P. Julian

TROPICAL WIND, ENERGY CONVERSION, REFERENCE LEVEL EXPERIMENT (TWERLE)

Status Report

(For the Period Ending 30 November 1972)

The major activities for this reporting period have been the preparation of the TWERLE Flight Test Program Data Report and continued work on the TWERLE electronics system.

Status of Flight System

A. Superpressure Balloon

The current design, fabrication and shipping techniques are satisfactory. No major changes are planned for the balloon. Sample tests for balloon integrity are planned at each launch site. An improved quality control and test procedure are required at the factory to ensure that seals meet cold temperature performance specifications.

A purchase order has been placed for twenty TWERLE balloons to be used during April 1973 test flights of the final flight system.

B. Solar Panel

The three-sided solar panel is in final design, the power output and weight meet design objectives.

C. Antenna

The balloon to satellite antenna is currently undergoing revision from the original design in order to optimize the gain at lower angles. The UWISC has fabricated a test model which has been tested on the GSFC antenna range. The balun design has not been completed.

D. Cutdown

This element has satisfactorily passed flight tests and the final circuit design and packaging has now been completed. Thermal testing of six existing prototypes is now being performed. Fabrication techniques have been developed for making the sensor coils and final sensor fabrication is now in process.

E. Data Encoder

Ten engineering models have been fabricated and are now being tested. Eight of these units will be incorporated in the platform simulator. The final data input format has not been finalized.

F. Transmitter and Stable Oscillator

The UWISC is proceeding with design and testing of the TWERLE transmitter, stable oscillator and crystal oven assembly.

G. Temperature Sensor

Evaluation of test flight data indicates that the current temperature sensor design is satisfactory for the TWERLE system. Recalibration of nine month old thermistors has shown that long-time storage does not significantly alter their characteristics. Prototype printed-circuit boards are now being fabricated for environmental testing.

H. Pressure Sensor

The UWISC pressure sensor is undergoing extensive thermal and aging testing. Several pressure capsules are being evaluated, as well as considerations for proper orientation within the package.

I. Radio Altimeter

This element has provided reasonable data during the last test flights. A modification is planned to relocate the two circuit boards and to use the original light-weight antenna. Further thermal testing is planned prior to final procurements.

J. Thermal Enclosures

Several foam packages have been designed and are being evaluated. As the remaining elements move into final design, the thermal enclosures will be adapted to the particular configuration.

K. Program Schedule

As can be seen from the attached bar chart, most components are currently on schedule, with a possible delay in completing the design phases of the Antenna and Pressure Sensor.

TWERLE Technical Description

The following pages have been revised and should be inserted in your copy of the TWERLE TECHNICAL DESCRIPTION.

List of Revised Pages Attached.

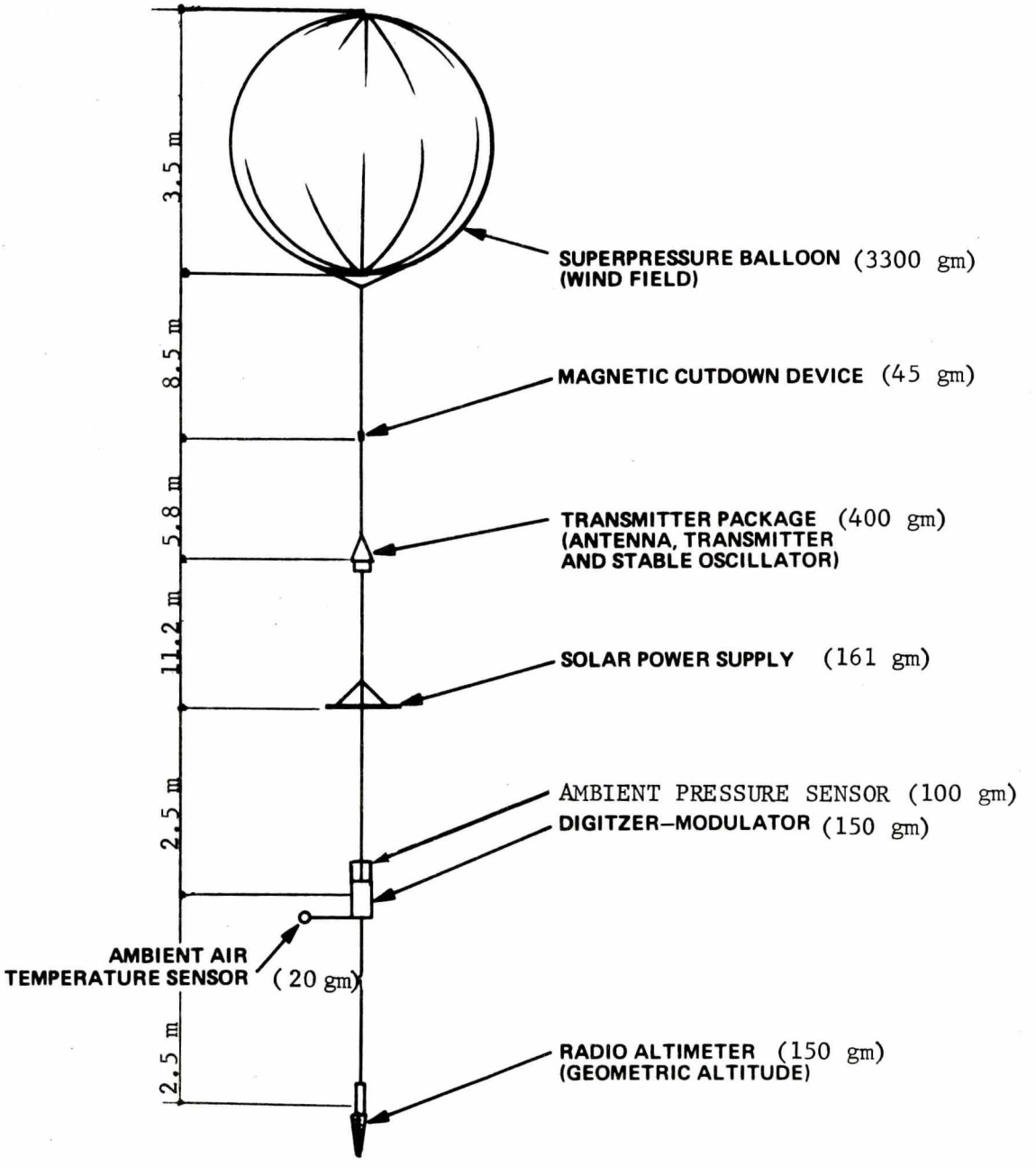


Figure II-1. TWERLE Balloon System

TABLE II-8

WEIGHT DISTRIBUTION, POWER REQUIREMENTS, AND APPROXIMATE COST OF FLIGHT TRAIN COMPONENTS

COMPONENT	WEIGHT (grams)	POWER (watts) RF On	RF Off	COST ($)
Balloon	(3300)			500
Solar Panel	161	(2.4)	(2.4)	215
Antenna	150			50
Cutdown	45	0.07	0.07	57
Data Encoder	150	0.10	0.10	150
Transmitter/ Oscillator	200	1.40	0.60	450
Temperature Sensor	20	0.05	0.05	50
Pressure Sensor	100		0.10	100
Radio Altimeter	150		0.84	300
Foam Packages &				75
Flight Train Rigging	160			25
	1136 gms	1.62	1.76	$1,972.

