LEVEL III

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THE ROSCOE MANUAL

Volume I-1 — Program Description

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

The ROSCOE computer code is designed specifically to be the "laboratory standard" for evaluating nuclear effects on radar and optical sensors. The program provides a means for (1) evaluating radar acquisition, discrimination, and tracking performance in a nuclear environment, (2) determining optical (SWIR) surveillance and tracking performance in the presence of nuclear effects, (3) measuring the degradation of microwave satellite communications systems due to transmission through nuclear disturbed regions, (4) estimating

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20. ABSTRACT (Continued)

various radar and optical propagation error sources, and (5) computing specific phenomenological data.

The ROSCOE documentation consists of a number of volumes; including user manuals (Volumes 1-3), systems code descriptions (Volumes 4, 20, and 21-1), code validation documents (Volumes 6 and 23), and phenomenology code descriptions (all others).

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1   INTRODUCTION

The ROSCOE computer code was designed specifically to be the "laboratory standard" for evaluating nuclear effects on radar and optical sensors. The design philosophy was to take "state-of-the-art" phenomenology models, couple these with a generalized systems modeling framework to allow the user flexibility in structuring different kinds of engagements, and finally, place these in a code structure that would be flexible for change and use. The idea was that ROSCOE would be used as a framework for the development of new physics models by the physicist-user, and as a technology assessment tool by the systems analyst.

The ROSCOE computer code provides an effective means for evaluating these kinds of problems:

1.   Radar acquisition, discrimination, and tracking performance in a nuclear environment.

2.   Optical (SWIR) surveillance and tracking in the presence of nuclear effects.

3.   The degradation of microwave satellite communication systems due to transmission through nuclear disturbed regions.

4.   Estimates of radar and optical propagation error sources along specified lines-of-sight.

5.   Specific phenomenological data in nuclear disturbed regions for use in other codes or for validating faster running codes.

The phenomenology portion of the code consists of a number of modules, each representing a major calculation type (e.g., chemistry, fireball properties and motion, weapon output, etc.). For each module type, existing phenomenology codes were surveyed to find candidate models for ROSCOE. Models were then selected considering computer constraints and the concept of "balanced accuracy" to yield the first-order ROSCOE phenomenology models.

These were then modified where necessary to match the latest test data and to include new phenomenological concepts.

The systems portion of the code consists of a flexible input/output structure and a library of systems routines from which specific systems modules can be built. For example, the user can specify multi-object attacks with varying object types and weapon types, multiple sensors of varying type, and various output options for many different system applications. General models of a phased-array radar and optical surveillance sensor are also available within the code. The user can simulate his particular radar or optical sensor by specifying a set of input parameters to these models, or he can replace these sensor models with his own. Similarly, simple models for the system functions of radar track and discrimination, optical surveillance, and satellite communications are provided, but can be replaced.

The code structure has been designed to allow for flexibility in making changes so that new phenomenology models can be inserted as they become available and other systems models can be added. The code is event-based, with each event consisting of an overlay of routines which compute some specific set of calculations. For example, many of the phenomenology modules mentioned above are separate events within the code. Thus, to change a phenomenology module, the user would write a replacement event for the one currently in ROSCOE, and insert it in the program structure file. Overlays are constructed at run time by the user, who selects the subroutines which are to be loaded from the program library. Thus to change a subroutine, the user merely inserts his subroutine in the program library and modifies the structure file to insert it in the proper overlay.

The program has several run options. First, the phenomenology block of the code (consisting of several overlays) can be run independently so that detailed phenomenology calculations can be made; second, radar and optical sensor propagation errors can be computed along specified lines-of-sight; third, the system models (radar track and discrimination, optical surveillance,

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or satellite communications) can be run independently—in an undisturbed environment; and finally, the systems models can be run in a nuclear environment.

The ROSCOE documentation is divided into thirty-six volumes including user manuals (Volumes 1-3), systems code descriptions (Volumes 4, 20 and 21-1), code validation documents (Volumes 6 and 23), and phenomenology code descriptions (all others). This volume is subdivided into two main sections. The first section, "Understanding ROSCOE", is designed to help the user understand the basic design and content of the code. This is followed by the section, "Using ROSCOE", which describes some elements of the program structure, the input/output routines, and the input/output variables.

2   UNDERSTANDING ROSCOE

This section begins with a program overview to acquaint the reader
with the basic assumptions made in developing the program and the compu-
tational flow of the code. Brief descriptions of the systems and physics
models are given later.

