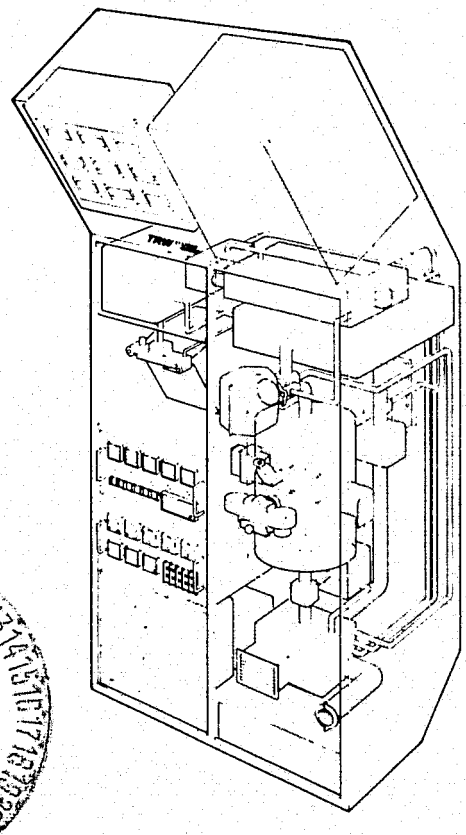
CONTRACT NAS8-31844

PHASE B-FINAL DEFINITION AND PRELIMINARY DESIGN STUDY FOR THE INITIAL ATMOSPHERIC CLOUD PHYSICS LABORATORY (ACPL) - A Spacelab Mission Payload

WORK BREAKDOWN STRUCTURE FOR PHASE C/D DR-MA-06 (PRELIMINARY ISSUE)



APRIL 1976

Prepared for

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By

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PREFACE

This document represents the preliminary issue of the Work Breakdown Structure (WBS) and Dictionary (DR-MA-06) for initial and subsequent flights of the Atmospheric Cloud Physics Laboratory (ACPL). A final version is to be supplied as part of the Phase B Study Final Report.

An attempt has been made at this early stage in the ACPL definition and preliminary design to identify specific equipment and components in each of the eleven subsystems; they are listed under the appropriate subdivisions of WBS elements 1.1.3 and 1.1.5. The reader is cautioned that some of these components are likely to change substantially during the course of the study, and the list provided should only be considered representative.

PROJECT FORECAST SYSTEM
WORK BREAKDOWN STRUCTURE

DATE- 03/30/76
PAGE- 1

SN-028682

LEVEL	WBS/JN	TITLE	MANAGER	CCC	PERFORMANCE FROM	PERFORMANCE TO	DOLLARS
1	028682	ACPL PROJECT			0/ 0	0/ 0	0
2	11	FIRST FLIGHT			0/ 0	0/ 0	0
3	111	PROJECT MANAGEMENT			0/ 0	0/ 0	0
	1111XX	PROJECT DIRECTION			0/ 0	0/ 0	0
	1112XX	PROJECT PLANNING ^ CONTROL			0/ 0	0/ 0	0
	1113XX	PERFORMANCE MANAGEMENT			0/ 0	0/ 0	0
	1114XX	CONFIGURATION MANAGEMENT			0/ 0	0/ 0	0
	1115XX	DATA MANAGEMENT			0/ 0	0/ 0	0
	1116XX	PROCUREMENT MANAGEMENT			0/ 0	0/ 0	0
	1117XX	GFE MANAGEMENT			0/ 0	0/ 0	0
3	112	SYSTEMS ENGR ^ INTEGRATION			0/ 0	0/ 0	0
	1121XX	SYSTEM ANALYSIS ^ INTEGRATION			0/ 0	0/ 0	0
	1122XX	MISSION REQUIREMENTS ^ ANALYSI			0/ 0	0/ 0	0
	1123XX	LOGISTICS REQUIREMENTS			0/ 0	0/ 0	0
	1124XX	SAFETY RELIABILITY ^ QA			0/ 0	0/ 0	0
	1125XX	SPECIAL STUDIES			0/ 0	0/ 0	0
3	113	SYSTEMS DESIGN ^ DEVELOP			0/ 0	0/ 0	0
	11301X	FLUID SUBSYSTEM			0/ 0	0/ 0	0
	11302X	AIR CLEANING SUBSYSTEM			0/ 0	0/ 0	0
	11303X	AEROSOL GENERATOR SUBSYSTEM			0/ 0	0/ 0	0
	11304X	AEROSOL COUNTER SUBSYSTEM			0/ 0	0/ 0	0
	11305X	CFD CHAMBER SUBSYSTEM			0/ 0	0/ 0	0
	11306X	EXPANSION CHAMBER SUBSYSTEM			0/ 0	0/ 0	0
	11307X	SOL CHAMBER SUBSYSTEM			0/ 0	0/ 0	0
	11308X	THERMAL CONTROL SUBSYSTEM			0/ 0	0/ 0	0
	11309X	CONTROL ^ DATA SUBSYSTEM			0/ 0	0/ 0	0

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LEVEL	------WBS/JN-----	TITLE	MANAGER	CCC	PERFORMANCE FROM	PERFORMANCE TO	DOLLARS
	11310X	OPTICAL ^ IMAGING SUBSYSTEM			0/ 0	0/ 0	0
	11311X	CONSOLE SUBSYSTEM			0/ 0	0/ 0	0
	11312X	FLIGHT SOFTWARE			0/ 0	0/ 0	0
	11313X	LEVEL IV INTEGRATION			0/ 0	0/ 0	0
	11314X	SYSTEM TESTING			0/ 0	0/ 0	0
	11315X	SDI CHAMBER SUBSYSTEM			0/ 0	0/ 0	0
3	114	GSE/STE DESIGN ^ DEVELOPMENT			0/ 0	0/ 0	0
	1141XX	ELECTRICAL			0/ 0	0/ 0	0
	1142XX	MECHANICAL			0/ 0	0/ 0	0
	1143XX	GROUND SOFTWARE			0/ 0	0/ 0	0
3	115	DELIVERABLE HARDWARE/SOFTWARE			0/ 0	0/ 0	0
	11501X	FLUID SUBSYSTEM			0/ 0	0/ 0	0
	11502X	GAS CLEANING SUBSYSTEM			0/ 0	0/ 0	0
	11503X	AEROSOL GENERATOR SUBSYSTEM			0/ 0	0/ 0	0
	11504X	AEROSOL COUNTER SUBSYSTEM			0/ 0	0/ 0	0
	11505X	CFD CHAMBER SUBSYSTEM			0/ 0	0/ 0	0
	11506X	EXPANSION CHAMBER SUBSYSTEM			0/ 0	0/ 0	0
	11507X	SDL CHAMBER SUBSYSTEM			0/ 0	0/ 0	0
	11508X	THERMAL CONTROL SUBSYSTEM			0/ 0	0/ 0	0
	11509X	CONTROL ^ DATA SUBSYSTEM			0/ 0	0/ 0	0
	11510X	OPTICAL ^ IMAGING SUBSYSTEM			0/ 0	0/ 0	0
	11511X	CONSOLE SUBSYSTEM			0/ 0	0/ 0	0
	11512X	FLIGHT SOFTWARE			0/ 0	0/ 0	0
	11513X	GSE/STE			0/ 0	0/ 0	0
	11514X	GROUND SOFTWARE			0/ 0	0/ 0	0
	11515X	OTHER DELIVERABLE HWDE			0/ 0	0/ 0	0
	11516X	ACCEPTANCE TESTING			0/ 0	0/ 0	0
3	116	OPERATIONAL SUPPORT			0/ 0	0/ 0	0

