MIL-STD-2071(AS)
15 August 1977

MILITARY STANDARD

TESTING OF CHAFF RADAR CROSS-SECTION

MISC

DEPARTMENT OF DEFENSE
Washington, DC 20301

Testing of Chaff Radar Cross-Section

1. This Military Standard is approved for use by the Naval Air Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

2.

COMMENTS OR RECOMMENDATIONS WHICH MAY BE OF USE IN IMPROVING THIS DOCUMENT MAY BE SENT TO THE PREPARING ACTIVITY WHEN A SELF-ADDRESSED STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL (DD FORM 1426) APPEARS AT THE END OF THIS DOCUMENT, OR BY LETTER ADDRESSED TO THE COGNIZANT ACTIVITY.

FOREWORD

The purpose of this standard is to describe and illustrate practices and procedures to be followed when measuring the radar cross-section (RCS) of airborne dispensed chaff countermeasures for acceptance purposes.

The standard relates the prescribed requirements to the existing stage of technological achievement, making the most effective use of commercially available, state-of-the-art equipment.

As new chaff types are developed, or new or revised methods, procedures, or techniques are conceived; the present text will be amended accordingly. In this connection, each of the military services and agencies of the Department of Defense is invited to provide suggestions for enhancing the value of this standard.

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1. SCOPE

1.1 General. This standard establishes the procedures, requirements, and instructions for testing chaff payloads under flight conditions to demonstrate compliance with general design specifications, performance goals, and applicable detailed equipment specifications. Detailed performance requirements for each type of chaff payload are contained in the applicable equipment specification sheet.

(For Ferrous Metals)

2. APPLICABLE DOCUMENTS

2.1 General. The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this standard to the extent specified herein.

PUBLICATIONS

Department of Defense

Flight Information Publication, IFR-Supplement, United States

Department of the Navy, Office of the Chief of Naval Operations

OPNAVINST 3710.7 - NATOPS General Flight and Operating Instructions

2.1.1 Availability of Documents. When requesting specifications, standards, drawings, and publications, refer to both title and number. Copies of this specification and applicable specifications required by contractors in connection with specific procurement functions may be obtained upon application to the Commanding Officer, Publications and Forms Center, Code 1051, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

3. DEFINITIONS

3.1 Antenna beamwidth. The angular width of the main beam in a plane (horizontal or vertical) measured between 3 dB points (one-way transmission).

3.2 Antenna polarization. The direction of maximum gain of the radiated wave when the antenna is excited. Alternatively, the polarization of an incident wave from the given orientation that results in maximum available power at the antenna terminals.

3.3 Aspect angle. The aspect angle is the angle formed by the intersection of two lines, one of which extends from the radar antenna to the point in the chaff cloud where measurements are being made and the other which extends through the axis of the chaff cloud along which it was deployed. The latter is usually a line along which the chaff deploying aircraft moves. The aspect angle is composed of two components, one in the elevation plane and the other in the horizontal or azimuth plane. The elevation angle is defined by altitude and range while the azimuth angle is defined by the true course of the aircraft and the offset distance from the radar to the true course line.

3.4 Chaff rocket. Chaff packaged in a container that is propelled by a rocket motor is called a chaff rocket. Chaff rockets may be air or surface launched, and may deploy discrete chaff units or continuous chaff.

3.5 Continuous chaff. Continuous chaff is that which is deployed continuously from a vehicle over a period of time. Continuous chaff forms a chaff cloud that is very long with respect to the other dimensions of the cloud.

3.6 Discrete chaff unit. A package, cartridge, or other container filled with chaff material that is deployed at one time to form a chaff cloud is called a discrete chaff unit. Discrete chaff units may be deployed singularly, in multiple units simultaneously, or in rapid sequence. Discrete chaff units form individual chaff clouds that may be spaced a considerable distance apart or may be overlapping.

3.7 On-Site data processor. A portable data analysis system which is capable of analyzing real time data and printing out resultant information at the test location.

3.8 Processing - Average pulse-to-pulse radar cross-section (RCS). A means of determining the average geometric cross-section of a chaff cloud or area within the cloud by averaging a large number of amplitude returns (pulses) from the cloud.

3.9 Processing - ΔK. A factor used to calibrate the RCS processing equipment to the measuring radar. ΔK is a ratio of transmitter power to receiver sensitivity, and affects the numerical RCS values by approximately 0.33 dB per ΔK integer.

3.10 Processing - First level statistics. First level processing of RCS data involves calculating average values, statistical data, and other information or presentations where the inputs to the processing are the raw pulse-to-pulse RCS values. First level processing is done for each discrete chaff unit or a sample (a given number of consecutive pulses) of continuous chaff or very large chaff clouds.

3.11 Processing - Normalization. Normalization is the smoothing of RCS statistics by compensating for factors which affect measured values. As applicable herein, RCS values shall be normalized to 10 degrees aspect angle and 0 degree antenna boresight gain.

3.12 Processing - Percentile value. In RCS statistics, the percentile value is that value which a given percent of data points equaled or exceeded. As an example, a percentile value of 70 percent of 10 square meters (m^2) would mean that 70 percent of the data points would have an RCS value of 10 m^2 or more. A data point in the first level statistics is the RCS value obtained on a given radar pulse, while a data point in the second level statistics is the average RCS value of a chaff unit or chaff sample.

3.13 Processing - Second level statistics. Results from the first level processing are used as inputs to calculate average RCS values, statistical data, or other information or presentations in the form of second level statistics.

3.14 Processing - Shadow graphs. Shadow graphs are a unique way to visually display RCS values as a function of time and range to pictorially show scintillation, physical cloud growth, homogeneity of the cloud, and other details. A printer/plotter is used to show pulse-to-pulse RCS values where a solid black line is calibrated to maximum RCS and white to no RCS. The various shades from black to white then show relative RCS values. Lines may be printed for each radar pulse, or spaced "N" pulses apart, where "N" may be any integer.

3.15 Processing - Spectral data. Spectral data is used to present the unique spectral signature of a chaff cloud as observed by the measuring radar, and is a function of the Fast Fourier Transform algorithm applied to the pulse-to-pulse amplitude data. The data is presented graphically to display the power spectral density of the chaff cloud ($volts^2$) relative to the frequencies of interest (approximately 0-500 Hz).

3.16 Radar cross-section (RCS). Radar cross-section (RCS) is defined as the return signal to a radar where

$$RCS = \sigma = 4\pi \frac{\text{Power reradiated by the target per steradian}}{\text{Power incident on the target per unit of area}}.$$

Physically, the RCS of a body is equal to the geometric cross-section of a sphere (large compared to wavelength) which would give the same return if placed at the same point in the radar antenna beam.

3.17 Radar gate sweeping. As applicable herein, gate sweeping is accomplished when collecting data on a mature chaff cloud. By slowly sweeping the radar antenna in elevation, the range-gates are, in effect, sweeping radially along the extent of the chaff cloud to collect RCS data on overall chaff cloud growth.

3.18 Radar pulse repetition frequency (PRF) - Also period (PRP), interval (PRI), and rate (PRR). The number of transmitted pulses per unit of time (seconds), or the time interval between the leading edges of consecutive pulses.

3.19 Radar pulsewidth (pulse duration). The time interval between the leading and trailing edges of the transmitted pulse.

3.20 Radar range-gate. As applicable to the processing equipment described herein, 15 adjacent range gates are measured in amplitude for each transmitted pulse. When the range-gate spacing within the processor is set equal to the pulse width of the radar, the range-gates can be equated to the resolution-cell as it moves out in range from a reference starting point to a distance of 15 adjacent cell spacings from that starting point.

3.21 Radar resolution-cell (radar cell). A term used to describe a volume from which return signals are received. For a pulse radar, the cell volume is defined by the pulse length and the half-power beamwidth (horizontal and vertical angular resolution) of the radar antenna.

3.22 Real time processor. A system providng absolute RCS values while the test run is being made.

3.23 Shielding. Shielding is a condition whereby some of the elements in the chaff cloud are not illuminated by the full power of the radar because other elements nearer to the radar have scattered part or all of the energy out of the beam. The shielded elements are responsible for less measured RCS than an equivalent number of unshielded elements. The degree of shielding can vary from zero, where each element makes maximum contribution to the RCS values, to 100 percent, where some of the elements contribute nothing to the measured RCS values.

