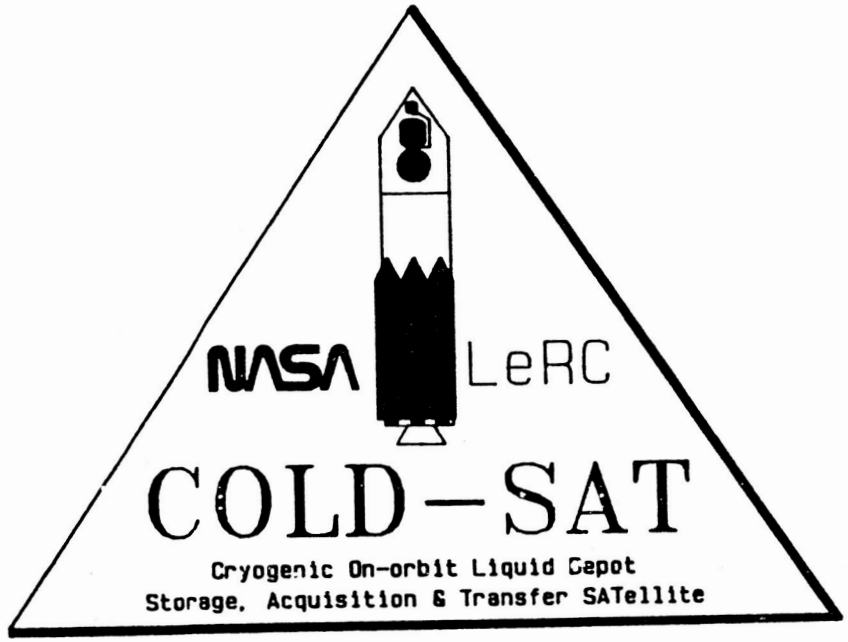
SPACE FLIGHT SYSTEMS DIRECTORATE

SPACE EXPERIMENTS DIVISION

NASA Lewis Research Center

CRYOGENIC FLUID MANAGEMENT PROGRAM FLIGHT CONCEPT DEFININTION



Presented At:

Cryogenic Fluid Management Technology Workshop

April 28, 1987

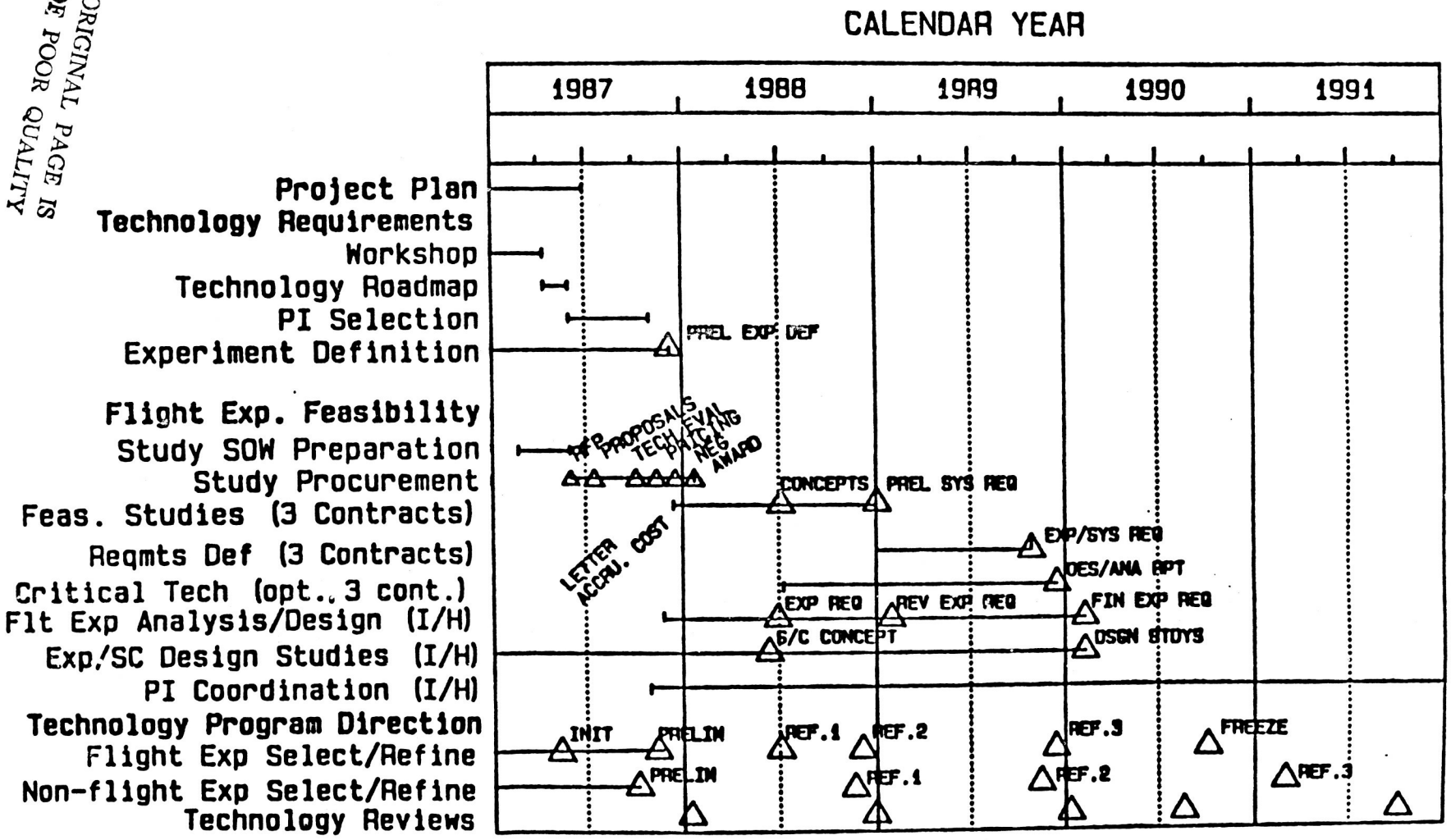
Erich Kroeger

LeRC CRYOGENIC FLUID MANAGEMENT PROGRAM FLIGHT EXPERIMENT CONCEPT DEFINITION

AGENDA

- SCHEDULE
