SD 73-SH-0067

SPACE SHUTTLE PROGRAM INFORMATION CONTROL AND RETRIEVAL SYSTEM

FEASIBILITY STUDY REPORT

November 1973

Prepared by:

C. P. Lingle

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TECHNICAL REPORT INDEX/ABSTRACT

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Space Shuttle Program Information Control & Retrieval System Feasibility Study Report

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PICRS, Common Data Base Study

ABSTRACT

A joint NASA/SD study, conducted to determine the feasibility of having a common information management network for Space Shuttle Program data, is reported. The study identified information types required, sources and users of the information, and existing techniques for acquiring, storing and retrieving the data. The study concluded a decentralized system is feasible, and described a recommended development plan for it.

CONTENTS

ILLUSTRATIONS

TABLES

GLOSSARY

ATS	Administrative Terminal System
BARS	Baseline Accounting and Reporting System
COMAT	Characteristics of Materials
CSR	Contract Status Reports
CTS	Change Tracking System
CVAS	Configuration Verification Accounting System
DDS	Document Distribution System
DELOG	Design Engineering Logistics
EDCC	Engineering Drawing Control Center
EDIV	Engineering Design Intent Verification
EODRS	Earth Observation Data Retrieval System
ERS	Engineering Release System
FMEA	Failure Modes Effects Analysis
IMAS-A	Institutional Management Accounting System
LIMS	Logistics Inventory Management System
LPS	Launch Processing System
MATCO	Material Control
MIS	Management Information System
NRS	Nonconformance Reporting System
OPL	Open Problem List
PACE	Product Acceptance Configuration Elements
PACO	Parts Control
PICRS	Program Information Control and Retrieval System
PMATS	Program Management and Tracking System
QUIC	Quality Information Control
RECP	Requested Engineering Change Proposals
RFI	Remote File Inquiry
RTS	Real Time Supply
SIMAS	Shuttle Information Management Accountability System
SIRS	Saturn Information Reporting System
SRA	Support Requirements Analysis
TOTAL	Total Data Base Management System
TRIS	Test and Reliability Information System
UCAR & IDAR	Unsatisfactory Condition Report & Initiated Corrective Action Report
VIS	Verification Information System

1.0 BACKGROUND

The Space Shuttle Program, with its multiple reflights, 2-week turnaround and variety of missions, will need a far more responsive data management system than those used on past programs which were oriented to the one vehicle/one mission concept. This change in program character is expected to result in a substantial increase in the quantity of data developed as well as a demand for improved accessibility and faster response time. An advanced information handling capability is required to meet these new requirements. New data handling requirements have already been recognized by several program functions and some positive progress is being made toward developing the necessary capability (i.e., VMMPS and LPS). Activities of this nature are viewed as necessary and important to the development of the total capability necessary to meet the established Space Shuttle Program objective. However, there is an inherent danger in allowing such data systems to be developed totally independent of each other and without coordination to assure that the efforts are compatible. Positive action is necessary to assure that this compatibility is addressed, that unnecessary redundancy is avoided, and that a technique is developed to assure that information users can extract information from a common data base that is current, complete and accurate.

2.0 PURPOSE

The purpose of this study was to investigate the feasibility of assuring that all pertinent program data (management and technical) is identified, controlled and retrievable at any time during the program (design, development and operations.) The intent was to accomplish this objective using existing or planned manual, automated and hybrid systems, rather than developing an entirely new "super" computer program, and identified data that should be included in the common data base, whether the data is appropriate for automation, and how that data is treated in current or planned systems. Data sources used in the study were JSC, KSC and Rockwell SD. The end result is an overview of the requirements, the activities underway, the ultimate capability considered necessary and, finally, an approach that is capable of achieving the desired results in an efficient manner.

3.0 SCOPE

This study encompassed definition of the scope, objectives, development approach, inputs, outputs, data requirements and data flow associated with the system. The study provided a definition of requirements, a recommended implementation plan, and an assessment of any costs associated with implementing the system. The effort was conducted under the guidance of a NASA Working Group chaired by the Space Shuttle Program Office, and made up of representatives from key program organizations.

4.0 CONCLUSIONS

Information requirements identified during the study are inherent in the Space Shuttle Program independent of whether Program Information Control and Retrieval System (PICRS) is adopted as the information management method. There are, however, significant advantages from a PICRS-type system in the areas of cost, flexibility and response. Cost of information management can be minimized by reduced independent duplication of systems, reduced manual interface activity and inherent correlation of data from different sources. The centrally controlled, modular approach facilitates adding and deleting of interface points, and adding or deleting modules with a minimum of necessary coordination. System response is enhanced by having a standard, established retrieval process with unique contact points. The built-in synchronization of data eliminates a large analytical effort that has, historically, been required.

The information requirements identified for the Space Shuttle Program demonstrate that significant innovations are required in the areas of information acquisition, control and communication. This should be accomplished by a program-wide PICRS organization, headed by a PICRS Administrator, representing the Program Manager. The PICRS Administrator should coordinate activities and delegate responsibilities to program participants as necessary to implement the objectives of an efficient and effective PICRS. There is an abundance of existing manual, and automated information handling systems that can be employed. It will be the function of the PICRS Administrator to select for implementation those that most adequately meet the needs of the program and can be expanded to accommodate the total program load. He will also allocate to each NASA Center the development and implementation responsibilities, as appropriate. Information handling systems, thus selected, should interface with a communication network that must provide the capability of accepting an information request, directing that request to the authoritative storage location, and return that information to the requestor. This communication network is a major, new capability that is not currently available, but which is a key factor to the implementation of a low cost IMS proposed by this study. In order to demonstrate the practicability of this approach, a limited effort should be initiated to implement a communication network and two information handling systems (modules) prior to full IMS implementation.

4.1 SUMMARY OF FINDINGS

Types of information which are or will be required by the Space Shuttle Program were identified by a requirements survey. Originators of the information and its users were identified for each information type. There will be multiple users retrieving information in most of the categories.

Differentiation among information types, expected storage volume requirements and retrieval requirements identified during the study demonstrate that systematic acquisition, storage, retrieval and control of the data will be essential. Implementation of the data processing task will vary between manual, computerized or a combination of the two as a function of storage volume and system response of the individual information types. In all cases involving manual data origination, data validation requirements necessitate controlled manual processes leading to system input. Development of uniform interface controls will permit allocation of development responsibility among the participants on a modular basis. In many cases, systems are in use locally that can be incorporated for joint use and operated by the originator of the module. Procedures must be instituted for each module based on the uniform interface controls.

Because there are substantial differences in response requirements, data content, data processing methods and Space Shuttle Program priorities among the information types, development and implementation should be performed on a module basis. Each module should be treated as a subsystem and integrated through controlled, subsystem interfaces within an overall system network. Information types identified by this study and the interrelationships among them define the network such that data used in conjunction reside together - a consideration influencing system operating economy. The survey of existing systems substantiates that this approach has proven to be functionally viable as well as cost effective. The system structure should be further defined as the initial step of system development. Concurrently, well defined, high-priority modules should be developed and implemented to confirm the selected approach. The remaining modules may then be developed and implemented independently within the network as required to support Space Shuttle Program priorities.

Historically, information management systems developed with the active assistance of primary users achieve earlier acceptance and greater effectiveness than those developed by an isolated specialist group. To that end, this study was performed by a working group consisting of JSC, MSFC, KSC and Rockwell/SD members. Further development of the system should include other element contractors, test centers and operational agencies as they are identified or selected to assure that neither critical requirements nor available capabilities are overlooked.

Systems already exist, or are being developed, on a local basis to acquire, store and retrieve data of most of the information types identified during the study. In many of the categories, multiple systems are available. The candidate systems for selected modules are identified in Table 1. Some adaptation of selected systems will be required in even the most applicable cases. Input edits, output formats and (in the case of computerized systems) equipment differences must be accommodated. Computerized systems, typically, are customized for the home data processing facility. Conversion for a different facility can involve substantial effort and, frequently, alteration of system performance. To achieve maximum available economies,

Table 1. Summary of PICRS Structure and Implementation Candidates

PICRS MODULE	INFORMATION TYPE *	SYSTEM CANDIDATES
Program Planning & Control Sched.	A-2	Commodity Source List, ATS, MIS, Monitor, PMATS, PR/397, SIRS, VIS.
Cost	A-3	Annual Procurement System, Basic Accounting, Costing Data Base, CSD Budgetary Control, CSR, IMAS-A, Labor Distribution, Medical Operations Survey, Monitor, Manpower Reporting System, RFI, R&D Appropriation Budget Estimate, Work Package Data Base.
Problem Status	A-4, A-10	Apollo Failure Data, ATS, MIS, NRS, OPL, Problem Data System, RFI, SIRS, VIS, UCR & ICAR.
Information Accession	A-8, F-3B	Books Control, Earth Resources, EODRS, Journals Control, ATS, SIMAS, TRIS.
Design Documentation	E-3, F-4C	DDS, EDCC, Engineering Standards, ERS, ATS.
Key Items Control	E-4, E-5, E-6, H-1, H-3	PACO, VIS, Commonality Information, Certification Records and Status, FMEA, ATS, SIRS.
Material Usage Control	E-7	Apollo Parts and Material System, COMAT, JSC Bonded Storage System, NRS, MATCO, Material Test Data, VIS.
Residual Hazards	H-2	Hazards/Residual Hazards Tracking System.
Measurements & Stimuli	E-9	Measurements/Stimuli List, RFI.
Instrument Calibrations	H-4	Calibration Program, KSC Calibration Recall System, Laboratory Equipment Information System.
Support Requirements & Planning	F-2, R-2, R-8	SRA, VMMPS, ATS, VIS, LPS.
Logistics Data	F-4A	Bendix-Peculiar Spares, DE Log, Federal Catalogue, LIMS, Logistic System, MSC Supply Catalogue, RTS.
Configuration Management	B-1, B-2, B-3	BARS, ATS, CTS, EDIV, MIS, RECP, RFI, TOTAL.
Quality Information	B-7, B-8, B-9, F-1, R-7	CVAS, NRS, ATS, PACE, QUIC, RFI, NRS, TOTAL, MIS, RTS.

