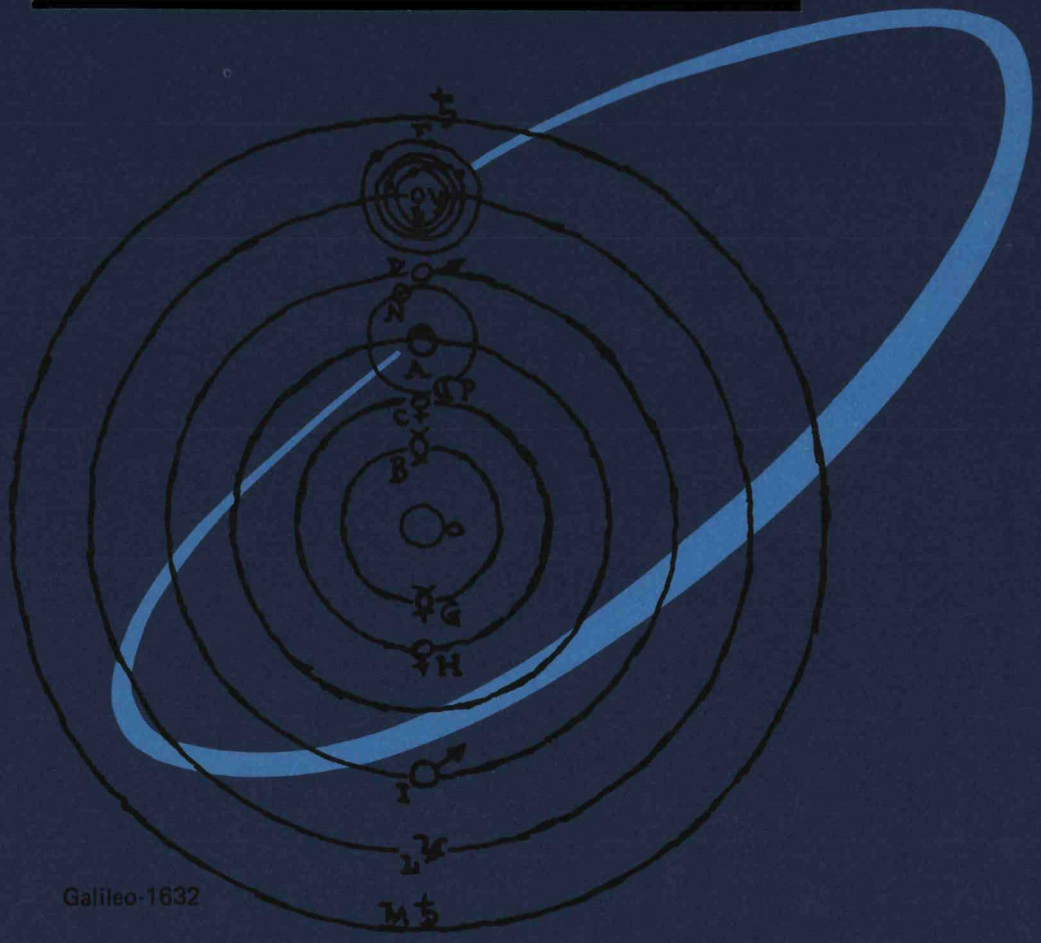
SELENIDE ISOTOPE GENERATOR

for the

GALILEO MISSION

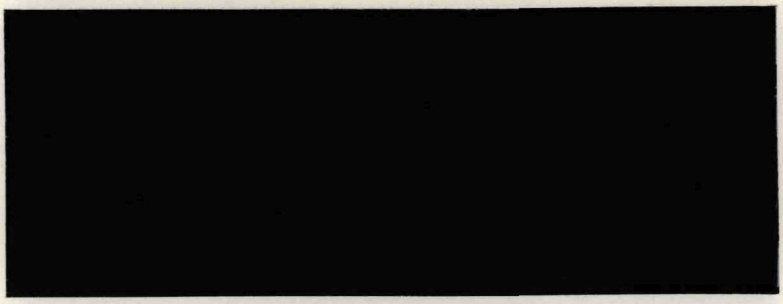
[redacted]