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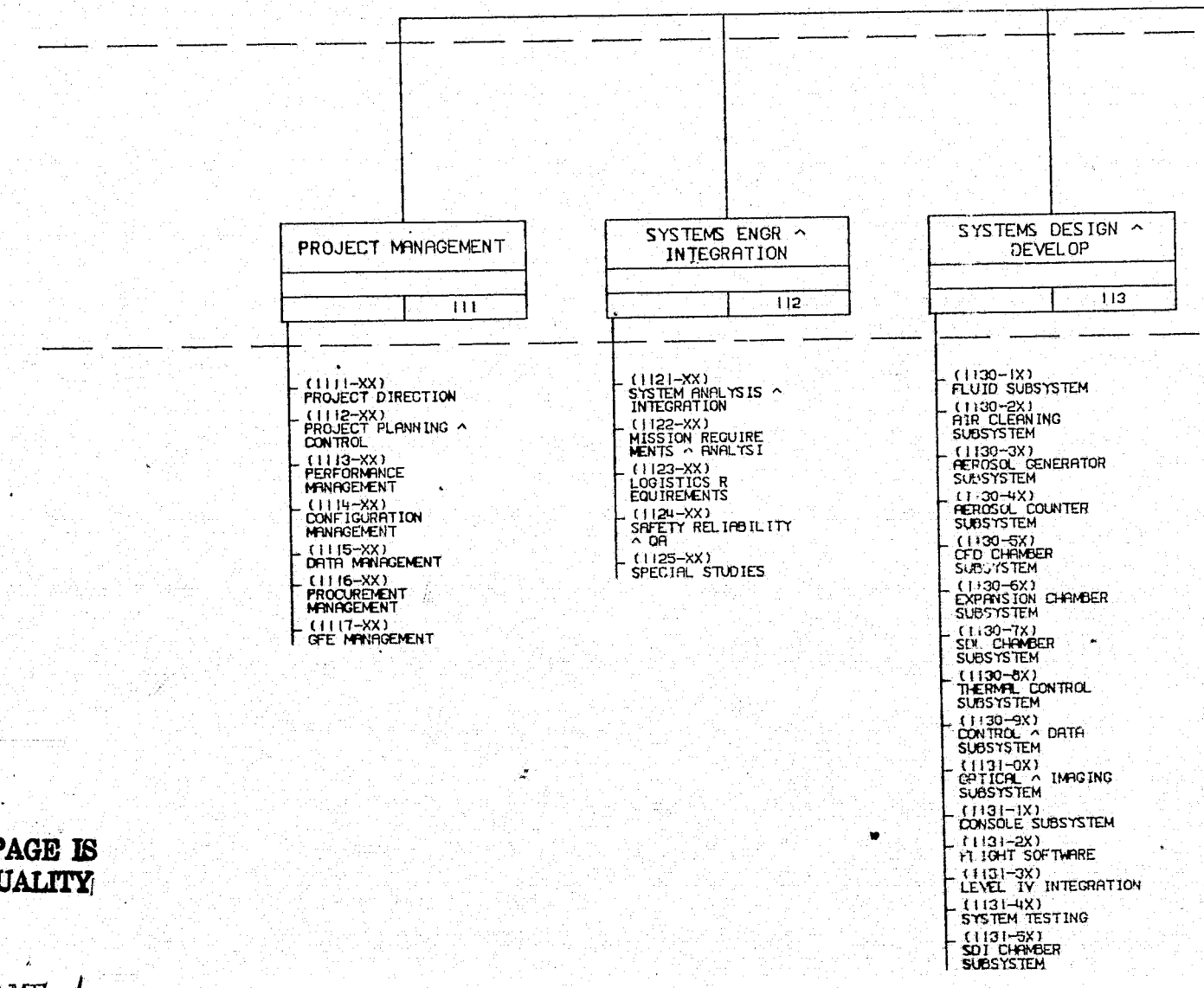
LEVEL	WBS/JN	TITLE	MANAGER	CCC	PERFORMANCE FROM	PERFORMANCE TO	DOLLARS
	1161XX	EXPER INTEGRATION ASSY ^ C/O			0/ 0	0/ 0	0
	1162XX	GROUND OPERATIONS			0/ 0	0/ 0	0
	1163XX	MISSION OPERATIONS			0/ 0	0/ 0	0
	1164XX	POST FLIGHT OPERATIONS			0/ 0	0/ 0	0
	1165XX	DATA PROCESSING			0/ 0	0/ 0	0
	1166XX	TRAINING			0/ 0	0/ 0	0
3	117	GOVERNMENT FURNISHED SUPT			0/ 0	0/ 0	0
	1171XX	SPACELAB RACKS			0/ 0	0/ 0	0
	1172XX	PRINCIPAL INVESTIGATORS			0/ 0	0/ 0	0
	1173XX	FACILITIES			0/ 0	0/ 0	0
	1174XX	TRANSPORTATION			0/ 0	0/ 0	0
	1175XX	USER CHARGE			0/ 0	0/ 0	0
	1176XX	IMS			0/ 0	0/ 0	0
2	12	SUBSEQUENT FLIGHTS			0/ 0	0/ 0	0
	121XXX	PROJECT MGT			0/ 0	0/ 0	0
	122XXX	SE^I			0/ 0	0/ 0	0
	123XXX	ADV SYSTEM DESIGN ^ DEVELOP			0/ 0	0/ 0	0
	124XXX	ADV GSE/STE DESIGN ^ DEVELOP			0/ 0	0/ 0	0
	125XXX	DELIVERABLE HARDWARE/SOFTWARE			0/ 0	0/ 0	0
	126XXX	OPERATIONAL SUPPORT			0/ 0	0/ 0	0
	127XXX	GOVERNMENT FURNISHED SUPPORT			0/ 0	0/ 0	0



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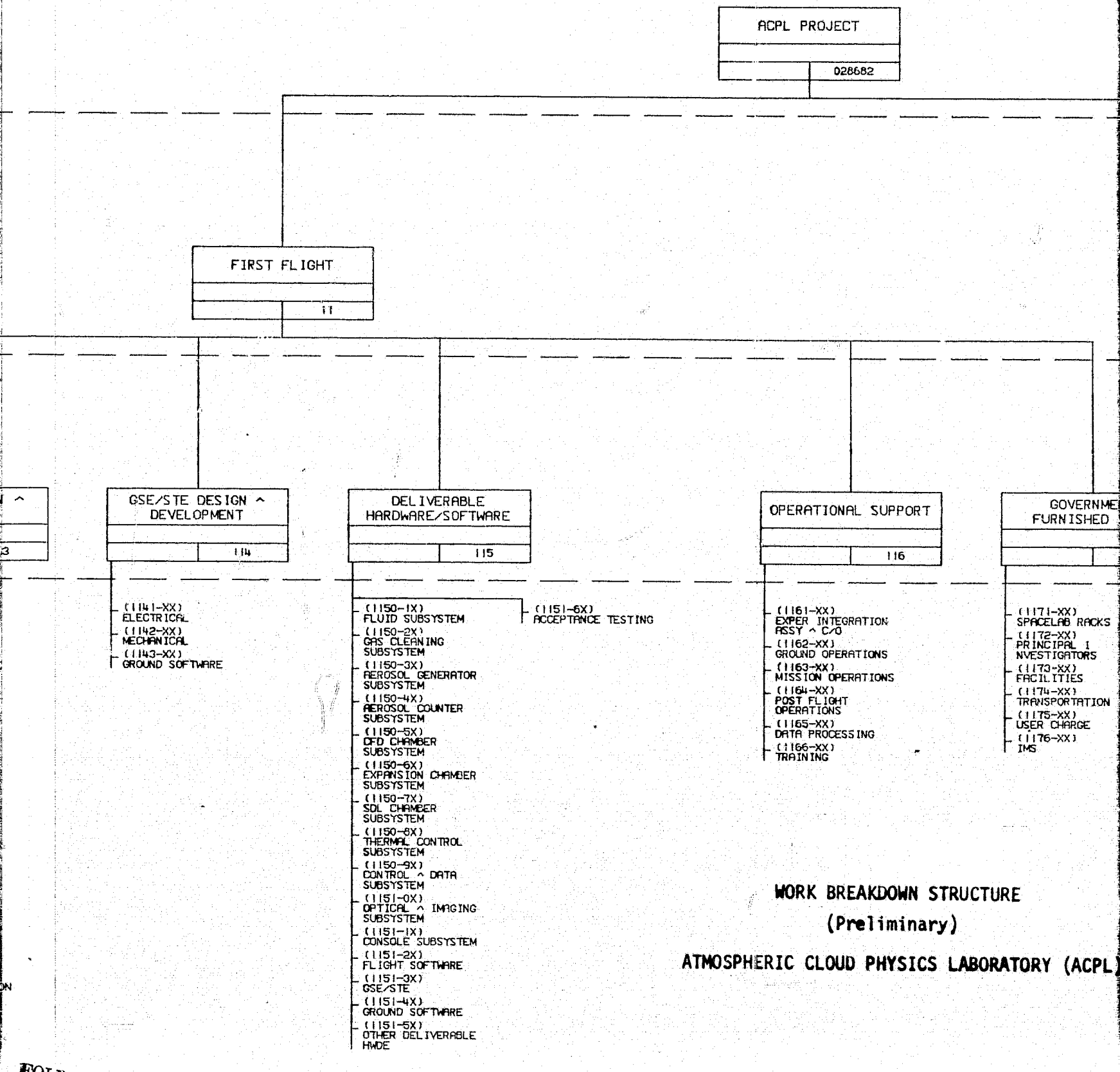

WORK BREAKDOWN STRUCTURE

(Preliminary)

ATMOSPHERIC CLOUD PHYSICS LABORATORY (ACPL)

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SUBSEQUENT FLIGHTS

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LEVEL 3

- (121X-XX) PROJECT MGT
- (122X-XX) SE^I
- (123X-XX) ADV SYSTEM DESIGN ^ DEVELOP
- (124X-XX) ADV GSE/STE DESIGN ^ DEVELOP
- (125X-XX) DELIVERABLE HARDWARE/SOFTWARE
- (126X-XX) OPERATIONAL SUPPORT
- (127X-XX) GOVERNMENT FURNISHED SUPPORT

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- (122X-XX) SE^I
- (123X-XX) ADV SYSTEM DESIGN ^ DEVELOP
- (124X-XX) ADV GSE/STE DESIGN ^ DEVELOP
- (125X-XX) DELIVERABLE HARDWARE/SOFTWARE
- (126X-XX) OPERATIONAL SUPPORT
- (127X-XX) GOVERNMENT FURNISHED SUPPORT

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Date: 1 April 1976

WBS No. 1.0

Level: 2

ATMOSPHERIC CLOUD PHYSICS LABORATORY (ACPL) PROJECT

DEFINITION

The design, development, fabrication, and operation of a unique multi-purpose laboratory facility for conducting atmospheric cloud physics research in the near zero gravity of Earth orbit as a partial payload on Spacelab flights aboard the Space Shuttle.