* Reference Section 5.1 for discussion of information types.

selected existing systems should continue in operation by their respective originators. They can be integrated by a common communications network with controlled interfaces.

4.2 SUMMARY OF RECOMMENDATIONS

The following recommendations are made based on findings of the study.

A. PICRS should be developed for the integration, management and operation of manual and computerized information handling modules to provide a capability necessary to sucessful accomplishment of the Space Shuttle Program objectives.

B. PICRS should be developed on a modular basis under the control of the PICRS Administrator. During the initial phase, the communications network should be designed and two high priority modules should be developed and implemented to verify the anticipated cost and technical effectiveness of the selected PICRS approach. Modules well suited to this initial development are the Accessioning List and the Levels II and III Configuration Baseline Accounting module.

C. To the extent that information storage and retrieval are performed using electronic data processing (EDP) equipment, available facilities should be utilized and interconnected by the communications network.

D. Computer software currently available or being developed independent of PICRS, which will perform the required storage/retrieval of a module, should be utilized and should be operated by its originator for the benefit of the system.

E. The communications network should be of the "dialup" type for increased flexibility and economy.

F. Special routines should be developed as required to accommodate differences of computing equipment and record format at both the input (preprocessor) and output (postprocessor) interfaces with the communications network. The compatibility with PICRS network standards and the need for additional preprocessors and postprocessors should be given consideration when selecting any new EDP equipment which may interface with the system.

G. Information which is controlled manually should be identified in the Information Accession module to facilitate its retrieval when

required. Manual systems currently available, which will perform the required storage/retrieval, should be utilized.

H. Information requirements identified by this study, but not already imposed on centers and contractors, should be imposed after verification of the requirement.

I. A PICRS administration organization should be instituted, headed by an Administrator in Space Shuttle Program Office. The PICRS Administrator should direct and control development of PICRS modules and operation of PICRS upon implementation. The administrative organization should consist of designed PICRS coordinators at the several system locations who, working through the local information systems staff, communicates between the PICRS Administrator and the local computing services, information management services and management systems functions. The organizational structure and functions of PICRS administration are illustrated in Figure 1.

The information-types analysis shows that some information types should be automated to adequately support program requirements. The decision to automate is based on several considerations such as:

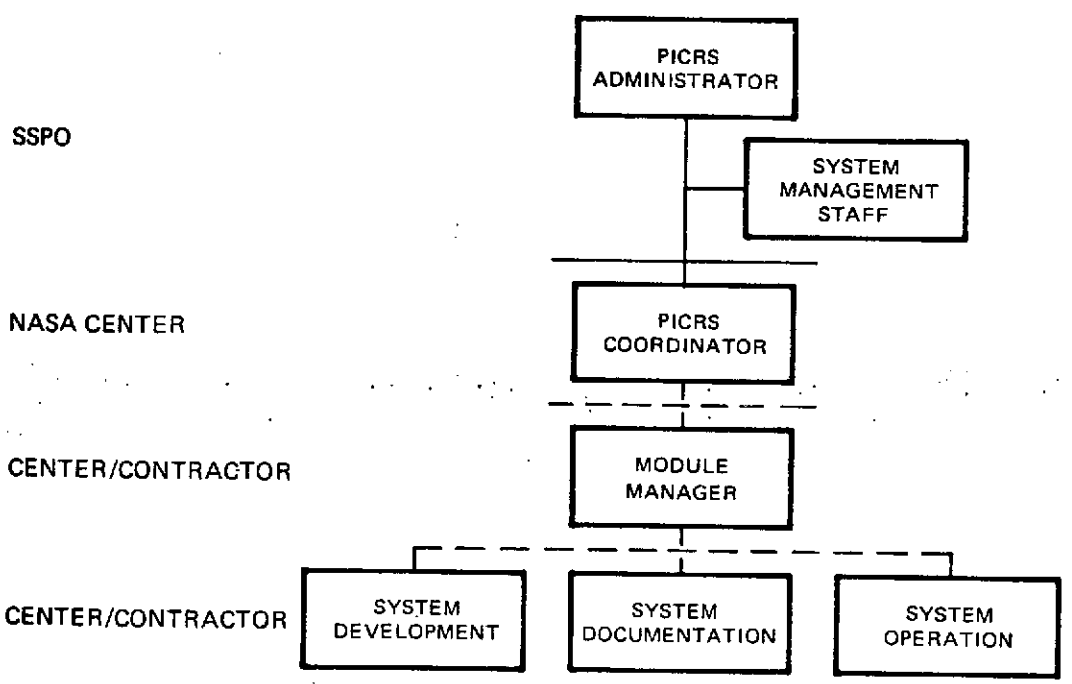

Figure 1. PICRS Organization and Functions

A. Volume of data to be handled.

B. Communications requirements (accuracy and timeliness).

C. Interface with automated systems.

D. Computation requirements.

Some of the data types appeared to be very desirable for automated processing, but not essential in that the manual systems employed are adequate. In themselves, these systems should not be automated, primarily because of the cost consideration. However, consideration should be given to including these data types with others that are to be automated when this can be accomplished with little or no additional cost to the program.

Those data types that are not recommended for automation are those from which no functional or cost advantage can be expected, and which have manual systems in being which are considered completely adequate.

In order to demonstrate the technique to be followed in implementing PICRS development activities, the following examples are provided.

Example #1. Level II and III Configuration Baseline Accounting - In view of the size of the Space Shuttle Program, the number of program participants involved, and the volume of changes expected to be processed against the various program/project baselines, it has been determined that the baseline accounting system should be automated. This seems to be a logical approach in view of the requirement to provide all program participants with an accurate description of the baseline, and changes in process, in order to permit their activities to be planned and executed in consonance with the current program objectives. There are several automated systems to choose from that will probably satisfy this requirement. If PICRS were operational, the task of selecting the optimum system would probably have been assigned to the Configuration Management Working Group (CMWG). As it is, the CMWG has recognized the requirement and is working on the problem. The selection criteria, in this case, should be based on several considerations such as:

1. Is the system proven?
2. Must it be modified to satisfy Space Shuttle requirements?
3. Is it responsive to user requirements?
4. Is it compatible with other planned information systems with which it may be required to interface in the future?
5. Is it cost effective?

Example #1 (Cont)

Upon the selection of the optimum system, it should be the responsibility of the data base administrator to allocate the development and/or implementation function to the appropriate program participant. This allocation could be to the CMWG or to the program participant having the selected system. The system should then be developed (as necessary), coordinated, and implemented within the guidelines established by the data base administrator.

Example #2. Information Accessioning - In view of the number of program participants and the quantity of documents, trade studies, program decisions, and etc. produced by each, it has been determined necessary to provide a visibility technique whereby each participant can have knowledge of existing data. For example, before a sizeable trade study is initiated, a search should be performed for existing data developed by other program participants which may negate the requirement for the study, or it may form a basis from which the study may commence thereby reducing the effort required. Further, this capability is necessary to enhance program capabilities to research problems, reconstruct program history, and support other requirements for data as necessary.

The technique for providing this visibility with the minimum flow of documentation is accessioning, and an automated capability is necessary because of the volume of data and the requirement to perform a variety of searches. There are several automated systems which could possibly satisfy this requirement. Since this is a primary information handling system and essentially involves all program documents, it should be investigated by the PICR Working Group. The requirements for the system should be established and the candidate systems should be evaluated. A system selection should be made based on much the same criteria as shown for the preceding Example #1. Upon system selection, the PICRS Administrator should allocate the development/implementation responsibility within specific guidelines which will make it compatible with the overall PICRS.

