CRONUS

Controlled Reentry Orbiting NUclear System

MARTIN

RTG/RB CIR AGE

Study for 250-Watt Controlled Reentry Orbiting NUclear System

VOLUME IV

SPECIFICATIONS AND DATA MANAGEMENT

DISCLAIMER

CRONUS

Controlled Reentry Orbiting NUclear System

Study for 250-Watt Controlled Reentry Orbiting NUclear System

VOLUME IV
SPECIFICATIONS AND DATA MANAGEMENT

RTG/RB CIR AGE

November 2, 1966

MND-2050-F-4 (Vol 4)

MARTIN COMPANY
BALTIMORE, MARYLAND 21203

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FOREWORD

The United States Atomic Energy Commission awarded the Martin Company Contract AT(29-2)-2050 for a six-month study, effective May 2, 1966, to develop and evaluate a feasible concept(s) for a 250-watt(e) radioisotopic thermoelectric generator providing controlled intact reentry of the fuel from earth orbit. A concept(s) for handling and fueling the RTG at a Titan III launch site was also to be developed and evaluated. Based upon the selected system concept, a development program plan was to be prepared, including estimated costs, for the design, development, flight test and delivery of operationally flight qualified hardware systems.

The flight and ground systems have been integrated by Martin into a single system concept designated CRONUS, an abbreviation for Controlled Reentry Orbiting NUclear System. Major CRONUS systems include the 250-watt(e) generator/reentry body (RTG/RB), the controlled intact reentry (CIR), and required ground support (AGE) systems which include fuel loading (GHE).

The following is a complete list of the documents prepared and submitted in accordance with Contract AT(29-2)-2050.

Volume I -- Summary

Volume II -- Technical

Volume II -- Appendices

Volume III -- Development Program Plan

Volume IV -- Specifications and Data Management

Volume V -- Budgetary Estimate

Volume VI -- Quality Assurance Plan

CRONUS

SPECIFICATIONS

INTRODUCTION

This volume contains the following CRONUS specifications:

MN-2050-1	Specification Plan
MN-2050-2	Documentation Plan
MN-2050-3	Configuration Management and Control Plan
MN-2050-10	RTG/RB-CIR Systems Interface Specification
MN-2050-20	AGE Interface Specification
MN-2050-100	RTG/RB-CIR Systems Design, Performance and Test Requirements
MN-2050-200	AGE Design, Performance and Test Requirements

These specifications have been prepared (in preliminary form) during Phase "0" under Contract AT(29-2)-2050 and will constitute the Program Requirements Baseline upon being finalized and incorporated into a contract covering Phase I of the CRONUS program.

STUDY FOR A 250-WATT CONTROLLED RE-ENTRY ORBITING NUCLEAR SYSTEM "CRONUS"

Specification Plan
MN-2050-1

NOTE: This document has been prepared under AEC Contract AT(29-2)-2050

Basic Approved By:

_____
Martin Marietta Corporation

Date: _____

MARTIN COMPANY
Baltimore, Maryland 21203

Manufacturer's Federal Supply Code 38597

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SPECIFICATION PLAN FOR THE CRONUS PROGRAM

1.0 SCOPE

This plan establishes the types of requirements for and methods of control of the contract specifications to be prepared by the contractor. The specifications required hereby are those considered essential for purposes of contractual definition and end item control. The areas covered by these specifications include documentation, configuration control, equipment requirements and interface control.

NOTE: See Section 6 of MN-2050-100 for nomenclature and definition of terms used herein.

2.0 APPLICABLE DOCUMENTS

2.1 General

The following documents of the issue date shown form a part of this document to the extent specified herein. In case of any conflict between this specification and any referenced document, the requirements of this document shall govern.

2.1.1 Air Force. AFSCM 375-1, 1 June 1964, Configuration Management During the Definition and Acquisition Phases.

2.1.2 Contractor. MN-2050-2, Documentation Plan for the CRONUS Program.

3.0 REQUIREMENTS

3.1 General

Contract specifications, whether prepared during Phase 0 or Phase 1 of the contract, are not restricted to any particular phase of the CRONUS program, but shall be maintained in an up-to-date status throughout the program.

3.1.1 Type. The specifications required hereby shall be Type 1 negotiated documents in accordance with MN-2050-2.

3.1.2 Status. The relationships between the contract, the statement of work and the contract specifications for the various phases of the CRONUS program are depicted in Fig. 1, "Contract Specification Tree."

3.1.3 Philosophy. The specifications described herein are intended to be formal contractual documents requiring Contractor-Procuring Agency negotiation and approval. Once approved and incorporated into the contract, further changes shall require separate negotiation and approval. The contract, statement of work and contract specifications, taken together, shall form the basis upon which all CRONUS systems and equipment will be designed, fabricated, tested and accepted.

Specifications shall be prepared, coordinated and negotiated as expeditiously as possible in order that:

(a) Work effort can be planned on the basis of firm contractual requirements.

(b) Technical problems affecting program schedules and contract can be resolved early.

(c) All personnel have a detailed baseline of agreement from which to work.

3.2 Implementation

See Fig. 2.

3.2.1 Coordination. All contract specifications defined herein shall be throughly coordinated within the Contractor's organization and with the AEC prior to negotiation. The coordination phase of specification development shall be carried out in the following sequence:

(a) The Contractor shall prepare and distribute interim specifications to cognizant agencies for review and comment.

(b) Coordination shall be completed through the convening of meetings, as required.

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All contract specifications, once approved, become applicable to and are maintained throughout all phases of the program.

Contract specifications prepared during Phase "O" form the

PROGRAM REQUIREMENTS BASELINE

Contract specifications prepared during Phase I form the

DESIGN REQUIREMENTS BASELINE

Contract specifications prepared during Phase II form the

PRODUCT CONFIGURATION BASELINE

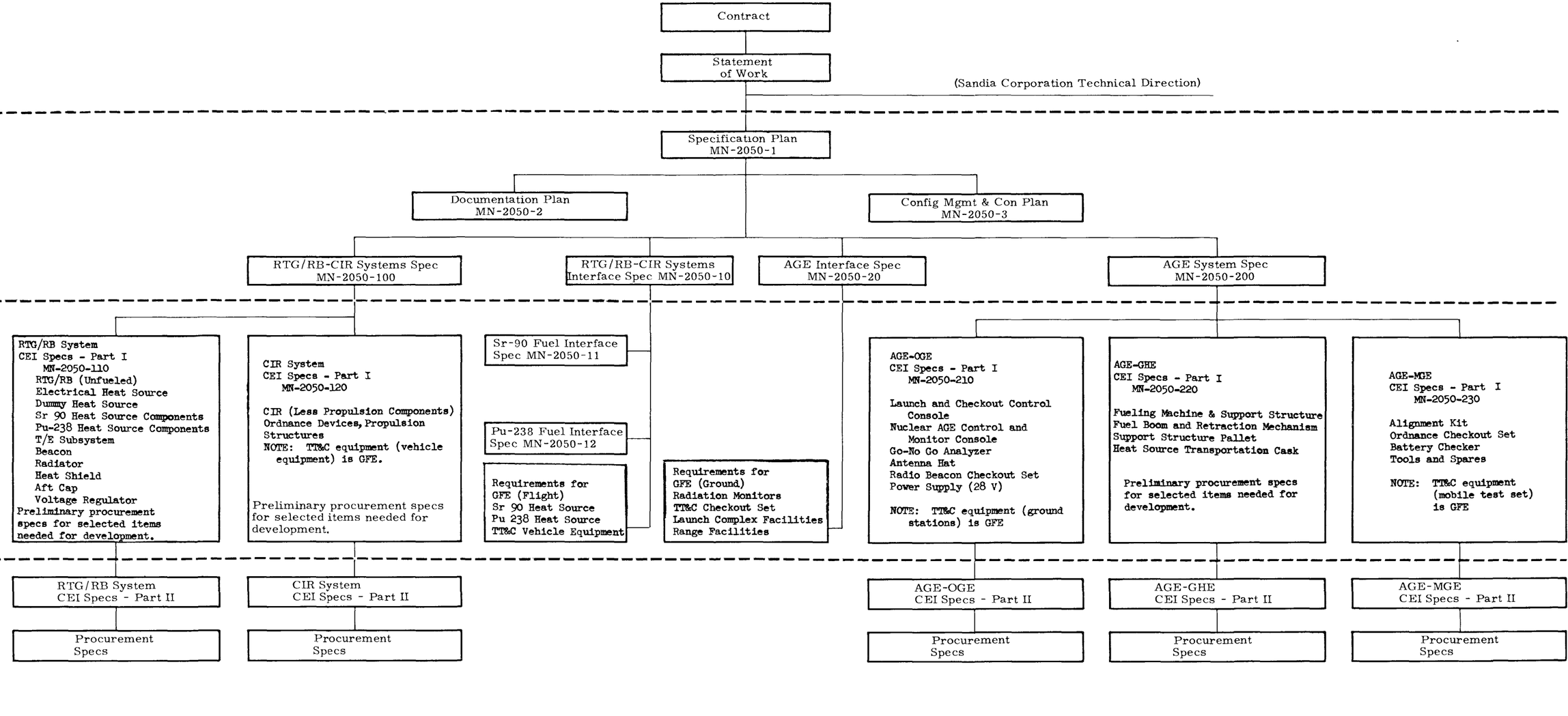

Fig. 1. CRONUS Specification Tree

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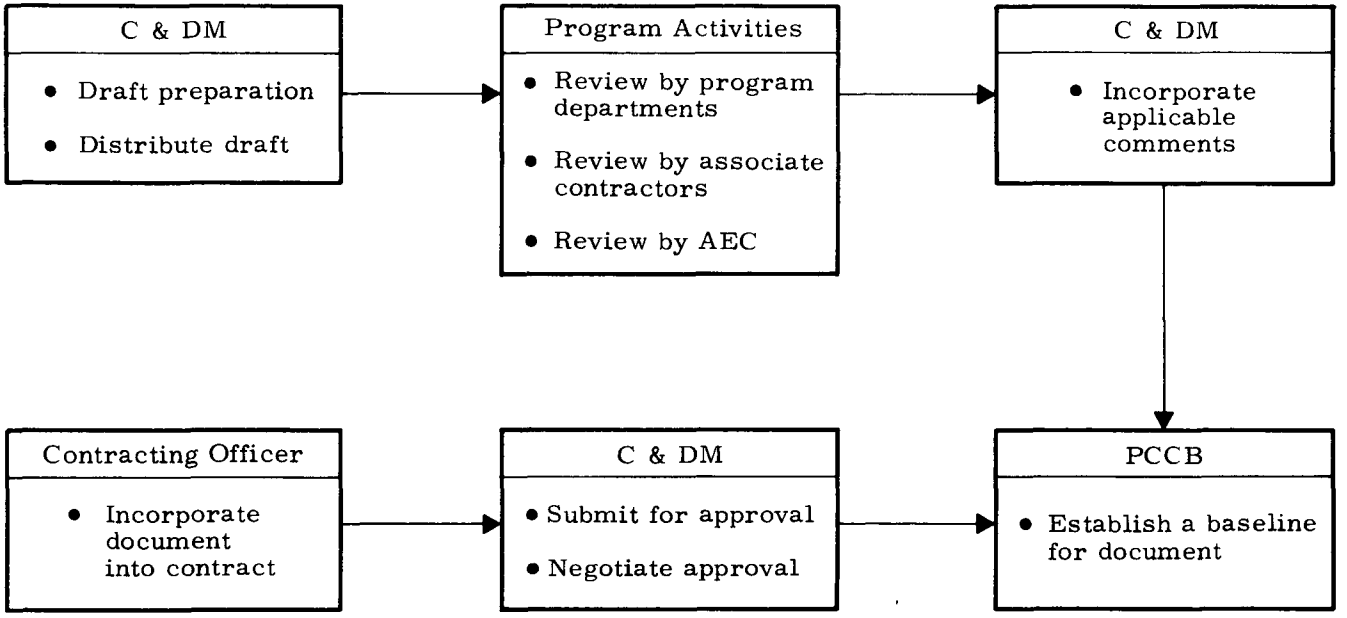

Fig. 2. Specification Implementation

3.2.2 Negotiation. Specification negotiation meetings shall be convened with the AEC as necessary to negotiate specification criteria and requirements not resolved during the coordination phase.

3.2.3 Approval. Upon completion of specification negotiations, the specifications shall be typed in final form, reproduced and submitted to the Contracting Officer for approval and incorporation by reference in the contract. Distribution of approved specifications shall be made by the Contractor in accordance with the requirements of the Documentation Plan (MN-2050-2) and/or the contract. Subsequent specification revisions shall be coordinated, negotiated and submitted for approval in the same manner as stated above.

3.3 Preparation

Specifications shall be prepared, using AFSCM Manual 375-1 as a guide for format and content. System specifications, interface specifications and CEI specifications shall use a basic format which includes six major sections as follows:

1. SCOPE
2. APPLICABLE DOCUMENTS
3. REQUIREMENTS
4. QUALITY ASSURANCE PROVISIONS
5. PREPARATION FOR DELIVERY
6. NOTES (including definitions)

3.4 Content

3.4.1 System Specification for the CRONUS RTG/RB and CIR Systems (MN-2050-100). This specification serves as the top system specification for the RTG/RB and CIR systems. It integrates all specifications in the specification tree and includes general requirements for the following areas:

(a) General design and construction requirements and criteria

(b) System performance and reliability

(c) Operational considerations, including maintenance

(d) System safety

(e) System quality assurance, including testing

(f) System documentation

(g) Requirements for Government-furnished equipment and services.

3.4.2 System Specification for the CRONUS AGE (MN-2050-200). This specification establishes criteria and requirements applicable to the CRONUS AGE. It facilitates identification of requirements peculiar to the support equipment and integrates all specifications and control documents in the specification tree applicable to AGE. The specification establishes general requirements for the following areas:

(a) Identification and utilization of CRONUS AGE

(b) Functional and performance requirements

(c) Design and construction criteria and requirements

(d) Requirements for development, qualification and acceptance testing

(e) Requirements for Government-furnished equipment and services.

3.4.3 Interface Specification for the CRONUS RTG/RB-CIR Systems (MN-2050-10). This specification identifies interface areas between the RTG/RB-CIR Systems and the launch/satellite vehicle and establishes requirements and criteria governing physical and functional interfaces and installation and integration responsibilities. This document, when approved, will become a formalized source of interface information affecting the AEC, User, Contractor and cognizant Government agencies. The specification encompasses the following interface areas:

(a) Functional

(b) Physical

(c) Installation and integration

(d) Nuclear fuel, fuel encapsulation and fuel handling responsibilities

(e) Safety criteria and constraints

(f) Requirements for Government-furnished equipment and services.

3.4.4 Interface Specification for the CRONUS AGE (MN-2050-20). This specification defines both sides of the interface between CRONUS AGE and the using vehicles (and their supporting equipment and facilities and support services). This interface specification will serve as the formal document in which interface agreements between contractors and Government agencies will be recorded. The specification defines interface criteria and requirements for:

(a) Identification of interface areas

(b) Operational and functional interfaces

(c) Physical interfaces

(d) Installation and integration interfaces

(e) Government-furnished equipment and services.

3.4.5 Documentation Plan for the CRONUS Program (MN-2050-2). The documentation requirements plan establishes the total requirements for Contractor-prepared documentation. The plan identifies the following areas:

(a) Nomenclature and document identification numbering system or specific numbers

(b) A statement of the purpose and content of the item

(c) Classification of documentation or classification guide

(d) Requirement(s) for preparation

(e) Submittal periods

(f) Documentation addressees

(g) Distribution quantities.

3.4.6 Configuration Management and Control Plan for the CRONUS Program (MN-2050-3). This document establishes the requirements to provide positive identification of all end items, strict control over changes throughout the program life and a detailed accounting of their authorization, incorporation, verification and documentation. The following areas are defined by the plan:

(a) Identification. Program requirements, baseline, design requirements baseline and product configuration baseline

(b) Control. Change classification, review and administration

(c) Verification. Change certification.

(d) Review and Inspection. Preliminary design review, critical design review and first article compliance inspection

(e) Accounting. Change status

(f) Reporting.

3.4.7 Subsidiary Specifications. Planned specifications subsidiary to those previously discussed are illustrated within dotted outlines in Fig. 2. Basically, these specifications shall be established for (1) control of contract end items (CEI), procured or subcontracted articles and services and (2) to more specifically define for AEC, the User and the Contractor, the equipment, facilities, procedures and responsibilities related to integration of CRONUS into the satellite program. The subsidiary specifications shall be prepared to define requirements and criteria for the designated subsystems and components. Particular emphasis shall be placed on definitions of design constraints, fabrication requirements and tests necessary for qualification and acceptance of Contractor-furnished articles.

3.5 Changes

3.5.1 Proposed Changes.

3.5.1.1 Format. Proposed changes to approved Contractor-prepared Contract Specifications shall be prepared on Specification Change Notice (SCN) forms, Fig. 3. Additional pages may be added as necessary to provide for all material to be included in the particular SCN.

3.5.1.2 SCN Identification. SCN's shall be identified by specification number, by volume number (if submitted against a multiple-volume specification) and alphabetically; e.g., "MN-2050-200, SCN-A," "MN-2050-100, SCN-AA," "MN-2050-120, SCN-III-A," etc. Revised SCN's shall be identified numerically as follows: "MN-2050-120, SCN-III-A, Revision 1," etc.

3.5.1.3 SCN Contents. The SCN shall identify the pages and paragraphs, etc., to be changed, the details of the change in such a manner that the change may be evaluated with a minimum of reference to the parent document, and the reason for the proposed change. Presentation of the change shall be confined to one of the following methods:

(a) Present the lowest possible identifiable paragraph, i.e., numbered paragraph or lettered subparagraph, showing in the proper position all words currently approved, those proposed for deletion and those proposed for addition. Deletions shall be indicated by striking through each letter of

CONTRACT NO: _____

PRIORITY: _____

SPECIFICATION CHANGE NOTICE

NUMBER: _____

DATE: _____

SPECIFICATION NO:

TITLE:

DATED:

CCP NUMBER:

CHANGE:

REASON FOR CHANGE:

Fig. 3. Specification Change Notice Form (pink copy)

the words deleted with a slash mark; additions shall be underlined in the proposed text (such as paragraph titles) which shall be double underlined.

Example:

Page 5, Paragraph IV. A. 1; Change the title and first sentence as follows:

~~Style~~ Format ~~Approved~~ Proposed changes to approved

~~SSD Exhibit~~ Contractor Prepared Contract Specifications defined herein shall be prepared on Specification Change Notice (SCN) form, Fig. 3.

(b) Where an individually numbered paragraph is to be added or deleted in its entirety, the proposed change shall indicate this fact in the following manner:

Deletion Example:

Page 3, Paragraph II. A. 4. c; Revise paragraph to show deletion as follows:

c. Deleted.

Addition Example:

Page , Paragraph III. A. 6; Add new subparagraph as follows:

6. NOTES (including Definitions).

3. 5. 1. 4 SCN Submittal. The SCN may be submitted independently or as part of a Contract Change Proposal (CCP) package. The SCN shall be printed on pink paper to aid in distinguishing it from an approved SCN. SCN's shall be submitted to AEC for all specification changes except for the following editorial-type changes, which may be issued by a Contractor-executed SCN with reference to this specification for authority:

a. Nomenclature changes

b. Typographical errors

c. Changes in format

d. Revision to Table of Contents.

3.5.2 Approved Changes. SCN changes shall be approved either by an AEC Contracting Officer's letter or formal approval of a CCP of which the SCN was a part.

3.5.2.1 Format and Identification. The approved SCN shall be identified by a numbering system, as opposed to the lettering system shown in Paragraph IV.A.2 herein; e.g., MN-2050-100, SCN-1, MN-2050-120, SCN-III-1, etc. The difference in the numbering system and the use of pink paper will aid in distinguishing the approved SCN from the unapproved SCN.

3.5.2.2 SCN Contents. The released SCN shall include a cover sheet (Fig. 4) and revised pages to be incorporated into the Specification. The revised pages shall be identified by an asterisk after the page number. The asterisk shall reference a note at the bottom of the page identifying the SCN and the Contracting Officer's authorization. The SCN number shall be placed in the left margin of the sheet opposite each paragraph which has been changed. If the changed paragraph has been previously changed, only the latest SCN number shall appear.

3.5.2.3 SCN Distribution. Approved SCN's shall be distributed by the Contractor to all recipients of the parent document against which the SCN is issued, as determined from the Contractor's distribution records.

3.5.3 Specification Revised Page Index. The Contractor shall prepare and maintain a Specification Revised Page Index (SRPI) for each Contractor-prepared specification required herein. The Specification Revised Page Index shall cumulatively list all authorized changes against the specification subsequent to approval. The index shall be prepared in general accordance with the format of Fig. 5 herein, with such modifications as may be needed in order to make the index compatible with its parent document. Specification Revised Page Indices provide a running clerical tabulation of events and need not be submitted for approval, but shall instead be prepared and issued as a part of every approved SCN released. For multiple volume specifications, a separate SRPI shall be used for each volume and shall contain information relative only to that volume.

3.5.4 Changes to Approved Interface Specifications.

3.5.4.1 Proposed Changes.

a. Coordination. The Contractor or User's Contractor, for changes which he originates, shall informally coordinate the proposed change with the other affected Contractors prior to submission of the change. The change shall be by an Interface Specification Change Notice Proposal (ISCNP) and shall be coordinated and submitted as "emergency," "urgent," "compatibility" or "routine" change, depending on pertinent scheduling considerations.

MARTIN COMPANY

CONTRACT NO: _____

PRIORITY: _____

SPECIFICATION CHANGE NOTICE

NUMBER: _____

DATE: _____

SPECIFICATION NO:

TITLE:

DATED:

SCN (PRELIMINARY):

CCP:

CHANGE:

INSTRUCTIONS:

AUTHORITY FOR CHANGE:

FILE THIS PAGE AFTER THE REVISED PAGE INDEX OF
THIS SPECIFICATION TO INDICATE LATEST CHANGE

MARTIN APPROVAL: _____

Fig. 4. Specification Change Notice Form (approved)

Martin Specification MN-2050-100 SRPI Sheet No. I

Dated

SPECIFICATION REVISED PAGE INDEX

AS OF _____

Superseding the SRPI Issue Dated _____

This Specification Revised Page Index identifies all authorized changes to, and all current pages of, this Specification, as of the date shown above. This index is cumulative and therefore supersedes all previous Indices. This Index should be inserted in the Specification immediately following the Title Page and immediately preceding the SCN sheets. Detailed information on each change may be found on the applicable SCN sheet.

PAGE NO.	PARA. NO.	SCN NO.		CCP NO.	UCN
		PRELIMINARY	APPROVED		

This Specification consists of a Title Page, _____ Specification Revised Page Index sheets, _____ SCN, _____ Table of Contents sheets, _____ Pages of Text (Page number _____ is the last page), and _____ Pages of Appendix _____ (Page number _____ is the last page).

MARTIN APPROVAL _____
& CERTIFICATION

Fig. 5. Specification Revised Page Index

b. ISCNP Format. The format for the Interface Specification Change Notice Proposal (ISCNP) is shown in Fig. 6 and is detailed below. All entries shall be made by the initiating Contractor unless otherwise specified herein.

(1) Indicate page number and total number of pages in ISCNP.

(2) ISCNP No. Insert identification including revision, when applicable, in accordance with paragraph IV. D. 1. 3a herein.

(3) Date. Insert date of initiation of the ISCNP.

(4) Specification No. and Date. Insert specification number including revision, if any, and date of the specification or the date of its revision, as applicable.

(5) Specification Title. Insert complete title of the interface specification against which the proposed change is directed.

(6) Name. Insert the names of the Custodian Contractor and Associate or Integrating Contractor(s) affected by the proposed change.

(7) Contract Number. Insert Contractor's applicable contract number.

(8) CCP No. Each Contractor shall insert his CCP number when applicable. If the proposed change is not part of a CCP, insert "NONE."

(9) Contract Price Effect. Each Contractor shall insert one of the following, as applicable:

(a) NONE.

(b) YES, see referenced CCP (or other proposal action).

(10) Other Contractual Documents Affected. Each Contractor shall list his other contractual documents which have an associated proposed change in process. Give complete titles, numbers, dates and ISCNP's when known. The proposed changes (SCN's) to such other documents shall also contain reference to the ISCNP. Insert "NONE" if there are no such documents affected.

(11) Proposed Change. Insert the proposed change, in accordance with the requirements of Paragraph IV. A. herein. If space does not permit complete description on the ISCNP form, the words "See Attached Sheets" or a similar phrase shall be used and supplemental pages added as required.

Page 1 of

INTERFACE SPECIFICATION CHANGE NOTICE PROPOSAL

ISCNP NO: DATE: _____

SPECIFICATION NUMBER: DATE: _____

SPECIFICATION TITLE:

	CUSTODIAN CONTRACTOR	ASSOCIATE CONTRACTOR
NAME:		
CONTRACT NO:		
CCP NO:		
CONTRACT PRICE EFFECT:		
OTHER CONTRACTUAL DOCUMENTS AFFECTED:		

PROPOSED CHANGE:

REASON FOR CHANGE:

EFFECTIVITY:

CUSTODIAN CONTRACTOR:
ASSOCIATE CONTRACTOR:

CONTRACTOR APPROVAL:

CUSTODIAN CONTRACTOR _____ DATE _____
(Typed Name and Title)

ASSOCIATE CONTRACTOR _____ DATE _____
(Typed Name and Title)

Fig. 6. Interface Specification Notice Proposed Form

(12) Reason for Change. The reasons shall be brief while maintaining complete clarity. Supporting data to substantiate the reasons for the change shall be attached to the ISCNP when necessary. AEC/Sandia-requested changes shall be supported by reference to the document requesting the change.

(13) Effectivity. Each Contractor shall indicate the effectivity for this change to his own "side" (portion for which he is contractually responsible) of the interface.

(14) Contractors Approval. Insert the names of other affected Contractor(s) where indicated. Each Contractor shall type the name and title of the individual authorized to sign. Each Contractor shall indicate approval by the signature above the typed name and title and the date of the signature.

c. ISCNP Identification. ISCNPs shall be identified by document number and ISCNP number, e.g., MN-2050-10 ISCNP-25, etc. Blocks of ISCNP identification numbers to be used by affected Contractors will be preassigned through intercontractor coordination.

d. Classification. The forwarding letter, or the ISCNP transmittal, shall indicate whether the ISCNP is classed as Emergency, Urgent, Compatibility or Routine. Definition of priority classifications--Emergency, Urgent, Compatibility and Routine--shall be as described in AFSCM 357-1, Exhibit XIX.

e. Submittal. The originating Contractor shall forward the reproducible action copy of the ISCNP to other affected Contractors. An information copy of the forwarding letter and the ISCNP shall be submitted to AEC/Sandia and the using agency (see Figs. 7 and 8). The letter forwarding the ISCNP shall:

(1) Indicate the date and/or event on which contractual approval is required.

(2) If the ISCNP is classed as emergency or urgent, indicate the reasons for such classification, including consequences if the approval date is not met.

(3) For the purpose of expedited reaction, all correspondence generated by the initiating Contractor, which is addressed to (including copies) others, shall be sent to the attention of the specification control group in that Contractor's organization and shall contain the name and phone number of the person in the originating Contractor's organization who is responsible for the change.

