DECLASSIFIED

[redacted]

REPORT No. R-2289

DATE MAY 22, 1944.

SUBJECT

DECLASSIFIED by NRL Contract Declassification Team
Date: 10 AUG 2016
Reviewer's name(s): A. THOMPSON, P. HANNA
Declassification authority: NAVY DECLASS MANUAL, 11 DEC 2012, 08 SERIES

REPORT ON

FEATURES OF DESIGN, PREPARATION AND

USE OF NAVAL WINDOW

FR-2289

Classification changed from SECRET
to Unclassified

NAVAL RESEARCH LABORATORY

BELLEVUE, D. C.

DISTRIBUTION STATEMENT A APPLIES
Further distribution authorized by UNLIMITED only.

U. S. GOVERNMENT PRINTING OFFICE 16—21006

DECLASSIFIED

Un-[redacted] 7/1/46 [redacted]

SERIAL No. 61

May 22 1944

NRL Report R-2289
BuShips Problem S15R-S

DECLASSIFIED

Navy Department

Report on

Features of Design, Preparation and Use of Naval Window

Naval Research Laboratory

Anacostia Station

Washington, D. C.

No. of Pages: Text: 20 Tables: 1 Plates: 20 Appendices: 5

Authorization: Bureau of Ships letter S-S67-5(924) Serial S-920-5123 to NRL dated 6 July 1943 Assigning Problem S15R-S.

Prepared by: T.D. Hanscome
T.D. Hanscome, Contract Physicist.

Submitted by: R.C. Guthrie
R.C. Guthrie, Head of Search Radar Section.

Reviewed by: A. Hoyt Taylor
A. Hoyt Taylor, Supt. of Radio Division.

Approved by: A.H. VanKeuren
A.H. VanKeuren, Rear Admiral USN
Director.

CLASSIFICATION CHANGED TO UNCLASSIFIED
BY AUTHORITY OF Navy Reg Art 76-4 5 f+c
Reference Authority
ON 19/20
(DATE)
Louis A. Rayford
Signature of Custodian

[redacted] [redacted]

DECLASSIFIED

DECLASSIFIED [redacted]

Distribution List

1 Commander-in-Chief (Readiness Code F4) Navy Department, Washington, D.C.
1 Chief of Naval Operations, Code Op-20S, Navy Department, Washington, D.C.
1 Chief of Naval Operations, Code Op-16-1V, Navy Department, Washington, D.C.
2 Chief of Naval Operations, Code Op-16-FA-1 (for transmission 1 copy to Alusna, London, 1 copy retain).
3 Chief of the Bureau of Ships, Code 920, Navy Department, Washington, D.C. (1 copy to Comnaveu, 1 copy to Code 920Dh, 1 copy retain).
1 Chief of the Bureau of Ships, Code 910, Navy Department, Washington, D.C.
1 Chief of the Bureau of Aeronautics, Code Aer-E-3143, Navy Department, Washington, D.C.
1 Chief of the Bureau of Ordnance, Code Re4f, Navy Department, Washington, D.C.
8 Commander-in-Chief, Pacific Fleet, Fleet P.O. San Francisco. (For distribution within command as desired).
2 Commander, 7th Fleet, Fleet P.O., San Francisco.
1 Commander, 8th Fleet, Fleet P.O., New York, N.Y.
1 Commandant, U.S. Marine Corps, Washington, D.C.
1 Coordinator of Research and Development, Navy Department, Washington, D.C.
1 Officer-in-Charge Post Graduate School, U.S. Naval Academy, Annapolis, Md.
8 Dissemination Unit MID, Room 2C835, Pentagon, Washington, D.C. Attention: Lt. Col. Harry L. Smith, GSC.
3 British Admiralty Delegation, Room 3030, Navy Department, Washington, D.C. Attention: Lt. Comdr. J.H. Buscombe, R.N.V.R. (for transmission to Admiralty Signal Establishment).
1 Royal Air Force Delegation, Room 717, 1424 - 16th St., N.W., Washington, D.C., Attention: Director of Signals (for transmission to TRE, London).
1 British Army Staff, Grafton Hotel, Room 528, 1139 Connecticut Ave., N.W., Washington, D.C., Attention: Col. A.J. Fisher (for transmission to A.D. R.D.E.).
1 Joint Intelligence Committee, Canadian Joint Staff, 2222 S Street, N.W., Washington, D.C.
2 New Zealant Air Mission, Room 2503, Munitions Bldg., Washington, D.C. Attention: Squadron Leader A.W. Stockwell.
1 NDRC, Division 15, 1 River Road, Schenectady, New York.
2 OSRD, Liaison Office, Room 724, Dupont Circle Bldg., Washington, 25, D.C. (1 for transmission to ABL-15; 1 retain).
1 Navy Liaison Office, Radio Research Laboratory, Harvard University, Cambridge, Mass.
1 Navy Liaison Office, Radiation Laboratory, Massachusetts Institute of Technology, Cambridge, Mass.
1 Special Projects School, Naval Research Laboratory, Anacostia, D.C.
1 Naval Representative JEIA, c/o Joint Communications Board, Room 2103, Munitions Bldg., Washington, D.C. (Title page, Table of Contents and Distribution List only).

[redacted] DECLASSIFIED [redacted]

[redacted]

Table of Contents

[redacted]

[redacted]

Table of Contents (Cont'd)

Appendices

DECLASSIFIED

[redacted]

1. ABSTRACT.

1-1. It is the purpose of this report to supply general information on a type of Window suited to use in theatres of war where advance information of enemy radar frequencies is not ordinarily available. This type of Window is designed to satisfy field preparation requirements, to be readily stowed or shipped and to handle and disperse efficiently. The results of tests of many types of Window to determine package size, dispersion, rate of fall, effects of polarization, effects of temperature, methods of ejection from aircraft, and practicability of ejection by means of shells and rockets are given. The recommended design has been accepted and is described in Appendix 4. General directions for field use of Naval Window are included.

2. INTRODUCTION.

2-1. The work on which this report is made was authorized by BuShips S-S67-5(924) Serial S-920-5123 dated 6 July 1943 to NRL assigning Problem S15R-S. Other references pertinent to this report are as follows:

(a) "Reflecting Material as a Radar Countermeasure" - NRL Secret Report R-2022 of 13 March 1943.
(b) "Resonance Tests on "Straw" Reflectors" - NRL secret letter S-S67-5/RCM(378)(GFM) Serial 1713 to BuShips dated 27 August 1943.
(c) "Tests on Window for Radar Countermeasures" - OpNav conf. ltr Op-20-S-4/dca(SC) S67-5 Serial 01126220 dated 6 August 1943.
(d) BuShips letter of intent NXsr-26737 to Standard Rolling Mills, Inc., Brooklyn, N.Y.
(e) "Use of Window" - BuShips secret letter S-S67-5(920-Dh) Serial S-920-07787 to ComAirPac via CNO dated 7 March 1944.
(f) "Rocket Window Test" - NRL secret letter S-S67-5/RCM(379-JSK) Serial 2717 to BuShips dated 21 March 1944.
(g) "Rocket Window Test" - NRL secret letter S-S67-5/RCM(379-WSA) Serial 2867 to BuShips dated 20 April 1944.
(h) Comnaveu Intelligence Report Serial X5134 dated 12 December 1943.
(i) Comnaveu Intelligence Report Serial X969 dated 17 March 1944.
(j) "Test Report on Double Tape Dispenser" RRL Technical Report 411-TR-6 dated 7 February 1944.
(k) "Test Report on G1106 Double Tape Dispenser" - RRL Technical Report 411-TR-11.
(l) "6801 Airborne Cutter" - RRL Technical Report 411-TR-5 dated 5 February 1944.

2-2. The fundamental principle underlying radar is the fact that any material body having electrical characteristics that differ from the characteristics of the propagation medium will reflect and scatter a portion of the incident electromagnetic energy. The magnitude of the signal returned to the radar receiver at a given frequency depends on several factors; namely (a) composition of the target (wood, steel, aluminum, etc.), (b) dimensions and shape of the target, (c) altitude of target, (d) range of target, (e) the position of the target relative to the interference pattern produced by the image of the target in the plane of the earth (or sea). The effects of items (a) and (b) above, which are characteristic of the target itself, are combined in a single constant called the cross section or equivalent relfecting area. This constant is a function of the frequency. Window is a material which has a large equivalent reflecting area for its weight and bulk. Consequently its use is desirable for simulating targets, for blackout jamming and for "noise jamming". "Noise jamming" as applied to Window is the term designating Window interference of less amplitude than blackout jamming.

2-3. An intelligence report from Comnaveu, reference (h), requests information for the Air Ministry of Great Britain concerning the plans of the United States Navy for use of Window. Although this report was in preparation at the time the communication was received, and is not an answer to the request, it is felt that the questions raised in the intelligence report, reference (h), are answered in the body of this report. It should be noted that the United States Navy is in essential agreement with the statements A, B, and C of paragraph 1 of reference (h). The many turn "Diploma" type of package is not used. Widths have been standardized at 3/16" and 1/4" (i.e. $4\frac{1}{2}$ mm and 6 mm approximately). The package design is such that with minor modifications the units can be used with the "double tape" type, the "sausage" type, or the "ammunition belt" type of dispenser.

2-4. Free use has been made of information collected by other research agencies. Theoretical reports and test reports by other workers are listed in appendix 5.

3. WINDOW.

3-1. Description.

3-1-1. "Window" is the code term for aluminum strips backed with paper and cut to approximately one-half the wavelength of the radar equipment to be jammed. These half wave dipoles act as reflectors to the radar energy and when properly used can return echoes and "clutter" sufficient to jam the radar presentation or deceive the radar operator.

3-1-2. Many types of Window have been used and tested. The earliest types used by the Royal Air Force were merely rectangular sheets of paper-backed foil. These were aperiodic and affected all radars down to a frequency corresponding to a wavelength equal to twice the diagonal of the sheet. Large quantities were required for operation with this type of Window. For the sake of economy Window was modified. The sheets were cut into dipoles of length great compared to their width, the choice of width being a compromise between bandwidth and weight of material.

Further development led to very narrow dipoles crimped down the center to give them rigidity. In the 100 Mc/s band the length required for Window is in the order of 5 ft. To overcome the limpness of the forms of Window used at higher frequencies foil was made into cylinders called "Straws".

3-2. Requirements for Window.

3-2-1. The design and development of Window for use by the United States Navy has been based on the following assumptions:

(a) Window must be produceable in large quantities.
(b) Available production facilities must be used.
(c) Window must be available for all frequencies from 100 Mc/s up.
(d) Window will be used for both jamming and deception.
(e) Window must be available at short notice for use against new (hitherto unreported) frequencies.
(f) Window material must survive hot and humid storage.
(g) Window must occupy the minimum shipping space.
(h) The material itself must be designed and packaged for flexibility and reliability in use and in final field preparations.
(i) The mechanical design must permit tight packing in rockets and shells.
(j) Suitable means for ejection from aircraft must be provided.

3-3. Considerations in Design of Window.

3-3-1. The length of time that Window is effective depends upon its rate of fall, and (if it is falling from a great altitude) also upon its rate of lateral and vertical dispersion. If the time of fall is great, the Window may become too dispersed to give the required echo. The rate of fall can be decreased by the use of light materials. A light backing, however, detracts from the stiffness of the dipoles and a compromise must be made between rate of fall and dispersion.

3-3-2. The failure of some of the Window to disperse has been termed "Birdnesting". The undispersed Window falls in a clump much like a birdnest. The efficiency of a given type of Window is proportional to the percentage that disperses. The percentage of dispersion depends heavily on type of package, materials of package, treatment of Window in manufacturing, stiffness of the dipoles, and method of launching. Percent dispersion also depends to a minor degree on the length to width ratio.

3-3-3. Theoretical treatments on Window have assumed that the orientation of the falling dipoles is random. It is exceedingly difficult to design Window that will satisfy this theoretical assumption with respect to the angle the dipole makes with the vertical. The angle of orientation of the dipoles in a horizontal plane is truly random, hence, if all the dipoles are horizontal, the theoretical assumption is valid. For frequencies up to approximately 300 Mc/s Window material falls in a random manner so that the theoretical requi[redacted] are met. From this

[redacted]

region on up to 2,000 Mc/s the dipoles begin to have a pronounced vertical component which falls more rapidly than the horizontal component. The percentage of dipoles in the vertical component has a maximum somewhere between 800 and 2,000 Mc/s depending on the length to width ratio. Above 2,000 Mc/s the vertical component decreases rapidly. At 3,000 Mc/s there is practically no vertical component; almost without exception the dipoles spin about an axis parallel to the long dimension and fall with this axis horizontal.

3-3-4. In view of the foregoing, it seems that vertically polarized radars will see the Window as well as horizontally polarized radars except in the microwave region. Special types of Window must be used to jam vertically polarized microwave radar.

4 TESTS OF WINDOW.

4-1. Introduction.

4-1-1. The Window tests here reported began in September 1943. Tests made previous to this date are described in a report, reference (a), and a letter, reference (b). This report gives the results of preliminary tests using 10" x 10" sheets of paper-backed aluminum foil. The Window echoes were observed at 100, 400, 700, 3,000, and 10,000 Mc/s. A complete motion picture film record of these tests is available. The letter reported the results of bandwidth measurements on the tubular form of Window named "Straws". These measurements gave a bandwidth of approximately 11 Mc/s at 116 Mc/s for straws 1/4" diameter and 90% of a half wavelength at 116 Mc/s. This experimental figure checks rather well with the approximate theoretical value.

4-1-2. At the beginning of the tests in September Window material of the following types was available:

(a) Samples of CHA and CHB and CHC from Radio Research Laboratory.
(b) Manufacturers' samples of guillotine cut Window laminated to several weights of paper and packed in stacks of 200 strips 1/4" wide. Each 200 strips was enclosed in a craft paper tube. The strips were secured at the ends by scotch cellophane tape. See Plate 1.
(c) Manufacturers' samples of Window 1/4" wide, stacked 200 and 300 high - 23 stacks per box. See Plate 2.

4-1-3. The following types of backing were available in either form of package, (b) or (c) above:

(a) ".00035 foil glue laminated on one side to approximately 30 lb. bond paper.
(b) ".00035 foil glue laminated between sheets of approximately 30 lb, bond paper.
(c) ".00035 foil wax laminated between sheets of 12 to 16 lb. tissue.
(d) ".00035 foil glue laminated between sheets of 70 lb. kraft and 30 lb. bond. [redacted]

[redacted]

(c) ".00035 foil glue laminated between sheets of 110 to 120 lb. board and 30 lb. bond.

4-2. Preliminary Operational Test of Window.

4-2-1. Operational tests were needed to determine operator reaction and to gain some information on anti-jam techniques. In compliance with a Chief of Naval Operations request, reference (c), material was prepared for tests at St. Simon Island, Georgia, and at Fleet Service School, Virginia Beach, Virginia.

