NASA CONTRACTOR REPORT 166454

X-Wing Noise Data Acquisition Program

Gerald J. Healy

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Gerald J. Healy
Lockheed Corporation
Lockheed-California Company
Burbank, California

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Space Administration

Ames Research Center
Moffett Field California 94035

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SECTION 1
SUMMARY

The X-Wing circulation controlled rotor system model was tested for hover performance at the Lockheed-California Company (CALAC) Rye Canyon Research Laboratories whirl tower test facility. During these performance tests noise data from twelve microphones was recorded on magnetic tape for subsequent data reduction. The rotor system was operated at four (4) tip speeds ranging from 529 to 650 ft./sec. (404 to 497 RPM), collective angles of attack from 0° to 8.5° (maximum) and blade pressure ratios from 1.0 (no blowing) to a maximum of 2.1. The twelve microphones included eleven in the far field and one in the transmission area.

The noise measurement program began on 10 March 1982 and concluded on 5 April 1982 with measurements of sub-system noise. Following completion of the rotor and sub-system noise measurements, sound field calibration measurements were made of both the rotor "bowl" and the loudspeaker system used in the "bowl" calibration measurements. The location of ten (10) far field microphones were measured by a surveyor. Additionally, detailed tape logs were prepared for the six reels of tape used for the program.

The entire program encompassed recording 218 individual test conditions including 56 cases not in the original test plan and 22 repeated conditions. Mistaken placement of a completed data tape among blank tapes resulted in the inadvertant erasure of 30 test cases (including nine not originally scheduled) plus eighteen repeated cases for a total loss of 48 cases. Consequently, there remains a total of 170 individual data cases which includes 47 cases not originally scheduled and 4 repeated cases.

The resulting data tapes are to be processed by the NASA Langley acoustics organization.

SECTION 2
INTRODUCTION

The DARPA/Lockheed developed X-Wing rotor is a circulation controlled system capable of providing blowing of the tip, leading edge and/or trailing edge of the rotor blades as the means whereby circulation control is obtained. For the test runs during which noise measurements were made there was no leading edge blowing and only half of the available tip blowing was used.

One potential advantage of the circulation controlled type of rotor, from a noise viewpoint, is the ability to slow the rotor (reduce the rotational speed) without loss of lifting capability which would occur with a conventional rotor system. Because the noise produced by a rotor is strongly influenced by the rotational speed of the rotor, the potential for noise reduction by slowing the rotor is readily apparent.

Acoustic measurements were not included in the DARPA-funded X-Wing rotor performance test program; however, just prior to commencement of the performance testing a measurement-only program was funded by the NASA and administered by the DARPA as an add-on to the performance test program. These noise measurements were to be made simultaneously with the performance tests on a non-interference basis.

SECTION 3
OBJECTIVES

The primary objective of the X-Wing noise measurement program was to tape record the noise produced by the X-Wing circulation controlled rotor system for selected operating conditions. These operating conditions were selected from the rotor performance test plan, with the emphasis placed on the basic hover performance cases. The noise data were to be recorded simultaneously with the performance data on a non-interference basis. Actual test cases run and recorded were to be dictated by the rotor performance test program and any modifications thereto. At the conclusion of the performance testing, supplemental noise measurements were to be made for the purpose of evaluating the noise produced by operational systems not directly responsible for the major noise produced by the X-Wing rotor system. These operational systems contribute to the overall background noise present during rotor system operation and represent a lower bound for rotor system noise measurements.

A secondary objective of the program was the acoustical calibration of the whirl tower test facility "bowl". The purpose of the calibration was to obtain data from which the physical influence of the test facility on the radiated sound field of the X-Wing rotor could be determined. Calibration tests were to be performed using an impulsive noise produced by a small cannon and both pure tones and broadband random noise broadcast from a loudspeaker. Both the cannon and loudspeaker were to be located at the top of the whirl tower. Additionally, recordings were to be made of the frequency response of the loudspeaker system with microphones positioned at the same angles as used at the whirl tower test facility.

Finally, detailed tape data log sheets were to be prepared to supplement the test "run cards". At the conclusion of the foregoing tasks, the original data tapes were to be sent to the NASA Langley Research Center, Hampton, Virginia for processing.

The objectives of the X-Wing Noise Measurement Program (original and expanded scope), as delineated in the foregoing paragraphs, were met.

SECTION 4
PROGRAM SCOPE

The noise measurements program for the X-Wing rotor system encompassed wiring the rotor test "bowl" for twelve widely disbursed microphone systems, setting-up and calibrating these systems prior to each test run, tape recording the X-Wing noise during performance runs, calibrating and disassembling these systems at the conclusion of each run, recording the noise produced by major sub-systems, acoustic calibration of the rotor "bowl", acoustic calibration of the bowl-calibration loudspeaker, surveying the microphone locations, preparation of detailed tape log sheets, and removal of the twelve microphone cables from the rotor bowl. The actual X-Wing noise measurements spanned a wide range of basic hover performance operating conditions. These measurements involved tape recording the noise received by eleven far field and one drive transmission area microphone. Ten of eleven far field microphones were arrayed along two lines, each having five microphones, plus one free field microphone in the plane of the rotor.

The noise measurement program, when first proposed by the Lockheed-California Company, incorporated 252 individual hover test conditions selected from the performance test plan. Because the noise measurements were to be made simultaneously with the performance tests on a non-interference basis, the actual conditions tested, and consequently measured, were dictated entirely by the performance test program. As a result, a number of changes were made to the test plan -- some prior to commencement of the tests and others during the tests. At the conclusion of the performance phase of the program, noise measurements had been taken on 212 individual conditions including 166 basic hover cases (of which 56 had been added to the original test plan), 22 repeated hover cases, 9 cases where control power was applied to the rotor, 5 cases where the blades were not rotated, 3 cases where then blades were removed and 5 sub-system noise cases. Following the performance test phase, the rotor test facility "bowl" was acoustically calibrat... determine the influence of the test facility configuration on the sound field of the X-Wing rotor system. The loudspeaker system used in the rotor test facility calibration was then calibrated in an anechoic chamber. At this point a total of 218 individual test conditions had been recorded. A surveyor measured the locations of the ten far field "ground level" microphones. The location of the eleventh microphone, on top of the gantry, was measured with a steel tape measure. Finally, a detailed log of each of the six magnetic tapes, using the IRIG time code for marking the start and stop of each condition, was prepared.

Upon completion of the tape logging process, a cross-check with the list of runs compiled from the run cards revealed that the data from run cards 27 and 28 were missing. It was subsequently determined that the data tape containing these runs had been mistakenly placed among the blank tapes and inadvertantly re-used, resulting in erasure of these runs. This tape contained 30 test conditions (including 9 not in the original test program) plus 18 repeated cases for a total of 48 cases. These test conditions covered the majority of the high pressure runs -- only those high pressure runs made at 1.5^{o} collective angle of attack remain. Also lost was one of the two sets of runs made at 4.5^{o} collective angle of attack. Consequently, there remains a total of 172 individual test cases (149 X-Wing (rotating), 8 non-rotating (5 with and 3 without blades), 5 sub-system, 5 bowl calibration and 3 loudspeaker calibrations) which include 47 additional rotor operating test conditions not in the original test plan and 9 cases where control power was applied to the rotor system.

The scope of the proposed test program, in the form of tables listing the anticipated test conditions, is presented in Appendix A while the scope of the data acquisition program (including those test conditions inadvertantly erased) is presented in Appendix B.

SECTION 5
DATA ACQUISITION

The far field noise produced by the X-Wing rotor system was measured during hover performance testing while operating over a wide range of conditions. Included herein is a description of the whirl tower test facility (as it pertains to this program), the X-Wing test model rotor system, the acoustic test program, the acoustic test instrumentation and the acoustic and performance test procedures.

During the period of data acquisition, several occurances took place that severely inhibited program progress. The first was rainfall, typical for Southern California at that time of the year, and the second was a one-per-rev "chirp" sound that developed at the very onset of the performance a noise measurement program. This sound was intermittent at first, but by end of the test program it occurred at some time on nearly all the d runs. The first few times it occurred, the tests were halted to determine if physical damage was associated with the sound. When it was determined that damage was apparently not taking place, testing proceeded even in the presence of the "chirp". Consequently, many of the acoustic data records contain this additional sound. When it did ooccur it appeared to affect the 2500 and/or 3150 Hz one-third octave bands the most. The source of this sound was never located.

5.1 ROTOR TEST FACILITY

The CALAC rotor whirl tower is situated in the center of a man-made bowl created by cutting and filling a small natural canyon. Figure 1 is a plan view drawing of the bowl to which has been added the whirl tower, gantry tracks and microphone locations. A cross-sectional drawing of the facility,

Figure 2, shows some of the major bowl and tower dimensions. Figures 3 through 6 show the bowl, whirl tower, gantry, and X-Wing test model from various perspectives. The control room in located on the second floor of the maintenance/control building behind the narrow horizontal windows.

Access to the whirl tower main platform is provided by a movable gantry. For test runs the gantry is moved back to the edge of the bowl floor.

Installation of the X-Wing test model on the whirl tower required modification of both the tower and gantry. These modifications involved structural extensions for supporting the test model on the tower and an added work platform on the gantry for access to the elevated rotor head and blades. In addition, a high pressure air supply line was installed between the wind tunnel holding tanks and the top of the whirl tower to supply air for the blade circulation control.

5.2 X-WING TEST MODEL

The X-Wing rotor system, as stated earlier, is classified as a circulation controlled rotor. The X-Wing blades are designed to provide both leading edge and trailing edge blowing as well as tip blowing. For the majority of the present test program only trailing edge blowing and half of the available tip blowing was used. Noise measurements were confined to these test conditons for consistency of data.

Control of the blade blowing air was provided by a flow control valve in the high pressure supply line from the wind tunnel holding tanks. After leaving the flow control valve, located below the rotor drive transmission, the air entered a conical expansion section, then up past the transmission to a four-branch manifold and into the rotor head plenum. During pre-test trial runs it was determined that the mid-frequency far field noise was dominated by flow noise produced at the control value. Acoustic insulation, in the form of two inches of compressed fiberglass batting covered by heavy lead impregnated vinyl cloth, was applied to all the pipe downstream of the control valve and also about two feet upstream of the valve. This acoustical treatment completely removed the control valve flow noise as a measurable source of far field noise.

The X-Wing rotor system, unlike a conventional helicopter rotor system, does not have a mechanical cyclic change in angle of attack. The X-Wing achieves this effect by azimuthally varying the amount of blade blowing. A total of 9 individual data cases were recorded when control power of this nature was applied to the X-Wing rotor. The two drive motors and the mixing/step-up gearbox are shown in Figure 5 projecting to the left beyond the whirl tower platform below the X-Wing model. Drive power for the X-Wing was provided by two 800 HP, 400 Hz electric motors. The output from the motors was combined in a step-up gearbox which was then coupled to a step-down gearbox to match the input RPM requirement of the Bell Helicopter transmission used to drive the X-Wing rotor.

Variable 400 Hz power for the rotor drive motors was provided by a 60 Hz to 400 Hz motor-generator set in the maintenance/control system building.

The rotor and its drive system are protected from damage by a number of redundant safeguards. Drive motor current and temperature and rotor torque are three of the systems that operated during the test program, resulting in an automatic shut-down of the X-Wing.

5.3 ACOUSTIC TEST PROGRAM

The purpose of the X-Wing Noise Measurement Program was to record the far field noise produced by the subject rotor system as a function of the three primary operational variables -- rotor tip speed (V_t)/rotor rotational speed (RPM), collective angle of attack (θ_c) and blade pressure ratio (BPR). The test program detailing the specific values of these variables, as originally planned, is presented in Appendix A. Changes in this test plan made prior to and during testing were dictated by the performance test program. The conditions actually measured are itemized in Appendix B. Several of the major changes are: 1) deletion of the 700 ft./sec. tip speed cases due to RPM limits of the Bell Helicopter drive transmission; 2) limitations on maximum collective angle of attack (θ_c) at high RPM and/or high blade pressure ratio (BPR) due to the rotor torque limit; and 3) limitations on BPR also due to the rotor torque limit. In particular, θ_c of 4.5^o was substituted for the planned θ_c of 6^o on two runs. Also, examination of the performance test data showed a substantial gap between θ_c of 0^o and 3^o resulting in an additional set of runs at $\theta_c = 1.5^o$.

The performance tests were organized into two basic groups -- low BPR and high BPR. The low BPR group covered values of 1.0 (no blowing) up to 1.6 or 1.7, depending on RPM. Each high pressure run would begin with a repeat of two low pressure values, 1.4 and 1.6.

Near the end of the performance tests, a non-rotation test was performed in which the rotor was placed in the "X" position, i.e. blades at 45^o to the "aircraft" centerline, and air ejected from the blades at five pressure ratios. After completion of the performance testing program, during disassembly of the X-Wing, the rotor hub (no blade attached) was placed in the same "X" position and air ejected from the hub at air flow values corresponding to three of the five pressure ratios (lowest, mid-point and highest) used in the aforementioned non-rotation tests. Also during the X-Wing disassembly, acoustic data were acquired on four major noise-producing subsystems (those that ran whenever the rotor ran) while they were operated individually and together.

Calibration of the rotor bowl, to determine the influence of the "bowl" configuration on the X-Wing sound field, was carried out following disassembly of the X-Wing rotor system. Two different types of calibration measurements were conducted. The first type involved broadcasting electronically generated sounds from a loudspeaker system mounted on top of the whirl tower while the second type involved impulsive sounds produced by a small cannon. The electronically generated sounds were of two distinct forms -- a continuously swept pure tone covering the frequency range of 20 Hz to 2 KHz and a broadband random "pink" noise. The impulsive sounds were produced by blank 10 gauge shot gun shells fired in a small cannon. A total of ten (10) test firings were made, five (5) each with the cannon axis normal (perpendicular) to each of the two lines of far field microphones as requested by NASA Langley acoustics personnel.

Frequency response measurements of the rotor bowl calibration loudspeaker system were made in the anechoic chamber of the Rye Canyon Acoustics Laboratory. Microphone-to-loudspeaker angles used for the loudspeaker system frequency response measurements matched those for the rotor bowl calibration measurements. These angles were measured with a surveyors transit at both the rotor whirl tower and in the anechoic chamber. The radial distance from the center point on the face of the loudspeaker system to each of the eleven microphones was measured. Also, the loudspeakers system drive signals were the same (type and magnitude) as used for the rotor bowl calibration measurements.

Following completion of the bowl calibration measurements the positions of the ten "ground level" rotor bowl microphones, in terms of radial and elevation distances and azimuthal angle relative to the whirl tower and the centerline of the gantry tracks, were measured by a surveyor. The location distance for the eleventh (gantry) microphone had been measured at the beginning of the test program. Dimensional data for the rotor bowl tests and anechoic chamber measurements are presented in Appendix C.

At the conclusion of the test program, detailed tape data logs were prepared for each of the six data tapes. These log sheets give the start and stop times for each data case using the IRIG time codes. These tape log sheets are presented in Appendix D.

5.4 ACOUSTIC TEST INSTRUMENTATION

A total of twelve microphones were used in the X-Wing noise measurement program -- eleven far field and one in close proximity to the rotor drive transmission and drive motor gearboxes. Ten of the eleven far field microphones were positioned along two radial lines (five microphones per line) emanating from the center of the whirl tower. The eleventh far field microphone, mounted at the top of the movable gantry on an added work platform, measured the in-plane rotor noise under nearly free field conditions. The twelfth microphone was mounted in the vacinity of the gearboxes and drive transmission. This microphone location was included to provide a diagnostic capability in the event unexplainable discrete frequencies appeared in the far field sound spectra. In the event this occurred, a correlation analysis, using the transmission area microphone and one of the far field microphones, could be performed to determine if the unexplained discrete frequency had its origin in one of the three transmissions.

The microphone positions are shown in Figure 1, as mentioned earlier. Photographs were taken from the top of the whirl tower in the direction of microphones 1 to 5 (Figure 7) and microphones 6 to 10 (Figure 8). Because all of the microphones are not clearly visible, these two photographs have the microphone locations marked to aid identification. The azimuthal angles for these two microphone arrays, using the centerline of the gantry tracks and the center of the whirl tower as measurement references, were $125^{\circ}\ 34'$ (125.57°) for microphones 1 through 5 and $26^{\circ}\ 0.2'$ (26.04°) for microphones 6 through 10. Because the microphones were not perfectly aligned, microphones 3 and 8 were arbitrarily selected as reference points for measuring these two angles. Appendix C presents the relevant dimensional data.

Microphone 11 was mounted on the forward extremity of the added gantry work platform, as seen in Figure 9 (a close-up view of this microphone taken from ground level). The diaphragm of this microphone was approximately 5.125 inches below the bottom of the X-Wing blades.

Microphones 1, 2, 3, 8, 9 and 10 were of the "flush", or ground proximity, type in which the diaphragm is positioned 0.5 inch above ground level, a height corresponding to one microphone diaphragm diameter for the microphones used in this test. This positioning of the microphone causes a pressure doubling effect whereby the measured sound pressure level is 6 dB greater than the corresponding free field level. The advantage of this mounting is that there are no cancellation/reinforcement effects to be compensated for as there is with the typical pole mounting. These effects are particularly strong in the presence of discrete frequencies, such as produced by rotating blades. Figure 10 shows microphone 2, one of the ground proximity microphones, mounted in the holder/windscreen. Each holder/windscreen assembly consists of an 8 inch x 8 inch aluminum base plate, a wire frame including a microphone positioning support (seen through the windscreen) and a nylon mesh windscreen mounted over the wire frame. The wire frame is held to the base plate with small screws that permit removal of the wire frame. An alligator clip grips the microphone cable to hold the diaphragm at a fixed height above the base plate. The spacing was measured with a steel measuring tape following pre-test calibration each time the microphones were set up. Accurate and repeatable positioning of these six microphones was achieved by attaching 12 inch X 12 inch aluminum plates to the floor of the rotor bowl with explosive nails. An "X" was painted on each plate to facilitate repeatable positioning of the individually numbered microphone holder/windscreen base plates to the rotor bowl floor mounting plates thereby preventing movement following careful placement. Maximum microphone positioning error for these six microphones is estimated to be $\pm$0.25 inches.

Microphone 12 was mounted near the drive motor gearboxes and the Bell Helicopter transmission used to drive the X-Wing rotor. This microphone is shown on the left side of Figure 11 (clamped to the guard rail) while the Bell transmission is seen on the right side. Heavy buffetting during rotor operation necessitated tying the windscreen to the microphone clamp -- hence the slight depression across the top of the windscreen. Foam was placed in the microphone clamp to provide isolation from structure-borne vibration.

Each microphone, cable and battery operated power supply was numbered so that the same units would be in the same position each time data were taken to further ensure repeatability.

Rotor bowl sound calibration using the loudspeaker system caused some re-arrangement of equipment. Microphone 12 was used to monitor the output of the loudspeaker system since there was no transmission noise to record. This microphone was placed 2 feet in front of the center of the loudspeaker system, as seen in Figures 12 (without the windscreen). The loudspeaker monitor microphone did have the windscreen installed for the calibration tests; however, the photograph was taken prior to microphone calibration -- hence the missing windscreen.

Another change made for the bowl calibrations involved microphone 11, the gantry-mounted microphone. Upon completion of the performance and sub-system noise measurements, the X-Wing model and supporting structure, including the added gantry work platform that held microphone 11, were removed. To compensate for the missing platform, microphone 11 was attached to a metal pole and strapped to a gantry handrail. The microphone was elevated 11 feet 11 inches above the whirl tower platform, placing it at the same height as during the X-Wing tests. In addition to compensating for the height of microphone 11, it was also necessary to compensate for the 7 feet 10 inches forward projection of the microphone relative to the front of the gantry. This was accomplished by stopping the gantry 7 feet 10 inches forward of the X-Wing test position. Microphone 11 (black foam windscreen) can be seen in Figure 13 at the top of the metal pole projecting upward from the nearest forward corner of the gantry.

