PROJECT STORMFURY

OPERATION PLAN NO. 1-69

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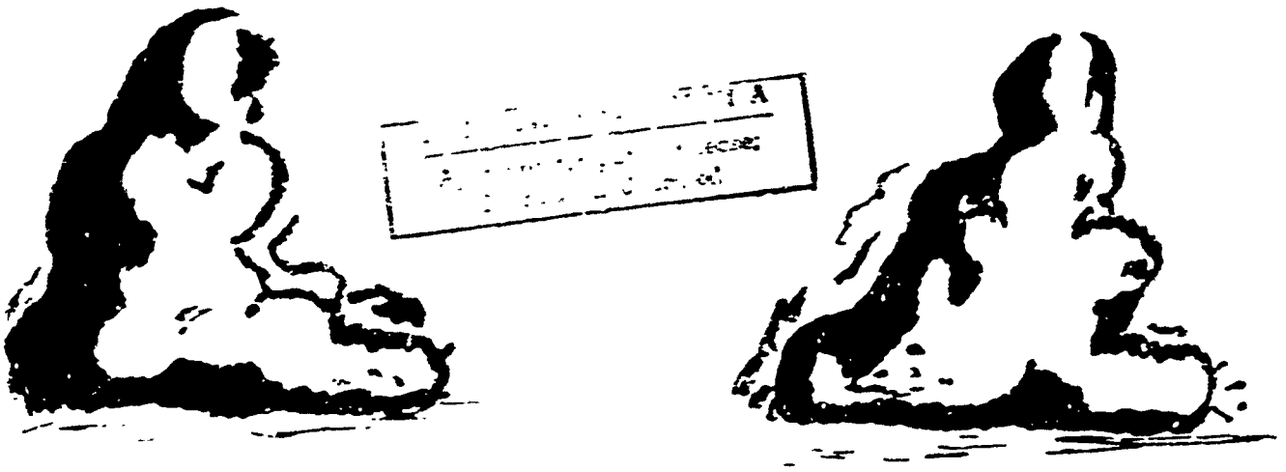

U. S. FLEET WEATHER FACILITY • NAVAL AIR STATION • JACKSONVILLE, FLA., 32212

JUNE 1969

NATIONAL TECHNICAL
INFORMATION SERVICE

PROJECT STORMFURY
U. S. FLEET WEATHER FACILITY
U. S. NAVAL AIR STATION
JACKSONVILLE, FLORIDA 32212
JUNE 1969

OPERATION PLAN
FWF JAX NO. 1-69

REFERENCE: (a) Navy Coordinator, Project STORMFURY ltr with enclosures

TIME ZONE: ZULU Time Zone will be used for all operations.

TASK ORGANIZATION:

a.	Project Director	Dr. R. C. Gentry, NHRL
b.	Assistant Project Director	Commanding Officer, Fleet Weather Facility, Jacksonville, Florida
c.	Navy Project Coordinator	Commanding Officer, Fleet Weather Facility, Jacksonville, Florida
d.	Alternate Project Director	Assistant Director, NHRL
e.	Alternate-Assistant Project Director/Navy Project Coordinator	Executive Officer, Fleet Weather Facility, Jacksonville, Florida
f.	WEARECONRON FOUR (VW-4)	Commanding Officer, Weather Reconnaissance Squadron FOUR
g.	Naval Weapons Center (NWC)	Dr. S. D. Elliott, Project Officer
h.	Navy Weather Research Facility	Mr. C. J. Todd, Scientific Advisor
i.	ATKRON ONE SEVENTY-SIX (VA-176)	Commanding Officer, Attack Squadron ONE SEVENTY-SIX
j.	NAVSTA Roosevelt Roads	Officer in Charge, Naval Weather Service Environmental Detachment Roosevelt Roads
k.	ESSA/Research Flight Facility	Chief, ESSA/RFF
l.	53RD WRS	Commander, 53RD Weather Reconnaissance Squadron

m.	CARCAH (Chief, Aerial Reconnaissance Coordination, Atlantic Hurricanes)	Mr. R.E. Hairston
n.	CHINFO (Chief of Information)	Mr. A.E. Eastman
o.	ESSA Public Affairs Officer	Mr. H. Lieb

FORCES:

a.	WEARECONRON FOUR	4 WC-121N Aircraft
b.	ESSA/RFF	2 DC-6 Aircraft 1 C-54 Aircraft 1 WB-57 Aircraft
c.	53rd WRS	1 WB-47 Aircraft 1 WC-130 Aircraft
d.	ESSA/Weather Bureau	Personnel as assigned
e.	Navy	Personnel as assigned
f.	Air Force	Personnel as assigned
g.	ATKRON ONE SEVENTY-SIX	4 A-6 Aircraft

1. SITUATION: An interdepartmental agreement, executed in 1962, between the U. S. Weather Bureau (ESSA) and the U. S. Navy, provided for joint sponsorship of an experimental program of weather modification in hurricanes. This original 3-year agreement has been renewed and updated annually since 1965. The Chief of Naval Operations provides direction and authority for the deployment of Naval personnel and equipment involved and also requires that airborne operational control be exercised by the Navy.

A cloudline experiment will be scheduled in September during a ten-day deployment to Naval Station, Roosevelt Roads. Naval Weapons Center, China Lake will provide seeder aircraft; other aircraft required in accordance with Annex G.

OPERATION PLAN
FWF JAX NO. 1-69

Chief of Naval Operations has directed the Commander, Naval Weather Service Command to appoint the Commanding Officer, Fleet Weather Facility, Jacksonville as Navy Project Coordinator.

2. MISSION:

a. Conduct experimental seeding of a hurricane eyewall over an eight-hour period. This seeding will consist of five separate drops of pyrotechnic canisters with continous monitoring for a total of 18 hours.

b. Conduct experimental seeding of a tropical cyclone rainband.

c. Conduct a "dry run" exercise for (a) and (b) above during the period 28-31 July.

d. Conduct "Fallback Research Missions" if unable to complete the primary mission, i.e., forces deployed, but tropical cyclone evades seeding area, etc..

3. EXECUTION:

a. Conduct dry run exercise in accordance with Annex D.

b. Conduct experimental seeding of one or more hurricane eyewalls in accordance with Annex E.

c. Conduct experimental seeding of one or more tropical cyclone/hurricane rainbands in accordance with Annex F.

d. Conduct cloudline or fallback research missions in accordance with Annex G.

4. ADMINISTRATION AND LOGISTICS: Administration and logistics requirements are listed in Annex B.

5. COMMAND AND SIGNAL:

a. Communications Procedures will be followed in accordance with Annex C.

b. Supervisory control of participating aircraft for the "at sea" portion of the project will be exercised by the Commanding Officer, Weather Reconnaissance Squadron FOUR (VW-4).

LELAND J. UNDERWOOD
Commander, U. S. Navy
Navy Project Coordinator/
Assistant Project Director
for Project STORMFURY

ANNEXES

A - Concept of Operations

B - Administration and Logistics

C - Communications

D - Dry Run Exercise

E - Hurricane Eyewall Seeding Experiment

F - Hurricane/Tropical Cyclone Rainband Seeding Experiment

G - Cloudline and Fallback Research Missions

R - Radar Equipments, Operations and Photography

T - Airspace Reservation Agreement

U - Flight Reporting Forms

W - Public Affairs

X - Distribution

ANNEXES

A - Concept of Operations

B - Administration and Logistics

C - Communications

D - Dry Run Exercise

E - Hurricane Eyewall Seeding Experiment

F - Hurricane/Tropical Cyclone Rainband Seeding Experiment

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ANNEX A

CONCEPT OF OPERATIONS

1. General. Two basic experiments have been proposed for Project STORMFURY Operations 1969. In addition, fallback missions have been included in the event the basic experiments cannot be conducted. Several technical and operational planning conferences by Navy and ESSA representatives have resulted in operational plans for conducting these experiments. An advisory panel composed of five prominent scientists has reviewed the proposed experiments and has made recommendations to ensure the scientific validity of the proposed experiments.

a. Eyewall Experiment. Seeding and monitoring of the changes in the structure and circulation of a well-developed hurricane will be attempted, if nature provides the proper storm at the right time and place. The area for conducting seeding operations has been prescribed by joint DOD (Navy)/DOC (ESSA) agreements. Hurricane seeding will be done at two-hour intervals over an eight-hour period. This experiment is essentially a continuation, on a larger scale, of seeding operations conducted on Hurricane BEULAH in 1963.

b. Rainband Experiment. The four primary objectives of this experiment are: (1) Conduct a detailed, dynamic and thermodynamic investigation of the rainband; (2) Carry out seeding experiments to determine if the basic character of the rainband can be changed by

seeding; (3) study the role the rainband plays in the total storm structure; and (4) investigate how its modification might affect the total behavior of the storm.

c. Fallback Mission. As described in Annex G.

2. Operating Areas. As depicted in Appendix I to this Annex.

3. Aircraft. Take-off times are scheduled so as to arrive on station in accordance with the Tango times assigned for each flight as prescribed in the annex for each experiment.

4. Command Relation. The Aircraft Commander of the Command Control Aircraft shall assume the duties of On-Scene Commander. In this capacity, he shall assume SAR responsibility for all aircraft under his control.

5. Sequence of Events.

a. Prior to 1 August 1969 - All pyrotechnic canisters available delivered to staging bases, as directed by the Navy Coordinator.

b. 1 August to 15 October 1969 - All participating units will be on a 48-hour standby to conduct eyewall and rainband experiments.

c. 9 September to 19 September 1969 - A cloudline experiment will be conducted during a ten-day deployment to Naval Station, Roosevelt Roads. Naval Weapons Center, China Lake will provide seeder aircraft; other aircraft in accordance with Annex G.

6. Air Operations.

a. Aircraft will file VFR/IFR flight plans at the staging base to the designated on-station points, then proceed "STORMFURY Operations" under positive control of the Command Control Aircraft. Aircraft will remain within the airspace reserved by ATC NOTAM. Upon completion of operations, aircraft will activate flight plans and proceed from the boundary of "STORMFURY Operations" to the staging base. The Command Control Aircraft will notify the appropriate ARTCC when all aircraft have departed the "STORMFURY Operations" area so that airspace reservations may be officially terminated. Identification as a "STORMFURY Aircraft" shall be included in the remarks portion of the individual flight plan.

b. Due regard will be given to crew fatigue and safety of flight so that time on station will not represent flight to exhaustion of aircraft or crew capabilities, particularly in regards to all jet aircraft.

c. Only pyrotechnic canisters approved by Naval Air Systems Command will be carried and used by Navy aircraft.

d. "Seeder" pilots will be alert not to exceed the "G" limits of their aircraft and will seed VFR when feasible. Otherwise, they will penetrate the "soft" areas, as indicated by radar. The decision to abort the mission is an inherent responsibility of the Plane Commander for each aircraft.

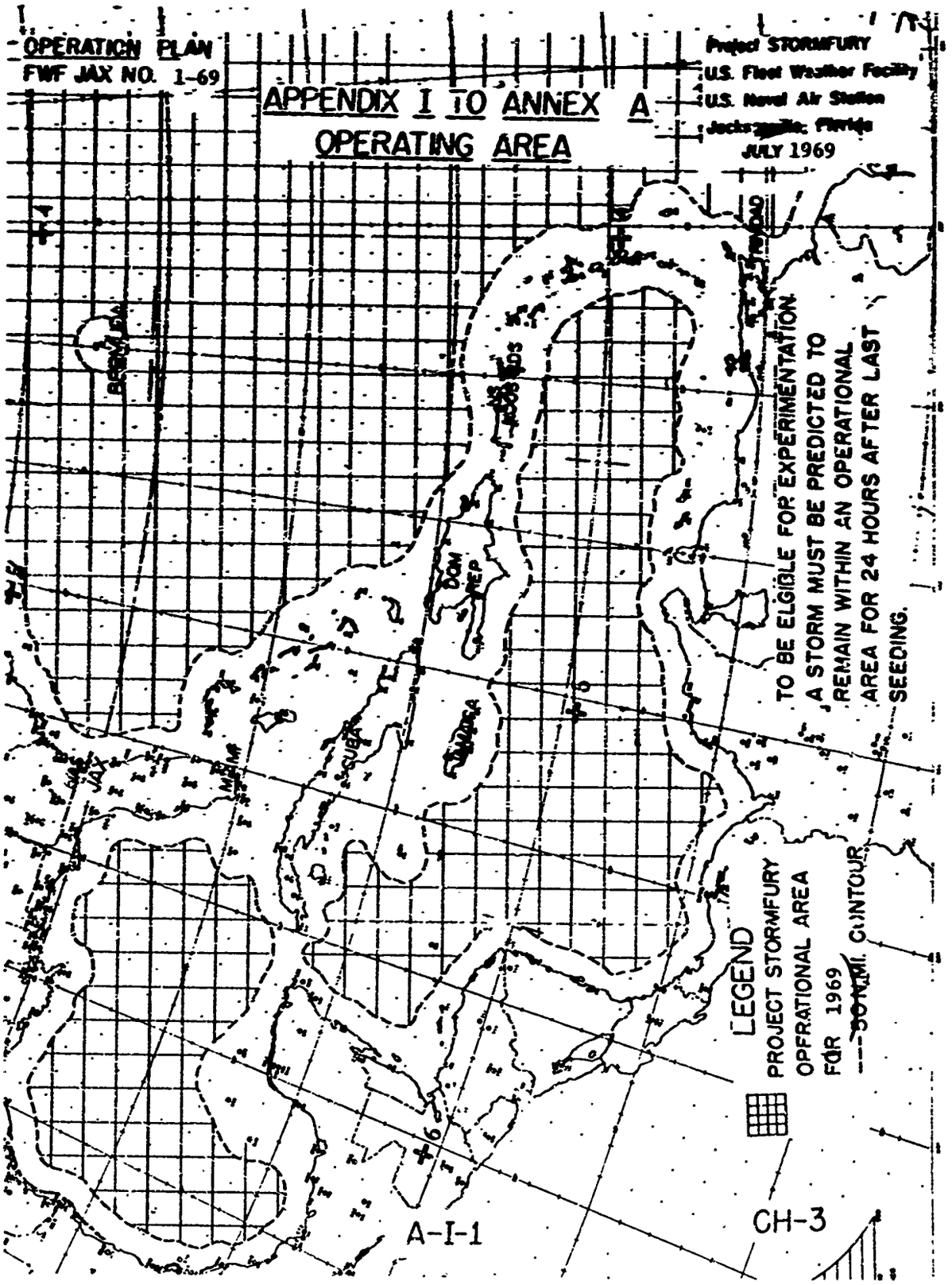
e. Seeding of the hurricane eyewall must be carried out at no lower elevation than 35,000 feet. Back-up seeding aircraft will not follow the first aircraft, but orbit until called for.

7. Times. All times noted in this Operation Plan are Greenwich Mean Time, Time Zone ZULU All reports, records, clocks, voice communications and other references to time will be likewise expressed in ZULU time.

LELAND J. UNDERWOOD
Commander, U. S. Navy
Navy Project Coordinator/
Assistant Project Director
for Project STORMFURY

Appendix

I - Operating Area


OPERATION PLAN
FWF JAX NO. 1-69
APPENDIX I TO ANNEX A
OPERATING AREA
Project STORMFURY
U.S. Fleet Weather Facility
U.S. Naval Air Station
Jacksonville, Florida
JULY 1969
BERMUDA
JAX
MIAMI
CUBA
BOM
NEP
TO BE ELGIBLE FOR EXPERIMENTATION
A STORM MUST BE PREDICTED TO
REMAIN WITHIN AN OPERATIONAL
AREA FOR 24 HOURS AFTER LAST
SEEDING.
LEGEND
PROJECT STORMFURY
OPERATIONAL AREA
FOR 1969
50 NM. CONTOUR
A-I-1
CH-3

ANNEX B

ADMINISTRATION AND LOGISTICS

I. ADMINISTRATION

A. General. The importance of sensing, recording, collecting, processing and analyzing the many types and kinds of research grade data pertinent to the STORMFURY experiments cannot be overemphasized. To achieve these ends, it is incumbent upon each unit/activity participating in these experiments to ensure that all instruments/equipment utilized are in peak operating condition, and that all data collected are recorded as neatly and completely as possible. To ensure that all data, including time lapse and radarscope photography film, are systematically collected, inventoried and distributed, two functional assignments have been established - the duties and responsibilities of these offices are as follows:

1 Data Quality Control Coordinator (DQCC). This position of responsibility will be filled by a person appointed by the Project Director. The duties of this representative will include, but not necessarily be limited to, the following:

a. Chair the Committee of Data Quality Coordinators, composed of one representative each from VW-4, Seeder Squadron, RFF, NWC, 53rd WRS and NHRL.

b. Coordinate the design and content of all records and/or forms used.

c. Provide sufficient copies of all STORMFURY recording forms to units/activities participating in the experiment prior to the Dry Run exercises.

d. Be on the scene at the staging base during all STORMFURY operations.

e. Receive, inventory and catalog all data collected, including film and personal notes, at the termination of each day's operations.

f. Report daily to the Project Director any discrepancies noted concerning data missing from an experiment.

g. Hand deliver all dropsonde data to the VW-4 Data Quality Coordinator for evaluation and duplication of coded messages.

h. Hand deliver to the NWRF Data Quality Coordinator a duplicate copy of data, except film and dropsondes.

i. Hand deliver to the designated Photo Lab all radar and time lapse film data for printing of one positive and three negative copies of all film.

j. As soon as possible after the completion of the processing of the film, an evaluation report will be forwarded to the generating agency. This report should comment on the quality of the photography, areas requiring improvement, and other pertinent remarks.

k. Make distribution of the processed film as follows: (1) Master positive to NWRC Asheville; (2) original and one duplicate negative to NHRL Miami; (3) one duplicate negative to NWRF Norfolk; and (4) one duplicate negative to the generating agency.

2. Assistant Data Quality Control Coordinator. This position will be filled by an appointee of the Project Director. The Assistant Data Quality Control Coordinator will assist the DQCC Officer, as requested.

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B. Pre-Deployment Alert. At the earliest possible time, usually 48-72 hours, in advance of a STORMFURY exercise, the Assistant Project Director/Navy Project Coordinator will originate a naval message alerting and directing deployment of forces to the staging base. Telephone calls may precede message traffic.

C. Annual Report. An annual report will be prepared covering the experiments conducted during the year. The Project Director will be responsible for the organization and scientific content of the report, drawing upon the scientific staffs of the ESSA and the Navy for assistance.

D. NOTAM Responsibility. For the Eyewall, Rainband, and Cloudline experiments, NOTAMS will be sent 48 hours, or earlier if possible, in advance of each operation. The Navy Project Coordinator will carry out this responsibility, as outlined in the Letter of Agreement with the Federal Aviation Agency.

E. STORMFURY Data Storage. The National Hurricane Research Laboratory, Coral Gables, Florida will eventually be the repository of all STORMFURY data. Copies of these data will be made available upon request by interested parties. Necessary funding for reprinting will be provided by requestors.

II. LOGISTICS

A. NAVSTA Roosevelt Roads. The following services and equipment are required:

1. General.

a. Reproduction Machine. Recommend Bruning or Ozalid capable of reproducing to a width of 30 inches.

b. Office Copier. Recommend dry copier such as Xerox.

c. Briefing space for approximately 40 people to be used for general briefing approximately 24 hours before each operation.

d. Limited briefing area to be used just prior to each flight. Recommend some area close to flight line, preferably in the Operations Building.

e. Telephone in BOQ rooms for Project Director, Navy Project Coordinator, Alternate Assistant Project Director, Data Quality Control Coordinator, Commanding Officer of WEARECONRON FOUR, Chief of Research Flight Facility and the Navy Scientific Advisor.

f. Three office spaces with three desks in each; a total of two telephones required. Project Director and Navy Project Coordinator will assign.

g. Debriefing area required.

2. Specific.

a. WEARECONRON FOUR (VW-4)

(1) BOQ billeting for 30 officers.

(2) Billeting for 85 enlisted men (includes 5 mess cooks and 2 stewards).

(3) Ground Support Equipment:

(a) Workstands, B4	4
(b) Workstands, B5	4
(c) Compressor, Air (3000 psi capacity)	1
(d) Cart, Oxygen (aviators breathing)	1
(e) Ground Power Unit, RY-400 or NC-12C	3

b. Naval Weapons Center (NWC) China Lake

(1) BOQ billeting for four officers and six civilians, GS-9 through GS-16.

(2) Billeting for four enlisted men.

(3) Storage.

(a) Magazine storage for approximately 3000 MK-112 photoflash canisters (pyrotechnic devices) from about 15 July to approximately 1 November 1969. Space required is approximately 10'x12'x14'.

(4) Transportation.

(a) One pick-up or bomb truck for transporting technics and personnel.

(b) Two GSA, Navy, or rental station wagons.

c. ESSA/Research Flight Facility (ESSA/RFF)

(1) BOQ billeting for 34 civilians.

(2) Ground Support Equipment:

(a) Three power units, Type MD-3 (28V DC 400 cycle three phase 115V)

(b) Routine aircraft support.

(3) Fuel/oil - DC-6's:

(a) AVGAS-115/145, 100,000 gallons

(b) Oil - AD-1120 grade, 960 gallons

(4) Fuel/oil - W-57:

(a) JP-4 - RFF will provide.

(b) Oil - RFF will provide.

(5) Fuel/oil - C-54:

(a) AVGAS-100/130, 26,000 gallons

(b) Oil - AD-1100, ashless dispersant, 480 gallons

(6) Transportation

(a) One half-ton pick-up truck.

(b) One station wagon.

d. Navy Weather Research Facility (NWRF)

(1) BOQ billeting for three civilians, GS-12 through 15.

e. Fleet Weather Facility, Jacksonville (FWF JAX)

(1) BOQ billeting for the Navy Project Coordinator and his alternate.

(2) Transportation.

(a) One rental (Navy) sedan.

f. National Hurricane Research Laboratory (NHRL)

(1) BOQ billeting for eight civilians, GS-9 through 16.

g. CHINFO

(1) Billeting for two enlisted men.

h. ATKRON ONE SEVENTY-SIX (VA-176)

(1) BOQ billeting for 11 officers.

(2) Billeting for 1 CPO and 19 enlisted men.

(3) Ground Support Equipment:

(a) Pre-oiler PONG

(b) LOX cart

(c) Air compressor

(d) Tow tractor

(e) Aircraft jacks:

1. 6000 pound capacity

2. 3400 pound capacity

3. 25,000 pound capacity

(f) Hydraulic test stand (3000 psi, 6-25 gal/min)

(g) GTC-85 (or equivalent)

(h) NB-2 electrical power unit (or equivalent)

A-6A electrical power requirements are very critical as to frequency, phase rotation and voltage fluctuations. 115/200 V 400 cps AC 23 (CVA)

(i) Air conditioner (35° to 50° F) NR-2A/B (NR-2B preferred)

(j) Nitrogen cart (3000 psi)

(k) Single point JP refueler

(l) Mil-L-23699 oil

(m) Pick-up truck

B. Pooling of Resources. It is realized that NAVSTA Roosevelt Roads may not have the capability to provide all of the equipment requested by each separate activity. In this eventuality, pooling of equipment compatible to each type aircraft may be necessary. The Project Officer, NAVSTA Roosevelt Roads, will determine what equipment is available and forward this information to the Navy Project Coordinator.

LELAND J. UNDERWOOD
Commander, U. S. Navy
Navy Project Coordinator/
Assistant Project Director
for Project STORMFURY

C - Comm.

OPERATION PLAN
FWF JAX NO. 1-69

Project STORMFURY
Fleet Weather Facility
Naval Air Station
Jacksonville, Florida
June 1969

ANNEX C

COMMUNICATIONS PLAN

1. Effectiveness. Communications in accordance with NWP 16(B) and appropriate Joint Allied and Navy Department publications. NWP 16(B) is effective throughout as applicable to the existing situation unless modified or amplified by this Annex.

2. General. This Annex provides communications instructions and procedures for aircraft operations during Project STORMFURY.

3. Call Signs. Aircraft call signs are listed in Appendices I and II to this annex.

4. Frequency Plan.

a. Frequencies and guard assignments are contained in Appendices I and II to this annex.

b. All aircraft will contact the command control aircraft (STORMFURY E, F or G) on UHF (STORMFURY Common) or SSB when prepared to submit OPS Normal report.

5. Distress and SAR Communications. Aircraft shall inform the command control aircraft of intentions on assigned frequency. If no contact, aircraft shall attempt communications with ground stations on VHF, UHF or HURRECO frequencies in Appendices I and II to this annex. If unable to contact any station on these frequencies, utilize 243.0 MCS (AERONAUTICAL EMERGENCY) or 121.5 MCS (INTERNATIONAL AERONAUTICAL EMERGENCY).

6. IFF Plan. IFF Plan will be in accordance with Appendices I and II of this annex. If available, separate squawking modes will be assigned for aircraft departing operating area.

7. Lost Communication Plan. Should an aircraft develop transmitter malfunctions and be unable to transmit, the aircraft shall squawk MODE 3 CODE 01 and "Ident". Should an aircraft develop receiver difficulties and be unable to receive, or should the aircraft experience both transmitter and receiver difficulties, the aircraft shall squawk MODE 3 CODE 02 and "Ident".

8. Emission Control Plan (EMCON). EMCON will be directed by the command control aircraft for all experiments.

9. Communications with ARTCC. The Command Control Aircraft or designated alternate will maintain a continuous communication watch with the appropriate ARTCC and make hourly OPS Normal Reports thereto in addition to updating the geographical coordinates of the center of the airspace reservation area. The frequencies are:

a. San Juan Radio: SSB 6724.5 KCS, 4712.5 KCS
HF 6567 KCS

b. Jacksonville/Miami ARTCC: (1) Day SSB 6724.5
(2) Night SSB 4712.5

LELAND J. UNDERWOOD
Commander, U. S. Navy
Navy Project Coordinator/
Assistant Project Director
for Project STORMFURY

Appendices:

I - Eyewall Experiment, Communications Plan
II - Rainband Experiment, Communications Plan

APPENDIX I TO ANNEX C

PROJECT STORMFURY COMMUNICATION PLAN
EYEWALL EXPERIMENT

UHF	SSB	VHF	IFF MODE 3 CODE	VOICE CALL
COMMON 377.1 AIR CTL 282.3 AIR CTL 371.9 AIR CTL 387.9 JAX ARTCC 327.0	PRI 15082.5 SEC 18000.5 SEC 23228.5 TER 4701.5 TER 9011.5 TER 13222.5 SAN JUAN ARTCC 6724.5	PRI 141.96 SEC 142.68 JAX ARTCC 135.05 123.05	21 Approaching 26 Departing STORMFURY Op Area	
ESSA/RFF (DC-6) 12,000 MONITOR A/C "A"			41	STORMFURY A
ESSA/RFF (DC-6) 12,000 MONITOR A/C "A2"			41	STORMFURY A
ESSA/RFF (DC-6) 12,000 MONITOR A/C "B"			41	STORMFURY B
ESSA/RFF (W-57) OUTFLOW LEVEL (35-40M) MONITOR A/C "C"	NA		14	STORMFURY C
ESSA/RFF (W-57) OUTFLOW LEVEL (35-40M) MONITOR A/C "C2"	NA		14	STORMFURY C
ESSA/RFF (C-54) 1,000 MONITOR A/C "D"			05	STORMFURY D
VW-4 (WC-121N) 6,000 COMMAND CONTROL A/C "E"			04	STORMFURY E
VW-4 (WC-121N) 1,000 MONITOR A/C "F"			05	STORMFURY F
VW-4 (WC-121N) 1,000 MONITOR A/C "G"			05	STORMFURY G

APPENDIX I TO ANNEX C (Continued)

UNIT	UHF	SSB	VHF	IFF MODE 3 CODE	VOICE CALL
VW-4 (WC-121N) 10,000 MONITOR A/C "H"				07	STORMFURY H
53RD WRS (c-130) 29,000 MONITOR A/C "I"				14	STORMFURY I
53RD WRS (WB-47) OUTFLOW LEVEL (35-40M) MONITOR A/C "J"				14	STORMFURY J
VA-176 (A-6) 33-35,000 SEEDING A/C "L"				20	STORMFURY L
VA-176 (A-6) 33-35,000 SEEDING A/C "M"				20	STORMFURY M
VA-176(A-6) 33-35,000 SEEDING A/C "N"				20	STORMFURY N
VA-176 (A-6) 33-35,000 SEEDING A/C "O"				20	STORMFURY O
VA-176 (A-6) 33-35,000 SEEDING A/C "P"				20	STORMFURY P
VA-176 (A-6) 33-35,000 SEEDING A/C "Q"				20	STORMFURY Q

APPENDIX II TO ANNEX C

PROJECT STORMFURY COMMUNICATION PLAN
RAINBAND EXPERIMENT

UNIT	UHF	SSB	VHF	IFF MODE 3 CODE	VOICE CALL
	COMMON 377.1 AIR CTL 282.3 AIR CTL 371.9 AIR CTL 387.9 JAX ARTCC 327.0	PRI 15082.5 SEC 18000.5 SEC 23228.5 TER 4701.5 TER 9011.5 TER 13222.5 SAN JUAN ARTCC 6724	PRI 141.96 SEC 142.68 JAX ARTCC 135.05	21 Approaching 26 Departing STORMFURY Op Area	
ESSA/RFF (DC-6) 12,000 MONITOR A/C "A"				50	STORMFURY A
ESSA/RFF (DC-6) 18,000 MONITOR A/C "B"				44	STORMFURY B
ESSA/RFF (W-57) OUTFLOW LEVEL MONITOR A/C "C"				26	STORMFURY C
ESSA/RFF (c-54) 1,000 BACK-UP FOR STORMFURY "D"				05	STORMFURY D
VW-4 (WC-121N) 6,000 COMMAND CONTROL A/C "E"				04	STORMFURY E
VW-4 (WC-121N) 1,000 MONITOR A/C "F"				41	STORMFURY F
VW-4 (WC-121N) 1,000 MONITOR A/C "G"				02	STORMFURY G
VW-4 (WC-121N) 1,000 MONITOR A/C "H"				05	STORMFURY H
53RD WRS (C-130) 29,000 MONITOR A/C "I"				14	STORMFURY I
53RD WRS (W-47) 35-40M MONITOR A/C "J"				14	STORMFURY J

APPENDIX II TO ANNEX C (Continued)

UNIT	UHF	SSB	VHF	IFF MODE 3 CODE	VOICE CALL
VA-176 (A-6) 35,000 SEEDING A/C "L"				2C	STORMFURY L
VA-176 (A-6) 37,000 PHOTO & SEEDING A/C "M"				24	STORMFURY M

ANNEX D

DRY RUNS FOR RAINBAND, EYEWALL AND CLOUDLINE EXPERIMENTS

1. General. Dry runs of eyewall and rainband experiments will be conducted on three separate days during late July or early August in accordance with Annexes E, F and G, with the following exceptions:

a. Dry runs will be conducted in an area to be determined by the Assistant Director, after consulting with the Director.

b. Center and movement of the eye for the eyewall and rainband experiments will be simulated. Position and direction of movement will be announced prior to the exercise. The Cloudline experiment will also be simulated if actual cloudlines are not available in the area.

c. The abbreviated flight times, as shown in Appendices I and II, will allow each flight to complete at least one entire flight track.

d. Services of the following aircraft will be required for the cloudline experiment, as shown in Annex G:

(1) ESSA - All RFF aircraft

(2) Navy - Two WC-121N's

(3) USAF - One WC-130, One WB-47

2. General Briefing.

a. Time. The Project Director and/or Navy Coordinator will notify all activities/units by message of the specific dates and times for conducting the dry run exercises.

b. Place. Conference room to be designated.

c. Attendees. All STORMFURY personnel.

d. Agenda.