4-2-2. The material to be used was first used in a preliminary test at the Chesapeake Bay Annex of this laboratory. This Window (1/4" x 20") was laminated between 12 to 16 lb. tissue and packed 23 stacks of 200 to a box. The Window was cut in the box and packed for manual ejection. A PV1 aircraft was used to drop the Window material. First trials were made against the FD fire control radar. Window cut for FD frequency was dropped in packages of 4,600 dipoles at a rate of 12 packages per square mile. (Effectiveness was judged visually and results used to plan the tests for CNO). The FD was unable to detect the PV1 in an area bounded by ranges 8,000 and 14,000 yards and bearings 92° to 115°. The run was monitored on the SG search radar. Some interference was observed on the SG, however the interference was not great enough to prevent tracking the plane.

4-2-3. In the second trial, material cut for SG frequency was used. The area density of packages was four times as great as that used against the FD because of the higher resolution of the SG equipment. Each package contained 18,000 dipoles. The Window was dropped so as to screen a destroyer anchored at approximately 3 miles range. The dropping pattern was designed for 6 miles range and consequently the Window interference on the SG "A" presentation failed to screen the destroyer. The amplitude of the Window return was too small, indicating that larger numbers of dipoles should have been used. However the PPI presentation showed good screening.

4-2-4. The St. Simons test was not run because of foul weather. On the return trip a successful test was run at the Fleet Service School at Virginia Beach. Radars used were SC-2, SK, FD, SL, SG and ASG. The operators of these equipments were the regular instructors at the Fleet Service School all of whom had had fleet experience. The operators were not informed as to the nature of the exercise, but were merely required to plot a track on the aircraft. In every case except one the target was lost for most of the exercise. Observers trained in operation in the presence of Window had little difficulty in identifying the aircraft echo. These tests support the claim that operator training is the <u>first</u> anti-jam countermeasure for Window. The multiplicity of returns confused the operators. Time was wasted attempting to plot a track for each Window pip.

[redacted]

4-3. Package Size Tests.

4-3-1. The number of dipoles to be dropped at a time depends on a number of factors. The echo from the Window must be approximately the same in amplitude as the echo from the target to be protected. It is more economical to drop Window in bunches than to drop it continuously. It would be possible to produce a uniform density of dipoles great enough to achieve the desired protection, but it requires much more material. If the Window is dropped in bunches large enough to give an echo from each bunch approximately equal to the echo from the target, maximum protection can be achieved with a minimum amount of Window. (The rate at which the bundles are dropped depends on enemy radar characteristics). Hence the number of dipoles per bundle depends on the size of the target. The number of dipoles per bundle also depends on the frequency, the higher the frequency the more dipoles required. The number required is roughly proportional to the square of the frequency. In the centimeter region, the efficiency of Window falls off rapidly with increasing frequency and consequently many more than the calculated amount must be used. The efficiency of dispersion of the material is an important factor in determining minimum package size. If a percentage of the dipoles clump together and fall as a group (birdnest) a larger number must be included in the package to guarantee a sufficient number of free dipoles.

4-3-2. On 20 October tests were made to determine numbers of dipoles per drop to simulate a medium bomber (PV1) at 100, 200, 400 and 700 Mc/s. The following values were determined:

Frequency (Mc/s)	No. of Dipoles to Simulate PV1 Return
100	25
200	100
400	500
700	2,500
3,000*	20,000 to 30,000
10,000*	500,000

*The last two items in the table are the results of other tests.

4-3-3. On the basis of foregoing tests, procurement of Window was begun by Bureau of Ships/under Specification RE 13A 836A, reference (d). This specification calls for two types of Window material:

(a) CAFJ - 10270 (200) (See Plate 3-b). The letters are the manufacturer's designation. The numbers after the dash are the type designation. The numbers within the parenthesis indicate the length, the first two giving the number of inches, the third the number of eighths of inches. This is a package of window 20" long containing 8 stacks of 200 dipoles each. Dipoles are 1/4" wide. The dipoles are wrapped in 1-1/2" turns of tag board open at the ends. The tag board is not secured in any way. The ends of the dipoles are secured with scotch cellophane tape or glue binding (necessary for manufacturing facility). The foil is glue laminated between 12 lb. [redacted]

[redacted]

(b) CAFJ - 10271 (600) is similar to CAFJ - 10270 (200) except that it is 60" long and contains 1 stack of 50 dipoles. (See Plate 4-b). The foil is glue laminated between 8 point board and 30 pound bond paper, or between two 6 point boards. [redacted]

4-3-4. A modification of the letter of intent of reference (d) was made to procure the 10270 type and the 10271 type cut to length and ready for use for training and test purposes.

4-4. Dispersion.

4-4-1. It is necessary that the Window packages open without fail and that the dipoles themselves fall independently. In order to determine the percentage dispersion, four series of tests were conducted at Webster Field (an auxiliary to Naval Air Station, Patuxent River, Md.). The method used was the same as that used by Radio Research Laboratory in their tests of dispersion of Chaff in order that results could be compared directly. The plane (PV1) flew at 300 ft. altitude, speed 180 knots, down the length of a runway selected so that the Window would fall to the runway. In each flight over the runway a package of Window was dropped every 500 to 700 feet until six packages had been dropped. The Window that failed to disperse was recovered and placed in paper bags to be weighed after the runs. Altogether, 512 packages of Window were dropped in the series of tests. A description of the types of Window tested follows:

(a) CAFJ - 10270 ( ). This material is ".00035 foil 1/4" wide glue laminated between unbleached 12 lb. tissue. Dispersion was measured for 19", $9\frac{1}{2}$", 6-1/3", 4-3/4" and 1-7/8" lengths all packed in the standard sleeve arrangement (See Plate 5).
(b) CAFJ - 10271 ( ). This material is ".00035 foil 1/4" wide glue laminated between 8 point board and 30 lb. paper. Dispersion was measured for 60" and 30" lengths packed in the standard sleeve.
(c) 30 x 30. This material is ".00035 foil x 1/4" wide glue laminated between 30 lb. bond paper. Dispersion was measured for 19" and $9\frac{1}{2}$" lengths.
(d) 30 x 70. This material is ".00035 foil 1/4" wide glue laminated between 30 lb. bond and 70 lb. kraft. Dispersion was measured for 19" and $9\frac{1}{2}$" lengths.
(e) 1/16 wax. This material is ".00035 foil 1/16" wide wax laminated between 12 to 16 lb. tissue. Dispersion was measured for 19", $9\frac{1}{2}$", 4-3/4", 1-7/8" lengths. (See Plates 6 and 7).
(f) 1/8" wax. This material is ".00035 foil 1/8" wide wax laminated between 12 to 16 lb. tissue. Dispersion was measured for 19", $9\frac{1}{2}$", 6-1/3", 4-3/4", and 1-7/8" lengths. (See Plates 6 and 7).
(g) 3/16" wax. This material is ".00035 foil 3/16" wide wax laminated between 12 to 15 lb. tissue. Dispersion was measured for 19", $9\frac{1}{2}$", 6-1/3", 4-3/4", and 1-7/8" lengths. (See Plates 6 and 7).

[redacted]

4-4-2. The results of the tests of the foregoing materials are shown in graphs (Plates 11 and 12) in which the percentage dispersion is plotted against the length of the dipole.

4-4-3. Four sample sets of data are as follows:

Material	No. of Pkgs.	% Dispersion in Each Drop
CAFJ - 10270 (190) 19" long	14	67, 66, 58, 90, 69, 58, 60, 58, 66, 59, 68, 55, 76, 59 (Ave. 62%).
CAFJ - 10271 (600) 60" long	24	76, 58, 50, 48, 54, 12, 44, 42, 48, 68, 79, 62, 22, 12, 60, 38, 100, 100, 100, 100, 100, 100, 100, 100 (Ave. 65%).
CAFJ - 10271 (300) 30" long	24	23 dispersed 100% 1 dispersed 68%
30 x 30 19" long	12	70, 100, 100, 95, 91, 57, 93, 96, 85, 89, 85, 86, 72 (Ave. 87%).

4-4-4. Complete results are:

	Length	No. Drops	% Dispersion
CAFJ - 10270 (190)	19"	36	69%
CAFJ - 10270 (094)	9½"	22	86%
CAFJ - 10270 (066)	6-3/4"	9	95%
CAFJ - 10270 (046)	4-3/4"	20	99%
CAFJ - 10270 (017)	1-3/8"	7	92%
30 x 30	19"	19	82%
30 x 30	9½"	19	97%
30 x 70	19"	19	87%
30 x 70	9½"	12	96%
CAFJ - 10271 (600)	60"	39	56%
CAFJ - 10271 (300)	30"	48	95%
*30#	19"	4	85%
*30#	9½"	4	79%
*1/16" wax	19"	3	71%
*1/16" wax	9½"	2	70%
1/16" wax	4-3/4"	4	89%
1/16" wax	1-9/16"	3	100%
1/8" wax	19"	15	68%
1/8" wax	9½"	13	68%
1/8" wax	4-3/4"	9	97%
1/8" wax	1-7/8"	3	100%
3/16" wax	19"	13	73%
3/16" wax	9½"	13	92%
3/16" wax	6-3/4"	4	100%
3/16" wax	4-3/4"	[redacted]	[redacted]
3/16" wax	1-7/8"	[redacted]	[redacted]

(*These figures inaccurate. Because of loss of material in the wind, many items of data were thrown out).

[redacted]

4-5. Rate of Fall.

4-5-1. During this series of tests, rate of fall measurements were made. Measurements were made two ways. First by timing the fall from the plane to the ground with a stop watch. This gives a slightly large value for the rate of fall. The second method was to time the effectiveness of a batch of Window dropped from 5,000 ft. altitude. The figures obtained by these two methods do not check at all. Measurements made visually from the ground give rather large rates of fall. These are probably the true rates of fall in still air. Measurements made of rate of fall from 5,000 ft. altitude vary over a factor of 2. Ground measurements gave 300 ft/min fall for CAFJ - 10270 (   ) and 600 ft/min for 10271 (   ). Measurements using a radar and computing rate of fall by dividing the altitude in feet at which the Window was dropped by the time of effectiveness (i.e. the length of time that the Window pip remained on the scope) gives, surprisingly enough, much smaller values; 250 ft/min for 10270 and 450 ft/min for 10271. The measurements of rate of fall as computed from time to fall through a lobe from minimum to minimum agrees with the figures for fall in still air. It should be noted, however, that if window is dropped from great altitude the life of the Window may be much less than the time it takes the Window to fall to the ground. The lateral dispersion of the Window is large even in still air. If there is a substantial vertical velocity gradient in the wind, the Window may lose effectiveness long before it reaches the ground. CAFJ - 10271 (280) maintains its effectiveness for as much as an hour and a half against equipments with large pulse length. In the/ other extreme, CAFJ - 10270 (081) has become ineffective as soon as ten minutes after it was dropped against the FD radar. In both cases above, the Window was dropped at great enough altitude to fall for well over one-half hour.

4-6. Polarization.

4-6-1. During the tests at Webster Field phenomena of non-random fall were noted. Window material longer than 12" seemed to fall at random. For dipoles somewhat shorter than this a fraction fell such that the length of the dipole was vertical and the balance fell with the length horizontal. There was very little variation from these two modes of fall. The vertical component fell more rapidly than the horizontal component (about 15% faster). The percentage of vertical component increased for lengths down to 4", then decreased abruptly. There was apparently no vertical component present in 1/4" x 2" Window. An attempt was made to observe the two components at Chesapeake Bay Annex of Naval Research Laboratory. At 100 Mc/s the response on the Guadalcanal Japanese radar (horizontal polarization) was compared to the response on the SD-1 fitted with vertically polarized antenna. At 400 Mc/s two Mark 5 fire control radars were used, one with horizontal and one with vertical polarization. At 700 Mc/s the FD fitted with a full parabola and a rotating dipole was used. At 3,000 Mc/s the SG and the Mark 8 were used.

4-6-2. The inherent difficulty with the measurements of echoes versus polarization was the fact that the ratio of vertical to horizontal return for the PV1 was not known. Because of this, the results

[redacted]

[redacted]

are in terms of ratios of Window echo to aircraft echo for vertical polarization compared to the same ratios for horizontal polarization. It was found that the ratios are roughly equal except in the centimeter region. For the frequency range from 100 Mc/s to 700 Mc/s the ratio of Window echo to aircraft echo for vertical polarization was slightly greater (15%) than the same ratio for horizontal polarization. This indicates that for the above frequency range, less Window material can be used if enemy's gear is vertically polarized. At the time of test there were no radars available between 700 and 3,000 Mc/s. No polarization tests have been made in this region. At 3,000 Mc/s no echo was observed from even the largest Window drops when the Mark 8 was used. The SG and SF however showed large echoes. The Window cut for 3,000 Mc/s was 1-7/8" long by 1/4" wide. This material falls entirely horizontal. A type of Window was designed to give a vertical component to the fall. Six dipoles were wax laminated between 12 lb. tissue. (See Plate 8). The spacing between centers of the individual dipoles was approximately 0.8 wavelength. This spacing phases the return from each individual dipole so that the strip acts like a Marconi Franklin Collinear array. These were packaged in groups of 1,600 strips of 6 dipoles each. Preliminary tests with this material (called coherent dipoles) indicate that 1,600 to 3,200 strips of 6 dipoles each will simulate a heavy bomber. 6,400 strips (or 4 packages) return an echo approximately equal to that from a DE or DD. The experimental coherent dipoles proved to be impractical from the viewpoint of dispersion. Birdnesting was serious. Furthermore, the fall was random, and consequently the efficiency was very low for vertical polarization. A modified type now in procurement should increase the efficiency against vertical polarization. Since the orientation of the dipole for maximum reflection becomes more critical when the dipoles are tied together, nothing is to be gained by using coherent dipoles unless (1) they are used against vertically polarized radars and (2) they fall with long dimension vertical. The modified material will be comprised of 6 individual dipoles spaced 0.8 wavelength between centers laminated between 30 lb. bond paper. To give a preferred fall, the dipole at the end of the strip will be made of lead foil weighing approximately four times as much as an aluminum dipole. Thus the echo should be large for vertical polarization. This type of Window is to be available in small quantities for 3,000 Mc/s and 10,000 Mc/s. The 10,000 Mc/s Window will have approximately 20 dipoles per strip, the last three or four being lead foil.

4-6-3. Coherent strips for vertically polarized radars in the region from 82 Mc/s to 150 Mc/s have also been designed. Tests were made at 100 Mc/s using the Japanese radar from Guadalcanal and the SD-1 which has a vertically polarized antenna. At 100 Mc/s, 6 dipoles spaced 0.8 wavelength on a long strip are sufficient to return an echo equivalent to a heavy bomber echo. The strips used in this test were wound on a bakelite core and launched from the aircraft with the first few turns loose. (See Plate 8). The strips fell with their length vertical. The rate of fall was large, (600 to 700 ft. per min.). In the second test parachutes were used. The rate of fall was reduced to approximately 300 ft. per minute. The parachutes used were supplied by Beistle Company of Shippenburg, Pa., and the C.A. Reed Company of Williamsport, Pa. Although the strips designed to fall with their length vertical, the wind keeps them at an angle so that a substantial return was observed on the Japanese gear in spite of the fact that the Japanese antenna is horizontally polarized.

chute arrangements. Further work on chutes was done under a project by the Bureau of Aeronautics (See Appendix 1). It should be noted that all bombers that have waist gunner's bays can be used to eject Window. When the bay door is open, a deflector plate on the leading edge of the opening serves to make the pressure negative just outside the bay (as in B17, B24 and B26). The chute designed for the TBF by the Bureau of Aeronautics mounts in the window just ahead of the rear gunner's door. Two of the designs are acceptable. One design results in negative pressure in the chute at all times, but the Window packages tend to be bent on launching and sometimes stick in the chute. The other design eliminates the sticking, but permits some in-draft. This necessitates a trap door in the chute, to prevent carbon monoxide from entering when the chute is not in use.