4.3 IMPLEMENTATION PLAN

Development of PICRS should proceed in two serial phases.

During Phase 1, the communications network should be designed in detail. Uniform interface controls should be specified to stabilize the network side of preprocessors and postprocessors developed as modules are implemented. Two of the modules identified by this study (Levels II and III Configuration Information, Information Accessioning) should be developed to implementation in order to demonstrate the feasibility concluded

by the study and to validate design of the communications network and its interface provisions. The Configuration Management module should be assigned to the Configuration Management Working Group which is already charged with making the appropriate determinations. The Information Accessioning module should be assigned to JSC where the task is currently being performed for local use. The communications network should be developed under direct control of the PICRS Working Group. Because interface controls will be defined during Phase 1, close coordination among the module teams (including the communications network team) will be essential. Phase 1 will require approximately six months to complete.

Following completion of Phase 1, the system should be demonstrated to the Space Shuttle Program Manager for his evaluation and decision to proceed with total implementation.

During Phase 2, the remaining modules can be implemented in any sequence required by the priorities of the Space Shuttle Program. Table 2 summarizes the priorities as they are currently seen. The PICRS Administrator should allocate the modules for implementation after study of the candidate systems. Interface provisions should be formally specified for the direction of module implementation assignees. Module need dates shown in Table 2 indicate that module implementation can be phased with the latest identified need occurring in early 1978. Figure 2 summarizes the implementation schedule derived from Table 2 need dates.

As Phase 2 proceeds, new information requirements may be identified. The new requirements should be analyzed to the same degree as employed for the recognized information types, and they may be satisfied by incorporation into an existing module or by instituting a new module. The flexibility inherent in the PICRS design permits additon of modules without impact on the system itself. New modules are subject to the same interface controls and constraints as are the existing modules.

As the initial step toward implementation, detailed requirements for each module should be documented and the most cost effective technique selected between manual and automated processing.

Beginning at the onset of Phase 2, control of PICRS should be vested in the PICRS Administrator. Operating through the structure described in Section 4.2, the Administrator should allocate module responsibility, evaluate the selected implementation technique (manual, computerized, etc.), and otherwise control Phase 2 implementation. During Phase 2, the PICRS Administrator should be the primary interface with the PICRS Working Group and the Space Shuttle Program Manager as required.

Table 2. Data Types Analysis Summary

Description of Chart Codes

A - Automated. This column is used to denote which data types should be automated in order to properly support Space Shuttle Program requests.

Y = Yes; these data should be automated.

D = Desirable; these data should be automated only if it is compatible with, and can be worked in conjunction with, other automated data types (Cat. Y) wherein a very minor cost impact is realized.

N = No; should not be automated. No potential benefit has been identified which would justify the cost of automating.

N - Need. This column is used to denote the estimated first requirement for data which is to be automated. These dates are preliminary estimates of the need for automated operation. Adjustments may be made based on the capability of existing manual systems to handle the data requirements.

E4 & L3 = Early 1974 and late 1973. This is the date automated products for the identified data types are required.

P - Priority. This column shows the priority to be assigned for automated system development and/or activation. Priorities are assigned based primarily on need dates.

	Automated	Need	Priority
A. Management Data			
1. Logic	D		
2. Schedules and status	D		
3. Cost per flight data	Y	E4	1
4. Problem status	Y	E4	
5. Alerts	N		
8. Accessioning	Y	L3	1
10. Action item status	D		
B. Configuration Management Data			
1. Level II Acctg	Y	L3	1
2. Level III Acctg	Y	L3	1
3. Chg ident and status	Y	L3	1
7. Traceability	Y	L3	1
8. ADP	D		
9. Verification	D		

Table 2. (Cont'd.)

	Automated	Need	Priority
C. Test and Checkout			
4. Integ test requirements and data	D		
5. Element test requirements and data	D		
6. Horiz flt test requirements and data	D		
7. Vert flt test requirements and data	D		
E. Tech Integration Data			
3. Dwgs and specs	Y	L4	2
4. SAID	Y	L4	2
5. Where used list	Y	E5	3
6. Commonality	D		
7. Matl's Usage contl	D		
9. Measurements and Stimuli	Y	L5	3
10. Mass Properties	Y	L3	1
11. Vehicle dynamics	D		
F. Facilities, Maintenance and Logistics			
1. Station set rqmts and data	N		
2. Alt indy site requirements	N		
3. Maint data	D		
3B. Manuals	N		
3C. Inter & depot maint rqmt and data	D		
4. Logistics data	Y	L5	3
4A. Spares rqmts, status & data	Y	L5	3
4B. Consumables rqmts & data	Y	L5	3
4C. Trans, storage & handling	D		
H. Operational Hardware Data			
1. Certification status	Y	L4	2
2. Resid hazards	D		
3. Critical items list	Y	L4	2
4. Instr calibrations	Y	M5	

Table 2. (Cont'd.)

		Automated	Need	Priority
M.	Mission Planning and Control Data			
	1. Flt ops capability & pro data	Y	L4	2
	4. Ref. trajectory	Y	L6	
	5. Mission rules (launch and recovery)	D		
	6. Mission rules (flight)	D		
	8. Mission data book	Y	E6	4
	11. Flight plan	Y	L6	
	12. Abort rqmts and data	D		
	14. Meteorological data	D		
	15. Tracking comm rqmts	Y	L6	
	16. Oper data book	Y	L4	2
R.	Turnaround Data			
	1. Ferry rqmts and data	D		
	2. Turnaround & processing flows	D		
	7. Limited life items	Y	L6	4
	8. Turnaround rqmts & data	Y	E8	4
T.	Training Data			
	2. Job certification	D		
	3. Certified personnel	D		
	4. Tng course outlines	N		
	5. Tng sched's	D		
	6. Tng facilities	D		
G.	Software Data	D		
P.	Payload Data	Y	E4	1
S.	Simulator Data	D		

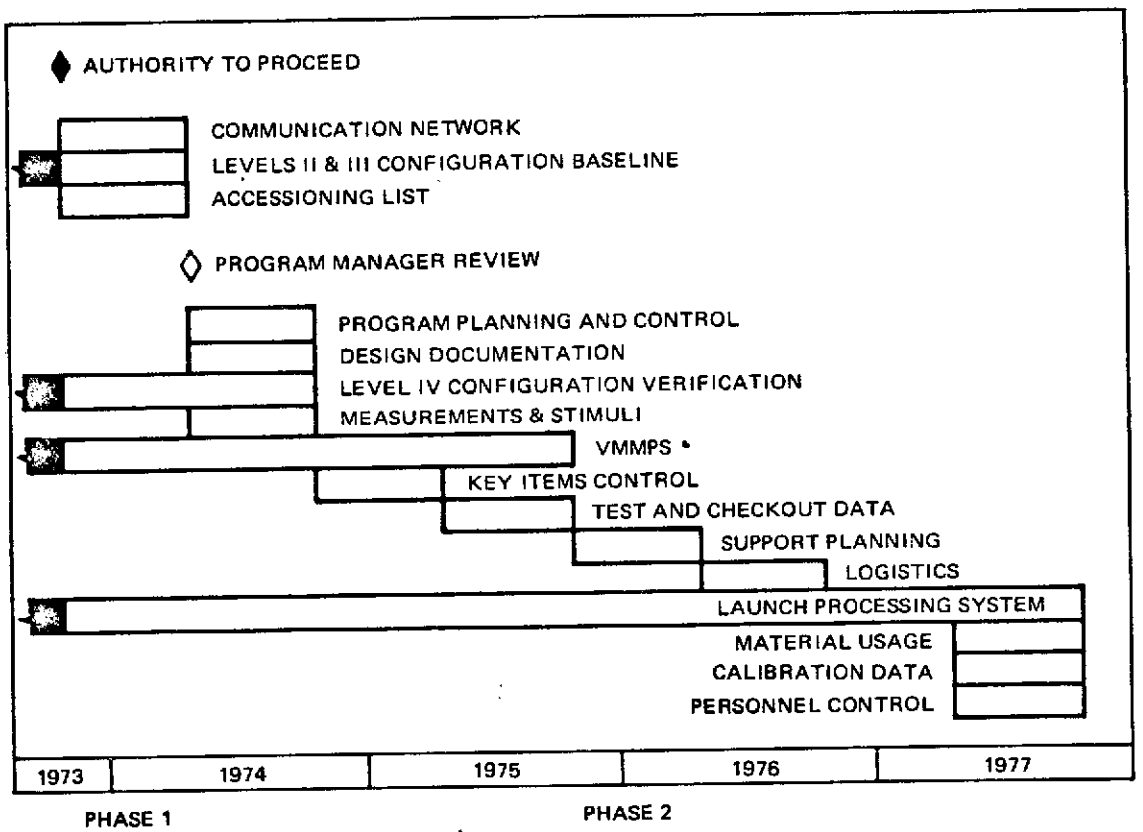

Figure 2. PICRS Implementation Plan

5.0 STUDY METHODOLOGY

The study was performed by a special working group chaired by the Space Shuttle Program Office (SSPO) and made up of NASA and contractor representatives from key program organizations. The working group was supported by functional specialists working on a task team basis at JSC, KSC and Rockwell/Space Division.

