

DRAFT

MODIS LEVEL 1B SOFTWARE

DESIGN DOCUMENT

Preliminary

Developed by members of the
MODIS Characterization Support Team (MCST)
Code 925-Sensor Concepts and Development Branch
NASA Goddard Space Flight Center
Greenbelt, Maryland 10771

FROM NASA-DID-P400

DRAFT

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1.0 INTRODUCTION

1.1 Identification of Document

This is the Software Design Document (SDD) for the Moderate-Resolution Imaging Spectroradiometer (MODIS) Level 1B calibration software. This third release corresponds to the Version 1 delivery in February, 1996.

1.2 Scope of Document

This SDD describes the software implementation of the MODIS Level 1B calibration algorithms. These algorithms are documented in the Algorithm Theoretical Baseline Document (ATBD), published by the MODIS Calibration Support Team (MCST). MCST is responsible for developing the MODIS Level 1B algorithms and the software system which implements them. This software will be installed at the National Aeronautics and Space Administration (NASA) Goddard Space Flight Center (GSFC) and is expected to have an operational lifetime on the order of 15 years. The software development complies with NASA Earth Observing System (EOS) Data and Information System (EOSDIS) requirements and guidelines and Science Data Support Team (SDST) guidelines. This program is sponsored by NASA.

1.3 Purpose and Objectives of Document

The purpose of this SDD is to record the design information for the MODIS Level 1B software. This includes design rationale and trade-offs and the selected design of the software, including

its decomposition into compilation and code units,
the design of all interfaces,
the mapping between the logical or functional design of the software and its detailed design units.

1.4 Document Status and Schedule

This SDD will be updated to describe and support the software delivery milestones below

Beta 2 Delivery	October, 1994
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Beta 3 Delivery	April, 1995
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Version 1 Delivery	February 1996
Version 2 Launch Ready Delivery	February, 1997
Version 2.1 Pre-Launch Update	February, 1998
Version 2.2 Post A&E (Launch + 6 months)	January, 1999)

-

1.5 Document Organization

Section 1 describes the scope of this document.

Section 2 describes related documents.

Section 3 describes the design approach and tradeoffs.

Section 4 describes the detailed design.

Section 5 describes the external interfaces.

Section 6 contains coding and implementation notes.

Section 7, the firmware support manual, is not applicable.

Section 8 defines abbreviations and acronyms used in this document.

Section 9 is the glossary

Section 10 contains notes.

Section 11 contains the appendices..

2.0 RELATED DOCUMENTATION

2.1 Parent Documents

- (a) *MODIS Calibration Support Team Management Plan*, NASA Technical Memorandum, under development, MODIS Technical Report Series.

2.2 Applicable Documents

- (a) *MODIS Software and Data Management Plan*, NASA Technical Memorandum, DRAFT, MODIS Technical Report Series, April 11, 1995.
- (b) *MODIS Level 1B Software Baseline Requirements*, NASA Technical Memorandum, under development, MODIS Technical Report Series.
- (c) *Product Specification DIDS, Detailed Design*, NASA DID P400, NASA Software Documentation Standard, Software Engineering Program, NASA-STD-1200-91.

2.3 Information Documents

- (a) *MODIS Algorithm Theoretical Basis Document*, 1994, NASA Technical Memorandum, under development, MODIS Technical Report Series.
- (b) *Structured Analysis and System Specification*, Tom DeMarco, Yourdon Press, 1979.

3.0 DETAILED DESIGN APPROACH

The requirements analysis used for the development of the design of the MODIS Level 1B software system was done using the DeMarco structured analysis methodology. This methodology is described in *Structured Analysis and System Specification*, Tom DeMarco, Yourdon Press, 1979. The requirements analysis also used CADRE's Teamwork suite of Computer Automated Software Engineering (CASE) tools, as prescribed in Sections 4.3.1.2 and 4.2.1.1 of *MODIS Software and Data Management Plan*, NASA Technical Memorandum, DRAFT, MODIS Technical Report Series, April 11, 1995.

The architecture of the design is object oriented. Object oriented methodology encapsulates the implementation of the algorithms. This approach allows the interfaces to remain stable, so that maintenance or updates to the algorithms will not affect the architecture itself. This will improve maintainability of the production system.

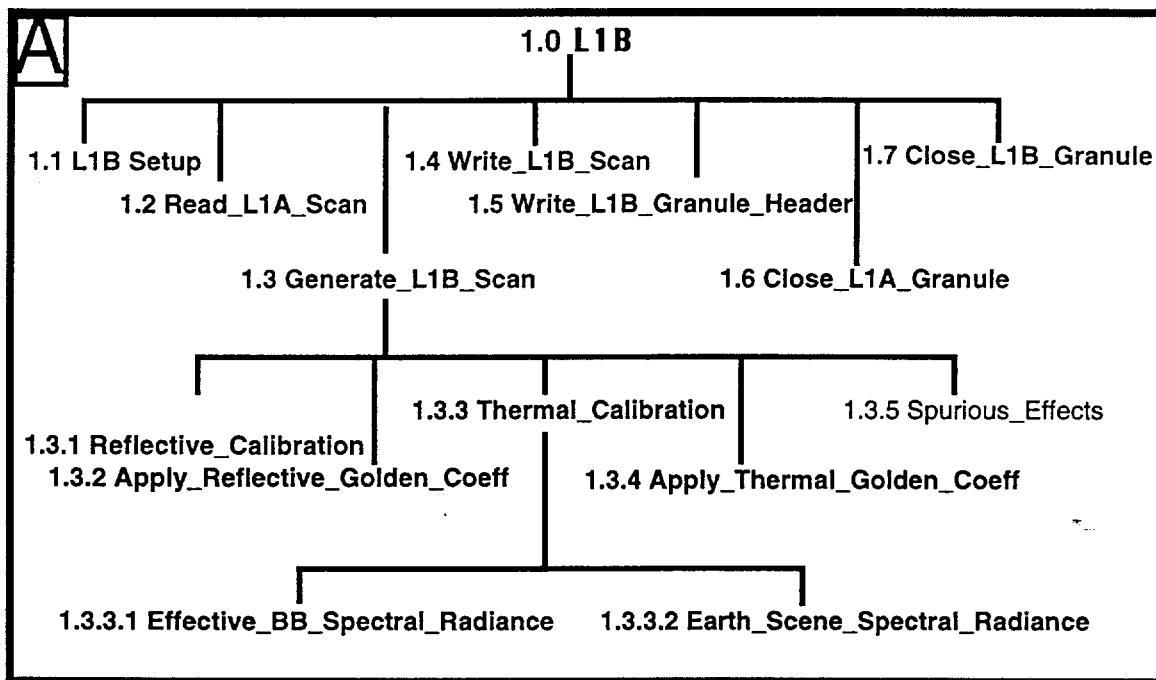
4.0 DETAILED DESIGN DESCRIPTION

4.1 Compilation Unit Design

Appendix A contains the data flow diagrams generated using CADRE's CASE tool. These diagrams decompose the design into compilation units. The inputs and outputs for each unit are specified. The function for each unit is stated in the circle for that unit. The diagrams maintain traceability from the architectural design elements to the compilation units by using numerical identifiers.

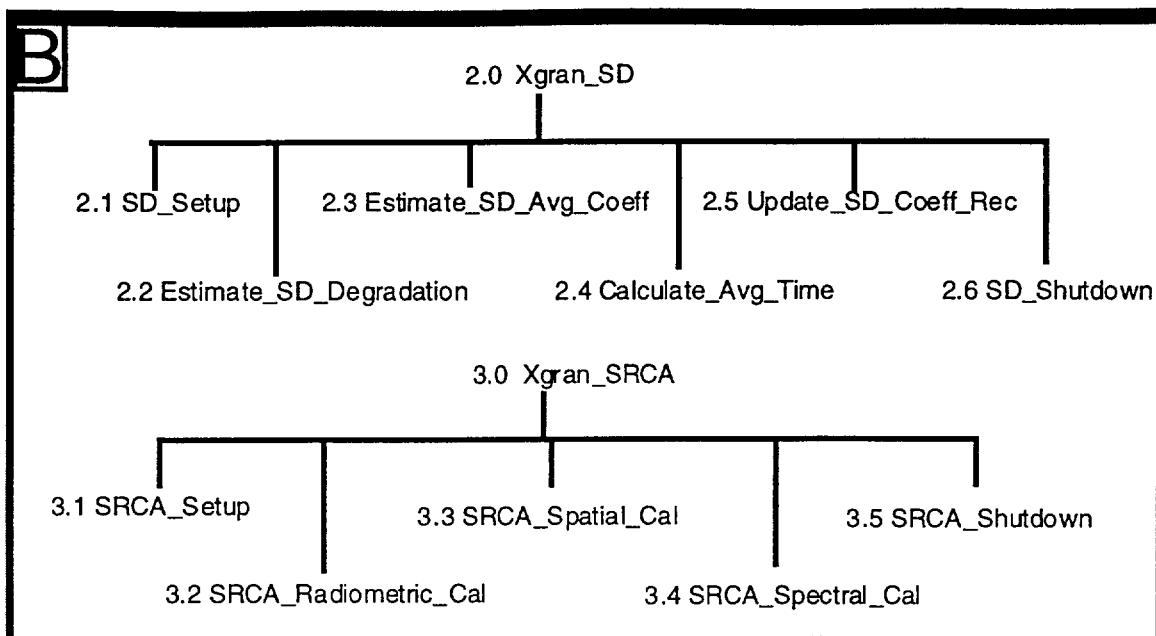
Tables 1 and 2 are the requirements traceability matrices. Table 1 provides the mapping from requirements to compilation units. Table 2 provides the mapping from compilation units to requirements.

Level 1B Software Hierarchy



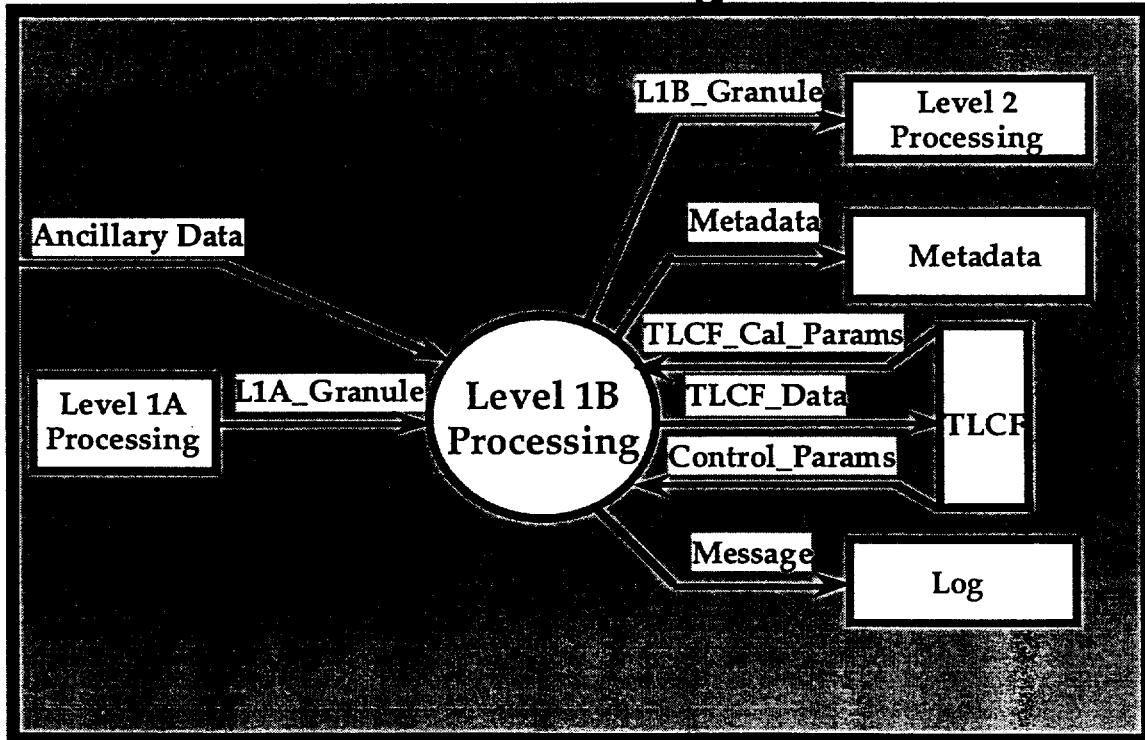
A section(**bold**) = Within-Granule processing
Core Algorithm

Level 1B Software Hierarchy

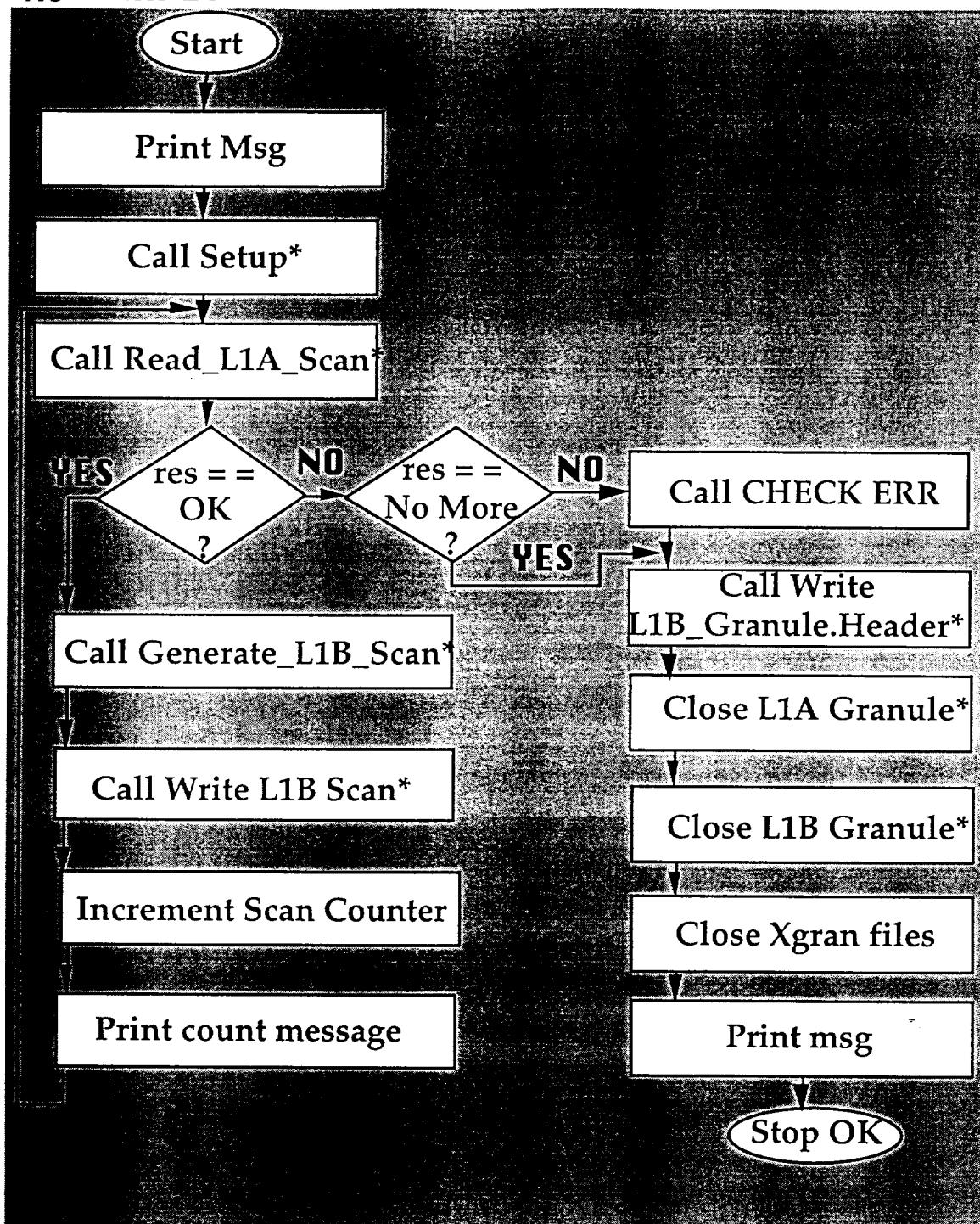


B section(bold) = Cross-granule processing

Level 1B Processing Context



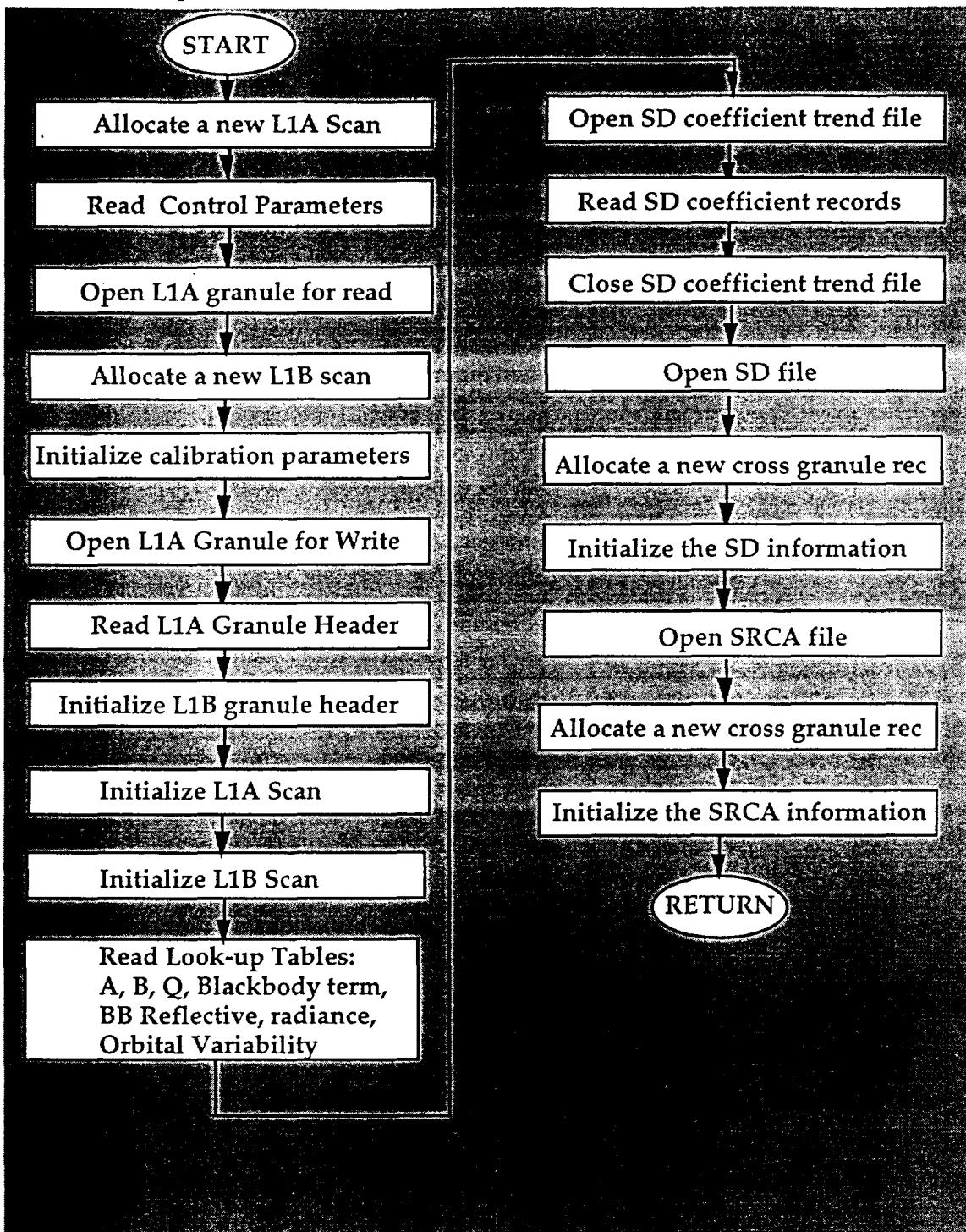
1.0 Main L1B



*Call CHECK ERR

```
*****  
*  
* Joan Baden  
* MODIS/GSC/SAIC/RDC  
* baden@highwire.gsfc.nasa.gov *  
* (301) 352-2128  
*  
*****  
/* main(int argc, char *argv[]) */  
/*  
C*****  
*  
* Purpose: Top level Level 1B main calibration module  
*  
* Description:  
*  
* Input parameters:  
*  
*     int *argv  
*  
*     char *argv[]  
*  
* Output parameters:  
*  
*  
* Revision history:  
*  
*     Revision 01.00 1995/05/16  
*     Prologue development, Joan Baden/RDC  
*     Code, Geir Kvaran, SAIC/GSC  
*  
*  
* Team-unique header:  
*  
* . References and Credits  
*     This software is developed by the MODIS Characterization Support  
*     Team (MCST) for the National Aeronautics and Space Administration,  
*     Goddard Space Flight Center, under contract NAS5-32373.  
*  
*     HDF portions developed at the National Center for Supercomputing  
*     Applications at the University of Illinois at Urbana-Champaign.  
*  
*     Design Notes  
*  
END*****  
*/
```

