26 February 1970

MEMO TO: Charles A. Palmer

FROM : V. E. Lally vel

SUBJECT: Mother GHOST Demonstration Project.

WHY

The COSPAR Working Group VI met in Paris in February 1970 to provide a better definition on the observing and data processing systems required for the First GARP Global Experiment, which is outlined in GARP Publication No. 3. A report of the Working Group's findings will be submitted to JOC at the Brussels conference on 16 March 1970. In the summary of the report is the following paragraph:

> A special carrier-balloon dropsonde subsystem is suggested to meet fully the FGGE requirement for winds in at least four tropospheric levels in the tropics. Lacking such a complete subsystem, adequate vertical resolution of wind will not be obtained from cloud and constant-level balloon tracers. At this time, this appears to be the most serious need for special effort for FGGE.

Please note that the underlined statement was underlined by the Working Group, not by myself.

The following statements are extracted from the body of the report:

> 1.1.5. However, WG 6 regards it technically possible using techniques that are reasonably well known, to construct a special subsystem consisting of carrier balloons and navigation aide dropsondes commanded via geostationary satellites to meet this requirement fully. The implementation of such a subsystem would have the further benefit of reducing the needs for certain other subsystems considered heretofore which, by themselves, do not fully meet the stated requirements. These details are discussed below in section 3.5.3.3.
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> 3.5.3.3. Carrier-Balloon Launched Dropsondes. (a) On the basis of earlier tests in the U.S. of large constant-level balloons with heavy payloads, and with the development of large super-pressure balloons and launch techniques in preparation by NCAR for the Nimbus IV IRLS experiment to be conducted in 1970, it is considered feasible to develop a large stratospheric carrier balloon to launch dropsondes.
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> (b) This concept calls for a very large superpressure (carrier) balloon, flying at an altitude between 25 to 30 km and loaded with about 100 dropsondes (see Fig. 1). The dropsonde is released upon command from one of the geostationary satellites. The dropsonde telemeters data through the superpressure balloon and the geo-stationary satellite to a ground station where the signals are

unscrambled to provide a complete sounding of wind, temperature, pressure and humidity.

(c) All of the key components of the carrier balloon subsystem (large superpressure balloons to carry heavy loads, launch capability of such balloons, omega dropsondes with adequate accuracy for one minute averaging, satellite command and data relay, etc.) are technically proven and feasible. WG 6 believes it feasible to integrate these components into a state-of-the-art subsystem for FGGE, at less cost than other unconventional techniques to meet the wind requirement fully.

(d) On account of the zonal flow with little divergence at stratospheric altitudes of 30 to 10 mb, all carrier balloons are expected to stay within the tropical zone during their full operational lifetime. Consequently, only two launching facilities are expected to be required.

(e) It is estimated that an ensemble of 300 carrier balloons, each launching a minimum of two (2) dropsondes per day (the number will depend, of course, on the number of 400 x 400 km resolution elements that will be traversed per day), will be adequate to perform about 600 soundings per day during one Special Observing Period of 30-50 days.

(f) It is estimated that each carrier balloon with a store of 100 dropsondes will cost on the order of $20,000-$30,000, accounting for the superpressure balloon carrier, dropsondes, ground-to-satellite transponder, release mechanism, and the necessary housekeeping subsystems.

(g) On the basis of these estimates, and the possible number of carrier balloons that may be required for the two Special Observing Periods, it is estimated that the total subsystem to meet FGGE requirements fully will cost on the order of $12 to $18 million, and that two special launch facilities (capital equipment plus operation) will cost about $0.6 million.

3.5.4. Conclusion

(a) WG 6 recommends consideration of the carrier-balloon dropsonde subsystem as the best possible solution apparent at this time to meet fully the tropical wind requirement for FGGE.

(b) Since the proposed technique has not yet been proven as an integrated system, its implementation for the First GARP Global Experiment would require:

(i) a very early decision (first half of 1970) to include provisionally the necessary (about 30, it is estimated) narrow-band dedicated communication channels on all geostationary spacecraft planned for FGGE (the command and data relay capability must be fully compatible among the four spacecraft);

(ii) an early decision to start a very energetic system engineering development program which should lead to flight tests no later than 1973. (In this regard, NCAR is planning

to test prototype balloon and launch systems, with omega sondes, in the fall of 1970).