5.1 IDENTIFICATION OF INFORMATION REQUIREMENTS

A questionnaire was prepared and distributed to key personnel at JSC, KSC, MSFC and Rockwell/SD in order to identify types of information that must be accommodated by PICRS. The questionnaire shown in Table 3 provided for identifying information requirements including the source, purpose, frequency, and ultimate users. In additon, similar information required in prior programs was described in terms of format, transmission method, and degree of acceptability for Shuttle. Approximately five hundred responses were received and analyzed. The responses were grouped according to similarity of the requirements. The information subdivisions are shown together with their anticipated information originators and users in the matrix chart of Appendix A. A summary description of each subdivision follows. The subdivisions were coded to facilitate reference during the study and the codes have been retained. The alphabetic characters were mnemonically selected and are discontinuous. Numerical characters were sequential, initially, but category deletions during the study introduced discontinuities.

A. Common Management Data consist of the types of information needed to plan and control the Space Shuttle Program. Typically, the Management Information Center displays (schedule, status, progress, outlook, etc.) are derived from this subdivision. Categories of information included are:

A-1. Program Summary Logic - Key program events and activities interrelated in a logical network.

A-2. Management Data, Schedules & Status - Schedule and resource status, and technical assessment data of the Space Shuttle Program and the several element projects.

A-3. Cost Per Flight and Other Cost Data - Costs and estimates at a level of detail required to ascertain the cost per flight and to support senior-level management of the Space Shuttle Program.

Table 3. Shuttle Program Input Data Requirement

I. User Identification

A. Center or Contractor (JSC, KSC, MSFC, RI, etc.)_____

B. Organizational Element (Dir/Div/Br/Sect, etc.)_____

C. Responsible NASA organization if A is a contractor._____

D. Individual responsible for requirement (Name/Mail Code/Ext)_____

_____

II. Data Requirement Identification

A. Project-(Circle) Orbiter - Main Engine - ABE - External Tank - SRB - Payloads - All.

B. Shuttle Program Function-(Circle) Program Management - Institutional Mgmt - Systems Engineering - Engineering Design - Subsystem Management - Ground Operations - Mission Operations - Crew Operations - Logistics - SR&QA - Payload Accommodation - Software Systems - Other (Define)_____

_____

C. Requirement is associated with WBS #_____of Contract_____

D. Data Requirement Description:_____

_____

_____

_____

_____

E. Has this data been categorized Type 1, Type 2 or Type 3?_____

F. What is the security/proprietary classification of the data?_____

III. Data Source

A. Who will generate the data? (Org/Name/Mail Code)_____

_____

B. Who will validate the data, if different than A? (Org/Name/Mail Code)

_____

C. Who will distribute the data, if different than A and/or B?_____

_____

IV. Data Application and Mode of Transmission

A. Was this type data required on past program(s)?

(Circle) Mercury - Gemini - Apollo - Skylab - None

B. In what form was the data received?

(Circle) Document/Book - Letter - Tape - Card Deck - Computer Printout - Microform - Drawing - Verbal - Other _____

If received in document/book form, notate title and/or description (i.e., ICD, ODB, MRD, etc.) _____

C. In what format was the data provided?

(Circle) Text - Graphic - Tabular - Other _____

D. If the data was required on previous programs, will the same mode (data form and format) satisfy Shuttle Requirements? _____

If not, what is the problem with the previous mode? _____

Mode Preferred for Shuttle: _____

E. If this data was not required on previous programs, describe the mode (data form and format) preferred for the Shuttle program. _____

V. Timing

A. Is this data requirement milestone related? If so, indicate requirement for initial data input on chart by marking minus or plus months in relationship to the milestone (i.e., CDR - 2 mos.):

	DEVELOPMENT & TEST					
PROGRAM	SRR	PDR	CDR	FDF		FVF
PROJECT	PRR	PDR	CDR	HFT	FRF	VFT

B. Is this data requirement operations related? If so, indicate requirement for initial data input on chart by marking minus or plus weeks/months in relationship to the milestone (i.e., SS1 Launch - 2 weeks):

FLIGHT	OPERATIONS				
	SS1	SS2	SS3	SS4	ALL

C. Is this data requirement calendar oriented? If so, indicate on the table below by marking an "X" at the appropriate time(s) of the month it is required?

TYPICAL WORK MONT:	1st	5th	10th	15th	20th	25th	30th

VI. Frequency

A. On what basis is this data required after initial receipt?

One time use? Explain _____

_____

Periodic? Weekly - Monthly - Other _____

_____

Continuous? Explain _____

_____

_____

_____

B. Is this input data to be used for 1 day - 1 week - 1 month - Other _____

_____

Is permanent retention required? _____

VII. Data Management

A. Briefly describe the work activity in which this data will be used. _____

_____

_____

B. After receipt, what system/mechanism is used for management of the data in this activity? Describe briefly. _____

_____

_____

_____

Is the system manul?	Or is it automated?
Correspondence File	On-Line (Remote Access)
Document Library	Batch Processing
Microform Storage	
Other: _____	Other: _____

If automated, notate hardware system and location. _____

_____

C. Does/will the present system satisfy the Shuttle requirements? _____

If not, what is preferred and why? (i.e., response time, data volume, input and output, etc.) Also include need date. _____

_____

_____

D. Is there a different system in the conceptual or developmental stage for management of Shuttle data? If so, provide description. _____

_____

_____

VIII. Justification

A. Is the data mandatory, highly desirable or desirable? (Circle One)

B. Give a brief justification if one of the following conditions is pertinent to this data requirement:

- Was not required on a previous program or project.
- Requires increased level of automation.
- Requires increased frequency of data receipt.
- Requires increased period of data retention.

_____

_____

_____

IX. Output

What is the output/product of this activity? _____

_____

_____

Who is the primary user of this output? _____

_____

A-4. Hardware Problem Status - Current status of problems that could affect safety, contribute to delay of a scheduled event or result in a design change. Information applies to open or recently closed problems only.

A-5. Quality/Safety/Reliability Alerts - A special identification of problems or special events having broad, immediate significance and requiring urgent action.

A-8. Document Accession List - A cumulative index of element and integration contractor generated documentation.

A-10. Program Review Data, Action & Status - Information necessary for planning, scheduling and presenting major program reviews, and for recording and tracking actions resulting from the reviews.

B. Configuration Management Data consist of the requirements baseline, changes and compliance information. Categories of information included are:

B-1. Program (Level 2) Requirements Identification and Status - The system level requirements baseline.

B-2. Project (Level 3) Requirements Identification and Status - The elements project level requirements baseline.

B-3. Change Identification and Status - Changes to Level 2 and Level 3 baselines that have not yet been incorporated into the baseline itself.

B-7. Traceability Data - Specific traceability of critical components of hardware and software and the incorporation of requirements.

B-8. Acceptance Data Pack - Various elements of information historically included as part of the acceptance data pack, but which comprise a continuing stream of information rather than having specific relevance to acceptance of an end item. Included are approved waivers and deviations, material review dispositions, technical photographs, various historical logs, etc.

B-9. Configuration Verification - Information that relates details of requirements, design and physical configuration, and

verifies their mutual compatibility or identifies their specific variances.

C. Test & Checkout Data consist of test requirements, procedures and results applicable at various points in the history of an end item and/or integrated Space Shuttle vehicle. Categories of information included are:

C-4. Integrated Test Requirements & Data - Data pertinent to ground test of the integrated vehicle.

C-5. Element Test Requirements & Data - Data pertinent to ground test of an element.

C-6. Horizontal Flight Test Requirements & Data - Data pertinent to ground checkout and flight test in the horizontal flight test program.

C-7. Vertical Flight Test Requirements and Data - Data pertinent to ground checkout and flight test in the vertical flight test program.

E. Technical Integration Data consist of specific engineering information relevant to integration of the Space Shuttle system, but not already included in another subdivision. Categories of information included are:

E-1. Performance Capabilities and Limitations - Subsystem performance parameters.

E-3. Drawings & Specifications - The documents themselves, their release status, change status and interrelationships.

E-4. SAID/SALUD/Non-Approved Items - A list of critical items indexed to differentiate among items approved for use (SAID), approved for limited use (SALUD) and those not yet approved.

E-5. Where Used List - The design applications of designated classes of items used in the Space Shuttle Program.

E-6. Commonality List - Hardware, materials, services, facilities and procedures designated by Space Shuttle Program Office as common throughout the Space Shuttle Program.

E-7. Material Usage Control - The design applications of materials having specific, pre-designated characteristics such as flammability, toxicity, hydrogen embrittlement susceptibility, etc.