1.1 Setup

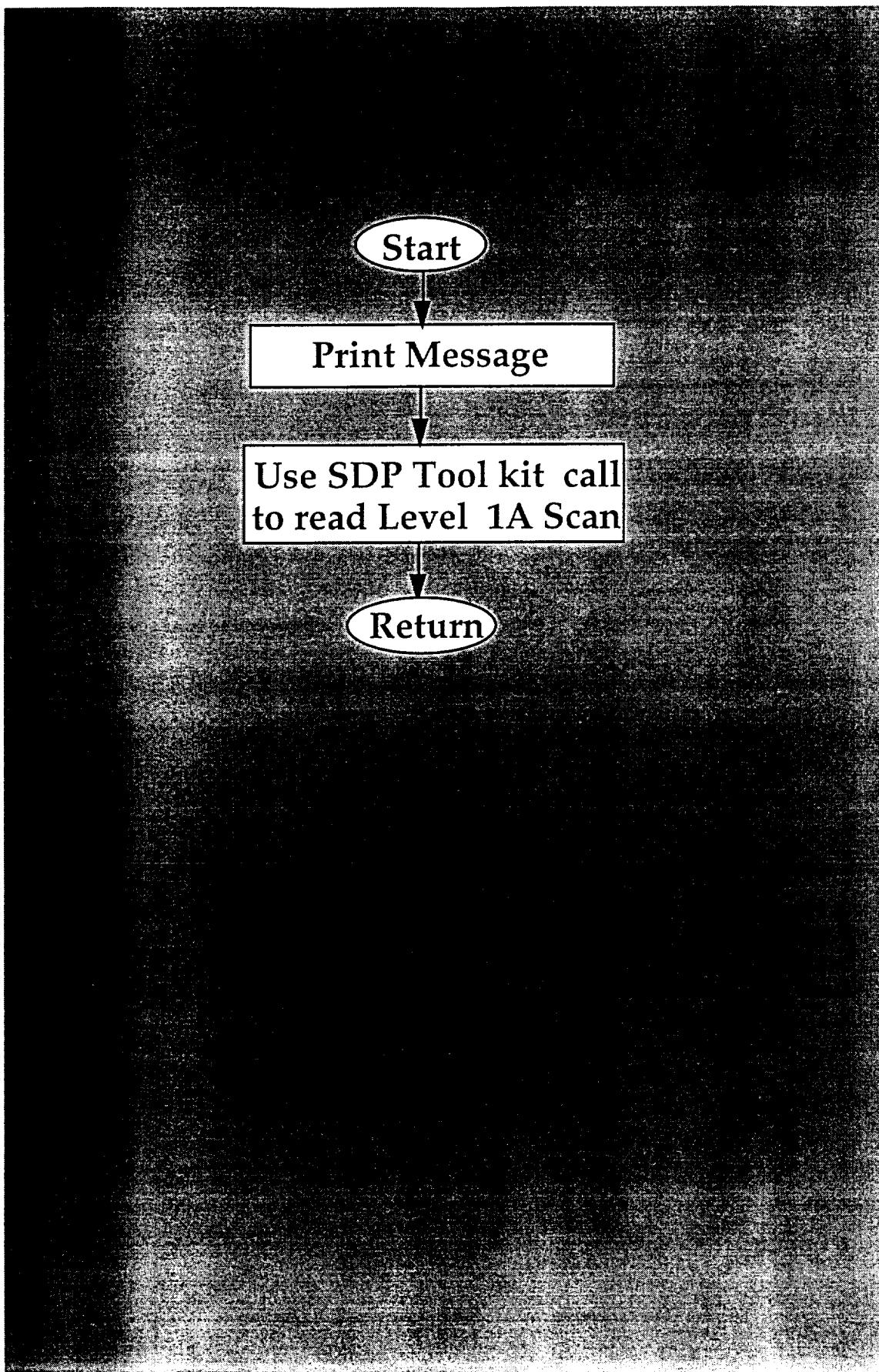


```

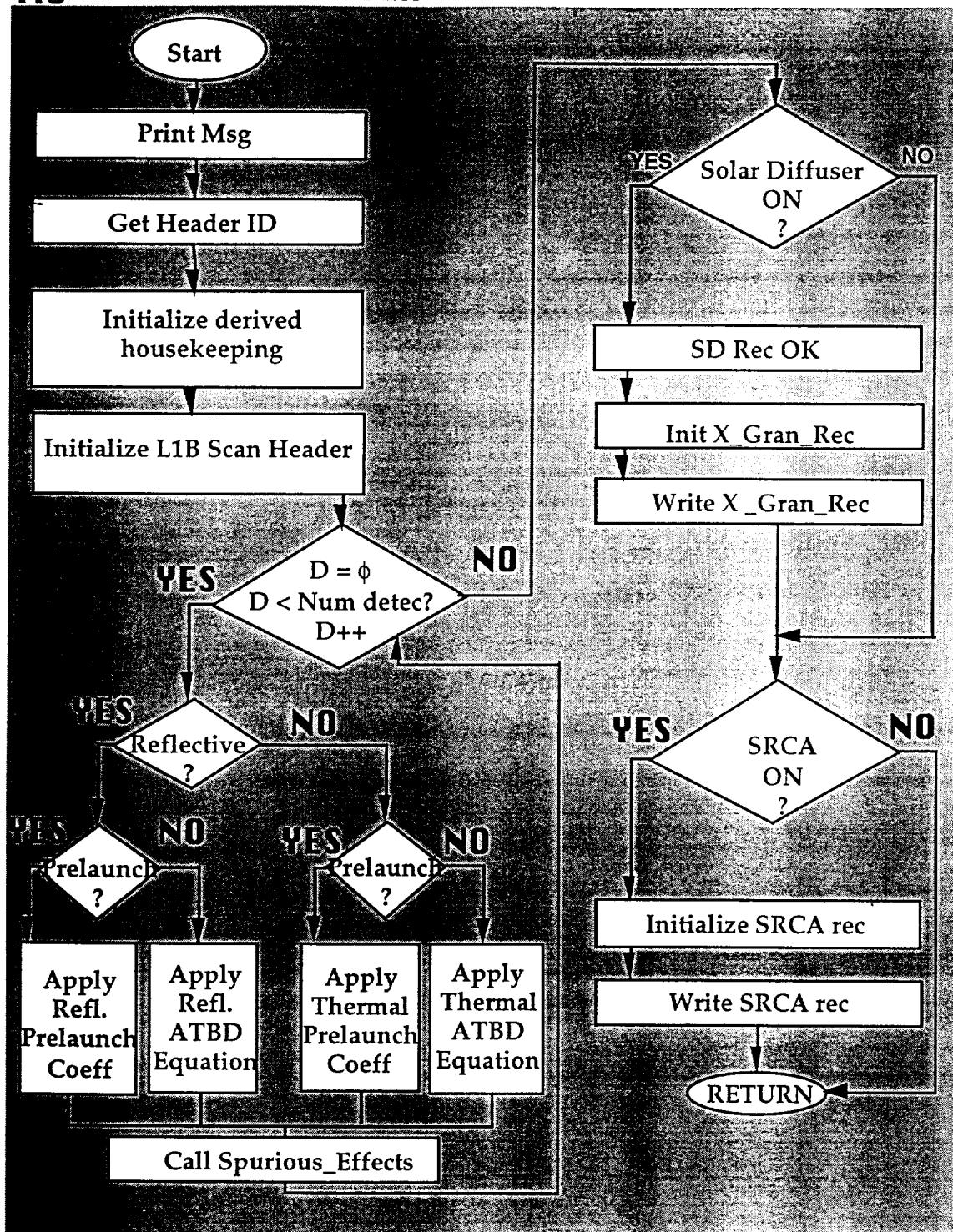
*****
* Joan Baden
* MODIS/SAIC/GSC/RDC
* baden@highwire.gsfc.nasa.gov
* (301) 352-2128
*****
*/
/*status_t Setup(int argc,
   char * argv[],
   cal_param_t * Cal_P,
   Control_Param_t * Cont_P,
   geom_param_t * Geom,
   L1A_granule_t * L1A_Gran,
   L1B_granule_t * L1B_Gran,
   L1A_Granule_Header_t * L1A_Gran_Hdr,
   L1B_Granule_Header_t * L1B_Gran_Hdr,
   L1A_Scan_t * L1A_Scan,
   L1B_Scan_t * L1B_Scan,
   SIL_t A [],
   DIL_t B [],
   SIL_t Q [],
   SIL_t BB_term [],
   SIL_t L_BB_refl[],
   DIL_t O_V [],
   SD_Coeff_Rec_t * SD_Trend,
   FILE ** SD_f,
   X_Gran_Rec_t * X_Gran_Rec,
   sd_info_t * SDI);
*/
C*****
*
* Purpose: Calibration of Reflective Bands
*
* Description:
*
* Input parameters:
*
*      int argc,
*      char * argv[],
*      cal_param_t * Cal_P,
*      Control_Param_t * Cont_P,
*      geom_param_t * Geom,
*      L1A_granule_t * L1A_Gran,
*      L1B_granule_t * L1B_Gran,
*      L1A_Granule_Header_t * L1A_Gran_Hdr,
*      L1B_Granule_Header_t * L1B_Gran_Hdr,
*      L1A_Scan_t * L1A_Scan,
*      L1B_Scan_t * L1B_Scan,
*      SIL_t A [],
*      DIL_t B [],
*      SIL_t Q [],
*      SIL_t BB_term [],
*      SIL_t L_BB_refl[],
*      DIL_t O_V [],
*      SD_Coeff_Rec_t * SD_Trend,
*      FILE ** SD_f,
*      X_Gran_Rec_t * X_Gran_Rec,
*      sd_info_t * SDI
*
* Output parameters:
*
*
* Revision history:
*
*      Revision 01.00 1995/05/17
*      Prologue, Joan Baden/RDC
*      Code, Geir Kvaran, SAIC/GSC
*
*
* Team-unique header:
*
* References and Credits
* This software is developed by the MODIS Characterization Support
* Team (MCST) for the National Aeronautics and Space Administration,
* Goddard Space Flight Center, under contract NAS5-32373.
*
* HDF portions developed at the National Center for Supercomputing
* Applications at the University of Illinois at Urbana-Champaign.
*
* Design Notes
*
END*****
*/

```

1.2 Read_L1A_Scan



1.3 Generate L1B Scan

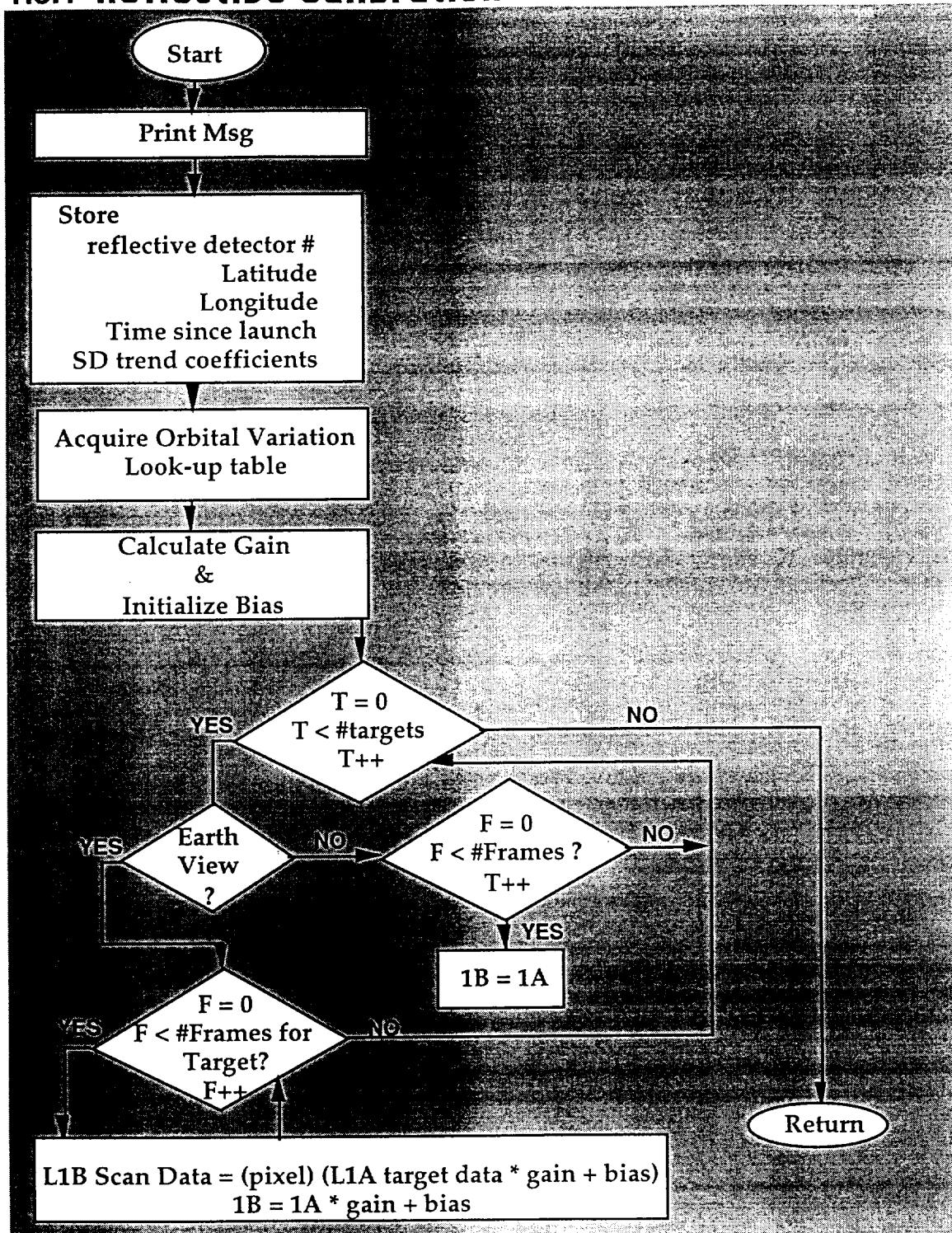


```
*****
* Joan Baden
* MODIS/SAIC/GSC/RDC
* baden@highwire.gsfc.nasa.gov
* (301) 352-2128
*****
```

```
*****
/* status_t Generate_L1B_Scan( cal_param_t * Cal_P,
*                             Control_param_t * Cont_P,
*                             geom_param_t * Geom,
*                             L1A_granule_t * L1A_Gran,
*                             L1B_granule_t * L1B_Gran,
*                             L1A_Granule_Header_t * L1A_Gran_Hdr,
*                             L1B_Granule_Header_t * L1B_Gran_Hdr,
*                             L1A_Scan_t * L1A_Scan,
*                             L1B_Scan_t * L1B_Scan,
*                             SIL_t * A [],
*                             DIL_t * B [],
*                             SIL_t * Q [],
*                             SIL_t * BB_term [],
*                             SIL_t * L_BB_refl(),
*                             DIL_t * O_V [],
*                             SD_Coeff_Rec_t * SD_Trend,
*                             FILE * SD_f,
*                             X_Gran_Rec_t * X_Gran_Rec,
*                             sd_info_t * SDI); */

*****
C*****
*
* Purpose: Generate Level 1B Scan
*
* Description:
*
* Input parameters:
*
*   cal_param_t * Cal_P,
*   Control_param_t * Cont_P,
*   geom_param_t * Geom,
*   L1A_granule_t * L1A_Gran,
*   L1B_granule_t * L1B_Gran,
*   L1A_Granule_Header_t * L1A_Gran_Hdr,
*   L1B_Granule_Header_t * L1B_Gran_Hdr,
*   L1A_Scan_t * L1A_Scan,
*   L1B_Scan_t * L1B_Scan,
*   SIL_t * A [],
*   DIL_t * B [],
*   SIL_t * Q [],
*   SIL_t * BB_term [],
*   SIL_t * L_BB_refl(),
*   DIL_t * O_V [],
*   SD_Coeff_Rec_t * SD_Trend,
*   FILE * SD_f,
*   X_Gran_Rec_t * X_Gran_Rec,
*   sd_info_t * SDI
*
*
* Output parameters:
*
*
* Revision history:
*
*   Revision 01.00 1995/05/16
*   Prologue development, Joan Baden/RDC
*   Code, Geir Kvaran, SAIC/GSC
*
*
* Team-unique header:
*
*   References and Credits
*   This software is developed by the MODIS Characterization Support
*   Team (MCST) for the National Aeronautics and Space Administration,
*   Goddard Space Flight Center, under contract NAS5-32373.
*
*   HDF portions developed at the National Center for Supercomputing
*   Applications at the University of Illinois at Urbana-Champaign.
*
*   Design Notes
*
*****
END*****
*/
```

