at measurement station, 22 hours, 22 min after launch.
4. Ready to record data 1 day, plus 50 min after launch.

DAY 2

5. Arrival at measurement station 46 hours, 24 min after launch.
6. Ready to record data, 2 days plus 1 hour after launch.
7. "Recorders on" command will be initiated by Sonic Boom Coordinator.

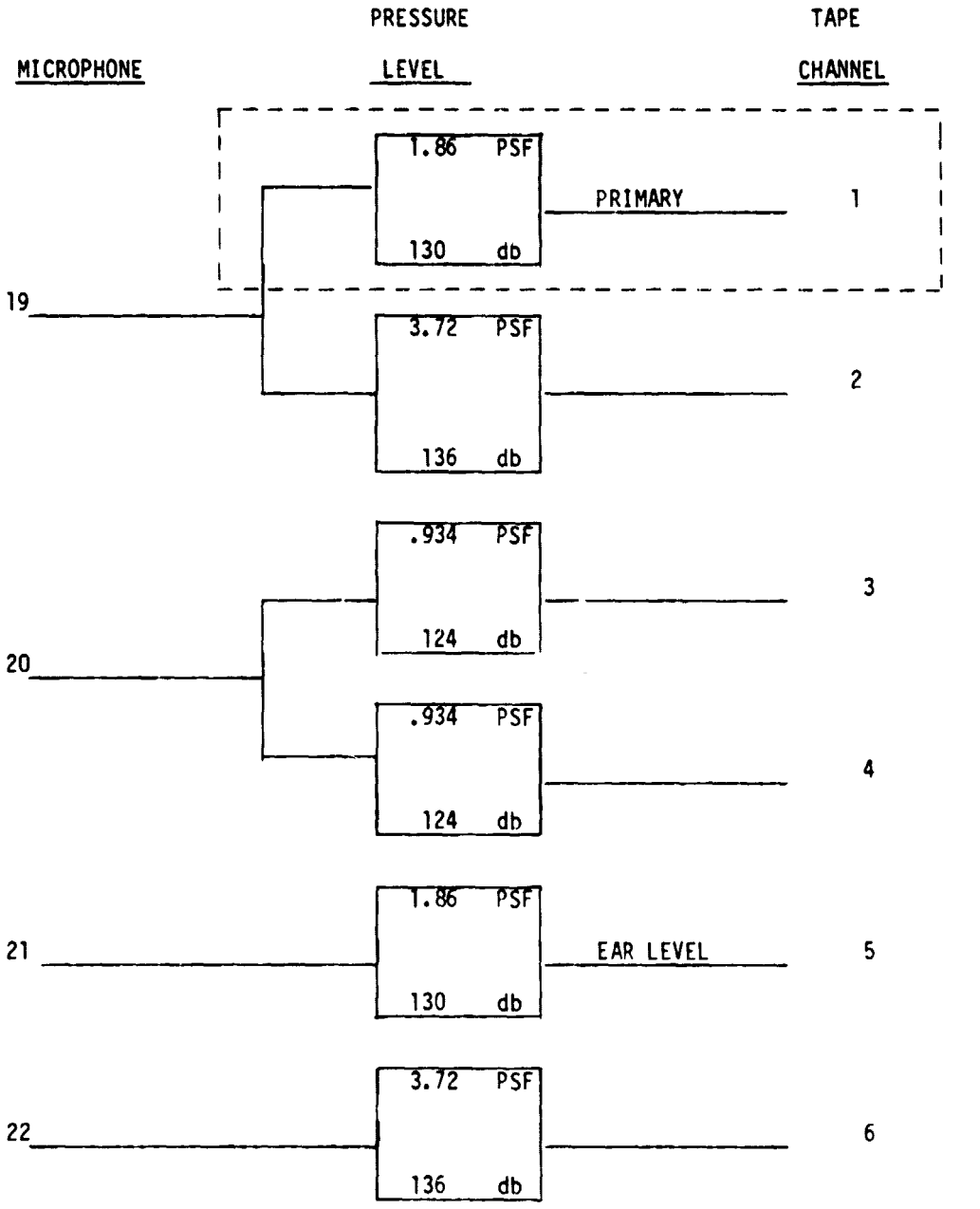
STATION RELEASE

8. Sonic Boom Coordinator will advise station release time for all situations.

Pressure Level Assignment

STATION - 5

PREDICTED OVERPRESSURE LEVEL 1.81 PSF



CALIBRATION AND OVERPRESSURE LEVEL SETTINGS

CONSOLE 5 DATE

STATION 5 OPERATOR

SYSTEM NUMBER	D.G TUNES	CAL. SETTINGS D.G ATTN. SETTING	CAL. SETTINGS B.B. AMP. SETTING	ASSIGNED RUN LEVELS		RUN SETTINGS D.G ATTN. SETTING	RUN SETTINGS B.B. AMP. SETTING	TAPE CH
19	3.3 at 42	15	1 6	130	db	21	1 6	1
			2 6	136	db		2 0	2
20	3.2 at 43	18	3 10	124	db	18	3 10	3
			4 10	124			4 10	4
21	3.2 at 45	18	5 8	130	db	18	5 2	5
22	4.0 at 45	9		136	db	21		6

Cal. Level 124dB, set system gain for 2 vpp input to tape recorder.

NOTE: D.G attn. setting must satisfy 2 B.B. amp settings where applicable.
Avoid setting D.G attn. below 6 db if possible.