WORK CONTENT

Provide the services and materials required for the first and subsequent flights of the ACPL.

Date: 1 April 1976

WBS No. 1.1

Level: 3

FIRST FLIGHT

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element contains all the Government and contractor effort, materials and services required to provide the ACPL, its necessary support equipment and software, and to support integration and mission operations activities as necessary to accomplish project requirements for the first flight on the Spacelab.

WORK CONTENT

Provide project management, system engineering and integration, ACPL system design, development and qualification, GSE/STE design, development and qualification, deliverable hardware/software fabrication and testing, and operational support.

The NASA will provide Government furnished support.

WBS 1.1.1

PROJECT MANAGEMENT

- 1.1.1.1 Project Direction
- 1.1.1.2 Project Planning and Control
- 1.1.1.3 Performance Management
- 1.1.1.4 Configuration Management
- 1.1.1.5 Data Management
- 1.1.1.6 Procurement Management
- 1.1.1.7 GFE Management

Date: 1 April 1976

WBS No. 1.1.1

Level: 4

PROJECT MANAGEMENT

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element contains overall effort to manage and administer the ACPL Project: including planning, organizing, authorizing, scheduling, budgeting, performance and cost measurement and analysis, status reporting, providing early visibility of potential problems, and controlling required to accomplish project objectives for the first flight.

WORK CONTENT

Provide project direction, schedule and cost control, and overall performance management and administration. Control configuration of hardware and software. Manage and control activities of subcontractors and suppliers. Control, operate, maintain, and account for Government property in your possession. Provide the primary interface with NASA and appropriate members of the science community.

Date: 1 April 1976

WBS No. 1.1.1.1

Level: 5

PROJECT DIRECTION

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

The direct efforts of the ACPL Project Manager, Deputy Manager, Executive or Scientific Assistant (if required) and administrative and secretarial support.

WORK CONTENT

Management review, control, and direction in executive, engineering and scientific areas necessary to assure proper progress and attainment of project goals.

Continuous monitoring of all functional management disciplines for central direction and control of the overall project. Ensure timely resolutions of scientific, technical or programmatic problem areas.

Provide primary interface with NASA and appropriate members of the Cloud Physics science community.

Date: 1 April 1976

WBS No. 1.1.1.2

Level: 5

PROJECT PLANNING AND CONTROL

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes those management efforts associated with integrated planning, scheduling, budgeting, cost control and reporting necessary to provide management visibility and control of overall project. activities.

WORK CONTENT

Prepare and maintain an ACPL Program Plan including a master project schedule and those planning documents associated with definition of the ACPL project.

Establish and implement a financial planning and control system including the preparation and monitoring of budgets and cost collection and control.

Prepare reviews and reports as required for presentation and submission of project management data.

Date: 1 April 1976

WBS No. 1.1.1.3

Level: 5

PERFORMANCE MANAGEMENT
ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes those management activities associated with monitoring and control of technical performance for all tasks performed during the ACPL project. It provides project performance planning including performance measurement methods; establishment of project performance criteria; control of changes to these parameters; and analysis and summary of measurement data.

WORK CONTENT

Provide a cost-effective, comprehensive, integrated performance management system consisting of integrated planning, scheduling, budgeting, work authorization and cost accumulating of all activities to be performed during the ACPL Project. Provide project performance planning and control, control of changes to the planned project performance, measurement of progress toward achievement of planned project performance parameters, and visibility with regard to project performance at the WBS cost account level.

Establish performance measurement criteria, analyze and summarize technical measurement data, identify potential problems, and track their resolution.

Date: 1 April 1976

WBS No. 1.1.1.4

Level: 5

CONFIGURATION MANAGEMENT

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes those management activities associated with defining, controlling, and accounting for the hardware and software configurations at any point in time throughout the project life cycle. The configuration management system developed will provide identification of configuration and programmatic baselines; control changes to and maintain current status accountability of these baselines; and progressively verify that the as-built configuration agrees with the current configuration baseline (or that differences are identified). Included in the element are establishment, implementation, and maintenance of specification formats, end item selection criteria; and procedures for control and accounting of configurations and changes. Provisions for design support; conducting design reviews, audits and analyses, and Class II change control are also included in the element as well as participation in configuration verification to support CEI acceptance.

WORK CONTENT

Provide an efficient and effective configuration management system which will define configurations at any point in time throughout the period of performance of the project. Provide for the identification of configuration, interface and programmatic baselines, the control of changes to those baselines, the maintenance of a current accountability of the status of those baselines, and a progressive verification that the "as-built" configuration agrees with the current configuration baseline or that differences are identified. Inherent in these activities are the identification of all

management and technical interfaces with other program elements, and the appropriate participation in the management and control of these interface areas.

Date: 1 April 1976

WBS No. 1.1.1.5

Level: 5

DATA MANAGEMENT
ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes those overall management activities required to ensure proper information control, compatibility, availability, and currency. Included are services to identify, control, monitor the preparation of, reproduce, distribute and maintain status of the internal and deliverable documentation for the ACPL Project. Establishment, implementation, and maintenance of the Data Management Plan and procedures are also part of this element. Acquisition and control of data from governmental agencies, subcontractors and vendors are also included. Preparation, maintenance, and submittal of the review materials, review minutes, and action identification, tracking and control are parts of this element. Audio-visual/photograph support and training presentations are also included.

WORK CONTENT

Analyze project documentation requirements and develop, implement, maintain, and control an efficient and cost effective system for the preparation, distribution, and maintenance of the documentation, data, and information necessary and sufficient for the project's internal management as well as for the NASA management of the project. Optimum utilization will be made of existing systems and formats to reduce project cost, particularly where data is made available to NASA upon request.

Operate a Management Information Center to provide management visibility to the contractor and the NASA. All contractually required data submittals will be provided as part of this WBS element.

Date: 1 April 1976

WBS No. 1.1.1.6

Level: 5

PROCUREMENT MANAGEMENT

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes management and technical control of efforts by subcontractors and vendors. Tasks included are the providing of work direction to subcontractors and vendors; authorizing subcontractor tooling and equipment; analyzing subcontractor reports; conducting subcontractor and vendor reviews; and on-site coordination and evaluation of procurements. Also, included are the maintenance of records and submission of required reports relating to the geographic dispersion of minority and small business participation in ACPL project procurements and subcontracts.

WORK CONTENT

Conduct overall planning and management of the total procurement system.

Assure that technical, business, and management activities performed by all functional elements (e.g., engineering, manufacturing, quality, reliability, configuration,management, safety, material, project/program management, motivation) in support of or interfacing with procurement operations are fully and effectively integrated. Implement a Total Procurement System to provide and assure both technical adequacy and minimum project cost.

Date: 1 April 1976

WBS No. 1.1.1.7

Level: 5

GOVERNMENT FURNISHED PROPERTY (GFP) MANAGEMENT

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes identification, receipt, inspection, maintenance, checkout, operations, storage, and/or accounting of Government furnished property. The property included are tooling, equipment, hardware, and associated documentation.

WORK CONTENT

Establish, implement, and maintain a system for the management of tooling, equipment, hardware, and documentation furnished by the NASA.

Provide for the requirements identification, analysis, scheduling, tracking, problem identification and resolution, and spares and operational status reporting relative to all GFP hardware and documentation.

Provide procedures for receiving, inspecting, maintaining, storing, and accounting for GFP.

WBS 1.1.2

SYSTEM ENGINEERING AND INTEGRATION

- 1.1.2.1 System Analysis and Integration
- 1.1.2.2 Mission Requirements and Analysis
- 1.1.2.3 Logistics Requirements
- 1.1.2.4 Safety, Reliability and Quality Assurance
- 1.1.2.5 Special Studies

Date: 1 April 1976

WBS No. 1.1.2

Level: 4

SYSTEM ENGINEERING AND INTEGRATION
ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element incorporates all ACPL system level analyses, trade studies, and logistics activities, including performance of studies and analyses, development of requirements and definitions necessary to direct and control design of the ACPL. This element also includes all program safety, reliability and quality assurance activities required on ACPL.

WORK CONTENT

Perform analyses, studies and evaluations to establish design and system test requirements.

Perform Spacelab/ACPL interface analyses. Maintain interface control documents.

Plan and conduct ACPL reviews.

Verify the ACPL meets functional requirements.

Define, implement, operate, and maintain an efficient flexible logistics activity for support of the ACPL and its associated GSE/STE throughout the project.

Conduct safety, reliability and quality assurance activities to produce satisfactory hardware/software through systematic procedures, training analysis, review and assessment.

Perform special studies and analyses as directed by the NASA.

Provide sustaining engineering as directed by the NASA

Date: 1 April 1976

WBS No. 1.1.2.1

Level: 5

SYSTEM ANALYSIS AND INTEGRATION

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element incorporates analyses, studies, and evaluations necessary to establish design test requirements, and to support the development and verification of design solutions.

WORK CONTENT

Provide analyses, studies, and evaluations to assure ACPL system performance requirements are satisfied. Provide data to the NASA and the scientific community to permit their evaluation of ACPL system performance. Work to be accomplished shall include trade studies, interface design, mathematical modeling and providing specific data relative to the configuration and capability of the ACPL subsystems.