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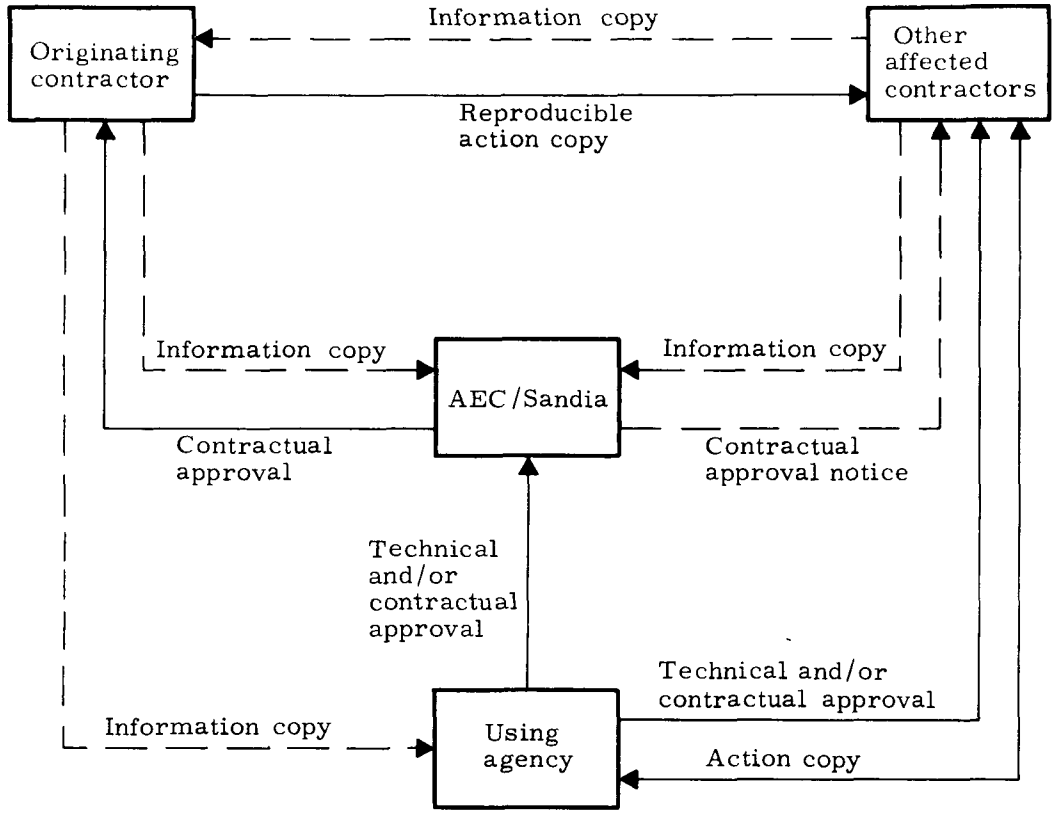

Fig. 7. User/Contractor Flow Diagram for ISCNP Submittal and Approval

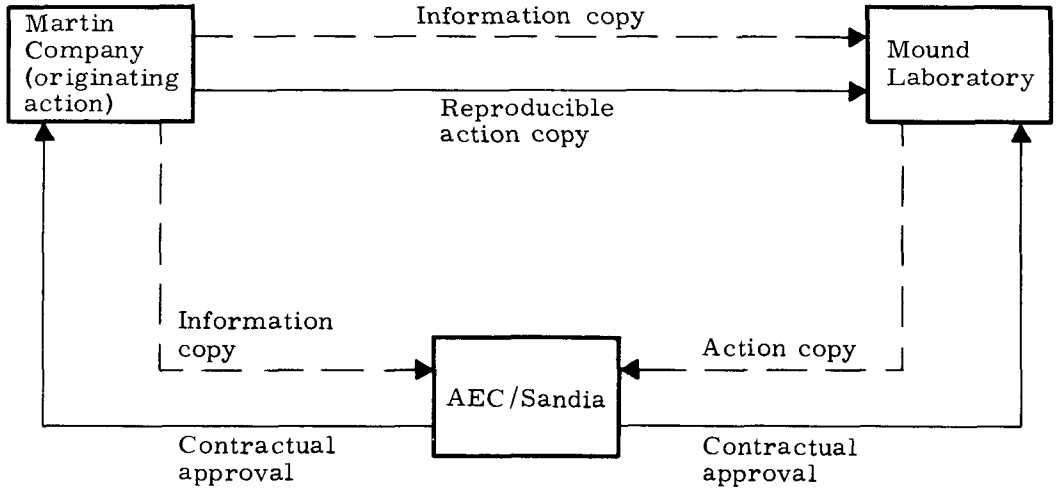

Fig. 8. Associate Contractor Flow Diagram for ISCNP Submittal and Approval

f. Reaction Time. All affected Contractors and Government agencies shall react to and reply to ISCNP's directed to that agency within the reaction times specified herein. Unless the originating Contractor specifies an increased time limit, the following time limits shall be adhered to:

(1) Emergency ISCNP. As soon as possible, but not more than 24 hours after receipt.

(2) Urgent ISCNP. 5 working days after receipt.

(3) Routine ISCNP. 15 working days after receipt.

g. Associate/Integrating Contractor Review. The Contractor receiving the ISCNP for review shall complete the items of the ISCNP as specified in Paragraph IV. D. 1. 2 h, i, j and m herein and indicate his approval or disapproval.

(1) When approved, the approval will be noted on the ISCNP as specified in Paragraph IV. D. 1. 2n herein. The approved ISCNP shall be forwarded to AEC, with an information copy to the originating Contractor.

(2) If the Contractor cannot approve the ISCNP, effort to resolve the areas of disagreement shall be made. If complete agreement cannot be achieved, the disapproval shall be noted in a letter or teletype to AEC with an information copy to the originating Contractor. The Contractor shall indicate the specific portion of the ISCNP that he disapproves together with sufficient reasons to enable AEC to render disposition of the ISCNP.

3. 5. 4. 2 Approved Changes

a. Authority. All approved changes to an ISCNP shall be as directed in writing by the AEC Contracting Officer. The approval or disapproval shall be directed in a concurrent and compatible manner to all affected Contractors and shall direct affected Contractors to work to the approved change and shall further direct the Custodian Contractor to prepare and distribute an ISCN. This authorization shall be by one of the following:

(1) Letter approval

(2) Teletype approvals carrying the word "signed" and the name and title of the Contracting Officer shall be construed to be written direction within the intent of this paragraph.

(3) Contract Change Notice (CCN) or other contractual documentation approving a CCP shall be construed as written direction within the intent of this paragraph for all ISCNP's related to the CCP when such ISCNP's are received prior to, concurrent with or as a physical part of the CCP submittal.

(4) Disapproval shall be by AEC letter.

b. ISCN Format. Changes approved in accordance with Paragraph 2.1 above shall be prepared by the Custodian Contractor on Interface Specification Change Notice (ISCN) forms (Fig. 9).

c. ISCN Identification. ISCN's shall be identified by specification number, and numerically, e.g., MN-2050-200 ISCN-3 etc.

d. ISCN Contents. The ISCN shall reflect the Contracting Officer's letter(s) of approval (authorization) or other authorizing medium, shall reference appropriate ISCNP(s), CCP(s) and shall include revised pages to be incorporated into the Specification.

(1) The revised pages shall be identified by an asterisk after the page number. The asterisk shall reference a note at the bottom of the page identifying the ISCN and Contracting Officer's authorization.

(2) The ISCN number shall be placed in the left margin of the sheet opposite each paragraph which has been changed. If the changed paragraph has been previously changed, only the latest ISCN number shall appear.

(3) A single ISCN may be used to release changes approved by more than one (1) ISCNP, providing the approved ISCNPs have the same effectivity.

e. Specification Revised Page Index. The Contractor shall prepare and maintain a Specification Revised Page Index (SRPI) for each Interface Specification for which the Contractor has been designated as custodian. The Specification Revised Page Index shall cumulatively list all authorized changes against the specification. The Custodian Contractor shall prepare and issue a revised and current SRPI as a part of every ISCN issued in accordance with this specification. The SRPI shall be prepared in general accordance with the format of Fig. 5 herein, with such modifications as may be needed in order to make the index compatible with its parent document. SRPI's shall be prepared by the Custodian Contractor as described above, without specific individual direction of the Procuring Activity and need not be submitted for approval.

f. ISCN Distribution. ISCN's shall be distributed by the Custodian Contractor to all recipients of the parent document as determined by the Custodian Contractor's distribution records.

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INTERFACE SPECIFICATION CHANGE NOTICE

NUMBER: _____
DATE: _____

SPECIFICATION NO:

TITLE:

DATED:

ISCNP:

CCP/ECP: Custodian Contractor:

Associate Contractor:

PURPOSE OF CHANGE:

EFFECTIVITY:

Custodian Contractor:

Associate Contractor:

INSTRUCTIONS:

AUTHORIZATION: Custodian Contractor:

Associate Contractor:

FILE THIS PAGE AFTER THE REVISED PAGE INDEX OF THIS SPECIFICATION TO INDICATE LATEST CHANGE.

CUSTODIAN CERTIFICATION: _____

Fig. 9. Interface Specification Change Notice Form

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3.5.5 Urgent and Emergency Submittals. The Contractor is authorized to submit SCN's and ISCNP's to AEC by teletype for urgent and compatibility submittals and by telephone with teletype followup for emergency submittals.

3.5.6 Specification Revisions. All proposed specification revisions, as opposed to changes, to approved contractual specifications shall be submitted to the AEC Procuring Activity Configuration Management Officer for negotiation, and to the AEC Procuring Activity Procurement Division for approval.

3.5.7 Usage of Reference Specifications. The extent of applicability of Specifications, Standards, Exhibits and other similar documents referenced in Contractor-prepared and Government-issued documents shall be one of the following categories, as applicable:

3.5.7.1. Total Applicability. The reference makes all terms and conditions of the document applicable.

3.5.7.2 Partial Applicability. The reference makes part of the document, such as a specific paragraph, applicable.

3.5.7.3 Applicability with Deviation. The reference makes the document totally or partially applicable and further states specific deviations.

3.5.7.4 Applicability as a Guide. The reference states applicability as a guide or design objective. It vests in the Contractor the responsibility for selecting and implementing the applicable requirements of those documents, the selection being based on the Contractor's sound management and engineering judgment.

4.0 QUALITY ASSURANCE PROVISIONS

Quality of documentation shall be as specified in MN-2050-2

5.0 PREPARATION FOR DELIVERY

Preparation for delivery shall be as specified in MN-2050-2.

6.0 NOTES

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STUDY FOR A 250-WATT CONTROLLED REENTRY ORBITING NUCLEAR SYSTEM "CRONUS"

Documentation Plan
MN-2050-2

Note: This document has been prepared under AEC Contract AT(29-2)-2050

Basic Approved By:

_____
Martin Marietta Corporation

Date: _____

MARTIN COMPANY
Baltimore, Maryland 21203

Manufacturer's Federal Supply Code 38597

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DOCUMENTATION PLAN FOR THE CRONUS PROGRAM

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DOCUMENTATION PLAN FOR THE CRONUS PROGRAM

1.0 SCOPE

1.1 Scope and Purpose

This plan establishes the types and quantities of documentation to be furnished and delivered to the Procuring Activity (The United States Atomic Energy Commission) by the Contractor. This plan covers the requirements for documentation applicable to the CRONUS program management, development, design, fabrication and testing. Nothing contained in this documentation plan shall affect the rights of the Commission to any reports, documents, or data required to be submitted under this contract. The Commission and the Contractor have endeavored to incorporate in this plan the current requirements for documents, reports and data the submittal of which is known to be required on a periodic basis or at some identifiable point in time in the course of the CRONUS program. It is understood, however, that failure to include herein any documents, reports, or data does not relieve the Contractor of any obligation to submit such documents, reports or data.

1.2 Plan Organization

This document is organized essentially in two major sections:

a. Contract Data Requirements List, i.e., data, manuals, plan, reports

b. Basic specification requirements, i.e., system specifications and end item specifications

NOTE: See Section 6 of MN-2050-100 for nomenclature and definition of terms used herein.

2.0 APPLICABLE DOCUMENTS

2.1 General

The following documents of the issue date shown form a part of this document to the extent specified herein. In case of any conflict between this specification and any referenced document, the requirements of this document shall govern.

2.1.1 Military Specifications.

MIL-D-1000	Drawings, Engineering and Associated Lists, dated 1 March 1965
MIL-M-5474C (USAF)	Technical Manuals: General Requirements for Preparation of, dated 30 April 1960 and Amendment 3 dated 15 April 1963
MIL-E-6051C Amendment 1	Electrical-Electronic System Compatibility and Interference Control Requirements for Aeronautical Weapon System, Associated Subsystem and Aircraft, dated 10 September 1964
MIL-M-38310	Mass Properties Control Requirements for Missiles and Space Vehicles, dated 15 December 1964
MIL-STD-785	Requirements for Reliability Program (For System and Equipments), dated 30 June 1965
MIL-STD-826	Electromagnetic Interference Test Requirements and Test Methods, dated 20 January 1964
NPC 250-1	Reliability Program Provisions for Space System Contractors, dated July 1963

2.1.2 Contractor Specifications.

MN-2050-1	Specification Plan for the CRONUS Program, dated September 30, 1966
MN-2050-3	Configuration Management and Control Plan for the CRONUS Program, September 30, 1966

2.1.3 AEC

M-3679	Standard Distribution for Classified Scientific and Technical Reports

2.1.4 DOD

Industrial Security Manual

3.0 REQUIREMENTS

3.1 General

This plan establishes the requirements for the preparation, maintenance, and submittal of documentation by the Contractor. The documentation specified herein shall be in accordance with the requirements for a development program.

3.2 Types of Documentation

The documentation required by this specification will be classified into three major categories as follows:

3.2.1 Type I Negotiated Documentation. Documentation required to be submitted for Contracting Officer approval, negotiated to the point of mutual agreement, and formally made a part of the contract. Once approved in writing by the Contracting Officer, these documents may be changed only by formal Contract Change Procedures. This documentation shall be considered as Contract Documentation.

3.2.2 Type II Non-Negotiated Documentation. Documentation required to be submitted for the unilateral approval of the Procuring Activity. Such documents may require administrative or technical approval but will not be formally incorporated into the contract.

3.2.3 Type III Documentation. Documentation required to be prepared and submitted to the Procuring Activity for information purposes only.

3.3 Documentation Approval

3.3.1 Type I Negotiated Documentation. The approval of Type I Documentation shall be contingent upon the mutual assent of the Procuring Activity and the Contractor. All Type I negotiated documentation shall require the written approval of the Contracting Officer.

3.3.2 Type II Non-Negotiated Documentation. All Type II non-negotiated documentation shall be subject to the unilateral approval of the Procuring Activity (administrative or technical) and shall require the written approval of the person in the Procuring Activity's organization who is responsible for the area of effort to which the document pertains, or the Contracting Officer.

3.3.3 Type III Documentation. Approval not required.

3.4 Documentation Changes

3.4.1 Type I Documentation. Changes affecting or requiring a change to Contract Type I Documents shall be classified as Class I changes in accordance with MND-2050-3, "Configuration Management and Control Plan, for the CRONUS Program." Class I changes shall be processed as follows:

3.4.1.1 In-scope changes. Any change to the approved Contract Type I Documents which is in-scope to the contract shall be submitted to the AEC for approval in the form of proposed Specification Change Notices (SCN's), without an accompanying Contract Change Proposal (CCP), and in accordance with MND-2050-1, "Specification Plan, for the CRONUS Program."

3.4.1.2 Out-of-scope changes. Any change to the approved Contract Type I Documents which is out-of-scope to the contract shall be submitted to the AEC for approval in the form of proposed SCN's with an accompanying CCP, and in accordance with MND-2050-3.

3.4.2 Type II Documentation. Changes affecting or requiring a change to Contract Type II Documents shall be proposed by the Contractor as necessary to maintain compatibility with program requirements and design constraints. Each change shall be processed through the Program Configuration Control Board (PCCB) in accordance with the Contractor's internal Configuration Management operating procedures. After review of the change by the PCCB, the affected Type II Document page(s) shall be changed and submitted by letter for Procuring Agency technical approval. At the Contractor's discretion, the affected Type II Document may be revised in its entirety by assigning a revision letter to it, revising the affected pages and including an index page in it which references the changed paragraphs and pages.

3.5 Contract Data Requirements List

Documentation to be furnished under the contract shall be as specified in the Contract Data Requirements List attached hereto. This data is arranged in the following categories.

C - Configuration Management Data

E - Engineering Analyses and Data

M - Manuals

P - Plans

R - Reports

S - Specifications

The Contract Data Requirements List contains the following information for each document:

Title

Classification (Security)

Number

Purpose and Content

Authority (or source of requirement)

Distribution (addressees and quantity)

Type

Frequency of Issue

As of Date (cut-off date)

Due Date

3.6 Format

3.6.1 Reports and Plans. Report and plan formats shall be consistent with the level of coverage required for the specific report or plan. In general, the format shall include introduction, summary, detailed discussions of the areas covered, and any appendices necessary to back up the discussions. Illustrations and tabular matter shall be used in supporting the discussions. Photographic coverage shall be used to the extent required by the subject matter.

3.6.2 Manuals. Manuals shall be prepared using the provisions of MIL-M-5474C as a guide. The manuals shall contain sufficient information to provide adequate coverage for operation and maintenance purposes. Sufficient text and illustrative material shall be provided to promote early familiarization with the equipment and identification of component parts.

3.6.3 Drawings. Engineering drawings shall be in accordance with the Contractor's normal drafting practices which are consistent with Specification MIL-D-1000, Form 3, Category A.

3.6.4 Document Numbering. All documentation will be numbered according to the overall numbering system established by Martin. The numbers provide identification of the document to the work breakdown structure (control points). Subsidiary numbers will be assigned to the

basic four digit work breakdown structure number to uniquely identify each document. Document identification numbers will be used for control of classified documents.

3.7 Publication

3.7.1 Reports and Plans. Reports and Plans shall be published either in an economical form such as ditto or copy-flo for relatively brief documents with small distribution (i.e., monthly reports) or offset printed for more comprehensive and wide spread final distribution (i.e., quarterlies to C-92a).

3.7.2 Manuals. Preliminary Operating and Maintenance manuals shall be reproduced by ditto, copy-flo or similar method. The final Operating and Maintenance manuals shall be reproduced in offset-printed form.

3.7.3 Drawings. Drawings required to be submitted to the Customer shall be legible copies of the Contractor's original or working copy.

3.8 Documentation Coordination with Other Government Agencies and Associate Contractors

The Contractor shall establish a direct working relationship with other Government Agencies and Associate Contractors for the purpose of coordination of documentation pertinent to their efforts on the CRONUS Program affecting interfaces of equipment and responsibilities. The coordination of documentation as defined above shall be made with the cognizance of the Procuring Activity. Informational copies of documentation to be coordinated shall be forwarded to the Procuring Activity simultaneously with its transmittal for coordination.

3.9 Distribution

Documentation shall be distributed according to categories, to the following offices and in the specified quantities.

TABLE 1

Documentation Distribution

Category	General Topic	Distribution	No. of Copies
A.	Technical and Contract Administration	To be determined	8
B.	Safety	To be determined	10

TABLE 1 (continued)

Category	General Topic	Distribution	No. of Copies
C.	Integration	To be determined	25
D.	Major Technical Milestones	C-92a of M-3672 Latest Edition	1 reproducible
E.	Drawings (Prototype & Operational)	To be determined	3
F.	Drawings (all Basic Release)	To be determined	2
G.	Film	To be determined	3
H.	Technical (Selective Issues)	Mound Laboratories	1

3.10 Evidence of Delivery

Documentation and changes thereto required by this plan shall be transmitted from the Contractor under cover letter signed by an individual(s) in the Contractor's organization who is (are) designated as responsible for documentation transmittal. Evidence of delivery of said documentation and changes thereto shall be its signed and dated cover letter.

3.11 Classification

The security classification of documentation prepared by the Contractor shall be determined by reference to the classification guide or specific instructions set forth in the contract and as directed by the Procuring Agency. All classified material shall be handled and safeguarded in accordance with the Industrial Security Manual.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 Quality of Documentation

All data submitted hereunder shall be legible. Every line, number, letter and character shall be totally and clearly visible.

5.0 PREPARATION FOR DELIVERY

5.1 Packaging

Documentation shall be packaged in accordance with standard commercial procedures with due consideration being given to the Security Classification of the contents.

6.0 NOTES

The identification and definition of the contractual documentation requirements for the CRONUS Program shall be as defined on the attached tables.

TABLE 2

Contract Data Requirements

Category Configuration Management Data (C)

Line Item No.	Title	Class.	Document Number	Purpose and Content	Authority	Type	Distribution	Freq.	As of Date	Due Date
C-1	Specification Plan	U	MN-2050-1	Identifies the complete contractual specification requirements and how they will be controlled.		I	A	One time		At end of phase "0"
C-2	Documentation Plan	U	MN-2050-2	Identifies the complete contractual documentation requirements and how they will be controlled.	MN-2050-1	I	A	One time		At end of phase "0"
C-3	Configuration Management and Control Plan	U	MN-2050-3	Describes uniform system of configuration identification, control and accounting.	MN-2050-1	I	A	One time		At end of phase "0"
C-4	Configuration Management Report	U	later	Monthly report of top systems and subsystems. Appendix to Monthly Progress Report. (R-1)	MN-2050-3	III	A	Mthly	Last c/d of month	15th of month
C-5	Contract Change Proposal	U or C	N/A	Defines proposed changes to the "Baseline" or contractual configuration.	MN-2050-3	I	A	As req'd	Time of submittal	N/A
C-6	CCP/Specification Change Status Tabulation	U	N/A	Identifies Status of all Contract Change Proposals (CCP) and status of changes to Type I and II documentation.	MN-2050-3	III	A	Mthly	Last c/d of month	15th of month
C-7	Data Status Tabulation	U	N/A	Identifies Status of deliverable documentation under the Contract	MN-2050-3	III	A	Mthly	Last c/d of month	15th of month

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TABLE 2 (continued)

Category: Engineering Analysis and Data (E)

Line Item No.	Title	Class.	Document Number	Purpose and Content	Authority	Type	Distribution	Freq.	As of Date	Due Date
E-1	Engineering Drawing	U or C		Basic release of drawings and changes. Format and content per Martin Drawing. Manual Class III (MIL-D-1000 para. 3.3.3, drawing form 3, category A).		III	F & H	One time	Issue dated	As required
E-2	Engineering Drawing	U or C		As required for Contractor fabrication of prototype units and operational units. Format and content per Martin Drawing Manual Class III (MIL-D-1000 para. 3.3.3, drawing form 3, category A).		III	E	One time	Issue dated	As required
E-3	Repair parts provisioning list	U		Recommended list of spares for selection and provisioning authorization.		III	A	One time	Issue dated	60 c/d after critical design review
				Category: Manuals (M)						
M-1	Preliminary Operating and Maintenance Manual	C		Procedures for end item operation and maintenance.		III	A	One time	N/A	1 month prior to launch of unfueled prototype
M-2	Final Operating and Maintenance Manual	C		Procedures for end item operation and maintenance.		II	A & C	One time	N/A	2 months prior to launch of first fueled gen. Phase 3

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TABLE 2 (continued)

Category: Plans (P)

Line Item No.	Title	Class.	Document Number	Purpose and Content	Authority	Type	Distribution	Freq.	As of Date	Due Date
P-1	Electrical/Electromagnetic Interference Control Plan	C		Defines program to assure that equipment will operate in an electromagnetic environment without malfunctions or unacceptable responses per MIL-E-6051C and MIL-STD-826.	MN-2050-10 and -20 Para. 3.4.1.1	II	A	One time	N/A	At end of Phase 1
P-2	CRONUS Reliability Program Plan	U		Defines reliability tasks to meet contract requirements.		I	A	One time	N/A	At end of Phase 1
P-3	CRONUS Quality Program Plan	U		Defines the planned quality actions and techniques.	Para. 4.1 MN-2050-100	I	A	One time	N/A	At end of Phase 0
P-4	Development Plan	S		Describes engineering approaches and activities necessary to develop the systems.		I	A & H	One time		At end of Phase 0
P-5	CRONUS Test Program Plan	U		Describes testing of complete systems, major subsystems, assemblies and components for development, qualification, reliability and acceptance purposes.		II	A & H	One time	N/A	At end of Phase 1
P-6	CRONUS Fabrication Plan	U		Flow charts showing fabrication of complete systems, major subsystems, assemblies and components.		III	A	One time	N/A	At end of Phase 1
P-7	PERT Time Summary Networks	C		This network shows all major milestones required for the CRONUS Program.		II	A & H	One time		At end of Phase 0

TABLE 2 (continued)

Category: Plans (P) (continued)

Line Item No.	Title	Class.	Document Number	Purpose and Content	Authority	Type	Distribution	Freq.	As of Date	Due Date
P-8	PERT Time Detailed Networks	U		This network supports the major milestone summary network and identifies detail requirements, i.e., design, procurement, fabrication and test.		III	A	One time	End of Phase 1	At end of Phase 1
P-9	PERT Time Reports	U		Computerized report.		III	A	Mthly	Last c/d of month	15th of month
P-10	CRONUS Program Operational Training Plan	U		This Plan identifies the necessary operational instruction for training of using agency personnel.		II	C	One time	N/A	Prior to prototype delivery
P-11	CRONUS Operations Plan	C		Establishes the operational sequencing for integrating accepted hardware into the specific overall mission.		II	A	One time	N/A	90 c/d after firm mission definition
P-12	Maintenance Plan	U		Defines approaches to maintenance at launch site, integrating contractors facility and system contractors facility.		II	A	One time	N/A	90 c/d after firm mission definition
				Category: Reports (R)						
R-1	Monthly Progress Report	C or S		Includes PERT analysis and cost/schedule integration data as well as technical progress and status information.		III	A & H	Mthly	Last c/d of month	15th c/d of next month

TABLE 2 (continued)

Category: Reports (R) (continued)

Line Item No.	Title	Class.	Document Number	Purpose and Content	Authority	Type	Distribution	Freq.	As of Date	Due Date
R-2	Quarterly Progress Report	C or S		Includes monthly information plus revised estimates to complete, and Problem Analysis Report.		III	A & D	Quarterly	Last c/d of quarter	45 c/d after ea. report period
R-3	Final Program Phase Report	S		Final report of results of program activity during each phase.		III	A & D	One time per phase	Phase completion	At end of each phase
R-4	Weight and Balance Report	U		Mass property status report per MIL-M-38310 Table 1, Column 3.	MN-2050-100 Para 3.2.9.5	III	A & C	Semi-annually	Last c/d of report period	30 c/d after each (first report at end of Phase 1) report period
R-5	Safety Analysis Report Preliminary	C		Estimates the response of the nuclear system to normal and abnormal environments and the consequences. Identifies areas of analytical or test data deficiency.		III	B	One time	Completion of conceptual design	At end of Phase 1
R-6	Safety Analysis Report, Interim	C		Presents improved estimates of radiological consequences from accidents of higher probability and severity. Describes analytical models to evaluate response and interactions.		III	B	One time		At least 4 mo prior to del. of opp. system

TABLE 2 (continued)

Category: Reports (R) (continued)

Line Item No.	Title	Class.	Document Number	Purpose and Content	Authority	Type	Distribution	Freq.	As of Date	Due Date
R-7	Safety Analysis Report, Final	C		Provides basis for mission approval. Presents complete justification for mission safety, including calculated probability and consequences of radiological interactions. Compares results with safety criteria.		II	B	One time		At least 6 mo prior to flight
R-8	RTG/RB System Qualification Test Report	C		Report of test on complete RTG/RB. Contains copies of the certified test data, summary of results, description of failures and retests.		II	A	One time	Test completion	45 c/d after test completion
R-9	CIR Systems Qualification Test Report	C		Report of test on complete CIR. Contains copies of the certified test data, summary of results, description of failures and retests.		II	A	One time	Test completion	45 c/d after test completion
R-10	AGE Qualification Test Report	U		Report of test on complete AGE. Contains copies of the certified test data, summary of results, description of failures and retests.		II	A	One time	Test completion	45 c/d after test completion
R-11	AGE Demonstration Test Report (GHE)	C		Report of test on complete GHE. Contains copies of the certified test data, summary of results, description of failures and retests.		III	A	One time	Test completion	45 c/d after test completion
R-12	Flight Test Report	C		Results at conclusion of flight test of first flight RTG/RB-CIR.		III	A & D	One time	Test completion	45 c/d after test completion

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TABLE 2 (continued)

Category: Reports (R) (continued)

Line Item No.	Title	Class.	Document Number	Purpose and Content	Authority	Type	Distribution	Freq.	As of Date	Due Date
R-13	RTG/RB-CIR Systems Acceptance Test Report	C		RTG/RB-CIR Systems quality acceptance documentation.		III	A	One per delivered flight RTG/RB-CIR	Acceptance	45 c/d after acceptance
R-14	AGE Acceptance Test Report	U		AGE quality acceptance documentation.		III	A	One time per delivered end item	Acceptance	45 c/d after acceptance
R-15	Reliability - Initial Apportionment Report	C		CRONUS subsystems reliability apportionments to meet overall reliability goals or requirements.		III	A	One time	N/A	At end of Phase 1
R-16	Film Photographic Reports	C	N/A	Documentary film report covering program highlights.		III	G	Two reports	N/A	
				Category: Specifications (S)						
S-1	Specification for CRONUS RTG/RB-CIR Systems	C	MN-2050-100	Describes the RTG/RB-CIR Systems performance requirements as installed in the vehicle.	MN-2050-1	I	A	One time	Submittal	At end of Phase 0
S-2	Technical Interface Specification for the CRONUS RTG/RB-CIR Systems	C	MN-2050-10	Describes the functional and physical interface criteria between the operational RTG/RB-CIR Systems and the flight vehicle and ground equipment.	MN-2050-1	I	A	One time	Submittal	At end of Phase 0

TABLE 2 (continued)

Category: Specifications (S) (continued)

Line Item No.	Title	Class.	Document Number	Purpose and Content	Authority	Type	Distribution	Freq.	As of Date	Due Date
S-3	Specification for CRONUS AGE	C	MN-2050-200	Describes the AGE performance requirements.	MN-2050-1	I	A	One time	Submittal	At end of Phase 0
S-4	Technical Interface Specification for CRONUS AGE	C	MN-2050-20	Describes the functional and physical interfaces between the AGE and the RTG/CIR and launch facilities.	MN-2050-1	I	A & H	One time	Submittal	At end of Phase 0
S-5	RTG/RB-CIR Systems CEI Specifications Part I	C		Describes the performance, design and verification requirements of the deliverable RTG/RB-CIR Systems CEI.	MN-2050-1	I	A	One time	Submittal	At end of Phase 1
S-6	AGE CEI Specification, Part I	U		Describes the performance, design and verification requirements of the deliverable AGE CEI's.	MN-2050-1	I	A	One time	Submittal	At end of Phase 1
S-7	GFE Requirements List	U		Identifies all GFE to be supplied to the contractor.	MN-2050-1	I	A	One time	Submittal	At end of Phase 1

STUDY FOR A 250-WATT CONTROLLED RE-ENTRY ORBITING NUCLEAR SYSTEM "CRONUS"

Configuration Management and Control Plan
MN-2050-3

Note: This document has been prepared under AEC Contract AT(29-2)-2050

Basic Approved By:

_____
Martin Marietta Corporation

Date: _____

MARTIN COMPANY
Baltimore, Maryland 21203

Manufacturer's Federal Supply Code 38597

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CONFIGURATION MANAGEMENT AND CONTROL PLAN FOR THE CRONUS PROGRAM

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CONFIGURATION MANAGEMENT AND CONTROL PLAN FOR THE CRONUS SYSTEM

1.0 SCOPE

This plan establishes the configuration management requirements to be used on the CRONUS Program. The disciplines of configuration management, defined herein, provide the methods by which the system requirements are controlled and validated in the end item. The CRONUS Program shall implement the formal procedural concepts to ensure a uniform system of configuration identification, control, accounting, verification, review and inspection, and reporting for all equipment and components.