(1) Opening remarks - Director, Project STORMFURY

(2) Eyewall Experiment - Director, Project STORMFURY

(3) Rainband Experiment - Director, Project STORMFURY

(4) Operation Plan Review - Assistant Director, Project STORMFURY

(5) Data Collection & Reporting - Data Quality Control Coordinator

(6) Forces Status Reports - Senior Representative Present, each activity.

3. Communications. As described in Annex C.

4. Abort Contingencies. Decision to abort the mission is an inherent responsibility of the plane commander of each aircraft. However, the decision to abort for reason of specific communications equipment failure only should be made after due coordination with the Project Director aboard the command control aircraft.

5. Operations.

a. As directed in Annexes E, F and G, with the following exceptions:

(1) Status reports will be provided the Navy Project Officer at 1900Z of the day preceding the Dry Run Exercise.

(2) Take-off times for Eyewall Experiments - Dry Run:

(a) WC-121, FLIGHT G, will take off so as to be on station from 1200Z to 2000Z. At 1730, FLIGHT G will assume the role of FLIGHT F.

(b) W-57, FLIGHT C, will take off so as to be on station from 1330Z to 1500Z.

(c) DC-6, FLIGHT A, will take off so as to be on station from 1345Z to 1630Z.

(d) WC-121, FLIGHT H, will take off so as to be on station from 1400Z to 1815Z. Provide working/ditching station for photographer.

(e) WC-121, FLIGHT E, will take off so as to be on station from 1415Z to 1900Z.

(f) Seeding aircraft will take off so as to be on station at 1430Z to 1530Z, 1530Z to 1630Z, and 1630Z to 1730Z.

(g) C-130, FLIGHT I, will take off so as to be on station from 1500Z to 1700Z.

(h) C-54, FLIGHT D, will take off so as to be on station from 1530Z to 1730Z.

(i) WB-47, FLIGHT J, will take off so as to be on station from 1615Z to 1800Z. This flight scheduled for 53rd WRS aircraft.

(j) DC-6, FLIGHT B, will take off so as to be on station from 1730Z to 1930Z.

(3) Take-off times for Rainband Experiment - Dry Run

(a) WC-121, FLIGHT F, will take off so as to be on station from 1200Z to 1500Z.

(b) DC-6, FLIGHT B, will take off so as to be on station from 1300Z to 1730Z.

(c) WC-121, FLIGHT E, will take off so as to be on station from 1400Z to 1800Z.

(d) DC-6, FLIGHT A, will take off so as to be on station from 1400Z to 1800Z.

(e) C-130, FLIGHT I, will take off so as to be on station from 1400Z to 1730Z.

(f) A-6, FLIGHT L, will take off so as to be on station from 1430Z to 1630Z.

(g) A-6, W-57, FLIGHTS M and C, will take off so as to be on station from 1430Z to 1615Z.

(h) WC-121, FLIGHT G, will take off so as to be on station from 1500Z to 1900Z.

(i) WB-47, FLIGHT J, will take off so as to be on station from 1615Z to 1800Z.

(4) Take-off times for Cloudline Experiments - Dry Run:

(a) On-station times for all participating aircraft will be announced at the briefing.

6. Data. Records of all data collected, including film for each flight, will be delivered to the DOCC, as specified in Annexes E and F of this Operation Plan.

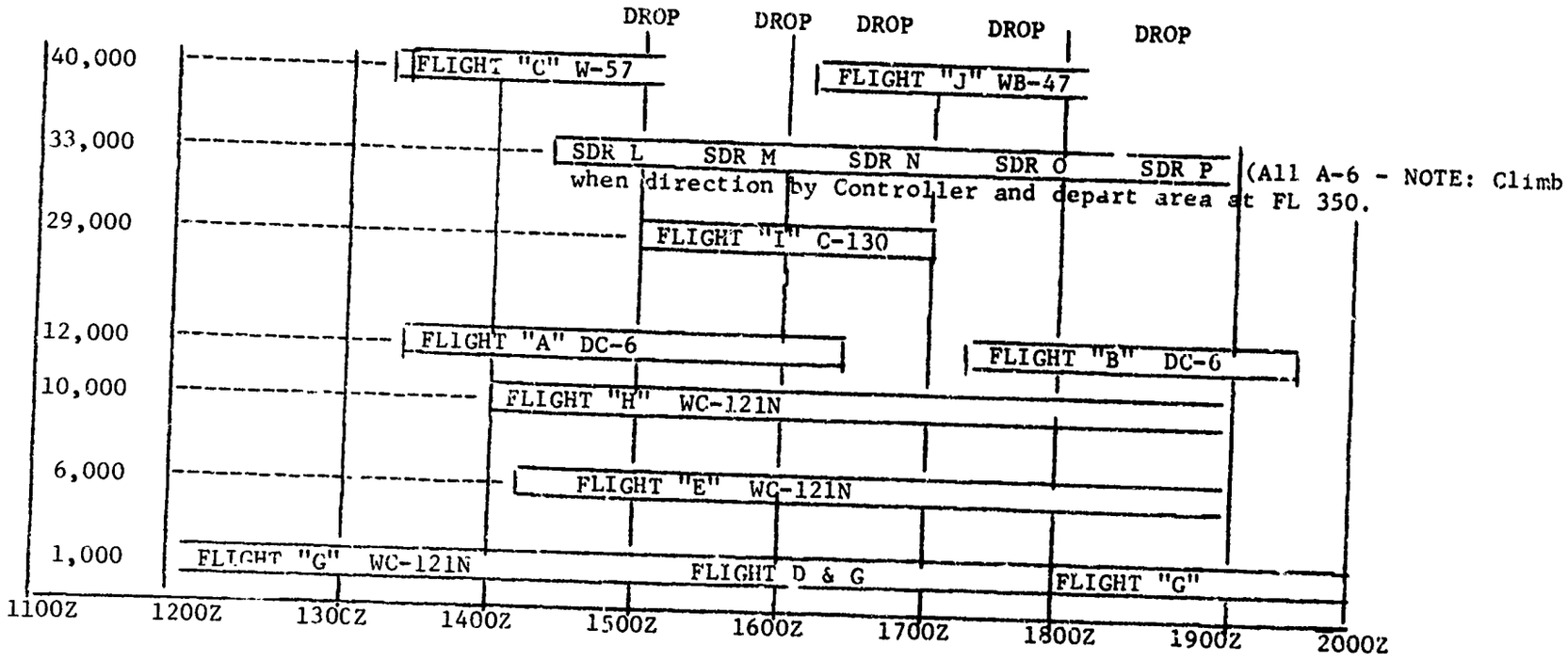
LELAND J. UNDERWOOD
Commander, U. S. Navy
Navy Project Coordinator/
Assistant Project Director
for Project STORMFURY

Appendices:

I - Time Table for Dry Run - Eyewall Experiment
II - Time Table for Dry Run - Rainband Experiment

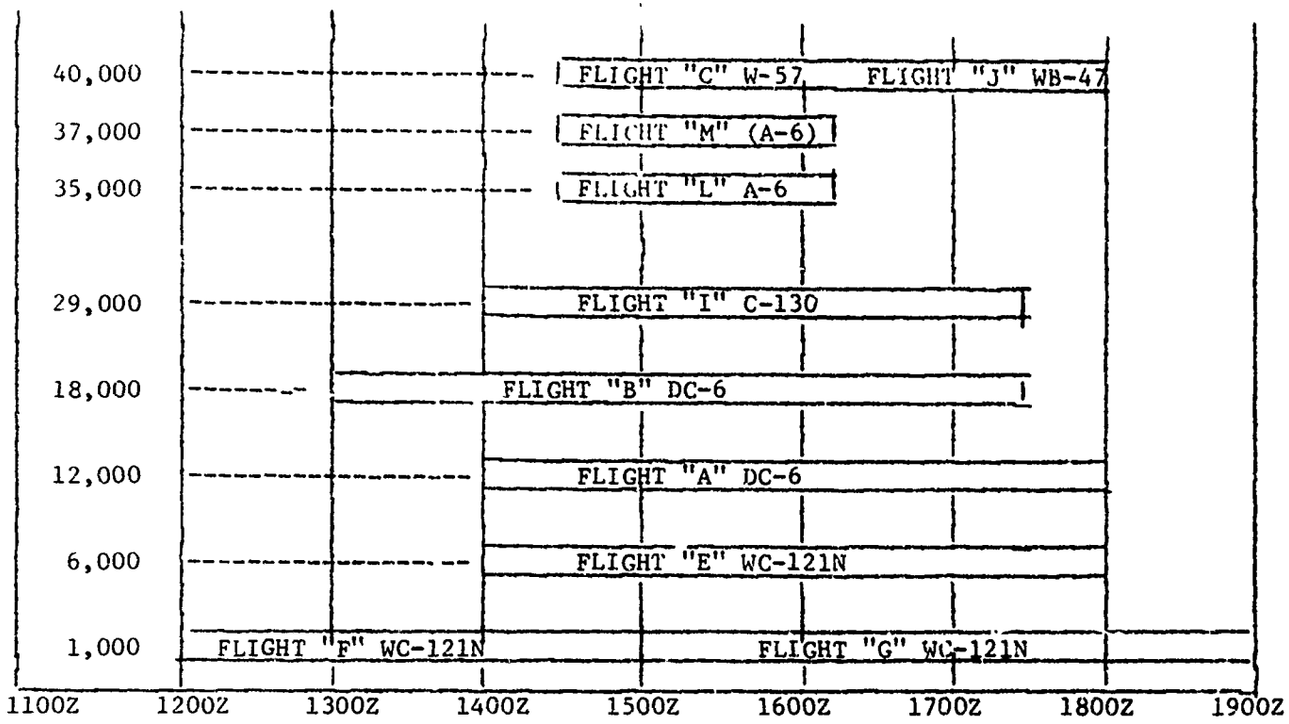
APPENDIX I TO ANNEX D

TIME TABLE FOR DRY RUN - EYEWALL EXPERIMENT



APPENDIX II TO ANNEX D

TIME TABLE FOR DRY RUN - RAINBAND EXPERIMENT



ANNEX E

HURRICANE EYEWALL SEEDING EXPERIMENT

1. General Briefing.

a. Time - 1300Z on day before seeding operations or as soon thereafter as practicable.

b. Place - To be designated.

c. Agenda -

(1) Opening Remarks - Director, Project STORMFURY

(2) Operations Plan Review - Assistant Director, Project STORMFURY

(3) Review Applicable Parts of Operations Plan - Air Controller

(4) Forces Status Reports - Senior Representative of Each Activity

d. Attendees - All personnel participating in the hurricane Eyewall Seeding Experiment of Project STORMFURY.

2. Operations.

a. Aircraft and equipment status reports - The Senior Representative Present of each participating activity will provide the Project Director and the Navy Project Coordinator with the initial aircraft and equipment status reports by 1300Z on the day before the actual experiment and daily thereafter by 0100Z until the experiment is terminated. The Data Quality Control Coordinator (DQCC) will advise the Director of the status of instruments and sensor systems in accordance with the same schedule.

b. Fueling Requirements - All aircraft will be fueled at the discretion of the aircraft commander.

c. Flight Operations - Flight operations will be conducted in accordance with the following appendices, as appropriate:

(1) USN Flights - Appendix I

(2) ESSA Flights - Appendix II

(3) USAF Flights - Appendix III

3. Position Assignment of Key Personnel: To be assigned by Project Director and Assistant Project Director at or before briefing session for each mission. Key personnel assigned to flights will arrive at respective aircraft 45 minutes prior to takeoff.

4. Air Operations.

a. Filing a Flight Plan. Aircraft will file VFR/IFR flight plans at the staging base to a geographical position to be decided at the preflight briefing. Aircraft departing from other bases file flight plans, as appropriate, in order to be on station at scheduled times. Coordination of takeoff and on-station times should be accomplished through STORMFURY Project Officers at the staging base or Fleet Weather Facility, Jacksonville

b IFF/SIF Procedures. As assigned. See Annex C. Procedures for aircraft entering and departing STORMFURY operating area will be promulgated at the briefing

c. Initial Report. After takeoff, report to ARTCC as required.

d. "OPS Normal" Report. As soon as practical after reporting to ARTCC, each flight will contact the Command Control Aircraft via UHF/SSB communications and submit an "OPS Normal" report, verify altitude, and standby to be assigned an air controller and air control frequency.

Each aircraft will report "OPS Normal", or appropriate condition, to the Command Control Control Aircraft every hour while under his positive control.

e. Air Control. Upon assignment of an air controller and air control frequency, each flight will then establish communications on the assigned UdF frequency. Upon establishing UHF communications, the Command Control Aircraft, a Navy WC-121N, will assume air control responsibility for the reporting aircraft by notifying the appropriate ARTCC of the exercise voice call, FAA radio call, altitude and time of assuming control. The Command Control Aircraft will retain this responsibility until either the controlled aircraft or the Command Control Aircraft departs the operating area, at which time another WC-121N will acknowledge receipt for the air control of each respective flight, after establishing respective voice communications. In the event that a shift in mission is required, all aircraft will maintain original voice call. Ensure compliance with air control procedures set forth by FAA in Annex T.

f. Forces Status Report. The Command Control Aircraft will notify the appropriate ARTCC of the status of each aircraft under its control once each hour. This report will be in the form of a collective "OPS Normal" report to the ARTCC.

g. Departing STORMFURY Operating Area. Thirty minutes prior to departing from the STORMFURY operating area, each flight will advise the appropriate Oceanic Control of such plans, obtain clearance, and return independently to the staging base or other operating base.

5. Radar.

a. Sensitivity Checks. (FLIGHTS E, F, G and H only) All radars will be checked for sensitivity in accordance with the procedures described in Annex R.

6. Radarscope Photography. Radarscope photography will be conducted in accordance with Annex R and the schedule provided by Modus Operandi Appendix applicable to each flight. Radarscope photography log, as shown in Annex R and Annex U, will be completed for each radarscope photographed.

7. Doppler Calibration. All aircraft equipped with Doppler Navigation Equipment will fly a wind calibration box on the outbound and inbound legs of each flight for doppler calibration. Commence wind calibration box pattern using 2½ minute legs. Data will be entered on forms furnished by the Data Quality Control Coordinator as in Annex U.

8. Data Collection Forms. See Annex U.

9. Aircraft Employment. Aircraft will be employed in accordance with the time table, mission and altitude assignments, as described in the appendices of this annex.

10. Altitude Assignments. All flights fly pressure altitude (altimeter set 29.92), except Flights D, F and G, which fly absolute altitude).

11. Abort Contingency.

a. Decision to abort the mission is an inherent responsibility of the plane commander for each aircraft. However, the decision to abort for reason of data measuring instruments failure only should be made after due coordination with the Project Director aboard the Command Control Aircraft.

12. Debriefing. (Key personnel to be designated for two separate debriefings: 1) operational; 2) scientific.)

a. Time - As soon as possible after last aircraft lands.

b. Place - To be designated.

c. Agenda -

Assistant Director, Project STORMFURY - Chairman of Operations Debriefing.

Director, Project STORMFURY - Chairman of Scientific Debriefing.

On-Scene Commander attends both meetings.

Director, Project STORMFURY - Review of operational success of the experiment.

Data Quality Control Coordinator - Review of data quality and quantity.

Debriefings will be held back-to-back, with Operational Debriefing first. Selected key personnel will also attend follow-on scientific debriefing.

LELAND J. UNDERWOOD
Commander, U. S. Navy
Navy Project Coordinator/
Assistant Project Director
for Project STORMFURY

EYEWALL EXPERIMENT

Appendices:

I - Navy Flight Procedures
II - ESSA Flight Procedures
III - USAF Flight Procedures
IV - Time Table for STORMFURY (Eyewall) Aircraft Employment
V - Chronological Summary for STORMFURY Aircraft
VI - Composite Flight Tracks for Eyewall Experiment

APPENDIX I TO ANNEX E

EYEWALL EXPERIMENT

Navy Flight Procedures

1. WC-121, FLIGHT "G"

a. Mission. Low Level Inflow Monitor

(1) Mission priorities

(a) Meteorological/oceanographic data

(b) Radarscope photography, radar video

(2) Modus Operandi

(a) Take off in time to arrive at the nearest point 90 NM from the hurricane eye center at an absolute altitude of 1,000 feet at 0800Z. Make two circumnavigations at 75 NM radius from the eye center with an eye penetration approximately midway in patter in accordance with Tab A.

b. General Communications. FLIGHT G, Voice Call "STORMFURY GOLF", will guard the appropriate UHF/SSB frequencies for ARTCC and air control in accordance with Annex C.

(1) Initial Report. After takeoff, report to ARTCC as required.

(2) Command Control. FLIGHT G will assume command control of FLIGHTS A, C, and H until relieved of these duties at 1100Z by FLIGHT E.

(3) Forces Status Report. See page E-3, paragraph 4.f.

c. Data Collecting Requirements (within 100 nautical miles of eye). Record data in accordance with Annex U.

Interval	Data Collected
Every 30 seconds during penetration; every 1 minute elsewhere	Channel 00-10, 14-17

Data Collecting Requirements (continued)

Interval	Data Collected
Every 5 minutes if DLS inoperative.	Data on channel 00-10, 14-17
Every 10 minutes	Visual wind for doppler check.
Every 15 minutes routinely, and at every significant change of course.	Aircraft position (range/ bearing from eye center)
Every hour	WWV time check

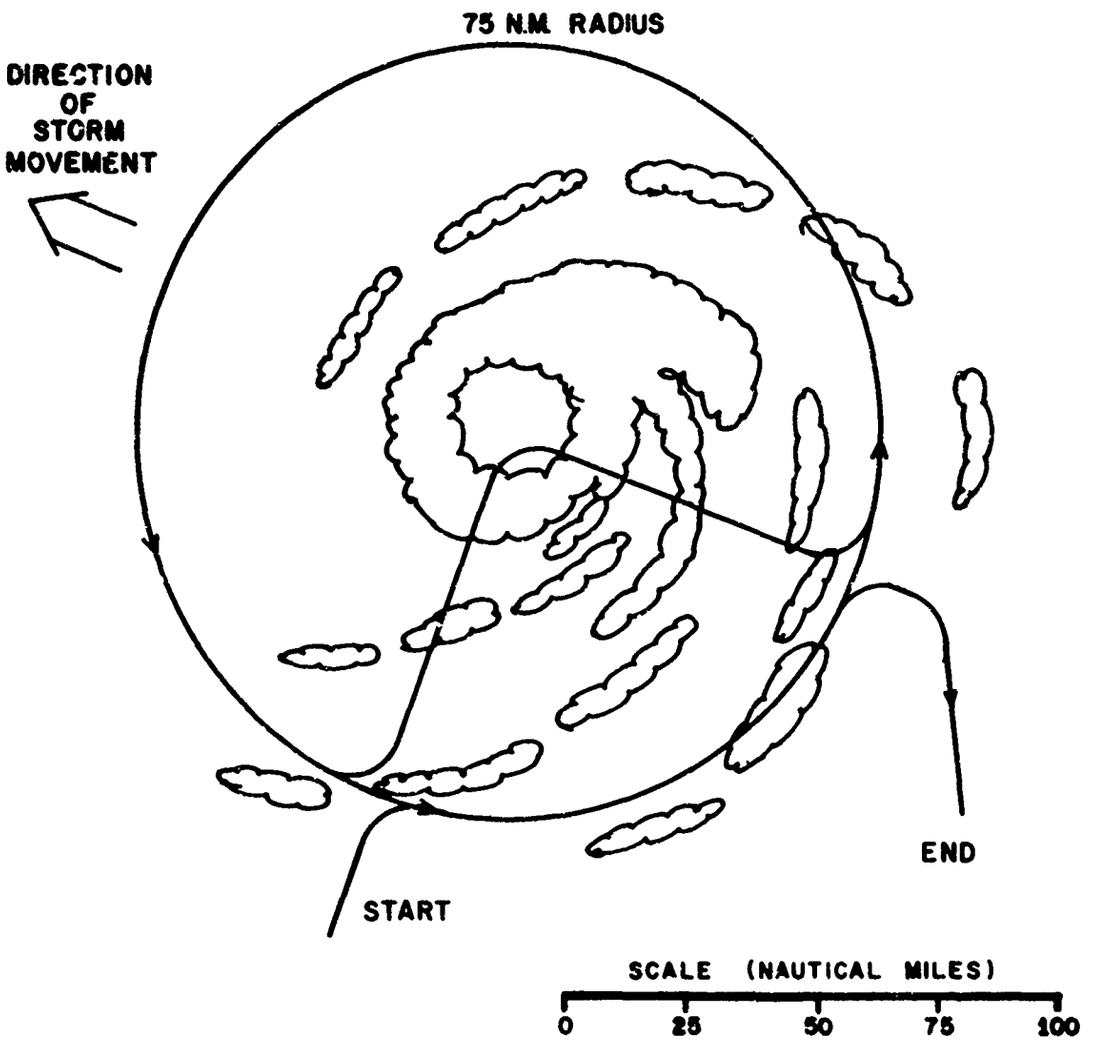
d. Radars. Operate in accordance with Annex R.

e. Post-Flight Debriefing. Turn in all records of data collected, including radar film, to the DQCC.

TAB A: Flight Pattern for FLIGHT G

TAB A TO APPENDIX I TO ANNEX E

FLIGHT PATTERN - EYEWALL EXPERIMENT
FLIGHT "G" (NAVY WC-121N) ALTITUDE 1,000 ft. INFLOW MONITOR
TWO CIRCUMNAVIGATIONS



2. WC-121, FLIGHT "H"

a. Mission. Radar and Dropsonde

(1) Mission Priorities

(a) Back-up command control aircraft

(b) Radarscope photography, radar video

(c) Dropsonde

(d) Meteorological data, mid-level

(2) Modus Operandi

(a) Take off in time to arrive in the eye or left front quadrant of the hurricane at 10,000 feet at 1030Z and conduct flight operations in accordance with Tab B of this appendix.

b. General Communications. FLIGHT H, Voice Call "STORMFURY HOTEL", will guard appropriate UHF/SSB frequencies for ARTCC and air control. See Annex C.

(1) Initial Report. After takeoff, report to ARTCC, as required.

(2) Reporting for Control. Prior to arrival in STORMFURY operations area, contact FLIGHT "G" to report "OPS Normal". Verify altitude and standby for assignment of an air control frequency and Air Controller. Establish UHF communications with assigned Air Controller for conducting flight along track described in Tab B of this appendix.

(3) Operations Normal Report. See page E-2, paragraph 4.d.

c. Data Collecting Requirements (within 100 nautical miles of the eye). Record data in accordance with Annex U.

Data Collecting Requirements (continued)

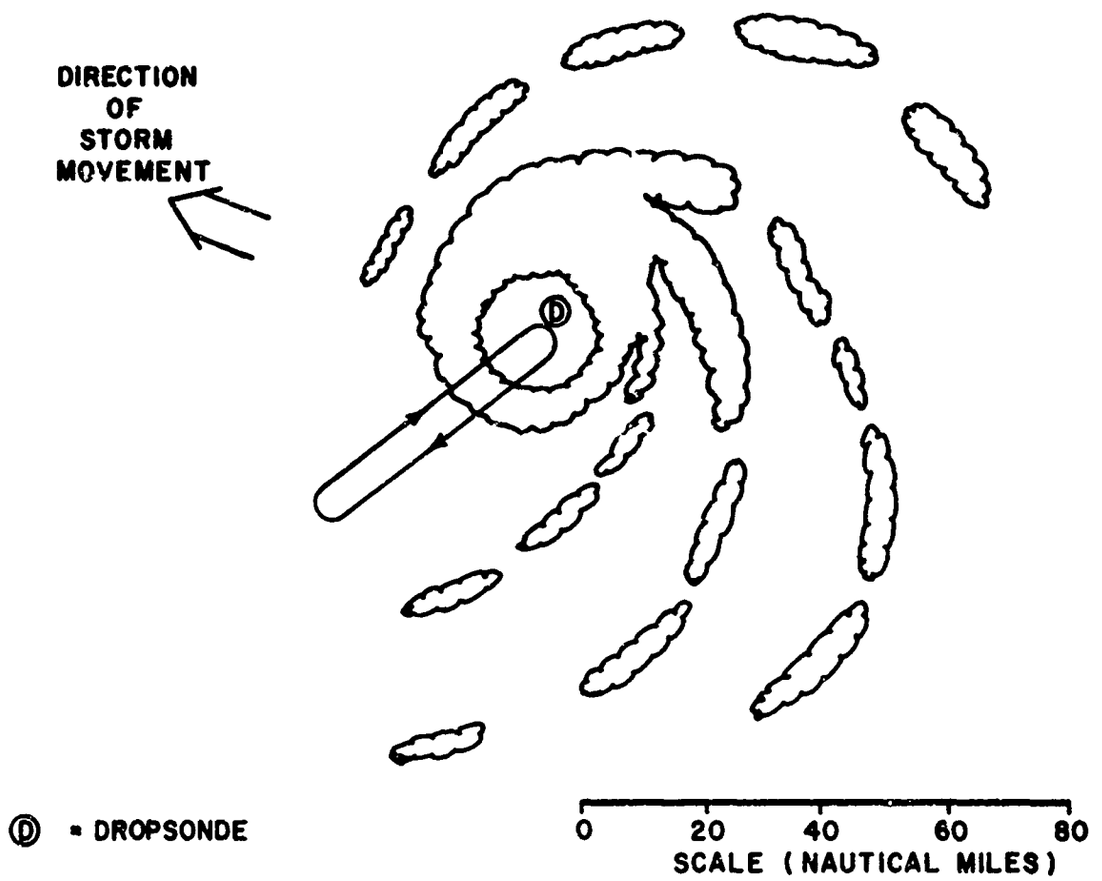
Interval	Data Collected
1 minute (or 5 minutes if automatic recorders are inoperative)	Time, latitude, longitude, absolute altitude, wind direction/speed, temperature, relative humidity and pressure
10 minutes	Visual wind for doppler check

d. Radar. Operate in accordance with Annex R.

e. Post-Flight Debriefing. Turn in all records of data collected, including film, to the DQCC.

TAB B: Flight Pattern for FLIGHT H

FLIGHT PATTERN - EYEWALL EXPERIMENT
FLIGHT "H" (NAVY WC-121 N) ALTITUDE 10,000 ft.
RADAR AND DROPSONDE



3. WC-121, FLIGHT "E"

a. Mission. Command Control Aircraft.

(1) Mission priorities

(a) Aircraft control and command

(b) Radarscope photography, radar and IFF video

(2) Modus Operandi

(a) Take off in time to arrive at a position relative to hurricane for best radar data collection, consistent with the most efficient air control of Project aircraft at 6,000 feet at 1100Z, and conduct flight operations in accordance with Tab C of this appendix.

b. General Communications. FLIGHT E, Voice Call "STORMFURY ECHO", will guard the appropriate UHF/SSB frequencies for ARTCC and air control. See Annex C.

(1) Initial Report. After takeoff, report to ARTCC, as required.

(2) Reporting for Control. As soon as FLIGHTS A, C, G, and H aircraft are held independently on radar, contact FLIGHT G on UHF/SSB and copy air control frequencies assigned to each flight. As soon as each flight is contacted on these respective frequencies, notify FLIGHT G that he is relieved of on-scene command for these flights. Adjust radar operating schedule of all flights as necessary to reduce mutual radar interference. Proceed to determine the axis and area for the initial seeding run. Notify ARTCC when air control responsibilities for these flights have been assumed by reporting the flight identification, A/C type, altitude and radius of operation from the center of the reserved air space for each aircraft.

(3) Operations Normal Report. See page E-2, paragraph 4.d.

c. Assignment of Air Control Frequency and Air Controller. As each flight checks in on UHF/SSB, reports OPS Normal, and verifies altitudes and flight identification, assign an air control frequency and air controller for each aircraft, except the seeding aircraft. All seeding aircraft will be assigned to the same air control frequency and air controller.

d. Vector Control. Appendix VI is a complete plan view of the tracks of all aircraft participating in the experiment. Air Controller will vector aircraft to perform assigned missions along applicable flight tracks. Appendix IV of Annex E is the Time Table for STORMFURY aircraft employment. Appendix V of Annex E is a chronological summary of all aircraft employed in the STORMFURY experiments.

e. Forces Status Report. Once every hour, collect an "OPS Normal" report from all STORMFURY aircraft on station. Report a collective "OPS Normal" for all aircraft in the reserved airspace to ARTCC once every hour.

f. Shift of Command Control. At time "Tango" plus 8½ hours, contact FLIGHT F. After verification that the APS-20 is in "up" status, FLIGHT F will notify FLIGHT E that he will assume command control of FLIGHT B at "Tango" plus 9 hours. When FLIGHT C^2 reports on station, FLIGHT F will exercise command control for both FLIGHTS B and C^2.

g. Data Collection. Record data in accordance with Annex U.