E-9. Measurements & Stimuli - A master list of instrumented locations which identifies system, measurement type, usage period, signal format and sensor location.

E-10. Mass Properties - Weight and c.g. locations of elements, subsystems, consumables, crew, payloads and transferable items. Timelines of c.g. locations are included as applicable.

E-11. Vehicle Dynamics - Inertia, damping and stiffness matrices defines in terms of launch, staging, flight and re-entry.

F. Facilities, Maintenance & Logistics Data consist of the facility configuration, off-line maintenance and basic logistical support information. Categories of information included are:

F-1. Station Set Requirements & Data - The facility & GSE station set at each primary location.

F-2. Alternate Landing Site Requirements - The resources required at each of the designated alternate landing sites.

F-3. Maintenance Manuals - The information necessary to perform Level II and III maintenance on any item of equipment or its components.

Intermediate and Depot Maintenance Requirements and Data - Minimum off-line maintenance requirements including identification of Lowest Repairable Units (LRU's), frequency of repair/retest, level at which the LRU will be repaired, location at which the LRU will be repaired.

F-4. Logistics Data - The basic spares inventory management information and forecast of consumables and other logistics information. Identification of equipment, procedures, tests, etc., associated with ground transport or prolonged storage of flight vehicles and GSE.

H. Operational Hardware Data consist of details relevant to operational hardware (as opposed to special test or manufacturing equipment). Categories of information included are:

H-1. Shuttle Certification Status - Requirements and status of Space Shuttle element certification, subsequent variance from certified configuration and status of recertification.

H-2. Residual Hazards Data - Unresolved hazards, status of resolution and relevant effects of a failure.

H-3. Critical Items List - Identity of hardware having criticality 1 and 2 single failure points, and selected criticality 3 components.

H-4. Instrument Calibrations - Recorded calibrations of instruments/instrument systems.

H-7. Quality Acceptance Standards - Standards of workmanship required as a minimum for acceptance of the work by an inspection agency.

M. Mission Planning & Control Data consist of information specifically oriented toward vertical flight missions. Categories of information included are:

M-1. Flight Operations Capabilities & Procedures Data - Limitations, constraints and operating procedures for each subsystem during ascent and flight.

M-4. Reference (Operational) Trajectory - The baseline trajectory for operational flights.

M-5. Launch & Recovery Mission Rules - Minimum equipment, redline values, mandatory/desirable characteristics.

M-6. Flight Mission Rules - Redline values and subsystem timelines.

M-8. Mission Data Book - Specific values of basic mission elements such as orbital altitude & inclination, OMS/RCS ΔV, payload, etc.

M-11. Detail Flight Plan - System and subsystem detail timelines for each specific flight.

M-12. Abort Requirements & Data - Reference trajectory, entry interface, tank descent data, etc. for an operational abort during launch and from orbit.

M-14. Meteorological Data - Atmospheric and wind data for launch, entry and abort locations.

M-15. Tracking & Communications Requirements - Vehicle tracking and communications, payload communications, tracking and communications network requirements.

M-16. Operational Data Book - Parametric data which describes operational conditions of the system and its subsystems.

O. Simulation Data consist of information required for simulation activities which reflects current Shuttle configuration and capabilities. Some specific examples of simulators are the horizontal flight test simulator, Shuttle Mission simulator and Space Avionics Integration Laboratory (SAIL). Categories of information are formally undefined beyond the general content.

P. Payload Data consist of physical and environmental interface definition, mission service and performance provisions, payload design, characteristics and operational plans. Categories of information are formally undefined beyond the general content.

R. Turnaround Data consists of information which defines technical and schedule requirements, planning and tracking of the turnaround of a vehicle/element between flights. Categories of information included are:

R-1. Orbiter Ferry Requirements & Data - Modifications, rework and refurbishment of the Orbiter in preparation for ferry flight and special remote site requirements to accommodate the Orbiter.

R-2. Turnaround & Processing Flows - Planning of the detailed activities which must be accommodated between flights. This data includes the incremental requirements for consumables, personnel by skill category, elapsed time and associated constraints.

R-7. Limited Life Items - Identification and histories of items that have limited shelf life, operating time and/or operating cycles.

R-8. Turnaround Requirements & Data - Specification of activities (including retest) that must be completed prior to reflight and evidence of specific compliance.

S. Software Data consist of information concerning on-board software, software used to perform automatic checkout of a vehicle, and software for technical and management systems. Categories of information are undefined.

T. Training Data consist of information which defines training requirements and opportunities, and the availability of suitably trained personnel. Categories of information included are:

T-2. Job Certification Requirements - Identification of jobs which must be performed by certified personnel and specification of the certifications required.

T-3. Certified Personnel Data - Identity and locations of personnel holding each of the various certificates.

T-4. Training Course Outlines - Summary descriptions of available training courses used to prepare personnel for certification.

T-5. Training Schedules - Near-term schedules of training courses available.

T-6. Training Facilities - Identifications and locations of facilities available for use in training personnel in the specialities which require certification.

5.2 IDENTIFICATION OF AVAILABLE SYSTEMS

The selection of manual and computerized systems to be employed for PICRS should be guided by the following three criteria:

A. Utilize existing software for computerized information management to the greatest extent practical.

B. Employ manual techniques unless the nature of the information managed, data access requirements or the relative economics justifies computerized treatment.

C. The nature and use of information in PICRS will evolve as the Space Shuttle Program progresses. The system must accommodate changes to support requirements evolution.

Existing systems and systems already being developed that are nominally suitable for PICRS were identified by a second survey of NASA centers and contractors involved in the Space Shuttle Program. A second questionnaire (Table 4) was employed to ascertain relevant characteristics of manual and computerized systems. System size, function, documentation and degree of implementation were determined in all cases. For computerized systems, programming language, EDP hardware identity, and operating system employed were determined for preliminary analysis of possible integration into a single system. Proprietary interest in privately developed software was also ascertained for guidance should acquisition become necessary.

Each system identified in the survey was evaluated for its record capacity, total storage capacity, and general compatibility with other candidate systems. Care was taken to assure that all computerized candidates are programmed in one of the standard languages (FORTRAN IV, COBOL, etc.) to avoid problems inherent with programs that employ machine language, or a special language used only by the system developed. Because of the large volume of storage and system traffic expected in PICRS, large size computers having a family of auxiliary and peripheral equipment (third generation) were considered important. These characteristics were shared by almost all of the computerized candidates. Similarity of current application of a system to its proposed application in PICRS was also a key factor in the evaluation. Seventy-six computerized systems and three manual systems were evaluated. These systems are listed in Table 1 together with the applicable module and the related information categories. All system acronyms that have noun equivalents are explained in the glossary. Candidate systems were identified for every module; however, the candidates for three of the modules (Program Planning and Control-Problem Status, Measurements and Stimuli, Personnel Certification Index) are expected to be unsuitable for PICRS. It was determined to be in the best interest of Space Shuttle Program to establish systems for these three modules.

5.3 DATA BASE PARTITIONING

In Section 5.1, the discussion of information requirements demonstrates that although several distinctly different types of information will be contained in PICRS, they can be categorized on a logical basis. The concept of partitioning, which was a convenient device for analyzing requirements during the study, also offers advantages in the ultimate system configuration. Partitioning the data base into subdivisions defined on the basis of "most frequent association in use"; similarity of input or retrieval frequency, technique, etc.; or other logical considerations can materially reduce the time (hence

Table 4. Information Systems Questionnaire

I. General

A. Types of information (from matrix)

Item(s)_____

Description(s)_____

_____

(Attach form DSM 410 if not previously submitted)

B. Name of information system_____

C. Attach system data elements (fields) summary.

D. Attach brief narrative description of the system.

E. Will the system accommodate the full scope of the indicated types of information?

Without modification/with modification; explain.

_____

_____

_____

No; explain.

_____

_____

_____

F. Name, address, phone number, and organization of responder.

_____

_____ _____ _____

G. Responder is systems programmer_____, analyst_____, or other _____. Explain.

_____

_____

_____

H. Name, phone number of department/division manager responsible for system operation.

_____ _____

I. The system is computerized_____: will be computerized_____; will remain manual_____. If the system is manual, do not continue.