2.0 APPLICABLE DOCUMENTS

None.

NOTE: See Section 6 of MN-2050-100 for nomenclature and definition of terms used herein.

3.0 REQUIREMENTS

3.1 General

Configuration management is essentially change management. It will be implemented on the CRONUS program with a uniform system of configuration identification, control, accounting, verification, review and inspection, and reporting. The functional elements of the Contractor's configuration management are:

(a) Configuration identification (baselines)

(b) Configuration control (change control)

(c) Configuration accounting (change status)

(d) Configuration verification (change incorporation)

(e) Configuration review and inspection

(f) Configuration reporting.

The control of these areas shall provide for the development and negotiation of technical contractual specifications; the preparation, integration and submittal of required documentation; the control of hardware and documentation changes from evaluation, authorization through implementation; and the accounting of all approved changes and resulting reactions to related documentation and end items.

3.1.1 Configuration Management Requirements. The CRONUS Configuration Management System shall provide the AEC and the Contractor with the following:

(a) A method for accurately identifying the configuration of both hardware and software during the life of the CRONUS Program

(b) A system of disciplines to provide Management with sufficient information to make appropriate, timely decisions regarding specification and hardware changes

(c) A system to assure proper evaluation of changes regarding interfaces, specifications, system requirements, and their effect on cost and schedule

(d) A method for prompt identification and traceability for all change activity

(e) A computerized accountability system whereby the authorized configuration and actual configuration of each end item may be compared

(f) A system for requesting AEC approval for all changes requiring their approval

(g) A computer report to identify the configuration of all deliverable end items.

3.1.2 Configuration and Data Management Responsibilities. Configuration and Data Management provides configuration and data requirements to all other departments. C & DM is responsible for the preparation, negotiation and maintenance of contract specifications, preparation of Contract Change Proposals (CCP's), establishment of a configuration control numbering and accounting system, verification of compliance with Contract Technical Requirements and guidance as regards performance of design reviews. C & CM also provides management and guidance on matters pertaining to contractually required data and the negotiation and monitoring of data submittal and approval. The C & DM function assures compatibility among contract technical requirements, released drawings and related data, and hardware.

3.1.3 Configuration Management Approach. The configuration controls are tailored to the program needs and requirements and are briefly summarized below.

3.1.3.1 During the initial portion of the Program, the Configuration Management activity shall be limited to identification of development drawings, development changes, specifications, procedures, processes and the review and control of changes to the Program Requirements Baseline (Ref. Paragraph 3.2.1) by the Program Configuration Control Board. The drawings and changes will be recorded to provide an identification of all equipment, systems and subsystems developed. This effort will culminate with the approval of Part I of the Contract End Item Specifications.

3.1.3.2 Following the establishment of the Design Requirements Baseline, Configuration Management functions shall provide the Program with identification, control and accounting.

a. Strict disciplines shall be imposed on the release of engineering to assure that only drawings and drawing changes authorized through the release system are incorporated into the hardware.

b. Proposed changes will be reviewed by the Program Configuration Control Board for approval, scheduling for incorporation, effect on specifications, and interface.

c. A computer record of the configuration shall be maintained and verified.

3.1.3.3 Following the establishment of the Product Configuration Baseline, the configuration functions will continue the identification, control and accounting functions. These functions shall be expanded to include retrofit of all delivered end items of equipment, when required by the contract.

a. Disciplines shall be maintained on the release of engineering consistent with requirements.

b. Program Configuration Control Board shall review all proposed changes for approval, scheduling for incorporation, effect on specifications, and interface.

c. A computer report of the configuration shall be maintained and verified.

d. The baseline configuration identifications shall be prepared for each Contract End Item.

3.2 Configuration Identification (baselines)

Three baselines shall be established for the CRONUS Program (see Figs. 1 and 2):

(a) Program requirements baseline

(b) Design requirements baseline

(c) Product configuration baseline

3.2.1 Program Requirements Baseline. The program requirements baseline shall be established and defined by the approved Systems Specifications. This baseline defines the program mission, identifies deliverable end items, tests and test specimens that comprise the program, and the quality provisions by which it can be determined that the requirements have been met. Any change to this baseline will require the Procuring Agency's approval.

3.2.2 Design Requirements Baseline. The design requirements baseline shall be established and defined by the approved Part I of the Contract End Item Detail Specification.

This baseline consists of the technical requirements which govern the performance and design of the end item and the quality provisions by which it can be determined that such requirements have been met.

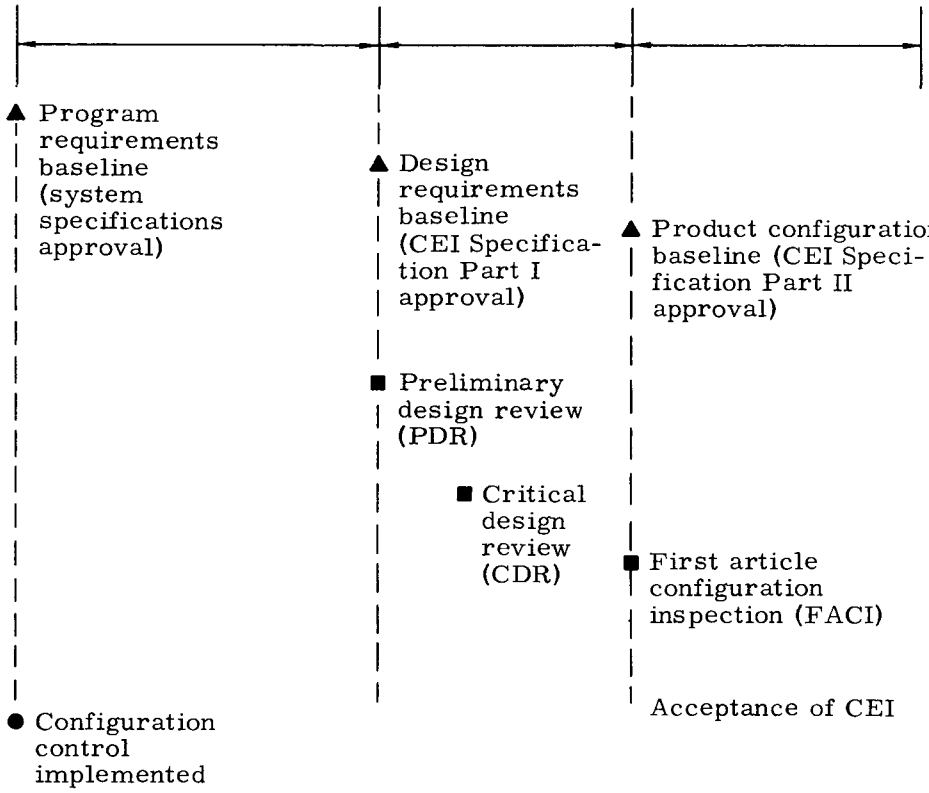


Fig. 1. CRONUS Configuration Management Baselines, Reviews and Inspections

PRELIMINARY DESIGN REVIEW (PDR)

FORMAL TECHNICAL REVIEW OF BASIC DESIGN APPROACH FOR CEIs

CRITICAL DESIGN REVIEW (CDR)

FORMAL TECHNICAL REVIEW OF PRODUCTION DESIGN PRIOR TO COMMITTING HARDWARE DESIGN TO BUILD FOR PROTOTYPE CEIs

FIRST ARTICLE CONFIGURATION INSPECTION (FACI)

REVIEW & ACCEPTANCE OF CONTRACT END ITEM (FIRST ARTICLE)

DOCUMENTATION

- BASELINE CONFIGURATION IDENTIFICATION
- COMPLETE SET OF DRAWINGS
- SPECIFICATION COMPLIANCE INSPECTION LOGS
- CONTRACTUAL DOCUMENTATION STATUS (CCP, SCN, CO, SA)
- TEST DATA LOGS
- QUALIFICATION TEST DATA LOGS
- QUALIFICATION CERTIFICATION LOGS

PRODUCTION CONFIGURATION BASELINE ACCEPTANCE

- DD FORM 250 OR EQUIVALENT

Fig. 2. Configuration Reviews and Inspections

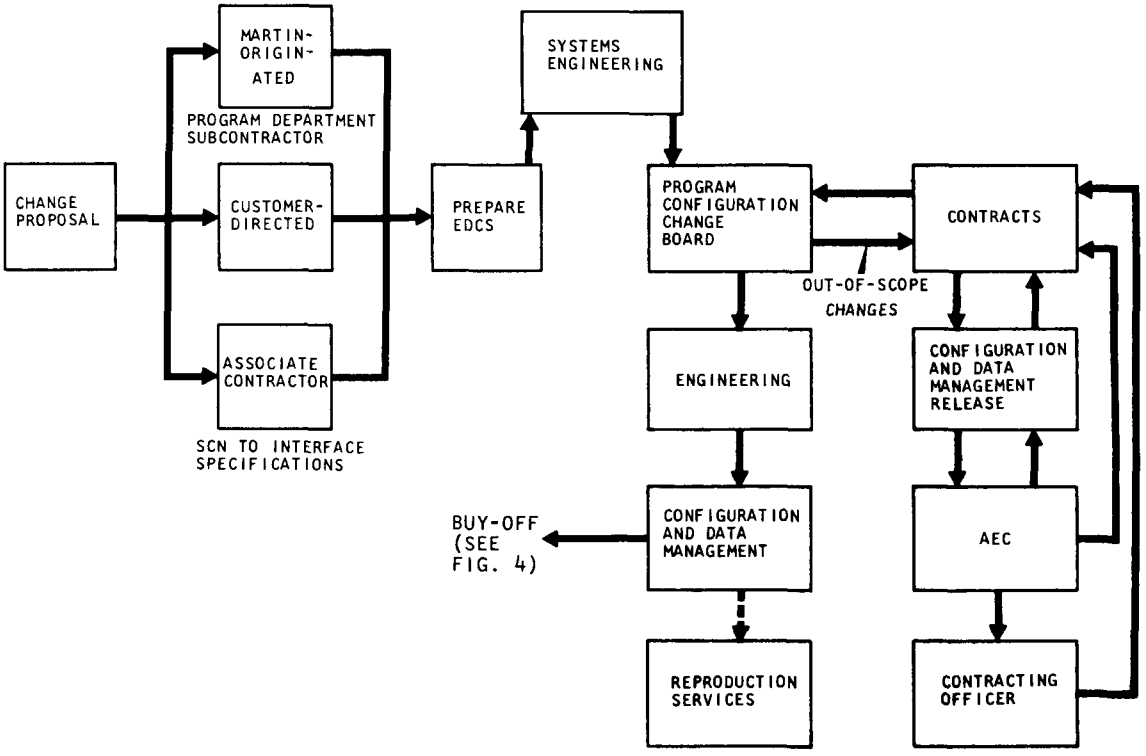


Fig. 3. CRONUS Change Control Flow

3.2.3 Product Configuration Baseline. The product configuration baseline shall be established at the initial delivery of a Contract End Item. The following actions shall be taken to establish the product configuration baseline:

(a) A First Article Configuration Inspection (FACI) will be held for each Contract End Item. The first article configuration inspection shall be convened at the Contractor's facility and shall be co-chaired by the Contractor (C & DM) and the AEC.

(b) Part II, Product Configuration and Acceptance Test Requirements of the CEI Specification will be formally approved by the Customer to technically define the configuration baseline for the end item.

(c) Test reports, quality control logs, configuration verification reports, Change Order/Contract Change Proposal/Specification Change Notice status and the end item shall be submitted and reviewed by the Customer for conformance with Part II of the Contract Specification. The signing of the Baseline Configuration Identification (BCI) by the Customer and approval of Part II of the CEI Detail Specification shall constitute completion of the FACI.

(d) The proposed DD Form 250 will be reviewed to ensure that it adequately defines the item being shipped; all shortages and unincorporated or recapped changes and/or differences between the configuration specified in Part II of the CEI Detail Specification and the end item.

Upon completion of FACI, formal acceptance of the Contract End Item shall be acknowledged by the Customer signing of the DD Form 250 or equivalent.

3.3 Configuration Control

Configuration control is essentially the management and control of changes to both hardware and software. Configuration control starts with the Program Requirement Baseline and continues for the life of the program. Once the initial set of requirements for a baseline are documented, any change in requirements must be documented so that the change can be fully evaluated in terms of the approved system and equipment, mission requirements, cost, schedule and effect upon other contract end items. The extent of change control increases and becomes more sophisticated as the design requirement baseline is reached (see Figs. 3 and 4).

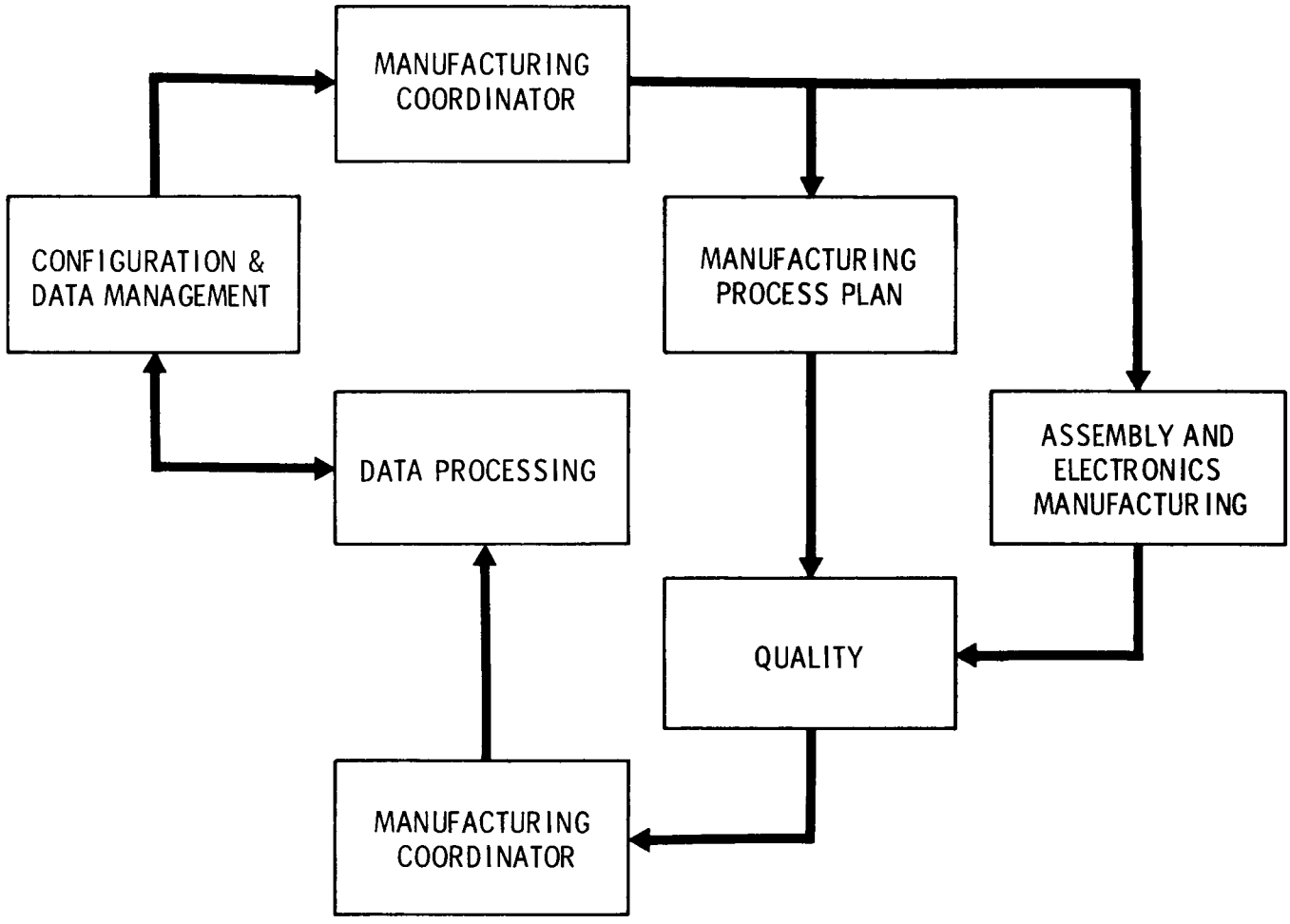


Fig. 4. Configuration Management Buy-Off

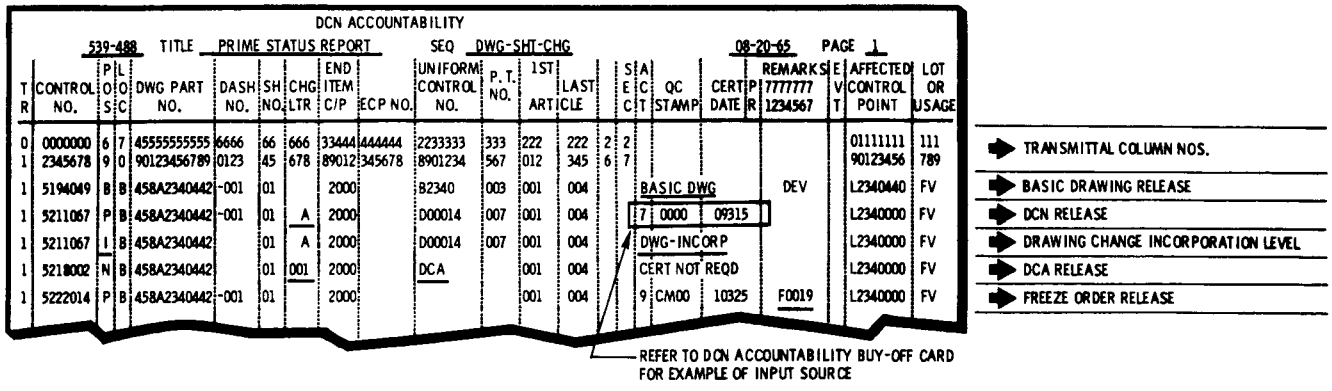


Fig. 5. DCN Accountability Report

3.3.1 Engineering Design Change Schedule (EDCS).

a. Configuration control is implemented and enforced by the use of a numbered Engineering Design Change Schedule system (EDCS) and a Configuration Control Board (CCB).

b. Proposed changes are presented on an EDCS form and are assigned a Uniform Control Number which continues to be related to all aspects of that change throughout the life of the program. The EDCS describes the proposed change, indicates its desirability and impact upon the program, and is used to establish proposed schedules for the implementation of the change.

c. A requirement for a Class I or II change (Ref. 3.3.2) may originate with any Contractor department, associated Contractor or the Procuring Agency. Regardless of the source of the change, EDCS's are prepared by Engineering and reviewed by an Engineering Review Board to identify all the affected equipment and design interfaces prior to being forwarded to the CCB.

3.3.2 Change Classification. All changes to program baselines including specifications, Contract End Items, test procedures, processes, data requiring AEC approval and other program specified data will be formally processed in accordance with the following:

(a) All proposed changes shall be classified thus: all changes affecting or requiring a change to Contract Specifications, contract price and/or contract schedule shall be classified as Class I; all other changes shall be classified as Class II regardless of delivery status of the CEI.

(b) Class II change proposals will not be submitted to AEC and do not require AEC approval.

(c) Any change to the approved Contract Specifications which is in-scope to the contract shall be submitted to the AEC for approval in the form of proposed Specification Change Notices (SCN's) or equivalent, without an accompanying Contract Change Proposal (CCP) and in accordance with the Specification Plan.

(d) The Contractor shall prepare and submit CCP's to the AEC in accordance with the requirements defined in Paragraph 3.3.4 for all Class I changes which are out-of-scope to the contract.

3.3.3 Configuration Control Board. Proposed chages are submitted to the Configuration Control Board (CCB), which establishes the advisability of each EDCS considering the impact on cost, schedule and performance, classifies the change, assures that all intrasystem and intersystem interfaces have been identified, prepares a schedule for the

preparation and submittal of proposed Specification Change Notices (SCN's) and/or Contract Change Proposals (CCP's), if required, prepares and issues schedules consistent with PERT events for the incorporation of the change.

Configuration control action is implemented throughout the program by having members on the CCB from each affected department, such as Contracts, Finance, Planning, Engineering, Reliability, Quality, Manufacturing and Procurement. The Board members determine the impact upon their departmental organizations and present their evaluations; the CCB Chairman weighs these inputs and makes the final decisions. Each member is capable of committing his department to perform in accordance with the CCB action. Changes approved by the CCB are implemented or directed to be submitted to the Customer for approval.

3.3.4 Contract Change Proposals (CCP's). The Contractor shall prepare and submit to the AEC CCP's for all Class I changes which are out-of-scope to the contract.

a. When a CCP affects system requirements and design requirements, only one CCP shall be prepared and shall include proposed Specification Change Notices (SCN's) or equivalent for all affected contractual Contract Type I Documents.

b. When CCP's are submitted, they shall include the proposed Specification Change Notices (SCN's) or equivalent of the affected CEI specification or system specification and other Class I Type Documentation.

c. CCP types and their uses shall be as follows:

(1) Preliminary CCP - A preliminary CCP may be used for the purposes:

(a) To furnish the Procuring Agency with available initial information relative to a change under consideration by the Contractor, in order to permit a preliminary evaluation of the change (this evaluation will be relative to determining the merits of a proposed change and the desirability of continuing the expenditure of resources required to further explore and develop the proposal).

(b) To permit a preliminary choice of one of various alternative proposals

(c) To facilitate early contractual coverage for changes that require study before a formal contract change proposal can be submitted.

(2) Formal CCP - A formal CCP shall be used when the engineering information and other data are established in sufficient detail to support formal change approval and contractual authorization and may follow the submission of preliminary CCP's.

(3) Expedited CCP - An expedited CCP is used in cases requiring a priority of "emergency" or "urgent." The term "expedited" also applies to CCP's initiated by teletype or telephone message.

d. CCP priorities and their usage shall be as follows:

(1) Emergency - This priority is used on unsafe conditions, the uncorrected existence of which could result in fatal or serious injury to personnel or extensive damage or destruction of equipment.

(2) Urgent - This priority is used on potentially hazardous conditions, the uncorrected existence of which could result in the probable serious injury to personnel or damage to equipment and reduce the mission effectiveness of the equipment. This classification may also be used for those changes necessary to meet contractual requirements when lead time would necessitate slipping approved production or delivery schedules. Changes associated with interface problems, resulting from compatibility changes made by other Contractors, shall be classified as urgent.

(3) Routine - All other CCP's.

e. Expedited CCP's shall be processed as follows: Cases requiring expedited action (emergency or urgent priority) shall be reported by the most expedient means (teletype, telephone, personal contact, etc.) to the Procuring Agency. For an expedited CCP, a CCP number shall be assigned to identify the initial message, such number being suffixed by the letter E. If the initial communication regarding an expedited change was other than by written message, it shall be confirmed by written message within 24 hours. In such cases, a formal CCP shall be prepared and submitted to the Procuring Agency within 30 days after the initial communication regarding the necessary expedited action. This formal CCP shall indicate the original communications, individuals contacted, method of communication and whether contractual direction was received and source thereof.

f. CCP Reaction Time - The classification of the CCP denotes degree of urgency regarding criticality to the systems and/or equipment. However, each CCP could impact program schedule. The following total maximum reaction time shall be allotted to AEC from receipt of the CCP until disposition is given to the Contractor.

Classification	Reaction Time
Emergency	Immediately, but not later than 24 hours
Urgent	5 working days
Routine	15 working days

3.3.4.1 Contract Change Proposals Approvals. The AEC shall be considered the authorizing Agency for CCP's. Authorization for CCP's shall be in accordance with the terms and conditions of the Changes Clause of the Contract.

3.4 Configuration Accounting and Verification

The Contractor shall establish and maintain a configuration record documenting all engineering drawings and approved Class I and II changes for each Contract End Item. The accounting system shall provide for two basic types of reports: Change Status Reports and Change Verification Reports. The CRONUS Accounting Report System shall be programmed computer reports.

3.4.1 Change Status Reports will provide for each Contract End Item a Complete record of all changes released and authorized for incorporation. The Report shall identify the scheduled incorporation of the change by reference to a PERT event.

3.4.2 Change Verification Reports (DCN Accountability Report, Figs. 5 and 6) shall be used periodically to provide verification of the configuration of the end item at significant points in time such as assembly or subsystem, test, delivery, etc. The purpose of this report will be to show the quality certification of change incorporation.

The status and verification accounting system shall be maintained on a daily basis to provide the program and the Customer with the immediate availability of accurate configuration data for each end item either in production or test.

3.5 Configuration Reviews and Inspection

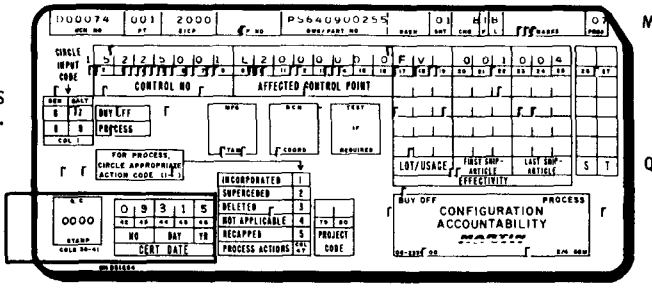
Major reviews shall be conducted of the CRONUS Program at discrete points during the evolution of the system to review development status.

These reviews shall be identified as follows:

HARDWARE BUY-OFF:

APPLICABLE FOR EQUIPMENT ITEMS MANUFACTURED LESS PROCESS PLANS (AGE), CHANGES WORKED OUT-OF-POSITION, ETC.