The power amplifier used to drive the loudspeaker was placed on the tower platform behind the loudspeaker. The various driving signals were sent to the amplifier from the control room. During the bowl calibration, each electrical signal (swept pure tones or broadband "pink" noise) sent to the power amplifier was simultaneously recorded on the data tape using the channel previously occupied by the tachometer signal.

The impulsive noise portion of the bowl calibration involved firing blank shotgun shells from a small cannon (Figure 14). A total of ten (10) shots were recorded as two groups of five shots. The cannon was first placed with the axis of the barrel normal (perpendicular) to the line formed by microphones 1 through 5, i.e. the plane of the muzzle was in the vertical plane containing these five microphones. Several test shots were fired to get the proper attenuator settings prior to the first five test shots. The cannon was then re-oriented with the barrel axis normal to the vertical plane containing microphones 6 through 10 and five more test shots fired.

Prior to and/or following each set of noise measurements the twelve microphone systems were calibrated for both absolute level and frequency response. Absolute level calibration was performed using a pistonphone, while frequency response was checked using a random noise insert voltage. In general, the preferred sequence for pre-test calibrations was to do the insert voltage first and then the pistonphone while the post-test calibrations were performed in the reverse order. The reason for this was that the electrical continuity was interrupted for the insert voltage but not for the pistonphone. Therefore, the system continuity was left undisturbed for data acquisition following the pistonphone calibration on pre-test calibrations and, likewise, was not yet disturbed following data acquisition and pistonphone calibration on post-test calibrations.

Frequency response measurements for the bowl calibration loudspeaker system were made in the Rye Canyon Acoustics Laboratory anechoic chamber. The instrumentation used for these measurements was the same as that used for the whirl tower bowl calibration with the exception of absolute cable lengths.

The acoustic data acquisition instrumentation employed for the X-Wing tests consisted of twelve Bruel & Kjaer (B & K) microphone systems composed of Type 4134 half-inch microphones (positioned for grazing incidence except for the six ground proximity microphones), Model 2619 preamplifiers and Model 2804 battery operated power supplies. The output from the B & K power supplies was connected to Ithaco Differential Amplifiers (Model 435 or 481) which provided both gain control and high-pass filtering (DC blockage). The high-pass filter (on the Ithaco units) was set at 10 Hz for the twelve audio channels and the time code channel while the tachometer channel filter was set at 1 Hz. The output of the Ithaco units were fed to the data tape recorder.

Absolute sound level calibration (123.6dB sine wave at 250 Hz) for the microphone systems was obtained with a B & K Model 4220 Pistonphone while system frequency response calibration was obtained with a Hewlett-Packard Model 15124A Half-Inch Insertion Device connected to a IVIE Model IV-20B Noise Generator which provided a "pink" noise calibration signal.

Data were recorded on a fourteen (14) channel Sangamo Model 3500 tape recorder using one (1) inch wide tape and operating in standard wide-band mode at a speed of 30 ips. All fourteen channels were recorded in the FM mode using a carrier frequency of 108 KHz thereby providing a usable frequency response range of DC to 20 KHz. IRIG "B" time code was produced by a Sytron Donner Model 8154 generator. Voice annotations were recorded on edge track "A".

The X-Wing rotor tachometer signal was a sine wave having one cycle per revolution and synchronized with the position of blade number one. The initial zero value corresponded to the blade over the tail position with the rotor turning counter-clockwise when viewed from above. Therefore, the 90^{o} position (maximum positive value) occurred when the reference blade was to the right side of the model, 180^{o} over the nose and 270^{o} (maximum negative value) at the left side.

At the outset of the test program, the tachometer (tach) signal available for tape recording was of such a low l[illegible] that considerable noise was picked up between the source point at the [illegible] control panel and the acoustic data recording system. This high noise level was discovered prior to commencement of the performance testing and was cured by inserting a Disa Model 55D26 filter in the circuit ahead of the Ithaco differential amplifier. The Disa filter, set to pass DC to 10 Hz (low pass configuration), corrected the problem and provided a very "clean" sine wave signal to the tape recorder. The combination of the Disa low-pass filter (10 Hz) and the high-pass filter (1 Hz) in the Ithaco Differential Amplifier resulted in a net 1 to 10 Hz band-pass filter (at the -3dB points). During performance testing the level of the tach signal was increased appreciably, thereby obviating the need for the Disa filter. However, in the interest of maintaining overall system continuity, the Disa filter was left in the circuit, the higher signal level being compensated for by re-setting the gain of the Disa unit.

Figure 15 shows the two racks of sound recording equipment used for the X-Wing noise measurement program. The racks were located in the whirl tower control room throughout the test program and bowl calibration measurements. The rack on the left (Figure 15) contains, from top to bottom, the following equipment: a CEI Type S Audio Monitor, the Sytron Donner Time Code Generator and Sangamo 3500 tape recording system consisting of a circuit card rack, voice track unit, another circuit card rack and the tape unit.

The rack on the right contains the following equipment, again from top to bottom: 14 channel monitoring meters (individually selectable for monitoring either the input signal level or the signal level played back from the tape), six Ithaco Model 481 Differential Amplifiers, eight Ithaco Model 435 Differential Amplifiers, an input channel monitoring selector switch, a B & K Model 2416 Voltmeter (for monitoring input signal levels in terms of peak or true R.M.S. values), and a Hewlett-Packard Model 8054 Real Time Audio Spectrum Analyzer (for input channel monitoring in 1/3 octave bands from 50 Hz to 10 KHz). On top of the right-hand equipment rack is a Tectronix Model 305 Duel-Trace Oscilloscope (left side) and the Disa Model 55D26 Filter. The oscilloscope was used for monitoring the filtered tachometer signal (lower trace) and the output from the selector switch (upper trace).

The additional equipment used for the whirl tower bowl calibration measurements consisted of the following: a Spectral Dynamics Model 104A-2 Sweep Oscillator, a Crown DC-300A Audio Power Amplifier, and a JBL Studio Monitor Loudspeaker System. The sweep generator provided the swept pure tone (20 Hz to 2 KHz) input to the Crown Amplifier while the pink noise input was provided by the IVIE Model IV-20B Noise Generator, the same unit used in the calibration of the microphone systems. As mentioned earlier, these input signals were recorded directly on the data tape simultaneously with the microphone data. The JBL loudspeaker system is a tuned port (modified bass reflex) design employing a 15 inch diameter bass driver and a horn-type mid-range driver with an acoustic lens used to increase the overall dispersion pattern of this driver unit.

5.5 ACOUSTIC AND PERFORMANCE TEST PROCEDURES

The X-Wing rotor system acoustic measurements were to be performed simultaneously with the performance tests on a non-interference basis. This requirement placed a number of constraints, discussed in subsequent paragraphs, on the acoustic data acquisition procedures. The emphasis of this section is placed on the acoustic test procedures with discussion of the performance test procedures restricted to only those relative to the acoustic tests.

The set-up and calibration procedure for each test run followed, for the most part, the same basic pattern. The first two microphone systems to be assembled were the gantry and tower (microphones 11 and 12, respectively). The reason for this being the fact that the motorized gantry would be moved away from the whirl tower just prior to running the rotor, thereby obviating further access to both these microphone locations. The ten bowl "ground level" microphone systems would then be assembled. The microphone calibration sequence followed microphone numbering unless commencement of testing was imminent, in which case microphones 11 and 12 would be calibrated first. On several occasions only microphone system assembly was completed prior to test readiness. The non-interference nature of the acoustic measurement program meant that the test could not be held up until the microphones were calibrated -- a 45 to 60 minute duration task for both pistonphone and pink noise on the twelve widely scattered systems. On these occasions only a post-calibration was performed. Also, there were a number of cases where all the microphone systems were assembled and calibrated only to have the test cancelled due to problems with the performance measuring instrumentation or rainfall. On several other occasions the pre-calibration was completed but delays caused by the aforementioned performance instrumentation problems resulted in testing that ended too late in the day to both post-calibrate and disassemble the microphone systems. These tests have only the pre-calibrations performed. Examination of the tape log sheets (Appendix D) will show those tests with only a pre-calibration or post-calibration.

A typical performance run would usually proceed along a fixed routine, as follows.

Upon completion of the X-Wing model preparations for the performance run, the gantry would be moved back away from the whirl tower to the test position indicated by aligning a bright orange line painted on the gantry with a similar line painted on the bowl floor. This ensured a consistent positioning of microphone 11 with respect to the X-Wing rotor system within an accuracy of approximately ± 1 inch.

Prior to the start of a test, "run cards" listing all the planned test conditions, in sequence, would be distributed to the test engineers. Then, while the gantry was being moved, the various support sub-system -- cooling blowers, pumps, etc. -- would be activated from the control room. In the control room the run procedure also followed a fixed routine determined, to some extent, by the sequence in which the three variables -- rotor speed, blade collective angle of attack and blade pressure ratio -- were changed for each successive test condition. Each set of runs would be made by first setting the rotor speed (RPM) and then the collective angle of attack (θ_c). Next the blade pressure ratio (BPR) would be varied over the planned range of values, or until the torque limit was reached. Upon completion of a BPR sweep the next blade angle (θ_c) would be set and the BPR again varied over the range of test values. This procedure continued until all scheduled angles of attack were run, at which point the next RPM would be set and the entire process repeated.

The foregoing sequence of events was executed in the following manner. Three engineers were each responsible for setting and monitoring one of the three primary variables. Once the RPM and blade angle were set, the BPR would be adjusted to the current test value. When that BPR value was attained, the test engineer would call out the pressure setting. The head test engineer would then announce the total set of the three variables currently being tested, whereupon the numerous performance data values would be recorded and the run cards annotated.

Concurrent with the foregoing performance data "take", the acoustic data were also being acquired. The rapid succession of performance test conditions necessitated keeping the acoustic data tape recorder running to maximize the duration of the data record. Between data takes, the 12 microphone attenuators would be adjusted, as required, to prevent system overload. If time permitted, the up-coming test condition would be announced on the voice track. When the engineer responsible for adjusting and monitoring the BPR announced that the current BPR test value was set, the acoustic test engineer would announce the start of the test condition and then read the 12 microphone attenuator settings onto the voice track for later logging -- the test conditions went too fast to make written notes of attenuator settings. The end of the test condition would then be announced giving a typical acoustic data record length of approximately 20 seconds. Several records were much shorter, particularly at the high power settings. Under these circumstances it is suggested that these cases be read into the data processing system two or three times in sequence (end-to-end) to double or triple, respectively, the total record length and consequently the total available averaging time. The brevity of performance data case run times, resulting from the non-interference nature of these tests, placed another constraint on the acoustic data acquisition program since record lengths of at least 30 seconds are preferrable to the 20 second (or less) records of these tests.

After completion of a test run, copies of the "run cards" containing the aforementioned performance annotations were distributed to the participating engineers. During testing the acoustic personnel made notations on the initial run cards distributed to the tests. Important notations have been transferred to the tape log sheets.

The computer-calibrated rotor performance data are presented in the Lockheed report LR 30254, "Data Compilation Report, 25 Foot Diameter X-Wing Module

Whirl Test". Requests for this report should be sent to Mr. Kenneth R. Reader (Code 1605), David Taylor Naval Ship Research and Development Center, Bethesda, Maryland 20084 (202/227-1482).

Despite the constraints imposed on the acoustic tests by the non-interference basis of this program, the problems caused by the weather (rainfall) or the unfortunate inadvertant erasure of one reel of recorded data, the acoustics test program did succeed in acquiring a large quantity of noise data at eleven far field microphone locations simultaneously with extensive performance data on a unique rotor system operating over a wide range of performance parameter values.

APPENDIX A

ORIGINAL PROGRAM TEST PLAN

APPENDIX A

ORIGINAL PROGRAM TEST PLAN

Presented herein are Table I and II from the original proposal that itemize the planned performance runs (Table I) and sub-system tests (Table II). (Only the page numbers have been changed to conform with those of the present report).

TABLE I
X-WING NOISE TEST CONDITIONS

θ_c (deg) (ANGLE OF ATTACK)	V_t (fps) (TIP VELOCITY)	PR_B (PRESS. RATIO-BLADE)	COMMENTS
0	600	1.0	Without
		1.1	Tip
		1.2	Blowing
		1.3	
		1.4	
		1.5	
		1.6	
		1.7	
		1.75	
6	600	1.0	Without
		1.1	Tip
		1.2	Blowing
		1.3	
		1.4	
		1.5	
		1.6	
		1.7	
		1.75	
0	600	1.0	With
		1.1	Tip
		1.2	Blowing
		1.3	
		1.4	
		1.5	
		1.6	
		1.7	
		1.75	
6	600	1.0	With
		1.1	Tip
		1.2	Blowing
		1.3	
		1.4	
		1.5	
		1.6	
		1.7	
		1.75	

TABLE I
X-WING NOISE TEST CONDITIONS

θ_c (deg) (ANGLE OF ATTACK)	V_t (fps) (TIP VELOCITY)	PR_B (PRESS. RATIO-BLADE)	COMMENTS
0	413	1.0	RPM
	500		Sweep
3	413		(Rest of
	500		of RPM's
6	413		With
	500		Other
8.5	413		Runs)
	500		
0	529	1.0	Blowing
		1.1	Map
		1.2	
		1.3	
		1.4	
		1.5	
		1.6	
		1.7	
3	529	1.0	
		1.1	
		1.2	
		1.3	
		1.4	
		1.5	
		1.6	
		1.7	
6	529	1.0	
		1.1	
		1.2	
		1.3	
		1.4	
		1.5	
		1.6	
		1.7	

TABLE I
X-WING NOISE TEST CONDITIONS

θ_c (deg) (ANGLE OF ATTACK)	V_t (fps) (TIP VELOCITY)	PR_B (PRESS. RATIO-BLADE)	COMMENTS
8.5	529	1.0	Blowing
		1.1	Map(cont)
		1.2	
		1.3	
		1.4	
		1.5	
		1.6	
		1.7	
0	550	1.0	
		1.1	
		1.2	
		1.3	
		1.4	
		1.5	
		1.6	
		1.7	
6	550	1.0	
		1.1	
		1.2	
		1.3	
		1.4	
		1.5	
		1.6	
		1.7	
0	600	1.0	
		1.1	
		1.2	
		1.3	
		1.4	
		1.5	
		1.6	
		1.7	

TABLE I
X-WING NOISE TEST CONDITIONS

θ_c (deg) (ANGLE OF ATTACK)	V_t (fps) (TIP VELOCITY)	PR_B (PRESS. RATIO-BLADE)	COMMENTS
3	600	1.0	Blowing
		1.1	Map(cont)
		1.2	
		1.3	
		1.4	
		1.5	
		1.6	
		1.7	
6	600	1.0	
		1.1	
		1.2	
		1.3	
		1.4	
		1.5	
		1.6	
		1.7	
8.5	600	1.0	
		1.1	
		1.2	
		1.3	
		1.4	
		1.5	
		1.6	
		1.7	
0	650	1.0	
		1.1	
		1.2	
		1.3	
		1.4	
		1.5	
		1.6	

TABLE I
X-WING NOISE TEST CONDITIONS

θ_C (deg) (ANGLE OF ATTACK)	V_t (fps) (TIP VELOCITY)	PR_B (PRESS. RATIO-BLADE)	COMMENTS
6	650	1.0	Blowing
		1.1	Map(cont)
		1.2	
		1.3	
		1.4	
		1.5	
		1.6	
0	700	1.0	
		1.1	
		1.2	
		1.3	
		1.4	
		1.5	
		1.6	
3	700	1.0	
		1.1	
		1.2	
		1.3	
		1.4	
		1.5	
		1.6	
6	700	1.0	
		1.1	
		1.2	
		1.3	
		1.4	
		1.5	
		1.6	
8.5	700	1.0	
		1.1	
		1.2	
		1.3	
		1.4	
		1.5	
		1.6	

TABLE I
X-WING NOISE TEST CONDITIONS

θ_c (deg) (ANGLE OF ATTACK)	V_t (fps) (TIP VELOCITY)	PR_B (PRESS. RATIO-BLADE)	COMMENTS
0	529	1.8	Blowing
		1.9	Map(cont)
		2.0	
		2.1	
		Max	
3	529	1.8	
		1.9	
		2.0	
		2.1	
		Max	
6	529	1.8	
		1.9	
		2.0	
		2.1	
		Max	
8.5	529	1.8	
		1.9	
		2.0	
		2.1	
		Max	
0	550	1.8	
		1.9	
		2.0	
		2.1	
		Max	
6	550	1.8	
		1.9	
		2.0	
		2.1	
		Max	
0	600	1.8	
		1.9	
		2.0	
		2.1	
		Max	

TABLE I
X-WING NOISE TEST CONDITIONS

θ_c (deg) (ANGLE OF ATTACK)	V_t (fps) (TIP VELOCITY)	PR_B (PRESS. RATIO-BLADE)	COMMENTS
3	600	1.8	Blowing
		1.9	Map(cont)
		2.0	
		2.1	
		Max	
6	600	1.8	
		1.9	
		2.0	
		2.1	
		Max	
8.5	600	1.8	
		1.9	
		2.0	
		2.1	
		Max	
0	650	1.7	
		1.8	
		1.9	
		2.0	
		2.1	
		Max	
6	650	1.7	
		1.8	
		1.9	
		2.0	
		2.1	
		Max	
0	700	1.7	
		1.8	
		1.9	
		2.0	
		2.1	
		Max	

TABLE I
X-WING NOISE TEST CONDITIONS

θ_c (deg) (ANGLE OF ATTACK)	V_t (fps) (TIP VELOCITY)	PR_B (PRESS. RATIO-BLADE)	COMMENTS
3	700	1.7	Blowing
		1.8	Map(cont)
		1.9	
		2.0	
		2.1	
		Max	
6	700	1.7	
		1.8	
		1.9	
		2.0	
		2.1	
		Max	
8.5	700	1.7	
		1.8	
		1.9	
		2.0	
		2.1	
		Max	

Note: Actual number of test conditions may difffer from the above listed conditions due to last minute test program changes.

TABLE II

SUPPLEMENTAL NOISE TEST CONDITIONS

TEST NUMBER	TEST CONDITION	DESCRIPTION
1	Rotor locked and plenum sealed - system pressurized	The system will be pressurized to levels corresponding to test blade pressure ratios of 1.1 to max. in 0.1 increments. This will establish system air supply leakage (background) noise.
2	Rotor locked and plenum unsealed - system pressurized	The system will be pressurized to levels corresponding to blade pressure ratios of 1.1 to max. in 0.1 increments. This will establish the upper bound of blade slot blowing jet noise. The actual levels and spectra should be lower due to the difference in relative jet velocity.
3*	Rotor blades removed - drive system RPM sweep	The drive system will be operated at each of the test RPM's. This will determine the extent to which the transmission radiates into the far field. Decibel level differences at Mic. No. 12 should indicate the actual test condition contribution to the far field noise. Sound level differences are anticipated due to unloaded transmission in this test.

* Up to one hour of noise-only whirl tower testing time is requested for this test. In the event Tests 1 and 2 consume this time, Test 3 will be eliminated.

APPENDIX B

CONDITIONS MEASURED FOR NOISE

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APPENDIX B
CONDITIONS MEASURED FOR NOISE

Lists of the data runs actually recorded, including those inadvertantly erased (see text), the sub-system runs and both the bowl calibration and loudspeaker calibration runs are presented in this Appendix.

