SWALES & ASSOCIATES, INC.

AEROSPACE ENGINEERING/STRUCTURAL ANALYSIS
5050 Powder Mill Road
Beltsville, Maryland 20705
(301) 595-5500

August 28, 1995

To: Distribution

From: I.L. Goldberg

Subject: Icing Effects In The MODIS EM Cooled Optics Ports

References: SBRC memo PL3095-NO5203 "H_2O Frost in MODIS MWIR and LWIR Optics", J. Bauer, 24 July, 1995.

Bertie, J.E, Labbe, H.J. and Whalley, E. "Absorptivity of Ice I in the Range 4000-30 cm^{-1}", The Journal of Chemical Physics, Vol. 50, No. 10, 15 May, 1969.

Physics Of Ice, eds Nikolaus Riehl, Bernhard Bullemer, Hermann Engelhardt, Plenum Press, 1969, p.271-286.

The recent revelation that there may have been frost in the cooled detector optical ports during the EM TV tests is an eye opener. When combined with other problems like the thermal short caused by the screwing down (up?) of the radiation cooler and operating the instrument under abnormal conditions it may lead some people to be dubious of the calibration data. I have studied the LWIR data which I found in the reference SBRC memo. I do not fully concur with the mildness of the SBRC conclusion that the data may possibly indicate the existence of ice in the cooled optics ports. I do not agree at all with the idea of adding the very questionable (to say the least) PV data to the PC data and trying to make sense out of the combination. When this was done for one case SBRC came to the conclusion "The response of the ambient data relative to the 275 K thermal vacuum data does nothing to resolve the question of H_2O frost on the windows." Unfortunately they chose to combine the best PC data with the generally terrible band-to-band PV data. I think the following analysis can reveal compelling evidence for ice accretion and perhaps a better understanding of what was happening (thermally) during the course of the tests.

From the test data for UAID 452 Band 32 (12 μm), Channel 5, I estimated the ice transmission to be about .38. This corresponds to an ice thickness of 2.3 μm (see table). After normalizing the UAID 452 data to eliminate ice transmission loss I divided the calibration slopes in the other tests by the corresponding band slopes in the normalized data to obtain the ice transmission in each PC band of UAID 254 AND 397. This yields convincing evidence of ice for test UAID 254 as can be seen in the figure because the calculated MODIS transmision agrees fairly well with transmission through 3.5 μm of ice. An important identification consideration is that the lowest ice transmision in the spectral region from 10 μm to 15 μm occurs between 11.7 μm and 12 μm. Actually the only place that ice

transmission is smaller in the visible and infrared regions is at the very intense 3.1 μm absorption band. The transmission for UAID 397 does not quite follow a fixed ice thickness transmission curve. This suggests that there was a non-uniform ice distribution in the optical paths of the different infrared bands. This is likely the case for the other tests as well.

It is of interest to note that the ice thickness appeared to decrease slowly with time from the first test of UAID 254 on April 5 and ending with UAID 452 on May 26. The UAID 397 test on April 26 is the one that most noticeably indicated non-uniform icing in the various optical paths. Slowly getting rid of water over this period of time is not at all uncommon. In an OGO satellite experiment in which a mass spectrometer was employed to measure the distribution of the various molecules and particles that existed in space the dominant material turned out to be H_2O -- outgassing from the spacecraft upon which it was mounted. The H_2O concentration decreased rapidly at first and then the rate of decrease became gradually slower and slower and it took about 8 or 9 months for the outgassing to become negligible.

If ice was slowly subliming during the course of a test (a reasonable assumption) it could decrease the curvature of the plot of output signal vs source radiance (as compared to a typical ice-free calibration curve) and in some cases even make the curve bend in the opposite direction (which is like going from the sublime to the ridiculous). It is probably not a coincidence that the EM calibration of the LWIR bands showed these characteristics.

As for the PV channels I agree with SBRC that "any possible effects due to ice in the optical path were completely lost against other effects". No mention is made of the interesting value of Q/L (ratio of incident flux at the detector to the source radiance), and which is proportional to the optical throughput, that was calculated for Band 24 in the July 20 test. It is 13 orders of magnitude lower than that for Band 23 ! Even neglecting this extreme discrepancy the Q/L values for the other PV bands with respect to each other bounce around wildly with unusually large differences. No explanation is given in the reference memo for this strange behavior. It may be due to the abnormal test conditions and/or the manipulations that were made to compensate for them. Hopefully, the problem will evaporate when the water does and the radiant cooler is working properly.

Conclusions:

There is little doubt that ice existed in the cold optical paths during the tests.

The MODIS EM calibration of the cooled detector bands is not valid.

Larry Goldberg

Distribution

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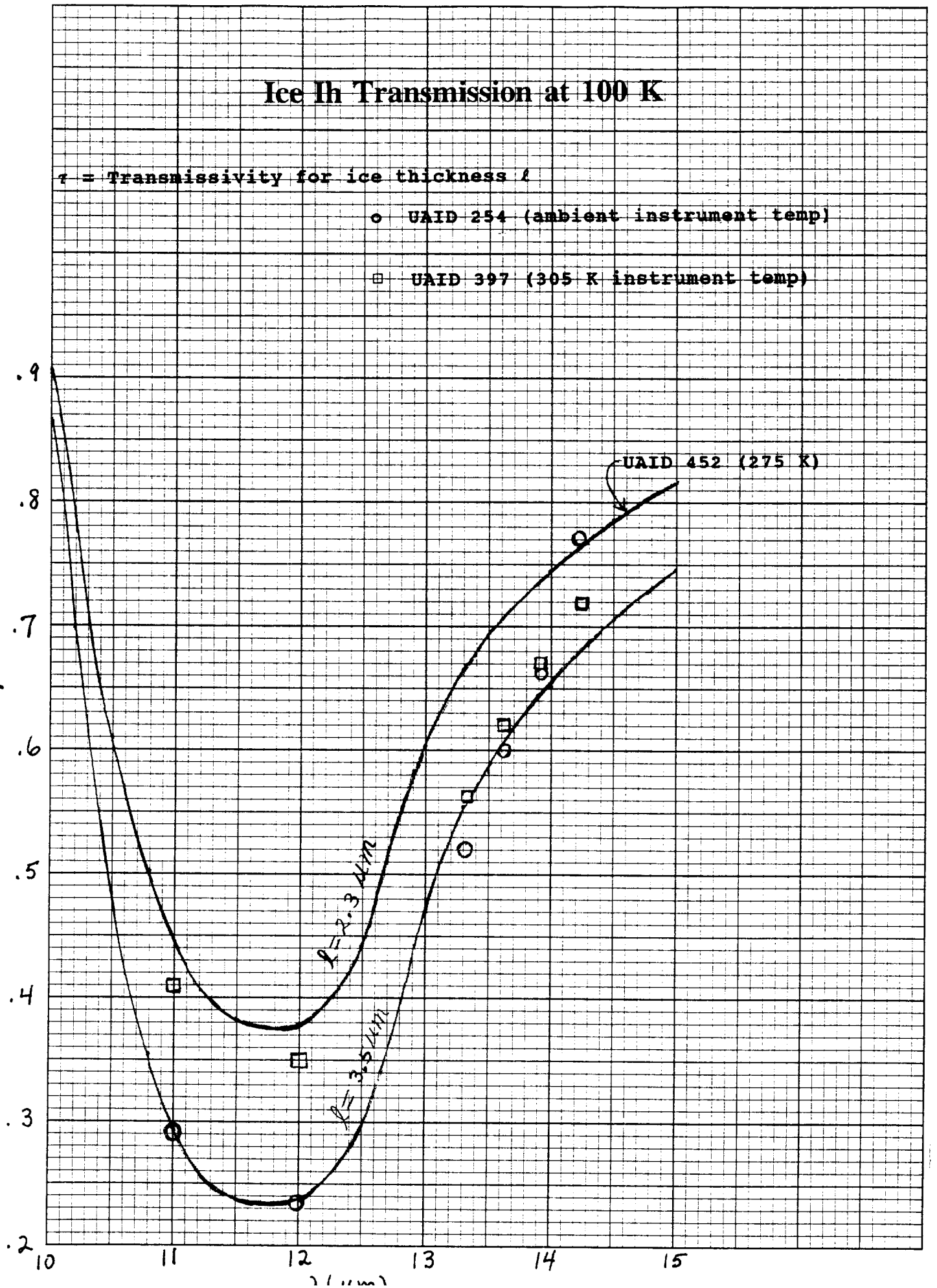

NO. XY-1001- SP 1
RECORDING CHARTS
GRAPHIC CONTROLS CORPORATION
BUFFALO, NEW YORK
PRINTED IN U.S.A.

Ice Ih Transmission at 100 K

$\tau = (1-R)\, e^{-\kappa \ell}$, R = Reflectivity

λ (μm)	κ (μm^{-1})	R	τ $\ell = 2.3 \mu m$	τ $\ell = 3.5 \mu m$
10.0	.0399	.0077	.905	.863
10.2	.100	.0080	.788	.699
10.5	.2053	.0095	.618	.483
10.8	.292	.019	.501	.353
11.0	.340	.0298	.444	.295
11.3	.388	.036	.395	.248
11.5	.400	.041	.382	.236
11.8	.405	.0405	.378	.233
12.0	.400	.0515	.378	.234
12.2	.380	.055	.394	.250
12.5	.330	.059	.441	.296
12.8	.25	.0585	.530	.392
13.0	.195	.056	.603	.477
13.3	.1535	.0525	.666	.554
13.5	.137	.0507	.693	.588
13.7	.124	.0489	.715	.616
14.0	.108	.046	.744	.654
14.3	.095	.0433	.769	.686
14.5	.085	.042	.788	.711
15.0	.071	.040	.815	.749

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MODERATE RESOLUTION IMAGING SPECTRORADIOMETER (MODIS) PROGRAM

SOFTWARE TEST READINESS REVIEW DATA PACKAGE
(CDRL 026)

PREPARED FOR
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
GREENBELT ROAD
GREENBELT, MARYLAND 20771

Contract No. NAS5-30800
CDRL 026
DM VJ50-0217
PREPARED JULY 1995

MODIS SOFTWARE TEST READINESS REVIEW

August 1, 1995

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AGENDA

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• Introduction	Vernon Alferd
• Software Configuration Management	Adele Sommers
• Software Assurance	Arlind Bettencourt
• MODIS Flight Software	Joe Auchter
• GSE Software (without TAC)	Rod Ontjes & John Leonard
• Test Analysis Controller Software	Joe Bauer
• Wrap-up and Summary	Vernon Alferd

INTRODUCTION

Vernon Alferd

INTRODUCTORY REMARKS

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- Flight software and GSE software are temporally decoupled:
  - Flight Software detailed design and implementation is complete.
  - Most Flight Software SWTRR documents are complete.
  - This SWTRR is adequately timed for Flight Software.
  - GSE detailed design and implementation is still in progress:
    - Stimulus Controller Software
    - System Test Controller Software
    - Archiver Software
    - Test Analysis Controller Software
- SBRC proposes that a ΔTRR be held for GSE on October 3, 1995.
  - STE software testing is scheduled for mid-October 1995
- SBRC proposes a GSE SWAR in late November 1995

MODIS SOFTWARE MANPOWER

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• MODIS Flight Software	Joe Auchter
• GSE Test Analysis Controller Software	Joe Bauer Mike Schienle
• Remaining GSE Software	Rod Ontjes* Eric Augustine** John Leonard* Gary Gensler David Capps (new)**

* OASIS-CC Experienced.