Trade Studies and Analyses. Analyses and design to be accomplished in support of system level trade studies include:

- Thermal Analyses of ACPL Subsystems (Reporting only - analyses performed in 1.1.3.8)
- Supplemental Stress Analysis (Reporting only - analyses performed in 1.1.3.11)
- Cost/Other Resource and Cost/Requirement Sensitivity
- Weights Analysis
- Design Layouts
- Maintainability Analyses
- GSE and STE Interface Analyses

Mathematical Models. Provide the following mathematical models to the NASA:

- Thermal mathematical model with thermal conductances and capacities delivered at physical interfaces
- Structural analysis model and inertia distributions for use in overall ACPL system static and dynamic analyses

Interface Design. Participate in the definition of the design for and monitor development of the structural, thermal, electrical, CDMS and fluid interfaces between the ACPL and Spacelab. Participate in the preparation and maintain the interface control documents between the ACPL and Spacelab.

ACPL Configuration and Design Data. Provide, on request of the ACPL Project Office, specific configuration and design data. Maintain CEI Specifications current.

Reviews. Plan and conduct ACPL reviews; i.e., preliminary design review, critical design reviews, flight readiness reviews, etc., and prepare minutes.

Sustaining Engineering. Provide ACPL sustaining engineering as directed by the NASA.

Date: 1 April 1976

WBS No. 1.1.2.2

Level: 5

MISSION REQUIREMENTS AND ANALYSIS

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes analyses, studies and evaluations associated with determination and establishment of mission operation requirements, establishment of flight and mission operations plans and evaluation of associated procedures.

WORK CONTENT

Provide analyses, evaluations, and an integrated set of test requirements to thoroughly evaluate and validate the ACPL capabilities through all phases of ground, flight, and mission operations. Develop and implement a mass properties analysis and control plan during operations on Spacelab with allocations to establish a performance baseline. Develop plans for flight and mission operations; review and evaluate associated procedures.

Date: 1 April 1976

WBS No. 1.1.2.3

Level: 5

LOGISTICS REQUIREMENTS
ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes that effort required to establish, implement, operate and maintain Logistics Management for support of the ACPL and its related support equipment.

WORK CONTENT

Define, implement, operate and maintain an efficient, flexible logistics activity for support of the ACPL system and its associated GSE/STE throughout the project. This includes identification of spares requirements, analysis of support requirements, inventory, repair requirements, pressurants identification and utilization requirements, warehousing and storage, and transportation analyses and planning.

Date: 1 April 1976

WBS No. 1.1.2.4

Level: 5

SAFETY, RELIABILITY & QUALITY ASSURANCE
ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element incorporates all safety, reliability, and quality assurance activities for the ACPL Project to assure that these considerations are included in the design, development and test phases in a cost-effective manner. This WBS element also includes those efforts associated with the establishment, implementation, and maintenance of safety, reliability and quality assurance activities to ensure satisfactory hardware/software delivery and operation through procedures, training, analysis, review and assessment.

WORK CONTENT

Define, coordinate, and evaluate the requirements for safety, reliability, and quality assurance pertinent to the ACPL hardware/software and the ACPL Project in terms of actual or potential risk, implementation cost, and cost per flight. Devise, plan, implement, and maintain a cost effective system to ensure that the requirements are addressed and implemented in the design, fabrication, test, and operation of the ACPL.

Define ways and conduct trade studies (typified by increasing tolerances and safety margins to reduce or eliminate inspection requirements) to provide a basis for implementing cost avoidances and cost reductions. Establish effective safety, reliability, and quality assurance measures for all subcontract and vendor items, including location of contractor personnel at subcontractor and vendor facilities, if required. Assure effective use of off-the-shelf items, qualification of multiple sources, and utilization of prior qualification data.

Perform a safety and hazards analysis for the ACPL operation on Spacelab.

Date: 1 April 1976

WBS No. 1.1.2.5

Level: 5

SPECIAL STUDIES

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes the necessary management, labor, facilities, materials and equipment (excluding that to be furnished by the government) to perform ACPL special analyses as directed by the NASA. These special analyses shall include ACPL peculiar studies and analyses which are not mandatory for the contractor to complete design, development, fabrication, test or operation of the ACPL as contractually defined at the time of commencement of a special analysis.

WORK CONTENT

Special Analyses will be conducted in the following areas:

a) Mission and Operations - These analyses shall include all aspects of usage from completion of fabrication through mission cycle completion and the relationships of the ACPL with facilities and with supporting equipments.

b) Technical descriptions and systems integrity investigations - These analyses shall include the potential changes within the ACPL design or its development, fabrication or testing as these relate to the hardware/software design. They shall also include analyses pertinent to the safety, maintainability or reliability of the ACPL. Technical evaluation of ACPL capability to perform additional science experiments or to accommodate new technology developments is included in this area.

c) Cost Analyses and Trade-Offs - These analyses shall include the cost/other resource impact of variations in the ACPL and the effects

of these variations on the design-to-cost parameters.

d) Supporting Research and Technology Requirements - These analyses shall address the identification of research or technology requirements necessary in support of the ACPL project and shall address analyses of existing technology in search of solution to ACPL development difficulties or problems.

NOTE: Work to be performed under this WBS will be within the broad parameters listed above and will be more specifically defined by means of technical directives executed by the NASA Technical Manager. Each directive will contain the scope of work, time of performance desired and such other instructions as necessary to properly define the desired effort.

As promptly as practicable and no more than 10 calendar days after receiving a technical directive, the contractor shall submit for approval to the Technical Manager a proposed study plan for accomplishing this task, and estimated equivalent manhours. Upon receipt of the Technical Manager's written authorization, the contractor shall promptly commence work on the task assigned.

WBS 1.1.3

ACPL SYSTEM DESIGN AND DEVELOPMENT

- 1.1.3.1 Fluid Subsystem
- 1.1.3.2 Air Cleaning Subsystem
- 1.1.3.3 Aerosol Generator Subsystem
- 1.1.3.4 Aerosol Counter Subsystem
- 1.1.3.5 CFD Chamber Subsystem
- 1.1.3.6 Expansion Chamber Subsystem
- 1.1.3.7 SDL Chamber Subsystem
- 1.1.3.8 Thermal Control Subsystem
- 1.1.3.9 Control and Data Subsystem
- 1.1.3.10 Optical and Imaging Subsystem
- 1.1.3.11 Console Subsystem
- 1.1.3.12 Flight Software
- 1.1.3.13 Level IV Integration
- 1.1.3.14 System Testing
- 1.1.3.15 SDI Chamber Subsystem*

*Advance Planning Only

Date: 1 April 1976

WBS No. 1.1.3

Level: 4

ACPL SYSTEM DESIGN AND DEVELOPMENT

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element incorporates all directly related efforts associated with the design, development, development test hardware/software, development test, qualification test and maintainability of ACPL subsystems, flight software, Level IV integration, system testing and advance planning for growth required to produce the ACPL which satisfies project requirements.

WORK CONTENT

Design, develop, produce parts and materials, fabricate development test hardware/software, perform development testing, integrate and qualify the ACPL, which includes all subsystems, flight software and the integration and installation of any Government Furnished Property (GFP).

System growth, including a static diffusion ice chamber, will be planned for during the design of the ACPL.

NOTE: Qualification test hardware/software is provided under WBS 1.1.5.

Date: 1 April 1976

WBS No. 1.1.3.1

Level: 5

FLUID SUBSYSTEM

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

The Fluid Subsystem is the element that processes the air throughout the ACPL. It includes the pressure and flow controls and the humidification and temperature conditioning. This WBS element includes all the effort associated with the design, development, development testing, and qualification of the Fluid Subsystem.

WORK CONTENT

Provide the services necessary for the design, development, development testing and qualification of the Fluid Subsystem. The following is a list of components which are incorporated in this subsystem:

- Air side fans and plenums
- Pressure and flow control valves
- Interconnecting air ducting and valves
- Flow restrictors
- Humidifier (including temperature sensors)
- Pressure sensors and reference

Date: 1 April 1976

WBS No. 1.1.3.2

Level: 5

AIR CLEANING SUBSYSTEM

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

The Air Cleaning Subsystem is the element that cleans the air to a specified quality for experimentation. It includes both filtration, absorption and dehumidification.

This WBS element includes all the effort associated with the design, development, development testing and qualification of the Air Cleaning Subsystem.

WORK CONTENT

Provide the services necessary for the design, development, development testing, and qualification of the Air Cleaning Subsystem. The following is a list of components which are incorporated in this subsystem:

- CO_2 absorber
- Dehumidifier
- Particulate filters
- Trap for hydrocarbon molecules
- Containers
- Air Quality Monitoring Equipment

Date: 1 April 1976

WBS No. 1.1.3.3

Level: 5

AEROSOL GENERATOR SUBSYSTEM

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

The Aerosol Generator Subsystem is the element that generates and disperses the specified nuclei. This WBS element includes all the effort associated with the design, development, development testing and qualification of the Aerosol Generator Subsystem.