1.3.1 Reflective Calibration



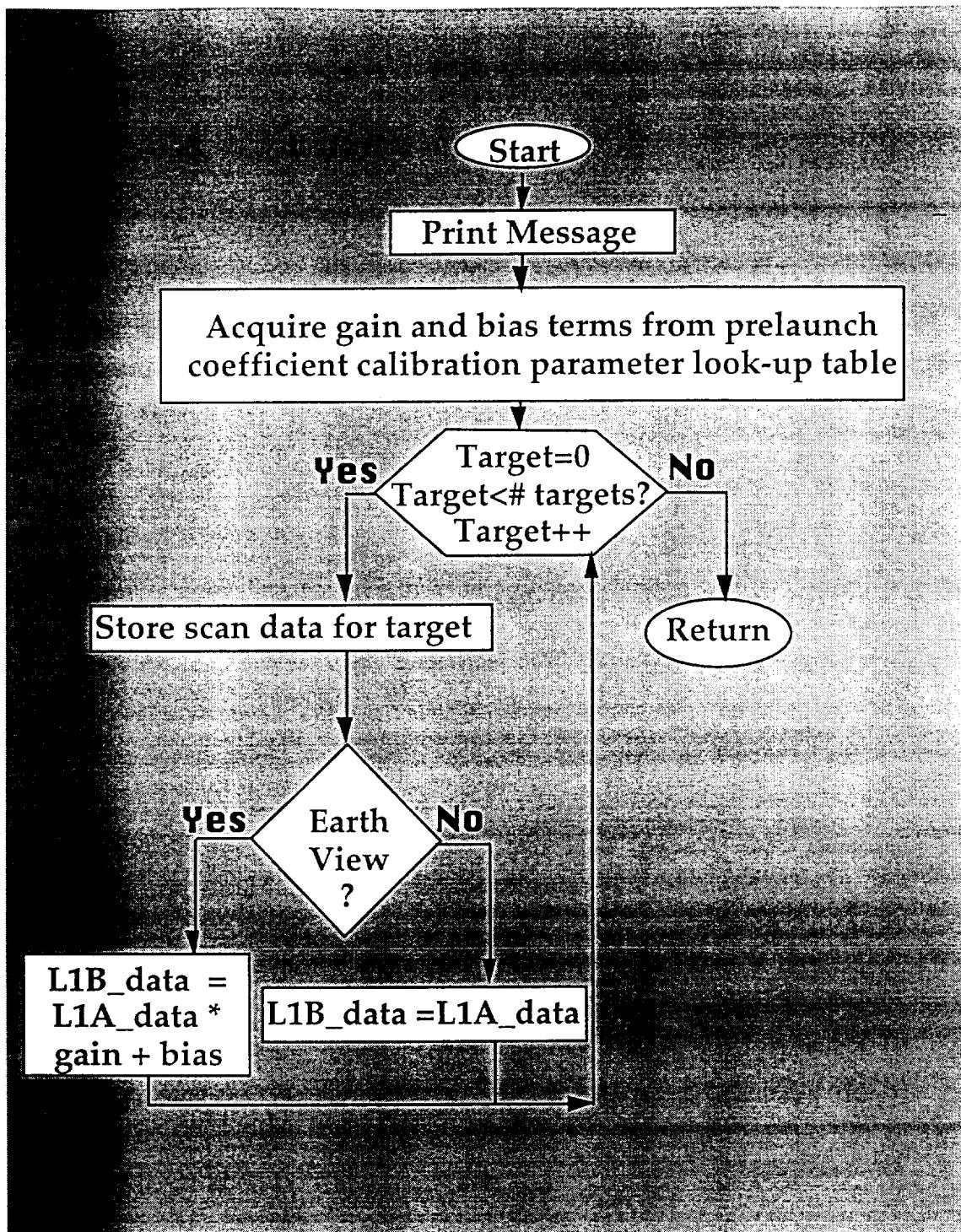
```

*****
*
* Joan Baden
* MODIS/SAIC/GSC/RDC
* baden@highwire.gsfc.nasa.gov
*
```

```

* (301) 352-2128      *
*                      *
***** ****
/*      status_t    Reflective_Cal(  cal_param_t      * Cal_P,
*                           L1A_Scan_t      * L1A_Scan,
*                           L1B_Scan_t      * L1B_Scan,
*                           DIL_t          * O_V,
*                           SD_Coeff_Rec_t  * SD_Trend,
*                           Derived_Housekeeping_t * DH,
*                           int             D) ;
*                      */
*/
C***** ****
*
* Purpose: Calibration of of Reflective Bands
*
* Description:
*
* Input parameters:
*
*      cal_param_t      * Cal_P,
*      L1A_Scan_t      * L1A_Scan,
*      L1B_Scan_t      * L1B_Scan,
*      DIL_t          * O_V,
*      SD_Coeff_Rec_t  * SD_Trend,
*      Derived_Housekeeping_t * DH,
*      int             D
*
* Output parameters:
*
*
* Revision history:
*
*      Revision 01.00 1995/05/17
*      Prologue development, Joan Baden/RDC
*      Code, Geir Kvaran, SAIC/GSC
*
*
* Team-unique header:
*
* References and Credits
*      This software is developed by the MODIS Characterization Support
*      Team (MCST)for the National Aeronautics and Space Administration,
*      Goddard Space Flight Center, under contract NAS5-32373.
*
*      HDF portions developed at the National Center for Supercomputing
*      Applications at the University of Illinois at Urbana-Champaign.
*
* Design Notes
*
END*****
*/
```

1.3.2 Apply_Reflective_Prelaunch_Coeff



```

*****
*          *
*  Joan Baden      *
*  MODIS/SAC/GSC/RDC  *
*****

```

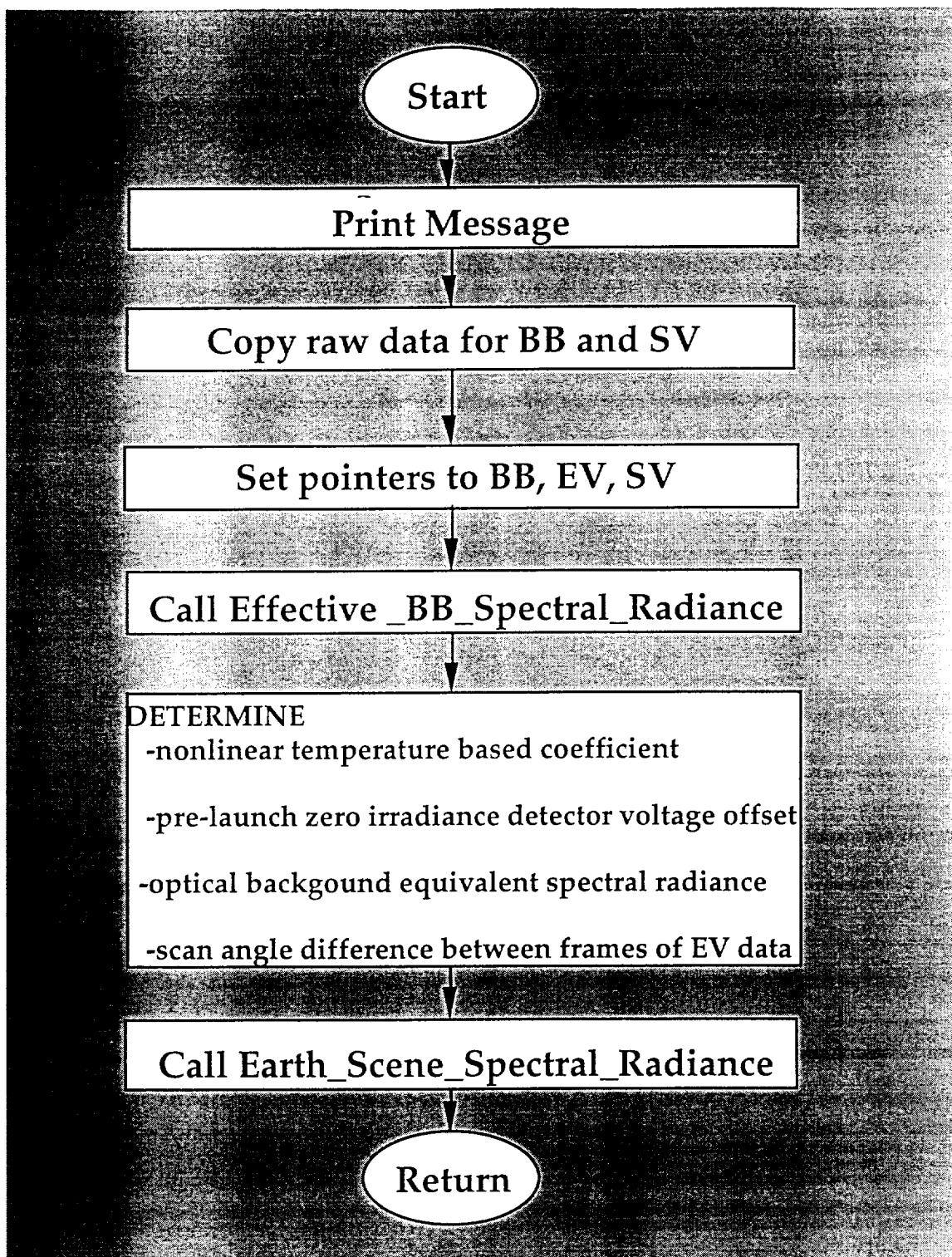
```

*   baden@highwire.gsfc.nasa.gov *
*   (301) 352-2128
*
***** */
/*status_t Apply_Reflective_Prelaunch_Coeff(cal_param_t      * Cal_P,
*                                              L1A_Scan_t      * L1A_Scan,
*                                              L1B_Scan_t      * L1B_Scan,
*                                              Derived_Housekeeping_t  * DH,
*                                              int             D); */

/*
C***** ****
*
* Purpose: Calibration of Thermal Bands
*
* Description:
*
* Input parameters:
*
*   cal_param_t          * Cal_P,
*   L1A_Scan_t           * L1A_Scan,
*   L1B_Scan_t           * L1B_Scan,
*   Derived_Housekeeping_t * DH,
*   int                 D
*
*
* Output parameters:
*
*
* Revision history:
*
*   Revision 01.00 1995/05/17
*   Prologue development, Joan Baden/RDC
*   Code, Geir Kvaran, SAIC/GSC
*
*
* Team-unique header:
*
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*   Goddard Space Flight Center, under contract NAS5-32373.
*
*   HDF portions developed at the National Center for Supercomputing
*   Applications at the University of Illinois at Urbana-Champaign.
*
*   Design Notes
*
END*****
*/

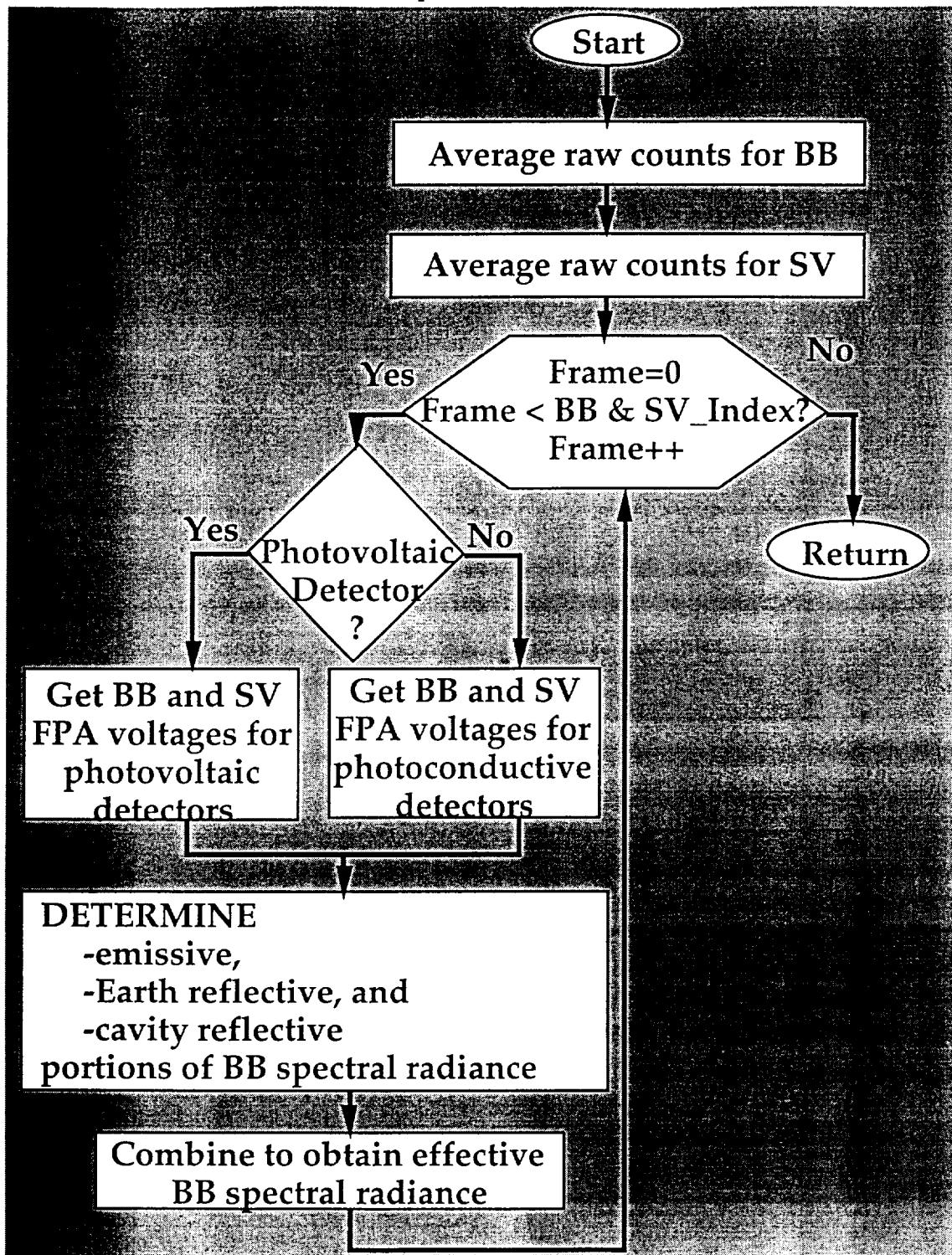
```

1.3.3 Thermal Band Calibration

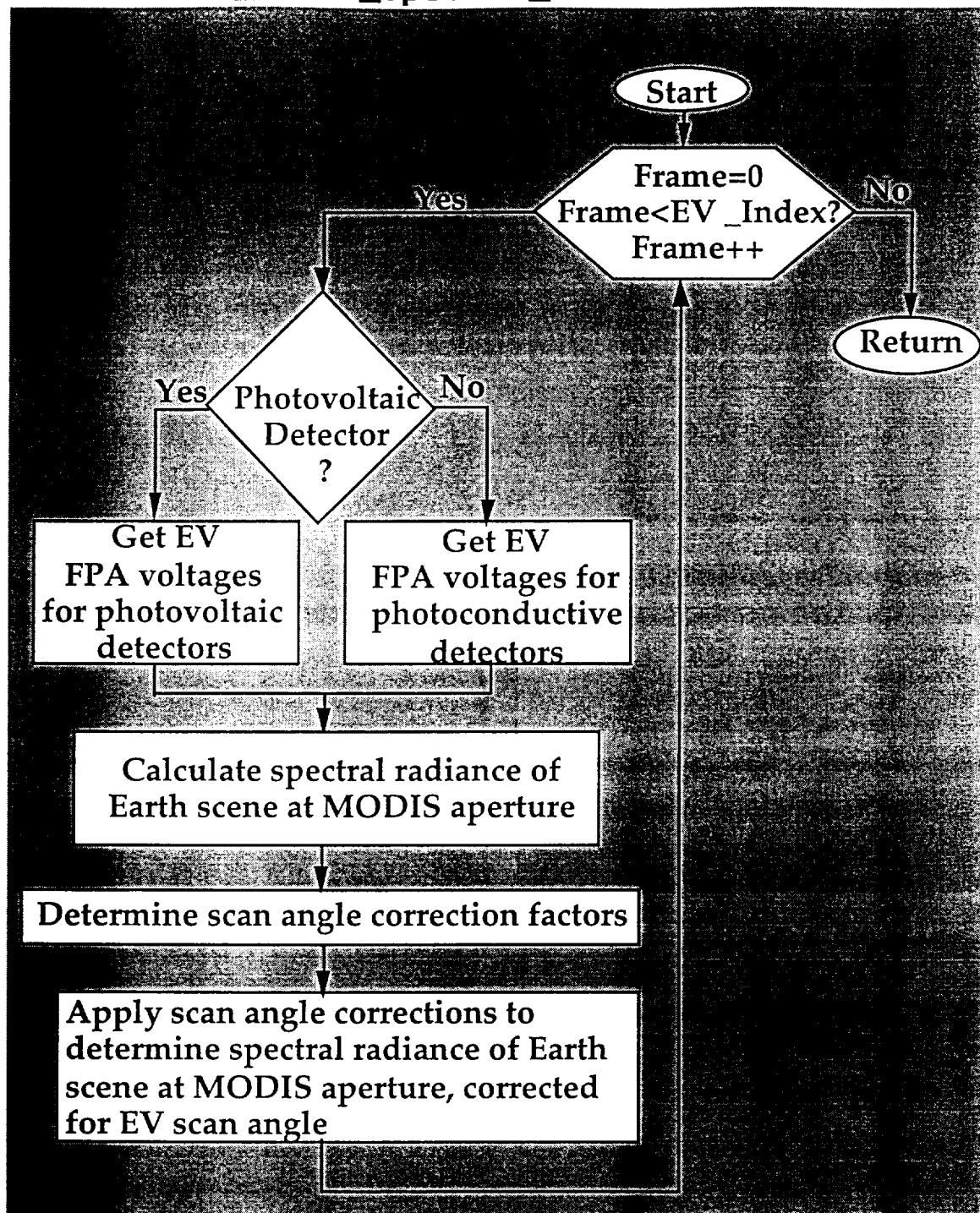


```
*****
* Joan Baden *
* MODIS/SAIC/GSC/RDC *
* baden@highwire.gsfc.nasa.gov *
* (301) 352-2128 *
*****
/*      status_t      Thermal_Cal(cal_param_t
*      L1A_Scan_t          * Cal_P,
*      L1B_Scan_t          * L1A_Scan,
*      SIL_t               * L1B_Scan,
*      DIL_t               * A,
*      SIL_t               * B,
*      SIL_t               * Q,
*      SIL_t               * BB_term,
*      SIL_t               * L_BB_refl,
*      Derived_Housekeeping_t   * DH,
*      int                  D,
*      geom_param_t         * Geom);
*/
/*
C*****
* Purpose:      Calibration of MODIS Thermal Bands.
*
* Description:   Applies the ATBD April 1995 version equations
*                 to calibrate bands 20-25, 27-36.
*
* Input parameters:
*
*      cal_param_t          * Cal_P,      Prelaunch determined values
*                            which will be used for
*                            on-orbit calibration.
*      L1A_Scan_t          * L1A_Scan,  Level 1A on-orbit telemetry
*      SIL_t               * A,        Single-Index Lookup Table
*                            called by Scan Mirror.
*                            Angle and returns multiplicative
*                            Scan Mirror correction factor.
*      DIL_t               * B,        Dual-Index Lookup Table called
*                            by Scan Mirror Angle and mirror
*                            temp and returns additive
*                            Scan Mirror correction factor.
*      SIL_t               * Q,        Single-Index Lookup Table
*                            called by temperature of
*                            detector and returns the
*                            non-linear calibration
*                            coefficient, Q.
*      SIL_t               * BB_term,  Single-Index Lookup Table
*                            called by Blackbody temp and
*                            returns emissive radiance
*                            of Blackbody.
*      SIL_t               * L_BB_refl, Single-Index Lookup Table
*                            called by either Cavity temp
*                            or effective Earth temp
*                            and returns reflective
*                            radiance of Blackbody.
*      Derived_Housekeeping_t   * DH,      On-orbit telemetry which is
*                            in useable units.
*      int                  D,        Gives the detector being used.
*      geom_param_t         * Geom);    Prelaunch set values which
*                            describe the configuration of
*                            the detector.
*
* Output parameters:
*
*      L1B_Scan_t          * L1B_Scan  Level 1B(calibrated) on-orbit
*                            telemetry.
*
* Revision history:
*      Revision 01.00 1995/05/16
*      Prologue development, Joan Baden/RDC, Dan Knowles/GSC,
*      G. Kvaran/GSC
*      Code, Geir Kvaran, SAIC/GSC
* Team-unique header:
*
*      References and Credits
*      This software is developed by the MODIS Characterization Support
*      Team (MCST) for the National Aeronautics and Space Administration,
*      Goddard Space Flight Center, under contract NAS5-32373.
*
*      HDF portions developed at the National Center for Supercomputing
*      Applications at the University of Illinois at Urbana-Champaign.
*      Design Notes
END*****
```