4-8. Automatic Dispensers.

4-8-1. Several mechanical dispensers are in design stage for the Bureau of Ships. At the Naval Research Laboratory a bottom feed motor driven dispenser is in the shop. In this design, each package of Window rests in a compartment comprised of partitions and flexible steel tapes. In operation the tapes are withdrawn at a pre-determined rate. As the bottom tape is withdrawn, the bottom layer of Window packages is released one at a time. When the last package in the bottom layer is dropped, the tapes for the next layer are withdrawn. (See Appendix #2 for plan drawing). The dispenser is designed to hang in a bomb bay. Tests on this development are required to determine the best method of launching from the bomb bay. Arrangements must be provided to prevent the Window from blowing back into the bomb bay.

4-8-2. Many other types of automatic dispenser have been designed. In Great Britain, the Bombing Development Unit has tested an automatic launching machine (Fairey) of the "ammunition belt" type. Detailed information on this machine can be obtained from Report No. BDU. 31, Part II, reference (i). On 18 March 1944 a meeting was held in Washington, D.C. to standardize dispenser design. A paper presented by Wing Commander P.H. Cribb outlined the requirements of Great Britain. In this paper the machines in design are discussed in detail including the B.D.U. (Z2400) "Sausage" type machine, the Radio Research Laboratory Model G1106 reference (j) and reference (b) twin tape G1107 "Screw" type and G801 reference (1) "Airborne Cutter" types of dispenser.

4-9. Rocket and Shell Window.

4-9-1. Projection of Window from Surface Vessels. (See Appendix #3, "Use of Projectiles and Rockets as Window Dispensers".

4-10. Temperature Tests - Stowage.

4-10-1. Present specifications call for glue laminated Window materials. Glue laminated Window requires more cutting effort than wax laminated Window. The wax used for lamination of test samples has a melting point of 130° F. It is estimated that for tropical storage this is not unusually high temperature. The wax laminated foil (using 130° F wax)

[redacted]

was found to block badly under the pressure bar of the cutter when heated to 130°F. However, when allowed to cool to room temperature it could be cut without blocking. Test samples of 180° wax laminated Window are in preparation. If the 180° wax laminated Window is satisfactory as far as blocking is concerned it would be desirable for the following reasons:

(a) There is a possibility of greater production facilities.
(b) It can be cut faster (requires less cutting effort, and consequently more packages can be cut at one time).
(c) The life of the cutter blade is increased because of the lubricating action of the wax.

Navy Ships Specification RE 13A 836A and RE 13A 836B (See Appendix #4) call for glue lamination. The present material is not effected by temperatures encountered in stowage. See specifications for details on cartons and shipping containers.

5. USE OF WINDOW.

5-1. Advance Information Required.

5-1-1. In general, Window has been used to create confusion by disturbing radar fire control apparatus and ground radar controlled aircraft intercept systems. The use of Window as a deception device has not been fully exploited. The actual use of Window will be determined by operational requirements. Regardless of how the Window is to be used, certain information on enemy gear is necessary. Most important and necessary is the knowledge of enemy frequencies. Other desirable information is the enemy pulse length, beam width and polarization.

5-2. Plant Equipment.

5-2-1. With the knowledge of the enemy frequencies, the material can be prepared. If enemy frequencies are bunched, e.g. German Wurzburg, the material can be prepared at the factory and delivered to the field service ready for use. Otherwise, the foil will be cut to length in the field using guillotine paper cutters (See Plates 9 and 10). Because of end effects, the length to which the dipoles are cut is not exactly 0.5 wavelength, but somewhat less. The exact value depends on the length to width ratio. For very large values of length to width ratio the length required approaches 0.5 wavelength. Standard Window has a maximum length to width ratio of 240 for 60" lengths of CAFJ 10271. For lengths of 1/4" wide Window approaching 60", the length should be approximately .475 wavelength. The opposite extreme is for centimeter waves (S band). Here the length should be about .44 wavelength. Standard pre-cut Window is cut to .475 wavelength. Standard Window is 1/4" and 3/16" wide. Consequently the bandwidth, which depends on length to width ratio, increases with increasing frequency. The bandwidth at the higher frequencies, where 0.475 wavelength would be in error, is great enough to permit the use of one formula for the length, namely .475 wavelength (See graph Plate 13).

[redacted]

[redacted]

[redacted]

5-3. Window Cutter.

5-3-1. The guillotine cutter supplied for field preparation is the 26½" Challenge Model 265 paper cutter. Each cutter is shipped with extra blades and extra sticks to be placed in the table of the cutter beneath the blade. The life of the cutting blade is not great unless the following precautions are taken: After each cut wipe the blade with waste or heavy felt dipped in light oil; this lubricates the blade for the next cut and brushes away small pieces of foil and dirt that may be clinging to the blade. After about 100 cuts hone the blade lightly. Be sure that the angle of the blade bevel is not changed in this process. The stone should be flat against the back of the blade or flat against the bevel. A small amount of sharpening can be effected by removing the blade for a prolonged honing. Complete resharpening of the blade requires a grinding machine. Since these are not ordinarily available in advance bases, several blades are supplied. It is permissible to give the blade considerable momentum before it begins to cut the Window. The amount of momentum is a matter of skill for manual cutting and should be just large enough to carry the blade through the Window in one stroke. The blade should not sink into the stick in the table. The life of the blade will be increased if a sheet of cardboard is placed beneath the Window. Then if the cutting effort is properly applied, the blade will come to rest in the cardboard above the wooden stick. The foregoing is obviated if a stop is provided to prevent the blade from travelling too far. The Challenge 265 is provided with such a stop. It is found on the shaft below the cutting table. Sharpness of the blade can be judged by the effort required to cut a given amount of Window with a single stroke.

5-4. Field Preparation.

5-4-1. A stock of uncut material is required, also a cutter with maintenance wrenches (2), cartons, and gummed paper tape. If an automatic dispenser is to be used, the cartons and gummed tape are not necessary. The cartons in which the uncut material is shipped will serve for stowage in the dispensing plane. Each carton of Window contains extra 20" sleeves. If the Window is to be cut in short lengths and if several are to be used per drop, several units can be packed together in a single outer sleeve. For example, 10 packages of Window cut for 3,000 Mc/s can be placed end to end inside of one of the extra sleeves.

5-5. Ejection of Window from Aircraft.

5-5-1. If aircraft are to be used to drop Window, there are several possible uses:

(a) Protection of a few aircraft by one aircraft dropping Window. For this case it is assumed that the aircraft are flying toward the radar installations, and that confusion is the object rather than complete blackout. The Window aircraft leading the formation then drops packages of Window of appropriate size at intervals of approximately one pulse length in range. If the pulse length is one microsecond, this

[redacted]

[redacted]

 [redacted]

would require one package every 500 ft. approximately. For an aircraft flying 180 knots, the speed is roughly 300 ft/sec and consequently a package should be dropped every 1-2/3 seconds in order to put one package in each pulse length of range. If the package is a bit oversize, one every 2 seconds is quite sufficient. If several widely separated radars are to be jammed, the beam width of the enemy gear must be considered. It should be noted that as long as the aircraft fly along a radius, the rate for dropping is constant and independent of range. However, if the aircraft is moving in azimuth, the rate is greater when close to the radar than when afar. The rate is inversely proportional to the distance for a given beam width when the aircraft flies in azimuth.

(b) <u>Protection of many sorties</u>. In this case, every aircraft carries Window. The rate of dropping now depends on the number, distribution in range and altitude of the aircraft, in addition to the enemy radar characteristics.

(c) <u>Area Blackout</u>. This is the least economical use of Window. Large quantities are needed, and considerable care must be exercised in order to get maximum protection within the blackout area. The quantities required again depend on enemy radar characteristics. The length of time that blackout is required determines the altitude at which the Window must be dropped and whether or not the area must be sowed more than once.

(d) <u>Simulated Surface Target</u>. If the false target is at large range from the enemy radar (or if the enemy's vertical beam width is large) the Window for the false echo can be dropped from great height. The quantity in the bundle of Window should be great enough to return an echo of proper magnitude. If the enemy gear has a very short pulse length, care should be taken that the Window be dropped as nearly as possible within the volume of a single pulse wave packet. For example at 3,000 Mc/s, pulse length 1 microsecond, a greater echo is produced if the Window is dropped while the aircraft flies in azimuth since the Window is spread out in azimuth rather than in range.

5-6. <u>Examples</u>.

5-6-1. Suppose it is desired to protect a few aircraft with Window dropped from a single plane. It is assumed that two radars defend the enemy position and that they are close together, i.e., within a mile or two of each other. Characteristics of one radar are:

Pulse width	30 microseconds.
Resolution in azimuth	5 degrees.
Frequency	150 Mc/s.

Characteristics of second radar are:

Pulse width	2 microseconds.
Resolution in azimuth	2 degrees.
Frequency	1,000 Mc/s.

[redacted]

[redacted]

DECLASSIFIED

[redacted]

To compute the length for each case, use the factor .561.

$$L = \text{length} \ \frac{.561 \times 10^4}{f \ (\text{Mc/s})} \ \text{inches.}$$

$$\text{Since } L = .475\,\lambda \qquad \lambda = \frac{c}{f}$$

$$= \frac{.475\,c}{f}$$

c = vel. of propagation

3×10^{10} cm/sec.

f = frequency in cycles/second.

This gives L in cm.

To express L in inches:

$$L = \frac{.475 \times 3 \times 10^{10}}{2.54 \times f_{Mc/s}\, 10^6}$$

$f_{Mc/s}$ = frequency in Mc/s.

$$L = \frac{5610}{f_{Mc/s}}$$

For the 150 Mc/s set, $L = \frac{5610}{150} = 37.3''$. $37\frac{1}{2}''$ is close enough since the band width is roughly 10% at this frequency. For the 1,000 Mc/s set, $L = \frac{5610}{1000} = 5.61''$. 5-5/8" suffices for this case.

5-6-2. For the 150 Mc/s set, Window must be dropped in each pulse length, i.e., every 30 x 500 = 15,000 ft. or once each 5,000 yards. For the 1,000 Mc/s set, Window should be dropped every 2 x 500 = 1,000 ft. or six every 2,000 yds. In other words the Window cut for 1,000. Mc/s must be dropped 15 times as often as the 150 Mc/s Window. To insure facility in manual ejection, it would be well to pack the Window so that the ratio would be maintained, i.e., 15 for 1,000 Mc/s to one for 150 Mc/s. If the ground speed of the aircraft is 180 knots, the aircraft will travel one mile every 20 seconds or 1,000 ft. in 3-1/3 seconds. Hence one unit of Window should be dropped every 3 seconds for optimum protection. The dropping rate can be much less than this when the planes are far from the objective, but should increase to this value when closing on the objective in order to increase the confusion when the squadron is within anti-aircraft range.

5-6-3. The number of dipoles to use per unit depends on the number of planes to be protected. At 150 Mc/s 50 dipoles will simulate a heavy bomber. If the formation is tight enough to return a single echo, this number should be multiplied by the number of aircraft in the flight. Suppose six bombers are used, then 300 dipoles per unit should be used, for example six $37\frac{1}{2}''$ lengths cut from CAFJ - 10271 (600). For the 1,000 Mc/s set 3,200 dipoles return a bomber echo and 6 x 3,200 or 19,200 dipoles per

[redacted] [redacted]

DECLASSIFIED

unit are required. Since three units of 1,600 dipoles can be packed within a sleeve (extra sleeves are supplied with each carton of 10,270 (200)) four sleeves of 4,800 dipoles comprise a 6 bomber unit. Although the foregoing quantities are required for optimum protection, it has been found that much less than these quantities still affords good protection because of the confusion of radar operators in the presence of Window.

5-6-4. The aircraft that drops the Window should fly ahead and above the flight. It should fly on the windward side of the flight. It should be noted again that the Window aircraft is vulnerable to ground control intercept.

5-6-5. Protection of many sorties is best affected by having each aircraft drop Window, or at least one aircraft out of every three or four. The best use of Window in this case is primarily an operational problem, but the following principles should be considered. At great distances when the whole flight of bombers fills a volume less than that filled by a pulse packet (a pulse packet is the total radiation emitted by the transmitter during a pulse. It occupies a volume one pulse length deep by one horizontal beam width wide by one vertical beam width high), the Window drops can be relatively infrequent but should be large enough to simulate the whole flight. As the objective is approached, the rate of dropping should be increased and the size of Window bundles decreased. Consider a flight of 500 bombers covering an area of 500 square miles 10 miles wide and 50 miles deep. Suppose the enemy radar has a pulse width of 5 microseconds, azimuth resolution of 5 degrees, and elevation resolution of 10 degrees. Suppose the main body flies at 10,000 ft. and that the operation permits the leading aircraft to fly at 15,000 ft. The range resolution will be about 1/2 mile for a 5 microsecond pulse. 5° azimuth at 100 miles range is approximately 10 miles; 10° elevation at 100 miles is approximately 20 miles. Hence at great range, the bombers would be resolved in range only. At 100 miles range the dropping rate can be small if each bomber drops single units or if one bomber drops multiple units once every 1,000 yards (approximately every 10 seconds if aircraft fly at 180 knots). There should be as many units of Window in the volume occupied by the bombers as there are bombers. (Each unit should give an echo comparable to the echo from a bomber). The advantage in having each bomber carry Window, is that the protection offered does not depend upon one bomber. If all aircraft carry Window, the instructions to operators are simplified, and the load is divided among the aircraft. The leading aircraft should be supplied with more than average amounts, because they are unprotected. On the other hand, the following aircraft need less Window because they enjoy the protection of Window dropped by the preceding aircraft. The actual design of large bomber raids using Window, of course, depends on operational requirements. It is desirable that Window be dropped in such a manner that there is always as many Window units per pulse packet as there are bombers per pulse packet at any particular point in range.

5-6-6. The area blackout with Window might be useful in certain types of operations, e.g. protection of small surface craft or protection of highly localized operations from radar controlled gun fire. This

[redacted]

use of Window requires information on enemy pulse width and angular resolution. Window should be dropped continuously during the operation and frequently enough to keep at least one effective bundle of Window in each pulse packet throughout the area to be affected. This may require the use of several aircraft to maintain a sufficient density of Window. The number of units to be dropped per square mile of area is inversely proportional to the range from the radar installation (since the beam width in miles is proportional to the range). It should be remembered that one unit must be dropped in every pulse length of range to assure blackout densities; hence it is desirable to have the Window aircraft drop Window while flying on a radial path to or from the enemy installation. For a good example and discussion of this use of Window see letter of reference (c). It is important that each unit or bundle of Window shall be chosen to give an echo comparable to the echo from the craft to be screened. Information on quantities of Window required to simulate surface craft will be the subject of a future report from this laboratory.