TELEDYNE ENERGY SYSTEMS

DISCLAIMER

Pictured on the cover is Galileo's drawing of the solar system, which includes the four satellites of Jupiter he discovered in the 1600's. A Renaissance professor, inventor and astronomer, Galileo perfected the telescope with which he made his Jupiter discoveries. The 1982 NASA mission to Jupiter is named in his honor. Like Galileo and his telescope, the NASA mission to the far reaches of outer space will be contributing to Mankind's never ending quest for knowledge.



SELENIDE ISOTOPE GENERATOR

for the

GALILEO MISSION

DOE/TES/3M INTERFACE AGREEMENT

TES -2865-10

SEPTEMBER 1978

Prepared for the U.S. Department of Energy
under Contract ET—78—C—01—2865

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SELENIDE ISOTOPE GENERATOR (SIG)
FOR THE GALILEO MISSION

DOE/TES/3M INTERFACE AGREEMENT

SEPTEMBER 1978

TES-2865-10

Agreed to by:

Wm E Osmeyer Date 9/27/78

W. E. Osmeyer, Program Manager
SIG/Galileo Mission Program
Teledyne Energy Systems

R. S. Reylek Date 9-28-78

R. S. Reylek, Program Manager
SIG/Galileo Mission Program
3M Company

R. C. Brouns Date 10/3/78

R. C. Brouns
SIG Program Manager
U. S. Department of Energy

REVISIONS

Revision Number	Page	Date	Description

The margins of the Revised Pages are marked by a vertical bar and the revision (Rev. X) to indicate where changes (additions, modifications, corrections, deletions) from the previous issue were made.

TABLE OF CONTENTS

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1.0 Scope and Objective

This agreement establishes the procedures and defines the responsibilities that are a part of the DOE/TES/3M interface for the duration of the SIG/Galileo Mission Program. The agreement is intended to expand upon the Interface Document which is Attachment IV to both the 3M and TES Contract Statement of Work. The agreement is effective upon approval by DOE, TES and 3M Company.

2.0 Document Publication and Revision

Teledyne Energy Systems, with assistance from the 3M Company, is responsible for preparation of this document. After approval by the responsible individuals on the title page, TES will publish the document and provide a controlled distribution. In the event that changes to the agreement become necessary, they will be accomplished by submitting the change to TES (W. R. Menchen) prior to a scheduled monthly interface meeting (paragraph 5.). After approval by the responsible individuals on the title page, TES will issue revised pages of the agreement and an updated Revision Page to the controlled distribution.

3.0 Responsibilities

Organizational responsibility and authority for certain specific aspects of the DOE/TES/3M Interface are given in Table 3-1.

3.1 Department of Energy

DOE will provide the overall program control including financial, contractual and technical direction to TES, the 3M Company and all other agencies and organizations who may directly or indirectly support interface activities. However, this DOE oversight function is not meant to alleviate the Systems Integration Contractor from his responsibilities as described in paragraph 3.2, below.

DOE will provide inspection activities and acceptance documentation for all deliverable Government Furnished Equipment and Materials to verify compliance to the appropriate interface drawings, specifications and procedures. In the event documentation data are not available for acceptance and confirmation, DOE will provide written assurance to the recipient Contractor that the deliverable items do meet the governing specifications. Only after acceptance has been accomplished in accordance with the Inspection and Acceptance provisions and any other inspection or acceptance procedures set forth in the contract, may Government Furnished Equipment or Materials be shipped to or used by the intended recipient of that equipment or material.

DOE personnel may participate in interface meetings with the acknowledgement of the DOE Program Manager. DOE will assist in resolving interface problems which, for technical or contractual reasons, cannot be worked out solely between TES and the 3M Company.

DOE may have on-site at both TES and 3M a full time DOE program office representative and a quality representative.