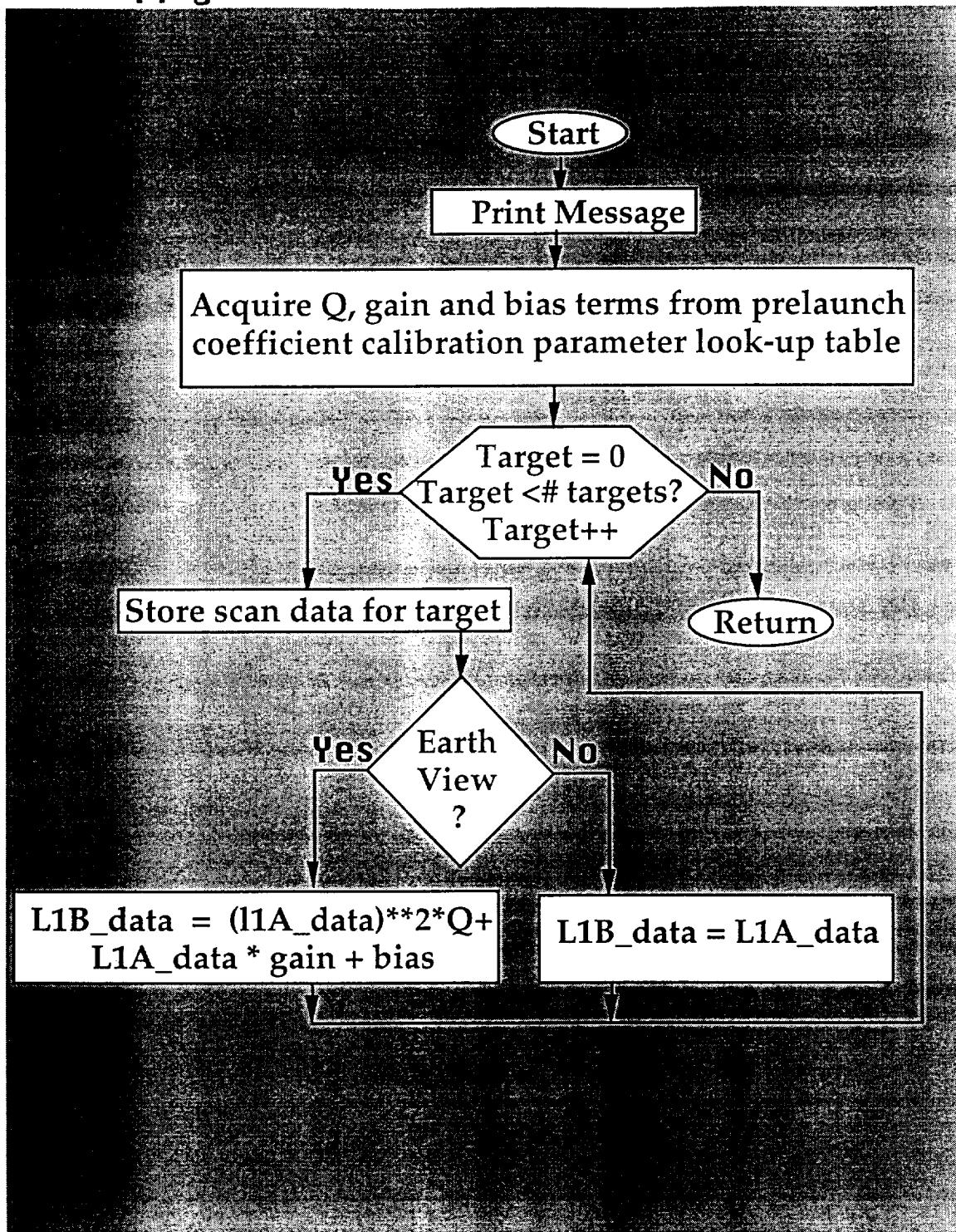
1.3.3.1 Effective_BB_Spectral_Radiance



1.3.3.2 Earth_Scene_Spectral_Radiance



1.3.4 Apply_Thermal_Prelaunch_Coeff



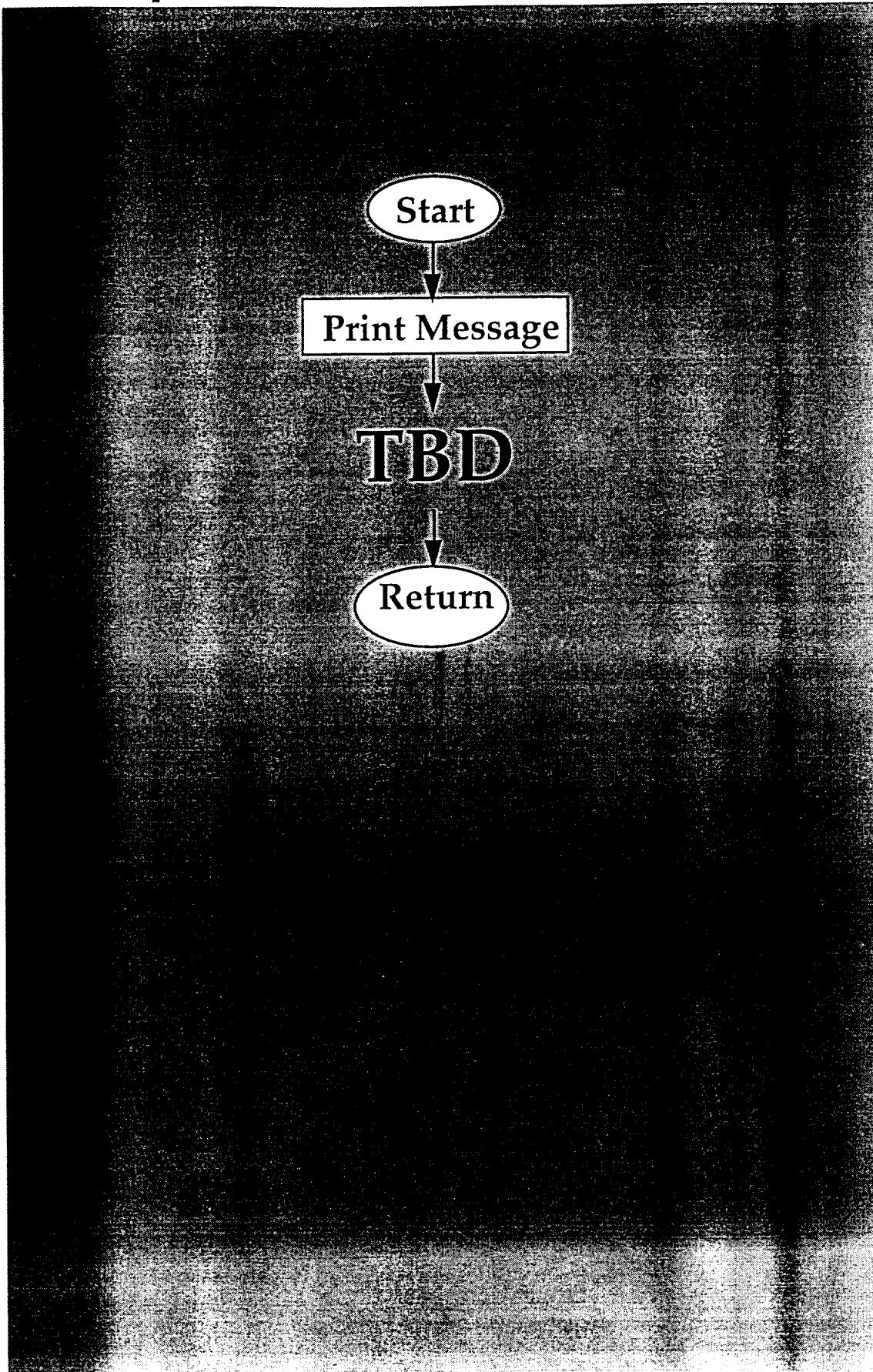
```
*****
* Joan Baden *
* MODIS/SAIC/GSC/RDC *
* baden@highwire.gsfc.nasa.gov *
* (301) 352-2128 *
*****
```

```

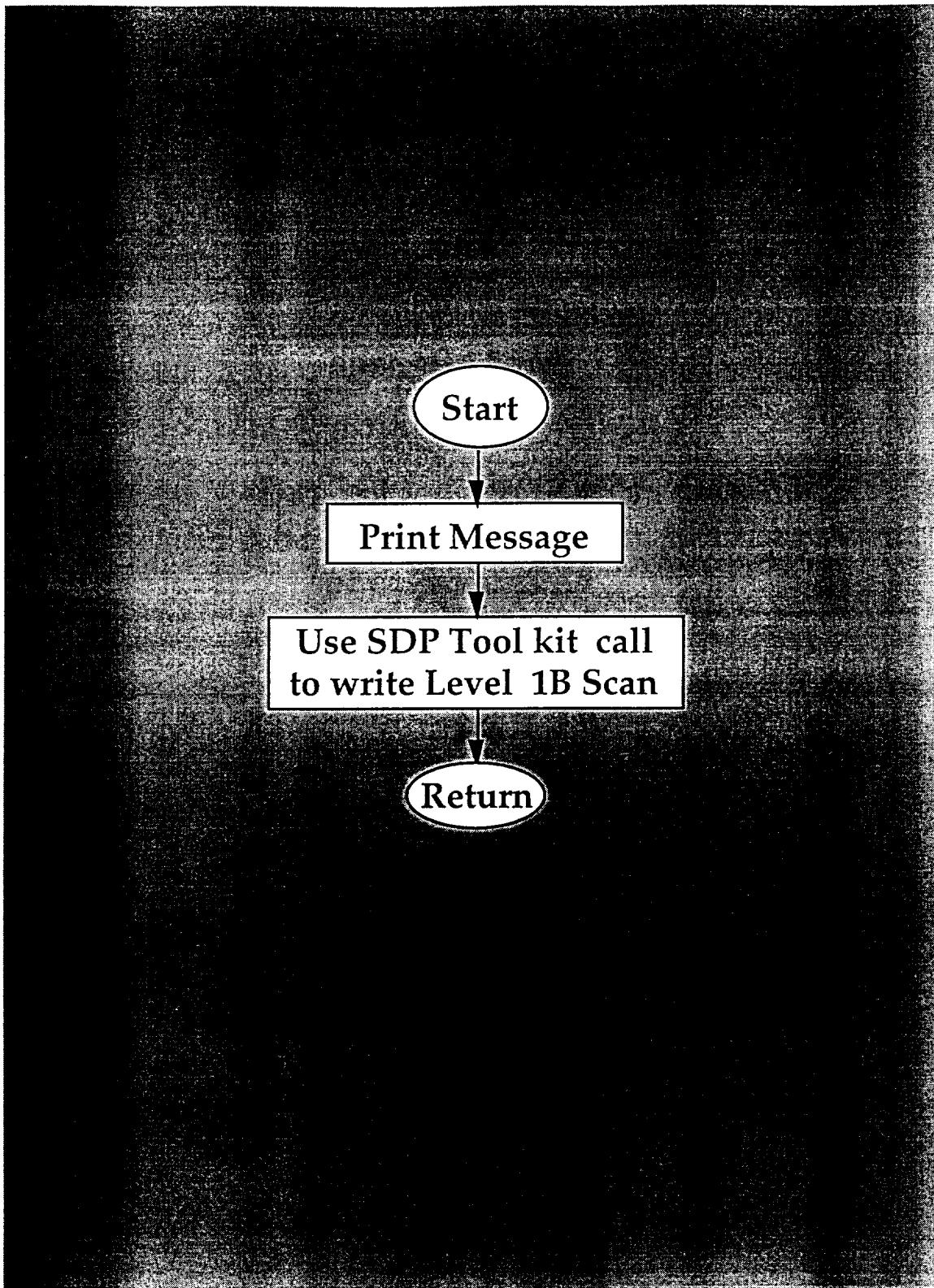
*
*****
*/
/*status_t Apply_Thermal_Prelaunch_Coeff(      cal_param_t      * Cal_P,
*                                             L1A_Scan_t      * L1A_Scan,
*                                             L1B_Scan_t      * L1B_Scan,
*                                             Derived_Housekeeping_t  * DH,
*                                             int             D);*/
/*
C*****
*
* Purpose:      Test calibration of MODIS Thermal Bands.
*
* Description:   Test module that enables the user
*                 to manually input calibration coefficients.
*
* Input parameters:
*
*     cal_param_t      * Cal_P,      Prelaunch determined values
*                         which will be used for
*                         on-orbit calibration.
*     L1A_Scan_t      * L1A_Scan,   Level 1A on-orbit *
*                         telemetry.
*     Derived_Housekeeping_t  * DH,      On-orbit telemetry which is
*                         in useable units.
*     int             D);           Gives the detector being used.
*
*
* Output parameters:
*
*     L1B_Scan_t      * L1B_Scan,   Level 1B(calibrated) on-orbit
*                         telemetry.
*
* Revision history:
*
*     Revision 01.00 1995/05/16
*     Prologue development, Joan Baden/RDC, Dan Knowles/GSC, G. Kvaran/GSC
*     Code, Geir Kvaran, SAIC/GSC
*
*
* Team-unique header:
*
* References and Credits
*     This software is developed by the MODIS Characterization Support
*     Team (MCST) for the National Aeronautics and Space Administration,
*     Goddard Space Flight Center, under contract NAS5-32373.
*
*     HDF portions developed at the National Center for Supercomputing
*     Applications at the University of Illinois at Urbana-Champaign.
*
* Design Notes
*
END*****
*/

