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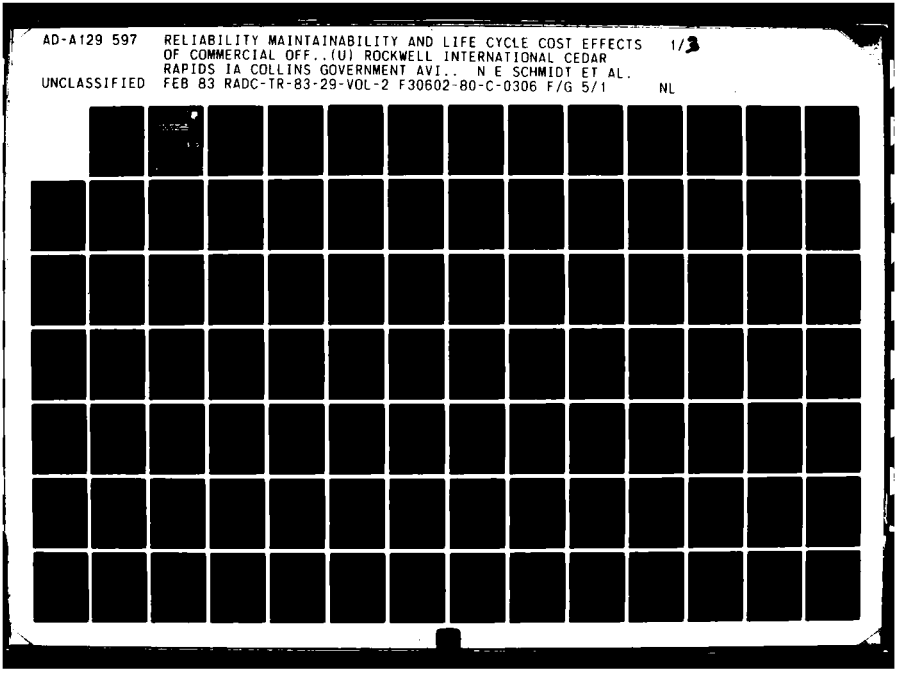

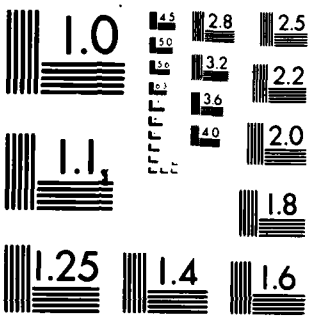

RADC-TR-83-29, Vol II (of two)
Final Technical Report
February 1983

RELIABILITY, MAINTAINABILITY, AND LIFE CYCLE COST EFFECTS OF COMMERCIAL OFF-THE-SHELF EQUIPMENT Appendices

Rockwell International Corporation

Norbert E. Schmidt and J. G. Vecellio

ROME AIR DEVELOPMENT CENTER
Air Force Systems Command
Griffiss Air Force Base, NY 13441

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RADC-TR-83-29, Vol II (of two) has been reviewed and is approved for publication.

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Electronic Equipment
Life Cycle Cost
Acquisition Strategy
Program Management
Environmental Effects

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report documents the results of a study to determine the effects of using commercial off-the-shelf electronic equipment in a military environment. A key element of confusion in applying commercial technology is understanding what design criteria is a part of such terms as "best commercial practices," etc. The report clarifies how this term and other common ones relate to "militarized." The choice of a militarized vs commercial approach must be done on a case-by-case basis. Therefore, (over)

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rather than firm acquisition strategy being given for all cases, an analytical procedure is presented that may be applied for each unique acquisition situation. Key to making the best decision is the determination of the appropriate weighting for the operational factors necessary for program success as well as the relative weighting of cost and risk. The results indicate that there is merit in considering the use of "best commercial practices" in "ground fixed" and airborne inhabited transport" environments, but it is unlikely that they can be applied successfully in "airborne inhabited fighter" applications. Regardless of the choice of acquisition strategy, use of the guideline technique formalizes management consideration of all factors contributing to the strategy decision and identifies areas of potential risk reduction.

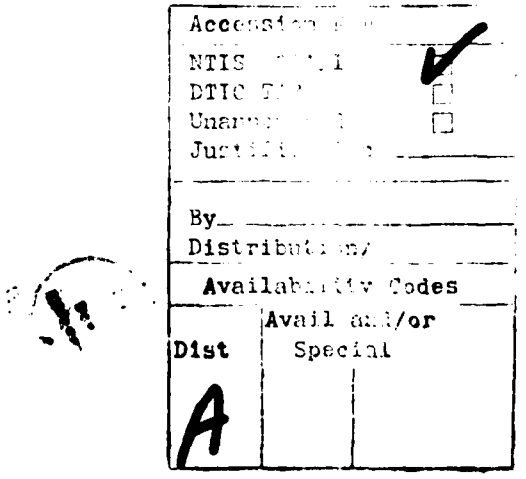
EVALUATION

1. The objective of this study was to develop guidelines indicating the most advantageous class of equipment, militarized or commercial off-the-shelf, for a given military environment. The guidelines were to define for a Program Manager the advantages/disadvantages of each class in terms of reliability, maintainability, cost, risk and other pertinent factors. Precautionary steps that a Program Manager should take to minimize the risks and disadvantages of each class of equipment were to be pointed out for each of the given environments.

2. The objectives have been achieved in a broad sense. Although clearcut decision guidelines could not be developed for all acquisition situations, a procedure tailorable for each unique acquisition situation was formulated. The procedure serves as a guideline in the decision process by forcing the Program Manager to address the risk of achieving success with respect to a variety of program variables. The procedure enables trading off risk against cost and identifies elements for further risk reduction. Terms such as "best commercial practices," "ruggedized" and "militarized" are clarified in terms of how they compare with respect to a series of design disciplines.

3. Use of the procedure introduced will provide a more rigorous process for acquisition decision making. Use of a team of experts in risk quantification is recommended. Clarification of commonly used design descriptions aids the Program Manager in further understanding the risks and payoffs of a particular acquisition decision.

PRESTON R. MACDIARMID
PROJECT ENGINEER



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APPENDIX 1

INDUSTRIAL SURVEY

A1.0 INTRODUCTION

Appendix 1 contains the results of the industry survey performed as part of this study. Included is a copy of the cover letter sent out with the surveys, followed by the results of each survey. The first page of each survey is listed by company as follows:

COLLINS AVIONICS INDUSTRY SURVEY

Rockwell International, Collins Avionics Division is under contract to the Rome Air Development Center (Contract Number F30602-80-C-0306) to evaluate and report on the possible cost/benefits of using commercial off-the-shelf equipment in place of military equipment in airborne inhabited fighter, airborne inhabited transport and fixed ground environments. A guideline will be included for implementation by Government Program Managers which will include recommendations whether commercial equipments can be effectively used in a given environment, with extra measures imposed to reduce risks. As a part of this contract, we have been requested to solicit inputs from industrial firms that have substantial background in both commercial and military electronics manufacturing to obtain opinions and viewpoints on at least the following questions:

a. Discuss the design difference in 1.) Good Commercial Practices, 2.) Best Commercial Practices, 3.) Ruggedized and, 4.) Militarized, all of which are commonly used equipment manufacturer's terms. The discussion may consider any of the following factors:

    1. Thermal design
    2. Derating practices
    3. Part qualities
    4. Packaging concepts
    5. Shock and vibration limits
    6. Temperature limits
    7. Humidity limits
    8. Quality assurance provisions

b. Briefly discuss, if applicable, your experiences in adapting commercial off-the-shelf equipment to a military environment.
c. Discuss benefits which you have or would expect to experience in using commercial off-the-shelf equipment in a military environment.
d. Discuss drawbacks which you have or would expect to experience in using commercial off-the-shelf equipment in a military environment.

We would appreciate your comments on these questions together with any related information or observations that you feel may be of benefit to our study. If possible, we would like to receive your comments by July 15, 1981 so that we may expand or clarify comments received. In addition to your textual response to the listed questions, we would appreciate your completing the attached form to supply background information about your company and to summarize your overall opinions in a way suited for easy tabulation.

Thank you for your assistance in this matter. Should further information be desired, please contact either Mr. Norbert Schmidt, (319) 395-4585 or Mr. Bruce Johnson, (319) 395-3485.

INDUSTRY SURVEY: RELIABILITY, MAINTAINABILITY AND LIFE CYCLE COST EFFECT OF USING COMMERCIAL OFF-THE-SHELF EQUIPMENT

RETURN TO:

COLLINS AVIONICS GROUP
400 COLLINS ROAD, N.E.
CEDAR RAPIDS, IOWA 52406
ATTENTION: MR. BRUCE JOHNSON
M/S 108-275

COMPANY A

ADDRESS _____ ZIP CODE _____

CONTACT _____ PHONE NUMBER: _____

PRINCIPAL PRODUCT LINE	COMMERCIAL	MILITARY
Airborne Weather Radar	None	None

1. ORGANIZATIONS GENERAL VIEW OF COMMERCIAL OFF-THE-SHELF EQUIPMENT USED IN MILITARY APPLICATIONS.

	APPLICABLE	NOT APPLICABLE	APPLICABLE WITH EXTRA MEASURES
AIRBORNE INHABITED FIGHTER		X	
AIRBORNE INHABITED TRANSPORT	X		
FIXED GROUND		X	

COMPANY A

We have reviewed your request for data on the application of commercial avionics equipment to military aircraft. Enclosed is the completed four page questionaire contained in your letter.

Our experience in applying commercial avionics to military aircraft is in the area of weather radar and navigation equipment. In general, the application has worked very well. Equipment performance has measured up to expectations, reliability has been good, maintenance is below projections, and cost is far below equipment designed to military specifications and standards.

The two principal areas of concern in determining the applicability of commercial equipment are both environmental. The temperature ranges experienced in military equipment (particularly fighters) can often far exceed the normal environment of a commercial air transport aircraft. The shock and vibration environment may also be much more severe. Some improvement can be realized in both areas by substituting MIL qualified components for standard ones (at considerable expense), but MIL components don't always exist as a direct substitute for the selected commercial component. If redesigning is required, the unit is no longer considered a commercial item.

Some recent information on the application of a commercial weather radar in the Air Force's C-141 transport aircraft might be available in a report issued by the Military Aircraft Command. The report is identified below but is currently limited in distribution to U.S. Government agencies. Requests for information pertaining to the report must be referred to HQ MAC/XPQT, Scott AFB, IL 62225.

COMPANY A

2. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED FIGHTER ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY			X	Shock and vibration requirements usually too severe for commercial equipment.
MAINTAINABILITY	X			Commercial equipment is usually designed for ease of maintenance.
AVAILABILITY		X		Depends on requirements.
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL			X	MIL-Standard parts not normally used.
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT		X		
SPECIAL HANDLING	X			Commercial equipment is designed for rapid LRU replacement.
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS			X	Equipment not designed for use in a combat environment.
NON-STANDARD POWER DEMANDS	X			Most equipment operates at 115 VAC 400 Hz or 28 VDC.
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE			X	MIL-STD-454 requirements are much more severe than DO-160A.
SMALL BUSINESS OPPORTUNITY			X	Major systems are not currently produced by small business organizations.
SPARES PROVISIONING, AVAILABILITY	X			Commercial equipment is well supported.
GUARANTEES AND WARRANTIES	X			RIW, RAW & LCC conditions have been applied to commercial equipment for military applications
GOVERNMENT DATA RIGHTS		X		Data is available but often considered proprietary.

COMPANY A

3. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED TRANSPORT ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY	X			Environment is same as commercial air transport. Proven results.
MAINTAINABILITY	X			
AVAILABILITY		X		Low risk for existing systems.
PERSONNEL, SAFETY, TRAINING	X			Usually provided.
PART QUALITY LEVEL		X		Non MIL spec. parts generally used in design.
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT		X		
SPECIAL HANDLING	X			See page 2.
QUALITY ASSURANCE PROVISIONS		X		See page 2.
COMBAT READINESS		X		Transport combat environment is judged less severe then fighter environment.
NON-STANDARD POWER DEMANDS	X			See Page 2.
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE		X		Equipment generally complies with DO-138 or DO-160.
SMALL BUSINESS OPPORTUNITY			X	See Page 2.
SPARES PROVISIONING, AVAILABILITY	X			See Page 2.
GUARANTEES AND WARRANTIES	X			See Page 2.
GOVERNMENT DATA RIGHTS		X		See Page 2.

COMPANY A

4. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY GROUND FIXED ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY	☐	☐	☐	See Page 3. This is an exact replica of that form.
MAINTAINABILITY	☐	☐	☐	
AVAILABILITY	☐	☐	☐	
PERSONNEL, SAFETY, TRAINING	☐	☐	☐	
PART QUALITY LEVEL	☐	☐	☐	
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	☐	☐	☐	
SPECIAL HANDLING	☐	☐	☐	
QUALITY ASSURANCE PROVISIONS	☐	☐	☐	
COMBAT READINESS	☐	☐	☐	
NON-STANDARD POWER DEMANDS	☐	☐	☐	
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE	☐	☐	☐	
SMALL BUSINESS OPPORTUNITY	☐	☐	☐	
SPARES PROVISIONING, AVAILABILITY	☐	☐	☐	
GUARANTEES AND WARRANTIES	☐	☐	☐	
GOVERNMENT DATA RIGHTS	☐	☐	☐	

INDUSTRY SURVEY: RELIABILITY, MAINTAINABILITY AND LIFE CYCLE COST EFFECT OF USING COMMERCIAL OFF-THE-SHELF EQUIPMENT

RETURN TO:

COLLINS AVIONICS GROUP
400 COLLINS ROAD, N.E.
CEDAR RAPIDS, IOWA 52406
ATTENTION: MR. BRUCE JOHNSON
M/S 108-275

COMPANY B

ADDRESS _____ ZIP CODE _____

CONTACT _____ PHONE NUMBER : _____

PRINCIPAL PRODUCT LINE	COMMERCIAL	MILITARY

1. ORGANIZATIONS GENERAL VIEW OF COMMERCIAL OFF-THE-SHELF EQUIPMENT USED IN MILITARY APPLICATIONS.

	APPLICABLE	NOT APPLICABLE	APPLICABLE WITH EXTRA MEASURES
AIRBORNE INHABITED FIGHTER	1	9	6
AIRBORNE INHABITED TRANSPORT	2	0	14
FIXED GROUND	11	1	5

COMPANY B

2. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED FIGHTER ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY	1	4	11	
MAINTAINABILITY	6	3	7	
AVAILABILITY	8	6	2	
PERSONNEL, SAFETY, TRAINING	8	4	4	
PART QUALITY LEVEL	1	9	5	
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	6	5	4	
SPECIAL HANDLING	6	5	4	
QUALITY ASSURANCE PROVISIONS	1	9	4	
COMBAT READINESS	2	5	8	
NON-STANDARD POWER DEMANDS	12	2	1	
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE	4	4	7	
SMALL BUSINESS OPPORTUNITY	8	2	2	
SPARES PROVISIONING, AVAILABILITY	8	3	5	
GUARANTEES AND WARRANTIES	7	2	5	
GOVERNMENT DATA RIGHTS	5	4	5	

COMPANY B

3. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED TRANSPORT ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY	2	14	1	
MAINTAINABILITY	8	5	4	
AVAILABILITY	9	7	1	
PERSONNEL, SAFETY, TRAINING	10	4	3	
PART QUALITY LEVEL	3	13	1	
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	11	4	2	
SPECIAL HANDLING	6	10	1	
QUALITY ASSURANCE PROVISIONS	0	17	0	
COMBAT READINESS	2	13	2	
NON-STANDARD POWER DEMANDS	12	4	1	
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE	5	7	5	
SMALL BUSINESS OPPORTUNITY	7	2	2	
SPARES PROVISIONING, AVAILABILITY	8	3	3	
GUARANTEES AND WARRANTIES	7	5	3	
GOVERNMENT DATA RIGHTS	5	4	6	

COMPANY B

4. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY GROUND FIXED ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY	8	7	0	
MAINTAINABILITY	9	5	1	
AVAILABILITY	8	7	0	
PERSONNEL, SAFETY, TRAINING	12	1	2	
PART QUALITY LEVEL	3	12	0	
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	10	2	3	
SPECIAL HANDLING	11	4	0	
QUALITY ASSURANCE PROVISIONS	5	9	1	
COMBAT READINESS	7	8	0	
NON-STANDARD POWER DEMANDS	14	1	0	
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE	3	9	3	
SMALL BUSINESS OPPORTUNITY	7	3	3	
SPARES PROVISIONING, AVAILABILITY	6	3	7	
GUARANTEES AND WARRANTIES	8	5	2	
GOVERNMENT DATA RIGHTS	4	4	7	

COMPANY C

INDUSTRY SURVEY: RELIABILITY, MAINTAINABILITY AND LIFE CYCLE COST EFFECT OF USING COMMERCIAL OFF-THE-SHELF EQUIPMENT

RETURN TO:

COLLINS AVIONICS GROUP
400 COLLINS ROAD, N.E.
CEDAR RAPIDS, IOWA 52406
ATTENTION: MR. BRUCE JOHNSON
M/S 108-275

COMPANY C

ADDRESS _____ ZIP CODE _____

CONTACT _____ PHONE NUMBER: _____

PRINCIPAL PRODUCT LINE	COMMERCIAL	MILITARY
Radar (85%)		80% 10% 10% AF/Army/Navy
Radar/Communications (15%)	FAA (100%)	

1. ORGANIZATIONS GENERAL VIEW OF COMMERCIAL OFF-THE-SHELF EQUIPMENT USED IN MILITARY APPLICATIONS.

	APPLICABLE	NOT APPLICABLE	APPLICABLE WITH EXTRA MEASURES
AIRBORNE INHABITED FIGHTER	[ ]	[X]	[ ]
AIRBORNE INHABITED TRANSPORT	[ ]	[ ]	[X]
FIXED GROUND	[X]	[ ]	[ ]

COMPANY C

2. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED FIGHTER ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY			X	
MAINTAINABILITY			X	Very little BIT handling could be a problem.
AVAILABILITY			X	
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL			X	
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT			X	
SPECIAL HANDLING		X		
QUALITY ASSURANCE PROVISIONS		X		Benign 20 dynamic environ.
COMBAT READINESS			X	
NON-STANDARD POWER DEMANDS		X		
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE			X	No shielding, A/C power, etc.
SMALL BUSINESS OPPORTUNITY	X			
SPARES PROVISIONING, AVAILABILITY	X			
GUARANTEES AND WARRANTIES			X	
GOVERNMENT DATA RIGHTS	X			

COMPANY C

3. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED TRANSPORT ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY		X		Temp/vib. more closely controlled.
MAINTAINABILITY			X	No/little self test.
AVAILABILITY		X		
PERSONNEL, SAFETY, TRAINING		X		
PART QUALITY LEVEL		X		Not as critical as fighter.
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT		X		
SPECIAL HANDLING		X		
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS		X		
NON-STANDARD POWER DEMANDS		X		
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE			X	
SMALL BUSINESS OPPORTUNITY	X			
SPARES PROVISIONING, AVAILABILITY	X			
GUARANTEES AND WARRANTIES		X		
GOVERNMENT DATA RIGHTS	X			

4. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY GROUND FIXED ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY	☐	☐	☐	Same as Sheet 3.
MAINTAINABILITY	☐	☐	☐	
AVAILABILITY	☐	☐	☐	
PERSONNEL, SAFETY, TRAINING	☐	☐	☐	
PART QUALITY LEVEL	☐	☐	☐	
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	☐	☐	☐	
SPECIAL HANDLING	☐	☐	☐	
QUALITY ASSURANCE PROVISIONS	☐	☐	☐	
COMBAT READINESS	☐	☐	☐	
NON-STANDARD POWER DEMANDS	☐	☐	☐	
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE	☐	☐	☐	
SMALL BUSINESS OPPORTUNITY	☐	☐	☐	
SPARES PROVISIONING, AVAILABILITY	☐	☐	☐	
GUARANTEES AND WARRANTIES	☐	☐	☐	
GOVERNMENT DATA RIGHTS	☐	☐	☐	

COMPANY D

Attached for your information are various replies received from Field Service & Support Division managers who have had extensive experience supporting the use, repair, calibration and overhaul of commercial test equipment in the military environment.

You will note they do not all agree; that is to be expected because their experience has been associated with different supporting activities.

A more precise definition of potential applications for commercial test equipment might result in significantly different opinions. For example, the levels of maintenance (i.e., organizational, intermediate or depot) would most likely be the dominant influence on suitability of commercial test equipment as opposed to the type of system being supported.

COMPANY D

(Comments not specifically applicable to a particular survey.)

A request was received to provide a materials and processes oriented response to the industry survey questionnaire from Collins Avionics Division of Rockwell International. The request came about because of a contract Rockwell has with Rome Air Development Center to evaluate the cost/benefits of using commercial off-the-shelf equipment in airborne and ground military hardware.

There are really two facets to the proposition of materials and processes for commercial equipment. The first is the materials and processes one would normally find in off-the-shelf commercial equipment such as a Lambda power supply or a Hewlitt-Packard frequency counter. The second facet is use of off-the-shelf commercial materials (or processes) in the contract design of military hardware. The risks, costs, and benefits of these two facets are separate considerations.

As a general rule, the materials and processes in commercial equipment do not meet the military requirements, or at least cannot be verified that they do, imposed on contracts. Examples would be the requirement to meet MIL-STD-454, Requirements 3, 5, 16, 23 etc. On the other hand, materials and processes used in this commercial equipment may perform the required mission with very minimal risk and problems since the equipment may not be subjected to the worst military environment. The obvious conclusion is that although contractual requirements are intended to cover any worst case situation, they often impose more complexity than is needed.

The experiences of this company in furnishing systems with some hardware of commercial origin, is that the materials and processes included therein are usually the same if the equipment is either ruggedized or militarized. Often, things like platings, paints, lubricants, printed wiring, welding, etc., in best commercial practice equipment is entirely adequate since it is frequently made for the severe industrial use market. Good commercial practice built equipment does pose a moderate risk since materials often chosen will not withstand common military use and environments for very long. This company has had to adapt off-the-shelf commercial equipment for military contracts, any required modifications are not hindered by the materials and processes; the problems come in verifying that all the myriad MIL-spec requirements in the contract "boiler-plate" are met.

The other facet of the question, using commercial materials for military hardware, is quite straightforward. Commercial off-the-shelf materials and processes are quite suitable and pose negligible risks or problems. This situation is because the industry that formulates and supplies raw materials for the most part does not have a special higher quality level line of products for the military market. Materials and processes for the military market (i.e.: platings, resins, high strength alloys, etc.) are characterized mainly by different marketing and quality record keeping. The products are not manufactured differently. Indeed, many key materials and processes used in military electronic systems are commercial items chosen by careful design practices and perform better than the alternate Mil-spec covered materials.

In order to enhance the effectiveness of using commercial off-the-shelf equipment, the military procurement activities should modify their practices slightly. Their current practice of requiring Mil-spec control of materials and processes from beginning to end should be supplemented by an additional method of allowing design analysis and test to show suitability of commercial equipment. In such a scheme, the design contractor's engineering task could include engineering documentation of the degree of suitability of a given piece of commercial equipment and any needed modifications to make it suitable for that specific military use.

An illustration of what this might entail is a chart recorder that has internal wires and components spot bonded for improved vibration resistance, openings sealed for moisture and dust protection, and fitted with a special plastic front cover to provide fungus resistance. It would not be possible to impose such actions on the manufacturer, but by documenting the as-supplied condition of the equipment and modifications needed, the government's primary concerns of reprocurement and maintainability could be assured. Approaches such as these and simplified documentation procedures for off-the-shelf materials and processes, would greatly facilitate fulfillment of design and development projects for military equipment.

COMPANY D

(Comments not specifically applicable to a particular survey.)

In response to the referent, it appears that the detailed questions asked in the Industry Survey have already, by your distribution, been addressed to the activities in the best position to respond. Specifically these are the Product Design, Technology Support, Support Systems and Subcontract and Material Procurement activities.

RSG Contracts observations regarding the use of commercial, off-the-shelf equipment are somewhat more general in nature. They can best be summarized in two areas of applicability.

In airborne inhabited fighters, equipment specification requirements have generally precluded use of commercial equipment, although in at least one instance (the Sperry Disc Memory in the F-18 radar data processor) the development prior to contract of a strong technical position permitted its use. The equipment involved is best described as a ruggedized item (designed for air vehicle use) with some additional measures taken to ensure its suitability in its intended application.

In fixed ground (which includes transportable) applications, use of commercial, off-the-shelf equipment is an increasingly common practice, at least where equipment designed to best commercial practices is available. As with equipment intended for airborne inhabited fighters, however, it is almost mandatory to anticipate the potential applicability prior to issuance of a contract.

In all cases the most significant impediments to use of anything less than fully militarized equipment are contractually required specifications that do not adequately anticipate the potential applicability of such lesser specified equipment. Any revisions to acquisition policy designed to encourage use of commercial off-the-shelf equipment should recognize and remedy in an appropriate manner this existing contractual problem.

INDUSTRY SURVEY: RELIABILITY, MAINTAINABILITY AND LIFE CYCLE COST EFFECT OF USING COMMERCIAL OFF-THE-SHELF EQUIPMENT

RETURN TO:

COLLINS AVIONICS GROUP
400 COLLINS ROAD, N.E.
CEDAR RAPIDS, IOWA 52406
ATTENTION: MR. BRUCE JOHNSON
M/S 108-275

COMPANY D, Division 1

ADDRESS _____ ZIP CODE _____

CONTACT _____ PHONE NUMBER: _____

PRINCIPAL PRODUCT LINE	COMMERCIAL	MILITARY

1. ORGANIZATIONS GENERAL VIEW OF COMMERCIAL OFF-THE-SHELF EQUIPMENT USED IN MILITARY APPLICATIONS.

	APPLICABLE	NOT APPLICABLE	APPLICABLE WITH EXTRA MEASURES
AIRBORNE INHABITED FIGHTER	X		
AIRBORNE INHABITED TRANSPORT	X		
FIXED GROUND	X		

COMPANY D

DIVISION 1

Following are several comments on the subject summary; attached are the completed forms.

1. On the subject of design differences:

   - Good commercial practice is design/manufacture to the level needed for general household/industrial use. I would say this level produces merchandise of varied quality and reliability based on random events rather than planning.

   - Best commercial practice would be one grade higher; premium products having higher price tags with some improved quality, safety, operability, etc, some planning and control to assure a better mousetrap. This may also include more expensive packaging with lower level innards to allow a higher price for no more quality.

   - Ruggedized products require some control for application in mobile environment, such as aircraft, boats, and automobiles. Ruggedizing may be applied to the installation problem, although we would also expect some concern for ruggedization of the inner workings of the device.

   - Militarized products are designed to withstand the rigors of war and the military environment. However, somewhere along the way, the complexity of the equipment comprises the reliability and quality. The container may be the most serviceable part of the equipment; the working portion may have discontinued operating long before being subjected to the severe military environment.

2. I have no experience adapting off-the-shelf equipment to the military environment.

3. My observation of applications of commercial equipment to airlines, ships, and autos makes me believe we would have increased operational readiness at reduced cost. However, the commercial equipment is not war-tested and I do not know if it would hold-up as well or worse than the militarized equipment in use; chances are it would operate at least as well. The airlines subject their equipment to relatively severe environments and they seem to maintain their readiness with few major interruptions due to equipment failures.

4. I do not foresee any serious drawbacks using commercial equipment. Consideration should be given to and designed into the equipment for standardization, safety, packaging, and environmental limits. I don't believe, however, that all equipment have to be designed for operation from -55°C to +71°C, a sure way to reduce cost. In the event a severe environment is expected, consideration might be given to controlling the environment within which the equipment is installed rather than redesigning the equipment.

COMPANY D

DIVISION 1

2. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED FIGHTER ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY	X			Redundancy for flight essential functions.
MAINTAINABILITY	X			
AVAILABILITY	X			
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL	X			
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	X			
SPECIAL HANDLING			X	Assume aircraft modified and accept installation.
QUALITY ASSURANCE PROVISIONS	X			
COMBAT READINESS	X			I believe the airlines have a higher ready rate than military.
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE	X			
SMALL BUSINESS OPPORTUNITY	X			
SPARES PROVISIONING, AVAILABILITY	X			
GUARANTEES AND WARRANTIES	X			
GOVERNMENT DATA RIGHTS	X			

COMPANY D

DIVISION 1

3. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED TRANSPORT ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY	X			
MAINTAINABILITY	X			
AVAILABILITY	X			
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL	X			
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	X			
SPECIAL HANDLING	X			
QUALITY ASSURANCE PROVISIONS	X			
COMBAT READINESS	X			
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE	X			
SMALL BUSINESS OPPORTUNITY	X			
SPARES PROVISIONING, AVAILABILITY	X			
GUARANTEES AND WARRANTIES	X			
GOVERNMENT DATA RIGHTS	X			

COMPANY D

DIVISION 1

4. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY GROUND FIXED ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY	X			
MAINTAINABILITY	X			
AVAILABILITY	X			
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL	X			
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	X			
SPECIAL HANDLING	X			
QUALITY ASSURANCE PROVISIONS	X			
COMBAT READINESS	X			
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE	X			
SMALL BUSINESS OPPORTUNITY	X			
SPARES PROVISIONING, AVAILABILITY	X			
GUARANTEES AND WARRANTIES	X			
GOVERNMENT DATA RIGHTS	X			

INDUSTRY SURVEY: RELIABILITY, MAINTAINABILITY AND LIFE CYCLE COST EFFECT OF USING COMMERCIAL OFF-THE-SHELF EQUIPMENT

RETURN TO:

COLLINS AVIONICS GROUP
400 COLLINS ROAD, N.E.
CEDAR RAPIDS, IOWA 52406
ATTENTION: MR. BRUCE JOHNSON
M/S 108-275

COMPANY D, Division 2

ADDRESS _____ ZIP CODE _____

CONTACT _____ PHONE NUMBER: _____

PRINCIPAL PRODUCT LINE	COMMERCIAL	MILITARY

1. ORGANIZATIONS GENERAL VIEW OF COMMERCIAL OFF-THE-SHELF EQUIPMENT USED IN MILITARY APPLICATIONS.

	APPLICABLE	NOT APPLICABLE	APPLICABLE WITH EXTRA MEASURES
AIRBORNE INHABITED FIGHTER	[ ]	[X]	[ ]
AIRBORNE INHABITED TRANSPORT	[ ]	[ ]	[X]
FIXED GROUND	[ ]	[ ]	[X]

COMPANY D

DIVISION 2

My immediate reaction, based on extensive experience (sometimes painful) is that use of commercial off-the-shelf equipment is high risk almost across the board for reasons which are stated below.

While the initial cost would appear to be cheaper, this is deceptive from the standpoint of usefullness of the equipment in military use.

Because usually there is no suitable specification to which the manufacturer must adhere, there is degradation in operative capability caused by temperature, humidity, shock and vibration, particularly during use in manned airborne vehicles. The operational quality of equipment I have seen varies from excellent to completely unsatisfactory. Some of the other disadvantages include: no configuration management, i.e. the manufacturer is free to change parts and operating characteristics at will; there are usually limited buys and production runs and the manufacturer does not maintain a parts bank for spares; the purchase agreement does not usually include such amenities as provisioning, standardized technical data and training. The user is severely hampered in attempting to maintain the equipment in an operational status. The technical data is sparse at best with no information usually available on trouble-shooting and in some cases even on calibration requirements. A notable example is Hewlett Packard. They build excellent test equipment, usually very reliable, but refuse to provide detailed technical information under the guise of proprietorship and further refuse to do business directly with the Government. The choice of several items of Hewlett Packard equipment for use in the AWM-23 and the DSM-130 was dictated by the Government which has left the Phoenix Program in bad shape some years later when the equipment is out of production and parts cannot be identified. In addition, Hewlett Packard will not provide assistance without an expensive service contract.

Other equipment, like radios, compasses and similar avionics are also high risk for many of the reasons stated above.

In summary, quality and reliability are obtainable, but Maintainability is severely hampered. The ruggedization/militarization/military spec. are worth the extra cost in the long term.

COMPANY D

DIVISION 2

2. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED FIGHTER ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY		X		
MAINTAINABILITY			X	
AVAILABILITY		X		
PERSONNEL, SAFETY, TRAINING			X	
PART QUALITY LEVEL		X		
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT			X	
SPECIAL HANDLING			X	
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS			X	
NON-STANDARD POWER DEMANDS		X		
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE		X		
SMALL BUSINESS OPPORTUNITY				
SPARES PROVISIONING, AVAILABILITY			X	
GUARANTEES AND WARRANTIES		X		
GOVERNMENT DATA RIGHTS			X	

COMPANY D

DIVISION 2

3. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED TRANSPORT ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY		X		
MAINTAINABILITY			X	
AVAILABILITY		X		
PERSONNEL, SAFETY, TRAINING			X	
PART QUALITY LEVEL		X		
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT			X	
SPECIAL HANDLING			X	
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS			X	
NON-STANDARD POWER DEMANDS		X		
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE		X		
SMALL BUSINESS OPPORTUNITY			X	
SPARES PROVISIONING, AVAILABILITY			X	
GUARANTEES AND WARRANTIES		X		
GOVERNMENT DATA RIGHTS			X	

COMPANY D

DIVISION 2

4. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY GROUND FIXED ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY		X		
MAINTAINABILITY		X		
AVAILABILITY		X		
PERSONNEL, SAFETY, TRAINING			X	
PART QUALITY LEVEL		X		
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT			X	
SPECIAL HANDLING		X		
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS		X		
NON-STANDARD POWER DEMANDS		X		
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE		X		
SMALL BUSINESS OPPORTUNITY			X	
SPARES PROVISIONING, AVAILABILITY			X	
GUARANTEES AND WARRANTIES		X		
GOVERNMENT DATA RIGHTS			X	

INDUSTRY SURVEY: RELIABILITY, MAINTAINABILITY AND LIFE CYCLE COST EFFECT OF USING COMMERCIAL OFF-THE-SHELF EQUIPMENT

RETURN TO:

COLLINS AVIONICS GROUP
400 COLLINS ROAD, N.E.
CEDAR RAPIDS, IOWA 52406
ATTENTION: MR. BRUCE JOHNSON
M/S 108-275

COMPANY D, Division 3

ADDRESS _____ ZIP CODE _____

CONTACT _____ PHONE NUMBER: _____

PRINCIPAL PRODUCT LINE	COMMERCIAL	MILITARY

1. ORGANIZATIONS GENERAL VIEW OF COMMERCIAL OFF-THE-SHELF EQUIPMENT USED IN MILITARY APPLICATIONS.

	APPLICABLE	NOT APPLICABLE	APPLICABLE WITH EXTRA MEASURES
AIRBORNE INHABITED FIGHTER		X	
AIRBORNE INHABITED TRANSPORT			X
FIXED GROUND	X		

COMPANY D

DIVISION 3

2. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED FIGHTER ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY			X	
MAINTAINABILITY			X	
AVAILABILITY		X		
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL		X		
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	X			
SPECIAL HANDLING			X	
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS			X	
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE			X	
SMALL BUSINESS OPPORTUNITY				
SPARES PROVISIONING, AVAILABILITY			X	
GUARANTEES AND WARRANTIES				
GOVERNMENT DATA RIGHTS				

COMPANY D

DIVISION 3

3. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED TRANSPORT ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY		X		
MAINTAINABILITY		X		
AVAILABILITY		X		
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL		X		
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	X			
SPECIAL HANDLING		X		
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS		X		
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE			X	
SMALL BUSINESS OPPORTUNITY				
SPARES PROVISIONING, AVAILABILITY		X		
GUARANTEES AND WARRANTIES				
GOVERNMENT DATA RIGHTS				

COMPANY D

DIVISION 3

4. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY GROUND FIXED ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY		X		
MAINTAINABILITY	X			
AVAILABILITY	X			
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL		X		
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	X			
SPECIAL HANDLING	X			
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS	X			
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE			X	
SMALL BUSINESS OPPORTUNITY				
SPARES PROVISIONING, AVAILABILITY			X	
GUARANTEES AND WARRANTIES				
GOVERNMENT DATA RIGHTS				

INDUSTRY SURVEY: RELIABILITY, MAINTAINABILITY AND LIFE CYCLE COST EFFECT OF USING COMMERCIAL OFF-THE-SHELF EQUIPMENT

RETURN TO:

COLLINS AVIONICS GROUP
400 COLLINS ROAD, N.E.
CEDAR RAPIDS, IOWA 52406
ATTENTION: MR. BRUCE JOHNSON
M/S 108-275

COMPANY D, Division 4

ADDRESS _____ ZIP CODE _____

CONTACT _____ PHONE NUMBER : _____

PRINCIPAL PRODUCT LINE	COMMERCIAL	MILITARY
Radars, Missiles & Test Equipment		

1. ORGANIZATIONS GENERAL VIEW OF COMMERCIAL OFF-THE-SHELF EQUIPMENT USED IN MILITARY APPLICATIONS.

	APPLICABLE	NOT APPLICABLE	APPLICABLE WITH EXTRA MEASURES
AIRBORNE INHABITED FIGHTER		X	
AIRBORNE INHABITED TRANSPORT			X
FIXED GROUND	X		

COMPANY D

DIVISION 4

This company has had considerable experience using commercial grade Test equipment in various military ground and shipboard environments. I am not aware of any of this company's airborne systems which have used commercial equipment.