NATIONAL CENTER FOR ATMOSPHERIC RESEARCH
Box 1470, Boulder, Colorado 80302

SUPERPRESSURE BALLOON SPECIFICATION

PROJECT NAME TWERLE-4 Date November 1972

NCAR REQUEST NO. _____ PROPOSAL DEADLINE _____

BALLOON QUANTITY ten (10) BALLOON SHIPMENT SCHEDULE 15 February 1973

SUSPENDED LOAD 1000 gms (2.2) lbs	NCAR USE ONLY
FLOAT ALTITUDE 150 mb (44.647) ft	manufacturer _____
HELIUM LIFT AT FLOAT ALTITUDE 0.20785 Kg/M^3	unit price _____
DENSITY ALTITUDE FOR FLOAT 0.24120 Kg/M^3	
BALLOON SHAPE Spherical	DIAMETER 3.5052 m (11.5) ft
GORE MATERIAL 23 x 23 μ bilam Celanar	VOLUME* 22.5268 m^3 (796.0) ft^3
MAXIMUM GORE WIDTH 0.548 m (1.8) ft	AREA* 38.5814 m^2 (415.3) ft^2
ENDCAP MATERIAL 23 x 23 x 23 μ trilam Celanar	WEIGHT* 3.370 kgs (7.43) lbs
OUTSIDE TAPE GT-300 1 x 1 x 1.5 (or NCAR approved equal)	GORE NUMBER 20
INSIDE TAPE GT-300 1 x 2 x 1 (or NCAR approved equal)	GORE LENGTH 5.4864 m (18) ft
	*Nominal values

INFLATION FITTING (number/size/diffuser/location):
one/ 1.905 cm I.D./yes/centered in bottom end cap.

LOAD ATTACHMENT (capacity/design/materials):
1 Kg sustained, 10 Kg shock/ great circle, 4 lines/nylon, coreless, 90.7Kg B.S. Flat

TESTING REQUIREMENTS: Pressure to 703 Kg/cm^2 stress (10K psi stress), hold for 5 hours at room temp (21^oC). Leak test (halogen) at 492 Kg/cm^2 (7K psi), test and repair until no leaks are present. Measure diameter two places: across equator on seam and mid-gore, measure pressure 24 mb. (9.5 in H_2).

QUALITY REQUIREMENTS (drawings/specifications, etc.):
1. Manufacturer to provide detailed drawings and tolerances and specifications for NCAR approval. prior to fabrication.
2. See NCAR Quality Specification, N-14A.

SPECIAL ATTACHMENTS, etc.
1. Aluminized polyester film (1-2 ohms/square, 6μ thick) outer cap to cover top 1/3 of sphere area
2. Polyethylene launch sleeve, Ref. NCAR Sketch 10/72. After testing balloon to be folded and placed in sleeve ready for inflation and launching.

PACKAGING (material/liner/size):
Outer box fiberboard (NCAR supplied)/Mil 131-E in box/balloons packed in individual single wall cardboard cartons (64 x 24 x 4 inches). Ref. NCAR Sketch, 298-72 sleeved balloon wrapped in air-pac polyethylene.

SHIP TO: Shipping instructions to be provided by NCAR prior to shipment

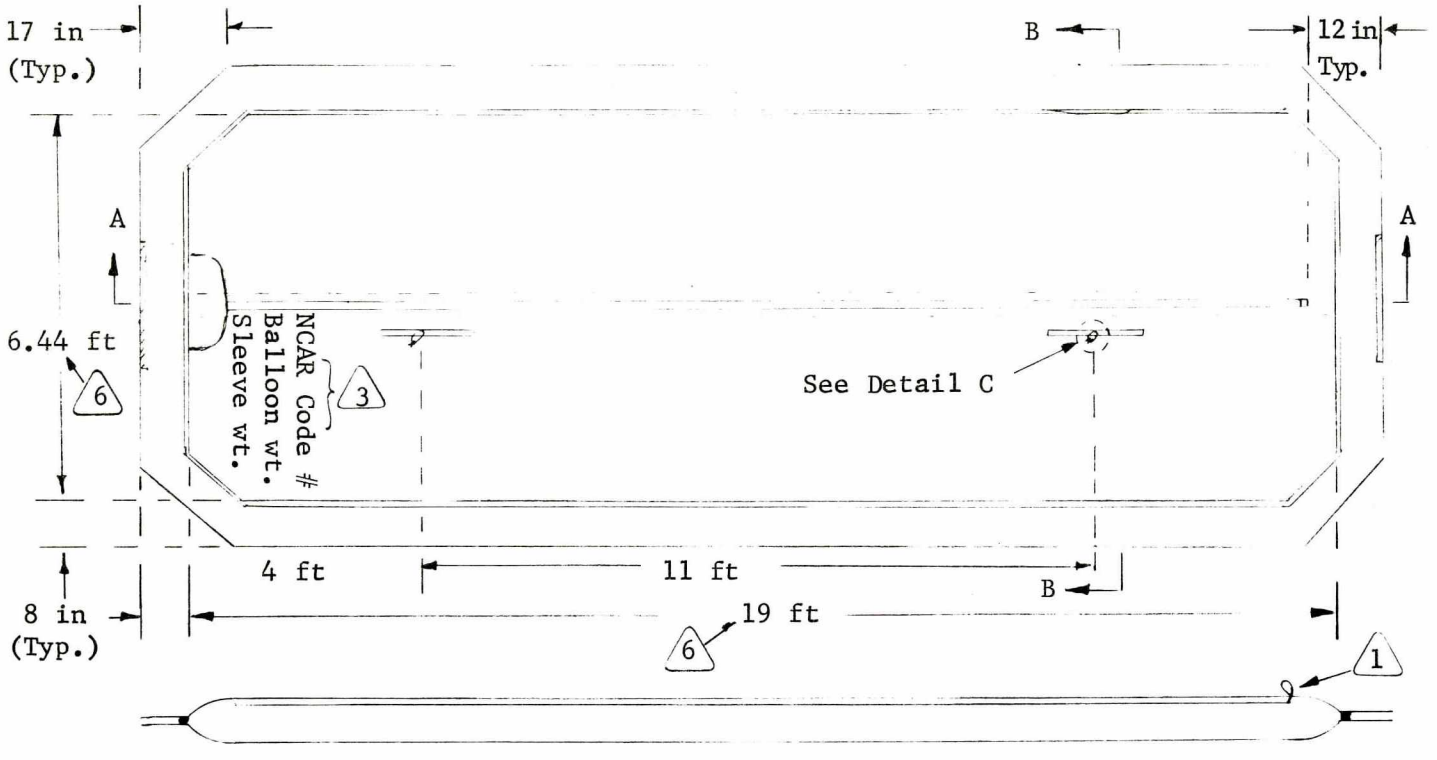
(FOB manufacturers dock)

MARK: FOR "STORE IN SHELTERED AREA"
"HOLD FOR NCAR REPRESENTATIVE"
TWERLE-4

1 kg	= 2.205 lb	1 lb	= 453.6 gms
1 m_2	= 3.281 ft_2	1 ft_2	= .3048 m_2
1 m_3	= 10.764 ft_3	1 ft_3	= .0929 m_3
1 m^3	= 35.314 ft^3	1 ft^3	= .0283 m^3

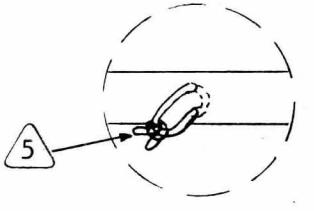
rev. 30 November 1972

BY _____
Global Atmospheric Measurements Program



Sect. A-A

Sect. B-B



Detail C

6 Inside dimension

5 Tie loop knot on 100# test nylon line, loop diameter 2 inches, attach to 1 ft. long filament tape.

4 Balloon (not shown) centered in sleeve length and crosswise, flight ready.

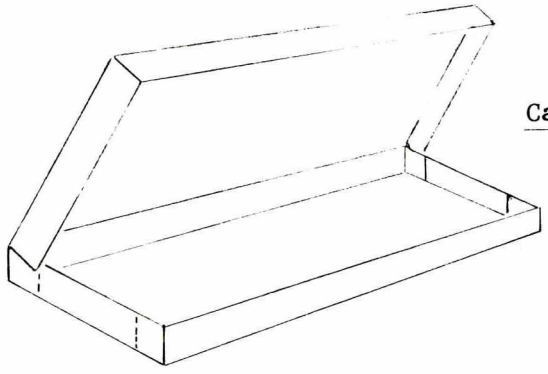
3 Mark as shown with one-inch letters, black ink.