```

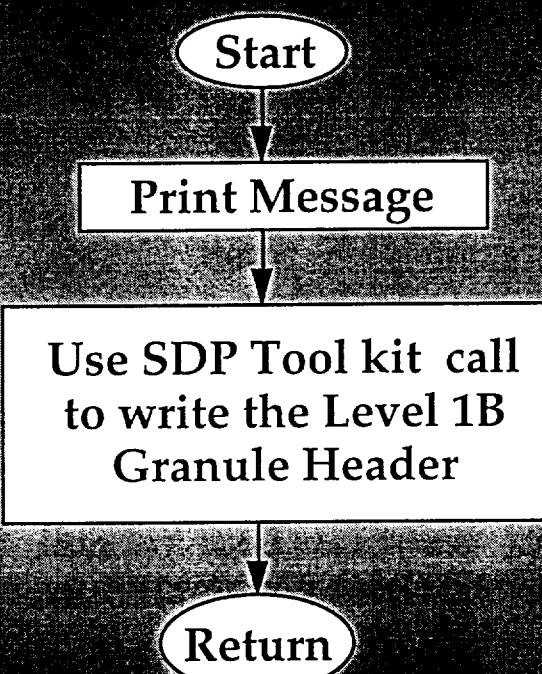
1.3.5 Spurious_Effects



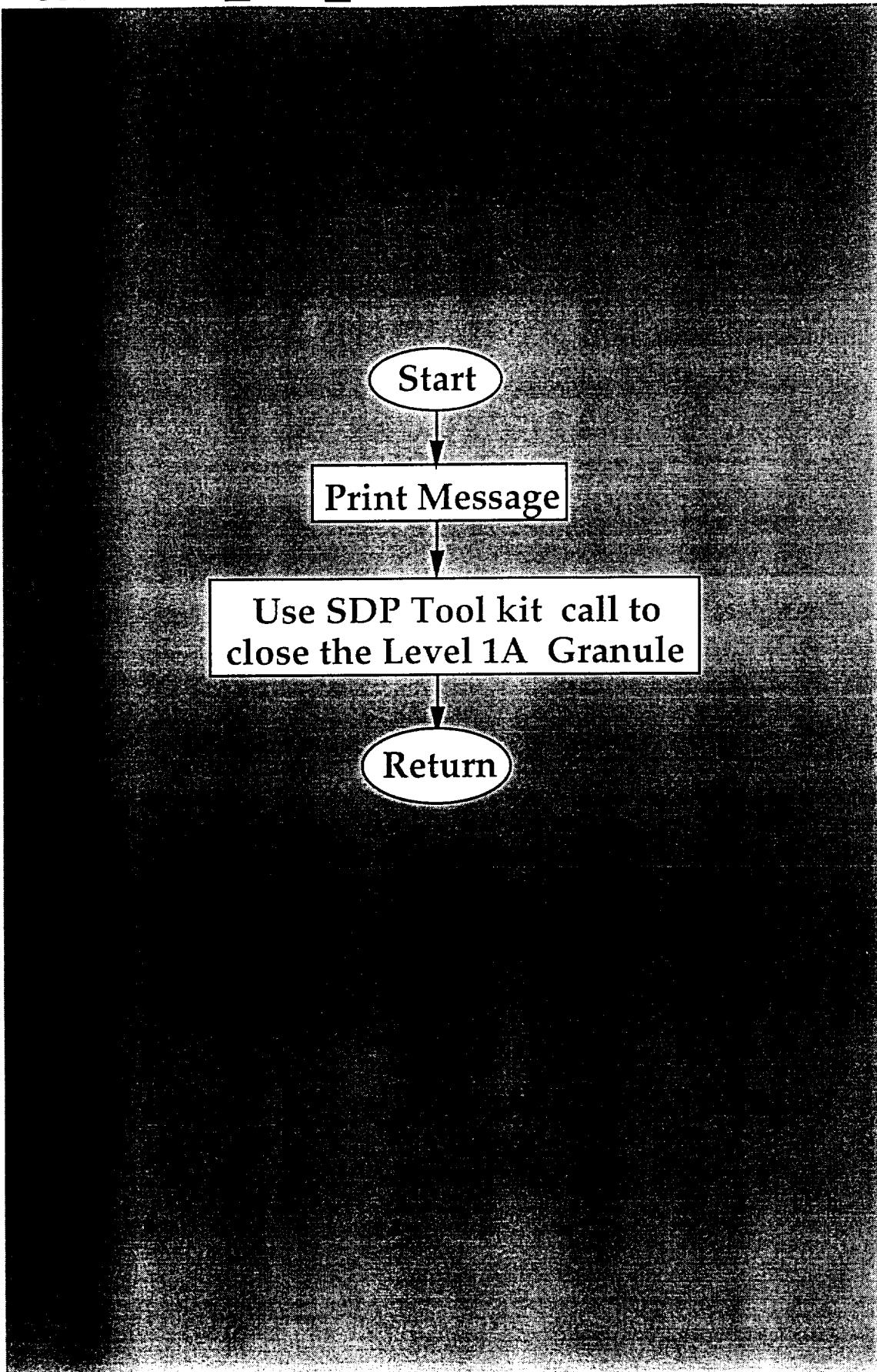
1.4 Write_L1B_Scan



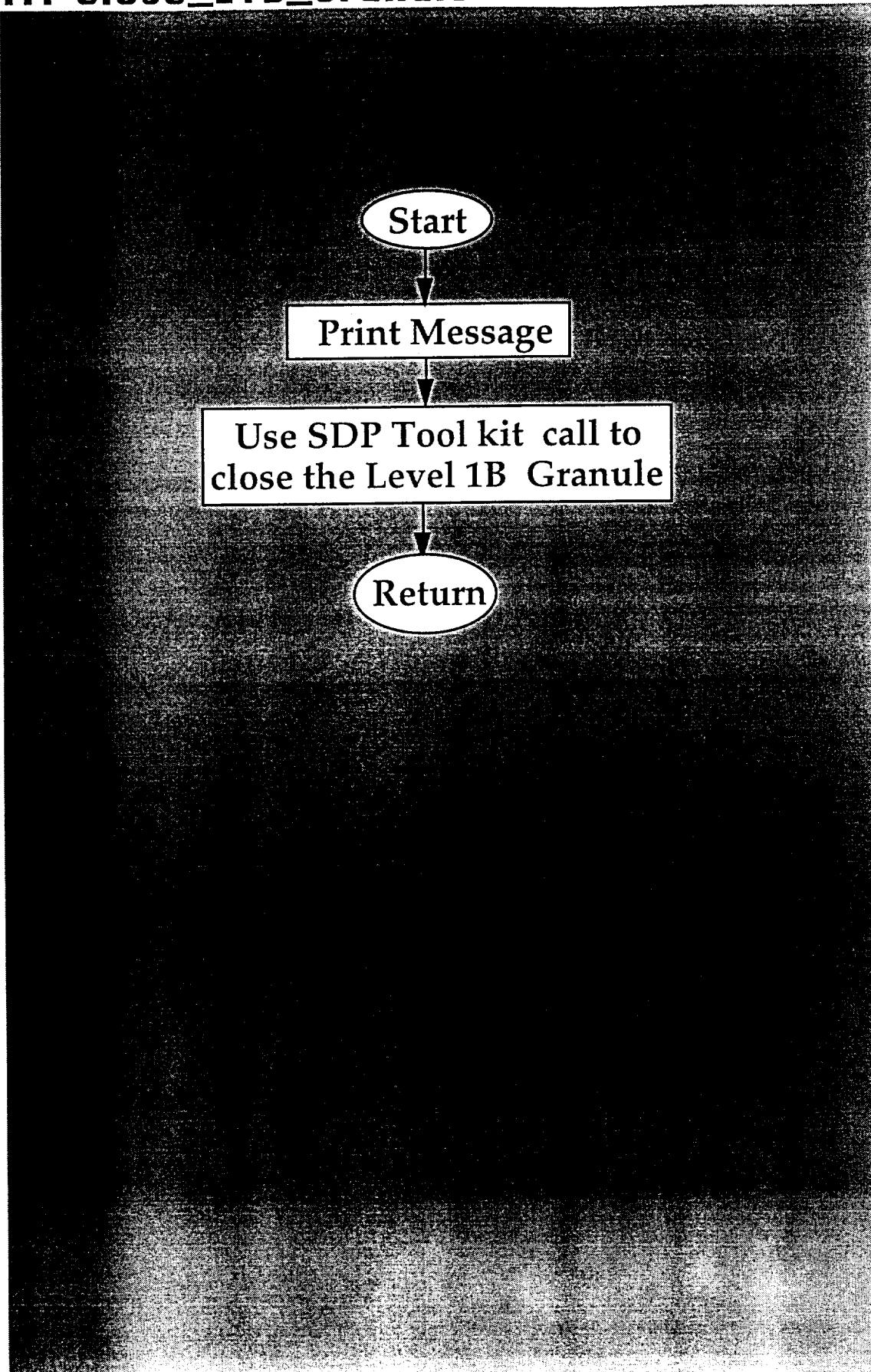
1.5 Write_L1B_Granule_Header



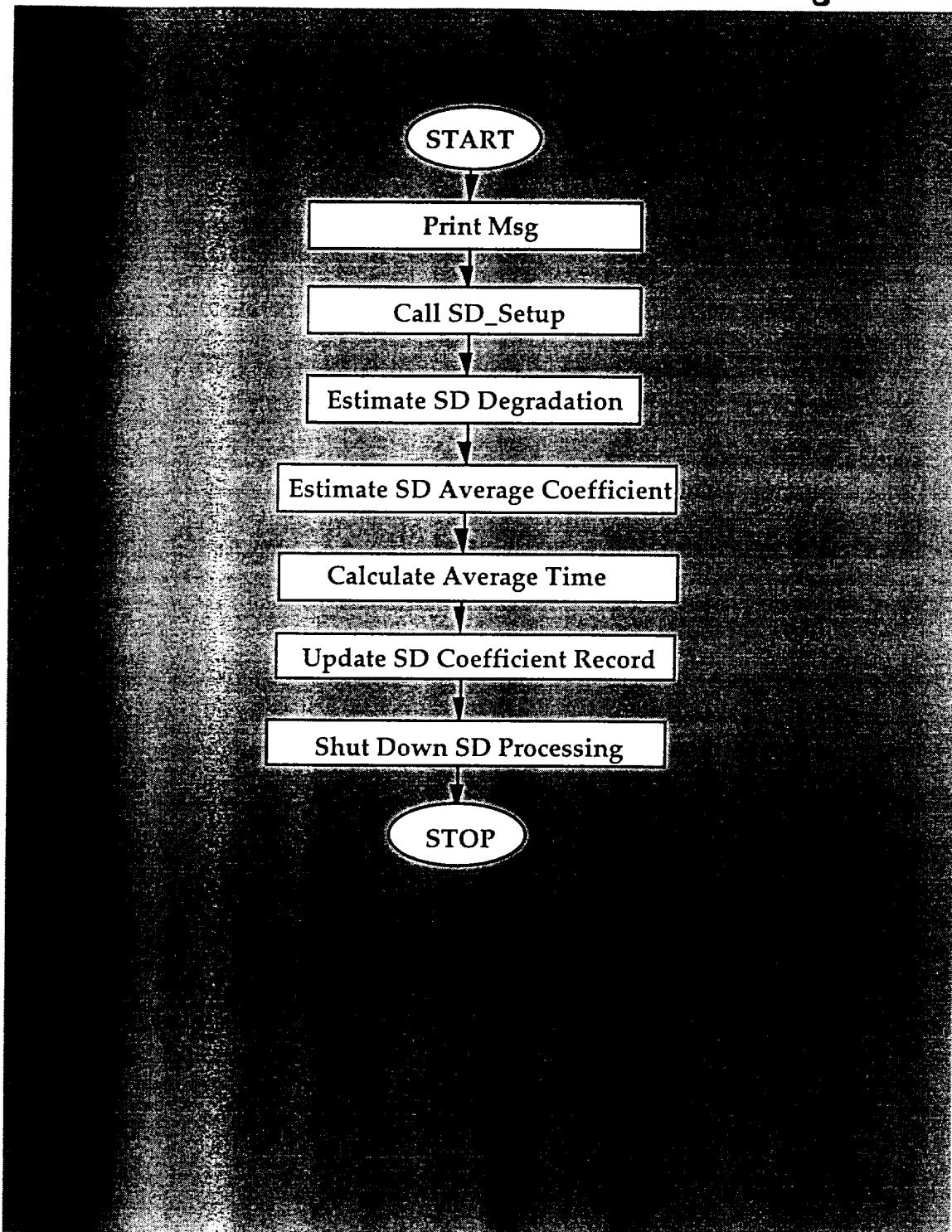
1.6 Close_L1A_Granule



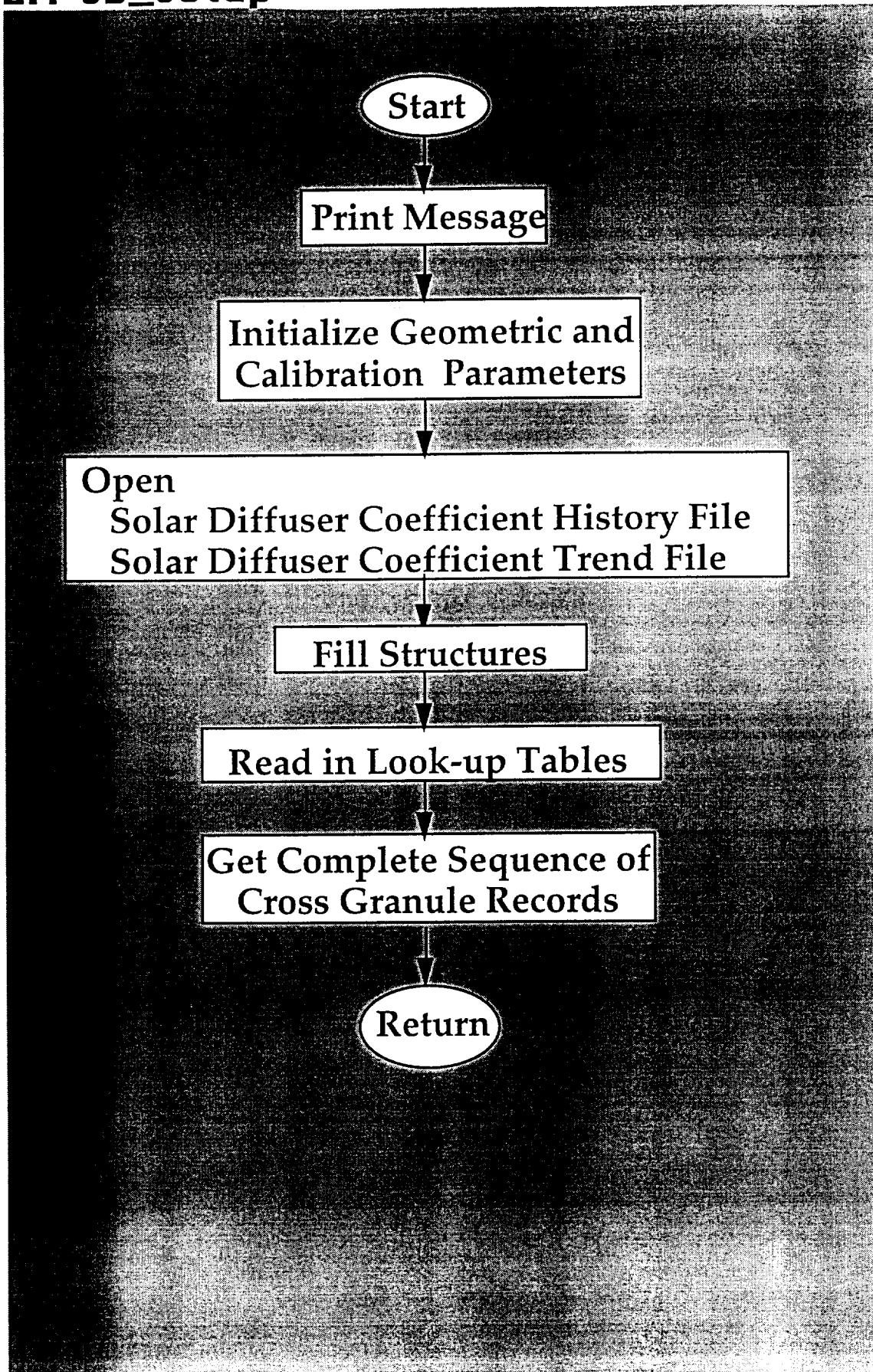
1.7 Close_L1B_Granule



2.0 Cross Granule Solar Diffuser Processing



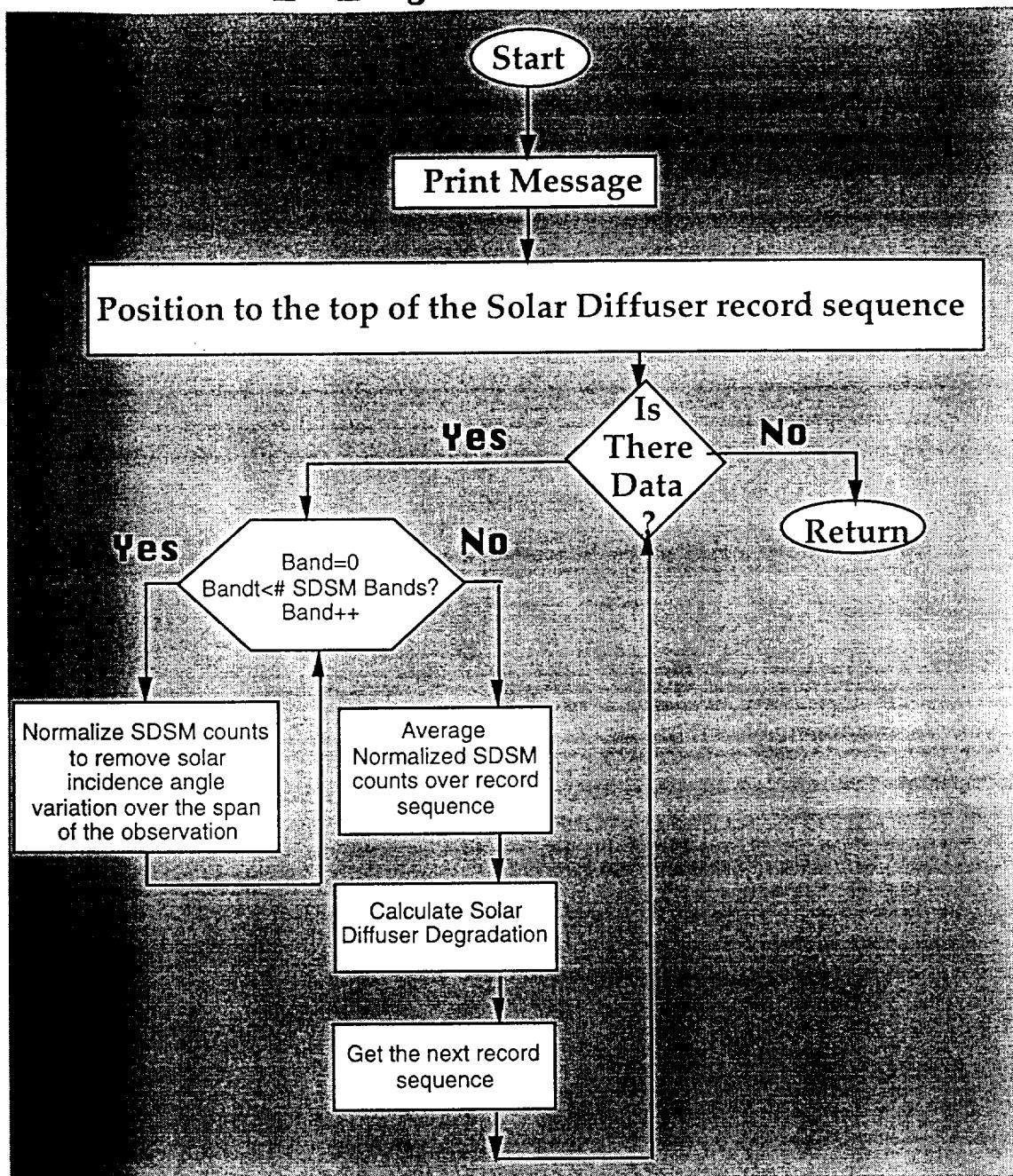
2.1 SD_Setup



```
*****
* Joan Baden
* MODIS/SAIC/GSC/RDC
* baden@highwire.gsfc.nasa.gov
* (301) 352-2128
*****
*/
/*status_t SD_Setup( FILE ** SD_Coeff_Trend_f,
* FILE ** SD_Coeff_History_f,
* list_t * sd_coeff_history,
* DIL_t SDSM_Norm_BRDF[NUM_SDSM_BANDS],
* DIL_t L_sd_ideal[MODIS_DETECTORS],
* sd_info_t * SDI,
* list_t ** sd_rec_sequence,
* list_t ** sd_recs_out,
* SD_Coeff_Rec_t * SD_Coeff_Trend_Rec);*/
/*
C*****
*
* Purpose: Solar Diffuser Setup.
*
* Description:
*
* Input parameters:
*
*     FILE      ** SD_Coeff_Trend_f,
*     FILE      ** SD_Coeff_History_f,
*     list_t    * sd_coeff_history,
*     DIL_t     SDSM_Norm_BRDF[NUM_SDSM_BANDS],
*     DIL_t     L_sd_ideal[MODIS_DETECTORS],
*     sd_info_t * SDI,
*     list_t    ** sd_rec_sequence,
*     list_t    ** sd_recs_out,
*     SD_Coeff_Rec_t * SD_Coeff_Trend_Rec;
*
* Output parameters:
*
*
* Revision history:
*
*     Revision 01.00 1995/05/16
*     Prologue, Joan Baden/RDC
*     Code, Geir Kvaran, SAIC/GSC
*
*
* Team-unique header:
*
* References and Credits
* This software is developed by the MODIS Characterization Support
* Team (MCST) for the National Aeronautics and Space Administration,
* Goddard Space Flight Center, under contract NASS-32373.
*
* HDF portions developed at the National Center for Supercomputing
* Applications at the University of Illinois at Urbana-Champaign.
*
* Design Notes
*
END*****
*/