Data Collection (continued)

(1) Meteorological parameters

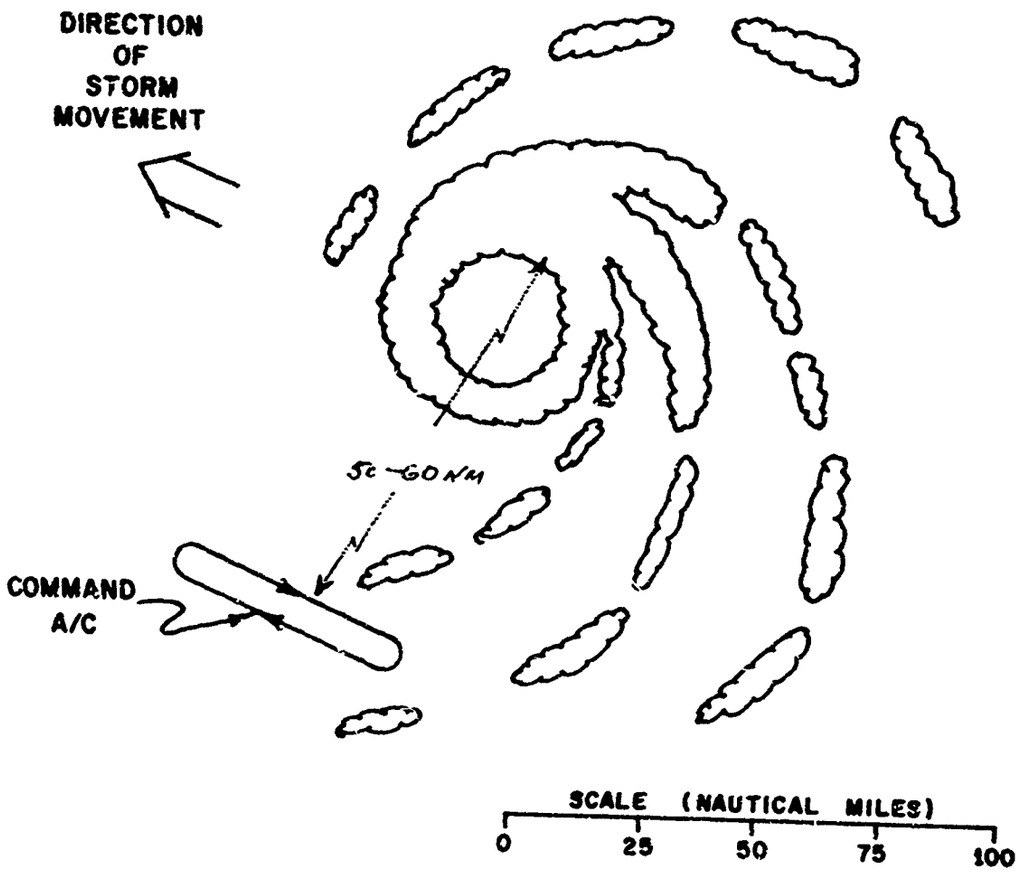
Interval	Data Required
Every 1 minute if DLS is operative; every 5 min. if inoperative.	Time, pressure, temperature, relative humidity.
Every 5 minutes	Absolute altitude, pressure altitude, range/bearing from eye. Wind direction/speed (or raw navigation data to obtain same).
Every 10 minutes	Latitude, longitude.

(2) Radar. Operate radars as required for airborne air control of all aircraft under positive control. Photograph IFF and weather video as prescribed in Annex R.

h. Post-Flight Debriefing. Selected crew members attend debriefing(s). Deliver flight records and film to the DOCC.

TAB C: Flight Pattern for FLIGHT E

FLIGHT PATTERN - EYEWALL EXPERIMENT
FLIGHT "E" (NAVY WC-121N) ALTITUDE 6,000 ft.
CONTROL AND COMMAND



4. WC-121, FLIGHT "F"

a. Mission. Low Level Inflow Monitor.

(1) Mission Priorities

(a) Back-up for FLIGHT H

(b) Meteorological and oceanographic data

(c) Radarscope photography, radar video

(2) Modus Operandi

(a) Take off in time to arrive at a point 75 nautical miles from the hurricane eye center at 1,000 feet absolute at 1900Z. Make two (2) circumnavigations at 75 nautical miles radius from eye center with an eye penetration approximately midway in pattern in accordance with Tab D.

b. General Communications. FLIGHT F, Voice Call "STORMFURY FOXTROT", will guard the appropriate UHF/SSB frequencies in accordance with Annex C.

(1) Initial Report. After takeoff, report to ARTCC, as required.

(2) Command Control. FLIGHT F will assume command of FLIGHT A^2 at 2100Z and FLIGHT C^2 at 2230Z when FLIGHT E departs the area.

(3) Forces Status Report. See page E-3, paragraph 4.f.

c. Data Collecting Requirements (within 100 nautical miles of eye). Record data in accordance with Annex U.

Interval	Data Collected
Every 30 seconds during penetration; every 1 min. elsewhere	Channel 00-10, 14-17
Every 5 minutes if DLS inoperative	Data on Channel 00-10, 14-17
Every 10 minutes	Visual wind for doppler check.

Data Collecting Requirements (continued)

Interval	Data Collected
Every 15 minutes routinely, and at every significant change of course	Aircraft position (range/ bearing from eye center)
Every hour	WWV time check

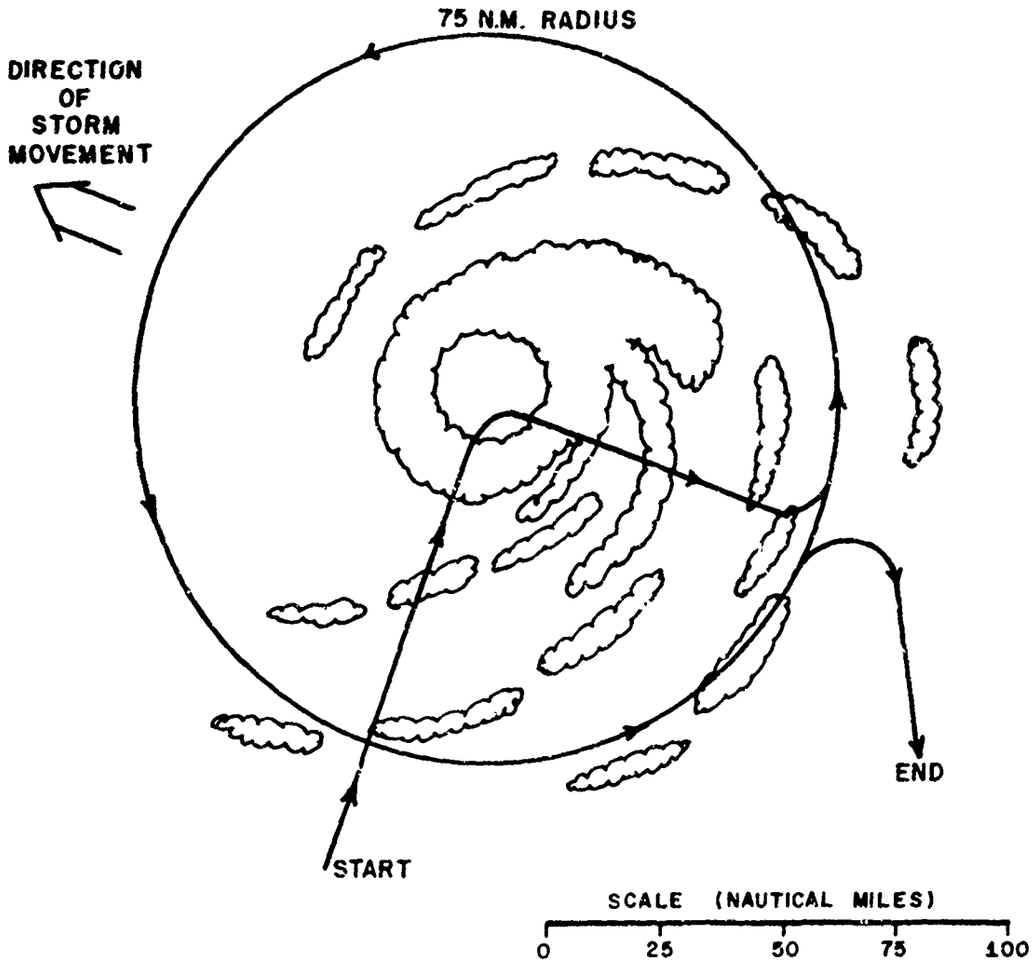
d. Cancelling of Reserved Airspace. At "Tango" plus 14 hours, FLIGHTS F and A^2 will proceed independently to staging base. As soon as both flights are outside of the reserved airspace boundary, FLIGHT F will contact ARTCC to report all STORMFURY aircraft are clear of the reserved airspace.

e. Post-Flight Debriefing. Turn in all records of data collected, including film, to the DQCC.

Inc B D: Flight Pattern for FLIGHT F

TAB D TO APPENDIX I TO ANNEX E

FLIGHT PATTERN – EYEWALL EXPERIMENT
FLIGHT "F" (NAVY WC-121N) ALTITUDE 1,000 ft. INFLOW MONITOR
TWO CIRCUMNAVIGATIONS



5. A-6 FLIGHTS L, M, N, O, P, Q

a. Mission. Seeding Aircraft.

(1) Mission Priorities

(a) Pyrotechnic devices delivery

(b) Meteorological data, high level

(c) Time lapse photography, if available

(d) Radarscope photography, if available

(2) Modus Operandi

(a) Seeding Aircraft. Take off in time to arrive on station for seeding at not less than 33,000 feet at times shown in Tab E. Conduct flight operations in accordance with Tab F.

b. General Communications. FLIGHTS L, M, N, O, P and Q, Voice Calls "STORMFURY LIMA, MIKE", etc., will guard UHF/SSB frequencies for ARTCC and air control in accordance with Annex C.

(1) Initial Report. After takeoff, report to ARTCC, as required.

(2) Reporting for Control. Prior to entering STORMFURY operating area, contact Command Control (STORMFURY GOLF) prior to 1100Z, thereafter STORMFURY ECHO on UHF (STORMFURY Common) or SSB. When communications are established with Command Control, submit an "OPS Normal" report, and standby for assignment of an air control frequency and air controller. Upon assignment of an air control frequency, establish UHF communications with the assigned air controller. The Primary and Back-up Aircraft (Seeding) will be assigned the same UHF air control frequency. While on station, all maneuvers will be as directed by, or coordinated with, the air controller.

(3) "OPS Normal" Report. See page E-2, paragraph 4.d.

(4) Departing Area. Report to Command Control when departing area. See page E-3, paragraph 4.g for clearance procedure.

c. Flight Operations. Optimum track to be flown as shown in Tab E-2 of this appendix. Track will be best possible, considering restrictions on seeding aircraft, available to satisfy scientific requirements of experiment.

(1) Pre-seeding. Prior to the actual seeding run, each seeding flight will be vectored around the hurricane so as to fly a circumnavigation track as practicable and arrive in the seeding run area fifteen minutes prior to scheduled drop time. During the fifteen minute interval before the actual seeding run is made, the primary and back-up seeding aircraft will be vectored into the same initial point area for visial contact if possible. If unable to maintain visual contact, an altitude separation of 2,000 feet clearance (minimum) will be assumed. Notify air controller when visual contact is acquired and/or lost. Calibrated air speed during the preceding phase of the experiment should be 240 knots ± 10 knots. Pyrotechnic canister drop will commence 5 seconds after entering the wall cloud, outbound.

(2) Seeding. The track to be flown during the seeding run will be determined by the Project Director and Navy Project Coordinator and relayed to each flight by the assigned air controller. This track will take into account "hard core" areas, if any, which will be avoided by use of radar information (ASB-1/APS-20 or other). The air controller will notify each aircraft at the 25, 10, 5 and every mile thereafter to the drop point.

The primary seeding aircraft will commence the release of two hundred eight (208) pyrotechnic canisters at a rate of approximately twelve each mile (approximately one every ½ second). If unable to commence release of pyrotechnic canisters within 30 seconds after being so directed, notify the back-up seeding aircraft and Command Control. The back-up seeding aircraft, 2,000 feet below the primary seeding aircraft, will then begin a seeding run, using procedures outlined above.

(3) Post-seeding.

(a) Primary seeding aircraft will report on the estimated degree of completion of his seeding run to include verification of beginning and ending times of the drop. After delivery or abort of the pyrotechnic canister loads, activate flight plan, check out with Command Control and proceed independently to the staging base. Immediately upon arrival, he will determine the exact number of pyrotechnic canisters dropped and communicate this to the Command Control Aircraft.

(b) Back-up seeding aircraft continue under the direction of the assigned air controller in completing a circumnavigation track around the hurricane for photo mission.

d. Data Collection. Record data in accordance with Annex U.

(1) Radar Settings. Unless otherwise directed by Command Control, seeding aircraft equipped with the ASB-1 radar system will operate radar in accordance with Annex R.

(2) Cloud Photography. Operate hand-held camera to obtain vertical profiles of clouds, as briefed.

(3) Meteorological Data. Collect and correlate with time as much of the following information as possible:

(a) CAS

(b) Temperature

(c) Absolute Altitude

(d) Pressure Altitude

(e) Ground Speed

(f) Drift Angle

(g) Ambient Pressure

e. Post-flight. Attend debriefing and turn in all records and film to the DQCC.

TAB E-1: Seeding Aircraft Flight Schedule

TAB E-2: Flight Track for Seeding Aircraft

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TAB E TO APPENDIX I TO ANNEX E

SEEDING AIRCRAFT FLIGHT SCHEDULE

(Based on hurricane center not more than 600 NM from staging base.)

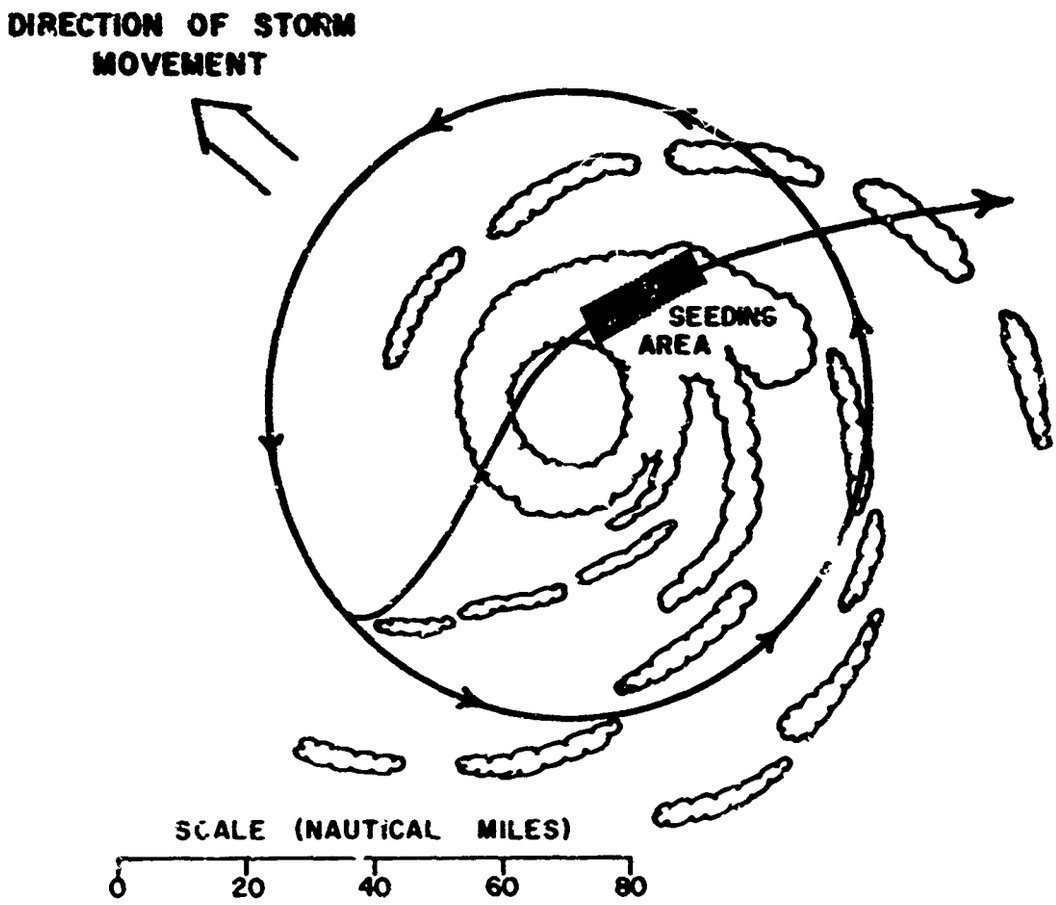
FLIGHT	AIRCRAFT	TANGO(T) 1200Z	T+2 1400Z	T+4 1600Z	T+6 1800Z	T+8 2000Z
L	A-6	DROP				
M	A-6	HOLDING STANDBY	DROP			
N	A-6		HOLDING STANDBY	DROP		
O	A-6			HOLDING STANDBY	DROP	
P	A-6				HOLDING STANDBY	DROP
Q	A-6					HOLDING STANDBY

First seeding aircraft arrive on station at 1150Z at 35,000 feet.

All subsequent seeding aircraft arrive on station 20 minutes prior to scheduled drop time, for the aircraft they are to back-up.

FLIGHT PATTERN-EYEWALL EXPERIMENT
FLIGHTS "L,M,N,O,P,Q" (NAVY A-6's) ALTITUDE 33,000 ft.
SEEDERS

FLIGHT TRACK FOR SEEDING AIRCRAFT



APPENDIX II TO ANNEX E

EYEWALL EXPERIMENT

ESSA Flight Procedures

1. DC-6, FLIGHTS A, B, A2

a. Mission. Mid-level Cloud Physics Monitor.

(1) Mission Priorities

(a) Meteorological data

(b) Radarscope photography, IFF video

(c) Cloud physics measurements

(d) Back-up dropsonde

(2) Modus Operandi

(a) Take off in time to arrive at a point relative to the hurricane track of 180 degrees, 60 miles from the eye center at 12,000 feet at 0900Z, 1500Z and 2100Z, FLIGHTS A, B, A2, respectively. Conduct operations in accordance with Tab A/B of this appendix.

b. General Communications. FLIGHTS A, B and A2, Voice Calls "STORMFURY ALPHA, STORMFURY BRAVO, and STORMFURY ALPHA TWO" respectively, will guard appropriate UHF/SSB frequencies for ARTCC and air control. See Annex C.

(1) Initial Report. After takeoff, report to nearest ARTCC as required.

(2) Reporting for Control. Check in with Command Control Aircraft on primary UHF/SSB frequency to report "OPS Normal", verify altitude and standby for assignment of air controller and air control frequency.

(3) Operations Normal Report. See page E-2, paragraph 4.d.

(4) Departing Area Report. Report to Command Control Aircraft when departing STORMFURY operating area. See page E-3, paragraph 5.g for clearance procedure.

c. Data Collection. Record data in accordance with Annex U.

(1) Radar and Radar Photography.

(a) Operations. Unless otherwise directed by Command Control, radars and cameras will be operated in accordance with Annex R.

(2) Photo-Panel Camera. Photo the following information every five (5) seconds:

(a) Time
(b) Latitude
(c) Longitude
(d) Radar Altitude
(e) Pressure Altitude
(f) Temperature (vortex)
(g) Wind Direction
(h) Wind Speed
(i) Absolute Humidity
(j) Engine Power (3MEP) (40C only)
(k) Interval Timer
(l) Flight Identification

(3) Meteorological Data Collection:

Interval	Data Recorded
Continuous when within 100 miles of eye, but particularly in eye-wall and major rainband.	Visicorder: Levine liquid water instrumentation.
Every second (digital tape)	(a) Time (b) Latitude (c) Longitude (d) Magnetic Heading (e) Magnetic Variation (f) D.T.C. (g) True Air Speed (h) Radar Altitude (i) Differential Pressure

Meteorological Data Collection (continued)

Interval	Data Recorded
Every second (digital tape)	(j) Absolute Pressure (k) Temperature (vortex) (l) Temperature (Rosemont) (m) Drift Angle (n) Wind Direction (o) Wind Speed (p) Pitch Angle (q) Roll Angle (r) Absolute Humidity (s) Liquid Water (J.W.) (t) C.S.I. Dew Pt Hygro (40C only) (u) Icing Detector (v) Flight Identification
Every 15 minutes	Observations as required to check automatic Doppler and meteorological system.
Every hour	WWV time check
At special positions relative to eye	Cold box samples at following positions: (a) Approaching hurricane first time; just before moving under cirrostratus shield. (b) Approaching eye first pass; at first evidence of gale force winds. (c) In eyewall; all passes in which time permits. Where there is insufficient time for samples in eyewall on both sides of center, select samples from the wall nearest radial of seeding. (d) At least one sample in eye before and two after seeding.

d. Dropsonde. Be prepared to make operational drops, as required by the Plan of the Day (POD).

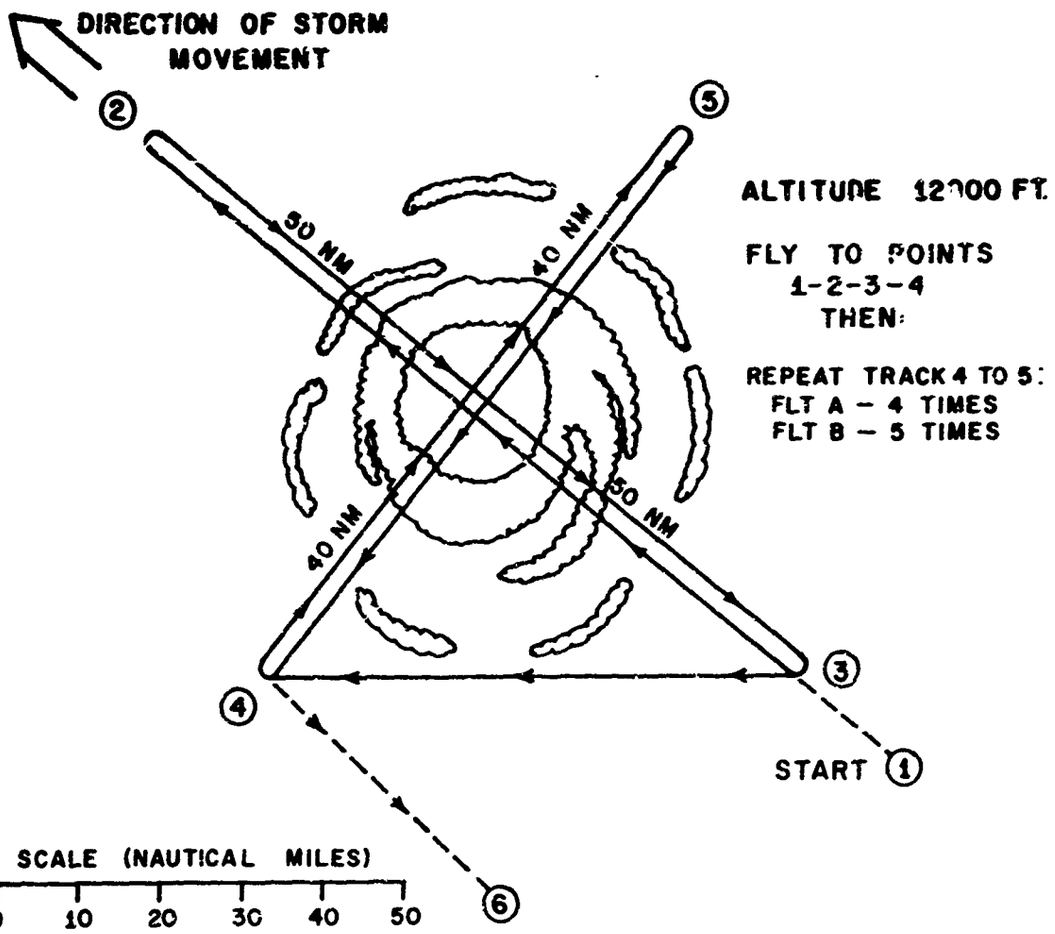
e. Center Fixes. Be prepared to make operational fixes of eye, as required by POD.

f. Departing STORMFURY Operations Area. Thirty minutes prior to scheduled departure from the STORMFURY operations area, contact appropriate ARTCC and obtain clearance for proceeding to staging base. Upon receipt of clearance, notify Command Control and proceed independently.

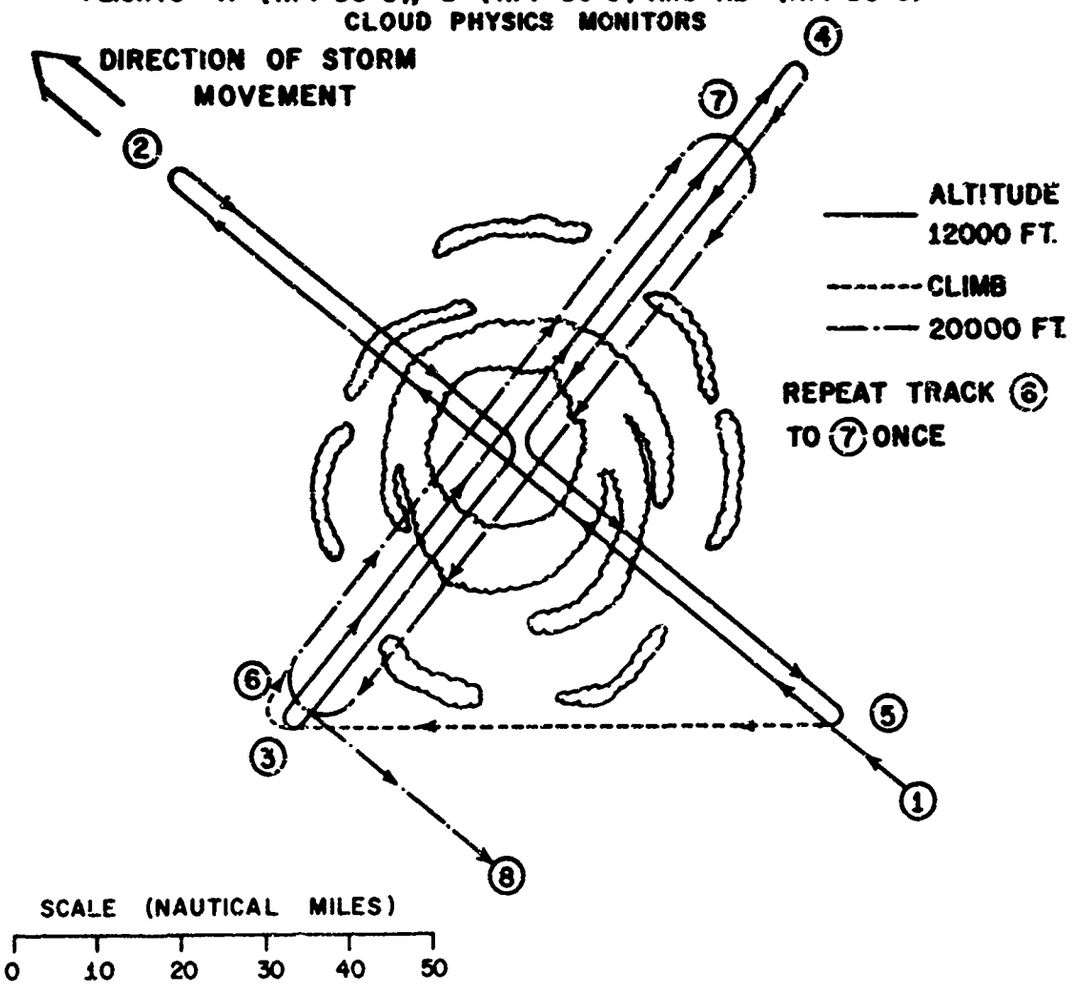
g. Post-Flight Debriefing. Selected crew members attend debriefings(s). Deliver flight records, including radar film, to the DQCC.

TAB A - Flight Track for FLIGHTS A, B and A2

FLIGHT PATTERN - EYEWALL EXPERIMENT
FLIGHTS "A" (RFF DC-6), "B" (RFF DC-6) AND "A2" (RFF DC-6)
CLOUD PHYSICS MONITORS



OPTIONAL FLIGHT PATTERN - EYEWALL EXPERIMENT
FLIGHTS "A" (RFF DC-6), "B" (RFF DC-6) AND "A2" (RFF DC-6)
CLOUD PHYSICS MONITORS



2. WB-57, FLIGHTS "C", "C2"

a. Mission. High Level Outflow Monitor.

(1) Mission Priorities

(a) Meteorological data

(b) Radarscope photography, radar video

(2) Modus Operandi

(a) Take off in time to arrive at the nearest point 100 miles south of the eye center at outflow level at 35,000 to 40,000 feet at 0930Z and 2330Z (FLIGHTS C and C2 respectively), as prescribed as briefing. Conduct operations in accordance with Tab C of this appendix.

b. General Communications. FLIGHTS C and C2, Voice Calls "STORMFURY CHARLIE" and "STORMFURY CHARLIE TWO", will guard appropriate UHF/SSB frequencies for ARTCC and air control. See Annex C.

(1) Initial Report. After takeoff, report to ARTCC, as required.

(2) Reporting for Control. Check in with Command Control Aircraft on primary UHF/VHF frequency, verify altitude and standby for assignment of air controller and air control frequency. FLIGHT C check in with FLIGHT G; FLIGHT C2 check in with FLIGHT F for control.

(3) Operations Normal Report. See page E-2, paragraph 4.d.

(4) Departing Area Report. Thirty minutes prior to scheduled departure from the STORMFURY operations area, contact appropriate ARTCC and obtain clearance for Proceeding to staging base. Upon receipt of clearance, notify Command Control and proceed independently.

c. Cloud Cameras. All nose camera cloud photographs.

d. Meteorological Data Collection. Record data in accordance with Annex U.

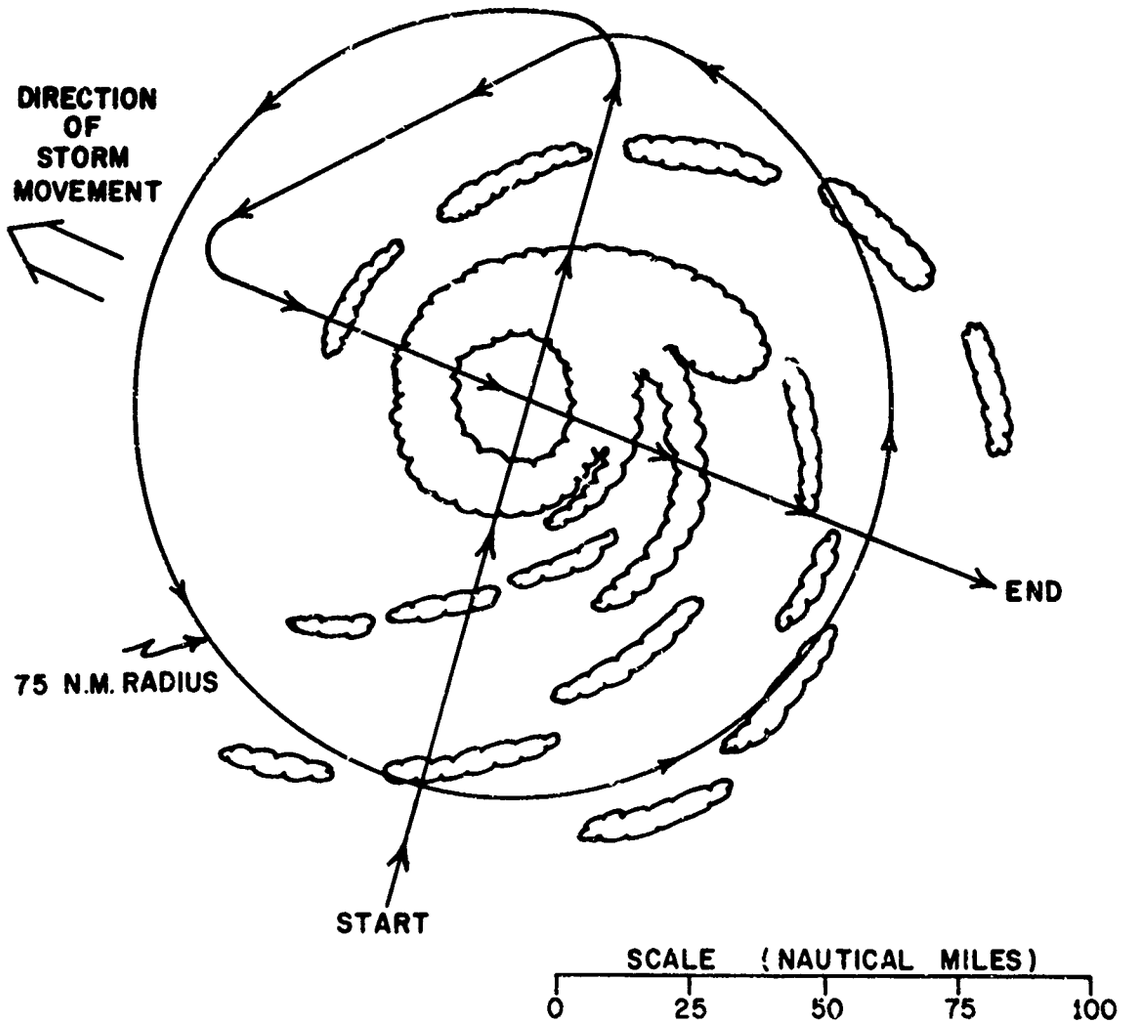
Interval	Data Recorded
1 second	Time, latitude, longitude, magnetic heading, magnetic variation, DTC, TAS, radar altitude, differential pressure, absolute pressure, temp (vortex), drift angle, wind direction and speed, pitch angle, roll angle
5 minutes	Manually recorded data for back-up: absolute altitude, pressure altitude, pressure, temperature, wind direction and speed (or raw navigation data required to compute same).

e. Radar and Radarscope Photography. Unless otherwise directed by Command Control, operate RDR-1 radar, radarscope and camera systems in accordance with Annex R.

f. Post-Flight. Selected crew members attend debriefings and turn in all records of data collected, including radar film, to the DQCC.