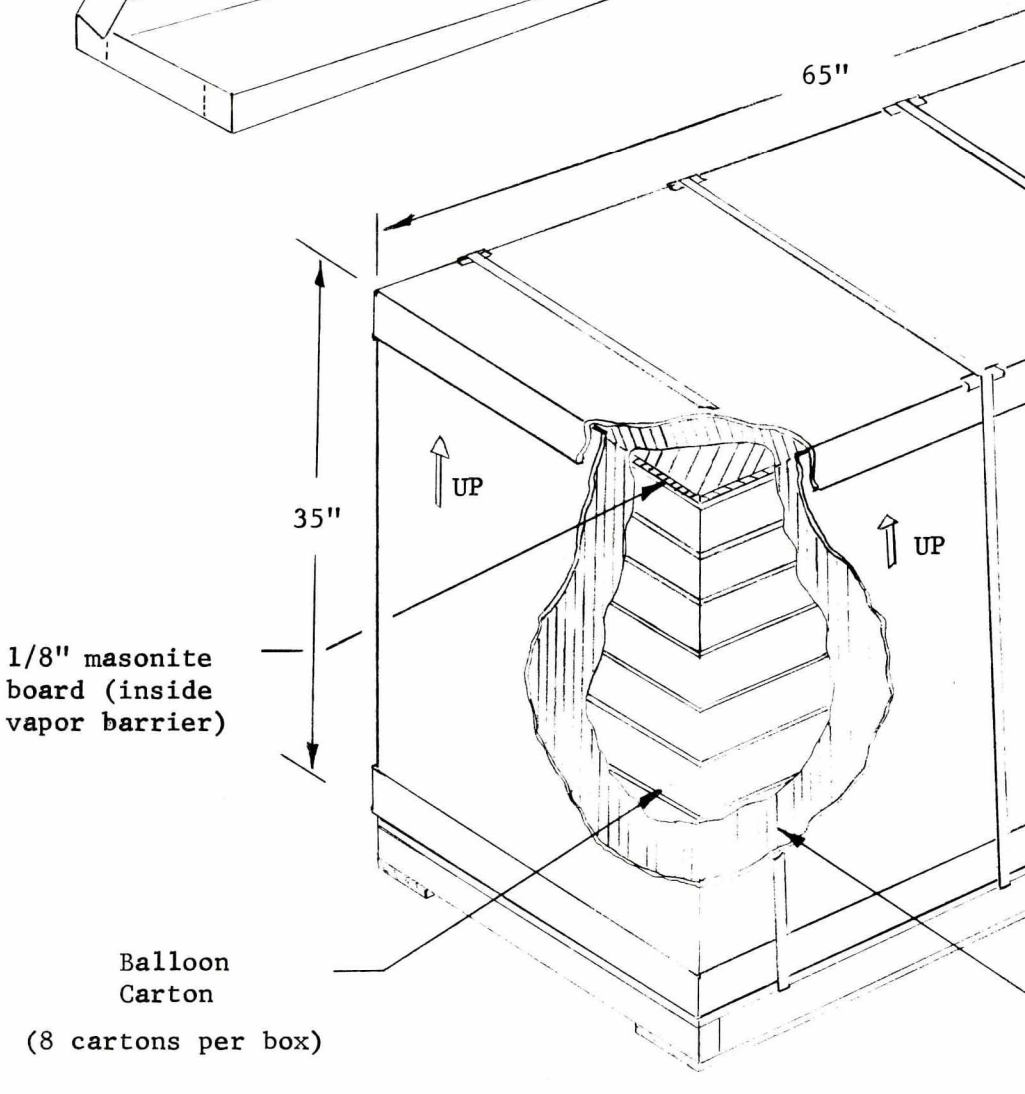
2 Heat seal around inside edge of 8-inch flap.

1 Tear tab opens sleeve with 200-300 gms force. Leave about one inch diameter loop at end.

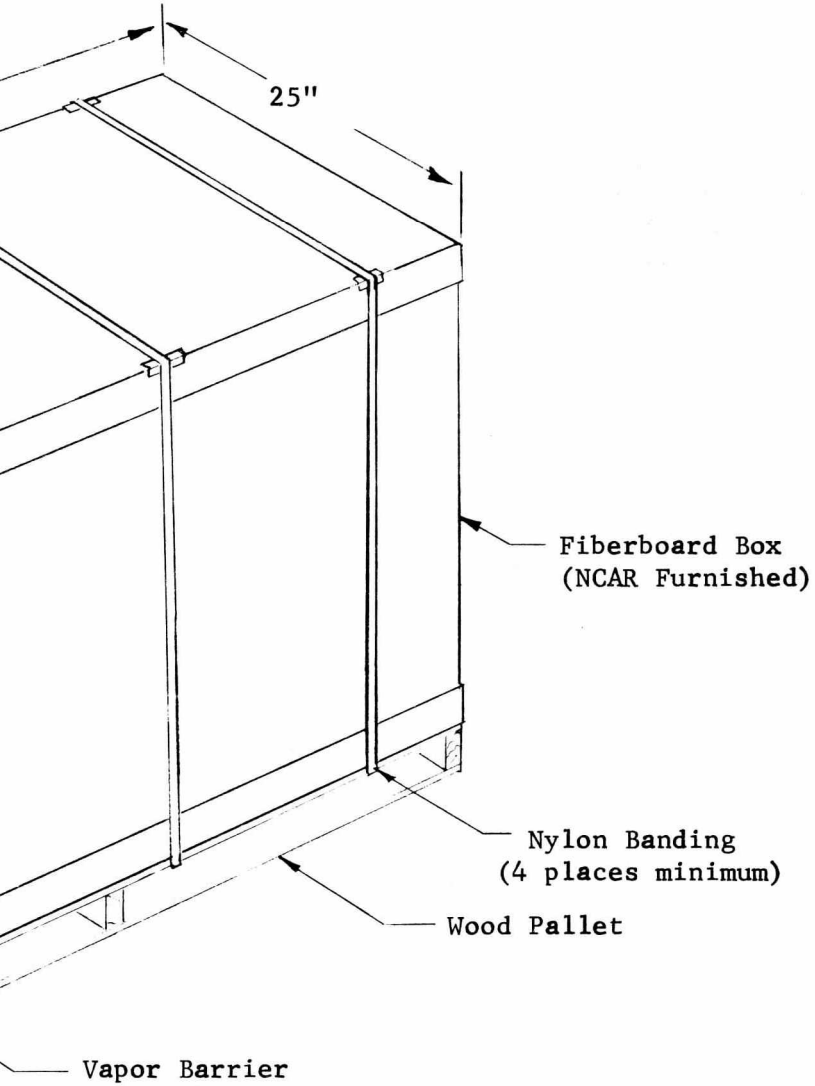
Material:	Launch Sleeve
Sleeve - clear polyethylene 3 mil	NCAR Sketch
Tab - Rayon filament tape	11/72

Carton Configuration





Notes:
- o Paint box white
- o List contents by NCAR Code #
- o Mark per TWERLE-4 Specification
- o Identify carton contents



Balloon Shipping Box
TWERLE-4

NCAR Sketch 298-72

SPECIFICATION

Superpressure Balloon Quality Requirements	PAGE 1 OF 4 SPECIFICATION NO. N-14 DATE ISSUED 10 May 1971 REVISION A

	REV	ECO	CHANGED
	A	101	26 October 1972

The following quality requirements are intended to serve as guidelines in addition to the balloon manufacturers established and well detailed quality programs. These requirements do not cover all areas of material control and workmanship standards necessary for this procurement. They are intended to cover certain special areas of minimum NCAR requirements and acceptance criteria. Any question about interpretation and meaning of these requirements should be discussed with NCAR representatives.