II. Computerized Systems

A. Hardware (e.g., S/370 Mod 145).

_____

B. Operating Systems (e.g., S/360 O.S.).

_____

C. Programming languages (e.g., COBAL, JOVIAL).

_____

_____

D. Input media (e.g., punched cards).

_____

E. Output media (e.g., microfilm).

_____

F. If the system is dependent on/or interfaces with other computer systems, explain.

_____

_____

_____

G. If the system is proprietary, state ownership.

_____

H. System is currently operating at location(s):

_____

_____

_____

I. Data Base

1. Storage media (e.g., paper tape, disc)_____

2. Number of records in data base_____

3. Average record length (bytes, characters, etc.)_____

4. Organization (e.g., physical sequential, ISAM, etc.)_____

_____

5. If maintained on-line, explain. _____

_____

_____

6. If maintained in batch mode, describe update cycle. _____

_____

_____

_____

J. Describe the methods of displaying information contained in the data base.

_____

_____

_____

_____

_____

K. State all access methods used by the system (e.g., ISAM, BDAM).

_____

_____

_____

_____

_____

L. Attach brief narrative description of computer system.

M. What system documentation is available? _____

_____

_____

_____

N. What is the extent of system implementation (e.g., development, programmer control)?

_____

_____

_____

_____

cost) of system operations. Furthermore, the concept of a partitioned data base makes possible the use of existing systems, thereby avoiding a costly and prolonged development period. By careful design of the system, new modules can be added readily as their need develops, thereby enhancing the system flexibility.

After study of information requirements, review of available implementation methods, and consideration of the economic implications, fifteen potential system modules were identified as follows:

Program Planning and Control consists of three modules: schedule, cost and problem status.

The schedule module should contain calendarized planning interrelated to depict key events, minimum intervals between successive events, constraint relationships and status. The events should be identified to the work breakdown structure. Uniform requirements for inputs by centers and contractors must be developed and imposed, and suitable preprocessing and postprocessing software will be necessary.

The cost module should contain basic cost accounting data summarizable by a cost-per-flight model. The quantity of data and system response required suggest batch mode processing will be inadequate.

Problems are inherently different than the information normally contained in a program planning schedule module. They require faster system response to update and more frequent access to the status data. The problem status module should be separate from the cost and schedule modules to provide the special features. Because of the multiple locations involved in this system, software should be developed to support the specific requirements.

Information Accession consists of identification of all documents relevant to the Space Shuttle Program indexed to facilitate access to specific documents, families of documents, subject, etc. Because of the multiplicity of document source and search requirements, system response is critical to avoid redundant systems and potential duplication of research due to apparent nonavailability.

Design Documentation consists of the release records of drawings and specifications, and distribution requirements of a general nature. Release status, tree relationship and distribution of drawings and specifications should be provided by the system. To maintain currentness of the data necessitates direct links with data originators. Uniform requirements must be developed and imposed on centers and contractors, and preprocessing and postprocessing will be necessary.

Key Items Control combines such categories as SAID, SALUD, Non-Approved Critical Items, Commonality List and Where-Used List. All of these categories consist of lists of components and their significant characteristics. Similarity of the records and record identifiers (part number) assure a fundamental compatibility. By coding each record to identify the applicable list(s), a single file could be maintained with a menu of available retrieval/reporting alternatives. Provision should be made for data differences between records, and for updating of each record to reflect changes in item status. An example of probable status change is, "approval of a Non-Approved Critical Item for limited use would delete the item and add it to the SALUD". Appropriate software should be developed for this module.

Material Usage Control consists of materials identifications, critical characteristics (such as flammability, toxicity, liquid oxygen compatibility, etc.), resolution of any resultant hazards potentials and usage within the designed configuration. Provision should be made to select and retrieve records by material, characteristic and location. Uniform reporting requirements should be imposed and the input information should be rigorously reviewed and verified as part of the preprocessing. Information in the data base should be readily available on demand.

Residual Hazards should contain all hazards together with their resolution. Residual (unresolved) hazards should be separately accessible as well as forming part of the data base. Information should be retrievable by vehicle for preflight review by safety personnel, and on an individual basis for special investigations.

Measurement and Stimuli integrates element and facility measurement lists in a single module which defines each measurement. Historically, measurement lists have been developed by each agency (center, contractor, etc.) that needed one. The lists were tailored to their respective, local application. Automatic correlation between measurements listed and wire lists (for example) was neglected. Integration of measurement lists into a comprehensive facility/vehicle list was difficult. To preclude these historical shortcomings, s system should be developed to implement the program-wide requirements for this module.

Instrument Calibrations provide for storing latest calibration measurements and the historical trend of an instrument. It provides the latest information directly to data analysis and produces reports for interpretation of anomalies and predictions of instrument replacement needs. Editing of inputs to ensure data validity will be essential. Computerized interface with analytical programs will be required.

Support Requirements and Planning consists of the relevant requirements and resource information, resource analysis capability and optimizing

simulation capability. To respond within the rapid turnaround expected, this module must be computerized. To support PICRS requirements, the development must be extended to provide the scheduling capability. Uniform requirements must be developed and imposed on all participating centers and element contractors.

Logistics Inventory Management provides for maintenance of spares and consumables inventories, identifications of withdrawal authority, analysis of reordering requirements and location of the inventoried items. The centralized inventory management reduces the need for redundant stock at the several using locations. Spares provisioning can be performed on a program basis rather than being repeated at each facility. Uniform requirements must be applied to all participating centers and element contractors. Provision must be made for direct communication among the several locations and, possibly, geographical subdivisions of the data base.

Configuration Management consists of the Level 2 and Level 3 requirements baselines, and control of changes to the baseline elements of information.

Information contained in the data base should include identification and approval status of interface control documents, system and subsystem specifications, change notices and change proposals. Provision should exist for controlled addition of baseline definition documents. Uniform requirements being developed by the Configuration Management Working Group (CMWG) should be imposed on all participating centers and element contractors, and the system approach selected by CMWG should be incorporated into PICRS.

Quality Information consists of the verified Level 4 configuration, configuration variances, hardware traceability records, nonconformance data and the logs and historical records frequently provided in an acceptance data package. The module should provide for maintenance of the records and their retrieval, as required, on a continuing basis. The nature of the information demands strict verification and control of inputs to maintain assured validity of the data.

Personnel Certification Index consists of two correlated lists: skill certification requirements and certified personnel. Entry to the module data base may be accomplished through either list to effect a skills pool for energy requirements and to reduce the need for personnel redundancies. Uniform certification requirements will be necessary to assure interchangeability of certified personnel from participating centers and element contractors.

In most cases, the diversity of data originators will require that inputs be edited extensively to maintain data base integrity and security, and reformatted from (potentially) different formats into a uniform format employed

by PICRS. Uniform reporting requirements imposed on manual inputs can, in part, accommodate this concern. Data base subdivisions which utilize computer techniques may require interface routines to perform the editing and reformatting required for inputs (preprocessors) and outputs (postprocessors).

Ideally, preprocessors should be able to accept an input, identify the relevant module of the data base, and effect the required action (update, inquiry response, etc.) from a standard input message. Similarly, the postprocessors should accept a report request, retrieve the necessary data, and reformat the output data for the indicated report. Although this approach introduces an additional development expense, the technique will facilitate operator training and activities, and will facilitate many system changes that will occur as the Space Shuttle Program progresses.

5.4 OTHER INFORMATION CATEGORIES

Several of the proposed information requirements discussed in section 4.2 are insufficiently developed at this time. In some cases, consolidation of the information with another category appears to be advantageous. Several categories are already being studied as a separate subject by a formal working group, and conclusions of those studies should be adopted for PICRS. Final disposition of the following categories will be established during implementation of phase 2 from more detailed definition of the data requirements.

A-1. Program Summary Logic is a method of displaying information contained in the Program Control module. The best method of display is strongly influenced by the management style of the senior responsible individual at each location. Development of a summary logic in PICRS which would satisfy all users appears not to be feasible. Logical relationships were included in the Program Planning and Control Schedule module.

A-5. Quality/Safety/Reliability Alerts are already handled in an effective, systematic fashion. There appears to be no advantage to be gained by computerizing the alert system in PICRS. The existing manual system should be retained.

A-10. Program Review Data, Action & Status are short-lived items that are resolved as expeditiously as possible. Typically, interest in any one item is limited to a single center/contractor pair. The method currently used for controlling these items should be retained.

C. Test & Checkout Data (all of Category C) involves detailed technical coordination during development of the data. When the data is developed, concern with it becomes limited to a

single center/contractor pair. Since general involvement is essentially defined when data becomes eligible for input to PICRS, the means of treating the category should be defined at that time.

E-10, E-11. Mass Properties and Vehicle Dynamics as nominal subjects have widespread relevance; however, each user of the data necessarily views it differently. These categories are currently being studied for control. Conclusions of that study should be adopted for PICRS.

F-2. Alternate Handling Site Requirements will have interchangeability primarily during development of site-specific requirements. Since the data would become eligible for input to PICRS only upon finalization of the requirements of each site, the category appears inappropriate. Should future developments prove this conclusion erroneous, the category can be re-evaluated.

F-3B. Maintenance Manuals should be listed in the Information Accession module.

F-3C. Intermediate and Depot Maintenance Requirements Data and Consummables Requirements and Data will be site-specific when they are sufficiently defined to be eligible for input to PICRS, and should be controlled locally.

14-7. Workmanship Standards are inherently very specialized and vary by center or contractor. Should common standards be developed and imposed on all contractors and centers, they should be documented and the documents listed in the Information Accession module.