** Attended recent OASIS-CC Class at LASP

FLIGHT SOFTWARE CDRL DELIVERY

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DOCUMENT	CDRL	Status
Concept Document	F306A	Complete
Requirements Specification	F306B/C	Complete
Architecture Document	F306D/F	Complete
Detailed Design Document	F306 E	Complete
Version Description Document	F306H	Complete
User's Guide	F306J	Complete
Operational Procedures	F306I	Complete
Maintenance Manual	F306K	Complete
Unit Test Procedures	F415A	Complete
Integration Test Procedures	F415B	Complete
Acceptance Test Procedures	F415C	Complete

DIFFERENCES IN GSE AND TAC DOCUMENTATION

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- Development Plan: TAC not using Hatley-Pirbhai methodology.
- Software Configuration Management Plan: No difference.
- Software Assurance Plan: No difference
- Concept Document: No difference
- Requirements Doc: TAC & STC are decoupled, but in same document
- Architecture Doc: TAC & STC Decoupled; TAC section Modified, but in same document.
- Detailed Design Doc: TAC & other STE separated into two documents.
- Assurance (Test) Procedures: TAC & other STE separated into two documents.
- Other Documents: No difference

STE SOFTWARE CDRL DELIVERY

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DOCUMENT	CDRL	Status	Complete Date
Management Plan	008	SECR	Aug 1995
Concept Document	G306A	Complete	CDR
Requirements Specification	G306B/C	SECR	Aug 95
Architecture Document	G306D/F	SECR	Aug 95
Detailed Design Document*	G306 E	SECR	ΔTRR
Version Description Documents*	G306H	In Process	ΔTRR
User's Guide	G306J	In Process	ΔTRR
Operational Procedures	G306I	In Process	ΔTRR
Maintenance Manual	G306K	In Process	ΔTRR
Unit Test Procedures*	G415A	In Process	ΔTRR
Integration Test Procedures*	G415B	In Process	ΔTRR
Acceptance Test Procedures*	G415C	In Process	ΔTRR

* There are different STE & TAC versions of these documents

TAC SOFTWARE CDRL DELIVERY

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DOCUMENT	CDRL	Status	Complete Date
Detailed Design Document	T306 E	SECR	ΔTRR
Version Description Documents	G306H*	In Process	ΔTRR
Unit Test Procedures	T415A	In Process	ΔTRR
Integration Test Procedures	T415B	In Process	ΔTRR
Acceptance Test Procedures	T415C	In Process	ΔTRR

* There are multiple GSE VDDs, one for each CSCI; they will all combine into CDRL G306H.

SBRC ENGINEERING DOCUMENT CONTROL REFERENCES

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Document	CDRL	Flight	GSE	TAC
Management Plan	008	- - - -	- - - -	- - - -
Concept Document	306A	152927	152894	- - - -
Requirements Specification	306B/C	152928	151904	- - - -
Architecture Document	306D/F	152929	151900	- - - -
Detailed Design Document*	306 E	152930	151865	TBA
Version Description Document*	306H	153533	TBA	TBA
User's Guide	306J	153530	151901	- - - -
Operational Procedures	306I	153531	153528	- - - -
Maintenance Manual	306K	152932	152462	- - - -
Unit Test Procedures*	415A	152933	152896	TBA
Integration Test Procedures*	415B	152934	153529	TBA
Acceptance Test Procedures*	415C	152935	152897	TBA

SOME COMMENTS ON HARDWARE TESTING

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There are some hardware tests independent of the STE software tests:

- There are lower level test procedures for portions of the STE
  - Circuit Card Test Procedures
  - Unit Level Chassis Test Procedures
- All STE lower level tests will be completed prior to the ΔTRR.
- There are specific test procedures for the optical parameters of the GSE stimulus assemblies.
  - A unique procedure for each stimulus assembly
  - Purely optical parameter measurements, <u>independent</u> from STE SIC software
- Some optical tests will occur <u>after</u> software testing

GSE SOFTWARE PERT CHART

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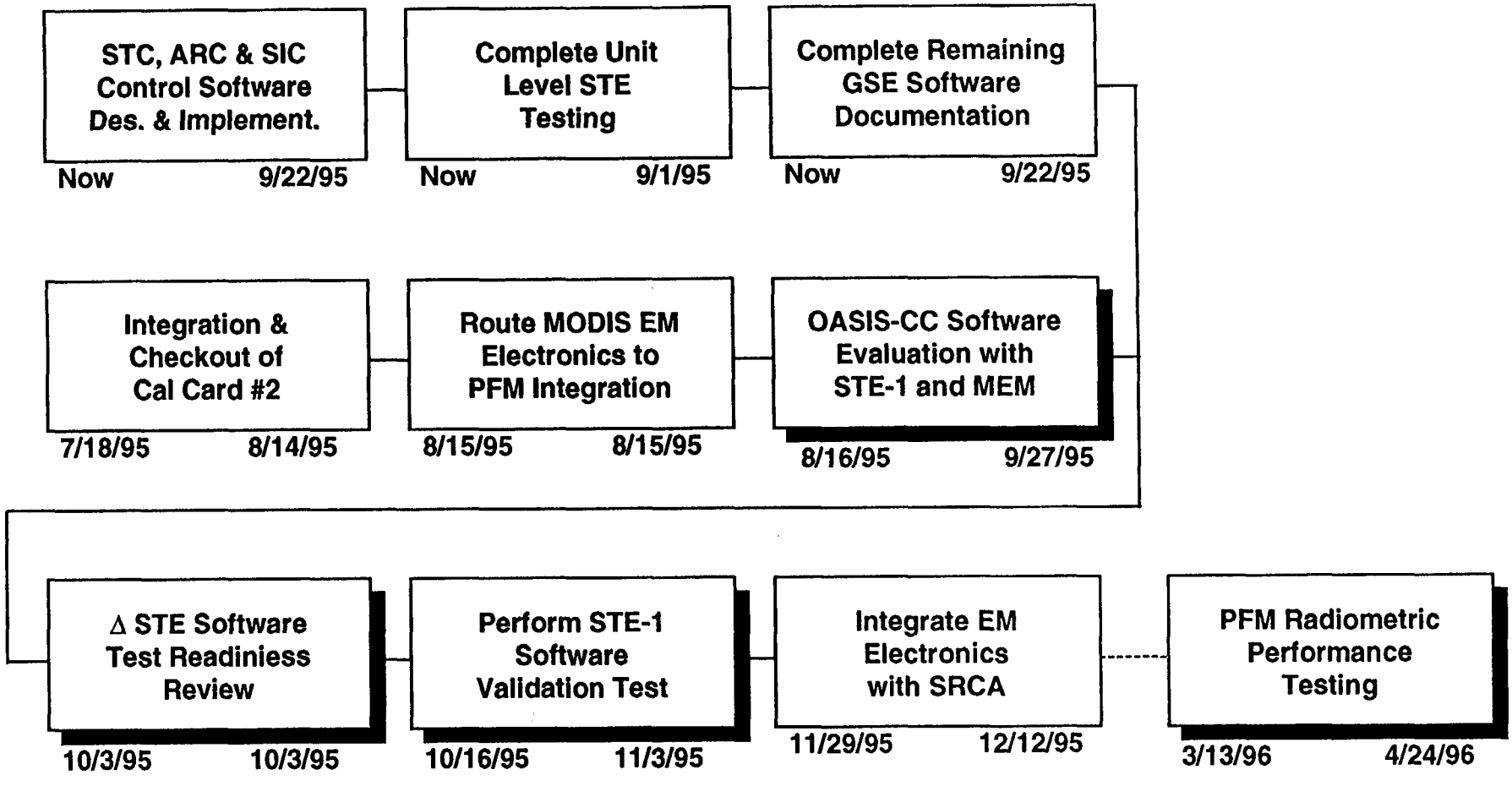

PLAN FOR SOLVING GSE OASIS-CC PROBLEMS

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- Suspected causes for OASIS crashes:
  - Epoch COTS software increases disk activity and network traffic.
  - PVWave COTS software increases CPU usage and conflicts with real-time aspects of OASIS.
  - Current versions of TAE+ and Motif have bugs identified by LASP.
  - VxWorks real-time software running on a VMEbus 68040 controller is interrupt driven by OASIS.
- Planned responses to these problems:
  - Localize disk space for logfiles
  - Process Priority reduction
  - Update Motif to v1.2 and OASIS-CC version 13
  - Remove Epoch from clients; add disk space for telemetry logging.
  - PVWave cannot be removed due to requirement for real-time display.
  - OASIS/VxWorks timing will be instrumented and monitored.

IDEAS FOR SOFTWARE DESCOPE

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- Bring only the following stimulus assemblies under SIC control per NASA-STD-2100-91
    - Integration & Alignment Collimator (IAC)
    - Spectral Measurement Assembly (SPMA)
- Maintain current Labview & Labwindows control software for
    - Polarized Source Assembly (PSA)
    - Blackbody Calibration Source (BCS)
    - Space View Source (SVS)
- Keep the Scatter Measurement Assembly (SPMA) Simple (ie: manual)
- Keep the Space Background Simulator (SBS) Controller independent from the STE.
- Link all independent controllers via Ethernet.

SOFTWARE CONFIGURATION MANAGEMENT

Adele Sommers

SOFTWARE CM - ENGINEERING CHANGE ANALYSIS

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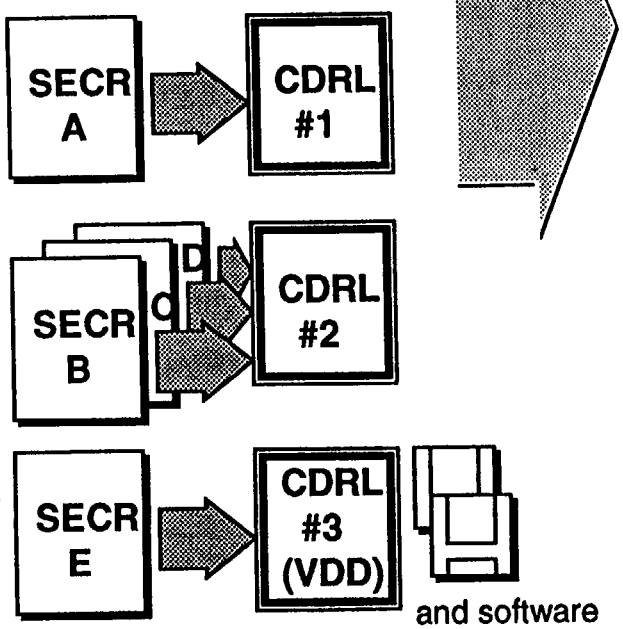
1

ECA (H/W or S/W)

Identifies general issue or problem. . .