EVENT TIMES

STATION - 6

DAY ZERO

1. Arrival at measurement station at launch time (launch time to be announced).
2. Ready to record data 2 hours, 22 min after launch.

DAY 1

3. Arrival at measurement station, 22 hours, 22 min after launch.
4. Ready to record data 1 day, plus 50 min after launch.

DAY 2

5. Arrival at measurement station 46 hours, 24 min after launch.
6. Ready to record data, 2 days plus 1 hour after launch.
7. "Recorders on" command will be initiated by Sonic Boom Coordinator.

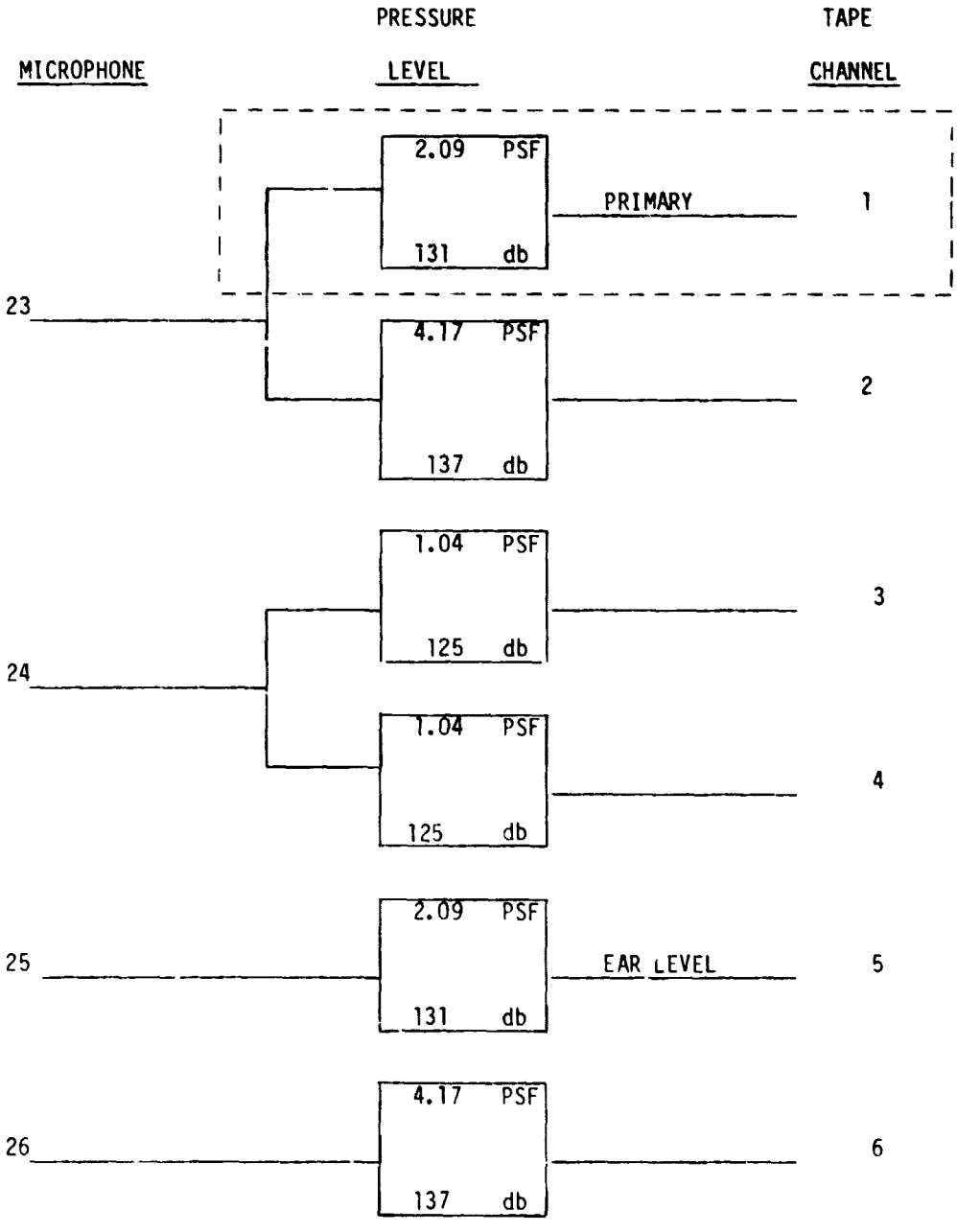
STATION RELEASE

8. Sonic Boom Coordinator will advise station release time for all situations.

Pressure Level Assignment

STATION - 6

PREDICTED OVERPRESSURE LEVEL 1.98 PSF



CALIBRATION AND OVERPRESSURE LEVEL SETTINGS

CONSOLE 6 DATE _____

STATION 6 OPERATOR _____

SYSTEM NUMBER	D.G TUNES	CAL. SETTINGS D.G ATTN. SETTING	CAL. SETTINGS B.B. AMP. SETTING	ASSIGNED RUN LEVELS	RUN SETTINGS D.G ATTN. SETTING	RUN SETTINGS B.B. AMP. SETTING	TAPE CH
23	3.4 at 47	15	1 4	131 db	24	1 6	1
			2 4	137 db		2 0	2
24	4.1 at 48	18	3 8	125 db	21	3 10	3
			4 8	125		4 10	4
25	4.3 at 44	18	5 6	131 db	21	5 2	5
26	4.3 at 54	12		136 db	24		6

Cal. Level 124dB, set system gain for 2 vpp input to tape recorder.

NOTE: D.G attn. setting must satisfy 2 B.B. amp settings where applicable.
Avoid setting D.G attn. below 6 db if possible.