3.24 Spectral frequency. The distribution of doppler frequencies caused by amplitude or cross-section fluctuations (scintillation) of the dipoles within a chaff cloud.

3.25 TACAN (tactical air navigation). Equipment installed in aircraft and capable of receiving signals from a ground station for bearing determination, and transmitting coded pulses to and receiving return pulses from the ground station for range determination.

4. REQUIREMENTS

4.1 General. The procedures contained herein provide the required detailed data for applicable test methods for performance testing of airborne chaff payloads. The flight test when conducted in accordance with the test procedures and test limits of this standard, will determine whether the chaff payloads perform properly under normal flight operations and conditions, and meet the specified performance requirements as delineated in the detailed specification sheet.

4.2 Supplemental procedures. The procedures contained herein shall be supplemented with detailed performance requirements contained in the applicable equipment specification sheet for the particular chaff payload, and by a detailed test plan prepared by the test agency designated by the procurement contracting officer (PCO) to perform the preproduction or production flight tests.

4.2.1 Detailed performance requirements. The detailed performance requirements shall contain all supplemental information necessary to ensure standardized testing of a particular chaff payload. The information shall include, but not be limited to the following:

a. The type of aircraft, dispenser, and dispenser installation

b. The types of and minimum number of radars to be used in making measurements

c. The technical characteristics of each radar including frequency, pulsewidth, PRF, polarization, and antenna beamwidth

d. Normalization factors necessary to compensate for off-boresight measurements made with the particular antenna beamwidths specified above

e. The number of chaff samples to be measured and the number of aircraft passes (runs)

f. The rate at which the chaff will be dispensed

g. The amount of chaff to be deployed on each run

h. The time after deployment at which measurements are to be made

i. The duration of each measurement

j. How the radar cross-section (RCS) data shall be processed

k. The minimum (RCS) requirement for the chaff payload

l. The flight profile including altitude, aspect angle relative to the measurement site, and calibrated airspeed.

4.2.2 Detailed test plan. The detailed test plan shall be prepared by the test engineer at the facility designated by the PCO. The test plan shall contain all information and requirements which are peculiar to the test facility or which will implement the requirements of this standard and the applicable detailed performance requirements as contained in the equipment specification sheet. In addition, the detailed test plan shall contain pre- and post-flight radar calibration procedures.

4.3 Test facilities, instrumentation, aircraft, and dispenser installation. The test facilities, instrumentation, aircraft, and dispenser installation used to conduct preproduction and production chaff measurements shall be capable of providing and maintaining the test conditions as specified in the detailed performance requirements, the detailed test plan, and as contained herein. The test facilities, instrumentation, aircraft, and dispenser installations specified shall be limited to those which have yielded comparative data for at least three previous tests of the same chaff type, and have thereby established a data base for minimum performance requirements. In addition, when a new facility or equipment is initiated, the data from the new facility or equipment shall be comparable to the existing baseline data. For individual chaff units, the three tests shall consist of a minimum of 30 units dispensed on each of three test days; while for continuous chaff, the three tests shall consist of a minimum of one roll or roll set dispensed on each of 3 test days.

4.3.1 Number and types of radars. The number and types of radars used for preproduction and production lot tests shall be specified in the detailed performance requirements. Ideally, one radar operating within ± 3 percent of each resonant frequency of the chaff unit dipole lengths shall be used. For units containing a large number of resonant dipoles separated by less than 50 percent in length, one radar for each peak in the frequency response curve which is separated from the other peaks by more than 50 percent should be used. In any case, the radars used for preproduction, initial production, and production lot testing must have been qualified as specified in 4.3 of this standard, and thereby have established the baseline requirements for that unit. The priority of test radar frequency assignments shall be proportional to the resonant lengths of the dipoles; i.e., the longest wavelength (lowest resonant frequency) shall be given first priority, and the shortest wavelength (highest resonant frequency) shall be given the lowest priority. In addition, for discrete chaff units, the radars must be capable of:

not be loosened during transportation

a. Containing the entire chaff cloud in one radar resolution cell (0.2 usec or greater pulsewidth)

b. Maintaining a PRF of at least twice the highest spectral frequency for which measurement is desired (for spectral data only)

c. Maintaining tracking geometry such that the antenna losses are no more than -3 dB of boresight gain (-3 dB two-way pattern).

All measurements shall be accomplished using radars having specified pulsewidths, and tracking the chaff cloud at aspect angles of 5 degrees to 20 degrees. The test results shall be normalized to an aspect angle of 10 degrees and boresight antenna gain for comparison and evaluation purposes.

4.3.1.1 Radar parameters. The PRF of the radar shall be adequate to define the spectrum out to the desired frequency as described above. The effective radiated power of the radar shall be sufficient to provide for calibration on a 6 inch diameter sphere at ranges out to 1500 yards with a 10-to-1 signal-to-noise ratio, and to make measurements on a 1 square meter target at the maximum drop range as specified in the detailed test plan. To the extent possible, the radar shall have nonscanning antennas and stable power and frequency characteristics.

4.3.2 Instrumentation. Instrumentation shall include equipment capable of measuring and processing RCS values for each radar pulse.

4.3.2.1 Measuring instrumentation. Measuring instrumentation shall be capable of meeting the requirements detailed in Note 6.5.

4.3.2.2 Processing instrumentation. The data processing equipment shall be capable of accepting RCS data from 9-track digital tapes using 8 or 16 bit words. The processing equipment shall be capable of providing the outputs and formats detailed in Note 6.2 and figures 4 through 11, and shall perform the normalizations for aspect angle and antenna boresight as discussed in Note 6.3.

4.3.3 Aircraft and dispenser installation. The type or types of aircraft and the location or locations of the dispensers must be specified for any test. The type(s) of aircraft and dispenser location(s) used for testing preproduction and production chaff must have an established data base as described in 4.3.

4.4 Standard conditions. All airborne chaff measurements used for acceptance tests shall be made under standard test conditions as defined herein.

4.4.1 Weather. Unless otherwise specified in the detailed performance requirements, all flight tests shall be conducted with turbulence intensity not exceeding occasional light chop as defined in the DOD Flight Information

Publication; with flight visibility of 3 statute miles or better, and cloud clearances of 1000 feet above, no clouds below the dispense altitude. In all cases, the weather shall be suitable for flight under visual flight rules (VFR) as defined in OPNAVINST 3710.

4.4.2 Aspect angle. The aspect angle during the chaff measurements shall be between 5 and 20 degrees and shall not vary more than 8 degrees on any one test run. The combination of range, antenna beamwidth, and aspect angle shall be acceptable as detailed in Note 6.3.1 and 6.3.2.

4.4.3 Flight profile. The specific flight profile shall be as specified in the detailed performance requirements and in the detailed test plan. The altitude shall be selected for ease in target acquisition and shall be compatible with the requirement of 4.4.2 and 4.4.4.

4.4.4 Drop ranges. The ranges of the chaff from the measuring radars shall be such as to meet the aspect angle requirements of 4.4.2, and to insure that a 1 square meter target shall be 10 dB above the minimum detectable signal level of the radar. The length of the drop zone shall provide for at least 15 seconds of continuous chaff dispensing, or provide for adequate spacing of discrete chaff units and ensure that at least six drops can be made on a single run.

4.4.5 Drop sequence. The drop sequence for discrete chaff units shall be chosen to ensure that no two consecutive chaff units may provide energy to one radar resolution cell during the time of measurements. It is normally desired that three or more full radar resolution cell spaces be provided between successive chaff drops. The same spacing requirements shall be met for the pulsed mode of continuous chaff dispensers. Only one drop sequence per run shall be used for continuous chaff deployment.

4.5 Test report. A test report shall be prepared following each acceptance test. As a minimum, the test report shall contain processed second level statistics of both raw and normalized (aspect angle and boresight) first level statistics as defined in Note 6.3, test data provided by the test engineer, and log sheets provided by the ground crew operator. Pre- and post-flight calibration data shall also be included in the test report.

4.5.1 Test data. The test data shall be taken at the time of test and shall be included in the test report. The test data shall include the aircraft flight profile including calibrated air speed; complete identification of the chaff payloads being measured; details on drop zones, drop spacings, and drop sequences; characteristics of the radar; weather conditions; method of positioning the sample gates; spacing between the sample gates; and all other pertinent information delineated in the detailed performance requirements, detailed test plan, and as contained herein.