MEASURED X-WING NOISE TEST CONDITIONS

Angle of Attack (deg.)	Tip Speed (fps)	RPM	Blade Press. Ratio	Run Card Number	Data Tape Number	Comments
0	529	404	1.0	18	1	
			1.1	18	1	
			1.2	18	1	
			1.3	18	1	
			1.4	18/(27E)*	1/-	
			1.5	18	1	
			1.6	18/(27E)*	1/-	
			1.7	18	1	
			1.8	(27E)*	1	
			1.9	(27E)*	-	
			2.0	(27E)*	-	
			2.1	(27E)*	-	
1.5	529	404	1.0	32	4	
			1.2	32	4	
			1.4	32	4	
			1.5	32	4	
			1.6	32	4	
			1.7	32	4	
			1.8	32	4	
			1.9	32	4	
			2.0	32	4	
			2.1	32	4	
3	529	404	1.0	18	1	
			1.1	18	1	
			1.2	18	1	
			1.3	18	1	
			1.4	18/(27E)*	1/-	
			1.5	18	1	
			1.6	18/(27E)*	1/-	
			1.7	18	1	
			1.8	(27E)*	-	
			1.9	(27E)*	-	
			1.9	(27E)*	-	Pitch up

*Note: These data inadvertantly erased

MEASURED X-WING NOISE TEST CONDITIONS - (Continued)

Angle of Attack (deg.)	Tip Speed (fps)	RPM	Blade Press. Ratio	Run Card Number	Data Tape Number	Comments
6	529	404	1.0	18	1	
			1.1	18	1	
			1.2	18	1	
			1.3	18	1	
			1.4	18	1	
			1.5	18	1	
			1.6	18	1	
			1.7	18	1	
8.5	529	404	1.0	18	1	
			1.1	18	1	
			1.2	18	1	
			1.3	18	1	
			1.4	18	1	
			1.5	18	1	
			1.6	18	1	
0	550	420	1.0	18	1	
			1.1	18	1	
			1.2	18	1	
			1.3	18	1	
			1.4	18/(28E)*	1/-	
			1.5	18	1	
			1.6	18/(28E)*	1/-	
			1.7	18	1	
			1.8	(28E)*	1/-	
			1.9	(28E)*	1/-	
			2.0	(28E)*	1/-	
			2.1	(28E)*	1/-	
1.5	550	420	1.0	32	4	
			1.2	32	4	
			1.4	32	4	
			1.5	32	4	
			1.6	32	4	
			1.7	32	4	
			1.8	32	4	
			1.9	32	4	
			2.0	32	4	
			2.1	32	4	

*Note: These data inadvertantly erased

MEASURED X-WING NOISE TEST CONDITIONS - (Continued)

Angle of Attack (deg.)	Tip Speed (fps)	RPM	Blade Press. Ratio	Run Card Number	Data Tape Number	Comments
4.5	550	420	1.0	(28E)*	-	
			1.1	(28E)*	-	
			1.2	(28E)*	-	
			1.3	(28E)*	-	
			1.4	(28E)*	-	
			1.5	(28E)*	-	
			1.6	(28E)*	-	
			1.7	(28E)*	-	
			1.74	(28E)*	-	
6	550	420	1.0	18	1	
			1.1	18	1	
			1.2	18	1	
			1.3	18	1	
			1.4	18	1	
			1.5	18	1	
			1.6	18	1	
			1.7	18	1	
0	600	458	1.0	20	2	
			1.1	20	2	
			1.2	20	2	
			1.3	20	2	
			1.4	20/(28E)*	2/-	
			1.5	20	2	
			1.6	20/(28E)*	2/-	
			1.7	20	2	
			1.8	(28E)*	-	
			1.9	(28E)*	-	
			2.0	(28E)*	-	
			2.1	(28E)*	-	
1.5	600	458	1.0	32	4	
			1.2	32	4	
			1.4	32	4	
			1.5	32	4	
			1.6	32	4	
			1.7	32	4	
			1.8	32	4	
			1.9	32	4	
			2.0	32	4	

*Note: These data inadvertantly erased

MEASURED X-WING NOISE TEST CONDITIONS -(Continued)

Angle of Attack (deg.)	Tip Speed (fps)	RPM	Blade Press. Ratio	Run Card Number	Data Tape Number	Comments
3	600	458	1.0	20/(28E)*	2/-	
			1.1	20/(28E)*	2/-	
			1.2	20/(28E)*	2/-	
			1.3	20/(28E)*	2/-	
			1.4	20/(28E)*	2/-	
			1.5	20/(28E)*	2/-	
			1.6	20/(28E)*	2/-	
			1.6	20	2	Pitch up
			1.6	20	2	Pitch down
			1.6	20	2	Right roll
			1.6	20	2	Left roll
			1.7	20/(28E)*	2/-	
			1.8	20/(28E)*	2/-	
6	600	458	1.0	20	2	
			1.1	20	2	
			1.2	20	2	
			1.3	20	2	
			1.4	20	2	
			1.5	20	2	
			1.5	20	2	Pitch up
			1.5	20	2	Pitch down
			1.5	20	2	Right roll
			1.5	20	2	Left roll
			1.6	20	2	
8.5	600	458	1.0	20	2	
			1.1	20	2	
			1.2	20	2	
			1.3	20	2	
			1.4	20	2	
			1.5	20	2	

*Note: These data inadvertantly erased

MEASURED X-WING NOISE TEST CONDITIONS - (Continued)

Angle of Attack (deg.)	Tip Speed (fps)	RPM	Blade Press. Ratio	Run Card Number	Data Tape Number	Comments
0	650	497	1.0	20/21	3/3	
			1.1	20/21	3/3	
			1.2	20/21	3/3	
			1.3	20/21	3/3	
			1.4	21/(28E)*	3/-	
			1.5	21	3	
			1.6	21/(28E)*	3/-	
			1.7	(28E)*	-	
			1.8	(28E)*	-	
			1.9	(28E)*	-	
			2.0	(28E)*	-	
			2.1	(28E)*	-	
1.5	650	497	1.0	32	5	
			1.2	32	5	
			1.4	32	5	
			1.5	32	5	
			1.6	32	5	
			1.7	32	5	
			1.8	32	5	
			1.9	32	5	
			2.0	32	5	
4.5	650	497	1.0	32	5	
			1.1	32	5	
			1.2	32	5	
			1.3	32	5	
			1.4	32	5	
			1.5	32	5	
			1.6	32	5	
			1.7	32	5	
			1.8	32	5	
6	650	497	1.0	21	3	
			1.1	21	3	
			1.2	21	3	
			1.3	21	3	
			1.4	21	3	
			1.5	21	3	
			1.6	21	3	

*Note: These data inadvertantly erased

MEASURED X-WING NOISE TEST CONDITIONS - (Continued)

Angle of Attack (deg.)	Tip Speed (fps)	RPM	Blade Press. Ratio	Run Card Number	Data Tape Number	Comments
0	0	0	1.2	31	4	Rotor in
			1.4	31	4	"X" position
			1.6	31	4	(non-rotating)
			1.8	31	4	
			2.0	31	4	
0	0	0	1.2	-	5	Blades re-
			1.6	-	5	moved - hub in
			2.0	-	5	"X" position

SUB-SYSTEM NOISE MEASUREMENTS (DATA TAPE NUMBER 5):

1. Drive motor cooling blower system (in the whirl tower)
2. Control building "cooling tower"
3. Bell Helicopter transmission lubrication pump (in the whirl tower)
4. Hydraulic system (in the base of the whirl tower)
5. All of above operating together

BOWL CALIBRATION (DATA TAPE NUMBER 6):

1. Tone sweep up (20 Hz to 2000 Hz)
2. Tone sweep down (2000 Hz to 20 Hz)
3. Pink noise
4. Five cannon shots for microphones 1 - 5
5. Five cannon shots for microphones 6 - 10

LOUDSPEAKER CALIBRATION (DATA TAPE NUMBER 6):

1. Tone sweep up (20 Hz to 2000 Hz)
2. Tone sweep down (2000 Hz to 20 Hz)
3. Pink noise

APPENDIX C

DIMENSIONAL DATA

APPENDIX C
DIMENSION DATA

Dimensional information necessary for determining the exact location of the X-Wing test rotor system, the measurement microphones for both the X-Wing tests and bowl calibration, the bowl calibration loudspeaker and the anechoic chamber microphone locations are presented herein. Also, Figures 1 and 2 show some relevant dimensional information.

Any system of measurements requires a frame of reference. The reference for these dimensions are the vertical axis of the whirl tower, the plane through the base of the whirl tower and the centerline of the gantry tracks, which is coincident with the longitudinal axis of the X-Wing model fuselage. The term "forward" refers to the direction away from the gantry and toward the control building. Likewise, the terms "left" and "right" are relative to this orientation.

The X-Wing rotor system vertical axis was not coincident with that of the whirl tower. Therefore, Table C-1 gives the necessary information to accurately position the X-Wing with respect to the aforementioned frame of reference.

The position information for the eleven far field microphones used during the X-Wing data acquisition runs is presented in Table C-2. The "range" values are the horizontal radial distances from the whirl tower vertical axis to each microphone as measured by the surveyor. The "elevation" values are referenced to the plane of the base of the whirl tower -- negative values are below the plane and positive values are above the plane. The negative values arise from the bowl contour for water drainage. The "azimuthal angles" are formed between the centerline of the gantry tracks and imaginary lines passing through the center of the whirl tower and microphones 3 and 8.

These two microphones were selected as references for their respective arrays because they were the farthest bowl "floor-level" microphones. The "deviations" are the distances to the right (R) or left (L) of the two aforementioned reference lines as viewed from the tower to the microphones. The microphone 11 information is self-explanatory.

The major difference between the X-Wing tests and the bowl calibration runs was the missing added gantry work platform and the X-Wing model itself (see text). This necessitated re-mounting microphone 11 and adjusting the stopping position of the gantry to place this microphone in the same point in space as for the X-Wing tests. Also, the loudspeaker was placed on the whirl tower platform in the only available space at the same side of the platform as the microphone arrays. Table C-3 presents the loudspeaker position information for the bowl calibration tests. The pitch axis passes through the center of the whirl tower and is perpendicular to the direction of the reference axis (centerline of the gantry track) while the roll axis coincides with the direction of the reference axis. Table C-4 gives the declination angles for microphones 1 to 10 and microphone 11 dimensional data. The declination angles were measured with a surveyors transit located in the same position as the loudspeaker on the whirl tower platform. All other dimensional information is the same as for the data acquisition runs (Table C-2). The transit was approximately the same height as the loudspeaker top; therefore, these angles will differ somewhat from those calculated using the surveyed distances referred to the center of the loudspeaker front.

Calibration of the loudspeaker system in the anechoic chamber involved placing the microphones at the same angles that were used for the bowl calibration measurements; however, different radial distances from the center of the front of the loudspeaker system to each individual microphone were necessary due to the physical constraints of the anechoic chamber. These radii are given in Table C-5.

Microphone number 12, located in the transmission area, was included for diagnostic purposes only (see text), consequently, the position was not measured.

TABLE C-1
X-WING POSITION MEASUREMENTS

Height above base plane of whirl tower to under side of X-Wing blades	62'2"
X-Wing vertical axis forward of tower vertical axis	2'4"
Height of X-Wing blades above whirl tower platform	12'4 1/2"

TABLE C-2
MICROPHONE LOCATIONS - ROTOR BOWL - X-WING TEST RUNS

I. MICROPHONES 1 TO 10

Mic. No.	Range (ft.)	Elevation (ft.)	Azimuth Angle (deg.)	Deviations* (in.)
1	49.84	- 2.31	125.57	3 5/16 R
2	74.71	- 3.21	"	4 1/8 R
3	99.69	- 3.82	"	0
4	134.70	+16.92	"	11 15/16 R
5	163.88	+33.32	"	3 3/4 L
6	160.95	+36.61	26.04	19 1/2 L
7	134.00	+18.23	"	3 1/8 L
8	99.38	- 1.61	"	0
9	74.47	- 1.16	"	2 L
10	49.59	- 0.80	"	1 3/16 L

* "R" and "L" indicate right and left, respectively, with respect to radial line (see explanation on page 44).

II. MICROPHONE 11 (GANTRY):

61' 8 3/4" (61.729 ft.) above base plane of whirl tower

53' 8 1/6" (53.680 ft.) radial distance to X-Wing vertical axis

4.7° azimuthal angle between the radius from microphone 11 to the X-Wing center and the reference longitudinal axis of the X-Wing model (corresponding to a distance of 4' 4 3/4" measured in a counter clockwise direction from the longitudinal axis to the microphone).

TABLE C-3
BOWL CALIBRATION LOUDSPEAKER POSITION MEASUREMENTS

The center of the "face" (loudspeaker mounting board) relative to the center (vertical axis) of the whirl tower is:

15 1/2" above the whirl tower platform

35" forward of the pitch axis

88 3/4" to the right of the roll axis (the right side of the roll axis is the side toward the two microphone arrays)

90° azimuthal angle (relative to the centerline of the gantry tracks)

The height of the whirl tower platform above the plain of the base of the tower (reference plain) is 49' 9 1/2".

TABLE C-4
MICROPHONE LOCATIONS -- ROTOR BOWL - CALIBRATION TEST RUNS

I. MICROPHONES 1 TO 10:

Mic. No.	Declination Angle (deg.; min.)
1	52°
2	39°50'
3	31°30'
4	15°45'
5	7°15'
6	5°45'
7	13°45'
8	28°45'
9	36°
10	47°10'

II. MICROPHONE 11 (GANTRY):

61' 8 3/4" (61.729 ft.) above base plane of whirl tower.

55' 3 1/4" (55.270 ft.) radial distance to center of front of the loudspeaker system.

1.8° aximuthal angle "behind" the front of the loudspeaker system (corresponding to a horizontal distance of 1' 8 1/2" measured between the plane of the loudspeaker front and the pole supporting microphone 11).

11.1° elevation angle for the above radial distance (corresponding to a height of 10' 7 3/4" above the center of the loudspeaker system).

TABLE C-5
MICROPHONE LOCATIONS - ANECHOIC CHAMBER

Mic. No.	Radial Distance (ft.; in.)
1	10'7"
2	14'
3	18'1"
4	17'
5	17'1"
6	10'
7	9'11"
8	9'11"
9	10'9"
10	11'9"
11	9'6"

NOTE: The azimuthal angle for microphone 11 was 0° (in the plane of the loudspeaker) not 1.8° behind as in the bowl calibration measurements. All other angles are the same (see Tables C-2 and C-4).

APPENDIX D

TAPE LOG SHEETS

APPENDIX D
TAPE LOG SHEETS

This Appendix contains the data tape log sheets giving run start and stop points based on the IRIG time code. Also shown are the barometric pressure readings, dry and wet bulb temperatures for humidity calculations and wind data (velocity and direction).

DATA TAPE IDENTIFICATION

TEST IDENTIFICATION

TEST X-WING-NOISE TAPE # 1 TEST SITE Rotor Tower DATE 3/10/82

TAPE RECORDER IDENTIFICATION

MAKE SANGAMO MODEL 3500 MODIFICATIONS N/A

TAPE IDENTIFICATION

RECORD MODE FM CARRIER FREQUENCY 108 KHZ DEVIATION ± 40%

SPEED 30 IPS (EXT) TAPE WIDTH 1 IN NUMBER OF TRACKS 14

REWOUND NOT REWOUND

TAPE IDENTIFICATION

TRACK 1	MIC #1	TRACK 8	MIC #8
TRACK 2	MIC #2	TRACK 9	MIC #9
TRACK 3	MIC #3	TRACK 10	MIC #10
TRACK 4	MIC #4	TRACK 11	MIC #11
TRACK 5	MIC #5	TRACK 12	MIC #12
TRACK 6	MIC #6	TRACK 13	TACH (1 per rev)
TRACK 7	MIC #7	TRACK 14	IRIG B

EDGE TRACK A VOICE

SEQUENCE OF EVENTS

(PRE-CALIBRATIONS, TEST START AND STOP TIMES, POST-CALIBRATIONS, ETC.)

See data log sheets

*FILL IN ALL BLANKS. IF NOT APPLICABLE, WRITE N/A

CALAC FORM 8267

TAPE NO. 1
RUN CARD NOS. 18
Sheet 1 of 3

X-WING NOISE TEST DATA LOG

DATE	TIME CODE START	TIME CODE STOP	ATTENUATOR SETTING CH. 1	CH. 2	CH. 3	CH. 4	CH. 5	CH. 6	CH. 7	CH. 8	CH. 9	CH. 10	CH. 11	CH. 12	RPM/V_c	θ_c	SPB	BAR. PRESS. In. Hg	HUMIDITY INFO. °F DRY	°F WET	TIME	WIND VEL. (MPH)	DIR.	REMARKS
[illegible]	RUN ON 09 28 00	09:28:40					PN																	P = Pistonphone
	09.49:06	09:49.24					P																	123.6 dB at 250 Hz
	09.57.55	09:58.21							PN															Gain at 0 dB on Amp.
	09.59.16	09:59.34							P															
	10.03 20	10.03:37								PN														PN = Pink noise
	10.04:52	10:05.06								P														Gain at 0 dB on Amp.
	10 06:22	10.06:55									PN													
	10 08 22	10.08:52									P													
	10.10:33	10:11.10										PN												
	10.12.00	10:12.22										P												
	10.19:57	10:20:44											PN											
	10.21:33	10 22 01											P											
	10.24.28	10.25.02												PN										
	10.25.56	10.26:40												P										
	10.34:16	10.34.35	P																					
	10 35 32	10.35 53		P																				
	10.36:51	10 37 23		PN																				
	10 40:00	10:40 24			P																			
	10 43.36	10.44.00				PN																		
	10 44.55	10.45 25				P																		
	11:06:27	11:07 00						PN																
	11:08 01	11:08:30						P																
	13 20:05	13:20.23								P														
	13 21 14	13 21:[illegible]								PN														
																								1.0 DATA MISSED
	14 35 40	14:36 10	30	30	36	36	42	42	34	36	15	25	30	15	404	0	1.1	2873	72	60	—	2-3	SW	
	14 36:10	14 37.04	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1.2					2	SW	
	14 37.20	14 37 35	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1.3					4-5	SW	
	14 38.04	14 38 11	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	5	↓	↓	1.4					3-4	SW	
	14 38.50	14.39.10	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	-5	↓	↓	1.5					3-4	SW	
	14 39 40	14 39:53	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	-10	↓	↓	1.6					3-4	W	
	14 40 23	14 40 38	↓	↓	18	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1.7					5	W	
	14.41 42	14:42:06	30	30	30	36	30	36	34	36	15	25	30	-10	404	3	1.0					2-3	NW	
	14 42 31	14:42:[illegible]	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1.1					3-4	W	
	14 43 05	14 43:18	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	0	↓	↓	1.2					2-3	W	
↓	14 43.48	14 44 30	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1.3					2-3	NW	

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TAPE NO. 1
RUN CARD NOS. 18
Sheet 2 of 3