EVENT TIMES

STATION - 7

DAY ZERO

1. Arrival at measurement station at launch time (launch time to be announced).
2. Ready to record data 2 hours, 22 min after launch.

DAY 1

3. Arrival at measurement station, 22 hours, 22 min after launch.
4. Ready to record data 1 day, plus 50 min after launch.

DAY 2

5. Arrival at measurement station 46 hours, 24 min after launch.
6. Ready to record data, 2 days plus 1 hour after launch.
7. "Recorders on" command will be initiated by Sonic Boom Coordinator.

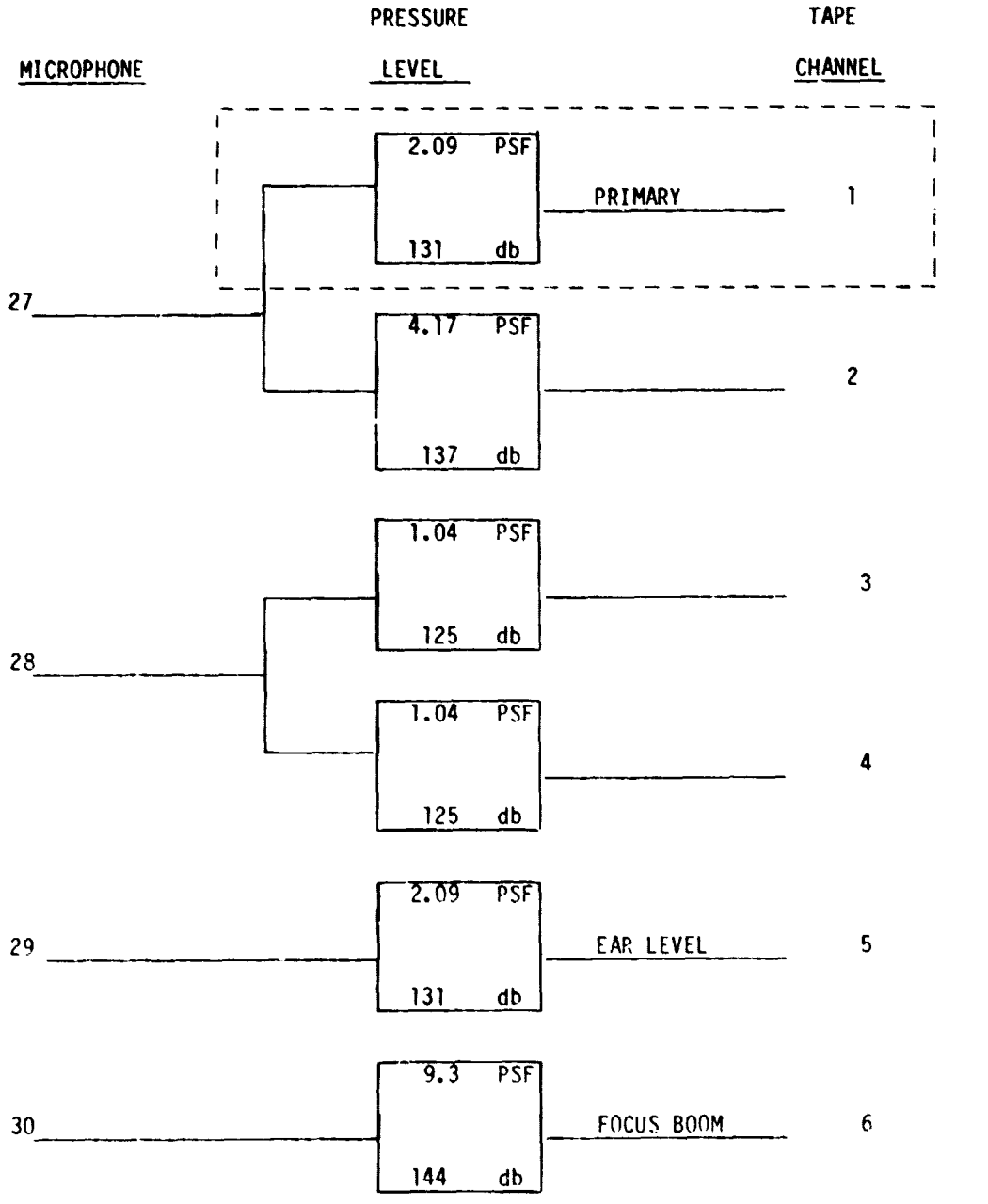
STATION RELEASE

8. Sonic Boom Coordinator will advise station release time for all situations.

Pressure Level Assignment

STATION - 7

PREDICTED OVERPRESSURE LEVEL 2.13 PSF



CALIBRATION AND OVERPRESSURE LEVEL SETTINGS

CONSOLE 7 DATE _____

STATION 7 OPERATOR _____

SYSTEM NUMBER	D.G TUNES	CAL. SETTINGS D.G ATTN. SETTING	CAL. SETTINGS B.B. AMP. SETTING	ASSIGNED RUN LEVELS	RUN SETTINGS D.G ATTN. SETTING	RUN SETTINGS B.B. AMP. SETTING	TAPE CH
27	4.2 at 45	15	1 6	131 db	24	1 8	1
			2 6	137 db		2 2	2
28	4.0 at 49	18	3 10	125 db	21	3 12	3
			4 10	125		4 12	4
29	4.1 at 48	18	5 8	131 db	21	5 4	5
30	4.1 at 51	0		145 db	21		6

Cal. Level 124dB, set system gain for 2 vpp input to tape recorder.