TABLE 3-1

ORGANIZATIONAL RESPONSIBILITY AND AUTHORITY

	Responsible Organizations	Informed	Concurrence/ Approval
Converter Performance Specifications	3M	-	TES/DOE
Converter Production Drawings	3M	TES	DOE
System Interface Drawings	TES		3M/TES/DOE
Converter Quality Assurance Program Plan	3M	TES	DOE
Converter Reliability Plan, Test Reports and Data	3M	TES	DOE
Converter Configuration Management Plan	3M	TES	DOE
Converter Data Package and Preshipment Review Record	3M	TES	DOE
System Configuration Control Board (Interface)	TES	3M	3M/DOE
Converter Configuration Control Board (Interface)	3M	-	TES/DOE
System Materials Review Board (Interface)	TES	3M	DOE
Converter Materials Review Board (Interface)	3M	-	TES/DOE
Converter Sell-off Inspection	DOE	3M/TES	-
TES/3M Interface Agreement	TES/3M		DOE
Converter Acceptance Specification	3M	TES	DOE
Housing Data Package and Preshipment Review Record	TES	3M	DOE
Housing Acceptance Specification	TES	3M	DOE
Reliability Plan	TES	3M	DOE
Quality Assurance Plan	TES	3M	DOE
Configuration Management Plan	TES	3M	DOE

3.2 Teledyne Energy Systems

Teledyne Energy Systems will coordinate interface activities as specifically defined in this document. These include preparation of interface documentation, coordination and direction of interface meetings as defined in Para. 5., and coordination of preliminary and final design review presentations.

Teledyne Energy Systems is to conduct the appropriate program liaison as necessary to assure the efforts of all participating agencies and organizations (NASA, 3M, ORNL, LASL, MRC, SR, APL, JPL, Sandia, and GA) are in accordance with the Program Plan and the DOE/NASA system interface requirements.

Teledyne Energy Systems is responsible to DOE as the SIG/GM system integration contractor. As such, TES will design, develop, fabricate, assemble, test and deliver to DOE the SIG/GM power systems in compliance with contractual performance specifications and delivery milestones. Major system components to be supplied to TES as GFE are the processed selenide thermoelectric converters delivered in hermetic shipping containers.

3.3 3M Company

The 3M Company will design, fabricate, test and deliver to DOE the SIG thermoelectric converters in accordance with the approved specifications. The 3M Company will provide all necessary analyses, data and drawings to the DOE such that a successful interface between TES and 3M hardware can be accomplished and that performance and reliability of the SIG system can be predicted and verified in accordance with the User's requirements and specifications.

The 3M Company will participate in established monthly interface meetings, design reviews, and informal interface meetings as may be required to resolve specific problem areas.

3.4 Interface Key Personnel

3.4.1 Department of Energy

Mr. R. C. Brouns will be the responsible DOE person for interface activities.

3.4.2 Teledyne Energy Systems

Mr. W. R. Menchen will have TES responsibility and authority for all DOE/TES/3M interface activities covered by this agreement.

3.4.3 3M Company

Mr. R. S. Reylek will have 3M responsibility and authority for all DOE/TES/3M interface activities covered by this agreement.

4.0 Interface Definition

4.1 Housing/Converter Interface Drawing

4.1.1 Scope and Preparation

The TES/3M interface drawing will be prepared by TES according to standard TES drawing practices. Before initial release or revision of the drawing, discussions will be held at a monthly interface meeting between 3M, DOE and TES to verify that technical agreement has been achieved. Release of the drawing by TES to the distribution defined in the TES Contract, will not occur until TES, DOE and 3M approvals have been obtained on the face of the drawing.

The interface drawing will define the mechanical and electrical characteristics of the interface between the 3M thermoelectric hardware and the TES housing assembly. The drawing will be used by 3M to determine if the GFE housings meet interface requirements. TES will similarly employ the drawing to determine conformance of the GFE converter with interface requirements.

4.1.2 Content

At least the following aspects of the interface will be defined by the interface drawing.