The commercial test equipment has been found to be suitable in the AWM-23 in both shore-based and shipboard applications. The major problem has been a lack of support on the part of the U.S. Navy. There has been a shortfall in practically every element of support for CTE. This includes training, spares provisioning, and technical pubs for calibration/repair. If the CTE was given adequate logistic support it would be entirely suitable for most fixed ground environments.

COMPANY D

DIVISION 4

2. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED FIGHTER ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY	☐	☐	☐	This page not applicable.
MAINTAINABILITY	☐	☐	☐	
AVAILABILITY	☐	☐	☐	
PERSONNEL, SAFETY, TRAINING	☐	☐	☐	
PART QUALITY LEVEL	☐	☐	☐	
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	☐	☐	☐	
SPECIAL HANDLING	☐	☐	☐	
QUALITY ASSURANCE PROVISIONS	☐	☐	☐	
COMBAT READINESS	☐	☐	☐	
NON-STANDARD POWER DEMANDS	☐	☐	☐	
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE	☐	☐	☐	
SMALL BUSINESS OPPORTUNITY	☐	☐	☐	
SPARES PROVISIONING, AVAILABILITY	☐	☐	☐	
GUARANTEES AND WARRANTIES	☐	☐	☐	
GOVERNMENT DATA RIGHTS	☐	☐	☐	

COMPANY D

DIVISION 4

3. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED TRANSPORT ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY		X		
MAINTAINABILITY		X		
AVAILABILITY		X		
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL		X		
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	X			
SPECIAL HANDLING		X		
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS		X		
NON-STANDARD POWER DEMANDS		X		
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE			X	
SMALL BUSINESS OPPORTUNITY		X		
SPARES PROVISIONING, AVAILABILITY			X	
GUARANTEES AND WARRANTIES		X		
GOVERNMENT DATA RIGHTS			X	

COMPANY D

DIVISION 4

4. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY GROUND FIXED ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY	X			
MAINTAINABILITY		X		
AVAILABILITY				
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL		X		
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	X			
SPECIAL HANDLING		X		
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS	X			
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE			X	
SMALL BUSINESS OPPORTUNITY	X			
SPARES PROVISIONING, AVAILABILITY			X	Lack of configuration control in out-years.
GUARANTEES AND WARRANTIES		X		
GOVERNMENT DATA RIGHTS			X	

INDUSTRY SURVEY: RELIABILITY, MAINTAINABILITY AND LIFE CYCLE COST EFFECT OF USING COMMERCIAL OFF-THE-SHELF EQUIPMENT

RETURN TO:

COLLINS AVIONICS GROUP
400 COLLINS ROAD, N.E.
CEDAR RAPIDS, IOWA 52406
ATTENTION: MR. BRUCE JOHNSON
M/S 108-275

COMPANY D, Division 5

ADDRESS _____ ZIP CODE _____

CONTACT _____ PHONE NUMBER: _____

PRINCIPAL PRODUCT LINE	COMMERCIAL	MILITARY
Air to Air, Air to Ground	None	All Sources
Missiles		

1. ORGANIZATIONS GENERAL VIEW OF COMMERCIAL OFF-THE-SHELF EQUIPMENT USED IN MILITARY APPLICATIONS.

	APPLICABLE	NOT APPLICABLE	APPLICABLE WITH EXTRA MEASURES
AIRBORNE INHABITED FIGHTER	[ ]	[ ]	[X]
AIRBORNE INHABITED TRANSPORT	[ ]	[ ]	[X]
FIXED GROUND	[X]	[ ]	[ ]

COMPANY D

DIVISION 5

The Collins Avionic Survey on cost/benefits of using "off-the-shelf" commercial equipment should be answered primarily by TSD. The usage of this type of equipment as seen from the FSO standpoint is after the commercial equipment is selected and specific acceptance and design requirements are established by either Standard Drawings (900 000 specs) or specification/source control drawings. TSD can better determine if commercial equipment is usable without controls being established. The terms cited: good or best commercial practice, militarized or ruggedized, is not defined and if used would require specific definition or development of industry standards.

It is recommended that FSO defer to the design activities for comments.

COMPANY D

DIVISION 5

2. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED FIGHTER ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY		X		
MAINTAINABILITY			X	
AVAILABILITY		X		
PERSONNEL, SAFETY, TRAINING			X	
PART QUALITY LEVEL		X		
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	X			
SPECIAL HANDLING	X			
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS		X		
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE		X		
SMALL BUSINESS OPPORTUNITY			X	
SPARES PROVISIONING, AVAILABILITY			X	
GUARANTEES AND WARRANTIES	X			
GOVERNMENT DATA RIGHTS			X	

COMPANY D

DIVISION 5

3. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED TRANSPORT ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY		X		
MAINTAINABILITY			X	Data availability.
AVAILABILITY		X		
PERSONNEL, SAFETY, TRAINING			X	Data availability.
PART QUALITY LEVEL		X		
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	X			
SPECIAL HANDLING	X			
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS		X		
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE		X		
SMALL BUSINESS OPPORTUNITY				
SPARES PROVISIONING, AVAILABILITY				
GUARANTEES AND WARRANTIES	X			
GOVERNMENT DATA RIGHTS			X	

COMPANY D

DIVISION 5

4. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY GROUND FIXED ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY		X		
MAINTAINABILITY			X	Data availability.
AVAILABILITY		X		
PERSONNEL, SAFETY, TRAINING			X	Data availability.
PART QUALITY LEVEL		X		
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	X			
SPECIAL HANDLING	X			
QUALITY ASSURANCE PROVISIONS	X			
COMBAT READINESS		X		
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE		X		
SMALL BUSINESS OPPORTUNITY		X		
SPARES PROVISIONING, AVAILABILITY			X	
GUARANTEES AND WARRANTIES	X			
GOVERNMENT DATA RIGHTS			X	

INDUSTRY SURVEY: RELIABILITY, MAINTAINABILITY AND LIFE CYCLE COST EFFECT OF USING COMMERCIAL OFF-THE-SHELF EQUIPMENT

RETURN TO:

COLLINS AVIONICS GROUP
400 COLLINS ROAD, N.E.
CEDAR RAPIDS, IOWA 52406
ATTENTION: MR. BRUCE JOHNSON
M/S 108-275

COMPANY D, Division 6

ADDRESS _____ ZIP CODE _____

CONTACT _____ PHONE NUMBER: _____

PRINCIPAL PRODUCT LINE	COMMERCIAL	MILITARY

1. ORGANIZATIONS GENERAL VIEW OF COMMERCIAL OFF-THE-SHELF EQUIPMENT USED IN MILITARY APPLICATIONS.

	APPLICABLE	NOT APPLICABLE	APPLICABLE WITH EXTRA MEASURES
AIRBORNE INHABITED FIGHTER		X	
AIRBORNE INHABITED TRANSPORT			X
FIXED GROUND	X		

COMPANY D

DIVISION 6

2. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED FIGHTER ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY			X	
MAINTAINABILITY	X			
AVAILABILITY	X			
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL		X		
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT		X		
SPECIAL HANDLING	X			
QUALITY ASSURANCE PROVISIONS				
COMBAT READINESS		X		
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE			X	
SMALL BUSINESS OPPORTUNITY				
SPARES PROVISIONING, AVAILABILITY	X			
GUARANTEES AND WARRANTIES		X		
GOVERNMENT DATA RIGHTS			X	

COMPANY D

DIVISION 6

3. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED TRANSPORT ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY		X		
MAINTAINABILITY	X			
AVAILABILITY	X			
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL	X			
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	X			
SPECIAL HANDLING		X		
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS		X		
NON-STANDARD POWER DEMANDS		X		
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE		X		
SMALL BUSINESS OPPORTUNITY				
SPARES PROVISIONING, AVAILABILITY	X			
GUARANTEES AND WARRANTIES		X		
GOVERNMENT DATA RIGHTS			X	

COMPANY D

DIVISION 6

4. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY GROUND FIXED ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY	X			
MAINTAINABILITY	X			
AVAILABILITY	X			
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL	X			
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	X			
SPECIAL HANDLING	X			
QUALITY ASSURANCE PROVISIONS	X			
COMBAT READINESS	X			
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE		X		
SMALL BUSINESS OPPORTUNITY				
SPARES PROVISIONING, AVAILABILITY	X			
GUARANTEES AND WARRANTIES		X		
GOVERNMENT DATA RIGHTS			X	

INDUSTRY SURVEY: RELIABILITY, MAINTAINABILITY AND LIFE CYCLE COST EFFECT OF USING COMMERCIAL OFF-THE-SHELF EQUIPMENT

RETURN TO:

COLLINS AVIONICS GROUP
400 COLLINS ROAD, N.E.
CEDAR RAPIDS, IOWA 52406
ATTENTION: MR. BRUCE JOHNSON
M/S 108-275

COMPANY D, Division 7

ADDRESS _____ ZIP CODE _____

CONTACT _____ PHONE NUMBER: _____

PRINCIPAL PRODUCT LINE	COMMERCIAL	MILITARY

1. ORGANIZATIONS GENERAL VIEW OF COMMERCIAL OFF-THE-SHELF EQUIPMENT USED IN MILITARY APPLICATIONS.

	APPLICABLE	NOT APPLICABLE	APPLICABLE WITH EXTRA MEASURES
AIRBORNE INHABITED FIGHTER			X
AIRBORNE INHABITED TRANSPORT			X
FIXED GROUND	X		

COMPANY D

DIVISION 7

2. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED FIGHTER ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY			X	
MAINTAINABILITY			X	
AVAILABILITY			X	
PERSONNEL, SAFETY, TRAINING		X		
PART QUALITY LEVEL			X	
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT		X		
SPECIAL HANDLING		X		
QUALITY ASSURANCE PROVISIONS			X	
COMBAT READINESS			X	
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE			X	
SMALL BUSINESS OPPORTUNITY		X		
SPARES PROVISIONING, AVAILABILITY			X	
GUARANTEES AND WARRANTIES			X	
GOVERNMENT DATA RIGHTS	X			

COMPANY D

DIVISION 7

3. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED TRANSPORT ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY			X	
MAINTAINABILITY			X	
AVAILABILITY			X	
PERSONNEL, SAFETY, TRAINING		X		
PART QUALITY LEVEL			X	
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT		X		
SPECIAL HANDLING		X		
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS			X	
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE			X	
SMALL BUSINESS OPPORTUNITY		X		
SPARES PROVISIONING, AVAILABILITY			X	
GUARANTEES AND WARRANTIES			X	
GOVERNMENT DATA RIGHTS	X			

COMPANY D

DIVISION 7

4. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY GROUND FIXED ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY		X		
MAINTAINABILITY		X		
AVAILABILITY		X		
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL		X		
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	X			
SPECIAL HANDLING	X			
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS		X		
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE		X		
SMALL BUSINESS OPPORTUNITY		X		
SPARES PROVISIONING, AVAILABILITY			X	
GUARANTEES AND WARRANTIES		X		
GOVERNMENT DATA RIGHTS	X			

INDUSTRY SURVEY: RELIABILITY, MAINTAINABILITY AND LIFE CYCLE COST EFFECT OF USING COMMERCIAL OFF-THE-SHELF EQUIPMENT

RETURN TO:

COLLINS AVIONICS GROUP
400 COLLINS ROAD, N.E.
CEDAR RAPIDS, IOWA 52406
ATTENTION: MR. BRUCE JOHNSON
M/S 108-275

COMPANY D, Division 8

ADDRESS _____ ZIP CODE _____

CONTACT _____ PHONE NUMBER: _____

PRINCIPAL PRODUCT LINE	COMMERCIAL	MILITARY

1. ORGANIZATIONS GENERAL VIEW OF COMMERCIAL OFF-THE-SHELF EQUIPMENT USED IN MILITARY APPLICATIONS.

	APPLICABLE	NOT APPLICABLE	APPLICABLE WITH EXTRA MEASURES
AIRBORNE INHABITED FIGHTER	☐	☐	☐
AIRBORNE INHABITED TRANSPORT	☐	☐	☐
FIXED GROUND	☐	☐	☐

COMPANY D

DIVISION 8

2. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED FIGHTER ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY			X	Obvious
MAINTAINABILITY			X	Obvious
AVAILABILITY	X			
PERSONNEL, SAFETY, TRAINING			X	Obvious
PART QUALITY LEVEL				
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT				
SPECIAL HANDLING				Not much applicability in the commercial world.
QUALITY ASSURANCE PROVISIONS				
COMBAT READINESS				
NON-STANDARD POWER DEMANDS				
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE				
SMALL BUSINESS OPPORTUNITY	X			
SPARES PROVISIONING, AVAILABILITY	X			
GUARANTEES AND WARRANTIES				Can be had for a price for commercial equipment?
GOVERNMENT DATA RIGHTS				

COMPANY D

DIVISION 8

3. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED TRANSPORT ENVIRONMENT WITH RESPECT TO THE LISTEDMAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY	☐	☐	☐	Essentially the same as Page 2.
MAINTAINABILITY	☐	☐	☐	
AVAILABILITY	☐	☐	☐	
PERSONNEL, SAFETY, TRAINING	☐	☐	☐	
PART QUALITY LEVEL	☐	☐	☐	
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	☐	☐	☐	
SPECIAL HANDLING	☐	☐	☐	
QUALITY ASSURANCE PROVISIONS	☐	☐	☐	
COMBAT READINESS	☐	☐	☐	
NON-STANDARD POWER DEMANDS	☐	☐	☐	
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE	☐	☐	☐	
SMALL BUSINESS OPPORTUNITY	☐	☐	☐	
SPARES PROVISIONING, AVAILABILITY	☐	☐	☐	
GUARANTEES AND WARRANTIES	☐	☐	☐	
GOVERNMENT DATA RIGHTS	☐	☐	☐	

COMPANY D

DIVISION 8

4. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY GROUND FIXED ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY	☐	☐	☐	
MAINTAINABILITY	☐	☐	☐	
AVAILABILITY	☐	☐	☐	Alot of commercial equipment is already used in fixed ground environment, and much more could be used.
PERSONNEL, SAFETY, TRAINING	☐	☐	☐	
PART QUALITY LEVEL	☐	☐	☐	
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	☐	☐	☐	Some commmercial equipment is better than military equipment. Good examples are voice communications and video transmitters and receivers.
SPECIAL HANDLING	☐	☐	☐	
QUALITY ASSURANCE PROVISIONS	☐	☐	☐	
COMBAT READINESS	☐	☐	☐	
NON-STANDARD POWER DEMANDS	☐	☐	☐	Alot of commercial equipment is suitable for trainers and simulators.
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE	☐	☐	☐	
SMALL BUSINESS OPPORTUNITY	☐	☐	☐	The best bargains in test equipment are commercial.
SPARES PROVISIONING, AVAILABILITY	☐	☐	☐	
GUARANTEES AND WARRANTIES	☐	☐	☐	
GOVERNMENT DATA RIGHTS	☐	☐	☐	

INDUSTRY SURVEY: RELIABILITY, MAINTAINABILITY AND LIFE CYCLE COST EFFECT OF USING COMMERCIAL OFF-THE-SHELF EQUIPMENT

RETURN TO:

COLLINS AVIONICS GROUP
400 COLLINS ROAD, N.E.
CEDAR RAPIDS, IOWA 52406
ATTENTION: MR. BRUCE JOHNSON
M/S 108-275

COMPANY D, Division 9

ADDRESS _____ ZIP CODE _____

CONTACT _____ PHONE NUMBER: _____

PRINCIPAL PRODUCT LINE	COMMERCIAL	MILITARY

1. ORGANIZATIONS GENERAL VIEW OF COMMERCIAL OFF-THE-SHELF EQUIPMENT USED IN MILITARY APPLICATIONS.

	APPLICABLE	NOT APPLICABLE	APPLICABLE WITH EXTRA MEASURES
AIRBORNE INHABITED FIGHTER			X
AIRBORNE INHABITED TRANSPORT			X
FIXED GROUND	X		

COMPANY D

DIVISION 9

Based on experience of the Material staff and discussions with manufacturers, distributors, and vendors with which we do business, the following comments regarding use of commercial off-the-shelf equipment are submitted.

1. The end use application of the item in question is a critical factor in the consideration of need for control over the exact characteristics, reliability and dependability of the item. Military specifications do not make a reliable item. They only provide the specifications to which an item is supposed to be manufactured or built, and they provide Government control over the item. Commercial items may be as dependable, reliable and durable as any Mil Spec item, or more. Assuming equivalent quality assurance for both, from a performance standpoint, the major difference in specifying commercial or Mil Spec items boils down to the technical task of determining that the specifications for the item, including QA, meet the requirement of the application. The job is minimized for the buyer (Government when a Mil Spec can be specified). It becomes much more extensive and expensive in terms of manpower (for the buyer) when the buyer (Government) must make a separate determination for each application and across a range of vendors as to the acceptability of several commercial items. Further, control is lost, or may be lost, on specification stability for follow-up buys after an initial determination has been made. Then another determination of acceptability may be necessary for each subsequent acquisition. The Mil Spec obviates this necessity, albeit at generally higher acquisition cost, in most cases.

2. In applications of lesser criticality, e.g., ground support, adminstrative and other such applications, a trade-off of perhaps higher risk (at least some higher degree of uncertainty about the risk) for the lesser cost and higher availability of commercial off-the-shelf items certainly seems in order. In general, those are the advantages to be expected: Generally lower cost for the item itself; in general, a wider range of sources for the requirements, most assuredly to include more small businesses; and the resultant greater degree of short-term availability.

3. It is doubtful that the Government will ever be able to afford the manpower necessary to insure that the requirements of critical applications are met from commercial off-the-shelf items. Further, it is doubtful that the responsibilty for that assurace can be delegated through contracts with private industry. Moreover, the need for safeguarding information concerning military combat vehicles dictates against use of commonly available equipment. Thus, the continuation of military specifications and standards for critical military combat applications seems unavoidable. A program to accept commercial off-the-shelf items for less critical military applications however, seems very desirable from a cost, support effectiveness and operational viewpoint.

4. A copy of the Collins questionnaire with some positions reflected is attached.

COMPANY D
DIVISION 9

2. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED FIGHTER ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY			X	
MAINTAINABILITY		X		
AVAILABILITY		X		
PERSONNEL, SAFETY, TRAINING		X		
PART QUALITY LEVEL		X		
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT		X		
SPECIAL HANDLING			X	
QUALITY ASSURANCE PROVISIONS			X	
COMBAT READINESS		X		
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE			X	
SMALL BUSINESS OPPORTUNITY			X	
SPARES PROVISIONING, AVAILABILITY		X		
GUARANTEES AND WARRANTIES			X	
GOVERNMENT DATA RIGHTS			X	

COMPANY D
DIVISION 9

3. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED TRANSPORT ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY		X		
MAINTAINABILITY		X		
AVAILABILITY	X			
PERSONNEL, SAFETY, TRAINING		X		
PART QUALITY LEVEL		X		
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	X			
SPECIAL HANDLING		X		
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS		X		
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE		X		
SMALL BUSINESS OPPORTUNITY		X		
SPARES PROVISIONING, AVAILABILITY	X			
GUARANTEES AND WARRANTIES		X		
GOVERNMENT DATA RIGHTS			X	

COMPANY D
DIVISION 9

4. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY GROUND FIXED ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY		X		
MAINTAINABILITY	X			
AVAILABILITY	X			
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL		X		
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	X			
SPECIAL HANDLING	X			
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS		X		
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE			X	
SMALL BUSINESS OPPORTUNITY		X		
SPARES PROVISIONING, AVAILABILITY		X		
GUARANTEES AND WARRANTIES		X		
GOVERNMENT DATA RIGHTS			X	

INDUSTRY SURVEY: RELIABILITY, MAINTAINABILITY AND LIFE CYCLE COST EFFECT OF USING COMMERCIAL OFF-THE-SHELF EQUIPMENT

RETURN TO:

COLLINS AVIONICS GROUP
400 COLLINS ROAD, N.E.
CEDAR RAPIDS, IOWA 52406
ATTENTION: MR. BRUCE JOHNSON
M/S 108-275

COMPANY D, Division 10

ADDRESS _____ ZIP CODE _____

CONTACT _____ PHONE NUMBER: _____

PRINCIPAL PRODUCT LINE	COMMERCIAL	MILITARY

1. ORGANIZATIONS GENERAL VIEW OF COMMERCIAL OFF-THE-SHELF EQUIPMENT USED IN MILITARY APPLICATIONS.

	APPLICABLE	NOT APPLICABLE	APPLICABLE WITH EXTRA MEASURES
AIRBORNE INHABITED FIGHTER	☐	☐	X
AIRBORNE INHABITED TRANSPORT	☐	☐	X
FIXED GROUND	☐	☐	X

COMPANY D
DIVISION 10

2. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED FIGHTER ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK
RELIABILITY		X	
MAINTAINABILITY	X		
AVAILABILITY		X	
PERSONNEL, SAFETY, TRAINING		X	
PART QUALITY LEVEL		X	
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT			X
SPECIAL HANDLING	X		
QUALITY ASSURANCE PROVISIONS		X	
COMBAT READINESS		X	
NON-STANDARD POWER DEMANDS	X		
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE		X	
SMALL BUSINESS OPPORTUNITY ?			
SPARES PROVISIONING, AVAILABILITY			*
GUARANTEES AND WARRANTIES			X
GOVERNMENT DATA RIGHTS			X

COMMENTS

*The principal problem encountered in using commercial parts in military applications is in the interface between drawing requirements, procurement requirements and, ultimately, provisioning. The military contractor's procurement system is based on standardized part numbers. The drawing system does not handle multiple part numbers with any efficiency. The resulting provisioning documentation can become a nightmare. Commercial suppliers are unlikely to develop an industry standard for numbering. Lacking that, the massive drawing/procurement/ILS system of the military must be dramatically changed if commercial parts are to be used. Considerations such as reliability are miniscule compared to the baroque controls that are required to bring a commercial part into a MIL-grade procurement system.

COMPANY D
DIVISION 10

3. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED TRANSPORT ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK
RELIABILITY		X	
MAINTAINABILITY	X		
AVAILABILITY		X	
PERSONNEL, SAFETY, TRAINING		X	
PART QUALITY LEVEL		X	
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT			X
SPECIAL HANDLING	X		
QUALITY ASSURANCE PROVISIONS		X	
COMBAT READINESS		X	
NON-STANDARD POWER DEMANDS	X		
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE		X	
SMALL BUSINESS OPPORTUNITY ?			
SPARES PROVISIONING, AVAILABILITY			*
GUARANTEES AND WARRANTIES			X
GOVERNMENT DATA RIGHTS			X

COMMENTS

*The principal problem encountered in using commercial parts in military applications is in the interface between drawing requirements, procurement requirements and, ultimately, provisioning. The military contractor's procurement system is based on standardized part numbers. The drawing system does not handle multiple part numbers with any efficiency. The resulting provisioning documentation can become a nightmare. Commercial suppliers are unlikely to develop an industry standard for numbering. Lacking that, the massive drawing/procurement/ILS system of the military must be dramatically changed if commercial parts are to be used. Considerations such as reliability are miniscule compared to the baroque controls that are required to bring a commercial part into a MIL-grade procurement system.

INDUSTRY SURVEY: RELIABILITY, MAINTAINABILITY AND LIFE CYCLE COST EFFECT OF USING COMMERCIAL OFF-THE-SHELF EQUIPMENT

RETURN TO:

COLLINS AVIONICS GROUP
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CEDAR RAPIDS, IOWA 52406
ATTENTION: MR. BRUCE JOHNSON
M/S 108-275

COMPANY D, Division 11

ADDRESS _____ ZIP CODE _____

CONTACT _____ PHONE NUMBER: _____

PRINCIPAL PRODUCT LINE	COMMERCIAL	MILITARY

1. ORGANIZATIONS GENERAL VIEW OF COMMERCIAL OFF-THE-SHELF EQUIPMENT USED IN MILITARY APPLICATIONS.

	APPLICABLE	NOT APPLICABLE	APPLICABLE WITH EXTRA MEASURES
AIRBORNE INHABITED FIGHTER			
AIRBORNE INHABITED TRANSPORT			
FIXED GROUND	X		X

COMPANY D

DIVISION 11

If we are permitted used of Commercial Off-the-Shelf equipment it is obvious that the opportunity for dealing with small business firms will be greatly expanded, and lead times for spares will be significantly reduced. It does not appear that our warranty obligations will be significantly affected. There should be no affect on Government Data Rights except that there may be a reduction in requests for limited rights data since procurement would probably be more straight forward and less complex; however, this is not of significance.

COMPANY D
DIVISION 11

3. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED TRANSPORT ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY	☐	☐	☐	
MAINTAINABILITY	☐	☐	☐	
AVAILABILITY	☐	☐	☐	
PERSONNEL, SAFETY, TRAINING	☐	☐	☐	
PART QUALITY LEVEL	☐	☐	☐	
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	☐	☐	☐	
SPECIAL HANDLING	☐	☐	☐	
QUALITY ASSURANCE PROVISIONS	☐	☐	☐	
COMBAT READINESS	☐	☐	☐	
NON-STANDARD POWER DEMANDS	☐	☐	☐	
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE	☐	☐	☐	
SMALL BUSINESS OPPORTUNITY	X	☐	☐	Greatly expanded opportunity
SPARES PROVISIONING, AVAILABILITY	X	☐	☐	Less lead times, much greater availability
GUARANTEES AND WARRANTIES	X	☐	☐	Not significantly affected
GOVERNMENT DATA RIGHTS	X	☐	☐	No affect. If anything, a reduction in requests for limited rights.

COMPANY D
DIVISION 11

4. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY GROUND FIXED ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY		X		* The principal problem encountered in using commercial parts in military applications is in the interface between drawing requirements, procurement requirements and, ultimately, provisioning. The military contractor's procurement system is based on standardized part numbers. The drawing system does not handle multiple part numbers with any efficiency. The resulting provisioning documentation can become a nightmare. Commercial suppliers are unlikely to develop an industry standard for numbering. Lacking that, the massive drawing/procurement/ILS system of the military must be dramatically changed if commercial parts are to be used. Considerations such as reliability are miniscule compared to baroque controls that are required to bring a commercial part into a MIL-grade procurement system.
MAINTAINABILITY	X			
AVAILABILITY		X		
PERSONNEL, SAFETY, TRAINING		X		
PART QUALITY LEVEL		X		
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT			X	
SPECIAL HANDLING	X			
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS		X		
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE		X		
SMALL BUSINESS OPPORTUNITY ?				
SPARES PROVISIONING, AVAILABILITY			*	
GUARANTEES AND WARRANTIES			X	
GOVERNMENT DATA RIGHTS			X	

COMPANY D
DIVISION 12

INDUSTRY SURVEY: RELIABILITY, MAINTAINABILITY AND LIFE CYCLE COST EFFECT OF USING COMMERCIAL OFF-THE-SHELF EQUIPMENT

RETURN TO:

COLLINS AVIONICS GROUP
400 COLLINS ROAD, N.E.
CEDAR RAPIDS, IOWA 52406
ATTENTION: MR. BRUCE JOHNSON
M/S 108-275

COMPANY D, Division 12

ADDRESS _____ ZIP CODE _____

CONTACT _____ PHONE NUMBER: _____

PRINCIPAL PRODUCT LINE	COMMERCIAL	MILITARY

1. ORGANIZATIONS GENERAL VIEW OF COMMERCIAL OFF-THE-SHELF EQUIPMENT USED IN MILITARY APPLICATIONS.

	APPLICABLE	NOT APPLICABLE	APPLICABLE WITH EXTRA MEASURES
AIRBORNE INHABITED FIGHTER		X	
AIRBORNE INHABITED TRANSPORT			X
FIXED GROUND	X		

COMPANY D
DIVISION 12

2. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED FIGHTER ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY			X	
MAINTAINABILITY		X		
AVAILABILITY	X			
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL		X		
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	X			
SPECIAL HANDLING	X			
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS		X		
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE	X			
SMALL BUSINESS OPPORTUNITY	X			
SPARES PROVISIONING, AVAILABILITY	X			
GUARANTEES AND WARRANTIES	X			
GOVERNMENT DATA RIGHTS		X		

COMPANY D
DIVISION 12

3. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED TRANSPORT ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY		X		
MAINTAINABILITY		X		
AVAILABILITY	X			
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL		X		
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	X			
SPECIAL HANDLING	X			
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS		X		
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE	X			
SMALL BUSINESS OPPORTUNITY	X			
SPARES PROVISIONING, AVAILABILITY	X			
GUARANTEES AND WARRANTIES	X			
GOVERNMENT DATA RIGHTS		X		

COMPANY D

DIVISION 12

4. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY GROUND FIXED ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY	X			
MAINTAINABILITY	X			
AVAILABILITY	X			
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL		X		
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	X			
SPECIAL HANDLING	X			
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS		X		
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE	X			
SMALL BUSINESS OPPORTUNITY	X			
SPARES PROVISIONING, AVAILABILITY	X			
GUARANTEES AND WARRANTIES	X			
GOVERNMENT DATA RIGHTS		X		

COMPANY D

DIVISION 13

INDUSTRY SURVEY: RELIABILITY, MAINTAINABILITY AND LIFE CYCLE COST EFFECT OF USING COMMERCIAL OFF-THE-SHELF EQUIPMENT

RETURN TO:

COLLINS AVIONICS GROUP
400 COLLINS ROAD, N.E.
CEDAR RAPIDS, IOWA 52406
ATTENTION: MR. BRUCE JOHNSON
M/S 108-275

COMPANY D, Division 13

ADDRESS _____ ZIP CODE _____

CONTACT _____ PHONE NUMBER: _____

PRINCIPAL PRODUCT LINE	COMMERCIAL	MILITARY

1. ORGANIZATIONS GENERAL VIEW OF COMMERCIAL OFF-THE-SHELF EQUIPMENT USED IN MILITARY APPLICATIONS.

	APPLICABLE	NOT APPLICABLE	APPLICABLE WITH EXTRA MEASURES
AIRBORNE INHABITED FIGHTER			X
AIRBORNE INHABITED TRANSPORT			X
FIXED GROUND	X		

Commercial environment in many cases are no less severe than military. For example, the temperature under the hood of a car exceeds the temperature limits of the inhabited portion of an aircraft.

FAA qualified equipment may exceed mil-spec in some cases.

Commercial piece parts can and have been used in military equipments - their quality level proven either by piece part burn-in and test or by burn-in at the assembly level.

Knowledge of commercial product design is very limited, but feel that good or best commercial quality equipment could be qualified to a reasonable mil environment.

COMPANY D
DIVISION 13

2. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED FIGHTER ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY			X	
MAINTAINABILITY	X			
AVAILABILITY	X			
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL			X	
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	X			
SPECIAL HANDLING		X		
QUALITY ASSURANCE PROVISIONS			X	
COMBAT READINESS			X	
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE	X			
SMALL BUSINESS OPPORTUNITY				
SPARES PROVISIONING, AVAILABILITY				
GUARANTEES AND WARRANTIES				
GOVERNMENT DATA RIGHTS				

COMPANY D
DIVISION 13

3. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED TRANSPORT ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY		X		
MAINTAINABILITY	X			
AVAILABILITY	X			
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL		X		
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	X			
SPECIAL HANDLING		X		
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS		X		
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE	X			
SMALL BUSINESS OPPORTUNITY				
SPARES PROVISIONING, AVAILABILITY				
GUARANTEES AND WARRANTIES				
GOVERNMENT DATA RIGHTS				

COMPANY D
DIVISION 13

4. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY GROUND FIXED ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY		X		
MAINTAINABILITY	X			
AVAILABILITY	X			
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL	X			
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	X			
SPECIAL HANDLING		X		
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS		X		
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE	X			
SMALL BUSINESS OPPORTUNITY				
SPARES PROVISIONING, AVAILABILITY				
GUARANTEES AND WARRANTIES				
GOVERNMENT DATA RIGHTS				

COMPANY D

DIVISION 14

INDUSTRY SURVEY: RELIABILITY, MAINTAINABILITY AND LIFE CYCLE COST EFFECT OF USING COMMERCIAL OFF-THE-SHELF EQUIPMENT

RETURN TO:

COLLINS AVIONICS GROUP
400 COLLINS ROAD, N.E.
CEDAR RAPIDS, IOWA 52406
ATTENTION: MR. BRUCE JOHNSON
M/S 108-275

COMPANY D, Division 14

ADDRESS _____ ZIP CODE _____

CONTACT _____ PHONE NUMBER: _____

PRINCIPAL PRODUCT LINE	COMMERCIAL	MILITARY

1. ORGANIZATIONS GENERAL VIEW OF COMMERCIAL OFF-THE-SHELF EQUIPMENT USED IN MILITARY APPLICATIONS.

	APPLICABLE	NOT APPLICABLE	APPLICABLE WITH EXTRA MEASURES
AIRBORNE INHABITED FIGHTER			
AIRBORNE INHABITED TRANSPORT			
FIXED GROUND	X		X

COMPANY D

DIVISION 14

Military fixed ground equipment can meet design objectives utilizing commercial off-the-shelf equipments. Most CTE vendors are reluctant to alter their product lines for the added requirements of the military applications. To reduce "high risk" areas the contract gives should relax specification which drive the life cycle costs. High risk areas which could be reduced are non-standard parts T & W , etc., and guaratees and warranties. If the Government or some agency would review CTE and establish a preferred list for design selection of non-standard parts, tools, logistics, etc., could be reduced. If the selected items were then used "unaltered" by the user. The CTE vendor warranties

COMPANY D
DIVISION 14

4. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY GROUND FIXED ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY	X			Using enclosed select to provide favorable environment.
MAINTAINABILITY		X		Varies with vendor; some good, some bad.
AVAILABILITY		X		Vendor can discontinue a given model or product line.
PERSONNEL, SAFETY, TRAINING	X			Mainly a user problem; not the vendor.
PART QUALITY LEVEL		X		Commercial equipment uses penny saving parts.
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT			X	Inventory could be larger.
SPECIAL HANDLING		X		Difficult to asses.
QUALITY ASSURANCE PROVISIONS			X	Varies.
COMBAT READINESS	X			Cannot answer
NON-STANDARD POWER DEMANDS	X			Many CTE are designed with CONUS European power options
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE		X		Federal regulations are beginning to minimum requirements.
SMALL BUSINESS OPPORTUNITY			X	Must sell "as is" or will lose shirt.
SPARES PROVISIONING, AVAILABILITY			X	Prone to being discontinued by vendor
GUARANTEES AND WARRANTIES			X	If modified by user, vendor warranty null and void
GOVERNMENT DATA RIGHTS			X	Vendors reluctant to provide manufacturing data.