X-WING NOISE TEST DATA LOG

DATE	TIME CODE START	TIME CODE STOP	ATTENUATOR SETTING CH. 1	CH. 2	CH. 3	CH. 4	CH. 5	CH. 6	CH. 7	CH. 8	CH. 9	CH. 10	CH. 11	CH. 12	RPM/V_c	θ_c	DPR	BAR. PRESS. In. Hg	HUMIDITY INFO. °F DRY	°F WET	TIME	WIND VEL. (MPH)	DIR.	REMARKS
	DAY 069																							
2/10/[illegible]	14:46:24	14:45:39	30	30	30	36	42	36	34	36	15	25	30	-0	404	3	1.4					0		
	14:45:59	14:46:16	24	24													1.5					2-3	W	
	14:46:40	14:47:06					36							-10			1.6					2-3	W	
	14:47:33	14:47:40	18	18	24												1.7					3-4	SW	
	14:48:45	14:48:51	30	30	30					26					404	6	1.0					0-2	W	
	14:49:11	14:49:33	24	24													1.1					3-4	SW	
	14:50:06	14:50:17								36	25						1.2					3-4	SW	
	14:50:37	14:50:52															1.3					3-4	SW	
	14:51:17	14:51:32								35							1.4					4-5	SW	
	14:51:56	14:52:26	18	24	24	36	36	36	34	35	25	25	30	-10			1.5					4-5	W	
	14:52:38	14:53:00															1.6					3-4	SW	
	14:53:20	14:53:46								30		20					1.7					3-4	W	
	14:54:54	14:55:19	30	30	30					35					404	8.5	1.0					2-3	W	
	14:55:44	14:56:03									30	35					1.1					2-3	W	
	14:56:22	14:56:46										20					1.2					3-4	SW	
	14:57:03	14:57:30															1.3					2-3	SW	
	14:57:50	14:58:13	24	24													1.4					2-3	W	
	14:58:38	14:58:51								30							1.5					2-3	W	
	14:59:09	14:59:25	18	18	24						35						1.6					2-3	W	
	15:02:02	15:02:18	30	30	30	36	36	36	34	30	25	20	30	-10	420	0	1.0					2-3	SW	
	15:02:50	15:03:25															1.1					2-3	SW	
	15:03:38	15:04:01															1.2					2-3	SW	
	15:04:20	15:04:44															1.3					0		
	15:05:04	15:05:32	24														1.4					0-2	SW	
	15:05:41	15:06:01															1.5					0-2	W	
	15:06:23	15:06:49															1.6					5	NW	
	15:07:20	15:07:54		24													1.7							
	15:08:56	15:09:20	30	30											420	6	1.0					3-4	W	
	15:09:49	15:10:09															1.1					2-3	W	
	15:10:28	15:10:50															1.2					3-4	W	
	15:[illegible]	15:11:36	24	24													1.3					2-3	N	
	15:[illegible]	15:12:20			24												1.4					3-4	SW	
	15:[illegible]	15:13:04															1.5					3-4	N	
	15:[illegible]:26	15:13:50	18	18		30											1.6					3-4	W	
	15:[illegible]:19	15:14:44															1.7					3-4	NW	

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TAPE NO. 1
RUN CARD NOS. 18
Sheet 3 of 3

X-WING NOISE TEST DATA LOG

DATE	TIME CODE		ATTENUATOR SETTING												RPM/V_t	θ_c	RPR	BAR. PRESS. In.Hg	HUMIDITY INFO.			WIND		REMARKS
	START DAY 069	STOP	CH. 1	CH. 2	CH. 3	CH. 4	CH. 5	CH. 6	CH. 7	CH. 8	CH. 9	CH. 10	CH. 11	CH. 12					°F DRY	°F WET	TIME	VEL. (MPH)	DIR.	
3/10/82	15:59:35	16:00:10	PN	OSC	P																			
↓	16:02:15	16:02:50	P	[illegible]	PN																			
	16:06:00	16:06:41				PN	P																	
	16:09:10	16:09:41				P	PN																	
	16:13:56	16:14:46						PN	P															
	16:17:02	16:17:33						P	PN															
	16:20:58	16:21:27								P	PN													
	16:23:07	16:23:36								PN	P													
	16:30:11	16:30:41										P												
	16:36:43	16:37:05												P										
	16:39:30	16:40:03											PN	P										
	16:42:45	16:43:13											P	PN										
↓	16:55:45	16:56:16										PN												

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DATA TAPE IDENTIFICATION

TEST IDENTIFICATION

TEST X-WING-NOISE TAPE # 2 TEST SITE Rotor Tower DATE 3/12/82

TAPE RECORDER IDENTIFICATION

MAKE SANGAMO MODEL 3500 MODIFICATIONS N/A

TAPE IDENTIFICATION

RECORD MODE FM CARRIER FREQUENCY 108 KHZ DEVIATION ± 40 %

SPEED 30 IPS (EXT) TAPE WIDTH 1 IN NUMBER OF TRACKS 14

REWOUND NOT REWOUND

TAPE IDENTIFICATION

TRACK 1	MIC # 1	TRACK 8	MIC # 8
TRACK 2	MIC # 2	TRACK 9	MIC # 9
TRACK 3	MIC # 3	TRACK 10	MIC # 10
TRACK 4	MIC # 4	TRACK 11	MIC # 11
TRACK 5	MIC # 5	TRACK 12	MIC # 12
TRACK 6	MIC # 6	TRACK 13	TACH (1 per rev)
TRACK 7	MIC # 7	TRACK 14	IRIG 3

EDGE TRACK A VOICE

SEQUENCE OF EVENTS

(PRE-CALIBRATIONS, TEST START AND STOP TIMES, POST-CALIBRATIONS, ETC.)

See data log sheets

*FILL IN ALL BLANKS. IF NOT APPLICABLE, WRITE N A.

CALAC FORM 8267

TAPE NO. 2
RUN CARD NOS. 20

X-WING NOISE TEST DATA LOG

Sheet 1 of 2

DATE	TIME CODE START (DAY 071)	TIME CODE STOP	CH. 1	CH. 2	CH. 3	CH. 4	CH. 5	CH. 6	CH. 7	CH. 8	CH. 9	CH. 10	CH. 11	CH. 12	RPM/V_t	θ_c	BPR	BAR. PRESS. In. Hg	HUMIDITY INFO. °F DRY	HUMIDITY INFO. °F WET	HUMIDITY INFO. TIME	WIND VEL. (MPH)	WIND DIR.	REMARKS
3/12/82	08.49.25	08.50.00											P	PN										P = Pistonphone
↓	08:56.20	08.56.55											PN	P										123.6 dB at 250 HZ.
	10.53.00	10.53.47	PN									P												Gain of 0 dB on Amp
	10.55.40	10.56.45	P									PN												except where noted
	10:59:30	11:00.30		P	PN																			
	11.05.05	11:06:05		PN	P																			PN = Pink noise
	11:08 30	11:09:30								P	PN													Gain of 0 dB on Amp.
	11:10:40	11:11:40								PN	P													
	11.49.12	11:49:45				P	PN																	
	11:57:25	11:58.06				PN	P																	
	12.03:50	12:04:35						P	PN															
	12.06.30	12:07:10						PN	P															
	15.02:19	15:02.55	24	24	30	30	36	36	35	30	25	25	25	10	458	0	1.0	28.46	58	53	—	5	SW	
	15:03:24	15:03:43	24	24	30	30	36	36	35	30	25	25	25	10	↓	↓	1.1					3-4	N	
	15.04.01	15.04:22	24	24	30	30	36	36	35	30	25	25	25	10			1.2					2-3	N	
	15.04:37	15.04:55	24	24	30	30	36	36	30	30	25	25	25	10			1.3					4-5	N	
	15.05:13	15.05:33	24	24	30	30	36	36	30	30	25	25	25	5			1.4					3-4	SW	
	15 05:51	15:06.11	24	24	30	30	30	30	30	30	25	25	25	5			1.5					5	W	
	15:06:36	15:07:00	24	24	24	30	30	30	30	30	25	25	25	0			1.6					5	SW	
	15.07:19	15.07.40	18	18	24	24	30	30	20	30	25	20	25	0	↓	↓	1.7					3-4	W	
	15 08:44	15.09:15	24	30	30	30	36	36	20	30	25	20	25	0	458	3	1.0					4-5	N	
	15.09:29	15:09.52	24	24	30	30	36	36	30	30	25	20	25	10	↓	↓	1.1					3-4	W	
	15 10.08	15.10:29	24	24	30	30	36	36	30	30	25	20	25	10			1.2					3-4	N	
	15:10:51	15.11:12	24	24	30	30	36	36	30	30	25	20	25	10			1.3					2-3	N	
	15:11:36	15:11:56	18	18	24	24	30	36	30	30	25	20	25	5			1.4					3-4	SW	
	15 12.13	15.12:33	18	18	24	24	30	36	30	30	25	20	25	5			1.5					3-4	N	
	15.12:53	15.13.22	18	18	24	24	30	30	30	30	25	20	25	0			1.6					3-4	N	
	15:13:40	15.13:52	18	18	24	24	30	30	30	30	25	20	20	0			1.6					3-4	N	+ Pitch
	15.14.17	15:14:45	18	18	24	24	30	30	30	30	25	20	20	0			1.6					3-4	N	− Pitch
	15 15.10	15.15.35	18	18	24	24	30	30	30	25	20	20	20	0			1.6					5	W	+ Roll
	15.15.51	15.16:30	18	18	24	24	30	30	30	25	20	20	20	0			1.6					2-3	SW	− Roll
	15.16:56	15.17:19	18	18	24	24	30	30	30	25	20	20	20	0	↓	↓	1.7					5	NW	
	15.18.14	15.18:29	24	24	24	30	36	36	35	30	25	24	25	10	458	6	1.0					5	N	
	15.18.43	15.19:08	24	24	24	30	36	36	35	30	25	25	25	10	↓	↓	1.1					5	NW	
↓	15.19:20	15.19:44	24	24	24	30	36	36	35	30	25	25	25	10	↓	↓	1.2					4-5	NW	

TAPE NO. 2
RUN CARD NOS. 20
Sheet 2 of 2

X-WING NOISE TEST DATA LOG

DATE	TIME CODE START (DAY 071)	TIME CODE STOP	ATTENUATOR SETTING CH. 1	CH. 2	CH. 3	CH. 4	CH. 5	CH. 6	CH. 7	CH. 8	CH. 9	CH. 10	CH. 11	CH. 12	RPM/V_c	θ_c	BPF	BAR. PRESS. In. Hg	HUMIDITY INFO. °F DRY	°F WET	TIME	WIND VEL. (MPH)	WIND DIR.	REMARKS
3/6/82	15:20:03	15:20:22	24	24	24	30	30	36	35	30	25	25	25	10	458	6	1.3					4-5	N	
	15:20:50	15:21:20	18	18	24	30	30	36	35	30	25	20	20	0			1.4					2-3	N	
	15:21:37	15:21:57	18	18	24	24	30	36	30	30	25	20	20	0			1.5					4-5	N	
	15:22:15	15:22:55	18	18	24	24	30	36	30	30	25	20	20	0			1.5					3-4	N	+ Pitch
	15:23:10	15:23:35	18	18	24	24	30	36	30	30	25	20	20	0			1.5					4-5	NE	- Pitch
	15:24:05	15:24:18	18	18	24	24	30	36	30	30	25	20	20	0			1.5					2-3	N	+ Roll
	15:24:42	15:25:07	18	18	24	24	30	30	30	30	25	20	20	0			1.5					3-4	NW	- Roll
	15:25:38	15:26:03	18	18	24	24	30	30	30	30	25	20	20	0			1.6					3-4	N	
	15:26:45	15:27:11	18	18	24	24	30	30	30	30	25	20	20	0	458	8.5	1.0					3-4	NW	
	15:27:22	15:27:48	24	24	30	30	36	36	30	30	25	20	20	0			1.1					5	NW	
	15:27:57	15:28:17	24	24	30	30	36	36	30	30	25	20	25	10			1.2					4-5	NW	
	15:28:33	15:28:53	24	24	30	30	30	36	30	30	25	20	25	10			1.3					4-5	NW	
	15:29:10	15:29:45	18	24	24	30	30	30	30	30	25	20	25	5			1.4					5	NW	
	15:30:02	15:30:29	18	18	24	24	30	30	30	30	25	20	25	5			1.5					5	NW	

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DATA TAPE IDENTIFICATION

TEST IDENTIFICATION

TEST X-WING-NOISE TAPE # 3 TEST SITE Rotor Tower DATE ~~3/12/82~~ 3/15/82

TAPE RECORDER IDENTIFICATION

MAKE SANGAMO MODEL 3500 MODIFICATIONS N/A

TAPE IDENTIFICATION

RECORD MODE FM CARRIER FREQUENCY 108 KHZ DEVIATION ± 40%

SPEED 30 IPS (EXT) TAPE WIDTH 1 IN NUMBER OF TRACKS 14

REWOUND NOT REWOUND

TAPE IDENTIFICATION

TRACK 1	MIC # 1	TRACK 8	MIC # 8
TRACK 2	MIC # 2	TRACK 9	MIC # 9
TRACK 3	MIC # 3	TRACK 10	MIC # 10
TRACK 4	MIC # 4	TRACK 11	MIC # 11
TRACK 5	MIC # 5	TRACK 12	MIC # 12
TRACK 6	MIC # 6	TRACK 13	TACH (1 per rev)
TRACK 7	MIC # 7	TRACK 14	IRIG B

EDGE TRACK A VOICE

SEQUENCE OF EVENTS

(PRE-CALIBRATIONS, TEST START AND STOP TIMES, POST-CALIBRATIONS, ETC.)

See data log sheets

*FILL IN ALL BLANKS. IF NOT APPLICABLE, WRITE N A.

CAL AC FORM 6267

TAPE NO. 3
RUN CARD NOS. 20421
Sheet 1 of 2

X-WING NOISE TEST DATA LOG

DATE	TIME CODE START	TIME CODE STOP	ATTENUATOR SETTING CH. 1	CH. 2	CH. 3	CH. 4	CH. 5	CH. 6	CH. 7	CH. 8	CH. 9	CH. 10	CH. 11	CH. 12	RPM/V_t	θ_c	UPR	BAR. PRESS. In. Hg	HUMIDITY INFO. °F DRY	°F WET	TIME	WIND VEL. (MPH)	DIR.	REMARKS
	DAY 071																							
[illegible]	15:34:17	15:34:28	18	24	24	20	30	26	30	25	20	20	25	5	497	0	1.0	28.46	58	53	—	5	SW	
	15:34:47	15:35:25	18	24	24	24	30	30	70	25	20	20	25	5	↓	↓	1.1					4	W	
	15:35:47	15:36:13	18	24	24	24	30	30	30	25	20	20	25	5			1.2					3-4	W	
	Pot	Call															1.3							
	15:48:40	15:49:10	PN									P												Auto Stop Down
	15:50:55	15:51:22	P									PN												
	15:53:14	15:53:40		P	PN																			
	15:55:05	15:55:32		PN	P																			
	15:58:28	15:59:03				+ [illegible] PN	P																	
	16:02:00	16:02:31				P	PN																	Bad Noise - bad - bad grounds
	16:07:55	16:08:30						PN	P															NG
	16:11:02	16:11:36						P	PN															
	16:16:12	16:16:44								PN	P													
	16:17:50	16:18:21								P	PN													
	16:23:40	16:24:14											PN	P										
	16:27:03	16:27:35											P	PN										
	DAY 074																							
[illegible]	10:08:46	10:09:17	P																					
	10:12:30	10:13:01		P																				
	10:15:45	10:16:17			P																			
	10:21:30	10:22:00				P																		
	10:25:40	10:26:10					P																	
	10:30:00	10:30:32						P																
	10:34:00	10:34:30							P															
	10:37:35	10:38:06								P														
	10:41:05	10:41:36									P													
	10:43:25	10:43:55										P												
	10:50:20	10:50:50											P											
	10:55:55	10:56:20												P										
	11:05:25	11:05:55	PN																					
	11:07:40	11:08:10		PN																				
	11:10:45	11:11:15			PN																			
	11:13:00	11:13:30				PN																		
	11:15:45	11:16:15					PN																	
	11:19:20	11:19:50						PN																

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OF POOR QUALITY

TAPE NO. 3
RUN CARD NOS. 20621
Sheet 2 of 2

X-WING NOISE TEST DATA LOG

DATE	TIME CODE START	TIME CODE STOP	ATTENUATOR SETTING CH. 1	CH. 2	CH. 3	CH. 4	CH. 5	CH. 6	CH. 7	CH. 8	CH. 9	CH. 10	CH. 11	CH. 12	RPM/V_c	θ_c	SPR	BAR. PRESS. In. Hg	HUMIDITY INFO. °F DRY	°F WET	TIME	WIND VEL. (MPH)	DIR.	REMARKS
	DAY 074																							
[illegible]	11.42.25	11.42:40	24	24	24	30	30	36	25	25	20	20	25	5	497	0	1.0	28.44	57	52	2:27	4-5	E	
	11.43:08	11:43:33	24	24	24	30	30	36	25	25	20	20	25	5			1.1					2-3	E	
	11 43:57	11 44 37	24	24	24	24	30	30	25	25	20	20	25	5			1.2					4-5	E	
	11:44.52	11.45:14	24	24	24	24	30	30	25	25	20	20	25	5			1.3					4-5	E	
	11.45.25	11:45:52	24	24	24	24	30	30	25	25	20	20	25	5			1.4					4-5	W	
	11:46:00	11:46:18	24	24	24	24	30	30	25	25	20	20	25	5			1.5					4-5	SW	
	11.46:45	11:47:10	24	24	24	24	30	30	25	25	20	20	25	0			1.6					4-5	E	
	11.48.14	11:48:35	18	18	24	24	30	30	25	25	20	20	25	0	497	6	1.0					4-5	S	
	11 48 57	11.49:22	18	18	24	24	30	30	25	25	20	20	25	0			1.1					3-4	E	
	11:49:33	11:49:58	18	18	24	24	30	30	25	25	20	20	25	0			1.2					3-4	E	
	11:50 08	11:50:28	18	18	24	24	30	30	25	25	20	20	25	0			1.3					3-4	S	
	11:50.43	11:51:00	18	18	24	24	30	30	25	25	20	20	25	0			1.4					3-4	SE	
	11 51.13	11:51:31	18	18	24	24	30	30	25	25	20	20	20	0			1.5					3-4	SE	
	11 51.50	11:52:08	12	12	18	24	24	30	25	25	20	20	20	0			1.6					3-4	SE	
	12 07:05	12:07:35							PN															
	12:09:10	12:09:45								PN														
	12:11:15	12:11:45									PN													
	12:15:05	12:15:35										PN												
	12:19:00	12:19:30											PN											
	12:22:15	12:22:55												PN										
	14 27:00																		57	52	[illegible]			

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OF POOR QUALITY

DATA TAPE IDENTIFICATION

TEST IDENTIFICATION

TEST X-WING-NOISE TAPE # 4 TEST SITE Rotor Tower DATE 3/29/82 3/30/82

TAPE RECORDER IDENTIFICATION

MAKE SANGAMO MODEL 3500 MODIFICATIONS N/A

TAPE IDENTIFICATION

RECORD MODE FM CARRIER FREQUENCY 108 KHZ DEVIATION ± 40%

SPEED 30 IPS (EXT) TAPE WIDTH 1 IN NUMBER OF TRACKS 14

REWOUND NOT REWOUND

TAPE IDENTIFICATION

TRACK 1	MIC #1	TRACK 8	MIC #8
TRACK 2	MIC #2	TRACK 9	MIC #9
TRACK 3	MIC #3	TRACK 10	MIC #10
TRACK 4	MIC #4	TRACK 11	MIC #11
TRACK 5	MIC #5	TRACK 12	MIC #12
TRACK 6	MIC #6	TRACK 13	TACH (1 per rev)
TRACK 7	MIC #7	TRACK 14	IRIG B

EDGE TRACK A VOICE

SEQUENCE OF EVENTS

(PRE-CALIBRATIONS, TEST START AND STOP TIMES, POST-CALIBRATIONS, ETC.)

See data log sheets

*FILL IN ALL BLANKS. IF NOT APPLICABLE, WRITE N A.