4.1.2.1 General

- Geometrical arrangement of parts using views as appropriate.
- Materials, finishes and complete dimensions.
- Detail drawing reference where applicable.
- Special process restrictions including temperature limitations.

- Procedural notes.

4.1.2.2 Specific

- Wiring between rings.
- Magnetic compensation loops, if any.
- Current strap detail if it affects interface.
- Changes between S/N 1, S/N 2 and subsequent systems (if any).
- Converter/multifoil interfaces.
- Instrumentation routing and identification.
- Power lead details.

4.1.3 Review and Approval Process

The interface drawing and all DCN's to the drawing will contain the following signatures:

DOE: Program Manager or his designated alternate.

TES: Normal signature route.

3M: Normal signature route.

Changes to the TES/3M interface drawing made after the design freeze will require prior approval of DOE and the respective Contract/Configuration Change Boards at 3M and TES.

Accumulation of six (6) outstanding DCN's will require incorporation and release of the complete original drawing.

When prior agreement has been reached at an interface meeting, complex changes to the interface drawing may be implemented through use of an incorporated DCN. For this case, 3M and DOE will sign off on a job sheet which has been prepared and signed by TES. The job sheet will be accompanied

by the original drawing containing the incorporated change. 3M and DOE will initial the change block of the drawing.

Initial release and incorporation of future changes to the interface drawing will be governed by the following schedule:

First version sent out by TES for 3M and DOE review.	Within 2 weeks after August 1978 interface meeting.
DOE and 3M approvals for first release.	2 weeks after September 1978 interface meeting.
First release.	5 days after last approval.
DOE and 3M approval for subsequent changes.	15 days after receipt from TES.
Release of subsequent changes.	10 days after 3M and DOE approval.

4.2 Housing/Converter Shipping Container - 3M Tooling

4.2.1 Description

An interface exists between the TES housing and the 3M shipping container and such other tooling as 3M may employ in order to process the module prior to delivery to TES. Specific parts of the interface include but are not limited to the following items:

- TES housing cooling tube/3M container fittings and tubes.
- TES housing mounting lug/3M container mounting provisions.
- Housing radiator fin dimensions.

4.2.2 Approach to Interface

Information concerning this interface will be transmitted between 3M Company and TES, in writing, on an agreed upon schedule. Pre-release versions of housing assembly, shipping container assembly and 3M tooling drawings will be a part of the data transmittal. Agreement on the

interface configuration will be finalized at the appropriate monthly interface meetings. Changes to the established interface will not be made without mutual agreement between TES and 3M.

4.3 Converter Shipping Container/TES Facilities

4.3.1 Description

An interface exists between the 3M shipping container and TES facilities/tooling. Specific parts of the interface include:

- Electrical feedthroughs and mating plugs used for monitoring pressure, temperature and electrical resistance.
- Shipping container dimensions, weight, handling and disassembly provisions.
- Accelerometer records disposition.
- Special instrumentation readout requirements such as high vacuum gauges.

4.3.2 Approach to Interface

Information concerning this interface will be transmitted between 3M Company and TES, in writing, on an agreed upon schedule. Pre-release versions of 3M shipping container assembly, 3M shipping crate and TES module checkout procedure/drawings will be a part of the data transmittal. Agreement on the interface configuration will be finalized at the appropriate monthly interface meetings. Changes to the established interface will not be made without mutual agreement between 3M and TES.

5.0 Interface Meetings

5.1 Primary Monthly Meetings

Monthly interface meetings will be held for the purpose of reviewing progress and discussing specific issues that affect the interface between 3M and TES.

Scheduled monthly meetings will usually require certain decisions to be made by the meeting participants. The primary representatives of 3M Company and TES will be prepared to make such decisions and accept action items that reflect their companys' position. These decisions will be recorded in the minutes of the meeting.

Organizational attendance at regular monthly interface meetings will be limited to DOE SIG/Galileo, TES and 3M Company personnel. Attendance by other organizations will require prior approval by DOE and concurrence by TES and 3M prior to the approval.