COMPANY D
DIVISION 15

INDUSTRY SURVEY: RELIABILITY, MAINTAINABILITY AND LIFE CYCLE COST EFFECT OF USING COMMERCIAL OFF-THE-SHELF EQUIPMENT

RETURN TO:

COLLINS AVIONICS GROUP
400 COLLINS ROAD, N.E.
CEDAR RAPIDS, IOWA 52406
ATTENTION: MR. BRUCE JOHNSON
M/S 108-275

COMPANY D, Division 15

ADDRESS _____ ZIP CODE _____

CONTACT _____ PHONE NUMBER: _____

PRINCIPAL PRODUCT LINE	COMMERCIAL	MILITARY

1. ORGANIZATIONS GENERAL VIEW OF COMMERCIAL OFF-THE-SHELF EQUIPMENT USED IN MILITARY APPLICATIONS.

	APPLICABLE	NOT APPLICABLE	APPLICABLE WITH EXTRA MEASURES
AIRBORNE INHABITED FIGHTER		X	
AIRBORNE INHABITED TRANSPORT			X
FIXED GROUND			X

COMPANY D

DIVISION 15

BASIS FOR RESPONSE

The attached inputs were prepared by several of the more experienced test equipment engineers in the Depot Support Systems Engineering (DSSE) organization; each with 20 or more years experience in the use of test equipment for military applications: The DSSE organization has been one of the primary suppliers of field and depot test equipment in support of the company's products for all branches of the service. The test equipment provided by DSSE has been primarily specialized equipment developed to military specifications. Some of the more recent equipment for shop use includes high quality commercial equipment from suppliers such as Hewlett Packard, Tektronix, and Fluke.

SUMMARY OF COMMENTS

1. Characteristics of Military Test Equipment

   a. Procured to specification.
   b. Standard performance requirements established for reliability, parts and components, EMI, and other parameters.
   c. Normally supported by technical manuals and complement of spare parts.
   d. Configuration control maintained throughout operating life.

2. Characteristics of Commercial Equipment

   a. Develop to broad generalized applications.
   b. Documentation is generally concise.
   c. Spare parts information is often hard to obtain.
   d. Configuration control is generally not maintained.
   e. Spare parts may go out of production during equipment operating life.

3. Airborne fighters experience temperature extremes, shock and vibration levels, and other environmental characteristics not normally faced by ground equipment. Therefore, commercial equipment, if used in flight, must be carefully selected, particularly for critical applications.

4. Transport aircraft can accommodate equipment in the fuselage bays and racks. The experienced environmental conditions are comparable with high quality commercial equipment.

5. Ground equipment must be selected on the basis of its intended use. Flight line equipment not protected from the temperature extremes and environmental elements require ruggedized features and functional design parts not normally available in commercial equipment. Units intended for shop and depot use may function very well with commercial quality components. However, replacement parts may be a problem.

COMPANY D

DIVISION 15

GENERAL COMMENTS

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY		X		
MAINTAINABILITY	X			
AVAILABILITY	X			
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL	X			
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT		X		
SPECIAL HANDLING		X		
QUALITY ASSURANCE PROVISIONS	X			
COMBAT READINESS				
NON-STANDARD POWER DEMANDS		X		
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE			X	
SMALL BUSINESS OPPORTUNITY			X	
SPARES PROVISIONING, AVAILABILITY	X			
GUARANTEES AND WARRANTIES	X			
GOVERNMENT DATA RIGHTS			X	

COMPANY D

DIVISION 15

2. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED FIGHTER ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY			X	
MAINTAINABILITY			X	
AVAILABILITY	X			
PERSONNEL, SAFETY, TRAINING			X	
PART QUALITY LEVEL		X		
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT		X		
SPECIAL HANDLING		X		
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS			X	
NON-STANDARD POWER DEMANDS			X	
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE			X	
SMALL BUSINESS OPPORTUNITY	X			
SPARES PROVISIONING, AVAILABILITY		X		Long term problem.
GUARANTEES AND WARRANTIES			X	
GOVERNMENT DATA RIGHTS		X		

COMPANY D

DIVISION 15

3. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED TRANSPORT ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY	☐	X	☐	
MAINTAINABILITY	☐	X	☐	
AVAILABILITY	X	☐	☐	
PERSONNEL, SAFETY, TRAINING	☐	☐	X	
PART QUALITY LEVEL	☐	X	☐	
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	☐	X	☐	
SPECIAL HANDLING	☐	X	☐	
QUALITY ASSURANCE PROVISIONS	☐	X	☐	
COMBAT READINESS	☐	X	☐	
NON-STANDARD POWER DEMANDS	☐	☐	X	
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE	☐	☐	X	
SMALL BUSINESS OPPORTUNITY	X	☐	☐	
SPARES PROVISIONING, AVAILABILITY	☐	X	☐	Long term problem.
GUARANTEES AND WARRANTIES	☐	☐	X	
GOVERNMENT DATA RIGHTS	☐	X	☐	

COMPANY D

DIVISION 15

4. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY GROUND FIXED ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY		X		
MAINTAINABILITY		X		
AVAILABILITY	X			
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL		X		
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT		X		
SPECIAL HANDLING	X			
QUALITY ASSURANCE PROVISIONS	X			
COMBAT READINESS		X		
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE		X		
SMALL BUSINESS OPPORTUNITY	X			
SPARES PROVISIONING, AVAILABILITY		X		Long term problem.
GUARANTEES AND WARRANTIES	X			
GOVERNMENT DATA RIGHTS		X		

COMPANY D
DIVISION 16

INDUSTRY SURVEY: RELIABILITY, MAINTAINABILITY AND LIFE CYCLE COST EFFECT OF USING COMMERCIAL OFF-THE-SHELF EQUIPMENT

RETURN TO:

COLLINS AVIONICS GROUP
400 COLLINS ROAD, N.E.
CEDAR RAPIDS, IOWA 52406
ATTENTION: MR. BRUCE JOHNSON
M/S 108-275

COMPANY D, Division 16

ADDRESS _____ ZIP CODE _____

CONTACT _____ PHONE NUMBER: _____

PRINCIPAL PRODUCT LINE	COMMERCIAL	MILITARY

1. ORGANIZATIONS GENERAL VIEW OF COMMERCIAL OFF-THE-SHELF EQUIPMENT USED IN MILITARY APPLICATIONS.

	APPLICABLE	NOT APPLICABLE	APPLICABLE WITH EXTRA MEASURES
AIRBORNE INHABITED FIGHTER		X	
AIRBORNE INHABITED TRANSPORT			X
FIXED GROUND	X		

COMPANY D
DIVISION 16

2. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED FIGHTER ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY			X	
MAINTAINABILITY		X		
AVAILABILITY	X			
PERSONNEL, SAFETY, TRAINING		X		
PART QUALITY LEVEL			X	
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT			X	
SPECIAL HANDLING		X		
QUALITY ASSURANCE PROVISIONS			X	
COMBAT READINESS			X	
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE		X		
SMALL BUSINESS OPPORTUNITY	X			
SPARES PROVISIONING, AVAILABILITY	X			
GUARANTEES AND WARRANTIES	X			
GOVERNMENT DATA RIGHTS		X		

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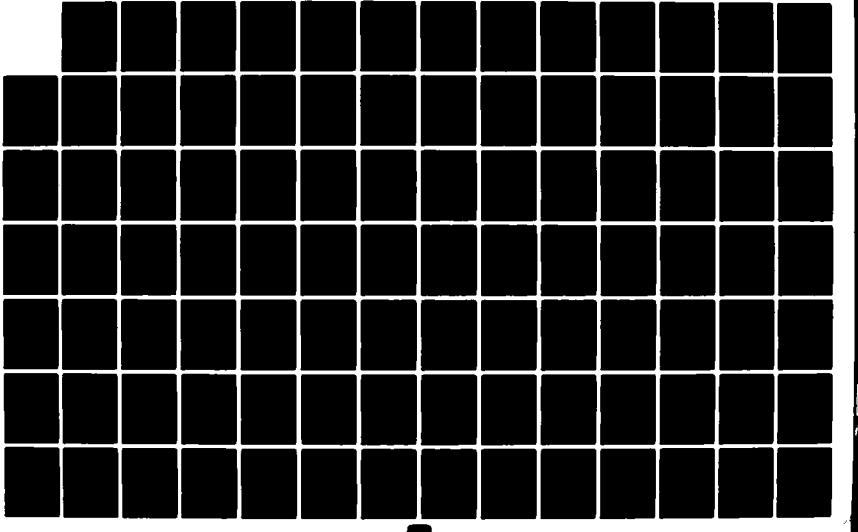

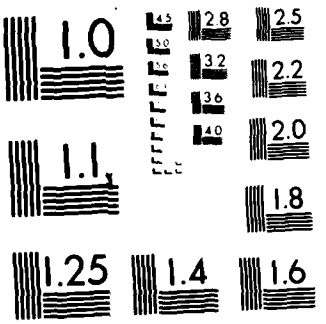

COMPANY D
DIVISION 16

3. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED TRANSPORT ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY		X		
MAINTAINABILITY	X			
AVAILABILITY	X			
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL		X		
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	X			
SPECIAL HANDLING		X		
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS		X		
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE		X		
SMALL BUSINESS OPPORTUNITY	X			
SPARES PROVISIONING, AVAILABILITY	X			
GUARANTEES AND WARRANTIES	X			
GOVERNMENT DATA RIGHTS		X		

COMPANY D
DIVISION 16

4. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY GROUND FIXED ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY	X			
MAINTAINABILITY	X			
AVAILABILITY	X			
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL	X			
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	X			
SPECIAL HANDLING		X		
QUALITY ASSURANCE PROVISIONS	X			
COMBAT READINESS	X			
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE		X		
SMALL BUSINESS OPPORTUNITY	X			
SPARES PROVISIONING, AVAILABILITY	X			
GUARANTEES AND WARRANTIES	X			
GOVERNMENT DATA RIGHTS		X		

COMPANY E

INDUSTRY SURVEY: RELIABILITY, MAINTAINABILITY AND LIFE CYCLE COST EFFECT OF USING COMMERCIAL OFF-THE-SHELF EQUIPMENT

RETURN TO:

COLLINS AVIONICS GROUP
400 COLLINS ROAD, N.E.
CEDAR RAPIDS, IOWA 52406
ATTENTION: MR. BRUCE JOHNSON
M/S 108-275

COMPANY E

ADDRESS _____ ZIP CODE _____

CONTACT _____ PHONE NUMBER: _____

PRINCIPAL PRODUCT LINE	COMMERCIAL	MILITARY

1. ORGANIZATIONS GENERAL VIEW OF COMMERCIAL OFF-THE-SHELF EQUIPMENT USED IN MILITARY APPLICATIONS.

	APPLICABLE	NOT APPLICABLE	APPLICABLE WITH EXTRA MEASURES
AIRBORNE INHABITED FIGHTER	☐	☐	X
AIRBORNE INHABITED TRANSPORT	☐	☐	X
FIXED GROUND	☐	☐	X

COMPANY E

2. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED FIGHTER ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY		X		AFTER LIMITED SCREENING OF THERMAL SHOCK AND BURN-IN, COMMERCIAL PARTS SHOW SAME FAILURE RATES AS MIL-SPEC SCREENED PARTS, WHILE OPERATING IN SYSTEMS.
MAINTAINABILITY	X			
AVAILABILITY	X			
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL		X		
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	X			
SPECIAL HANDLING	X			
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS	X			
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE	X			
SMALL BUSINESS OPPORTUNITY	X			
SPARES PROVISIONING, AVAILABILITY		X		
GUARANTEES AND WARRANTIES	X			
GOVERNMENT DATA RIGHTS	X			

COMPANY E

3. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY AIRBORNE INHABITED TRANSPORT ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY		X		AFTER LIMITED SCREENING OF THERMAL SHOCK AND BURN-IN, COMMERCIAL PARTS SHOW SAME FAILURE RATES AS MIL-SPEC SCREENED PARTS, WHILE OPERATING IN SYSTEMS.
MAINTAINABILITY	X			
AVAILABILITY	X			
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL		X		
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	X			
SPECIAL HANDLING	X			
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS	X			
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE	X			
SMALL BUSINESS OPPORTUNITY	X			
SPARES PROVISIONING, AVAILABILITY		X		
GUARANTEES AND WARRANTIES	X			
GOVERNMENT DATA RIGHTS	X			

COMPANY E

4. ORGANIZATIONS VIEW OF RISK INVOLVED IN THE USE OF COMMERCIAL OFF-THE-SHELF EQUIPMENT IN A MILITARY GROUND FIXED ENVIRONMENT WITH RESPECT TO THE LISTED MAJOR FACTORS.

MAJOR FACTORS	LOW RISK	MODERATE RISK	HIGH RISK	COMMENTS
RELIABILITY	X			AFTER LIMITED SCREENING OF THERMAL SHOCK AND BURN-IN, COMMERCIAL PARTS SHOW SAME FAILURE RATES AS MIL-SPEC SCREENED PARTS, WHILE OPERATING IN SYSTEMS.
MAINTAINABILITY	X			
AVAILABILITY	X			
PERSONNEL, SAFETY, TRAINING	X			
PART QUALITY LEVEL		X		
NON-STANDARD PARTS, TOOLS, MATERIALS, PROCESSES, TEST EQUIPMENT	X			
SPECIAL HANDLING	X			
QUALITY ASSURANCE PROVISIONS		X		
COMBAT READINESS	X			
NON-STANDARD POWER DEMANDS	X			
ELECTROMAGNETIC COMPATIBILITY, INTERFERENCE	X			
SMALL BUSINESS OPPORTUNITY	X			
SPARES PROVISIONING, AVAILABILITY		X		
GUARANTEES AND WARRANTIES	X			
GOVERNMENT DATA RIGHTS	X			

APPENDIX 2

LIFE CYCLE COST MODEL COMPUTER LISTING

A2.0 INTRODUCTION

This Appendix contains a complete listing of the program LCC, Version 2 life cycle cost model dated April 1976 as implemented on a UNIVAC 1100/81 computes for use on the Reliability, Maintainability and Life Cycle Cost Effects of Using Commercial Off-The-Shelf Equipment study contract. This LCC program was developed by the Analytic Sciences Corporation for the Aeronautical Systems Division (AFSC), USAF under contract number F33657-75-C-0674.

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C FIRST SECTION OF TASC LCC MODEL 1/25/80
C 7/25/79 VERSION REVISED 1/25/80 - INCREASED MAX NRU 50 TO 500
C 6/04/79 VERSION REVISED 7/25/79 - LCC-2A VERSION FROM DRC
C 5/30/79 VERSION REVISED 6/4/79 -INCREASED MAX SE FROM 10 TO 40
C 12/8/78 VERSION REVISED 5/30/79 -INCREASED MAX SYS PER BASE TO 400
C      AND OTHER CORRECTIONS.
      CHARACTER*4 STYTL(8)
      COMMON /PRINT/IPRT(9),STYTL,CTIME,CDATE
      COMMON ISWTCH
      COMMON / BLK A /SIE, SBR, SDR,SDR2, SPSC, SPSO, SID, SIM,
     &                SDM, SBMC, SDMC, SDC2, DF
      CHARACTER*8 CTIME,CDATE
      CALL ADATE(CTIME,CDATE)
      READ (  5,50) (IPRT(I),I=1,9),(STYTL(I),I=1,8)
   50 FORMAT (9I2,11X,8A4)
      CALL READA
      CALL READB
      CALL READC
      CALL READD
      CALL READE
      CALL LCCIN1
      IF(IPRT(1).NE.1)GO TO 100
      CALL WRTA
      CALL WRTB
      CALL WRTC
      CALL WRTD
      CALL WRTE
  100 CONTINUE
      CALL CCHECK
  200 CONTINUE
      CALL CCOMP
      CALL GRCOMP
      CALL VALID
      CALL SERC
      IF(IPRT(2).EQ.1.AND.ISWTCH.LE.0) CALL OUTOP2
      CALL SREQ
      IF(IPRT(4).EQ.1.AND.ISWTCH.LE.0) CALL OUTOP3
      CALL MPREQ
      IF(IPRT(5).EQ.1.AND.ISWTCH.LE.0) CALL PRNTMP
      IF(IPRT(5).EQ.1.AND.ISWTCH.LE.0) CALL REJECT
      CALL ACE
      CALL OMC
      CALL SUCM(0)
      CALL DCM
      CALL SUCM(1)
      CALL OUTOP4
      IF(ISWTCH.NE.0) CALL COMPOS
      ISWTCH=-ISWTCH
      IF(ISWTCH.EQ.-1) GO TO 200
      CALL LCCIN2
```

```
      GO TO 200
      END
      SUBROUTINE ACE
      COMMON / SYSBAS /NALCC(400),IALCC(400),NALCO(400),IALCO(400),
     &                 NSC,NSO
      COMMON / SPRDAT /NRS(500),SRUS(500),LRUS(500),SRUMAX, LRUMAX,
     &                 NRS2(500)
      INTEGER SRUS, SRUMAX
      COMMON / ACEDAT /AC(9,26), DAC(9,26)
      COMMON / ACTSCH /NAC(12,25), NCUM(12,25),   MACDEX
      COMMON / BLK A /SIE, SBR, SDR,SDR2, SPSC, SPSO, SID, SIM,
     &                 SDM, SBMC, SDMC, SDC2, DF
      COMMON / BLK B /NY, NBC, NIC, NBO, NIO, SIN, OH, NDS, RSTC,
     &                 RSTO, DMC, DRC, BDSC, BDSO, TAT, WP, ISP, AO1,
     &                 AO2, DSSF, NIS
      INTEGER WP
      COMMON / BLK C /NRU,LN(500),IN(500),ANAME(500,5),NQ(500),CRU(500),
     &           MTBF(500),UFP(500),W(500),FVS(500),RLS(500),RRS(500),
     &                RMS(500),NRTS(500),COND(500),LV(500),LV2(500),
     &                LSEV(500),USEV(500),LR(500),LR2(500),LSER(500,4),
     &          USER(500,4),RTS(500),LREM(500),NRTS2(500),COND2(500)
      REAL NRTS,NRTS2, MTBF
      CHARACTER*8 NAME(9)
      CHARACTER*4 ANAME,ANSE
      COMMON / BLK D /NSE, LSE(40), ANSE(40,5), CSE(40), COM(40)
      COMMON / BLK E /ACS, BTC, DTC, DCB, DCD, DCO, NPB, NPD, NPO,
     &                 NI, CRSC, CRSO, CDMC, WPR
      COMMON / SUPDAT /IBREQ(40), IDREQ(40), IBR2(40), IDR2(40)
      COMMON /PRINT/IPRT(9),STYTL(8),CTIME,CDATE
      COMMON ISWTCH
      DIMENSION NOP(25), NCUMEQ(300),AC2(9,26)
      EQUIVALENCE (NCUMEQ,NCUM)
      DATA NAME /'INT TRIN','DATA AQ ','ITEM ENT','DATA MGT','PRIM HDR',
     &           'S.E.    ','INIT SP ','INST    ','WARRANTY'/
      KSTAR = ( MACDEX+11)/12
      DO 200 I=1,8
      DO 100 J=1,25
      AC(I,J)=0.0
  100 CONTINUE
  200 CONTINUE
      NTOT = NSC+NSO
      KSTAR1 = KSTAR-1
      DO 300 K = 1,KSTAR1
      NOP(K) = NCUM(12,K)
  300 CONTINUE
      NOP(KSTAR) = NCUMEQ( MACDEX)
      AC(1,1)=BTC
      AC(1,WP+1)=AC(1,WP+1)+DTC
      AC(2,1)=DCB+DCO
```

```
      AC(2,WP+1)=AC(2,WP+1)+DCD
      AC(3,WP+1)=FLOAT(NI)*SIE
      AC(4,1)=FLOAT((NPB+NPO)*(2*(NBC+NBO)+NTOT+5))*SID
      AC(4,WP+1)=AC(4,WP+1)+FLOAT(NPD*(2*(NBC+NBO)+NTOT+5))*SID
      AC(5,1)=FLOAT(NOP(1))*ACS
      IF(KSTAR.EQ.1)GO TO 700
      DO 600 K=2,KSTAR
      AC(5,K) = FLOAT(NOP(K)-NOP(K-1))*ACS
  600 CONTINUE
  700 CONTINUE
      TERM1=0.0
      TERM=0.0
      DO 800 J=1,NSE
      TERM=TERM+ FLOAT(IBREQ(J)-IBR2(J))*CSE(J)
      TERM1=TERM1+FLOAT(IDREQ(J)-IDR2(J))*CSE(J)
  800 CONTINUE
      IF(WP.EQ.0)TERM=TERM+TERM1
      AC(6,1)= FLOAT(NOP(1))*TERM/FLOAT(NTOT)
      IF(KSTAR .EQ. 1) GO TO 1000
      DO 900 K=2,KSTAR
      AC(6,K)= FLOAT(NOP(K)-NOP(K-1))*TERM/FLOAT(NTOT)
  900 CONTINUE
 1000 CONTINUE
      IF(WP.NE.0)AC(6,WP+1)=AC(6,WP+1)+TERM1
      IF(ISWTCH.NE.-1) GO TO 1005
      TERM2=0.0
      DO 1003 J=1,NSE
      TERM2=TERM2+FLOAT(IBR2(J)+IDR2(J))*CSE(J)
 1003 CONTINUE
      AC(6,ISP+1)=AC(6,ISP+1)+TERM2
 1005 CONTINUE
      TERM=0.0
      TERM1=0.0
      DO 1010 I=2,NRU
      IF(LREM(I).NE.2)TERM=TERM+FLOAT(NRS(I)-NRS2(I))*CRU(I)
      IF(LREM(I).EQ.2)TERM1=TERM1+FLOAT(NRS(I)-NRS2(I))*CRU(I)
 1010 CONTINUE
      IF(WP.EQ.0)TERM=TERM+TERM1
      AC(7,1)=FLOAT(NOP(1))*TERM/FLOAT(NTOT)
      IF(KSTAR.EQ.1)GO TO 1030
      DO 1020 K=2,KSTAR
      AC(7,K)=FLOAT(NOP(K)-NOP(K-1))*TERM/FLOAT(NTOT)
 1020 CONTINUE
 1030 CONTINUE
      IF(WP.NE.0)AC(7,WP+1)=AC(7,WP+1)+TERM1
      IF(ISWTCH.NE.-1) GO TO 1035
      TERM2=0.0
      DO 1032 I=2,NRU
      TERM2=TERM2+FLOAT(NRS2(I))*CRU(I)
 1032 CONTINUE
```

```
150.        AC(7,ISP+1)=AC(7,ISP+1)+TERM2
151.   1035 CONTINUE
152.        AC(8,1)=FLOAT(NOP(1))*SIN
153.        IF(KSTAR.EQ.1)GO TO 1050
154.        DO 1040 K=2,KSTAR
155.        AC(8,K)=FLOAT(NOP(K)-NOP(K-1))*SIN
156.   1040 CONTINUE
157.   1050 CONTINUE
158.        IF(WP.EQ.0) GO TO 1070
159.        AC(9,1)=FLOAT(NOP(1))*WPR/FLOAT(NTOT)
160.        IF(KSTAR.EQ.1)GO TO 1070
161.        DO 1060 K=2,KSTAR
162.        AC(9,K)=FLOAT(NOP(K)-NOP(K-1))*WPR/FLOAT(NTOT)
163.   1060 CONTINUE
164.   1070 CONTINUE
165.   9997 FORMAT(//15X,'ACQUISITION COST BREAKDOWN BY CATEGORY AND BY YEAR',
166.       &          /15X,50(1H-))
167.   9998 FORMAT(//' CATEGORY',30X,'YEAR'/' ',8(1H-),30X,'----'/8X,7I10)
168.        IF(ISWTCH) 1150,1170,1130
169.   1130 DO 1140 J=1,ISP
170.        DO 1135 I=1,9
171.        AC2(I,J)=AC(I,J)
172.   1135 CONTINUE
173.   1140 CONTINUE
174.        RETURN
175.   1150 DO 1160 J=1,ISP
176.        DO 1155 I=1,9
177.        IF(I.EQ.6.OR.I.EQ.7) GO TO 1155
178.        AC(I,J)=AC2(I,J)
179.   1155 CONTINUE
180.   1160 CONTINUE
181.   1170  IF(IPRT(7).NE.1) RETURN
182.        WRITE(6,9997)
183.        NY1=1
184.   1200 NY2=NY1+6
185.        IF(NY2.GT.NY) NY2=NY
186.        WRITE( 6,9998) (I,I=NY1,NY2)
187.        IF(NY2.EQ.NY) GO TO 9990
188.        WRITE( 6,9993)(NAME(N),(AC(N,IY),IY=NY1,NY2),N=1,9)
189.        NY1=NY1+7
190.        GO TO 1200
191.   9990  DO 9992 N=1,9
192.        WRITE( 6,9993)NAME(N),(AC(N,IY),IY=NY1,NY2)
193.   9992 CONTINUE
194.   9993 FORMAT(9(' ',A8,2X,7F10.0/))
195.   9995 RETURN
196.        END
197.        SUBROUTINE BSPARE(NSYS,ICONUS)
198.        COMMON / SPRDAT /NRS(500),SRUS(500),LRUS(500),SRUMAX, LRUMAX,
199.       &                 NRS2(500)
```

```
      INTEGER SRUS, SRUMAX
      COMMON / RELIAB   /G(26), GR(12,25), GM,ENR(500,25), EPM(25)
      COMMON / BLK E /ACS, BTC, DTC, DCB, DCD, DCO, NPB, NPD, NPO,
     &                NI, CRSC, CRSO, CDMC, WPR
      COMMON / BLK B /NY, NBC, NIC, NBO, NIO, SIN, OH, NDS, RSTC,
     &                RSTO, DMC, DRC, BDSC, BDSO, TAT, WP, ISP, AO1,
     &                AO2, DSSF, NIS
      INTEGER WP
      COMMON / BLK C /NRU,LN(500),IN(500),ANAME(500,5),NQ(500),CRU(500),
     &           MTBF(500),UFP(500),W(500),FVS(500),RLS(500),RRS(500),
     &               RMS(500),NRTS(500),COND(500),LV(500),LV2(500),
     &               LSEV(500),USEV(500),LR(500),LR2(500),LSER(500,4),
     &          USER(500,4),RTS(500),LREM(500),NRTS2(500),COND2(500)
      REAL NRTS,NRTS2, MTBF
      CHARACTER*4 ANAME
      COMMON / BSPR /BLAMDA(500), BT(500),NSB(500)
      INTEGER SRUDEX
      DO 10 I = 1,500
      NSB(I) = 0
   10 CONTINUE
      IF ( ICONUS .EQ. MCONUS ) GO TO 20
      IF ( ICONUS .EQ. 1 .AND. WP .EQ. 0 ) RSTM = RSTC
      IF ( ICONUS .EQ. 3 .AND. WP .EQ. 0 ) RSTM = RSTO
      IF ( ICONUS .EQ. 1 .AND. WP .NE. 0 ) RSTM = CRSC
      IF ( ICONUS .EQ. 3 .AND. WP .NE. 0 ) RSTM = CRSO
   20 MCONUS = ICONUS
      IF ( SRUMAX .LT. 1 ) GO TO 150
      IF(ICONUS.EQ.1.OR.ICONUS.EQ.3) GO TO 150
      DO 100 SRUDEX = 1,SRUMAX
      IDEX = SRUS(SRUDEX)
      BT(IDEX) = BTCOMP(IDEX,RSTM,NSYS)
  100 CONTINUE
      CALL MARGNL(NSYS,SRUS,SRUMAX,AO2)
      RETURN
  150 DO 200 LRUDEX = 1,LRUMAX
      IDEX = LRUS(LRUDEX)
      BT(IDEX) = BTCOMP(IDEX,RSTM,NSYS)
  200 CONTINUE
      CALL MARGNL(NSYS,LRUS,LRUMAX,AO1)
      RETURN
      ENTRY BSINIT
      MCONUS = 999
      DUM =  ESDINT(DUM)
      LRUDEX = 0
      SRUDEX = 0
      DO 400 I = 2,NRU
      IF ( LREM(I) .EQ. 0 ) GO TO 300
      IF ( LREM(I) .NE. 1 ) GO TO 400
      SRUDEX = SRUDEX + 1
      SRUS(SRUDEX) = I
```

```
      GO TO 400
  300 CONTINUE
      LRUDEX = LRUDEX + 1
      LRUS(LRUDEX) = I
  400 CONTINUE
      LRUMAX = LRUDEX
      SRUMAX = SRUDEX
      DO 500 I = 2,NRU
      BLAMDA (I) = FLOAT(NQ(I))*(OH/730.)/((1.-UFP(I))*GM*MTBF(I))
  500 CONTINUE
      RETURN
      END
      FUNCTION BTCOMP(IDEX,RSTM,NSYS)
      COMMON / BLK C /NRU,LN(500),IN(500),ANAME(500,5),NQ(500),CRU(500),
     &            MTBF(500),UFP(500),W(500),FVS(500),RLS(500),RRS(500),
     &                RMS(500),NRTS(500),COND(500),LV(500),LV2(500),
     &                LSEV(500),USEV(500),LR(500),LR2(500),LSER(500,4),
     &           USER(500,4),RTS(500),LREM(500),NRTS2(500),COND2(500)
      REAL NRTS,NRTS2, MTBF
      CHARACTER*4 ANAME
      COMMON / XVALS /XNRTS(500),XRTS(500),XCOND(500)
      COMMON / BLK B /NY, NBC, NIC, NBO, NIO, SIN, OH, NDS, RSTC,
     &                RSTO, DMC, DRC, BDSC, BDSO, TAT, WP, ISP, AO1,
     &                AO2, DSSF, NIS
      INTEGER WP
      IF ( LV(IDEX) .EQ. 1 .AND. LR(IDEX) .EQ. 1 )
     & BTCOMP = (XNRTS(IDEX)+XCOND(IDEX))*RSTM + XNRTS(IDEX)*ESD(IDEX) +
     &          (XRTS(IDEX)+UFP(IDEX))*TAT + XRTS(IDEX)*EBD(IDEX,NSYS)
      IF ( LV(IDEX) .EQ. 1 .AND. LR(IDEX) .EQ. 2 )
     & BTCOMP = (XNRTS(IDEX)+XRTS(IDEX))*(RSTM+ESD(IDEX)) +
     &             XCOND(IDEX)*RSTM + UFP(IDEX)*TAT
      IF ( LV(IDEX) .EQ. 2 .AND. LR(IDEX) .EQ. 2 )
     & BTCOMP = RSTM + (XNRTS(IDEX)+XRTS(IDEX)+UFP(IDEX))*ESD(IDEX)
      RETURN
      END
      SUBROUTINE CCOMP
      COMMON/PRINT/IPRT(9),STYTL,CTIME,CDATE
      CHARACTER*8 CTIME,CDATE
      CHARACTER*4 STYTL(8)
      COMMON / BLK C /NRU,LN(500),IN(500),ANAME(500,5),NQ(500),CRU(500),
     &            MTBF(500),UFP(500),W(500),FVS(500),RLS(500),RRS(500),
     &                RMS(500),NRTS(500),COND(500),LV(500),LV2(500),
     &                LSEV(500),USEV(500),LR(500),LR2(500),LSER(500,4),
     &           USER(500,4),RTS(500),LREM(500),NRTS2(500),COND2(500)
      REAL NRTS,NRTS2, MTBF
      COMMON / XVALS /XNRTS(500),XRTS(500),XCOND(500)
      IF(IPRT(9).GT.0) THEN
      WRITE (6,49)
      ENDIF
   49 FORMAT('1CCOMP  I',5X,'RTS',9X,'XNRTS',9X,'XRTS',8X,'XCOND',9X,
```

```
      1'COND',9X,'NRTS',9X,'UFP',/)
       DO 100 I = 1,NRU
       RTS(I) = 1. - COND(I) - NRTS(I)
       XNRTS(I) = NRTS(I)*(1.-UFP(I))
       XRTS(I) = RTS(I)*(1.-UFP(I))
       XCOND(I) = COND(I)*(1.-UFP(I))
       IF(IPRT(9).GT.0) THEN
       WRITE (6,50) I,RTS(I),XNRTS(I),XRTS(I),XCOND(I),COND(I),NRTS(I),
      1UFP(I)
       ENDIF
    50 FORMAT('      ',I3,7E13.5)
   100 CONTINUE
       DO 300 I = 1,NRU
       LREM(I) =0
       IND = IN(I) - 1
       IF ( IND .EQ. 0 ) GO TO 300
       DO 200 J = 2,I
       INDEX = I-J+1
       IF ( IN(INDEX) .NE. IND ) GO TO 200
       LREM(I) = LR(INDEX)
       GO TO 300
   200 CONTINUE
   300 CONTINUE
       IF(NRU.GT.20) RETURN
       IF(IPRT(9).GT.0) THEN
       WRITE (6,500)  (LREM(I),I=1,NRU)
       ENDIF
   500 FORMAT (' *',20I3)
       RETURN
       END
       SUBROUTINE CSPARE
       COMMON/PRINT/IPRT(9),STYTL,CTIME,CDATE
       CHARACTER*8 CTIME,CDATE
       CHARACTER*4 STYTL(8)
       COMMON / BLK C /NRU,LN(500),IN(500),ANAME(500,5),NQ(500),CRU(500),
      &            MTBF(500),UFP(500),W(500),FVS(500),RLS(500),RRS(500),
      &                RMS(500),NRTS(500),COND(500),LV(500),LV2(500),
      &                LSEV(500),USEV(500),LR(500),LR2(500),LSER(500,4),
      &           USER(500,4),RTS(500),LREM(500),NRTS2(500),COND2(500)
       REAL NRTS,NRTS2, MTBF
       CHARACTER*4 ANAME
       COMMON / BLK B /NY, NBC, NIC, NBO, NIO, SIN, OH, NDS, RSTC,
      &                RSTO, DMC, DRC, BDSC, BDSO, TAT, WP, ISP, AO1,
      &                AO2, DSSF, NIS
       INTEGER WP
       COMMON / CSPR / NCS(500)
       COMMON / RELIAB   /G(26), GR(12,25), GM,ENR(500,25), EPM(25)
       COMMON / XVALS /XNRTS(500),XRTS(500),XCOND(500)
       LL=1
       IF(WP.GT.0)LL=WP+1
```