```

2.2 Estimate_SD_Degradation

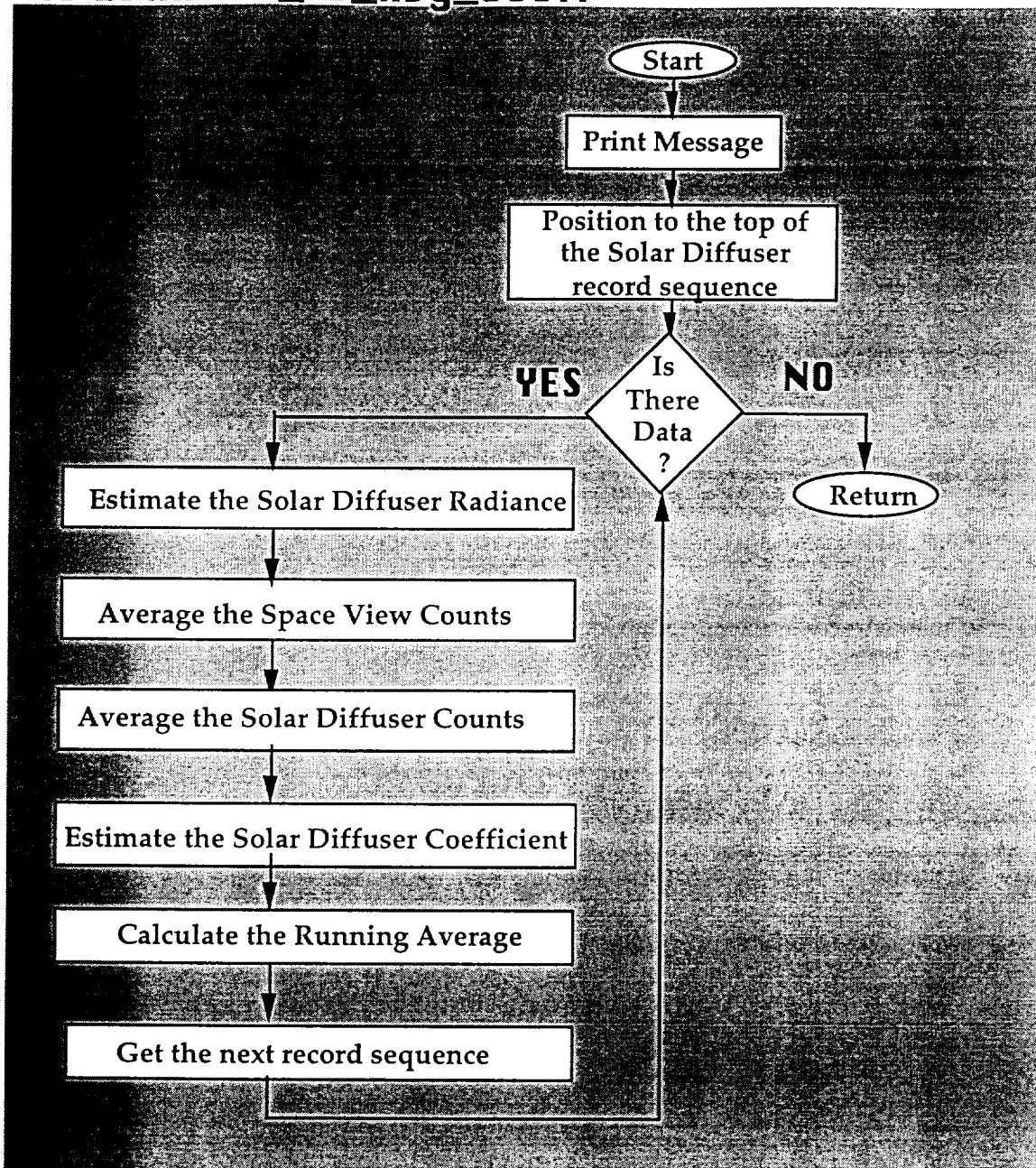


```

*****
* Joan Baden
* MODIS/SAIC/GSC/RDC
* baden@highwire.gsfc.nasa.gov
* (301) 352-2128
*****
/*status_t Estimate_SD_Degradation( list_t           * sd_rec_sequence,
*                                 sd_info_t          * SDI,
*                                 float              SD_Degradation[NUM_SDSM_BANDS] [NUM_SD_MODES],
*                                 boolean_t          Mode_Found[NUM_SD_MODES],
*                                 DIL_t              SDSM_Norm_BRDF[NUM_SDSM_BANDS]);
*/
C*****
*****
* Purpose: Estimate Solar Diffuser Degradation
*
* Description:
*
* Input parameters:
*
*      list_t      * sd_rec_sequence,
*      sd_info_t   * SDI,
*      float       SD_Degradation[NUM_SDSM_BANDS] [NUM_SD_MODES],
*      boolean_t   Mode_Found[NUM_SD_MODES],
*      DIL_t       SDSM_Norm_BRDF[NUM_SDSM_BANDS]);
*
* Output parameters:
*
*
* Revision history:
*
*      Revision 01.00 1995/05/16
*      Prologue, Joan Baden/RDC
*      Code, Geir Kvaran, SAIC/GSC
*
*
* Team-unique header:
*
* References and Credits
* This software is developed by the MODIS Characterization Support
* Team (MCST) for the National Aeronautics and Space Administration,
* Goddard Space Flight Center, under contract NAS5-32373.
*
* HDF portions developed at the National Center for Supercomputing
* Applications at the University of Illinois at Urbana-Champaign.
*
* Design Notes
*
END*****
*/

```

2.3 Estimate_SD_Avg_Coeff



```

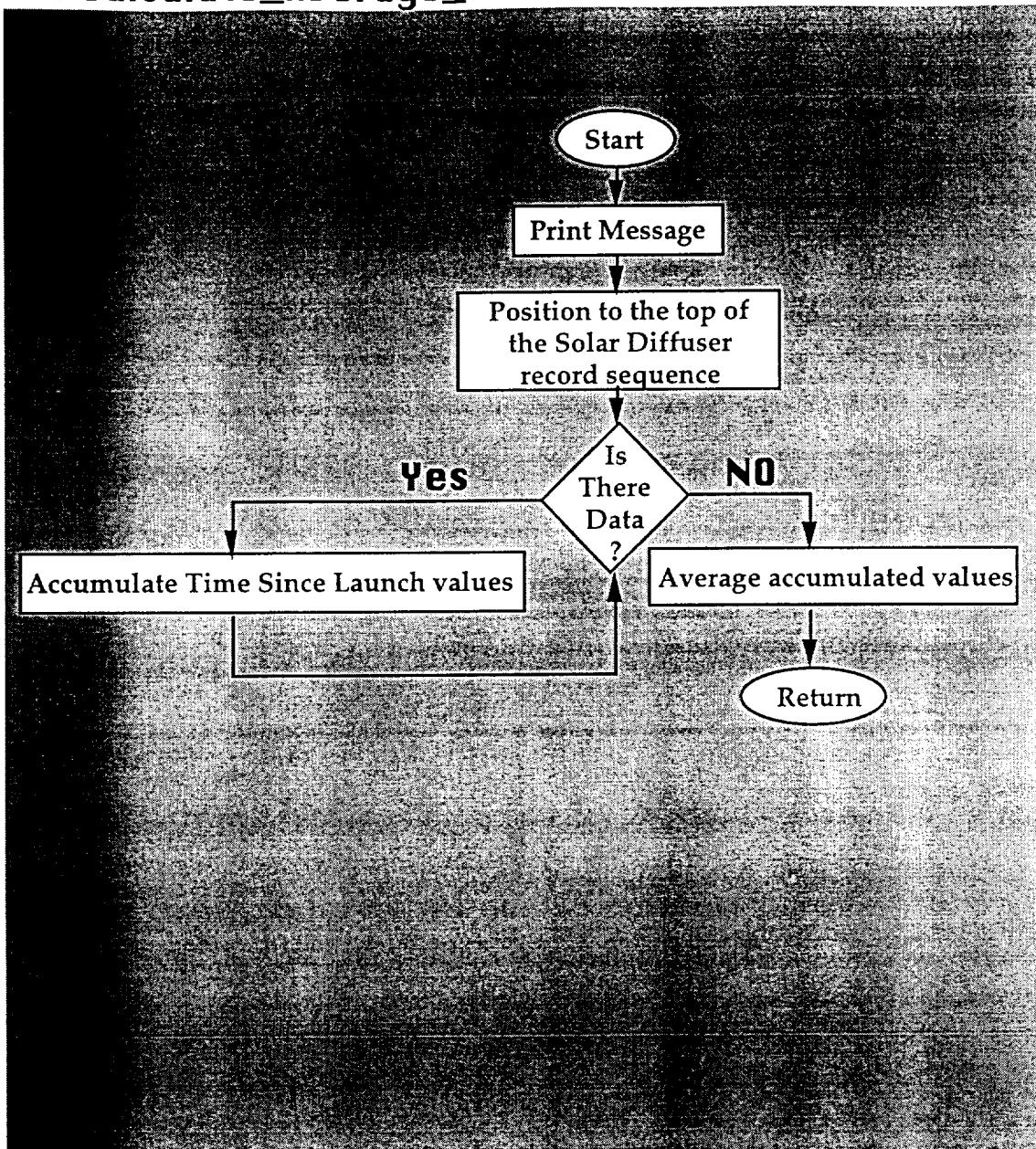
*****
* Joan Baden
* MODIS/SAIC/GSC/RDC
* baden@highwire.gsfc.nasa.gov
* (301) 352-2128
*****
*/
status_t Estimate_SD_Avg_Coeff(      list_t          *sd_rec_sequence,
*                                     sd_info_t        *SDI,
*                                     DIL_t           L_sd_ideal[MODIS_DETECTORS],
*                                     float            SD_Degradation[NUM_SDSM_BANDS
] [NUM_SD_MODES],
*                                     boolean_t        Mode_Found [NUM_SD_MODES ]
*                                     float            Avg_Gain [MODIS_REFLECTIVE_DETECTORS] ,
*                                     float            Avg_Bias  [MODIS_REFLECTIVE_DETECTORS]);
*/

```

MODIS Level 1B Detailed Design, Draft, June 11, 1995

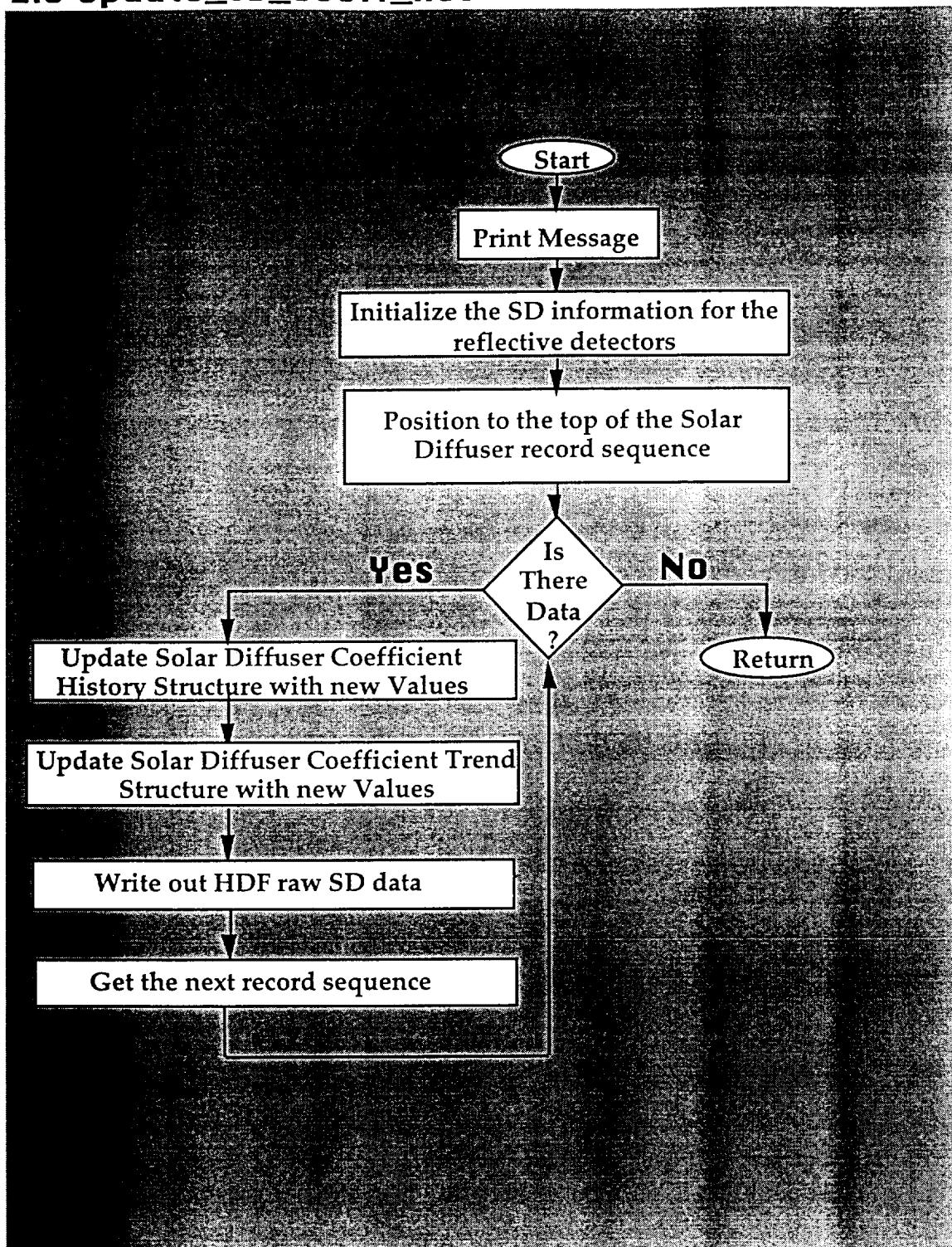
```
/*
C***** ****
*
* Purpose: Estimate Solar Diffuser Average Coefficients.
*
* Description:
*
* Input parameters:
*
*     list_t          * sd_rec_sequence,
*     sd_info_t       * SDI,
*     DIL_t           L_sd_ideal[MODIS_DETECTORS],
*     float           SD_Degradation[NUM_SDSTM_BANDS ][NUM_SD_MODES],
*     boolean_t        Mode_Found    [NUM_SD_MODES ]
*     float            Avg_Gain     [MODIS_REFLECTIVE_DETECTORS] ,
*     float            Avg_Bias     [MODIS_REFLECTIVE_DETECTORS]);
*
* Output parameters:
*
*
* Revision history:
*
*     Revision 01.00 1995/05/16
*     Prologue development, Joan Baden/RDC
*     Code, Geir Kvaran, SAIC/GSC
*
*
* Team-unique header:
*
* References and Credits
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* Team (MCST) for the National Aeronautics and Space Administration,
* Goddard Space Flight Center, under contract NAS5-32373.
*
* HDF portions developed at the National Center for Supercomputing
* Applications at the University of Illinois at Urbana-Champaign.
*
* Design Notes
*
END*****
*/
```

2.4 Calculate_Average_Time



```
*****
* Joan Baden
* MODIS/SAIC/GSC/RDC
* baden@highwire.gsfc.nasa.gov
* (301) 352-2128
*****
/*status_t Calc_Avg_Time(    list_t      * sd_rec_sequence,
*                         float       * avg_time);
*/
C*****
* Purpose: Calculates the average time of the SD record sequence.
*
* Description:
*
* Input parameters:
*
*     list_t  * sd_rec_sequence,
*     float   * avg_time;
*
* Output parameters:
*
*
* Revision history:
*
*     Revision 01.00 1995/05/16
*     Prologue development, Joan Baden/RDC
*     Code, Geir Kvaran, SAIC/GSC
*
*
* Team-unique header:
*
* References and Credits
* This software is developed by the MODIS Characterization Support
* Team (MCST) for the National Aeronautics and Space Administration,
* Goddard Space Flight Center, under contract NAS5-32373.
*
* HDF portions developed at the National Center for Supercomputing
* Applications at the University of Illinois at Urbana-Champaign.
*
* Design Notes
*
END*****
*/
```

2.5 Update_SD_Coeff_Rec

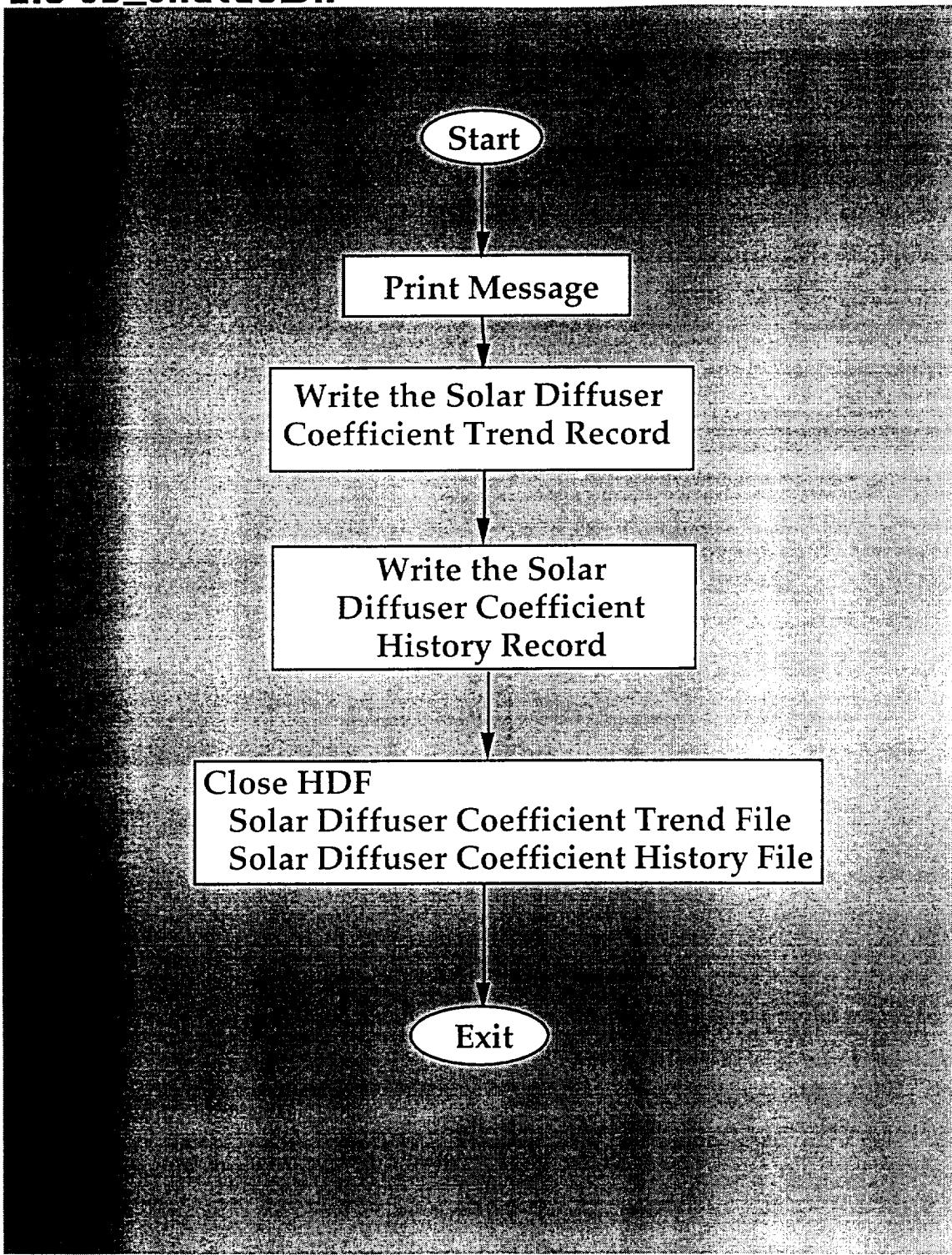


```
*****
* Joan Baden
* MODIS/SAIC/GSC/RDC
* baden@highwire.gsfc.nasa.gov
* (301) 352-2128
*****
```