5.1.1 Responsibilities

TES: TES will organize and chair each monthly interface meeting. Attendance at monthly meetings will consist of W.R. Menchen or his designee and such other TES personnel as are appropriate to discuss agenda items.

3M: 3M Company will attend each monthly interface meeting. Attendance will consist of R.S. Reylek or his designee and such other 3M personnel as are appropriate to discuss agenda items.

DOE: DOE attendance at interface meetings will be at DOE's option.

3M and TES will be prepared to discuss each item on the meeting agenda and will exert their best efforts to resolve all issues during the meeting. It is recognized that monthly meetings are the primary mode of data transferral

between 3M Company and TES. Therefore both 3M and TES will back up discussion of agenda items, as appropriate, with informal written material handed out as the agenda item is discussed.

5.1.2 Agenda

The agenda for each meeting will be prepared according to the following rules:

- TES will compile and distribute the agenda.
- As many agenda items as possible will be agreed to at the prior meeting.
- 3M will supply TES with their proposed agenda items at least eight (8) days before a scheduled meeting.
- TES will telecopy a complete agenda to 3M one week prior to the meeting date. The agenda will be sent to DOE one week before the meeting date.
- New agenda items uncovered during the week prior to the meeting will be covered as meeting time permits but will not necessarily be prepared for.

5.1.3 Meeting Dates and Location

Interface meetings will be held monthly at a date as near to the 15th as possible. The exact date for each meeting will be selected approximately one month in advance by agreement between 3M and TES.

Meetings will normally be held at either 3M Company or TES with the location alternating each month.

Regular interface meetings will normally be confined to one working day.

5.1.4 Meeting Minutes

Minutes of the interface meetings will be prepared in a draft memorandum format by TES and submitted to 3M for review and concurrence within five (5) working days after each meeting. 3M will review and submit concurrence within three (3) working days after receipt of draft minutes from TES. TES will distribute the approved minutes to the distribution shown in Table 5-1 within three (3) working days after receipt of 3M concurrence.

5.1.5 Action Items

Action items may be assigned to 3M, TES or DOE at monthly meetings. The action items will be documented in the meeting minutes and in each case, have an associated response date. TES will maintain a log of open action items, and update it at each monthly meeting. Copies will be provided to DOE and 3M at the time of distribution of the monthly meeting agenda.

5.2 Secondary Meetings

From time to time special 3M/TES meetings may be convened for the purpose of resolving specific problems that arise which cannot be handled at the regular monthly interface meeting. DOE will be notified of such meetings but an agenda will not necessarily be prepared. Attendance will be limited to those required for discussion of a narrow subject area and location will be decided upon by 3M and TES.

TABLE 5-1

DISTRIBUTION OF APPROVED
MONTHLY INTERFACE MEETING MINUTES

Individual	Organization	Copies
J. J. Lombardo	DOE/ASMP	1
W. Von Flue	DOE/SAN	1
L. Lanni	DOE/SAN	1
R. S. Reylek	3M Co.	3
W. R. Menchen	TES	(as required)
A. Schock	FI	1
P. O'Riordan	DOE/ASMP	1
R. Harner	Sandia	1
W. Boyes	Sandia	1
F. Dieringer	DOE/ASMP	1
R. Brouns	DOE/ASMP	1
R. Morrow	DOE/ASMP	1
DOE Site Rep. at TES	--	2
DOE Site Rep. at 3M	--	2

6.0 Interface Configuration Control

6.1 Definitions

Design Freeze	Date after which all 3M and TES configuration changes are subject to formal configuration management control and approval by DOE.
CCB	Contract/Configuration Change Board. TES and 3M will each have a CCB.
CAB	Corrective Action Board. -- Part of Quality Assurance Program at TES.
MRB	Material Review Board. -- Part of Quality Assurance Program at 3M.