```
      DO 200 I = 2,NRU
      FNCS = 0.
      IF(IPRT(9).GT.0) THEN
      WRITE (6,500) I,LL,WP,XCOND(I)
      ENDIF
  500 FORMAT (' CSPARE 1',3I10,E12.4)
      DO 100 K = LL,NY
      FNCS = FNCS + ENR(I,K)*XCOND(I)
  100 CONTINUE
      NCS(I) = ICEIL(FNCS)
  200 CONTINUE
      RETURN
      END
      SUBROUTINE DCM
      COMMON / OMCDAT /OM(7,26), DOM(7,26)
      COMMON / ACEDAT /AC(9,26), DAC(9,26)
      COMMON / BLK A /SIE, SBR, SDR,SDR2, SPSC, SPSO, SID, SIM,
     &               SDM, SBMC, SDMC, SDC2, DF
      COMMON / BLK B /NY, NBC, NIC, NBO, NIO, SIN, OH, NDS, RSTC,
     &               RSTO, DMC, DRC, BDSC, BDSO, TAT, WP, ISP, AO1,
     &               AO2, DSSF, NIS
      INTEGER WP
      TERM1 = 1.0
      TERM = 1.0/(1.0 + DF)
      DO 300 K = 1 , NY
      DO 100 I = 1 , 8
      DAC(I,K)=AC(I,K) * TERM1
  100 CONTINUE
      IF(WP.NE.0)DAC(9,K)=AC(9,K) * TERM1
      DO 200 I = 1 , 7
      DOM(I,K)=OM(I,K) * TERM1
  200 CONTINUE
      TERM1=TERM1*TERM
  300 CONTINUE
      RETURN
      END
      SUBROUTINE DECODE(NAME,IDIM,ICOMN,ICOMDX,ITYPE,IERR)
      COMMON / BLK D /NSE, LSE(40), ANSE(40,5), CSE(40), COM(40)
      COMMON / BLK C /NRU,LN(500),IN(500),ANAME(500,5),NQ(500),CRU(500),
     &          MTBF(500),UFP(500),W(500),FVS(500),RLS(500),RRS(500),
     &              RMS(500),NRTS(500),COND(500),LV(500),LV2(500),
     &              LSEV(500),USEV(500),LR(500),LR2(500),LSER(500,4),
     &          USER(500,4),RTS(500),LREM(500),NRTS2(500),COND2(500)
      REAL NRTS,NRTS2, MTBF
      COMMON / BLK B /NY, NBC, NIC, NBO, NIO, SIN, OH, NDS, RSTC,
     &               RSTO, DMC, DRC, BDSC, BDSO, TAT, WP, ISP, AO1,
     &               AO2, DSSF, NIS
      INTEGER WP
      CHARACTER*4 ANAME,NAME,ANSE,NAMES(66)
      DIMENSION IDIMA(3),INFO(66)
```

```
      INTEGER TLIM
      DATA TLIM/63/
      DATA NAMES/
     &    'SIE',    'SBR',    'SDR',    'SDR2',   'SPSC',   'SPSO',
     &    'SID',    'SIM',    'SDM',    'SBMC',   'SDMC',   'SDC2',
     &    'DF',
     &    'SIN',    'OH',     'NDS',    'RSTC',   'RSTO',   'DMC',
     &    'DRC',    'BDSC',   'BDSO',   'TAT',    'WP',     'ISP',
     &    'AO1',    'AO2',    'DSSF',   'NIS',
     &    'NQ',     'CRU',    'MTBF',   'UFP',    'W',      'FVS',
     &    'RLS',    'RRS',    'RMS',    'NRTS',   'COND',   'LV',
     &    'LV2',    'LSEV',   'USEV',   'LR',     'LR2',
     &    'CSE',    'COM',
     &    'ACS',    'BTC',    'DTC',    'DCB',    'DCD',    'DCO',
     &    'NPB',    'NPD',    'NPO',    'NI',     'CRSC',   'CRSO',
     &    'CDMC',   'WPR',
     &    'G',
     &    3*' '/
      DATA INFO/
     &    0010001,  0010002,  0010003,  0010004,  0010005,  0010006,
     &    0010007,  0010008,  0010009,  0010010,  0010011,  0010012,
     &    0010013,
     &    0020006,  0020007,  0120008,  0020009,  0020010,  0020011,
     &    0020012,  0020013,  0020014,  0020015,  0120016,  0020017,
     &    0020018,  0020019,  0020020,  0020021,
     &    1130352,  1030402,  1030452,  1030502,  1030552,  1030602,
     &    1030652,  1030702,  1030752,  1030802,  1030852,  1130902,
     &    1130952,  1031002,  1131052,
     &    2040062,  2040072,
     &    0050001,  0050002,  0050003,  0050004,  0050005,  0050006,
     &    0150007,  0150008,  0150009,  0150010,  0050011,  0050012,
     &    0050013,  0050014,
     &    3060001,
     &    5*0/
      IDIMA(1) = NRU
      IDIMA(2) = NSE
      IDIMA(3)=NY+1
      DO 100 I = 1 , TLIM
      INDEX = I
      IF ( NAMES(I) .EQ. NAME ) GO TO 200
  100 CONTINUE
      IERR = 1
      RETURN
  200 CONTINUE
      ITEMP = INFO(INDEX)
      IDIMX = ITEMP/1000000
      ITEMP = ITEMP - IDIMX*1000000
      ITYPE = ITEMP/100000
      ITEMP = ITEMP - ITYPE*100000
      ICOMN = ITEMP/10000
```

```
      ICOMDX = ITEMP - ICOMN*10000
      IDIM=0
      IF ( IDIMX .NE. 0 ) IDIM = IDIMA(IDIMX)
      IERR = 0
      RETURN
      END
      SUBROUTINE DSPARE
      COMMON/PRINT/IPRT(9),STYTL,CTIME,CDATE
      CHARACTER*8 CTIME,CDATE
      CHARACTER*4 STYTL(8)
      COMMON / BLK E /ACS, BTC, DTC, DCB, DCD, DCO, NPB, NPD, NPO,
     &                NI, CRSC, CRSO, CDMC, WPR
      COMMON / SYSBAS /NALCC(400),IALCC(400),NALCO(400),IALCO(400),
     &                 NSC,NSO
      COMMON / BLK B /NY, NBC, NIC, NBO, NIO, SIN, OH, NDS, RSTC,
     &                RSTO, DMC, DRC, BDSC, BDSO, TAT, WP, ISP, A01,
     &                A02, DSSF, NIS
      INTEGER WP
      COMMON / BLK C /NRU,LN(500),IN(500),ANAME(500,5),NQ(500),CRU(500),
     &           MTBF(500),UFP(500),W(500),FVS(500),RLS(500),RRS(500),
     &               RMS(500),NRTS(500),COND(500),LV(500),LV2(500),
     &               LSEV(500),USEV(500),LR(500),LR2(500),LSER(500,4),
     &          USER(500,4),RTS(500),LREM(500),NRTS2(500),COND2(500)
      REAL NRTS,NRTS2, MTBF
      CHARACTER*4 ANAME
      COMMON / RELIAB   /G(26), GR(12,25), GM,ENR(500,25), EPM(25)
      COMMON / DSPR /DLAMDA(500),DT(500),NSD(500)
      NTOT = NSC+NSO
      GX = GM
      IF ( WP .NE. 0 ) GX = G(WP+1)
      DO 300 IDEX = 1,NRU
      I = NRU-IDEX+1
      IF ( I .EQ. 1 ) GO TO 300
      DLAMDA(I) = FLOAT(NTOT*NQ(I))*(OH/730.)*X(I) /
     &            ((1.-UFP(I))*GX*MTBF(I))
      XYZ = X(I)
      IF(IPRT(9).GT.0) THEN
      WRITE (6,550) I,NTOT,NQ(I),UFP(I),GX,MTBF(I),XYZ
      ENDIF
  550 FORMAT (' DSPARE 1',3I5,4E12.3)
      IF ( LREM(I) .NE. 2 ) GO TO 100
      DT(I) = TD(I)
      GO TO 200
  100 CONTINUE
      DT(I) = BDSC*FLOAT(NSC)/FLOAT(NTOT) + BDSO*FLOAT(NSO)/FLOAT(NTOT)
      IF ( WP .EQ. 0 ) DT(I) = DT(I) + TD(I)
      IF ( WP .NE. 0 ) DT(I) = DT(I) + CDMC
  200 CONTINUE
      TEMP = DLAMDA(I)*DT(I)
      NSD(I) = ICEIL(TEMP+DSSF*SQRT(TEMP))
```

```
      IF(IPRT(9).GT.0) THEN
      WRITE (6,500) I,TEMP,DLAMDA(I),DT(I),DSSF
      ENDIF
  500 FORMAT (' ** ',I3,4E12.3)
  300 CONTINUE
      RETURN
      END
      FUNCTION EBD(I,NSYS)
      COMMON / BSPR /BLAMDA(500), BT(500),NSB(500)
      COMMON / BLK C /NRU,LN(500),IN(500),ANAME(500,5),NQ(500),CRU(500),
     &           MTBF(500),UFP(500),W(500),FVS(500),RLS(500),RRS(500),
     &               RMS(500),NRTS(500),COND(500),LV(500),LV2(500),
     &               LSEV(500),USEV(500),LR(500),LR2(500),LSER(500,4),
     &          USER(500,4),RTS(500),LREM(500),NRTS2(500),COND2(500)
      REAL NRTS,NRTS2, MTBF
      CHARACTER*4 ANAME
      EBD = 0.
      I1 = I + 1
      IF ( I1 .GT. NRU ) RETURN
      XNUMER = 0.
      XDENOM = 0.
      DO 100 IDEX = I1,NRU
      INDEX = IDEX
      IF ( IN(IDEX) .NE. IN(I)+1 ) GO TO 200
      FNSLAM = FLOAT(NSYS) * BLAMDA (IDEX)
      XNUMER = XNUMER + FNSLAM
      XDENOM = XDENOM + FNSLAM*POISON (FNSLAM,BT(IDEX),NSB(IDEX))
  100 CONTINUE
      GO TO 300
  200 CONTINUE
      IF ( INDEX .EQ. I1 ) RETURN
  300 CONTINUE
      IF ( ABS(XDENOM) .GT. 1.E-9 ) EBD = XNUMER/XDENOM
      RETURN
      END
      FUNCTION EDD(I)
      COMMON / BLK C /NRU,LN(500),IN(500),ANAME(500,5),NQ(500),CRU(500),
     &           MTBF(500),UFP(500),W(500),FVS(500),RLS(500),RRS(500),
     &               RMS(500),NRTS(500),COND(500),LV(500),LV2(500),
     &               LSEV(500),USEV(500),LR(500),LR2(500),LSER(500,4),
     &          USER(500,4),RTS(500),LREM(500),NRTS2(500),COND2(500)
      REAL NRTS,NRTS2, MTBF
      CHARACTER*4 ANAME
      COMMON / DSPR /DLAMDA(500),DT(500),NSD(500)
      EDD = 0.
      I1 = I+1
      IF ( I1 .GT. NRU ) RETURN
      XNUMER = 0.
      XDENOM = 0.
      DO 100 IDEX = I1,NRU
```

```
      INDEX = IDEX
      IF ( IN(IDEX) .NE. IN(I)+1 ) GO TO 200
      DL = DLAMDA(IDEX)
      XNUMER = XNUMER + DL*POISON (DL,DT(IDEX),NSD(IDEX))
      XDENOM = XDENOM + DL
  100 CONTINUE
      GO TO 300
  200 CONTINUE
      IF ( INDEX .EQ. I1 ) RETURN
  300 CONTINUE
      IF ( ABS(XDENOM) .GT. 1.E-9 ) EDD = XNUMER/XDENOM
      RETURN
      END
      SUBROUTINE EDNUM(LEN,IDECS,AMOUN,OUTPUT)
      CHARACTER*1 OUTPUT(20),OLL(4)
      CHARACTER*1 NUM(10),DECPT,COMMA,MINUS,BLANK,OUTSTR(20),IOLL
      EQUIVALENCE (OLL(1),IOLL)
      DATA NUM/'0','1','2','3','4','5','6','7','8','9'/
      DATA DECPT,COMMA,MINUS,BLANK/'.',',','-',' '/
      IF (AMOUN.GT.1E12) GO TO 600
      NEG = 0
      IF ( AMOUN .LT. 0. ) NEG = 1
      AMOUNT = ABS(AMOUN) + .5*(10.**(-IDECS))
       MOSTSG = 1
      IF ( AMOUNT .GE. 1. )  MOSTSG = ALOG10(AMOUNT) + 1
      NUMCOM = ( MOSTSG - 1)/3
      DO 10 I = 1,LEN
      OUTSTR(I) = BLANK
   10 CONTINUE
      IAMT = AMOUNT
      IF ( IDECS .EQ. 0 ) GO TO 200
      B = AMOUNT - IAMT
      IB = B * (10**IDECS) + .000001
      ISTRT = LEN-IDECS+1
      ID = 10**(IDECS-1)
      DO 100 I=ISTRT,LEN
      IB1 = IB/ID
      OUTSTR(I) = NUM(IB1 + 1)
      IB = IB - IB1*ID
      ID = ID/10
  100 CONTINUE
  200 OUTSTR(LEN-IDECS) = DECPT
      ISTOP = LEN - IDECS - 1
      ISTRT = ISTOP - ( MOSTSG+NUMCOM) + 1
      ID = 10**( MOSTSG-1)
      IF(ISTRT.LE.0.OR.ISTOP.LT.ISTRT) GO TO 700
      DO 400 I = ISTRT,ISTOP
      IF (MOD(ISTOP-I+1,4).EQ.0)GO TO 300
      IB1 = IAMT/ID
      OUTSTR(I) = NUM(IB1 + 1)
```

```
      IAMT = IAMT - IB1*ID
      ID = ID/10
      GO TO 400
  300 OUTSTR(I) = COMMA
  400 CONTINUE
      IF ( NEG .EQ. 1 ) OUTSTR(ISTRT-1) = MINUS
      II=((LEN+3)/4)*4
  450 DO 500 I=1,II
      IOLL=OUTSTR(I)
  500 OUTPUT(I) = OLL(1)
      RETURN
  600 WRITE (6,650) AMOUN
  650 FORMAT('  VALUE INPUT TO EDNUM IS TOO LARGE',E12.3)
      RETURN
  700 DO 750 I=1,20
  750 OUTSTR(I)=MINUS
      GO TO 450
      END
      FUNCTION ESD(I)
      COMMON / BLK C /NRU,LN(500),IN(500),ANAME(500,5),NQ(500),CRU(500),
     &            MTBF(500),UFP(500),W(500),FVS(500),RLS(500),RRS(500),
     &                RMS(500),NRTS(500),COND(500),LV(500),LV2(500),
     &                LSEV(500),USEV(500),LR(500),LR2(500),LSER(500,4),
     &           USER(500,4),RTS(500),LREM(500),NRTS2(500),COND2(500)
      REAL NRTS,NRTS2, MTBF
      CHARACTER*4 ANAME
      COMMON / DSPR /DLAMDA(500),DT(500),NSD(500)
      DIMENSION XESD(500)
      IF ( XESD(I) .GT. 1.E30 ) XESD(I) = POISON (DLAMDA(I),DT(I),
     &                                            NSD(I))
      ESD = XESD(I)
      RETURN
      ENTRY  ESDINT(DUM)
      DO 200 I = 1,NRU
      XESD(I) = 1.E31
  200 CONTINUE
      ESDINT = DUM
      RETURN
      END
      SUBROUTINE GRCOMP
      COMMON /PRINT/IPRT(9),STYTL(8),CTIME,CDATE
      CHARACTER*8 CTIME,CDATE
      COMMON / BLK C /NRU,LN(500),IN(500),ANAME(500,5),NQ(500),CRU(500),
     &            MTBF(500),UFP(500),W(500),FVS(500),RLS(500),RRS(500),
     &                RMS(500),NRTS(500),COND(500),LV(500),LV2(500),
     &                LSEV(500),USEV(500),LR(500),LR2(500),LSER(500,4),
     &           USER(500,4),RTS(500),LREM(500),NRTS2(500),COND2(500)
      REAL NRTS,NRTS2, MTBF
      COMMON / ACTSCH /NAC(12,25), NCUM(12,25),   MACDEX
      COMMON / BLK B /NY, NBC, NIC, NBO, NIO, SIN, OH, NDS, RSTC,
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650.       &                RSTO, DMC, DRC, BDSC, BDSO, TAT, WP, ISP, AO1,
651.       &                AO2, DSSF, NIS
652.        INTEGER WP
653.        COMMON / RELIAB   /G(26), GR(12,25), GM,ENR(500,25), EPM(25)
654.        DIMENSION GREQ(300)
655.        EQUIVALENCE (GREQ,GR)
656.        DO 500 K = 1,NY
657.        GR(1,K) = G(K)
658.  ***** WRITE(6,2020) K,(NCUM(J,K),J=1,12)
659.   2020 FORMAT(2X,13I8)
660.        IDENOM = 0
661.        DO 200 J = 1,12
662.        IDENOM = IDENOM + NCUM(J,K)
663.    200 CONTINUE
664.        DO 400 M = 2,12
665.        NUMER = 0
666.        LIM = M-1
667.        DO 300 J = 1,LIM
668.        NUMER = NUMER + NCUM(J,K)
669.    300 CONTINUE
670.        GR(M,K) = ( G(K+1)-G(K) ) * FLOAT(NUMER) / FLOAT(IDENOM) + G(K)
671.    400 CONTINUE
672.  ***** WRITE (6,2010) K,(GR(M,K),M=1,12)
673.   2010 FORMAT (2X,I5,12F10.3)
674.    500 CONTINUE
675.        ICV=15
676.        IF(NY.LT.ICV) ICV=NY
677.        IF(IPRT(9).GT.0) THEN
678.        WRITE(    6,95000)(STYTL(I),I=1,8),CTIME,CDATE
679.  95000 FORMAT('1',3X,8A4,2(3X,A8))
680.        WRITE(    6,95001)
681.        ENDIF
682.  95001 FORMAT('0  I LREM(I) ENR(I,K) K=1,NY     (SUB GRCOMP)',/)
683.        DO 800 I = 1,NRU
684.        DO 700 K = 1,NY
685.        ENR(I,K) = 0.
686.        IF ( I .EQ. 1 ) GO TO 700
687.        DO 600 M = 1,12
688.        ENR(I,K) = ENR(I,K) + FLOAT(NCUM(M,K)*NQ(I))*OH/((1.-UFP(I))*
689.       &                      GR(M,K)*MTBF(I))
690.    600 CONTINUE
691.    700 CONTINUE
692.        IF(IPRT(9).GT.0) THEN
693.        WRITE (6,2030) I,LREM(I),(ENR(I,K),K=1,ICV)
694.        ENDIF
695.   2030 FORMAT (2I4,2X,15F7.1)
696.    800 CONTINUE
697.        GM = GREQ( MACDEX)
698.        IF(IPRT(9).GT.0) THEN
699.        WRITE (6,2050) RTS(1),MTBF(1)
```

```
      ENDIF
2050  FORMAT (2X,2F12.3)
      DO 1000 K = 1,NY
      EPM(K) = 0.
      DO 900 M = 1,12
      EPM(K) = EPM(K) + FLOAT(NCUM(M,K)*NQ(1))*OH*RTS(1) /
     &                  (GR(M,K)*MTBF(1))
 900  CONTINUE
1000  CONTINUE
      IF(IPRT(9).GT.0) THEN
      WRITE (6,2060) (EPM(K),I=1,NY)
      ENDIF
2060  FORMAT ('0EPM(K),K=1,NY',/,2X,25F5.1)
      RETURN
      END
      FUNCTION ICEIL(X)
      ICEIL = IFIX(X)
      TEMP = FLOAT(IFIX(X))
      IF ( ABS(TEMP-X) .LT. 1.E-9 ) RETURN
      ICEIL = IFIX(X) + 1
      RETURN
      END
      SUBROUTINE LCCIN
      COMMON / BLK B /NY, NBC, NIC, NBO, NIO, SIN, OH, NDS, RSTC,
     &               RSTO, DMC, DRC, BDSC, BDSO, TAT, WP, ISP, A01,
     &               A02, DSSF, NIS
      INTEGER WP
      COMMON / COSSUM /TOTACQ(26), TOTOM(26), TOTCOS(26),
     &                 DOTACQ(26), DOTOM(26), DOTCOS(26)
      COMMON /PRINT/IPRT(9),STYTL(8),CTIME,CDATE
      DIMENSION SUMHLD(500,3)
      CHARACTER*8 TIME,DATE,CONTRL ,FILE(5),FNAME
      CHARACTER*4 NEW,NO,OLD,YES,CFSTAT,END,INPUT
      CHARACTER*4 OPT(9,8),STRING
      DATA OLD /' OLD'/
      DATA NEW /' NEW'/
      DATA YES/' YES'/
      DATA NO/'  NO'/
      DATA CFSTAT/' OLD'/
      DATA END /'END '/
      DATA OPT
     &  /'PARA','METE','R FI','LE P','RINT','OUT ',3*'    ',
     &   'SUPP','ORT ','EQUI','PMEN','T RE','QUIR','EMEN','TS  ','    ',
     &   'SPAR','ES R','EQUI','REME','NTS ','(DET','AILE','D)  ','    ',
     &   'SPAR','ES R','EQUI','REME','NTS ','(UNI','T TO','TALS',')   ',
     &   'MANP','OWER',' REQ','UIRE','MENT','S   ',3*'    ',
     &   'TOTA','L CO','ST S','UMMA','RY (','BY C','ATEG','ORY)','    ',
     &   'TOTA','L CO','ST S','UMMA','RY (','BY Y','EAR)','    ','    ',
     &   'SENS','ITIV','ITY ','ANAL','YSIS',4*'    '/
      CALL ADATE(TIME,DATE)
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      WRITE(  6,100)DATE
  100 FORMAT(20X,'LIFE CYCLE COST ANALYSIS PROGRAM'/
     &       20X,32(1H-)//32X,A8/32X,'--------')
      WRITE(  6,200)
  200 FORMAT(//' YOU WILL BE PROMPTED FOR THE NECESSARY CONTRL  INPUT'/,
     &' TO RUN LCC. ANSWER ALL QUESTIONS CAREFULLY')
  250 WRITE(  6,300)
  300 FORMAT(/' *****CONTRL  FILE STATUS*****'/6X,19(1H-))
      WRITE(  6,400)
  400 FORMAT(/1X,'YOU MAY USE AN OLD CONTRL  FILE OR CREATE A NEW ONE'//
     &,             ' (ENTER OLD OR NEW) ')
  500 READ(  5,  2)CFSTAT
      IF ( CFSTAT .EQ.  OLD  ) GO TO 600
      IF ( CFSTAT .EQ.  NEW  ) GO TO 800
      GO TO 500
  600 CONTINUE
      WRITE(  6,1200)
  700 WRITE(  6,1300)
      READ(  5,  1)CONTRL
      GO TO 1600
  760 WRITE(  6,1400)CONTRL
      GO TO 700
  800 CONTINUE
      WRITE(  6,1100)
  900 WRITE(  6,1300)
      READ(  5,  1)CONTRL
      FNAME = CONTRL
      GO TO 1600
  950 WRITE(  6,1550)CONTRL
      STOP
 1000 CONTINUE
      WRITE(  6,1500)CONTRL
      GO TO 900
 1100 FORMAT(' THIS RUN WILL CREATE A NEW CONTRL  FILE')
 1200 FORMAT(' THIS RUN WILL ACCESS AN EXISTING CONTRL  FILE')
 1300 FORMAT(/' ENTER CONTRL  FILE NAME')
 1400 FORMAT(/' CONTRL  FILE ',A8,' NOT FOUND IN CATALOG. TRY AGAIN,'
     &     /' OR HIT BREAK AND CHECK YOUR CATALOG BEFORE RERUNNING LCC')
 1500 FORMAT(/' A NEW CONTRL  FILE WAS REQUESTED, BUT ',A8,
     &      /' COULD NOT BE CREATED. TRY AGAIN')
 1550 FORMAT(/1X,A8,' WAS CREATED BUT COULD NOT BE ATTACHED. RERUN ',
     & /'LCC AFTER CHECKING YOUR AFT')
 1600 CONTINUE
      WRITE(  6,1700)CONTRL
 1700 FORMAT(' THE CONTRL  FILE FOR THIS RUN IS ',A8)
      IF( CFSTAT .EQ.  OLD  )GO TO 2400
      WRITE(  6,1800)
 1800 FORMAT(/,' *****PARAMETER FILE NAMES*****'/6X,20(1H-))
      READ(  5,  1)FILE
      DO 2200 I=1,5
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2000 CONTINUE
     FNAME = FILE(I)
     LCODE = I+9
     GO TO 2200
2050 CONTINUE
     GO TO 2000
2200 CONTINUE
     DO 2300 I=1,5
     WRITE(     6,10000)FILE(I)
2300 CONTINUE
     GO TO 2800
2400 CONTINUE
     DO 2700 I=1,5
     READ(      5,10000)FILE(I)
2500 CONTINUE
     FNAME = FILE(I)
     LCODE = I+9
     GO TO 2700
2550 CONTINUE
     READ(  5,  1)FILE(I)
     GO TO 2500
2700 CONTINUE
     READ(      5,10000)IPRT
     IF ( IPRT(1)+IPRT(2)+IPRT(3)+IPRT(4)+IPRT(5)+
    &    IPRT(6)+IPRT(7)+IPRT(8) .NE. 0 ) GO TO 3750
     WRITE(  6,2750)
     STOP
2750 FORMAT(/' *****ERROR...NO OUTPUT REQUESTED, PROGRAM HALTED')
2800 CONTINUE
2900 WRITE(  6,3000)
3000 FORMAT(///' *****PRINT CONTRL  OPTIONS*****'/6X,21(1H-)/
    &       /' DO YOU WANT OUTPUT OTHER THAN A TOTAL COST SUMMARY,'/
    &       ' BY CATEGORY AND BY YEAR'/
    &       ' (YES OR NO) ')
     READ(  5,  2)INPUT
     IF(INPUT.EQ. NO )GO TO 3700
     IF ( INPUT .NE.  YES  ) GO TO 2900
     WRITE(  6,3100)
3100 FORMAT(' YOU WILL BE PROMPTED FOR PRINT CONTRL  INPUT'/
    &       ' IF YOU WANT A GIVEN REPORT ENTER (1) ELSE ENTER (0)')
     WRITE(  6,3200)
3200 FORMAT(///)
3250 DO 3500 J = 1,8
     WRITE(  6,3300)J,(OPT(I,J),I=1,9)
3300 FORMAT(' OPTION ',I2,' ',9A4)
3400 READ(  5,  3)IPRT(J)
     IF(IPRT(J).NE.1.AND.IPRT(J).NE.0)GO TO 3400
3500 CONTINUE
     IF ( IPRT(1)+IPRT(2)+IPRT(3)+IPRT(4)+IPRT(5)+
    &     IPRT(6)+IPRT(7)+IPRT(8) .NE. 0 ) GO TO 3570
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      WRITE(  6,3550)
      GO TO 3250
3550 FORMAT(/' NO OUTPUT REQUESTED, TRY AGAIN')
3570 WRITE(     6,3600)IPRT
3600 FORMAT(8(1X,I5))
      GO TO 3750
3700 IPRT(1)=0
      IPRT(2)=0
      IPRT(3)=0
      IPRT(4)=0
      IPRT(5)=0
      IPRT(6)=1
      IPRT(7)=1
      IPRT(8)=1
      WRITE(     6,3600)IPRT
3750 CONTINUE
      RETURN
    1 FORMAT (A8)
    2 FORMAT (A4)
    3 FORMAT (I4)
    4 FORMAT (F10.0)
    5 FORMAT (2F10.0,I5)
      ENTRY LCCIN1
      IF( CFSTAT .EQ.  OLD  )GO TO 5300
      WRITE(  6,3800)
3800 FORMAT(/' *****PARAMETER CHANGES*****'/6X,17(1H-))
3900 WRITE(  6,4000)
4000 FORMAT(/' DO YOU WISH TO MAKE ANY PARAMETER CHANGES FOR THIS RUN',
     &       ' (YES OR NO) ')
      READ(  5,  2)INPUT
      IF(INPUT.EQ. NO )GO TO 5200
      IF ( INPUT .NE.  YES  ) GO TO 3900
      WRITE(  6,4100)
4100 FORMAT(/
     & ' YOU WILL BE PROMPTED FOR CHANGES TO FILE PARAMETERS. IF YOU WIS
     &H'/
     & ' TO CHANGE ALL ELEMENTS OF AN ARRAY ENTER 0 WHEN PROMPTED FOR AR
     &RAY'/
     & ' ELEMENT. TO CHANGE ONE ELEMENT OF AN ARRAY ENTER AN ELEMENT NUM
     &BER'/
     & ' WHEN PROMPTED FOR ARRAY ELEMENT. WHEN NO FURTHER PARAMETER CHAN
     &GES'/
     & ' ARE TO BE MADE ENTER (END) FOR THE PARAMETER TO BE CHANGED')
4200 WRITE(  6,4300)
4300 FORMAT(//' ENTER PARAMETER TO BE CHANGED ')
      READ(  5,  2)STRING
      IF ( CFSTAT .EQ.  OLD  ) GO TO 5310
      IF(STRING.EQ. END  )GO TO 5200
      CALL DECODE(STRING,IDIM,ICOMN,ICOMDX,ITYPE,IERR)
      IF(IERR.EQ.0)GO TO 4500
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900.        WRITE(  6,4400)STRING
901.   4400 FORMAT(' ****ERROR..PARAMETER ',A4,' NOT FOUND, RETRY')
902.        GO TO 4200
903.   4500 IELMT=0
904.        IF(IDIM.EQ.0)GO TO 4900
905.   4600 WRITE(  6,4700)
906.   4700 FORMAT(' ENTER THE ARRAY ELEMENT TO BE CHANGED ')
907.        READ(  5,  3)IELMT
908.        IF ( CFSTAT .EQ.  OLD  ) GO TO 5400
909.        IF(IELMT.GE.0.AND.IELMT.LE.IDIM)GO TO 4900
910.        WRITE(  6,4800)IELMT,IDIM
911.   4800 FORMAT(' ****ERROR..ELEMENT SPECIFIED ',I3/
912.       &       ' OUT OF RANGE 0 TO ',I3)
913.        GO TO 4600
914.   4900 WRITE(  6,5000)
915.   5000 FORMAT(' ENTER NEW VALUE ')
916.        READ(  5,  4)VALNEW
917.        IF( CFSTAT .EQ.  OLD  )GO TO 5400
918.        WRITE(     6,10000)STRING,IELMT,VALNEW
919.        IF(IELMT.NE.0)IDIM=0
920.        IF(IELMT.EQ.0)IELMT=1
921.        IOFF=IELMT+ICOMDX-2
922.        DO 5100 I=1,IDIM
923.        IOFF=IOFF+1
924.        CALL SET(VALNEW,ICOMN,IOFF,ITYPE,1)
925.   5100 CONTINUE
926.        GO TO 4200
927.   5200 WRITE(     6,10000)
928.        GO TO 5800
929.   5300 CONTINUE
930.        READ(     5,10010)STRING,IELMT,VALNEW
931.   5310 IF(STRING.EQ. END )GO TO 5800
932.        CALL DECODE(STRING,IDIM,ICOMN,ICOMDX,ITYPE,IERR)
933.        IF(IERR.EQ.0)GO TO 5400
934.        WRITE(  6,4400)STRING
935.   5400 CONTINUE
936.        IF ( IDIM .EQ. 0 ) IELMT = 0
937.        IF(IELMT.GE.0.AND.IELMT.LE.IDIM)GO TO 5600
938.        WRITE(  6,5500)STRING,IELMT,IDIM
939.   5500 FORMAT(' ****ERROR..VARIABLE ',A4,' ELEMENT SPECIFIED ',I3/
940.       &       ' OUT OF RANGE 0 TO ',I3/' RETRY')
941.        GO TO 5300
942.   5600 CONTINUE
943.        IF(IELMT.NE.0)IDIM=0
944.        IF(IELMT.EQ.0)IELMT=1
945.        IOFF=IELMT+ICOMDX-2
946.        DO 5700 I=1,IDIM
947.        IOFF=IOFF+1
948.        CALL SET(VALNEW,ICOMN,IOFF,ITYPE,1)
949.   5700 CONTINUE
```

```
      GO TO 5300
5800  CONTINUE
      IF( CFSTAT .EQ.  OLD  )GO TO 7400
      WRITE(  6,5900)
5900  FORMAT(///,' *****SENSITIVITY ANALYSIS*****'/6X,20(1H-)//)
6000  WRITE(  6,6100)
6100  FORMAT(' DO YOU WANT A SENSITIVITY ANALYSIS (YES OR NO) ')
      READ(  5,  2)INPUT
      IF(INPUT.EQ. NO )GO TO 7600
      IF ( INPUT .NE.  YES  ) GO TO 6000
6200  WRITE(  6,6300)
6300  FORMAT(' ENTER NAME OF SENSITIVITY PARAMETER ')
      READ(  5,  2)STRING
      CALL DECODE(STRING,IDIM,ICOMN,ICOMDX,ITYPE,IERR)
      IF(IERR.EQ.0)GO TO 6400
      WRITE(  6,4400)STRING
      GO TO 6200
6400  CONTINUE
      IELMT=0
      IF(IDIM.EQ.0)GO TO 6600
      WRITE(  6,4700)
      READ(  5,  3)IELMT
      IF(IELMT.GT.0.AND.IELMT.LE.IDIM)GO TO 6500
      WRITE(  6,5500)STRING,IELMT,IDIM
      GO TO 6400
6500  CONTINUE
6600  WRITE(  6,6700)
      IELHLD = IELMT
6700  FORMAT(/' ENTER THE INITIAL VALUE, FINAL VALUE, AND NUMBER OF'/
     & ' STEPS FOR WHICH RUNS ARE TO BE MADE. SEPARATE ENTRIES BY COMMAS
     &.'/
     & ' (INITIAL,FINAL,STEPS)? ')
      READ(  5,  5)STRT,STP,NINC
      IF(NINC.GT.1.AND.NINC.LE.50)GO TO 6900
      WRITE(  6,6800)
6800  FORMAT(' ****ERROR..MINIMUM OF 2  MAXIMUM OF 50 STEPS')
      GO TO 6600
6900  IF ( CFSTAT .EQ.  NEW  )
     & WRITE(     6,10000)STRING,IELMT,STRT,STP,NINC
7000  CONTINUE
      VINC=(STP-STRT)/(NINC-1)
      INCCTR=0
      VAL=STRT-VINC
      ENTRY LCCIN2
      IF(NINC.EQ.0)STOP
      IF(INCCTR.LT.1)GO TO 7100
      SUMHLD(INCCTR,2)=TOTCOS(NY+1)
      SUMHLD(INCCTR,3)=DOTCOS(NY+1)
7100  INCCTR=INCCTR+1
      VAL=VAL+VINC
```