MODIS Level 1B Detailed Design, Draft, June 11, 1995

```
/*status_t      Update_SD_Coeff_Rec(      SD_Coeff_Rec_t    * SD_Coeff_Rec,
*                                         sd_info_t       * SDI,
*                                         list_t          * sd_rec_sequence,
*                                         boolean_t        Mode_Found[NUM_SD_MODES],
*                                         float           Avg_Gain [MODIS_REFLECTIVE_DETECTORS],
*                                         float           Avg_Bias [MODIS_REFLECTIVE_DETECTORS],
*                                         float           B_0 [MODIS_REFLECTIVE_DETECTORS],
*                                         float           B_1 [MODIS_REFLECTIVE_DETECTORS],
*                                         float           avg_time);RS);
*/
/*
C***** ****
*
* Purpose: Update Solar Diffuser Coefficient Record.
*
* Description:
*
* Input parameters:
*
*     SD_Coeff_Rec_t    * SD_Coeff_Rec,
*     sd_info_t       * SDI,
*     list_t          * sd_rec_sequence,
*     boolean_t        Mode_Found[NUM_SD_MODES],
*     float           Avg_Gain [MODIS_REFLECTIVE_DETECTORS],
*     float           Avg_Bias [MODIS_REFLECTIVE_DETECTORS],
*     float           B_0 [MODIS_REFLECTIVE_DETECTORS],
*     float           B_1 [MODIS_REFLECTIVE_DETECTORS],
*     float           avg_time);RS));
*
* Output parameters:
*
*
* Revision history:
*
*     Revision 01.00 1995/05/16
*     Prologue, Joan R. Baden/RDC
*     Code, Geir E. Kvaran, SAIC/GSC
*
*
* Team-unique header:
*
*     References and Credits
*     This software is developed by the MODIS Characterization Support
*     Team (MCST) for the National Aeronautics and Space Administration,
*     Goddard Space Flight Center, under contract NAS5-32373.
*
*     HDF portions developed at the National Center for Supercomputing
*     Applications at the University of Illinois at Urbana-Champaign.
*
*     Design Notes
*
END*****
*/
```

2.6 SD_Shutdown

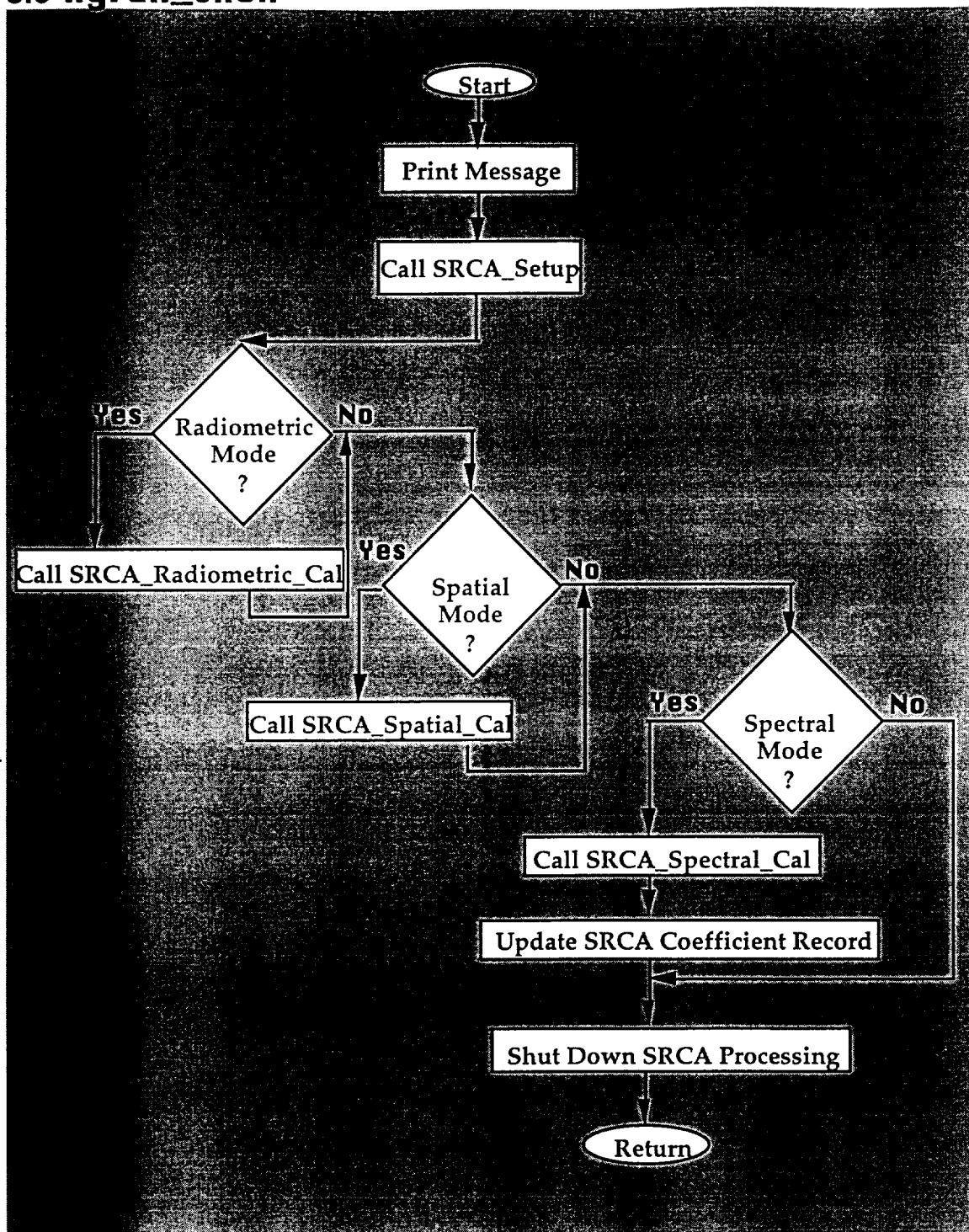


```
*****
* Joan Baden
* MODIS/SAIC/GSC/RDC
* baden@highwire.gsfc.nasa.gov
* (301) 352-2128
*****
/*status_t SD_Shutdown( SD_Coeff_Rec_t * SD_Coeff_Trend_Rec,
```

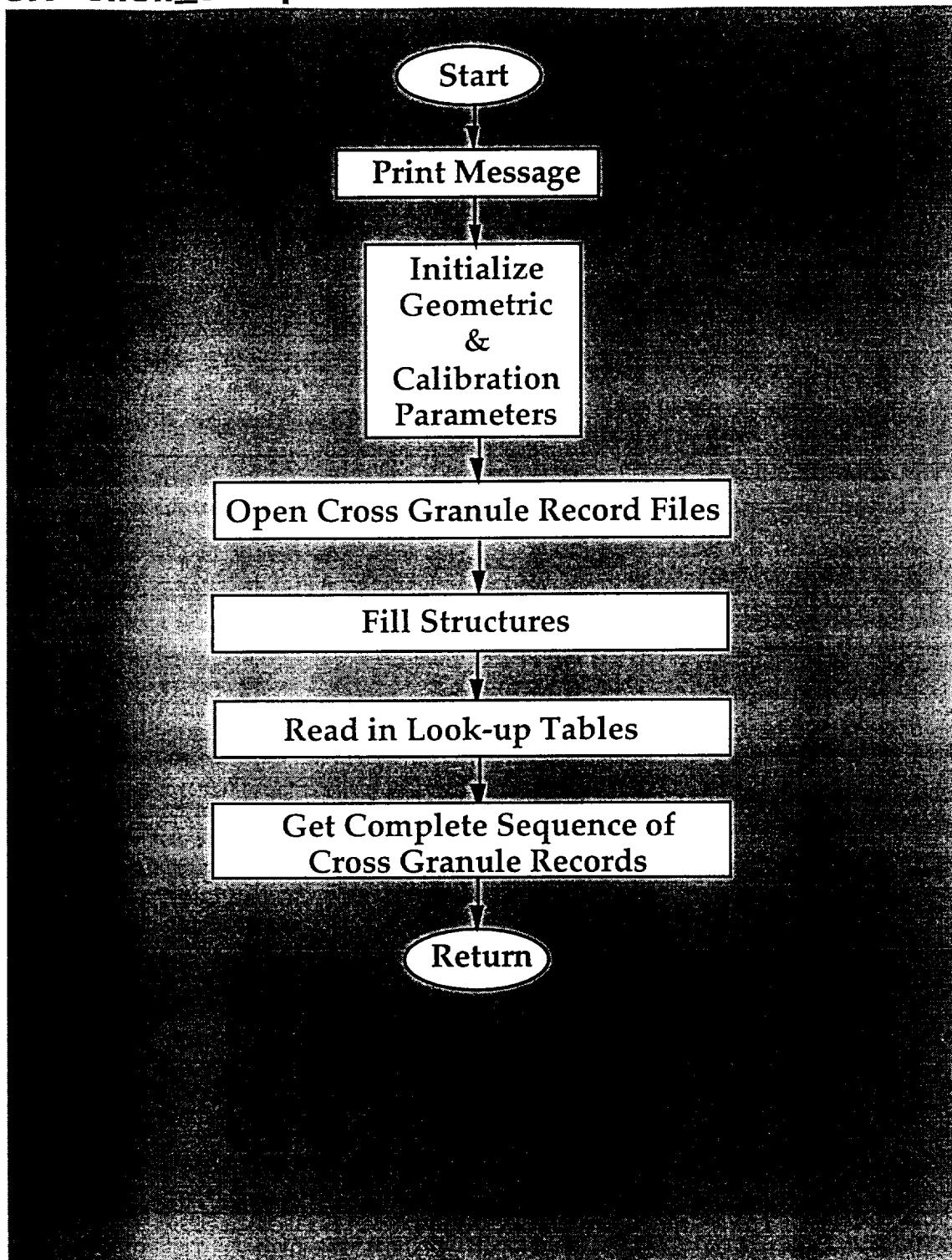
MODIS Level 1B Detailed Design, Draft, June 11, 1995

```
*                      FILE          * SD_Coeff_Trend_f,
*                      FILE          * SD_Coeff_History_f); */
/*
C***** ****
*
* Purpose: Routine is executed in the event of Solar Diffuser shutting down.
*
* Description:
*
* Input parameters:
*
*      SD_Coeff_Rec_t    * SD_Coeff_Trend_Rec,
*      FILE              * SD_Coeff_Trend_f,
*      FILE              * SD_Coeff_History_f);
*
* Output parameters:
*
*
* Revision history:
*
*      Revision 01.00 1995/05/16
*      Prologue, Joan Baden/RDC
*      Code, Geir Kvaran, SAIC/GSC
*
*
* Team-unique header:
*
* References and Credits
* This software is developed by the MODIS Characterization Support
* Team (MCST) for the National Aeronautics and Space Administration,
* Goddard Space Flight Center, under contract NAS5-32373.
*
* HDF portions developed at the National Center for Supercomputing
* Applications at the University of Illinois at Urbana-Champaign.
*
* Design Notes
*
END*****
*/
```