6.2 Responsibilities

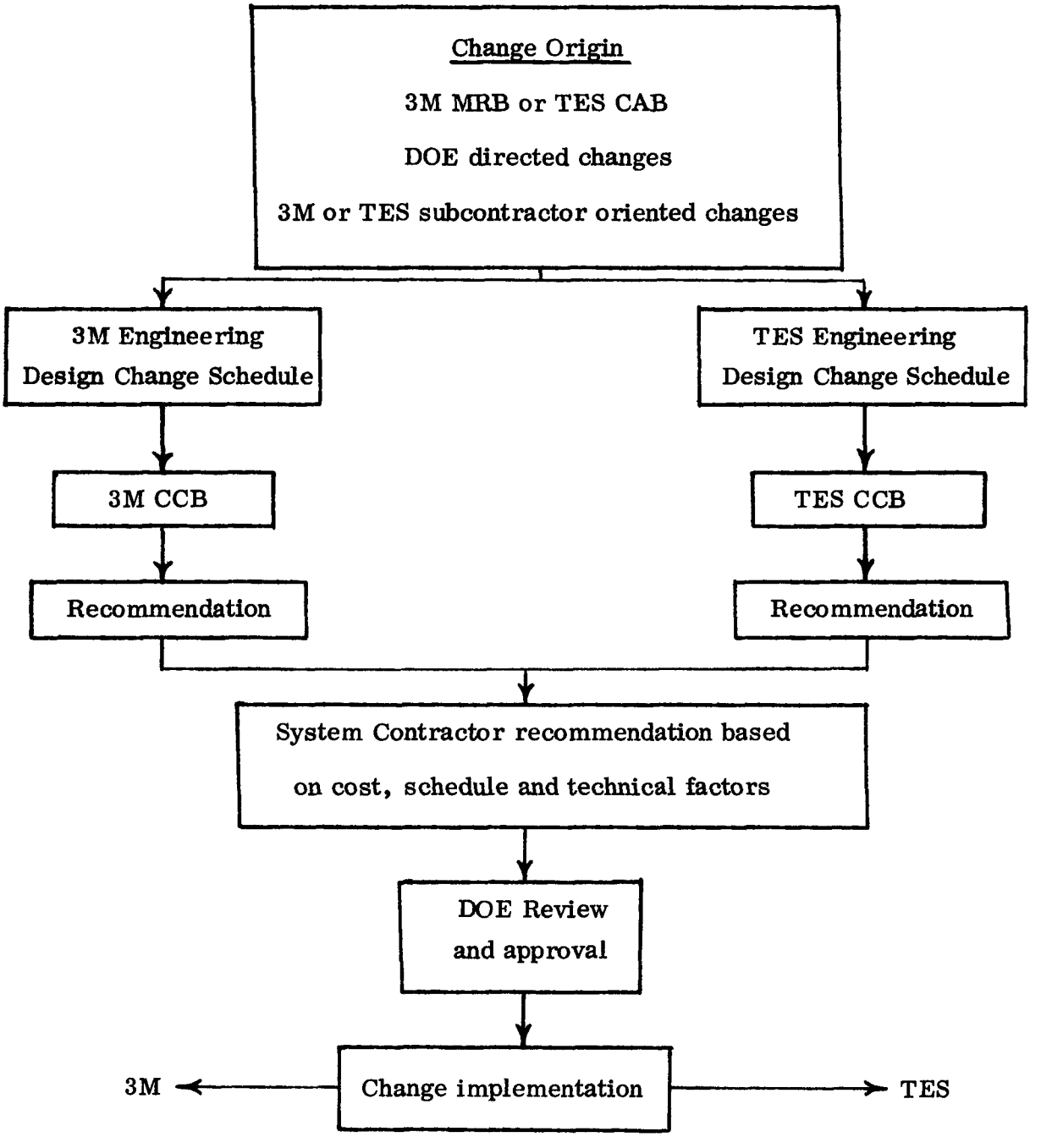
During the contract period, 3M and TES will notify each other when a change is being considered that could affect the other contractor. Changes that affect the other contractor include a change to the 3M/TES interface drawing (Para. 4.1), the performance specifications related to the interface, the mechanical and electrical interfaces defined by Paragraphs 4.2 and 4.3 and schedule changes on GFE items.