WORK CONTENT

Provide the services necessary for the design, development, development testing and qualification of the Aerosol Generator Subsystem. The following is a list of components which are incorporated in this subsystem:

- Aerosol generators
- Supply fan with ducting, filters, valves
- Control bag
- Injector

Date: 1 April 1976

WBS No. 1.1.3.4

Level: 5

AEROSOL COUNTER SUBSYSTEM

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

The Aerosol Counter Subsystem is the element required to define and characterize the nuclei size distribution for the entire spectrum of particles generated for experimentation, and to measure droplet number densities leaving the CFD. It includes the real-time particle counter(s) and any devices required to retrieve and maintain the samples for analysis after the mission.

This WBS element includes all the effort associated with the design, development, development testing, and qualification of the Aerosol Counter Subsystem.

WORK CONTENT

Provide the services necessary for the design, development, development testing, and qualification of the Aerosol Counter Subsystem. The following is a list of components which are included in this subsystem.

- Electrical aerosol analyzer
- Optical particle counter optical bench
- Electrostatic aerosol precipitator
- Electronic signal processor
- Storage units

Date: 1 April 1976

WBS No. 1.1.3.5

Level: 5

CONTINUOUS FLOW DIFFUSION (CFD) CHAMBER SUBSYSTEM

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

The CFD Chamber Subsystem is the element required to establish and maintain supersaturation of the air used in experimentation. It includes the CFD chamber and its associated hardware.

This WBS element includes all the effort associated with the design, development, development test and qualification of the CFD Chamber Subsystem.

WORK CONTENT

Provide the services necessary for the design, development, development test and qualification of the CFD Chamber Subsystem. The following components are included in this subsystem:

- Continuous Flow Diffusion Chamber
- Control bag
- Temperature sensors

Date: 1 April 1976

WBS No. 1.1.3.6

Level: 5

EXPANSION (E) CHAMBER SUBSYSTEM

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

The E Chamber Subsystem is the element required to provide natural cloud simulation. It includes the E Chamber, the cooling and control devices that are a structural part of the E. Chamber, and associated hardware.

This WBS element includes all the effort associated with the design, development, development testing and qualification of the E Chamber Subsystem.

WORK CONTENT

Provide the services necessary for the design, development, development testing and qualification of the E Chamber Subsystem. The following components are included in this subsystem:

- Expansion chamber walls
- Windows
- Thermoelectric elements on the walls (if used)
- Inlet and exhaust plenums
- Pressure and temperature sensors
- Expansion unit

Date: 1 April 1976

WBS No. 1.1.3.7

Level: 5

STATIC DIFFUSION LIQUID (SDL) CHAMBER SUBSYSTEM

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

The SDL Chamber Subsystem is the element required to produce a supersaturation which is a maximum near the midpoint between the plates for the air used in experimentation. It includes the SDL Chamber and its associated hardware.

This WBS element includes all the effort associated with the design, development, development testing and qualification of the SDL Chamber Subsystem.

WORK CONTENT

Provide the services necessary for the design, development, development testing and qualification of the SDL Chamber Subsystem. The following components are included in this subsystem:

- SDL Chamber walls
- Windows
- Water supply system
- Temperature sensors
- Inlet and outlet ducting

Date: 1 April 1976

WBS No. 1.1.3.8

Level: 5

THERMAL CONTROL SUBSYSTEM

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

The Thermal Control Subsystem is the element required to maintain the desired environment for the other subsystems and experimental samples. It includes the specific heat transfer equipment unique to the ACPL and that equipment that interfaces with the heat transfer loop and air cooling ducts of the Spacelab.

This WBS element includes all the effort associated with the design, development, development testing and qualification of the Thermal Control Subsystem.

WORK CONTENT

Provide the services necessary for the design, development, development testing and qualification of the Thermal Control Subsystem. The following components are included in this subsystem:

- Pumps
- Accumulators
- Liquid reservoirs
- Mixing control valves
- Refrigerators
- Heat Exchangers
- Piping and valves
- Temperature and pressure sensors
- Heaters
- Avionics air cooling ducts

Date: 1 April 1976

WBS No. 1.1.3.9

Level: 5

CONTROL AND DATA SUBSYSTEM

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

The Control and Data Subsystem is the element required to record and format the data and commands for specific ACPL activities, and to provide signals to control other ACPL subsystems. It includes a central channeling device which will receive data from and send commands to sensors and controllers, and limited manual controls and data displays that are used for monitoring and controlling the other subsystems.

This WBS element includes all the effort associated with the design, development, development testing and qualification of the Control and Data Subsystem.

WORK CONTENT

Provide the services necessary for the design, development, development testing and qualification of the Control and Data Subsystem. The following components are included in this subsystem:

- Spacelab RAU (GFE)
- Card Cage and Interconnecting Power and Data Bus
- Functional Modules
- Operators Control and Display Panel

Date: 1 April 1976

WBS No. 1.1.3.10

Level: 5

OPTICAL AND IMAGING SUBSYSTEM

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

The Optical and Imaging Subsystem is the element required to illuminate and take pictures of the various experiments in the expansion and static diffusion liquid chambers. It includes the camera(s), illumination devices, film drives, associated hardware, and any necessary film handling equipment.

This WBS element includes all the effort associated with the design, development, development testing and qualification of the Optical and Imaging Subsystem.

WORK CONTENT

Provide the services necessary for the design, development, development testing and qualification of the Optical and Imaging Subsystem. The following components are included in this subsystem:

- Camers, optics and film driver for the Expansion and Static Diffusion Liquid chambers
- Flash lamps, collectors and focusing optics for the two chambers
- UV and IR filters
- Additional film

Date: 1 April 1976

WBS No. 1.1.3.11

Level: 5

CONSOLE SUBSYSTEM

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

The Console Subsystem is the element required for mounting and supporting all ACPL subsystems in the Government supplied standard Spacelab double rack. It includes the distribution and conditioning of electrical power required by the other subsystems and any necessary modifications required to the Spacelab double rack.

This WBS element includes all the effort associated with the design, development, development testing and qualification of the Console Subsystem.

WORK CONTENT

Provide the services necessary for the design, development, development testing and qualification of the Console Subsystem. The following list of components are included in this subsystem:

- Spacelab double rack (GFE)
- Support bracketry
- Storage compartments
- Experiment power switching panel (GPE)
- DC to DC converters
- DC to AC inverters
- Power Harness

Date: 1 April 1976

WBS No. 1.1.3.12

Level: 5

FLIGHT SOFTWARE

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

The Flight Software is the element required to provide commands to operate the ACPL in flight. It includes all provisions required to interface with the Spacelab computer and any provisions required to control specific subsystems of the ACPL.

This WBS element includes all the effort associated with the design, development, and verification of the Flight Software.

WORK CONTENT

Provide the services necessary for the design, development, and verification of the Flight Software.

Date: 1 April 1976

WBS No. 1.1.3.13

Level: 5

LEVEL IV INTEGRATION

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

The Level IV Integration is the element required to integrate the subsystems with each other and assemble them into an ACPL system for qualification test. It includes all systems level engineering required to integrate the subsystems (including preparation of the top assembly drawing). Also included is planning and the physical integration activities associated with assemblying the ACPL.

This WBS element includes all the effort associated with assembly of the subsystems into an ACPL for qualification testing.

WORK CONTENT

Provide the services necessary for assembly of the ACPL including the following activities:

- Perform system level engineering to integrate ACPL subsystems.
- Prepare a top assembly drawing.
- Prepare planning required for physical ACPL integration.
- Perform the hardware integration.
- Perform, as necessary, in-process testing during ACPL integration.

Date: 1 April 1976

WBS No. 1.1.3.14

Level: 5

SYSTEM TESTING

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

The System Testing is the element required to perform the qualification testing of the ACPL as a total system. It includes the test procedures, test setup and test report.

This WBS element includes all the effort associated with the system testing of the ACPL.

WORK CONTENT

Provide the services necessary to perform and document qualification testing of the ACPL as a total system. Not included is qualification or development testing of the individual subsystems.

Date: 1 April 1976

WBS No. 1.1.3.15

Level: 5

STATIC DIFFUSION ICE (SDI) CHAMBER SUBSYSTEM

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

The SDI Chamber Subsystem is the element required to establish and maintain supersaturation at temperatures below freezing of the air used in experimentation. It includes the SDI Chamber and its associated hardware.

This WBS element includes all the effort associated with the design, development, development testing, and qualification of the SDI Chamber Subsystem.

WORK CONTENT

Provide only the necessary advanced engineering and planning that would allow this subsystem to be added to the ACPL for later missions.

WBS 1.1.4
GROUND SUPPORT EQUIPMENT AND SPECIAL TEST EQUIPMENT DESIGN AND DEVELOPMENT

1.1.4.1 Electrical
1.1.4.2 Mechanical
1.1.4.3 Ground Software

Date: 1 April 1976

WBS No. 1.1.4

Level: 4

GROUND SUPPORT EQUIPMENT (GSE) AND SPECIAL TEST EQUIPMENT (STE) DESIGN AND DEVELOPMENT

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes directly related efforts associated with the design, development, development test hardware/software, development test and qualification test of the mechanical and electrical GSE/STE and Ground Software required to support the ACPL per the project requirements.

WORK CONTENT

Design, develop, produce parts and materials, fabricate development test hardware/software and test the GSE/STE and Ground Software.

NOTE: Qualification test hardware/software is provided under WBS 1.1.5.