. . . and relates to detailed proposal(s).



2

Change requests are reviewed by SRB & CRB. . .

. . . impact of change is analyzed, and visibility is maintained by SRB reports.

3

ECA ISSUE #1	STATUS
SECR A. . .CDRL#1	OPEN
SECR B. . .CDRL#2	OPEN
SECR C. . .CDRL#2	OPEN
SECR D. . .CDRL#2	OPEN
SECR E. . .CDRL#3	OPEN
ECA ISSUE #2	
SECR F. . .CDRL#4	OPEN
. . .	

SOFTWARE CM - CDRL CHANGE & RELEASE FLOW

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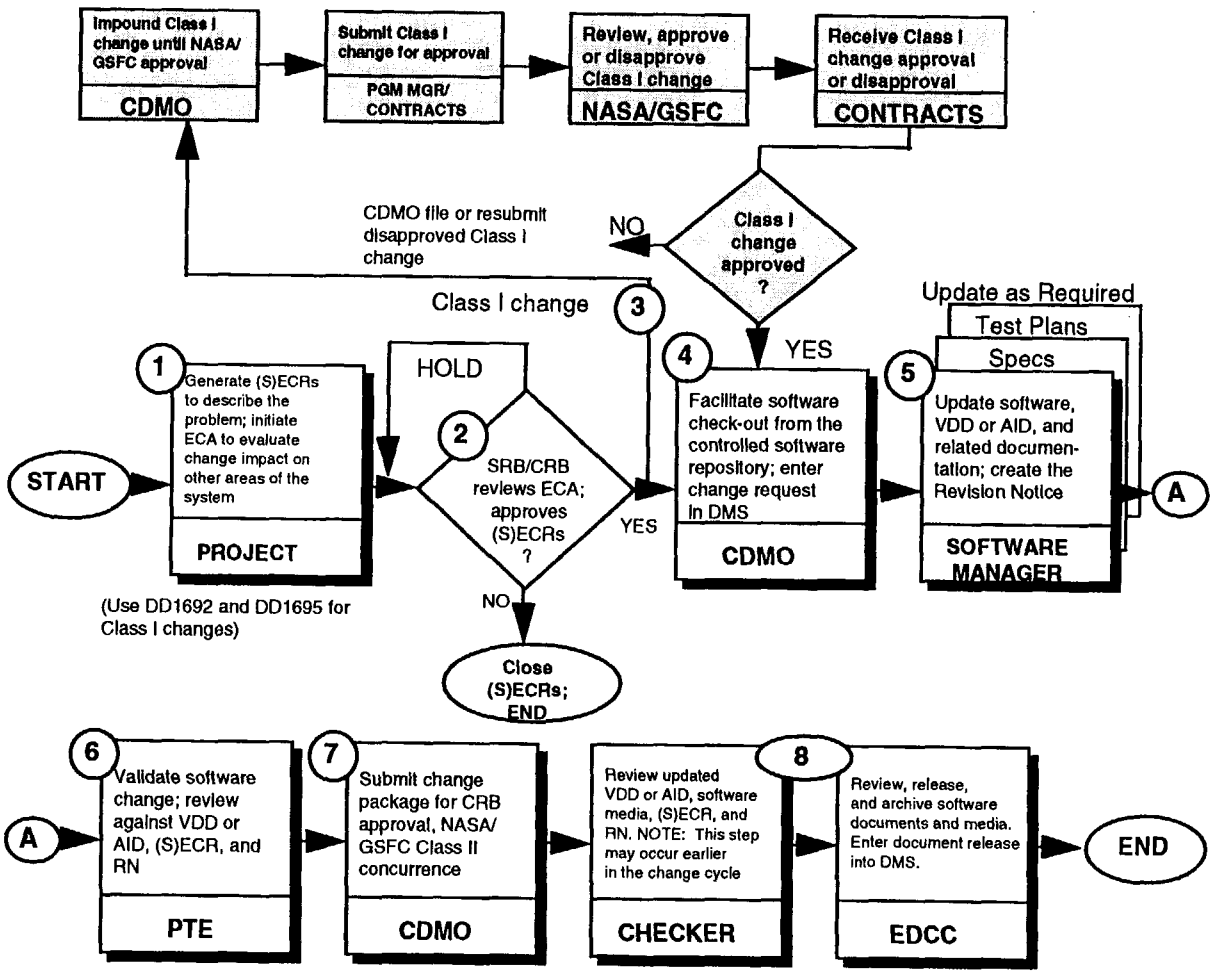

Figure 4-2 (CDRL 008C). SBRC "Baseline Version" (Formal) Change Control Process

Sequence for updating SBRC-released MODIS CDRL items:

1. Project member initiates ECA and (S)ECR(s), e.g., to capture and track customer comments, as a Software Discrepancy Report (SDR) result, etc.
2. SRB/CRB reviews ECA & (S)ECRs.
3. If Class I, CDMO (DM) submits ECP to NASA/GSFC for approval.
4. CDMO (CM) enters (S)ECRs in DMS.
5. SW Mgr. updates CDRL, creates RN.
6. PTE (& SRB) review updated CDRL against Revision Notice.
7. CDMO (CM) submits CDRL change package to CRB; (DM) obtains CDRL Inspection Record approvals, sends CDRL change package to GSFC for change classification concurrence.
8. CDMO (CM) submits CDRL for final checking, internal release in EDCC* during GSFC classification review.

***CDRLs requiring GSFC approval are not official "working documents" until approval is received. This applies to released & non-released CDRLs.**

SOFTWARE CM - INFORMATION REPOSITORIES

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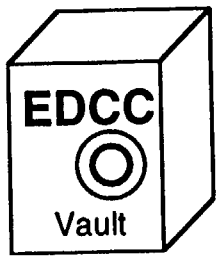
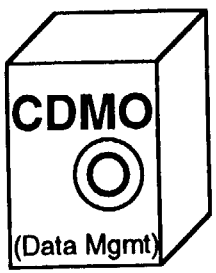
Official copies of information reside in the following locations:



Released software CDRLs (e.g., 306 & 415 series); all software baseline media; all released (S)ECRs & RNs

On-line copies:
CDRL 306, 415-series documents on EDCC & project file servers.



Non-released software CDRLs (e.g., 008 & Report series); all CDRL Inspection Records; all MODIS Project Instructions

On-line copies:
Non-released CDRL documents on CDMO & project file servers.

All SRB agendas and minutes; SRB-reviewed change requests & Software Discrepancy Reports; Dept. Operating Instructions.

On-line copies:
SRB minutes, Dept. Operating Instructions on CDMO file server.

SOFTWARE CM - UPCOMING CM MILESTONES

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- GSE "delta" SWTRR in October - to complete documentation and software releases.

- SWAR milestones (internal and formal) - to prepare for system integration activities. Finalize all procedures for MODIS system integration and test phase, including software change controls.

- Pre-Shipment and Pre-Storage Reviews - to perform verification of "as-built" software system against "as-designed" system.

NOTE: The Protoflight reviews occur in the Sept./Oct. 1996 time frame; the software portion still needs to be scheduled.

SOFTWARE CM - HIGHLIGHTS SINCE THE CDR

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- MODIS Software Configuration Management Plan (CDRL 008C) has been updated two more times to reflect:
  - a revision of Table 4-1 (software CDRLs) to synchronize once again with 422-20-04, Software Management Requirements
  - addition of Table 4-1 columns to explicitly identify documents belonging to major software subsystems (GSE and Flight)
  - changes made to original references to "PCA" milestone (the contract calls for "Pre-Shipment" and "Pre-Storage" reviews)
  - clarifications and minor changes requested by NASA/GSFC in formal correspondence exchanged since the time of the CDR
- 40+ non-GSE, non-flight software packages have been released in EDCC and controlled per PI 7.9 (SBRC's "best business practice").

SOFTWARE CM - SOFTWARE REVIEW BOARD (SRB)

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- The SRB comprises the following representatives:
  - Systems Engineering
  - Software Engineering (Flight, GSE, TAC)
  - Product Assurance PTE (SRB chair)
  - CDMO (SRB secretary)
- The role of the SRB is to:
  - review and approve all software CDRL documentation
  - perform a screening function related to software changes
  - forward software ECAs, (S)ECRs, RNs to CRB for review
  - review and take action on Software Discrepancy Reports
- Systems Engineering reviews hardware ECAs and approves software ECAs as the interface control function between flight products and the GSE system/software.

SOFTWARE ASSURANCE

Arlind Bettencourt

PRODUCT TEST ENGINEERING

- RESPONSIBLE FOR SOFTWARE ASSURANCE OF:
  - FLIGHT SOFTWARE
  - STE SOFTWARE
  - IN-PROCESS/MANUFACTURING SOFTWARE
- REPORT TO PRODUCIBILITY AND DESIGN ASSURANCE MANAGEMENT
- MODIS PTE MANPOWER IS PRESENTLY TWO ENGINEERS

GSE/STE SOFTWARE

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- BRASS BOARD ANALOG ELECTRONICS MODULE (BAEM)
- INTEGRATION AND ALIGNMENT COLLIMATOR (IAC)
- POLARIZING SOURCE ASSEMBLY (PSA)
- SPECTRAL MEASUREMENT ASSEMBLY (SPMA)
- ARCHIVER (ARC)
- PAYLOAD INTERFACE CONTROLLER (PIC)
- STIMULUS INTERFACE CONTROLLER (SIC)
- SYSTEM TEST CONTROLLER (STC)
- TEST ANALYSIS CONTROLLER (TAC)

INPROCESS / MANUFACTURING SOFTWARE

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- 21 TEST SETS IN THE DETECTOR/FPA AREA
- 23 TEST SETS IN THE SYSTEMS AREA
- VALIDATION CONSITS OF THE FOLLOWING:
  - REVIEW OF TEST METHOD FOR COMPLIANCE WITH THE TEST PLAN
  - MATHEMATICAL REVIEW OF THE DATA PROCESSING ALGORITHMS FOR COMPLIANCE TO SPCIFICATIONS
  - SOFTWARE IS LOADED AND EXECUTED TO VALIDATE CORRECT SYSTEM OPERATION
  - CALIBRATION PROCEDURE IS REVIEWED, APPROVED AND PERFORMED IN ACCORDANCE WITH QUALITY PRACTICE 2.2
  - TEST PROCEDURES ARE REVIEWED AND APPROVED
  - VERSION DESCRIPTION DOCUMENT (VDD) IS REVIEWED, APPROVED AND RELEASED THROUGH THE ENGINEERING DOCUMENT CONTROL CENTER (EDCC)