```
1000.         IF(INCCTR.GT.NINC)GO TO 7300
1001.         IF(IELMT.EQ.0)IELMT=1
1002.         IOFF = IELMT+ICOMDX-1
1003.         IF((IPRT(2)+IPRT(3)+IPRT(4)+IPRT(5)+IPRT(6)+IPRT(7)).NE.0)
1004.        & WRITE(  6,7200)INCCTR,STRING,VAL
1005.    7200 FORMAT(  '1  CYCLE ',I2,' VARIABLE - ',A4,' SET TO ',F14.4)
1006.         CALL SET(VAL,ICOMN,IOFF,ITYPE,1)
1007.         SUMHLD(INCCTR,1)=VAL
1008.         RETURN
1009.    7300 IF(IPRT(9).EQ.1)CALL OUTOP6(STRING,NINC,SUMHLD,IELHLD)
1010.         STOP
1011.    7400 CONTINUE
1012.         READ(     5,10020)STRING,IELMT,STRT,STP,NINC
1013.         IELHLD = IELMT
1014.         IF ( STRING .EQ.  END  ) GO TO 7700
1015.         CALL DECODE(STRING,IDIM,ICOMN,ICOMDX,ITYPE,IERR)
1016.         IF(IERR.EQ.0)GO TO 7500
1017.         WRITE(  6,4400)STRING
1018.    7500 CONTINUE
1019.         IF ( IDIM .EQ. 0 .AND. IELMT .EQ. 0 ) GO TO 7000
1020.         IF ( IDIM .GE. IELMT .AND. IELMT .GT. 0 ) GO TO 7000
1021.         WRITE(  6,5500)STRING,IELMT,IDIM
1022.    7600 CONTINUE
1023.         WRITE(     6,10000)
1024.    7700 CONTINUE
1025.         NINC=0
1026.         RETURN
1027.   10000 FORMAT('  END,0,0,0,0')
1028.   10010 FORMAT(A4,I5,F10.0)
1029.   10020 FORMAT (A4,I6,2F10.0,I4)
1030.         END
1031.         SUBROUTINE MARGNL(NSYS,NRUS,NRUMAX,AO)
1032.         COMMON / BSPR /BLAMDA(500), BT(500),NSB(500)
1033.         COMMON / BLK C /NRU,LN(500),IN(500),ANAME(500,5),NQ(500),CRU(500),
1034.        &            MTBF(500),UFP(500),W(500),FVS(500),RLS(500),RRS(500),
1035.        &                RMS(500),NRTS(500),COND(500),LV(500),LV2(500),
1036.        &                LSEV(500),USEV(500),LR(500),LR2(500),LSER(500,4),
1037.        &           USER(500,4),RTS(500),LREM(500),NRTS2(500),COND2(500)
1038.         REAL NRTS,NRTS2, MTBF
1039.         DIMENSION NRUS(NRUMAX), D(500),NSPR(500),DELT(500),T(500)
1040.         CHARACTER*4 ANAME
1041.         DIMENSION DOL(500)
1042.         B = 0.
1043.         DO 100 I = 1,NRU
1044.         NSPR(I) = 0
1045.     100 CONTINUE
1046.         DO 200 IDEX = 1 , NRUMAX
1047.         I = NRUS(IDEX)
1048.         D(I) = FLOAT(NSYS)*BLAMDA (I)*BT(I)
1049.         B = B + D(I)
```

VOLUME II OF II

RELIABILITY, MAINTAINABILITY AND LIFE CYCLE COST EFFECTS OF USING COMMERCIAL OFF-THE-SHELF EQUIPMENT

TECHNICAL REPORT

APPENDICES

PREPARED FOR
UNITED STATES AIR FORCE
AIR FORCE SYSTEMS COMMAND
ROME AIR DEVELOPMENT CENTER
GRIFFISS AIR FORCE BASE, NEW YORK
UNDER CONTRACT
F30602-80-C-0306
STATEMENT OF WORK
PR NO. N-0-5227
CLIN A003

NOVEMBER 9, 1982

APPROVED BY: A.J. HAUTER

PREPARED BY: N.E. SCHMIDT

COLLINS GOVERNMENT AVIONICS DIVISION
ROCKWELL INTERNATIONAL CORPORATION
CEDAR RAPIDS, IOWA

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1050.          T(I) = EXP(-D(I))
1051.          DELT(I) = 1. - T(I)
1052.          DOL(I)=DELT(I)/CRU(I)
1053.      200 CONTINUE
1054.           LOPCNT = 0
1055.      300 BOBJ = B / FLOAT(NSYS)
1056.          IF( BOBJ .LE. (1. - AO) )GO TO 600
1057.          I = NRUS(1)
1058.          DLMAX = DOL(I)
1059.          MINDEX = I
1060.          IF ( NRUMAX .EQ. 1 ) GO TO 500
1061.          DO 400 IDEX = 2 , NRUMAX
1062.          I = NRUS(IDEX)
1063.          TEMP = DOL(I)
1064.          IF( TEMP .LE. DLMAX ) GO TO 400
1065.          MINDEX = I
1066.          DLMAX = TEMP
1067.      400 CONTINUE
1068.      500 NSPR(MINDEX) = NSPR(MINDEX) + 1
1069.          B = B - DELT(MINDEX)
1070.          T(MINDEX) = T(MINDEX)*D(MINDEX)/FLOAT(NSPR(MINDEX))
1071.          DELT(MINDEX) = DELT(MINDEX) - T(MINDEX)
1072.          DOL(MINDEX)=DELT(MINDEX)/CRU(MINDEX)
1073.          LOPCNT = LOPCNT + 1
1074.          IF ( LOPCNT .GT. 150 ) GO TO 800
1075.          GO TO 300
1076.      800 WRITE(  6,900) BOBJ,AO
1077.      600 DO 700 I = 1,NRU
1078.          NSB(I) = NSB(I) + NSPR(I)
1079.      700 CONTINUE
1080.          RETURN
1081.      900 FORMAT('****ERROR...MARGINAL ANALYSIS DID NOT CONVERGE',2F10.3)
1082.          END
```

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C SECOND PORTION OF TASC LCC MODEL REVISED 1/25/80
C 7/25/79 VERSION REVISED 1/25/80 - INCREASED MAX NRU 50 TO 500
C 6/04/79 VERSION REVISED 7/25/79 - LCC-2A VERSION FROM DRC
C 5/30/79 VERSION REVISED 6/4/79 - INCREASED MAX SE FROM 10 TO  40
C 12/7/78 VERSION REVISED 5/30/79 - INCREASED MAX SYS PER BASE TO
C       400 SYSTEMS PLUS OTHER MINOR CHANGES
      SUBROUTINE MPREQ
      COMMON / XVALS /XNRTS(500),XRTS(500),XCOND(500)
      COMMON / MANPWR   /FLMH(25), BLMH(25), DLMH(25)
      COMMON / RELIAB   /G(26), GR(12,25), GM,ENR(500,25), EPM(25)
      COMMON / BLK C /NRU,LN(500),IN(500),ANAME(500,5),NQ(500),CRU(500),
     &            MTBF(500),UFP(500),W(500),FVS(500),RLS(500),RRS(500),
     &                RMS(500),NRTS(500),COND(500),LV(500),LV2(500),
     &                LSEV(500),USEV(500),LR(500),LR2(500),LSER(500,4),
     &           USER(500,4),RTS(500),LREM(500),NRTS2(500),COND2(500)
      REAL NRTS,NRTS2,MTBF
      COMMON / BLK B /NY, NBC, NIC, NBO, NIO, SIN, OH, NDS, RSTC,
     &                RSTO, DMC, DRC, BDSC, BDSO, TAT, WP, ISP, AO1,
     &                AO2, DSSF, NIS
      INTEGER WP
      COMMON ISWTCH
          CHARACTER*4 ANAME
      DIMENSION FLMH2(25),BLMH2(25),DLMH2(25)
      DO 40 K = 1,NY
      FLMH(K) = EPM(K)*RLS(1)
      DO 10 I = 2,NRU
      IF ( LREM(I) .EQ. 0 ) FLMH(K) = FLMH(K) + ENR(I,K)*RRS(I)
   10 CONTINUE
      BLMH(K) = 0.
      DO 20 I = 2,NRU
      IF ( LV(I) .EQ. 1 ) BLMH(K) = BLMH(K) + ENR(I,K)*FVS(I)
      IF ( LREM(I) .EQ. 1 ) BLMH(K) = BLMH(K) + ENR(I,K)*RRS(I)
   20 CONTINUE
      DLMH(K) = 0.
      IF ( K .LE. WP ) GO TO 40
      DO 30 I = 2,NRU
      IF ( LV(I) .GE. 2 ) DLMH(K) = DLMH(K) + ENR(I,K)*FVS(I)
      IF ( LR(I) .GE. 1 ) DLMH(K) = DLMH(K) + ENR(I,K)*
     &                              XNRTS(I)*RLS(I)
      IF ( LREM(I) .GE. 2 ) DLMH(K) = DLMH(K) + ENR(I,K)*RRS(I)
   30 CONTINUE
   40 CONTINUE
      IF(ISWTCH) 60,70,50
   50 DO 55 K=1,ISP
      FLMH2(K)=FLMH(K)
      BLMH2(K)=BLMH(K)
      DLMH2(K)=DLMH(K)
   55 CONTINUE
      RETURN
```

```
50.      60 DO 65 K=1,ISP
51.         FLMH(K)=FLMH2(K)
52.         BLMH(K)=BLMH2(K)
53.         DLMH(K)=DLMH2(K)
54.      65 CONTINUE
55.      70 RETURN
56.         END
57.         SUBROUTINE OMC
58.         COMMON / XVALS /XNRTS(500),XRTS(500),XCOND(500)
59.         COMMON / SUPDAT /IBREQ(40), IDREQ(40), IBR2(40), IDR2(40)
60.         COMMON / RELIAB   /G(26), GR(12,25), GM,ENR(500,25), EPM(25)
61.         COMMON / ACTSCH  /NAC(12,25), NCUM(12,25),  MACDEX
62.         COMMON / SYSBAS /NALCC(400), IALCC(400), NALCO(400),IALCO(400),
63.        &                 NSC, NSO
64.         COMMON / BLK A /SIE, SBR, SDR, SDR2, SPSC, SPSO, SID, SIM,
65.        &                 SDM, SBMC, SDMC, SDC2, DF
66.         COMMON / BLK B /NY, NBC, NIC, NBO, NIO, SIN, OH, NDS, RSTC,
67.        &                 RSTO, DMC, DRC, BDSC, BDSO, TAT, WP, ISP, AO1,
68.        &                 AO2, DSSF, NIS
69.         INTEGER WP
70.         COMMON / BLK C /NRU,LN(500),IN(500),ANAME(500,5),NQ(500),CRU(500),
71.        &           MTBF(500),UFP(500),W(500),FVS(500),RLS(500),RRS(500),
72.        &                 RMS(500),NRTS(500),COND(500),LV(500),LV2(500),
73.        &                 LSEV(500),USEV(500),LR(500),LR2(500),LSER(500,4),
74.        &           USER(500,4),RTS(500),LREM(500),NRTS2(500),COND2(500)
75.         REAL NRTS,NRTS2,MTBF
76.         COMMON / BLK D /NSE, LSE(40), ANSE      , CSE(40), COM(40)
77.         COMMON / BLK E /ACS, BTC, DTC, DCB, DCD, DCO, NPB, NPD, NPO,
78.        &                 NI, CRSC, CRSO, CDMC, WPR
79.         COMMON / OMCDAT /OM(7,26), DOM(7,26)
80.         COMMON ISWTCH
81.         COMMON / PRINT /IPRT(8),STYTL   ,CTIME,CDATE
82.         CHARACTER*8 NAME
83.             CHARACTER*4 STYTL(8),ANAME,ANSE(40,5)
84.         DIMENSION OM2(7,26),NAME(7)
85.         DATA NAME /'FLT L MT','BASE MT ','DEPOT MT','ITEM MGT',
86.        &           'DATA MGT','PK & SHP','S.E. MT.'/
87.         DO 200 K=1,25
88.         DO 100 J=1,7
89.         OM(J,K)=0.0
90.     100 CONTINUE
91.     200 CONTINUE
92.         DO 400 K = 1,NY
93.         DO 300 I = 2,NRU
94.         IF ( LV(I) .EQ. 1 ) OM(2,K) = OM(2,K) + ENR(I,K)*FVS(I)*SBR
95.         IF ( LREM(I) .EQ. 1 ) OM(2,K) = OM(2,K)+ENR(I,K)*RRS(I)*(SBR+SBMC)
96.     300 CONTINUE
97.     400 CONTINUE
98.         N = WP + 1
99.         DO 600 K=N,NY
```

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      DO 500 I=2,NRU
      IF ( LV(I) .GE. 2 ) OM(3,K) = OM(3,K) + ENR(I,K)*FVS(I)*SDR
      IF ( LR(I) .GE. 1 ) OM(3,K) = OM(3,K) + ENR(I,K)*XNRTS(I)*
     &                    (RLS(I)*(SDR+SDMC)+RMS(I))
      IF ( LREM(I) .GE. 2 ) OM(3,K) = OM(3,K) + ENR(I,K)*RRS(I)*
     &                     (SDR+SDMC)
  500 CONTINUE
  600 CONTINUE
      N = WP + 1
      TEMP=FLOAT(NI)*SIM
      DO 700 K=N,NY
      OM(4,K)=TEMP
  700 CONTINUE
      TEMP=FLOAT(NPB+NPO)*SDM
      TEMP1=FLOAT(NPD)*SDM
      DO 800 K=1,NY
      OM(5,K)=TEMP
      IF(K.GT.WP)OM(5,K)=OM(5,K)+TEMP1
  800 CONTINUE
      PSC = (FLOAT(NSC)*SPSC+FLOAT(NSO)*SPSO)/FLOAT(NSC+NSO)
      DO 1000 K=1,NY
      DO 900 I=2,NRU
      TERM = 2.*XNRTS(I) + XCOND(I)
      IF ( LR(I) .GE. 2 ) TERM = TERM + 2.*XRTS(I)
      IF ( LV(I) .GE. 2 ) TERM = TERM + 2.*UFP(I)+XCOND(I)
      IF ( LREM(I) .LE. 1 ) OM(6,K) = OM(6,K) + ENR(I,K)*TERM*W(I)*PSC
  900 CONTINUE
 1000 CONTINUE
      DO 1400 K = 1,NY
      DO 1100 J = 1,NSE
      OM(7,K) = OM(7,K) + FLOAT(IBREQ(J))*CSE(J)*COM(J)
 1100 CONTINUE
      IF ( K .LE. WP ) GO TO 1400
      ACTAVG = 0.
      DO 1200 M = 1,12
      ACTAVG = ACTAVG + FLOAT(NCUM(M,K))
 1200 CONTINUE
      ACTAVG = ACTAVG/12.
      DO 1300 J = 1,NSE
      OM(7,K) = OM(7,K) + FLOAT(IDREQ(J))*CSE(J)*COM(J)*ACTAVG/
     &                    FLOAT(NSC+NSO)
 1300 CONTINUE
 1400 CONTINUE
      DO 1600 K = 1,NY
      OM(1,K) = OM(1,K) + EPM(K)*(RLS(1)*SBR+RMS(1))
      DO 1500 I = 2,NRU
      IF ( LREM(I) .EQ. 0 ) OM(1,K) = OM(1,K) + ENR(I,K)*RRS(I)*SBR
 1500 CONTINUE
 1600 CONTINUE
 9997 FORMAT(//18X,'O & M COST BREAKDOWN BY CATEGORY AND BY YEAR'
```

```
150.       &/18X,44(1H-))
151.   9998 FORMAT(//' CATEGORY',30X,'YEAR'/' ',8(1H-),30X,'----'/8X,7I10)
152.        IF(ISWTCH) 1750,1770,1730
153.   1730 DO 1745 K=1,ISP
154.        DO 1740 J=1,7
155.        OM2(J,K)=OM(J,K)
156.   1740 CONTINUE
157.   1745 CONTINUE
158.        RETURN
159.   1750 DO 1760 K=1,ISP
160.        DO 1755 J=1,7
161.        OM(J,K)= OM2(J,K)
162.   1755 CONTINUE
163.   1760 CONTINUE
164.   1770 IF(IPRT(7).NE.1) RETURN
165.        WRITE( 6,9997)
166.        NY1=1
167.   2000 NY2=NY1+6
168.        IF(NY2.GT.NY) NY2=NY
169.        WRITE ( 6,9998) (J,J=NY1,NY2)
170.        IF(NY2.EQ.NY) GO TO 2020
171.        WRITE(6,9999) (NAME(N),(OM(N,IY),IY=NY1,NY2),N=1,7)
172.        NY1=NY1+7
173.        GO TO 2000
174.   2020 DO 2022 N=1,7
175.        WRITE( 6,9999) NAME(N),(OM(N,IY),IY=NY1,NY2)
176.   2022 CONTINUE
177.   9995  RETURN
178.   9999 FORMAT(7(' ',A8,2X,7F10.0,/))
179.        END
180.        SUBROUTINE OUTOP2
181.        COMMON / BLK D /NSE, LSE(40), ANSE      , CSE(40), COM(40)
182.        COMMON / SUPDAT /IBREQ(40), IDREQ(40), IBR2(40), IDR2(40)
183.        COMMON / PRINT /IPRT(8),STYTL   ,CTIME,CDATE
184.        CHARACTER*8 CTIME,CDATE
185.            CHARACTER*4 STYTL(8),ANSE(40,5)
186.        CHARACTER*4 ACOST(4)
187.        WRITE(   6,95000)(STYTL(I),I=1,8),CTIME,CDATE
188.   95000 FORMAT('1',10X,8A4,2(3X,A8))
189.        WRITE(  6,90000)
190.        DO 100 J=1,NSE
191.        IF ( IBREQ(J) .EQ. 0 ) GO TO 100
192.        COST = FLOAT(IBREQ(J))*CSE(J)
193.        CALL EDNUM(16,0,COST,ACOST)
194.        WRITE(  6,90001)(ANSE(J,K),K=1,5),IBREQ(J),ACOST
195.     100 CONTINUE
196.        WRITE(  6,90010)
197.        DO 200 J=1,NSE
198.        IF ( IDREQ(J) .EQ. 0 ) GO TO 200
199.        COST = FLOAT(IDREQ(J))*CSE(J)
```