1. Drawing and Specification Approval

After procurement award and prior to balloon fabrication the manufacturer will submit design drawings and specifications to NCAR technical representatives for review and approval. Before submission, the manufacturer will conduct a design review to insure compliance with NCAR specifications, completeness and compatibility of the proposed documents within his own organization. Representatives of Production, Quality, Assurance, Drafting, Engineering and Management will participate in the review. A review report will be submitted to NCAR upon completion. These drawings and specifications will include, but not be limited to, the following:

	A		added "design review . . ."

Drawings

- o balloon assembly
- o fittings and hardware
- o load attachment
- o balloon folding and packaging — A — added "folding"
- o box marking

Specifications

- o materials for gores, end caps, seals, load attachment, hardware and packaging — A — added "packaging"
- o balloon specification which indludes:

SPECIFICATION

	REV	ECO	CHANGED
a. model number b. design parameters, dimensions and weights c. list of drawings and specifications d. weighing procedure e. packing method o quality plan and/or checklist			
2. Discrepancy Reports, Failures and ECO's Failures and discrepancies which occur during the manufacturing process will be reported to NCAR technical representatives as they happen. The manufacturer will provide a failure reporting system which reports failures, analyses causes and provides corrective action to insure failures are not repeated. Written reports will be submitted to NCAR within 24 hours after the failure occurrance. Analysis and corrective reports will be submitted within seven days of the failure report.	A		added "failure reports . . ."
3. Allowable Repairs The type and number of repairs of the following defects are permitted when performed under the supervision of the Project Engineer. The defects and repairs will be recorded in manufacturing and quality control records. 1. Holes which are less than one-fourth inch diameter (three per balloon maximum). 2. Surface scratches which are less than six inches long and are repairable, i.e., repaired area must exceed strength of original parent material (three per balloon maximum). 3. Encapsulated foreign particles which are detrimental to seals or bilaminate material and require removal, i.e., which is hard and sharp and could puncture the film (size limited by paragraph 1. Holes). Three per balloon maximum.			

SPECIFICATION

SPECIFICATION NO. N-14

DATE ISSUED 10 May 1971

REVISION A

REV	ECO	CHANGED
A		added (total repairs . . .)

4. Delaminated areas which are less than three inches long and one-eighth inch wide (three per balloon maximum).

5. Tears which are less than two inches long (three per balloon maximum).

(The total number of above allowable repairs shall not exceed six per balloon.)

6. Tape splices* - not more than one splice per 100 ft of tape, except the final seal, which may have four splices in addition.

Needed repairs beyond and other than the above listed will require approval by NCAR depending on circumstances involved.

4. Inplant Testing and Inspection

When possible, NCAR representatives will visit the manufacturing processes. These inspections will serve as a first level acceptance, but final acceptance will be made after balloon delivery, i.e., manufacturers responsibility continues through delivery to NCAR field sites.

5. Manufacturing, Testing and Quality Record Review

After packaging, but before shipping, the manufacturer's testing and quality records will be submitted to NCAR for acceptance review. After NCAR approval, the manufacturer will be notified to proceed with shipment.

6. Field Inspection and Final Acceptance

In all cases final acceptance will be made during field inspection, usually during launch preparation. When the balloon is found satisfactory and flown, the

* A splice is defined as where one tape, either inside or outside, stops and restarts with an overlap.

SPECIFICATION

SPECIFICATION NO. N-14

DATE ISSUED 10 May 1971

REVISION A

manufacturer will be notified.

If the balloon is found defective due to manufacturer's negligence, the manufacturer will be notified and the balloon will be returned for re-work or replacement, depending on the situation.

Reasons for rejection and return will result from unsuitable materials or workmanship. Specific examples of these are as follows:

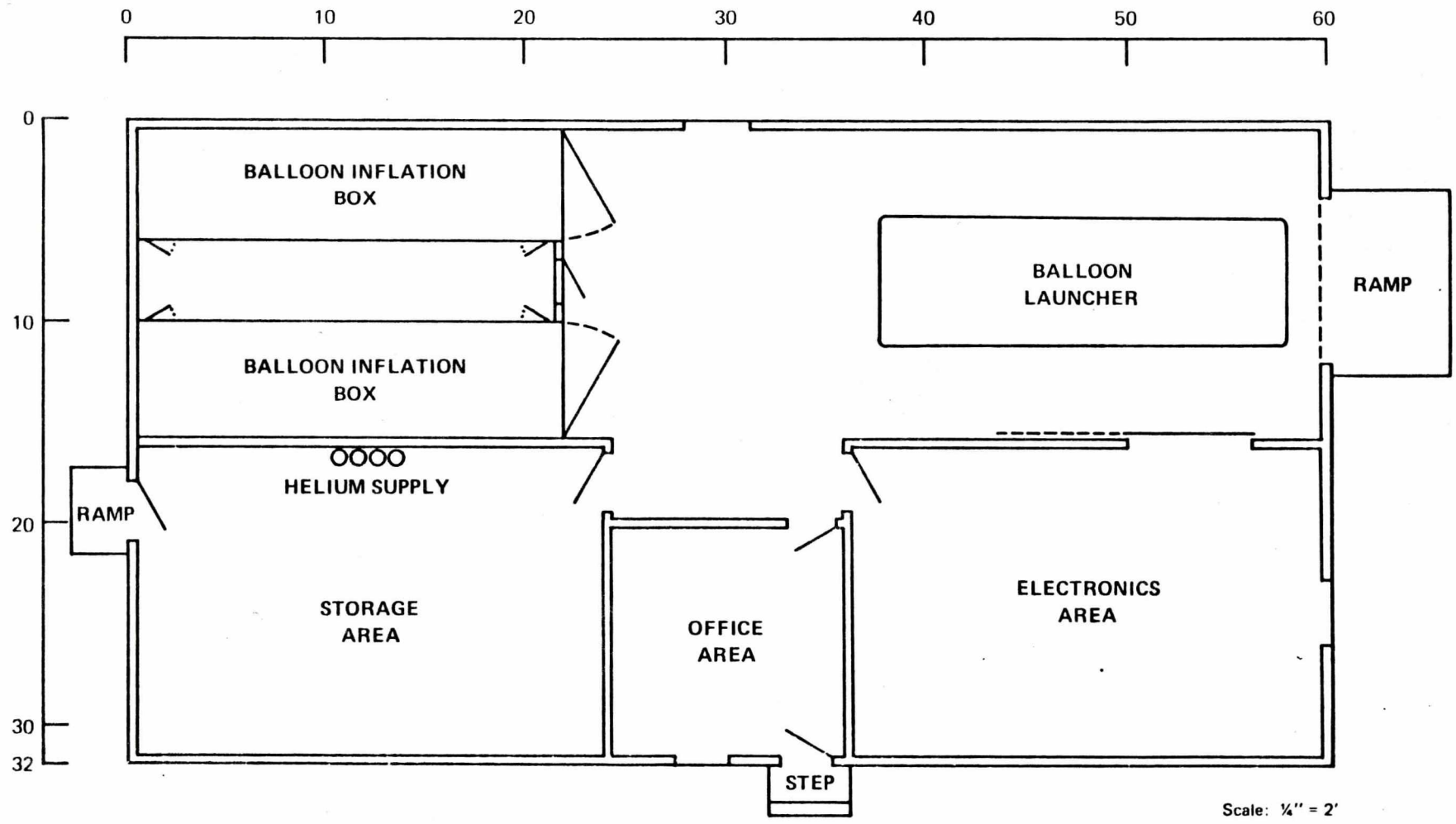
- o blocking of material
- o improper packaging resulting in damage
- o incomplete manufacture, i.e., open seals, etc.
- o incomplete or inaccurate records and weights
- o improper workmanship, i.e., shrunken seams, holes, more than allowable size or number of repairs, inoperative hardware, etc.