Responsibilities associated with configuration control are defined in Figure 3-1. A change which affects the interface will pass concurrently through both the TES and 3M configuration management systems. The recommendations evolving from 3M and TES CCB's will be combined by TES in a package and submitted to DOE for review and approval. The process for changes which affect the 3M/TES interfaces is shown schematically in Figure 6-1.

As Systems Integration Contractor, TES has the contractual responsibility for recommending action that will correct incompatibilities between TES and 3M Company

FIGURE 6-1

3M/TES Change Control Process for Changes Which Have Been Judged to Affect the TES/3M Interface



interface items. Therefore, TES will utilize both 3M and TES CCB outputs to make a systems recommendation consistent with SIG/GM cost, schedule and technical constraints. 3M Company will provide TES and DOE with CCB packages on interface items. These packages will include cost, schedule and technical data.

7.0 Shipping, Handling and Storage

The schedule for GFE is shown in the following table:

System	Housing to 3M	Converter to TES
S/N 1	12-1-78	3-7-79
S/N 2	3-1-79	6-7-79
S/N 3	10-1-79	2-7-80
S/N 4	1-1-80	5-7-80
S/N 5	7-1-80	10-7-80
S/N 6	10-1-80	1-7-81
S/N 7	1-1-81	4-7-81

Plans are that all shipments will be made via air freight.

8.0 Acceptance of Government Furnished Property

8.1 Housing Data Package

SIG housings shipped to 3M by TES/DOE will be accompanied by a data package containing the housing assembly and detail drawings, TES inspection data, all TES non-conformance reports (TES RS tags) associated with the housing and DOE acceptance data for GFE. A list of items should be included:

1. The maximum outside diameter dimensions referenced to the housing diagram.
2. The minimum inside diameter dimensions referenced to the housing diagram.
3. The diameter of the interface slot, referenced to the housing diagram.
4. Surface finish of converter interface, roughness and waviness along the axis and around the diameter.
5. Width of the converter interface area at a number of locations referenced to the housing diagram.
6. All RS tags associated with the housing.
7. Material Certification associated with the housing.
8. Hardness data after all TES processes are completed.
9. Weight and length.
10. Crate disassembly procedures.
11. Manufacture history, including metal preparation, cleaning, plating, and welding steps.
12. DOE acceptance data.

8.2 Converter Data Package

Each SIG converter shipped to TES by 3M/DOE will be accompanied by a data package containing at least the following elements:

1. Assembly and detail drawings for converter and converter shipping container.
2. P & N leg lot qualification data for lots used in the converter.
3. Crate disassembly procedure.
4. Insulation resistance measurements of each module ring at ambient and operating temperatures.
5. All non-conformance reports and design/process changes related to items described on the TES/3M interface drawing or the converter performance specification.
6. Weight of each converter ring and weight of total converter assembly including wiring up to flight 3M/TES interface. *
7. Converter processing history including partial pressure analyses at each temperature/pressure/time step as defined by 3M processing procedures.
8. Power in and out for each ring during processing at stabilized conditions.
9. Open circuit voltage, load voltage, load resistance, thermocouple temperature readings and voltage tap readings for each stabilized data point.
10. Diagram to interpret data of item 9.
11. Calculation sheet showing data for converter efficiency and power output projections to 1000 operating hours.
12. 3M acceptance test data.
13. DOE acceptance data.

*To be obtained by subtraction of tooling and housing weights.

9.0 Data Transmittal

9.1 Drawings and Procedures

All drawings and procedures and reports will be transmitted as called out in the Contractor Data Requirements List (CDRL) of TES and 3M. In addition to the CDRL requirements, three (3) copies of the following drawings will be transmitted after each complete release:

3M/TES Mechanical and Electrical Interface Drawings (TES to 3M).

TES Housing Assembly Drawing (TES to 3M).

3M Converter Assembly Drawing (3M to TES).

9.2 Informal Data

TES, 3M and DOE will maintain a telecopy type of telephone data link for transmittal of information during normal working hours.