SOFTWARE DISCREPANCY REPORTING

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- CONTROLING DOCUMENT IS PROJECT INSTRUCTION 5.12
- A SOFTWARE DISCREPANCY IS A DEPARTURE FROM SPECIFICATION THAT IS DETECTED DURING INSPECTION OR PROCESS CONTROL TESTING, ETC., WHILE THE SOFTWARE IS NOT FUNCTIONING OR OPERATING
- SOFTWARE REVIEW BOARD PREFORMS THE FOLLOWING:
  - REVIEWS THE SOFTWARE DISCREPANCY REPORT (SDR) AND ASSIGNS RESPONSIBLILITY / SCHDULE
  - DOCUMENTS THE PROGRESS OF EACH OPEN SDR
  - VERIFIES THE CORRECTIVE ACTION IS ADEQUATE
  - REVIEWS THE SDR METRICS FOR TRENDS AND LEVELS OF CRITICALITY
  - ESTABLISHES INTERNAL REPORT DISTRIBUTION
  - DETERMINES THE SOFTWARE DEFECT CODE

AREAS FOR IMPROVEMENT

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- MORE TRAINING IS NEEDED ON THE REQUIREMENTS OF THE SOFTWARE MANAGEMENT PLAN
- SYSTEM SAFTY NEEDS MORE ATTENTION AND DOCUMENTATION
- FORMAL COMMUNICATION BETWEEN SYSTEM ENGINEERING AND SOFTWARE DEVELOPMENT TEAM NEEDS IMPROVEMENT
- CONCURRENT ENGINEERING COMMUNICATIONS BETWEEN DEVELOPMENT GROUPS AND PRODCUT TEST ENGINEERING

MODIS FLIGHT SOFTWARE

Joe Auchter

FLIGHT SOFTWARE VIEWGRAPHS
WILL NOT BE READY UNTIL THE TEST READINESS
REVIEW

MODIS GSE SOFTWARE WITHOUT TAC

Rod Ontjes & John Leonard

IMPLEMENTATION PHASE METRICS

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- The table below reflects changes per CDR Comments and changes likely to be proposed in the near future.

	ARC	PIC	SIC	STC	TOTAL
Requirements Modified	22\1	8\4	2\6	0\0	32\11
Requirements Added	0\0	0\0	0\0	0\0	0\0
Requirements Deleted	4\2	1\3	0\22	0\0	5\22
Total No. of Requirements	61	111	69	23	264

Key: Changes due to CDR comments\Changes to be proposed
Note 1: Changes to be proposed are estimates at this time
Note 2: Total No. of Requirements = performance requirements @ CDR

EM TESTING SOURCE CODE STATISTICS PIC SOFTWARE

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- PIC-RT
  - Number of C source and header files: 52
  - Number of C functions: 250
  - Number of lines of C code: 9697
  - Number of lines of comments: 8348
- PIC Workstation
  - Number of C source and header files: 39
  - Number of C functions: 30
  - Number of lines of C code: 1365
  - Number of lines of comments: 494

EM TESTING SOURCE CODE STATISTICS STC & ARC SOFTWARE

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- STC
  - Number of C source and header files: 9
  - Number of C functions: 9
  - Number of lines of C code: 508
  - Number of lines of comments: 28
- ARC
  - Number of C source and header files: 56
  - Number of C functions: 183
  - Number of lines of C code: 6138
  - Number of lines of comments: 6503

EM TESTING OASIS PROCEDURE STATISTICS

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- PIC/WS
  - Number of OASIS Procedures: 181
  - Number of OASIS Statements: _____
  - Number of Lines of Comments: _____
- STC
  - Number of OASIS Procedures: 114
  - Number of OASIS Statements: _____ *(doesn't include I&T procs)*
  - Number of Lines of Comments: _____
- SIC
  - Number of OASIS Procedures: _____
  - Number of OASIS Statements: _____
  - Number of Lines of Comments: _____

CODE STATISTICS SUMMARY

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	PIC-RT	PIC/WS	STC	ARC	Totals
Source & Header Files	52	39	9	56	156
C Functions	250	30	9	183	472
Lines of Code	9697	1365	508	6138	17708
Lines of Comments	8348	494	28	6503	15373
OASIS Procedures	0	181	114	0	295
OASIS Statements	0	0	0	0	0
Lines of Comments	0	0	0	0	0

ARC & STC WALKTHROUGHS & UNIT TESTING

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- ARC
  - Walkthroughs performed on code representing 15 of 21 (non-COTS) Design Modules (71% coverage)
  - Unit tests done at the Architecture Module level
    - Unit Tests of 2 of 4 modules performed.
  - No unit test failures were encountered.
- STC
  - Very little code in comparison to ARC (8%)
  - No walkthroughs or unit tests were performed on user code executed from the OASIS environment

PIC WALKTHROUGHS & UNIT TESTING

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- PIC-RT
  - Walkthroughs performed on code representing 22 of 58 PIC -RT Design Modules (38% coverage)
  - Unit tests done at the Architecture Module level
    - No Unit Tests performed to date.
- PIC/WS
  - Very little code in comparison to PIC-RT (14%)
  - No walkthroughs or unit tests were performed on user code executed from the OASIS environment

TESTING IN PREPARATION FOR EM TESTING - 1553 BUS

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- Bus Analyzer used to simulate MODIS Instrument
  - Primary and Redundant Checked
  - Subaddresses Verified
    - Sync with Data Word, SCC OK, Housekeeping
    - Ancillary Data, Time Code
  - Mode Codes Checked
  - Check Commands Generated via OASIS

TESTING IN PREPARATION FOR EM TESTING - SCIENCE DATA PATH

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- TPG Test patterns looped into FDDI Receiver Card
  - Data Acquisition Commands issued from OASIS, collect stored to Archiver
  - Science Data Display (Fast Display) verified

TESTING IN PREPARATION FOR EM TESTING

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- Power Supply Control
  - Ability to set limits, set voltage, control Power Beacon, Bus Select
- RTIU Control
  - verify that OASIS commands control relays, simulated telemetry verified
- Telemetry Scale Factors
  - System Engineering verified all scale factors
- MODIS On-Time & Remote File Archiving Proven In
- Instrument Commands
  - OASIS-to-Instrument Commands Verified During EM Tests

ARC REQUIREMENT EVOLUTION PAGE 1

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- Trending
  - Data trending on the ARC has been moved to the TAC due to schedule constraints and the TAC has already implemented some of the trending.
  - These ARC requirements 014 thru 021 are based on GSE requirement 023 which is a derived requirement. Analyzing long and short term trends in archived data should not be impacted.
- Modify Tables
  - These tables are only utilized by the TAC and therefore this has been moved to the TAC.
  - This is a derived requirement. Moving this to the TAC should have no impact.

ARC REQUIREMENT EVOLUTION PAGE 2

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- EOSDIS
  - The GUI tool for query of archived data has been deleted due to schedule constraints.
  - The ARC data will be available via a WAN and can be retrieved using existing tools like ftp. The UniSQL database can also be used for data inquiries.
  - The ARC requirements 011, 012, and 013 are all derived requirements.

ARC REQUIREMENT EVOLUTION PAGE 3

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- Results Data Handling
  - The recorded results data was intended to be accessible by database query or direct file transfer. We have found that a query of the database for the results data was not needed for the TAC analysis. Therefore we will remove the reference to database query from the ARC results requirement 004.
  - Since the results will not be stored in the UniSQL database the Results data handling requirements will be moved to the TAC.
  - The software impact of the requirements move to TAC is minimal.
  - The ARC requirements are 004, 038, 039, 040, 047, 048, 063 thru 066.

ARC ARCHITECTURE EVOLUTION

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- Trend Analyzer (COTS)
  - This task has been moved to the TAC.
- Archive Data Retriever
  - This task is no longer required as the TAC retrieves it's data directly from the Archiver. It is not necessary for the TAC to query the database to get the data files needed.
  - No requirements are impacted by this removal.
- It was intended to have a user interactive window interface with the database, due to schedule constraint this feature will not be implemented.
  - There is no immediate impact.

ARC DETAILED DESIGN EVOLUTION

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- Trend Analyzer (COTS)
  - This task has been removed from the Architecture therefore it will not be implemented in the Detailed Design.
- Archive Data Retriever
  - This task has been removed from the Architecture therefore it will be deleted from the Detailed Design.
- The user interactive interface to the database was removed from the architecture therefore it will not be implemented in the Detailed Design.

PIC REQUIREMENT EVOLUTION

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- SIS Low Rate Data Bus is no longer available
- Image Data Display won't be implemented due to schedule constraints
- Command & Telemetry Bus task schedule requirement needs to be modified to remove Instrument requirements.
- Critical Limit Audible Alarm capability is not part of OASIS, so requirements will be deleted.
- Sending MODIS "OFF" command when any monitored parameter exceeds critical limits, is too simplistic and will not be implemented.
- Impact of these proposed changes is documentation only
- No affect on software already implemented

STC EVOLUTION

- Requirements for STC have not changed
- Capability fulfilling the requirements was exercised extensively during EM testing

SIC SW REQUIREMENTS EVOLUTION POST CDR

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- Critical Limit Audible Alarm capability is not part of OASIS, so requirements will be deleted
- Sending SIC subsystem "OFF" command when any monitored parameter exceeds critical limits is too simplistic and will not be implemented
- Monitor and control requirements for Modis Ground Based Calibrator (MGBC) will be deleted due to elimnation of MGBC
- SW control and monitoring requirements for Space Background Simulators (SBS) have been downscoped and will not be implemented
- SIC SW external elements include the following Optical Stimulus Equipment:
  - IAC, SPMA, SIS, and BCS/SVS

SIC SW REQUIREMENTS STATUS SUMMARY

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SIC-SSS- Rqmt #	Requirement Name	Status	Description
92-95, 115,188, 229, 232, 233,	Monitor MGBC	Delete	MGBC function eliminated
186, 82, 83, 103, 221, 222, 234	Control MGBC	Delete	MGBC function eliminated
225-227	Monitor SBS temperature	Delete	Downscope of SBS SW monitor requirements
55, 62, 69	Select SBS temperature	Delete	Downscope of SBS SW control requirements
37	Critical limit "OFF command	Delete	Requirement is inappropriate
35	Display telemetry messages	Modify	Audible alarm requirement will be deleted
32	Monitor status of all subassemblies	Modify	Monitor status of IAC, SPMA, SIS, and BCS/SVS
231	Monitor SPMA mirror select stage position	Modify	Monitor SPMA source select stage position
25	Remote control of all subassemblies	Modify	Remote control of IAC, SPMA, SIS, and BCS/SVS
26	Local control of all subassemblies	Modify	Local control of IAC, SPMA, SIS, and BCS/SVS
162	Control SPMA parameters	Modify	SW control of chopper speed not required
79	Control SPMA mirror select stage position	Modify	Control SPMA source select stage position
163, 230	Monitor SPMA parameters	Unchanged	
223	Monitor 100cm SIS lamp currents	Unchanged	
224	Monitor BCS cavity temperature	Unchanged	
228	Monitor SVS temperature	Unchanged	
33, 34, 36, 38, 39, 212-215	Generic monitoring	Unchanged	
27	Implement STOL	Unchanged	
28	Manual TCL commands at SIC	Unchanged	
220	Control SIS data acquisition	Unchanged	
41	Control BCS cavity temperature	Unchanged	
48	Activate SVS temperature	Unchanged	
129	Control SPMA translation stage position	Unchanged	
218	Control IAC data acquisition	Unchanged	
29-31, 197-211	Generic control	Unchanged	