- INFORMATION FLOW AND TIMING
- CRITICAL PATH
- CFMFE/STS
- COLD-SAT/ELV

CRYOGENIC FLUID MANAGEMENT PROGRAM

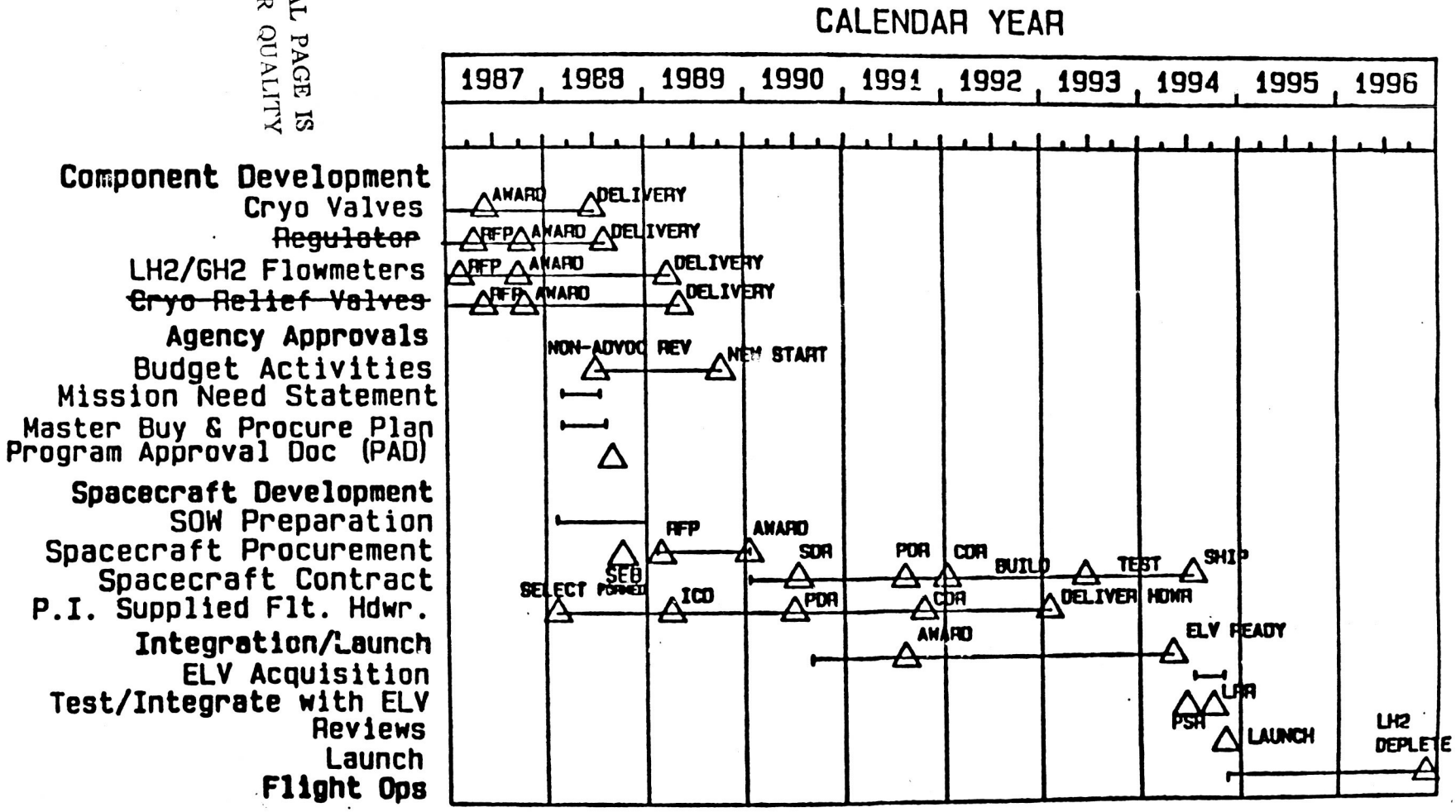


Technology Review, Analysis, & Cost Estimation

Revised 04/01/87

TRAC91.DRW