REFER TO CHART "DCN ACCOUNTABILITY REPORT" FOR EXAMPLE OF PRINT-OUT



MANUFACTURING

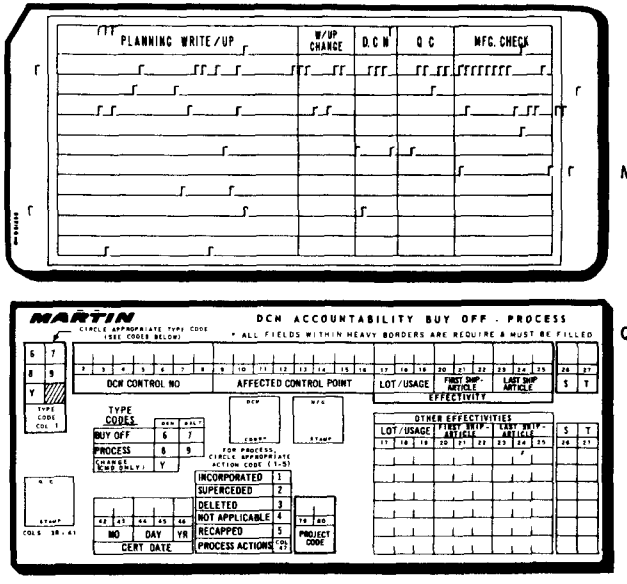
- CHECK CARD DATA
- INSERT EFFECTIVITY
- CIRCLE INPUT CODE "7"
- STAMP
- PRESENT TO QUALITY

QUALITY (INSPECTION)

- INSPECT ENGINEERING/HARDWARE
- COMPATIBILITY
- STAMP & DATE BUY-OFF CARD
- FORWARD BUY-OFF CARD TO C&DM

PROCESS ACTION BUY-OFF:

APPLICABLE FOR EQUIPMENT ITEMS MANUFACTURED PER PROCESS PLAN, I.E., FOR CHANGES WORKED IN-LINE



MANUFACTURING

- INCORPORATE DCN IN PROCESS PLAN(s)
- DENOTE PLAN(s) AFFECTED ON REVERSE SIDE OF BUY-OFF CARD
- CIRCLE INPUT CODE "9" & PROCESS ACTION CODE "1"
- STAMP & PRESENT TO QUALITY

QUALITY (PLANNING)

- INSPECT DCN/PROCESS PLAN COMPATIBILITY
- STAMP & DATE BUY-OFF CARD
- FORWARD BUY-OFF CARD TO C&DM

Fig. 6. DCN Accountability Buy-Off Card

a. Preliminary design review (PDR)

b. Critical design review (CDR)

c. First Article Configuration Inspection (FACI)

3.5.1 Preliminary Design Review. This is a formal technical review of the basic design approach for the Contract End Item. The primary product of the PDR is formal identification of specific engineering documentation which establishes the existence of physical interfaces and functional interface relationship of the CEI to other system equipment and approval of Part I of the Detail Specification for the CEI. The following shall be accomplished as part of the PDR:

(a) The compatibility of the selected design approach with Part I of the Detail Specification for the CEI shall be established.

(b) The compatibility of the CEI with other system interface and other CEI specifications shall be established.

(c) The integrity of the selected design approach shall be established. This shall be accomplished by review of analytical and test data.

3.5.2 Critical Design Review (CDR). The CDR is a formal technical review of the design of a Contract End Item. The CDR shall normally be accomplished immediately prior to committing the design to production of the article which will establish the Product Configuration Baseline. However, design drawings may be released for fabrication prior to this review when required to meet schedule requirements. The following shall be accomplished as part of each CDR.

(a) The compatibility of the CEI, as designed, with Part I of the Detail Specification for the CEI shall be established.

(b) The system compatibility of the completed design shall be established. This shall be accomplished by comparison of the interface control drawings with the engineering drawings for the CEI.

(c) The integrity of the design shall be established by review of analytical and test data.

3.5.3 First Article Configuration Inspection (FACI). FACI shall be conducted in accordance with Paragraph 3.2.3.

4.0 QUALITY ASSURANCE PROVISIONS

Not applicable.

5.0 PREPARATION FOR DELIVERY

Not applicable

6.0 NOTES

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PRELIMINARY

STUDY FOR A 250 WATT CONTROLLED REENTRY ORBITING NUCLEAR SYSTEM "CRONUS"

TECHNICAL INTERFACE SPECIFICATION FOR THE CRONUS RTG/RB-CIR SYSTEMS

MN-2050-10

Basic Approved by:

_____

Martin Marietta Corporation

Date: _____

Note: This specification has been prepared under AEC Contract AT(29-2)-2050

MARTIN MARIETTA CORPORATION
MARTIN COMPANY - NUCLEAR
Baltimore, Maryland 21203

Manufacturer's Federal Supply Code 38597

PRELIMINARY

FOREWORD

This specification and other Contractor prepared subsidiary specifications referred to herein have been established to define requirements, characteristics, and interface criteria for a radioisotope fueled thermoelectric generator (RTG) system and a controlled intact reentry system (CIR) which along with the associated aerospace ground equipment (AGE) form an overall system designated as "CRONUS." The content of this specification reflects the results and efforts of the Contractor under Phase "Zero" of the CRONUS Program (Contract AT(29-2)-2050); however, the specification is not restricted to any particular phase of design, development and production.

In the preparation of this document, emphasis has been placed on definition of areas applicable to the initial portion of a complete program to provide flight systems. It is expected that this document will be made more definitive and up-dated and completed through modifications as integration of Government Agency and Contractor effort is accomplished and as more firm design information and test results become available. In final form and representing the results of mutual agreement, it is expected that this specification will be referenced in contractual agreements between the Contractor and the AEC.

The relation of this specification to other Contractor prepared specifications and the contract is shown in Figure 1 of the Specification Plan MN-2050-1.

TECHNICAL INTERFACE SPECIFICATION FOR THE CRONUS RTG/RB-CIR SYSTEMS

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TECHNICAL INTERFACE SPECIFICATION FOR THE CRONUS RTG/RB-CIR SYSTEMS

1.0 SCOPE.- This technical interface control specification, along with interface control drawings referred to herein, defines requirements and criteria governing and establishing interfaces between the CRONUS (Controlled Reentry Orbiting Nuclear System) RTG/RB-CIR Systems and the space/launch vehicle comprising an earth orbital satellite program.

1.1 Mission.- The CRONUS RTB/RB-CIR Systems are intended as a primary source of electric power for unmanned space vehicle application on low earth orbital missions. The reentry features are intended to provide the capability of reentering the generator with its nuclear fuel intact within the fuel containment structure and effect impact in deep ocean areas.

1.2 Interface Identification.- This interface control specification identifies interface criteria and requirements between the following.

a. RTG/RB-CIR Systems with Space Vehicle
b. RTG/RB-CIR Systems with Launch Vehicle
c. RTG/RB-CIR Systems with Launch Site Facilities
d. RTG/RB-CIR Systems with CRONUS AGE
e. RTG/RB-CIR Systems with Ground Tracking Telemetry and Control Stations

1.3 Responsibilities.- To effect integration of the CRONUS RTG/RB-CIR Systems into the satellite mission, areas of responsibility and the effort to be performed to accomplish such responsibility and/or permit others to carry-out their responsibilities shall conform to the following.

1.3.1 AEC.- The AEC shall be responsible to the User for the performance of the Contractor in accordance with the provisions of the contract between the Contractor and the AEC.

NOTE: See Section 6 of MN-2050-100 for Nomenclature and Definition of Terms used herein

In addition, with respect to design, fabrication, and use of the System, the AEC shall:

1.3.1.1 Furnish direction and assistance to the Contractor in the conduct of liaison and coordination activity with the User.

1.3.1.2 Accomplish and arrange for necessary approvals and efforts by other Government agencies which are necessary to authorize and accomplish integration of the CRONUS RTG/RB-CIR into the satellite mission and program. Obtain all required licenses and permits for nuclear material possession and use at the launch site.

1.3.1.3 Furnish, in conjunction with Contractor furnished articles and services, the equipment and services necessary to accomplish radiation monitoring and control of nuclear safety during all prelaunch, launch and post launch operations at the launch site. This shall include fuel accountability, radiation surveys and monitoring and the conduct of health physics programs.

The AEC shall be responsible for establishing the necessary radiation control area(s) during Radioisotope Thermoelectric Generator (RTG) fueling and/or defuleing operations (any any other operations involving handling of the Nuclear Heat Source.

1.3.1.4 Furnish, in conjunction with a Fueling Agency, the nuclear fuel material, fuel processing and encapsulation equipment (but using heat source components furnished by the Contractor) and services necessary to accomplish loading of the Nuclear Heat source as follows and in accordance with the requirements of MN-2050-11, MN-2050-12 and the applicable heat source CEI specifications.

a. Encapsulation of nuclear fuel material and fabrication of heat source assemblies in accordance with Contractor prepared and coordinated documents. Encapsulation shall include performance of a quality control program, development and qualification of manufacturing processes required in fuel encapsulation, determination of the thermal output and surface temperature(s) of completed fuel capsules and/or heat source and radiation surveys external to loaded transportation casks to assure conformance with applicable shipping regulations.

b. Performance of special tests (where such tests require the use of nuclear materials) required to develop and/or assure necessary fuel form properties and characteristics and compatibility of the fuel form with materials of containment.

c. Furnishing and encapsulation of simulated inert-isotope material in Contractor furnished test specimens where authorized by the AEC. Shipment of such specimens between the Fueling Agency and the Contractor shall be the responsibility of the Contractor.

d. Preparation and delivery of the data listed below (for each heat source) to the Contractor.

(1) Certified results of calorimetric tests on each capsule contained in the heat source versus capsule serial number.

(2) Location of each capsule in the heat source (by serial number).

(3) Certified results of a radiation survey of the heat source and/or individual fuel capsules.

(4) Certification of the fuel purity and composition for each batch of fuel used in the heat source.

(5) Certification of contamination level (measured by wipe test prior to shipment) of heat source surfaces and transportation cask interior.

1.3.2 User.- The User shall make available to the Contractor requirements, constraints, design data, specifications, test results, mission objectives and parameters affecting the design and programming of the RTG/RB/CIR Systems and related aerospace ground equipment. Data made available shall be that selected and furnished by the User or alternatively, that data and documentation which the User elects to provide in response to specific requests by the Contractor. Data requested by the Contractor shall be made available or in lieu thereof the Contractor and the AEC shall both be provided with recommendations as to the basis to be used in design and programming efforts (see also 1.3.3 following).

The User shall be responsible for submitting documentation to, coordinating procedures with and obtaining approvals from the test range as necessary to satisfy test range requirements.

The User, in conjunction with the Contractor and AEC, shall furnish facilities and equipment, perform work and furnish services and carry out responsibilities, all as provided for herein, upon acceptance of this document. This shall include vehicle modification as required by paragraph 3.5 hereof, the provision, modification and operation of launch complex and test range facilities and the operation (for all operational flights) and maintenance of all CRONUS equipment with the exception of actual nuclear fuel handling operations.

1.3.3 Contractor.- The Contractor shall perform studies, design, fabricate, test and deliver RTG/RB-CIR Systems, provide support services and furnish associated equipment (including aerospace ground equipment) all in accordance with the provisions of its contract* with the AEC. Effort, articles and services provided shall be in accord with program phasing as established by the contract which refers to this specification and shall be in conformance with the interface requirements of this specification. The Contractor shall perform all nuclear fuel handling, fueling and defueling operations at the launch site. The Contractor shall design (prepare drawings and specifications covering fabrication and assembly) the fuel containment structure (Heat Source).

Heat source design, fabrication, testing and delivery requirements shall be coordinated with the AEC designated Fueling Agency to assure feasibility of fabrication, compatibility with the Fueling Agency's handling and processing facilities and to assure the necessary quality level of delivered items.

The Contractor shall furnish documentation to the User (in support of range safety and nuclear material requirements) in accordance with a document (to be referenced herein following coordination) to be titled "Safety Documentation Requirements for Space Nuclear Power Systems." This document shall become applicable in lieu of such documents as AFETRM 127-1, AFETRM 160-1 and AFWTRM 550-2.

1.3.4 Joint Responsibility.- The User/AEC shall issue and maintain a set of interface control specifications and drawings (prepared and coordinated in certain instances by the Contractor) to assure compatibility between the satellite program and the CRONUS RTG/RB-CIR Systems. All such specifications and drawings shall be applicable only after incorporation by direct or indirect reference in this specification. Subsequent to approval and acceptance of this document, changes and additions shall only be accomplished in the manner provided for in MN-2050-1. The User/AEC (with technical support provided by the Contractor) shall obtain all approvals required to launch the nuclear material into space.

* For purposes of this document as a reference source under Contract AT(29-2)-2050, articles of equipment to be furnished by the Contractor shall consist of those shown in Table I.

TABLE 1

Hardware Articles to be Furnished by the Contractor

Flight Articles (Qualified)	Qty.	Deliver to
RTG/RB (unfueled)	7	SIC
CIR (less propulsion components)	7	SIC
Set of propulsion components for CIR	7	Launch Complex
Set of Nuclear Heat Source components	7	Fueling Agency
Development and Test Articles		
RTG/RB (unfueled) (for dynamic testing)	1	SIC
(for electrical testing)	1	SIC
Special RTB/RB (unfueled) (for demonstration flight)	2	SIC
CIR (without propulsion components) (for dynamic testing)	1	SIC
(for electrical testing)	1	SIC
(for demonstration flight)	2	SIC
Set of propulsion components for CIR (for demonstration flight)	2	Launch Complex
Set of Dummy propulsion components for CIR (for dynamic testing)	1	SIC
(for electrical testing)	1	SIC
Set of Nuclear Heat Source Components (for fueling demo)	1	Fueling Agency
Electrical Heat Source (for ground use prior to demonstration flight and operational flights)	2	Launch Complex
(for electrical testing)	2	SIC
(for fueling demonstration)	1	Launch Complex
Fuel Capsule Components (for fuel loading practice)	10	Fueling Agency
Mock-ups, experimental and engineering models, test specimens and articles (for development, life, qualification, safety and reliability testing and for the fueling demonstration)	As req'd by test plan	Non-deliverable

TABLE 2

Major Hardware Articles to be Furnished by the Government

Note: Quantities and schedules shall be as coordinated with the Contractor, the AEC and the User.

Flight Articles (Qualified)	Qty.	Deliver to
Nuclear Heat Source	7	Launch Complex
Airborne Telemetry and Command Control Equipment (for installation in CIR)	7	Contractor
Development and Test Articles		
Nuclear Heat Source (for fueling demo)	1	Launch Complex
Airborne Telemetry and Command Control Equipment for installation in CIR (for demo flight)	2	Contractor
Airborne Telemetry and Command Control Equipment for installation in RTG/RB (for demo flight)	2	Contractor

NOTES: Dummy Heat Source = non-nuclear, non-thermal heat source simulator
Electrical Heat Source - non-nuclear, electrically heated Heat Source simulator
SIC = Spacecraft Integration Contractor

2.0 APPLICABLE DOCUMENTS.-

2.1 General.-

2.1.1 Extent of Applicability.- The documents listed in this section form a part of this specification only to the extent specified in the text of this specification. Where a document or its provisions are to be "used as a guide" (or other similar phrases) the extent of applicability shall be based on the Contractor's management and technical judgment. For reference purposes only, the paragraph(s) in this specification where each document is called out are shown opposite each document in the following listing.

2.1.2 Dates of Issue.- References to documents in the text of this specification are made by basic number only. Such basic reference shall designate the exact issue as specified in this Section 2, including the cited amendments, changes, etc.

2.1.3 Rules of Procedures.- In case of conflict between this specification and the Contract, the Contract shall govern. In case of conflict between this specification and any document referenced herein, this specification (including any authorized changes, appendices, or addenda hereto), shall govern.

2.2 Documents.- In addition to the following listing, the documents referred to in Appendix "A" of MN-2050-100 are also applicable to the extent described in the appendix.

2.2.1 AEC-Sandia Corporation.-

	Para. No.
Technical direction provided in writing during Phase 0 of Contract AF(29-2)-2050.	3.2

2.2.2 Military.-

		Para. No.
Specifications		
MIL-E-6051C 10 Sept. 64 Amend. 1	Electrical Electronic System Compatibility and Interference Control Requirements for Aeronautical Weapon System	3.4.1.1
MIL-I-6181D 1 June 62 Change 3 22 June 65	Interference Control Requirements, Aircraft Equipment	3.4.1.1
Standards		
MIL-STD-826 (USAF) 20 Jan. 65	Electromagnetic Interference Test Requirements and Test Methods	3.4.1.1

2.2.3 Contractor.-

Specifications		
MN-2050-1 1 July 66	Specification Plan for the CRONUS Program	1.3.4, 6.4, 5.2
MN-2050-20	Technical Interface Specification for the CRONUS Aerospace Ground Equipment	3.0
MN-2050-100	Specification for CRONUS RTG/RB-CIR Systems Design, Performance and Test Requirements	2.2, 3.0, 4.1, 6.1, 5.1, 3.1, 3.3.2, 3.4.1, 3.4.5, 3.4.7
MN-2050-200 1 July 1966	Specification for CRONUS Aerospace Ground Equipment Design, Performance and Qualification	3.0

2.2.3 Continued

		Para. No.
Specifications		
MN-2050-11 (to be prepared)	Sr 90 Fuel Interface Specification	1.3.1.4 3.3.6
MN-2050-12 (to be prepared)	Pu 238 Fuel Interface Specification	1.3.1.4 3.3.6
Drawings	(Interface Control Drawings - to be prepared)	

2.2.4 Goddard Space Flight Center

S-652-N1-2A 21 Dec. 1965 (Uncl.)	GSFC Technical Interface Specification for the Nimbus B/SNAP-19 System	3.2

2.2.5 USAF

SSD-CR-65-18 Rev. 1 Sept. 1965	Titan III Standard Space Launch System (SSLS) Definition for Payload Contractors	3.2, 3.4.3
AFETRM 127-1 10 Sep 1965	Range Safety Manual; Air Force Eastern Test Range Manual	3.2, 1.3.3.7
AFETRM 160-1 10 Sep 1965	Radiation Control Program	3.4.1.5, 1.3.3.7
AFWTRM 550-2 1 Jan 1965	Range Safety Manual; Air Force Western Test Range Manual	3.2, 1.3.3.7
	Range User's Handbook Atlantic Missile Range-1962	3.2
IFS-TIII-20001 14 Dec 1964	Structural and Loading Standard Interface Capabilities and Requirements	3.4.3

2.2.5 Continued

		Para No.
IFS-TIII-20002 1 Sep 1964	Interface Specification SSLS to Spacecraft Electrical Standard Interface Capabilities Requirements	3.2, 3.3.2.2c
IFS-TIII-20004, Chg. Notice 3, 9 Sep 1965	Interface Specification SSLS to Spacecraft Environmental STD Interface Conditions and Requirements	3.2, 3.3.1.2

2.2.6 Other Publications.-

Dept. of Commerce Handbook 69, 5 June 1959	Maximum Permissible Body Burdens and Concentrations of Radionuclides in Air and in Water for Occupational Exposure	3.4.1.5
Tariff No. 19 (Agent T.C. George) Sept 5, 1966	Interstate Commerce Commission Regulations for Transportation of Explosives and Other Dangerous Articles	3.4.1.5

3.0 REQUIREMENTS.-

The following establishes the requirements and/or baselines for:

a. Functional, physical and installation interfaces and control of interfaces between the CRONUS RTG/RB-CIR Systems as described in Specification MN-2050-100, and the equipment facilities, and operations for a low Earth orbit satellite program.

b. The specific effort and/or responsibilities to be performed by the Contractor, AEC, User and cooperating Government agencies to effect integration of the CRONUS RTG/RB-CIR Systems into the satellite program.

c. Installation, support and training services to be performed by the Contractor.

d. Data and documentation to be provided and controlled by the Contractor.

Contractor furnished aerospace ground equipment associated with the CRONUS RTG/RB-CIR Systems and interface requirements and baselines applicable to the AGE are described in and shall conform with Specifications MN-2050-20 and MN-2050-200.

3.1 Program Functional Interface.- The primary functions of the CRONUS RTG/RB-CIR Systems are to furnish operational electrical power to an earth orbital satellite and to provide for the safe reentry of its radioisotope fuel. The specific performance characteristics of the CRONUS RTG/RB-CIR Systems to enable it to perform its intended functions shall be as described in specification MN-2050-100 and, with respect to interfaces with the mission and satellite and launch vehicle, in accordance with the requirements and baselines of this specification.

3.2 Interface Baselines.- The objective of the Contractor's design, development, manufacturing and test efforts under its CRONUS program shall be to develop and provide a system operable with and compatible functionally and physically with a low earth orbit satellite, (e.g., NIMBUS) the Titan IIIC launch vehicle and associated launch complex facilities, equipment and procedures at ETR and ground tracking telemetry and control stations. However, pending specific definition of the satellite mission and the criteria and requirements of the facilities and equipment comprising the satellite program, the Contractor's design, development, fabrication and test efforts shall be based on the documents listed in 2.2.1, 2.2.4 and 2.2.5 as guides.

3.2 Continued

The extent to which the CRONUS RTG/RB-CIR Systems shall be operative and compatible with the designated vehicles and their development, manufacturing, test, and utilization programs shall be as provided for in this specification.

3.3 Specific Interfaces.- The major functional and physical interfaces involving the RTG/RB-CIR Systems shall be as follows.

3.3.1 Launch Vehicle.-

a. Mechanical.- The aft cone of the re-entry body shall be connected to the launch vehicle fairing (modified in accordance with interface control drawing (to be prepared)) so that opening and closing the fairing will also open or close the aft cone. The connection shall include a separable (pyrotechnic actuated) link to permit jettison of the fairing.

Mechanical ICD No. (to be prepared)

b. Electrical.- The RTG/RB-CIR Systems shall be connected (via the space vehicle to launch vehicle interface) to launch vehicle electrical umbilical connections to provide instrumentation and control (hardwire) links to the Launch Control Center and shall be connected (via the space vehicle to launch vehicle interface) to the launch vehicle MDS.

Electrical ICD No. (to be prepared)

c. Thermal.- The RTG/RB-CIR Systems shall deliver thermal energy at a level of approximately 6500 watts within the launch vehicle fairing in the absence of air conditioning. (See 3.3.3, below for cooling air requirements).

d. Nuclear.- The RTG/RB-CIR Systems shall deliver nuclear radiation (subsequent to nuclear fueling of the RTG) to materials and/or components of the launch vehicle as shown in Tables 3 and 4 for a Sr 90 fueled generator and in Tables 5 and 6 for a Pu 238 fueled generator. The data given in these tables is based on the simplified generator design model.

TABLE 3

Dose along vehicle longitudinal axis measured from center of Heat Source (Sr 90 fuel)

Distance (ft)	Gamma (R/hr)	Neutrons ($n/cm^2/sec$)
1	9,020	4,300
2	1.980	2,400
4	282	780
6	102	-
12	25	-
24	6	-
50	1	-

TABLE 4

Dose perpendicular to longitudinal axis measured from center of Heat Source (Sr 90 fuel)

Distance (ft)	Gamma (R/hr)	Neutrons ($n/cm^2/sec$)
2	5,410	5.090
3	2,210	1.880
6	851	424
12	129	103
24	32	26
50	8	6

TABLE 5

Dose along vehicle longitudinal axis measured from center of Heat Source (Pu 238 fuel)

Distance (ft)	Gamma (R/hr)	Neutrons ($n/cm^2/sec$)
1	*	*
2	*	*
3	*	*
4	*	*
5	*	*
6	*	*

* - To be determined

TABLE 6

Dose perpendicular to longitudinal axis measured from center of Heat Source (Pu 238 fuel)

Distance (ft)	Gamma (R/hr)	Neutrons ($n/cm^2/sec$)
1	0.24	18,900
2	0.06	4,900
3	0.025	2,100
4	0.014	1,260
5	0.009	770
6	0.006	560

3.3.2 Space Vehicle.-

a. Mechanical.- The CIR System shall be mounted on the space vehicle by means of a track assembly to permit ejection of the CIR (carrying the RTG/RB System) from the space vehicle upon command (ground, or MDS). Prior to ejection, the CIR shall be locked in place by a retaining pin. The pin shall be removed by a pyrotechnic actuated "pin puller" to permit ejection.

The total weight of the RTG/RB-CIR Systems (fueled) as installed aboard the space vehicle shall not exceed 800 pounds.

Mechanical ICD No. (to be prepared)

b. Electrical.- The RTG/RB-CIR Systems shall be connected to the space vehicle by means of quick-disconnect electrical connector(s) to provide power leads from the generator system to the space vehicle, to provide signal leads from the launch vehicle MDS to the CIR System and to provide instrumentation and control leads from the RTG/RB-CIR Systems to the launch vehicle electrical umbilical.

The RTG/RB-CIR Systems electrical ground shall be connected to the space vehicle electrical ground at a single point.

c. Thermal.- The CIR System shall deliver negligible thermal energy to the space vehicle.

d. Nuclear.- The RTG/RB-CIR Systems shall deliver nuclear radiation (subsequent to nuclear fueling of the RTG) to materials and/or components of the space vehicle as shown in Tables 3 and 4 for a Sr90 fueled generator and Tables 5 and 6 for a Pu 238 fueled generator.

3.3.3 Launch Site Facilities.-

a. Mechanical.- Where the RTG/RB-CIR Systems require mechanical interfaces with the launch site facilities (e.g., lifting and handling), such interfaces shall be via the CRONUS MGE (maintenance ground equipment).

b. Electrical.- Where the RTG/RB-CIR Systems require electrical interfaces with the launch site facilities (e.g., instrumentation and control cabling), such interfaces shall be via the launch/space vehicle interfaces.

c. Air Conditioning.- Conditioned air (70 lbs. per minute of 60-65°F, 42-50% RH air) shall be available within the launch vehicle fairing during and after nuclear fueling of the RTG.

3.3.4 CRONUS AGE.-

a. Mechanical.- The mechanical interfaces between the RTG/RB-CIR Systems and the CRONUS AGE (for lifting, positioning and handling of major components/systems) shall be in accordance with Mechanical ICD No. (to be prepared).

b. Electrical.- The electrical interfaces between the RTG/RB-CIR Systems and the CRONUS AGE (for instrumentation and control functions) shall be via launch site facilities (launch vehicle umbilical connections).

c. Electromagnetic.- The electromagnetic interfaces between the RTG/RB-CIR Systems and the CRONUS AGE (for telemetry and command control functions) shall be via range facilities (ground TT&C stations).

3.3.5 Ground TT&C Stations.-

Electromagnetic.-

a. The RTG/RB System radio beacon (for tracking by ground TT&C stations) shall have the following signal characteristics:

Frequency: *

Modulation: *

Effective Radiated Power: *

* - To be determined on the basis of mission requirements and compatibility with range facilities and ground TT&C stations.

b. The CIR System telemetry and command control equipment shall have the following signal characteristics:

(To be determined on the basis of mission requirements, RTG/RB-CIR requirements and compatibility with range facilities and ground TT&C stations).

3.3.6 Nuclear Fuel Interfaces.- Mechanical, thermal, nuclear and manufacturing interfaces between the Nuclear Heat Source and other elements of the program shall be as specified in fuel interface specifications MN-2050-11 and MN-2050-12.

3.4 General Interface Requirements.- The RTG/RB-CIR Systems shall conform to the general interface requirements of this paragraph wherever applicable.

3.4.1 Equipment Design.- The general design of the CRONUS RTG/RB-CIR Systems shall be as specified in MN-2050-100. Specific details of design shall be as specified in the applicable RTG/RB-CIR Systems CEI specifications.

3.4.1.1 Electro, Electro-Magnetic Interference.- The CRONUS RTG/RB-CIR Systems shall be designed to meet the electromagnetic interference standards of MIL-E-6051C and MIL-STD-826 and the interference control requirements of MIL-I-6181. The standards shall be applicable during operations which are conducted at or in the immediate vicinity of the launch pad and during launch and orbital operations. The Contractor shall furnish calculated electromagnetic interference characteristics (both conducted and radiated interference) of the CRONUS RTG/RB-CIR Systems along with a recommended plan for control of such electromagnetic characteristics. The plan shall identify parametric tests to be performed by the Contractor to determine interference characteristics during electrically heated generator system operation and detail tests to assure electromagnetic compatibility of the CRONUS RTG/RB-CIR Systems with the satellite and launch vehicles and space vehicle ground operations. Requirements for Contractor performance of electro-magnetic testing of the CRONUS RTG/RB-CIR Systems shall be considered as unspecified pending coordination of the test plan for fueled systems with the User Organization.

3.4.1.2 Protective Devices and Procedures.- The CRONUS RTG/RB-CIR Systems shall not be required to contain devices (such as fuses or circuit breakers) for protection against internal or external electrical faults. Contractor prepared instruction manuals shall include precautionary procedures so as to avoid equipment damage resulting from improper connections or operation.

3.4.1.3 Telemetry and Command Control.- Instrumentation sensors and control devices/circuitry provided in the CRONUS RTG/RB-CIR Systems shall be compatible with the telemetry and command control equipment provided by the User (in accordance with a "GFE Requirements (Airborne)" document and a "GFE Requirements (Ground)" document to be prepared by the Contractor and coordinated with the AEC and the User).

3.4.2 Electrical Installation.- All electric leads and connectors, including those for instrumentation, command control and telemetry, between the CRONUS RTG/RB-CIR Systems and the space vehicle shall be of a type to be negotiated with the User.

3.4.3 Mechanical Installation.- Mounting surfaces and structures, but not including hardware (such as bolts, nuts, clamps, etc.) required to install the CRONUS RTG/RB-CIR Systems at the launch site shall be the responsibility of the User. The Contractor shall furnish locating templates or mounting hole patterns, if necessary, for Contractor furnished articles. The CRONUS RTG/RB-CIR Systems as installed and operated at the launch complex shall be compatible with space-launch vehicle equipment and/or procedures.