5-7. General Discussion.

5-7-1. In general, Window will add to the confusion of enemy radar operators by returning many spurious echoes. Although Window is most effective when proper size units are dropped in correctly determined patterns, it can still be quite effective in smaller quantities used in a statistical way as a sort of noise jamming. It should be noted, however, that radar can see through Window. Window is not like a "smoke screen". The object to be protected must be completely within the Window infected area.

6. BASIS OF CHOICE.

6-1. General.

6-1-1. The first consideration for the design of Navy Window was the contemplated use. No definite information exists as to the frequency distribution of enemy sets in all theatres of the war. It was decided that the width should be standardized. In this way the Window could be cut to the standard width in the factory and sent thus to the field in convenient lengths where it could be cut to the correct length immediately upon receipt of information on enemy frequencies. The only possibility for pre-cutting to length would be to have many standard lengths close enough together to cover the entire frequency range. This would require a vast amount of shipping and stowage because of the necessity of keeping a complete stock at every base. Hence for convenience in getting odd lengths at short notice, a standard width was chosen (recent specifications call for two widths because birdnesting could be minimized by such a choice). Factors influencing this choice are the facts that (1) all commercial processing can be done on existing machines and (2) that the final field preparation can be done with manually operated guillotine machines already in production.

[redacted]

[redacted]

[redacted]

6-2. Package.

6-2-1. The package as designed by the Bureau of Ships and Naval Research Laboratory in cooperation with the manufacturer weighs slightly more per effective dipole than other packages designed for the same purpose (See table for comparison). This disadvantage is offset by smaller storage space and the ease of production of Navy Specification Window.

6-3. Construction of Foil.

6-3-1. Soft aluminum foil ".00035 thick is used throughout. Early samples were backed with 30 lb. paper on one side. When used in foul weather or under humid conditions, this type tended to curl. The curling tended to increase the birdnesting. This type was discarded in favor of double backed foil with 12 to 15 lb. tissue glue laminated to both sides of the foil. Wax laminated samples were obtained, but it was found that the foil blocked seriously under the cutter if the stowage temperature approached 130° F. Present specifications require glue lamination. The tissue is laminated to the foil with the glossy side out. A small amount of very fine oil is used in the mounting machine as a preventative for blocking and edge welding in the guillotine cutter. Unbleached tissue is used because its greater strength permits faster production. For further details on packaging see Navy Ships Specification RE 13A 836B, Appendix 4.

6-4. Weight and Stowage Space.

6-4-1. (See Table No. 1). The use of Window by fighters and aircraft in which space is at a premium dictates the choice of that kind of Window taking the least space per unit. Regularly stacked guillotine cut Window packed in rectangular sleeves was chosen because it fulfills this requirement better than "Chaff" or randomly packed guillotine cut Window.

6-5. Dispersion.

6-5-1. Birdnesting is minimized by proper choice of materials, packaging, and manufacturing methods.

6-6. Field Service.

6-6-1. The needs of the field service were considered in that the Window is designed so that it will be of general utility regardless of newly discovered enemy frequencies. Final field preparation can be effected by use of manually operated machines - a distinct advantage at advanced bases where power sources may be anything from 32 volt d-c-systems to 440 volt 800 cycle generators.

7. PRESENT TYPES.

7-1. Present production is on the basis of Navy Ships Specification RE 13A 836A (See Appendix #4) which calls for two types of Window, 1/4" x 20" in packages of 1,600 and 1/4" x 60" in packages of 50.

[redacted]

[redacted]

DECLASSIFIED

[redacted]

8. PROPOSED TYPES.

8-1. Types of Window specified by Navy Ships Specification RE 13A 836B are scheduled for early delivery. Production began 1 April 1944. Nineteen types are specified. All but three of these are pre-cut to chosen frequencies for training purposes and for use in regions where frequencies are already known (See Appendix #4). Experiments and tests are continuing on the types 10325 (017), 10325 (005) and the 10326 series. The specifications for these are to be considered tentative. The 10326 series (called "streamers" in this report) is known by others in the field as "tuned rope". It is hoped that the region from 80 Mc/s to 150 Mc/s at least can be covered either by a single tuned rope having a selection of dipoles of different lengths or by the untuned rope as designed by Radio Research Laboratory. It should be noted, however, that ropes in general are effective only against radars using vertically polarized antennas. Specially designed ropes may be available in the near future.

8-2. Standard Rolling Mills, Inc., Brooklyn, New York deserves a great deal of the credit for adapting Naval Window to production. Without the cooperation of this company, production development would still be in its early stages. The cooperation of Standard Rolling Mills has taken the form of quick production of test samples and suggestions for design of Window particularly with respect to improving dispersion, packaging, and production.

[redacted]

[redacted]

DECLASSIFIED

Table No. 1

[redacted]

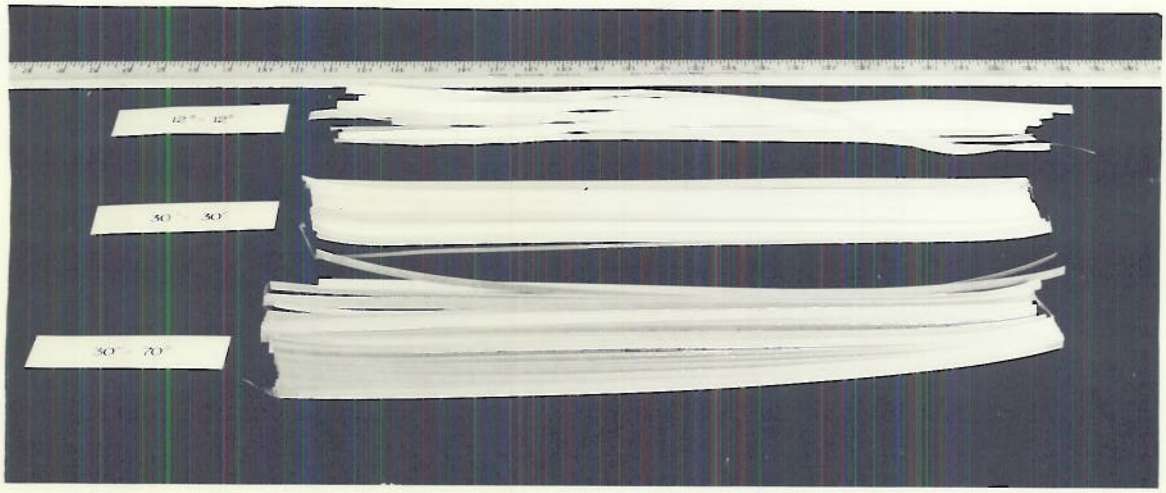
Window Type	Net Weight of Material	Total Weight of Package	No. Di-poles	% Bird-nest	[redacted] of Carton	[redacted] Carton	Volume per Unit
Band 0, 100 mc.							
Streamers	.57 oz.	1.65 oz.	6	0	---	---	1 cu. in.
10271 (560)	3.6 oz.	5.08	50	44%	68 lb.	200	21 cu. in.
No data on RRL material.							
Band 1, 200 mc.							
Streamers	1.1 oz.	2.18 oz.	12	0	---	---	2 cu. in.
10271 (282)	1.8 oz.	2.79	50	5%	68 lb.	400	10 cu. in.
No data on RRL material.							
Band 2, 375 mc.							
10325 (150)	7.3 oz.	9.4 oz.	600	15%	-	100-120	18 cu. in.
AN/CHA-2	3.0 oz.	4.0 oz.	1000	-	-		29 cu. in.
AN/CHB-2	5.5 oz.	6.5 oz.	1000	-	-		43 cu. in.
Band 3, 550 mc.							
10270 (102) ¼"	7.46 oz.	8.27 oz.	1600	14%	65 lb.	200-250	17 cu. in.
10270 (102) 3/16"	5.41 oz.	6.12 oz.	1600	8%	65 lb.	250-300	11 cu. in.
AN/CHA-3	2.7 oz.	3.5 oz.	2000	64%	-	-	24 cu. in.
AN/CHB-3	6 oz.	7 oz.	2000	-	-	-	52 cu. in.
Band 4, 700 mc.							
10270 (081) ¼"	11.1 oz.	13.8 oz.	3200	10%	65 lb.	70	27 cu. in.
10270 (081) 3/16"	8.22 oz.	10.6 oz	3200	4%	65 lb.	100	18 cu. in.
AN/CHA-4	2.9 oz.	3.7 oz.	3200	-	-	-	43 cu. in.
AN/CHB-4	6.73 oz.	7.7 oz.	3200	-	-	-	52 cu. in.
Band 5, 3000 mc.							
10270 (017) ¼"	26.4 oz.	32.4 oz.	32,000	8%	65 lb.	35	57 cu. in.
10270 (017) 3/16"	19.2 oz.	24.2 oz.	32,000	4%	65 lb.	50	38 cu. in.
AN/CHA-5	6.0 oz.	12.0 oz.	50,000	(55%) (62%) (42%)	-	-	-
		Values for different packages.					

[redacted]

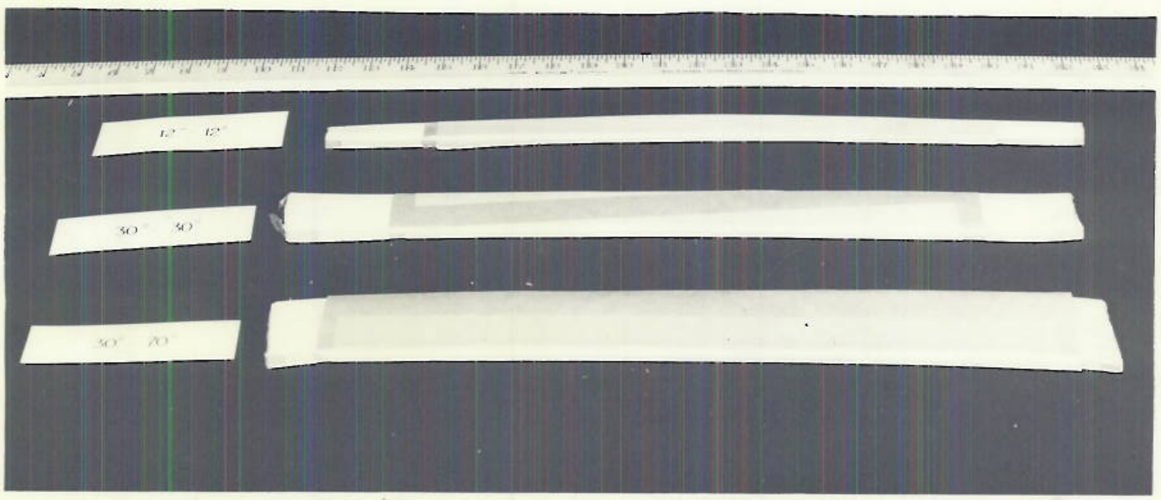
[redacted]

DECLASSIFIED

[redacted]



1a



1b

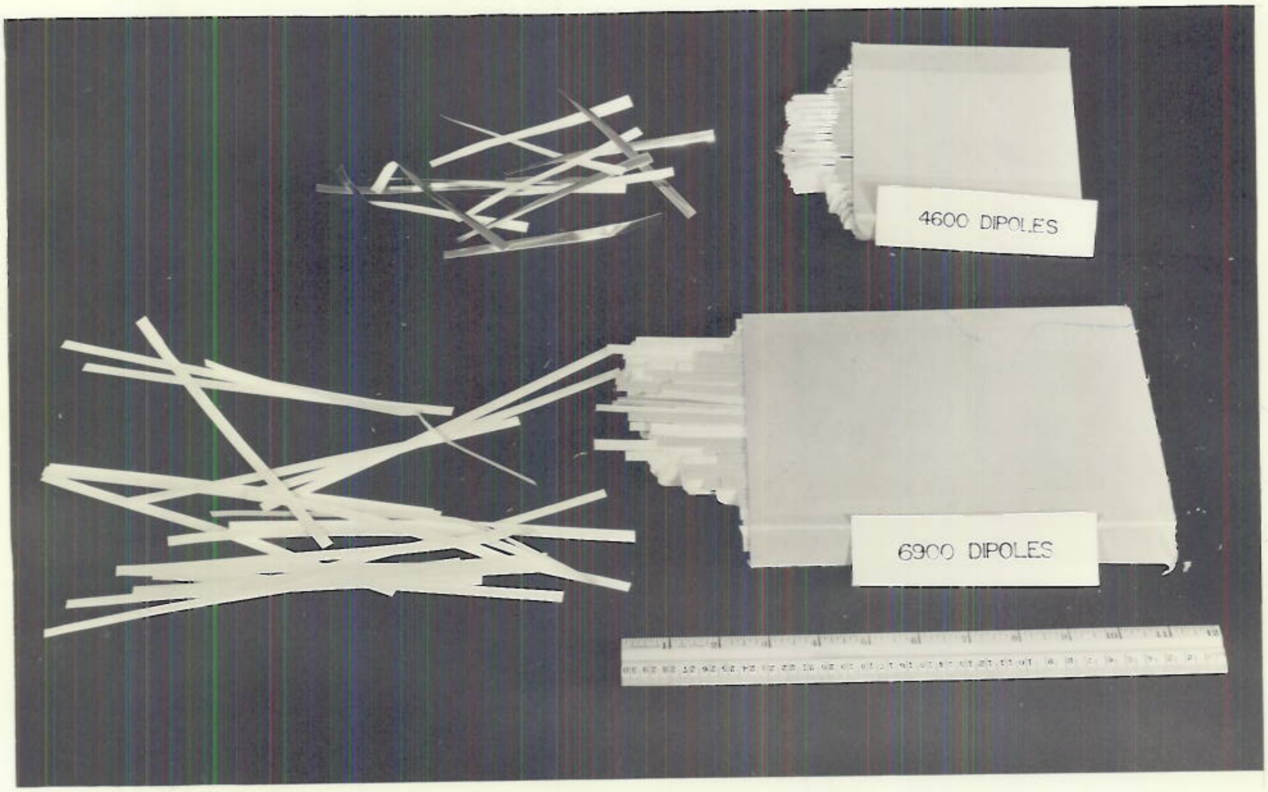
[redacted]

[redacted]