CRYOGENIC FLUID MANAGEMENT PROGRAM



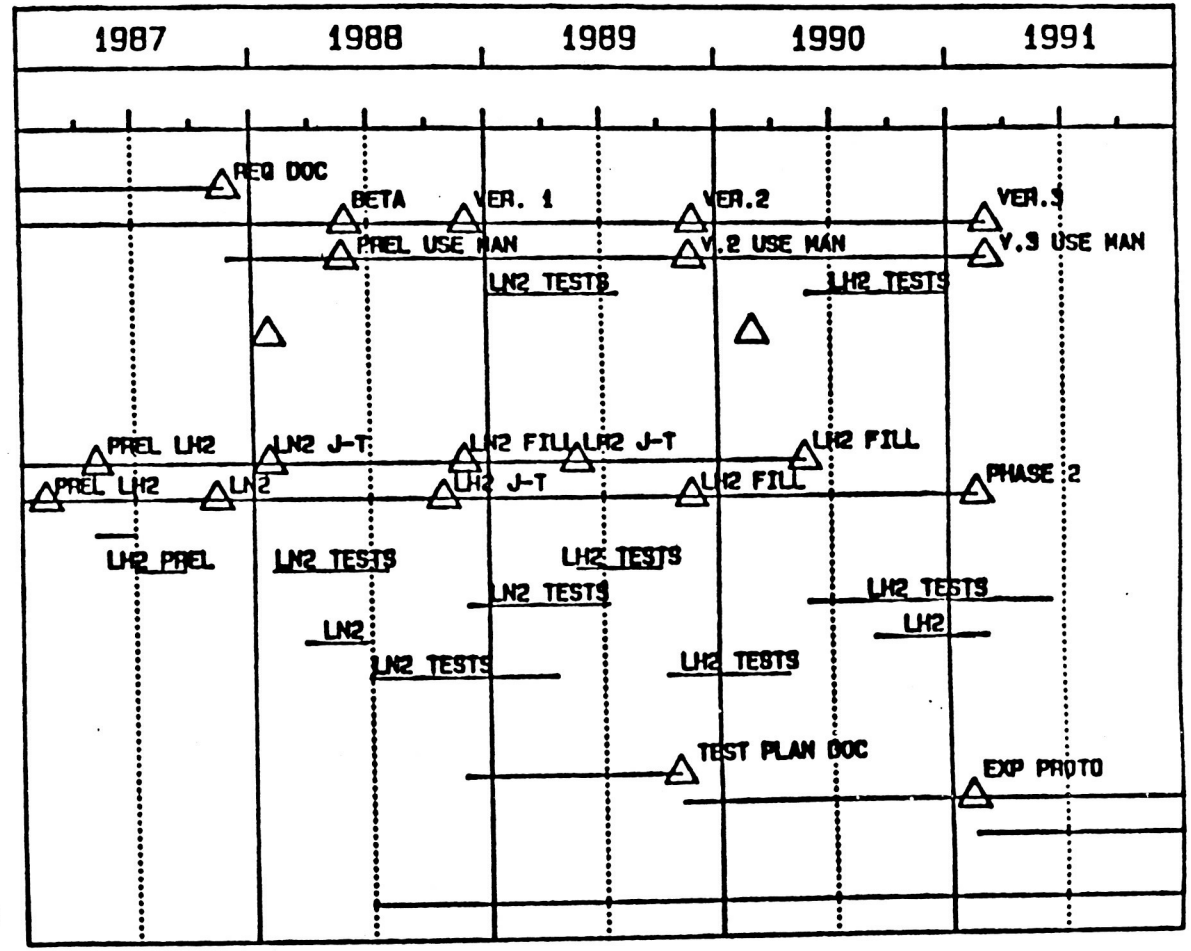
Flight Experiment Development

Revised 3/26/87

FLT98.DRW

CRYOGENIC FLUID MANAGEMENT PROGRAM

CALENDAR YEAR



Modeling, Analysis & Non-flight Experiments