The CRONUS RTG/RB-CIR Systems shall be compatible with the Titan III-C standard payload fairing (as modified for the CRONUS programs) under any dynamic conditions and shall conform to the limiting payload envelope shown in Figure II-2 of SSD-CR-65-18. Structural rigidity, frequency and moments of inertia at the payload to enable conformance with this requirement and to satisfy the structural interface criteria between payload and launch vehicle in conformance with IFS-TIII-20001 shall be the responsibility of the User.

3.4.4 Interchangeability.- Complete operational CRONUS RTG/RB-CIR Systems shall be interchangeable with respect to mechanical mounting and electrical interconnection and with respect to the specified limits of performance characteristics.

3.4.5 Maintenance.- Maintenance of Contractor furnished equipment shall be the Contractor's responsibility during installation and operation (at an integrating contractor's facility and/or at a launch site) prior to acceptance by the AEC/User for operational use. Such maintenance, however, shall be limited to "maintenance type" adjustments and replacement of parts (limited to those spares specified in the contract).

Additional requirements applicable to repair and maintenance efforts shall be considered as unspecified.

3.4.6 Standardization.- In the design and fabrication of the CRONUS RTG/RB-CIR Systems, the selection and use of specifications, standards, parts, materials and processes of fabrication shall conform to criteria of MN-2050-100.

3.4.7 Handling Provisions.- Lifting eyes, guides, alignment and indexing points, and/or other pertinent features shall be incorporated in the CRONUS RTG/RB-CIR System to facilitiate hoisting, handling, and installation of the unfueled system in the space/launch vehicle. Such handling provisions shall be compatible with ground handling concepts developed for the system and use of Contractor furnished maintenance ground equipment.

3.4.8 Furnishing of Articles and Services to an Integrating Contractor.- The furnishing of articles and services to other than the launch site, such as to the facilities of an integrating contractor or a space vehicle contractor, shall be limited to experimental and/or engineering models in accordance with the contract.

3.4.9 Training of User Personnel.- The Contractor shall conduct training of launch complex and User personnel covering installation, check-out, operation and routine maintenance of the Contractor furnished CRONUS RTG/RB-CIR Systems.

3.5 Government Furnished Articles and Services.- In conjunction with the services and articles furnished by the Contractor at the launch site the User and/or AEC shall be responsible for the following.

a. Furnishing the equipment listed in Table 2 as Government Furnished articles in accordance with requirements set forth in a "GFE Requirements" document to be prepared by the Contractor and coordinated with the AEC and the User.

b. Furnishing and/or modifying and operating equipment supplied by others in accordance with the provisions and criteria of interface documents coordinated with and accepted by the User. The User shall provide access to site facilities and equipment and furnish services necessary to performance of the Contractor's services. The use of site facilities shall be provided to store and safeguard Contractor furnished articles and other items which may be provided on a loan or other temporary basis by the AEC and/or Contractor.

c. Development and conduct of a test and control program to verify the radiation characteristics of the Heat Source as necessary to assure conformance with the applicable radiation standards for storage, handling and use of radioisotope materials.

d. Modification of the Titan III nose fairing in accordance with coordinated interface control drawings.

3.6 Data and Documentation.-

3.6.1 Drawings, Manuals and Data.- CRONUS RTG/RB-CIR systems data such as engineering drawings, instruction manuals and other documentation shall be prepared and distributed in accordance with MN-2050-2 and furnished F.O.B. destination.

3.6.2 Documentation Control.- Contractor preparation, coordination and use of CRONUS RTG/RB-CIR Systems interface control documents and supporting data shall conform to the Specification Plan MN-2050-1 and the Configuration Control Plan MN-2050-3.

3.6.3 Facility Design Interface.- All details of the Contractor's CRONUS RTG/RB-CIR Systems design shall be subject to coordination with the functional and physical provisions, limitations and capabilities of the standard and special facilities (launch site, test range and tracking system) provided by the User's mission program for launch and orbital flight operations.

3.6.4 Program Procedures Interface.- All operational procedures prepared by the Contractor for the CRONUS RTG/RB-CIR Systems shall be subject to coordination, with the intents and constraints of the standard procedures of the User's mission program for launch operations.

4.0 QUALITY ASSURANCE PROVISIONS.-

4.1 Quality Inspection and Test.- Quality control measures for the CRONUS RTG/RB-CIR Systems during manufacture and prior to delivery shall be as specified in MN-2050-100. Inspection and verification of work performed by the Contractor on the CRONUS RTG/RB-CIR Systems subsequent to delivery shall, in general, be in accordance with the same procedures and to the same standards as used prior to delivery.

4.2 Fueling Demonstration.- Requirements for the CRONUS fueling demonstration shall be as specified in MN-2050-200.

4.3 Demonstration Flight.- Requirements for the demonstration flight shall be as specified in MN-2050-100.

5.0 PREPARATION FOR DELIVERY.-

Not applicable.

6.0 NOTES.-

6.1 Definition of Terms.- Certain terms as used herein shall be defined as follows.

(See Specification MN-2050-100, para. 6.1)

6.2 Supersession Data.- This Specification, when contractually authorized, shall supersede all other similar requirements in the Contract of which it is a part.

6.3 Authorization.- This Specification, and any changes thereto, shall be authorized for use upon receipt of written approval of the Contracting Officer and issuance of an appropriate Contract Change incorporating this Specification in the Contract.

6.4 Revisions and Changes.- This specification shall be revised only upon written direction from the Contracting Officer. Changes to this Specification shall be authorized as described in MN-2050-1. All such changes shall be subject to the Contract clause entitled "Changes".

PRELIMINARY

STUDY FOR A 250 WATT CONTROLLED REENTRY ORBITING NUCLEAR SYSTEM "CRONUS"

TECHNICAL INTERFACE SPECIFICATION FOR THE CRONUS AEROSPACE GROUND EQUIPMENT MN-2050-20

Basic Approved By:

_____
Martin Marietta Corporation

Date: _____

Note: This specification has been prepared under AEC Contract AT(29-2)-2050

MARTIN MARIETTA CORPORATION
MARTIN COMPANY - NUCLEAR
Baltimore, Maryland 21203

Manufacturer's Federal Supply Code 38597

PRELIMINARY

FOREWORD

This specification and other Contractor prepared subsidiary specifications referred to herein have been established to define requirements, characteristics, and interface criteria for a radioisotope fueled thermoelectric generator (RTG) system and a controlled intact reentry system (CIR) which along with the associated aerospace ground equipment (AGE) form an overall system designated as "CRONUS." The content of this specification reflects the results and efforts of the Contractor under Phase "Zero" of the CRONUS Program (Contract AT(29-2)-2050); however, the specification is not restricted to any particular phase of design, development and production.

In the preparation of this document, emphasis has been placed on definition of areas applicable to the initial portion of a complete program to provide flight systems. It is expected that this document will be made more definitive and up-dated and completed through modifications as integration of Government Agency and Contractor effort is accomplished and as more firm design information and test results become available. In final form and representing the results of mutual agreement, it is expected that this specification will be referenced in contractual agreements between the Contractor and the AEC.

The relation of this specification to other Contractor prepared specifications and the contract is shown in Figure 1 of the Specification Plan MN-2050-1.

TECHNICAL INTERFACE SPECIFICATION FOR THE CRONUS AEROSPACE GROUND EQUIPMENT

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TECHNICAL INTERFACE SPECIFICATION
FOR THE
CRONUS AEROSPACE GROUND EQUIPMENT

1.0 SCOPE.- This technical interface control specification, along with interface control drawings referred to herein, defines requirements and criteria governing and establishing interfaces between the CRONUS (Controlled Reentry Orbiting NUclear System) AGE (Aerospace Ground Equipment) and the various facilities, vehicles and efforts comprising an earth orbital satellite program.

1.1 Mission.- The CRONUS AGE is intended to service and support the performance of the CRONUS RTG/RB and CIR systems during installation, checkout, launch, orbital flight and reentry operations.

1.2 Interface Identification.- This interface control specification identifies interface criteria and requirements between the following.

a. CRONUS AGE with transportation equipment

b. CRONUS AGE with storage facilities

c. CRONUS AGE with launch facilities

d. CRONUS AGE with CRONUS RTG/RB-CIR systems

e. CRONUS AGE with launch vehicles

1.3 Responsibilities.- To effect integration of the CRONUS AGE into the satellite mission, areas of responsibility and the effort to be performed to accomplish such responsibility and/or permit others to carry-out their responsibilities shall conform to the following.

1.3.1 AEC.- The AEC shall be responsible to the User for the performance of the Contractor in accordance with the provisions of the contract between the Contractor and the AEC. In addition, with respect to design, fabrication, and use of the AGE, the AEC shall:

a. Furnish direction and assistance to the Contractor in the conduct of liaison and coordination activity with the User Organization.

b. Accomplish and arrange for necessary approvals and efforts by other Government agencies which are necessary to authorize and accomplish integration of the CRONUS AGE into the satellite mission and program.

NOTE: See Section 6 of MN-2050-100 for nomenclature and definition of terms used herein.

c. Furnish, in conjunction with Contractor furnished articles and services, the equipment and services necessary to accomplish radiation monitoring and control of nuclear safety during all prelaunch, launch and post launch operations at the launch site.

The AEC shall be responsible for establishing the necessary radiation control area(s) during Radioisotope Thermoelectric Generator (RTG) fueling and/or defueling operations (and any other operations involving handling of the heat source).

1.3.2 User.- The User shall make available to the Contractor requirements, constraints, design data, specifications, test results, mission objectives and parameters affecting and/or to be met in the design and programming of the CRONUS AGE. Data made available shall be that selected and furnished by the User or alternatively, that data and documentation which the User elects to provide in response to specific requests by the Contractor. Data requested by the Contractor shall be made available or in lieu thereof the Contractor and the AEC shall both be provided with recommendations as to the basis to be used in design and programming efforts (see also 1.3.3 following).

The User, in conjunction with the Contractor and AEC, shall furnish facilities and equipment, perform work and furnish services and carry out responsibilities, all as provided for herein, upon acceptance of this document. This effort shall include facility modification as required by Paragraph 3.5 hereof.

1.3.3 Contractor.- The Contractor shall perform studies, design, fabricate, test and deliver CRONUS AGE and provide support services in accordance with the provisions of its contract* with the AEC. Effort, articles and services provided shall be in accord with program phasing as established by the contract which refers to this specification and shall be in conformance with the interface requirements of this specification.

The Contractor shall obtain the necessary Interstate Commerce Commission permit for shipment of the Heat Source Transportation Cask.

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*For purposes of this document as a reference source under Contract AF(29-2)-2050, articles of equipment to be delivered by the Contractor shall consist of those shown in Table I.

Table I

Hardware Articles to be Furnished by the Contractor

	Deliver to		
	Launch Complex	Fueling Agency	SIC*
Ground Handling Equipment including:			
Fueling Machine and Support Structure	1	-	-
Fuel Boom and Retracting Mechanism	1	-	-
Support Structure Pallet	1	-	-
Heat Source Transportation Cask	-	-	-
(including sling and skid)	-	1	-
Refurbishing Kit (one for each launch)	8	-	-
Fueling Probe (for cask loading)	-	1	-
Operational Ground Equipment including:			
Launch and Checkout Control Console	1	-	-
Nuclear AGE Control and Monitor Console	1	-	-
Go-No Go Analyzer	1	-	-
Radio Beacon Checkout Set	1	-	-
Power Supply (28 volt dc)	1	-	-
Antenna Hat	1	-	-
Maintenance Ground Equipment including:			
Ordnance Checkout Set	1	-	1*
Alignment Kit	1	-	-
Battery Checker	1	-	1*
Tools and Spares	1	-	1*

* Specific items of equipment to be furnished to the spacecraft integration contractor shall be as coordinated with the AEC, the SIC and the Contractor.

Table 2

Related Hardware Articles and Facilities to be Furnished by the Government

Radiation Monitors for Nuclear Fuel Storage Area and Umbilical Tower Nuclear Fueling Area	1 set	Launch Complex
TT&C Ground Station Equipment	X sets	As required for the range stations used for the mission
TT&C Checkout Set for Vehicle Equipment	1 1 1	Launch Complex SIC Contractor
Launch Complex Facilities	-	-
Test Range Facilities	-	-

Requests to the User for data and documentation shall state the specific kind or nature of the information required, the purpose or reason for requesting the information, and the general basis on which the Contractor will proceed in the event the information is not provided. In the event requested information or appropriate recommendations (see 1.3.2) are not provided, the Contractor shall document, in reports required under the Contract, the bases used in lieu of User furnished information.

1.3.4 Joint Responsibility.- The User/AEC shall issue and maintain a set of interface control specifications and drawings (prepared and coordinated in certain instances by the Contractor) to assure compatibility between the satellite program and the CRONUS AGE. All such specifications and drawings shall be applicable only after incorporation by direct or indirect reference in this specification. Subsequent to approval and acceptance of this document, changes and additions shall only be accomplished in the manner provided for in MN-2050-1.

2.0 APPLICABLE DOCUMENTS.-

2.1 General.-

2.1.1 Extent of Applicability.- The documents listed in this section form a part of this specification only to the extent specified in the text of this specification. Where a document or its provisions are to be "used as a guide" (or other similar phrases) the extent of applicability shall be based on the Contractor's management and technical judgment. For reference purposes only, the paragraph(s) in this specification where each document is called out are shown opposite each document, in the following listing.

2.1.2 Dates of Issue.- References to documents in the text of this specification are made by basic number only. Such basic reference shall designate the exact issue as specified in the Section 2, including the cited amendments, changes, etc.

2.1.3 Rules of Procedures.- In case of conflict between this specification and the Contract, the Contract shall govern. In case of conflict between this specification and any document referenced herein, this specification (including any authorized changes, appendices, or addendums hereto), shall govern.

2.2 Documents.- In addition to the following listing, the documents referred to in Appendix "A" of MN-2050-100 are also applicable to the extent described in the appendix.

2.2.1 AEC-Sandia Corporation

	Para. No.
Technical direction provided in writing during Phase 0 of Contract AF(29-2)-2050	3.2

2.2.2 Military.-

Specifications:

MIL-E-6051C 10 Sep 1964 Amendment 1	Electrical-Electronic System Compatibility and Interference Control Requirements for Aeronautical Weapon System	3.4.1.1

Standards:

MIL-STD-137C 25 Jun 1963	Materials Handling Equipment	3.4.8

		Para. No.
MIL-STD-826 (USAF) 20 Jan 1965	Electromagnetic Interference Test Requirements and Test Methods	3.4.1.1

2.2.3 Contractor.-

Specifications:

MN-2050-1	Specification Plan for the CRONUS Program	6.4, 5.2
MN-2050-10	Technical Interface Specification for the CRONUS RTG/RB-CIR Systems	3.0, 3.4.1.5
MN-2050-100	Specification for CRONUS RTG/RB-CIR Systems Design, Performance and Test Requirements	2.2, 3.0, 6.1
MN-2050-200	Specification for CRONUS Aerospace Ground Equipment Design, Performance and Test Requirements	3.0, 3.1, 3.4.1, 3.4.5, 3.4.7, 4.1, 5.1

Drawings

(Interface Control Drawings to be prepared during Phase I)

2.2.4 Goddard Space Flight Center.-

S-652-N1-2A 21 Dec 1965 (Uncl.)	GSFC Technical Interface Specification for the Nimbus-B/ SNAP-19 System	3.2

2.2.5 USAF.-

SSD-CR-65-18 Rev. 1 - Sep 1965	Titan III Standard Space Launch System (SSLS) Definition for Payload Contractors	3.2
AFSCM 80-6 Aug 1966	Handbook of Instructions for Aerospace Ground Equipment Design (HIAGED, First Edition)	3.2, 3.4.1
AFETRM 127-1 10 Sep 1965	Range Safety Manual; Air Force Eastern Test Range Manual	3.2

		Para. No.
AFWTRM 550-2 1 Jan 1965	Range Safety Manual; Air Force Western Test Range Manual	3.2
	Range User's Handbook Atlantic Missile Range - 1962	3.2
IFS-TIII-20002	Interface Specification SSLS to Spacecraft Electrical Standard Interface Capabilities Requirements	3.2
IFS-TIII-20004 Chg. Notice 3, 9 Sep 1965	Interface Specification SSLS to Spacecraft Environmental STD Interface Conditions and Requirements	3.2

2.2.6 Other Publications.-

Dept. of Commerce Handbook 69, 5 Jun 1959	Maximum Permissible Body Burdens and Concentrations of Radionuclides in Air and in Water for Occupational Exposure	3.2
Tariff No. 19 (Agent T. C. George) effective 5 Sep 1966	Interstate Commerce Commission Regulations for Transportation of Explosives and Other Dangerous Articles	3.2
NBFU No. 70 1959	National Electric Code	3.4.2

3.0 REQUIREMENTS.- The following establishes the requirements and/or baselines for:

a. Functional, physical and installation interfaces and control of interfaces between the CRONUS AGE, as described in Specification MN-2050-200, and the equipment, facilities, and operations for an Earth Orbit Satellite program.

b. The specific effort and/or responsibilities to be performed by the Contractor, AEC, User Organization and cooperating Government agencies to effect integration of the CRONUS AGE into the satellite program.

c. Installation, support and training services to be performed by the Contractor.

d. Data and documentation to be provided and controlled by the Contractor.

Contractor furnished flight hardware associated with the CRONUS RTG/RB-CIR Systems and interface requirements and baselines applicable to the RTG/RB-CIR Systems are described in and shall conform with Specifications MN-2050-10 and MN-2050-100.

3.1 Program Functional Interface.- The primary function of the CRONUS AGE is to support the CRONUS RTG/RB-CIR Systems during pre-launch and launch operations. Support of these systems during orbital and reentry operations shall be by GFE facilities. The specific performance characteristics of the CRONUS AGE to enable it to perform its intended functions shall be as described in Specification MN-2050-200 and, with respect to interfaces with the mission and space launch vehicles, in accordance with the requirements and baselines of this specification.

3.2 Interface Baselines.- The objective of the Contractor's AGE design, development, manufacturing and test efforts under its CRONUS program shall be to develop and provide AGE operable with and compatible functionally and physically with the "Nimbus B" satellite, the Titan III-C launch vehicle and associated launch complex facilities, equipment and procedures at ETR and space mission tracking, telemetry and control ground stations. However, pending specific definition of the satellite mission and the criteria and requirements of the facilities and equipment comprising the satellite program, the Contractor's design, development, fabrication and test efforts shall use the documents listed in 2.2.1, 2.2.4, 2.2.5 and 2.2.6 as a guide. The extent to which the CRONUS AGE shall be operative and compatible with the designated vehicle and its development, manufacturing, test, and utilization programs shall be as provided for in this specification.

The basic categories of CRONUS AGE, and the functions of each, shall be as follows.

3.2.1 Operational Ground Equipment (OGE).- The general functions of the CRONUS Operational Ground Equipment shall be to check-out, control and monitor the CRONUS RTG/RB-CIR Systems during pre-launch and launch operations and to control and monitor the operation of the GHE during fueling and defueling operations.

3.2.2 Ground Handling Equipment (GHE).- The general functions of the CRONUS Ground Handling Equipment (Fueling Equipment) shall be to handle, protect, store and transport radioisotope material used as fuel for the CRONUS RTG.

3.2.3 Maintenance Ground Equipment (MGE).- The general functions of the CRONUS Maintenance Ground Equipment shall be to service and support the CRONUS RTG/RB-CIR Systems.

3.3 Specific Interfaces.- The major functional and physical interfaces involving the CRONUS AGE shall be as follows.

3.3.1 Transportation Equipment.-

a. Heat Source Transportation Cask.- The User shall provide a flat bed trailer of at least 5 tons capacity for transporting the Heat Source Transportation Cask from the nuclear fuel storage area (at the launch complex) to the launch pad. (Delivery to the launch complex shall be the Contractor's responsibility.)

b. Fueling Equipment.- The User shall provide a moving van of the "cushion-air" type and of at least 5 tons capacity for transporting the Fueling equipment from launch complex storage to the launch pad. (Delivery to the launch complex shall be the Contractor's responsibility.)

c. All Other CRONUS AGE.- The user shall provide standard "freight type" vehicles of appropriate capacities for transporting CRONUS AGE articles from launch complex storage to the launch site. (Delivery to the launch complex shall be the Contractor's responsibility.)

3.3.2 Storage Facilities.-

a. Heat Source Transportation Cask.- The User shall provide ample and satisfactory semi-remote, protected, secure storage space (approximately 40 square feet) for the Heat Source Transportation Cask at the launch complex. Radiation monitoring (surveillance) of this area shall be the User's responsibility. The User shall assure that unrestricted circulation of ambient air around the cask is permitted at all times.

b. All Other CRONUS AGE.- The User shall provide ample and satisfactory protected and secure storage space (approximately 300 square feet) for temporary storage of CRONUS AGE articles at the launch complex.

3.3.3 Launch Facilities.-

3.3.3.1 Vertical Integration Building.- CRONUS AGE (OGE) shall be installed in a Launch Control Center (in a Vertical Integration Building) at the launch site and shall serve to monitor the operation of the RTG/RB-CIR Systems during installation, checkout and launch operations and to control and monitor nulcear fueling/defueling operations.

a. Mechanical Interface.- The User shall provide ample and satisfactory space (approximately 100 square feet) to install and operate consoles and equipment racks.

Mechanical ICD - (to be prepared)

b. Electrical Interface.- The Contractor shall provide all cables, connectors, junction boxes, etc., necessary to interconnect all contractor furnished OGE located within the Launch Control Center and including those wiring devices necessary to connect contractor cabling to facility cabling at facility distribution/junction boxes.

The User shall provide all wiring and cabling (including distribution and switching equipment) between the Launch Control Center (distribution/junction boxes) and the RTG/RB-CIR Systems (via umbilical connections) and between the Launch Control Center and the Fueling Equipment (via the umbilical tower).

The User shall provide the following electrical facilities.

110 volt ac, single phase power
220 volt ac, 3 phase power
28 volt dc power

Electrical ICD - (to be prepared)

3.3.3.2 Umbilical Tower.- CRONUS AGE (GHE) shall be installed on a work platform of the umbilical tower at the payload level and shall serve to fuel and/or defuel the CRONUS RTG under remote control from the Launch Control Center.

a. Mechanical Interface.- The User shall provide ample and satisfactory space (approximately 50 square feet with a total loading of 13,000 pounds) to install and operate the Fueling Equipment. Radiation monitoring (surveillance) of the fueling area shall be the User's responsibility.

Mechanical ICD - (to be prepared)

b. Electrical Interface.- The User shall provide the following electrical facilities.

220 volt ac, 3 phase power (5 KW)
110 volt ac, single phase power
28 volt dc power
Control and instrumentation cabling (Sec. 3.3.3.1b)

Electrical ICD - (to be prepared)

c. Piping Interface.- The User shall provide 2 lb/sec of dry nitrogen at 3000 psi

Piping ICD - (to be prepared)

3.3.3.3 TT&C Station.- CRONUS AGE (OGE) shall be installed at a test range Tracking Telemetry and Control ground station (station nearest to the launch site) to process data received from the RTG/RB-CIR Systems (via the GFE TT&C equipment) for performance monitoring purposes.

a. Mechanical Interface.- The User shall provide equipment rack space to install and operate the Go-No Go Analyzer.

Mechanical ICD - (to be prepared)

b. Electrical Interface.- The User shall provide power and instrumentation cabling as follows:

110 volt ac, single phase power
data leads from TT&C ground station equipment (GFE)

Electrical ICD - (to be prepared)

3.3.4 CRONUS RTG/RB-CIR Systems.- CRONUS AGE (antenna hat(s)--part of OGE) shall be provided for use in the Vertical Integration Building and on the launch pad for TT&C checkout during pre-launch operations.

a. Mechanical Interface.- The antenna hat(s) shall mate with the radio beacon antenna and telemetry and control antennas on the RTG/RB-CIR Systems.

Mechanical ICD - (to be prepared)

b. Electrical Interface.- The User shall provide RF cabling from the payload level of the umbilical tower to the Launch Control Center.

Electrical ICD - (to be prepared)

3.3.5 Launch Vehicle.- The User shall provide umbilical connections to the launch vehicle (and thence to the CRONUS RTG/RB-CIR Systems via the launch vehicle-space vehicle interface) sufficient to accommodate instrumentation and control leads for pre-launch checkout of the RTG/RB-CIR systems and for control and monitoring leads for opening and closing the launch vehicle nose fairing.

3.4 General Interface Requirements.- All CRONUS AGE shall conform to the general interface requirements of this paragraph wherever applicable.

3.4.1 Equipment Design.- The design of the CRONUS AGE shall be as specified in MN-2050-200 and, as applicable, in general accordance with AFSCM 80-6.

3.4.1.1 Electro, Electro-Magnetic Interference.- The AGE shall be designed to meet the electromagnetic interference standards of MIL-E-6051C and MIL-STD-826. The standards shall be applicable during operations which are conducted at or in the immediate vicinity of the launch pad. Within 120 days after the effective date of the contract, the Contractor shall furnish the calculated electromagnetic interference characteristics (both conducted and radiated interference) of the AGE (OGE and GHE only) along with a recommended plan for control of such electromagnetic characteristics. The plan shall identify parametric tests to be performed by the Contractor to determine interference characteristics during electrically heated generator system operation and detail tests to assure electromagnetic compatibility of the OGE and GHE with the space and launch vehicles and space vehicle ground operations. Requirements for Contractor performance of electromagnetic testing of CRONUS AGE shall be considered as unspecified pending coordination of the test plan for fueled systems with the User.

3.4.1.2 Protective Devices and Procedures.- The AGE shall include devices (such as circuit breakers) for protection from external electrical faults. Precautions and procedures to assure safe operation shall be furnished by the Contractor.

3.4.2 Electrical Installation.- Electrical installations shall conform to the applicable rules of the National Electrical Code. AGE power distribution and ground shall be separate from the launch vehicle structure and ground and shall have its neutrals and/or grounds connected at the spacecraft ground point only.

3.4.3 Mechanical Installation.- Mounting surfaces and structures, but not including hardware (such as bolts, nuts, clamps, etc.) skids or wheels, required to install the CRONUS AGE at the launch site shall be the responsibility of the User. The Contractor shall furnish locating templates of mounting hole patterns, if necessary, for Contractor furnished articles. CRONUS AGE, as installed and operated at the launch complex shall not interfere with space/launch vehicle equipment and/or procedures.

3.4.4 Interchangeability.- Complete items and sets of CRONUS AGE shall be interchangeable physically, electrically and functionally within the limits of specified performance characteristics.

3.4.5 Maintenance.- Maintenance of Contractor furnished equipment shall be the Contractor's responsibility during installation and operation (at an integrating Contractor's facility and/or at a launch site) prior to acceptance by the AEC/User for operational use. Such maintenance, however, shall be limited to "maintenance type" adjustments and replacement of parts (limited to those spares specified in the contract.

Additional requirements applicable to repair and maintenance effort shall be considered as unspecified.

3.4.6 Standardization.- In the design and fabrication of the CRONUS AGE, the selection and use of specifications, standards, parts, materials and processes of fabrication shall conform to criteria of MN-2050-200.

3.4.7 Handling Provisions.- Lifting eyes, guides, alignment and indexing points, and other pertinent features shall be incorporated in the CRONUS GHE to facilitate hoisting, handling, and installation of the Fueling Equipment on the Umbilical Tower. Handling provisions of all other AGE items shall be compatible with standard materials handling equipment conforming to MIL-STD-137.

3.4.8 Training of User Personnel.- The Contractor, in accordance with the provisions of the contract, shall conduct training of launch complex and User personnel covering installation, checkout, operation and routine maintenance of Contractor furnished AGE articles (not to include training in operation of GHE).

3.4.9 Fuel Handling.- The Contractor's personnel shall perform all fuel handling, fueling and defueling operations at the launch site for demonstrations and for operational flights.

3.5 Government Furnished Articles and Services.- In conjunction with the services and articles furnished by the Contractor at the launch site, the User and/or AEC shall be responsible for the following:

a. Furnishing, installing and operating those hardware items listed in Table 2 as Government Furnished Equipment in accordance with requirements set forth in a "GFE (Ground) Requirements" document to be prepared by the Contractor and coordinated with the AEC and the User.

b. Furnishing and/or modifying and operating equipment supplied by others in accordance with the provisions and criteria of interface documents coordinated with and accepted by the User. The User shall provide access to site facilities and equipment and furnish services necessary to performance of the Contractor's services. The use of site facilities shall be provided to store and safeguard Contractor furnished articles and other items which may be provided on a loan or other temporary basis by the AEC and/or Contractor. Facility modifications shall include:

(1) Strengthen umbilical tower work platform at payload level so as to bear a minimum of 13,000 lbs and provide attachment points for CRONUS GHE in accordance with applicable Contractor Interface Control Drawing(s).