TAB C - Flight Pattern for FLIGHTS C and C2

FLIGHT PATTERN - EYEWALL EXPERIMENT
FLIGHTS "C" AND "C2" (RFF WB-57) ALTITUDE 35-40,000 ft.
OUTFLOW MONITOR



3. C-54, FLIGHT "D"

a. Mission. Low level Inflow Monitor.

(1) Mission Priorities

(a) Meteorological data

(b) Radarscope photography

(c) Sea surface temperature

(2) Modus Operandi

(a) Take off in time to arrive at the nearest point 100 miles south of the eye center at 1,000 feet absolute at 1500Z. Conduct operations in accordance with Tab D of this appendix.

b. General Communications. FLIGHT D, Voice Call "STORMFURY DELTA", will guard appropriate UHF/SSB frequencies for ARTCC and air control. See Annex C.

(1) Initial Report. After takeoff, report to ARTCC, as required.

(2) Reporting for Control. Check in with Command Control Aircraft on primary UHF/VHF frequency, verify altitude and standby for assignment of air controller and air control frequency.

(3) Operations Normal Report. See page E-2, paragraph 4.d.

(4) Departing Area Report. Thirty minutes prior to scheduled departure from the STORMFURY Operations Area, contact appropriate ARTCC and obtain clearance for Proceeding to staging base. Upon receipt of clearance, notify Command Control and proceed independently.

c. Data Collection (within 100 nautical miles of the eye). Record data in accordance with Annex U.

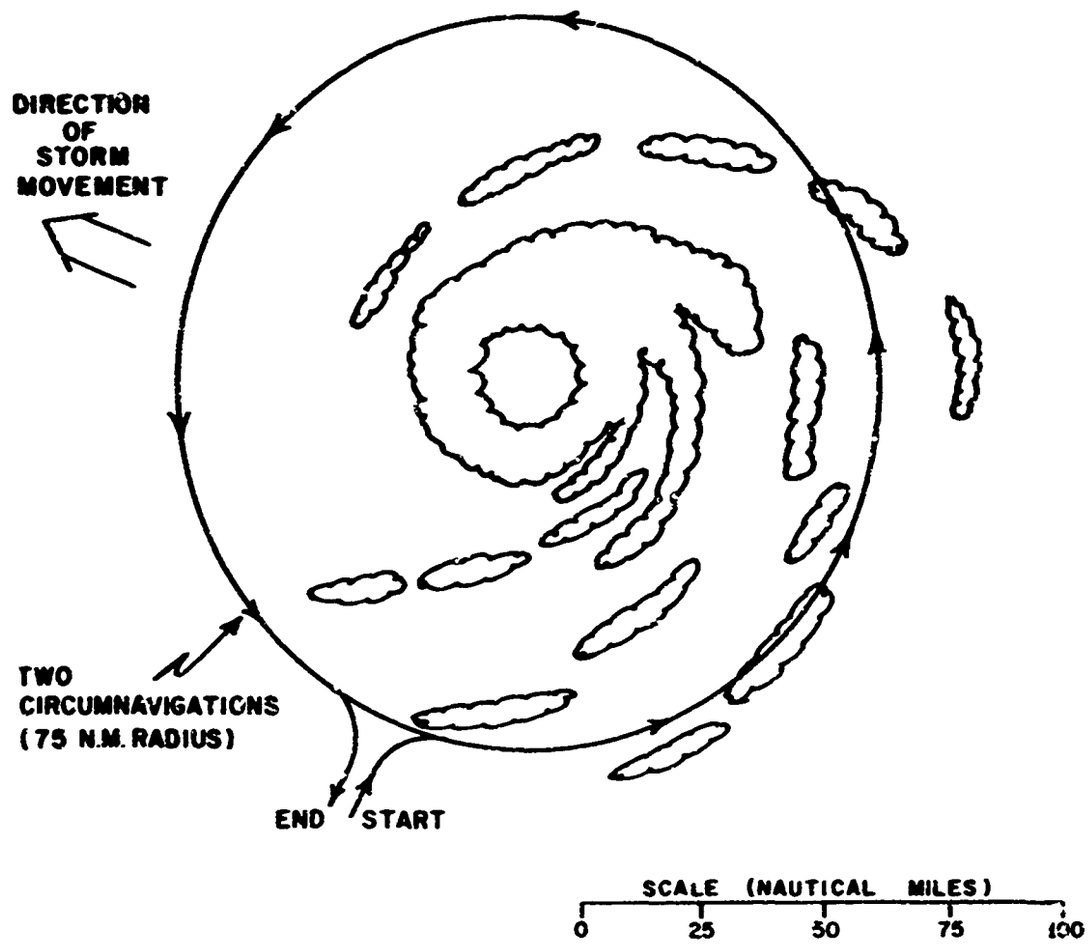
Data Collection (continued)

Interval	Data Recorded
Every 10 seconds	Time, latitude/longitude, magnetic heading, indicated airspeed, radar altitude, pressure altitude, temp (vortex), wind speed and direction, absolute humidity, flight identification.
Every 1 minute if AMQ-17 operative; every 5 minutes if AMQ-17 inoperative.	Doppler wind direction/speed. (Visual wind when doppler inoperative)
Every 10 minutes	Visual wind for doppler check
Every 15 minutes routinely, and at every significant change of course	Aircraft position (range/bearing from eye)
Every hour	WWV time check

d. Post-Flight Debriefing. Turn in all records of data collected, including radar film, to the DQCC.

TAB D - Flight Pattern for FLIGHT D

FLIGHT PATTERN – EYEWALL EXPERIMENT
FLIGHT "D" (RFF-54) ALTITUDE 1,000 ft.
INFLOW MONITOR



APPENDIX III TO ANNEX E

EYEWALL EXPERIMENT

Air Force Flight Procedures

1. WB-47, FLIGHT "J"

a. Mission. High Level Outflow Monitor.

(1) Mission Priorities

(a) Meteorological data

(b) Raderscope photography

(2) Modus Operandi

(a) Take off in time to arrive at the nearest point 100 miles south of the eye center at outflow level at 35,000 to 40,000 feet at 1600Z. Conduct operations in accordance with Tab A of this appendix.

b. General Communications. FLIGHT J, Voice Call "STORMFURY JULIETT", will guard appropriate UHF/SSB frequencies for ARTCC and air control. See Annex C.

(1) Initial Report. After takeoff, report to ARTCC, as required.

(2) Reporting for Control. Check in with Command Control Aircraft on primary UHF/VHF frequency to report "OPS Normal", verify altitude and standby for assignment of air controller and air control frequency.

(3) Operations Normal Report. See page E-2, paragraph 4.d.

(4) Departing Area Report. Thirty minutes prior to scheduled departure from the STORMFURY operations area, contact appropriate ARTCC and obtain clearance for proceeding to staging base. Upon receipt of clearance, notify Command Control and proceed independently.

c. Data Collection. Record data in accordance with Annex J.

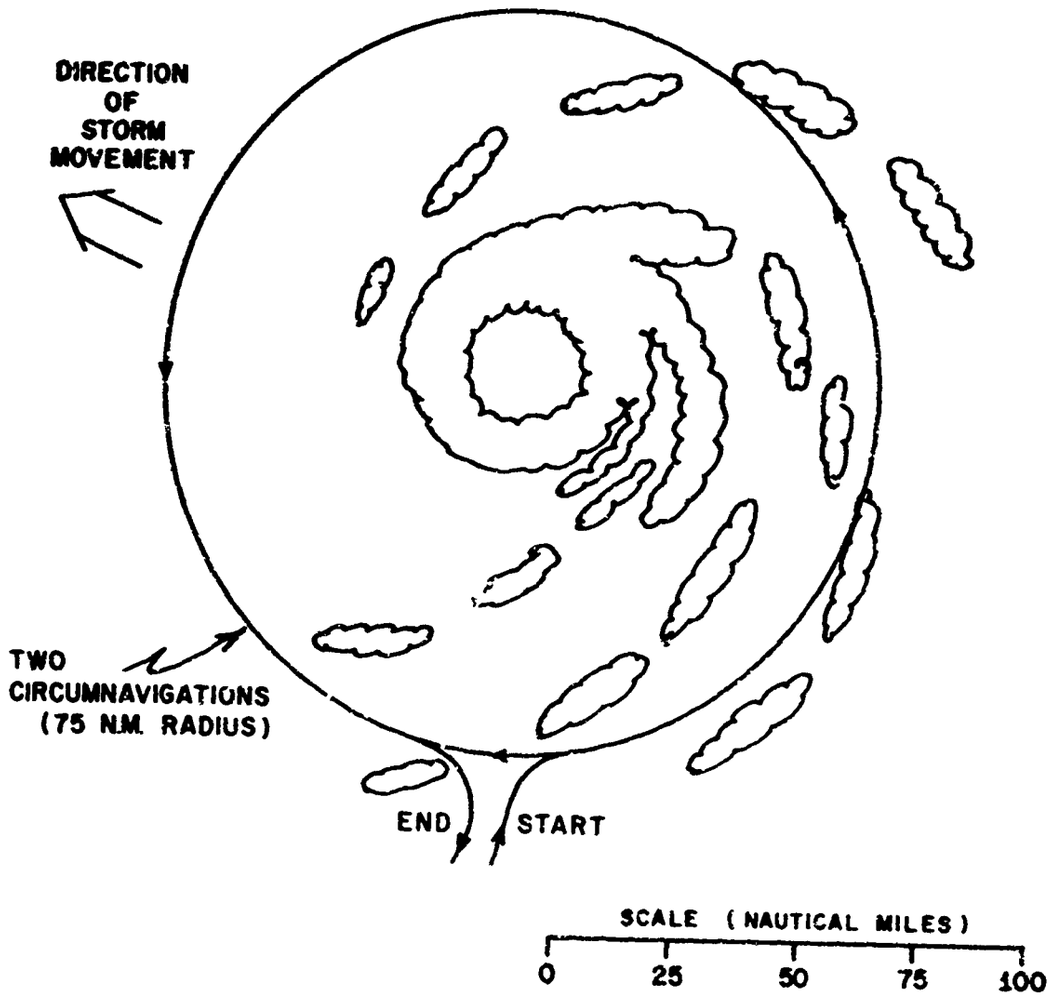
(1) Manually recorded data. Fill in WB-47 Report Form, in triplicate, as supplied by Project Director. Record data requested on pre-assembled triplicate forms (see Tab B of this appendix) supplied at pre-flight.

(2) Radar and Radarscope Photography. Operate APS-64 radar and O-15 camera system in accordance with Annex R.

d. Post-Flight. Selected crew members attend debriefing(s) and turn in all records of data collected, including film, to the DOCC.

TAB A - Flight Pattern for FLIGHT J

FLIGHT PATTERN – EYEWALL EXPERIMENT
FLIGHT "J" (AF WB-47) ALTITUDE 35-40,000 ft.
OUTFLOW MONITOR



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2. WC-130, FLIGHT "I"

a. Mission. High Level Cloud Physics Monitor.

(1) Mission Priorities

(a) Meteorological data

(b) Radarscope photography, radar video

(2) Modus Operandi

(a) Take off in time to arrive at a position approximately 90 nautical miles south of the hurricane eye center at 29,000 feet at 1500Z. Conduct operations in accordance with Tab B of this appendix.

b. General Communications. FLIGHT I, Voice Call "STORMFURY INDIA", will guard appropriate UHF/VHF frequencies for ARTCC and air control. See Annex C.

(1) Initial Report. After takeoff, report to ARTCC, as required.

(2) Reporting for Control. Check in with Command Control Aircraft on primary UHF (STORMFURY Common) or VHF 134.1 to report "OPS Normal", verify flight altitude and standby for assignment of air controller and air control frequency.

(3) Operations Normal Report. See page E-2, paragraph 4.d.

(4) Departing Area Report. Report to Command Control Aircraft when departing area. See page E-3, paragraph 4.g for clearance procedures.

c. Data Collection. Record data in accordance with Annex U.

(1) Meteorological:

Interval	Data Recorded
Every 5 minutes	Time, wind direction, wind speed, ambient temperature, pressure, altitude and radar altitude.
Every 5 minutes	A/C position (latitude/longitude)

Meteorological Data Collection (continued)

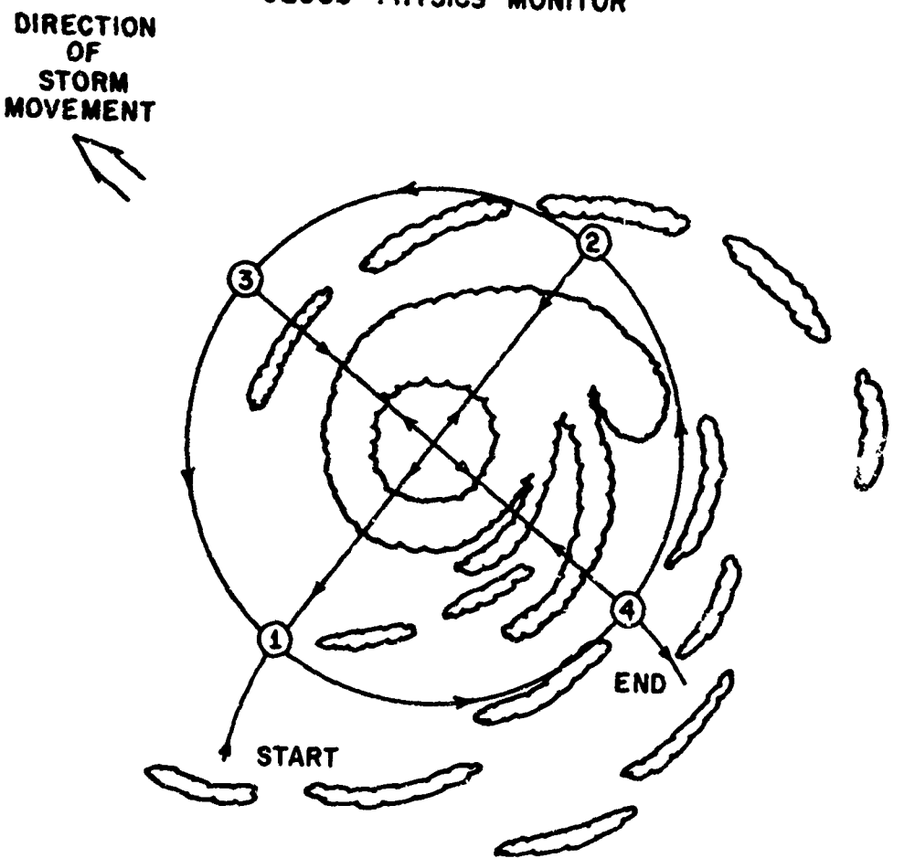
Interval	Data Recorded
Every 10 minutes	Range and bearing of center of eye.
Every 15 minutes	Observations as required for updating Doppler and automatic recording equipment.
Every hour	WWV time check

(2) Radar. Operate in accordance with Annex R.

d. Post-Flight. Attend post-flight debriefing. If not feasible, retain all copies of all data collected, including film, at base of flight origin to be hand-delivered to the DQCC. Under no circumstances will records or film be mailed.

TAB B - Flight Pattern for FLIGHT "I"

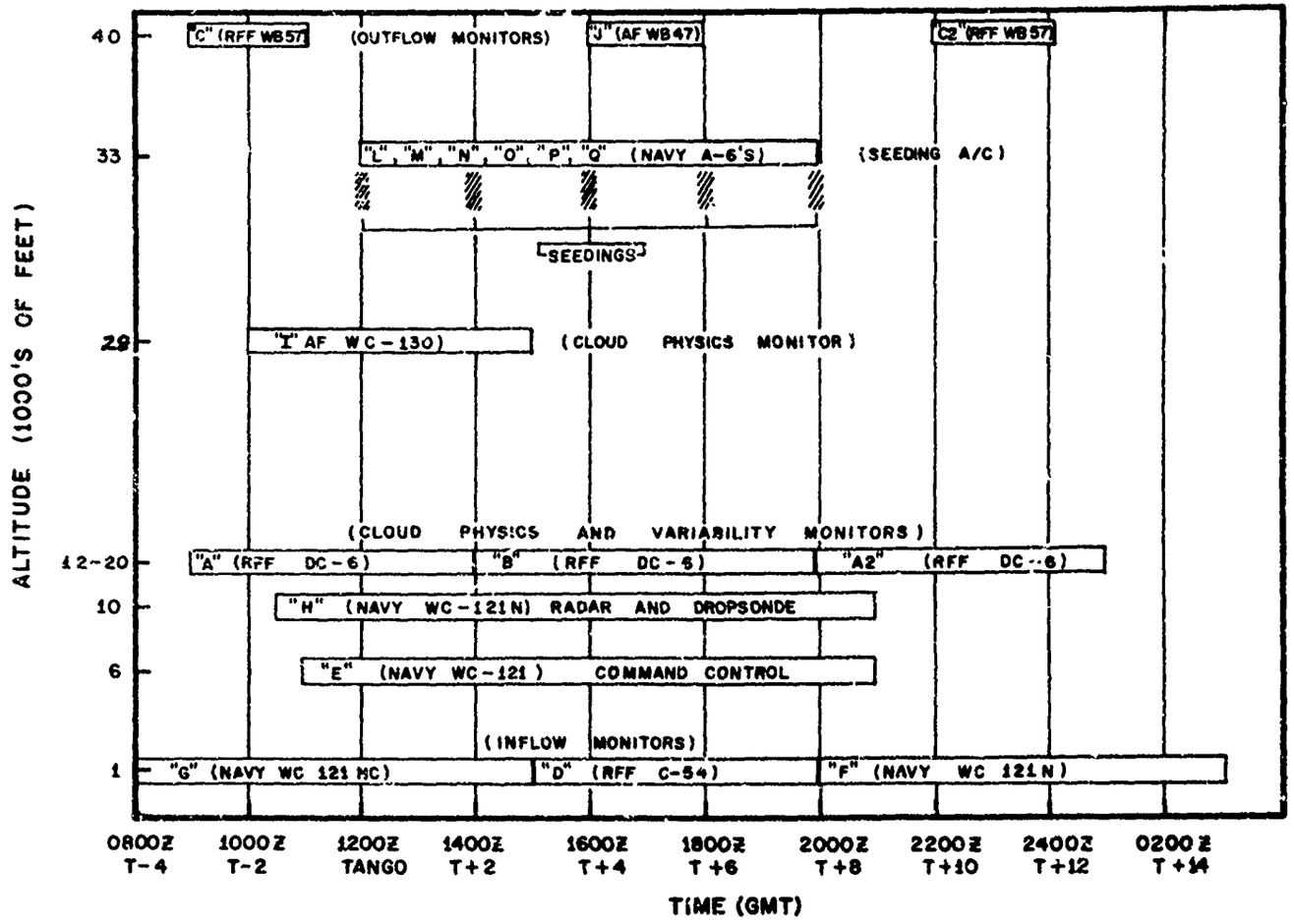
FLIGHT PATTERN-EYEWALL EXPERIMENT
FLIGHT "I" (AF WC-130) ALTITUDE 20,000 ft.
CLOUD PHYSICS MONITOR



ORDER OF FLIGHT PATTERN BY POINTS
(1-2-1) 25,000 FT. DESCEND
(1-4-3-4-2-1-2-3-4-3-1-2-1) 22,000 FT.
(1-4) CLIMB
(4-3-4) 25,000 FT.

SCALE (NAUTICAL MILES)
0 25 50 75 100

TIME TABLE FOR STORMFURY AIRCRAFT EMPLOYMENT - EYEWALL EXPERIMENT



CHRONOLOGICAL SUMMARY

APPENDIX V TO ANNEX E

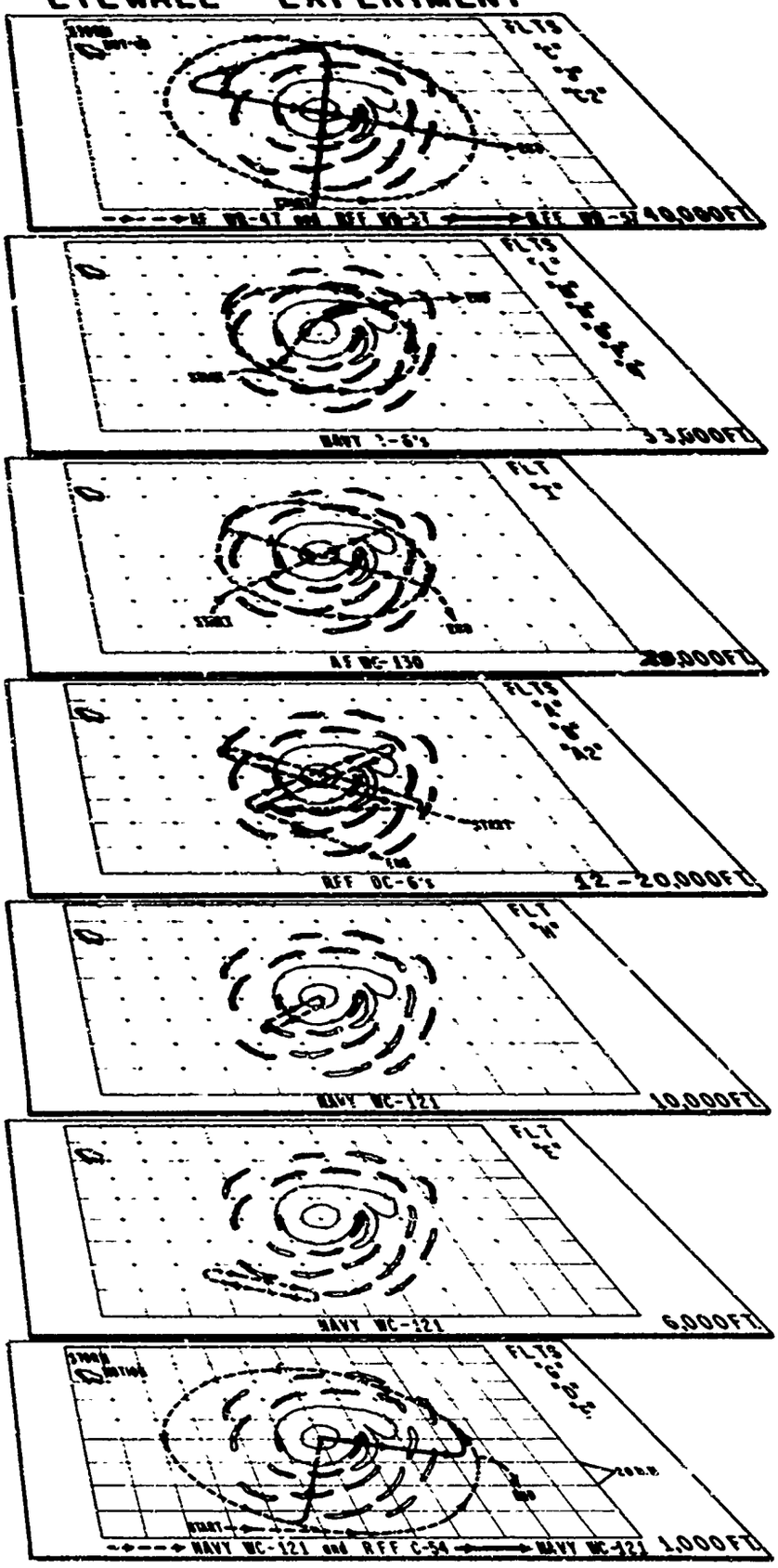
EYEWALL EXPERIMENT

AIRCRAFT	FLIGHT	VOICE CALL	ON-STATION TIME (Z)	ALTITUDE	DISTANCE FROM CENTER OF AIRSPACE (NM)
WC-121N	G	STORMFURY G	0800-1500	1,000 ABS	100
DC-6	A	STORMFURY A	0900-1400	12,000 MSL	75
WB-57	C	STORMFURY C	0930-1100	35-40,000 MSL	100
*WC-121N	H	STORMFURY H	1030-2100	10,000 MSL	75
*WC-121N	E	STORMFURY E	1100-2100	6,000 MSL	75
**A-6	L-Q	STORMFURY L-Q	1200-2000	33,000 MSL	100
DC-6	B	STORMFURY B	1500-2000	12,000 MSL	75
C-54	D	STORMFURY D	1500-1900	1,000 ABS	100
WC-130	I	STORMFURY I	1500-1900	29,000 MSL	90
WB-47	J	STORMFURY J	1600-1800	35-40,000 MSL	100
WC-121N	F	STORMFURY F	1900-0200	1,000 ABS	100
DC-6	A2	STORMFURY A2	2100-0200	12,000 MSL	75
WB-57	C2	STORMFURY C2	2230-2400	35-40,000 MSL	100

*NOTE: STORMFURY H will be Command Control Aircraft until relieved by STORMFURY E on station.

**NOTE: Seeder aircraft will enter area at FL 330, climb to FL 350 when directed by the STORMFURY Controller and exit at FL 350.

EYEWALL EXPERIMENT



OPERATION PLAN
FWF JAX NO. 1-69

Project STORMFURY
Fleet Weather Facility
Naval Air Station
Jacksonville, Florida
June 1969

ANNEX F

HURRICANE/TROPICAL CYCLONE RAINBAND SEEDING EXPERIMENT

1. General Briefing.

a. Time: 1300Z on day before seeding operations.

b. Place: To be designated.

c. Agenda:

(1) Opening Remarks - Director, Project STORMFURY

(2) Operation Plan Review - Assistant Director, Project STORMFURY

(3) Review Applicable Parts of Operation Plan - Air Controller

(4) Forces Status Reports - Senior Representative, Each Activity

d. Attendees: All personnel participating in the hurricane rainband seeding experiment of Project STORMFURY.

2. Operations.

a. Aircraft and Equipment Status Reports. The Senior Representative Present of each participating activity will provide the Navy Project Coordinator with initial aircraft and equipment status reports by 1300Z on the day before the actual seeding experiment, and daily thereafter by 0100Z until the experiment is completed or terminated. The Data Quality Control Coordinator (DQCC) will advise the Director of the status of aircraft instruments and sensor systems in accordance with the same schedule.

b. Fueling Requirements. All aircraft will be fueled at the discretion of the aircraft commander.

c. Flight Operations. Operations will be conducted in accordance with the following appendices, as appropriate:

(1) USN Flights - Appendix I

(2) ESSA Flights - Appendix II

(3) USAF Flights - Appendix III

3. Position Assignment of Key Personnel. To be assigned by Project Director and Assistant Project Director at or before briefing session for each mission.

4. Air Operations.

a. Filing a Flight Plan. Aircraft will file VFR/IFR flight plans at staging base to a geographical position to be decided at the pre-flight briefing. This position will be based on information received from the "Early" mesoscale monitor, FLIGHT "F". Aircraft departing from other bases file flight plans, as appropriate, in order to be on station at scheduled times. Coordination of takeoff times and on-station times should be accomplished through STORMFURY Project Officers at staging base or Fleet Weather Facility, Jacksonville.

b. Outbound. Fly a wind calibration box for Doppler calibration as required; then proceed to the Project STORMFURY operating area (airspace reservation).

c. IFF/SIF Procedures. See Annex C. Procedures for entering and departing the STORMFURY operating area will be promulgated at the briefing.

d. Initial Report. After takeoff, report to ARTCC, as required.

e. OPS Normal Report. As soon as practical after reporting to ARTCC, each flight will contact the Command Control Aircraft via UHF/SSB communications and submit an "OPS Normal" report, verify altitude, and standby to be assigned an air controller and air control frequency. Each aircraft will report "OPS Normal", or appropriate condition, to the Command Control Aircraft every hour while in the STORMFURY operating area.

f. Air Control. Upon assignment of an air controller and air control frequency, each flight will then establish communications with Command Control on the assigned UHF frequency. Upon establishing UHF communications, the Command Control Aircraft, a Navy WC-121N, will assume air control responsibility for the reporting aircraft by notifying the appropriate ARTCC of the voice call/FAA radio call, altitude and time of assuming positive control. The Command Control Aircraft will retain this responsibility until either the controlled aircraft or the Command Control Aircraft departs the operating area, at which time another WC-121N will acknowledge receipt for the air control of each respective flight, after establishing respective voice communications. Ensure compliance with air control procedures set forth by the FAA in Annex T.

g. Forces Status Report. The Command Control Aircraft will notify the appropriate ARTCC of the status of each aircraft under its control once each hour. This report will be in the form of a collective "OPS Normal" report to ARTCC. The center of the airspace reservation will also be updated at this time.

h. Departing STORMFURY Operating Area. Thirty minutes prior to departing from the STORMFURY operating area, each flight will advise

appropriate Oceanic Control of such plans, obtain clearance, and return independently to the staging base or other operating base.

5. Radar

a. Calibration. All radars will be calibrated in accordance with the procedures described in Annex R.

6. Radarscope Photography. Radarscope photography will be conducted in accordance with Annex R and the schedule provided by Modus Operandi Appendix applicable to each flight. Radarscope photography log, as shown in Annex R and Annex U, will be completed for each radarscope photographed.

7. Data Collection Forms. See Annex U.

8. Aircraft Employment. Aircraft will be employed in accordance with the time table, mission and altitude assignments, as described in Appendices I through IV of this annex.

9. Altitude Assignments. All aircraft will fly at assigned pressure altitudes (altimeters set at 29.92), except FLIGHTS "F", "G" and "H", which will fly at 1,000 feet absolute altitude while on station.