4.5.2 Log sheet. A log sheet shall be prepared by the ground crew operator for inclusion in the test report. The log sheet shall include the type of aircraft used, the dispenser location on the aircraft, complete information on the type of chaff payload being tested, and complete pre- and post-flight information on the chaff payload. The format for the log sheet shall be in accordance with figures 1 through 3 of this standard. All information blocks shall be completed, and additional information may be provided in the remarks section of the log sheet.

4.6 Acceptance criteria. Acceptance criteria shall be specified in the detailed performance requirements of the applicable equipment specification. Acceptance criteria shall include performance requirements for individual chaff units or for continuous chaff as applicable. For individual chaff units, acceptance criteria shall be the average RCS during the time the chaff is in a specified radar resolution cell or cells in terms of position with respect to the deploying aircraft. Acceptance criteria for continuous chaff shall be as above, except that homogeneity of the chaff trail shall form a part of the acceptance criteria. Usually the position of the radar resolution cell used for acceptance measurements will be 2 seconds behind the dispensing aircraft; however, for break lock chaff, measurements shall be made closer to the aircraft; and for low frequency rope, measurements shall be made farther from the aircraft with respect to time. Acceptance criteria for preproduction and production chaff payloads shall be formulated in accordance with the requirements of 4.3 herein. In cases where detailed performance requirements do not exist, the acceptance criteria shall be approved by the PCO and made a part of the contractual document.

5. TEST PROCEDURES

5.1 General. The test procedures contained herein are for the purpose of providing uniform detailed instructions to be used in measuring the RCS of preproduction and production samples of airborne chaff payloads. All measurements shall be made using conventional pulsed weapon control radars equipped with pulse-to-pulse RCS processing instrumentation capable of meeting the requirements of 6.5. Deviations from the procedures contained herein or in the detailed performance requirements shall be approved by the PCO prior to initiation.

5.2 Pre-Test preparation.

5.2.1 Test data. Prior to initiation of any test, the appropriate information shall be entered in the test data and log sheet as described in 4.5.1 and 4.5.2 herein.

5.2.2 Radar checks. Prior to initiation of any test, the following radar checks shall be made, and appropriate entries shall be made in the test data.

a. Power up and stabilize the radar.

b. Use standard procedures from the radar manual to set operating frequency, and record the frequency on the test data sheet.

c. Measure, and when necessary adjust the PRF, and record on the test data sheet.

d. Use a radar test set or external signal generator to inject a signal into the radar, and measure the minimum detectable signal level. Record this value on the test data sheet. Ensure this value compares with normal operating values.

e. During sphere calibration discussed in 5.2.4, record the maximum range tracked in autotrack mode for indication of transmitter power output; or use a radar test set to measure transmitted power. Record this value on the test data sheet.

f. Verify overall radar performance in accordance with the applicable radar manual.

5.2.3 Instrumentation checks. Prior to initiation of any test, the following instrumentation checks shall be performed. (Equivalent instrumentation checks may be used when the measuring instrumentation is not compatible with the following procedure.)

a. Power up and stabilize the instrumentation.

b. Follow equipment operating procedure to initialize the system, and proceed to data taking (run) mode using $\Delta K = 0$.

c. Set full scale RCS = 10 square meters; set range = 2560 yards; set gate spacing = 200 nanoseconds.

d. Press TEST button on A/D converter. Gate 1 RCS shall read 50 percent of full scale.

e. Set radar coordinates to Range = 2560; Azimuth = 45 degrees; Elevation = 11.25 degrees. Azimuth and Elevation readouts shall indicate 25 percent of full scale.

f. Change coordinates to Range = 2560; Azimuth = 90 degrees; Elevation = 22.5 degrees. Azimuth and Elevation readouts shall indicate 50 percent of full scale.

g. Initiate TAPE switch. Press and hold A/D converter TEST button for 3 seconds.

h. Terminate processor run and verify correct time printout on teletype.

i. Replay run just executed and verify identical RCS, Azimuth, and Elevation values.

5.2.4 Radar and instrumentation calibration. Calibrate the radar and instrumentation relative to 1 square meter using the radar and instrumentation calibration procedures and a standard calibration sphere and balloon. Acquire 5 seconds of sphere calibration data for reference.

5.2.5 Loading and verification of payload. Prior to loading, conduct a check on dispenser performance using the appropriate ground checkout procedures. If the dispenser pod is instrumented, ensure that all instrumentation is functioning properly. Using the procedures published in the dispensing equipment manual, load the payload in the amount specified in the detailed performance specification sheet. Install marker units in accordance with the requirements of the detailed performance specification sheet. Record the exact load and deployment sequence on the log sheet. Conduct pre-mission ground check to ensure that the loading has been conducted in accordance with the loading requirements, log sheet, detailed test plan, and detailed performance specification sheet.

5.3 Control procedures. Central control of the test shall be from the ground radar installation using the standard ground-to-air communications equipment in use at the particular test facility. Commands for starting and stopping deployment of chaff, and commands for correction to the flight path due to the presence of old chaff or other detrimental conditions shall be given by the test engineer at the test facility. All corrections to the flight path shall be noted in the test data.

5.4 Aircraft operation. The type of aircraft used to conduct the flight test shall be specified in the detailed performance specification sheet. The aircraft flight profile and weather conditions shall be as defined in 4.4 herein. Unless otherwise specified, the aircraft shall be equipped with a radar beacon or reflective lens to be used as a target for the tracking radar.

5.5 Radar operation. When practicable, the radar shall track the aircraft in the beacon mode or be slaved in both range and angle to a radar that is tracking in the beacon mode. In those cases where beacon tracking is not practicable, range tracking shall be accomplished in the aided manual mode.

The radar shall lock-on and track the aircraft on each run prior to the deployment of chaff. After the data system is initialized, chaff drops shall begin, and the radar shall continue to track the aircraft in both angle and range. Except for measuring old chaff (chaff which has been deployed for more than a minute), data shall be taken only when the radar is locked on and tracking the deploying aircraft.

The operation of the radar(s) shall be continuously monitored during the test to ensure that the radar is stable and satisfactory.

5.6 Instrumentation operating procedures. The general operating procedures supplied with the RCS processor and other instrumentation shall be utilized. Additionally, the procedures of 5.6.1 or 5.6.2 shall be used depending on the type of test being conducted as specified in the detailed performance requirements.

5.6.1 Procedures for collecting data on chaff immediately behind the aircraft. For those cases where the chaff is measured immediately behind the aircraft, the following procedures shall be used.

a. Sample gate number 2 shall be used to track the aircraft. When a beacon track is available, the processor gates shall be slaved to the beacon range gate. Where beacon track is not available, the operator shall choose either the radar slaved mode or processor track mode - whichever appears to be most suitable.

b. Fifteen sample gates shall be used to collect RCS data. One gate shall be in front of the aircraft, 1 on the aircraft, and 13 gates behind the aircraft. Data shall be taken in all gates starting just before (approximately 2 seconds) chaff is first deployed during a run and ending just about 1 second after the chaff has passed through the fifteenth gate.

c. The 15 sample gates shall be spaced such that they fall within the 3 dB two-way beamwidth of the radar antenna. The gates will most usually be spaced one radar pulsewidth apart, however, for very long pulsewidth radars, the spacing may be less than one pulsewidth when it would otherwise be impossible to keep all gates within the 3 dB beamwidth restriction.

5.6.2 Procedures for collecting data on old chaff. For those cases where measurements are made on old chaff, the following procedures shall be used.

a. Data shall be taken with the gates stationary and positioned over the chaff cloud. This may require repositioning the gates when the cloud is very long.

b. Data shall also be taken when the gates are swept in range over the cloud at a rate of approximately 400 feet per second. The processor shall be operated such that all gates sweep over the cloud in one direction and then reverse across the cloud at the same rate. At least four sweeps shall be made across the cloud per data run.

c. The gate spacings shall be as listed in 5.6.1.c.

5.6.3 Other data. In addition to the RCS data, the azimuth and elevation angles from the radars, and the time of day shall be recorded. Other data, such as the type of aircraft, type of chaff, type of radar, pulsewidth, PRF, altitude, and calibrated airspeed shall be recorded at the beginning of each test mission and at such times as there is a change in any of these parameters. These data shall be recorded on 9-track magnetic tape for permanent record.