REV	ECO	CHANGED
A		added "inoperative hardware . ."

7. Field Reports

A report will be prepared by the field inspection and launch crew to provide feedback to the manufacturer. This report will provide information about the balloons condition on arrival, package adequacy, damage to balloon and performance after launch while the balloon is in the immediate launch area.

This report is intended to assist manufacturers to improve any areas that are needed, as well as giving them information about the flight.



TWERLE LAUNCH BUILDING

Figure III-5.

TWERLE TEST FLIGHT SERIES

TWERLE I - Ascension Island - October 1971

A. Balloon evaluation tests:

10 flights at 150 mb, with caps
10 flights at 150 mb, without caps
5 flights at 200 mb, without caps
5 flights at 200 mb, with caps

B. Launch technique - evaluation and crew training.

C. Radio altimeter tests.

D. Evaluation of flight train configuration and launch technique.

E. Package temperature measurements.

F. Balloon gas temperature measurements (day and night).

G. Wind trajectory data from both altitudes.

TWERLE II - Christchurch, New Zealand - November 1971

A. Verification of cutdown device on actual flight.

B. Balloon evaluation tests (control):

5 flights at 150 mb with caps
5 flights at 150 mb without caps

TWERLE III - Ascension Island - July 1972

A. Wind trajectory data - approximately 20 flights (corresponding with Nimbus-F launch in mid1974).

B. Testing and evaluation of final TWERLE balloon/sleeve design.

C. Testing and evaluation of final launcher design.

D. Evaluation of flight electronics; pressure, temperature, radio altimeter sensors and data encoding technique.

E. Evaluation of thermal enclosures.

TWERLE IV - Ascension Island - March/April 1973

A. Flight tests of final TWERLE balloon configuration ($\sim$ 10 flights).

VI. Program Schedule

A. Major Milestones:

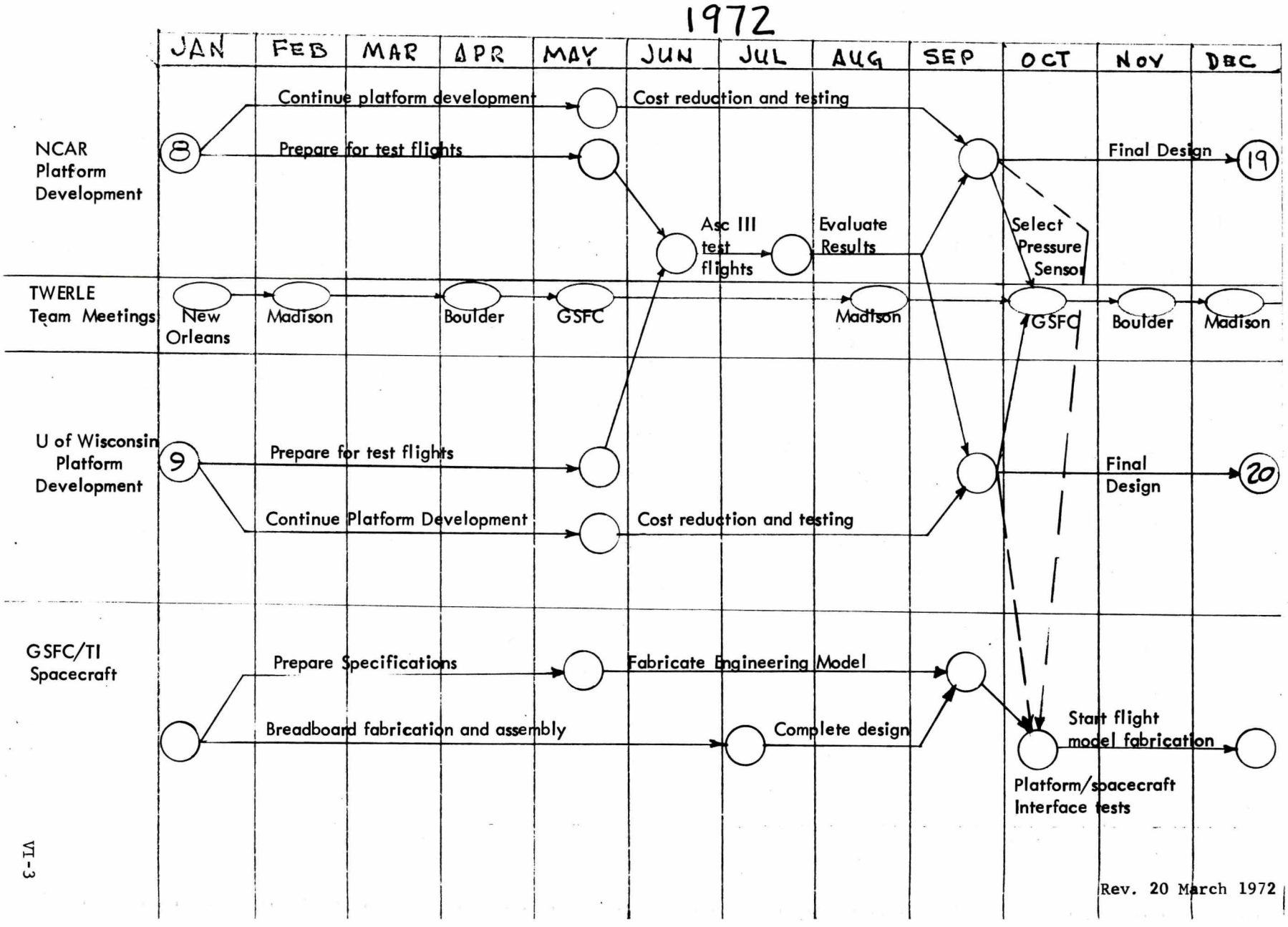
		Calendar Year				
		1971	1972	1973	1974	1975
1.	Evaluate potential launch sites.	xxx	xxx			
2.	State Department approval for TWERLE and test flights.	xx	xxx			
3.	Design and fabricate 50 prototype electronic packages for test vehicles (Digi-GHOST telemetry).	xxx	xx			
4.	Fabricate five radio altimeters for flight test.	xx				
5.	Design and fabricate prototype launcher.	xx				
6.	Design and fabricate 40 test flight vehicles.	xx				
7.	Tropical Campaign I (Ascension Island), launch 30 prototype systems.	x				
8.	Track and evaluate I flights	x	xx			
9.	Inspect potential launch sites	x	xxx			
10.	Mid-latitude Campaign II (Christchurch), launch ten prototype systems.	x				
11.	Track and evaluate II flights.	x	x			
12.	Fabricate 20 test flight vehicles (final design).		xx			
13.	Tropical Campaign III (Ascension Island), launch 20 prototype systems.		x			
14.	Track and evaluate tropic wind patterns.		xxx			
15.	Select launch sites. Begin diplomatic negotiations for site development.		xx	xxxx		
16.	Complete final system design.			xx		
17.	Fabricate 330 flight systems.			xx	xx	
18.	Flight operations.				xx	
19.	Track balloons.				xxx	x
20.	Analyze data.				xx	xx
21.	Tropical Campaign IV (Ascension Island), launch 10 flights, final design.			x		

B. Since there are numerous elements in the TWERLE Balloon System, an arrow diagram of major events and elapsed time (in weeks between events) is included in this report.