M. Mission Planning and Control Data (all of Category M) is being studied by a separate working group. Currently, it is expected the results will be defined in manual form. Treatment of this category should be determined by the special working group.

D. Payload Data (all of Category D) are also the subject of a special working group. Conclusions of that working group should determine treatment of the category.

R-1. Orbiter Ferry Requirements and Data of general concern should be controlled by specification and treated by PICRS in the Design Documentation module.

T-0, Training Course Outlines, Training Schedules and Training
T-5, Facilities have limited use providing certification standards
T-6. are centrally controlled. Only the training staff make active use of the information. The Personnel Certification Index module provides valid PICRS data only if certification standards are uniform. Training schedules are tied geographically, and should be publicized on that basis.

5.5 SYSTEM ADMINISTRATION

In addition to establishing uniform data requirements for input, operating a dispersed system requires centralized data base administration as a continuing activity. The PICRS Administrator must:

A. Establish overall policies.
B. Evaluate new requirements.
C. Allocate development/operational responsibilities.
D. Monitor and control operations.

Overall policy should specify standards of documentation and provide for coordinated change control. Strict control of changes to the system is particularly critical in view of the geographic separation of the NASA centers and contractors that will be storing and retrieving data in PICRS. It should institute and enforce means to safeguard the PICRS data base both with regard to integrity and security of the data. It should delineate criteria for allocating development/operation responsibilities for accommodating new requirements on a continuing basis.

Allocation of development/operation responsibilities should be guided by the two precepts: Keep the storage, retrieval and reporting functions as close to the point of origin of the information as possible; and use existing resources, capabilities and systems to the greatest extent practical. Originators of information, identified generally by WBS responsibility, should be responsible for supplying it to others in the program to maintain currentness of the information, improve the potential for user understanding of the information, and allow multi-use of internal information management systems. The functions of developing and operating system modules should be assigned on the basis of such criteria as: resource availability, user location, systems capability, WBS responsibility, and residual benefits to the government.

As part of the monitor and control function, a program information center should be established to provide directory service between users and originators of information. The directory service should be able to advise what information exists or is planned, who its originator is, and how it may be obtained.

A PICRS Administration organization should be instituted as described in Figure 1 to facilitate control of PICRS, coordinate among all of the PICRS users, and provide continuity throughout the duration of the Space Shuttle Program.

5.6 POTENTIAL PROBLEM AREAS

The special nature of PICRS involves several problem areas beyond the normal difficulties of a complex information management system. Three problems that will require resolution relate to diversity of equipment, data security and the potential of an inherent conflict between PICRS requirements and the integral management processes of a center or contractor.

The two surveys conducted during the study to develop relevant information about requirements and existing systems revealed substantial diversity of the computing equipment currently utilized by the NASA centers in their information management processes. Teleprocessing software and PICRS data management software will add an additional dimension to the complexity of factors that must be integrated by PICRS. Interfacing hardware systems of different origin entails technical problems that must be treated throughout the life of PICRS.

The security of information stored in a PICRS-type system is a continuing problem, both from a national security standpoint and from the standpoint of contractors who participate directly in PICRS operation. Computer data base security techniques currently progress at about the same rate as do the techniques for penetrating them. Maintenance of data base security must be a continuing concern of the PICRS Administrator and the system management staff.

Data stored in PICRS are generated by systems that are integral to the management processes of the originators. Because no requirement existed, heretofore, that the systems be compatible, significant differences can be expected. Nomenclature, timing and system response will be oriented to the needs of the center or contractor which developed the system. Acquisition of information required by PICRS may entail a customized approach for each originator. A special effort is justified to develop acquisition techniques that have multiple applications. This problem should be resolved during development of the communications network.

6.0 SYSTEM COSTS

As defined in the foregoing section, the exact configuration of PICRS requires determination of lower level detail than has been possible during this study. For the purpose of scoping cost aspects, the Phase 1 system was judged to be representative. That system is described as follows:

A communications network tentatively utilizing telephone lines on a dial-up basis.

Terminals at all locations initially required in the network.

Software to interface between the network and implemented modules.

System modules to support Accessioning List and Levels II and III Configuration Management Information.

6.1 COMMUNICATIONS NETWORK

Two alternative approaches are available to provide the communications network: dial-up and dedicated (leased) lines. The dedicated-line approach would necessitate connecting each location in the net with all other locations. For a network of twelve locations, this approach would require sixty-six lines. Higher transmission rate would be possible and video (cathode ray tube) type terminals could be used if required. Addition of locations would be difficult.

The dial-up approach offers greater system flexibility and economy. The transmission rate will be slower. Greater care will be required to provide data integrity and system security. Basic cost of the dial-up network will vary between $15 and $100 per month for each terminal. Specific terminals utilized at each of the network locations will largely determine precise costs. On the basis of twelve locations, basic network cost will be $14,400 per year. Cost beyond the basic network cost will depend on traffic in the system and on the billing rates. The Federal Telecommunications System (FTS) might be used to minimize traffic costs.

6.2 TERMINALS

The PICRS design approach provides for each participant (location) in the system to utilize his own data processing equipment. Computing equipment identified during the study consists of IBM, Univac and GE products,

predominantly. Since special terminals will not be required for PICRS, there will be no additional costs for terminals.

6.3 INTERFACE SOFTWARE

The computer type most commonly encountered in PICRS will determine the interface software required and operation system (OS) provisions to support the terminals.

6.4 INITIAL SYSTEM MODULES

The two modules proposed for implementation during the initial phase are Levels II and III Configuration Management Information and the Accessioning List.

System provisions for the Levels II and III Configuration Management Information have been defined by the Configuration Management Working Group (CMWG). The Baseline Accounting and Reporting System (BARS) has been selected as an interim solution by CMWG. Other alternatives are being evaluated by CMWG for long-term processing of requirements and change activity of Program (Level II) and Project (Level III) Configuration Management Information. Incorporation of the CMWG solution into PICRS should generate no additional costs.

Accessioning, index and retrieval of reports and other documents is currently being performed at JSC. The inherent flexibility of the JSC system can accommodate PICRS requirements. The PICRS cost of implementing the JSC system should be limited to enlarging the application.

APPENDIX A. PICRS INFORMATION REQUIREMENTS SUMMARY

A. COMMON MANAGEMENT DATA

ITEM	DESCRIPTION	ORIGINATORS														USERS												
		ABE	ET	SRB	ME	ORB	P/L *	INT	JSC	SAMSO	MSFC	EAFB	KSC	WTR	OTHER	ABE	ET	SRB	ME	ORB	P/L *	INT	JSC	SAMSO	MSFC	EAFB	KSC	WTR	OTHER
A-1	PROGRAM SUMMARY LOGIC							X								X	X	X	X	X	X	X	X	X	X	X	X	X	X
A-2	MANAGEMENT DATA SCHEDULES AND STATUS	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
A-3	COST-PER-FLIGHT AND OTHER COST DATA	X	X	X	X	X	X	X	X	X	X	X	X	X	1	X	X	X	X	X	X	X	X	X	X		X	X	2
A-4	HARDWARE PROBLEM STATUS	X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
A-5	QUALITY/SAFETY/RELIAB ALERTS	X	X	X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	
A-8	DOCUMENT ACCESSION	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	
A-10	PGM REVIEW DATA, ACTION AND STATUS	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	

1 ALTERNATE LANDING SITES
2 NASA HEADQUARTERS
* PAYLOAD COLUMNS ON ALL SHEETS ARE TENTATIVE, TO BE RE-EVALUATED

B. CONFIGURATION MANAGEMENT DATA

ITEM	DESCRIPTION	ORIGINATORS														USERS												
		ABE	ET	SRB	ME	ORB	P/L	INT	JSC	SAMSO	MSFC	EAFB	KSC	WTR	OTHER	ABE	ET	SRB	ME	ORB	P/L	INT	JSC	SAMSO	MSFC	EAFB	KSC	WTR	OTHER
B-1	PGM (LVL 2) REQUIREMENTS IDENTIFICATION & STATUS								X							X	X	X	X	X	X	X	X	X	X	X	X	X	
B-2	PJT (LVL 3) REQUIREMENTS IDENTIFICATION & STATUS								X		X		X			X	X	X	X	X	X	X	X	X	X	X	X	X	
B-3	CHANGE IDENTIFICATION & STATUS	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	
B-7	TRACEABILITY DATA (HDWR, S/W & REQUIREMENTS)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
B-8	ACCEPTANCE DATA PACK	X	X	X	X	X	X						X										X		X	X	X	X	
B-9	CONFIGURATION VERIFICATION (HDWR, W/W)	X	X	X	X	X	X		X		X	X	X	X									X	X	X	X	X	X	