3.6 Data and Documentation.-

3.6.1 Drawings, Manuals and Data.- CRONUS AGE data such as engineering drawings, instruction manuals and other documentation shall be prepared and distributed in accordance with MN-2050-2 and furnished F.O.B. destination.

3.6.2 Documentation Control.- Contractor preparation, coordination and use of CRONUS AGE interface control documents and supporting data shall conform to the Specification Plan MN-2050-1 and the Configuration Control Plan MN-2050-3.

3.6.3 Facility Design Interface.- All details of the Contractors CRONUS AGE design shall be subject to coordination with the functional and physical provisions, limitations and capabilities of the standard and special facilities (launch site, test range and tracking system) provided by the User's mission program for launch and orbital flight operations.

3.6.4 Program Procedures Interface.- All operational procedures prepared by the Contractor for the CRONUS AGE shall be subject to coordination with the intents and constraints of the standard procedures of the User's mission program for launch operations.

4.0 QUALITY ASSURANCE PROVISIONS.-

4.1 Quality Inspection and Test.- Quality control measures for the CRONUS AGE shall be as specified in MN-2050-200.

4.2 GHE Mock-Up Test.- Requirements for a CRONUS GHE mock-up test shall be as specified in MN-2050-200

4.3 Fueling Demonstration.- Requirements for a CRONUS fueling demonstration shall be as specified in MN-2050-200.

4.4 Demonstration Flight.- Requirements for a CRONUS demonstration (unfueled) shall be as specified in MN-2050-200.

5.0 PREPARATION FOR DELIVERY.- Not applicable

6.0 NOTES.-

6.1 Definition of Terms.- Certain terms as used herein are defined as follows:

(See Specification MN-2050-100 para. 6.1)

6.2 Supersession Data.- This Specification, when contractually authorized, shall supersede all other similar requirements in the Contract of which it is a part.

6.3 Authorization.- This Specification, and any changes thereto, shall be authorized for use upon receipt of written approval of the Contracting Officer and issuance of an appropriate Contract Change incorporating this Specification in the Contract.

6.4 Revisions and Changes.- This specification shall be revised only upon written direction from the Contracting Officer. Changes to this specification shall be authorized as described in MN-2050-1. All such changes shall be subject to the Contract clause entitled "Changes."

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STUDY FOR A 250 WATT
CONTROLLED REENTRY ORBITING NUCLEAR SYSTEM
"CRONUS"

SPECIFICATION FOR CRONUS RTG/RB-CIR SYSTEMS
DESIGN, PERFORMANCE AND TEST REQUIREMENTS (U)

NOTE: This specification has been prepared under AEC Contract AT(29-2)-2050

Basic Approved By:

_____
Martin Marietta Corporation

Date: _____

MARTIN MARIETTA CORPORATION
MARTIN COMPANY - NUCLEAR
Baltimore, Maryland 21203

Manufacturer's Federal Supply Code 38597

FOREWORD

This specification and other Contractor prepared subsidiary specifications referred to herein have been established to define requirements, characteristics, and interface criteria for a radioisotope fueled thermoelectric generator (RTG) system and a controlled intact reentry system (CIR) which along with the associated aerospace ground equipment (AGE) form an overall system designated as "CRONUS." The content of this specification reflects the results and efforts of the Contractor under Phase "Zero" of the Cronus program (Contract AT(29-2)-2050) but is not restricted to any particular phase of design, development and production.

In the preparation of this document, emphasis has been placed on definition of areas applicable to the initial portion of a complete program to provide flight systems. It is expected that this document will be made more definitive and completed through modifications as integration of efforts is accomplished and as more firm design information and test results become available. In final form and representing the results of mutual agreement, it is expected that this specification will be referenced in contractual agreements between the Contractor and the AEC.

The relation of this specification to other Contractor prepared specifications and the contract is shown in Figure 1 of the Specification Plan MN-2050-1.

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REVISED PAGE INDEX

As of

This Revised Page Index (RPI) identifies all authorized changes to, and all current pages of, this specification as of the date shown above. This RPI is cumulative and supersedes all previous RPI's. Detailed information on each change may be found on the applicable Specification Change Notice.

Page No.	Para. No.	SCN	CCP	Effectivity

This specification consists of a Title Page, this Revised Page Index Sheet, no SCN's, 2 Table of Contents Sheets, 34 Pages of Text, (Page 34 is the last page).

File this page after the Table of Contents

Martin Approval _____

The undersigned certifies that all superseded classified pages have been destroyed in accordance with the appropriate security regulations.

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SPECIFICATION FOR CRONUS RTG/RB-CIR SYSTEMS
DESIGN, PERFORMANCE AND TEST REQUIREMENTS (U)

1.0 SCOPE.-

1.1 General.- This specification establishes the general design, performance and test requirements for a radioisotope fueled thermoelectric power generation system and a low earth orbit reentry system combined to form the CRONUS RTG/RB-CIR Systems. These requirements, taken along with the AGE requirements of MN-2050-200 define the CRONUS program requirements baseline.

1.2 Mission.- The CRONUS RTG/RB-CIR Systems are intended as a primary source of electric power for unmanned space vehicle applications on low earth orbital missions. The reentry features are intended to provide the capability of re-entering the nuclear fuel of the thermoelectric generator, intact within its containment structure, and effect impact in deep ocean areas.

1.3 Description.- For purposes of this specification, the CRONUS RTG/RB- CIR Systems are considered to consist of a radioisotope fueled thermoelectric generator/reentry body system (RTG/RB) and a controlled intact reentry system (CIR). Basically, the composition of each system is as follows.

1.3.1 RTG/RB System.-

a. Radioisotope Thermoelectric Generator (RTG) - converts the decay heat of a radioisotope to electrical energy. This system includes the nuclear heat source (complete structure containing the fuel capsules), the thermoelectric subsystem (thermoelectric couples, thermal insulation and structures), the radiator (section of reentry body surface for radiating waste heat to the space environment) and the voltage regulator (electronic subsystem-physically housed within the CIR System).

b. Reentry Body (RB) - provides physical protection of the nuclear fuel during reentry. This system includes the ablative heat shield (to withstand the aerothermal effects of reentry), the aft cap (which serves to provide fueling access to the RTG, to aerodynamically orient the reentry body and to enclose RTG components), the radio beacon (to permit ground tracking) and miscellaneous structures, connectors and wiring.

NOTE: See Section 6. for nomenclature and definitions of terms used herein.

1.3.2 CIR System.- Controlled Intact Reentry (CIR) - to de-orbit the Reentry Body under controlled conditions in order to effect safe reentry and earth impact of the Reentry Body in the event that satisfactory orbit (nuclear safety standpoint) is not achieved. This system includes:

a. Propulsion Subsystem - rockets for RTG/RB-CIR ejection from the space vehicle, spin-up, de-orbit and de-spin. (Reentry Body separation from the CIR is accomplished by a stored mechanical energy device.)

b. Ordnance Subsystem - pyrotechnic devices to sequence various functions and actuate various mechanical devices.

c. Telemetry and Command Control Subsystem - electronic equipment to transmit certain RTG/RB-CIR status and performance data to ground TT&C stations, to reveive and execute "ejection" and "de-orbit" commands from ground TT&C stations and to receive and execute an "ejection" command from the launch vehicle MDS (this command is locked out until the point during ascent at which the launch vehicle fairing is jetisoned).

1.4 Program Concepts.- The contents of this section are for reference purposes only and supplement the requirements of the interface specification referenced herein.

1.4.1 Employment.- The CRONUS RTG/RB-CIR Systems as described herein are intended for use with a low earth orbital space vehicle (e.g. Nimbus) as a power source. The space vehicle is intended to be launched into a low earth orbit by the Titan III "C" booster.

CRONUS RTG/RB-CIR Systems functions, performance characteristics and capabilities, and provisions for nuclear safety shall be compatible with the following desired flight profiles.

1.4.1.1 Space vehicle attainment of a nominal 600 nautical mile circular orbit with the possibility that the attained orbit may vary from nominal to an eccentric orbit with an apogee of 600 N.M. and a perigee as low as 100 N.M. The orbit shall be obtained in a launch from ETR with perigee initially occurring nearly over the launch site with a posigrade orbital plane inclination of $30^{\circ} \pm 1^{\circ}$ with the equator.

1.4.1.2 Launch of the space vehicle from WTR into an orbit as described above except that orbital inclination with the equator shall be $90^{\circ} \pm 1^{\circ}$.

1.4.2 Deployment.- The RTG/RB-CIR Systems as described herein are intended to be a part of a space vehicle launched from the Eastern or Western Test Range and monitored and controlled from a Satellite Test Center through use of ground tracking telemetry and control stations.

1.4.3 Logistics.-

1.4.3.1 Spares.- The spare items to be provided for maintenance of the RTG/RB-CIR Systems shall be as specified in the Contract incorporating this specification.

1.4.3.2 Maintenance.- Field maintenance (at any location other than the Contractor's manufacturing facility) of the RTG/RB-CIR Systems shall be limited to adjustment and/or replacement (limited to those spares specified in the Contract.

1.4.4 Training.- All personnel who will handle, operate or control Contractor furnished items should receive training by the Contractor as provided for in the contract incorporating this specification.

All personnel who will be in the immediate vicinity of nuclear fueling operations or the nuclear fuel itself should receive special nuclear safety training by the AEC.

2.0 APPLICABLE DOCUMENTS.-

2.1 General.-

2.1.1 Extent of Applicability.- The following documents form a part of this Specification only to the extent specified in the text of this Specification. Where a document or its provisions are to be "used as a guide" (or other similar phrases) the extent of applicability shall be determined by the Contractor based on management and technical judgment. For reference purposes only, the paragraphs in this Specification where each document is called out are shown opposite each document in the following list.

2.1.2 Dates of Issue.- References to documents in the text of this Specification are made by basic number only. Such basic reference shall mean the exact issue specified in this Section 2, including the cited amendments, changes, etc.

2.1.3 Rules of Procedure.- In case of conflict between this Specification and the Contract, the Contract shall govern. In case of conflict between this specification and any document referenced herein, this Specification including any authorized changes, appendices, or addenda hereto, shall govern.

2.2 Documents.- In addition to the following listing the documents referred to in Appendix "A" hereto are also applicable to the extent described in the appendix.

2.2.1 AEC - Sandia Corporation.-		Para. No.
Technical direction provided in writing during Phase 0 of Contract AT(29-2)-2050		3.2.1.3

2.2.2 Military.-

2.2.2.1 Specification.-

MIL-T-5021C-1	Tests, Aircraft and Missile Welding Operators' Qualification	3.2.9.2
MIL-B-5087B	Bond, Electrical and Lightning Protection for Aerospace Systems	3.2.8.3

2.2.2.1 Specification (Cont'd).-		Para. No.
MIL-C-6021C 4 Nov. 64	Castings, Classification and Inspection of	3.2.9.3
MIL-W-6858C 20 Oct. 64	Welding, Resistance, Aluminum, Magnesium, Non-Hardening Steels or Alloys, Nickel Alloys, Heat Resisting Alloys, and Titanium Alloys, Spot and Seam	3.2.9.2
MIL-W-8160D 24 Dec. 63 Amend. 1	Wiring, Guided Missile, Installation of, General Specifications for	3.2.8.1 3.2.8.5
MIL-I-8500B 10 Oct. 60	Interchangeability and Replaceability of Component Parts for Aircraft and Missiles	3.2.12
MIL-W-8604 8 Oct. 59 Amend. 1	Welding of Aluminum Alloys, Process for	3.2.9.2
MIL-W-8611A 24 July 57	Welding, Metal Arc and Gas, Steels, and Corrosion and Heat Resistance Alloys, Process for	3.2.9.2
MIL-Q-9858A 16 Dec. 63	Quality Program Requirements	4.1
MIL-W-16878D 5 July 61 Suppl. #1	Wire, Electrical, Insulated High Temperature	3.2.8.5
MIL-W-18326A	Welding of Magnesium Alloys Gas and Arc, Manual and Machine Processes for	3.2.9.2
MIL-C-26482C 20 Feb. 63 Amend. 1 Suppl. #1 Change 1	Connectors, Electrical, Circular, Miniature, Quick Disconnect	3.2.8.6

2.2.2.1 Specification (Cont'd).-		Para. No.
MIL-M-38310 15 Dec. 64	Mass Properties Control Requirements for Missiles & Space Vehicles	3.2.9.5
MIL-W-45223 26 June 62	Welding, Spot, Hardenable Steels	3.2.9.2

2.2.2.2 Standards.-

MIL-STD-143A 14 May 63	Specifications and Standards Order of Precedence for the Selection of	3.2.2
MIL-STD-130B 7 Feb. 64 Change 1	Identification Marking of U.S. Military Property	3.2.6.1

2.2.3 Contractor.-

2.2.3.1 Specifications.-

MN-2050-1	Specification Plan for the CRONUS Program	6.4
MN-2050-10	Technical Interface Specification for the CRONUS RTG/RB-CIR Systems	3.6.3.5 3.3.1 3.2.7 3.2.5.3.0 3.2.13
MN-2050-20	Technical Interface Specification for the CRONUS Aerospace Ground Equipment	3.0
MN-2050-200	Specification for CRONUS Aerospace Ground Equipment Design, Performance and Test Requirements	3.0

(CEI Specifications - to be prepared - see MN-2050-1)

2.2.3.2 Drawings.-

(CEI Drawings - to be prepared)

2.2.4 Air Force.-

		Para. No.
SSD-CR-65-18 Rev. 1 Sept. 65	Titan III Standard Space Launch System (SSLS) Definition for Payload Contractors	3.2.10.2

3.0 REQUIREMENTS.- This section establishes general requirements for the design, performance and test of the CRONUS RTG/RB-CIR Systems. Specific items of CRONUS equipment shall be in accordance with the requirements set forth in the following Contract End Item (CEI) specifications.

List of CRONUS RTG/RB-CIR Systems CEI specifications.
(To be determined - See MN-2050-1.)

Requirements for the interface of the various elements of the CRONUS RTG/RB-CIR Systems with elements of equipment and program of others shall be in accordance with Technical Interface Specification MN-2050-10.

Design, performance, test and interface requirements for Aerospace Ground Equipment to support the CRONUS RTG/RB-CIR Systems shall be as specified in MN-2050-20 and MN-2050-200.

3.1 Primary Performance Characteristics.- The CRONUS RTG/RB-CIR Systems shall be capable of:

(C) 3.1.1 Power.- Furnishing electrical power (250 watts at 28 volts ± 10%, direct current) to the space vehicle regulated bus. The required output shall be provided after exposure to the non-operational environmental conditions and during exposure (while in orbit) to the operational environmental conditions specified in Paragraph 3.2.10 herein and following not more than 30 days of fueled ground operation and not more than 60 days of nominally steady state electrically heated operation.

(C) 3.1.2 Reentry.- The RTG/RB-CIR Systems shall be capable of effecting controlled, intact reentry (of the Reentry Body containing the Nuclear Heat Source) with impact within specific areas to be selected on the basis of nuclear safety considerations.

Controlled reentry shall be possible from the orbits specified herein with space vehicle orientation errors (at the time of RTG/RB-CIR ejection) of up to 5° in angle with angular rate of change up to 30° per second and roll rates up to 150° per second.

Reentry without atmospheric burnup shall be possible from the orbits specified herein regardless of the space vehicle orientation or angular rate of change (at time of RTG/RB-CIR ejection) but with roll rates not more than 600° per second.

(C) 3.1.2 Reentry (Cont'd.).-

Controlled reentry shall be possible within a period of (to be determined) hours after jetison of the launch vehicle fairing with not more than 9 hours between ejection of the RTG/RB-CIR from the space vehicle and initiation of the de-orbit sequence.

Attitude control and guidance prior to RTG/RB-CIR ejection shall be provided by the space/launch vehicle. Attitude error sensing and the provision of the automatic ejection signal shall be functions of the launch vehicle MDS.

Reentry shall be accomplished by the following functions:

a. Ejection (upon ground command or upon automatic command from the launch vehicle MDS) of the RTG/RB-CIR Systems from the space vehicle at any time after jetison of the launch vehicle fairing and before attainment of acceptable orbit by the space vehicle.

b. Automatic (self sequenced) spin stabilization of RTG/RB-CIR attitude during ejection and de-orbit.

c. Deceleration (upon ground command) of the ejected RTG/RB-CIR Systems to reentry velocity.

d. Automatic (self sequenced) de-spin of the RTG/RB-CIR after deceleration.

e. Automatic (self sequenced) separation of the Reentry Body from the CIR System following de-spin.

f. Automatic (aerodynamically induced) orientation of the Reentry Body (with respect to its reentry trajectory) during atmospheric reentry.

g. Ablative dissipation of reentry heat (Reentry Body only).

h. Containment of nuclear material during ocean impact and during immersion in sea water at depths up to 6000 feet for a minimum period of (to be determined on consideration of the ultimate biological hazard) years. Containment integrity shall not be required following burial in soil or media other than water nor in ocean depths greater than 6000 feet.

3.1.3 Safety.- Assuring nuclear safety during operation and in the event of malfunctions of the space/launch vehicle by means of positive containment of the nuclear material. Malfunctions and the resultant accident environments to be considered shall be as follows:

3.1.3 Safety (Cont'd).-

(To be determined on the basis of mission and equipment definitions.)

The basic consideration in safety evaluation shall be the ultimate biological hazard.

Each fuel capsule contained in the heat source shall be capable of withstanding (maintaining structural integrity) the following conditions. (These are tentative conditions used for preliminary consideration only and, as such, shall be subject to revision on the basis of data available during design and analysis phases of the program.)

Normal operating conditions as specified herein

Prelaunch exposure to air

Sea water corrosion (time to be determined on the basis of biological hazard analysis)

Blast overpressure of at least 100 psi

Hydrostatic pressure (external) equivalent to 6000 feet of sea water

Fireball resulting from launch pad or in-flight explosion of launch vehicle.

Reentry from orbit (within the Reentry Body)

Earth impact (on granite) at its free flight terminal velocity at sea level.

Verification of performance capabilities shall be accomplished in accordance with the requirements of Section 4 of this specification and the requirements of subsidiary specifications prepared and coordinated in subsequent program phases.

3.2 Design and Construction.-

3.2.1 General.- All elements of the CRONUS RTG/RB-CIR Systems shall conform to the following design and construction requirements except where such compliance would be in conflict with the performance requirements of Section 3.1 or of the CRONUS RTG/RB-CIR Systems CEI specifications. In case of such conflict, the Contractor shall recommend suitable deviation, obtain approval of the AEC and document the change in the appropriate specification.

3.2.2 Specifications and Standards.- The Contractor shall select and use specifications and standards for materials, parts and processes (where not otherwise called out herein) using MIL-STD-143 as a guide but based on the Contractor's evaluation of the following criteria. These criteria shall be applied in the order of priority shown with all being met where possible.

a. Suitability for use for the mission (including safety considerations).

b. Parts, processes, etc. previously qualified for similar applications.

c. Government standard parts, processes, etc.

d. Low cost.

Military Specifications and Standards shall be applicable to the design and construction of the CRONUS RTG/RB-CIR Systems to the extent provided for herein and in Appendix "A" hereto. The performance of tests and the furnishing of data in accordance with the requirements of Military Specifications and Standards shall be accomplished to the extent specifically provided for herein and in other Contractor prepared documentation furnished in accordance with the provisions of the contract but shall not be deemed to be required merely by virtue of specification reference.

3.2.3 Materials, Parts and Processes.- Materials, parts and processes selected by the Contractor shall be compatible with the CRONUS RTG/RB-CIR Systems performance and environmental requirements. Strategic or critical materials shall not be used, however, unless essential to the attainment of required performance and for conformance with environmental requirements.

3.2.3.1 Standard and Commercial Parts.- The Contractor may use commercial or Contractor standard materials, parts or processes when all CRONUS RTG/RB-CIR Systems requirements are met thereby and the Commercial or Contractor standards to be used are equivalent to or exceed the requirements of other documents or there are no applicable and satisfactory Government or industry standard documents.

3.2.3.2 Parts Qualification.- All materials and parts used in portions of the CRONUS RTG/RB-CIR Systems which are designated in CEI specifications as "critical" shall be qualified for the intended application as follows:

a. QPL - Standard parts procured to Government specifications controlled by Qualified Products Lists and applied within limits specified in applicable CEI specifications shall be considered qualified for use in the CRONUS RTG/RB-CIR Systems.

b. Use - Parts or materials having demonstrated records of satisfactory previous performance in applications equally or more severe than the intended application shall be considered qualified for use in the CRONUS RTG/RB-CIR Systems.

c. Similarity - Parts or materials identical to QPL or use qualified items except for details which are not affected by the intended application shall be considered qualified for use in the CRONUS RTG/RB-CIR Systems.

d. Analysis - A part, not otherwise qualified, shall be considered qualified for use in the CRONUS RTG/RB-CIR Systems upon submission of analysis substantiating to the satisfaction of the AEC and the User that such item will withstand the requirements of its intended application.

e. Test - A part, not otherwise qualified and not subject to meaningful analysis shall be considered qualified for use in the CRONUS RTG/RB-CIR Systems upon successful completion of qualification tests as specified in the applicable CEI specification.

3.2.4 Workmanship.- During the fabrication of the CRONUS RTG/RB-CIR Systems, a high level of workmanship shall be ensured by the use of properly trained personnel equipped with correct tools in good condition, by the selection and careful use of adequate techniques and by the application of uniform standards.

3.2.5 Electromagnetic Interference.- The CRONUS RTG/RB-CIR Systems shall be designed to operate in conjunction with other equipment related to the space vehicle, launch vehicle and launch complex without detriment resulting from electromagnetic radiation of other devices and without causing detriment to other devices. Requirements for electromagnetic compatibility shall be as specified in Interface Control Specification MN-2050-10.

3.2.6 Identification and Marking.-

3.2.6.1 Each CRONUS RTG/RB-CIR Systems and all interchangeable units supplied as a part of the RTG/RB-CIR Systems shall be provided with an identification plate or decal conforming to MIL-STD-130 unless the availability of space, operating temperature, or other constraints prohibit such identification. In the event of such provisions, the items shall be marked as described in "3.2.6.2" following.

3.2.6.2 All replaceable parts, subassemblies and assemblies shall be marked with an identifying number consistent with the Contractor's Drawing System except where the size of the item prohibits such practice. Modified Government furnished property shall be re-identified. Unmodified GFP shall retain its original identification.

3.2.6.3 All interchangeable units, and all End Items that weigh forty-five (45) pounds or more shall have the weight marked to the next highest five pound increment on at least one easily visible external surface.

3.2.7 Materials Compatibility.- Materials compatibility between the CRONUS RTG/RB-CIR Systems and space vehicle equipment shall be controlled by coordination between the Contractor and the User and shall be documented in Interface Control Specification MN-2050-10. All metallic parts shall be protected against corrosion by finishes, coatings or selection of suitable base metals except where such protection is impractical due to operating temperature and/or performance considerations. All materials and parts used, unless contained in hermetically sealed assemblies, shall be incapable of supporting fungus growth or shall have suitable protective finishes or coatings.

3.2.8 Electrical Design.- The following requirements shall govern except that previously designed and qualified subsystems (such as the beacon and the telemetry and command control equipment) shall not be subject to rejection on the basis of non-conformance to these requirements.

3.2.8.1 Identification.- All external electric wire and cabling shall be identified by appropriate color coding, using as a guide MIL-W-8160 except that it shall be accomplished by imprinting on the cable or sleeve within three inches of each termination or junction. This requirement is not mandatory where the thermal environment prevents use of any such method.

3.2.8.2 Grounding.-

a. Output power - The output terminals (two) of the generator system provided for use by an external load shall not be grounded to the generator system.

b. All internal circuitry of the CRONUS RTG/RB-CIR Systems which draws power from RTG thermoelectric modules shall have ground or return lines floating with respect to the system structure.

3.2.8.2 Grounding (Cont'd).-

c. All electrical connections provided within the CRONUS RTG/RB-CIR Systems shall provide for integral single lead ground to termination except where electromagnetic interference characteristics dictate the use of individual ground or return circuits.

3.2.8.3 Bonding.- All interchangeable or replaceable assemblies (chassis, enclosures, etc.) used shall be electrically bonded in such a manner that an electrical path is established from each assembly to the external structure on which the RTG/RB-CIR is mounted. RF shielding shall be grounded through the local structure. RF bonding shall be in accordance with MIL-B-5087.

3.2.8.4 Circuit Protection.- Circuit protection devices such as fuses and circuit breakers need not be used in the generator system. The loss (by a fault resulting in open or short circuit) of any single thermoelectric couple shall not result in catastrophic failure of the generator, but shall be seen only as a reduction in generator output power.

3.2.8.5 Wire.- All wire used for electrical hookup shall meet or exceed the applicable requirements of MIL-W-16878. All wiring external to components shall be installed using MIL-W-8160 as a guide.

3.2.8.6 Electrical Connections.- Electrical connectors shall be in accordance with MIL-C-26482 unless functional requirements and/or severe conditions dictate the use of other connectors. Wires, lugs, terminals and connectors shall be so arranged and identified as to preclude incorrect CRONUS assembly and installation, and shall be such as to minimize ohmic losses and mechanical loosening of connections. Redundant or spare circuits need not be provided between the RTG/RB-CIR Systems and the satellite vehicle. A "quick disconnect" connector shall be provided for electrical (power and instrumentation) connections between the RTG/RB and the CIR System.

3.2.8.7 Batteries.- The CIR System shall include an alternate power supply (battery) for the telemetry and command control equipment which can be activated either by ground command or automatically upon loss of power from the RTG/RB System. The tracking beacon provided in the CRONUS RTG/RB System shall include a separate power supply (battery) which is activated automatically upon ejection of the RTG/RB-CIR Systems from the space vehicle.

3.2.9 Mechanical Design.- The following requirements shall govern except that the TT&C (being a previously designed and qualified subsystem) and other qualified parts shall not be subject to rejection on the basis of non-conformance to these requirements.

3.2.9.1 Handling and Servicing Provisions.- All interchangeable units weighing forty-five (45) pounds or more shall have convenient provisions for lifting by one or more persons as necessary. All units over ninety (90) pounds shall incorporate provisions for mechanically lifting the item.

3.2.9.2 Welding.- All welding, other than that provided for fuel containment integrity, shall be in accordance with MIL-W-6858, MIL-W-8604, MIL-W-8611, MIL-W-18326, or MIL-W-45223, as applicable. Operators (welding) shall be qualified in accordance with MIL-T-5021.

Welding of fuel capsules shall be as specified in the applicable CEI specifications.

3.2.9.3 Castings.- All castings shall be classified and inspected per the requirements of Specification MIL-C-6021.

3.2.9.4 Fasteners.- All mechanical fasteners shall be secured by lock wire, adhesive binding material, lock washers, or other similar devices.

3.2.9.5 Weight and Balance.- The total weight of the CRONUS RTG/RB-CIR Systems (fueled) as installed in the space vehicle shall not exceed 800 pounds. During the design and development of the RTG/RB-CIR Systems, the Contractor shall furnish calculated weight and center of gravity data to the User as may be required by the User to establish conformance with applicable interface control documents. Calculated data shall be verified by actual measurement at the earliest practicable date. Weight and balance reporting shall be in accordance with MIL-M-38310 Table 1, Column 3.

3.2.9.6 Structures.- Structural assemblies making up the RTG/RB-CIR Systems shall be capable of withstanding the mechanical loads indicated below without loss of ability to support internal components or components mounted externally and without deformation resulting in interference with any subsequent function such as separation, retrofire or reentry.

3.2.9.6 Structures (Cont'd).-

a. Ejection structure (track system) - must withstand shock load of RTG/RB-CIR Systems separation.

b. CIR system structure - same as a.

c. RTG/RB System - must withstand shock loads as in a, above, plus the airloads resulting from reentry.

3.2.10 Environmental Conditions.-

3.2.10.1 Non-Operational.- The CRONUS RTG/RB-CIR Systems shall withstand the following environmental conditions during transportation and/or storage without damage which results in subsequent impairment or degradation of performance beyond the limits of acceptability specified in the applicable CEI specifications.