Updated SIC SW External Interfaces

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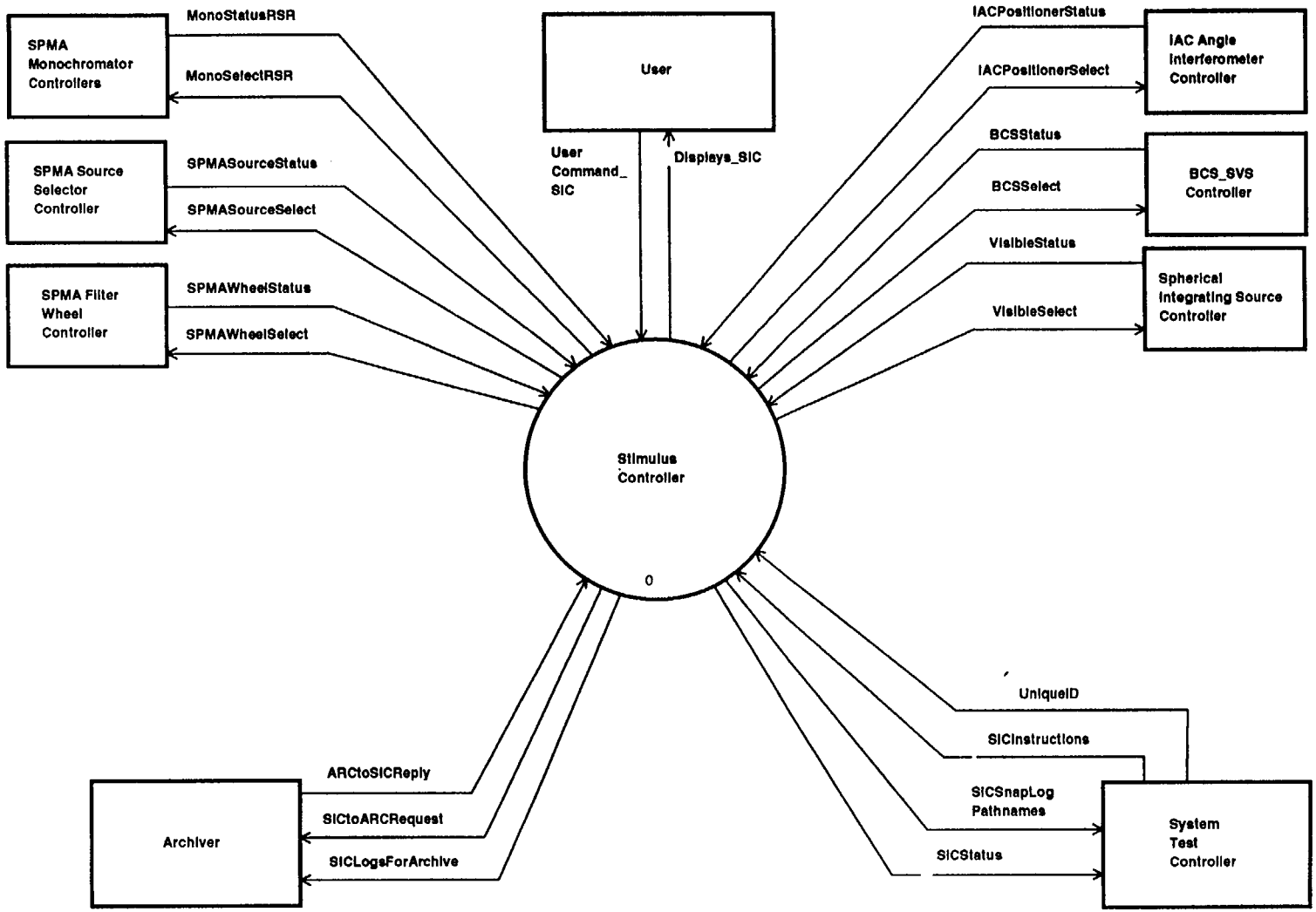

SIC SW Architecture Diagram

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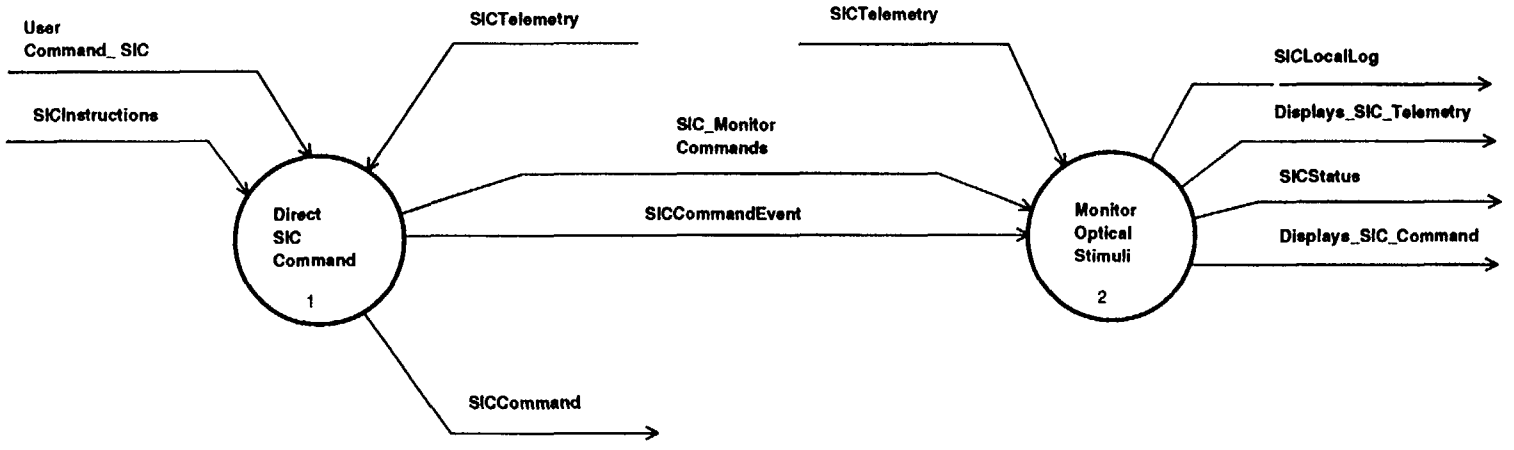

Impact of Requirement Changes on Design and Implementation

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- Proposed changes impact documentation only
- Architecture topology and operations concept are unaffected
- No affect on software already implemented
- External element changes impact corresponding OASIS database tables

SIC ACCEPTANCE TESTING

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- Acceptance test plans are unchanged from CDR
- Changes in external elements impact test procedure details
- All commands will be tested
- All telemetry limits and displays will be tested

SIC ACCEPTANCE TEST COVERAGE & METHODOLOGY SUMMARY

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Test ID	Test Name	Method	SIC-SSS-Rqmt	Description
AT-SICSW-001	External Command	Test	25, 26, 28, 29, 41, 48, 79, 129, 162, 197-199, 202-204, 214, 215, 218, 220,	Test syntax check, translation, and distribution over IEEE-488 bus of all external commands.
AT-SICSW-002	Internal Command	Test	29, 211, 214, 215	Test syntax check and execution of all internal commands.
AT-SICSW-003	Command File Interaction	Design	30, 31, 205-207	Verify halt, restart, abort, delay, and override interactive command capabilities of OASIS design.
AT-SICSW-004	STOL	Design	27	Compare STOL requirements to OASIS CSTOL design.
AT-SICSW-005	Command File Branching	Design	208-210	Compare command file branching requirements to OASIS branching capabilities.
AT-SICSW-006	Telemetry Display and Monitor	Test	32-36, 38, 39, 163, 212, 223, 224, 228, 230, 231	Test display and limit checking of all telemetry points.
AT-SICSW-007	Display Configuration	Test	213	Test the capability to change the configuration of the telemetry displays.
AT-SICSW-008	Command Format	Inspection	200	Verify OASIS input commands use English -like alpha mnemonics.
AT-SICSW-009	Command Pre-Check	Inspection	201	Verify commands requiring pre-check have corresponding entries in OASIS database.
AT-SICSW-010	Receive and Convert Telemetry	Inspection	32-36, 38, 39, 163, 212, 223, 224, 228, 230, 231	Verify receipt and conversion of telemetry by inspection of OASIS database tables.

OUTSTANDING TECHNICAL ISSUES

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- No outstanding technical issues are known at this time which could prevent STE Software completion

MAJOR REMAINING TASKS

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- STE-1
  - Address EM Testing Outstanding Issues
  - Complete SIC HW/SW Implementation
  - Complete ARC Implementation
  - Complete STC SW Implementation
  - Complete Walkthroughs and Unit Tests
  - Complete Acceptance Test Procedures
  - Complete Software Documentation
  - Release Software
- STE-2
  - Complete Software Implementation

MODIS TEST ANALYSIS CONTROLLER SOFTWARE

Joe Bauer

AGENDA

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- TAC objectives, ground rules
- Documentation requirements
  - Management, Development, Assurance, and Configuration Management Plans
  - Concept and Requirements Documents
  - Architecture Document
  - Detailed Design Document
  - Version Description Document (VDD)
  - User's Guide, Operational Procedure, and Maintenance Manual
  - Unit, Integration, and Acceptance Test Procedures
- TAC progress, achievements, and examples

TAC OBJECTIVES

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- Reduce all necessary data in order to verify MODIS compliance with performance specifications.
  - Compute actual values of functional parameters such as backgrounds, radiometry, and telemetry.
- Compute desired values for adjustable parameters such as gains and offsets.
- Display relevant data in tabular and graphical form.

TAC CODING RULES

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- Most code is in Fortran, some in C or PV_Wave.
  - Fortran Coding Standard, LOI-8101-1707
  - C Language Coding Conventions, LOI-8101-1702
- Follow requirements of SBRC CDRLs 008, 306, and 415, adapted as appropriate by SECRs.
- Follow requirements of NASA-STD-2100-91.