5.7 Data processing. After the test is completed, the data shall be processed using on-site data processing equipment. As a minimum, the following outputs shall be provided.

a. A printout of first level statistics as defined in Note 6.2.1.3.

b. A printout of second level statistics as defined in Note 6.2.1.4.

c. A printout of the second level statistics normalized to an aspect angle of 10 degrees as defined in Note 6.3.2.

d. A printout of the second level statistics normalized to an aspect angle of 10 degrees and also normalized to boresight antenna gain as defined in Note 6.3.1 and 6.3.2.

e. A growth curve of the normalized data from b, c, and d above.

f. A plot of the shadowgraph for chaff as defined in Note 6.2.1.4.

5.7.1 Data formats. The formats for the data listed in a. through f. above are shown in figures 4 through 9. In addition, the data may be processed in any or all of the other methods described in Note 6.2 as required by the detailed performance specification sheet.

5.7.2 Data retrieval. All processed data shall be coded for machine retrieval by any of the following parameters: type of aircraft, type of radar, type of chaff, manufacturer, test range, or date and type of test. Data retrieval codes are contained in the Appendix to this standard.

5.7.3 Data presentation. Data processed as described in 5.7 shall be reviewed by the test engineer. For tests which meet all of the criteria of the detailed performance requirements and the detailed test plan, a message shall be forwarded from the test activity to the cognizant activity for chaff procurement. This message shall contain the contract number, lot number, and serial number of the chaff which was tested; the date of the test; and the necessary information indicating that a satisfactory test was conducted and recommendation of lot acceptance. For tests which do not meet all of the criteria of the detailed performance requirements and the detailed test plan, a report shall be prepared by the test engineer presenting all of the available data relative to the test, including the data of 5.7 herein. This report shall be forwarded to the cognizant Naval activity for chaff engineering support along with recommended action.

6. NOTES

6.1 Intended use. This standard is intended to provide a uniform test procedure to be followed in making RCS measurements of preproduction, initial production, and production lot chaff samples to ensure satisfactory performance of procured chaff when deployed for self protection or saturation purposes in any combat or training operation.

6.2 Data processing.

6.2.1 Required data processing. The RCS data on permanent storage on 9-track digital tape shall be processed as follows for each test.

6.2.1.1 Select data. Data selection shall be performed by determining the time period when the chaff is in the radar resolution cell being measured, and processing only these data. The shadow graph requirement of 6.2.1.2 shall be used to aid in the selection of good data.

6.2.1.2 Shadow graph. Calculate and plot the shadow graph of first level statistics for discrete chaff units and continuous chaff trails in each of the sampling gates. The shadow graph processing technique depicts RCS as a function of time, and shall be used to determine when the chaff is in the radar resolution cell being measured and to define the size of any significantly weak or strong points along the chaff cloud. Upon determination of good data, the pulse-to-pulse information shall be omitted or included in the first and second level data processing depending upon the performance requirements of the detailed specification sheet for the applicable chaff type. The saturation level (solid black line) of the shadow graph shall be chosen such that no more than 15 percent of the pulses will be shown as saturated. The number of pulses per second that are printed on the shadow graph shall vary between 0 and 300 based upon the following sequence:

Radar PRF of 0 to 300 - every pulse
Radar PRF of 301 to 600 - alternate pulses
Radar PRF of 601 to 900 - every third pulse
Radar PRF of 901 to 1200 - every fourth pulse
Radar PRF of 1201 to 1500 - every fifth pulse
etc.

6.2.1.3 First level statistics. Calculate and print out the first level statistics of the RCS values for each of the discrete chaff units or samples of continuous chaff in each of the sampling gates. The first level statistics shall include: the average RCS values of all of the pulses processed in that test group; the standard deviation; the maximum RCS value for any pulse in that group; the minimum RCS value, the RCS value which was equaled or exceeded by 90 percent, 70 percent, 50 percent, 30 percent, and 10 percent of the pulses; and the number of pulses included in the group.

6.2.1.4 Second level statistics. Calculate and print out the second level statistics of RCS values for each type of discrete chaff unit or chaff sample that was tested under the same conditions. The statistics shall be the same as those listed in 6.2.1.3 except that the inputs will be first level averages instead of the pulse-to-pulse RCS data.

6.2.1.5 Growth curve. Calculate and plot the chaff growth curve; i.e., the second level average RCS values in each of the sample gates.

6.2.1.6 Normalized data. Calculate the aspect angle and the degrees off boresight for each of the data runs. Using these values, normalize the second level results to 10 degrees aspect angle and 0 degree antenna boresight using the processing equipment operating instructions and the information contained in Notes 6.3.1 and 6.3.2.

6.2.2 Optional data processing. Unless otherwise specified in the detailed specification sheet, the following data processing is optional and may be performed at the discretion of the test engineer.

6.2.2.1 First level statistics of selected sample gates. Plot the first level statistics of the RCS values for each discrete chaff unit or sample of continuous chaff for selected sample gates. The RCS value shall be plotted versus the percent of pulses that equaled or exceeded that RCS value. RCS values shall be quantized and plotted in approximately 0.3 dB steps.

6.2.2.2 First level spectrum data. Calculate and plot the first level spectrum data for each discrete chaff unit or sample of continuous chaff for selected sample gates. The number of points in the Fast Fourier Transform will depend upon the number of pulses of data available for processing. The energy contents shall be plotted against frequency out to one-half of the sampling rate (PRF of the radar). The average RCS value, the maximum energy content at any frequency, and the frequency resolution of the plot shall be printed on the data sheet.

6.2.2.3 First level filtered RCS data. Calculate and plot the first level filtered RCS data for selected sample gates. The time constant of the filter may be selected as desired. The RCS values into the filter shall be quantized in approximately 0.3 dB steps, and the filtered results shall be plotted as a function of time.

6.2.2.4 Pulse-to-pulse RCS data. Print out the pulse-to-pulse RCS values.

6.2.2.5 First level changes in RCS values. Calculate and print out the first level statistics of the changes in RCS values from pulse-to-pulse for each of the discrete chaff units or samples of continuous chaff in each of the sample gates. These statistics shall include: the average change in RCS values of all of the pulse pairs processed in that group; the standard deviation; the maximum change in RCS value for any two consecutive pulses in that group; the minimum RCS change for any two consecutive pulses;

the change in RCS value that was equaled or exceeded by 90 percent, 70 percent, 50 percent, 30 percent, and 10 percent of the consecutive pulses; and the number of pulse pairs included in the group.

6.2.2.6 First level changes in RCS values for selected sample gates. Plot the first level statistics of the changes in RCS values from pulse-to-pulse for each discrete chaff unit or sample of continuous chaff for selected sample gates. The changes in RCS values shall be plotted versus the percent of pulse pairs that equaled or exceeded that change in RCS value. RCS values shall be quantized in approximately 0.3 dB steps.

6.2.2.7 Second level spectrum data. Calculate and plot the second level spectrum data for selected sample gates. These plots are identical to those of 6.2.2.2 except they are an average of "N" first level spectrum plots, where the data for all "N" plots were taken under the same conditions.

6.2.2.8 Second level changes in RCS values. Calculate and print out the second level statistics of the changes in RCS values of the pulse-to-pulse RCS data. This printout is identical to that of 6.2.2.5 except it is the average of "N" first level printouts.

6.2.2.9 Second level changes in RCS values for selected sample gates. Calculate and plot the second level statistics of the changes in RCS values from pulse-to-pulse for each discrete chaff unit or sample of continuous chaff for selected sample gates. These plots are identical to those of 6.2.2.6 except they are the average of "N" first level plots, where the data for all "N" plots were taken under the same conditions.

6.3 Normalization. Normalization of data shall be accomplished to compensate for variations in measurements caused by changes in antenna boresight, changes in aspect angle, and changes in the effect of shielding caused by changing the dipole density of the cloud as seen by the radar.