NOTE: D.G attn. setting must satisfy 2 B.B. amp settings where applicable. Avoid setting D.G attn. below 6 db if possible.

EVENT TIMES

STATION - 8

DAY ZERO

1. Arrival at measurement station at launch time (launch time to be announced).
2. Ready to record data 2 hours, 22 min after launch.

DAY 1

3. Arrival at measurement station, 22 hours, 22 min after launch.
4. Ready to record data 1 day, plus 50 min after launch.

DAY 2

5. Arrival at measurement station 46 hours, 24 min after launch.
6. Ready to record data, 2 days plus 1 hour after launch.
7. "Recorders on" command will be initiated by Sonic Boom Coordinator.

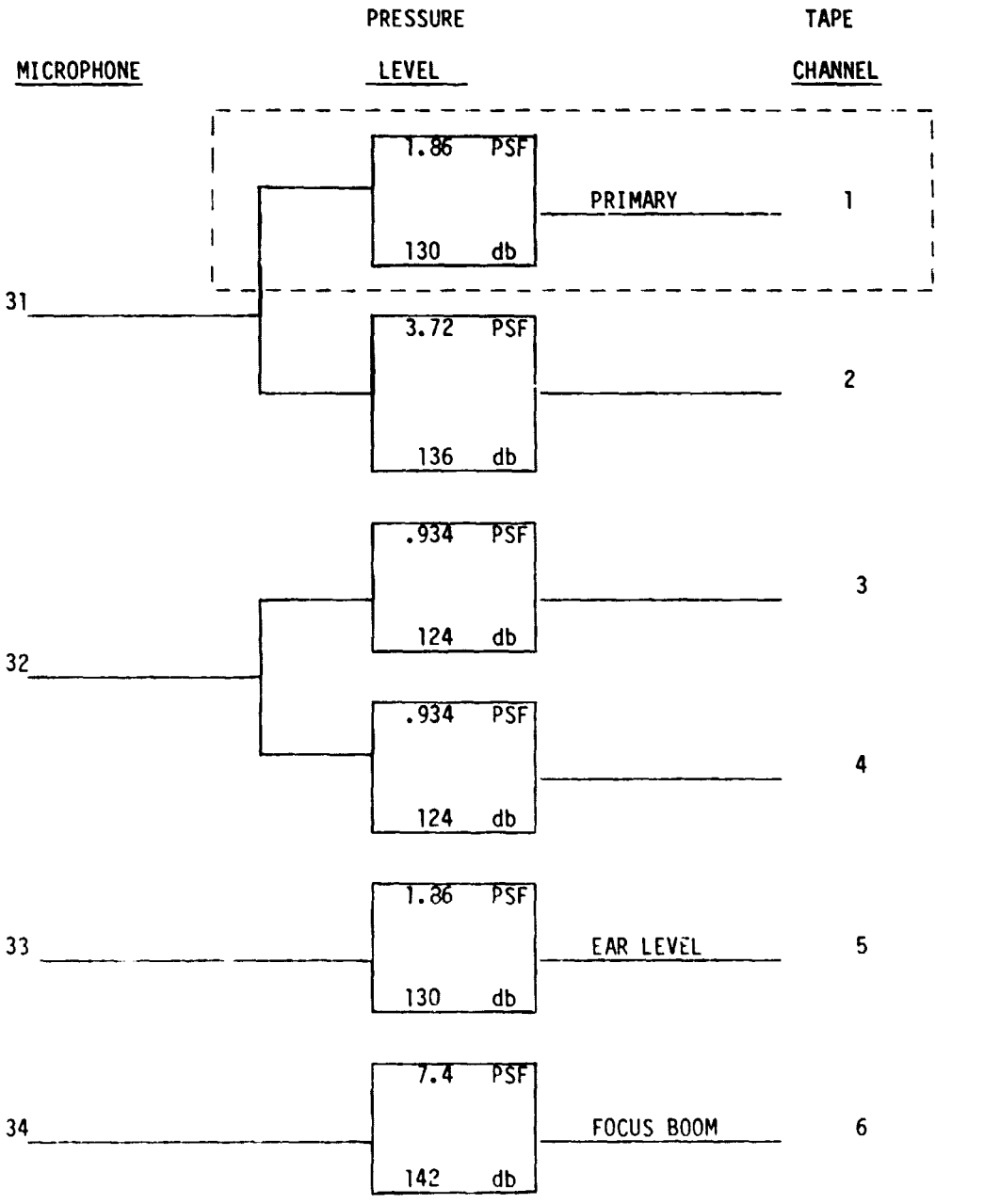
STATION RELEASE

8. Sonic Boom Coordinator will advise station release time for all situations.

Pressure Level Assignment

STATION - 8

PREDICTED OVERPRESSURE LEVEL 1.85 PSF



CALIBRATION AND OVERPRESSURE LEVEL SETTINGS

CONSOLE 8 DATE _____

STATION 8 OPERATOR _____

SYSTEM NUMBER	D.G TUNES	CAL. SETTINGS D.G ATTN. SETTING	CAL. SETTINGS B.B. AMP. SETTING	ASSIGNED RUN LEVELS	RUN SETTINGS D.G ATTN. SETTING	RUN SETTINGS B.B. AMP. SETTING	TAPE CH
31	3.1 at 46	15	1 4	131 db	24	1 6	1
			2 4	137 db		2 0	2
32	4.1 at 49	18	3 10	124 db	18	3 10	3
			4 10	124		4 10	4
33	4.4 at 51	15	5 8	130 db	15	5 2	5
34	4.1 at 48	0		142 db	18		6

Cal. Level 124dB, set system gain for 2 vpp input to tape recorder.