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      CALL EDNUM(16,0,COST,ACOST)
      WRITE(  6,90011)(ANSE(J,K),K=1,5),IDREQ(J),ACOST
  200 CONTINUE
      RETURN
90000 FORMAT('0',20X,'SUPPORT EQUIPMENT REQUIREMENTS',/21X,30(1H-)//
     &10X,'LINE ITEMS OF SUPPORT EQUIPMENT REQUIRED AT BASE LEVEL'
     &     /10X,54(1H-)///8X,'EQUIPMENT',22X,'QUANTITY',11X,'COST'/
     &8X,9(1H-),22X,8(1H-),11X,4(1H-)//)
90001 FORMAT(1X,5A4,19X,I3,5X,4A4)
90010 FORMAT(//10X,'LINE ITEMS OF SUPPORT EQUIPMENT REQUIRED AT DEPOT',
     &' LEVEL'/10X,55(1H-)///8X,'EQUIPMENT',22X,'QUANTITY',11X,'COST'/
     &8X,9(1H-),22X,8(1H-),11X,4(1H-)//)
90011 FORMAT(1X,5A4,19X,I3,5X,4A4)
      END
      SUBROUTINE OUTOP3
      COMMON / CSPR / NCS(500)
      COMMON / DSPR /DLAMDA(500),DT(500),NSD(500)
      COMMON / BLK C /NRU,LN(500),IN(500),ANAME(500,5),NQ(500),CRU(500),
     &           MTBF(500),UFP(500),W(500),FVS(500),RLS(500),RRS(500),
     &               RMS(500),NRTS(500),COND(500),LV(500),LV2(500),
     &               LSEV(500),USEV(500),LR(500),IR2(500),LSER(500,4),
     &           USER(500,4),RTS(500),LREM(500),NR1S2(500),COND2(500)
      REAL NRTS,NRTS2,MTBF
      COMMON / SPRDAT /NRS(500),SRUS(500),LRUS(500),SRUMAX, LRUMAX,
     &                 NRS2(500)
      INTEGER SRUS, SRUMAX
      COMMON / PRINT /IPRT(8),STYTL   ,CTIME,CDATE
      CHARACTER*8 CTIME,CDATE
          CHARACTER*4 STYTL(8),ANAME
      CHARACTER*4 ACOST(4)
      WRITE(   6,95000)(STYTL(I),I=1,8),CTIME,CDATE
95000 FORMAT('1',10X,8A4,2(3X,A8))
      WRITE(  6,90000)
      DO 100 I=1,NRU
      IF ( NRS(I) .EQ. 0 ) GO TO 100
      COST = FLOAT(NRS(I))*CRU(I)
      NSB = NRS(I) - NCS(I) - NSD(I)
      CALL EDNUM(16,0,COST,ACOST)
      WRITE(  6,90010)(ANAME(I,K),K=1,5),NSD(I),NSB,NCS(I),NRS(I),ACOST
  100 CONTINUE
90000 FORMAT('0',20X,'SPARES REQUIREMENTS (UNIT TOTALS)',/21X,33(1H-)//
     & 35X,'SPARES'/22X,32(1H-),8X,'TOTAL'/
     & 2X,'REPLACEABLE UNIT    DEPOT  BASE  CONDEMNATION  TOTAL',
     & 8X,'COST'/
     & 2X,'----------------    -----  ----  ------------  -----',
     & 8X,'----')
90010 FORMAT(1X,5A4,1X,I4,3X,I3,7X,I4,6X,I4,3X,4A4)
      RETURN
      END
      SUBROUTINE OUTOP4
```

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      COMMON / BLK B /NY, NBC, NIC, NBO, NIO, SIN, OH, NDS, RSTC,
     &                RSTO, DMC, DRC, BDSC, BDSO, TAT, WP, ISP, AO1,
     &                AO2, DSSF, NIS
      INTEGER WP
      COMMON / OMCDAT /OM(7,26), DOM(7,26)
      COMMON / ACEDAT /AC(9,26), DAC(9,26)
      COMMON / COSSUM /TOTACQ(26), TOTOM(26), TOTCOS(26),
     &                 DOTACQ(26), DOTOM(26), DOTCOS(26)
      COMMON / PRINT /IPRT(8),STYTL   ,CTIME,CDATE
      COMMON ISWTCH
          CHARACTER*4 STYTL(8)
      CHARACTER*8 CTIME,CDATE
      CHARACTER*4 ACH(6,9),ACTH(6),OMH(6,7),OMTH(6),TOTH(6)
      CHARACTER*4 COS1(4),COS2(4)
      DATA ACH/'    ','INIT','IAL ','TRAI','NING','    ',
     &         '    ','DATA',' ACQ','UISI','TION','    ',
     &         '    ','ITEM',' ENT','RY  ','    ','    ',
     &         '    ','DATA',' MAN','AGEM','ENT ','    ',
     &         '    ','PRIM','E HA','RDWA','RE  ','    ',
     &         '    ','SUPP','ORT ','EQUI','PMEN','T   ',
     &         '    ','INIT','IAL ','SPAR','ES  ','    ',
     &         '    ','INST','ALLA','TION','    ','    ',
     &         '    ','WARR','ANTY','    ','    ','    '/
      DATA OMH/'    ','FLIG','HT L','INE ','MAIN','T.  ',
     &         '    ','BASE',' LEV','EL M','AINT','.   ',
     &         '    ','DEPO','T LE','VEL ','MAIN','T.  ',
     &         '    ','ITEM',' MAN','AGEM','ENT ','    ',
     &         '    ','DATA',' MAN','AGEM','ENT ','    ',
     &         '    ','PACK','ING ','& SH','IPPI','NG  ',
     &         '    ','S.E.','MAIN','TENA','NCE ','    '/
      DATA ACTH/'  TO','TAL ','ACQU','ISIT','ION ','COST'/
      DATA OMTH/'  TO','TAL ','O&M ','COST','    ','    '/
      DATA TOTH/'TOTA','L LI','FE C','YCLE',' COS','T   '/
      IF(IPRT(6).EQ.0 .OR. ISWTCH .GT. 0) GO TO 100
      WRITE(  6,90021)
      WRITE(   6,95000)(STYTL(I),I=1,8),CTIME,CDATE
95000 FORMAT('1',10X,8A4,2(3X,A8))
      WRITE(  6,90050)
      DO 60 M=1,8
      CALL EDNUM(16,0,AC(M,NY+1),COS1)
      CALL EDNUM(16,0,DAC(M,NY+1),COS2)
      WRITE(  6,90040)(ACH(MH,M),MH=1,6),COS1,COS2
   60 CONTINUE
      IF ( WP .EQ. 0 ) GO TO 65
      CALL EDNUM(16,0,AC(9,NY+1),COS1)
      CALL EDNUM(16,0,DAC(9,NY+1),COS2)
      WRITE(  6,90040)(ACH(MH,9),MH=1,6),COS1,COS2
   65 CONTINUE
      WRITE(  6,90222)
      CALL EDNUM(16,0,TOTACQ(NY+1),COS1)
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      CALL EDNUM(16,0,DOTACQ(NY+1),COS2)
      WRITE(  6,90040)(ACTH(MH),MH=1,6),COS1,COS2
      WRITE(  6,90021)
      DO 70 M=1,7
      CALL EDNUM(16,0,OM(M,NY+1),COS1)
      CALL EDNUM(16,0,DOM(M,NY+1),COS2)
      WRITE(  6,90040)(OMH(MH,M),MH=1,6),COS1,COS2
   70 CONTINUE
      WRITE(  6,90222)
      CALL EDNUM(16,0,TOTOM(NY+1),COS1)
      CALL EDNUM(16,0,DOTOM(NY+1),COS2)
      WRITE(  6,90040)(OMTH(MH),MH=1,6),COS1,COS2
      WRITE(  6,90021)
      WRITE(  6,90222)
      CALL EDNUM(16,0,TOTCOS(NY+1),COS1)
      CALL EDNUM(16,0,DOTCOS(NY+1),COS2)
      WRITE(  6,90040)(TOTH(MH),MH=1,6),COS1,COS2
  100 CONTINUE
      IF(IPRT(7).EQ.0.OR.ISWTCH.GT.0) RETURN
      WRITE(   6,95000)(STYTL(I),I=1,8),CTIME,CDATE
      ICV=NY+1
      I1=8
      IF(I1.GT.ICV)I1=ICV
      IF(ICV.GT.16) ICV=16
      I2=1
      WRITE(6,1)I2,I1
    1 FORMAT('0ACQUISITION COST PER YEAR, YEARS',I3,' THRU',I3,/)
      DO 5 I=1,9
    5 WRITE(6,7) I,(AC(I,K),K=1,I1)
    7 FORMAT(' ',I2,8F10.0)
      IF(ICV.LE.8) GO TO 15
      I2=9
      WRITE(6,1) I2,ICV
      DO 10 I=1,9
   10 WRITE(6,7) I,(AC(I,K),K=9,ICV)
   15 WRITE(   6,95000)(STYTL(I),I=1,8),CTIME,CDATE
      I2=1
   20 WRITE(6,21) I2,I1
   21 FORMAT('0O&M COST PER YEAR, YEARS',I3,' THRU',I3,/)
      DO 25 I=1,7
   25 WRITE(6,7) I, (OM(I,K),K=1,I1)
      IF(ICV.LE.8) GO TO 30
      I2=9
      WRITE(6,21) I2,ICV
      DO 28 I=1,7
   28 WRITE(6,7) I, (OM(I,K),K=9,ICV)
   30 CONTINUE
      WRITE(   6,95000)(STYTL(I),I=1,8),CTIME,CDATE
      WRITE(  6,91000)NY
91000 FORMAT('0',20X,'TOTAL COST SUMMARY (BY YEAR)',/
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     &                21X,28(1H-)//,
     &       1X,'SYSTEM OPERATIONAL LIFE = ',I2,' YEARS'//
     &            1X,'YEAR OF',10X,'UNDISCOUNTED',12X,'PRESENT VALUE',/
     &,      1X,'PROGRAM',10X,'    COST    ',12X,'    COST',/
     &       1X,'-------',10X,'    ----    ',12X,'    ----',/)
      DO 1111 I=1,NY
      CALL EDNUM(16,0,TOTCOS(I),COS1)
      CALL EDNUM(16,0,DOTCOS(I),COS2)
      WRITE(  6,91010)I,COS1,COS2
91010 FORMAT(4X,I2,10X,4A4,8X,4A4)
 1111 CONTINUE
      WRITE(  6,91020)
91020 FORMAT(2X,5(1H-),10X,15(1H-),9X,15(1H-))
      CALL EDNUM(16,0,TOTCOS(NY+1),COS1)
      CALL EDNUM(16,0,DOTCOS(NY+1),COS2)
      WRITE(  6,91030)COS1,COS2
91030 FORMAT(2X,'TOTAL',9X,4A4,8X,4A4)
      RETURN
90021 FORMAT(1H )
90222 FORMAT(26X,'-------------- --------------')
90040 FORMAT(1X,14A4)
90050 FORMAT('0',18X,'TOTAL COST SUMMARY (BY CATEGORY)'/
     &                19X,32(1H-)//
     &       28X,'UNDISCOUNTED',4X,'PRESENT VALUE'/
     &       28X,'    COST    ',4X,'    COST'/
     &       28X,'    ----    ',4X,'    ----'/)
      END
      SUBROUTINE OUTOP6(CARY,NINC,SUMHLD,IELHLD)
      COMMON / PRINT /IPRT(8),STYTL   ,CTIME,CDATE
      CHARACTER*8 CTIME,CDATE
          CHARACTER*4 STYTL(8)
      DIMENSION SUMHLD(500,3),COS1(4),COS2(4)
      IF ( IELHLD .EQ. 0 ) WRITE(  6,90000)CARY
      IF ( IELHLD .NE. 0 ) WRITE(  6,90020)CARY,IELHLD
      DO 100 I = 1 , NINC
      CALL EDNUM(16,0,SUMHLD(I,2),COS1)
      CALL EDNUM(16,0,SUMHLD(I,3),COS2)
      WRITE(  6,90010)SUMHLD(I,1),COS1,COS2
  100 CONTINUE
      RETURN
90000 FORMAT('1',21X,'SENSITIVITY ANALYSIS'/22X,20(1H-)//
     & 5X,'SENSITIVITY'/
     & 6X,'PARAMETER',8X,'UNDISCOUNTED',6X,'PRESENT VALUE'/
     & 10X,A4,10X,'TOTAL COST',9X,'TOTAL COST'/
     & 6X,9(1H-),8X,'------------',6X,'------------'//)
90010 FORMAT(2X,F13.3,4X,4A4,2X,4A4)
90020 FORMAT('1',21X,'SENSITIVITY ANALYSIS'/22X,20(1H-)//
     & 5X,'SENSITIVITY'/
     & 6X,'PARAMETER',8X,'UNDISCOUNTED',6X,'PRESENT VALUE'/
     & 7X,A4,'(',I2,')',9X,'TOTAL COST',9X,'TOTAL COST'/
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400.       & 6X,9(1H-),8X,'------------',6X,'-------------'//)
401.        END
402.        FUNCTION POISON (LAMBDA,T,NS)
403.        REAL LAMBDA,LT,LOGLT,LOGSN1,LOGSN,LOGTRM
404.        IF ( NS .EQ. 0 ) GO TO 200
405.        T1 = FLOAT(NS)/LAMBDA
406.        LT = LAMBDA*T
407.        POISON  = T-T1+EXP(ALOG(T1)-LT)
408.        IF ( NS .EQ. 1 ) RETURN
409.        NS1 = NS-1
410.        LOGLT = ALOG(LT)
411.        FNS = FLOAT(NS)
412.        LOGSN1 = ALOG(FNS)
413.        LOGTRM  = LOGSN1-ALOG(LAMBDA)-LT
414.        DO 100 K = 1,NS1
415.        LOGSN = LOGSN1
416.        LOGSN1 = ALOG(FNS-FLOAT(K))
417.        LOGTRM  = LOGTRM +LOGLT+LOGSN1-LOGSN-ALOG(FLOAT(K))
418.        POISON  = POISON  + EXP(LOGTRM )
419.    100 CONTINUE
420.        RETURN
421.    200 CONTINUE
422.        POISON  = T
423.        RETURN
424.        END
425.        SUBROUTINE PRBSPR(NSYS,ICONUS)
426.        COMMON / BLK C /NRU,LN(500),IN(500),ANAME(500,5),NQ(500),CRU(500),
427.       &            MTBF(500),UFP(500),W(500),FVS(500),RLS(500),RRS(500),
428.       &                RMS(500),NRTS(500),COND(500),LV(500),LV2(500),
429.       &                LSEV(500),USEV(500),LR(500),LR2(500),LSER(500,4),
430.       &            USER(500,4),RTS(500),LREM(500),NRTS2(500),COND2(500)
431.        REAL NRTS,NRTS2,MTBF
432.        CHARACTER*4 ANAME,COS
433.        COMMON / SPRDAT /NRS(500),SRUS(500),LRUS(500),SRUMAX, LRUMAX,
434.       &                 NRS2(500)
435.        INTEGER SRUS, SRUMAX
436.        COMMON / SYSBAS /NALCC(400), IALCC(400), NALCO(400),IALCO(400),
437.       &                 NSC, NSO
438.        COMMON / BSPR /BLAMDA (500),BT(500),NSB(500)
439.        DIMENSION COS(4), NALC(400,2)
440.        EQUIVALENCE (NALC,NALCC)
441.        INTEGER SRUDEX
442.        NBASE = NALC(NSYS,ICONUS)
443.        IF(ICONUS.EQ.2 .OR. ICONUS.EQ.4) GO TO 150
444.        WRITE(  6,90010)NSYS,NBASE
445.        DO 100 LRUDEX = 1,LRUMAX
446.        IDEX = LRUS(LRUDEX)
447.        ITEMP = NSB(IDEX)*NBASE
448.        CALL EDNUM(14,0,CRU(IDEX)*ITEMP,COS)
449.        WRITE(  6,90020)(ANAME(IDEX,K),K=1,5),NSB(IDEX),ITEMP,COS
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  100 CONTINUE
      GO TO 300
  150 IF ( SRUMAX .EQ. 0 ) GO TO 300
      WRITE(  6,90030)
      DO 200 SRUDEX = 1,SRUMAX
      IDEX = SRUS(SRUDEX)
      ITEMP = NSB(IDEX)*NBASE
      CALL EDNUM(14,0,CRU(IDEX)*ITEMP,COS)
      WRITE(  6,90020)(ANAME(IDEX,K),K=1,5),NSB(IDEX),ITEMP,COS
  200 CONTINUE
  300 CONTINUE
      WRITE(  6,90040)
      RETURN
90010 FORMAT(/3X,I3,6X,I3,11X,'LRU SPARES REQUIREMENTS'/
     &       26X,23(1H-)//17X,'REPLACEABLE UNIT',
     &       4X,'SPARES/BASE  TOTAL       COST'/
     &       17X,16(1H-),4X,11(1H-),2X,5(1H-),7X,4(1H-))
90020 FORMAT(16X,5A4,5X,I3,6X,I4,2X,3A4,A2)
90030 FORMAT(//26X,'SRU SPARES REQUIREMENTS'/26X,23(1H-)//
     &       17X,'REPLACEABLE UNIT',
     &       4X,'SPARES/BASE  TOTAL       COST'/
     &       17X,16(1H-),4X,11(1H-),2X,5(1H-),7X,4(1H-))
90040 FORMAT(1H )
      END
      SUBROUTINE PRNTMP
      COMMON / MANPWR   /FLMH(25), BLMH(25), DLMH(25)
      COMMON / PRINT /IPRT(8),STYTL   ,CTIME,CDATE
      CHARACTER*8 CTIME,CDATE
          CHARACTER*4 STYTL(8)
      COMMON / BLK B /NY, NBC, NIC, NBO, NIO, SIN, OH, NDS, RSTC,
     &               RSTO, DMC, DRC, BDSC, BDSO, TAT, WP, ISP, AO1,
     &               AO2, DSSF, NIS
      INTEGER WP
      WRITE(   6,95000)(STYTL(I),I=1,8),CTIME,CDATE
95000 FORMAT('1',10X,8A4,2(3X,A8))
      WRITE(  6,90000)
      DO 10 K = 1,NY
      WRITE(  6,90010)K,FLMH(K),BLMH(K),DLMH(K)
   10 CONTINUE
90000 FORMAT('0',19X,'MANPWR   REQUIREMENTS'/21X,'(MANHOURS PER YEAR)'//
     &       1X,'YEAR',9X,'FLIGHT LINE',7X,'BASE',10X,'DEPOT'/
     &       1X,'----',9X,'-----------',7X,'----',10X,'-----')
90010 FORMAT(2X,I2,12X,F6.0,2(9X,F6.0))
      RETURN
      END
      SUBROUTINE READA
      COMMON / BLK A /SIE, SBR, SDR, SDR2, SPSC, SPSO, SID, SIM,
     &               SDM, SBMC, SDMC, SDC2, DF
      READ( 5,90000)SIE, SBR, SDR, SDR2, SPSC, SPSO, SID, SIM,
     &              SDM, SBMC, SDMC, SDC2, DF
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90000 FORMAT(13F6.0)
      RETURN
      END
      SUBROUTINE READB
      COMMON / BLK B /NY, NBC, NIC, NBO, NIO, SIN, OH, NDS, RSTC,
     &               RSTO, DMC, DRC, BDSC, BDSO, TAT, WP, ISP, AO1,
     &               AO2, DSSF, NIS
      INTEGER WP
      COMMON / ACTSCH  /NAC(12,25), NCUM(12,25),  MACDEX
      COMMON / SYSBAS /NALCC(400), IALCC(400), NALCO(400),IALCO(400),
     &                 NSC, NSO
      DIMENSION NACEQ(300), NCUMEQ(300)
      EQUIVALENCE (NACEQ,NAC), (NCUMEQ,NCUM)
      DO 3 M=1,300
    3 NACEQ(M) = 0
      DO 10 M=1,400
      NALCC(M) = 0
      NALCO(M) = 0
      IALCC(M) = 0
      IALCO(M) = 0
   10 CONTINUE
      READ( 5,90001)NY,NBC,NIC,NBO,NIO,NSC,NSO
      IF ( NBC .EQ. 0) GO TO 25
      IBTOT = 0
      ISTOT = 0
   20 READ( 5,90002)NBASE,NSYS
      IBTOT = IBTOT + NBASE
      ISTOT = ISTOT + NSYS*NBASE
      IF ( NALCC(NSYS) .NE. 0 ) WRITE(6,111) NSYS
      NALCC(NSYS) = NBASE
      IF ( IBTOT.EQ.NBC .AND. ISTOT.EQ.NSC ) GO TO 25
      IF ( IBTOT.GE.NBC .OR. ISTOT.GE.NSC ) WRITE(6,121)
      GO TO 20
   25 IBTOT = 0
      ISTOT = 0
      IF(NIC.EQ.0) GO TO 29
   27 READ( 5,90002) ISITE,ISYS
      IBTOT=IBTOT+ISITE
      ISTOT=ISTOT+ISYS*ISITE
      IF(IALCC(ISYS) .NE. 0) WRITE(6,111) NSYS
      IALCC(ISYS)=ISITE
      IF(IBTOT.EQ.NIC .AND. ISTOT.EQ.NSC) GO TO 29
      IF(IBTOT.GE.NIC .OR. ISTOT.GE.NSC) WRITE(6,126)
      GO TO 27
   29 IBTOT = 0
      ISTOT = 0
      IF ( NBO .EQ. 0 ) GO TO 35
   30 READ( 5,90002)NBASE,NSYS
      IBTOT = IBTOT + NBASE
      ISTOT = ISTOT + NSYS*NBASE
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      IF ( NALCO(NSYS) .NE. 0 ) WRITE(6,131) NSYS
      NALCO(NSYS) = NBASE
      IF ( IBTOT.EQ.NBO .AND. ISTOT.EQ.NSO ) GO TO 35
      IF ( IBTOT.GE.NBO .OR. ISTOT.GE.NSO ) WRITE(6,141)
      GO TO 30
   35 IBTOT = 0
      ISTOT = 0
      IF(NIO.EQ.0) GO TO 40
   37 READ( 5,90002) ISITE,ISYS
      IBTOT=IBTOT+ISITE
      ISTOT=ISTOT+ISYS*ISITE
      IF(IALCO(ISYS) .NE. 0) WRITE(6,131) NSYS
      IALCO(ISYS)=ISITE
      IF(IBTOT.EQ.NIO .AND. ISTOT.EQ.NSO) GO TO 40
      IF(IBTOT.GE.NIO .OR. ISTOT.GE.NSO) WRITE(6,146)
      GO TO 37
   40 READ( 5,90003)SIN, OH, NDS, NIS, RSTC, RSTO, DMC, DRC, BDSC,
     &              BDSO, TAT, WP, ISP, AO1, AO2, DSSF
   50 READ( 5,90004)I,J,NACT
      IF ( I .EQ. 0 .AND. J .EQ. 0 ) GO TO 55
      IF (I.LE.0.OR.I.GT.NY.OR.J.LE.0.OR.J.GT.12 ) WRITE(6,161)I,J,NACT
      NAC(J,I) = NACT
      GO TO 50
   55 CONTINUE
      NCUMEQ(1) = NACEQ(1)
       MACIVE = 0
      IF ( NACEQ(1) .LT. 0 ) WRITE(6,171)
      LIM = NY * 12
       MACDEX = 1
      DO 5 I = 2,LIM
      IF ( NACEQ(I) .LT. 0 .AND.  MACIVE .EQ. 0 ) WRITE(6,171)
      NCUMEQ(I) = NCUMEQ(I-1) + NACEQ(I)
      IF ( NCUMEQ(I) .GT. NSC+NSO ) WRITE(6,191) I
      IF ( NCUMEQ(I) .NE. NSC+NSO ) GO TO 5
      IF (  MACIVE .EQ. 0 )  MACDEX = I
       MACIVE = 1
    5 CONTINUE
      IF (  MACIVE .EQ. 0 ) WRITE(6,181)
      RETURN
  111 FORMAT(' ***ERROR...DUPLICATE CONUS SYSTEM ALLOCATION',I8)
  121 FORMAT (' ***ERROR...INCONSISTENT CONUS BASE/SYSTEM ALLOCATION')
  126 FORMAT (' ***ERROR...INCONSISTENT CONUS I-LEVEL SITE/SYSTEM ALLOCA
     &TION')
  131 FORMAT (' ***ERROR...DUPLICATE OVERSEAS SYSTEM ALLOCATION',I8)
  141 FORMAT (' ***ERROR..INCONSISTENT OVERSEAS BASE/SYSTEM ALLOCATION')
  146 FORMAT (' ***ERROR..INCONSISTENT OVERSEAS I-LEVEL SITE/SYSTEM ALLO
     &CATION')
  161 FORMAT (' ***ERROR...INVALID ACTIVATION SCHEDULE INPUT',3I8)
  171 FORMAT (' ***ERROR...DEACTIVATION BEFORE FULL ACTIVATION')
  181 FORMAT (' ***ERROR...FULL ACTIVATION NOT REACHED')
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  191 FORMAT (' ***ERROR...TOO MANY SYSTEMS ACTIVE IN MONTH',I5)
90001 FORMAT(5I4,2I5)
90002 FORMAT(2I4)
90003 FORMAT(F 8.0,F6.0,2I2,7F6.0,I3,I2,2F4.3,F5.4)
90004 FORMAT(2I3,I5)
      END
      SUBROUTINE READC
      COMMON / BLK C /NRU,LN(500),IN(500),ANAME(500,5),NQ(500),CRU(500),
     &            MTBF(500),UFP(500),W(500),FVS(500),RLS(500),RRS(500),
     &                RMS(500),NRTS(500),COND(500),LV(500),LV2(500),
     &                LSEV(500),USEV(500),LR(500),LR2(500),LSER(500,4),
     &           USER(500,4),RTS(500),LREM(500),NRTS2(500),COND2(500)
      REAL NRTS,NRTS2,MTBF
          CHARACTER*4 ANAME
      READ( 5,90000)NRU
      DO 10 I=1,NRU
      READ( 5,90010)(ANAME(I,J),J=1,5),LV2(I),LR2(I)
      READ( 5,90020)LN(I), IN(I), NQ(I), CRU(I), MTBF(I), UFP(I), W(I),
     &              FVS(I), RLS(I), RRS(I), RMS(I), NRTS(I), COND(I),
     &              LV(I), LSEV(I), USEV(I), LR(I), (LSER(I,J),J=1,4),
     &              (USER(I,J),J=1,4)
      IF(LV2(I).EQ.0) LV2(I)=LV(I)
      IF(LR2(I).EQ.0) LR2(I)=LR(I)
   10 CONTINUE
      RETURN
90000 FORMAT(  )
90010 FORMAT(5A4,28X,I2,5X,I2)
90020 FORMAT (I3,I1,I2,2F6.0,F3.3,4F4.0,F5.0,2F3.3,2I2,F3.0,5I2,4F3.0)
      END
      SUBROUTINE READD
          CHARACTER*4 ANSE(40,5)
      COMMON / BLK D /NSE, LSE(40), ANSE     , CSE(40), COM(40)
      READ( 5,90000)NSE
      DO 10 J=1,NSE
      READ( 5,90010)(ANSE(J,K),K=1,5)
      READ( 5,90020)LSE(J),CSE(J),COM(J)
   10 CONTINUE
      RETURN
90000 FORMAT(I2)
90010 FORMAT(5A4)
90020 FORMAT(I2,F7.0,F5.0)
      END
      SUBROUTINE READE
      COMMON / BLK B /NY, NBC, NIC, NBO, NIO, SIN, OH, NDS, RSTC,
     &               RSTO, DMC, DRC, BDSC, BDSO, TAT, WP, ISP, AO1,
     &               AO2, DSSF, NIS
      INTEGER WP
      COMMON / BLK E /ACS, BTC, DTC, DCB, DCD, DCO, NPB, NPD, NPO,
     &               NI, CRSC, CRSO, CDMC, WPR
      COMMON / RELIAB   /G(26), GR(12,25), GM,ENR(500,25), EPM(25)
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      NY1 = NY + 1
      READ( 5,90000)ACS,BTC,DTC,DCB,DCD,DCO,NPB,NPD,NPO,NI,CRSC,CRSO,
     &              CDMC,WPR
      READ ( 5,90010) (G(K),K=1,13)
      IF(NY1.GT.13) READ ( 5,90010 ) (G(K),K=14,NY1)
      RETURN
90000 FORMAT(F6.0,F5.0,3F6.0,F7.0,2I4,I5,I4,3F6.0,F9.0)
90010 FORMAT(13F6.0)
      END
      SUBROUTINE SERC
      COMMON / BLK B /NY, NBC, NIC, NBO, NIO, SIN, OH, NDS, RSTC,
     &               RSTO, DMC, DRC, BDSC, BDSO, TAT, WP, ISP, AO1,
     &               AO2, DSSF, NIS
      INTEGER WP
      COMMON / BLK C /NRU,LN(500),IN(500),ANAME(500,5),NQ(500),CRU(500),
     &           MTBF(500),UFP(500),W(500),FVS(500),RLS(500),RRS(500),
     &               RMS(500),NRTS(500),COND(500),LV(500),LV2(500),
     &               LSEV(500),USEV(500),LR(500),LR2(500),LSER(500,4),
     &           USER(500,4),RTS(500),LREM(500),NRTS2(500),COND2(500)
      REAL NRTS,NRTS2,MTBF
          CHARACTER*4 ANAME
      COMMON / BLK D /NSE, LSE(40), ANSE(40,5), CSE(40), COM(40)
      COMMON / RELIAB   /G(26), GR(12,25), GM,ENR(500,25), EPM(25)
      COMMON / SYSBAS /NALCC(400), IALCC(400), NALCO(400),IALCO(400),
     &                 NSC, NSO
      COMMON / SUPDAT /IBREQ(40), IDREQ(40), IBR2(40), IDR2(40)
      COMMON ISWTCH
      DIMENSION D(40),RBHPM(40),IBREQ2(40),IDREQ2(40)
      IBTOT=NBC+NBO
      NTOT = NSC + NSO
      WHPMAD = (5./7.) * (8.*FLOAT(NDS)/24.) * 730.
      GF = GM
      IF ( WP .GT. 0 ) GF = G(WP+1)
      DO 20 J=1,NSE
      IBR2(J)=0
      IDR2(J)=0
      IBREQ(J)=0
      RBHPM(J)=0
      D(J)=0.0
   20 CONTINUE
      DO 1400 I=1,NRU
      WHPS=(FLOAT(NQ(I))*OH)/(G(WP+1)*MTBF(I))
      IF(LV(I) .GT. 1)GO TO 700
      IF(LSEV(I) .EQ. 0)GO TO 250
      DO 100 J=1,NSE
      IF(LSEV(I) .EQ. LSE(J))GO TO 200
  100 CONTINUE
      WRITE(  6,90000)LSEV(I),I
      PRINT *,'STOP IGNORED*****************'
  200 RBHPM(J)=RBHPM(J)+WHPS*USEV(I)
```

```
700.     250 IF(LR(I) .GT. 1)GO TO 1000
701.         DO 500 K=1,4
702.         IF(LSER(I,K) .EQ. 0)GO TO 600
703.         DO 300 J=1,NSE
704.         IF(LSER(I,K) .EQ. LSE(J))GO TO 400
705.     300 CONTINUE
706.         WRITE(  6,90010)LSER(I,K),I
707.         PRINT *,'STOP IGNORED***************2'
708.     400 RBHPM(J)=RBHPM(J)+WHPS*USER(I,K)
709.     500 CONTINUE
710.     600 GO TO 1000
711.     700 IF(LSEV(I) .EQ. 0) GO TO 1000
712.         DO 800 J=1,NSE
713.         IF(LSEV(I).EQ.LSE(J))GO TO 900
714.     800 CONTINUE
715.         WRITE(  6,90000)LSEV(I),I
716.         PRINT *,'STOP IGNORED***************3'
717.     900 D(J) = D(J)+FLOAT(NTOT*NQ(I))*OH*USEV(I)/((1.-UFP(I))*GF*MTBF(I))
718.    1000 DO 1300 K=1,4
719.         IF(LSER(I,K).EQ.0)GO TO 1400
720.         DO 1100 J=1,NSE
721.         IF(LSER(I,K).EQ.LSE(J))GO TO 1200
722.    1100 CONTINUE
723.         WRITE(  6,90010)LSER(I,K),I
724.         PRINT *,'STOP IGNORED***************4'
725.    1200 CONTINUE
726.         FACTOR = NRTS(I)
727.         IF ( LR(I) .GT. 1 ) FACTOR = FACTOR + RTS(I)
728.         D(J) = D(J) + FLOAT(NTOT*NQ(I))*OH*USER(I,K) / (GF*MTBF(I))
729.        &            * FACTOR
730.    1300 CONTINUE
731.    1400 CONTINUE
732.         DO 1420 I=1,400
733.         IF(IALCC(I).EQ.0) GO TO 1420
734.         DO 1415 J=1,NSE
735.         IBREQ(J)=IBREQ(J)+ICEIL((RBHPM(J)*FLOAT(I))/(174.*FLOAT(NIS)))
736.        &*IALCC(I)
737.    1415 CONTINUE
738.    1420 CONTINUE
739.         DO 1450 I=1,400
740.         IF(IALCO(I).EQ.0) GO TO 1450
741.         DO 1445 J=1,NSE
742.         IBREQ(J)=IBREQ(J)+ICEIL((RBHPM(J)*FLOAT(I))/(174.*FLOAT(NIS)))
743.        &*IALCO(I)
744.    1445 CONTINUE
745.    1450 CONTINUE
746.         DO 1500 J=1,NSE
747.         IDREQ(J) = ICEIL(D(J)/WHPMAD)
748.    1500 CONTINUE
749.         IF(ISWTCH) 1700,2000,1600
```

```
 1600 DO1610 J=1,NSE
      IDREQ2(J)=IDREQ(J)
      IBREQ2(J)=IBREQ(J)
 1610 CONTINUE
      GO TO 2000
 1700 DO 1710 J=1,NSE
      IF(IDREQ2(J).LT.IDREQ (J)) IDR2(J)=IDREQ(J)-IDREQ2(J)
      IF(IBREQ2(J).LT.IBREQ (J)) IBR2(J)=IBREQ(J)-IBREQ2(J)
      IF(IDREQ2(J).GT.IDREQ(J)) IDREQ(J)=IDREQ2(J)
      IF(IBREQ2(J).GT.IBREQ(J)) IBREQ(J)=IBREQ2(J)
 1710 CONTINUE
 2000 RETURN
90000 FORMAT(1H1,1X,'SUPPORT ITEM',I3,1X,'VERIFYING LINE ITEM',I3,
     & 1X,'NOT FOUND')
90010 FORMAT(1H1,1X,'SUPPORT ITEM',I3,1X,'REPAIRING LINE ITEM',I3,
     & 1X,'NOT FOUND')
      END
      SUBROUTINE SET(VAL,ICOMN,IOFF,ITYPE,MODE)
      COMMON /BLKA/OLAY1(13)
      COMMON /BLKB/OLAY2(21)
      COMMON /BLKC/OLAY3(1751)
      COMMON /BLKD/OLAY4(81)
      COMMON /BLKE/OLAY5(14)
      COMMON /RELIAB  /OLAY6(1602)
      DIMENSION ILAY1(13),ILAY2(21),ILAY3(1701),ILAY4(81),ILAY5(14),
     &          ILAY6(1602)
      DIMENSION IN(500),CRU(500),TBF(500)
      EQUIVALENCE (ILAY3(1),NRU)
      EQUIVALENCE (OLAY3(402),CRU(1)),
     &            (OLAY3(452),TBF(1)),
     &            (OLAY3(52),IN(1)),
     &            (OLAY5(1),AC5)
      EQUIVALENCE (OLAY1(1),ILAY1(1)),
     &            (OLAY2(1),ILAY2(1)),
     &            (OLAY3(1),ILAY3(1)),
     &            (OLAY4(1),ILAY4(1)),
     &            (OLAY5(1),ILAY5(1)),
     &            (OLAY6(1),ILAY6(1))
      IF ( ICOMN .NE. 3 ) GO TO 90
      IF ( MODE .NE. 1 ) GO TO 90
      IF ( (IOFF.GE.402) .AND. (IOFF.LE.451) ) GO TO 600
      IF ( (IOFF.GE.452) .AND. (IOFF.LE.501) ) GO TO 700
   90 GO TO (100,200,300,400,500,550),ICOMN
  100 IF(MODE.EQ.1)GO TO 120
      VAL = OLAY1(IOFF)
      RETURN
  120 IF(ITYPE.EQ.1)GO TO 130
      OLAY1(IOFF)=VAL
      RETURN
  130 ILAY1(IOFF)=IFIX(VAL)
```

```
      RETURN
  200 IF(MODE.EQ.1)GO TO 220
      VAL = OLAY2(IOFF)
      RETURN
  220 IF(ITYPE.EQ.1)GO TO 230
      OLAY2(IOFF)=VAL
      RETURN
  230 ILAY2(IOFF)=IFIX(VAL)
      RETURN
  300 IF(MODE.EQ.1)GO TO 320
      VAL = OLAY3(IOFF)
      RETURN
  320 IF(ITYPE.EQ.1)GO TO 330
      OLAY3(IOFF)=VAL
      RETURN
  330 ILAY3(IOFF)=IFIX(VAL)
      RETURN
  400 IF(MODE.EQ.1)GO TO 420
      VAL = OLAY4(IOFF)
      RETURN
  420 IF(ITYPE.EQ.1)GO TO 430
      OLAY4(IOFF)=VAL
      RETURN
  430 ILAY4(IOFF)=IFIX(VAL)
      RETURN
  500 IF(MODE.EQ.1)GO TO 520
      VAL = OLAY5(IOFF)
      RETURN
  520 IF(ITYPE.EQ.1)GO TO 530
      OLAY5(IOFF)=VAL
      RETURN
  530 ILAY5(IOFF)=IFIX(VAL)
      RETURN
  550 IF(MODE.EQ.1)GO TO 560
      VAL = OLAY6(IOFF)
      RETURN
  560 IF(ITYPE.EQ.1)GO TO 570
      OLAY6(IOFF)=VAL
      RETURN
  570 ILAY6(IOFF)=IFIX(VAL)
      RETURN
  600 CONTINUE
      OLDV = OLAY3(IOFF)
      RATIO = VAL/OLDV
      DIFF = OLDV - VAL
      ITEM = IOFF + 1 - 402
      IND1 = IN(ITEM)
      IF ( ITEM .LT. 2 ) GO TO 615
      DO 610 I = 2 , ITEM
      J = ITEM - I + 1
```

```
850.          IND = IN(J) + 1
851.          IF ( IND1 .NE. IND ) GO TO 610
852.          IND1 = IND - 1
853.          CRU(J) = CRU(J) - DIFF
854.      610 CONTINUE
855.      615 CONTINUE
856.          IND = IN(ITEM)
857.          DO 620 J = ITEM , NRU
858.          IF ( (IND.EQ.IN(J)) .AND. (J.NE.ITEM) ) GO TO 630
859.          CRU(J) = CRU(J) * RATIO
860.      620 CONTINUE
861.      630 ACS=CRU(1)
862.          RETURN
863.      700 CONTINUE
864.          OLDV = 1./OLAY3(IOFF)
865.          RATIO = (1./VAL)/OLDV
866.          DIFF =OLDV - 1./VAL
867.          ITEM = IOFF + 1 - 452
868.          IND1 = IN(ITEM)
869.          IF ( ITEM .LT. 2 ) GO TO 715
870.          DO 710 I = 2 , ITEM
871.          J = ITEM - I + 1
872.          IND = IN(J) + 1
873.          IF ( IND1 .NE. IND ) GO TO 710
874.          IND1 = IND-1
875.          TBF(J) = 1./(1./TBF(J) - DIFF)
876.      710 CONTINUE
877.      715 CONTINUE
878.          IND = IN(ITEM)
879.          DO 720 J = ITEM , NRU
880.          IF ( (IND.EQ.IN(J)) .AND. (J.NE.ITEM) ) GO TO 730
881.          TBF(J) = 1./((1./TBF(J)) * RATIO)
882.      720 CONTINUE
883.      730 RETURN
884.          END
```

```
1.        SUBROUTINE SREQ
2.        COMMON / SPRDAT /NRS(500),SRUS(500),LRUS(500),SRUMAX, LRUMAX,
3.       &                 NRS2(500)
4.        INTEGER SRUS, SRUMAX
5.        COMMON / BLK C /NRU,LN(500),IN(500),ANAME(500,5),NQ(500),CRU(500),
6.       &            MTBF(500),UFP(500),W(500),FVS(500),RLS(500),RRS(500),
7.       &                RMS(500),NRTS(500),COND(500),LV(500),LV2(500),
8.       &                LSEV(500),USEV(500),LR(500),LR2(500),LSER(500,4),
9.       &            USER(500,4),RTS(500),LREM(500),NRTS2(500),COND2(500)
10.       REAL NRTS,NRTS2,MTBF
11.       COMMON / PRINT /IPRT(8),STYTL   ,CTIME,CDATE
12.       CHARACTER*8 CTIME,CDATE
13.           CHARACTER*4 STYTL(8),ANAME,ANSE(40,5),COS
14.       COMMON / DSPR /DLAMDA(500),DT(500),NSD(500)
15.       COMMON / BSPR /BLAMDA (500),BT(500),NSB(500)
16.       COMMON / SYSBAS /NALCC(400), IALCC(400), NALCO(400),IALCO(400),
17.      &                 NSC, NSO
18.       COMMON / CSPR / NCS(500)
19.       DIMENSION COS(4),NSD2(500),NCS2(500),NSBC2(50 ,500),NSBO2(50 ,500)
20.       DIMENSION ISBC2(50 ,500),ISBO2(50 ,500)
21.       COMMON ISWTCH
22.       CALL DSPARE
23.       IF ( IPRT(3) .NE. 1 .OR. ISWTCH.GT.0 ) GO TO 50
24.       WRITE(   6,95000)(STYTL(I),I=1,8),CTIME,CDATE
25. 95000 FORMAT('1',10X,8A4,2(3X,A8))
26.       WRITE(  6,90010)
27.    50 DO 300 I = 2,NRU
28.       IF(ISWTCH) 200,250,100
29.   100 NSD2(I)=NSD(I)
30.       GO TO 300
31.   200 NRS2(I)=0
32.       IF(NSD(I).LE.NSD2(I)) GO TO 240
33.       NRS2(I)=NSD(I)-NSD2(I)
34.       GO TO 250
35.   240  NSD(I)=NSD2(I)
36.   250 IF(IPRT(3).NE.1) GO TO 300
37.       CALL EDNUM(16,0,CRU(I)*NSD(I),COS)
38.       WRITE(  6,90020)(ANAME(I,K),K=1,5),NSD(I),COS
39.   300 NRS(I) = NSD(I)
40.       CALL BSINIT
41.       IF ( IPRT(3) .EQ. 1 .AND. ISWTCH.LE.0) WRITE ( 6,90030)
42.       IM=0
43.       DO 400 M = 1,400
44.       MX = M
45.       IF ( NALCC(M) .EQ. 0 ) GO TO 400
46.       IM = IM + 1
47.       CALL BSPARE(MX,1)
48.       DO 350 I = 2,NRU
49.       IF(ISWTCH) 325,350,310
```

```
310 NSBC2(IM,I)=NSB(I)
    GO TO 350
325  IF(NSBC2(IM,I).GE.NSB(I)) GO TO 330
    NRS2(I)=NRS2(I)+NSB(I)-NSBC2(IM,I)
    GO TO 350
330 NSB(I)=NSBC2(IM,I)
350 NRS(I)=NRS(I)+NSB(I)*NALCC(M)
    IF(IPRT(3).EQ.1 .AND. ISWTCH.LE.0) CALL PRBSPR(MX,1)
400 CONTINUE
    IM=0
    DO 440 M=1,400
    MX = M
    IF ( IALCC(M) .EQ. 0 ) GO TO 440
    IM=IM+1
    CALL BSPARE(MX,2)
    DO 430 I = 2,NRU
    IF(IN(I).EQ.2) GO TO 430
    IF(ISWTCH) 425,430,410
410 ISBC2(IM,I)=NSB(I)
    GO TO 430
425  IF(ISBC2(IM,I).GE.NSB(I)) GO TO 427
    NRS2(I)=NRS2(I)+NSB(I)       -ISBC2(IM,I)
    GO TO 430
427 NSB(I)=ISBC2(IM,I)
430 NRS(I)=NRS(I)+NSB(I)*IALCC(M)
    IF (IPRT(3) .EQ. 1.AND.ISWTCH.LE.0) CALL PRBSPR(MX,2)
440  CONTINUE
    IF (IPRT(3) .EQ. 1.AND.ISWTCH.LE.0) WRITE ( 6,90040)
    IM=0
    DO 500 M = 1,400
    MX = M
    IF ( NALCO(M) .EQ. 0 ) GO TO 500
    IM = IM+1
    CALL BSPARE(MX,3)
    DO 450 I=2,NRU
    IF(ISWTCH) 445,450,442
442 NSBO2(IM,I)=NSB(I)
    GO TO 450
445 IF(NSBO2(IM,I).GE.NSB(I)) GO TO 447
    NRS2(I)=NRS2(I)+NSB(I)-NSBO2(IM,I)
    GO TO 450
447 NSB(I)=NSBO2(IM,I)
450 NRS(I) = NRS(I) + NSB(I)*NALCO(M)
    IF (IPRT(3) .EQ. 1 .AND. ISWTCH.LE.0) CALL PRBSPR(MX,3)
500 CONTINUE
    IM=0
    DO 550 M=1,400
    MX = M
    IF (IALCO(M) .EQ. 0 ) GO TO 550
    IM=IM+1
```

```
      CALL BSPARE (MX,4)
      DO 540 I=2,NRU
      IF (IN(I).EQ.2) GO TO 540
      IF (ISWTCH) 525,540,510
  510 ISBO2(IM,I)=NSB(I)
      GO TO 540
  525 IF(ISBO2(IM,I).GE.NSB(I)) GO TO 530
      NRS2(I)=NRS2(I)+NSB(I)-ISBO2(IM,I)
      GO TO 540
  530 NSB(I)=ISBO2(IM,I)
  540 NRS(I)=NRS(I)+NSB(I)*IALCO(M)
      IF (IPRT(3).EQ. 1.AND.ISWTCH.LE.0) CALL PRBSPR(MX,4)
  550 CONTINUE
      CALL CSPARE
      IF ( IPRT(3) .NE. 1 .OR. ISWTCH.EQ.1) GO TO 700
      WRITE(   6,95000)(STYTL(I),I=1,8),CTIME,CDATE
      WRITE(  6,90050)
      DO 600 I = 2,NRU
      CALL EDNUM(16,0,CRU(I)*NCS(I),COS)
      WRITE(  6,90020)(ANAME(I,K),K=1,5),NCS(I),COS
  600 CONTINUE
  700 CONTINUE
      DO 800 I = 2,NRU
      IF(ISWTCH.EQ.1) NCS2(I)=NCS(I)
      IF(ISWTCH.EQ.-1 .AND. NCS2(I).GT.NCS(I)) NCS(I)=NCS2(I)
      NRS(I) = NRS(I) + NCS(I)
  800 CONTINUE
      RETURN
90010 FORMAT('0',18X,'SPARES REQUIREMENTS (DETAILED)'/19X,30(1H-)//
     &       19X,'DEPOT LEVEL SPARES REQUIREMENTS'/19X,31(1H-)//
     &       4X,'REPLACEABLE UNIT',11X,'SPARES',20X,'COST'/
     &       4X,'----------------',11X,'------',20X,'----'/)
90020 FORMAT(1X,5A4,10X,I5,12X,4A4)
90030 FORMAT('1',15X,'BASE LEVEL SPARES REQUIREMENTS (CONUS)'/16X,38
     & (1H-)//' SYSTEMS/'/2X,'BASE',5X,'BASES'/2X,'----',5X,'-----')
90040 FORMAT(//16X,'BASE LEVEL SPARES REQUIREMENTS (OVERSEAS)'/
     &       16X,41(1H-)//
     &       1X,'SYSTEMS/'/2X,'BASE',5X,'BASES'/2X,'----',5X,'-----')
90050 FORMAT('0',18X,'CONDEMNATION SPARES REQUIREMENTS'/19X,32(1H-)//
     &       4X,'REPLACEABLE UNIT',11X,'SPARES',20X,'COST'/
     &       4X,'----------------',11X,'------',20X,'----'//)
      END
      SUBROUTINE SUCM(IT)
      COMMON / BLK B /NY, NBC, NIC, NBO, NIO, SIN, OH, NDS, RSTC,
     &                RSTO, DMC, DRC, BDSC, BDSO, TAT, WP, ISP, AO1,
     &                AO2, DSSF, NIS
      INTEGER WP
      COMMON / OMCDAT /OM(7,26), DOM(7,26)
      COMMON / ACEDAT /AC(9,26), DAC(9,26)
      COMMON / COSSUM /TOTACQ(26), TOTOM(26), TOTCOS(26),
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```
     &                    DOTACQ(26), DOTOM(26), DOTCOS(26)
      IF(IT.EQ.1)GO TO 2000
      DO 100 K=1,26
      TOTACQ(K)=0.0
      TOTOM(K)=0.0
      TOTCOS(K)=0.0
  100 CONTINUE
      TOTACQ(NY+1)=0.0
      TOTOM(NY+1)=0.0
      DO 500 K=1,NY
      DO 300 I=1,8
      TOTACQ(K)=TOTACQ(K)+AC(I,K)
  300 CONTINUE
      IF(WP.NE.0)TOTACQ(K)=TOTACQ(K)+AC(9,K)
      DO 400 I=1,7
      TOTOM(K)=TOTOM(K)+OM(I,K)
  400 CONTINUE
      TOTCOS(K)=TOTACQ(K)+TOTOM(K)
  500 CONTINUE
      DO 700 I=1,8
      AC(I,NY+1)=0.0
      DO 600 K=1,NY
      AC(I,NY+1)=AC(I,NY+1)+AC(I,K)
  600 CONTINUE
  700 CONTINUE
      IF(WP.EQ.0)GO TO 720
      AC(9,NY+1)=0.0
      DO 710 K=1,NY
      AC(9,NY+1)=AC(9,NY+1)+AC(9,K)
  710 CONTINUE
  720 CONTINUE
      DO 800 K=1,NY
      TOTACQ(NY+1)=TOTACQ(NY+1)+TOTACQ(K)
  800 CONTINUE
      DO 1000 I=1,7
      OM(I,NY+1)=0.0
      DO 900  K=1,NY
      OM(I,NY+1)=OM(I,NY+1)+OM(I,K)
  900 CONTINUE
 1000 CONTINUE
      DO 1100 K=1,NY
      TOTOM(NY+1)=TOTOM(NY+1)+TOTOM(K)
 1100 CONTINUE
      TOTCOS(NY+1)=TOTACQ(NY+1)+TOTOM(NY+1)
      RETURN
 2000 CONTINUE
      DO  2100 K=1,26
      DOTACQ(K)=0.0
      DOTOM(K)=0.0
      DOTCOS(K)=0.0
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200.   2100 CONTINUE
201.        DOTACQ(NY+1)=0.0
202.        DOTOM(NY+1)=0.0
203.        DO 2500 K=1,NY
204.        DO 2300 I=1,8
205.        DOTACQ(K)=DOTACQ(K)+DAC(I,K)
206.   2300 CONTINUE
207.        IF(WP.NE.0)DOTACQ(K)=DOTACQ(K)+DAC(9,K)
208.        DO 2400 I=1,7
209.        DOTOM(K)=DOTOM(K)+DOM(I,K)
210.   2400 CONTINUE
211.        DOTCOS(K)=DOTACQ(K)+DOTOM(K)
212.   2500 CONTINUE
213.        DO 2700 I=1,8
214.        DAC(I,NY+1)=0.0
215.        DO 2600 K=1,NY
216.        DAC(I,NY+1)=DAC(I,NY+1)+DAC(I,K)
217.   2600 CONTINUE
218.   2700 CONTINUE
219.        IF(WP.EQ.0)GO TO 2720
220.        DAC(9,NY+1)=0.0
221.        DO 2710 K=1,NY
222.        DAC(9,NY+1)=DAC(9,NY+1)+DAC(9,K)
223.   2710 CONTINUE
224.   2720 CONTINUE
225.        DO 2800 K=1,NY
226.        DOTACQ(NY+1)=DOTACQ(NY+1)+DOTACQ(K)
227.   2800 CONTINUE
228.        DO 3000 I=1,7
229.        DOM(I,NY+1)=0.0
230.        DO 2900 K=1,NY
231.        DOM(I,NY+1)=DOM(I,NY+1)+DOM(I,K)
232.   2900 CONTINUE
233.   3000 CONTINUE
234.        DO 3100 K=1,NY
235.        DOTOM(NY+1)=DOTOM(NY+1)+DOTOM(K)
236.   3100 CONTINUE
237.        DOTCOS(NY+1)=DOTACQ(NY+1)+DOTOM(NY+1)
238.        RETURN
239.        END
240.        FUNCTION TD(I)
241.        COMMON / BLK C /NRU,LN(500),IN(500),ANAME(500,5),NQ(500),CRU(500),
242.       &             MTBF(500),UFP(500),W(500),FVS(500),RLS(500),RRS(500),
243.       &                 RMS(500),NRTS(500),COND(500),LV(500),LV2(500),
244.       &                 LSEV(500),USEV(500),LR(500),LR2(500),LSER(500,4),
245.       &             USER(500,4),RTS(500),LREM(500),NRTS2(500),COND2(500)
246.        REAL NRTS,NRTS2,MTBF
247.            CHARACTER*4 ANAME
248.        COMMON / BLK B /NY, NBC, NIC, NBO, NIO, SIN, OH, NDS, RSTC,
249.       &                 RSTO, DMC, DRC, BDSC, BDSO, TAT, WP, ISP, A01,
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250.       &                AO2, DSSF, NIS
251.        INTEGER WP
252.        COMMON / XVALS /XNRTS(500),XRTS(500),XCOND(500)
253.        XYZ = EDD(I)
254.        WRITE (6,500) I,XNRTS(I),XRTS(I),XYZ,UFP(I),DMC,DRC
255.    500 FORMAT (' ***',I3,6E12.4)
256.        IF ( LV(I) .EQ. 1 .AND. LR(I) .EQ. 1 ) GO TO 100
257.        IF ( LV(I) .EQ. 1 .AND. LR(I) .EQ. 2 ) GO TO 200
258.        IF ( LV(I) .EQ. 2 .AND. LR(I) .EQ. 2 ) GO TO 300
259.        GO TO 400
260.    100 CONTINUE
261.        TD = DRC
262.        RETURN
263.    200 CONTINUE
264.        IF ( (XRTS(I)+XNRTS(I)) .LT. 1.E-7 ) GO TO 400
265.        TD = (XRTS(I)*(DMC+EDD(I))+XNRTS(I)*DRC)/(XRTS(I)+XNRTS(I))
266.        RETURN
267.    300 CONTINUE
268.        IF ( (UFP(I)+XRTS(I)+XNRTS(I)) .LT. 1.E-7 ) GO TO 400
269.        TD = ((UFP(I)+XRTS(I))*DMC+XRTS(I)*EDD(I)+XNRTS(I)*DRC)/
270.       &      (UFP(I)+XRTS(I)+XNRTS(I))
271.        RETURN
272.    400 CONTINUE
273.        TD = 0.
274.        RETURN
275.        END
276.        SUBROUTINE VALID
277.        COMMON / BLK C /NRU,LN(500),IN(500),ANAME(500,5),NQ(500),CRU(500),
278.       &            MTBF(500),UFP(500),W(500),FVS(500),RLS(500),RRS(500),
279.       &                RMS(500),NRTS(500),COND(500),LV(500),LV2(500),
280.       &                LSEV(500),USEV(500),LR(500),LR2(500),LSER(500,4),
281.       &            USER(500,4),RTS(500),LREM(500),NRTS2(500),COND2(500)
282.        REAL NRTS,NRTS2,MTBF
283.            CHARACTER*4 ANAME
284.        COMMON / BLK B /NY, NBC, NIC, NBO, NIO, SIN, OH, NDS, RSTC,
285.       &                RSTO, DMC, DRC, BDSC, BDSO, TAT, WP, ISP, AO1,
286.       &                AO2, DSSF, NIS
287.        INTEGER WP
288.        IERR = 0
289.        IF ( AO1 .GT. 0. .AND. AO1 .LT. 1. ) GO TO 100
290.        WRITE (  6,  1)
291.      1 FORMAT  (' *****ERROR...SYSTEM AVAILABILITY OBJECTIVE INV')
292.        IERR = 1
293.    100 CONTINUE
294.        IF ( AO2 .GT. 0. .AND. AO2 .LT. 1. ) GO TO 200
295.        WRITE (  6,  2)
296.      2 FORMAT  (' *****ERROR...SHOP AVAILABILITY OBJECTIVE INVAL')
297.        IERR = 1
298.    200 CONTINUE
299.        IF ( IN(') .EQ. 1 ) GO TO 300
```

```
300.        WRITE (  6,  3) IN(1)
301.      3 FORMAT  (' *****ERROR...SYSTEM INDENTURE',I5   ,' NOT 1 ')
302.        IERR = 1
303.    300 CONTINUE
304.        IF ( LR(1) .EQ. 0 ) GO TO 400
305.        WRITE (  6,  4) LR(1)
306.      4 FORMAT  (' *****ERROR...SYSTEM REPAIR LEVEL', I5  ,' NE 0')
307.        IERR = 1
308.    400 CONTINUE
309.        DO 1300 I = 1,NRU
310.        IF ( LV(I) .LE. LR(I) .AND. LV(I) .GE. 0) GO TO 500
311.        WRITE (  6,  5) I
312.      5 FORMAT  (' *****ERROR...LV FOR UNIT',I8,' OUT OF RANGE')
313.        IERR = 1
314.    500 CONTINUE
315.        IF ( UFP(I) .GE. 0. .AND. UFP(I) .LT. 1. ) GO TO 600
316.        WRITE (  6,  6) I
317.      6 FORMAT  (' *****ERROR...UFP FOR UNIT',I8,' OUT OF RANGE')
318.        IERR = 1
319.    600 CONTINUE
320.        IF ( COND(I) .GE. 0. .AND. COND(I) .LE. 1. ) GO TO 700
321.        WRITE (  6,  7) I
322.      7 FORMAT  (' *****ERROR...COND FOR UNIT',I8,' OUT OF RANGE')
323.        IERR = 1
324.    700 CONTINUE
325.        IF ( RTS(I) .GE. -0.0001 .AND. RTS(I) .LE. 1.0001 ) GO TO 800
326.        WRITE (  6,  8) I
327.      8 FORMAT  (' *****ERROR...RTS FOR UNIT',I8,' OUT OF RANGE')
328.        IERR = 1
329.    800 CONTINUE
330.        IF ( NRTS(I) .GE. 0. .AND. NRTS(I) .LE. 1. ) GO TO 900
331.        WRITE (  6,  9) I
332.      9 FORMAT  (' *****ERROR...NRTS FOR UNIT',I8,' OUT OF RANGE')
333.        IERR = 1
334.    900 CONTINUE
335.        IF ( I .EQ. 1 ) GO TO 1300
336.        IF ( IN(I) .GT. 1 ) GO TO 1000
337.        WRITE (  6, 10) I
338.     10 FORMAT  (' *****ERROR...INVALID INDENTURE FOR UNIT',I8)
339.        IERR = 1
340.        GO TO 1300
341.   1000 CONTINUE
342.        IF ( IN(I) .EQ. IN(I-1) ) GO TO 1200
343.        I1 = I-1
344.        DO 1100 J = 1,I1
345.        K = I - J
346.        IF ( IN(I) .EQ. IN(K) + 1 ) GO TO 1200
347.   1100 CONTINUE
348.        WRITE (  6, 11) I
349.     11 FORMAT  (' *****ERROR...INVALID INDENTURE FOR UNIT',I8)
```

```
      IERR = 1
      GO TO 1300
 1200 CONTINUE
      IF ( LV(I) .GE. LR(K) ) GO TO 1300
      WRITE (  6, 12) I
   12 FORMAT  (' *****ERROR...LV INVALID FOR UNIT',I8)
      IERR = 1
 1300 CONTINUE
      IF ( IERR .EQ. 0 ) RETURN
      WRITE (  6, 13)
   13 FORMAT  (' ***INVALID DATA, ERRONEOUS RESULTS ARE POSSIBLE')
      STOP
      END
      SUBROUTINE WRTA
      COMMON / PRINT /IPRT(8),STYTL   ,CTIME,CDATE
      CHARACTER*8 CTIME,CDATE
          CHARACTER*4 STYTL(8)
      COMMON / BLK A /SIE, SBR, SDR, SDR2, SPSC, SPSO, SID, SIM,
     &                SDM, SBMC, SDMC, SDC2, DF
      WRITE(   6,95000)(STYTL(I),I=1,8),CTIME,CDATE
95000 FORMAT('1',10X,8A4,2(3X,A8))
      WRITE(  6,90000) SIE, SBR, SDR,SDR2, SPSC, SPSO, SID, SIM,
     &            SDM, SBMC, SDMC, SDC2, DF
90000 FORMAT('0',24X ,'STANDARD ELEMENTS FILE'/
     &       25X,22(1H-)//
     &      18X,'PARAMETER',30X,'VALUE'/18X,9(1H-),30X,5(1H-)/
     &      /5X,'SIE:  ITEM ENTRY COST/NEW ITEM',21X,F6.2
     &      /5X,'SBR:  BASE LABOR RATE/HOUR',25X,F6.2
     &      /5X,'SDR:  DEPOT LABOR RATE/HOUR',24X,F6.2
     &      /5X,'SDR2: DEPOT LABOR RATE/HOUR,#2', 21X,F6.2
     &      /5X,'SPSC: PACKAGING & SHIPPING COST/LB. - CONUS',8X,F6.2
     & /5X,'SPSO: PACKAGING & SHIPPING COST/LB. - OVERSEAS',5X,F6.2
     &      /5X,'SID:  INITIAL DATA MGT. COST/COPY/PAGE',15X,F6.4
     &      /5X,'SIM:  ITEM MGT. COST/ITEM/YEAR',21X,F6.2
     &      /5X,'SDM:  DATA MGT. COST/PAGE/YEAR',21X,F6.2
     &      /5X,'SBMC: BASE MATERIAL CONSUMPTION RATE',16X,F5.2
     &      /5X,'SDMC: DEPOT MATERIAL CONSUMPTION RATE',15X,F5.2
     &      /5X,'SDC2: DEPOT MATERIAL CONSUMPTION RATE,#2',12X,F5.2
     &      /5X,'DF:   DISCOUNT FACTOR',27X,F9.2
     &      )
      RETURN
      END
      SUBROUTINE WRTB
      COMMON / PRINT /IPRT(8),STYTL   ,CTIME,CDATE
      CHARACTER*8 CTIME,CDATE
          CHARACTER*4 STYTL(8)
      COMMON / BLK B /NY, NBC, NIC, NBO, NIO, SIN, OH, NDS, RSTC,
     &                RSTO, DMC, DRC, BDSC, BDSO, TAT, WP, ISP, AO1,
     &                AO2, DSSF, NIS
      INTEGER WP
```

```
      COMMON / SYSBAS /NALCC(400), IALCC(400), NALCO(400),IALCO(400),
     &                 NSC, NSO
      COMMON / ACTSCH  /NAC(12,25), NCUM(12,25),  MACDEX
      WRITE(  6,80000)NY,NBC,NIC,NBO,NIO,NSC,NSO
      WRITE(  6,90010)
      DO 10 I = 1 , 400
      IF ( NALCC(I) .EQ. 0 ) GO TO 10
      WRITE(  6,90011)NALCC(I),I
   10 CONTINUE
      WRITE ( 6,90012)
      DO 15 I = 1,400
      IF(IALCC(I) .EQ. 0) GO TO 15
      WRITE(  6,90011)IALCC(I),I
   15 CONTINUE
      WRITE(  6,90030)
      DO 20 I = 1 , 400
      IF ( NALCO(I) .EQ. 0 ) GO TO 20
      WRITE(  6,90011)NALCO(I),I
   20 CONTINUE
      WRITE( 6,90032)
      DO 25 I = 1,400
      IF(IALCO(I) .EQ. 0) GO TO 25
      WRITE( 6,90011) IALCO(I),I
   25 CONTINUE
      WRITE(  6,90000)SIN, OH, NDS,NIS,RSTC,RSTO,DMC,DRC,BDSC,BDSO,
     &            TAT, WP, ISP,AO1, AO2,DSSF
      WRITE(   6,95000)(STYTL(I),I=1,8),CTIME,CDATE
95000 FORMAT('1',10X,8A4,2(3X,A8))
      WRITE(  6,90020)
      DO 50 K = 1,NY
      DO 30 M = 1,12
      IF ( NAC(M,K) .NE. 0 ) GO TO 40
   30 CONTINUE
      GO TO 50
   40 CONTINUE
      WRITE(  6,90040)K,(NAC(M,K),M=1,12)
   50 CONTINUE
      RETURN
80000 FORMAT('1',24X,'LOGISTIC FACTORS FILE'/
     &   25X,21(1H-)//
     &  18X,'PARAMETER',32X,'VALUE'/18X,9(1H-),32X,5(1H-)//
     &  5X,'NY:   OPERATIONAL LIFE OF SYSTEM (YEARS)',11X,I6/
     &  5X,'NBC:  NUMBER OF BASES - CONUS',22X,I6/
     &  5X,'NIC:  NUMBER OF I-LEVEL SITES - CONUS',14X,I6/
     &  5X,'NBO:  NUMBER OF BASES - OVERSEAS',19X,I6/
     &  5X,'NIC:  NUMBER OF I-LEVEL SITES - OVERSEAS',11X,I6/
     &  5X,'NSC:  NUMBER OF SYSTEMS - CONUS',20X,I6/
     &  5X,'NSO:  NUMBER OF SYSTEMS - OVERSEAS',17X,I6/)
90000 FORMAT(//,
     &  5X,'SIN:  COST/SYSTEM INSTALLATION',21X,F9.2/
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450.       &  5X,'OH:   SYSTEM OPERATING HOURS/MONTH',17X,F8.1/
451.       &  5X,'NDS:  NUMBER OF DEPOT WORK SHIFTS',23X,I1/
452.       &  5X,'NIS:  NUMBER OF I-LEVEL WORK SHIFTS',21X,I1/
453.       &  5X,'RSTC: BASE RESUPPLY TIME - CONUS (HOURS)',11X,F7.0/
454.       &  5X,'RSTO: BASE RESUPPLY TIME - OVERSEAS (HOURS)',8X,F7.0/
455.       &  5X,'DMC:  DEPOT REPLACEMENT CYCLE TIME (HOURS)',9X,F7.0/
456.       &  5X,'DRC:  DEPOT REPAIR CYCLE TIME (HOURS)',14X,F7.0/
457.       &  5X,'BDSC: SHIPPING TIME TO DEPOT - CONUS (HOURS)',7X,F7.0/
458.       & 5X,'BDSO: SHIPPING TIME TO DEPOT - OVERSEAS (HOURS)',4X,F7.0/
459.       &  5X,'TAT:  BASE TURNAROUND TIME (HOURS)',17X,F7.0/
460.       &  5X,'WP:   SYSTEM WARRANTY PERIOD (YEARS)',15X,I6/
461.       &  5X,'ISP:  INITIAL SUPPORT PERIOD (YEARS)',15X,I6/
462.       &  5X,'AO1:  SPARES OBJECTIVE (SYSTEM)',24X,F6.3/
463.       &  5X,'AO2:  SPARES OBJECTIVE (SHOP)',26X,F6.3/
464.       &  5X,'DSSF: DEPOT STOCK SAFETY FACTOR',24X,F5.2/
465.       &  )
466.   90010 FORMAT(1HO,'NUMBER OF SYSTEMS AT EACH BASE - CONUS'/
467.       &  1X,'NUMBER OF BASES',5X,'SYSTEMS AT BASE')
468.   90011 FORMAT(4X,I5,17X,I4)
469.   90012 FORMAT(1HO,'NUMBER OF SYSTEMS AT EACH I-LEVEL SITE - CONUS'/
470.       &  1X,'NUMBER OF SITES',5X,'SYSTEMS AT SITE')
471.   90020 FORMAT(/,25X,'ACTIVATION SCHEDULE'
472.       &        /,25X,'--------------------'/
473.       &        /,32X,'MONTH'/
474.       &        2X,'YEAR   1    2    3    4    5    6    7    8    9',
475.       &           '   10   11   12'//)
476.   90040 FORMAT(3X,I2,1X,I2(I4,1X))
477.   90030 FORMAT(1HO,'NUMBER OF SYSTEMS AT EACH BASE - OVERSEAS'/
478.       &  1X,'NUMBER OF BASES',5X,'SYSTEMS AT BASE')
479.   90032 FORMAT(1HO,'NUMBER OF SYSTEMS AT EACH I-LEVEL SITE -OVERSEAS
480.       &'/,1X,'NUMBER OF SITES',5X,'SYSTEMS AT SITE')
481.        END
482.        SUBROUTINE WRTC
483.        COMMON / PRINT /IPRT(8),STYTL   ,CTIME,CDATE
484.        CHARACTER*8 CTIME,CDATE
485.            CHARACTER*4 STYTL(8)
486.        COMMON / BLK C /NRU,LN(500),IN(500),ANAME(500,5),NQ(500),CRU(500),
487.       &           MTBF(500),UFP(500),W(500),FVS(500),RLS(500),RRS(500),
488.       &                RMS(500),NRTS(500),COND(500),LV(500),LV2(500),
489.       &                LSEV(500),USEV(500),LR(500),LR2(500),LSER(500,4),
490.       &             USER(500,4),RTS(500),LREM(500),NRTS2(500),COND2(500)
491.        REAL NRTS,NRTS2,MTBF
492.            CHARACTER*4 ANAME,COS1(2),COS2(2)
493.        DIMENSION PUSER(4)
494.        WRITE(   6,95000)(STYTL(I),I=1,8),CTIME,CDATE
495.        WRITE(  6,90000)NRU
496.        DO 100 I=1,NRU
497.        CALL EDNUM(8,0,CRU(I),COS1)
498.        CALL EDNUM(8,0,MTBF(I),COS2)
499.        PUFP = UFP(I) + .000001
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      PW = W(I) + .000001
      PFVS = FVS(I) + .000001
      PRLS = RLS(I) + .000001
      PRRS = RRS(I) + .000001
      WRITE(  6,90030)LN(I), IN(I), (ANAME(I,J),J=1,5),NQ(I), COS1,COS2,
     &           PUFP, PW, PFVS, PRLS, PRRS
  100 CONTINUE
      WRITE(   6,95000)(STYTL(I),I=1,8),CTIME,CDATE
95000 FORMAT('1',10X,8A4,2(3X,A8))
      WRITE(  6,90040)
      DO 200 I=1,NRU
      CALL EDNUM(6,0,RMS(I),COS1)
      PNRTS = NRTS(I) + .000001
      PCOND = COND(I) + .000001
      PUSEV = USEV(I) + .000001
      DO 110 J = 1,4
      PUSER(J) = USER(I,J) + .000001
  110 CONTINUE
      WRITE(  6,90010)LN(I), COS1, PNRTS, PCOND, LV(I), LV2(I),LSEV(I),
     &PUSEV,LR(I),LR2(I),(LSER(I,J),J=1,4),(PUSER(J),J=1,4)
  200 CONTINUE
90000 FORMAT('0',24X,'HARDWARE DEFINITION FILE'/25X,24(1H-)//
     &    1X,'NUMBER OF REPLACEABLE UNITS = ',I2//
     &' LN IN    NOMENCLATURE     NQ    CRU     MTBF    UFP    W   FVS',
     &' RLS  RRS'/
     &' -- --    ------------     --    ---     ----    ---    -   ---',
     &' ---  ---'//)
90030 FORMAT(1X,I3,1X,I1,1X,5A4,1X,I2,2A4,1X,2A4,1X,F5.3,1X,F5.1,1X,
     &       2F4.1     ,1X,F4.1)
90040 FORMAT(//51X,'LSER',13X,'USER'/
     & ' LN   RMS   NRTS  COND LV LV2 LSEV USEV LR LR2  1  2  3  4    1
     &   2    3    4'/
     & ' --   ---   ----  ---- -- --- ---- ---- -- ---  -  -  -  -    -
     &   -    -    -'//)
90010 FORMAT(1X,I3,1X,A4,A2,1X,F5.3,1X,F5.3,2X,I1,2X,I1,3X,I2,2X,
     &       F4.1,2X,I1,2X,I1,2X,4(I2,1X),4(1X,F4.1))
      RETURN
      END
      SUBROUTINE WRTD
          CHARACTER*4 ANSE(40,5)
      COMMON / BLK D /NSE, LSE(40), ANSE     , CSE(40), COM(40)
      CHARACTER*4 COS(4)
      WRITE(  6,90000)NSE
      DO 100 J=1,NSE
      CALL EDNUM(14,0,CSE(J),COS)
      WRITE(  6,90010)LSE(J),(ANSE(J,K),K=1,5),COS,COM(J)
  100 CONTINUE
      RETURN
90000 FORMAT('1',13X,'SUPPORT EQUIPMENT DEFINITION FILE'/
     &          14X,'--------------------------------'//
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      &       1X,'NUMBER OF LINE ITEMS OF SUPPORT EQUIPMENT = ',I2//
      &       1X,'LINE NUMBER      NOMENCLATURE       COST(CSE)',
      &       '    O&M COST FACTOR(COM)'/
      &       1X,'-----------      ------------       --------- ',
      &       '    --------------------'//)
90010 FORMAT(5X,I2,7X,5A4,1X,3A4,A2,9X,F5.3)
      END
      SUBROUTINE WRTE
      COMMON / PRINT /IPRT(8),STYTL   ,CTIME,CDATE
      CHARACTER*8 CTIME,CDATE
          CHARACTER*4 STYTL(8)
      COMMON / BLK B /NY, NBC, NIC, NBO, NIO, SIN, OH, NDS, RSTC,
     &                RSTO, DMC, DRC, BDSC, BDSO, TAT, WP, ISP, AO1,
     &                AO2, DSSF, NIS
      INTEGER WP
      COMMON / BLK E /ACS, BTC, DTC, DCB, DCD, DCO, NPB, NPD, NPO,
     &                NI, CRSC, CRSO, CDMC, WPR
      COMMON / RELIAB   /G(26), GR(12,25), GM,ENR(500,25), EPM(25)
      CHARACTER*4 COS1(4),COS2(4),COS3(4),COS4(4),COS5(4),COS6(4),
     *  COS7(4)
      CALL EDNUM(14,0,ACS,COS1)
      CALL EDNUM(14,0,BTC,COS2)
      CALL EDNUM(14,0,DTC,COS3)
      CALL EDNUM(14,0,DCB,COS4)
      CALL EDNUM(14,0,DCD,COS5)
      CALL EDNUM(14,0,DCO,COS6)
      CALL EDNUM(16,0,WPR,COS7)
      WRITE(   6,95000)(STYTL(I),I=1,8),CTIME,CDATE
95000 FORMAT('1',10X,8A4,2(3X,A8))
      WRITE(  6,90000)COS1,COS2,COS3,COS4,COS5,COS6,NPB,NPD,NPO,NI,
     &          CRSC,CRSO,CDMC,COS7,(G(K),K=1,NY )
      RETURN
90000 FORMAT('0',19X,'CONTRACTOR DATA FILE'/
     &          20X,'--------------------'//
     &       10X,'PARAMETER',40X,'VALUE'/
     &       10X,'---------',40X,'-----'//
     &5X,'ACS:  ACQUISITION COST/SYSTEM',20X,3A4,A2/
     &5X,'BTC:  BASE LEVEL TRAINING COST',19X,3A4,A2/
     &5X,'DTC:  DEPOT LEVEL TRAINING COST',18X,3A4,A2/
     &5X,'DCB:  DATA ACQUISITION COST (BASE LEVEL MANUALS)',1X,3A4,A2/
     &5X,'DCD:  DATA ACQUISITION COST (DEPOT LEVEL MANUALS)',3A4,A2/
     &5X,'DCO:  DATA ACQUISITION COST (OTHER)',14X,3A4,A2/
     &5X,'NPB:  PAGES OF DATA (BASE LEVEL MANUALS)',18X,I4/
     &5X,'NPD:  PAGES OF DATA (DEPOT LEVEL MANUALS)',17X,I4/
     &5X,'NPO:  PAGES OF DATA (OTHER)',31X,I4/
     &5X,'NI:   NUMBER OF NEW INVENTORY ITEMS',23X,I4/
     &5X,'CRSC: CONTRACTOR BASE RESUPPLY TIME - CONUS',16X,F4.0/
     &5X,'CRSO: CONTRACTOR BASE RESUPPLY TIME - OVERSEAS',13X,F4.0/
     &5X,'CDMC: CONTRACTOR REPAIR CYCLE TIME',24X,F5.0/
     &5X,'WPR:  WARRANTY PRICE',27X,4A4/
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      &/5X,'RELIABILITY GROWTH PROFILE'//3(10(1X,F6.2)/))
       END
       FUNCTION X(I)
       COMMON / BLK C /NRU,LN(500),IN(500),ANAME(500,5),NQ(500),CRU(500),
      &            MTBF(500),UFP(500),W(500),FVS(500),RLS(500),RRS(500),
      &                RMS(500),NRTS(500),COND(500),LV(500),LV2(500),
      &                LSEV(500),USEV(500),LR(500),LR2(500),LSER(500,4),
      &            USER(500,4),RTS(500),LREM(500),NRTS2(500),COND2(500)
       REAL NRTS,NRTS2,MTBF
           CHARACTER*4 ANAME
       COMMON / XVALS /XNRTS(500),XRTS(500),XCOND(500)
       IF ( LV(I) .EQ. 1 .AND. LR(I) .EQ. 1 ) X = XNRTS(I)
       IF ( LV(I) .EQ. 1 .AND. LR(I) .EQ. 2 ) X = XNRTS(I)+XRTS(I)
       IF ( LV(I) .EQ. 2 .AND. LR(I) .EQ. 2 ) X =XNRTS(I)+XRTS(I)+UFP(I)
       RETURN
       END
       SUBROUTINE CCHECK
       COMMON / BLK A /SIE, SBR, SDR, SDR2, SPSC, SPSO, SID, SIM,
      &                SDM, SBMC, SDMC, SDC2, DF
       COMMON / BLK C /NRU,LN(500),IN(500),ANAME(500,5),NQ(500),CRU(500),
      &            MTBF(500),UFP(500),W(500),FVS(500),RLS(500),RRS(500),
      &                RMS(500),NRTS(500),COND(500),LV(500),LV2(500),
      &                LSEV(500),USEV(500),LR(500),LR2(500),LSER(500,4),
      &            USER(500,4),RTS(500),LREM(500),NRTS2(500),COND2(500)
       REAL NRTS,NRTS2,MTBF
           CHARACTER*4 ANAME
       COMMON ISWTCH
       ISWTCH=0
       JSDMC=SDMC*100.
       JSDC2=SDC2*100.
       JSDR=SDR*100.
       JSDR2=SDR2*100.
       IF(JSDR.NE.JSDR2) GO TO 20
       IF(JSDMC.NE.JSDC2) GO TO 20
       DO 10 I=1,NRU
       IF(LV(I).NE.LV2(I)) GO TO 20
       IF(LR(I).NE.LR2(I)) GO TO 20
    10 CONTINUE
       GO TO 30
    20 ISWTCH=1
       DO 25 I=1,NRU
       IF(LV(I).EQ.1.AND.LV2(I).EQ.2) WRITE(6,40)
       IF(LR(I).EQ.1.AND.LR2(I).EQ.2) WRITE(6,40)
       IF(IN(I).NE.2) GO TO 25
       IF(LV(I).EQ.LV2(I).AND.LR(I).EQ.LR2(I)) GO TO 25
       NRTS2(I)=NRTS(I)
       NRTS(I)=1.0
       COND2(I)=COND(I)
       COND(I)=0.0
    25 CONTINUE
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650.      30 CONTINUE
651.  **     WRITE (6,50) ISWTCH
652.  ** 50 FORMAT ('   SUBROUTINE CCHECK ....ISWTCH SET TO',I4)
653.        RETURN
654.      40 FORMAT ('   *** SWITCH FROM 3 LEVEL TO 2 LEVEL NOT ALLOWED **')
655.        END
656.        SUBROUTINE COMPOS
657.        COMMON / BLK A /SIE, SBR, SDR, SDR2, SPSC, SPSO, SID, SIM,
658.       &                 SDM, SBMC, SDMC, SDC2, DF
659.        COMMON / BLK C /NRU,LN(500),IN(500),ANAME(500,5),NQ(500),CRU(500),
660.       &            MTBF(500),UFP(500),W(500),FVS(500),RLS(500),RRS(500),
661.       &                RMS(500),NRTS(500),COND(500),LV(500),LV2(500),
662.       &                LSEV(500),USEV(500),LR(500),LR2(500),LSER(500,4),
663.       &             USER(500,4),RTS(500),LREM(500),NRTS2(500),COND2(500)
664.        REAL NRTS,NRTS2,MTBF
665.            CHARACTER*4 ANAME
666.        SDRT=SDR
667.        SDR=SDR2
668.        SDR2=SDRT
669.        SDMCT=SDMC
670.        SDMC=SDC2
671.        SDC2=SDMCT
672.        DO 10 I=1,NRU
673.        LVTEMP=LV(I)
674.        LRTEMP=LR(I)
675.        LV(I)=LV2(I)
676.        LR(I)=LR2(I)
677.        LV2(I)=LVTEMP
678.        LR2(I)=LRTEMP
679.        IF(IN(I).NE.2) GO TO 10
680.        IF(LV(I).EQ.LV2(I).AND.LR(I).EQ.LR2(I)) GO TO 10
681.        XTEMP=NRTS(I)
682.        NRTS(I)=NRTS2(I)
683.        NRTS2(I)=XTEMP
684.        XTEMP=COND(I)
685.        COND(I)=COND2(I)
686.        COND2(I)=XTEMP
687.      10 CONTINUE
688.        RETURN
689.        END
690.        SUBROUTINE REJECT
691.        COMMON / RELIAB   /G(26), GR(12,25), GM,ENR(500,25), EPM(25)
692.        COMMON / ACTSCH  /NAC(12,25), NCUM(12,25),  MACDEX
693.        COMMON / BLK B /NY, NBC, NIC, NBO, NIO, SIN, OH, NDS, RSTC,
694.       &                RSTO, DMC, DRC, BDSC, BDSO, TAT, WP, ISP, AO1,
695.       &                AO2, DSSF, NIS
696.        INTEGER WP
697.        COMMON / BLK C /NRU,LN(500),IN(500),ANAME(500,5),NQ(500),CRU(500),
698.       &            MTBF(500),UFP(500),W(500),FVS(500),RLS(500),RRS(500),
699.       &                RMS(500),NRTS(500),COND(500),LV(500),LV2(500),
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700.       &                LSEV(500),USEV(500),LR(500),LR2(500),LSER(500,4),
701.       &            USER(500,4),RTS(500),LREM(500),NRTS2(500),COND2(500)
702.        REAL NRTS,NRTS2,MTBF
703.            CHARACTER*4 ANAME
704.        WRITE( 6,5)
705.      5 FORMAT(////24X,'LRU OPERATING HOURS AND FAILURES'/
706.       &24X,32(1H-),//' LINE REPLACEABLE UNIT'/' ----',11(1H-),
707.       &1X,'----')
708.        DO 10 I=1,NRU
709.        IF(IN(I).NE.2) GO TO 10
710.        WRITE( 6,20)(ANAME(I,J),J=1,5)
711.        DO 8 K=1,NY
712.        OPHR=0.
713.        DO 6 M=1,12
714.      6 OPHR=OPHR+NCUM(M,K)*OH*NQ(I)
715.        RTOK=ENR(I,K)*UFP(I)
716.        FAIL=ENR(I,K)*(1.-UFP(I))
717.        WRITE( 6,30)K,ENR(I,K),RTOK,FAIL,OPHR
718.      8 CONTINUE
719.     10 CONTINUE
720.     20 FORMAT('0',5A4,' YEAR    REMOVALS     RTOK S   FAILURES',
721.       &'   OP.HOURS'/21X,'----    ',8(1H-),5X,'------   ',8(1H-),
722.       &3X,8(1H-)/)
723.     30 FORMAT(20X,I5,4F11.1)
724.        RETURN
725.        END
```