10. Abort Contingency. Decision to abort the mission is an inherent responsibility of the plane commander for each aircraft. However, the decision to abort for reason of data measuring instruments failure should be made only after due coordination with the Project Director aboard the Command Control Aircraft.

11. Debriefing

a. Time: As soon as possible after last aircraft lands.

b. Place: To be designated.

c. Agenda:

(1) Assistant Director, Project STORMFURY - Chairman of Operations Debriefing.

(2) Director, Project STORMFURY - Chairman of Scientific Debriefing.

(3) On-Scene Commander attends both meetings.

(4) Director, Project STORMFURY - Review of operational success of the experiment.

(5) Data Quality Control Coordinator - Review of data quality and quantity.

Debriefing will be held back-to-back, with Operational Debriefing first. Selected key personnel will also attend follow-on Scientific Debriefing.

LELAND J. UNDERWOOD
Commander, U. S. Navy
Navy Project Coordinator/
Assistant Project Director
for Project STORMFURY

Appendices:

I - Navy Flight Procedures
II - ESSA Flight Procedures
III - USAF Flight Procedures
IV - Time Table for STORMFURY (Rainband) Aircraft Employment
V - Chronological Summary for STORMFURY Aircraft
VI - Composite Flight Tracks for Rainband Experiment

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APPENDIX I TO ANNEX F

RAINBAND EXPERIMENT

Navy Flight Procedures

1. WC-121, FLIGHTS "F", "G", "H"

a. Mission. Low Level Mesoscale Monitor.

(1) Take off in time to arrive at a point 100 miles southwest of the storm/hurricane center at 1000 feet absolute altitude at 0600Z, 1400Z and 2200Z, respectively. Conduct operations in accordance with Appendix I, Tab A.

b. General Communications. FLIGHTS "F", "G" and "H", Voice Calls "STORMFURY FOXTROT", "STORMFURY GOLF", and "STORMFURY HOTEL", respectively, will guard the appropriate UHF/SSB frequencies for ARTCC and air control in accordance with Annex C.

(1) Initial Report. After takeoff, report to the nearest ARTCC, as required.

(2) Reporting for Air Control. As soon as possible after the arrival of FLIGHT "E" (WC-121N, STORMFURY ECHO) into the Project STORMFURY operating area (approximately 1000Z), FLIGHT "F" will establish UHF (STORMFURY Common)/SSB voice communications and standby for assignment of an air control frequency and air controller. After establishing UHF communications with the assigned air controller, all maneuvers will be as directed by the air controller.

(3) Operations Normal Report. See page F-3, paragraph 4.e.

(4) Departing STORMFURY Operating Area. Thirty minutes prior to scheduled time for departing the Project STORMFURY area (airspace reservation), contact appropriate Oceanic Control for clearance inbound; then proceed independently to the staging base. Report departure to Command Control Aircraft.

c. In-flight Procedures.

(1) Outbound. Fly a wind calibration box for Doppler calibration, then proceed to the Project STORMFURY operating area.

(2) Initial Rainband Description Report. As soon as practical after the aircraft has acquired the center of the storm/hurricane on radar, FLIGHT "F" will initiate an initial rainband description report to the appropriate ARTCC via Single Sideband, precedence "Immediate". This report will contain the coordinates of the center of the storm/hurricane, and the distance to the inbound and outbound extremities of each rainband at 15 degree increments:

Example - (Text)

N 45929 STORMFURY "F" A/C Posit Time (Z) 360-None 030-40/60
045-40/60 90/120 060-50/80 90/130 075-60/90 80/130 etc.

d. Penetration of Storm/Hurricane. FLIGHT "F" will make a penetration of the storm/hurricane at 0600Z and 1200Z; FLIGHT "G" at 1800Z; and FLIGHT "H" at 0000Z. Detailed eye reports will be filed for each penetration and transmitted to FWF JAX via SSB to fulfill Reconnaissance Plan of the Day requirements.

e. Peripheral Data. Upon exiting the storm/hurricane center, commence a peripheral data flight at a radius of 80 miles from the center.

f. Data Collection Requirements for FLIGHTS "F", "G" and "H". Record data in accordance with Annex U.

(1) Meteorological:

Interval	Data Collected
Every minute if DLS operative; every 5 minutes if AMQ-17 inoperative	Channel 00-10, 14-17, time, ambient pressure, temp and relative humidity.
Every 5 minutes	True heading, TAS, drift, ground speed and D values, range and bearing from center of eye, surface wind direction and velocity and surface pressure.
Every 15 minutes	Observations as required to check validity of readings from AMQ-17 and Doppler.
Every hour	A/C position and WWV time check. Indicate spiral band crossing angle used, if any.

(2) Radar. Operate in accordance with Annex R.

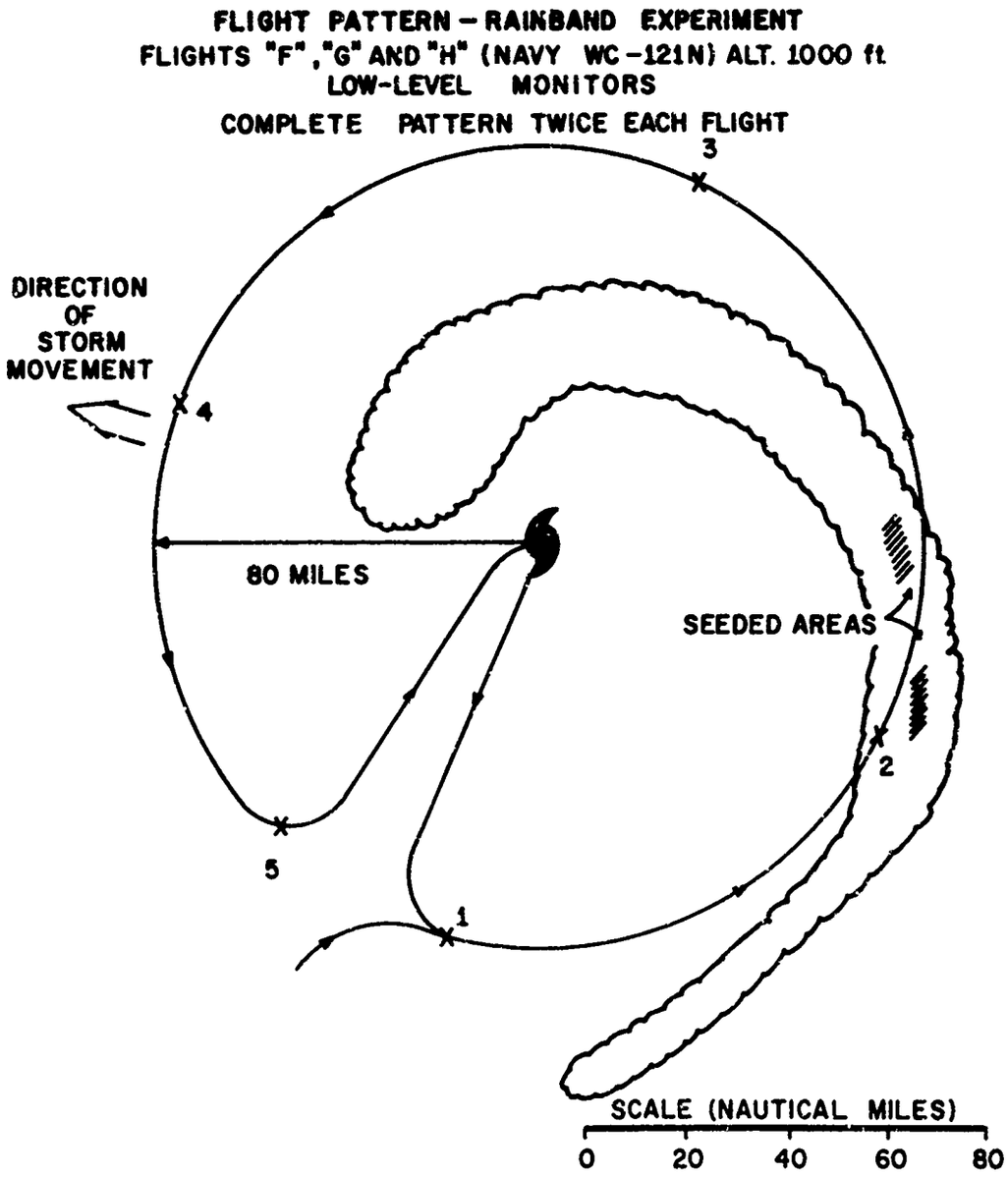
g. Cloud Photography. While on station, the time lapse 35 MM camera system will be operated as follows:

Frame Rate	1 frame/5 second
Vertical Tilt	zero degrees
Auxiliary Data	24-hour clock (Total elapsed time in seconds) Flight identification

h. Post-Flight. Attend post-flight debriefing and turn in all records of data, including film, to the DQCC.

TAB A - Flight Pattern for FLIGHTS F, G and H

TAB A TO APPENDIX I TO ANNEX F



2. WC-121, FLIGHT "E"

a. Mission. Command Control.

(1) Take off in time to arrive within sixty miles of the selected rainband at 6,000 feet by 1000Z. Conduct operations in accordance with Appendix I, Tab B.

b. General Communications. FLIGHT "E", Voice Call, "STORMFURY ECHO", will guard appropriate UHF/SSB frequencies for ARTCC and air control in accordance with Annex C.

(1) Initial Report. After takeoff, report to the nearest ARTCC, as required.

(2) Reporting on Station. Upon arrival in the Project STORMFURY operating area, establish UHF communications with FLIGHT "F" and assign an air control frequency and air controller. Notify ARTCC via SSB that FLIGHT "F" is under positive control, verifying flight identification and altitude and radius of operations of FLIGHT "F".

(3) Assignment of Air Control Frequency and Air Controller. As flights "B" through "G" report on station and UHF communications are established on STORMFURY Common, assign an air control frequency and air controller to each flight.

(a) Tracks to be flown by assigned aircraft. See composite flight tracks for Rainband Experiment, Appendix VI or Tabs for each flight, Appendices I through III of Annex F.

(4) Forces Status Report. Collect "OPS Normal" reports from all aircraft under positive control. Submit a forces status report to ARTCC every hour to verify the flight identification, altitude and radius of operation for each aircraft.

c. Data Collection. Record data in accordance with Annex U.

(1) Meteorological:

Interval	Data Recorded
Every minute if DLS operable. Every 5 minutes if DLS inoperable.	Channel 00-10, 14-17 Time, pressure, temperature, and relative humidity.
Every 5 minutes	True heading, TAS, drift, ground speed, D value
Every 15 minutes	Pressure/temp. observations as required to check validity of readings from AMQ-17 and Doppler. A/C latitude/longitude.
Every hour	WWV time check

(2) Radar. Operate radars as required for airborne air control of all aircraft under positive control.

(3) Radarscope Photography. Operate in accordance with Annex R.

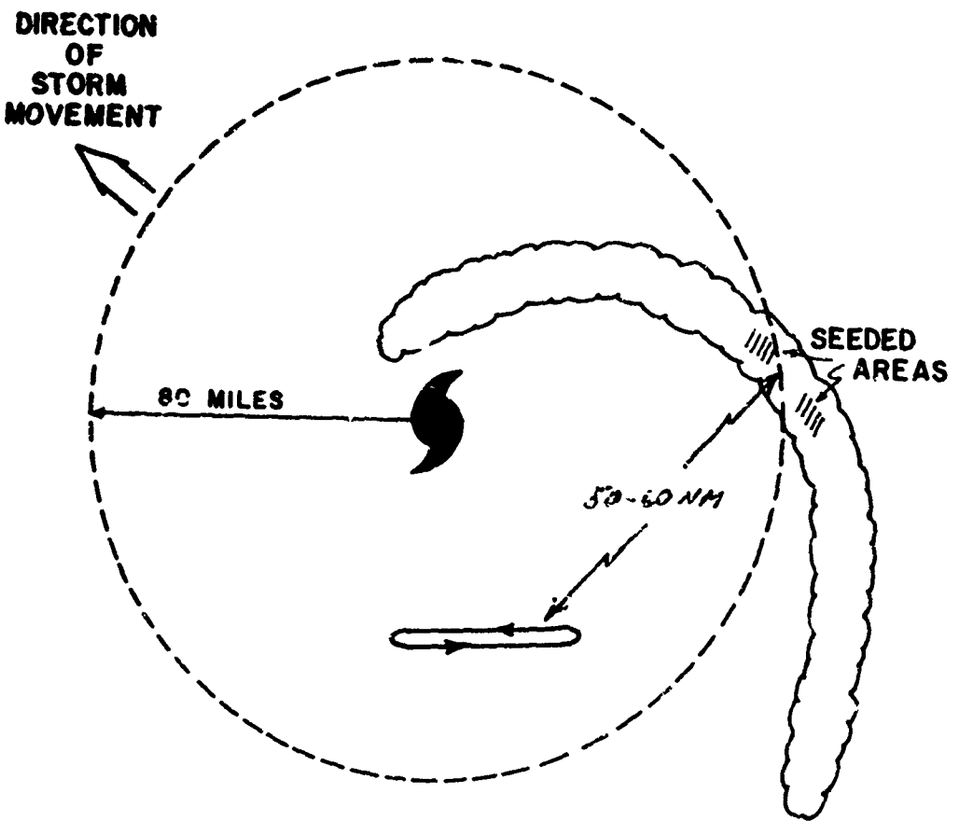
d. Inbound. Notify ARTCC when all aircraft have departed the reserved airspace area, verifying flight identification and altitude of each aircraft previously under positive control of the Command Control Aircraft.

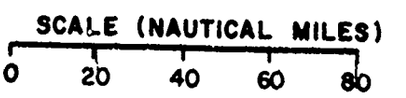
e. Post-Flight Conduct debriefing of flight crews. Turn in all records of data collected and radar film used to the DOCC.

TAB B - Flight Pattern for FLIGHT E

TAB B TO APPENDIX I TO ANNEX F

FLIGHT PATTERN — RAINBAND EXPERIMENT
FLIGHT "E" (NAVY WC-121) ALTITUDE 6000 ft.
COMMAND CONTROL





3. A-6, FLIGHT "L"

a. Mission. Seeding and High Level Macrostructure Monitor.

(1) Take off in time to arrive at a pre-determined geographical position approximately 100 miles east of the storm/hurricane center at 35,000 feet by 1100Z. Conduct operations in accordance with Appendix I, Tab C.

b. General Communications. FLIGHT "L", Voice Call "STORMFURY LIMA", will guard the appropriate UHF/SSB frequencies for ARTCC and air control in accordance with Annex C.

(1) Initial Report. After takeoff, report to the nearest ARTCC, as required.

(2) Reporting for Air Control. Prior to entering the STORMFURY operating area, contact Command Control Aircraft "STORMFURY ECHO" on UHF or SSB to report "OPS Normal", verify altitude and standby for assignment of an air control frequency and air controller.

(3) OPS Normal Report. See page F-3.

(4) Departing STORMFURY Operating Area. See page F-3.

c. Flight Operations

(1) Pre-seeding. Prior to the actual seeding, flight will be vectored to arrive in the seeding area fifteen minutes prior to scheduled drop time. Calibrated airspeed during the pre-seeding phase of the experiment should be 240 knots $\pm$ 10 knots.

(2) Seeding. The track to be flown during the seeding run will be determined by the Project Director and Navy Project Coordinator and relayed to the flight by the assigned air controller. This track will be flown in such a manner as to ensure that the seeding run is conducted under VFR

conditions, if possible, and does not exceed the "G" force limits of the seeder aircraft. Drop rate will be once each ½ second. A typical seeding track is shown on Tab C of this appendix.

(3) Post-seeding. The seeding aircraft will report on the estimated degree of completion of his seeding run to include verification of beginning and ending times of the drop. After delivery of the pyrotechnic devices, activate flight plan, check out with Command Control, and proceed independently to the staging base. Immediately upon arrival, determine the exact number of pyrotechnic canisters dropped and communicate this information to the Command Control Aircraft.

d. Data Collection.

(1) Radar Settings. Operate in accordance with Annex R.

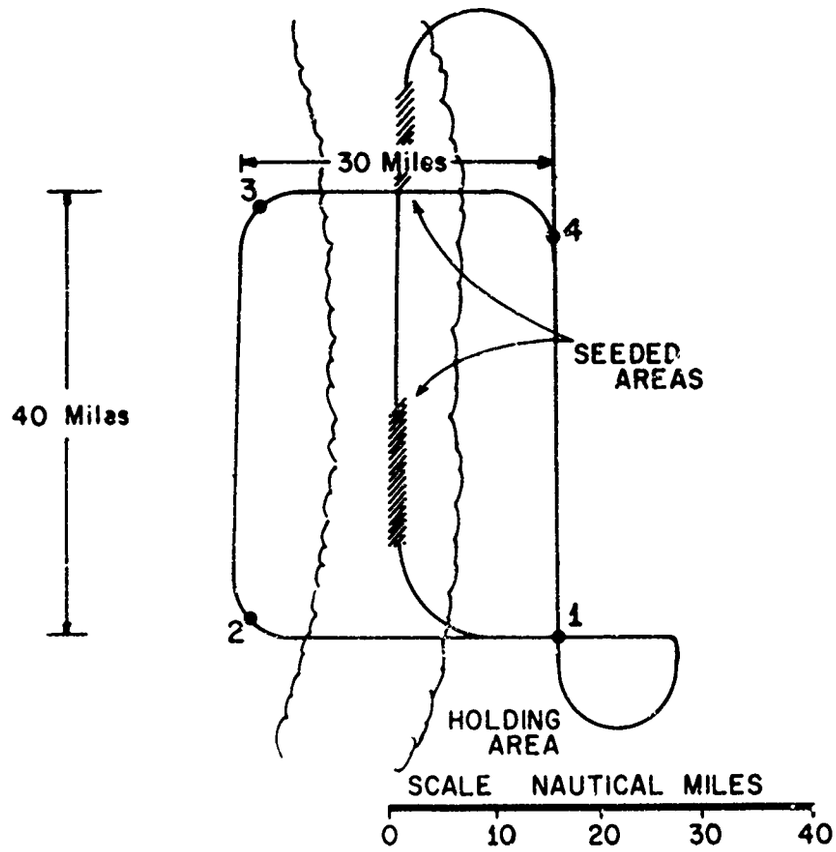
(2) Cloud Photography. Operate nose and right-side cameras if available to obtain vertical profiles of clouds, at a rate of one exposure every six seconds while on station.

(3) Meteorological Data. Collect and record these data in accordance with Annex U (Forms SF-3, SF-4, SF-5).

e. Post-Flight. Attend debriefing and turn in all records collected and film to the DQCC.

TAB C - Flight Pattern for FLIGHT L

FLIGHT PATTERN – RAINBAND EXPERIMENT
FLIGHT "L" (NAVY A-6) ALTITUDE 35,000 ft.
SEEDER AIRCRAFT
COMPLETE PATTERN 1-2-3-4-1 ONCE PRIOR TO SEEDING RUN AND CONTINUE THE SAME PATTERN AFTER THE SEEDING RUN UNTIL RELEASED



4. A-6, FLIGHT "M"

a. Mission Seeding Back-up/Cloud Photography.

(1) Take off in time to arrive at a pre-determined geographical position approximately 100 miles east of the storm/hurricane center at 37,000 feet by 1100Z. Conduct operations in accordance with Appendix I, Tab D.

b. General Communications. FLIGHT "M", Voice Call "STORMFURY MIKE", will guard the appropriate UHF/SSB frequencies for ARTCC and air control in accordance with Annex C.

(1) Initial Report. After takeoff, report to the nearest ARTCC, as required.

(2) Reporting for Air Control. Prior to entering the STORMFURY operating area, contact Command Control Aircraft "STORMFURY ECHO" on UHF or SSB to report "OPS Normal", verify altitude and standby for assignment of an air control frequency and air controller.

(3) OPS Normal Report. See page F-3.

(4) Departing STORMFURY Operating Area. See page F-3.

c. Data Collection.

(1) Radar. Operate in accordance with Annex R.

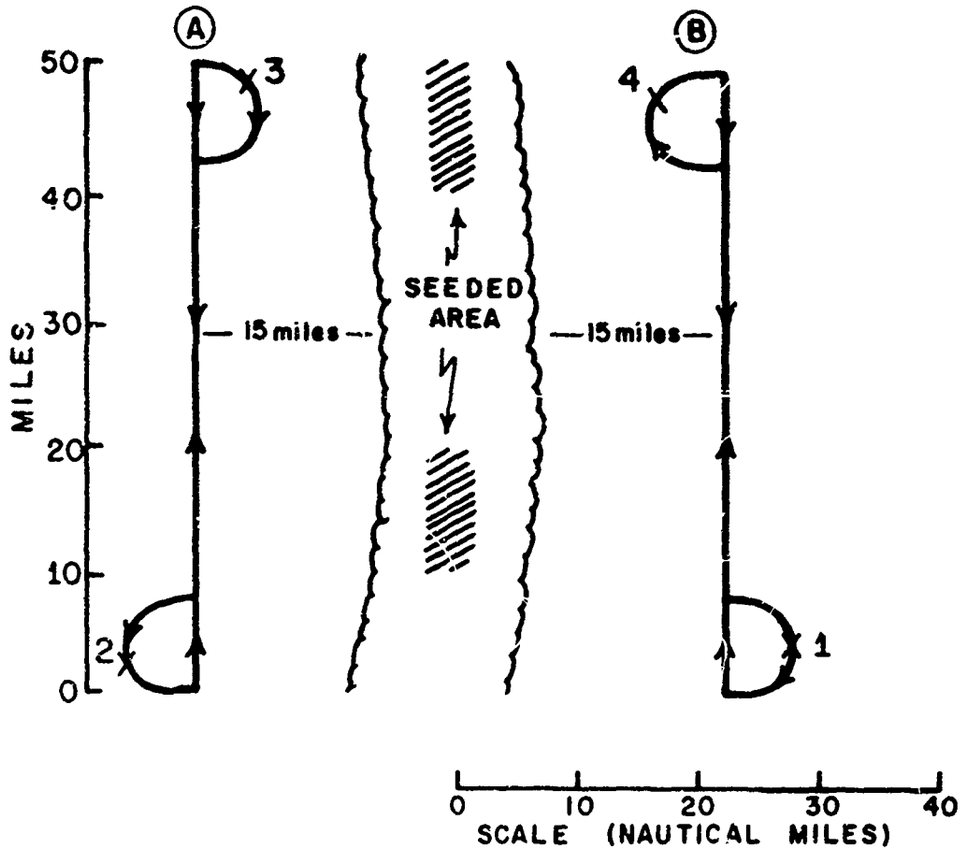
(2) Cloud Cameras. Operate, as required, to obtain maximum coverage of clouds from the 5,000 foot level to possible tops to 60,000 feet - one exposure every 6 seconds.

(3) Meteorological. Collect and record these data in accordance with Annex U.

d. Post-Flight. Attend post-flight debriefing and turn in all records of data collected and film to the DQCC.

TAB D - Flight Pattern for FLIGHT M

FLIGHT PATTERN – RAINBAND EXPERIMENT
FLIGHT "M" (NAVY A-6) ALTITUDE 37,000 ft.
PHOTO / SEEDING BACK UP
(CHOOSE PATTERN (A) OR (B) FOR BEST PHOTOGRAPHY)



APPENDIX II TO ANNEX F

RAINBAND EXPERIMENT

ESSA Flight Procedures

1. DC-6, FLIGHT "A"

a. Mission. Mid-level Macrostructure Monitor.

(1) Take off in time to arrive at a pre-determined geographical position at 12,000 feet by 1000Z. Conduct operations in accordance with this appendix (II), Tab A. Complete flight track patterns will be flown before, during, and after seeding run.

b. General Communications. FLIGHT"A", Voice Call "STORMFURY ALPHA", will guard the appropriate UHF/SSB frequencies for ARTCC and air control in accordance with Annex C.

(1) Initial Report. After takeoff, report to the nearest ARTCC, as required.

(2) Reporting for Air Control. Prior to entering the STORMFURY operating area, contact Command Control Aircraft "STORMFURY ECHO" on UHF or SSB to report "OPS Normal", verify altitude and standby for assignment of an air control frequency and air controller.

(3) OPS Normal Report. See page F-3.

(4) Departing STORMFURY Operating Area. See page F-3.

c. Calibration Procedures. FLIGHT "A" will climb to assigned altitude and obtain landfall for doppler calibration. Calibrate radars enroute to pre-determined geographical position within the STORMFURY operating area.

d. Data Collection. Data will be collected in accordance with Annex U.

Data Collection (continued)

(1) Meteorological

Interval	Data Recorded	Digital Tape	Photo Panel
Every 5 seconds for Photo Panel	Time	X	X
	Latitude	X	X
Every second for Digital Tape	Longitude	X	X
	Magnetic heading	X	
	Magnetic variation	X	
	D.T.C.	X	
	True Air Speed	X	
	Radar altitude	X	X
	Pressure altitude		X
	Differential pressure	X	
	Absolute pressure	X	
	Temp (vortex)	X	X
	Temp (Rosemont)	X	
	Drift angle	X	
	Wind direction	X	X
	Wind speed	X	X
	Pitch angle	X	
	Roll angle	X	
	Absolute humidity	X	
	Liquid water (J.W.)	X	
	C.S.I. Dew Pt Hygro	X	
	Engine power (BMEP)		X
	Icing-detector	X	
	Interval timer		X
	Flight ID	X	X
Every 15 minutes	Observations nad navigation fixes as required to update automatic systems		
Every hour	WWV time check		

(2) Radar. Operate in accordance with Annex R.

(3) Dropsondes. Drop as indicated on Tab A.

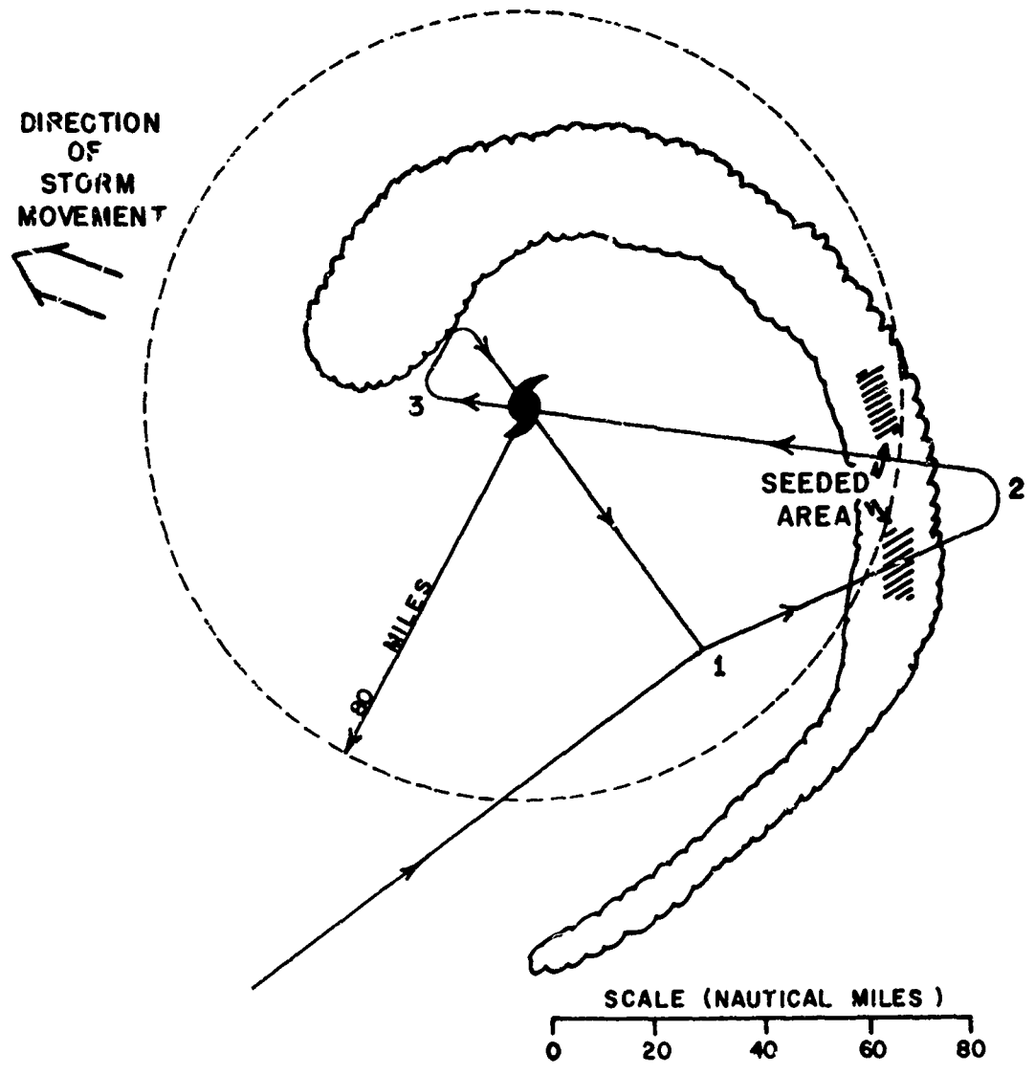
(4) Cloud Photography. While operating within 100 nautical miles of the center of the Project STORMFURY operating area, time lapse 35 MM camera system will be operated as follows:

Frame Rate	- 1 Frame/5 seconds
Vertical Tilt	- Zero degrees
Auxiliary Data	- 24-Hour clock (Total elapsed time in seconds) Flight Identification

e. Post-Flight Debriefing. Attend Post-Flight Debriefing and turn in all records of data collected, including film, to the DQCC.

TAB A - Flight Pattern for FLIGHTS A and C

FLIGHT PATTERN - RAINBAND EXPERIMENT
FLIGHT "A" (RFF DC-6) ALTITUDE 12,000 ft. AND
FLIGHT "C" (RFF WB-57) ALTITUDE 40,000 ft.
MID-LEVEL AND HIGH-LEVEL MONITORS
COMPLETE PATTERN 1-2-3-1 FOUR TIMES



2. DC-6, FLIGHT "B"

a. Mission. Mid-level Mesoscale Monitor.

(1) Take off in time to arrive at a pre-determined geographical position at 18,000 feet by 1000Z. Conduct operations in accordance with this Appendix II, Tab B.

b. General Communications. FLIGHT "B", Voice Call "STORMFURY BRAVO", will guard the appropriate UHF/SSB frequencies for ARTCC and air control in accordance with Annex C.

(1) Initial Report. After takeoff, report to the nearest ARTCC, as required.

(2) Reporting for Air Control. Prior to entering the STORMFURY operating area, contact Command Control Aircraft "STORMFURY ECHO" on UHF or SSB to report "OPS Normal", verify altitude and standby for assignment of an air control frequency and air controller.

(3) OPS Normal Report. See page F-3.

(4) Departing STORMFURY Operating Area. See page F-3.

c. Calibration Procedures. Fly a wind calibration box for doppler calibration enroute to the Project STORMFURY operating area.

d. Data Collection. Data will be collected in accordance with Annex U.