NOTE: D.G attn. setting must satisfy 2 B.B. amp settings where applicable.
Avoid setting D.G attn. below 6 db if possible.

EVENT TIMES

STATION - 9

DAY ZERO

1. Arrival at measurement station at launch time (launch time to be announced).
2. Ready to record data 2 hours, 22 min after launch.

DAY 1

3. Arrival at measurement station, 22 hours, 22 min after launch.
4. Ready to record data 1 day, plus 50 min after launch.

DAY 2

5. Arrival at measurement station 46 hours, 24 min after launch.
6. Ready to record data, 2 days plus 1 hour after launch.
7. "Recorders on" command will be initiated by Sonic Boom Coordinator.

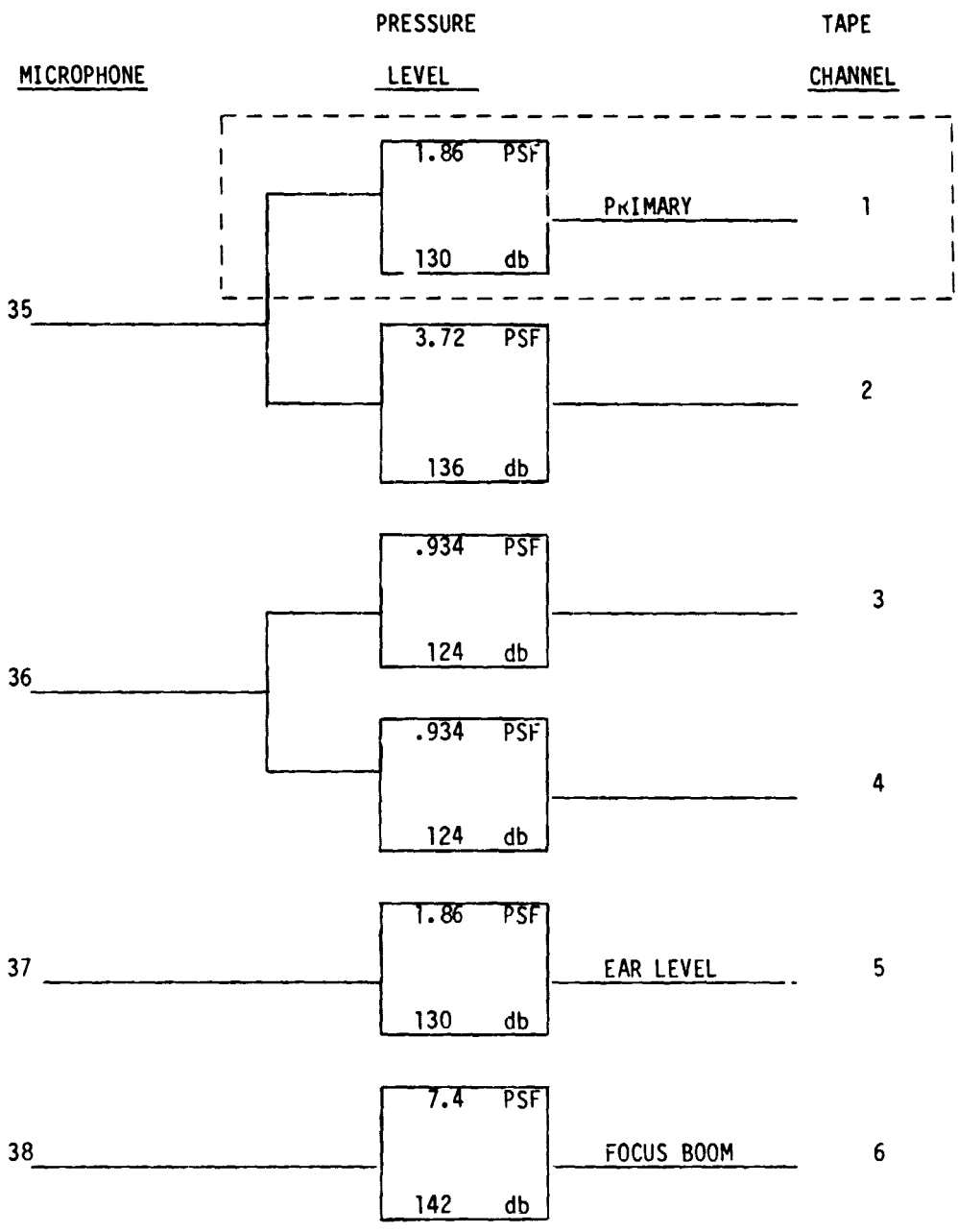
STATION RELEASE

8. Sonic Boom Coordinator will advise station release time for all situations.

Pressure Level Assignment

STATION - 9

PREDICTED OVERPRESSURE LEVEL 1.79 PSF



CALIBRATION AND OVERPRESSURE LEVEL SETTINGS

CONSOLE 9 ___ DATE _____

STATION 9 OPERATOR _____

SYSTEM NUMBER	D.G TUNES	CAL. SETTINGS D.G ATTN. SETTING	CAL. SETTINGS B.B. AMP. SETTING	ASSIGNED RUN LEVELS	RUN SETTINGS D.G ATTN. SETTING	RUN SETTINGS B.B. AMP. SETTING	TAPE CH
35	3.1 at 49	15	1 8	130 db	21	1 8	1
			2 8	136 db		2 2	2
36	3.4 at 48	18	3 10	124 db	18	3 10	3
			4 10	124		4 10	4
37	4.1 at 45	15	5 6	130 db	21	5 6	5
38	4.1 at 49	0 (1.8 vpp)		142 db	18 (1.8 vpp)		6

Cal. Level 124dB, set system gain for 2 vpp input to tape recorder.