APPENDIX 3

DEVELOPMENT PHASE OPERATIONAL FACTOR ASSESSMENT

A3.1 Introduction

This appendix contains data generated during our initial approach. Subsequent to the October request to try to include development costs into the LCC analyses, it was determined that these costs were unavailable. We still wanted to comply with the request so we formulated the following brief program descriptions and distributed them to various disciplines within Collins. The minimal objectives were to develop percentages of a full military design effort, identify risk areas and recommend corrective action.

The four alternatives, ranging from a full military design program to a commercial off-the-shelf acquisition were more difficult to describe than anticipated. We were soon faced with providing a fairly detailed procurement package (statement of work, specification, and contract data requirements list) for four alternatives for three types of equipment in three operating environments and then providing the funding resources to prepare and compile the bids.

The scope of this study would not accommodate such an effort in order to comply with a post award request. The revised approach was then developed.

A3.2 Development Program Definition

In order to delineate the development program differences, five development programs were described. These programs are as follows:

1. Full military design, development, test and qualification program.

   In this alternative, assume that the Air Force Program

Manager elects to procure equipment on the basis of a design specification with appropriate environmental requirements. Further, assume that he imposes the usual array of military specifications for drawings, labeling, reliability/maintainability program, tech pubs, software quality, qualification testing, reliability and maintainability verification, configuration management, etc.

The preferred method to assess these requirements is to delineate the tasks (but not the schedule) necessary to accomplish the requirements.

2. Commercial off-the-shelf equipment with military equivalent test, verification and qualification program.

   In this alternative, assume that the Air Force Program Manager elects to procure commercial off-the-shelf equipment with a specification equivalent to the commercial specification. In addition assume that he imposes the usual array of military requirements for all supporting (non-design) functions. The tasks should be the same tasks outlined for alternative 1 but the man hours and risks may change.

3. Commercial off-the-shelf equipment at catalog price with commercial verification and documentation.

   In this alternative, assume that the Air Force Program Manager elects to procure commercial off-the-shelf equipment without any additional tasks.

A3.2 Development Program Definition (Continued)

Since the Air Force does not (in general) know the extent of support functions such as reliability, maintainability, test and verification, quality program qualification testing, software quality assurance etc., discuss the extent and differences in the tasks identified in alternative 1 that are accomplished on commercial off-the-shelf equipment at the catalog price.

4. Commercial off-the-shelf equipment to a commercial specification with *your* recommended set of tasks defined to attenuate the risks discussed in alternative 3.

   In this alternative, recommend to the Air Force Program Manager the program in your discipline that you feel is optimum in terms of reduction of risk at the expense of development cost to accomplish the recommended tasks. For example, in the area of testing, Rockwell-Collins may want to recommend that equipment procured for the Airborne inhabited fighter environment be tested to ascertain the inherent nuclear hardening level of the commercial equipment.