Please note that the underlined conclusion is also provided by the Working Group and not by me.

TEST OBJECTIVES

In order to meet the schedules for implementation as well as the even more critical schedule for decision-making, it is essential that NCAR provide a complete feasibility demonstration before the end of 1970. This demonstration should include unequivocal proof that we can fly large, heavy payload balloons for periods exceeding three months at an altitude of 80,000 ft or higher. We must also prove that we can obtain wind data at all levels from 30 mb to the surface using dropsondes equipped with omega translators. It is desirable but not essential that this demonstration include communication through a geostationary satellite link. It is not necessary that this demonstration include a full-scale dropsonde dispenser system, but it should include a prototype of a dispenser which is capable of releasing up to four dropsondes using techniques that can be expanded to a full-scale dispenser capable of dropping up to 100 sondes.

TIMING

The timing for various test flights remains somewhat flexible. On the assumption that we should have (no later than November) two prototype balloon systems in the air launched from Australia, then we should have our first flight test from a blimp hangar such as Akron or Lakehurst in August, with a second test flight during the turn around period from Palestine in September.

SPECIFIC TASKS

A. Preparation of balloon specifications (near completion).

B. Mechanical and electronics design for dispenser system for initial tests, which can be scaled up for the final configuration.

C. Development of prototype dropsondes using standard radiosonde components plus a crystal-controlled transmitter.

D. Development of a frequency translator for retransmission from dropsonde to balloon to ground. An early decision can be made whether this retransmission will include a satellite link. The loan or purchase of a Beukers ground system.

E. Flight test from large blimp hangar.

F. Flight test from Palestine.

G. Flight test from Australia. (Note that these flight tests will all be to demonstrate balloon capability and will use conventional Palestine and GHOST electronics.)

H. Dropsonde tests from Palestine using polyethylene balloons.

FUNDS REQUIRED

The major expense item would be the purchase of a Beukers ground system, which together with engineering assistance will cost about $45,000. If we can obtain the loan from ESSA of a Beukers system, the engineering support from Beukers will be about $15,000.

Balloons will cost $5,000 each, and a minimum of four will be required. Assuming complete support from Palestine for American flights, the additional flight costs should not exceed $5,000, including the provision of small polyethylene balloons.

An additional $5,000 is estimated for procurement of electronics parts.

We are not able at this time to make a valid estimate of funds required by the NCAR shop facilities for development of the dropsonde dispenser. Total funds required are estimated at $45,000 to $75,000.

These funds should be available in FY '70 if we are to meet our timing goals. The funds required for the development of the complete system will be between $1-$2 million for hardware for flight testing. Approximately $1,000,000 for satellite hardware and perhaps $2,000,000 for the software required for central data processing. Only the first of these would be administered directly by NCAR. The estimate for the flight program for 1975-1976 is presently estimated between $12-$18 million. Obviously, no decision will be made on commitment of such major expenditures before a conclusive demonstration has been made of the basic system.

ASSISTANCE REQUIRED

At this time our limited resources are spread thin in the development of the hardware for the Experimental Operational Program and in the preparation for the Nimbus-D flights from Ascension Island.

At this time only Frykman and Lally are free to devote full time to this project. Lichfield will devote substantially full time commencing in June 1970. In order to do our job properly we require an additional engineer and technician for the balance of the year assigned to work directly with Frykman and Lichfield. We also require the assignment of an engineer from the Scientific Balloon Facility to work with Lally and Frykman on the flight test program. In addition, we require the commitment of a first-rate designer from the design facility, on a dedicated basis over a period of two to three years, to develop the prototype and the follow-on dispenser dropsonde systems. This commitment would include, of course, a substantial amount of machine shop assistance.

URGENCY

Decision must be made this year as to the final configuration of the observing system for the First GARP Global Experiment. The demonstration project must be completed this year to permit specifications on satellite designs and data processing designs to be established. If it is not possible to obtain the required funds through NCAR or NSF reprogramming, there is a reasonable possibility that the National Environmental Satellite Center

will provide the required funds. However, I do not feel we should solicit such funds unless we are willing to dedicate additional manpower resources at NCAR to the project objectives. We should either move aggressively on this project or admit to the National GARP Committee that we are not willing or able to accept the challenge.

End of Memo

VEL:nl