CAL AC FORM 8267

TAPE NO. 4
RUN CARD NOS. 31-32

X-WING NOISE TEST DATA LOG

Sheet 1 of 2

DATE	TIME CODE START (DAY 088)	TIME CODE STOP	ATTENUATOR SETTING CH. 1	CH. 2	CH. 3	CH. 4	CH. 5	CH. 6	CH. 7	CH. 8	CH. 9	CH. 10	CH. 11	CH. 12	RPM/V_T	θ_c	BPR	BAR. PRESS. In. Hg	HUMIDITY INFO. °F DRY	°F WET	TIME	WIND VEL. (MPH)	DIR.	REMARKS
3/29/82	09:20.00	09:20:29	PN																					P = Pistonphone
↓	09:21:10	09:21:40	P																					122.6 dB at 250 HZ
	09:22:40	09:23:10		PN																				Gain of 0 dB on Amp.
	09:24.00	09:24:29		P																				
	09:26:30	09:27:00			PN																			PN = Pink Noise
	09:27:50	09:28:20			P																			Gain of 0 dB on Amp.
	09:30:25	09:30:55				PN																		
	09:31:50	09:32:20				P																		
	09:34:20	09:34:50					PN																	
	09:35:40	09:36:10					P																	
	09:38:25	09:38:55						PN																
	09:39:55	09:40:24						P																
	09:42:20	09:42:50							PN															
	09:43:45	09:44:15							P															
	09:46:10	09:46:39								PN														
	09:47:55	09:48:25								P														
	09:50:10	09:50:39									PN													
	09:51:10	09:51:40									P													
	09:54:20	09:54:50										PN												
	10:00:05	10:00:35										P												
	10:04:30	10:05:00											PN											
	10:05:55	10:06:24											P											
	10:08:45	10:09:18												PN										
	10:10:20	10:11:00												P										
	12:10:50	12:11:48	48	NO DATA	48	48	48	48	48	48	48	48	48	48								5		Ambient
↓	DAY 089																							No Data Rain
3/30/82	No Pre-Calib																							
	13:14:40	13:15:02	42	42	42	42	42	42	42	42	42	42	42	42	0	X	1.2					—	—	8 Position Blowing Test
	13:15:28	13:15:50	42	42	42	42	42	42	42	42	42	42	42	42	↓	↓	1.4					—	—	
	13:16:19	13:16:53	36	36	42	42	42	42	42	42	42	42	35	30			1.6					—	—	
	13:17:24	13:17:52	36	36	36	36	42	42	35	30	30	30	35	[illegible]			1.8					—	—	
	13:18:15	13:18:35	30	30	30	30	36	36	35	35	35	35	35	[illegible]			2.0					—	—	
															↓	↓		25.67	56	49	3:35 PM			
	16:42:05	16:42:45	24	30	30	30	36	36	30	30	25	25	35	10	404	45	1.0					2-3	SW	
	16:43:09	16:43:35	24	30	30	30	36	36	30	30	25	25	30	10	↓	↓	1.2					5	SW	
↓	16:44:00	16:44:25	24	30	30	30	36	36	30	30	25	25	30	5			1.4					4-5	SW	

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TAPE NO. 4
RUN CARD NOS. 31432
Sheet 2 of 2

X-WING NOISE TEST DATA LOG

DATE	TIME CODE START (DAY OF?)	TIME CODE STOP	CH. 1	CH. 2	CH. 3	CH. 4	CH. 5	CH. 6	CH. 7	CH. 8	CH. 9	CH. 10	CH. 11	CH. 12	RPM/V_c	θ_c	BPR	BAR. PRESS. In. Hg	HUMIDITY INFO. °F DRY	°F WET	TIME	WIND VEL. (MPH)	WIND DIR.	REMARKS
[illegible]	16 44.47	16:45:12	24	24	30	30	36	36	30	30	25	25	30	0	404	1.5	1.5					2-3	SW	
	16:45.28	16 45.52	18	24	24	24	30	30	30	30	25	25	30	0			1.6					3-4	SW	
	16 46:09	16:46:31	18	24	24	24	30	30	30	30	20	20	30	-5			1.7					4-5	SW	
	16:46:50	16:47.16	18	24	24	24	30	30	25	25	20	20	25	-5			1.8					3-4	SW	
	16:47:29	16:47:56	12	18	24	24	30	30	25	25	20	15	25	-5			1.9					3-4	SW	
	16:48:11	16:48:49	12	18	24	24	30	30	25	25	20	15	25	-5			2.0					5	SW	
	16:49:01	16:49:26	12	18	24	24	24	30	25	25	20	15	25	-5			2.1					4-5	SW	
	16:52.02	16:52.39	23	30	30	30	36	36	30	30	25	25	30	10	420	1.5	1.0					4-5	SW	
	16:53:13	16:53.40	24	30	30	30	36	36	30	30	25	25	30	10			1.2					2-3	N	
	16:54:08	16:54.35	18	24	30	30	36	36	30	30	25	25	25	10			1.4					3-4	N	
	16.54.50	16.55.18	18	24	24	30	30	36	30	30	25	25	25	0			1.5					3-4	SE	
	16 55.36	16:56:00	18	24	24	30	30	36	30	30	25	20	25	-5			1.6					3-4	SE	
	16:56:20	16.56.45	18	24	24	30	30	30	30	30	25	20	25	-5			1.7					3-4	SE	
	16:56:58	16:57.22	12	18	24	24	30	30	30	30	25	20	25	-5			1.8					3-4	SE	
	16.57:40	16:58:22	12	18	24	24	30	30	30	25	20	20	25	-5			1.9					4-5	NW	
	16:58.40	16:59.07	12	18	18	18	30	30	25	25	20	20	25	-5			2.0					3-4	SW	
	16:59.32	16:59.56	12	18	18	18	24	24	25	25	20	15	20	-10			2.1					2-3	SW	
	17 01.46	17:02.05	18	24	24	30	30	36	30	30	25	20	25	10	458	1.5	1.0					3-4	SW	
	17:02.32	17:02:52	18	24	24	30	30	30	30	30	25	20	25	10			1.2					2-3	NW	
	17.03.11	17.03:39	18	24	24	30	30	30	30	30	25	20	25	0			1.4					3-4	E	
	17.03:52	17:04:15	18	24	24	30	30	30	30	30	25	20	25	-5			1.5					2-3	SW	
	17.04.29	17.04:58	18	18	24	24	30	30	30	30	25	20	25	-5			1.6					5	SW	
	17:05.14	17.05.34	18	18	24	24	30	30	30	30	21	20	25	-5			1.7					4-5	SW	
	17:05:55	17.06:18	12	18	24	24	30	30	25	25	20	15	20	-5			1.8					4-5	SW	
	17:06:33	17.07.00	12	18	18	24	30	30	25	25	20	15	20	-10			1.9					4-5	SW	
	17:07 18	17.07.42	12	18	18	24	24	24	25	25	20	15	20	-10			2.0					2-3	NW	

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DATA TAPE IDENTIFICATION

TEST IDENTIFICATION

3/30/82

TEST X-WING-NOISE TAPE # 5 TEST SITE Rotor Tower DATE 4/5/82

TAPE RECORDER IDENTIFICATION

MAKE SANGAMO MODEL 3500 MODIFICATIONS N/A

TAPE IDENTIFICATION

RECORD MODE FM CARRIER FREQUENCY 108 KHZ DEVIATION ± 40%

SPEED 30 IPS (EXT) TAPE WIDTH 1 IN NUMBER OF TRACKS 14

REWOUND NOT REWOUND

TAPE IDENTIFICATION

TRACK 1 MIC #1	TRACK 8 MIC #8
TRACK 2 MIC #2	TRACK 9 MIC #9
TRACK 3 MIC #3	TRACK 10 MIC #10
TRACK 4 MIC #4	TRACK 11 MIC #11
TRACK 5 MIC #5	TRACK 12 MIC #12
TRACK 6 MIC #6	TRACK 13 TACH (1 per rev)
TRACK 7 MIC #7	TRACK 14 IRIG B

EDGE TRACK A VOICE

SEQUENCE OF EVENTS

(PRE-CALIBRATIONS, TEST START AND TOP TIMES, POST-CALIBRATIONS, ETC.)

See data log sheets

Tape Not Re-wound with previous data was re-recorded over some tape and data can be heard during the second recording in the pause areas data on

*FILL IN ALL BLANKS. IF NOT APPLICABLE, WRITE N A.

CALAC FORM 8267

TAPE NO. 5
RUN CARD NOS. 24
Sheet 1 of 2

X-WING NOISE TEST DATA LOG

DATE	TIME CODE START (DAY 089)	TIME CODE STOP	CH. 1	CH. 2	CH. 3	CH. 4	CH. 5	CH. 6	CH. 7	CH. 8	CH. 9	CH. 10	CH. 11	CH. 12	RPM/V_c	θ_c	SPR	BAR. PRESS. In. Hg	°F DRY	°F WET	TIME	WIND VEL. (MPH)	WIND DIR.	REMARKS
[illegible]	17:12:10	17:12:36	18	24	24	24	30	30	25	25	20	20	25	5	497	15	1.0	28.67	56	49	3:25	4-5	W	
	17:12:52	17:13:18	18	24	24	24	30	30	25	25	20	20	25	5			1.2					3-4	SW	
	17:13:42	17:14:08	18	24	24	24	30	36	25	25	20	20	20	0			1.4					4-5	S	
	17:14:28	17:14:51	18	18	24	24	30	30	25	25	20	20	20	0			1.5					2-3	SE	
	17:15:09	17:15:32	18	18	24	24	30	30	25	25	20	15	20	-5			1.6					3-4	SW	
	17:15:47	17:16:18	12	18	24	24	24	30	25	25	20	15	20	-10			1.7					3-4	SW	
	17:16:33	17:16:58	12	18	18	24	24	24	25	25	20	15	20	-10			1.8					3-4	E	
	17:17:13	17:18:04	12	18	18	18	24	24	25	25	20	15	20	-10			1.9					5	SW	
	17:18:30	17:18:56	12	18	18	18	24	24	25	20	5	15	20	-10			2.0					5	SW	
	17:20:02	17:20:26	18	24	24	24	30	36	25	25	20	15	25	5	497	45	1.0					3-4	SW	
	17:20:46	17:21:14	18	24	24	24	30	30	25	25	20	15	25	5			1.1					3-4	SW	
	17:21:32	17:21:53	18	24	24	24	30	30	25	25	20	15	25	5			1.2					3-4	SW	
	17:22:15	17:22:40	18	24	24	24	30	30	25	25	20	15	25	5			1.3					4-5	NE	
	17:22:54	17:23:15	18	24	24	24	30	36	25	25	20	15	20	0			1.4					4-5	SW	
	17:23:34	17:23:59	12	18	24	24	30	30	25	25	20	15	20	-5			1.5					4-5	SW	
	17:24:14	17:24:36	12	18	18	24	24	30	25	25	20	15	20	-5			1.6					4-5	SW	
	17:25:01	17:25:27	12	18	18	24	24	30	25	25	20	15	20	-10			1.7					3-4	SW	
	17:32:43	17:33:09	P																					Post Cal.
	17:34:15	17:34:54	PN																					
	17:36:10	17:36:45		P																				P= Pistonphone
	17:38:00	17:38:34		PN																				122.6 dB at 250 Hz.
	17:40:00	17:40:34			P																			Gain of 0 dB on Amp.
	17:41:30	17:42:04			PN																			
	17:43:35	17:44:10				P																		PN= Pink Noise
	17:45:20	17:45:58				PN																		Gain of 0 dB on Amp
	17:47:30	17:48:05					P																	
	17:49:25	17:50:01					PN																	
	17:51:30	17:52:04						P																
	17:54:15	17:54:50						PN																
	17:56:25	17:57:02							P															
	17:58:00	17:58:35							PN															
	17:59:50	18:00:26								P														
	18:01:15	18:01:52								PN														
	18:03:00	18:03:34									P													
	18:04:30	18:05:04									PN													
	18:06:25	18:06:59										P												

TAPE NO. 5
RUN CARD NOS. 32
Sheet 2 of 3

X-WING NOISE TEST DATA LOG

DATE	TIME CODE START	TIME CODE STOP	ATTENUATOR SETTING CH. 1	CH. 2	CH. 3	CH. 4	CH. 5	CH. 6	CH. 7	CH. 8	CH. 9	CH. 10	CH. 11	CH. 12	RPM/V_c	θ_c	RPS	BAR. PRESS. in. Hg	HUMIDITY INFO. °F DRY	°F WET	TIME	WIND VEL. (MPH)	DIR.	REMARKS
	DAY 087																							
3/28/?	18.11.45	18.12.20										PN												
↓	18 16.15	18 16:50											P											
↓	18 18.00	18.18.34											PN											
↓	18 22.05	18.22.39												P										
↓	18.24.10	18.24.44												PN										
	DAY 095																							
4/5/?	10.28.22	10:29.35	42	42	48	48	48	48	50	50	50	40	45	35				—	62	56	1:50	WIND INSTRUMENTATION DISCONNECTED		Drive Motor Cooling System
↓	10:36:00	10.37.00	48	54	54	54	60	60	60	60	55	40	60	55										Cooling Tower Main Bldg.
↓	10 40.19	10:41:15	54	54	60	60	66	66	65	65	65	40	60	50										Bell Trans. Lube Pump
↓	10 46:50	10:48:12	54	54	60	60	66	66	65	65	65	45	65	60										Hyd System (Base of tower)
↓	10:50:36	10:52:03	42	42	48	48	48	54	50	50	45	40	46	30										All Systems Running (all of above)
↓																								
↓	11:35.12	11:36:12	36	42	42	42	48	48	45	45	45	40	40	20			1.2							Air Flow & Motion
↓	11 36.51	11.37.45	36	36	36	36	42	42	40	40	40	35	35	15			1.6							[illegible] "Nodes" [illegible] at
↓	11.38.15	11.39.10	30	30	30	30	36	36	40	35	35	30	35	10			2.0							array (1-5) BLADES REMOVED.
↓																								
↓	11.43.25	11.44.00											P											Post Calib.
↓	11.44.45	11.45:15											PN											
↓	11.48.08	11.48.40												P										P = pistonphone
↓	11 49.35	11.50:08												PN										123.6 dB at 250 HZ
↓	11 56:53	11.57.20	P																					Gain at 0 dB at Amp.
↓	11.58.55	11.59.28	PN																					
↓	12:00:30	12:01.00		P																				PN = Pink Noise
↓	12.02:52	12.03:25		PN																				Gain at 0 dB on Amp.
↓	12 04 28	12.04.58			P																			
↓	12 05.50	12.06.16			PN																			
↓	12 07.45	12.08.15				P																		
↓	12.09.30	12 10:00				PN																		
↓	12 11.42	12 12:15					P																	
↓	12 13.25	12 14.00					PN																	
↓	12.17.00	12 17.30						P																
↓	12 18.43	12 19.15						PN																
↓	12 20.55	12 21.25							P															
↓	12 22.27	12.23.05							PN															
↓	12 24.15	12.24.45								P														
↓	12 25 38	12 26.06								PN														

ORIGINAL PAGE IS OF POOR QUALITY

TAPE NO. 5
RUN CARD NOS. 24

Sheet 2 of 2

X-WING NOISE TEST DATA LOG

DATE	TIME CODE START	TIME CODE STOP	ATTENUATOR SETTING CH. 1	CH. 2	CH. 3	CH. 4	CH. 5	CH. 6	CH. 7	CH. 8	CH. 9	CH. 10	CH. 11	CH. 12	RPM/V_c	θ_c	SPL	BAR. PRESS. In. Hg	HUMIDITY INFO. °F DRY	°F WET	TIME	WIND VEL. (MPH)	DIR.	REMARKS
	DAY 095																							
[illegible]	12:27:13	12:27:41									P													
↓	12:28:39	12:29:03									PN													
↓	12:30:15	12:30:44										P												
↓	12:31:39	12:32:06										PN												

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DATA TAPE IDENTIFICATION

TEST IDENTIFICATION

TEST X-WING-NOISE TAPE # 6 TEST SITE Rotor Tower DATE 4/8/82

TAPE RECORDER IDENTIFICATION

MAKE SANGAMO MODEL 3500 MODIFICATIONS N/A

TAPE IDENTIFICATION

RECORD MODE FM CARRIER FREQUENCY 108 KHZ DEVIATION ± 40%

SPEED 30 IPS (EXT) TAPE WIDTH 1 IN NUMBER OF TRACKS 14

REWOUND NOT REWOUND

TAPE IDENTIFICATION

TRACK 1	MIC # 1	TRACK 8	MIC # 8
TRACK 2	MIC # 2	TRACK 9	MIC # 9
TRACK 3	MIC # 3	TRACK 10	MIC # 10
TRACK 4	MIC # 4	TRACK 11	MIC # 11
TRACK 5	MIC # 5	TRACK 12	MIC # 12
TRACK 6	MIC # 6	TRACK 13	TACH (1 per rev)
TRACK 7	MIC # 7	TRACK 14	IRIG B

EDGE TRACK A VOICE

SEQUENCE OF EVENTS

(PRE-CALIBRATIONS, TEST START AND STOP TIMES, POST-CALIBRATIONS, ETC.)

See data log sheets

*FILL IN ALL BLANKS. IF NOT APPLICABLE, WRITE N A.

CAL AC FORM 826

TAPE NO. 6
RUN CARD NOS. ____
Sheet 1 of 2

X-WING NOISE TEST DATA LOG

DATE	TIME CODE START	TIME CODE STOP	ATTENUATOR SETTING CH. 1	CH. 2	CH. 3	CH. 4	CH. 5	CH. 6	CH. 7	CH. 8	CH. 9	CH. 10	CH. 11	CH. 12	RPM/V_t	θ_c	BPB	BAR. PRESS. In. Hg	HUMIDITY INFO. °F DRY	°F WET	TIME	WIND VEL. (MPH)	DIR.	REMARKS
	DAY 079																							
[illegible]	12:42.15	12:42.55	PN																					P: Pistonphone
	12.44.40	12.45.09	P																					123.6 dB at 250 HZ.
	12.46.25	12.46:57		PN																				Gain of 0 dB on Amp
	12.47:35	12.47:58		P																				
	12.49.23	12.49:58			PN																			PN: Pink Noise
	12.50:35	12:51:01			P																			Gain of 0 dB on Amp.
	12:52:51	12:53:20				PN																		
	12.54.13	12.54.40				P																		
	12.56.04	12.56.30					PN																	
	12:57:30	12.57.58					P																	
	13.02:30	13.02.53						PN																
	13:03 42	13:04:11						P																
	13:05.20	13.05.48							PN															
	13.07.07	13.07:36							P															
	13.10.25	13.10.55								PN														
	13.11:30	13:12:00								P														
	13:13 30	13:14.00									PN													
	13.14:35	13:15.02									P													
	13.16:30	13:16:57										PN												
	13:17:35	13:18.03										P												
	13.24:55	13.25.22											PN											
	13.26.14	13:26.41											P											
	13.28.05	13.28:38												PN										
	13.30.00	13:30.30												P										
	13:57:58	14.00:26	36	36	42	42	42	48	45	45	40	40	45	10	Sweep	[illegible]	20Hz-2kHz			(NEV)				Oscillator Signal on CH 13
	14:00.40	14:03:05	36	36	42	42	42	48	45	45	40	40	45	10	"	[illegible]	"	"		(60V)				
	14.12.48	14.15.51	36	36	42	42	42	48	45	45	45	40	45	10	Pink	Noise				(100V)				Pink Noise Signal on CH 13
																		—	62	50	3:00			
	14.35.52	14.37.01	12	12	12	12	12	12	10	10	10	10	10	0	Slot #1									Nozzle Normal / No
		14.38:44	12	12	12	12	12	12	10	10	10	10	10	0	Slot #2									Mics (1-5)
		14.39.36	12	12	12	12	12	12	10	10	10	10	10	0	Slot #3									
		14.40:36	12	12	12	12	12	12	10	10	10	10	10	0	Slot #4									
		14:41.45	12	12	12	12	12	12	10	10	10	10	10	0	Slot #5									

NO CH 2 3 INSTRUMENTATION

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TAPE NO. 6
RUN CARD NOS. ____
Sheet 2 of 2