Revised 3/26/87

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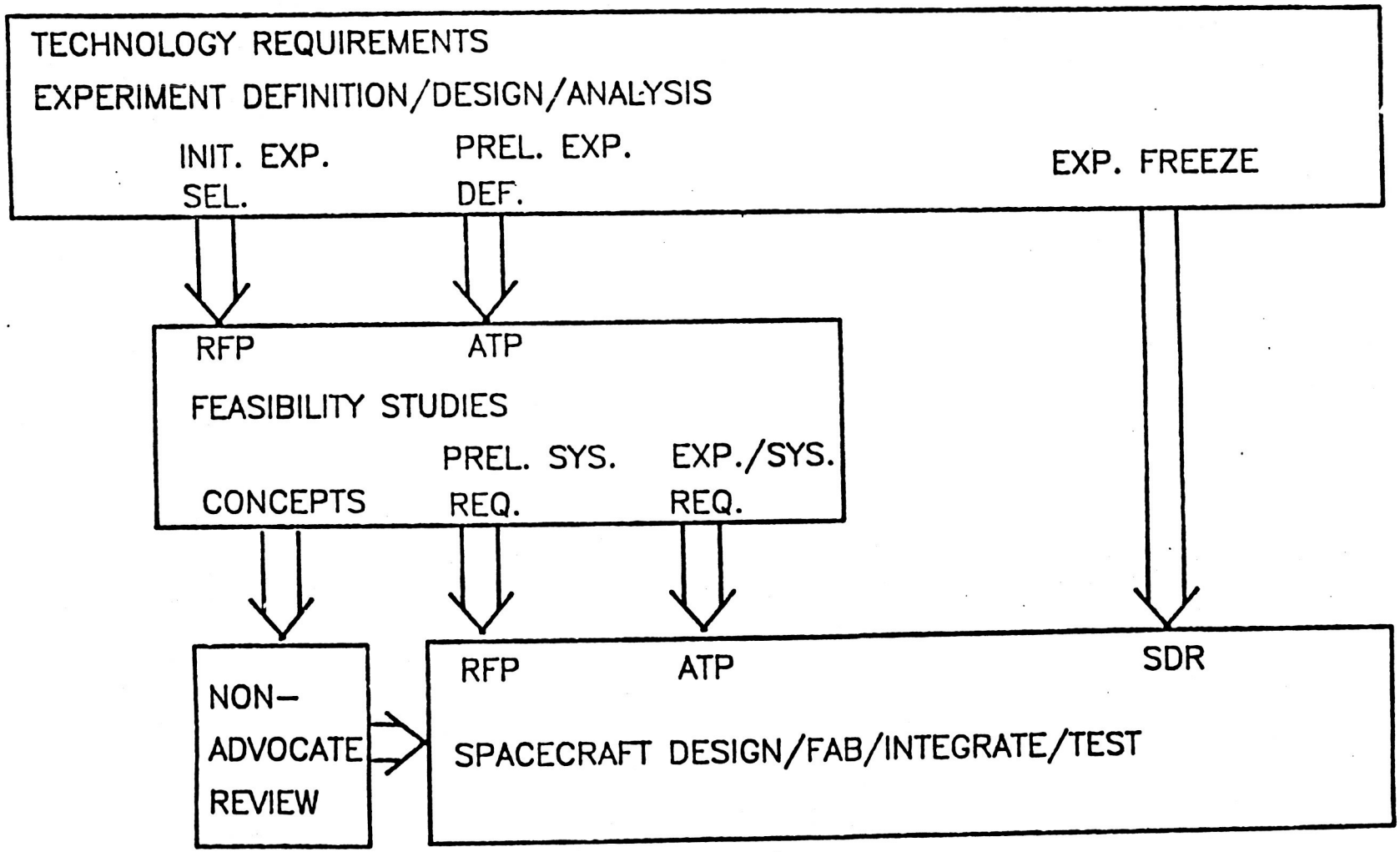
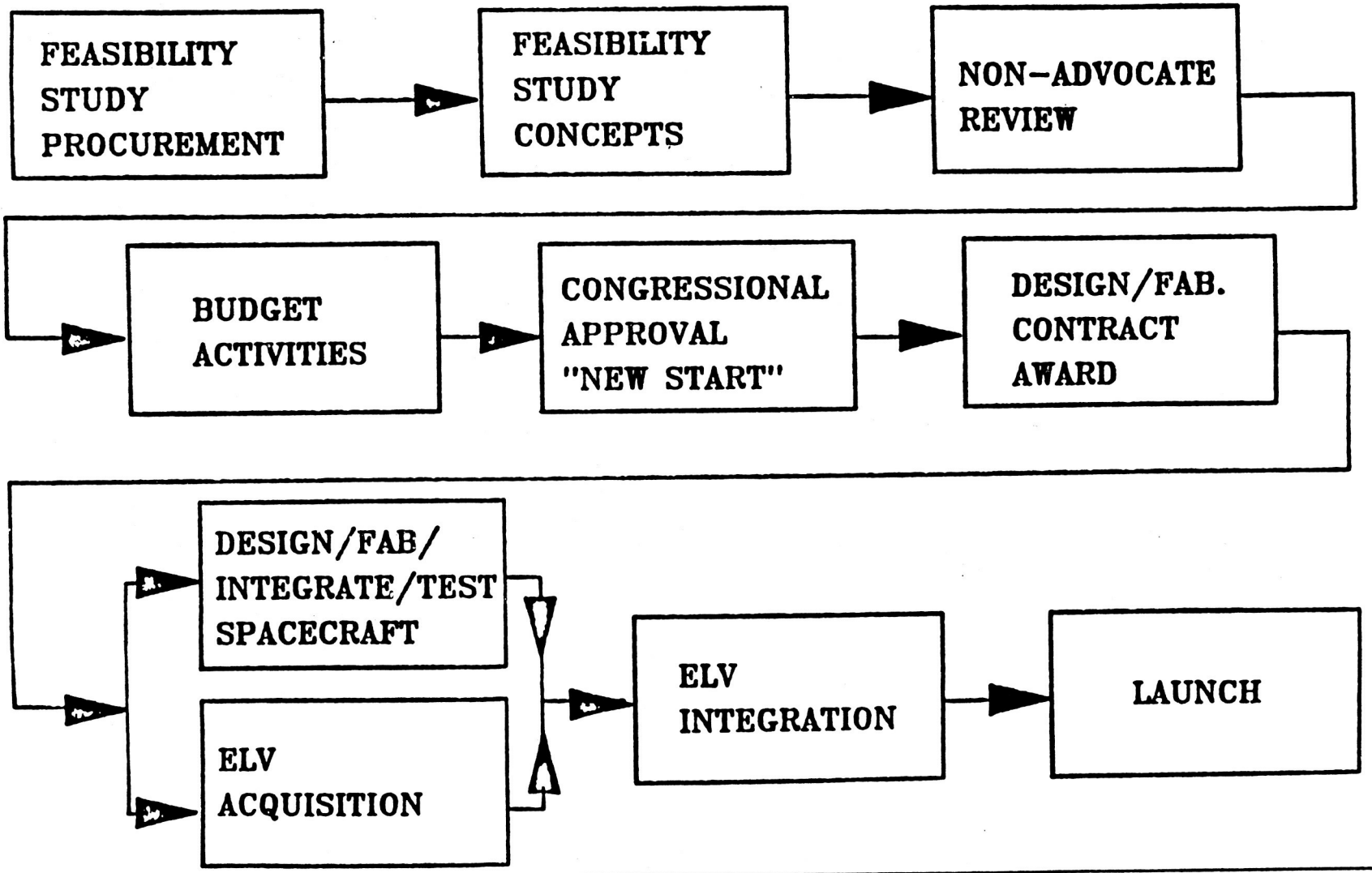
CRYOGENIC FLUID MANAGEMENT PROGRAM
INFORMATION FLOW AND TIMING