TAC MODIFICATIONS TO SOFTWARE DOCUMENTATION

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Title	Status	Complete date
• Management Plan	Complete	Complete
• Development Plan	SECR	Aug 95
• Assurance Plan	Complete	Complete
• Configuration Management Plan	Complete	Complete
• Concept Document	Complete	Complete
• Requirements Specification	SECR	Aug 95
• Architecture Document	SECR	Aug 95
• Detailed Design Document	In Process	Aug 95
• Version Description Document	In Process	Oct 95
• User's Guide	In Process	Oct 95
• Operational Procedures	In Process	Oct 95
• Maintenance Manual	In Process	Oct 95
• Unit Test Procedures	In Process	Oct 95
• Integration Test Procedures	In Process	Oct 95
• Acceptance Test Procedures	In Process	Oct 95

REVISIONS TO

MANAGEMENT, DEVELOPMENT, ASSURANCE, AND CM PLANS

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- No TAC changes to
  - Management Plan.
  - Assurance Plan.
  - Configuration Management Plan.
- TAC will be compliant with Development Activities Plan for STE design and development standards, including <u>most</u> parts of the Hatley-Pirbhai software development method. Exceptions will be specified so that the TAC Detailed Design Document:
  - may list and define input and output variable names but not use data dictionaries.
  - may use block diagrams rather than structure charts.

REVISIONS TO
CONCEPT AND REQUIREMENTS DOCUMENTS

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- No TAC changes to Concept Document. Applies as is.
- Changes to Requirements Specification:
  - Decouple TAC from STC.
  - No TAC changes to requirements cross-reference matrices.

REVISIONS TO
ARCHITECTURE DOCUMENT

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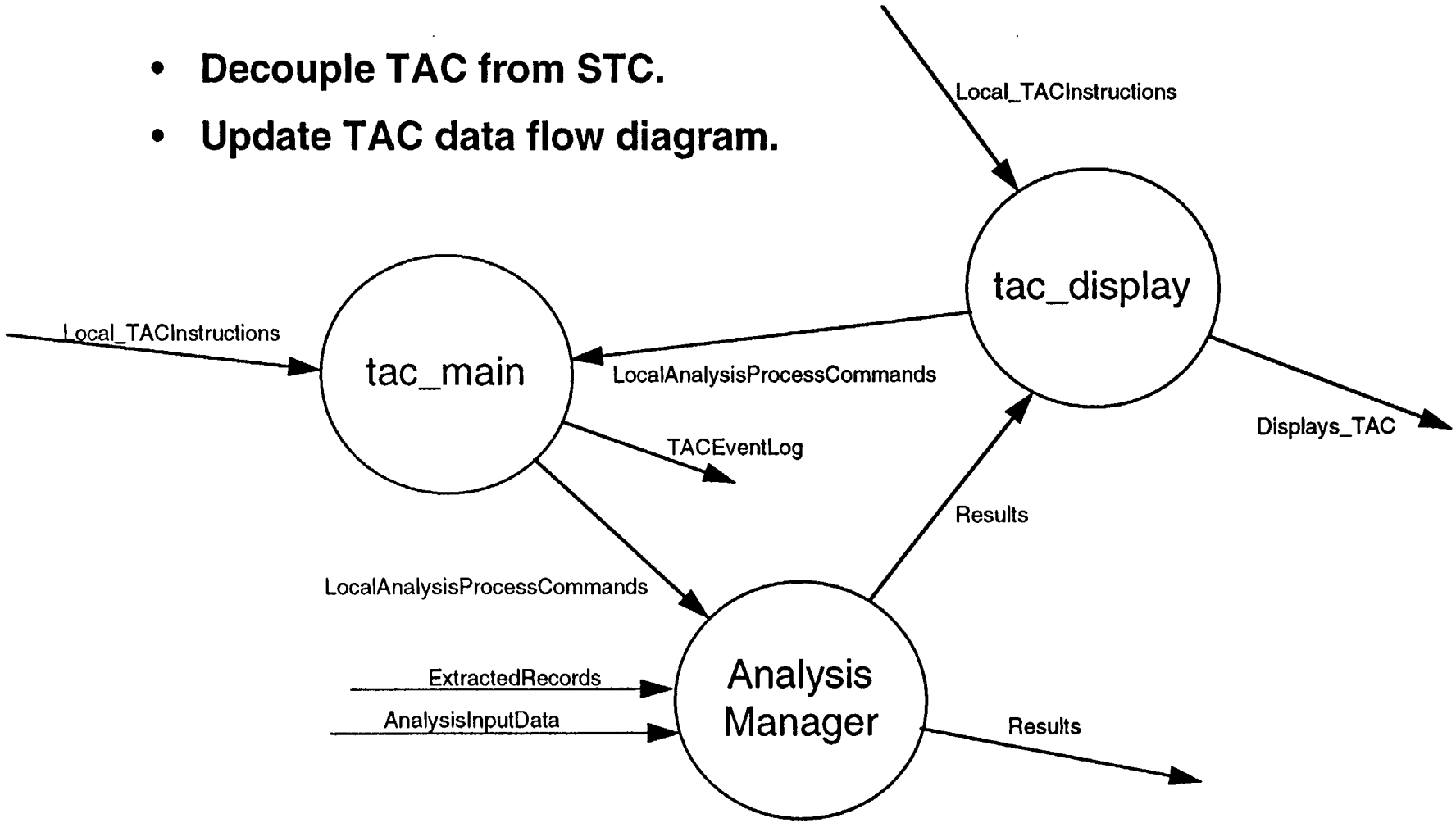
- **Decouple TAC from STC.**
- **Update TAC data flow diagram.**



ALGORITHM SPEC 151868
USED FOR DETAILED DESIGN DOCUMENT

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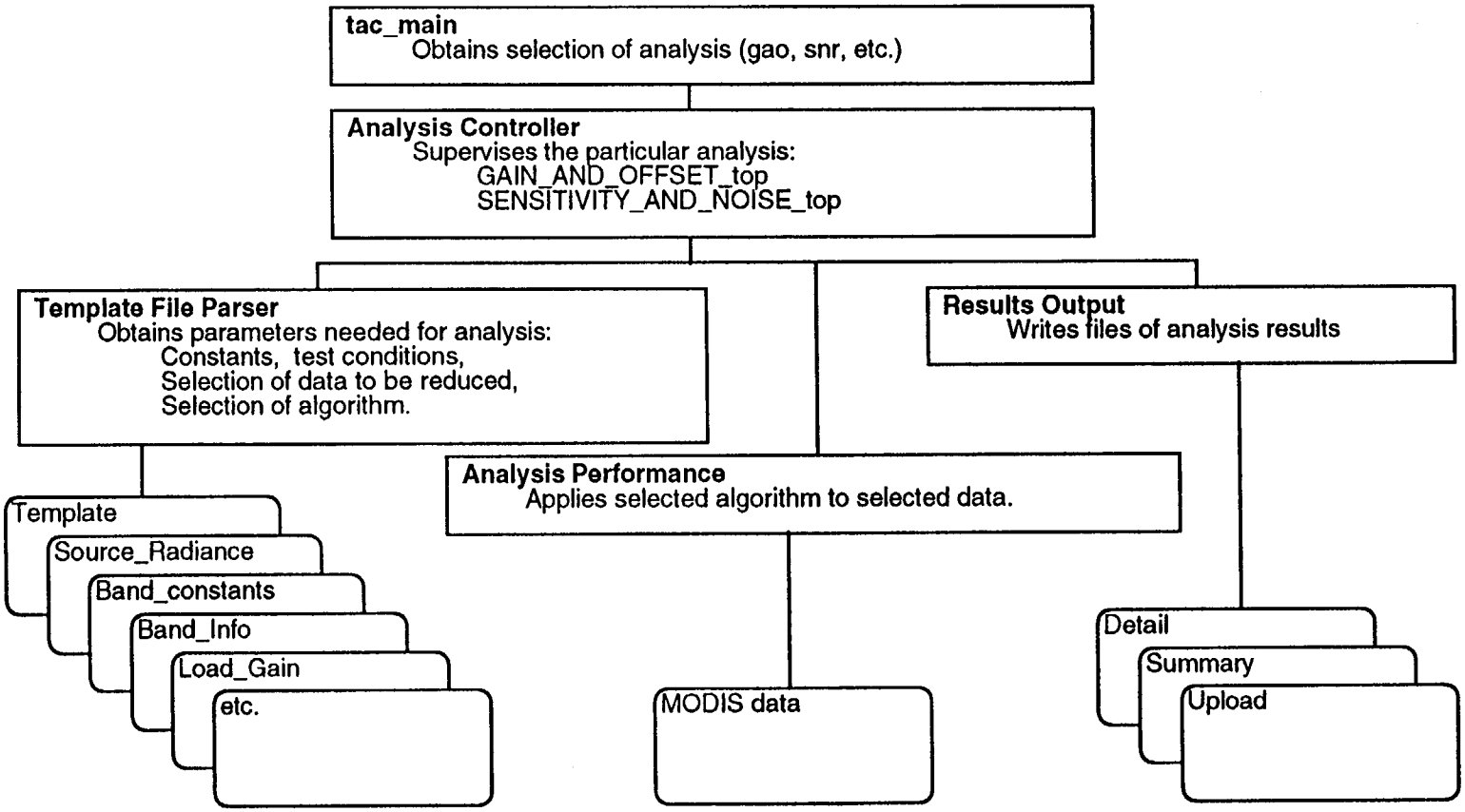
- **Algorithms revised with Engineering Model experience.**
- **Block diagrams included for each unit. For example:**