(1) Meteorological:

Interval	Data Recorded
Every 5 seconds for Photo Panel	(See page F-II-2
Every second for Digital Tape	(See page F-II-2)
Every 10 minutes	Observations and navigational fixes as required to update automatic systems.
Every hour	WWV time check

Data Collection (continued)

(2) Radar. Operate in accordance with Annex R.

(3) Dropsonde. Drop as indicated in Tab B.

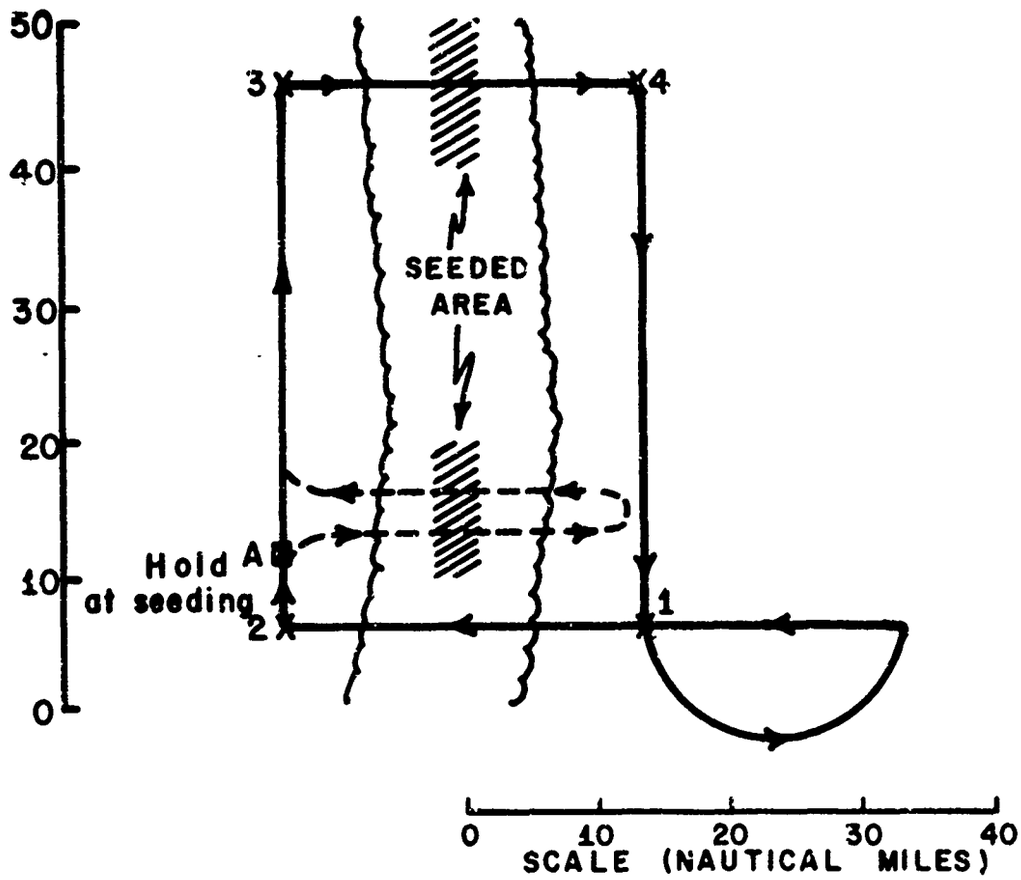
(4) Cloud Photography. While on station, the time lapse 35 MM camera system will be operated as follows:

Frame Rate	- 1 Frame/5 seconds
Vertical Tilt	- Zero degrees
Auxiliary Data	- 24- Hour clock (Total elapsed time in seconds)
	- Flight Identification

e. Post-Flight Debriefing. Attend post-flight debriefing and turn in all records of data collected, including film, to the DQCC.

TAB B - Flight Pattern for FLIGHT B

FLIGHT PATTERN - RAINBAND EXPERIMENT
FLIGHT "B" (RFF DC-6) ALTITUDE 18-20,000 ft.
CLOUD PHYSICS MONITOR
COMPLETE PATTERN 1-2-3-4-1 SIX TIMES (DASHED TRACK TO BE COMPLETED ONLY AT TIME OF SEEDING)



3. WB-57, FLIGHT "C"

a. Mission. High Level Macrostructure Monitor.

(1) Take off in time to arrive at a pre-determined geographical position at 40,000 feet by 1050Z. Conduct operations in accordance with Appendix II, Tab A. Complete flight track patterns will be flown before, during, and after seeding run.

b. General Communications. FLIGHT "C", Voice Call "STORMFURY CHARLIE", will guard appropriate UHF/SSB frequencies for ARTCC and air control. See Annex C.

(1) Initial Report. After takeoff, report to ARTCC, as required.

(2) Reporting for Control. Check in with Command Aircraft on primary UHF/VHF frequency, verify altitude and standby for assignment of air controller and air control frequency. FLIGHT "C" check in with FLIGHT "G".

(3) OPS Normal Report. See page F-3.

(4) Departing STORMFURY Operating Area. See page F-3.

c. Cloud Cameras. All nose camera cloud photographs.

d. Meteorological Data Collection. Record data in accordance with Annex U.

Interval	Data Recorded
1 second	Time, latitude, longitude, magnetic heading, magnetic variation, D.T.C., TAS, radar altitude, differential pressure, absolute pressure, temp (vortex), drift angle, wind direction and speed, pitch angle, roll angle
5 minutes	Manually recorded data for back-up: absolute altitude, pressure altitude, pressure, temp., wind direction and speed (or raw navigation data to compute same)

e. Radar and Radarscope Photography. Unless otherwise directed by Command Control, operate RDR-1 radar, radarscope and camera systems in accordance with Annex R.

f. Post-Flight Debriefing. Selected crew members attend debriefing(s) and turn in all records of data collected, including radar film, to the DQCC.

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APPENDIX III TO ANNEX F

RAINBAND EXPERIMENT

USAF Flight Procedures

1. WC-130, FLIGHT "I"

a. Mission. High Level Mesoscale Monitor.

(1) Take off in time to arrive at a pre-determined geographical position at 29,000 feet at 1000Z. Conduct operations in accordance with Appendix III, Tab A.

b. General Communications. FLIGHT "I", Voice Call "STORMFURY INDIA", will guard the appropriate UHF/SSB frequencies for ARTCC and air control in accordance with Annex C.

(1) Initial Report. After takeoff, report to the nearest ARTCC, as required.

(2) Reporting for Control. Prior to entering the STORMFURY operating area, contact Command Control Aircraft, "STORMFURY ECHO", on UHF or SSB to report "OPS Normal", verify altitude and standby for assignment of an air control frequency and air controller.

(3) OPS Normal Report. See page F-3.

(4) Departing STORMFURY Operating Area. See page F-3.

c. Data Collection. Data will be recorded on Form SF-1 in accordance with Annex U.

(1) Meteorological:

Interval	Data Recorded
Every 5 minutes	Time, wind direction, wind speed, ambient temperature, pressure, electrical field data.

Meteorological Data Collection (continued)

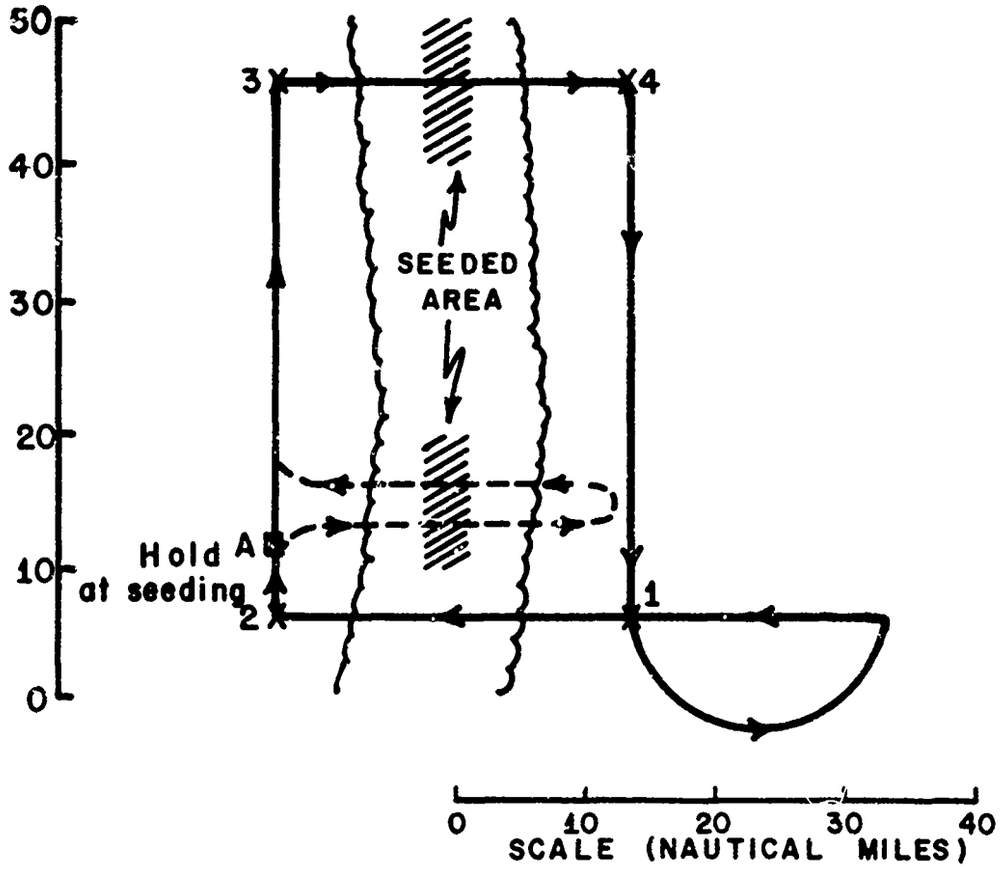
Interval	Data Recorded
Every 5 minutes	A/C position (latitude/longitude)
Every 10 minutes	Range and bearing of eye center
Every 15 minutes	Observations as required for updating doppler and automatic recording equipment
Every hour	WWV time check

(2) Radar. Operate APS-42 radar as directed in Annex R.

d. Post-Flight Debriefing. Attend post-flight debriefing if feasible. If unable, retain all copies of data collected, including film, at flight origin to be hand-delivered to the DOCC. Under no circumstances should any records or film be mailed.

TAB A - Flight Pattern for FLIGHT I

FLIGHT PATTERN — RAINBAND EXPERIMENT
FLIGHT PATTERN "I" (AF WC-130) ALTITUDE 29,000 ft.
CLOUD PHYSICS MONITOR
COMPLETE PATTERN 1-2-3-4-1 SIX TIMES (DASHED TRACK TO BE COMPLETED ONLY AT TIME OF SEEDING)



2. WB-47, FLIGHT "J"

a. Mission. High Level Macroscale Monitor.

(1) Take off in time to arrive at a pre-determined geographical position at 38,000 feet by 1400Z, to remain on station until 1800Z. Conduct operations in accordance with Appendix III, Tab B.

b. General Communications. FLIGHT "J", Voice Call "STORMFURY JULIETT", will guard the appropriate UHF/SSB frequencies for ARTCC and air control in accordance with Annex C.

(1) Initial Report. After takeoff, report to the nearest ARTCC, as required.

(2) Reporting for Air Control. Prior to entering the STORMFURY operating area, contact Command Control Aircraft, "STORMFURY ECHO", on UHF or SSB to report OPS Normal, verify altitude and standby for assignment of an air control frequency and air controller.

(3) OPS Normal Report. See page F-3.

(4) Departing STORMFURY Operating Area. See page F-3.

c. Data Collection. Data will be recorded in accordance with Annex U.

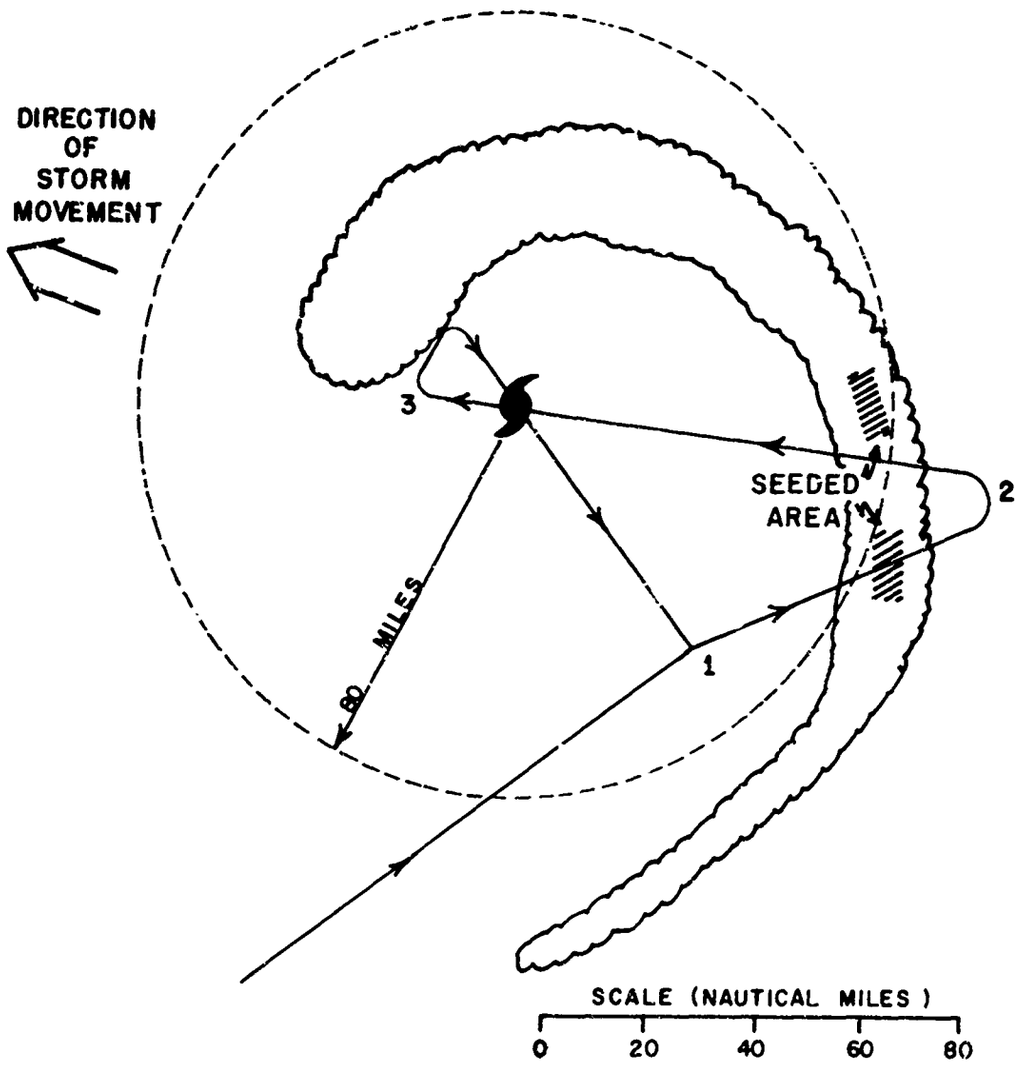
(1) Meteorological. Collect and record data on Form SF-2 every 3 or 4 minutes.

(2) Radar and Radarscope Photography. Unless otherwise directed by Command Control, operate APS-64 radar and O-15 camera system in accordance with Annex R.

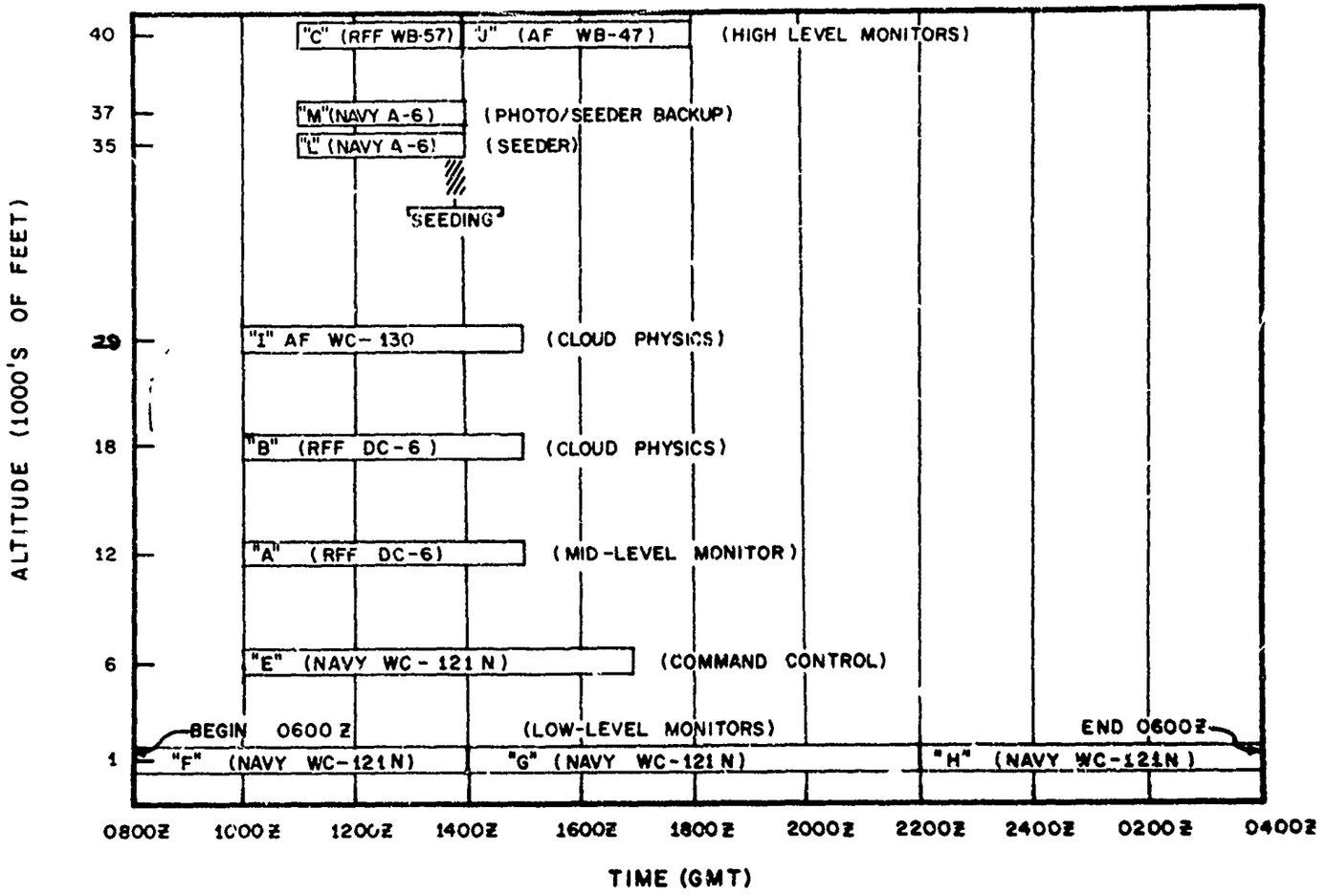
d. Post-Flight Debriefing. Attend post-flight debriefing. If not feasible, retain all copies of data collected, including film, at flight origin to be hand-delivered to the DQCC. Under no circumstances should any records or film be mailed.

TAB B - Flight Pattern for FLIGHT J

FLIGHT PATTERN — RAINBAND EXPERIMENT
FLIGHT "J" (AF WB-47) ALTITUDE 40,000 ft.
HIGH LEVEL MONITOR
COMPLETE PATTERN 1-2-3-1 FOUR TIMES



TIME TABLE FOR STORMFURY AIRCRAFT EMPLOYMENT – RAINBAND EXPERIMENT



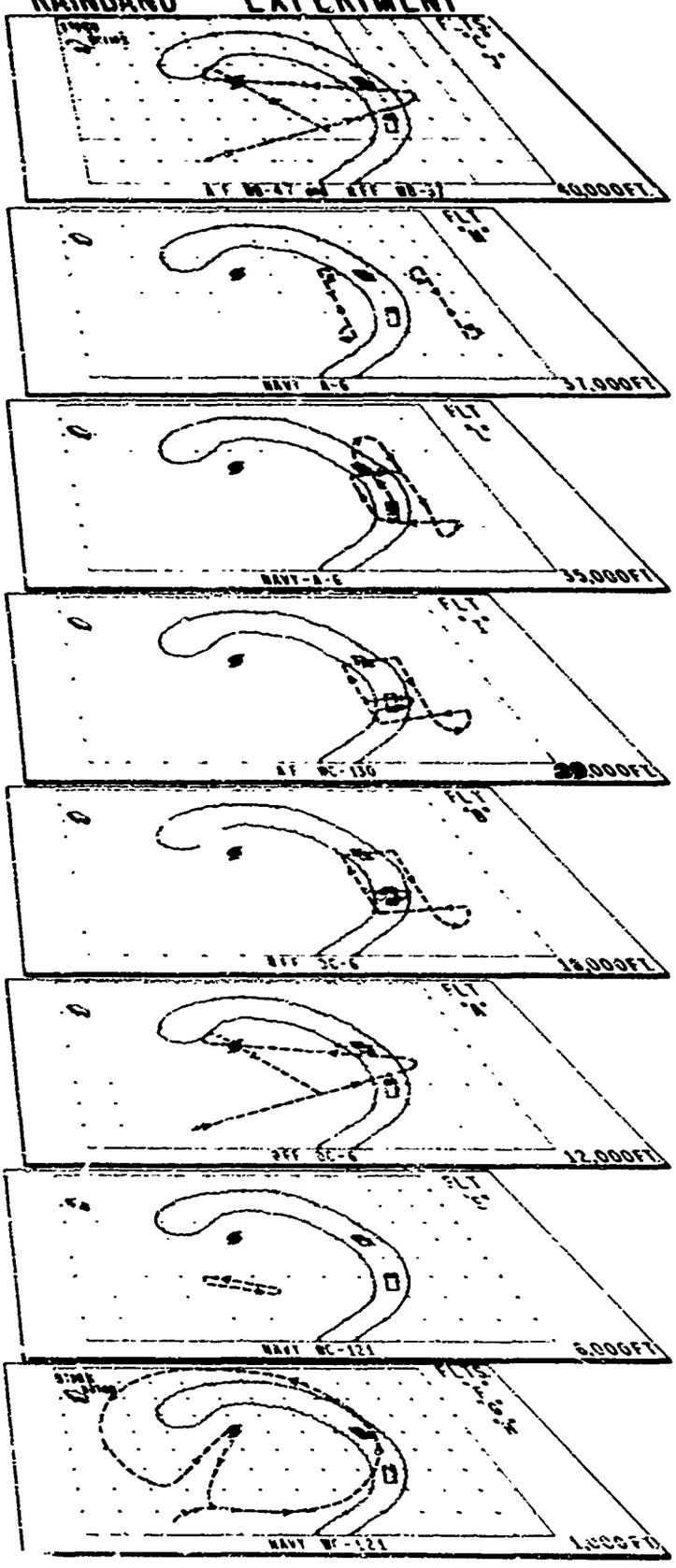
APPENDIX V TO ANNEX F

RAINBAND EXPERIMENT

Chronological Summary

AIRCRAFT	FLIGHT	VOICE CALL	PROPOSED ON-STATION TIME (Z)	(MSL) ALTITUDE	DISTANCE FROM CENTER OF AIR-SPACE (NM)
WC-121N	F	STORMFURY F	0600-1400	1,000 ABS	100
WC-121N	E	STORMFURY E	1000-1700	6,000	75
DC-6	A	STORMFURY A	1000-1500	12,000	75
DC-6	B	STORMFURY B	1000-1430	18,000	75
WC-130	I	STORMFURY I	1000-1400	29,000	150
WB-57	C	STORMFURY C	1050-1400	40,000	150
A-6	L	STORMFURY L	1100-1400	35,000	100
A-6	M	STORMFURY M	1100-1400	37,000	150
WC-121N	G	STORMFURY G	1400-2200	1,000 ABS	100
WB-47	J	STORMFURY J	1400-1800	40,000	150
WC-121N	H	STORMFURY H	2200-0600	1,000 ABS	100
C-54	D	STORMFURY D	BACK-UP FOR STORMFURY G OR H	1,000 ABS	100

RAINBAND EXPERIMENT



OPERATION PLAN
FWF JAX NO. 1-69

Project STORMFURY
Fleet Weather Facility
Naval Air Station
Jacksonville, Florida
June 1969

ANNEX G

CLOUDLINE AND FALL-BACK RESEARCH MISSIONS

1. Situation. In the event that aircraft and personnel are deployed to the staging base to accomplish the primary mission of Project STORMFURY (to conduct either an Eyewall or a Rainband Experiment) and this mission cannot be completed, a fall-back research mission will be conducted. This mission is a data collection program, utilizing the deployed USN, ESSA and USAF aircraft and personnel to collect hurricane, tropical storm, or easterly wave meteorological/oceanographic data. A cloudline experiment has been scheduled for a ten-day period at NAVSTA Roosevelt Roads commencing 9 September 1969.

2. Mission.

   a. Conduct FALLBACK ONE on a tropical cyclone.

   b. Conduct FALLBACK TWO on a tropical cyclone.

   c. Conduct FALLBACK THREE on an easterly wave.

   d. Conduct CLOUDLINE EXPERIMENT #1.

   e. Conduct CLOUDLINE EXPERIMENT #2.

3. Execution. When it appears that it will not be possible to conduct the primary mission of Project STORMFURY, the Navy Project Coordinator will direct execution of one of the following:

   a. Conduct FALLBACK ONE in accordance with Appendix I.

   b. Conduct FALLBACK TWO in accordance with Appendix II.

c. Conduct FALLBACK THREE in accordance with Appendix III.

d. Conduct CLOUDLINE EXPERIMENT #1 in accordance with Appendix IV.

e. Conduct CLOUDLINE EXPERIMENT #2 in accordance with Appendix V.

4. Flight Plans. Fallback research missions, not including cloudline, will require individual flight plans (DD-175) to be filed.

LELAND J. UNDERWOOD
Commander, U. S. Navy
Navy Project Coordinator/
Assistant Project Director
for Project STORMFURY

Appendices:

I - Fallback ONE
II - Fallback TWO
III - Fallback THREE
IV - Cloudline Experiment #1
V - Cloudline Experiment #2

APPENDIX I TO ANNEX G

FALLBACK ONE

Altitide Assignments

41,000' — B-57 (STORMFURY C)

36,000' — B-47 (STORMFURY J)

26,000' — C-130 (STORMFURY I)

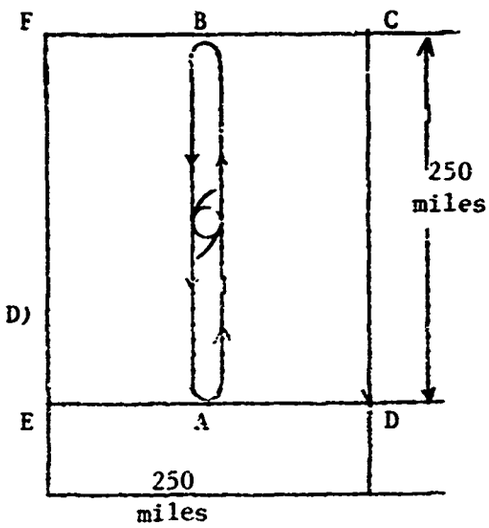
18,000' — DC-6 (STORMFURY B)

11,000' — WC-121 (STORMFURY E & G)

6,000' — DC-6 (STORMFURY A), C-54 (STORMFURY D)

1,000' — WC-121 (STORMFURY F & H)

Flight Tracks



1. Point A is 125 miles from the tropical cyclone center along a radial from the tropical cyclone center to the staging base.

2. STORMFURY A, B, C, E, F, I and J will fly the penetration pattern (A-B-A) and will take off at such time as required to arrive at Point A at 1245Z or at a time to be announced.

3. STORMFURY G, H and D will fly the box pattern (A-D-C-B-F-E-A) and will take off at such time as required to reach Point A at 1200Z or at a time to be announced.

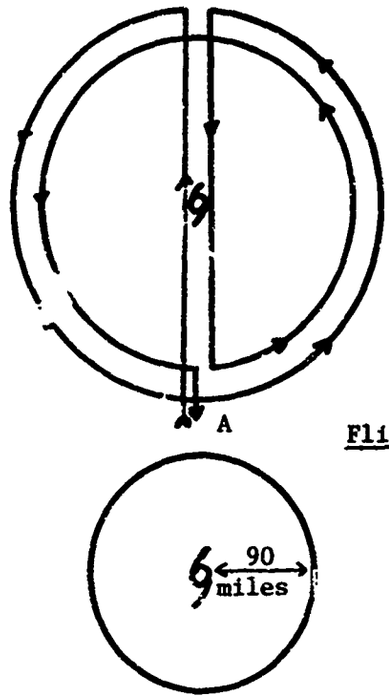
4. Data collected will be as in Annexes E and F, or as appropriate.

APPENDIX II TO ANNEX G

FALLBACK TWO

Altitude Assignments

41,000' — WB-57 (STORMFURY C)
37,000' — WB-47 (STORMFURY J)
30,000' — C-130 (STORMFURY I)
18,000' — DC-6 (STORMFURY B)
12,000' — C-121 (STORMFURY F)
7,000' — C-121 (STORMFURY E)
2,000' — DC-6 (STORMFURY A)



Flight Patterns

1. Point A is 90 miles from the tropical cyclone center along a radial from the center of the tropical cyclone to the staging base.

2. Each aircraft will make two circular patterns around and into the tropical cyclone as indicated. Takeoffs will be at such time as required to arrive at Point A at 1200Z or at a time to be announced.

3. Two options for FALLBACK TWO are as follows:

   a. One WC-121 on a 150-mile orbit or 60 miles further out.

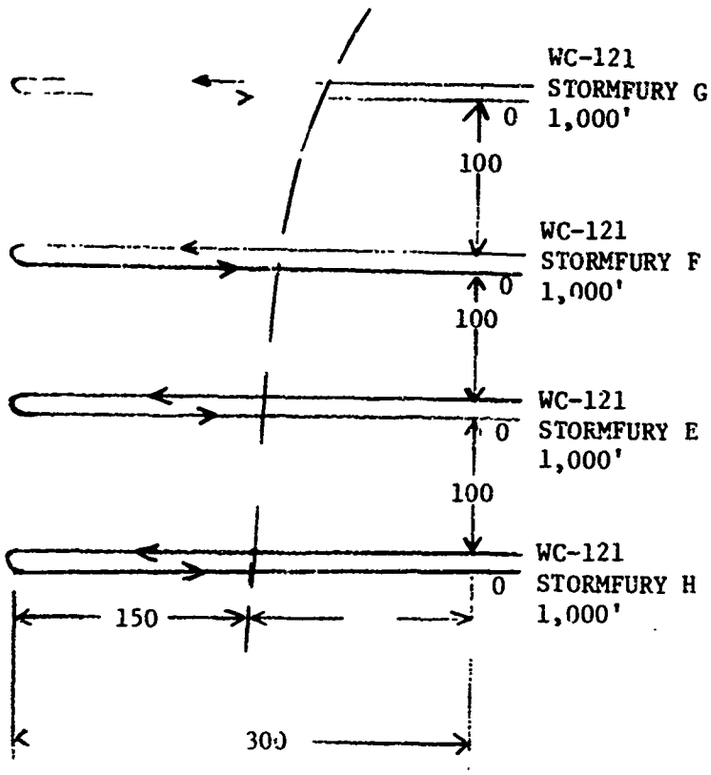
   b. Two WC-121's with 2,000 feet separation and 10 minutes apart.