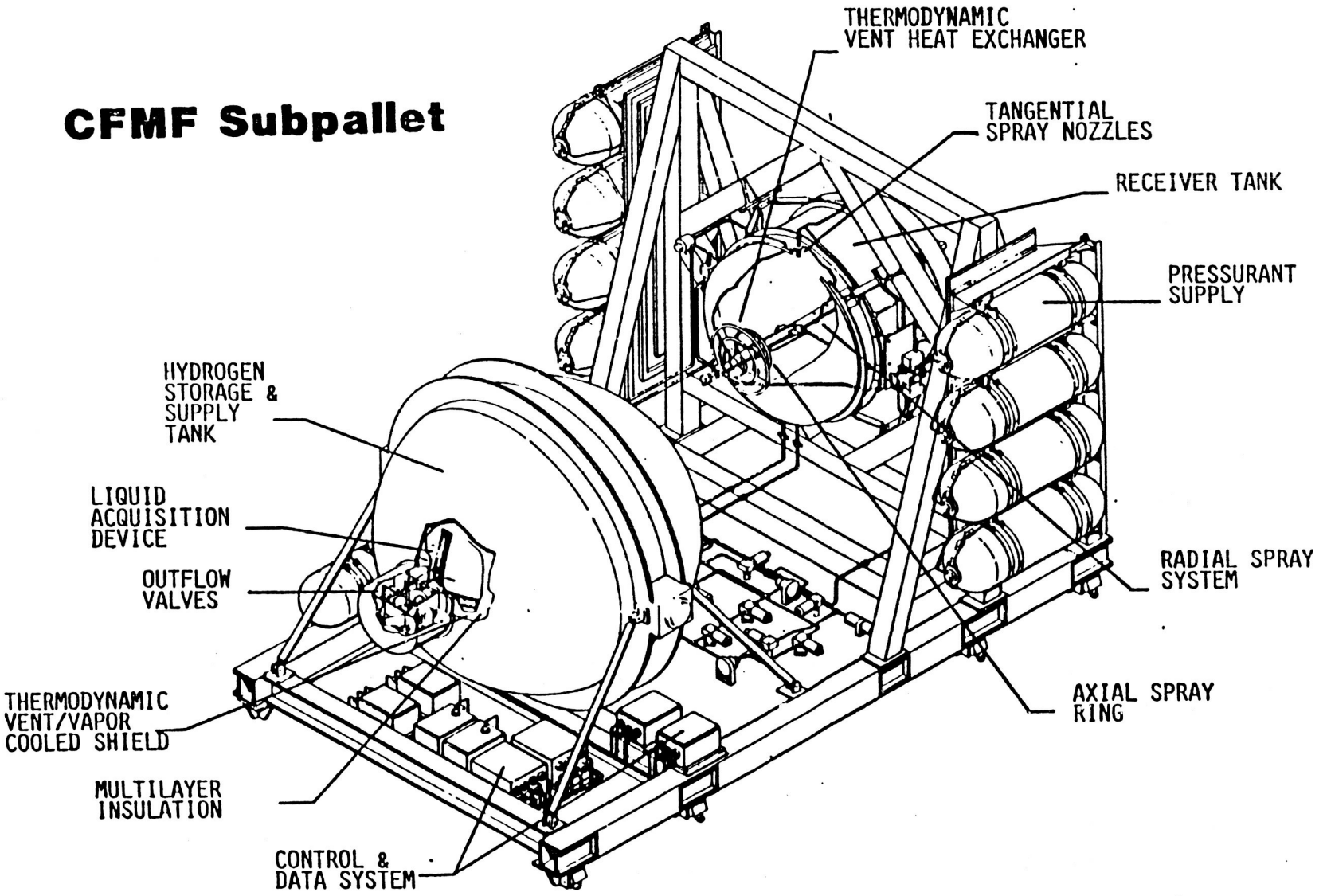


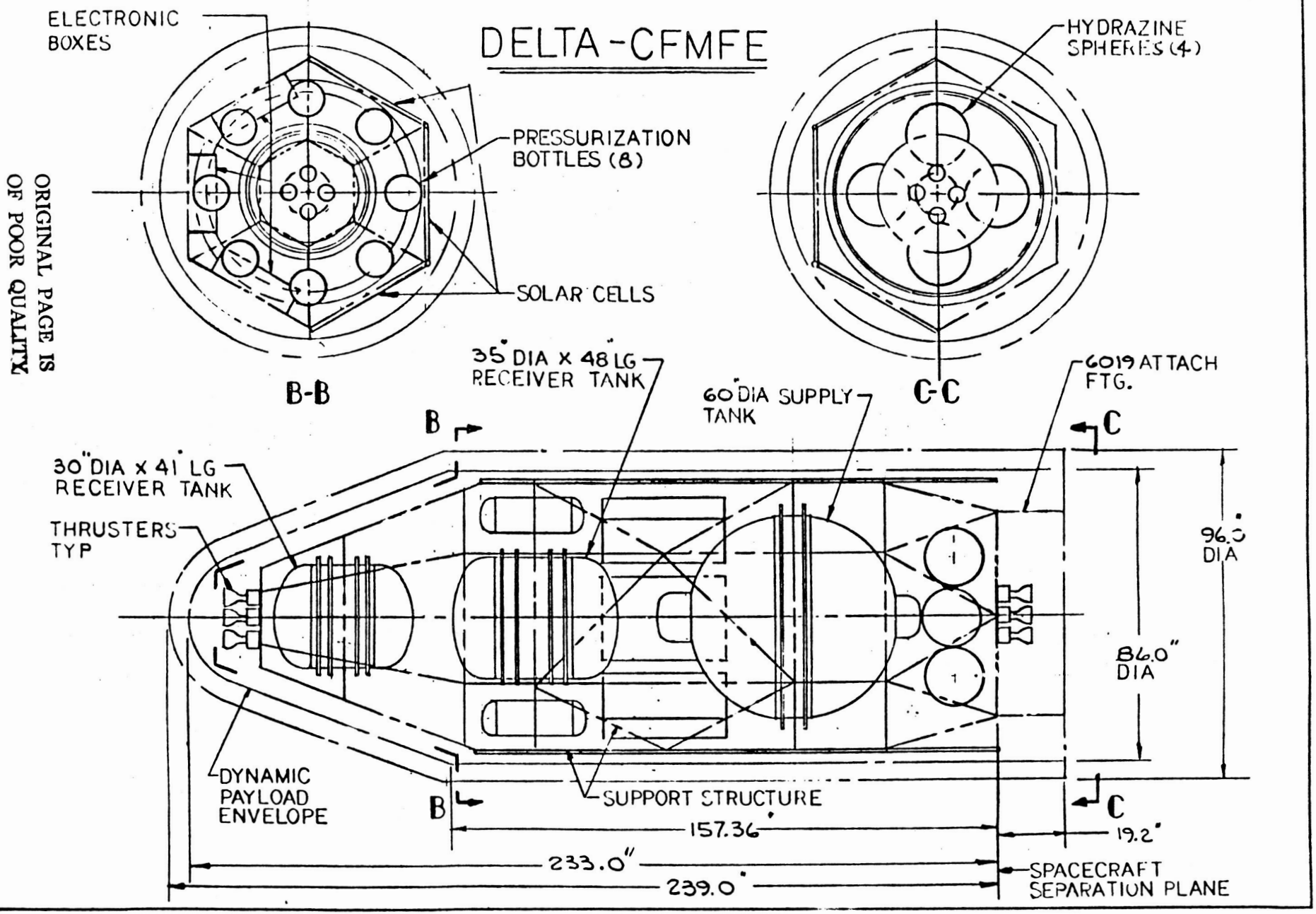
CRYOGENIC FLUID MANAGEMENT PROGRAM

CRITICAL PATH

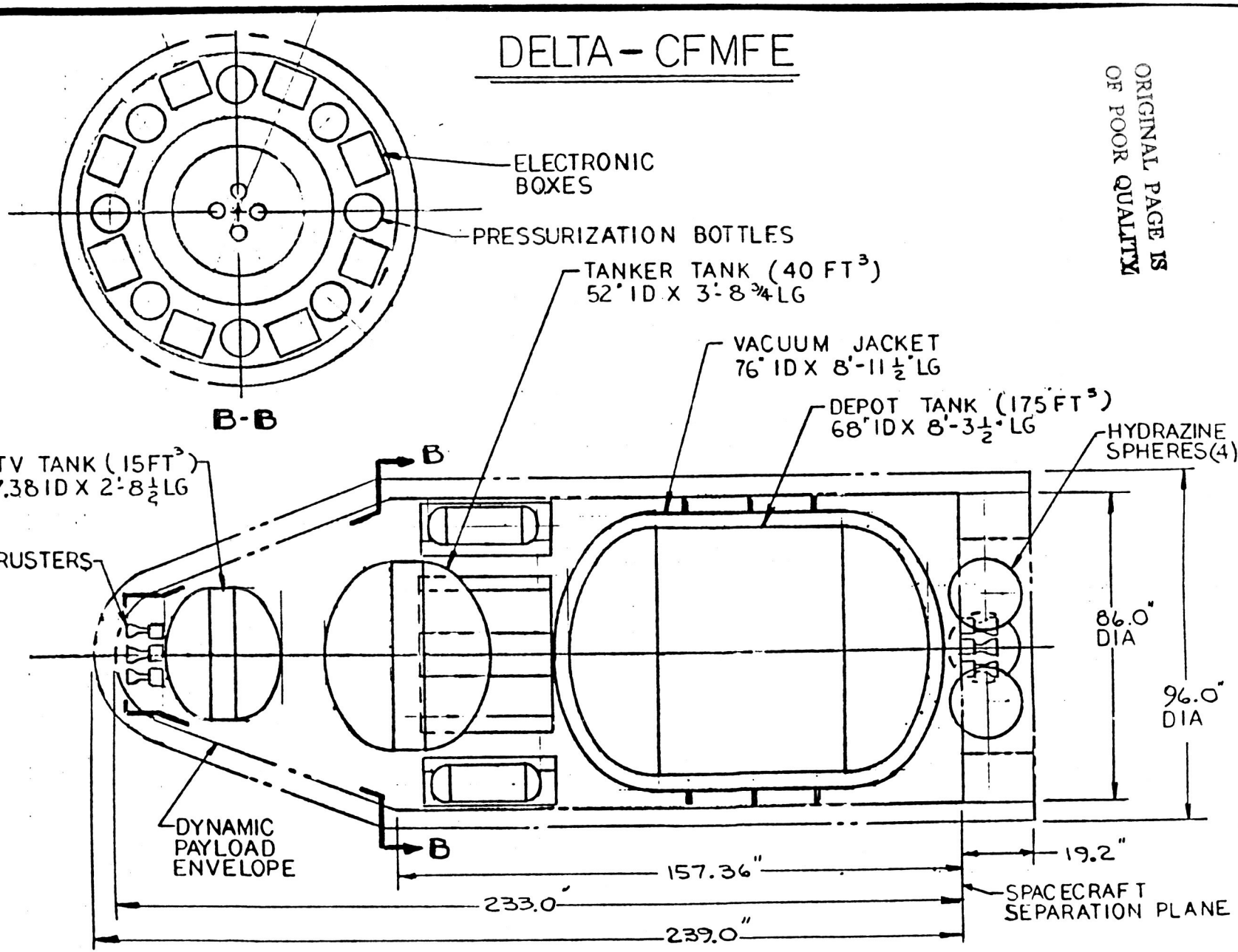


CFMF Subpallet





DELTA – CFMFE



PROJECT ACTIVITY PRODUCTS

PROJECT PLAN

Agreement between OAST and LeRC on the nature and scope of the project and the resources required.

TECHNOLOGY REQUIREMENTS

Workshop

Survey of the current status of low g cryogenic fluid management technology.

Identification of critical technological advances required to support future NASA missions.

Identification of technologies which require in-space experimentation.

Identification of candidate ground and flight experiments and analytical processes required to advance cryogenic fluid management technology.

Identification of expert technologists capable of conducting and directing the required experiments and analyses.

Technology Roadmap

Documented exposition of the current status of cryofluid management technology, of future NASA technology requirements, and of the time phased action sequence of experiments, analyses, data items, and numerical models needed to meet these requirements.

PI Selection

Initial selection of a group of qualified Principal Investigators to direct the investigations required to advance Cryofluid Management Technology to the point identified by the Technology Roadmap.