NOTE: D.G attn. setting must satisfy 2 B.B. amp settings where applicable.
Avoid setting D.G attn. below 6 db if possible.

EVENT TIMES

STATION - 10

DAY ZERO

1. Arrival at measurement station at launch time (launch time to be announced).
2. Ready to record data 2 hours, 22 min after launch.

DAY 1

3. Arrival at measurement station, 22 hours, 22 min after launch.
4. Ready to record data 1 day, plus 50 min after launch.

DAY 2

5. Arrival at measurement station 46 hours, 24 min after launch.
6. Ready to record data, 2 days plus 1 hour after launch.
7. "Recorders on" command will be initiated by Sonic Boom Coordinator.

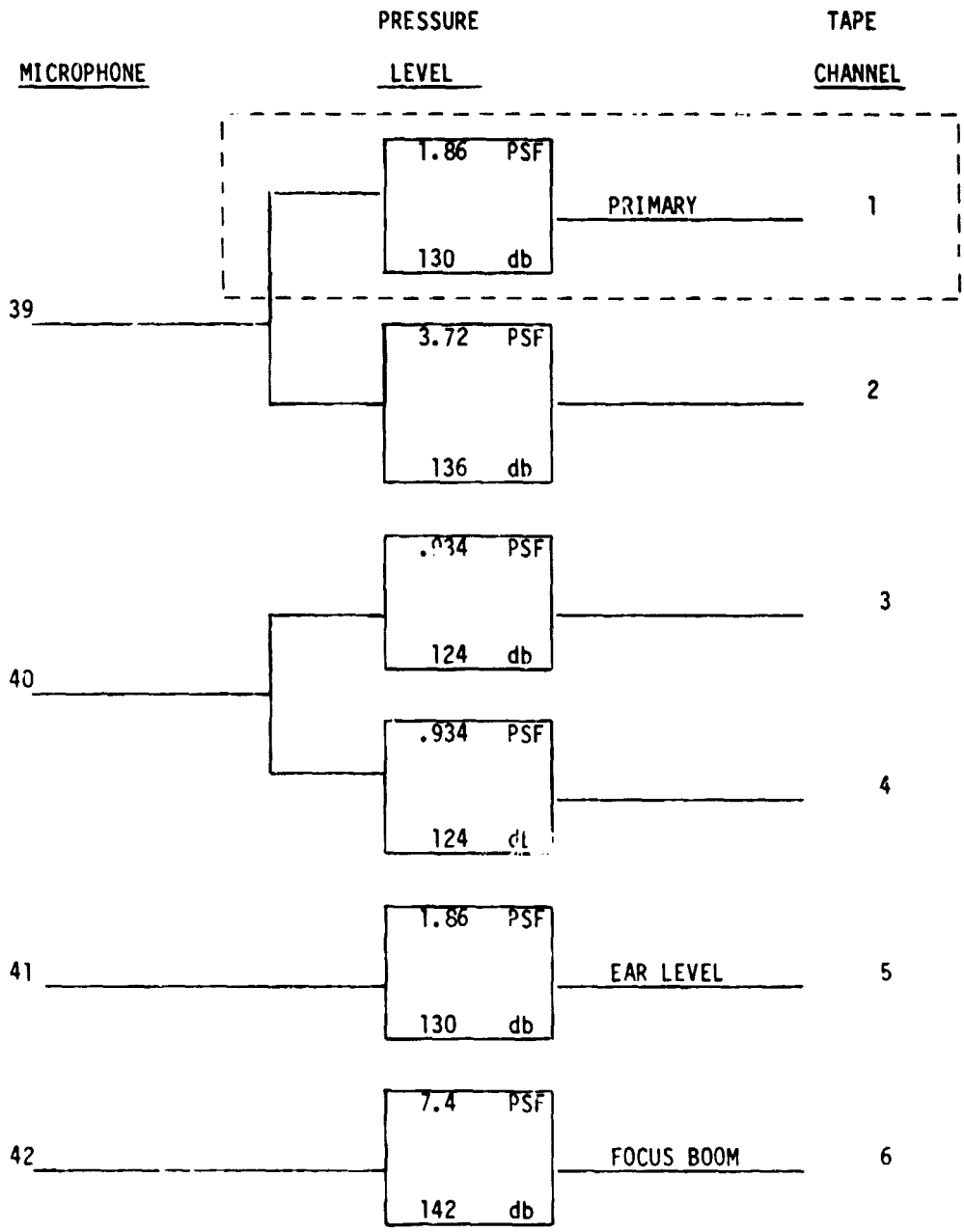
STATION RELEASE

8. Sonic Boom Coordinator will advise station release time for all situations.

Pressure Level Assignment

STATION - 10

PREDICTED OVERPRESSURE LEVEL 1.87 PSF



CALIBRATION AND OVERPRESSURE LEVEL SETTINGS

CONSOLE 10 DATE _____

STATION 10 OPERATOR _____

SYSTEM NUMBER	D.G TUNES	CAL. SETTINGS D.G ATTN. SETTING	CAL. SETTINGS B.B. AMP. SETTING	ASSIGNED RUN LEVELS	RUN SETTINGS D.G ATTN. SETTING	RUN SETTINGS B.B. AMP. SETTING	TAPE CH
39	4.0 at 47	15	1 10	130 db	21	1 10	1
			2 10	136 db		2 4	2
40	4.5 at 49	18	3 12	124 db	18	3 12	3
			4 12	124		4 12	4
41	3.2 at 55	21	5 8	130 db	21	5 2	5
42	4.1 at 44	0	(1.6vpp)	142 db	18	(1.6 vpp)	6

Cal. Level 124dB, set system gain for 2 vpp input to tape recorder.