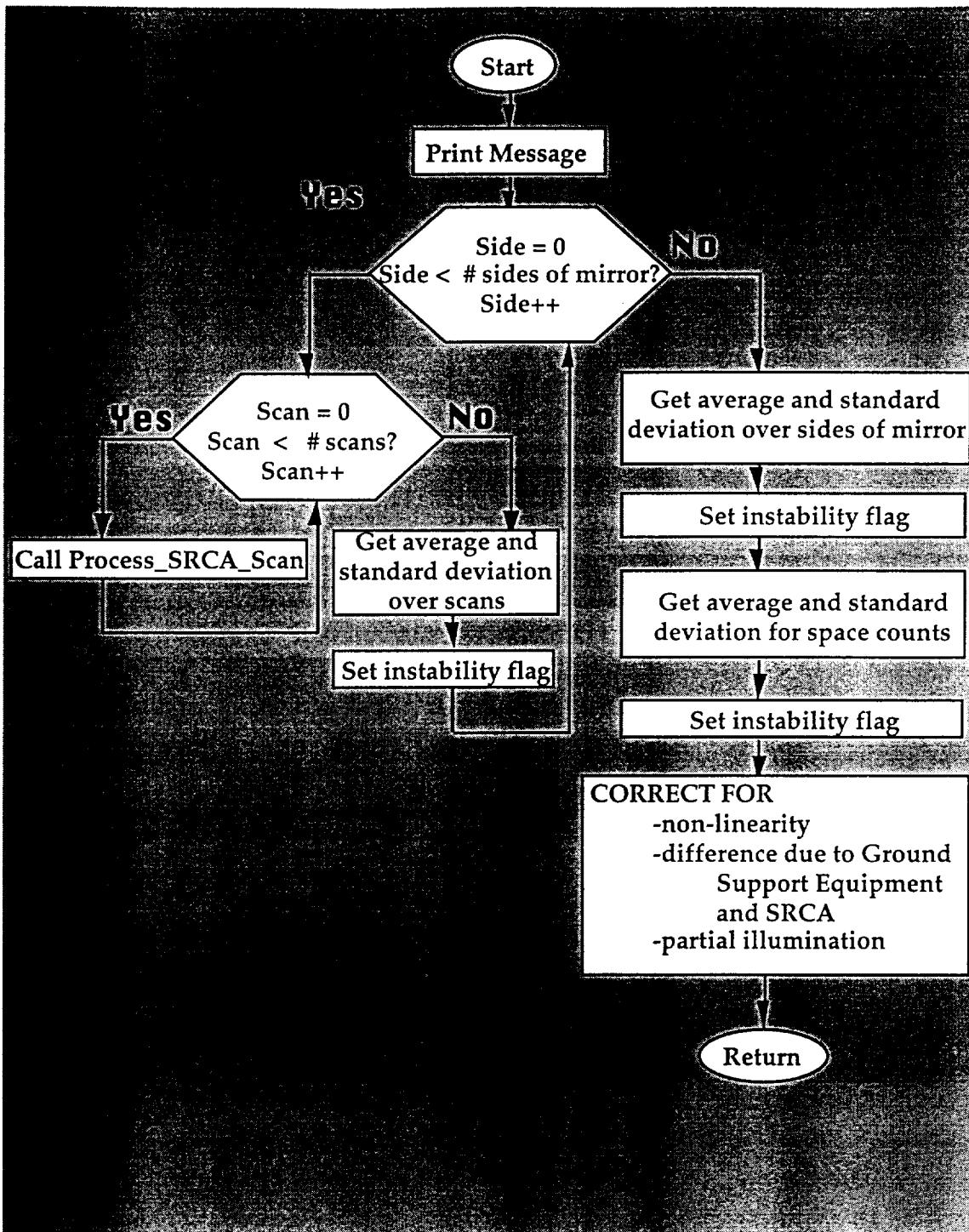
3.0 Xgran_SRCA



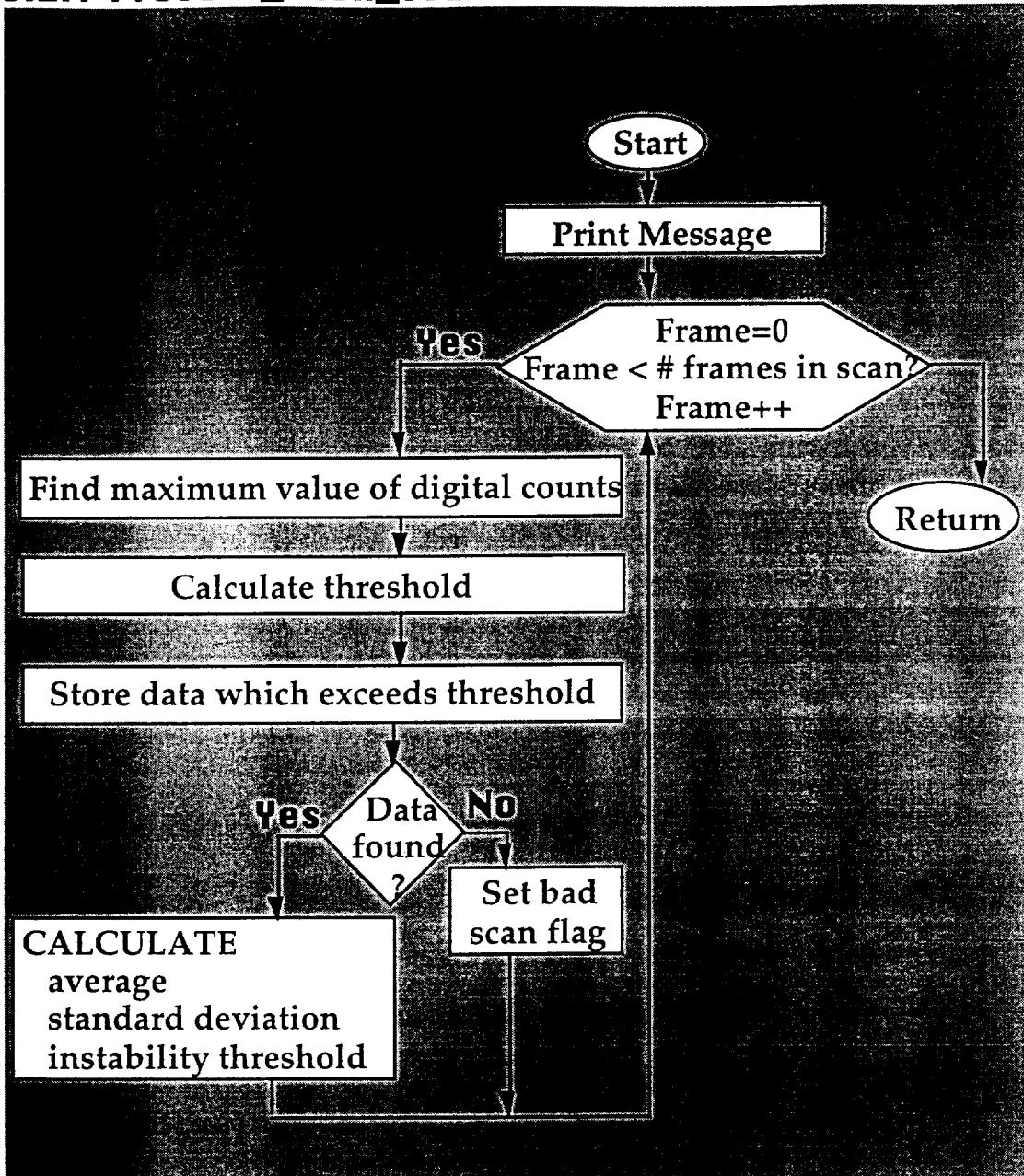
3.1 SRCA_Setup



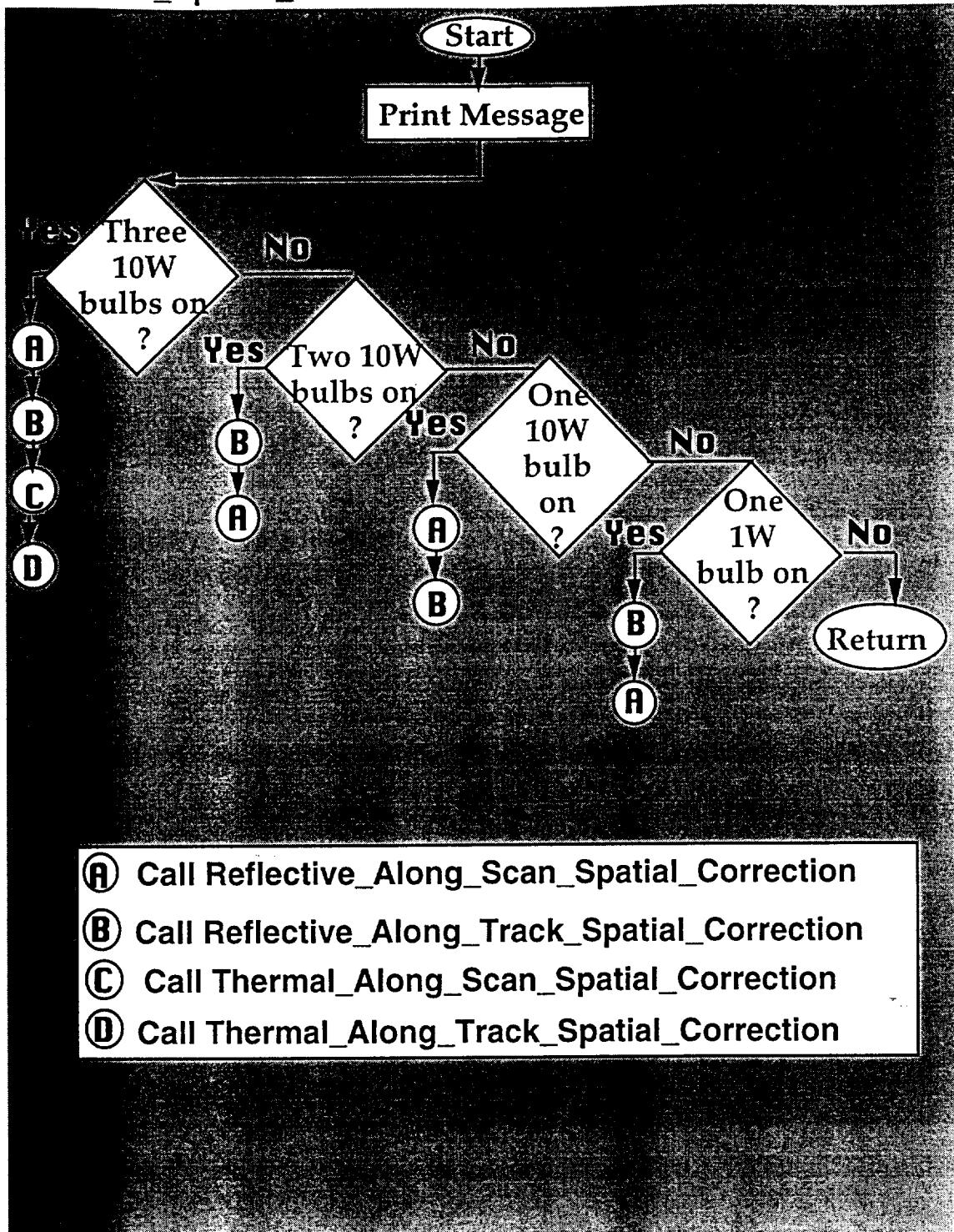
3.2 SRCA_Radiometric_Cal



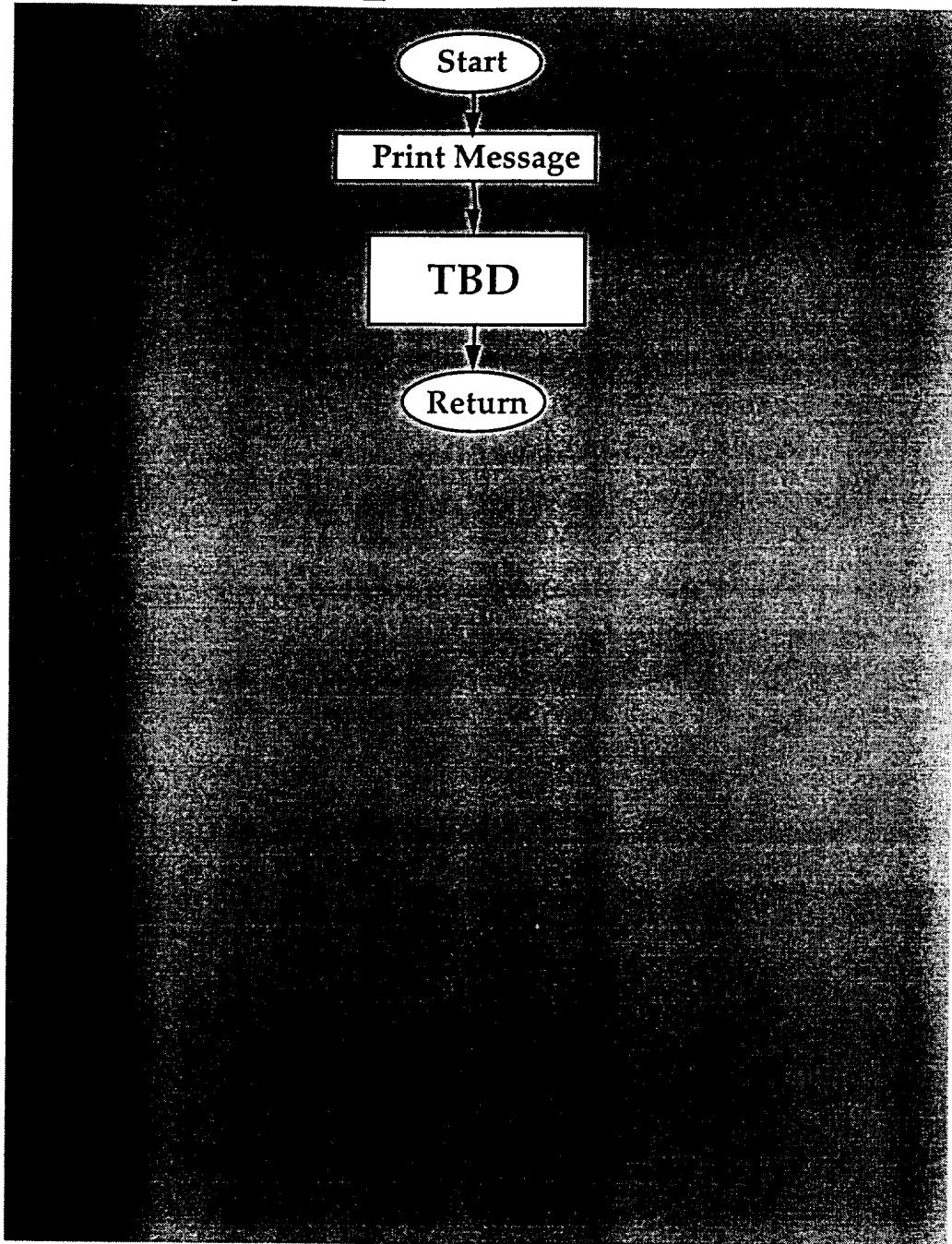
3.2.1 Process_SRCR_Scan



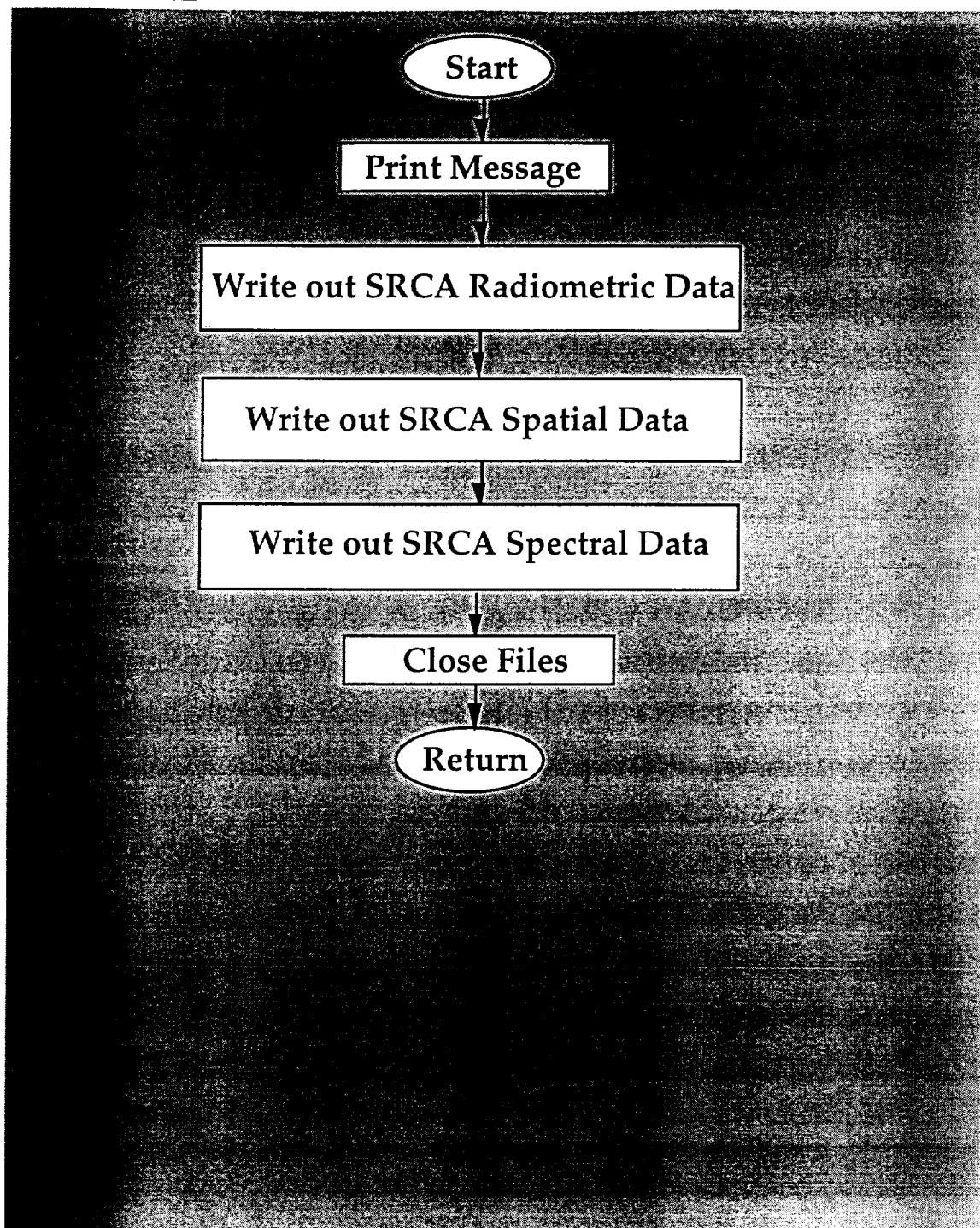
3.3 SRCA_Spatial_Cal



3.4 SRCR_Spectral_Cal



3.5 SRCA_Shutdown



Classes of Look-up Tables

Blackbody Radiance
Irradiance of the Sun
A(Thermal Gain)
B(Thermal Offset)
Blackbody Reflected Radiance
Solar Diffuser Coefficients
Detector BRDF
Q(Nonlinear Thermal Term)
Blackbody emissivity
Blackbody Term
Calibration Parameters
Reflective Detector Information
Within Orbit Variability
Blackbody Rho
Earth-view Rho
Relative Spectral Response (RSR)
Solar Diffuser Coefficient History
Solar Diffuser Coefficients
Solar Diffuser Information
Solar Diffuser Stability Monitor
BRDF

TOOLS

Memory (SDP Toolkit) Allocate Free SMF (SDP Toolkit) Transmit messages Files (SDP Toolkit) Open Close Build file names Read Write Granules Define Initialize Fill Manipulate headers Manipulate data Transform to HDF format Show Scans Define Initialize Fill Manipulate headers Manipulate data Show Lists Define Initialize Store record Remove list Insert list Next list Reset to top of list Join list	Look-up Tables Single_Indexed Double_Indexed Create Write Clean up Read Initialize Show Multiply Integrate Set a character string Extract an entry (or value) Arrays One-Dimensional Two-Dimensional Read Write
--	--

5.0 EXTERNAL INTERFACE DETAILED DESIGN

The MODIS Level 1B software system is required by ECS to produce all archivable data products in Hierarchical Data Format (HDF).

5.1 Interface Allocation Design

5.2 Physical Interface Design

Data Product Description?

6.0 CODING AND IMPLEMENTATION NOTES

TBS during coding phase.

7.0 FIRMWARE SUPPORT MANUAL

Not Applicable.

8.0 ABBREVIATIONS AND ACRONYMS

CASE	Computer Aided Software Engineering
ECS	EOS Core System
EOS	Earth Observing System
EOSDIS	EOS Data and Information System
GSFC	Goddard Space Flight Center
MCST	MODIS Characterization Support Team
MODIS	Moderate Resolution Imaging Spectroradiometer
NASA	National Aeronautics and Space Administration
PDL	Program Design Language
SDD	Software Design Document
SDST	Science Data Support Team
TBS	To be supplied

9.0 GLOSSARY

10.0 NOTES

11.0 APPENDICES

A. Requirements Traceability Matrix

Level 1B Requirements Traceability Matrix

Requirement	Software Module
IF01 Initiate Execution	1.0 L1B
IF02 Deleted	
IF03 Terminate Execution upon Completion	1.0 L1B
IF04 Input Data	1.2 Read_L1A_Scan
IF05 Ancillary Input Data	1.1 Setup
IF06 Input Data Limitation	1.1 Setup
IF07 Create Level 1B Data Product	1.3 Generate_L1B_Scan 1.5 Write_L1B_Granule_Header
IF08 Create Metadata	
IF09 Append Metadata	1.5 Write_L1B_Granule_Header
IF10 MODIS Processing Log	All Modules
IF11 Concurrent Execution	1.L1B
IF12 Termination Report	1.0 L1B
IF13 Alarm Messages.	All Modules
IF14 Overlapping Data	1.3.3 Thermal_Calibration
IF15 Sun Angles	
IF16 Pixel Angles	
IF17 Lunar Vector	
IF18 Normal Termination.	1.0 L1B
IF19 Abnormal Termination	1.0 L1B
FN01 Processing Scope.	Team Leader Working Agreement 3.3.4
FN02 Reprocessing	ECS Requirement EOSD1040
FN03 Solar Diffuser	2 Xgran_SD
FN04 Solar Diffuser Stability Monitor	2 Xgran_SD
FN05 SRCA Radiometric Mode	3 Xgran_SRCA 3.2 SRCA_Radiometric_Cal
FN06 SRCA Spatial Mode	3 Xgran_SRCA 3.2 SRCA_Spatial_Cal
FN07 SRCA Spectral Mode	3 Xgran_SRCA 3.2 SRCA_Spectral_Cal
FN08 Space View	1.3.3 Thermal_Calibration
FN09 Black Body	1.3.3 Thermal_Calibration
FN10 Lunar Look	MODIS Level 1B ATBD

FN11 Calibration Coefficients	2 Xgran_SD 3 Xgran_SRCA
FN12 Calibration Updates	2 Xgran_SD 3 Xgran_SRCA
FN13 Earth View Data Requirement	1.3.1 Reflective Calibration 1.3.3 Thermal_Calibration Software Module
FN14 Deleted	
FN15 Engineering Data.	1.0 L1B
FN16 Quality Assurance	1.3 Generate_L1B_Scan 2 Xgran_SD 3 Xgran_SRCA
FN17 Input Data Verification	1.1 Setup
FN18 Metadata Contents	1.4 Write L1B_Scan 1.5 Write L1B_Granule_Header
FN19 Data Format	1.4 Write L1B_Scan 1.5 Write L1B_Granule_Header
FN20 Data Contents	1.4 Write L1B_Scan 1.5 Write L1B_Granule_Header
FN21 Calibration Sources	1.3.1 Reflective_Calibration 1.3.3 Thermal_Calibration 1.3.5 Spurious_Effects 2 Xgran_SD 3 Xgran_SRCA
FN22 Non-Nominal Conditions	
FN23 Radiance Sensor Data	1.3.1 Reflective_Calibration
FN24 Infrared Sensor Data	1.3.3 Thermal_Calibration
FN25 Reflectance Sensor Data	1.3.1 Reflective_Calibration
PR01 Error Recovery	All Modules
PR02 Trending	2 Xgran_SD
PR03 Error Abort	All Modules
OR01 Scope	All Modules
OR02 Toolkits	All Modules
OR03 Maintainability	All Modules
OR04 Portability	All Modules
OR05 Reliability	All Modules