   If, in your opinion, this alternative should be addressed as 2, namely (a) mature commercial off-the-shelf equipment and (b) newly developed commercial off-the-shelf equipment, then address these situations as 2 alternatives namely 4(a) and 4(b).

A3.3 Operational Factor Assessment Instructions

These descriptions should provide sufficient guidelines for each discipline to accomplish the following estimates.

1. List the tasks necessary to fulfill the requirements of a full military specification defined design effort for a:

   - Communication system in a:
     - Airborne inhabited fighter environment
     - Airborne inhabited transport environment
     - Ground fixed environment

   and a:

   - Data processing system such as a computer in the same 3 environments

   and a:

   - Data processing peripherals such as a computer control head.

2. Estimate the man hours to accomplish the tasks.

3. Briefly discuss any risks associated with the program.

4. For alternatives 2, 3, and 4 identify the tasks to be deleted, reduced, or modified and estimate the man hours to accomplish the modified tasks.

5. Briefly discuss any risks associated with the programs defined by the remaining tasks as defined for alternatives 2, 3 and 4.

A3.3 Operational Factor Assessment Instructions (Continued)

For alternative 3, a commercial off-the-shelf system at catalog price without any added tasks to attenuate risk, be sure to delineate the tasks within your discipline that are accomplished on commercial off-the-shelf equipment and are, therefore, a part of the catalog price. We can only assume that the Air Force Program Manager thinks he is getting hardware that meets a commercial specification and has a given form, fit and function.

There is significant range of equipment that has been intentionally excluded from the definition of the 4 alternatives. That is the entire range of modification of commercial off-the-shelf equipment to meet added requirements. The reasons for this exclusion are:

1. Aspects of this will be discussed in the SOW task to define the design differences in (a) good commercial practices, (b) best commercial practices, (c) ruggedized and (d) militarized.

2. We interpret the term "commercial off-the-shelf" to be exactly that which does not include design modification or even parts substitution.

3. We recognize that modified commercial equipment has extensive appeal to both contractors and Air Force Program Managers and recommend that RADC initiate a follow-on program to investigate this aspect of commercial equipment used by the military.

A3.4 Operational Factor Assessment

The reliability, maintainability, technical publications and quality assurance responses are provided.

A3.4.1 Reliability

The delineation of the tasks and estimates for the man hours and dollars to accomplish those tasks for a communication system consisting of a receiver/transmitter, control and antenna made up of approximately 1800 electrical parts are shown on the following pages.

A3.4.1.1 Risk Assessment

As shown in the attached outline, several full military reliability program tasks have been deleted in the recommended set of tasks for the commercial off-the-shelf program (alternative 4). The risks associated with these deleted tasks are described below.

Task 303 Rel. Qualification Test

A reliability qualification test has been deleted on the assumption that reliability growth testing will still be conducted on a significant sample of equipments. The risks associated with this deletion will vary depending upon the thoroughness of the reliability growth test. If Rel growth testing is continued until the current MTBF reaches the required MTBF and if corrective actions are evaluated with additional test data, there is little need for conducting a reliability qualification test after the reliability growth project test is completed. It is even valid to project expected future reliability by discounting failures for which corrective action will prevent recurrence. Success of using "discounting" requires that the risk associated with such reclassifications is placed upon the contractor so that the process is not allowed to be a "numbers game" necessary to pass the test. This may be accomplished by field reliability guarantees such as an RIW.

Task 204 FMECA

Failure modes and effects analysis is a costly analysis which is a prime candidate for tailoring. Most military programs indiscriminately require FMEA even for single LRU communication equipments. Deletion of FMEA is a cost saving method which can be applied on many programs with zero risk. Basically, a FMEA should be accomplished for three

A3.4.1.1 Risk Assessment (Continued)

primary reasons: Safety, Input Data for Maintainability tasks such as Test Requirement Documents (TRD's), and to eliminate undesirable failure modes.

If an equipment is safety critical an FMEA should be conducted on a selected basis in conjunction with the safety analysis. The preferred approach here is a top down safety analysis which identifies which areas of an equipment are of sufficient criticality to require a bottom-up FMECA.

Most communication equipments are not safety critical and should not require FMEA unless required for maintenance TRD's. The benefits of performing FMEA to eliminate unwanted failure modes may be significant at a system or subsystem level, but is seldom worthwhile below the LRU level unless the LRU is identified as a safety critical item.

Task 207 Parts Program

Deletion of a Military Parts Control program is a variable risk item. It depends entirely upon how effective the commercial producer's component engineering activity is at controlling parts. For example, if a commercial producer maintains an active component engineering department and has such key elements as an internal preferred parts list, part qualification system and part specification control, there probably will be little risk in deleting parts program from the reliability requirement since parts control is provided as a part of the normal operating procedure.

A3.4.1.1 Risk Assessment (Continued)

Task 203 Rel Predictions

Task 203 has been reduced to include MTBF predictions based upon the parts count method. Stress analysis is performed on a selected basis only. The purpose of stress analysis for the recommended program is to identify overstressed parts and is not intended to provide a refined MTBF prediction. With this change in scope, stress analysis may be deleted on circuits which a cursary review indicates that the possibility of finding overstressed parts is minimal.

Task 104 FRACAS

A formal Failure Reporting and Correcting Action System (FRACAS) has been deleted from the recommended set of tasks. The risk associated with this deletion can vary, depending upon the suppliers internal failure recurrence control procedure. The risk can be reduced to an acceptable level if it is verified that the Design Engineering Organization follows through with corrective action for qualification test failures and reliability engineering monitors burn-in and early field failures as a part of their normal collateral effort.

Task 103 Program Reviews

Deletion of formal program reviews as a reliability program effort can be accomplished with minimal program risk.

Task 201 Reliability Modeling

Reliability modeling can be deleted since the parts count predictions will provide predictions to the SRU level.

ALTERNATE REL PROGRAM OUTLINE

COMMUNICATION SYSTEM

Alternative 1. Full Military Design, Development, Test & Qualification

Tasks, Ref. MIL-STD-785B	Hrs.	$
101 Rel. Prog. Plan	80	
103 Program Reviews	80	
104 FRACAS	250	
201 Reliability Modeling	20	
203 Rel. Predictions		
Initial P.C.	60	
Stress Analysis	600	
204 FMECA (Functional/SRU Level)	200	
207 Parts Program		
Derating Guideline	20	
Component Engineering Effort (MIL-STD-965)	NWD	
301 Environmental Stress Screening		
Plan & Procedure	80	
302 Rel. Development/Growth Test		
Procedures	80	
Monitor Test/FA (3 Months) (20 Fail)	320	
Test Tech. (Environmental	240	
Repairs $200/Failure (20 Fail)		4K
Special Test Equip.		20K
Report	80	
303 Rel. Qual. Test		
Procedure	40	
Monitor Test/FA (15 Fail)	255	
Test Tech.	240	
Repairs (15)		3K
Special T.E.		-
Report	80	
TOTAL	2725	81,750
	2725	$108,750

Alternative 2. Commercial Off-The Shelf with Military Equivalent Test, Verification and Qualification

Tasks, Ref. MIL-STD-785B		Hrs.	$
101	Rel. Program Plan	40	
203	Rel. Predictions		
	Initial P.C.	60	
	Selected S/A	120	
301	Environmental Stress Screening		
	Plan & Procedure	80	
302	Rel. Development/Growth Test		
	(Same as Alt. 1)	720	
	Less Special Test		24K
303	Rel. Qual. Test		
	(Same as Alt. 1)	615	
			3K
		2250	$ 67,500
			27,000
			$ 94,500

Alternative 3. Commercial Off-The-Shelf With Commercial Verification and Documentation

Tasks, Ref. MIL-STD-785B		Hrs.	$
203	Rel. Predictions		
	P.C. Predictions	60	
	Selected S/A	120	
302	Rel. Development/Growth Test		
	(Same as Alt. 1)	720	
	Less Special T.E.		14K
		900	$ 27,000
			14,000
			$ 41,000

Alternative 4. Commercial Off-The-Shelf With Recommended Set of Tasks

Tasks, Ref. MIL-STD-781B		Hrs.	$
101	Rel. Program Plan	40	
203	Rel. Predictions		
	P.C. Pred.	60	
	Selected S/A	120	
301	Environmental Stress Screening		
	Procedure	80	
302	Rel. Development/Growth Test	720	
		1020	14K
			$ 30,600
			14,000
			$ 44,600

A3.4.2 Maintainability

Maintainability Engineering is an important aspect of equipment design and support. Much similarity exists in the Maintainability (M) concerns addressed in the design of military and commercial equipments.

The Air Force realizes the importance of design for Maintainability as demonstrated by the extensive M requirements listed in equipment specifications as well as by the numerous M data items contracted. These requirements pertain to modularity, test points, repair times, repair levels, fault detection/isolation, and maintenance safety. The Air Force ensures the incorporation of such M features by having the contractor provide documentation (such as MTTR predictions, AAA Reports, Hazard Analyses, ORLA Report) during the design and perform formal testing (such as M demonstrations of repair and BIT performance) prior to equipment delivery.

Design requirements of commercial equipment are defined by the manufacturer's Internal Design Guidelines, as well as by customer specifications (when a customer has contracted the design). Many commercial M Design Requirements/Guidelines are based on military standards. Incorporation of these parameters into a commercial design is documented for Internal Product Integrity Reviews and for customers who are contracting the design. Internal documentation may not be as extensive or formal as data provided to a contracting customer. Equipments designed for a customer are likely to have some features/peculiarities which are of value perhaps only to that customer and may or may not cause problems for an off-the-shelf equipment purchaser. In general, it may be found that the customer

A3.4.2 Maintainability (Continued)

who contracts a commercial design (such as an airframe manufacturer) may also have previous experiences in working on Government contracts such that his specifications are likely to be biased toward a MIL-Standard direction.

This study is looking at alternatives to the full-scale development approach commonly used in Air Force Acquisition Programs. The alternatives addressed below are (1) purchase a new-design off-the-shelf commercial equipment with testing and support documentation performed to military specifications, (2) purchase of a new-design off-the-shelf commercial equipment with available documentation, and (3) purchase of a new-design or mature-design off-the-shelf commercial equipment with our recommended additional data and testing to reduce the risks associated with (2).

The maintainability tasks generally required for each procurement alternate are listed on the following pages. The risks incurred by the Air Force when purchasing commercial off-the-shelf equipment are discussed in detail in the following paragraphs. Also, recommendations for reducing risks are given. The Maintainability effort associated with Air Force purchase of commercial off-the-shelf equipment is quantitatively displayed in Table A4.1. The respective levels of effort for the various supporting data packages are expressed as a percentage of the normal effort expended in the full scale design of military equipment.

New Commercial Equipment with MIL Support Data (Table A4.1, Column 1)

The Air Force can bypass the lengthy equipment development time by purchasing commercial off-the-shelf equipment. The Air Force may

A3.4.2 Maintainability (Continued)

prefer to still specify full MIL supporting data and testing requirements. Such data and testing may not be as costly and require as much effort as during a full scale military development because the data and testing is being performed after the equipment design when internal documentation is complete. Since this study addresses only the purchase of off-the-shelf equipment without modification, the value of the Air Force specified supporting data and testing is diminished because corrective action indicated during the testing and data preparation will not be incorporated into the equipment design. However analyses (such as testability analysis and repair level analysis) and testing (such as M Demonstration and TPS validation/verification) are essential for tailoring the support items (support equipment, test procedures, sparing, facilities, manning, safety procedures) to the specified maintenance concept.

New Commercial Equipment with Available Supporting Data(Table A4.1, Column 2)

Purchasing an off-the-shelf commercial equipment with existing supporting data allows for lower acquisition cost, but data which is not written to MIL Specification may not fully access and support the integration of the equipment into the Air Force application and support scenario. For example, a maintenance manual may be written for a 2-level maintenance concept and thus cause problems when used in a 3-level maintenance scenario. Existing data may recommend and support use of peculiar support equipment which may not be in the Air Force inventory or may not even be appropriate for use by the Air Force. The maintenance skill levels required for accomplishing the procedures in the maintenance manuals may necessitate additional/special training for

A3.4.2 Maintainability (Continued)

A.F. technicians at one or more maintenance levels. Since no field data would be available on a new equipment, the performance of Built-In Test and the possibility of maintenance problems are not fully evident to the customer without special testing such as an M Demonstration.

Mature Commercial Equipment with Recommended Supporting Data (Table A4.1, Columns 3 and 4)

The risks associated with purchasing off-the-shelf commercial equipment with only the existing supporting data can be reduced by contracting for an optimized data package written to MIL Specifications. A test-ability analysis of the equipment projected into the military maintenance structure will expose problems with using different support equipment, different skill levels, different maintenance concept. A Test Requirement Document (TRD) will provide the detailed performance and diagnostic test steps which may not be fully documented in a commercial maintenance manual. Prediction of active repair times and performance of an M Demonstration will provide manning and equipment availability information and will point out improper and time-consuming test methods. A Material and Maintenance Hazard Analysis Report will provide a summary of hazards categorized by risk and probability of occurrence, will identify all built-in safety features which reduce/eliminate the hazards, and will recommend precautions and procedures. Data written for a mature commercial equipment will be influenced by available field information regarding repair time, revised test methods, and additional safety precautions. The Organic Maintenance approach for commercial equipment requires almost the same data as in a full MIL Design Program except for the data created solely

A3.4.2 Maintainability (Continued)

to monitor the design. A Reliability Improvement Warranty (RIW) approach for commercial equipment is a way of reducing risks without requiring all of the supporting data discussed above for the Organic Maintenance approach. Only data for Organizational Level Maintenance would be required. A comparison of the supporting data requirements for the Organic and RIW approaches for mature commercial equipment are shown in Table A4.1.

New Commercial Equipment with Recommended Supporting Data (Table A4.1 Columns 5 and 6)

Customer risks and recommended supporting data are essentially the same for new commercial equipment as for mature commercial equipment. However, field performance of a new commercial equipment obviously will not be available for incorporation into supporting data. The Organic Maintenance and the RIW approaches are both appropriate for support of new commercial equipment.

ALTERNATIVE I

MILITARY

Maintainability

Program Plan

Maintenance Concepts

Predictions

A. Mean Time To Repair (MTTR, Mct and Mmaxct)
B. Repair Level Analysis ORLA, LOR, GEMM
C. Apportionments

Testability

A. Performance Monitoring
B. Self Test
C. Built-In-Test
D. Test Connectors/Test Points
E. Fault Isolation
F. ATE Compatible

Maintainability Design Guidelines

A. Hardware
B. Safety

Demonstration Test

A. Physical Test of Hardware

Test Requirement Documents TRDS

A. System to LRU
B. LRU to SRU
C. SRU to Piece Parts

ALTERNATIVE II

COMMERCIAL WITH MILITARY TEST AND QUAL PROGRAM

Maintainability

Program Plan

Maintenance Concept

Predictions

A. Mean Time To Repair
B. Maintenance Manhours Per Flight Hour
C. Average Material Repair Costs

Testability

A. Performance Monitoring
B. Self Test
C. Built-In-Test
D. Test Connectors/Test Points
E. Fault Isolation

Maintainability Design Guidelines

A. Hardware
B. Safety

Demonstration Test

A. Analysis
B. A/C System Test Sequence

ALTERNATIVE III

COMMERCIAL OFF-THE-SHELF

Maintainability

Commercial "Off-the-Shelf" Equipment

This item would be the same as Alternative IV and is discussed in Alternative IV.

ALTERNATIVE IV

*RISK ITEMS FOR COMMERCIAL EQUIPMENT IN MILITARY ENVIRONMENT

Maintainability

Program Plan

Maintenance Concept

A. Define Concept To Be Used By Procurement Agency.

*Predictions

A. MTTRs and Mmaxct
B. Repair Level Analysis ORLA, LOR, GEMM
C. Apportionments

Maintainability Design Guidelines

*Testability

A. ATE Compatability

*Demonstration

A. Physical Demonstration

*Test Requirement Documents TRDs

A. System to LRU
B. LRU to SRU
C. SRU to Piece Parts

TABLE A3.1 MAINTAINABILITY EFFORT ON COMMERCIAL OFF-THE-SHELF EQUIPMENT

(% OF EFFORT RELATIVE TO FULL-SCALE MILITARY EQUIPMENT DESIGN)

MAINTAINABILITY ITEMS	NEW DESIGN W/MIL SUPPORTING DATA	NEW DESIGN W/AVAILABLE SUPPORTING DATA ONLY	MATURE DESIGN W/RECOMMENDED DATA		NEW DESIGN W/RECOMMENDED DATA	
			ORGANIC	RIW	ORGANIC	RIW
M PROGRAM PLAN	80	0	80	50	80	50
MTTR (O)	60	0	50	50	60	60
MTTR (I)	60	0	50	0	60	0
MTTR (D)	80	0	80	0	80	0
TESTABILITY/BIT (O)	120	0	120	120	120	120
TESTABILITY/BIT (I)	120	0	120	0	120	0
TESTABILITY/BIT (D)	120	0	120	0	120	0
TRD (O)	100	0	80	80	100	100
TRD (I)	100	0	80	0	100	0
TRD (D)	100	0	100	0	100	0
ORLA	50	0	50	0	50	0
M DEMO (O)	100	0	100	100	100	100
M DEMO (I)	100	0	100	0	100	0
TPS VAL/VER (D)	100	0	100	0	100	0
M AAA REPORTING	0	0	0	0	0	0
SYSTEM SAFETY PLAN	50	0	50	50	50	50
PRELIM. HAZARD ANALYSIS	0	0	0	0	0	0
BIOMEDICAL REPORT	100	0	80	80	100	100
MAINT. HAZARD ANALYSIS (O)	100	0	80	80	100	100
MAINT. HAZARD ANALYSIS (I)	100	0	80	0	100	0
MAINT. HAZARD ANALYSIS (D)	100	0	80	0	100	0
PROGRAM/DESIGN REVIEWS	40	0	40	40	40	40

A3.4.3 Technical Publications

RADC CONTRACT EFFORT

The objective of this effort is to show the publications department tasks in preparing military and commercial publications/data. This data provides alternatives for an Air Force Program Manager. Four alternatives are presented. A cost comparison estimate is listed.

		COST COMPARISON ESTIMATE
I	FULL MILITARY DESIGN, DEVELOPMENT, TEST AND QUALIFICATION	100%
	A. Bidding B. Military Publication Procedures	
II	COMMERCIAL OFF-THE-SHELF EQUIPMENT WITH MILITARY TEST, VERIFICATION, AND QUALIFICATION PROGRAM	90%
III	COMMERCIAL OFF-THE-SHELF EQUIPMENT WITH COMMERCIAL VERIFICATION AND DOCUMENTATION	70%
	A. Bidding B. Commercial Publication Procedures C. Risks	
IV	COMMERCIAL OFF-THE-SHELF EQUIPMENT TO COMMERCIAL SPECIFICATIONS WITH RECOMMENDED TASKS TO REDUCE RISKS	70 - 85%

I FULL MILITARY DESIGN, DEVELOPMENT, TEST AND QUALIFICATION PROGRAM

In this alternative, the Air Force Program Manager elects to procure newly designed equipment and supporting publications/data. A complete array of military specifications is imposed upon the manufacturer.

To produce the documentation required by this alternative, the publications department must first bid and then produce the data. These tasks are listed in the following paragraphs.

A. Bidding

1. Determine scope of effort. Exactly what data items are required: schematic diagrams, outline and mounting drawings, source data, instruction books, etc?

2. Research cited specification. Is specification valid for data item, and is it the latest version? Interpretation of poorly written specifications is one of the most difficult tasks for publications.

3. Determine depth of coverage. This will be based on the maintenance concept: organizational, intermediate, or overhaul.

4. Prepare a brief outline based on the cited specification.

5. Prepare a job estimate. This will include total man hours and cost based on the scope of effort.

I FULL MILITARY DESIGN, DEVELOPMENT, TEST AND QUALIFICATION PROGRAM (CONTINUED)

B. Military Publication Procedures

1. Determine if military nomenclature has been assigned by customer.

2. Determine if general purpose test equipment has been approved by customer.

3. Determine if special purpose test equipment has been approved by customer.

4. Determine delivery requirements (manuscript, reproducible copy, negatives, printed books, source data, etc.).

5. Review cited specification. Prepare a detailed outline if required by the specification or publications manager.

6. Submit detailed outline (if required) for approval.

7. Contact design engineer to coordinate data search.

8. Research data, write text, and plan/prepare illustrations.

9. Schedule validation. Notify DCASMA, design engineer, and others required.

10. Perform validation. Fill out Validation Completion form. Correct manuscript as required.

I FULL MILITARY DESIGN, DEVELOPMENT, TEST AND QUALIFICATION PROGRAM (CONTINUED)

11. If publication contains a part list, perform a compatibility check between the schematic diagrams and the parts list. Correct manuscript as required.

12. If publication contains a part list, incorporate SMR (source maintainability, and recoverability) codes.

13. Submit manuscript to design engineer, metrology, product integrity, program manager, quality control editor, etc. for review. Correct manuscript as required.

14. Submit manuscript for customer approval.

15. Review and evaluate customers review comments. Correct manuscript as required.

16. Submit manuscript to quality control editor for review.

17. Forward manuscript (text and drawings) to editing/composing.

18. Editing/composing prepares deliverable item (reproducible copy, negatives, printed matter, etc.).

19. Publications quality assurance editor checks deliverable item for specification compliance and corrects as required.

20. DCASMA inspects deliverable item. Corrections are made if required.

I FULL MILITARY DESIGN, DEVELOPMENT, TEST AND QUALIFICATION PROGRAM (CONTINUED)

21. Data support manager forwards deliverable item to customer.

22. Customer accepts/rejects deliverable item.

II COMMERCIAL OFF-THE-SHELF EQUIPMENT WITH MILITARY TEST, VERIFICATION, AND QUALIFICATION PROGRAM

In this alternative, the Air Force Program Manager elects to procure commercial off-the-shelf equipment, but he imposes military specification requirements for all publications/data. In this case, the same tasks listed for alternative I will apply.

The man-hours required to produce these military publications/data will be less than alternative I because most of the required data will be available in commercial format. This information will have to be reformatted to conform to the cited military specification. New data will be generated to satisfy additional requirements.

III COMMERCIAL OFF-THE-SHELF EQUIPMENT WITH COMMERCIAL VERIFICATION AND DOCUMENTATION

In this alternative, the Air Force Program Manager elects to procure commercial off-the-shelf equipment and publications/data without additional tasks. The program manager assumes risks that the commercial publications/data will not completely satisfy Air Force requirements. Some of these risks are listed in paragraph C.

The following tasks are performed to develop a commercial publication. These tasks may be compared to alternative I (a military publication). The publications department must first bid and then produce data.

A. Bidding

1. The scope of effort is determined by the program office.

2. The publication specification is an in-house Rockwell-Collins standard.

3. The depth of coverage is determined by the equipment design, maintainability recommendations, and available general and special purpose test equipment.

4. A publication outline is not required due to the familiarity with the Rockwell-Collins publication standard.

5. Prepare a job estimate. This will include total man hours and cost based on the scope of effort.

III COMMERCIAL OFF-THE-SHELF EQUIPMENT WITH COMMERCIAL VERIFICATION AND DOCUMENTATION (CONTINUED)

B. Commercial Publication Procedures

1. Determine if commercial nomenclature has been assigned locally.

2. Determine if general purpose test equipment has been approved by metrology and engineering.

3. Determine if special purpose test equipment has been approved by engineering.

4. Delivery requirements are printed books required by commercial/military customers to support the equipment.

5. Review Rockwell-Collins publication specification. A detailed outline is not required due to the familiarity with the in-house specification.

**6. Detailed outline approval is not required since none is written.

7. Contact design engineer to coordinate data search.

8. Research data, write text, and plan/prepare illustrations.

9. Schedule validation. Notify design engineer and others required.

10. Perform validation. Fill out Validation Completion form. Correct manuscript as required.

III. COMMERCIAL OFF-THE-SHELF EQUIPMENT WITH COMMERCIAL VERIFICATION AND DOCUMENTATION (CONTINUED)

11. Perform a compatibility check between the parts list and the schematic diagrams. Correct manuscript as required.

**12. SMR (source, maintainability, and recoverability) codes are not used in a commercial parts list.

13. Submit manuscript to design engineer, metrology, product integrity, program manager, quality control editor, etc. for review. Correct manuscript as required.

**14. Customer approval not required.

**15. Customer review comments not available.

16. Submit manuscript to quality control editor for final review.

17. Forward manuscript (text and drawings) to editing/composing.

18. Editing/composing prepares manuscript for printing.

19. Publication is printed and forwarded to Central Distribution Center for distribution/storage.

**These procedures are not performed for commercial publications. They are included for comparison with military publication procedures.

AD-A129 597 RELIABILITY MAINTAINABILITY AND LIFE CYCLE COST EFFECTS OF COMMERCIAL OFF..(U) ROCKWELL INTERNATIONAL CEDAR RAPIDS IA COLLINS GOVERNMENT AVI.. N E SCHMIDT ET AL. 3/3

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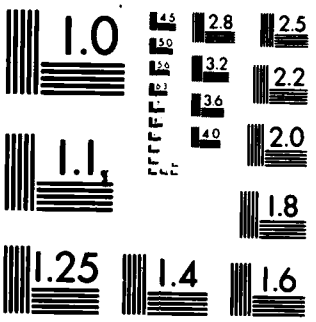

III COMMERCIAL OFF-THE-SHELF EQUIPMENT WITH COMMERCIAL VERIFICATION AND DOCUMENTATION (CONTINUED)

C. Risks

When comparing alternative I (military) to alternative III (commercial) publication/data procurement, the following risks are taken.

1. The maintenance concept (depth of coverage) may not be appropriate.

2. The general purpose test equipment may not be available in Air Force inventory.

3. The special purpose test equipment must be evaluated and procured.

4. The publication/data may cover several models not procured by the Air Force.

5. The parts list will not contain SMR codes.

6. The right to revise the material is vested in the manufacturer.

7. Revision service must be requested to provide for updating.

8. A record of validation may not be available.

IV COMMERCIAL OFF-THE-SHELF EQUIPMENT TO COMMERCIAL SPECIFICATIONS WITH RECOMMENDED TASKS TO REDUCE RISKS

In this alternative, the Air Force Program Manager elects to procure off-the-shelf equipment and publications/data to commercial specifications. He also wishes to reduce the risks associated with the procurement of publications/data to satisfy military requirements. First, a careful review of the commercial off-the-shelf publication is required. Second, the information provided by the review is used to provide recommendations that will reduce risks.

A. Review

MIL-M-7298C is the basic military specification for reviewing the minimum requirements for acceptable commercial manuals for use by all departments and agencies of the Department of Defense to install, operate, and maintain commercial equipment. This is a fairly good general specification written in broad general terms. It does not address many of the differences between military and commercial publications/data.

To ensure that commercial publications meet Air Force requirements, military specification MIL-M-7298C and the following items should be carefully reviewed.

1. Is the depth of coverage (organizational, intermediate, or overhaul) appropriate?

2. Is the general purpose test equipment, or equivalent, available in Air Force inventory?

3. Is the special purpose test equipment, or equivalent, available in Air Force inventory?

4. Does the publication cover only those models of equipment procured by the Air Force?

5. Does the parts list section satisfy Air Force requirements? Are SMR codes required or desired.

6. Will the manufacturer revise, update, and add an Air Force technical order number to the publication/data to satisfy the Air Force requirements?

7. Will the manufacturer provide a record of validation? The Air Force should verify publication/data before approval.

B. Recommendations

After carefully reviewing the commercial publications/data, the following procurement options are recommended for the Air Force Program Manager.

1. Purchase the existing publications/data. If the commercial publications/data meets the essential Air Force requirements, the program manager may wish to procure the existing publications/data without change.

IV COMMERCIAL OFF-THE-SHELF EQUIPMENT TO COMMERCIAL SPECIFICATIONS WITH RECOMMENDED TASKS TO REDUCE RISKS (CONTINUED)

2. Negotiate changes to the existing publications/data. Most commercial manuals will not satisfy all Air Force requirements. The program manager should negotiate with the manufacturer to incorporate the essential Air Force requirements into the existing publications/data. This option will result in substantial savings when compared to purchasing publications/data prepared to military specifications.

3. Purchase new commercial specification publications/data. If the program manager determines that recommendations 1 and 2 are not feasible, he may purchase a new commercial publications/data using the existing commercial manual for source data. A savings can be realized when compared to purchasing publications/data prepared to military specifications.

A3.4.4 Quality Assurance

The basic Quality Assurance Program tasks necessary to fulfill the requirements of a specific program or contract are listed in Table A4.2 For each of the four alternative program types listed in Table A4.3, a QA Program consisting of all of these tasks is required. The level of effort required to support each of the four alternative program types is shown as a percentage of the effort required to support a full military specification design effort. Each of these Quality Assurance Programs would, in effect, be basically the same regardless of equipment type (communications, data processing, etc.) or equipment environment (Airborne Tactical Fighter, Transport, or Ground Support). The only difference in each of these programs would be the amount of effort required to ensure equipment quality and performance meets the specific requirements imposed by each of these categories. This effort would depend on the actual technical requirements for performance, design, development, test, and compatability of equipment as defined in the procurement specification. Given the same technical requirements for a specific piece of equipment, the amount of effort required to support a Quality Assurance Program for each of the four alternatives listed would then be a function of the percent of effort required to ensure conformance to each of the military specifications imposed by the contract.

The major cost differential between each of the alternative programs shown can be attributed to the design effort required in Alternative I. This effort would include Preliminary and Critical Design Reviews, Program Reviews, Physical Configuration Audit, First Article Inspection, Functional Configuration Audit, and Product Readiness Reviews. In addition to these tasks, there would be increased Quality Assurance support for Engineering, Engineering Lab

Inspection, and Manufacturing during the design and development phase of the contract. Since Alternatives II, III, and IV relate to commercial off-the-shelf equipments, it is assumed that there is no additional design effort and that this effort is included in the catalog or contract purchase price. Additional cost differences between programs requiring full military verification, qualification and testing (Alternatives I and II) and those requiring commercial or recommended support (Alternatives III and IV) result from the reduced effort, in the second two alternatives, required to support MIL-STD-1520 A/B activity, MIL-STD-965 activity, production Reliability Testing, and Quality Assurance Reports and data items. In Alternative III (Full Commercial Program) these activities would be implemented through the use of in-house developed Quality standards and operating procedures. In Alternative IV (recommended verification, qualification, and testing) these tasks would be accomplished through the use of military specifications in conjunction with established in-house procedures covering extended Equipment Burn-In, Reliability Demonstrations, Production Qualification Testing, and Maintainability Demonstration Programs.

The Quality Program requirements set forth in the Quality plans for each of the four alternatives, and the level of effort required to support these plans, are established to ensure an effective and economical Quality Program. The increased Quality Assurance costs associated with Alternatives I and II reflect the increased effort required to support the additional qualification, verification, and testing necessary to ensure the equipment meets the additional requirements imposed by a military program. This increased effort aids in the early detection of both product and process deficiencies and provides for prompt corrective action. The use of extended Burn-In and Production Reliability Testing provides for increased detection of infant mortality and monitoring of equipment MTBF. In addition to these tasks,

the Quality Assurance Program would also include part procurement quality and usage requirements to ensure the equipment design meets the environmental requirements imposed by the contract. Since the first two alternative programs include the full range of military qualification, verification, and testing, the inherent risks involved in the use of a commercial design as outlined in Alternative II would relate directly to the requirements imposed during the design effort. This would include selection of parts, operational requirements, environmental requirements, and technical specifications for equipment design.

The reduced level of effort required to support a full commercial program as shown in Alternative III reflects the reduced monitoring effort during the production phase. Environmental, Reliability, and Qualification Testing is typically performed during the design phase to verify equipment operational parameters, ensure compliance with federal regulatory agencies' requirements (FAA, FCC, etc.), and to establish equipment MTBF's. Once in production, most of these tests are not repeated unless major design changes are incorporated in the equipment or field performance warrants the re-evaluation of parameters evaluated by these tests.

A reduced burn-in program is implemented in production to reduce the level of infant mortality related failures and to periodically monitor equipment performance at the operating temperature extremes. Although the workmanship requirements may be relaxed from those imposed by a military program, sufficient inspection points are maintained throughout the manufacturing process to ensure good equipment quality. The risks involved in the use of commercial equipment must then be evaluated in terms of part quality (commercial vs. military), equipment design requirements (operating limits, temperature, altitude, humidity, etc.), and the monitoring and verification

testing conducted on production equipment (Rel. Sample Tests, Burn-In Requirements, etc.). It is these areas in which additional testing, inspection, and verification would be accomplished in Alternative IV to attenuate the risks involved in the use of commercial equipment. This effort would include the use of extended burn-in programs to increase the detection of infant mortality related failures and to monitor equipment performance throughout its environmental envelope. The use of a production Reliability Sampling Plan would also aid to verify equipment design characteristics and establish a product baseline by which equipment performance could be measured. In addition to these tasks, additional effort would be included to support Corrective Action Board, Material Review Board, and Customer Quality Interface activities.

QUALITY ASSURANCE PROGRAM TASKS

TABLE A3.2

1. Review and interpret the contract in regard to contractual Quality requirements.

2. Prepare Quality Plans and Reports as required by the contract.

3. Provide the program engineering function with an interpretation of contractual Quality requirements.

4. Provide Quality Assurance collateral support for the Engineering Lab and Engineering Lab Inspection function.

5. Monitor program quality and adherence to contractual requirements throughout the design and development phase through the use of Design Reviews, Physical Audits, First Article Inspections, and Product Readiness Reviews.

6. Provide QA support to the program office in coordinating contractual Quality requirements with Manufacturing.

7. Provide support for the resolution of Manufacturing and field problems as they arise. Coordinate the resolution with the Program Office, Manufacturing, Engineering, and other related departments.

8. Provide liaison between Rockwell-Collins personnel and customer Quality representatives for products requiring source inspection.

9. Monitor Qualification, Environmental, and Reliability Testing throughout the design, development, and production phases of the contract.

10. Maintain interface with DCASMA or other Government Quality Representatives on Quality Program requirements.

11. Receive, process, and answer customer complaints pertaining to Quality deficiencies.

12. Provide program Quality support for change Control Board activities.

13. Establish and chair the Material Review Board and provide Quality Assurance assistance in the disposition of nonconforming material.

14. Conduct Corrective Action Board Meetings on a regular basis with the Program Manager, Manufacturing Manager, Manufacturing QC Manager, and the Design Technical Director.

15. Provide Quality Engineering support for periodical process, procedure, and product audits to ensure conformance to contractual and company Quality requirements.

QUALITY ASSURANCE PROGRAM COST

TABLE A3.3

Alternative I	100%
Alternative II	64%
Alternative III	38%
Alternative IV	51%

% of effort required to support a Quality Assurance Program for a full military specification detailing design, development, and production requirements.

ALTERNATIVE PROGRAM DESCRIPTION

I. Design, development, test, and verification to military standards and specifications.

II. Commercial off-the-shelf design with military test, verification, and qualification program with normal military support.

III. Commercial off-the-shelf design at catalog price with normal commercial support.

IV. Commercial off-the-shelf design with qualification, verification, and test program recommended by Rockwell Collins.

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