X-WING NOISE TEST DATA LOG

DATE	TIME CODE START	TIME CODE STOP	ATTENUATOR SETTING CH. 1	CH. 2	CH. 3	CH. 4	CH. 5	CH. 6	CH. 7	CH. 8	CH. 9	CH. 10	CH. 11	CH. 12	RPM/V_t	θ_c	RPM	BAR. PRESS. In. Hg	HUMIDITY INFO. °F DRY	°F WET	TIME	WIND VEL. (MPH)	DIR.	REMARKS
	DAY 098																							
4/6/??	14.41.54																							Muzzle Manual to
		14.45.16	12	12	12	12	12	12	10	10	10	10	10	0	Shot#1									Mics 6-10
		14.46.09	12	12	12	12	12	12	10	10	10	10	10	0	Shot#2									
		14.47.03	12	12	12	12	12	12	10	10	10	10	10	0	Shot#3									
		14.47.50	12	12	12	12	12	12	10	10	10	10	10	0	Shot#4									
		14.48.37	12	12	12	12	12	12	10	10	10	10	10	0	Shot#5									
	DAY 138																							
5/18	09.23.30	09.24.20	PN																					P = Pistonphone
	09.25.35	09.26.10	P																					123.6 dB at 250 HZ
	09.30.25	09.31.10		PN																				Gain of 0 dB on Amp.
	09.32.15	09.32.50		P																				
	09.35.00	09.35.35			PN																			PN = Pink Noise
	09.37.05	09.37.40			P																			Gain of 0 dB on Amp.
	09.39.40	09.40.20				PN																		
	09.41.35	09.42.10				P																		
	09.43.45	09.44.20					PN																	
	09.45.55	09.46.30					P																	
	09.49.26	09.50.00						PN																
	09.50.50	09.51.30						P																
	09.52.10	09.52.45							PN															
	09.53.25	09.54.00							P															
	09.56.05	09.56.40								PN														
	09.57.30	09.58.05								P														
	09.58.30	09.59.40									PN													
	10.00.20	10.00.55									P													
	10.03.25	10.04.00										PN												
	10.05.45	10.06.30										P												
	10.08.25	10.09.00											PN											
	10.09.40	10.10.15											P											
	10.11.45	10.12.26												PN										Anechoic Chamber
	10.13.05	10.13:40												P				—	72.5	59.5	10.20			Test
	10.29.10	10.31.30	18	24	30	24	24	24	30	25	25	25	25	5	Sine	Sweep	20Hz - 2kHz			(10v)				Oscillator Signal on Ch 13
	10.34.30	10.38.00	30	30	36	30	30	30	30	35	30	35	35	10	Pink	Noise				(Rel)				Pink Noise Signal on Ch 13

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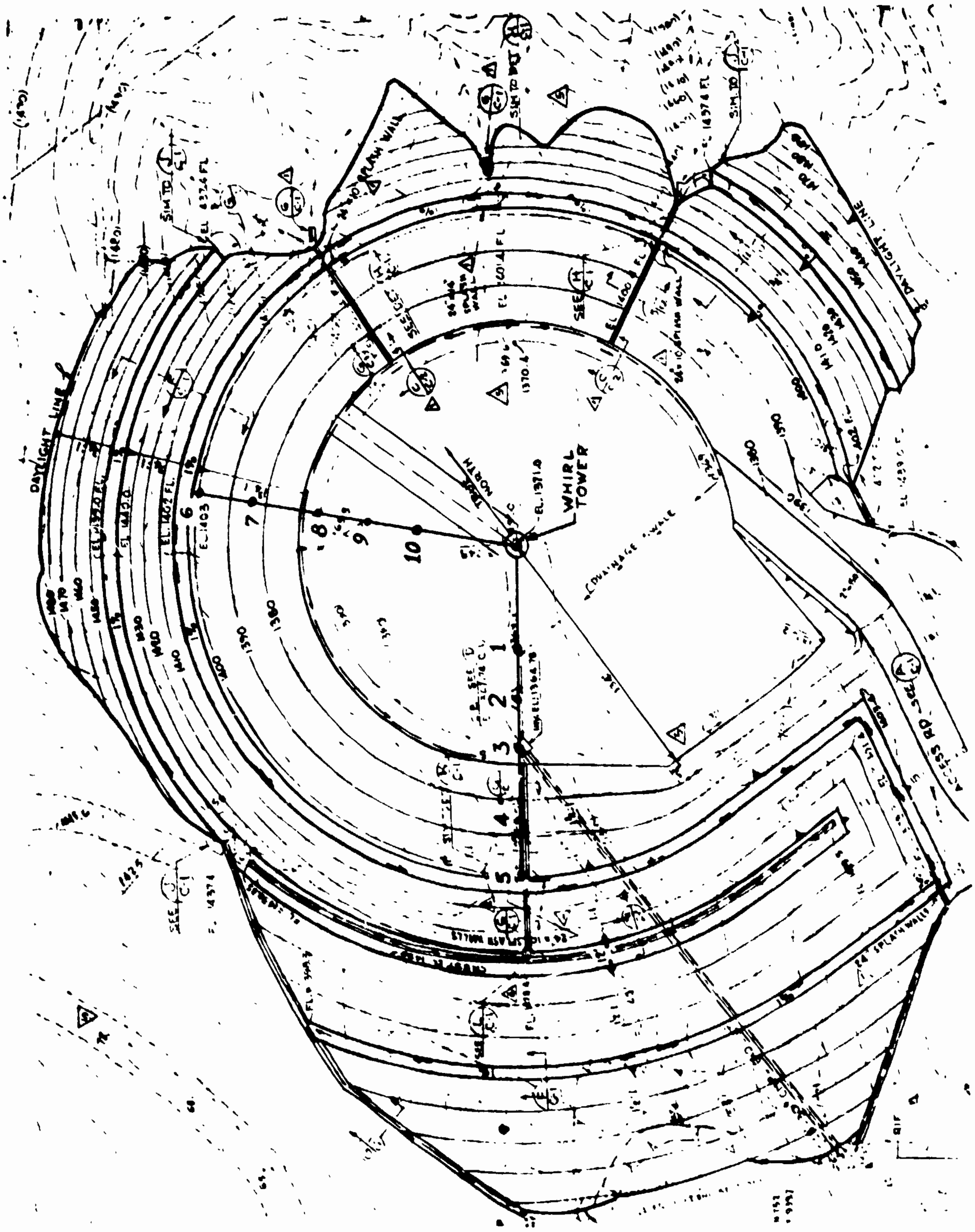

Figure 1: Plan View Drawing of Whirl Tower Bowl - Microphone Locations Numbered

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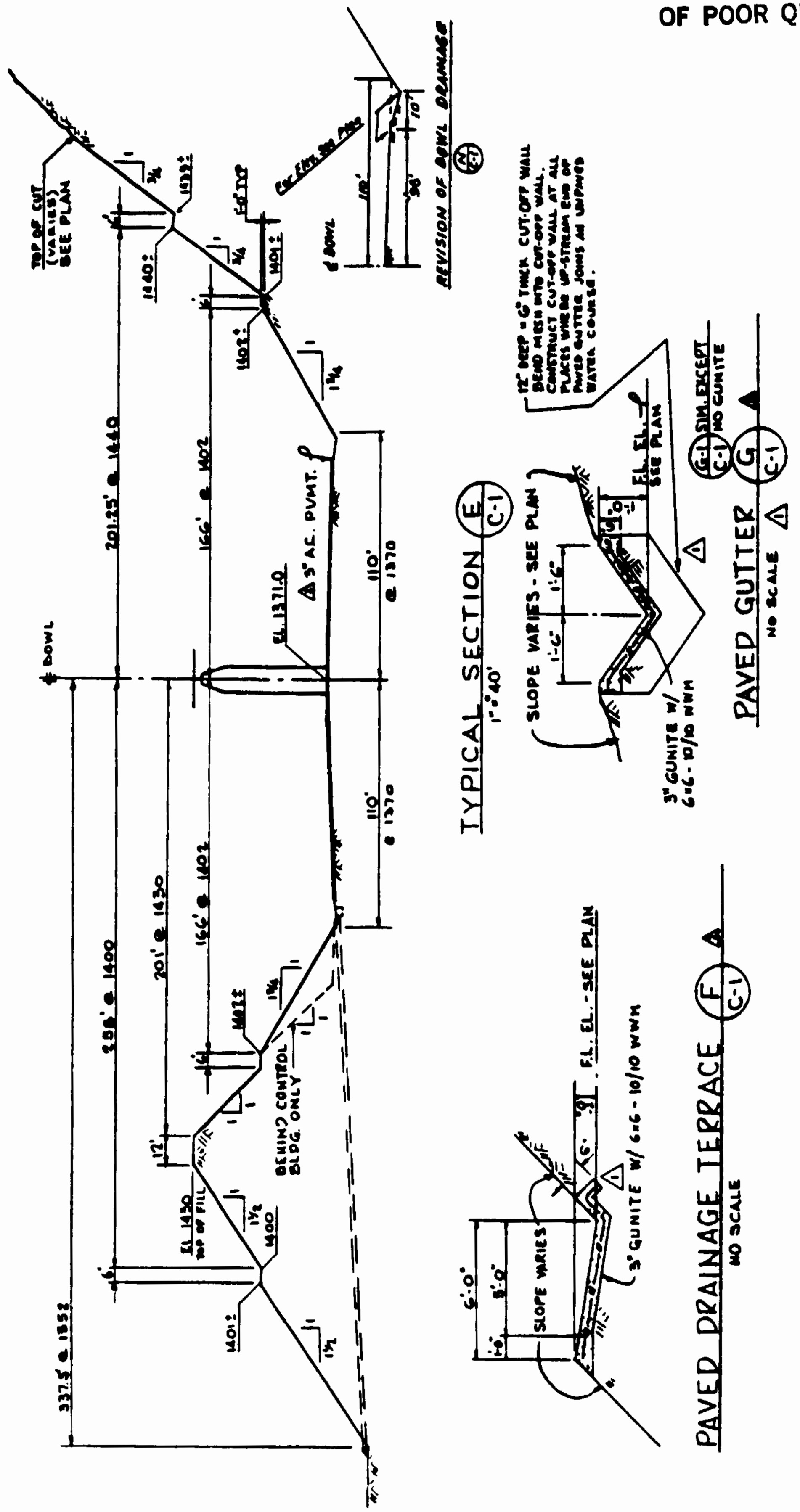