TAC CSCI
INCLUDES MANY UNITS

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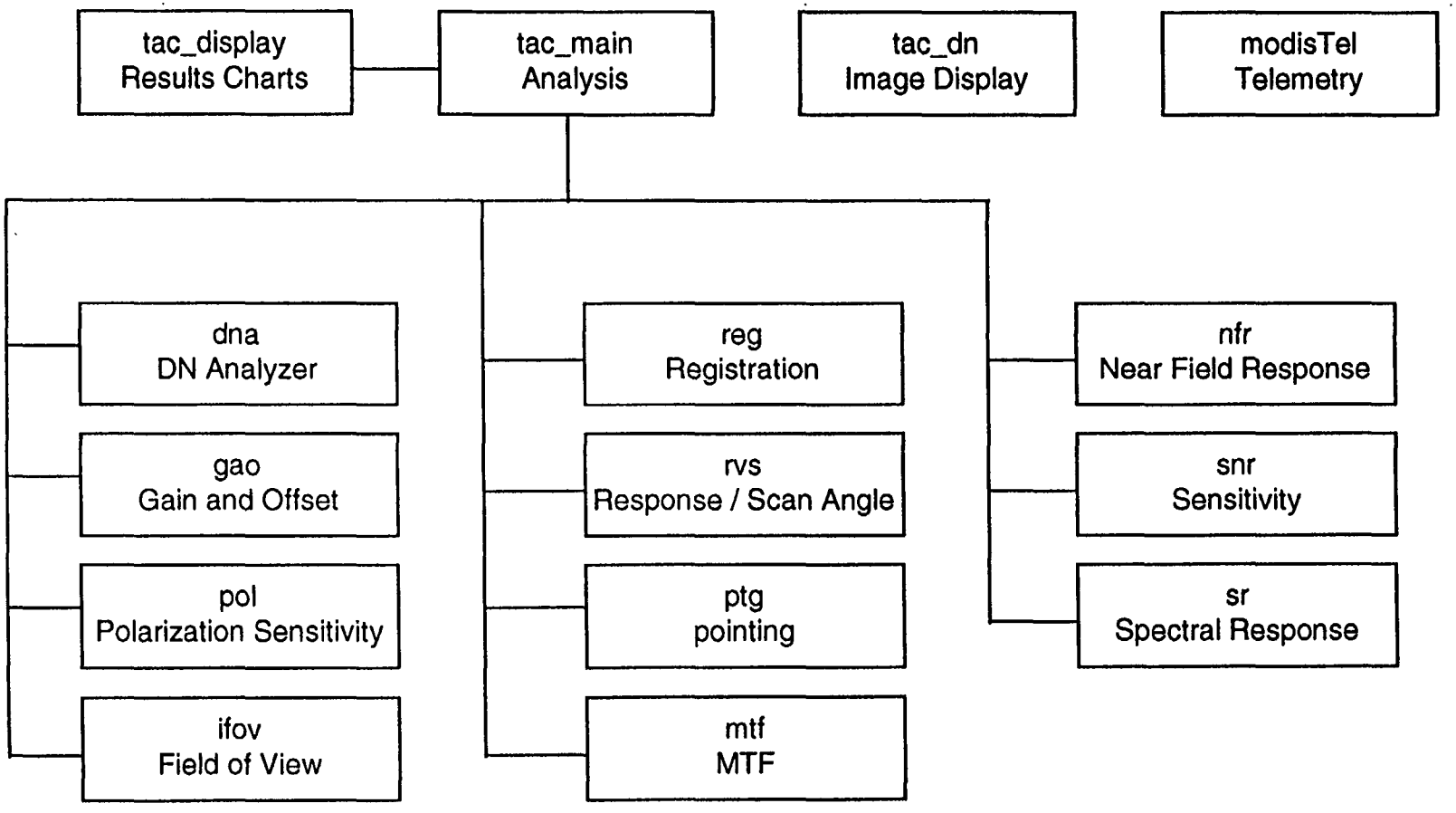

PLANS FOR REMAINING PRODUCT SPECS

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- Version Description Document (VDD):
  - Last item delivered after completion of all TAC units.
  - (Available source code has been informally delivered.)
- User's Guide, Operational Procedures, and Maintenance Manual:
  - Engineering Model test reports include the basis for these procedures. Files associated with each algorithm are described in full detail.
  - Documents will be generated by ΔTRR.

ASSURANCE PROCEDURES WILL FOLLOW TEST PLAN

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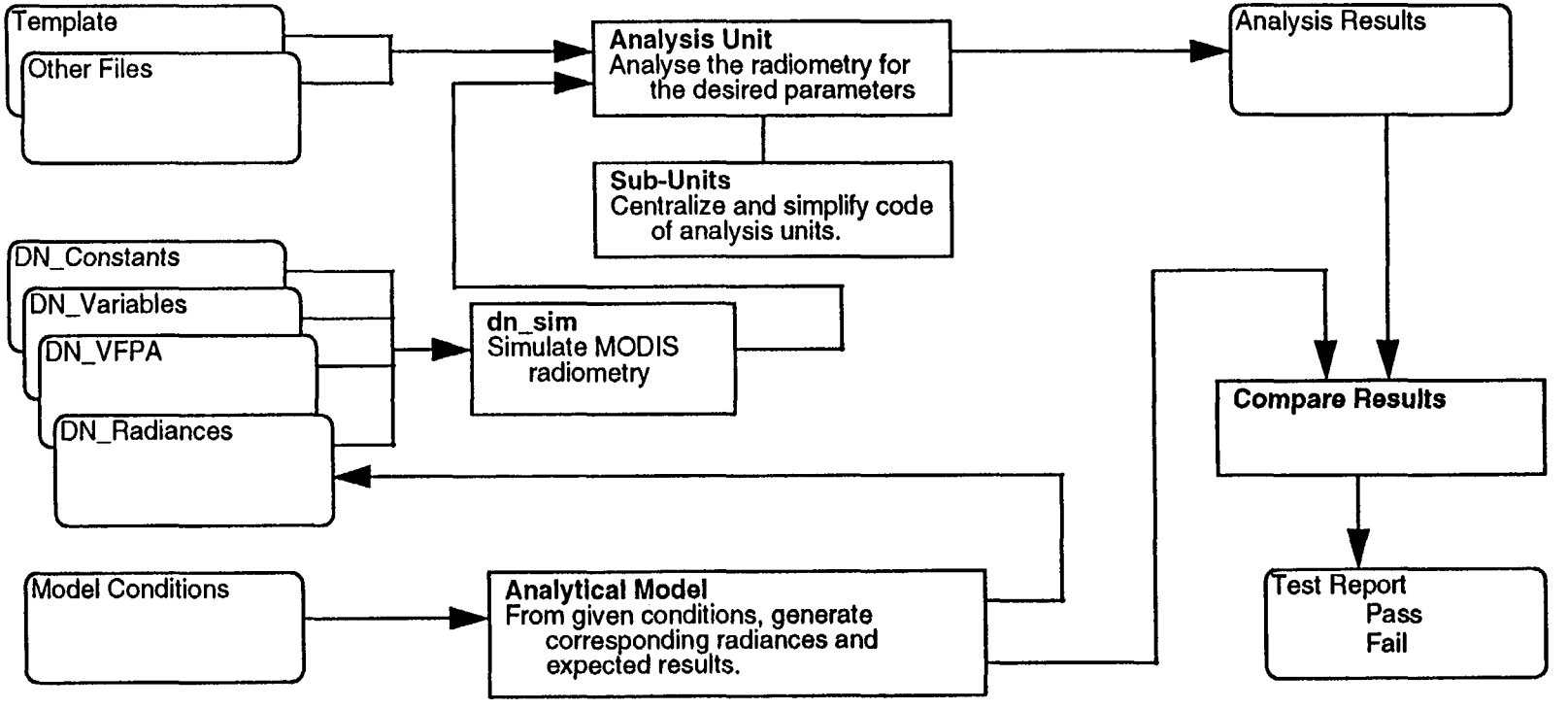
Generic Test Plan

Unit test will validate subunits as well.



ASSURANCE PROCEDURES
(CONTINUED)

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- Integration test procedure:
  - Put source code into proper directory.
  - Update "Makefile"s.
  - Add unit to tac_main menu.
  - Add unit to tac_display menu.
  - Test to confirm unit functionality.
- Acceptance test procedure:
  - Verify successful completion of integration test.
  - Verify that tac_display program can launch the unit.

TAC PROGRESS

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Test Analysis Controller
Software Development status Jun 95

Routine	Status	REA
Gain and Offset		
Gain and offset, PV	Complete	Bauer
DC Restore	In Test	Bauer
Charge subtraction	Complete	Bauer
Gain and offset, PC	In Test	Bauer
Sensitivity and noise		
SNR	Complete	Bauer
Dynamic range	In Code	Bauer
System noise	Completed	Bauer
Absolute Radiometric Accuracy		
Calibration coefficients and Nonlinearity	In Code	Bauer
Response vs Scan angle	Complete	Finn
Near field response	Not started	Bauer
Relative radiometric accuracy		
RMS deviation	Not started	Bauer
Channel uniformity	Not started	Bauer
Pattern noise	In Test	Schienle
Radiometric stability	Not started	Bauer
Near field response	Complete	Pagano
Polarization insensitivity	Complete	Pagano
BDW stray light	PFM	PFM
Stray light rejection	PFM	PFM
Spectral coverage		
In band	Complete	Osgood
Out of band	Complete	Osgood
Spatial		
Instantaneous Field Of View and MTF	In Test	Lommen
Field Of View	Complete	Finn
Spectral band registration	In Test	Lommen
Pointing knowledge and alignment	In Test	Lommen
Tools		
DN Analyzer	Complete	Pagano
DN Simulator	Complete	Pagano
DN Function	Complete	Therrien/Augustine
Graphics	Complete	Schienle
Telemetry	In Code	Augustine

TAC ACHIEVEMENTS

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- TAC development started in October 1994.
- Engineering Model tests started in March 1995.
  - Critical TAC functions available at time of Engineering Model test.
  - TAC provided prompt visibility of results for consent-to-proceed meetings.
  - TAC successfully processed much of the 33 GBytes of data collected from the Engineering Model.
  - TAC software contributed significantly to the great success of the Engineering Model Test Data Review .
  - tac_display program enabled good visual assessment of MODIS performance.

TAC DISPLAY PANEL

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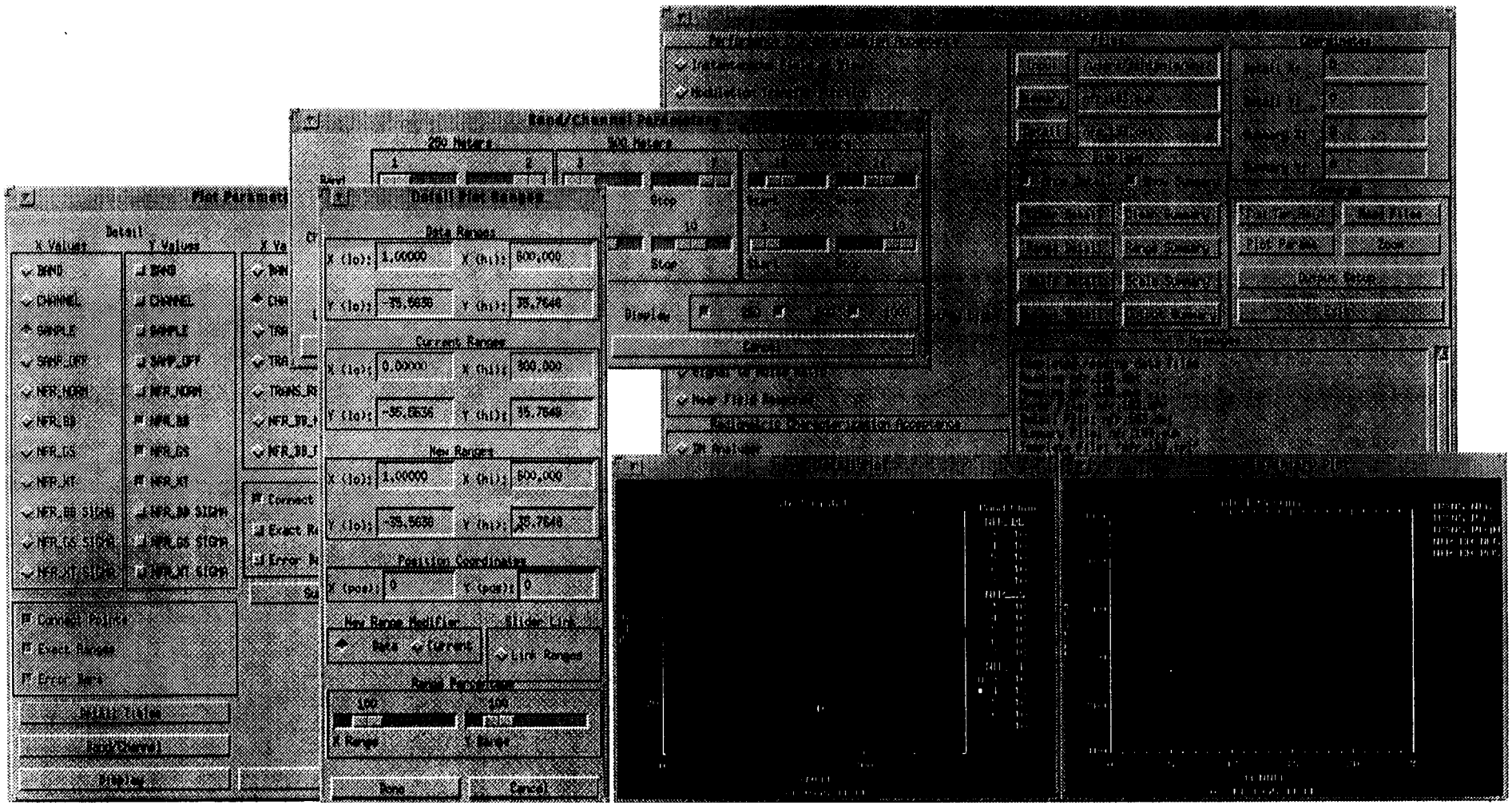