Date: 1 April 1976

WBS No. 1.1.4.1

Level: 5

ELECTRICAL

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

The Electrical GSE/STE is the element of electrical unique support and test equipment required to process and/or test the ACPL either pre- or post-flight.

This WBS element includes all the effort associated with the design and development of the Electrical GSE and STE.

WORK CONTENT

Provide the services necessary for the design, development and qualification of the unique electrical GSE and STE.

Date: 1 April 1976

WBS No. 1.1.4.2

Level: 5

MECHANICAL

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

The Mechanical GSE/STE is the element of mechanical unique support and test equipment required to process and/or test the ACPL either pre- or post-flight.

This WBS element includes all the effort associated with the design and development of the mechanical GSE and STE.

WORK CONTENT

Provide the services necessary for the design, development and qualification of the unique mechanical GSE and STE.

Date: 1 April 1976

WBS No. 1.1.4.3

Level: 5

GROUND SOFTWARE

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

The Ground Software is the element required to provide commands to operate the ACPL, GSE and STE on the ground. It includes the tapes required to control specific ACPL subsystem, GSE and STE.

This WBS element includes all the effort associated with the design, development, and verification of the Ground Software.

WORK CONTENT

Provide the services necessary for the design, development, and verification of the Ground Software.

WBS

1.1.5

DELIVERABLE HARDWARE/SOFTWARE

1.1.5.1	Fluid Subsystem
1.1.5.2	Air Cleaning Subsystem
1.1.5.3	Aerosol Generator Subsystem
1.1.5.4	Aerosol Counter Subsystem
1.1.5.5	CFD Chamber Subsystem
1.1.5.6	E Chamber Subsystem
1.1.5.7	SDL Chamber Subsystem
1.1.5.8	Thermal Control Subsystem
1.1.5.9	Control and Data Subsystem
1.1.5.10	Optical and Imaging Subsystem
1.1.5.11	Console Subsystem
1.1.5.12	Flight Software
1.1.5.13	GSE/STE
1.1.5.14	Ground Software
1.1.5.15	Other Deliverable Hardware
1.1.5.16	Acceptance Testing

Date: 1 April 1976

WBS No. 1.1.5

Level: 4

DELIVERABLE HARDWARE/SOFTWARE

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes the fabrication and delivery of the ACPL, flight and ground software, ground support equipment (GSE), special test equipment (STE), and other deliverable hardware such as spares, etc. This includes those items required for qualification test which will then become the protoflight article.

WORK CONTENT

Procure parts and materials and fabricate the ACPL, flight and ground software, GSE, STE, and other identified deliverable hardware.

Perform the acceptance test as required on each deliverable item.

Provide the delta cost to update the qualification units to protoflight units by subsystem and account for this separately under WBS 1.1.5.15.

Date: 1 April 1976

WBS No. 1.1.5.1

Level: 5

FLUID SUBSYSTEM

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes those activities and materials required to fabricate the Fluid Subsystem

WORK CONTENT

Procure parts and materials and fabricate the Fluid Subsystem. In-process testing and subsystem acceptance testing associated with fabrication are also included in this WBS element. The following components are incorporated in this subsystem:

- Air side fans and plenums
- Pressure and flow control valves
- Interconnecting air ducts and valves
- Flow restrictors
- Humidifier (including temperature sensors)
- Pressure sensors and reference

Date: 1 April 1976

WBS No. 1.1.5.2

Level: 5

AIR CLEANING SUBSYSTEM

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes those activities and materials required to fabricate the Air Cleaning Subsystem.

WORK CONTENT

Procure parts and materials and fabricate the Air Cleaning Subsystem. In-process testing and subsystem acceptance testing associated with fabrication are also included in this WBS element. The following components are incorporated in this subsystem:

- CO_2 absorber
- Dehumidifier
- Particulate filters
- Trap for hydrocarbon molecules
- Container
- Air Quality Monitoring Equipment

Date: 1 April 1976

WBS No. 1.1.5.3

Level: 5

AEROSOL GENERATOR SUBSYSTEM

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes activities and materials required to fabricate the Aerosol Generator Subsystem.

WORK CONTENT

Procure parts and materials and fabricate the Aerosol Generator Subsystem. In-process testing and subsystem acceptance testing associated with fabrication are also included in this WBS element. The following components are incorporated in this subsystem:

- Aerosol generators
- Supply fan with ducting, filters, valves
- Control bag
- Injector

Date: 1 April 1976

WBS No. 1.1.5.4

Level: 5

AEROSOL COUNTER SUBSYSTEM

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes those activities and materials required to fabricate the Aerosol Counter Subsystem.

WORK CONTENT

Procure parts and materials and fabricate the Aerosol Counter Subsystem. In-process testing and subsystem acceptanct testing associated with fabrication are also included in this WBS element. The following components are incorporated in this subsystem:

- Electrical Aerosol Analyzer
- Optical Particle counter optical bench
- Electrostatic Aerosol Precipitator
- Electronic signal processor
- Storage units

Date: 1 April 1976

WBS No. 1.1.5.5

Level: 5

CFD CHAMBER SUBSYSTEM

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes those activities and materials required to fabricate the CFD Chamber Subsystem.

WORK CONTENT

Procure parts and materials and fabricate the CFD Chamber Subsystem. In-process testing and subsystem acceptance testing associated with fabrication are also included in the WBS element. The following components are included in this subsystem:

- Continuous Flow Diffusion chamber
- Control bag
- Temperature sensors

Date: 1 April 1976

WBS No. 1.1.5.6

Level: 5

E CHAMBER SUBSYSTEM

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes those activities and materials required to fabricate the E Chamber Subsystem.

WORK CONTENT

Procure parts and materials and fabricate the E Chamber Subsystem. In-process testing and subsystem acceptance testing associated with fabrication are also included in this WBS element. The following components are included in this subsystem:

- Expansion chamber walls
- Windows
- Thermoelectric elements on the walls (if used)
- Inlet and exhaust plenums
- Pressure and temperature sensors
- Expansion Unit

Date: 1 April 1976

WBS No. 1.1.5.7

Level: 5

SDL CHAMBER SUBSYSTEM

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes those activities and materials required to fabricate the SDL Chamber Subsystem.

WORK CONTENT

Procure parts and materials and fabricate the SDL Chamber Subsystem. In-process testing and subsystem acceptance testing associated with fabrication are also included in this WBS element. The following components are included in this subsystem:

- SDL chamber walls
- Windows
- Water Supply system
- Temperature sensors
- Inlet and outlet ducting

Date: 1 April 1976

WBS No. 1.1.5.8

Level: 5

THERMAL CONTROL SUBSYSTEM

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes those activities and materials required to fabricate the Thermal Control Subsystem.

WORK CONTENT

Procure parts and materials and fabricate the Thermal Control Subsystem. In-process testing and subsystem acceptance testing associated with fabrication are also included in this WBS element. The following components are included in this subsystem:

- Pumps
- Accumulators
- Liquid reservoirs
- Mixing control valves
- Refrigerators
- Heat exchangers
- Piping and valves
- Temperature and pressure sensors
- Heaters
- Avionics air cooling ducts

Date: 1 April 1976

WBS No. 1.1.5.9

Level: 5

CONTROL AND DATA SUBSYSTEM

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes those activities and materials required to fabricate the Control and Data Subsystem.

WORK CONTENT

Procure parts and materials and fabricate the Control and Data Subsystem. In-process testing and subsystem acceptance testing associated with fabrication are also included in this WBS element. The following components are incorporated in this subsystem:

- Spacelab RAU (GFE)
- Card cage and Interconnecting Power and Data Bus
- Functional Modules
- Operators Control and Display Panel

Date: 1 April 1976

WBS No. 1.1.5.10

Level: 5

OPTICAL AND IMAGING SUBSYSTEM

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes those activities and materials required to fabricate the Optical and Imaging Subsystem.

WORK CONTENT

Procure parts and materials and fabricate the Optical and Imaging Subsystem. In-process testing and subsystem acceptance testing associated with fabrication are also included in this WBS element. The following components are included in this subsystem:

- Cameras, optics and film drivers for the Expansion and Static Diffusion Liquid chambers
- Flash lamps, collectors and focusing optics for the two chambers
- UV and IR filters
- Additional film

Date: 1 April 1976

WBS No. 1.1.5.11

Level: 5

CONSOLE SUBSYSTEM

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes those activities and materials required to fabricate the Console Subsystem.

WORK CONTENT

Procure parts and materials and fabricate the Console Subsystem. In-process testing and subsystem acceptance testing associated with fabrication are also included in this WBS element. The following components are included in this subsystem:

- Spacelab double rack (GFE)
- Support bracketry
- Storage compartments
- Experiment power switching panel (GFE)
- DC to DC converters
- DC to AC inverters
- Power harness

WBS No. 1.1.5.12

Date: 1 April 1976

Level: 5

FLIGHT SOFTWARE

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes those activities and materials required to generate the Flight Softwares.

WORK CONTENT

Procure parts, materials and services to generate the Flight Software.

NOTE: Design, development and verification of Flight Software is included in WBS element 1.1.3.12.

Date: 1 April 1976

WBS No. 1.1.5.13

Level: 5

GSE/STE

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

Activities and materials required to fabricate the GSE/STE.