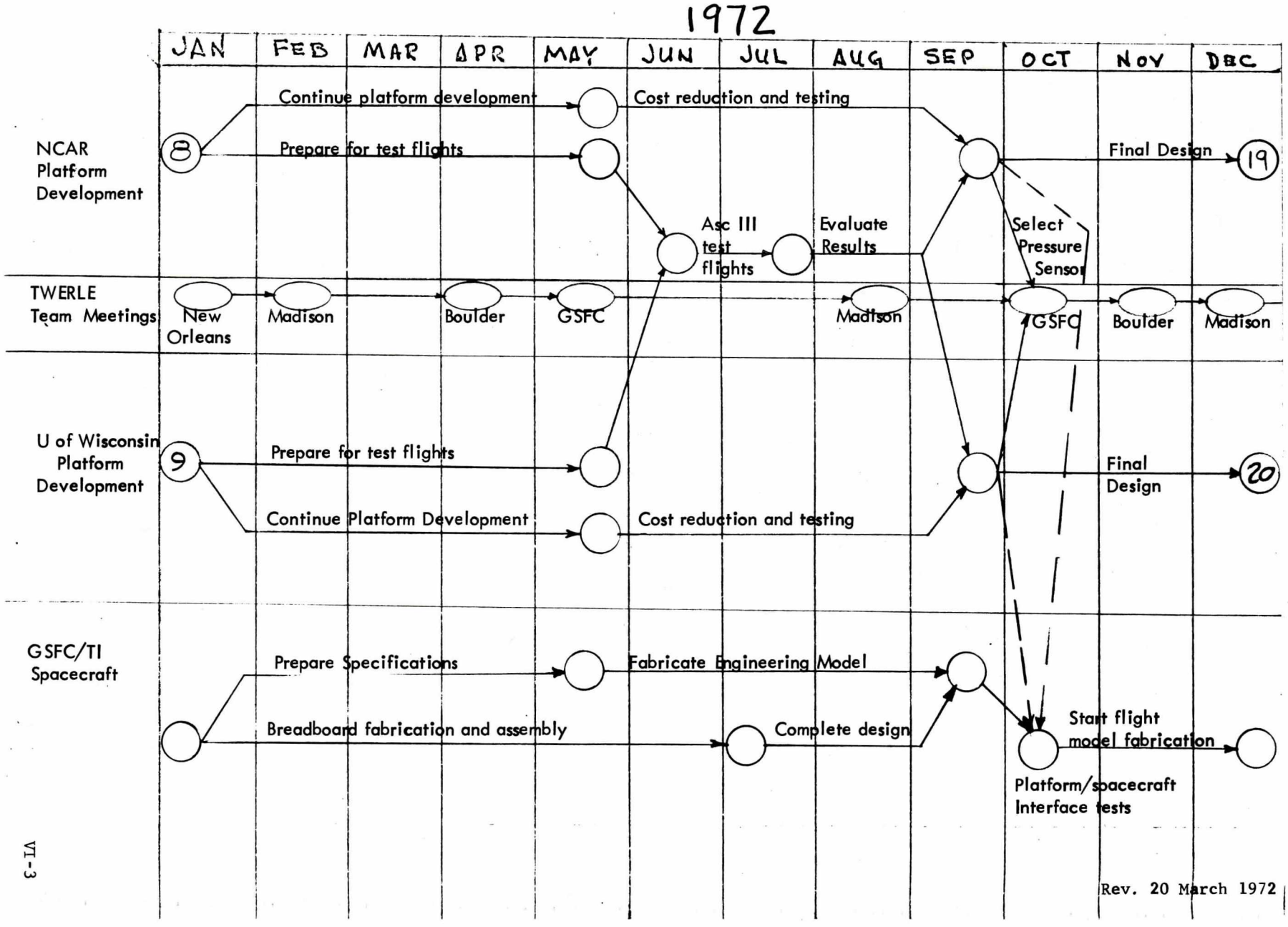
Three major efforts indicated on the diagram are electronics, vehicle, and facilities. The electronics area includes all flight packages, ground check-out equipment and indicates the interface with University of Wisconsin and GSFC.

The events are numbered in sequence only for easy reference to the explanation key. The time elapsed between events represents the best estimate presently available for each task described. Dotted lines between events indicate an interface requirement.

An additional Pert diagram is included with this revision, integrating the detailed events of 1972 from NCAR, the University of Wisconsin and GSFC (Texas Instruments). This diagram expands the original arrow diagram dated 15 December 1971. As detailed plans develop, another diagram will be provided for 1973-1974. The attached bar chart also describes the 1972-1974 events.