6.3.1 Normalization for antenna boresight. Antenna gain factors affect RCS measurements under two conditions. One condition is where the size of the chaff cloud, the range from the radar to the chaff cloud, the antenna beamwidth, and the aspect angle combine to put the chaff cloud in one radar resolution cell across the antenna beamwidth such that the chaff elements in one or more parts of the cloud are illuminated by more power than elements in other parts of the cloud due only to antenna gain. The other condition is when the radar tracks the deploying aircraft and chaff is measured at distances of several hundred feet back of the aircraft; and the range, antenna beamwidth, and aspect angle combine to reduce the gain of the antenna for measuring purposes as the chaff cloud moves back from the aircraft. Although antenna gain effects on large chaff clouds can usually be eliminated by proper test planning, discrepancies in RCS values caused by measurements made 1000 to 1500 feet behind the aircraft will occur, and must be corrected for by normalizing test results. The procedures to be used for normalizing to antenna boresight are as follows:

a. Plot a two-way antenna loss curve as a function of angle off boresight for each of the radars to be used in the chaff measurements program. This curve shall then be stored in memory and used in the data processing program to make the necessary corrections.

b. Calculate the point on the antenna pattern at which the radar resolution cell for chaff measurements occurs using the range, antenna beamwidth, aspect angle, and the distance from the tracking point to the point of measurement.

c. Normalize to antenna boresight using the results of "a" and "b".

d. The two-way loss of the antenna can be calculated by squaring the one-way loss. The angle off boresight for the measurements made in each gate may be defined by $\beta = \frac{d \sin \Psi}{R}$ where Ψ is the aspect angle, d is the distance from the point of tracking to the radar resolution cell being measured, R is the radar range, and β is the angle off boresight in radians. Second level statistics may be normalized using one aspect angle when the angle does not change significantly from the start to the end of the data run.

6.3.2 Normalization for aspect angle. Aspect angle is a critical factor in making repeatable RCS measurements. It is nearly impossible to make RCS measurements on several data runs using the same aspect angle, yet, changing the aspect angle will considerably affect the RCS values obtained. The computer program for normalizing to 10 degrees aspect angle takes in to account two effects of aspect angle as related to RCS measurements.

a. The change of the physical size of the chaff cloud as seen by radar

b. The change in shielding that occurs due to changes in the aspect angle.

The cloud size as seen by the radar is $A = \frac{\pi D^2}{4} \cos \Psi + \ell D \sin \Psi$ where D is the distance across the chaff cloud, ℓ is the radar pulsewidth divided by the cosine of Ψ, and Ψ is the aspect angle. Values of D range from 3 to 10 feet depending upon the aircraft and distance behind the aircraft. Using a value for ℓ/D, the ratios of A can be defined for different aspect angles. For other than continuous chaff or large chaff clouds, the length of the cloud is smaller than the radar pulsewidth, and thus becomes the value for ℓ in the formula. A typical ℓ/D ratio for continuous type chaff is 20, and for discrete type chaff is 6. These values vary with the type of chaff, type of aircraft and dispenser location, and time after deployment. Where possible, actual values should be measured and used.

When the values are not available, the nominal values listed above shall be used.

Shielding causes the RCS values to change when the dipole density of the cloud as seen by the radar changes. The dipole density, as seen by the radar, changes when the length of the cloud (measured along the direction of travel of the radar wave) changes. This distance through the chaff cloud is equal to the cloud width divided by the sine of the aspect angle. The dipole density for any aspect angle is determined by the dipoles per unit length of the chaff cloud divided by the area of the unit length as seen by the radar, and this quotient is multiplied by the unit distance the radar wave travels through the cloud. The amount of shielding resulting from these dipole densities is determined from normal shielding theory.

6.4 Calibration. Calibration shall be performed for absolute RCS and to ensure system performance.

6.4.1 Calibration for absolute RCS. Calibration for absolute RCS shall be performed prior to and following each test mission at each radar frequency at which measurements are being taken. Unless otherwise specified, calibration for absolute RCS shall be made using a sphere of known size that is lofted by a balloon, dropped from an aircraft, or towed by an aircraft. If exception is authorized and measurements are taken using a corner reflector, flat plate, or Luneburg lens; the calibration procedures shall ensure that the effects of lobe structures in the reflector pattern are eliminated. The procedures contained in the operating manual for the processing equipment shall be followed during calibration, and the signal-to-noise ratio used for calibration purposes shall be maintained at +10 dB or greater.

6.4.2 Calibration of system performance. Calibration of system performance versus power into the antenna shall be accomplished by injecting a signal into the radar receiver with a signal generator and measuring the video output as a function of input. Chart recordings or tables shall be made during the calibration, and these data shall be made a part of the test records.

6.5 Requirements for RCS instrumentation. The following requirements are provided for the RCS measurement instrumentation. These requirements shall be used to establish the suitability of RCS instrumentation for performance of the chaff measurement techniques described herein.

a. Instantaneous Dynamic Range: 60 dB required, 80 dB desirable

b. Operating Range: 0.3 to 65 nautical miles required, ranges out to 125 nautical miles desirable

c. RCS accuracy: ± 1 dB

d. Measurement (range) gates: 15

e. Permanent Record: Nine-track digital magnetic tape

f. Data output: Eight range gates in real time on chart recorders, with 15 range gates in permanent records on nine-track tape.

g. Data recorded: RCS in each range gate for each radar pulse. Range, time, azimuth, and elevation information at least four times per second.

h. Positioning of sample gates: Fixed, slaved to a radar, or swept

i. Gate sweep rate: 1 to 4095 ft/sec

j. Gate separation: 0.2 to 25 usec

k. IF frequency: To match the radar

l. IF bandwidth: At least 10 MHz.

6.6 Future Changes. Review and user information is current as of the date of this document. For future coordination of changes to this document, draft circulation should be based on the information in the current Federal Supply Classification Listing of DoD Documents.

6.7 Cognizance. This standard is under the cognizance of NAVAIR-5332A.

Custodian:
Navy - AS

Preparing Activity:
Navy - AS
Project No. MISC-NT60

SAMPLE TESTING, CHAFF ROLL

CHAFF TYPE	CONTRACT NUMBER		LOT NUMBER
SERIAL NUMBER	AIRCRAFT TYPE		AIRCRAFT SPEED/ALTITUDE
FLIGHT DATE/TIME	DISPENSER TYPE & S/N DISPENSER LOCATION		CONTROL SETTINGS
PREFLIGHT WEIGHT -	POST FLIGHT WEIGHT -	RESIDUE CHAFF WEIGHT	NET CHAFF DISPENSED
LEADER LENGTH	LENGTH CHAFF + DISPENSED	REMAINING CHAFF SANDWICH LENGTH	TOTAL CHAFF PAYLOAD LENGTH
TEST SITE		WEIGHT OF FILM, HUB, & END DISCS	
COMMENTS		SIGNATURE, DATE	

FIGURE 1. Log sheet for chaff roll flight tests.

SAMPLE TESTING, CHAFF PACKAGES

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible] [illegible]	[illegible]
[illegible]		[illegible]
[illegible]		
[illegible]		[illegible]

FIGURE 2. Log sheet for chaff cartridge flight tests.

SAMPLE TESTING, CHAFF CARTRIDGE

<table>
<tr><td>CHAFF TYPE</td><td colspan="2">CONTRACT NUMBER</td><td>LOT NUMBER</td></tr>
<tr><td>NUMBER OF CARTRIDGES INSTALLED IN DISPENSER</td><td colspan="2">AIRCRAFT TYPE</td><td>AIRCRAFT SPEED/ALTITUDE</td></tr>
<tr><td rowspan="2">TEST DATE/TIME</td><td colspan="2">DISPENSER TYPE & S/N</td><td rowspan="2">DUMMY CARTRIDGES</td></tr>
<tr><td colspan="2">DISPENSER LOCATION</td></tr>
<tr><td colspan="2">MARKER UNIT OR NO-CHAFF LOCATIONS</td><td colspan="2">TEST SITE</td></tr>
<tr><td colspan="3">CARTRIDGES NOT DISPENSED DURING TEST, AND CAUSE</td><td>IMPULSE CARTRIDGE DATA</td></tr>
<tr><td colspan="4">COMMENTS</td></tr>
<tr><td colspan="2"></td><td colspan="2">SIGNATURE, DATE</td></tr>
</table>

FIGURE 3. Log sheet for chaff cartridge flight tests.