Figure 2: Cross-Section Drawing of Whirl Tower Bowl

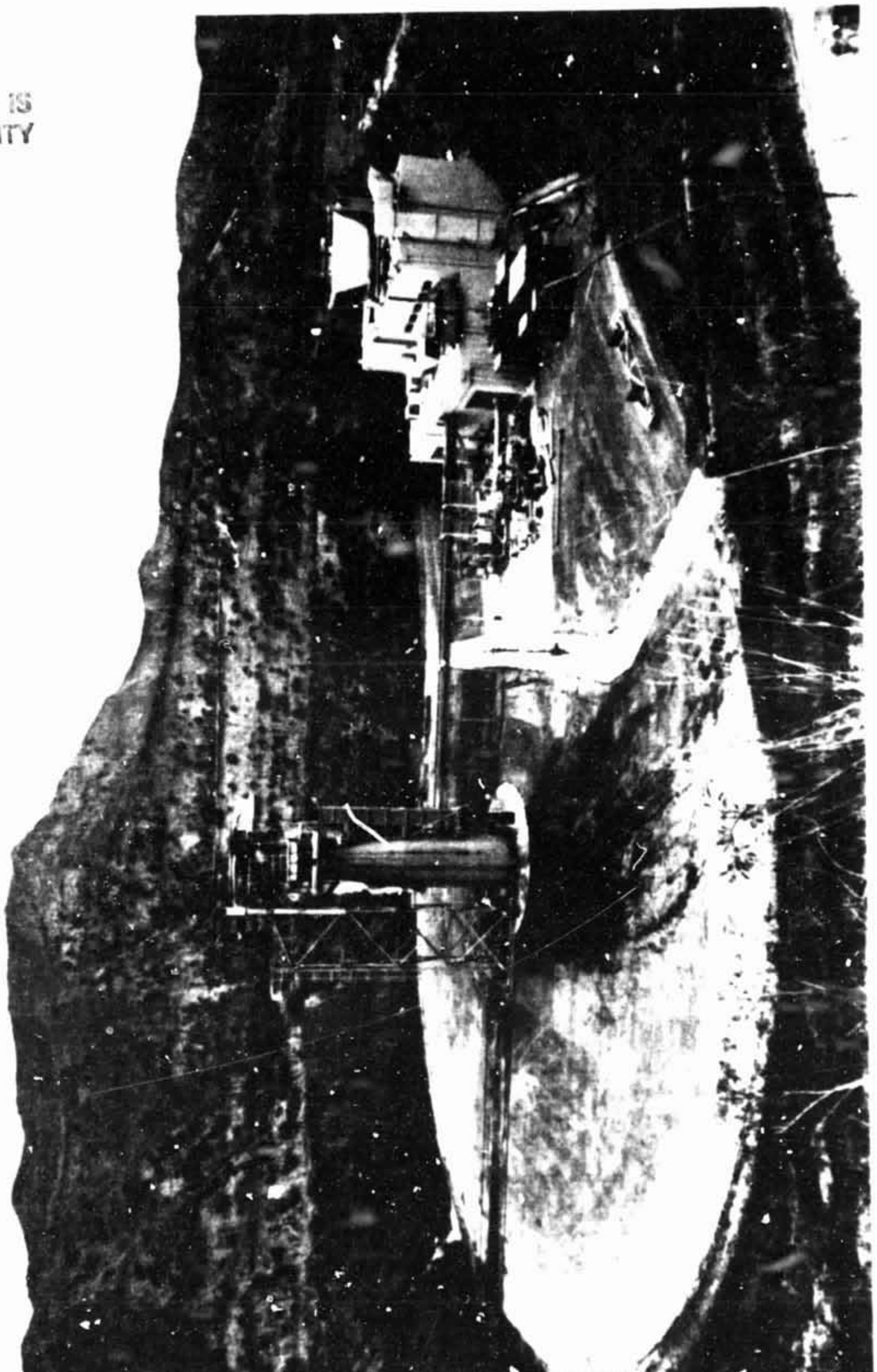

Figure 3: Side View of Bowl and X-Wing

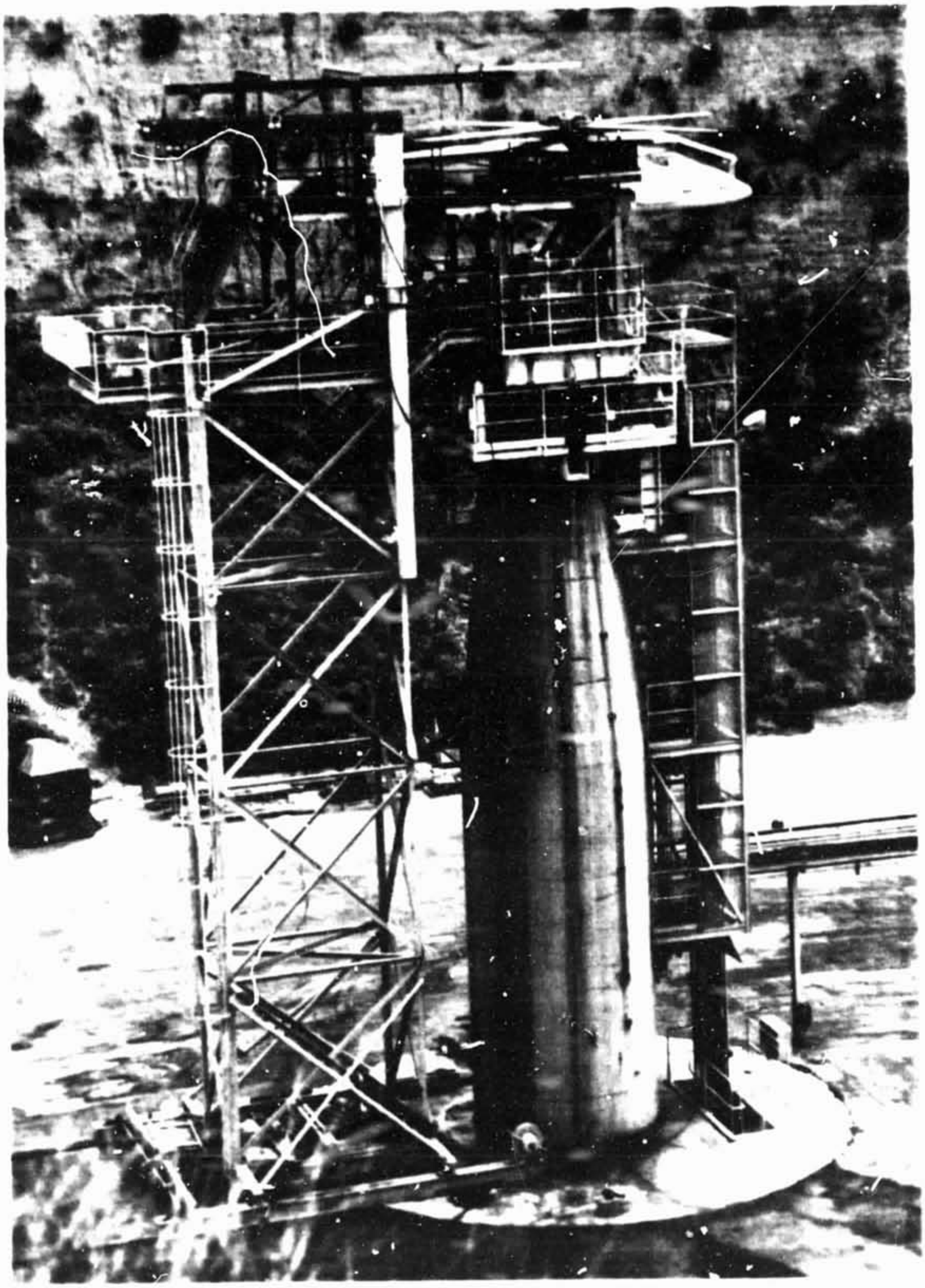

Figure 4: Whirl Tower and Gantry

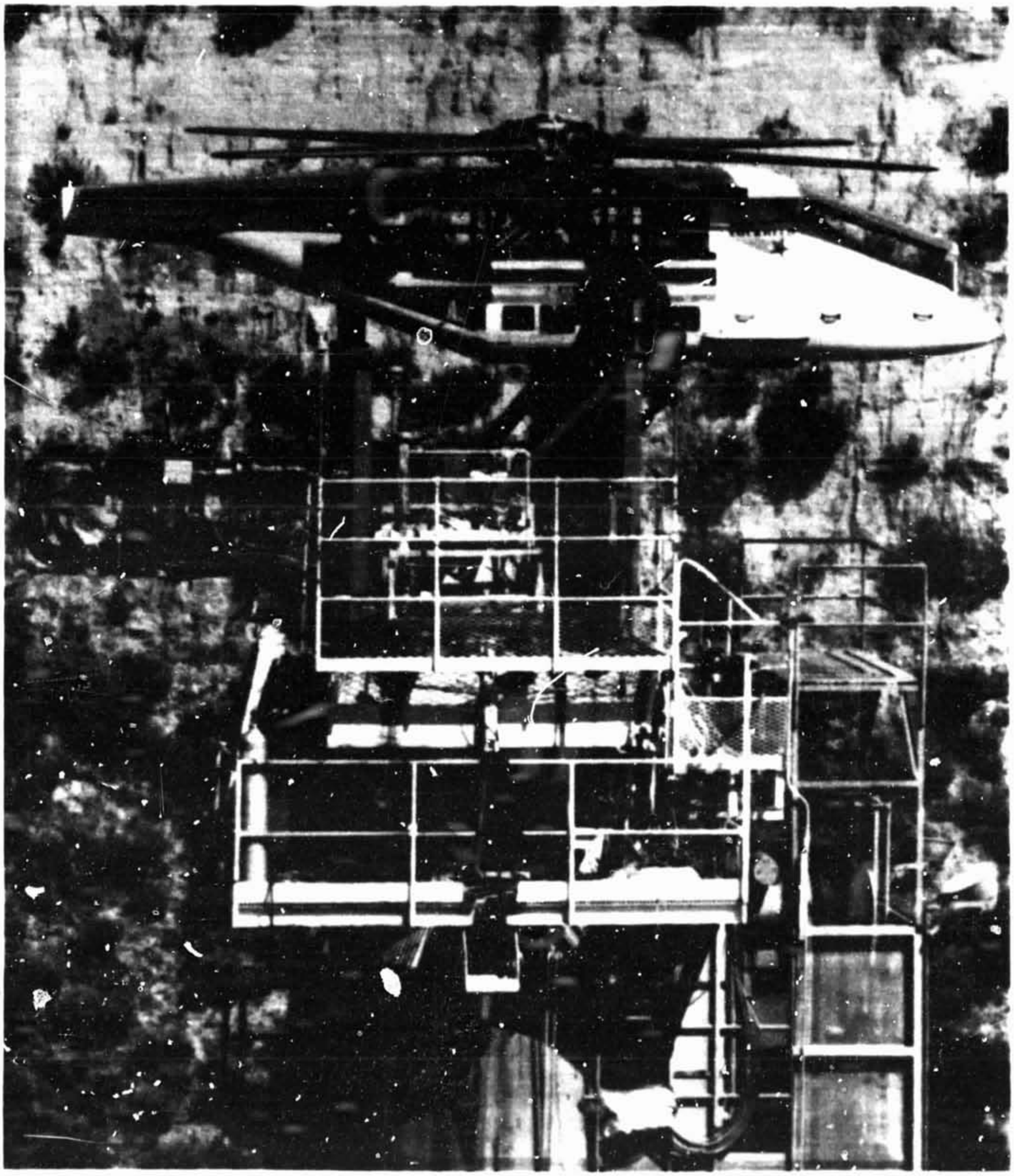

Figure 5: Close-up Side View of X-Wing in Test Configuration

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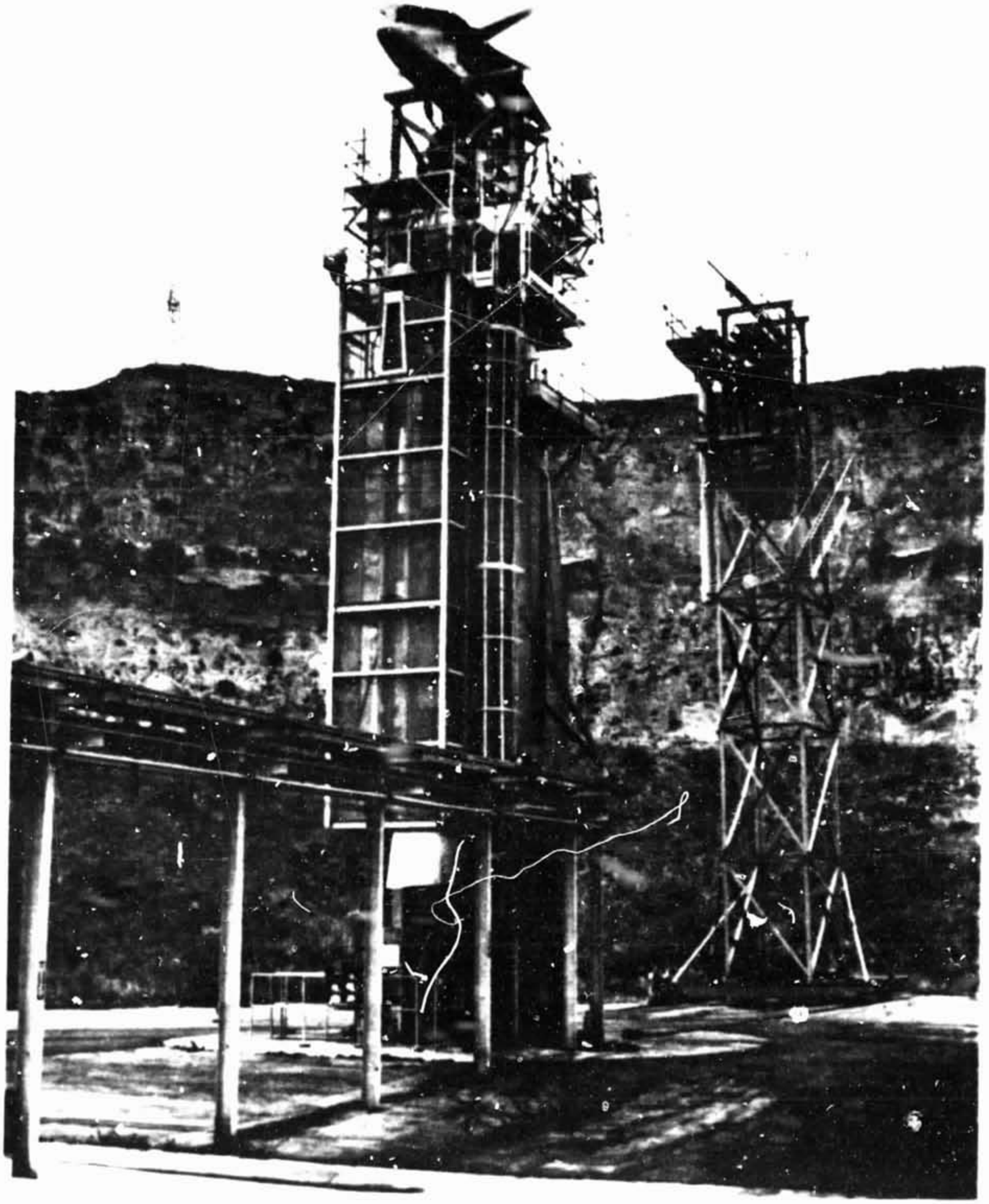

Figure 6: X-Wing Operating in Test Configuration

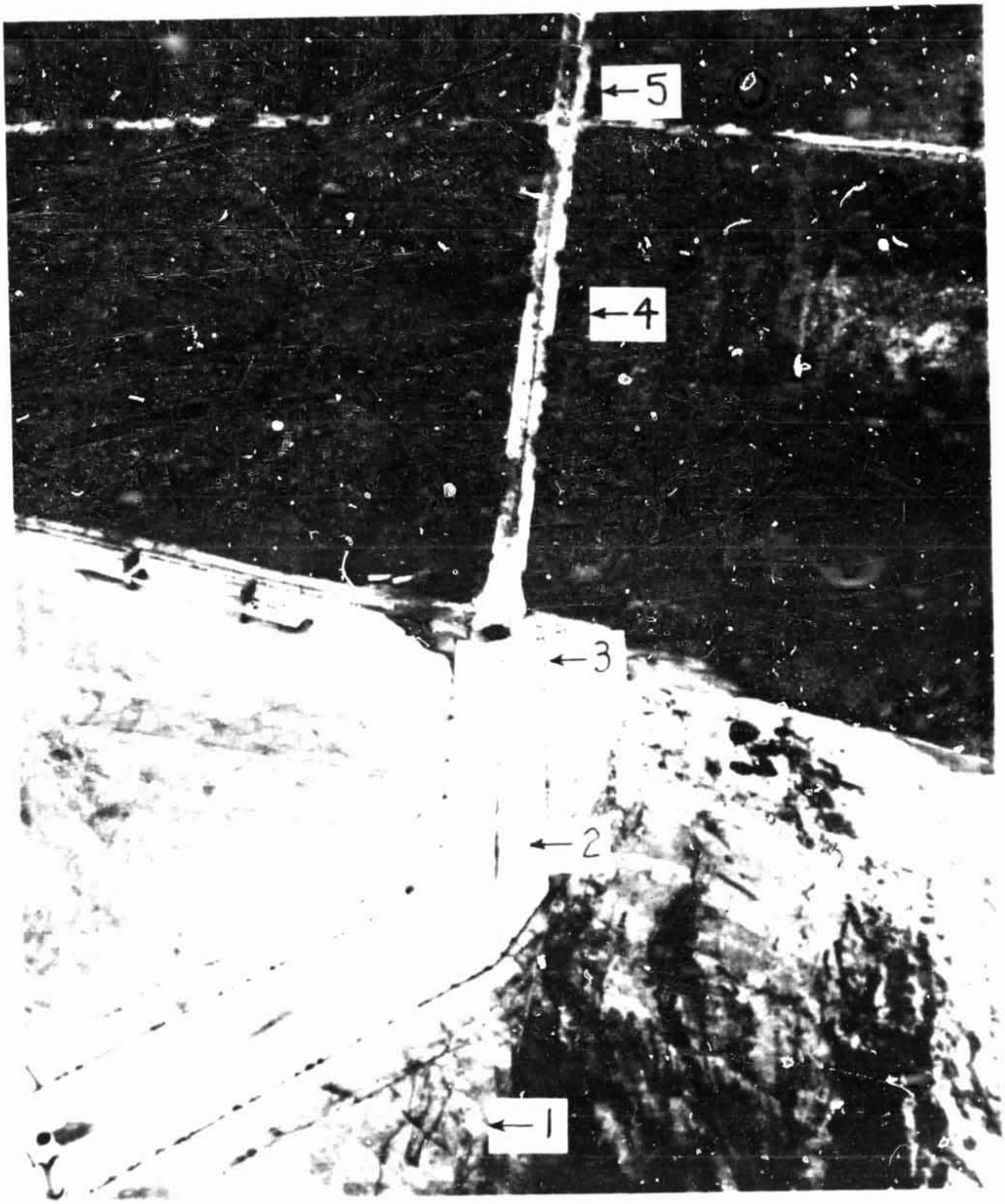

Figure 7: Microphones 1 Through 5 (From Whirl Tower)

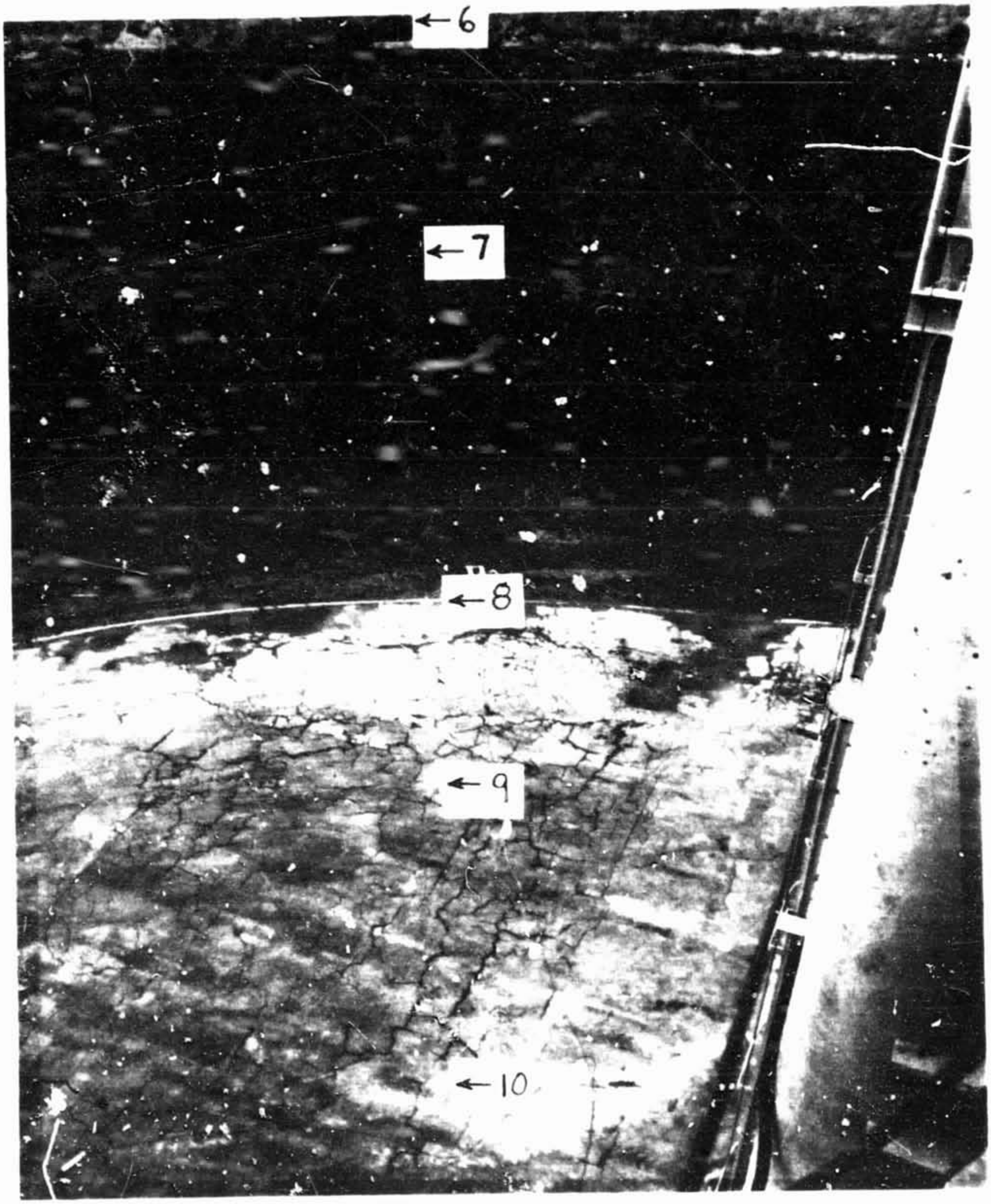

Figure 8: Microphones 6 Through 10 (From Whirl Tower)