NOTE: D.G attn. setting must satisfy 2 B.B. amp settings where applicable.
Avoid setting D.G attn. below 6 db if possible.

Table 1. - STS-1 Sonic Boom Theoretical Predictions for Edwards Air Force Base, CA, Area.

MACH NUMBER	ALTITUDE, ft,	Δ_p PSF	LATERAL DISTANCE FROM GROUND TRACK (n mi)	LONGITUDE, DEG	LATITUDE, DEG
5.89	127,196	0.8	0	120.746	35.88
4.02	106,657	1.07	0	119.324	35.85
3.5	99,096	1.02	0	118.967	35.08
2.97	90,394	1.34	0	118.632	35.05
2.45	83,269	1.54	0	118.336	35.05
2.04	77,714	1.81	0	118.119	35.01
1.83	73,161	1.98	0	118.013	35.99
1.52	64,828	2.13	0	117.863	34.95
1.52	64,828	1.85	5.69	117.869	34.85
1.52	64,828	1.79	5.69	117.805	35.03
1.31	59,549	1.87	0	117.757	34.92

Table 2. - Approximate Positioning Information for STS-1 Sonic Boom Measuring Stations for Edwards Air Force Base, CA area.

STATION, NO/NAME	MACH NUMBER	ALTITUDE K ft	Δp PSF	LATERAL DISTANCE FROM GROUND TRACK (n mi)	* LONGITUDE, DEG	* LATITUDE, DEG
0 - CAMP ROBERTS	5.9	127,196	1.05	0	120.666	35.833
1 - BUENA VISTA	4.01	106,657	1.39	0	119.333	35.168
2 - SOUTH BAKERSFIELD	3.5	99,096	1.47	0	118.963	35.082
3 - STALLION SPRINGS	2.97	90,394	1.66	0	118.635	35.083
4 - TEHACHAPI	2.45	83,269	1.69	0	118.333	35.070
5 - MOJAVE	2.03	77,714	1.86	0	118.113	35.033
6 - EAST-MOJAVE	1.83	73,161	2.00	0	118.012	35.007
7 - NORTH-BASE	1.51	64,828	2.12	0	117.850	35.000
8 - SOUTH BASE	1.51	64,828	1.81	6.5	117.875	34.867
9 - NORTH-EDWARDS	1.51	64,828	1.81	6.5	117.800	35.046
10 - ROBERT BASE	1.31	59,549	1.85	0	117.758	34.933

* Approximate positioning information obtained from 7.5 minute series topographic maps.