DECLASSIFIED

PLATE I

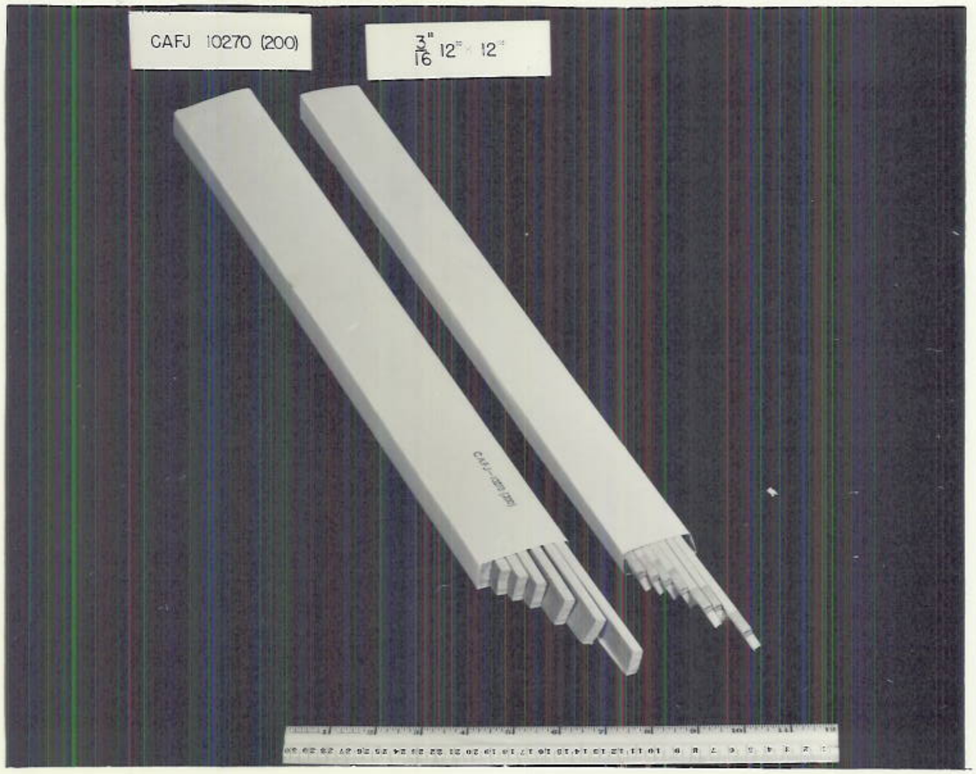
[redacted]



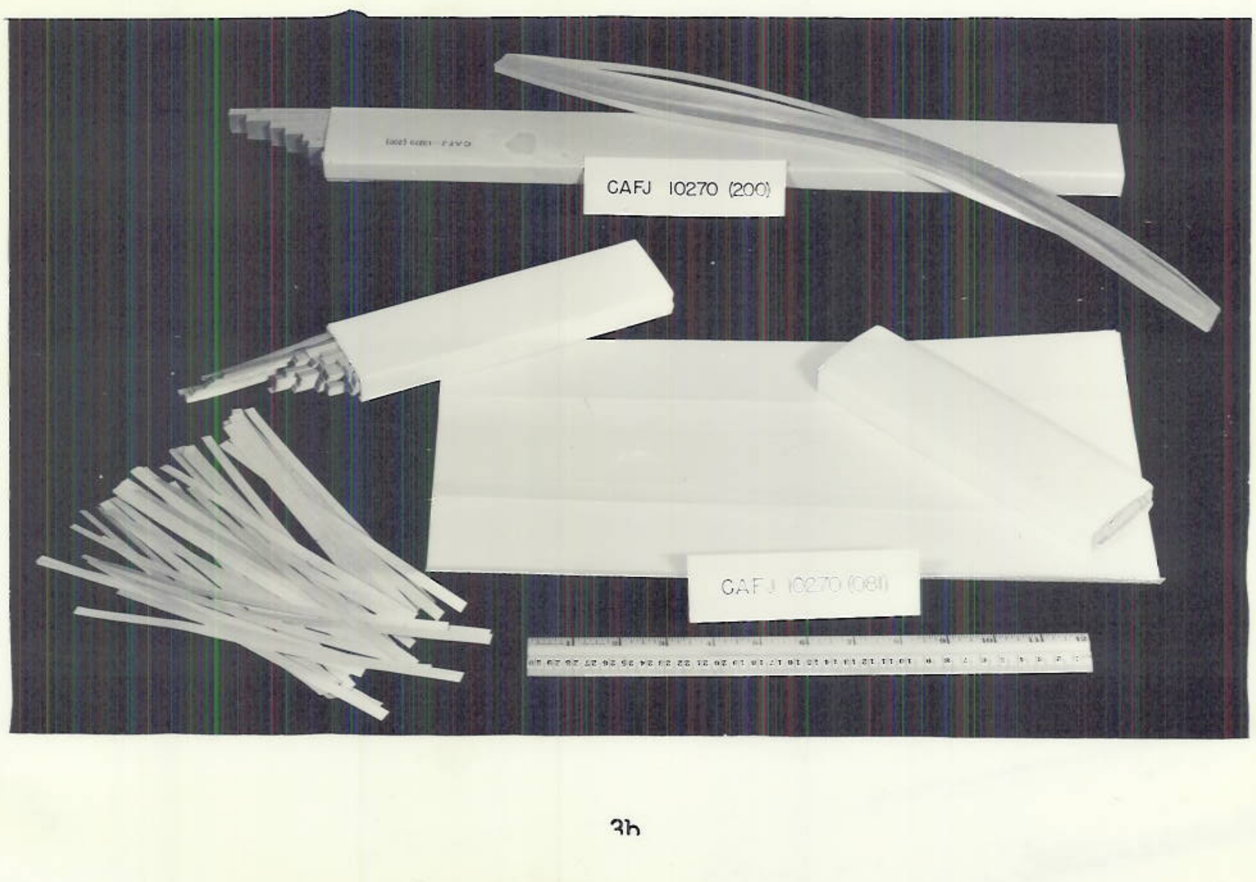
[redacted]

PLATE 2

[redacted]



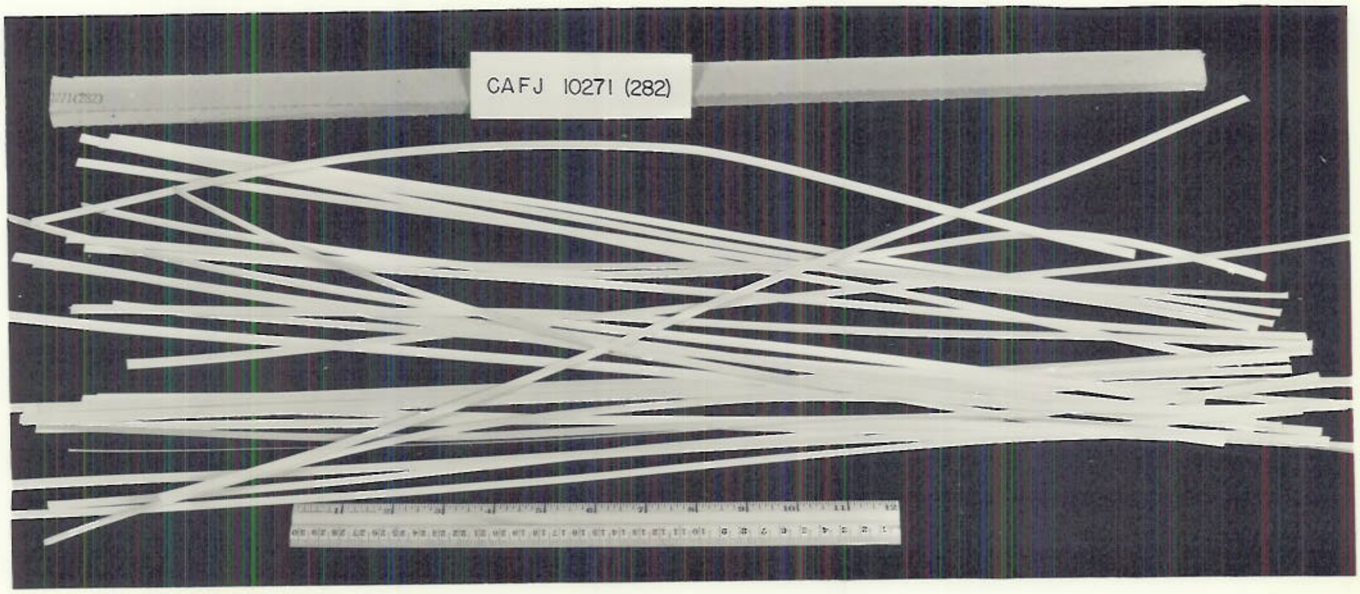
3a



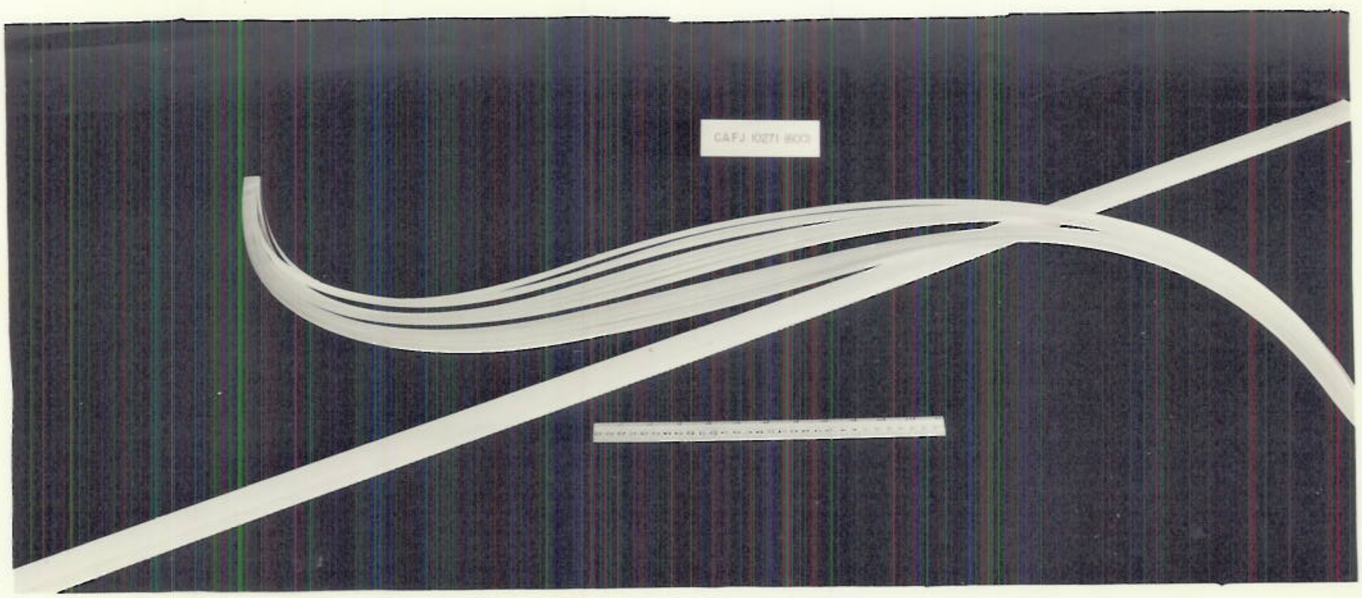
3b

PLATE 3

 [redacted]



4a



4b

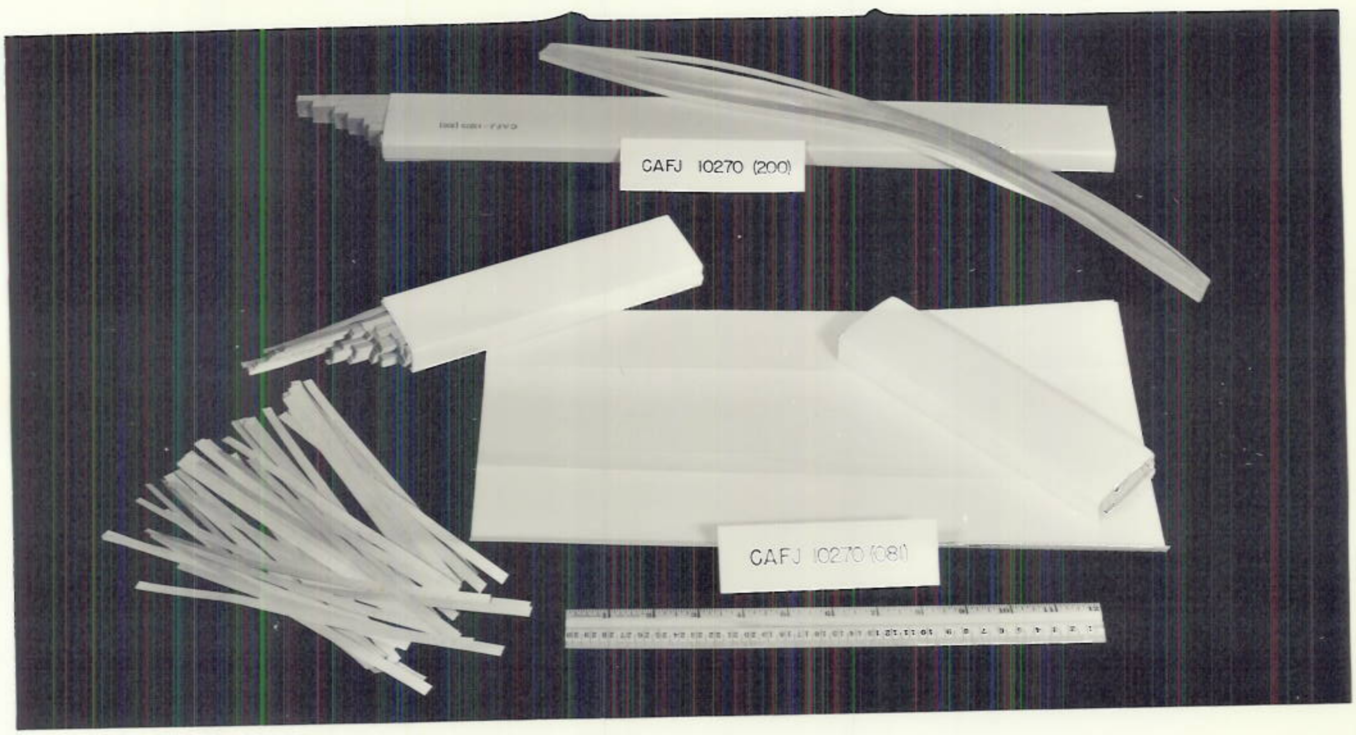
[redacted]

[redacted]

PLATE 4

 [redacted]