RCS STATISTICS

FIRST LEVEL

UNIT 3

DATE NO.	AVG RCS	STD DEV	MAX RCS	MIN RCS	90% RCS	70% RCS	50% RCS	30% RCS	10% RCS	# OF PTS
4	7.95	9.97	64.82	.24	.24	2.33	4.81	8.57	16.92	200
5	8.03	12.51	69.68	.24	.24	.24	1.75	9.21	23.58	200
6	4.71	12.05	69.68	.24	.24	.24	.24	.68	17.66	200
7	8.45	17.78	99.99	.24	.24	.24	.41	3.11	31.48	200
8	8.96	15.91	93.03	.24	.24	.24	.55	7.42	31.43	200
9	11.74	20.95	154.25	.24	.24	.28	1.62	10.65	36.37	200
10	14.25	24.15	124.19	.24	.24	.24	1.05	13.23	52.19	200
11	11.61	22.12	165.80	.24	.24	.24	.63	7.97	39.07	200
12	17.11	33.21	274.92	.24	.24	.26	5.17	17.66	56.10	200
13	17.21	29.75	178.22	.24	.24	.30	2.33	15.28	56.10	200
14	11.95	19.00	107.49	.24	.24	.24	.73	13.23	33.83	200
15	21.97	51.02	424.08	.24	.24	.35	2.51	15.28	56.10	200

FIGURE 4. Example of first level statistics data format.

RCS STATISTICS

SECOND LEVEL

CHAFF TYPE : 171 MANUFACTURER CODE : 3

DATE OF RUN : 1- 6- 77 AIRCRAFT CODE : 1

GATE NO	AVG RCS	STD DEV	MAX RCS	MIN RCS	90% RCS	70% RCS	50% RCS	30% RCS	10% RCS	# OF UNITS
4	4. 93	2. 01	14. 24	. 80	2. 20	3. 95	4. 87	5. 53	6. 96	135
5	5. 90	2. 53	13. 04	. 69	2. 49	4. 44	5. 76	7. 10	8. 66	135
6	6. 42	2. 50	12. 88	. 82	2. 36	5. 20	6. 44	7. 77	9. 41	135
7	6. 20	2. 43	11. 89	. 87	2. 18	4. 99	6. 29	7. 67	9. 31	135
8	5. 85	2. 29	12. 01	. 76	1. 89	4. 78	5. 96	7. 06	8. 71	135
9	5. 57	2. 22	11. 12	. 67	1. 82	4. 50	5. 90	6. 68	8. 28	135
10	5. 24	2. 16	10. 04	. 70	1. 66	4. 26	5. 44	6. 35	7. 72	135
11	4. 97	2. 28	10. 10	. 69	1. 22	4. 04	4. 77	6. 21	7. 72	135
12	4. 85	2. 43	12. 74	. 58	1. 01	3. 70	4. 78	6. 28	7. 63	135
13	4. 67	2. 48	10. 32	. 52	. 89	3. 30	4. 90	6. 29	7. 42	135
14	4. 42	2. 44	10. 16	. 35	. 61	2. 88	4. 65	5. 86	7. 21	135
15	3. 97	2. 30	10. 02	. 17	. 51	2. 63	4. 20	5. 40	6. 66	135

FIGURE 5. Example of second level statistics data format.

RCS STATISTICS

SECOND LEVEL

CHAFF TYPE : 171 MANUFACTURER CODE : 3
DATE OF RUN : 1- 6- 77 AIRCRAFT CODE : 1

CORRECTED FOR ASPECT ANGLE

GATE NO	AVG RCS	STD DEV	MAX RCS	MIN RCS	90% RCS	70% RCS	50% RCS	30% RCS	10% RCS	# OF UNITS
4	4.82	1.82	12.18	.76	2.08	4.02	4.78	5.50	7.00	135
5	5.78	2.35	11.19	.65	2.43	4.49	5.75	7.05	8.81	135
6	6.31	2.37	11.02	.77	2.23	5.15	6.39	7.61	9.17	135
7	6.11	2.39	12.10	.82	2.06	5.11	6.15	7.28	9.12	135
8	5.78	2.30	12.21	.72	1.78	4.51	5.93	7.10	8.51	135
9	5.52	2.25	10.78	.63	1.72	4.53	5.71	6.72	8.21	135
10	5.21	2.22	10.14	.66	1.56	4.12	5.24	6.34	7.80	135
11	4.96	2.36	10.20	.65	1.12	3.89	4.94	6.25	7.98	135
12	4.85	2.50	12.96	.55	.95	3.65	4.83	6.25	7.84	135
13	4.68	2.56	10.42	.49	.82	3.24	4.90	6.27	7.38	135
14	4.45	2.52	10.27	.30	.58	2.74	4.68	6.10	7.37	135
15	4.00	2.38	10.13	.15	.48	2.59	4.19	5.45	6.72	135

FIGURE 6. Example of second level statistics normalized for aspect angle.

RCS STATISTICS

SECOND LEVEL

CHAFF TYPE : 171 MANUFACTURER CODE : 3
DATE OF RUN : 1- 6- 77 AIRCRAFT CODE : 1

CORRECTED FOR ASPECT ANGLE AND ANTENNA GAIN

GATE NO.	AVG RCS	STD DEV	MAX RCS	MIN RCS	90% RCS	70% RCS	50% RCS	30% RCS	10% RCS	# O UNIT
4	4.83	1.95	13.81	.76	2.13	3.88	4.76	5.38	6.96	135
5	5.99	2.65	14.76	.68	2.55	4.48	5.89	7.17	8.79	135
6	6.88	3.05	20.06	.83	2.45	5.36	6.71	8.25	10.11	135
7	7.19	3.60	22.78	.90	2.40	5.31	6.66	8.58	10.70	135
8	7.51	4.38	24.61	.87	2.33	5.38	6.66	8.26	12.03	135
9	8.11	5.74	35.74	.80	2.12	5.30	7.02	8.15	15.98	135
10	8.77	7.35	39.48	.91	2.78	5.28	6.96	8.21	19.04	135
11	9.41	8.84	49.40	1.07	3.01	5.34	6.60	8.51	21.87	135
12	11.05	13.82	113.67	1.30	3.14	5.51	6.85	8.95	25.82	135
13	11.21	11.77	71.62	1.20	3.16	5.79	7.64	9.36	26.62	135
14	11.86	13.24	89.28	1.47	3.12	6.22	8.07	9.84	23.93	135
15	11.99	13.07	98.75	1.67	3.07	6.16	8.28	9.85	25.60	135

FIGURE 7. Example of second level statistics normalized for aspect angle and antenna gain.