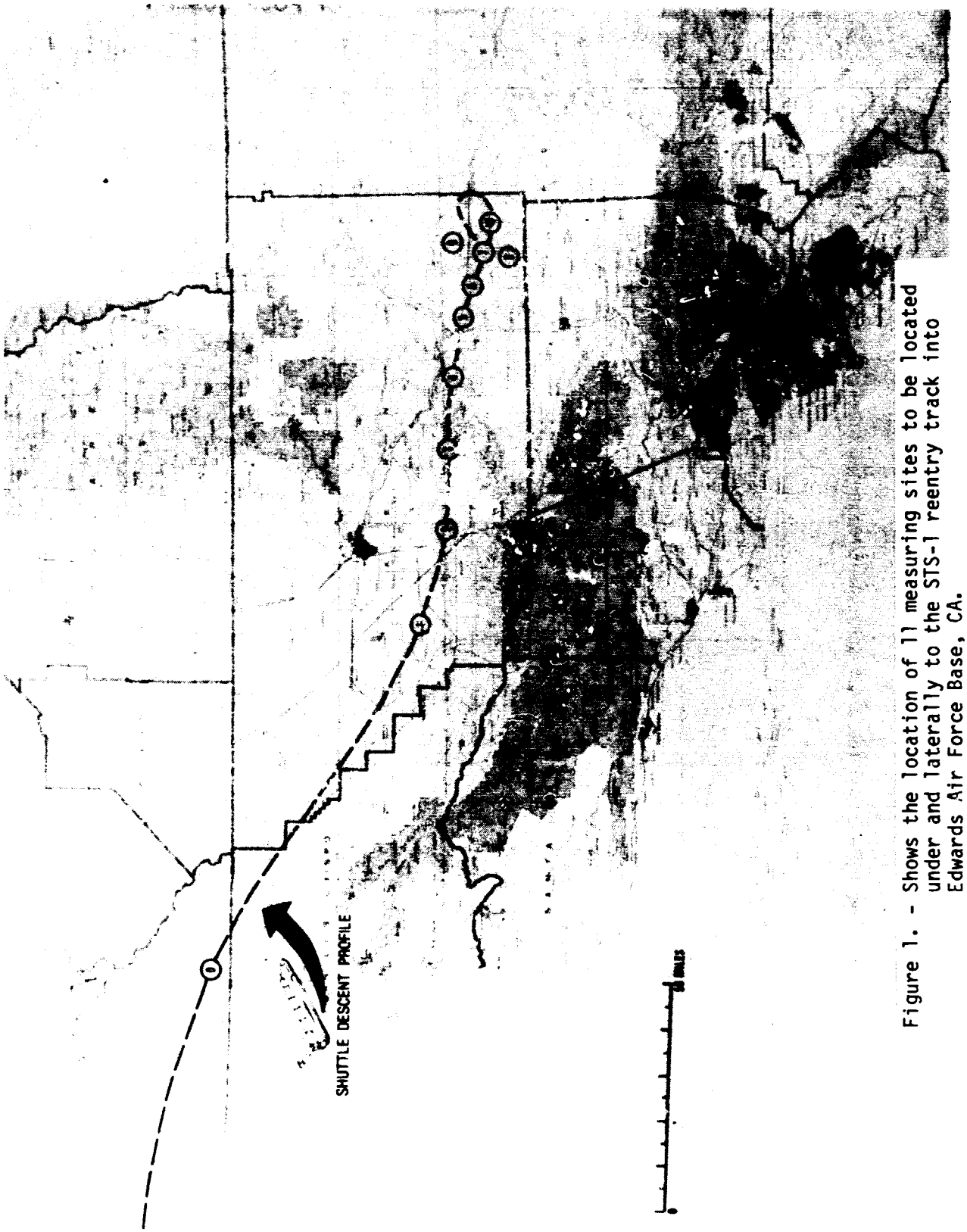


Figure 1. - Shows the location of 11 measuring sites to be located under and laterally to the STS-1 reentry track into Edwards Air Force Base, CA.

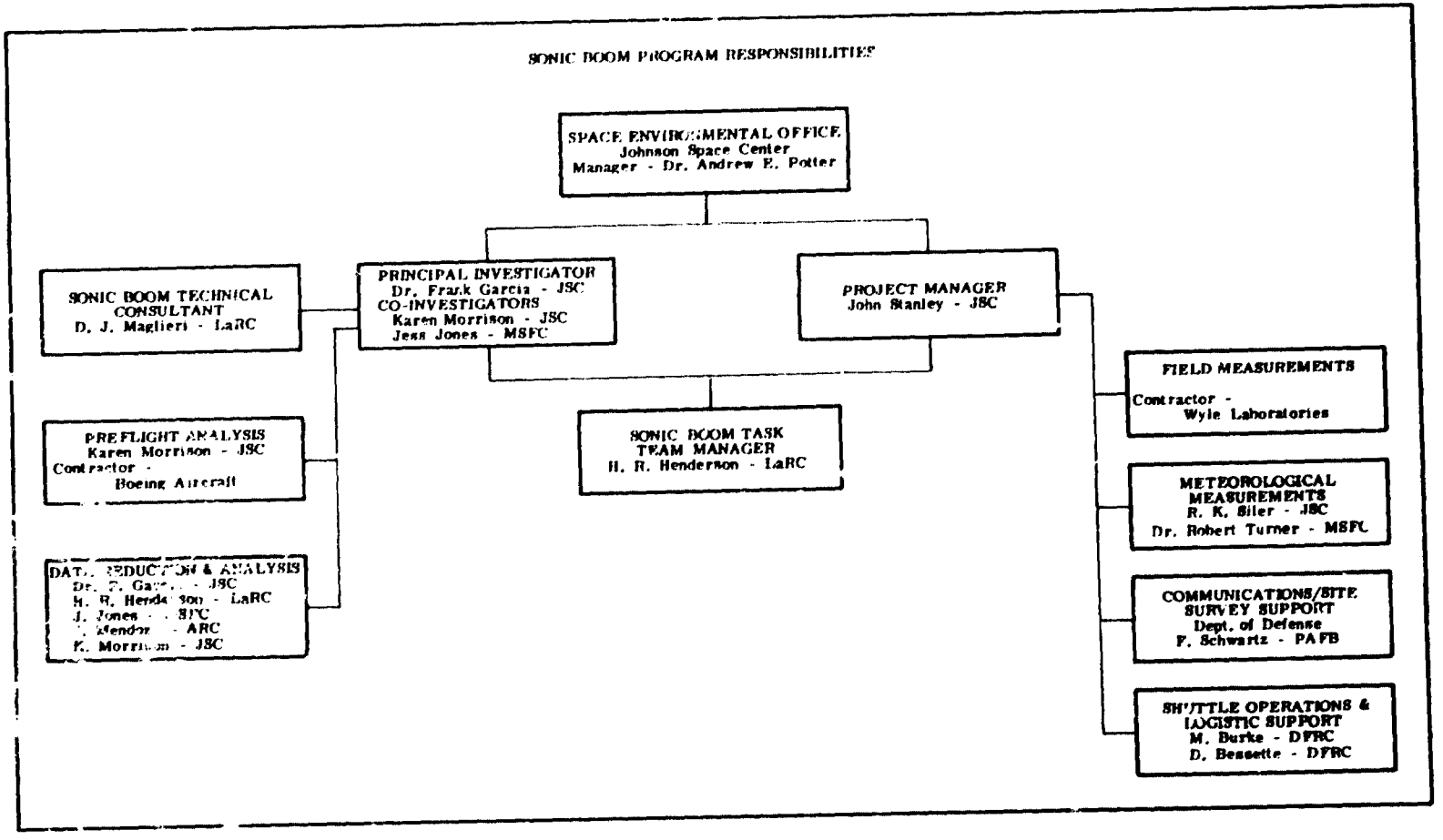


Figure 2. - Program Responsibilities.