5a



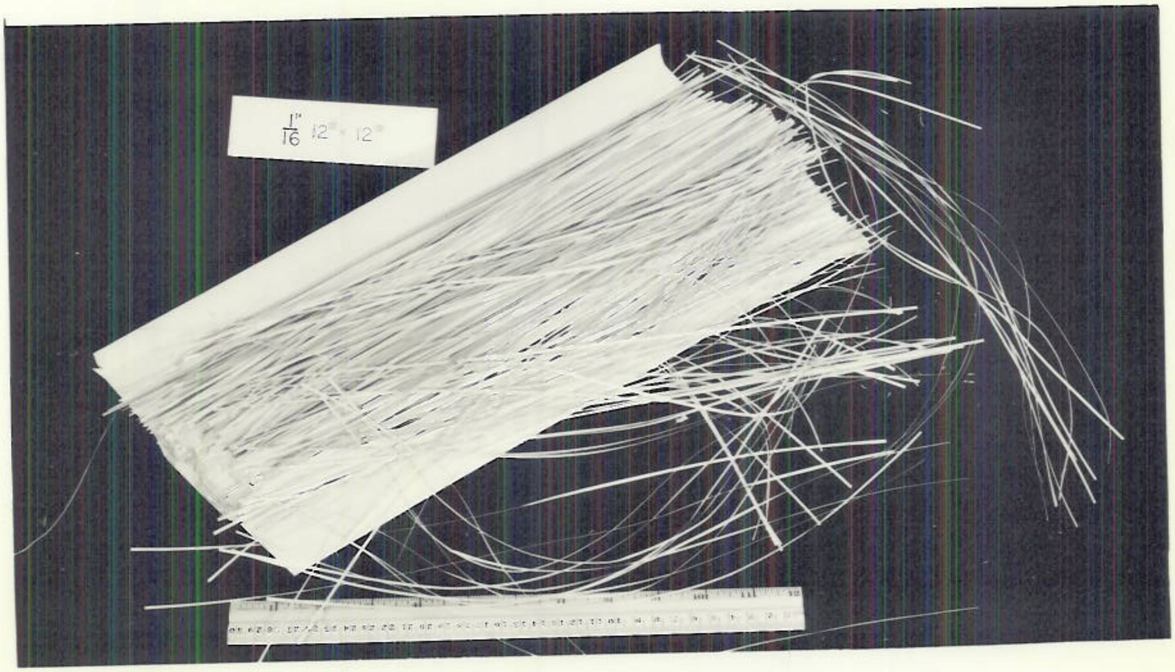
5b

[redacted]

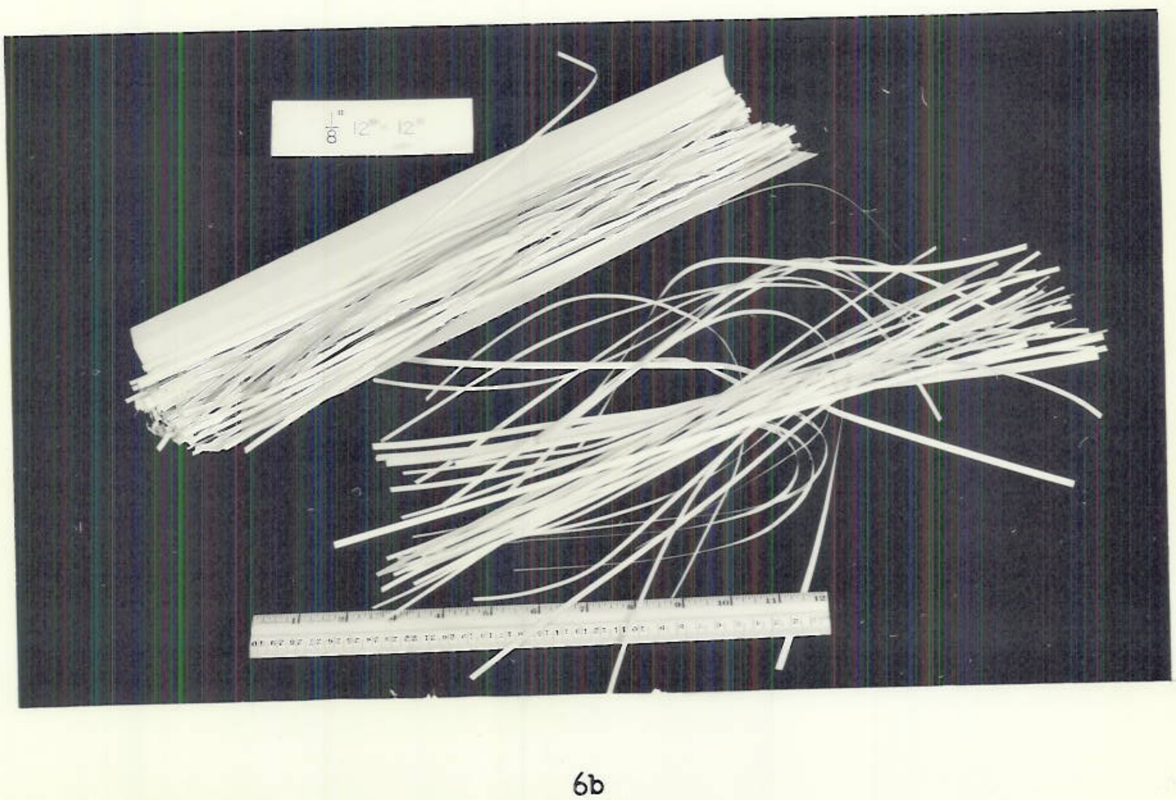
[redacted]

PLATE 5

[redacted]



6a

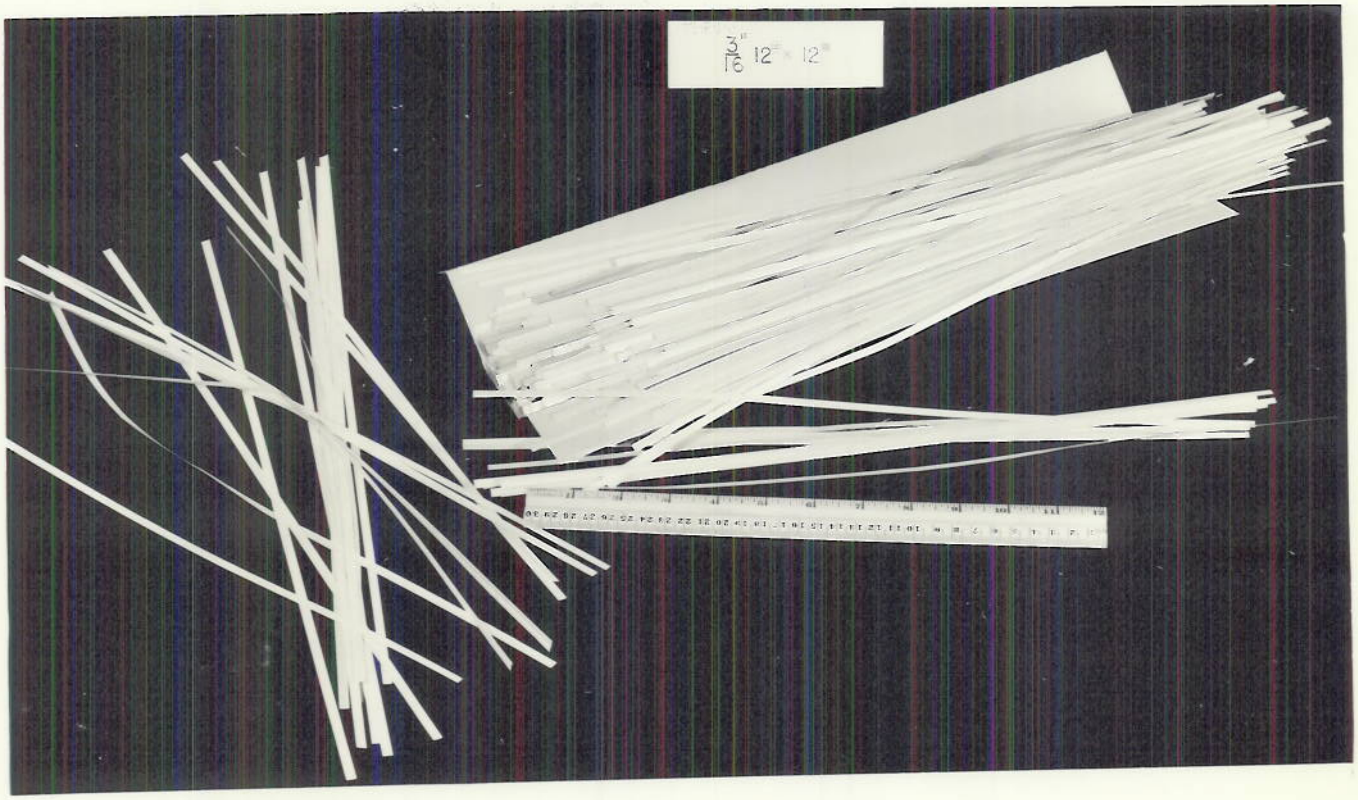


6b

[redacted] [redacted]

PLATE 6

 [redacted]

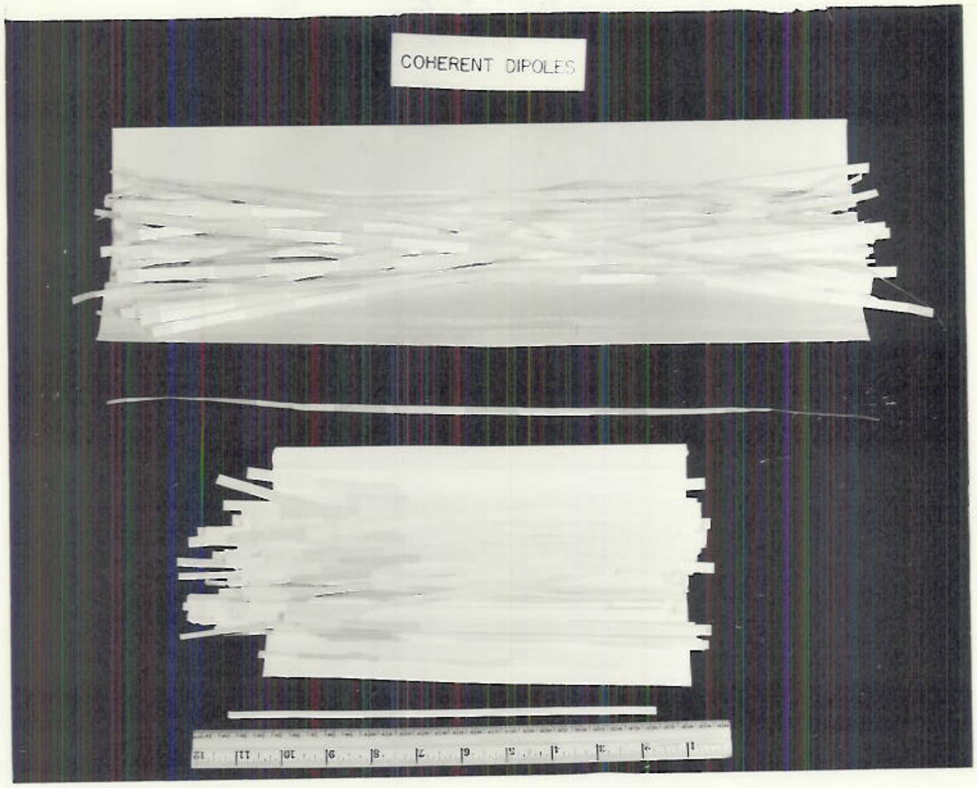


7a

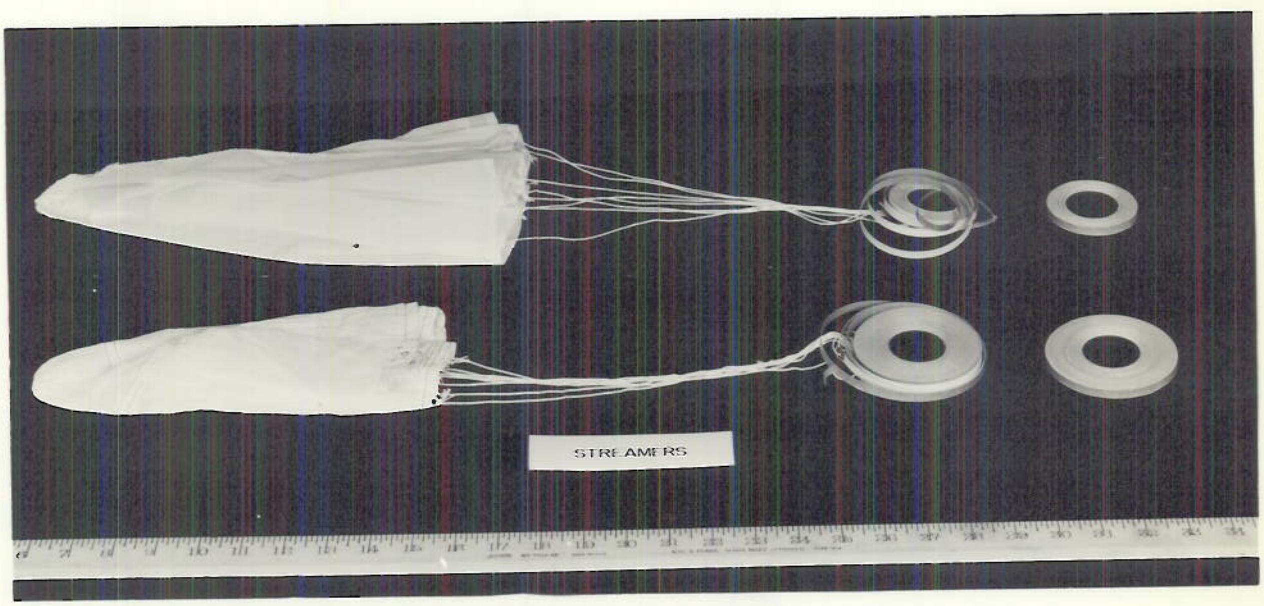
[redacted] [redacted]

PLATE 7

[redacted]



8a



8b

[redacted]

[redacted]

PLATE 8

DECLASSIFIED

[redacted]

DECLASSIFIED

[redacted]

[redacted]