Temperature:	$-35^{\circ}F$ to $+ 160^{\circ}F$ ($160^{\circ}F$ based on ambient air at 125° with equipment temperature increased $35^{\circ}F$ for up to 4 hours by solar radiation)
Altitude:	sea level to 35000 feet (rate of change not more than 1000 feet per second)
Relative Humidity:	up to 100% (including conditions resulting in condensation on equipment surfaces).
Salt Fog:	5% by weight.
Shock:	5 g shock loads to base of transportation container

Vibration:

Packaged Weight (lbs)	Frequency (cps)	Double Amplitude or Acceleration
All	5-15	0.4"
< 100	15-500	$\pm$ 5 g
100-300	15-50	$\pm$ 5 g
	50-500	Inversely proportional to weight
Over 300	15-50	$\pm$ 5 g

3.2.10.2 Operational.- The CRONUS RTG/RB-CIR Systems shall provide the specified performance while operating under any combination of the following environmental conditions.

a. Pre-launch and launch - as given in SSD-CR-65-18 and IFS-TIII-20004.

b. Orbital - thermal, vacuum and radiation (solar and ionizing) conditions as dictated by orbital altitudes between 100 and 600 nautical miles and including the following meteoroid environment:

(To be determined on the basis of best data available at time of mission definition.)

3.2.11 Propulsion Components and Ordnance Devices.-

3.2.11.1 General.- Devices using pyrotechnics and/or stored mechanical energy for propulsion, actuation, timing, etc., shall be solid fuel, state-of-the-art devices; shall be standard "off-the-shelf" items wherever possible; and shall be qualified by both test and analysis as specified in applicable CEI specifications.

The Contractor shall furnish three extra sets of shorting plugs for each hazardous ordnance item and for each accessible electro-explosive device used in the RTG/RB-CIR Systems and one extra set of safing pins (if used).

3.2.11.2 Ejection Rocket.- The rocket(s) used to eject the RTG/RB-CIR Systems from the space vehicle (separation rocket) shall be capable of imparting a velocity increment to the RTG/RB-CIR Systems in a direction perpendicular to the space vehicle's velocity vector sufficient to ensure complete separation to a distance sufficient to avoid any interference between the space/launch vehicle and the RTG/RB-CIR Systems during retro-fire.

3.2.11.3 Spin Rocket.- The rocket(s) used to spin the RTG/RB-CIR Systems during ejection (for spin stabilization) shall be capable of imparting spin (rotation about the longitudinal axis) to the RTG/RB-CIR Systems of 60 rpm (tentative).

3.2.11.4 Retro Rocket.- The rocket(s) used to de-orbit the RTG/RB-CIR Systems shall be capable of imparting a thrust to the RTG/RB-CIR Systems, in a direction opposite ($\pm 0.1^{o}$) to the RTG/RB-CIR Systems velocity vector sufficient to reduce the velocity of the RTG/RB-CIR Systems to that velocity required to assure earth impact in a deep ocean area.

3.2.11.5 De-spin Rocket.- The rocket(s) used to de-spin the RTG/RB-CIR Systems following retro-fire shall be capable of imparting an angular velocity to the RTG/RB-CIR Systems (rotation about the longitudinal axis) sufficient to reduce the spin to a nominal zero rpm spin rate.

3.2.11.6 Separation Device.- The stored mechanical energy device used to separate the Reentry Body from the CIR System following de-spin shall be capable of imparting a velocity increment to the Reentry Body in a direction parallel to the RTG/RB-CIR Systems velocity vector sufficient to ensure complete separation to a distance sufficient to avoid any interference between the CIR System and the Reentry Body during reentry.

3.2.12 Interchangeability and Replaceability.- Specification MIL-I-8500 shall be used as a guide in the design and selection of the interchangeable and replaceable parts. Demonstration of compliance and verification of the interchangeability or replaceability of articles shall not be required. Additional requirements applicable to repair and maintenance shall be considered as unspecified.

3.2.13 Nuclear Design.- Nuclear heat source design and development shall be based on radioisotope fuel characteristics as set forth in documents referenced in paragraph 2.2.1, herein; the results of required safety analyses, a preliminary hazards analyses report as approved by the AEC, and the results of safety tests of the heat source as performed by the Contractor and others. Calculations for safety analyses, system design, etc. shall be based on radiation data as specified in MN-2050-10.

3.2.14 Thermal Design.-

3.2.14.1 Heat Rejection.- The CRONUS RTG/RB-CIR Systems (particularly the RTG) shall be capable of dissipating the waste heat of the nuclear fuel, using passive heat rejection methods, during prelaunch (with supplementary air cooling by the User in accordance with MN-2050-10), launch, orbital and reentry operations.

3.2.14.2 Heat Shielding.- The Reentry Body ablative heat shield, in conjunction with the aft body, shall be capable of constraining the temperatures of vital components within the reentry body to acceptable limits during reentry resulting from any credible kinematic situation including natural orbital decay after a maximum of * in orbit. Heat shield design, construction and materials shall be qualified by testing as specified in the applicable CEI specification.

* Period of time (years) to be determined.

3.2.15 Radiation Shielding Design.- The CRONUS RTG/RB-CIR Systems shall not include biological shielding and shall not include shielding to protect space vehicle equipment or launch vehicle equipment.

3.2.16 Explosion Proofing.- The CRONUS RTG/RB-CIR Systems shall be so designed as not to cause ignition of an explosive atmosphere during normal operations. This requirement may be met by using a purge system during launch pad operations, if necessary.

3.3 Configuration and Installation.-

3.3.1 General.- All elements of the CRONUS RTG/RB-CIR Systems shall conform to the configuration requirements herein and to the installation requirements of Interface Control Specification MN-2050-10 and the following, except where such compliance would be in conflict with the performance requirements of section 3.1 or of the CRONUS RTG/RB-CIR Systems CEI Specifications. In case of conflict the Contractor shall recommend suitable deviation, obtain approval of the Procuring Activity and document the change in the appropriate specification in accordance with the requirements of MN-2050-1.

3.3.2 Basic Requirements.-

Item	Configuration	Installation
RTG/RB-CIR Systems	Complete, spaceworthy assembly of all CRONUS airborne components.	Space vehicle. Retained by ejection hardware.
RTG/RB System	Ballistic reentry body (of blunted cone design) with hinged access cap, radiator surface, and ablative heat shield.	CIR structure. Retained by separation hardware.
	Also includes:	
T/E Subsystem	Subassembly of thermoelectric couples, modules and hardware.	Within reentry body structure.
Heat Source	Nuclear subsystem. Cylindrical array of 36 fuel capsules in support structure with hardware and thermal insulation.	Within T/E Generator. Retained by latch hardware.
Voltage Regulator	Electronic subsystem	Within CIR structure.
Beacon	Electronic subsystem (with battery and antenna).	Within (and on) reentry body structure.

3.3.2 Basic Requirements (Cont'd).-

Item	Configuration	Installation
CIR System	Assembly of equipment and support structure	Space vehicle
Telemetry and Command Control	Electronic subsystem (with battery and antennas)	Within (and on) CIR structure
Propulsion and Ordnance	Pyrotechnic components (Reentry Body separation by stored mechanical energy device)	On CIR structure

3.3.3 Nuclear Requirements.- The RTG Heat Source shall be in accordance with drawing (to be prepared) for Sr-90 fuel or with drawing (to be prepared) for Pu-238 fuel. The Sr-90 and Pu-238 sources shall be physically interchangeable. Heat Source characteristics shall be as follows at time of encapsulation.

	Sr-90	Pu-238
Total thermal output of heat source	* (± 3%) watts	* (± 3%) watts
Maximum surface contamination (by wipe test) over the total surface of any single capsule	0.05 microcuries	0.05 microcuries
Thermal output of any single capsule	* watts (± 5%)	* watts (± 5%)
Maximum weight of encapsulated fuel in any single capsule	* grams	* grams
Maximum radiation dose from the heat source (in air, at any point one meter from the centroid of the heat source)	* roentgens/hr	* roentgens/hr.

*data to be determined on the basis of final generator design and coordination with Fueling Agency. A certified laboratory analysis shall be provided for all materials used in construction of heat source parts. Any deviation from the governing material specifications specified by procurement documents and/or manufacturing drawings shall be cause for rejection.

3.3.4 Prototype Requirements.- The prototype RTG/RB-CIR Systems intended for the demonstration (unfueled) flight (see paragraph 4.7, herein) shall be qualified and accepted as for operational flight units but may have electric power generation and regulation devices simulated and shall include special instrumentation and telemetry equipment (GFE) to verify proper execution of all RTG/RB-CIR functions during flight and to provide measurements of Reentry Body attitude, temperatures and pressures during reentry.

3.4 Reliability.- The performance capability and reliability allocations for each of the systems and subsystems which comprise the CRONUS RTG/RB-CIR Systems shall be as set forth in the applicable CEI specifications. The overall reliability program shall evaluate (by test and analysis) the unit-to-unit variability of the RTG/RB-CIR Systems capacity to survive and operate properly following exposure to the manufacture to orbit sequence of environments and shall evaluate the time rate of degradation of performance under simulated orbital conditions.

The probability that the RTG/RB will survive the launch environment and operate properly shall be as follows:

For One Year Orbital Life		For Five Year Orbital Life	
Probability	Confidence Level	Probability	Confidence Level
.99	*	.99	*
		.75	*

*To be determined on the basis of mission definition and as specified in the contract.

3.5 Interfaces.- The CRONUS RTG/RB-CIR Systems as installed and/or operated at the launch complex, shall operate compatibility with and shall not interfere with space/launch vehicle equipment and/or procedures. Specific requirements for interfaces between the CRONUS RTG/RB-CIR Systems and other equipment shall be as specified in Interface Control Specification MN-2050-10.

3.6 Configuration Control.- Any change to the operational CRONUS RTG/RB-CIR Systems which changes interface characteristics or performance as defined herein and in MN-2050-10 shall require a change in system identification as well as a change in the appropriate specification in accordance with the requirements of MN-2050-1.

3.7 Nuclear Safety.- The CRONUS RTG/RB-CIR Systems shall be designed, developed and fabricated to safely integrate into the facilities, equipment and operations of the satellite program and to provide the capability of effecting controlled intact reentry of the nuclear fuel from orbital flight and positive containment of the fuel.

The probability that localized radiation injury of people will result from reentry (without atmospheric burnup) shall be no greater than 1 in 10^6 per launch. The probability that atmospheric burnup of nuclear material during reentry will result in a widespread biological hazard shall be no greater than 1 in 10^7 per launch.

The Contractor shall prepare and furnish those reports and other documents necessary to establish the nuclear safety of the CRONUS RTG/RB-CIR Systems and shall assist the User (by preparing, providing and presenting data as directed by the AEC) to obtain required authorizations, for possession and use of nuclear materials at the launch site.

Provisions for nuclear safety shall be based on radioisotope fuel characteristics, mission orbit definitions, launch sites, and limiting probabilities for radiation injury and fuel release as set forth herein and in the documents listed in 2.2.1. The basic consideration in matters relating to safety shall be the ultimate biological hazard. All matters concerning range safety shall be subject to negotiation with the AEC, the User, the range and the Contractor.

4.0 QUALITY ASSURANCE PROVISIONS.-

4.1 General.- The quality assurance provisions specified herein include the major requirements which will assure adequate assessment, when coupled with a detailed quality control program, of development progress, verification of performance, and high standards of fabrication. The test program provided for herein shall provide supplementary data for use in the Quality and Reliability Programs evaluations. The Quality Control Program used in conjunction with these requirements shall be in accordance with MIL-Q-9858 and a Contractor prepared-Procuring Agency approved Quality Program Plan.

4.2 Classification.- All inspections and tests shall be classified in one of the categories specified below, and when so classified shall be conducted in accordance with the requirements of that category. Any changes in the testing program, or the need to repeat a previously accomplished test, caused by an authorized hardware or program change, shall be proposed and authorized as a part of the change, including modification and addition to the requirements of this specification.

4.2.1 Inspection.- Inspection shall be a detailed physical examination of an item to determine its conformance with the applicable contract requirements. The Contractor shall conduct inspection of all items from receipt inspection of parts and materials through final assembly. The Government may witness any such inspection at the Government's discretion upon notice to the Contractor prior to the start of such inspection.

4.2.2 Qualification.- Qualification shall be a detailed test and/or analysis of an item (or process) to establish the suitability of that item (or process) for its intended application. The Contractor shall qualify materials, parts and processes in accordance with the applicable material and/or parts specifications, Contractor's Test Plan and CEI specifications. Qualification shall be based on technical data that is available in reports, test results, laboratory notebooks, etc. Preparation of detailed data or special reports shall not be required. The Contractor shall present the informal data to the designated Procuring Activity Technical or Contractual representative, who shall execute a Certification of Qualification upon his satisfaction that the data does evidence qualification.

4.2.2.1 Prototype qualification of the RTG/RB-CIR Systems (prior to orbital flight) shall be accomplished by test (including life testing of electrically heated operational prototypes) as detailed in the appropriate CEI specifications.

4.2.2.2 Flight qualification of the RTG/RB-CIR Systems (for fueled flight safety and program integration purposes) shall be accomplished by flight test (functional demonstration of operational but unfueled components) as required by Paragraph 4.6, hereof.

4.2.3 Acceptance.- Acceptance of CRONUS RTG/RB-CIR Systems items for delivery shall be based on a detailed functional evaluation of each contract end item along with sufficient examination of records and data to establish that:

a. The item meets all requirements of Section 3 hereof and of the applicable CEI specification to the extent that such compliance can be verified at the Contractor's plant.

b. All contractual quality assurance requirements have been met.

c. All data and documentation requirements have been met.

4.3 Compliance Verification.- All of Section 3 of this specification shall be subject to compliance verification, when applicable. Verification shall consist of documented certification of compliance with contractual requirements as determined by inspection, analysis, demonstration, test or examination of records; shall be furnished to the Contracting Officer; and shall constitute proof of compliance of the requirements which have been verified.

4.4 Test Plan.- Engineering development, prototype, qualification, acceptance and system testing shall be accomplished in accordance with a Test Plan prepared by the Contractor and approved by the AEC and in accordance with the test requirements of the individual CEI specifications.

4.5 Fueling Demonstration.- The Contractor, using a mock up of the RTG/RB-CIR Systems (but portions of the actual GHE) shall demonstrate the capability of fueling and defueling the CRONUS RTG safely under simulated launch conditions. (See 4.6 of MN-2050-200).

4.6 Demonstration Flight.- The CIR capability of CRONUS shall be demonstrated by a simulated mission using an actual prototype CIR System along with a special Reentry Body incorporating flight performance instrumentation and telemetry equipment in place of the thermoelectric subsystem and nuclear fuel. (See 4.7 of MN-2050-200.)

5.0 PREPARATION FOR DELIVERY.-

All CRONUS RTG/RB-CIR Systems end items shall be cleaned, preserved and marked in accordance with the applicable CEI specifications and placed in the appropriate shipping containers. Loaded shipping containers shall be marked and shipped (FOB the Contractor's plant) in accordance with Contracting Officer direction.

6.0 NOTES.-

6.1 Definition of Terms.- Certain terms as used herein shall be defined as follows.

AGE - (Aerospace Ground Equipment) That equipment on the ground, including all implements, tools and devices (mobile or fixed), required to inspect, test, adjust, disassemble, transport, safeguard, record, store or otherwise function in support of a space vehicle or the like, either in the research and development phase or in an operational phase. AGE is not considered to include land or buildings, nor guidance station equipment but is considered to include ground handling equipment (GHE), operational ground equipment (OGE) and maintenance ground equipment (MGE).

ALO - U. S. Atomic Energy Commission, Albuquerque Office, P. O. Box 5400, Albuquerque, New Mexico 87115.

baseline - An agreed upon "point of departure" on which all subsequent design, fabrication, etc. will be based. Usually contained in contractual specifications.

booster - 1. The item which boosts the Satellite Vehicle into its initial trajectory. 2. Short for booster engine or rocket. 3. The Launch Vehicle.

CEI - See "Contract end item," below.

CIR - Controlled Intact Reentry System. The command electronics, sensory devices, orientation system, retro device, etc., required to effect the safe disposition of the radioisotope fuel by means of controlling its intact reentry.

cognizant agencies - Government agencies, including the Using Agency participating in the satellite program.

command - A signal which initiates or triggers an action in the device which receives the signal.

command control - A system whereby functions are performed as the result of a transmitted signal.

component - An article which is a self contained element of a complete operating unit and performs a function necessary to the operation of that unit.

6.1 Definition of Terms.- (Continued)

contract end item (CEI) - A deliverable item which is formally accepted by the procuring agency as an entity, on a DD Form 250, in accordance with the requirements of a specification. The prime level of assembly for technical and contractual management (customer) control, schedule, configuration, etc., and accountability for provisioning spares and preparing manuals.

controlled intact reentry system (CIR) - See CIR above.

Contractor - The Corporation (or other entity) selected by the Procuring Agency to furnish the CRONUS RTG/RB-CIR. In the event that the generator system (RTG/RB), the CIR system and the AGE are not all furnished by a single contractor, then the word Contractor, when used with reference to activity involving more than one of these three systems, shall mean that Contractor who has been assigned program integration responsibility by the Procuring Agency.

CRONUS - Controlled Reentry Orbiting NUclear System - consists of the complete set of equipment necessary to the function and operational use of the 250 watt(e) power system. Includes flight and ground equipment. (CIR + RTG/RB + AGE).

device - A mechanism that works to serve a particular purpose.

dummy heat source - A device to simulate the physical characteristics (non-nuclear and non-thermal) of the nuclear heat source.

electrical heat source - A device to simulate the thermal output (non-nuclear) of the nuclear heat source.

environment - An external condition or the sum of such conditions in which a piece of equipment or a system operates; as in "temperature environment," "vibration environment," or "space environment."

facility - That equipment (including land and buildings), guidance station equipment and S/V-L/V AGE provided as part of the test range, launch site, or vehicle rather than as part of the CRONUS System.

fuel - 1. The radioisotope material which serves as the source of power for the Generator (RTG). 2. Any substance used to produce heat, either by chemical or nuclear reaction; see propellant.

6.1 Definition of Terms.- (Continued)

fuel capsule - An individual container of radioisotope fuel; consisting of the fuel provided by the Fueling Agency within capsule shell components furnished by the Contractor.

fuel form - A particular composition of radioisotope fuel.

fuel handling equipment - see ground handling equipment.

fueling agency - The government agency or Contractor selected by the AEC to furnish and encapsulate the radioisotope fuel.

generator system (RTG/RB) - The composite of heat source, thermoelectrics, radiator, voltage regulator, heat shield, aft cap of the reentry body and RF beacon.

GFE - Government Furnished Equipment.

GHE - Ground Handling Equipment (see below).

ground handling equipment (GHE) - That handling equipment which will be required at the launch site for the sole purpose of loading radioisotope fuel into a spacecraft system.

heat source - The assembly or arrangement of encapsulated radioisotope material which serves as the source of energy for the RTG.

heat source transportation cask - The vessel used to contain the nuclear heat source during transportation from the fueling agency to the launch site and about the launch site.

ICD - Interface Control Drawing - A Contractor prepared, User-Contractor coordinated drawing intended to control a specific area of equipment interface.

integration - The process of assuring that the major elements of a system or program be conceived, designed, assembled, tested, operated, and documented in such a manner as to be compatible with each other and satisfy objectives.

interface - The point or area where a relationship exists between two or more parts, systems, programs, persons, or procedures wherein physical and/or functional compatibility is required.

6.1 Definition of Terms.- (Continued)

launch - 1. The action taken in launching a space vehicle.
2. The resultant of this action, i.e., the transition from static repose to dynamic flight.

launch complex - A general term intended to include all support facilities within a confined area which are vital to Vehicle pre-flight checkout and launching. Includes primary facilities, property and AGE used to launch a Launch Vehicle. Includes Launch Operations Building, launch pads, etc. Usually one complex is peculiar to a specific Booster, and sometimes to a specific Space Vehicle. Excludes multi-purpose support facilities such as range safety, tracking stations, etc. The launch pad is the area immediately surrounding the Space Vehicle, its composition varies according to needs.

launch control center (LCC) - That room or area within the Vertical Integration Building from which launch operations are conducted.

launch pad - see launch stand.

launch site - A group of adjacent launch positions, with the required storage, assembly and maintenance facilities necessary to launch the assigned Vehicles.

launch stand - A facility or station at which a Space Vehicle is launched, normally incorporating a launch pad with launcher.

launch vehicle - A rocket or other vehicle used to launch a probe, satellite, or the like. The launch vehicle includes transtage Vehicles but is not considered to include the Satellite Vehicle.

maintenance ground equipment (MGE) - Equipment used on the ground to transport, handle and maintain the CRONUS RTG/RB-CIR Systems and the CRONUS GHE. Does not include nuclear fueling equipment.

malfunction detection system (MDS) - An automatic, launch vehicle borne, system which detects malfunctions and initiates pre-programmed emergency actions as a result.

6.1 Definition of Terms.- (Continued)

mobile service tower (MST) - A massive scaffolding structure mounted on a bridge or platform supported by a pair of towers or trestles that normally run back and forth on parallel tracks, used to assemble and service a large rocket as the rocket rests on its launching pad. Often shortened to Gantry.

operational ground equipment (OGE) - Those elements of AGE that are directly involved in controlling and/or monitoring the performance of a flight article, or in controlling and monitoring the performance of the GHE.

posigrade motion - Motion in an orbit in the usual orbital direction of celestial bodies within a given system.

probability - The chance that a prescribed event will occur, represented as a pure number P in the range $0 \leq P \leq 1$. The probability of an impossible event is zero and that of an inevitable event is unity.

propellant - (symbol p, used as a subscript) - Any agent used for consumption or combustion in a rocket and from which the rocket derives its thrust, such as a fuel, oxidizer, additive, catalyst, or any compound or mixture of this; specifically, a fuel oxidant, or a combination or mixture of fuel and oxidant used in propelling a rocket.

quality assurance - A planned and systematic pattern of all actions necessary to provide adequate confidence that the end items will perform satisfactorily in actual operations.

radioisotope thermoelectric generator (RTG) - The fuel, encapsulation, insulation, thermoelectrics, radiator, and associated structures, used to convert the decay heat of the radioisotope fuel to electric energy.

RTG/RB-CIR Systems - The complete set of Contractor assembled items designed for installation and flight in the space vehicle.

recovery - The act of retrieving a portion of a Vehicle or Satellite which has survived reentry.

reentry body - In this instance the RTG/RB System (which reenters as a unit).

6.1 Definition of Terms.- (Continued)

reliability - The probability that system, subsystem, component, or part will perform its required functions under defined conditions at a designated time and for a specified operating period.

retrograde motion - Motion in an orbit opposite to the usual orbital direction of celestial bodies within a given system.

Sandia Corporation - A cost-type operating contractor of the Government formed by the Western Electric Company to perform work for the AEC.

Sandia Representative - The customer's Technical Director for the program.

satellite - An object designed to be placed in orbit but excluding companion bodies that may incidentally also orbit (see also spacecraft).

satellite vehicle (S/V) - The items launched by the Booster.

sheltered equipment - That equipment which shall operate in a laboratory or other areas where a degree of environmental protection is provided.

shield - A body of material used to prevent or reduce the passage of particles or radiation.

SIC - Spacecraft Integration Contractor. That contractor responsible to the AEC/User for the integration of all airborne equipment.

space - The volume in which all celestial bodies, including the earth move.

space vehicle - Device, manned and unmanned, which is designed to be placed into an orbit about the earth or into a trajectory to another celestial body.

system - Any combination of parts, assemblies and sets joined together to perform a specific operational function or functions.

telemetering - Data transmitted by means of electromagnetic propagation.

6.1 Definition of Terms.- (Continued)

TT & C - Tracking, Telemetry and Control. Equipment (both airborne and ground equipment) for communication with and remote control of a device or system at a distance.

umbilical connections - The electrical, hydraulic, and pneumatic connections between the ground equipment and the launch vehicle.

unsheltered equipment - That equipment exposed to the extremes of the natural environment.

using agency (or User) - The Government agency having overall cognizance of the mission program. The term encompasses Contractors and agencies working under the direction of this agency to carry out the satellite program.

vehicle - Specifically, a structure, machine or device, such as an aircraft or rocket, designed to carry a burden through air or space.

vertical integration building (VIB) - The building housing the Launch Control Center and personnel and equipment for launch operations.

6.2 Supersession Data.- This Specification, when contractually authorized, shall supersede all other similar requirements in the Contract of which it is a part.

6.3 Authorization.- This Specification, and any changes thereto, shall be authorized for use upon receipt of written approval of the Contracting Officer and issuance of an appropriate Contract Change incorporating this Specification in the Contract.

6.4 Revisions and Changes.- This Specification shall be revised only upon written direction from the Contracting Officer. Changes to this Specification shall be authorized as described in MN-2050-1. All such changes shall be subject to the Contract clause entitled "Changes."

APPENDIX A

Additional Applicable Documents

The documents listed below are not referenced elsewhere in the contract specifications but are considered as potentially applicable to the design, fabrication, test or delivery of CRONUS equipment.

Pending establishment (during negotiation and execution of Phase I of the CRONUS program) of firm design and interface criteria and acceptance of CRONUS CEI specifications, the extent of applicability of these documents shall be held in abeyance.

MIL-P-116D 4 Dec 1962 and Amend. 1	Preservation, Methods of - methods shall be selected by the Contractor for conformance with Level C of Fed. Std. 102B and shall be detailed in CEI specifications.
MIL-H-4440 28 Nov 1962	Handbooks, Operation and Servicing Instructions - Reproduction shall be as specified in MN-2050-2.
MIL-T-4807A 7 Oct 1958	Tests, Vibration and Shock, Ground Electronic Equipment, General Requirements for.
MIL-D-5480 5 Feb 1959	Data, Engineering and Technical, Reproduction, Requirements for.
MIL-M-7960A-1 13 Feb 1958	Handbook, Operating and Servicing Instructions (Test Equipment and Support Equipment).
MIL-A-8421B 5 May 1960	Air Transportability Requirements, General Specification for.
MIL-S-8512B-1 4 Feb 1959	Support Equipment, Aerospace, Special, General Specification for the Design of.
MIL-C-9883A-1 30 Oct 1961	Checklists for Missile and Space Systems Operation and Organizational Maintenance.
MIL-B-9972 16 May 1963	Brazing, Nickel Alloy, General Specification for.
MIL-E-17555F 5 Mar 1965	Electronic and Electrical Equipment and Associated Repair Parts, Preparation for Delivery of.

MIL-M-26512C 13 Dec 1963	Maintainability Requirements for Aerospace Systems and Equipment.
MIL-S-38130 30 Sep 1963	Safety Engineering of Systems and Associated Subsystems and Equipment, General Requirements for.
MIL-I-45208A 16 Dec 1963	Inspection System Requirements.
Fed. Std. 102B 29 Jan 1963	Preservation, Packaging and Packing Levels (limited to Level C).
Fed. Std. 151A & B 6 May 1959	Metals; Test Methods.
MIL-STD-22A 24 Oct 1956	Welded-Joint Design - Not applicable for heat source welds or non-structural welds.
MIL-STD-129D-2 1 July 1965	Marking for Shipment and Storage.
MIL-STD-410A 13 Aug 1962	Qualification of Inspection Personnel.
MIL-STD-756A 15 May 1963	Reliability Prediction.
MIL-STD-808 22 Dec 1960	Finishes, Protective, and Codes for Finishing Schemes for Ground and Ground Support Equipment.
MIL-STD-810A 14 June 1964	Environmental Test Methods for Aerospace Ground Equipment.
USAF Bulletin 515-2 29 July 1963	Control of Non-Conforming Supplies.
AFP 11-1-4 30 Oct 1959	Aerospace Terminology (for terms not defined elsewhere in contract documents).
SSD Exhibit 63-3 24 June 1963	Engineering for Transportability.

PRELIMINARY

STUDY FOR A 250 WATT CONTROLLED REENTRY ORBITING NUCLEAR SYSTEM "CRONUS"

SPECIFICATION FOR CRONUS AEROSPACE GROUND EQUIPMENT DESIGN, PERFORMANCE AND TEST REQUIREMENTS MN-2050-200

NOTE: This Specification has been prepared under AEC Contract AT(29-2)-2050

Basic Approved By:

_____
Martin Marietta Corporation

Date: _____

MARTIN MARIETTA CORPORATION
MARTIN COMPANY - NUCLEAR
Baltimore, Maryland 21203

Manufacturer's Federal Supply Code 38597

PRELIMINARY

FOREWORD

This specification and other Contractor prepared subsidiary specifications referred to herein have been established to define requirements, characteristics, and interface criteria for a radioisotope fueled thermoelectric generator (RTG) system and a controlled intact reentry system (CIR) which along with the associated aerospace ground equipment (AGE) form an overall system designated as "CRONUS." The content of this specification reflects the results and efforts of the Contractor under Phase "Zero" of the CRONUS program (Contract AT(29-2)-2050) but is not restricted to any particular phase of design, development and production.