WORK CONTENT

Procure parts and materials and fabricate the GSE/STE. In-process testing and acceptance testing associated with fabrication are also included in this element.

Date: 1 April 1976

WBS No. 1.1.5.14

Level: 5

GROUND SOFTWARE

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

Activities and materials required to generate the Ground Software.

WORK CONTENT

Procure parts and materials and generate the Ground Software.

NOTE: Design, development and verification of ground software is included in WBS element 1.1.4.3.

Date: 1 April 1976

WBS No. 1.1.5.15

Level: 5

OTHER DELIVERABLE HARDWARE

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

Other Deliverable Hardware is defined as those spares, mock-ups, any additional deliverable hardware or software necessary to satisfy project objective and not specifically listed above. The delta cost, by subsystem, necessary to refurbish or update (if required) the qualification ACPL to a protoflight configuration, should be included here.

WORK CONTENT

Procure the necessary parts and materials and fabricate the Other Deliverable Hardware as defined above.

Provide the services and materials to bring the ACPL to protoflight condition and configuration.

Date: 1 April 1976

WBS No. 1.1.5.16

Level: 5

ACCEPTANCE TESTING

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes those activities required to perform the final test and checkout on the completed ACPL and support hardware/software.

WORK CONTENT

Checkout of protoflight hardware/software in compliance with all applicable specifications, drawings, ICD's and other relevant documentation.

Complete all close-out work required to produce a completed article.

Insure that deliverable items function in accordance with design specifications and they they mate physically and functionally with other flight, ground test, and support equipment items.

Perform final acceptance checkout (DD-250) at contractor plant.

WBS 1.1.6

OPERATIONAL SUPPORT

1.1.6.1 Experiment Integration and Assembly
1.1.6.2 Ground Operations
1.1.6.3 Mission Operations
1.1.6.4 Post-Flight Operations
1.1.6.5 Data Processing
1.1.6.6 Training

Date: 1 April 1976

WBS No. 1.1.6

Level: 4

OPERATIONAL SUPPORT

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes those equipment and services required to support the ACPL during operations.

WORK CONTENT

Provide necessary hardware, software documentation and services to integrate specific experiment(s) into the ACPL for flight.

Perform the services required to support the Level I, II and III integration at the launch site. Provide the necessary support for mission operations. (T-4 hours to touch down plus 30 minutes).

Conduct post-flight operations and prepare ACPL for subsequent flights.

Reduce the data to engineering terms and develop negatives as required for specific experiments.

Establish and conduct necessary training required for both Principal Investigator(s) and/or Payload Specialist.

Date: 1 April 1976

WBS No. 1.1.6.1

Level: 5

EXPERIMENT INTEGRATION AND ASSEMBLY

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes the necessary hardware, software, documentation and services required to integrate the experiment(s) physically into the ACPL and to conduct the experiment(s).

WORK CONTENT

Coordinate the experiment(s) requirement with the Principal Investigator(s) and assure that the ACPL can accommodate the experiment(s).

Generate and/or modify procedural documentation, ACPL hardware/software (if required) for both ground and mission operations to integrate and checkout the ACPL and to conduct the experiment(s). Provide, as necessary, aerosols and data gathering tapes and film.

Provide any additional aerosol generators/ detectors or other experiment peculiar equipment as defined by the Principal Investigator(s).

Date: 1 April 1976

WBS No. 1.1.6.2

Level: 5

GROUND OPERATIONS

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes activities to process the ACPL from receipt at the launch site through the Level I, II and III integration.

WORK CONTENT

Perform the receiving inspection and checkout of the ACPL. Support the Level I, II and III integration activities.

Manage and maintain the GSE/STE provided to conduct ground operations of the ACPL.

Date: 1 April 1976

WBS No. 1.1.6.3

Level: 5

MISSION OPERATIONS

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes all effort to support the mission from T-4 hours until touchdown plus 30 minutes.

WORK CONTENT

Coordination with the mission control center and the Principal Investigator(s) throughout mission.

Provide instructions and/or anomaly resolution engineering to Payload Specialist. Maintain accounting of all consumables during the mission.

Date: 1 April 1976

WBS No. 1.1.6.4

Level: 5

POST-FLIGHT OPERATIONS

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes all services required to render the ACPL ready to accept additional experiments for the subsequent flights.

WORK CONTENT

Conduct post-flight evaluation and prepare a report on the performance of the ACPL hardware/software.

Passivate the ACPL and prepare the ACPL either for return to contractor plant or for initiation of activities for a subsequent flight.

Date: 1 April 1976

WBS No. 1.1.6.5

Level: 5

DATA PROCESSING

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes the services required to obtain and reduce ACPL hardware/software performance data and the experimental data to engineering terms and develop negatives of pictures taken during experiments.

WORK CONTENT

Secure the computer tapes from Spacelab, ACPL, and Payload Operational Center(s).

Process the tapes and reduce to engineering terms.

Conduct and record the debriefing of the Payload Specialists for the ACPL experiment(s).

Secure and develop negatives of pictures taken during experiment(s).

Prepare individual data packs for each experiment, or series of experiments, conducted by individual Principal Investigator(s).

Conduct post-flight engineering evaluation of ACPL performance and document.

Date: 1 April 1976

WBS No. 1.1.6.6

Level: 5

TRAINING

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes the necessary equipment documentation and services required to train the Principal Investigator(s) and Payload Specialist in the proper use of the ACPL.

WORK CONTENT

Establish the training requirements needed for the use of the ACPL.

Provide the necessary documentation and training aids to meet the established requirements.

Modify the basis training requirements as required to support specific experiment(s).

Conduct the training course(s).

WBS 1.1.7

GOVERNMENT FURNISHED SUPPORT

1.1.7.1 Spacelab Double Rack
1.1.7.2 Principal Investigator(s)
1.1.7.3 Facilities
1.1.7.4 Transportation
1.1.7.5 User Charge
1.1.7.6 IMS

Date: 1 April 1976

WBS No. 1.1.7

Level: 4

GOVERNMENT FURNISHED SUPPORT

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes all the effort, materials, facilities and services provided as required by the Government to support the prime contractor and Principal Investigator(s) to accomplish the ACPL project requirements for the first flight.

WORK CONTENT

Provide a standard Spacelab flight double rack to the prime contractor, including a Spacelab Remote Acquisition Unit (RAU) and Experiment Power Switching Panel. Contract for services and materials with Principal Investigator(s) for the first flight experiment(s).

Build, modify or provide facilities to support the ACPL project.

Provide Government bill of lading.

The free on board (FOB) will be at the contractor's plant and Principal Investigator's place of business for all hardware/software to be delivered to the Government.

Account for the User Charge of the Space Shuttle that is to be provided by the sponsor of the particular flight for the ACPL.

Provide the Institutional Management Support required for civil service and support contractor(s), if required.

Date: 1 April 1976

WBS No. 1.1.7.1

Level: 5

SPACELAB DOUBLE RACK

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes the effort, services and materials required to provide initially the standard double Spacelab rack, Remote Acquisition Unit and Experiment Power Switching Panel, and any subsequent modification kits to the prime contractor.

WORK CONTENT

Purchase the double Spacelab rack, Remote Acquisition Unit and Experiment Power Switching Panel and necessary documentation. Arrange for notification and purchase (if necessary) of any subsequent modification required to keep the Spacelab equipment in a flight configuration.

Provide the equipment, documentation and necessary modification kits to the prime contractor.

Date: 1 April 1976

WBS No. 1.1.7.2

Level: 5

PRINCIPAL INVESTIGATOR(S)

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

The contracted services of Principal Investigator(s) to provide experiments and results of experiments on the first flight of the ACPL on the Spacelab. It includes the coordination with the prime contractor, hardware, software, procedures, ground operations, mission operations, training and data analysis and reports for each experiment conducted on the first flight of the ACPL on the Spacelab.

WORK CONTENT

Negotiate, manage and maintain the necessary contract(s) with the Principal Investigator(s).

Distribute experiment(s) results to the cloud physics community.

Date: 1 April 1976

WBS No. 1.1.7.3

Level: 5

FACILITIES

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

The Government-owned or operated facilities required by the prime contractor and Principal Investigator(s) to meet the requirements of the ACPL project.

WORK CONTENT

Provide the facilities as required to the prime contractor and Principal Investigator(s).

Date: 1 April 1976

WBS No. 1.1.7.4

Level: 5

TRANSPORTATION

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

The funds and procedure by which deliverable hardware/software is shipped from the prime contractor and Principal Investigator(s) to the Government.

WORK CONTENT

Provide a Government bill of lading as required to ship deliverable hardware/software to the Government.

The Free on Board (FOB) shall be the prime contractor's plant and the Principal Investigator's place of business.

Date: 1 April 1976

WBS No. 1.1.7.5

Level: 5

USER CHARGE

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

The accounting of that portion of the Shuttle/Spacelab operation cost chargeable to the ACPL.

WORK CONTENT

Maintain the necessary records of what portion of the User Charge should be proportioned to each of the experiment(s) and Principal Investigator(s) that fly on the ACPL.

Date: 1 April 1976

WBS No. 1.1.7.6

Level: 5

INSTITUTIONAL MANAGEMENT SYSTEM (IMS)

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

The funding and accountability of the IMS charges required by the Government for the direct labor of civil service and support contractor(s) in support of the ACPL project.