PLATE 9

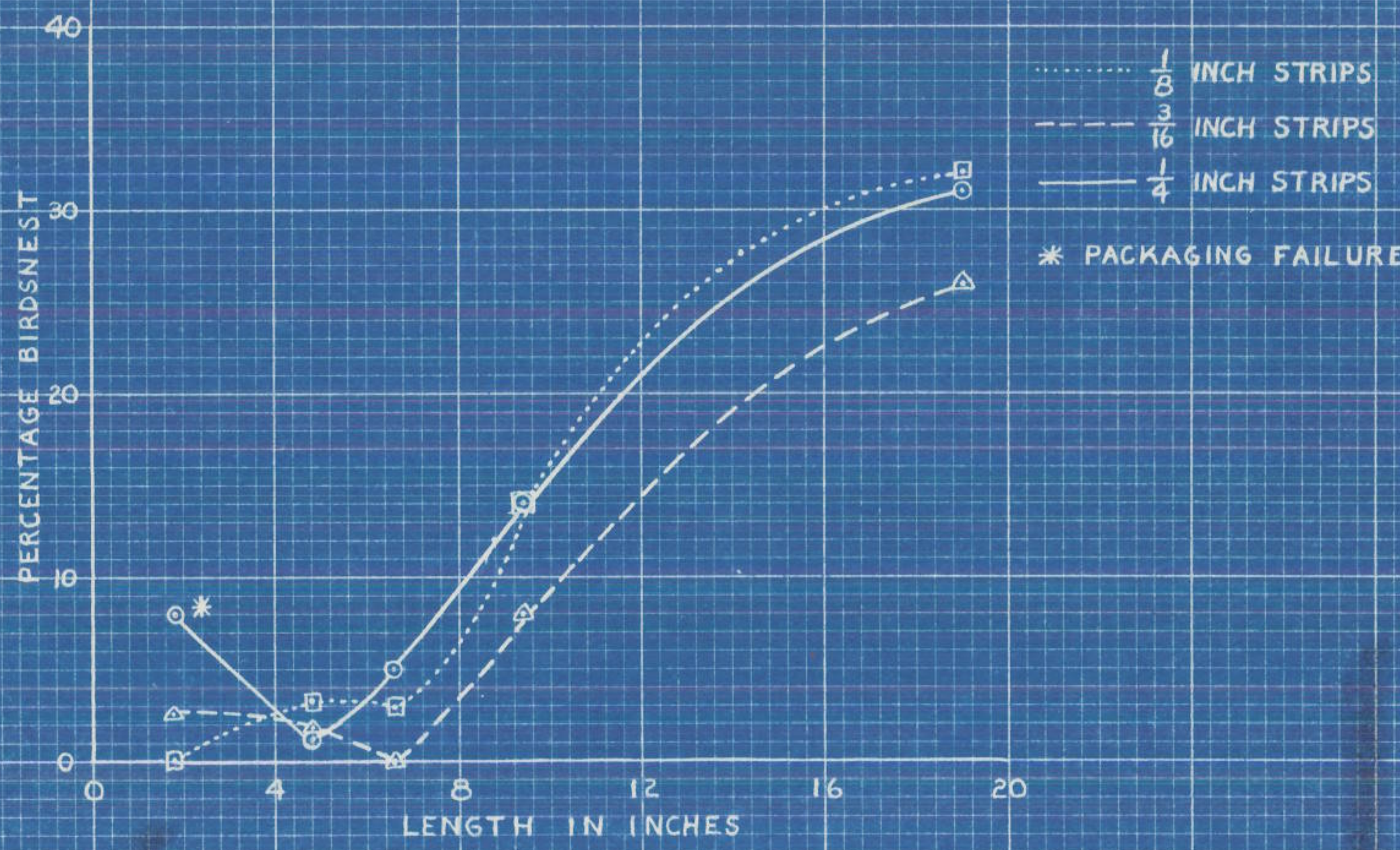
[redacted]

[redacted]

[redacted]

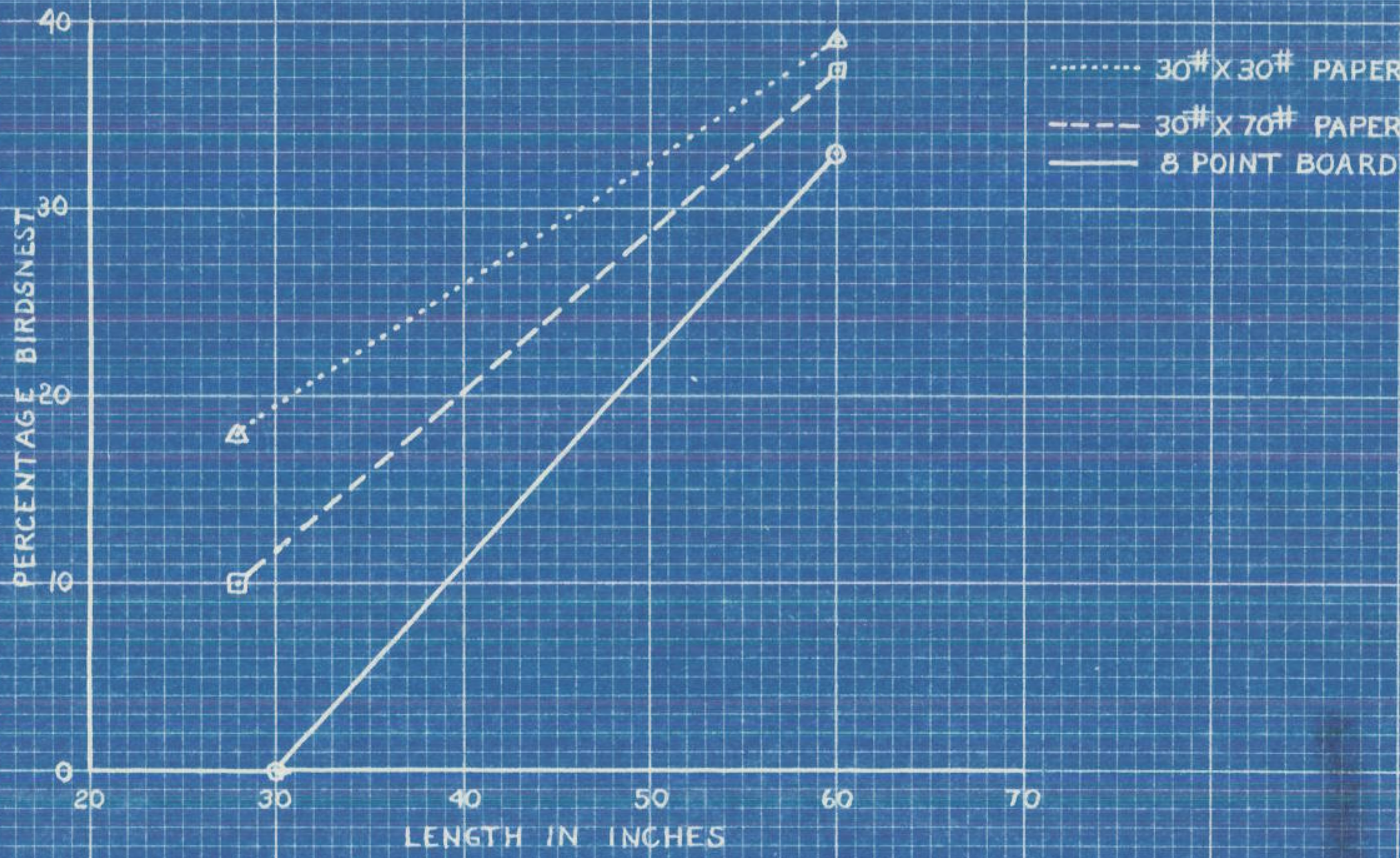
PLATE 10

PLATE II



PERCENTAGE UNDISPERSED WINDOW VERSUS LENGTH

DECLASSIFIED



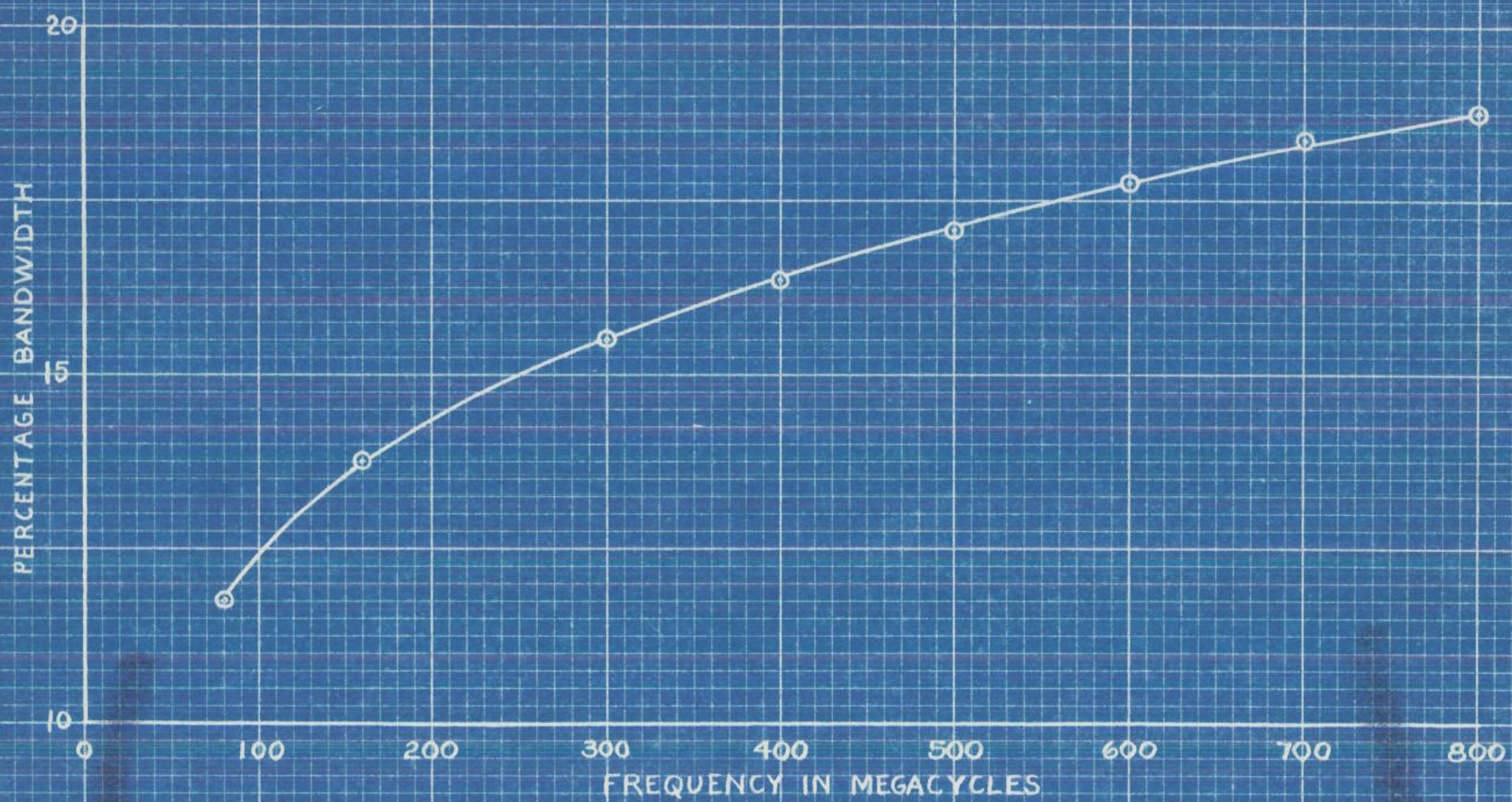
PERCENTAGE UNDISPERSED WINDOW VERSUS LENGTH

PLATE 12

[redacted]

DECLASSIFIED

PLATE 13



THEORETICAL BANDWIDTH OF 1/4 INCH DIPOLES (3 db down) VERSUS FREQUENCY

DECLASSIFIED

DECLASSIFIED [redacted]

U. S. NAVAL AIR STATION
PATUXENT RIVER, MARYLAND

F42-1/7/TBF-1
Proj. TED No. PTR 31545.0
NA83 Ser. 508 (RT)
Conf. No. 1120

MER/rn

MAR 22 1944

[redacted]

To: Chief of the Bureau of Aeronautics.

Subj: Design, Construction and Tests of Window in TBF-1 #23957 Airplane.

Ref: (a) BuAer Conf. ltr. Aer-E-3143-GHN F42-5/100, Ser. C00143, dated 3 Jan. '44.

1. In accordance with reference (a), "Windows" of two different designs were constructed and tested in a TBF-1 #23957 Airplane.

2. Fabrication, installation and flight test notes are submitted as enclosure (1).

By direction of the Commanding Officer.

G. M. GREENE
Commander, U. S. N
Radio Test Officer

Encls.(HW)
1. Conf. Installation Notes and Flight Test Notes.
2. (2) Conf. Drawings and (6) Photographs.

24644

cc:
BuAer (5)
ComAirPac (1)
Director of Test (1)

403177

DECLASSIFIED [redacted]

Encl. (A)

014215

DECLASSIFIED

[redacted] UNCLASSIFIED

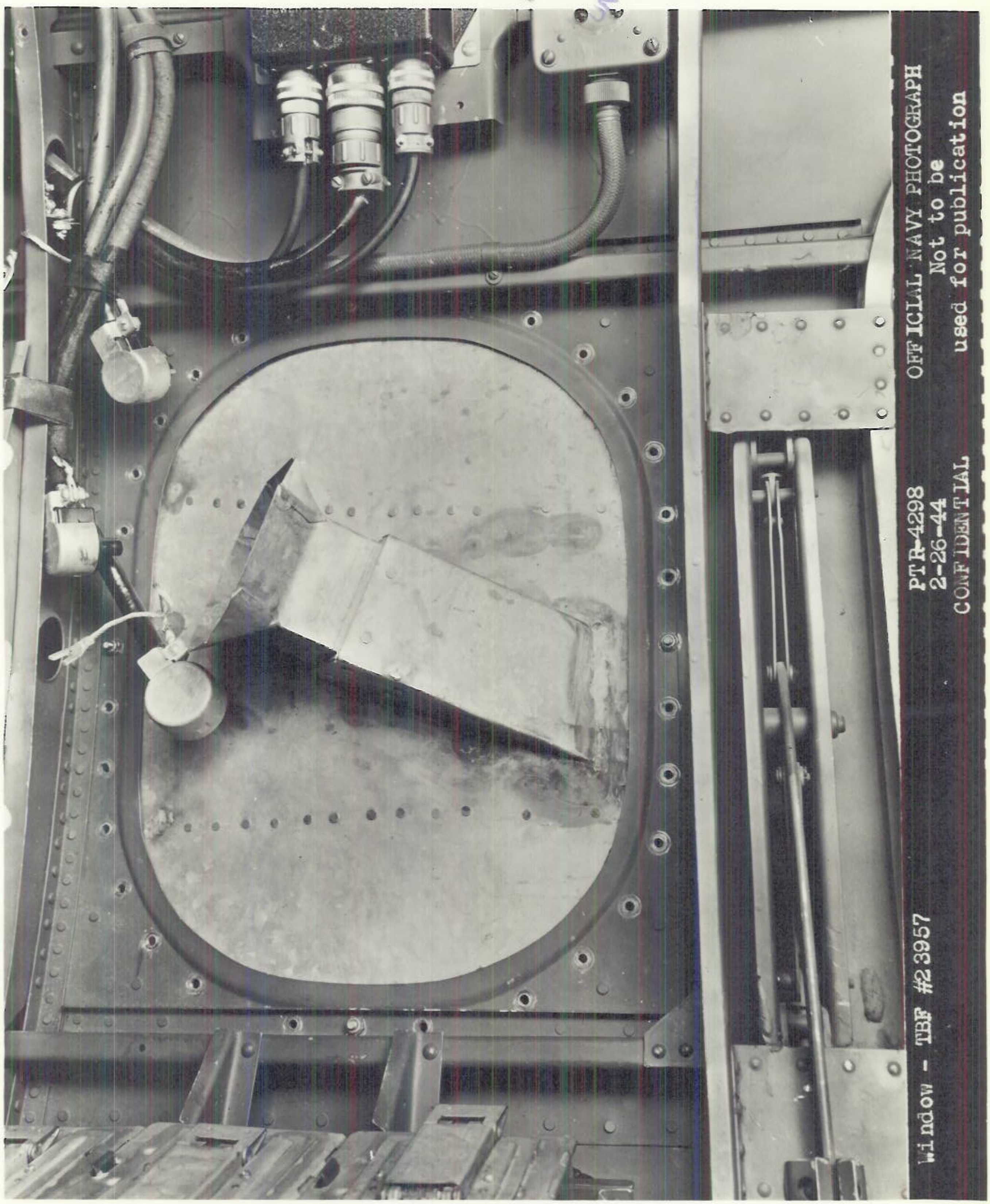
Window - TBF #2 3957

PTR-4299
2-26-44
CONFIDENTIAL

OFFICIAL NAVY PHOTOGRAPH
Not to be
used for publication

[redacted] DECLASSIFIED [redacted]