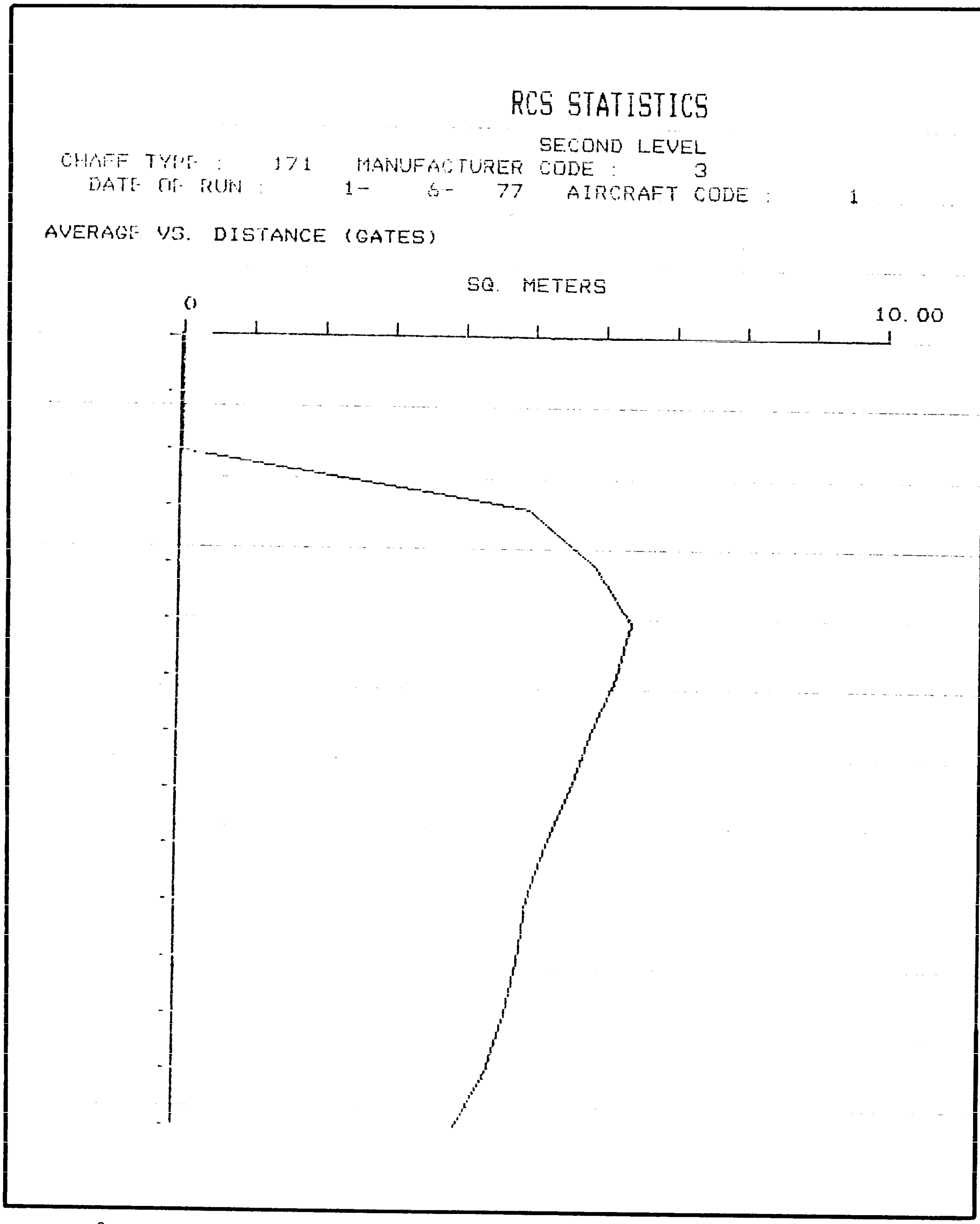

FIGURE 8. Example of second level growth curve data format.

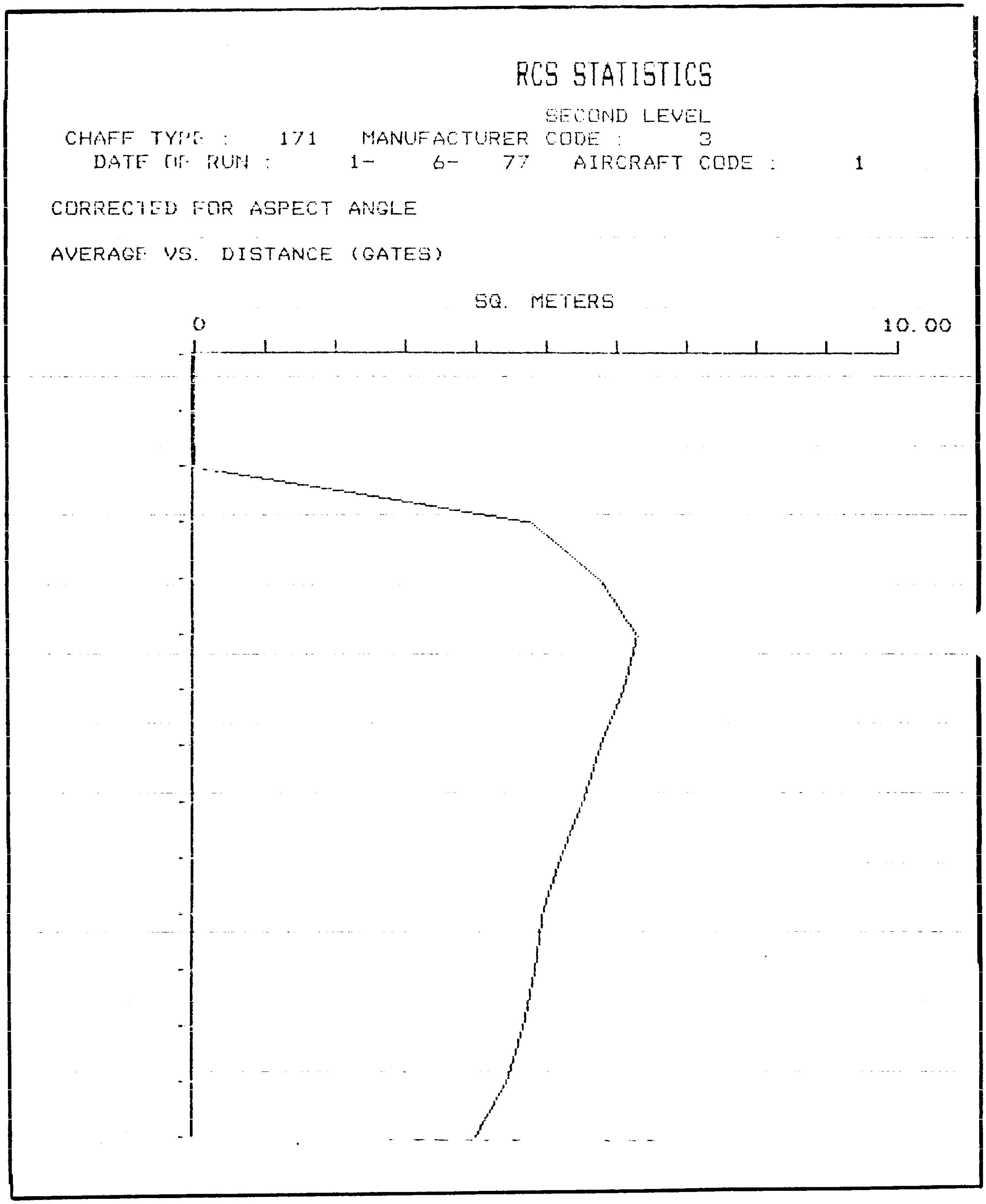

FIGURE 9. Example of second level growth curve normalized for aspect angle.

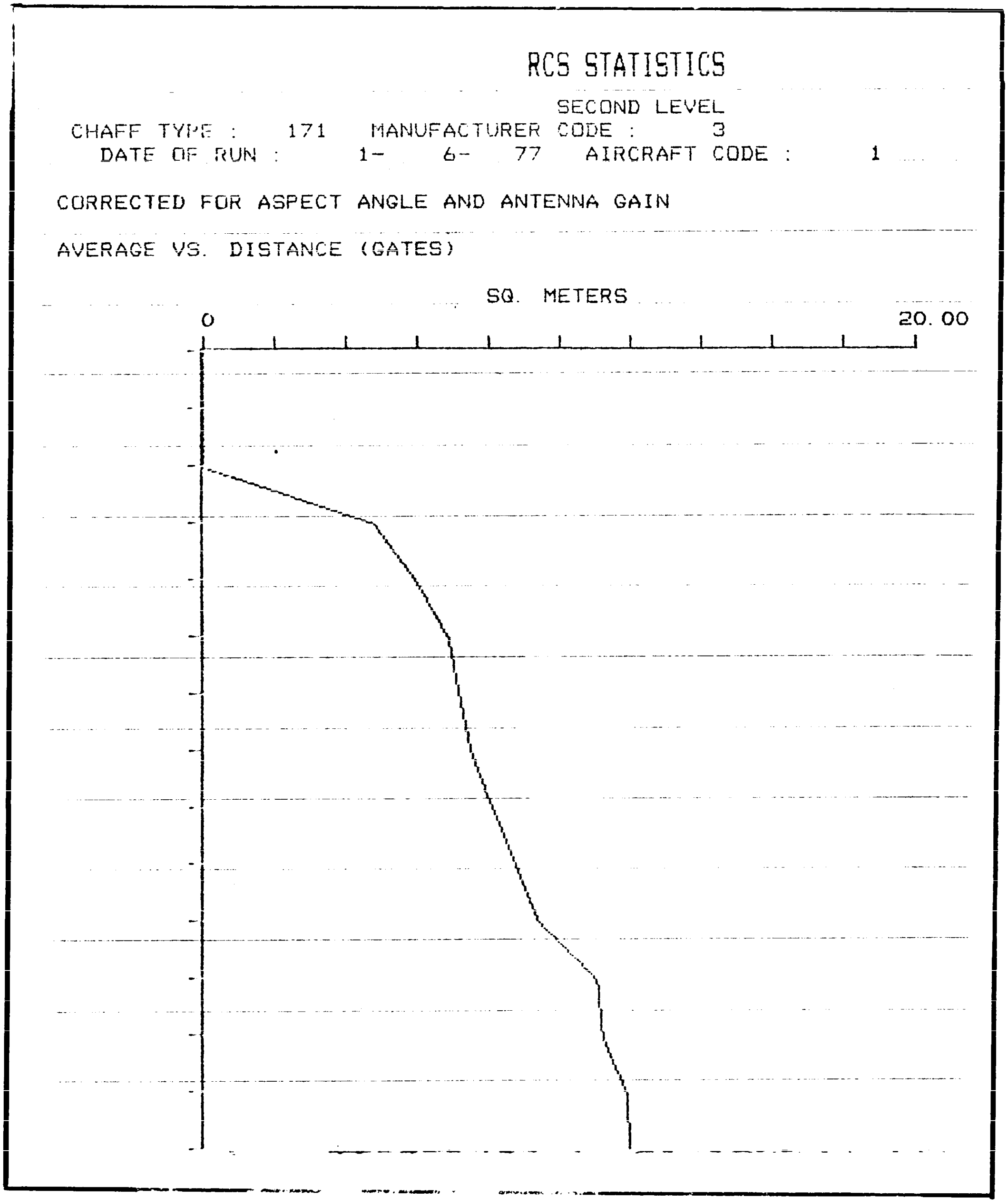

FIGURE 10. Example of second level growth curve normalized for aspect angle and antenna gain.