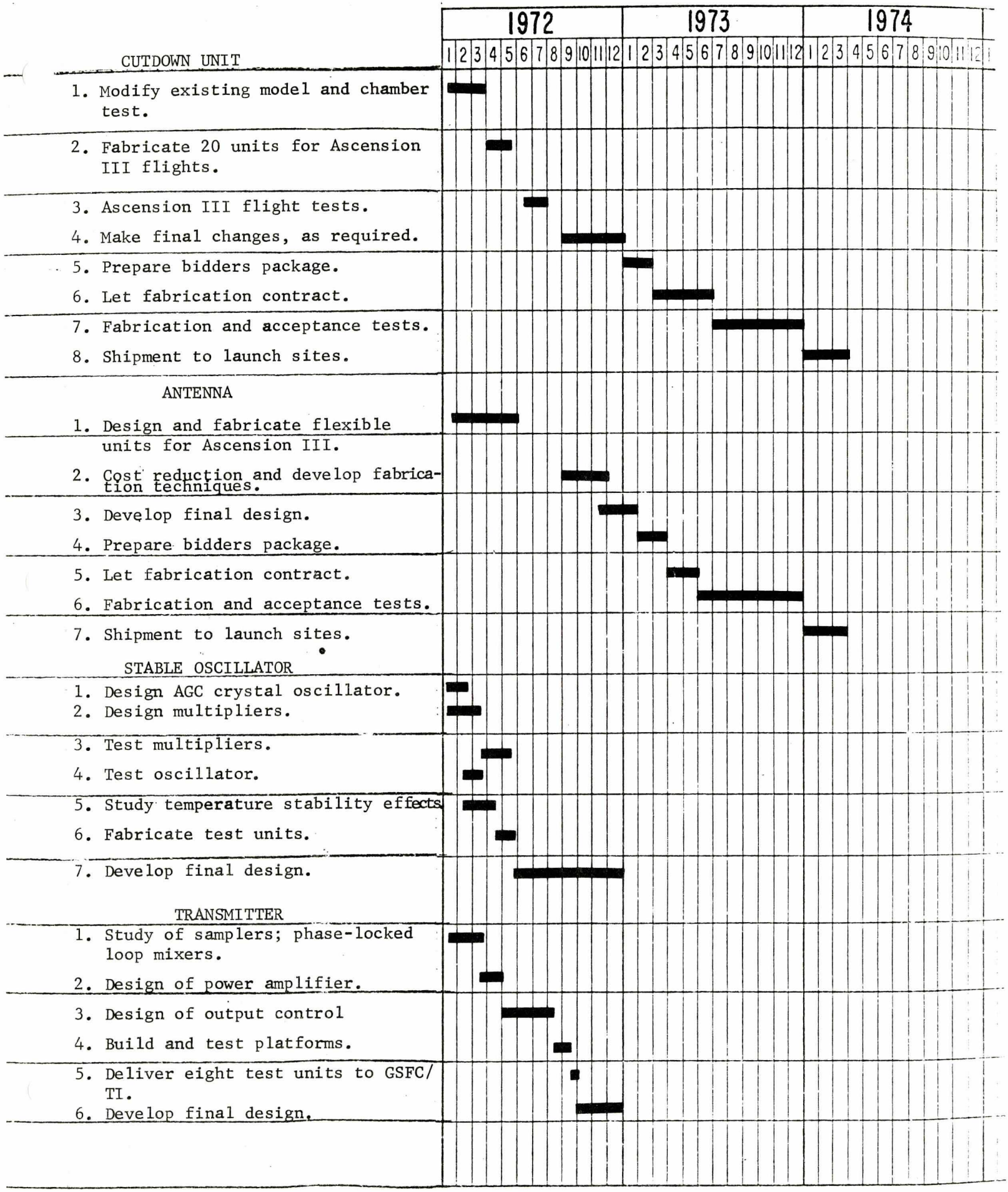


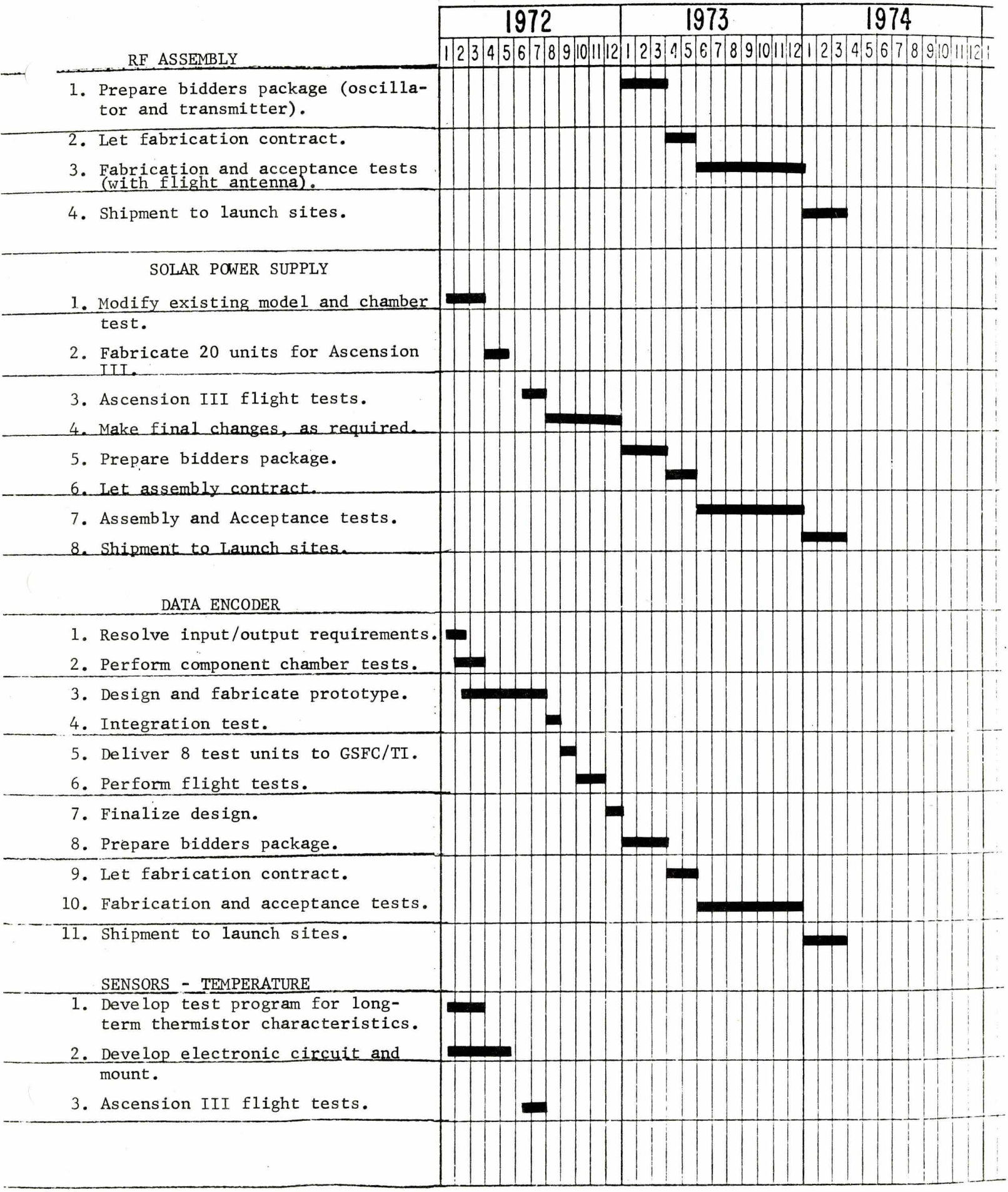
Rev. 20 March 1972

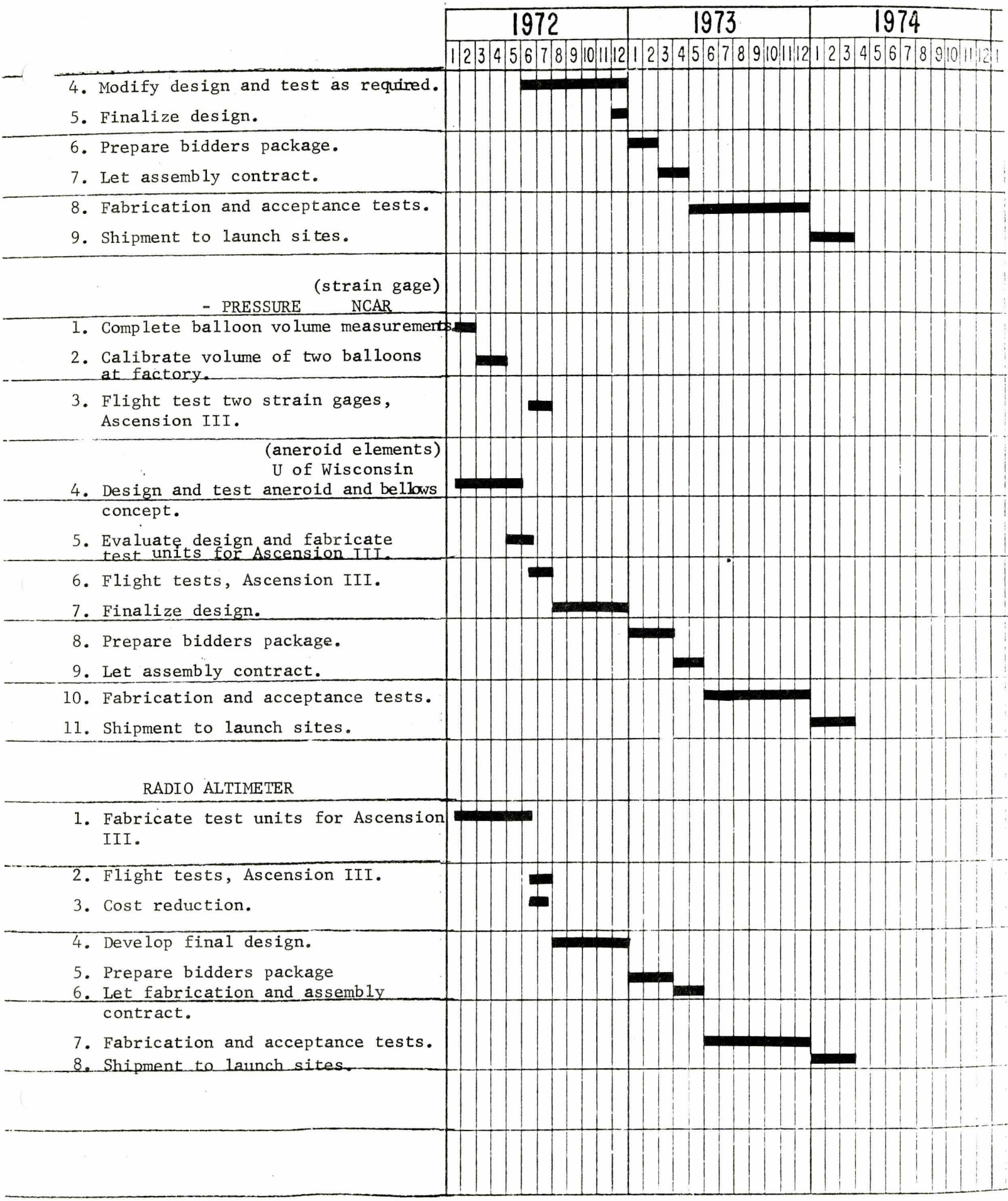


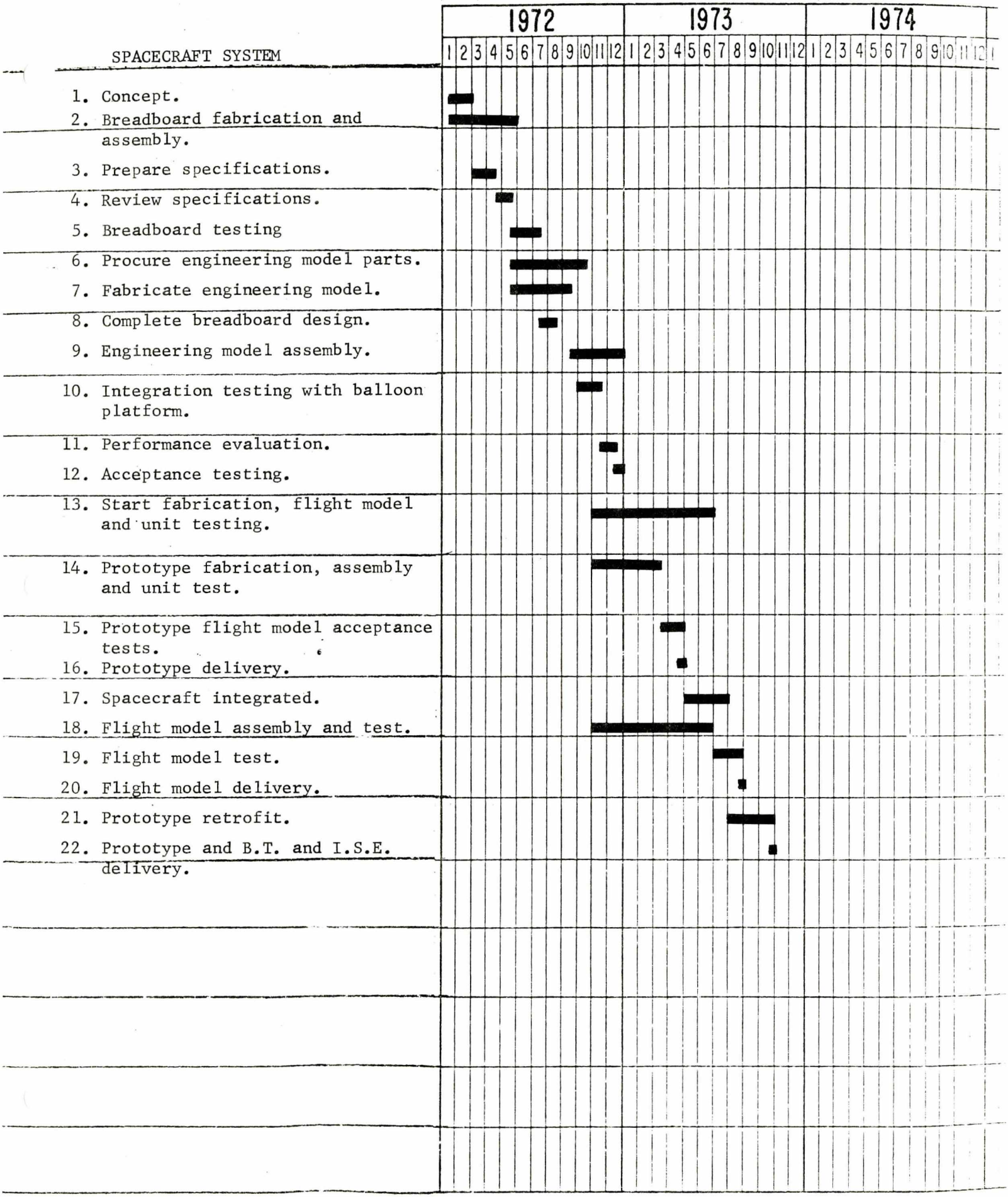
Rev. 20 March 1972

PLATFORM ELECTRONIC SYSTEMS




1972
1973
1974
1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
RF ASSEMBLY
1. Prepare bidders package (oscillator and transmitter).
2. Let fabrication contract.
3. Fabrication and acceptance tests (with flight antenna).
4. Shipment to launch sites.
SOLAR POWER SUPPLY
1. Modify existing model and chamber test.
2. Fabricate 20 units for Ascension III.
3. Ascension III flight tests.
4. Make final changes, as required.
5. Prepare bidders package.
6. Let assembly contract.
7. Assembly and Acceptance tests.
8. Shipment to Launch sites.
DATA ENCODER
1. Resolve input/output requirements.
2. Perform component chamber tests.
3. Design and fabricate prototype.
4. Integration test.
5. Deliver 8 test units to GSFC/TI.
6. Perform flight tests.
7. Finalize design.
8. Prepare bidders package.
9. Let fabrication contract.
10. Fabrication and acceptance tests.
11. Shipment to launch sites.
SENSORS - TEMPERATURE
1. Develop test program for long-term thermistor characteristics.
2. Develop electronic circuit and mount.
3. Ascension III flight tests.


1972
1973
1974
1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
4. Modify design and test as required.
5. Finalize design.
6. Prepare bidders package.
7. Let assembly contract.
8. Fabrication and acceptance tests.
9. Shipment to launch sites.