Initial agreement with these Principal Investigators and their parent organizations on the nature of the investigations to be performed, the expected results, the expected completion

date, any hardware to be provided, and the resources required to perform the needed analyses and one-g and low-g experiments.

Experiment Definition

Documented enumeration of a set of one-g and low-g experiments to be performed under this program including experiment objectives, required experimental conditions, required measurements, accuracies and data rates, conceptual hardware required to perform the experiments, and required data reduction techniques. Included in each experiment definition will be a clear and concise explanation of how the experimental results would be utilized to predict the performance of actual space systems.

FLIGHT EXPERIMENT FEASIBILITY

Study SOW Preparation

Documentation of the tasks to be performed (both required and optional) and the work product to be delivered under the flight experiment study contracts.

Selection Criteria for use in evaluating study contract proposals.

Study Procurement

Solicitation, selection and award of at least two contracts to perform studies supporting flight experiment selection, definition and costing.

Study Contracts

Feasibility Studies

Concepts

One or more concepts for a spacecraft and experimental hardware, ground support equipment, flight and ground operations, and experimental proceedures for performance of the preliminary set of flight experiments and supporting cost and schedule estimates.

Preliminary System Requirements

Documentation of the system level requirements for a spacecraft system (both ground and flight segments) supporting the selected concept.

Documentation of analyses and design studies supporting these system level requirements.

Top-level numerical models of the system using such codes as NASTRAN, SINDA, and CRYOTRAN.

Documentation of experimental operating proceedures and requirements supporting the system level requirements.

Identification of technology issues arising from the system requirements.

Detailed cost and schedule estimates for implementing the required systems.

Requirements Definition

Documented refinement of the system level requirements to at least the subsystem level.

Detailed definition of experimental operating proceedures and requirements.

Initial projection of expected experimental operations and fluid conditions.

Conceptual designs for all subsystems.

Initial interface requirements documents.

Identification of critical technology issues.

Detailed design studies of critical spacecraft system design features which are outside the existing spacecraft technology base.

Preliminary identification of existing designs and "off the shelf" hardware which will have application to the spacecraft concept.

Detailed examination and documentation of testing requirements and related facility requirements.

Detailed cost, schedule and resource requirements for the construction and operation of the spacecraft system. Identification of potential schedule conflicts and long lead items.

Critical Technologies (optional)

Analyses and design studies of components, subsystems, and control laws required for the conceptual system and which require resolution of potential problems to reduce risk or maintain schedule during the implementation of the concept.

Flight Experimenrt Analysis/Design (In House)

Experiment Requirements

Detailed documentation of required experimental operating conditions, hardware characteristics, measurement accuracies, types, locations, and rates, operational algorithms, critical sensors or sensor types, and experiment scale made in the light of analyses and modeling of the conceptual experimental hardware and of the results of the on-going contractual and in-house conceptual design studies.

Revised Experiment Requirements

Documented revision of the above experiment requirements made in light of the contractual and in-house spacecraft design studies and reflecting programmatic decisions down-selecting and revising the set of flight experiments.

Final Experiment Requirements

Documented revision of the above experiment requirements reflecting the results of the contracted and in-house spacecraft design studies and reflecting programmatic decisions down-selecting and revising the set of flight experiments. This set of

experiment requirements shall form the baseline for the design, fabrication, test, and operation of the flight system.

Experiment/Spacecraft Design Studies (In-house)

Spacecraft Concept

A documented spacecraft concept with supporting analyses paralleling the contracted effort and potentially incorporating features found in one or more of contractor-developed concepts. This effort will be strongly biased toward supporting the in-house experiment design and analysis effort.

Design Studies

Documented system-level design studies defining a spacecraft compatible with the final flight experiment requirements and potentially incorporating the germane results of the contractual efforts.

P.I. Coordination

Coordination of the in-house and contractual efforts with those of the principal investigators so that the various spacecraft concepts and systems requirements documents and experiment requirements definitions meet their experimental needs and are enlightened by their expertise and that their requirements reflect the realities of spacecraft design and project resources.

TECHNOLOGY PROGRAM DIRECTION

Flight Experiment Selection/Refinement

A series of decisions by the program manager selecting the flight experiments to be performed and refining their requirements. These decisions are guided by the analyses and studies performed to date and give direction to future work.

Non-flight Experiment Selection/Refinement

A series of decisions by the program manager selecting the one-g experiments to be performed and refining their requirements.

Technology Reviews

A series of reviews for senior management covering progress in the the technology program to date as measured against program goals and allocated resources and indicating planned future activities.

SPEAKER: ERICH KROEGER/LEWIS RESEARCH CENTER

Peter Mason/Jet Propulsion Laboratory:

Have you come up with a rough estimate of the total cost of the program?

Kroeger:

Well, we've come up with a cost of $100 to $400 million, depending on whose view you want to take; we'd like to keep it closer to the lower end. When we include the cost of a launch vehicle, we begin with a pretty good chunk already committed. In the past, most of the launch vehicles were supplied by NASA, so you really didn't see that cost showing up in the program cost, but now we are being told that will be included in our program cost.