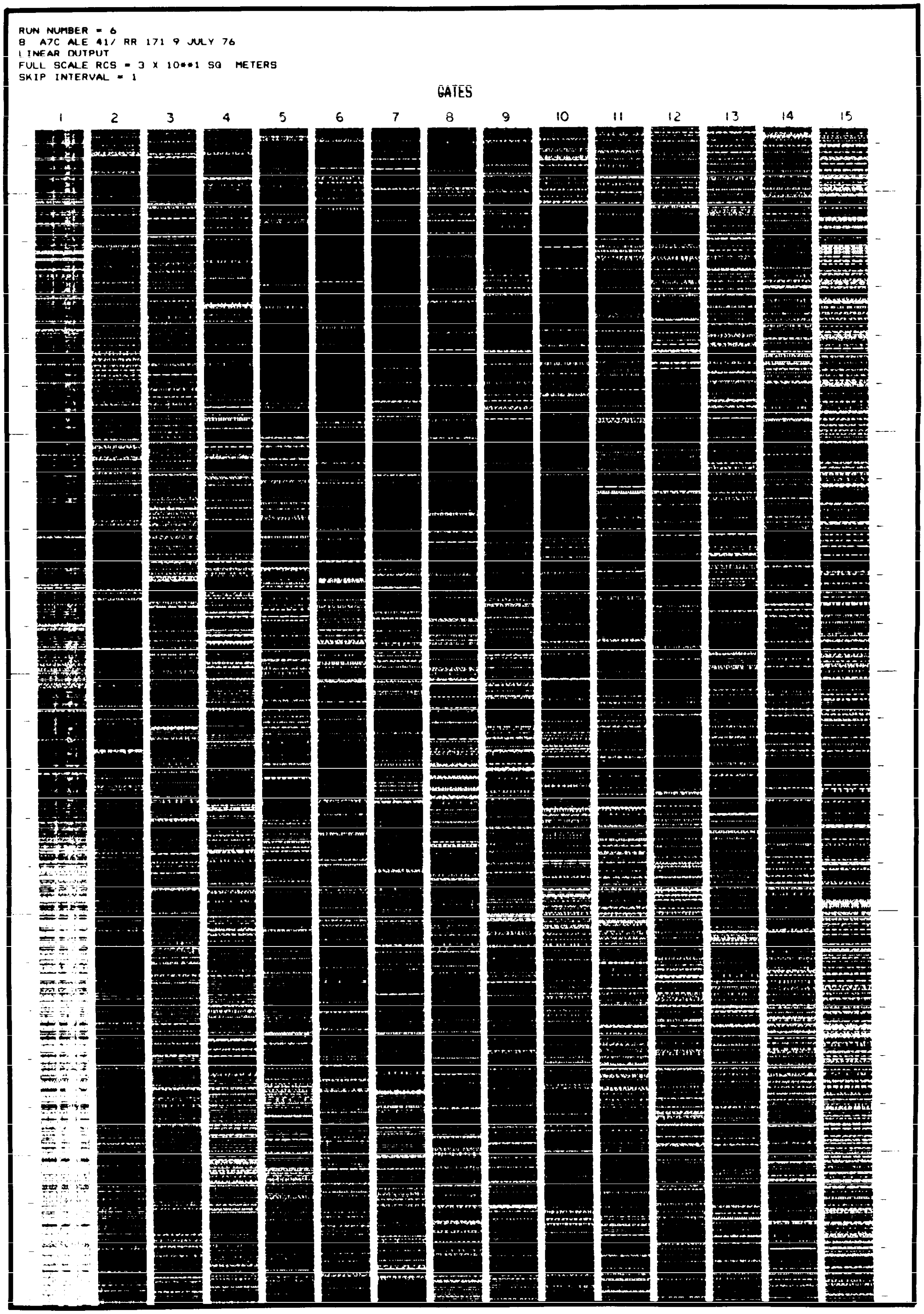

FIGURE 11. Example of shadow graph data format.

APPENDIX

10. GENERAL

10.1 Scope. This appendix establishes uniform data retrieval codes to be used for storage and archiving of processed chaff radar cross-section data.

20. REFERENCED DOCUMENTS
Not applicable

30. DEFINITIONS
Not applicable

40. GENERAL

40.1 Data Retrieval Codes. Data retrieval codes are provided so that archived data may be retrieved by the processing equipment operator when any combination of codes (radar, facility location, type of test, type of aircraft, type of chaff, chaff manufacturer, and date) are fed into the processor.

Data retrieval codes shall be recorded on the nine-track tape prior to each flight test with the appropriate information as contained herein.

Additional data retrieval code requirements shall be coordinated through Naval Avionics Facility, Indianapolis (Code 942) AV. 724-3855 prior to implementation.

50. DETAIL REQUIREMENTS

50.1 Retrieval Codes. Retrieval codes shall be assigned as follows:

50.1.1 Radar Codes. Radar codes shall be as contained in Table I.

TABLE I. Radar Code Assignments

Radar Type	Code
M-33	1
CBD Van (I Band)	2
CBD Van (J Band)	3
CBD Tracker	4
FPS-16	5
CBD K Band	6
CBD Pulse Doppler	7
Other CBD Radars	8-29
Special Radars at NWC, China Lake	30-49
Special Radars at NATC, Patuxent River	50-69

50.1.2 Location Codes. Location Codes shall be as shown in Table II.

TABLE II. Location Codes

Location	Code
Chesapeake Bay Division, Bldg. 2, Naval Research Laboratory	1
Chesapeake Bay Division Van	2
Wallops Island	5
Other Naval Research Laboratory Locations	3-100
White Sands Missile Range	101-200
Naval Weapons Center, China Lake	201-300
Naval Air Test Center, Patuxent River	301-400

50.1.3 Type of Test Codes. Type of test codes shall be as contained in Table III.

TABLE III. Type of Test Codes

Type	Code
Production Lot Test	1
Preproduction Test	2
Research and Development	3
Measure Signal Generators	4
Measure Standard Targets	5
RCS of Aircraft	6
RCS of Ships	7

50.1.4 Aircraft Codes. Aircraft codes shall be assigned as contained in Table IV.

TABLE IV. Aircraft Codes

Aircraft	Code
SH-3	1
S2-D	2
A-3	3
F-4	4
A-4	5
A-6	6
A-7	7
UH-1	8

50.1.5 Target Codes. Target codes shall be assigned as contained in Table V.

TABLE V. Target Codes

Target	Code
6 inch sphere	1
22 inch sphere	2
SIL (Lighthouse)	3
Spheres and Standard Targets	10
Air Force Low Frequency Chaff	38
Chaff Cutter Head No. 1	101
Chaff Cutter Head No. 2	102
Chaff Cutter Head No. 3	103
RR-129	129
RR-152	152
RR-153	153
RR-171	171
RR-172	172
RR-173	173
RR-172 (glass)	972
RBOC	1000

50.1.6 Manufacturer Codes. Manufacturer codes shall be assigned as contained in Table VI.

TABLE VI. Manufacturer Codes

Manufacturer	Code
Lundy	1
MB Associates	2
Tracor	3
DMAC	4
Reynolds Aluminum	5
North Star	6
Hycor	7
Goodyear	8

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