(strain gage)
- PRESSURE NCAR
1. Complete balloon volume measurements.
2. Calibrate volume of two balloons at factory.
3. Flight test two strain gages, Ascension III.
(aneroid elements)
U of Wisconsin
4. Design and test aneroid and bellows concept.
5. Evaluate design and fabricate test units for Ascension III.
6. Flight tests, Ascension III.
7. Finalize design.
8. Prepare bidders package.
9. Let assembly contract.
10. Fabrication and acceptance tests.
11. Shipment to launch sites.
RADIO ALTIMETER
1. Fabricate test units for Ascension III.
2. Flight tests, Ascension III.
3. Cost reduction.
4. Develop final design.
5. Prepare bidders package
6. Let fabrication and assembly contract.
7. Fabrication and acceptance tests.
8. Shipment to launch sites.


1972
1973
1974
1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
SPACECRAFT SYSTEM
1. Concept.
2. Breadboard fabrication and assembly.
3. Prepare specifications.
4. Review specifications.
5. Breadboard testing
6. Procure engineering model parts.
7. Fabricate engineering model.
8. Complete breadboard design.
9. Engineering model assembly.
10. Integration testing with balloon platform.
11. Performance evaluation.
12. Acceptance testing.
13. Start fabrication, flight model and unit testing.
14. Prototype fabrication, assembly and unit test.
15. Prototype flight model acceptance tests.
16. Prototype delivery.
17. Spacecraft integrated.
18. Flight model assembly and test.
19. Flight model test.
20. Flight model delivery.
21. Prototype retrofit.
22. Prototype and B.T. and I.S.E. delivery.