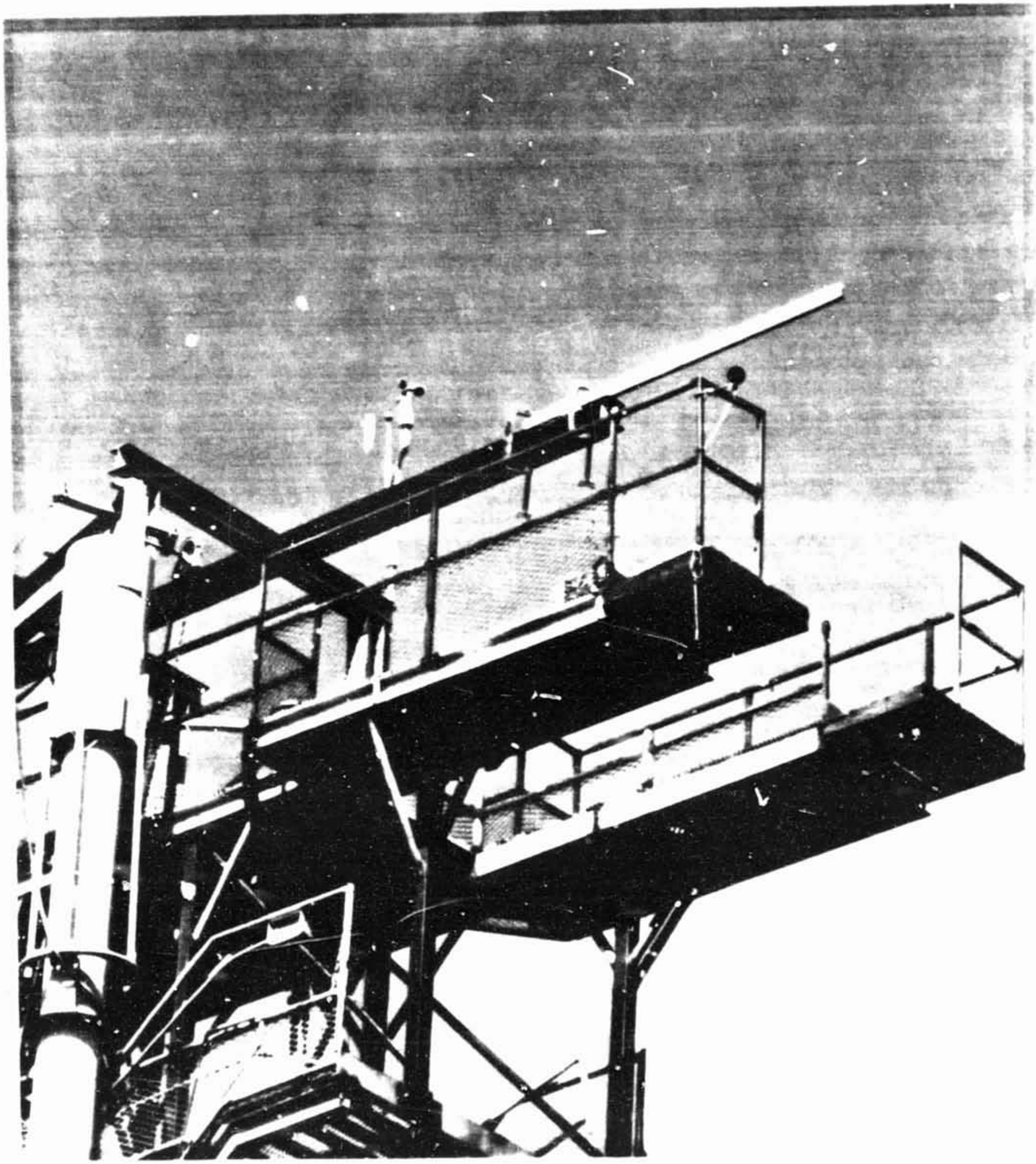

Figure 9: Close-Up of Gantry With Microphone 11

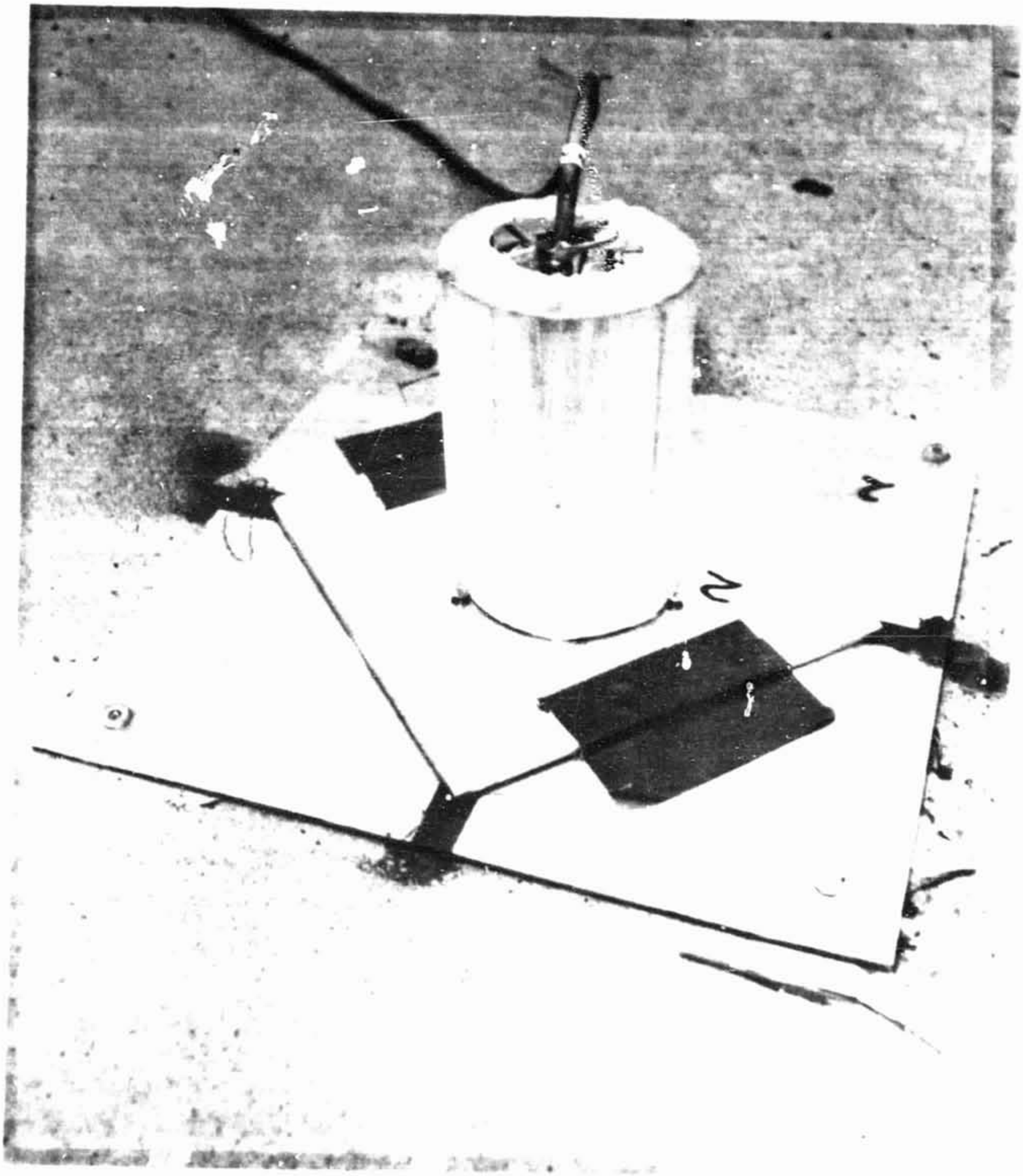

Figure 10: Ground Plane Microphone and Windscreen/Holder

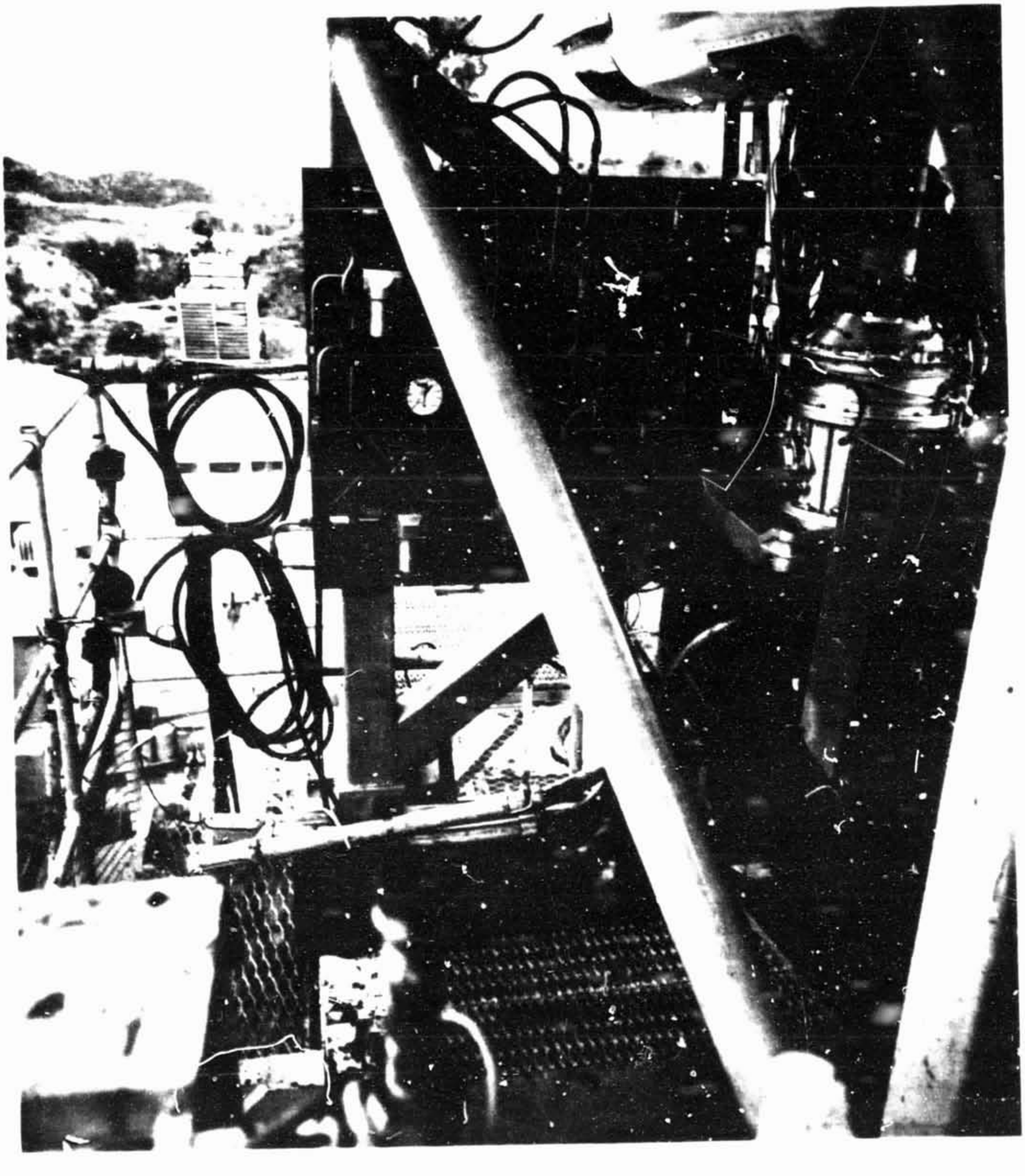

Figure 11: Microphone 12 and Bell Helicopter Transmission

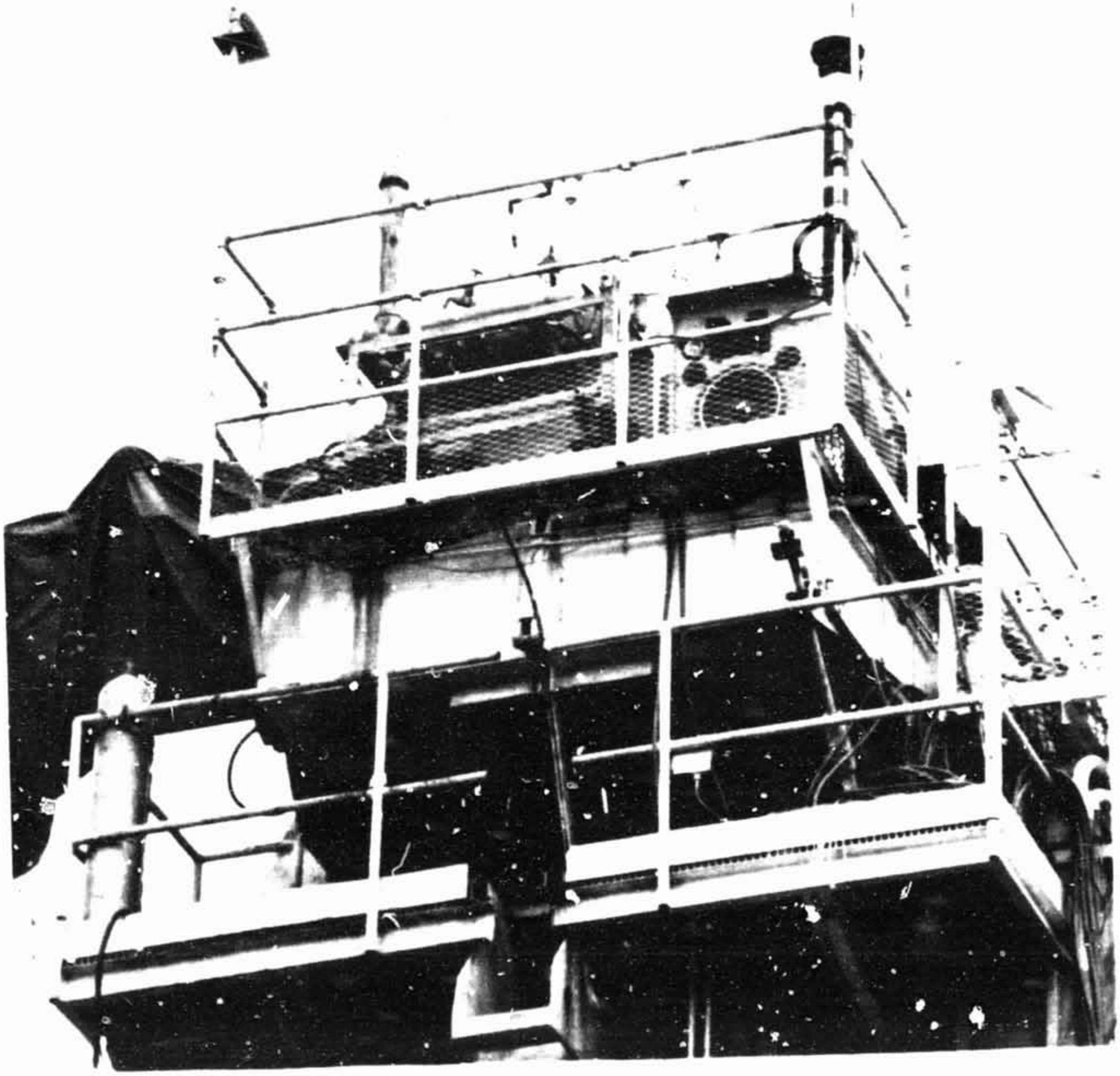

Figure 12: Bowl Calibration Loudspeaker Set-Up

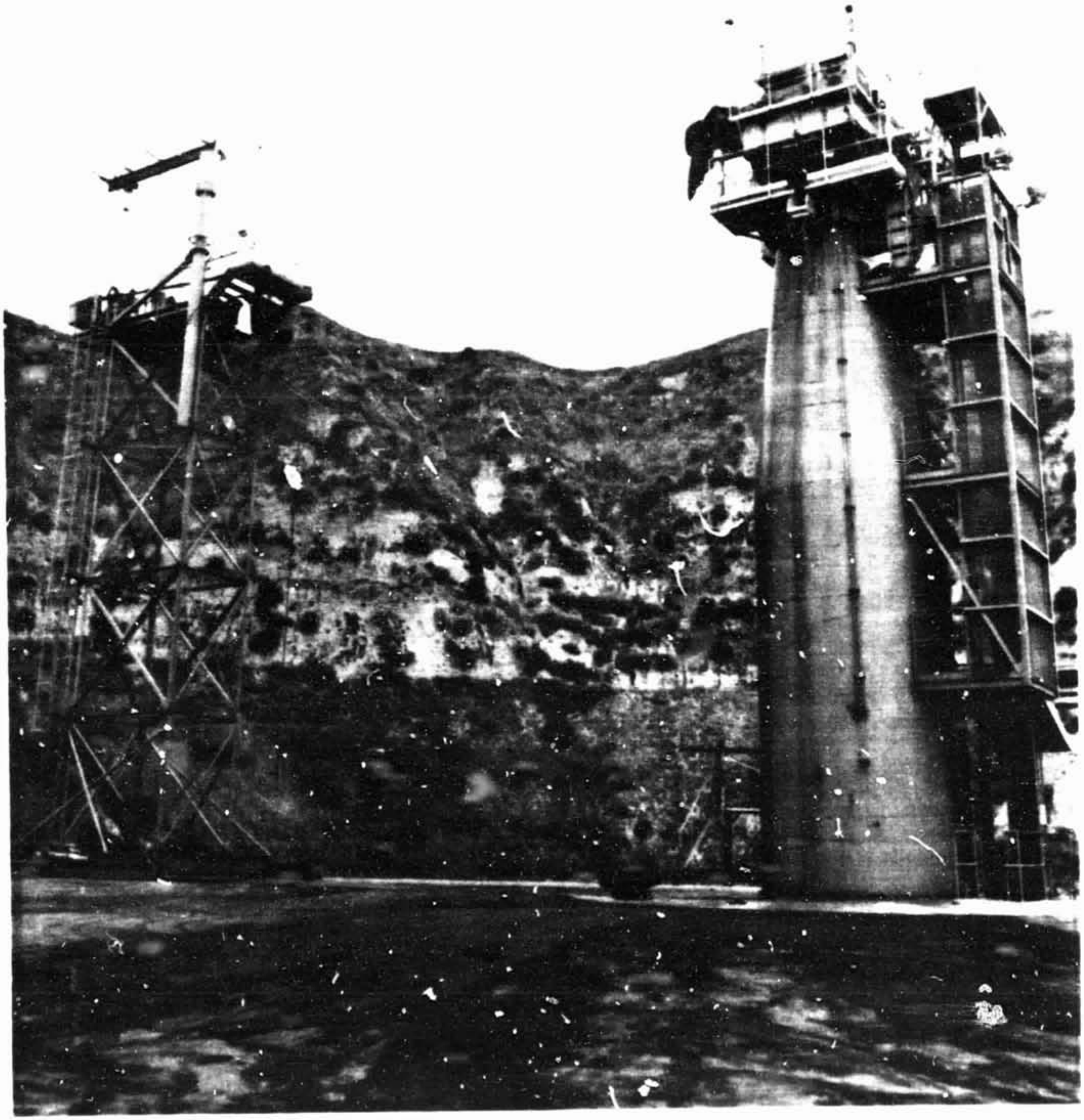

Figure 13: Tower With Gantry in Calibration Position

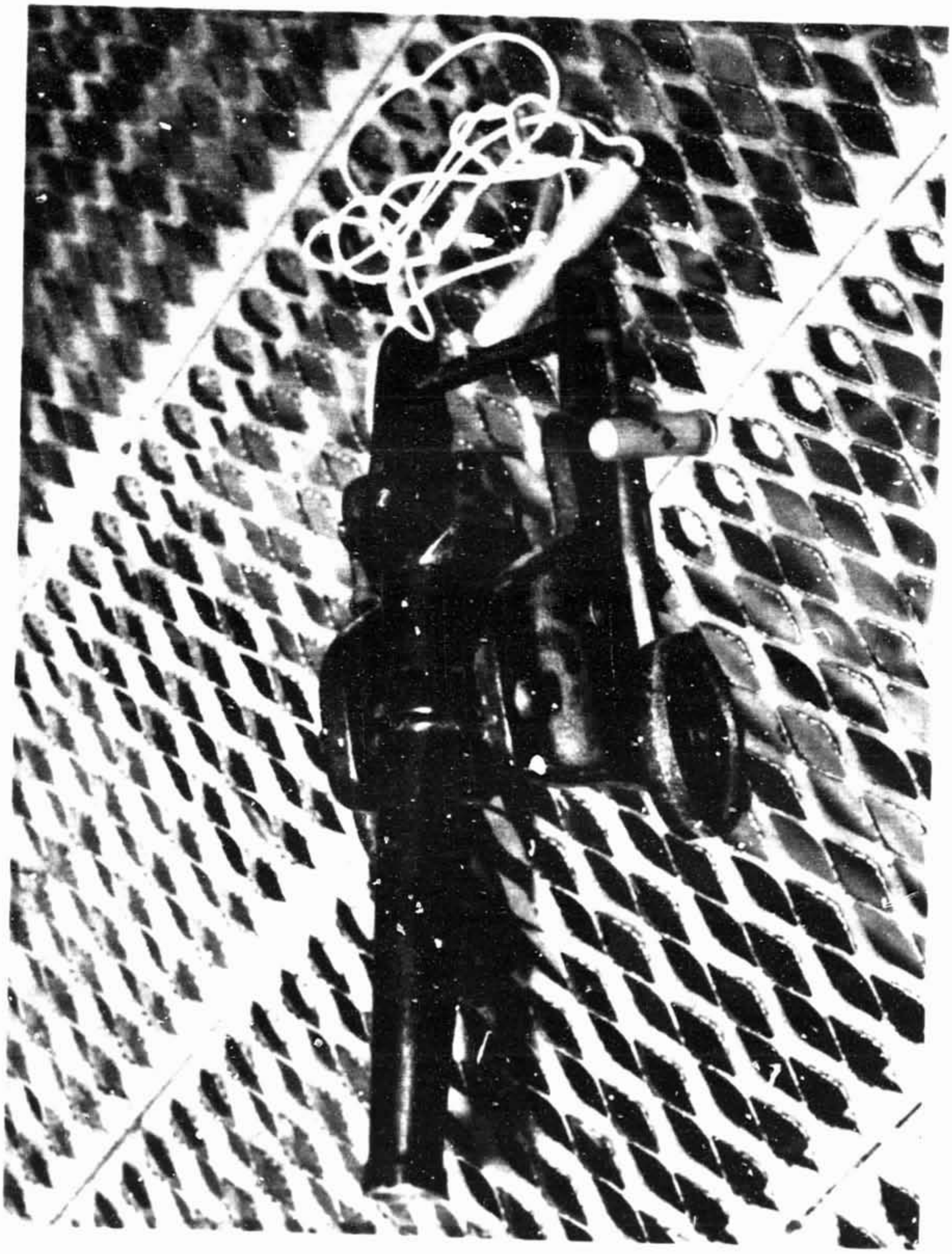

Figure 14: Bowl Calibration Cannon and Blank Shell

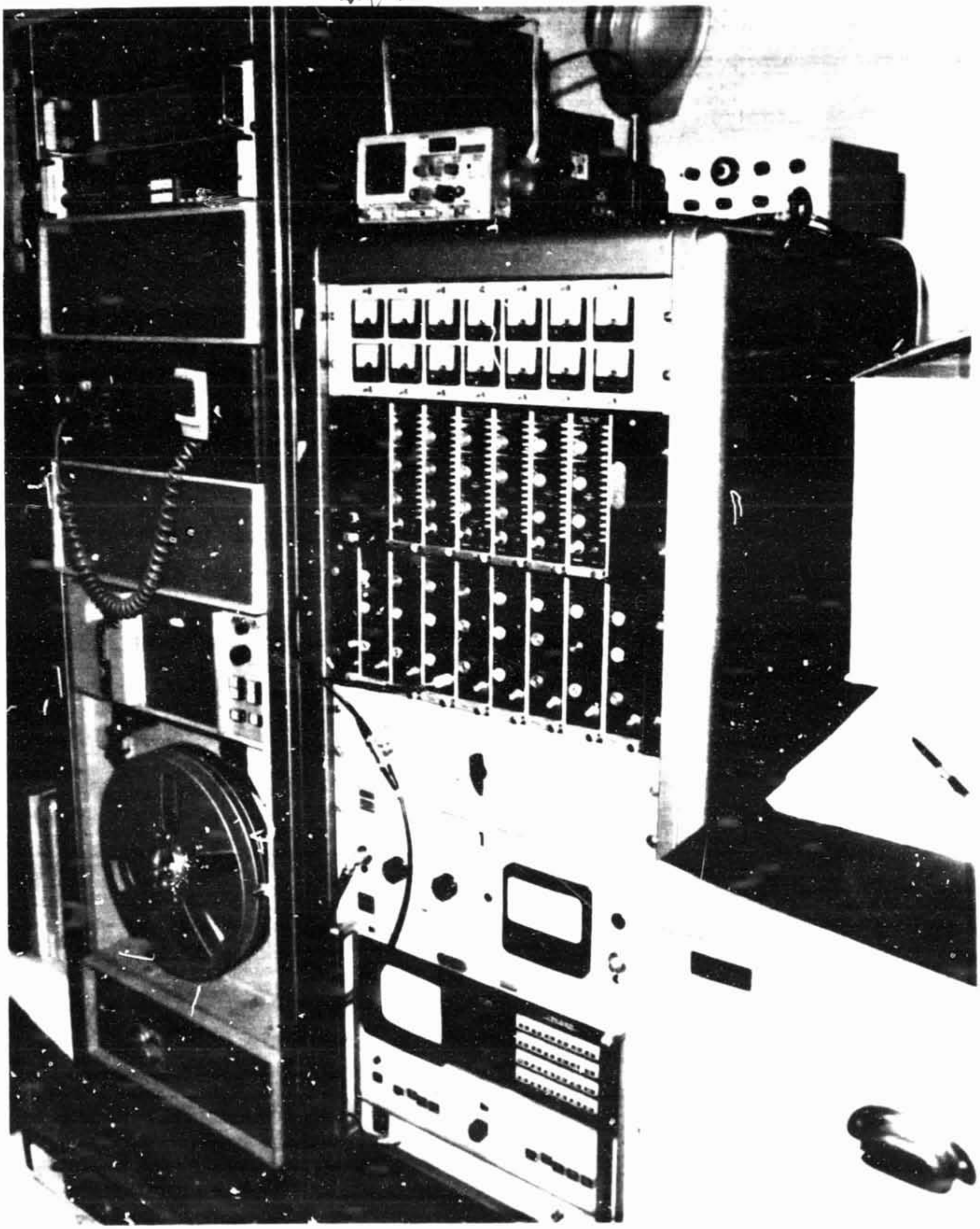

Figure 15: Acoustic Data Acquisition Equipment