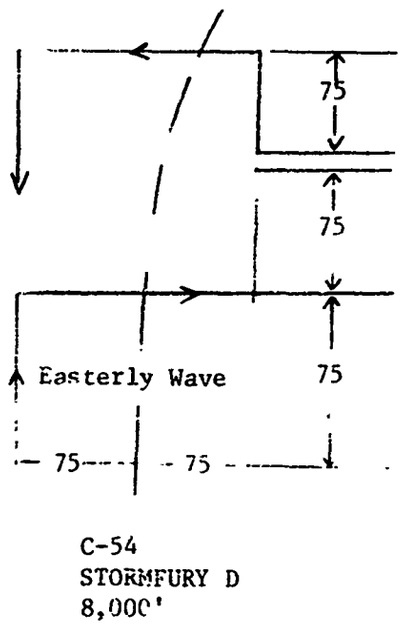
4. Data collected will be as in Annexes E and F, or as appropriate. Drops will be made by STORMFURY F and STORMFURY B every 30 minutes, keeping baseline checks while on radial legs. Drops will be copied, but not worked up until the aircraft has landed.

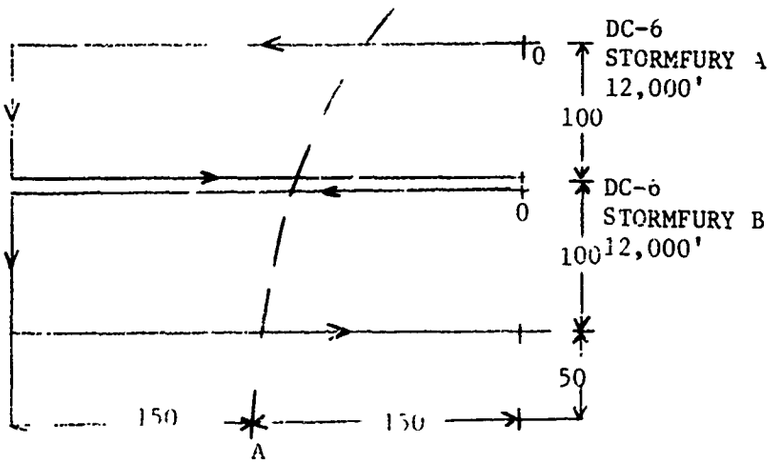
APPENDIX III TO ANNEX G

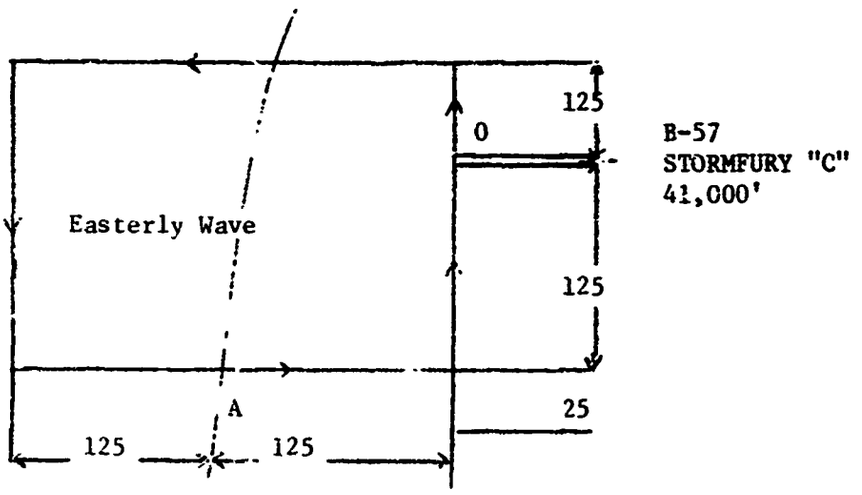
FALLBACK THREE

FLIGHT PATTERNS







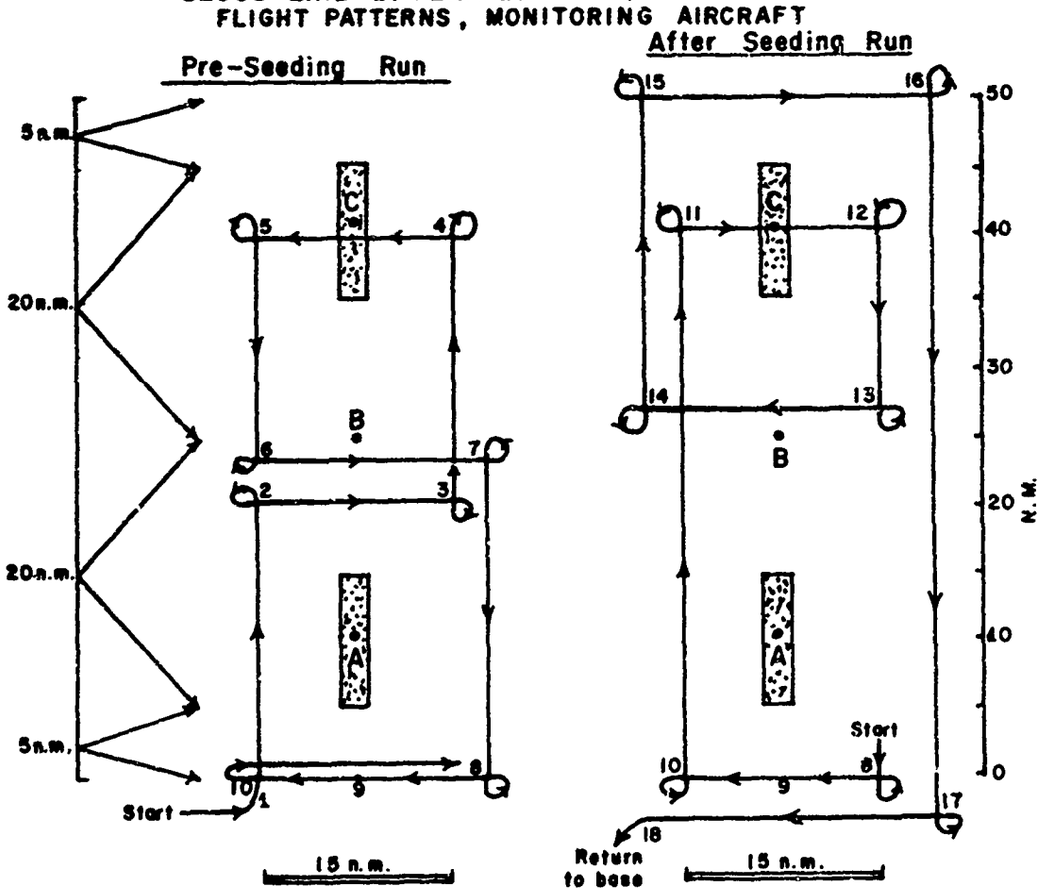


1. Point A in all FALLBACK THREE flight pattern is a point on an easterly wave determined by the Navy Project Coordinator. Point 0 in all flight patterns is the origin of the track to be flown. All distances are in nautical miles.

2. Takeoffs will be at such time as required to arrive at the respective point 0's at 1200Z, or at a time to be announced.

3. Data collected will be as in Annexes E and F, or as appropriate. Drops will be made by STORMFURY A and B every 30 minutes. Drops will be copies, but not worked up until the aircraft has landed.

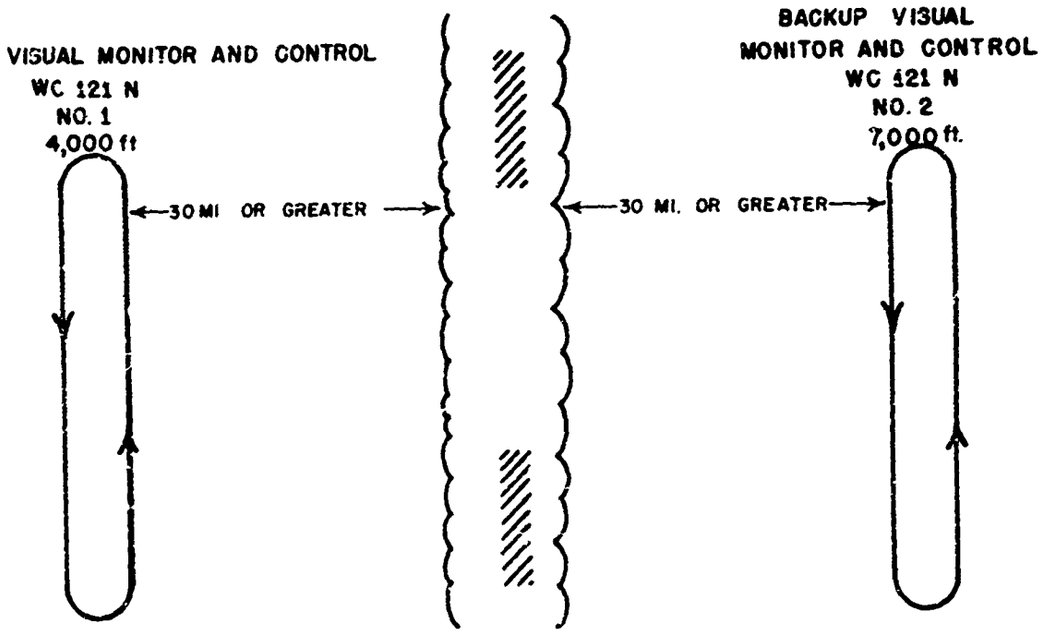
CLOUD LINE EXPERIMENT (NUMBER 1)
FLIGHT PATTERNS, MONITORING AIRCRAFT



Altitudes: C-54 - cloud base: DC-6, 12,000 feet; DC-6, 13,000 feet; C-130, 24,000 feet; WB-57, seeding altitude (to be decided on flight day).

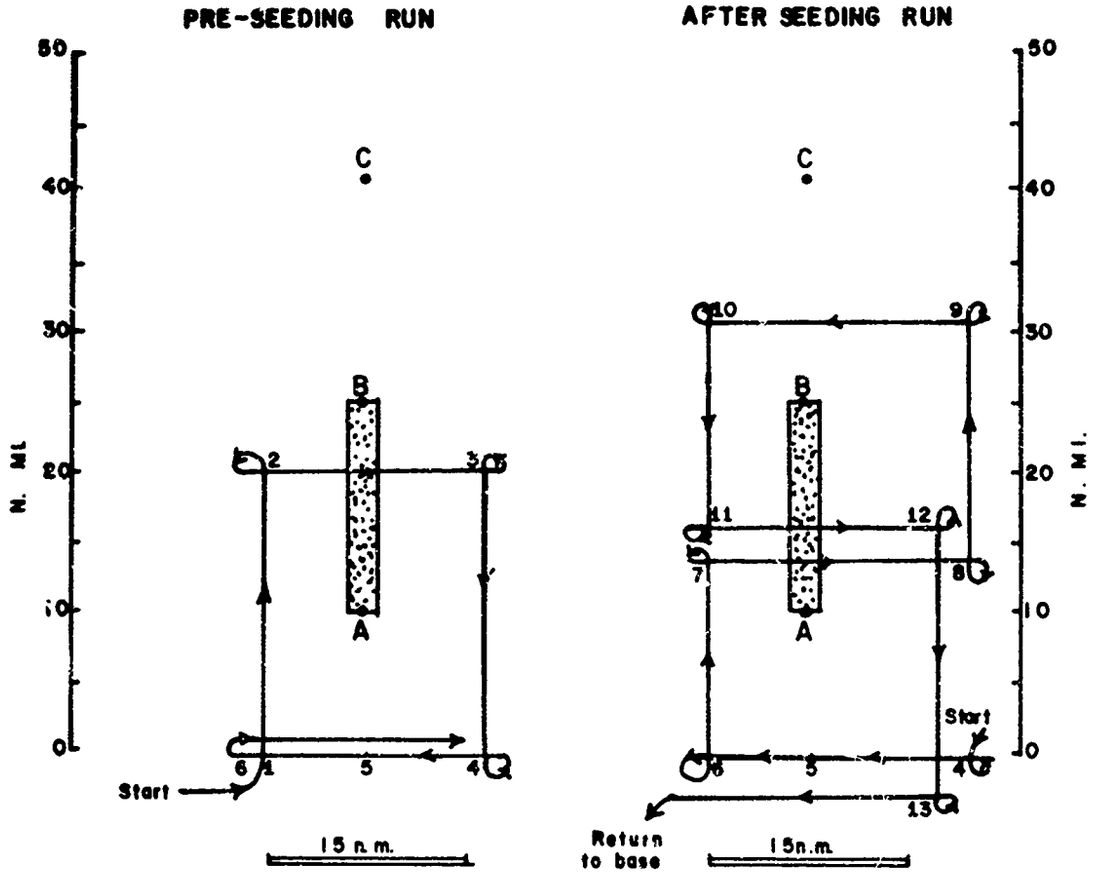
1. C-54, two DC-6's and C-130 execute boxes 1-8 before seeding run.
2. If B-57 has not joined pattern before point 6, other aircraft should do 8 → 10 → 6 while waiting.
3. After B-57 joins others, proceed in formation from 6 to 9 where B-57 will start along cloud line to begin seeding. B-57 will inform other A/C position of seeding runs asap.
4. Two DC-6's, C-54, and C-130 proceed 9, 10, 11 where will orbit if necessary until seeding run completed. Then complete pattern as indicated through point 16.
5. All turns are outside turns unless otherwise requested.
6. Seeded area length and distance between "A" and "C" may be varied by on-scene Project officials if required by available cloud lines.
7. Data collection and forms same as Rainband experiment except as specially requested.

FLIGHT PATTERN – CLOUD LINE EXPERIMENT NO. 1



Control A/C and backup A/C will fly patterns as depicted oriented on the cloud line selected by the Project Director. Any malfunction of APS/20 or APS/45 radar or radar cameras should be reported immediately so the backup plane can insure coverage.

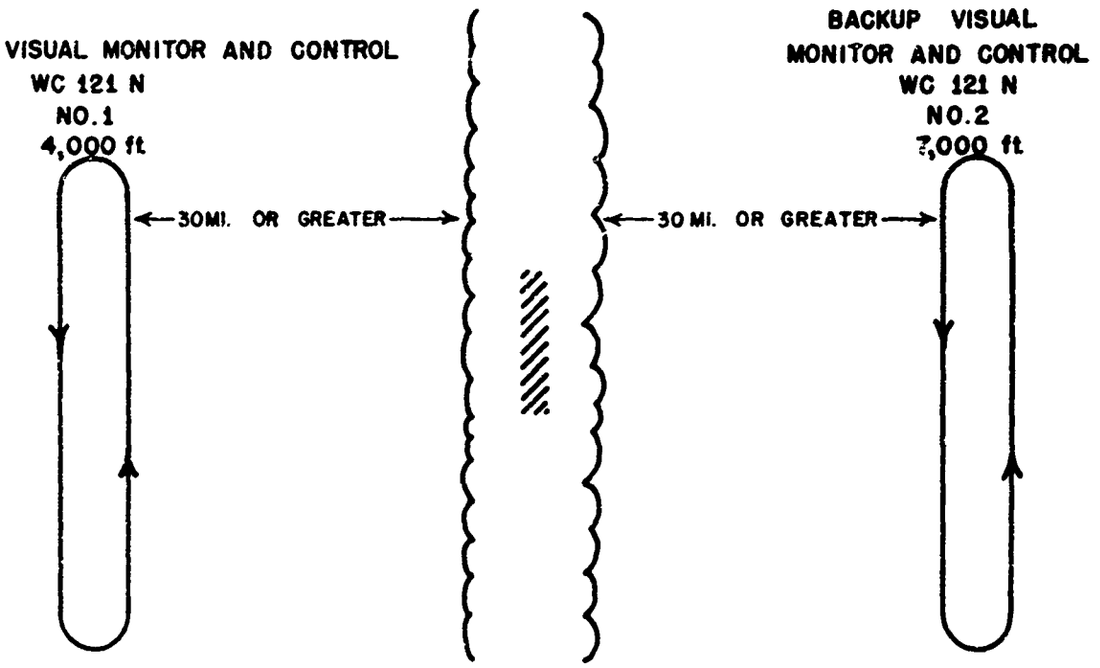
CLOUD LINE EXPERIMENT (NUMBER 2)
FLIGHT PATTERNS, MONITORING AIRCRAFT



Altitudes: C-54 - cloud base; DC-6, 12,000 feet; DC-6, 19,000 feet; C-130, 24,000 feet; WB-57, seeding altitude (to be decided on flight day).

1. C-54, two DC-6's and C-130 execute boxes 1-4 before seeding run.
2. If B-57 has not joined pattern before point 4, other aircraft should do 4 → 6 → 4 while waiting.
3. After B-57 joins others, proceed in formation from 4 to 5 where B-57 will start along cloud line to begin seeding. B-57 will inform other A/C position of seeding runs asap.
4. Two DC-6's, C-54, and C-130 proceed to 6 and 7 where will orbit if necessary until seeding run completed. Then complete pattern as indicated through point 13.
5. All turns are outside turns unless otherwise requested.
6. Seeded area length and distance between "A" and "C" may be varied by on-scene Project officials if required by available cloud lines.
7. Data collection and forms same as Rainband experiment except as specially requested.

FLIGHT PATTERN — CLOUD LINE EXPERIMENT NO. 2



Control A/C and backup A/C wil' fly patterns as depicted oriented on the cloud line selected by the Project Director. Any malfunction of APS/20 or APS/45 radar or radar cameras should be reported immediately so the backup plane can insure coverage.

ANNEX R

RADAR EQUIPMENTS, OPERATIONS AND PHOTOGRAPHY

1. General.

a. Radarscope photography, by presenting three-dimensional displays of the precipitation patterns, as well as precision TFF aircraft positional data, is one of the most important contributions to the success of the Project STORMFURY experiments. Radars and radarscope photographic facilities on such aircraft should therefore be maintained, tuned and calibrated to the highest standards in order to obtain research-grade data as well as contributing to flight control and safety.

b. Radar Data Advisors, designated by the Project Director, will be aboard each WC-121N aircraft to assist APS-45 operators and Photo Officers in the operations involved in obtaining optimum radar data for each experiment.

2. Radar Equipment and Operations.

a. All aircraft containing radars will operate within the guidelines specified for their flight designation in R-7 through R-10 of this annex and/or as modified by Command or Radar aircraft with Project Director exercising Emission Control for the experiment.

b. All radar antennas will be aligned on true north where possible. Aircraft configured with two or more radar systems will ensure that all radar antennas are in agreement before take-off.

Where possible, they will simultaneously photograph ground patterns after take-off to document such alignment and made an appropriate entry in the Radarscope Photography Log (see Annex U, Form SF-11).

c. All radarscope picture tubes which are photographed will be scribed with a narrow opaque line originating at the center of the tube face and extending to the outer edge of the glass surface to continuously and precisely indicate true north on all photographs.

d. All cameras aboard WC-121N aircraft will have ID code numbers affixed in the camera data chamber, separate from the clock and data card, such that the number appears on each radar photograph. (A typed number on white paper stuck on the right edge of the frame counter or other suitable location would accomplish this.) This camera number along with the film magazine number will be entered in the Radarscope Photography Log, Form SF-11.

e. Minimum Discernable Signal (MDS) and Peak Power transmitted (P_t) will be determined for each radar and entered in the Radarscope Photography Log (Form SF-11) under "Remarks" for all radars except APS-20. APS-20 radars will run special Photographic Documentation of Radar Sensitivity Checks as per instructions (R-10) and record results in the Minimum Discernable Signal (MDS) and Photographic Documentation of MDS Log, Annex U, Form SF-10.

3. Radarscope Photography Instructions.

a. Pre-Flight Checks, All Cameras.

(1) Darkroom load all film. Use Plus X Film. If possible, carry at least one spare magazine in addition to that required for

radarscope photography while within 200 miles of storm center and/or seeded area.

(2) Wind and set clocks only once per flight, noting clock error thereafter in seconds fast (F) or slow (S) on data card, as shown on data card sample below. Clock face will be conspicuously annotated with a (Z). This will be done by typing a capital Z on a small piece of paper, and attaching the paper to the clock crystal with glue. The paper must be small to minimize obscuration of clock hands.

(3) All radar data cards will be completed as follows:

A/C voice call sign/BuNo.....	STORMFURY H/1323	
Date (Z).....	3 Oct 1965	
Type radar/scope nomenclature	APS-20 IP-230	APS-45
Altitude/time error (in sec).	6,000 ft/8S	6,000 ft/1F
Range/range marks.....	100/50 mi. RM	60/20 mi. RM
RHI Stroke Ht, K ft, APS-45 or APS-20 MDS Test: ___DBM..		20 K Ht mark

STORMFURY 6/1232
: Aug 1967

Keep aircraft altitude and data correct and up-to-date on all data cards as changes occur in flight.

(4) Without magazine in place, check shutter operation for visible sweep through lens aperture.

(5) Check solenoid for single film advancement each shutter operation.

(6) Set f/stop (f/5.6 all APS-20 and APS-45 cameras).

(7) Check clock and data section illumination lights for proper operation, loose wires, smooth operation of azimuth wheel, etc..

(8) Check internal and external frame counter on camera for agreement; and film "backing plate" pressure all magazines.

(9) Never put magazine on camera without first turning camera off.

(10) After installing magazine first time and before removing last time, click off 20 frames; other intermediate times of magazine removal, click off 5 frames.

b. In-Flight Checks and Operations.

(1) Set up all scopes after reaching assigned altitude. First, set intensity so sweep is visible with video OFF; then set video until "noise" is visible on scope; then add proper range mark intensity. Except as prescribed later, leave all scope settings alone for entire flight (to facilitate data reduction and minimize data card changes, which are frequently overlooked).

(2) Short Test Film. In the event a special in-flight film test is necessary, use spare magazine to take about 20 frames of radar data (at assigned altitude and after setting all permanent modes of radar and camera operation for that flight). Do NOT include APS-20 radar calibration, APS-45 height line checks, etc. described elsewhere, which are necessary on each piece of operational film. Develop test film in dark bag. Show film to Radar Data Advisor and retain for inclusion with permanent radar data.

(3) A Radarscope Photography Log (Form SF-11) shall be maintained each hour for each radarscope while it is photographed in Order to ensure for continuous optimum operation and accuracy of time clocks being photographed to within one second each hour, reference WWV.

(4) At each hourly time check, as camera operates normally, check external film advancement (star wheels on side of magazine); note internal and external frame counters (log differences); check for clock and data section illumination; check data card for proper mode of radar operation and possible aircraft height or date changes; check APS-45 azimuth documentation wheel against console; check film footage for possible magazine replacement. Do NOT run out of film!

(5) Unless scope intensity, range marks, focus, etc. change appreciably, do not adjust at each time check.

(6) APS-20 Range Mark Documentation. After running Photographic Documentation of Radar Sensitivity Check (R-10), take 3 frames of film on each different range setting specified for flight with range mark intensity slightly higher than for normal photography before beginning normal radarscope operations. Document each properly by standard data card entry.

(7) APS-45 Range and Height Line Documentation. After setting up radar operation modes and clicking off 20 frames of film to clear magazine and check normal operation; take series of PPI north line and ground pattern orientation photography. Run photo height line film documentation by manually taking one picture with the height cursor line set at each 5,000 foot level from the surface 40,000 feet on 60 mile range. Range marks should be prominent on these photos. All RHI picture are taken with the height line at 20,000 feet above the surface. Origin of sweep should remain constant for entire flight. If changes do become necessary, redocument height lines. Documentation enroute to and from area are minimum requirements.

(8) APS-45 Console Azimuth, Camera Data Chamber Azimuth, and PPI Sweep Azimuth Documentation. At any time early and late in the flight (altitude is not important, but radar and camera operation modes should be as set for entire flight), adjust console azimuth manually to North or East (depending on alignment aid provided in camera for pointer on camera syncro), carefully twist camera syncro to bring data chamber pointer (long stripped end) to exact agreement with console azimuth indicator and document on film as follows: Install clock and data card in camera (write "AZ test north" on card), place scope in PPI mode, antenna fixed in azimuth, but rocking 16° vertically, "EMERGENCY SCAN" on, camera control box: lights "ON", set for "EVERY OTHER" scan, "JOHN'S BOX" on "RHI AUTO" to take 5 or 6 pictures.

(9) General APS-45 Camera Operation. Set C3-R camera control box to lights "ON"; voltage on RHI to maximum, PPI to 16V; "EVERY OTHER" scan and leave for entire flight. Operate camera entirely with "JOHN'S BOX" turning camera off by going to "PPI" - or "RHI MAN" modes, not by using C3-R control box. Operating modes are covered in Radarscope Photography requirements.

4. Radar Logs, Film Processing and Distribution.

a. MDS, Radarscope Photography, and Radar Data Advisor's logs will be disseminated before experiments and collected after flights by the Data Quality Control Coordinator (DQCC).

b. Copies of all logs and film will be made and sent by DQCC to NHRL Miami, NWRF Norfolk and the generating agency.

ALL VW-4 WC-121N FLIGHTS

1. **Radarscope Photographic Requirements:**

Radar	Scope	Range	RM	Presentation
APS-20	IP-230	200	50	Radar video only.
	APA-81	100	40	All except STORMFURY "H": Radar video and IFF, off-center or GPI, best presentation; except: when within 50 miles of eye or experimental area.
		50	40	
APS-45	PPI	60/120	20	Every 2 minutes. Series of PPI-2°, 0°, +2° tilt for flights above 5,000 feet; use 2-6 RPM if possible.
	RHI	60	20	All other times: Series of RHI, 360° survey of significant weather every half hour. Concentrate on eye (eyewall) or seeded and surrounding areas. Use RHI AUTO on 1-RPM except G & H which use manual azimuth control.

a. APS-20 photo every scan, APS-45 PPI every scan; RHI every other scan as above, when within 200 miles of eye and/or center of seeded area.

b. Operate APS-20's with moderate STC as necessary, FTC off, IAGC N, receiver gain at 20-30% "grass" for best weather video presentation. GPI may be used on "radar" and/or "command" scopes at discretion of Project Director. Log permanent antenna elevation +1° to +3° for best weather video depending on flight altitude. Log changes if necessary.

c. On all APS-20's where radar weather video and IFF data are gathered simultaneously, the weather video should be slightly visible above "noise" on the scope with the IFF appearing as a much stronger, but not "blooming", signal such that IFF data are best displayed on these scopes.

d. On "radar" and/or "command" aircraft, the APS-20 radar data program may be modified slightly by the Radar Data Advisor with consent of the Project Director in order to suit changing conditions of track, flight safety, control of aircraft, etc.. However, the basic intent on both aircraft is to obtain the highest quality of radar weather video on one scope and mixed video - IFF on the other for accurate aircraft positioning, both scopes on optimum range settings for maximum detail. Consequently, radarscope range settings might be changed for short periods on these aircraft, then returned for basic operation.

e. On Fallback missions, such as cloudline experiments, rely on flexibility provided in paragraph (d) above to modify APS-20 IP-230 ranges to 50 or 100 miles, depending on range of aircraft from seeded areas, leaving APA-81 and APS-45 programs basically as specified. On cloudline missions, operate APS-45 RHI survey series at plus or minus 45 degrees azimuth, centered on seeded areas, three hundred sixty (360°) degrees RHI every half hour.

ALL DC-6 FLIGHTS

1. **Radarscope Photographic Requirements:**

Radar	Range	RM	IEC	STC	Presentation
APS-20 Eyewall	100	20	-	On	IFF and radar video, permanent antenna tilt for best presentation (+1+2°), set and leave alone!
APS-20 Rainband					
STORMFURY "B"	100	20	-	On	IFF only within 100 miles.
	200	20	-	On	IFF and WX beyond 100 miles.
STORMFURY "A"	50	10	-	On	WX only within 100 miles.
	200	20	-	On	IFF and WX beyond 100 miles.
WP-101	50	10	On	On	Permanent antenna tilt best presentation.
RDR-1	20	5	On	On	Antenna: rotating vertical.

a. Photograph every scan (or at least once every 10 seconds, whichever occurs last) when within 200 miles of eye and/or center of seeded area.

b. Note proper documentation necessary on all data cards R-3.

c. Note hourly time checks necessary for equipment, cameras, radarscope clocks, etc., and maintain Radarscope Photography Log, Annex U, Form SF-11.

d. Operate APS-20's with moderate STC as necessary, FTC off, IAGS on, receiver gain at 20-30% "grass" for best weather video presentation.

e. On all APS-20's where radar weather video and IFF data are gathered simultaneously, the weather video should be slightly visible above "noise" on the scope, with the IFF appearing as a much stronger, but not "blooming" signal, such that IFF data are best displayed on these scopes.

f. On fallback missions, operate all radars as per Rainband Experiment.

C-54, C-130, WB-57, WB-47 AND SEEDERS

1. Radar Photographic Requirements:

Radar	Range	RM	IEC	STC	Presentation
Nose Radar	Intermediate-about 50 miles	10/20 miles visible	On	On	Weather video only - antenna tilt for best weather presentation-Log Antenna Tilt

a. Photo at least every other scan consistent with capability to record all radarscope data within 200 miles of eye and/or center of seeded area, except 50 mile radius for seeders.

b. Note proper documentation necessary all data cards R-3.

c. Note hourly time checks necessary for equipment, cameras, radarscope clocks, etc., on Radar Photography Log, Form SF-11.

d. Seeder aircraft and others with "turn-around" missions install freshly-loaded film magazine in radarscope cameras when refueling. Others carry necessary spare magazines consistent with paragraph (a) above.