[redacted]



Window - TBF #23957

PTR-4298
2-26-44
CONFIDENTIAL

OFFICIAL NAVY PHOTOGRAPH
Not to be
used for publication

[redacted]

[redacted]

DECLASSIFIED [redacted]

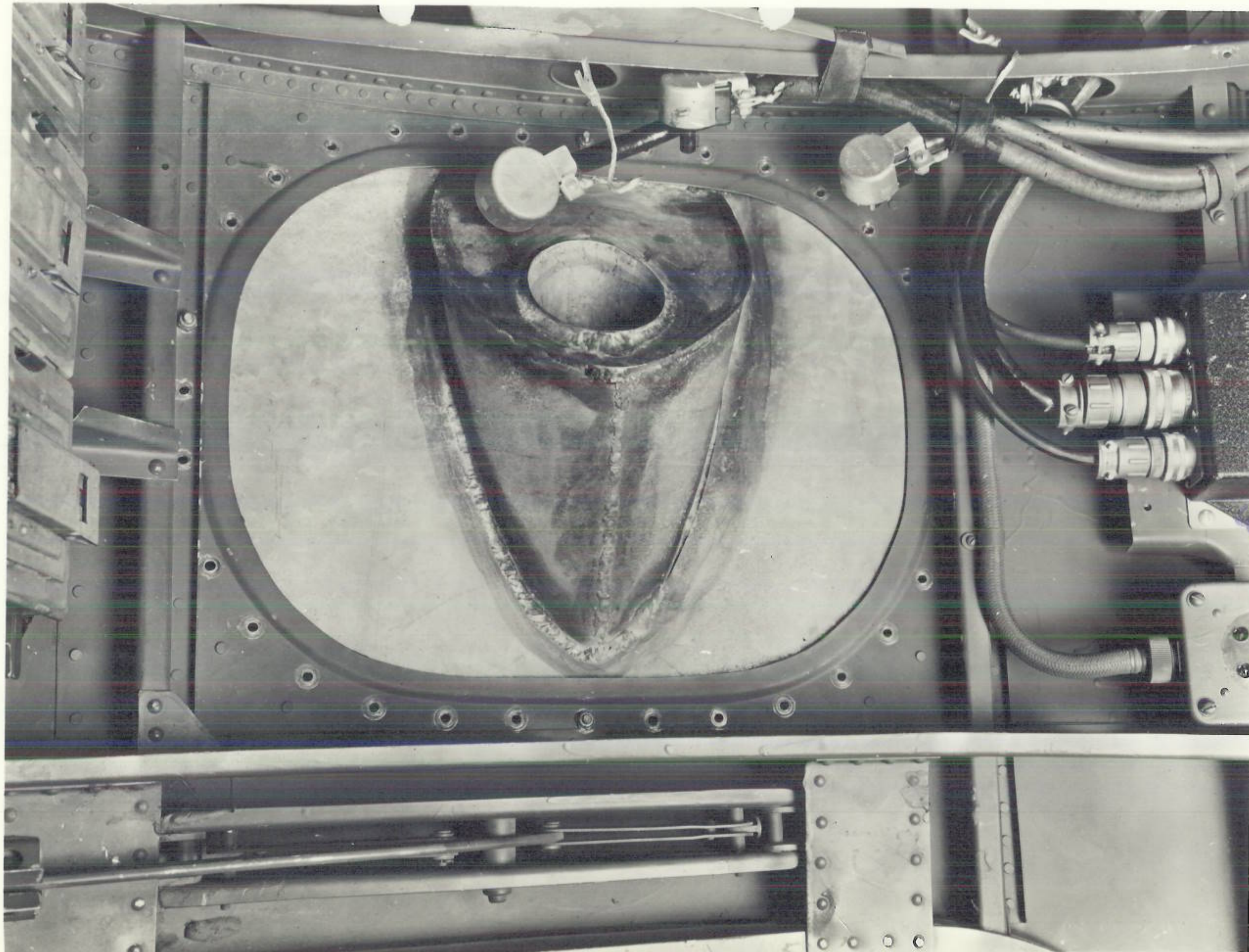
Window - TBF #2 3957

PTR-4297
2-26-44
CONFIDENTIAL

OFFICIAL NAVY PHOTOGRAPH
Not to be
used for publication

[redacted] [redacted] DECLASSIFIED

[redacted]



Window -
TBH #23957

PTR-4300
2-26-44
CONFIDENTIAL

OFFICIAL NAVY PHOTOGRAPH
Not to be
used for publication

[redacted]

[redacted]

[redacted]

Window - TBF #23957

PTR-4296
2-26-44
CONFIDENTIAL

OFFICIAL NAVY PHOTOGRAPH
Not to be
used for publication

[redacted]

[redacted]

Window - TBF # 23957

PTR-4295
2-26-44
CONFIDENTIAL

OFFICIAL NAVY PHOTOGRAPH
Not to be
used for publication

DECLASSIFIED

[redacted]

U.S. NAVAL AIR STATION
PATUXENT RIVER, MARYLAND

F42-1/7/SNB-1
Proj. TED.No. PTR-31382.0
NA83 Ser. 506 (RT)
Conf. Ser. 1119

MER/lds

MAR 22 1944

[redacted]

To: Chief of the Bureau of Aeronautics.

Subj: Design, Fabrication, Installation, and Flight Test of "Window" Chute for SNB-1 Airplane, #39819.

Ref: (a) BuAer conf. ltr Aer-E-3143-GHN F42-5/100, Ser. C04203, dated 17 Feb. 1944.

1. In accordance with reference (a), mock-up installation of the specified equipment was made and flight tests conducted.

2. Installation notes and flight test notes are submitted as Enclosure (1). Photographs and drawing are submitted as Enclosure (2).

By direction of the Commanding Officer,

G. M. Greene
G. M. GREENE
Commander, U.S.N.
Radio Test Officer

Encls.(HW)
1. Conf. Installation Notes and conf. Flight Test Notes.
2. (1) conf. Drawing and (2) conf. Photographs.

403177

cc:
BuAer (6)
ComAirPac (1)
Director of Test (1)

[redacted]

DECLASSIFIED Encl. (B) 014275

[redacted]

DECLASSIFIED

A. DESIGN, FABRICATION AND INSTALLATION OF "WINDOW" CHUTE IN SNB-1 AIRPLANE #39819.

1. Radio Test Photographs PTR-4457 and PTR-4456 show the chute designed in a mounting which replaces the standard camera mount in the SNB type of airplane. Radio Test Drawing B-195 contains the construction details and specifications for this chute. Installation is made by removing the section of the deck which contains the camera port, replacing it with the "window" chute which is secured to the deck by the use of four DZUS A5-40 fasteners.

B. FLIGHT TESTS AND CONCLUSIONS.

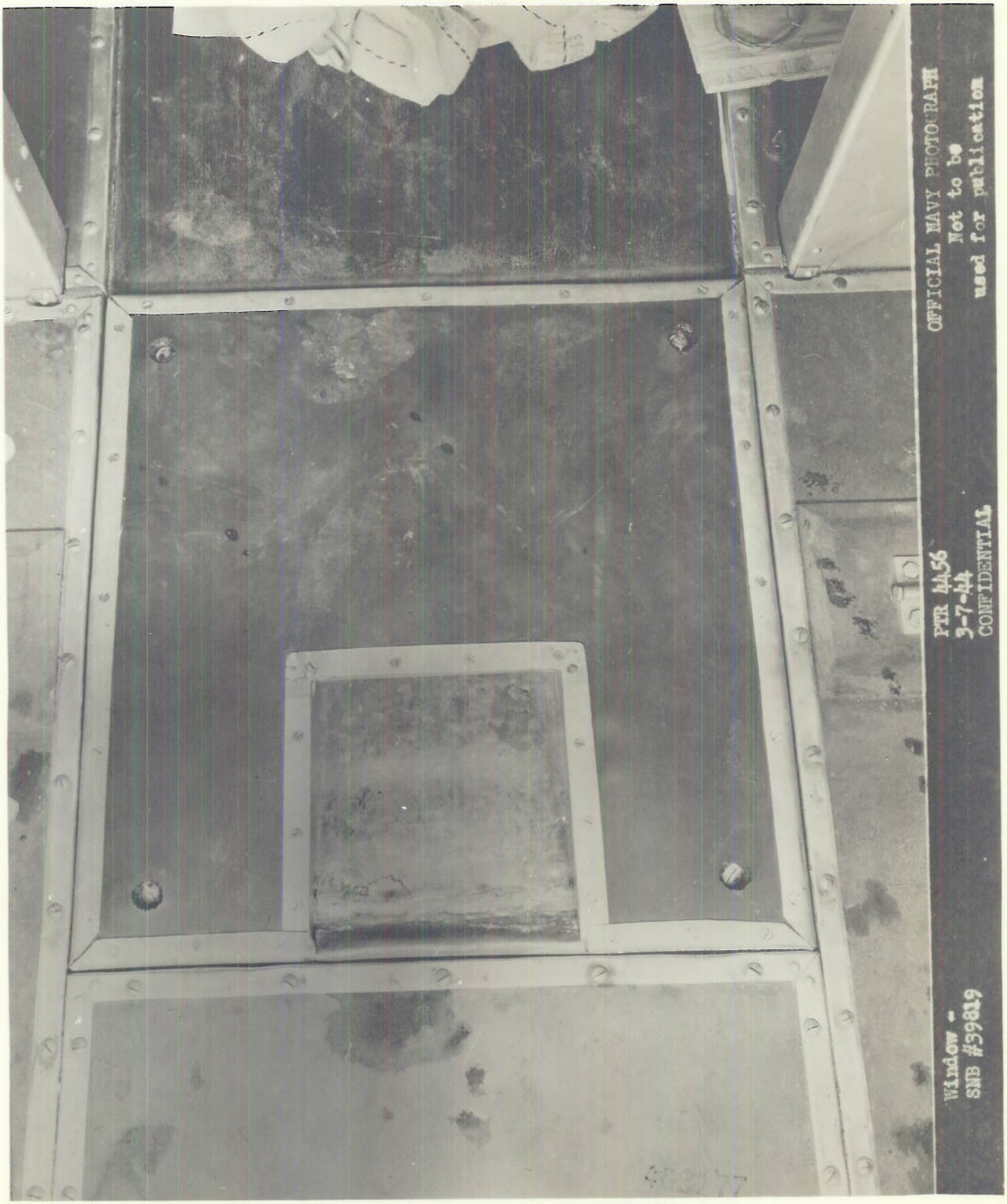
1. Several flights were made with this chute mounted in SNB-1 airplane #39819, and the material was dispensed satisfactorily. This chute is of simple construction and could be fabricated and installed at any Naval Air Station.

Enclosure (1)

4[illegible]3177

DECLASSIFIED

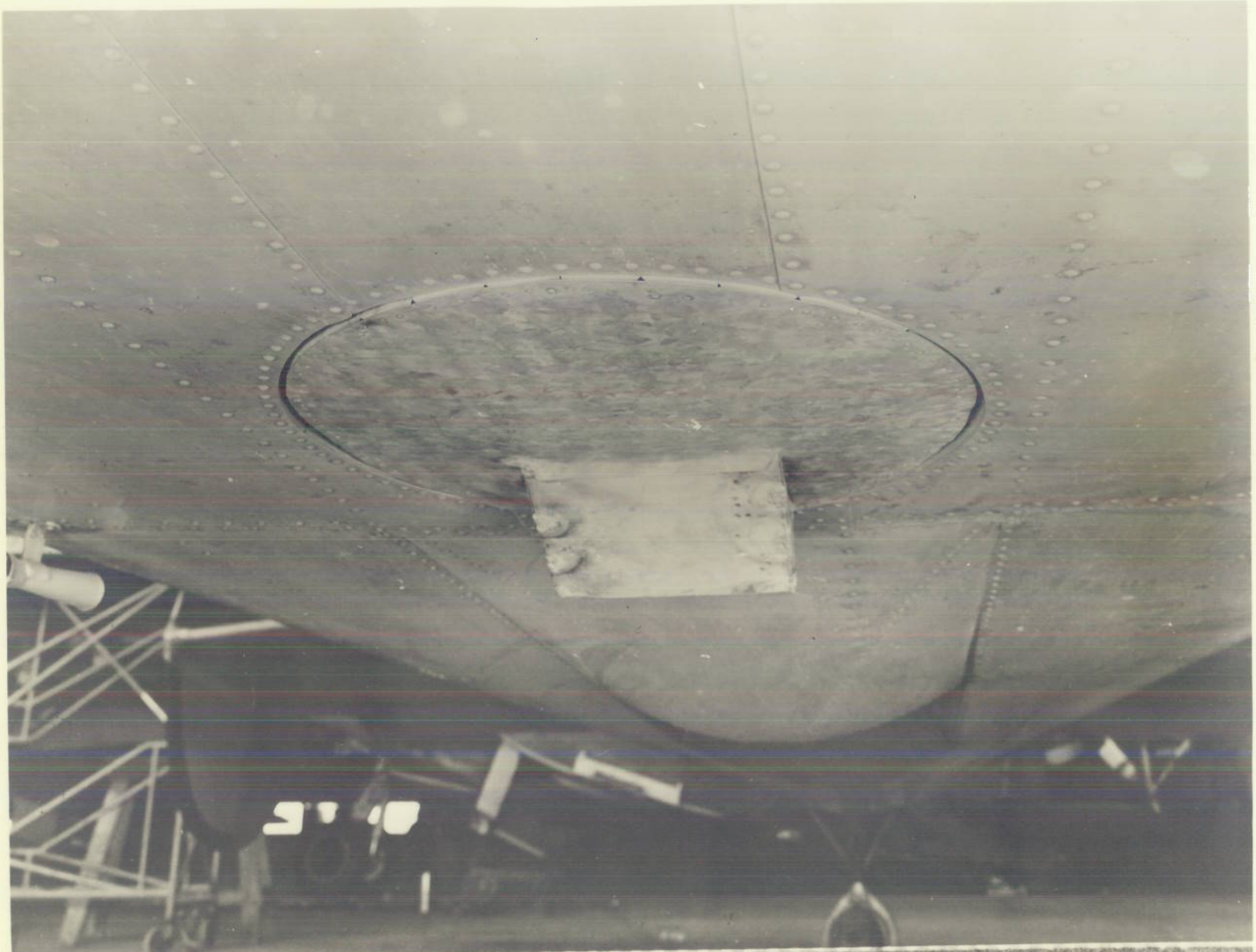
[redacted]



[redacted]

[redacted]

[redacted]



Window -
SHB #39819

PTR 4457
3-7-44
CONFIDENTIAL

OFFICIAL NAVY PHOTOGRAPH
Not to be
used for publication

[redacted]

[redacted]