TAC DISPLAY PANEL

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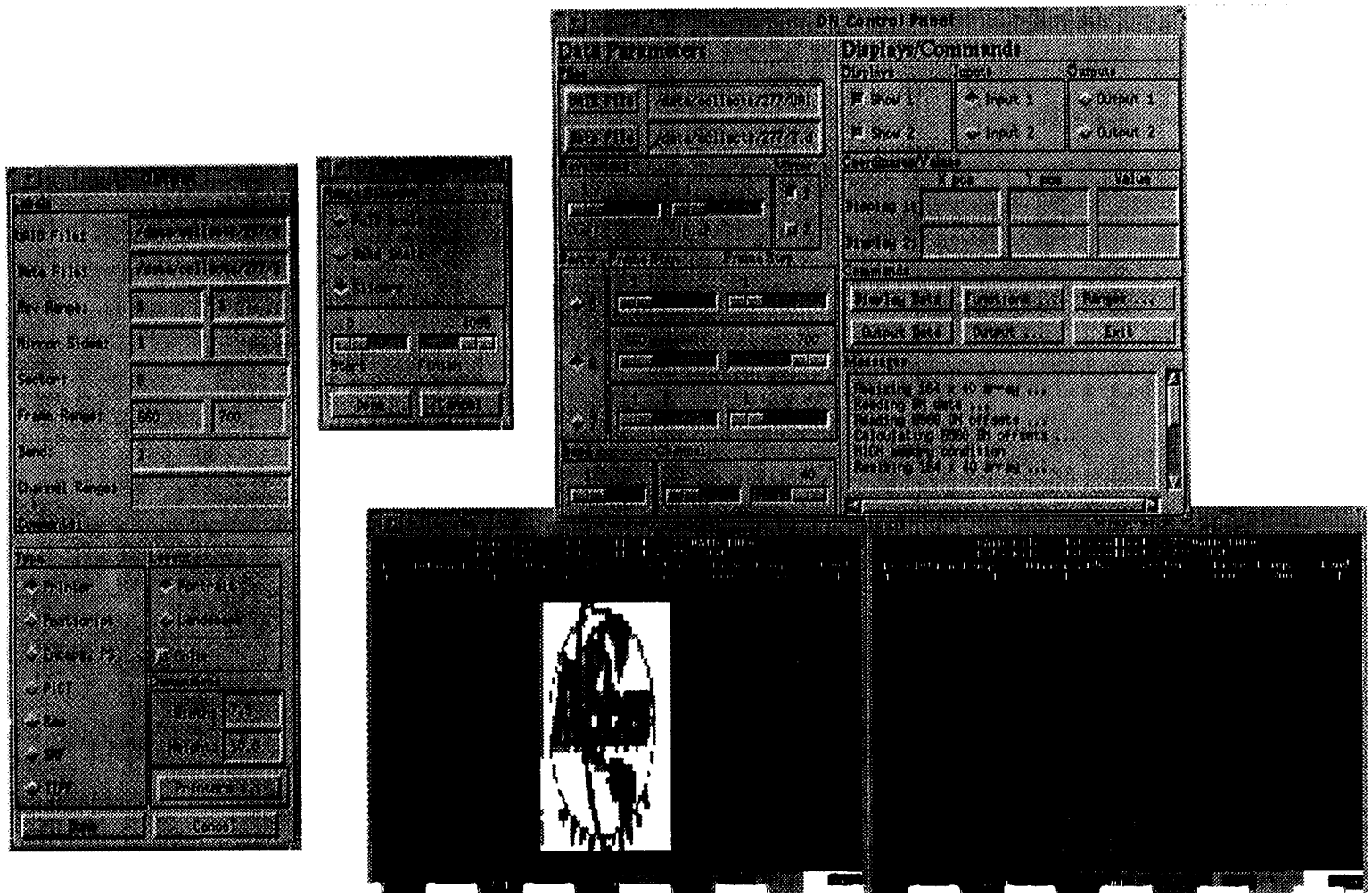

EXAMPLES OF PROCESSED DATA

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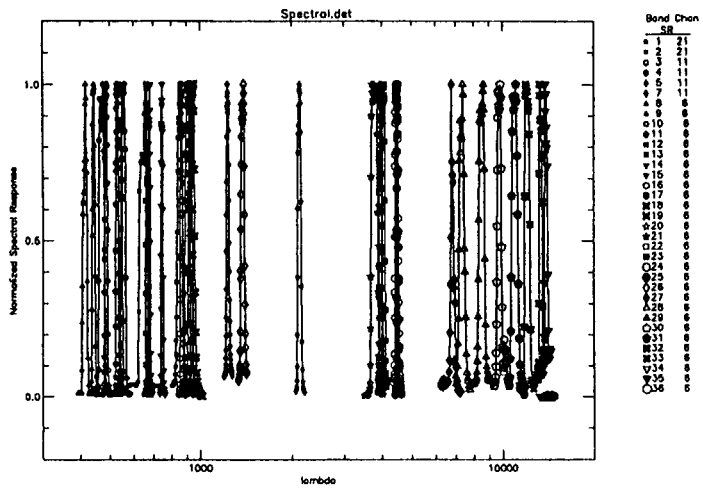

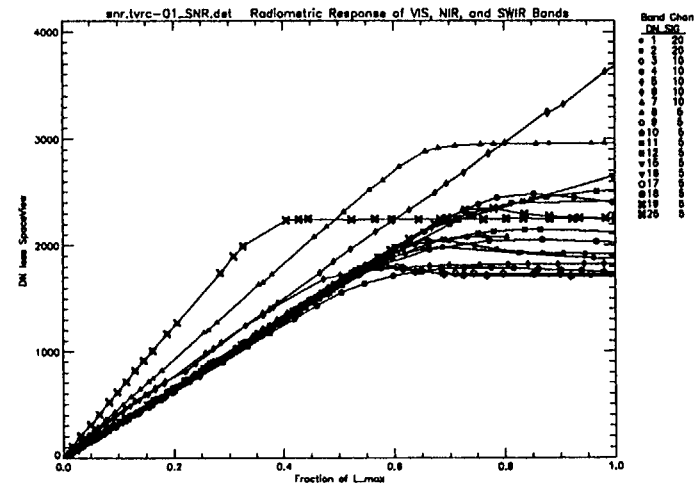

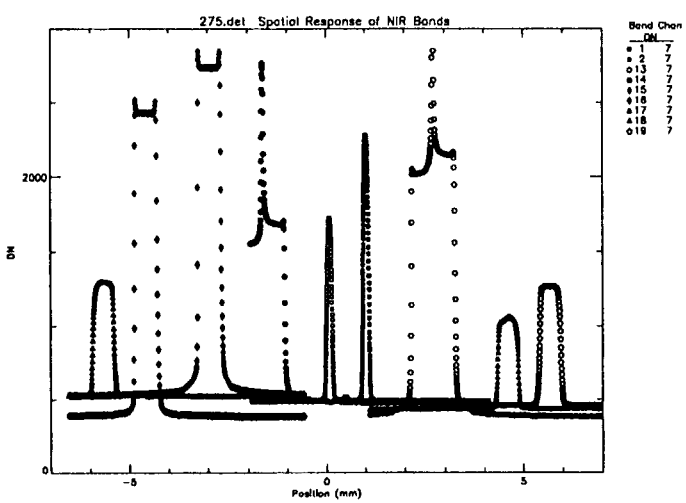

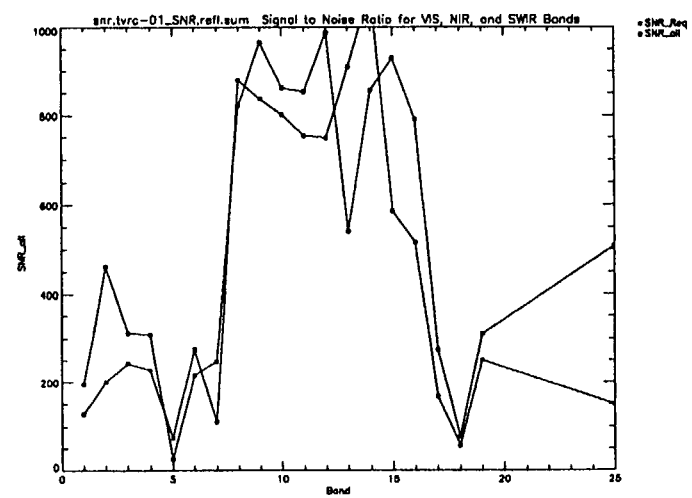

REMAINING TAC DEVELOPMENT
BY UNIT

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- Revise algorithms based on Engineering Model results, for example:
  - Near Field Response: Interlace scans
  - Spatial: Pedestal subtraction modification
- PC band gain determination
- Radiometric calibration coefficients
- Relative radiometric accuracy and stability
- Stray light rejection

SUMMARY & CONCLUSIONS

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- TAC is meeting its objectives.
- Documentation is being updated for full compliance.
- Test plan has been established. Procedures are in development.
- Quality of procedures to date contributed to successful Engineering Model Test Data Review.
- Overall, TAC development is on-track.

WRAP-UP AND SUMMARY

Vernon Alferd