OPERATION PLAN
FWF JAX NO. 1-69

PHOTOGRAPHIC DOCUMENTATION OF RADAR SENSITIVITY CHECK FOR ALL APS-20 RADARS

1. The following procedures will be used in the film documentation of the Radar Sensitivity Check by Photo Officer and technician, assisted by the Radar Data Advisor.

a. After the peak power transmitted, radar sensitivity checks and VISUAL MDS have been determined and entered in the MDS log (Form SF-10), and all other checks have been accomplished prior to radar operation for data collection, determine the PHOTOGRAPHIC MDS in the following manner.

b. Set up radar IF gain (mark setting knob for repeatability) and all other modes for permanent operation for the flight. NOTE: IF gain must remain constant entire flight. If changes are necessary for control of aircraft, etc., log time of change and return to original setting if possible. Otherwise, leave at new setting rest of flight. Document new VISUAL and PHOTOGRAPHIC MDS as soon as possible or enroute from area.

c. Set up IP-230 and APA-81 (all APS-20 photography) scopes for standard range, intensity, video, focus, data cards, etc., for the flight.

d. Take 10-20 frames of film to clear magazine, assure normal camera operation. Turn off camera. The following photographic MDS is not to be used as "test" film, but as a permanent part of the weather radar data.

e. Adjust UPM-44 to -91 DBM test signal (AFTER compensating for losses), pulse width 12 micro-seconds, delay to about 75 mile range.

f. Add the following line at the bottom of data card: "MDS-91 DBM". Take three pictures each camera. Turn camera off.

g. Repeat steps (e) and (f) for test signals -94, -97, -100, -103, -106 and -109 DBM. Do not forget to change data card entry for each step!

h. Set test signal -99 DBM at 40 miles for generating faint range mark on all APS-20 scopes for entire flight. Peak UPM-44 at least once each hour or as necessary.

i. Delete last line of data card and turn on cameras for gathering specified radar weather video and/or IFF data.

j. NOTE THAT SINCE ALL MODES OF BOTH RADAR AND CAMERA OPERATION WERE AS SPECIFIED FOR GATHERING DATA ON THE FLIGHT, NO FURTHER ADJUSTMENTS ARE REQUIRED BEFORE PLACING SYSTEM IN OPERATION IN STEP (i).

Leland J. UNDERWOOD
Commander, U. S. Navy
Navy Project Coordinator/
Assistant Project Director
for Project STORMFURY

OPERATION PLAN
FWF JAX NO. 1-69

Project STORMFURY
Fleet Weather Facility
Naval Air Station
Jacksonville, Florida
June 1969

ANNEX T

AIRSPACE RESERVATION AGREEMENT

1. Airspace reservations will be requested and utilized as outlined in Appendices I through VI inclusive.

LELAND J. UNDERWOOD
Commander, U. S. Navy
Navy Project Coordinator/
Assistant Project Director
for Project STORMFURY

Appendices:

I - Project STORMFURY Letter of Agreement with FAA
II - Eyewall Experiment Chronological Summary
III - Rainband Experiment Chronological Summary
IV - International NOTAMS, AIM Publication
V - 24-Hour NOTAM
VI - 3-Hourly NOTAM

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OPERATION PLAN
FWF JAX NO. 1-69

APPENDIX I TO ANNEX T

PROJECT STORMFURY LETTER OF AGREEMENT

EFFECTIVE 1 August 1969

SUBJECT: Airspace reservation for STORMFURY Operations, 1 August through 15 October 1969

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1. PURPOSE. The following agreement between San Juan Center, Houston Center, Miami Center, Jacksonville Center, New York Center, ESSA, and the Navy Project Coordinator, Project STORMFURY/Commanding Officer, Fleet Weather Facility, Jacksonville, Florida defines the airspace reservation area and certain Air Traffic Control procedures within U. S. CTA/FIR during Operation STORMFURY for the 1969 Hurricane Season, and is supplementary to the provisions contained in AT P 7110.9.

2. STORMFURY AREA. As contained within the area defined in Appendix I to Annex A, STORMFURY Operation Plan 1-69 that lies within the San Juan, Houston, Jacksonville, Miami, and New York CTA/FIR, the moving airspace reservation area to be protected shall be:

a. Within a 75-nautical mile radius of a point specified in coordinates from the surface upwards, and;

b. Within a 150-nautical mile radius of the same point at FL 350 and above for the Rainband experiment; within a 100-nautical mile radius of the same point at FL 350 and above for the Eyewall Experiment, except

c. At FL 290, within a 90-nautical mile radius for the Eyewall Experiment, or at FL 290, within a 150-nautical mile radius for the Rainband Experiment.

The Cloud Line Exercise for seeding wall-type Cumulus clouds not associated with a hurricane shall be contained within the same airspace as the Rainband Experiment at coordinates specified by the Navy Project Coordinator.

The Navy Project Coordinator shall coordinate with ATC for exceptions to the radius and altitudes specified herein on an individual basis should the requirements arise.

The center point, rate of movement, and track of the moving airspace reservation will be furnished by the Navy Project Coordinator, or the "STORMFURY" command aircraft. The reservation shall exist from 0800GMT on specified dates and continue until notification is received from the command control aircraft that the reservation is terminated. In no case is one reservation period to extend more than eighteen hours.

3. REQUEST FOR AIRSPACE. A request for a specific airspace reservation will be made to the appropriate Center 48 hours before "T" time by the Navy Project Coordinator. The coordinates of the designated center point of the requested airspace reservation will be validated or revised at T minus 24 hours, T minus 12 hours, and T minus 6 hours. Concurrent with the 12 hour notification, the Navy Project Coordinator will advise the type mission, either Rainband, Eyewall or Cloud Line Experiment.

The Navy Project Coordinator is responsible for obtaining approval for operations within Warning/Restricted Areas.

4. AIR TRAFFIC CONTROL PROCEDURES. Standard air traffic control procedures will be utilized enroute to and from the reservation area. Participating aircraft shall advise ATC when entering the airspace reservation, and shall obtain ATC clearance through the "STORMFURY" command aircraft,

prior to departing the area, or remain in VFR flight conditions. Should any deviation from the assigned protected airspace be necessary, it will be requested by the aircraft concerned on an individual basis through the "STORMFURY" command aircraft.

The Navy Project Coordinator will ensure that operational control and separation of participating aircraft in the STORMFURY airspace reservation, including all military and ESSA aircraft, will be exercised and maintained by the "STORMFURY" command aircraft. This MARSA concept shall become effective upon activation of the STORMFURY airspace reservation and remain in effect until the reservation is terminated.

Search and Rescue action, if necessary, shall be initiated by action of the Navy Project Coordinator, or his representative.

In the event radio failure should occur, the aircraft is to depart the reservation at a point nearest its destination. The flight is to proceed in VFR conditions, or maintain the altitude/flight level assigned in Appendix V Annex E and Appendix V Annex F to STORMFURY Operation Plan 1-69, as appropriate, or the minimum enroute altitude/flight level, whichever is higher. The "STORMFURY" command aircraft shall immediately advise ATC of known or suspected radio failure.

In the event a non-participating aircraft should enter the airspace reservation due to communication failure, or other circumstances, all available information will be forwarded to the "STORMFURY" command aircraft.

The decision for continuing pyrotechnic drops, or reassigning altitudes within the reservation, remains with the Navy Project Coordinator. Complete coordination will be effected in such an instance.

5. COMMUNICATIONS. Communications with aircraft operating within the reservation shall be conducted through the "STORMFURY" command aircraft, on station. Hourly "Operations Normal" reports are to be forwarded to the ATC(s) concerned. The reservation center point location, projected track, and rate of movement are to be forwarded to the ATC(s) concerned on an hourly basis by the "STORMFURY" command aircraft in order that an accurate reference point is available at all times. This information shall be relayed by the receiving Center to other Centers concerned.

6. NOTIFICATION OF AERONAUTICAL INTERESTS. NOTAM's are to be issued by the appropriate Center, except that the Miami Center shall issue the AIM Publication NOTAM, outlined in Appendix IV. The NOTAM's are to follow the format prescribed in Appendices IV, V and VI. Appendix IV is planned for pre-season publication in the Airman's Information Manual and International NOTAM's Publication.

NOTE: The appropriate Center is the facility within whose control area of responsibility the storm eye is located.

LELAND J. UNDERWOOD /s/
Commander, U. S. Navy
CO, Fleet Weather Facility
Jacksonville NAS

JAMES J. BOYLE /s/
Chief, New York ARTC Center

CHARLES R. HARRISON /s/
Chief, San Juan ARTC Center

WILLIAM P. LEVERETT /s/
Chief, Miami ARTC Center

HOWARD J. MASON, Jr. /s/
Chief, Research Flight Facility
Environmental Science Services
Administration

L. E. ANDERSON /s/
Chief, Houston ARTC Center

JAMES E. POUND /s/
Chief, Jacksonville ARTC Center

APPENDIX II TO ANNEX T

EYEWALL EXPERIMENT

Chronological Summary

AIRCRAFT	FLIGHT	VOICE CALL	ON-STATION TIME (Z)	ALTITUDE	DISTANCE FROM CENTER OF AIRSPACE (NM)
WC-121N	G	STORMFURY G	0800-1500	1,000 ABS	100
DC-6	A	STORMFURY A	0900-1400	12,000 MSL	75
WB-57	C	STORMFURY C	0930-1100	35-40,000 MSL	100
*WC-121N	H	STORMFURY H	1030-2100	10,000 MSL	75
*WC-121N	E	STORMFURY E	1100-2100	6,000 MSL	75
**A-6	L-Q	STORMFURY L-Q	1200-2000	33,000 MSL	100
DC-6	B	STORMFURY B	1500-2000	12,000 MSL	75
C-54	D	STORMFURY D	1500-1900	1,000 ABS	100
WC-130	I	STORMFURY I	1500-1900	29,000 MSL	90
WB-47	J	STORMFURY J	1600-1800	35-40,000 MSL	100
WC-121N	F	STORMFURY F	1900-0200	1,000 ABS	100
DC-6	A2	STORMFURY A2	2100-0200	12,000 MSL	75
WB-57	C2	STORMFURY C2	2230-2400	35-40,000 MSL	100

*NOTE: STORMFURY H will be Command Control Aircraft until relieved by STORMFURY E on station.

**NOTE: Seeder aircraft will enter area at FL 330, climb to FL 350 when directed by the STORMFURY Command Controller and exit at FL 350.

APPENDIX III TO ANNEX T

RAINBAND EXPERIMENT

Chronological Summary

AIRCRAFT	FLIGHT	VOICE CALL	PROPOSED ON-STATION TIME (Z)	(MSL) ALTITUDE	DISTANCE FROM CENTER OF AIRSPACE (NM)
WC-121N	F	STORMFURY F	0600-1400	1,000 ABS	100
WC-121N	E	STORMFURY E	1000-1700	6,000	75
DC-6	A	STORMFURY A	1000-1500	12,000	75
DC-6	B	STORMFURY B	1000-1430	18,000	75
WC-130	I	STORMFURY I	1000-1400	29,000	150
WB-57	C	STORMFURY C	1050-1400	40,000	150
A-6	L	STORMFURY L	1100-1400	35,000	100
A-6	M	STORMFURY M	1100-1400	37,000	150
WC-121N	G	STORMFURY G	1400-2200	1,000 ABS	100
WB-47	J	STORMFURY J	1400-1800	40,000	150
WC-121N	H	STORMFURY H	2200-0600	1,000 ABS	100
C-54	D	STORMFURY D	BACK-UP FOR STORMFURY G OR H	1,000 ABS	100

APPENDIX IV TO ANNEX T

INTERNATIONAL NOTAM'S

AIM PUBLICATION

NOTAM

"OPERATION STORMFURY" IDENTIFIES A GROUP OF LARGE-SCALE EXPERIMENTS TO BE CONDUCTED ON HURRICANES AND TROPICAL STORMS BY THE U.S. ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION AND DEPARTMENT OF DEFENSE DURING THE PERIOD 1 AUGUST - 15 OCTOBER 1969.

THE EXPERIMENTS WILL BE PERFORMED ON STORMS MOVING SEAWARD FIFTY OR MORE MILES FROM ANY LAND MASS IN THE WESTERN PORTION OF THE ATLANTIC, CARIBBEAN SEA AND GULF OF MEXICO. WITHIN THIS AREA, A MOVING AIRSPACE RESERVATION 75NM IN RADIUS, EXTENDING FROM THE SURFACE UPWARD WILL BE ESTABLISHED IN CLOSE PROXIMITY TO THE CENTER OF A NAMED TROPICAL STORM. IN ADDITION, FLIGHT LEVEL 330 AND ABOVE AND FLIGHT LEVEL 290 WILL BE BLOCKED WITHIN 150NM RADIUS OF THE SAME CENTER POINT, EXCLUDING LAND MASSES. THE RESERVATION AIRSPACE WILL TRAVEL IN A DIRECTION AND AT A RATE CONSISTENT WITH THE TROPICAL STORM'S MOVEMENT.

DETAILED NOTAM INFORMATION ON LOCATION, RATE AND DIRECTION OF MOVEMENT WITHIN U.S. CTA/FIR WILL BE ISSUED 24 HOURS IN ADVANCE OF OPERATION STORMFURY. INFORMATION RELATIVE TO DEVIATION OF THE RESERVATION FROM PROJECTED TRACK WILL BE ISSUED BY NOTAM AS IT BECOMES NECESSARY. AERONAUTICAL INTERESTS ARE URGED TO KEEP ALERT FOR NOTAM'S REFERRING TO "OPERATION STORMFURY".

APPENDIX V TO ANNEX T

24 HOUR NOTAM

INTERNATIONAL NOTAM _____ OPERATION STORMFURY HURRICANE RESEARCH PROJECT OF THE U. S. ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION AND DEPARTMENT OF DEFENSE WILL BE CONDUCTED (AUGUST, SEPTEMBER, OCTOBER) _____Z TO (AUGUST, SEPTEMBER, OCTOBER) _____Z WITHIN AN AIRSPACE RESERVATION 75NM RADIUS FROM COORDINATES _____N _____W. ADDITIONALLY, FLIGHT LEVELS 330 AND ABOVE AND FLIGHT LEVEL 290 ARE BLOCKED WITHIN 150NM (100NM FOR EYEWALL) RADIUS DURING THE PERIOD. THE RESERVATION WILL MOVE _____(DIRECTION)____ ON A TRACK OF _____ DEGS FROM INITIAL POINT AT _(KNOTS)_. DEVIATIONS IN SPEED AND/OR DIRECTION OF MOVEMENT CAUSED BY VARIATION OF HURRICANE _(NAME)_____. TRACK WILL BE ISSUED BY NOTAM AS NECESSARY, OR AT THREE HOURLY INTERVALS. ALL AIRCRAFT ARE ADVISED TO REMAIN CLEAR OF DEFINED AREAS DURING THE PERIOD AND TO MAINTAIN CONTACT WITH APPROPRIATE AIR TRAFFIC CONTROL CENTERS FOR LATEST INFORMATION.

APPENDIX VI TO ANNEX T

3-HOURLY NOTAM

INTERNATIONAL NOTAM _____ OPERATION STORMFURY.

CENTER OF AIRSPACE RESERVATION ESTABLISHED AT _____N _____ _W AT

_____Z. BLOCK ALL ALTITUDES WITHIN 75 NM RADIUS. BLOCK FLIGHT

LEVEL 330 AND ABOVE AND FLIGHT LEVEL 290 WITHIN 150 NM (100 NM FOR

EYEWALL) RADIUS. MOVEMENT WILL BE __(DIRECTION)_____ ON A TRACK

OF _____ DEGS AT _____ KNOTS.

ANNEX U

FLIGHT REPORTING FORMS

1. General. Proper data reporting is essential to the operational success of each mission. Appendices I and II of this annex tabulate flight reporting requirements for the Eyewall and Rainband experiments. Each unit/activity will use STORMFURY forms (see Appendices III through VI) provided prior to take off by the Data Quality Control Coordinator (DQCC) or forms standard to its routine operational requirements.

2. STORMFURY Coordinated Forms. All data collected on STORMFURY forms, Tab C through Tab K, will be recorded in triplicate. The original and copies will be distributed as follows:

a. Turn in original and first carbon to Data Quality Control Coordinator (DQCC) at post-flight debriefing.

b. DQCC will provide the first carbon of such data to Naval Weather Research Facility, Norfolk.

c. Retain second copy for squadron/unit utilization.

3. Unit/Activity Forms. If unit/activity forms standard to routine operational requirements are used, the minimum additional information necessary is as follows:

a. Date (Z)

b. Flight Identification (STORMFURY letter)

c. Take-off and landing time (Z)

d. Aircraft type

e. Time of obtaining each parameter recorded.

f. Hourly WWV time checks with error noted.

STORMFURY
DATA INVENTORY
EYEWALL EXPERIMENT

FLIGHT	A	A2	B	C	C2	D	E	F	G	H	I	J	L	M	N	O	P
SF-1 MET. LOG							X	X	X	X	X						
SF-2 WB-47 LOG												X					
SF-3 SENDER MET.													X	X	X	X	X
SF-4 RUN REPORT													X	X	X	X	X
SF-5 DAYS OPS													X	X	X	X	X
SF-6 WIND CALIB.	X	X	X			X	X	X	X	X	X	X					
SF-10 MDS LOGS							X	X	X	X							
SF-11 RADARSCOPE LOGS							X	X	X	X			X	X	X	X	X
SF-12 RADAR ADV. LOG	X	X	X			X	X	X	X	X							
AMQ 17 TAPE							X	X	X	X							
NAV LOG	X	X	X			X	X	X	X	X	X	X					
TRUE TRACK RECORD												X					
DIGITAL TAPE	X	X	X	X	X		X	X		X							
PHOTO PANEL FILM	X	X	X	X	X	X											
RADAR FILM						X							X	X	X	X	X
APS-20 FILM (230)	X	X	X				X	X	X	X							
APS-20 FILM (81)							X	X	X	X							
APS-64 FILM												X					
APS-45 FILM							X	X	X	X							
WP-101 FILM	X	X	X														
RDR-1 FILM	X	X	X	X	X												
CLOUD CAMERA FILM	X	X	X	X	X												
DROPSONDES	X	X	X							X	X						
COLD BOX LOG	X	X	X														
MET. LOG (RFF)	X	X	X			X											
RADAR LOG (RFF-5)	X	X	X	X	X	X											
FLIGHT PROG. (RFF-1)	X	X	X	X	X	X											
FLIGHT INFO. (RFF-2)	X	X	X	X	X	X											
FLIGHT DATA (RFF-3)	X	X	X	X	X	X											
DIGITAL STA. (RFF-4)	X	X	X	X	X	X											
DRT. (RFF)	X	X	X			X											
ELECT. STATUS (RFF)	X	X	X			X											
MET. SYSTEMS (RFF)	X	X	X			X											
CLOUD PHOTOS (RANDOM)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
PERSONAL NOTES	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
WWV TIME CHECKS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
FLIGHT DESIG.	A	A2	B	C	C2	D	E	F	G	H	I	J	L	M	N	O	P
TYPE AIRCRAFT	DC6	DC6	DC6	B57	B57	C54	121	121	121	121	130	B47	A6	A6	A6	A6	A6

Voice Call is STORMFURY plus Flight Letter (STORMFURY Echo).
(Each flight turn in the data collected to DQCC as soon as possible after landing).

STORMFURY
DATA INVENTORY
RAINBAND EXPERIMENT

FLIGHT	A	B	C	E	F	G	H	I	J	L	M
SF-1 MET. LOG				X	X	X	X	X			
SF-2 WB-57 LOG									X		
SF-3 SEEDER MET.										X	X
SF-4 RUN REPORT										X	X
SF-5 DAYS OPS.										X	X
SF-6 WIND CALIB.	X	X		X	X	X	X	X	X		
SF-10 MDS LOGS				X	X	X	X				
SF-11 RADAR SCOPE LOGS				X	X	X	X			X	X
SF-12 RADAR ADVISOR LOG				X	X	X	X				
SF-17 TAPE				X	X	X	X				
NAV LOG	X	X		X	X	X	X	X	X		
TRUE TRACK RECORD									X		
DIGITAL TAPE	X	X	X	X	X	X	X				
PHOTO PANEL FILM	X	X	X								
RADAR FILM									X	X	X
AFS-20 FILM (230)	X	X		X	X	X	X				
AFS-20 FILM (81)				X	X	X	X				
AFS-63 FILM									X		
AFS-43 FILM				X	X	X	X				
WP-101 FILM	X	X									
RDR-1 FILM	X	X	X								
CLOUD CAMERA FILM	X	X	X								
DROPSONDES	X	X						X			
COLD BOX LOG	X	X									
MET. LOG (REF)	X	X									
RADAR LOG (REF-5)	X	X	X								
FLIGHT PROG. (REF-1)	X	X	X								
FLIGHT INFO. (REF-2)	X	X	X								
FLIGHT DATA (REF-3)	X	X	X								
DIGITAL STA. (REF-4)	X	X	X								
DRT. (REF)	X	X									
ELECT. STATUS (REF)	X	X									
MET. SYSTEMS (REF)	X	X									
CLOUD PHOTOS (RANDOM)	X	X	X	X	X	X	X	X	X	X	X
PERSONAL NOTES	X	X	X	X	X	X	X	X	X	X	X
WWV TIME CHECKS	X	X	X	X	X	X	X	X	X	X	X
FLIGHT DESIG.	A	B	C	E	F	G	H	I	J	L	M
TYPE AIRCRAFT	121	DC6	B57	121	121	121	121	130	B47	A6	A6

Voice Call is STORMFURY plus Flight Letter (STORMFURY Echo).
(Each flight turn in the data collected to DOCC as soon as possible after landing.)

STORMFURY
METEOROLOGY DATA
(Every 5 min. on Station)

ON STA_____Z OFF STA_____Z FLIGHT_____ DATE_____ A.C. BuNo_____

VOICE CALL_____ FLIGHT METRO_____ CREW_____

TIME	POSIT	TEMP	RH	PRESS	ABS ALT	PRESS ALT	"D" VALUE	SLP	SFC WIND	FLT LVL WIND	RNG/BRG FR EYE	TH	TAS	DA	GS	SPRL X.S	WWV TIME

STORMFURY
WR-47P REPORT FORM

TRIPLICATE RECORD SET #_____OF_____.

3-4 MIN. IN-FLIGHT OBSERVATIONS (ALT. SET AT 29.92 IN.)
TRUE TRACK IN SPACE AND TIME TO BE ATTACHED WITH THIS FORM.

DATE_____ FLIGHT_____ AIRCRAFT_____

P.C. COMMANDER_____ CO-PILOT_____ NAVIGATOR_____

ON STATION AT_____Z DEPART STATION AT_____Z

OBS. #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
TIME (Z)														
BRNG/RNG OR CO-ORD.														
RADAR ALTITUDE														
PRESSURE ALTITUDE														
MHG°/IAS														
GS/DRIFT														
MACH/RES. OR TEMP.														
REMARKS (PROB. ERROR IN N.MI. & PERT. INFO.)														

STORMFURY
SEEDER REPORT FORM

INFLIGHT OBS. EACH 5 MIN. ON STATION (ALT. SET 29.92")

DATE_____ AIRCRAFT_____ FLIGHT_____

A.C. CDR_____ A.C. BUNO_____ ON STA_____Z OFF STA_____Z

TIME	POSIT	TH	IAS	TAS	GS	WINDS	ABS ALT	PRESS ALT	TEMP	MISC

SF-4

STORMFURY
SEEDING AIRCRAFT
RUN REPORT

SET ALTIMETER AT 29.92 INCHES

DATE _____ FLIGHT _____

SEEDING RUN (RELEASE) BEGAN _____ Z ENDED _____ Z

HEADING (TRUE) _____ DEGREES AIRSPEED _____ TAS

PRESSURE ALT. _____ FT

LOCATION START RUN _____ LOCATION END RUN _____

NUMBER OF UNITS RELEASED _____

EST. NO. OF UNITS ENTERING CLOUD _____

EST. CLOUD TOPS ON SEEDING RUN _____

REMARKS: (Please describe or sketch before and after appearance of clouds, turbulence, radar echoes, etc.)

STORMFURY
SEEDING AIRCRAFT
DAY'S OPERATION SUMMARY

DATE FLIGHT AIRCRAFT

BOMBARDIER/NAV_____ COMMANDER_____

ON STATION_____ _____Z DEPART STATION_____Z

_____Z _____Z

PLEASE ATTACH LOADING DIAGRAM INDICATING ANY ORDNANCE HUNG OR RETURNED.

RUNS MADE_____

RUNS ABORTED_____

IF ABORTED, GIVE REASON:

TOTAL NUMBER OF UNITS RELEASED:

REMARKS:

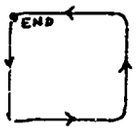
STORMFURY
WIND CALIBRATION TABULATION SHEET

FLIGHT_____ VOICE CALL_____ DATE_____

TIME (Every 30 sec.)	H D G	1 MAG HEAD	2 DRIFT	3 GROUND SPEED	4 WIND DIR	5 WIND SPEED	6 ALT.	7 TAS	8 IAS	9 TEMP	10	11
00	T											
30	O											
00												
30	S											
00	O											
30	U											
00	T											
30	H											
00	T											
30	O											
00												
30	E											
00	A											
30	S											
00	T											
30												
	T											
00	O											
30												
00	N											
30	O											
00	R											
30	T											
00	H											
30												
	T											
00	O											
30												
00	W											
30	E											
00	S											
30	T											
00												
30												

NOTES: 1. Box consists of four 2½-minute, straight and level legs on cardinal headings. Standard rate turns (3°/sec). If necessary, extend leg to obtain a minimum of two minutes of readings each heading after memory cycle ends.

2. Take readings every 30 seconds. Note beginning and ending of periods of memory.



STORMFURY
MDS LOG
MINIMUM DISCERNIBLE SIGNAL (MDS) AND
PHOTOGRAPHIC DOCUMENTATION OF MDS

FOR RADAR TYPE_____ FLIGHT/A.C. BuNo_____/_____

DIRECTIONAL COUPLER CABLE LOSS_____DBM EXPERIMENT_____

PEAK POWER TRANSMITTED_____MW A.C. MISSION_____

CREW/TECH_____ _____ CICO_____

	APPROX % GAIN	UPM-44 DIAL	VISUAL MDS	PHOTO FR#	TIME Z/ DAY / MONTH / YEAR
ENROUTE TO AREA					Z/ / /
INTER-MEDIATE					Z/ / /
INTER-MEDIATE					Z/ / /
ENROUTE FROM AREA					Z/ / /

1. All film tests are to be made with Radar Data Advisor.

2. Perform at least two film documentations of MDS: enroute to, and enroute from mission; other times if changes in gain or other equipments warrant.

3. Each UPM-44 Signal (level represented by video, not UPM-44 dial setting) must be entered on data cards of APS-20 radarscope cameras in turn!

STORMFURY
RADAR SCOPE PHOTOGRAPHY LOG

DATE_____ MISSION_____ RADAR/SCOPE_____/_____

CAMERA SER. NO._____ CREW_____ FLIGHT/BuNo_____/_____

MAGAZINE SIDE NO._____

PREFLIGHT AND HOURLY CHECK

1. DATA CHAMBER LIGHTS.
2. RANGE MARKER FUNCTIONING.
3. F STOP SET AT 5.6.
4. CLOCK TIME CHECKED & FUNCTIONING.
5. CAMERA MAGAZINE FILM ADVANCE FUNCTIONING.
6. FOCUS, VIDEO & INTENSITY CONTROLS FUNCTIONING.

PREFLIGHT COMPLETED BY_____

TIME CHECK	CLOCK ERROR FAST/SLOW (SECONDS)	FRAME NO.	START (ZULU)	STC (%)	ANT. ELEV.	RANGE (MI.)	RANGE MARKS (MI.)	ALT. (FT.)	STOP (ZULU)	FRAME NO.	OBSV. INIT.
Example: 1300	10/S	27	1303	0	+2½	100	20	6000	1401	160	RCS

NOTE:
1. Return this sheet to DQCC after each flight.
2. Use at least one new sheet per flight.
3. Log any malfunctions or gaps in photography below, new mag. #, time, etc.

REMARKS:

SF-12

STORMFURY
RADAR DATA ADVISOR'S RADAR METEOROLOGICAL LOG

EXPERIMENT_____ DATE_____ VOICE CALL_____

OBSERVERS_____ A.C. BuNo_____ FLIGHT_____

APS 20	ARS 45			
61	230	TIME	FRM	COMMENTS

OPERATION PLAN
FWF JAX NO 1-69

Project STORMFURY
Fleet Weather Facility
Naval Air Station
Jacksonville, Florida
June 1969

ANNEX W

PUBLIC AFFAIRS

1. General

a. In order to make accurate information available to the public, FSSA-Navy Public Affairs Teams located at the staging base, Miami and Washington will handle all public information relative to Project STORMFURY operations.

b. As in previous years, a coordinated press release on plans for Project STORMFURY will be distributed before the beginning of the season's operations. The Commander, Naval Weather Service Command will be responsible for all approvals and coordination within the Department of Defense. FSSA will exercise the same responsibility within the Department of Commerce. The release should carry both DOD and DOC mastheads and should be printed at the Department of Commerce. Initial release will be made simultaneously by DOD and DOC facilities in Washington, San Juan, Miami and Jacksonville.

c. Releases on a continuing basis during Project STORMFURY operations will be prepared at the staging base by the Public Affairs Team working directly with the Project Director or Assistant Project Director. Upon approval of the Project Director or Assistant Project Director, the release will be simultaneously transmitted to on-the-scene news media and, by the most expeditious means, to the National Hurricane Center, Miami. From there, it will be relayed to national news media,

as well as all ESSA and Navy facilities, utilizing the Hurricane Circuit and other means of dissemination. A Public Affairs Team assigned to the Hurricane Center at Miami during STORMFURY operations will be responsible for disseminating the releases and handling news media inquiries. Releases and news media may also be handled by the Navy and ESSA in Washington, D. C.

d. All releases will reflect proper credit to participating components and personnel. Copies of all releases will be distributed as widely as possible, and in particular to Commander, Naval Weather Service Command and Headquarters, Air Weather Service (Attention: DI).

e. Two aircraft seats will be made available on each day's operation for news media representatives on a pool basis. One seat will be provided for a representative of the printed news media and one seat for a cameraman representing TV networks. Prior to the beginning of the STORMFURY Operational Period, a letter will be forwarded to the major news and television outlets explaining the intent of this plan and requesting the selection of two pool representatives. Subject to DOD approval, transportation will be provided these two pool representatives and their equipment, on a space-available basis, to the staging base aboard VW-4 aircraft from Jacksonville. The pool representatives will be alerted at the same time as STORMFURY personnel are put on alert. All local requests for media participation will be referred to the ESSA and Navy Public Affairs Offices in Washington for coordination. During Dry Run operations, professional photographers may be contracted to make film footage and still photography of Project STORMFURY Operations. The resultant film and photographs will be

released by DOD/DOC to the media before actual operations.

f. All arrangements for press conferences and interviews with Project STORMFURY officials will be made by the Public Affairs Teams.

2. Releasable Information.

a. Releases prepared during Project STORMFURY operations will consist of background information, plans for the next day's operations and an operational summary of the day's operations.

b. In no case will release of information include unpublished experimental results or personal speculations about the experiment. However, this should in no way prohibit Project officials from freely participating in news conferences or interviews which have been previously arranged through the Public Affairs Team.

c. Joint ESSA/Navy Press Kits will be prepared by ESSA and Navy CHINFO offices prior to the start of the Project season. These kits should contain basic fact sheets, dry run and hurricane photography and feature material on Project personnel and programs.

LELAND J. UNDERWOOD
Commander, U. S. Navy
Navy Project Coordinator/
Assistant Project Director
for Project STORMFURY