C. TEST & CHECKOUT DATA

ITEM	DESCRIPTION	ORIGINATORS														USERS												
		ABE	ET	SRB	ME	ORB	P/L	INT	JSC	SAMSO	MSFC	EAFB	KSC	WTR	OTHER	ABE	ET	SRB	ME	ORB	P/L	INT	JSC	SAMSO	MSFC	EAFB	KSC	WTR	OTHER
C-4	INTEGRATED TEST REQUIREMENTS AND DATA	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	
C-5	ELEMENT TEST REQUIREMENTS AND DATA	X	X	X	X	X			X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	
C-6	HORIZONTAL FLT TEST REQUIREMENTS AND DATA	X			X	X		X	X	X	X	X	X			X			X	X		X	X	X	X	X	X	X	
C-7	VERTICAL FLT TEST REQUIREMENTS AND DATA		X	X	X	X	X	X	X	X	X		X				X	X	X	X	X	X	X	X	X	X	X	X	

E. TECHNICAL INTEGRATION DATA

ITEM	DESCRIPTION	ORIGINATORS														USERS												
		ABE	ET	SRB	ME	ORB	P/L	INT	JSC	SAMSO	MSFC	EAFB	KSC	WTR	OTHER	ABE	ET	SRB	ME	ORB	P/L	INT	JSC	SAMSO	MSFC	EAFB	KSC	WTR	OTHER
E-1	PERF. CAPA. & LIMITS	X	X	X	X	X	X	X	X	X	X	X																	
E-3	DRAWINGS & SPECIFICATIONS	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	
E-4	SAID/SALUD/NON-APPR. ITEMS	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	
E-5	WHERE-USED LIST	X	X	X	X	X		X	X	X	X		X			X	X	X	X	X		X	X	X	X	X	X	X	
E-6	COMMONALITY LIST	X	X	X	X	X		X	X	X	X		X			X	X	X	X	X			X	X	X		X		
E-7	MATERIALS USAGE CONTROL	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	
E-9	MEASUREMENTS & STIMULI	X	X	X	X	X	X	X	X		X		X			X	X	X	X	X	X	X	X	X	X	X	X	X	
E-10	MASS PROPERTIES	X	X	X	X	X	X	X	X		X											X	X	X	X		X	X	
E-11	VEHICLE DYNAMICS		X	X	X	X		X	X		X						X	X	X	X		X	X	X	X				

F. FACILITIES MAINTENANCE & LOGISTICS DATA

ITEM	DESCRIPTION	ORIGINATORS														USERS												
		ABE	ET	SRB	ME	ORB	P/L	INT	JSC	SAMSO	MSFC	EAFB	KSC	WTR	OTHER	ABE	ET	SRB	ME	ORB	P/L	INT	JSC	SAMSO	MSFC	EAFB	KSC	WTR	OTHER
F-1	STATION SET REQUIREMENTS AND DATA	X	X	X	X	X	X	X	X	X	X	X	X	X								X	X	X	X	X	X	X	
F-2	ALTERNATE LANDING SITE RQMTS					X			X	X			X										X	X		X	X	X	1
F-3	MAINTENANCE DATA																												
F-3B	MANUALS	X	X	X	X	X	X	X	X	X	X		X		2								X		X	X	X	X	
F-3C	INTERMEDIATE & DEPOT MAINT. REQUIREMENTS AND DATA	X	X	X	X	X	X		X	X	X		X	X	2	X	X	X	X	X	X		X	X	X	X	X	X	
F-4	LOGISTICS DATA																												
F-4A	SPARES RQMTS., STATUS & DATA	X	X	X	X	X	X	X	X	X	X	X	X	X	2	X	X	X	X	X	X	X	X	X	X	X	X	X	
F-4B	CONSUMABLES RQMTS & DATA	X	X	X	X	X	X	X	X	X	X	X	X	X									X	X	X	X	X	X	
F-4C	TRANS., STORAGE & HANDLING REQUIREMENTS AND DATA	X	X	X	X	X	X	X	X	X	X	X	X	X	1,2	X	X	X	X	X	X	X	X	X	X	X	X	X	1

G. SOFTWARE DATA

ITEM	DESCRIPTION	ORIGINATOR														USERS													
		ABE	ET	SRB	ME	ORB	P/L	INT	JSC	SAMSO	MSFC	EAFB	KSC	WTR	OTHER	ABE	ET	SRB	ME	ORB	P/L	INT	JSC	SAMSO	MSFC	EAFB	KSC	WTR	OTHER

H. OPERATIONAL HARDWARE DATA

ITEM	DESCRIPTION	ORIGINATORS														USERS													
		ABE	ET	SRB	ME	ORB	P/L	INT	JSC	SAMSO	MSFC	EAFB	KSC	WTR	OTHER	ABE	ET	SRB	ME	ORB	P/L	INT	JSC	SAMSO	MSFC	EAFB	KSC	WTR	OTHER
H-1	SHUTTLE CERTIFICATION STATUS	X	X	X	X	X	X	X	X		X		X									X	X	X	X	X	X	X	
H-2	RESIDUAL HAZARDS DATA	X	X	X	X	X	X	X	X		X		X									X	X	X	X	X	X	X	
H-3	CRITICAL ITEMS LIST	X	X	X	X	X	X	X	X		X		X									X	X	X	X	X	X	X	
H-4	INSTRUMENTATION CALIBRATIONS	X	X	X	X	X	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	
H-7	QUALITY ACCEPTANCE STANDARDS	X	X	X	X	X	X																						

M. MISSION PLANNING & CONTROL DATA

ITEM	DESCRIPTION	ORIGINATORS														USERS													
		ABE	ET	SRB	ME	ORB	P/L	INT	JSC	SAMSO	MSFC	EAFB	KSC	WTR	OTHER	ABE	ET	SRB	ME	ORB	P/L	INT	JSC	SAMSO	MSFC	EAFB	KSC	WTR	OTHER
M-1	FLT OPNS CAPABILITY AND PROC. DATA	X	X	X	X	X	X		X		X											X	X	X		X	X	X	
M-4	REFERENCE (OPNL) TRAJECTORY								X								X	X	X	X		X	X	X	X		X	X	
M-5	LAUNCH & RECOVERY MISSION RULES (HFT SIMILAR)	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	
M-6	FLIGHT MISSION RULES (HFT SIMILAR)	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	
M-8	MISSION DATA BOOK								X													X	X	X	X				
M-11	DETAIL FLIGHT PLAN								X												X		X	X	X				
M-12	ABORT RQMTS. & DATA	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	
M-14	METEOROLOGICAL DATA										X	X	X	X									X	X	X	X	X	X	
M-15	TRACKING COMM. RQMTS.						X	X	X	X	X	X	X	X	1			X		X	X	X	X	X	X	X	X	X	1
M-16	OPERATIONAL DATA BOOK								X							X	X	X	X	X	X	X	X	X	X	X	X	X	

P. PAYLOAD DATA

ITEM	DESCRIPTION	ORIGINATORS														USERS												
		ABE	ET	SRB	ME	ORB	P/L	INT	JSC	SAMSO	MSFC	EAFB	KSC	WTR	OTHER	ABE	ET	SRB	ME	ORB	P/L	INT	JSC	SAMSO	MSFC	EAFB	KSC	WTR	OTHER

R. TURNAROUND DATA

ITEM	DESCRIPTION	ORIGINATORS														USERS												
		ABE	ET	SRB	ME	ORB	P/L	INT	JSC	SAMSO	MSFC	EAFB	KSC	WTR	OTHER	ABE	ET	SRB	ME	ORB	P/L	INT	JSC	SAMSO	MSFC	EAFB	KSC	WTR	OTHER
R-1	ORBITER FERRY RQMTS. & DATA	X				X			X			X	X		1					X			X	X		X	X	X	1
R-2	TURNAROUND & PROCESSING FLOWS	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	
R-7	LIMITED LIFE ITEMS	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	
R-8	TURNAROUND RQMTS. & DATA	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	

S. SIMULATION DATA

ITEM	DESCRIPTION	ORIGINATORS														USERS												
		ABE	ET	SRB	ME	ORB	P/L	INT	JSC	SAMSO	MSFC	EAFB	KSC	WTR	OTHER	ABE	ET	SRB	ME	ORB	P/L	INT	JSC	SAMSO	MSFC	EAFB	KSC	WTR	OTHER

T. TRAINING DATA

ITEM	DESCRIPTION	ORIGINATORS														USERS												
		ABE	ET	SRB	ME	ORB	P/L	INT	JSC	SAMSO	MSFC	EAFB	KSC	WTR	OTHER	ABE	ET	SRB	ME	ORB	P/L	INT	JSC	SAMSO	MSFC	EAFB	KSC	WTR	OTHER
T-2	JOB CERTIFICATION REQUIREMENTS	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	
T-3	CERTIFIED PERSONNEL DATA	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	
T-3	TNG. COURSE OUTLINES	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	
T-5	TNG. SCHEDULES	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	
T-6	TNG. FACILITIES	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	