In the preparation of this document, emphasis has been placed on definition of areas applicable to the initial portion of a complete program to provide flight systems. It is expected that this document will be made more definitive and completed through modifications as integration of efforts is accomplished and as more firm design information and test results become available. In final form and representing the results of mutual agreement, it is expected that this specification will be referenced in contractual agreements between the Contractor and the AEC.

The relation of this specification to other Contractor prepared specifications and the contract is shown in Figure 1 of the Specification Plan MN-2050-1.

SPECIFICATION FOR CRONUS AEROSPACE GROUND EQUIPMENT DESIGN, PERFORMANCE AND TEST REQUIREMENTS

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LIST OF FIGURES

SPECIFICATION FOR CRONUS AEROSPACE GROUND EQUIPMENT DESIGN, PERFORMANCE AND TEST REQUIREMENTS

1.0 SCOPE.-

1.1 General.- This specification establishes the general design, performance and test requirements for aerospace ground equipment (AGE) required to support and service the CRONUS RTG/RB-CIR Systems. These requirements, taken along with the RTG/RB-CIR Systems requirements of MN-2050-100 define the CRONUS program requirements baseline.

1.2 Mission.- The CRONUS AGE is intended to handle, install, test, fuel and defuel, control and monitor the CRONUS RTG/RB-CIR Systems, subsystems and accessories during pre-launch, launch, orbital flight, de-orbiting and re-entry operations. The location, recovery, handling and final disposal of nuclear fuel after earth impact are beyond the scope of this specification.

1.3 Description.- For purposes of this specification, the CRONUS AGE is considered to consist of operational ground equipment (OGE), ground handling equipment (GHE) and maintenance ground equipment (MGE). Basically, the composition of each category is as follows:

1.3.1 Operational Ground Equipment.- Includes all equipment used at the launch site (but not available as part of the launch site facilities) to check out the operability of and verify the performance of the CRONUS RTG/RB-CIR Systems during pre-launch operations, to check out the critical functions and monitor the performance of the CRONUS RTG/RB-CIR Systems during launch operations (but prior to lift off) and to control and monitor the operation of the GHE during nuclear fueling and defueling operations.

NOTE: Monitoring and control of CRONUS RTG/RB-CIR Systems functions during ascent, orbit and deorbit shall be accomplished by Government furnished TT & C facilities.

1.3.2 Ground Handling Equipment.- Includes all equipment used at the launch site (but not available as part of the launch site facilities) to handle the nuclear fuel during fueling and defueling operations. (See Figure 1.)

NOTE: See Section 6 of MN-2050-100 for nomenclature and definition of terms used herein.

1.3.3 Maintenance Ground Equipment.- Includes all special equipment and accessories (not normally available at the launch site) to protect, position and support the RTG/RB System, the CIR System and/or the assembled RTG/RB-CIR Systems during transportation, ground handling and checkout and to adjust, calibrate and verify the operational status of the RTG/RB-CIR Systems.

1.4 Program Concepts.- The contents of this section are for reference purposes only and supplement the requirements of the interface specification referenced herein.

1.4.1 Employment.- The CRONUS AGE as described herein is intended for use with launch complex and range facilities as normally used for launch of Titan III "C" launch vehicles except as modified in accordance with MN-2050-20.

1.4.2 Deployment.- The CRONUS AGE as described herein is intended for use at the Eastern Test Range (ETR) with monitoring and control from a Satellite Test Center through the facilities of ground tracking telemetry and control stations. Except as specifically provided for in MN-2050-20, operational utilization of the CRONUS AGE shall be accomplished by personnel other than the Contractor's employees.

1.4.3 Logistics.-

1.4.3.1 Spares.- The spare items to be provided for maintenance of the CRONUS AGE shall be those items specified as such in the contract incorporating this specification.

1.4.3.2 Maintenance.- Maintenance of CRONUS AGE at locations other than the Contractor's manufacturing facility shall be capable of accomplishment by and limited to adjustment and simple mechanical removal and replacement of those spares specified in the contract.

1.4.4 Training.- All personnel who will handle, operate or control Contractor furnished items of CRONUS AGE should receive training by the Contractor as provided for in the contract incorporating this specification.

2.0 APPLICABLE DOCUMENTS.-

2.1 General.-

2.1.1 Extent of Applicability.- The following documents form a part of this Specification only to the extent specified in the text of this Specification. Where a document or its provisions are to be "used as a guide" (or other similar phrases) the extent of applicability shall be determined by the Contractor based on management and technical judgment. For reference purposes only, the paragraphs in this Specification where each document is called out are shown opposite each document in the following list.

2.1.2 Dates of Issue.- References to documents in the text of this Specification are made by basic number only. Such basic references shall mean the exact issue specified in this Section 2, including the cited amendments, changes, etc.

2.1.3 Rules of Procedure.- In case of conflict between this Specification and the Contract, the Contract shall govern. In case of conflict between this Specification and any document referenced herein, this Specification including any authorized changes, appendices or addenda hereto, shall govern.

2.2 Documents.- In addition to the following listing, the documents referred to in Appendix "A" of MN-2050-100 are also applicable to the extent described in the appendix.

2.2.1 AEC - Sandia Corporation.-

Technical direction provided in writing during Phase 0 of Contract AT(29-2)-2050.

2.2.2 Military.-

2.2.2.1 Specifications.-

MIL-E-4158C 9 July 1964 Amendment 7	Electronic Equipment, Ground, General Requirements for	3.2.1
MIL-P-5518C 9 July 1962	Pneumatic Systems, Aircraft, Design, Installation, and Data Requirements for	3.2.9.5
MIL-S-8512B 8 January 1958 Amendment 1 4 February 1959	Support Equipment, Aeronautical, Special, General Specification for the Design of	3.2.1

2.2.2 Military.- (Continued)

2.2.2.1 Specifications.- (Continued)

MIL-Q-9858A 16 Dec. 1963	Quality Program Requirements	4.2
MIL-W-27076 29 Sept. 1960	Workmanship Standards for Ground Electronic and Associated Equipment	3.2.4

2.2.2.2 Standards.-

MIL-STD-130B Change 1 7 Feb. 1964	Identification Marking of U. S. Military Property	3.2.6
MIL-STD-143A 14 May 1963	Specifications and Standards, Order of Precedence for the Selection of	3.2.2
MIL-STD-803A	Human Engineering Design Criteria for Aerospace Systems and Equipment	3.2.1
Part 1 27 Jan. 1964	Aerospace System Ground Equipment	
Part 2 1 Dec. 1964	Aerospace System Facilities and Facility Equipment	
MIL-W-27076 29 Sept. 1960	Workmanship Standards for Ground Electronic and Associated Equipment	

2.2.3 Contractor.-

2.2.3.1 Specifications.-

MN-2050-1	Specification Plan for the CRONUS Program	6.4
MN-2050-20	Technical Interface Specification for CRONUS Aerospace Ground Equipment	3.3.1, 3.5, 3.6, 3.2.7, 3.2.5, 3.0, 1.4

2.2.3 Contractor.- (Continued)

2.2.3.1 Specifications.- (Continued)

MN-2050-100	Specification for CRONUS RTG/RB-CIR Systems Design, Performance and Test Requirements	2.2, 6.1

(CEI Specifications - to be prepared)

2.2.3.2 Drawings.-

(Contract End Item Drawings - to be prepared)

2.2.4 USAF.-

AFSCM 80-6 August 1966	Handbook of Instructions for Aerospace Ground Equipment Design (HIAGED, First Edition)	3.2.1
SSD-CR-65-18 (Rev. 1) September 1965	Titan III Standard Space Launch System (SSLS) Definition for Payload Contractors	3.2.10.2

2.2.5 Other.-

T. C. George's Tariff 19 Effective September 5, 1966	3.3.3

3.0 REQUIREMENTS.-

This section establishes general requirements for the design, performance and test of the CRONUS AGE. Specific items of CRONUS AGE shall be in accordance with the requirements set forth in the following Contract End Item (CEI) specifications.

List of CRONUS AGE CEI Specifications (to be determined)

Requirements for the interfaces of the various elements of the CRONUS AGE with elements of equipment and programs of others shall be in accordance with Technical Interface Specification MN-2050-20.

3.1 Primary Performance Characteristics.- The CRONUS AGE shall be capable of:

a. Protecting the CRONUS RTG/RB-CIR Systems during transportation and storage.

b. Lifting, moving, positioning and supporting CRONUS RTG/RB-CIR Systems and equipment during testing and installation in the space vehicle.

c. Testing and adjusting CRONUS RTG/RB-CIR Systems functions prior to liftoff.

d. Fueling and defueling the CRONUS RTG.

e. Protecting personnel and equipment from excessive nuclear radiation exposure and from excessive temperatures (during heat source transportation/storage).

Verification of performance capabilities shall be accomplished in accordance with the requirements of Section 4 of this specification and the requirements of subsidiary specifications prepared and coordinated in subsequent program phases.

3.2 Design and Construction.-

3.2.1 General.- All elements of the CRONUS AGE shall be in general conformance with the design and construction requirements of AFSCM 80-6, MIL-STD-803, MIL-E-4158, MIL-S-8512 and the following, except where such conformance would be in conflict with the performance requirements of Section 3.1 or of the CRONUS AGE CEI Specifications. In case of such conflict, the Contractor shall recommend suitable deviation, obtain approval of the Procuring Activity and document the change in the appropriate specification.

3.2.2 Specifications and Standards.- The Contractor shall select (for use as specific requirements or as guides, at the Contractor's option) specifications and standards for materials, parts and processes (where not otherwise called out herein) using MIL-STD-143 as a guide but based on the Contractor's evaluation of the following criteria.

a. Criticality of material, part, process or function.

b. Availability of suitable standard parts.

c. Need for documentary control.

d. Cost effectiveness.

The performance of tests and the furnishing of data in accordance with the requirements of Military Specifications and Standards shall be accomplished to the extent specifically provided for herein or in the appropriate CEI specifications or in other Contractor prepared documentation furnished in accordance with the provisions of the contract incorporating this specification but shall not be deemed to be required merely by virtue of specification reference.

3.2.3 Materials, Parts and Processes.- Materials, parts and processes selected by the Contractor shall be compatible with the CRONUS AGE performance and environmental requirements. Strategic or critical materials shall not be used, however, unless essential to the attainment of required performance and/or for conformance with environmental requirements.

3.2.3.1 Standard and Commercial Parts.- The Contractor may use commercial or Contractor standard materials, parts or processes when:

a. All CRONUS AGE requirements are met thereby.

b. Commercial or Contractor standards are equivalent to or exceed the requirements of other documents.

c. There are no applicable and satisfactory Government or industry standard documents.

3.2.3.2 Parts Qualification.- All materials and parts used in portions of the CRONUS AGE which are designated in CEI specifications as "critical" shall be qualified for the intended application as follows:

a. QPL - Parts procured to Government specifications controlled by a Qualified Products List shall be considered qualified for use in CRONUS AGE.

3.2.3.2 Parts Qualification.- (Continued)

b. Use - Parts or materials having demonstrated records of satisfactory previous performance in applications equally or more severe than the intended application shall be considered qualified for use in CRONUS AGE.

c. Similarity - Parts or materials identical to QPL or use qualified items except for details which are not affected by the intended application shall be considered qualified for use in CRONUS AGE.

d. Analysis - A part, not otherwise qualified and subject to easy replacement in the field (including during fueling operations) shall be considered qualified for use in CRONUS AGE upon submission of analysis substantiating to the satisfaction of the AEC that such items will withstand the requirements of the intended application.

e. Test - A part, not otherwise qualified and not subject to easy replacement in the field shall be considered qualified for use in CRONUS AGE upon successful completion of qualification tests as specified in the applicable CEI specification.

3.2.4 Workmanship.- During the fabrication of the CRONUS AGE, a high level of workmanship shall be ensured by the use of properly trained personnel equipped with correct tools in good condition, by the selection and careful use of adequate techniques and by the application of uniform standards. Particular attention shall be given to the following:

a. Elimination of burrs and sharp edges.

b. Accuracy of tolerances and dimensions.

c. Correct marking.

d. Tightness of mechanical fasteners.

e. Neatness and thoroughness of processes.

f. Assurance of circuit integrity.

MIL-W-27076 shall be used as a guide to workmanship standards.

3.2.5 Electromagnetic Interference.- The CRONUS AGE (except for maintenance equipment) is intended to operate in conjunction with other equipment related to the spacecraft, launch vehicle and launch complex without detriment resulting from electromagnetic radiation of other devices and without causing detriment to other devices. Requirements for electromagnetic compatibility shall be as specified in Interface Control Specification MN-2050-20.

3.2.6 Identification and Marking.-

3.2.6.1 Each item of CRONUS AGE shall be provided with an identification plate or decal conforming to MIL-STD-130.

3.2.6.2 All replaceable parts, subassemblies and assemblies shall be marked with an identifying number consistent with the Contractor's drawing system except where the size of the item prohibits such practice. Modified Government property shall be reidentified. Unmodified GFP shall retain its original identification.

3.2.6.3 All interchangeable units, and all end items that weigh forty-five pounds or more shall have the weight marked to the next highest five pound increment on at least one external surface.

3.2.7 Materials Compatibility.- Materials compatibility between the CRONUS AGE and other equipment at the launch complex shall be controlled by coordination between the Contractor and the User and shall be documented in Interface Control Specification MN-2050-20. All metallic parts shall be protected against corrosion by finishes, coatings or selection of suitable base metals except where such protection is impractical due to operating temperature and/or performance considerations.

3.2.8 Electrical Design.-

3.2.8.1 Electrical installations (connections or attachments to launch site facilities) shall conform with the National Electrical Code.

3.2.8.2 CRONUS AGE shall incorporate devices (such as circuit breakers) for self-protection from external electrical faults and to isolate internal electrical faults from the launch complex power distribution system.

3.2.8.3 AGE which is intended for exposed operation within 100 feet of the centerline of the launch vehicle shall be so designed as not to cause ignition of an explosive atmosphere.

3.2.8.4 AGE power distribution and grounding shall be separate from the launch vehicle structure and ground. Its neutrals and/or grounds shall be connected to the spacecraft only at the spacecraft ground point. No electrical connection shall be made between the CRONUS AGE and the launch vehicle.

3.2.9 Mechanical Design.-

3.2.9.1 All electronic assemblies and critical mechanical parts of those items of CRONUS AGE intended for use during launch operations shall each be capable of easy removal and replacement in the field.

3.2.9.2 Lifting eyes, guides, alignment and indexing points, and other pertinent features shall be incorporated in the CRONUS AGE to facilitate hoisting, handling and installation operations.

3.2.9.3 All replaceable units (whether end items, parts or assemblies) weighing 45 pounds or more shall have lifting provisions. All units weighing 90 pounds or more shall have mechanical lifting provisions.

3.2.9.4 All mechanical fasteners shall be secured by lock wire, adhesive binding material, lock washers or other similar means.

3.2.9.5 Hydraulic system load factors, proof and burst values shall be in accordance with applicable portions of MIL-P-5518.

3.2.10 Environmental Conditions.-

3.2.10.1 Non-Operational.- The CRONUS AGE, in the packaged condition, shall withstand the following environmental conditions during transportation and/or storage without damage which results in subsequent impairment or degradation of performance beyond the specified limits of acceptability. Verification of compliance with this requirement shall be by inspection and/or analysis as specified in the applicable CEI specifications.

Temperature: -35°F to +160°F (160°F is based on ambient air of 125°F with equipment temperature increased by 35°F for up to 4 hours by solar radiation).

Altitude: Sea level to 35,000 feet (rate of change not more than 1000 feet per second).

Relative Humidity: Up to 100% (including conditions resulting in condensation of water on equipment surfaces).

Sand and Dust: Between 0.1 and 0.25 grams per cubic foot impinging at velocities of 100 and 500 feet per minute for periods up to 2 hours.

Salt Fog: 5% by weight.

3.2.10 Environmental Conditions.- (Continued)

3.2.10.1 Non-Operational.- (Continued)

Rain: 4 inches per hour (equipment may be dried prior to operation).

Shock: 5 g shock loads to the base of the transportation container.

Vibration:

Packaged Weight (lbs.)	Frequency (cps)	Double Amplitude or Acceleration
All	5 - 15	0.4"
<100	15 - 500	± 5 g
100 - 300	15 - 50	± 5 g
	50 - 500	inversely proportional to weight
Over 300	15 - 50	± 5 g

3.2.10.2 Operational.- The CRONUS AGE shall provide the specified performance while operating under any combination of the applicable environmental conditions listed in Table IV-9 of SSD-CR-65-18.

3.3 Configuration and Installation.-

3.3.1 General.- All elements of the CRONUS AGE shall conform to the configuration requirements herein and to the installation requirements of Interface Control Specification MN-2050-20 and the following except where such compliance would be in conflict with the performance requirements of Section 3.1 or of the CRONUS AGE CEI specifications. In case of such conflict, the Contractor shall recommend suitable deviation, obtain approval of the Procuring Activity and document the change in the appropriate specification. See Figure 1.

3.3.2 Basic Requirements.-

Item of CRONUS AGE	Configuration	Installation
Heat Source Transportation Cask	A reusable, cylindrical top loading, shielded, air cooled (natural circulation), skid mounted protective and storage container - includes personnel thermal protection cage, cask handling sling and temperature monitor. Air transportation not permitted.	Standard freight vehicles, protected, semi-remote storage area (equipped with GFE radiation monitors). Cask support movable platform of the support structure pallet. (See c., below.)
Ground Handling Equipment	Includes a, b, and c, below.	"Air cushion" type moving van required for transportation.
a. Fueling Machine and Support Structure	a. A carriage mounted, air (or nitrogen) powered, heat source handling machine including position locators and locks, fueling probe, heat source shroud, compliance mechanism and support structure (moving carriage).	a. Fuel boom of the fuel boom and retracting mechanism. (See b., below.)
b. Fuel Boom and Retracting Mechanism	b. A box beam type boom providing tracks for the fueling machine and means of retracting the boom in order to clear the launch vehicle during liftoff.	b. Support structure pallet. (See c., below.)
c. Support Structure Pallet	c. A palletized support structure including a cask support movable platform and providing all electrical and pneumatic interfaces with the umbilical tower.	c. Umbilical tower work platform (modified) at payload level.

3.3.2 Basic Requirements.- (Continued)

Item of CRONUS AGE	Configuration	Installation
OGE		
Nuclear AGE Control and Monitor Console	An electrical control console providing controls and indicators to operate and monitor the GHE.	Launch control center
Launch and Checkout Control Console	An electrical console and/or rack type equipment with power controls, air conditioning controls and display facilities.	Launch control center
Go-No Go Analyzer	Rack mounting equipment to process data received from RTG/RB-CIR Systems via telemetry.	Range TT & C Ground Station
MGE		
Alignment Kit	Mechano-optical devices to align the GHE at installation and checkout.	N/A
Ordnance Checkout Set	Devices and equipment to check out all ordnance devices.	N/A
Battery Checker	Equipment to check out the airborne batteries.	N/A
Tools and Spares	Special tools and test gear required for field maintenance and repair parts (as specified in the Contract).	N/A

3.3.3 Transportation.- The CRONUS nuclear heat source, when contained within the heat source transportation cask, shall meet all applicable requirements of Agent T. C. George's Tariff No. 19.

3.4 Reliability.- CRONUS AGE reliability shall be apportioned among various items of AGE and specific requirements for reliability analysis and/or testing shall be as specified in CRONUS AGE CEI specifications.

The probability that GHE failure will result in the release of radioactive fuel shall be no greater than 1 in 10^6 (air transportation of nuclear material shall be excluded).

Critical functions of CRONUS GHE shall be accomplished, insofar as practical, by redundant circuits, backup devices, or the use of other high reliability techniques, such that no single failure will result in the inability of the equipment to perform a critical function.

3.5 Interfaces.- CRONUS AGE, as installed and/or operated at the launch complex, shall operate compatibly with space/launch vehicle equipment and/or procedures. Specific requirements for interfaces between CRONUS AGE and other equipment shall be as specified in Interface Control Specification MN-2050-20.

3.6 Configuration Control.- Any change to the CRONUS AGE to be delivered under the contract which changes its interface characteristics or performance as defined herein and in MN-2050-20 shall require a change in identification as well as a change in the appropriate specification.

3.7 Maintenance and Repair.- All electronic assemblies and critical mechanical parts (as defined in the applicable CEI specifications) of those items of CRONUS AGE intended for use during launch operations shall each be capable of replacement. Additional requirements applicable to repair and maintenance shall be considered as unspecified.

4.0 QUALITY ASSURANCE PROVISIONS.-

4.1 General.- The quality assurance provisions specified herein include the major requirements which will assure adequate assessment, when coupled with a detailed quality control program, of development progress, verification of performance and high standards of fabrication. The test program provided for herein will provide supplementary data for use in Quality and Reliability Program evaluations.

The Quality Control Program used in conjunction with these requirements shall be in accordance with MIL-Q-9858 and shall include such testing of materials, parts and processes as is necessary in order to maintain high product quality.

4.2 Classification.- All inspections and tests shall be classified in one of the categories specified below, and when so classified, shall be conducted in accordance with the requirements of that category. Any changes in the testing program, or the need to repeat a previously accomplished test, caused by an authorized hardware or program change, shall be proposed and authorized as a part of the change, including modification and addition to the requirements of this specification.

4.2.1 Inspection.- Inspection shall be a detailed physical examination of an item to determine its conformance with the applicable contract requirements. The Contractor shall conduct inspection of all items from receipt inspection of parts and materials through final assembly. The Government may witness any such inspection at the Government's discretion upon notice to the Contractor prior to the start of such inspection.

4.2.2 Qualification.- Qualification shall be a detailed test and/or analysis of an item (or process) to establish the suitability of that item (or process) for its intended application. The Contractor shall qualify materials, parts and processes as required by the applicable CEI specifications. Qualification by analysis (when used) shall be based on technical data that is available in reports, laboratory notebooks or other informal documents and shall not require the preparation of special data presentations or formal reports.

4.2.3 Acceptance.- Acceptance of CRONUS AGE items for delivery shall be based on a detailed functional evaluation of each contract end item along with sufficient examination of records and data to establish that:

a. The item meets all requirements of Section 3 hereof and of the applicable CEI specification to the extent that such compliance can be verified at the Contractor's plant.

4.2.3 Acceptance.- (Continued)

b. All contractual quality assurance requirements have been met.

c. All data and documentation requirements have been met.

4.3 Compliance Verification.- All of Section 3 of this specification shall be subject to compliance verification, when applicable. Verification shall consist of documented certification of compliance with contractual requirements as determined by inspection, analysis, demonstration, test or examination of records; shall be furnished to the Contracting Officer; and shall constitute proof of compliance of the requirements which have been verified.

4.4 Test Plan.- Engineering development, prototype, qualification, acceptance and system testing shall be accomplished in accordance with a Test Plan prepared by the Contractor and approved by the AEC and in accordance with the test requirements of the individual CEI specifications.

4.5 GHE Mock-up Test.- The Contractor, using a wood and metal mock-up of portions of the GHE (full size critical components and control panel), shall demonstrate the feasibility of the fuel loading concept.

4.6 Fueling Demonstration.- The Contractor, using portions of the actual GHE (but a mock-up of the RTG/RB-CIR Systems), shall demonstrate the capability of fueling and defueling the CRONUS RTG safely under simulated launch conditions.

4.7 Demonstration Flight.- Flight systems and requirements for the demonstration flight shall be as specified in MN-2050-100.

During launch preparations for this flight, the Contractor shall fuel (using a Sr 90 heat source) and defuel a prototype RTG/RB System (under operational launch operations). The prototype RTG/RB System shall then be removed from the CIR System and replaced with the special Reentry Body in readiness for the demonstration flight.

5.0 PREPARATION FOR DELIVERY.-

All items of CRONUS AGE (except shipping containers) shall be cleaned, preserved and marked in accordance with the applicable CEI specifications and placed in the appropriate shipping container (if used). Loaded shipping containers and equipment prepared for shipment shall be marked and shipped (FOB the Contractor's plant) in accordance with Contracting Officer direction.

6.0 NOTES.-

6.1 Definition of Terms.- Certain terms as used herein are defined as follows:

(See Specification MN-2050-100, paragraph 6.1).

6.2 Supersession Data.- This specification, when contractually authorized, shall supersede all other similar requirements in the contract of which it is a part.

6.3 Authorization.- This specification, and any changes thereto, shall be authorized for use upon receipt of written approval of the Contracting Officer and issuance of an appropriate Contract Change incorporating this specification in the contract.

6.4 Revisions and Changes.- This specification shall be revised only upon written direction from the Contracting Officer. Changes to this specification shall be authorized as described in MN-2050-1. All such changes shall be subject to the contract clause entitled "Changes."

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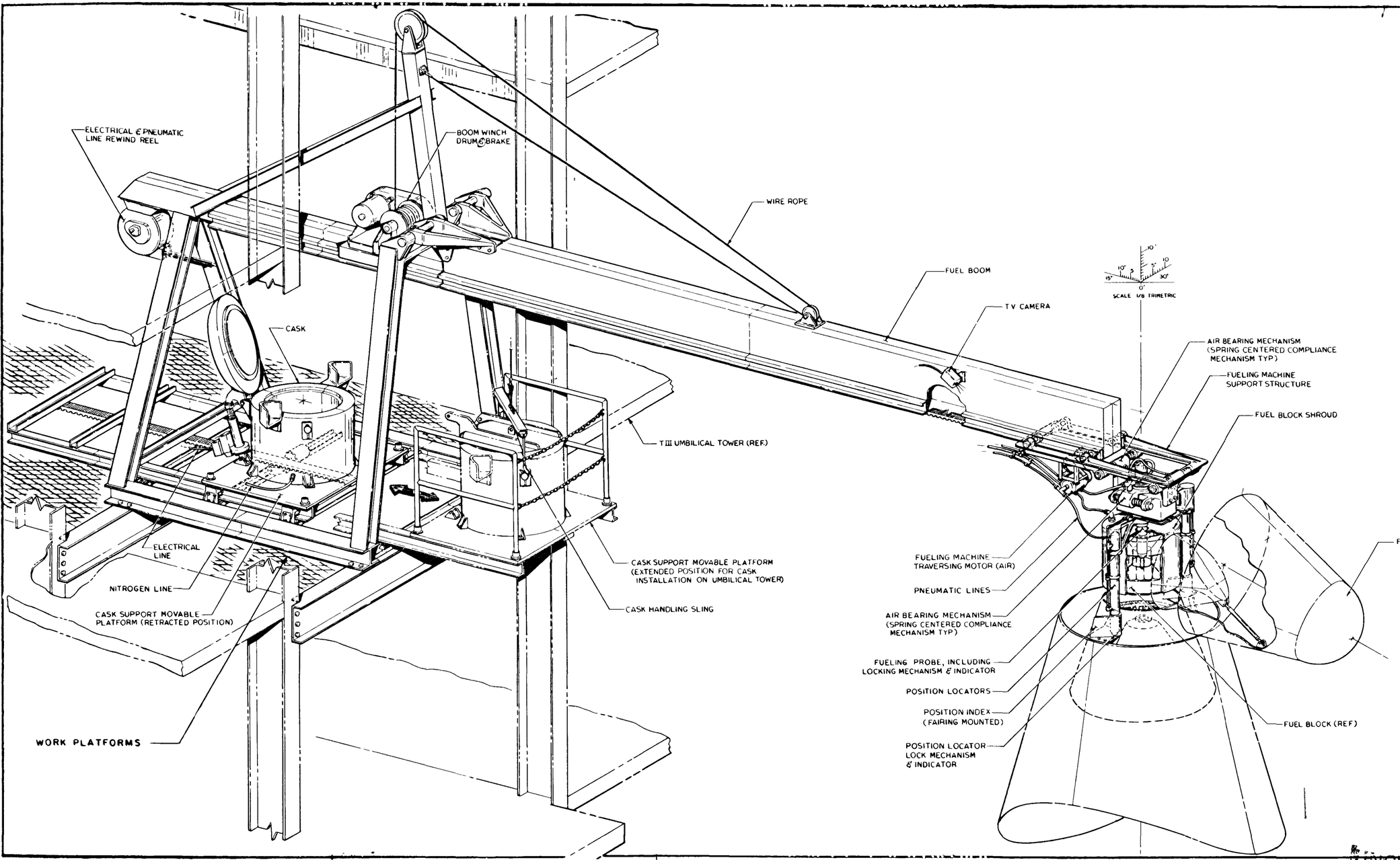

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MARTIN COMPANY
A DIVISION OF MARTIN MARIETTA CORPORATION
BALTIMORE INTERNATIONAL AIRPORT, MARYLAND

FUEL BLOCK LOADING CONCEPT
TOWER BOOM / TOP LOADING

38597		N0030020

UNCLASSIFIED