WORK CONTENT

Budget, fund and account for the IMS charges applicable to the ACPL project.

Date: 1 April 1976

WBS No. 1.2

Level: 3

SUBSEQUENT FLIGHTS

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element contains all the Government and contractor effort, materials and services required to provide the advanced ACPL, its necessary support equipment and software, and to support integration and mission activities as necessary to accomplish project requirements for the second and subsequent flights on the Spacelab.

WORK CONTENT

Provide project management, system engineering and integration, advanced ACPL system design, development and fabrication, advanced GSE/STE design, development and fabrication, deliverable hardware/software and operational support.

The NASA will provide Government furnished support.

WBS 1.2.1
PROJECT MANAGEMENT
1.2.1.1 Project Direction
1.2.1.2 Project Planning and Control
1.2.1.3 Performance Management
1.2.1.4 Configuration Management
1.2.1.5 Data Management
1.2.1.6 Procurement Management
1.2.1.7 GFE Management

Date: 1 April 1976

WBS No. 1.2.1

Level: 4

PROJECT MANAGEMENT

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element combine overall effort to manage and administer the ACPL Project: planning, organizing, authorizing, scheduling, budgeting, performance and cost measurement and analysis, status reporting, providing early visibility of potential problems, and controlling required to accomplish project objectives for the second and subsequent flights.

WORK CONTENT

Provide project direction, schedule and cost control, and overall performance management and administration. Control configuration of hardware and software. Manage and control activities of subcontractors and suppliers. Control, operate, maintain, and account for Government property in your possession. Provide the primary interface with NASA and appropriate members of the science community.

WBS 1.2.2
SYSTEM ENGINEERING AND INTEGRATION
1.2.2.1 System Analysis & Integration
1.2.2.2 Mission Requirements & Analysis
1.2.2.3 Logistics Requirements
1.2.2.4 Safety, Reliability & Quality Assurance
1.2.2.5 Special Studies

WBS No. 1.2.2

Date: 1 April 1976

Level: 4

SYSTEM ENGINEERING AND INTEGRATION

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element incorporates all ACPL system level analyses, trade studies, and logistics activities, including performance of studies and analyses, development of requirements and definitions necessary to direct and control design of the advanced ACPL. This element also includes all program safety, reliability and quality assurance activities required on the advanced ACPL.

WORK CONTENT

Perform analyses, studies and evaluations to establish, design and system test requirements for the advanced ACPL.

Perform Spacelab/ACPL interface analyses. Maintain interface control documents.

Plan and conduct ACPL reviews.

Verify the ACPL meets functional requirements.

Define, implement, operate, and maintain an efficient flexible logistics activity for support of the ACPL and its associated GSE/STE throughout the second and subsequent flights.

Conduct safety, reliability and quality assurance activities to produce satisfactory hardware/software through systematic procedures, training analysis, review and assessment.

Perform special studies and analyses as directed by the NASA.

Provide sustaining engineering as directed by the NASA.

WBS 1.2.3

ADVANCED ACPL SYSTEM DESIGN AND DEVELOPMENT

1.2.3.1 Fluid Subsystem
1.2.3.2 Air Cleaning Subsystem
1.2.3.3 Aerosol Generator Subsystem
1.2.3.4 Aerosol Counter Subsystem
1.2.3.5 CFD Chamber Subsystem
1.2.3.6 Expansion Chamber Subsystem
1.2.3.7 SDL Chamber Subsystem
1.2.3.8 Thermal Control Subsystem
1.2.3.9 Control and Data Subsystem
1.2.3.10 Optical and Imaging Subsystem
1.2.3.11 Console Subsystem
1.2.3.12 Flight Software
1.2.3.13 Level IV Integration
1.2.3.14 System Testing
1.2.3.15 SDI Chamber Subsystem

Date: 1 April 1976

WBS No. 1.2.3

Level: 4

ADVANCED

ACPL SYSTEM DESIGN AND DEVELOPMENT

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element incorporates all directly related efforts associated with the design, development, development test hardware/software, development test, qualification test of advanced ACPL subsystems and necessary modifications to existing subsystems, flight software modifications, Level IV integration and system testing which satisfies ACPL requirements for the second and subsequent flights.

WORK CONTENT

Design, develop, provide parts and materials, fabricate development test hardware/software, integrate and test the advanced ACPL which includes all subsystems, flight software and the integration and installation of any Government Furnished Property (GFP).

NOTE: Qualification test hardware/software is provided under WBS 1.2.5.

WBS 1.2.4
ADVANCED GROUND SUPPORT EQUIPMENT AND SPECIAL TEST EQUIPMENT DESIGN AND DEVELOPMENT
1.2.4.1 Electrical
1.2.4.2 Mechanical
1.2.4.3 Ground Software

Date: 1 April 1976

WBS No. 1.2.4

Level: 4

ADVANCED GROUND SUPPORT EQUIPMENT (GSE) AND SPECIAL TEST EQUIPMENT (STE) DESIGN AND DEVELOPMENT

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes all directly related efforts associated with the design, development, development test hardware/software, development test and qualification test of the mechanical and electrical advanced GSE/STE and ground software required to support the ACPL for the second and subsequent flights.

WORK CONTENT

Design, develop, produce parts and materials, fabricate development test hardware/software and test the GSE/STE and ground software.

NOTE: Qualification test hardware/software is provided under WBS 1.2.5.

WBS 1.2.5
DELIVERABLE HARDWARE/SOFTWARE

1.2.5.1 Fluid Subsystem
1.2.5.2 Air Cleaning Subsystem
1.2.5.3 Aerosol Generator Subsystem
1.2.5.4 Aerosol Counter Subsystem
1.2.5.5 CFD Chamber Subsystem
1.2.5.6 E. Chamber Subsystem
1.2.5.7 SDL Chamber Subsystem
1.2.5.8 Thermal Control Subsystem
1.2.5.9 Control and Data Subsystem
1.2.5.10 Optical and Imaging Subsystem
1.2.5.11 Console Subsystem
1.2.5.12 Flight Software
1.2.5.13 GSE
1.2.5.14 Ground Software
1.2.5.15 Other Deliverable Hardware
1.2.5.16 Acceptance Testing
1.2.5.17 SDI Chamber Subsystem

Date: 1 April 1976

WBS No. 1.2.5

Level: 4

DELIVERABLE HARDWARE/SOFTWARE

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes the fabrication and delivery of the new and modified subsystems of the ACPL, modified flight and ground software, modified or new ground support equipment (GSE), special test equipment (STE) and other deliverable hardware such as spares, etc. This includes those items required for qualification test which will become the flight articles.

WORK CONTENT

Procure parts and materials and fabricate the new and modified ACPL, modified flight and ground software, GSE and other identified deliverable hardware.

Perform the acceptance test as required on each deliverable item.

Provide the delta cost to update the qualification units to prototype units by new subsystem and account for this separately under WBS 1.2.5.15.

WBS 1.2.6

OPERATIONAL SUPPORT

1.2.6.1 Experiment Integration and Assembly
1.2.6.2 Ground Operations
1.2.6.3 Mission Operations
1.2.6.4 Post Flight Operations
1.2.6.5 Data Processing
1.2.6.6 Training
1.2.6.7 Maintenance and Refurbishment

Date: 1 April 1976

WBS No. 1.2.6

Level: 4

OPERATIONAL SUPPORT

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes those equipment and services required to support the ACPL during operations for the second and subsequent flights.

WORK CONTENT

Provide necessary hardware, software documentation and services to integrate specific experiment(s) into the ACPL for flight.

Perform the services required to support the Level I, II, and III integration at the launch site. Provide the necessary support for mission operations. (T-4 hours to touch down plus 30 minutes.)

Conduct post flight operations and prepare ACPL for subsequent flights.

Reduce the data to engineering terms and develop negatives as required for specific experiments.

Establish and conduct necessary training required for both Principal Investigator(s) and/or Payload Specialist.

Perform the maintenance and refurbishment required to prepare the ACPL for the second and subsequent flights.

WBS 1.2.7

GOVERNMENT FURNISHED SUPPORT

1.2.7.1 Spacelab Racks
1.2.7.2 Principal Investigator(s)
1.2.7.3 Facilities
1.2.7.4 Transportation
1.2.7.5 User Charge
1.2.7.6 IMS

Date: 1 April 1976

WBS No. 1.2.7

Level: 4

GOVERNMENT FURNISHED SUPPORT

ATMOSPHERIC CLOUD PHYSICS LABORATORY

DEFINITION

This WBS element includes all the effort, materials, facilities and services provided as required by the Government to support the prime contractor and Principal Investigator(s) to accomplish the ACPL project requirements for the second and subsequent flights.

WORK CONTENT

Provide the ACPL and support equipment to the prime contractor.

Contract for services and materials with Principal Investigator(s) for the second and subsequent flight experiments.

Build, modify or provide facilities to support the ACPL project.

Provide Government bill of lading.

The Free on Board (FOB) will be at the contractors' place of business for all hardware/software to be delivered to the Government for each flight.

Account for the User Charge of the Space Shuttle that is to be provided by the sponsor of the particular flight for the ACPL.

Provide the Institutional Management Support required for civil service and support contractor(s), if required.