2.1   OVERVIEW

2.1.1 Scenario

The basic scenario which ROSCOE is intended to simulate is shown in
Fig. 2.1. One or more sensors on various platforms attempt to discrimi-
nate, track or view one or more objects in the presence of a multiburst
nuclear environment. Both high-altitude and low-altitude phenomenology
modules are available in the code, and they can be run simultaneously.
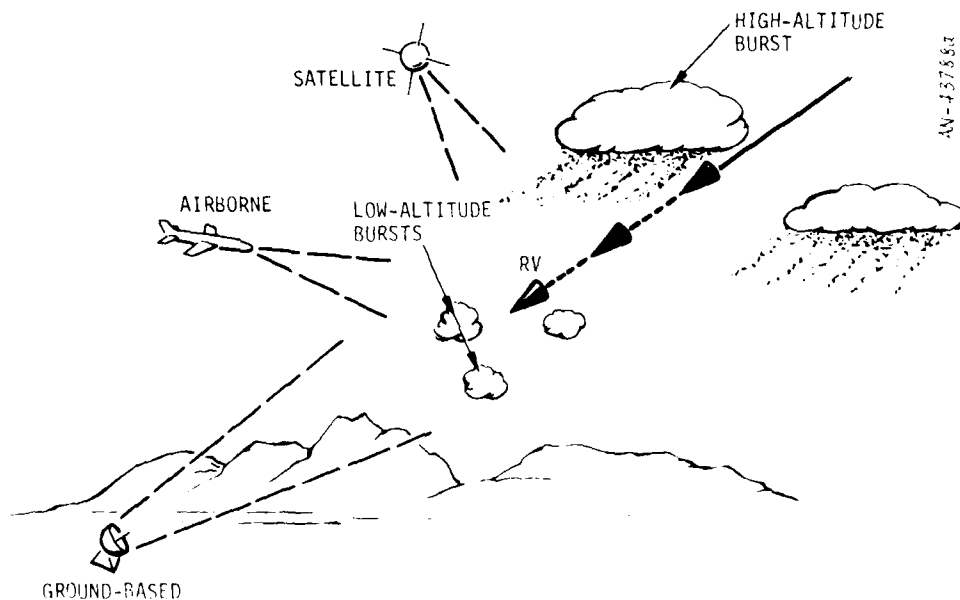
Figure 2.1. ROSCOE Scenario

The sensor platform types include ground-based, airborne and space-borne. Various sensor types can be specified. For example, radars with differing characteristics can be specified in a single run.

Similarly, a number of different object types can be specified in the input. These object types can be mixed in any desired fashion to generate quite complicated attacks.

There are no interceptors modeled in ROSCOE. Interceptor bursts as well as precursor bursts are specified in the input by designating a burst time and location. Weapon types can be mixed as required to simulate a specific engagement.

2.1.2 Basic Assumptions

The main portions of the ROSCOE code are written in Fortran IV, specifically in the version which is currently running on the 6000 and 7000 series computers of Control Data Corporation. In addition, there are a few machine-language subroutines taken from the GRC TRAID[1] library of BMD systems routines.

ROSCOE uses a spherical, rotating earth for trajectory calculations with a Cartesian coordinate system fixed in the earth. This coordinate system has the z-axis pointing out of the geographical north pole, the x-axis out of the equator at the Greenwich meridian, and the y-axis selected to complete a right-handed orthogonal triple (see Fig. 2.2). Since the coordinate system is a rotating one, object motion contains centrifugal and Coriolis terms. Motion of the earth around the sun is ignored except for some atmospheric calculations which require the solar position and flux.

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[1] T. Plambeck, The Compleat Traidsman, General Research Corporation IM-711/2, September 1968.

NORTH POLE Z

GREENWICH

ZERO LONGITUDE

**ORIGIN AT CENTER OF EARTH
SPHERICAL EARTH**

EQUATOR

X

+LONGITUDE

Y
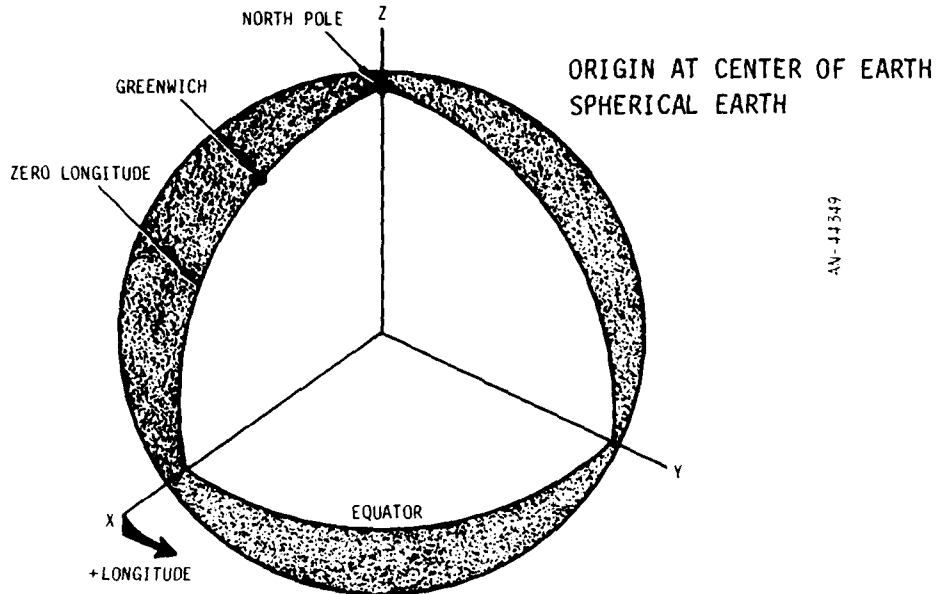
Figure 2.2. Coordinate System

Internal calculations are performed in the CGS system of units.
Input and output can be in any units convenient to the user, but non-
standard units will be converted to the CGS system within the program.

Two special-purpose program libraries are used in ROSCOE. The
first is a BMD systems library of subroutines called TRAID.[1] It provides
trajectory-generating programs, input/output routines, and some standard-
ized vector and matrix routines.

The second program library used in ROSCOE is GRC's Dynamic Storage
Allocation (DSA)[2] system. It provides an orderly data base structure
which is a key element in allowing for modularity in the code. Basically,
it replaces the usual organization of data into large multiply-dimensioned
arrays, which are accessed by means of indexing and searched by means of
Fortran DO-loops, by a scheme which organizes the data into individual
datasets (a list or vector of words) which are, in turn, organized into

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[1] T. Plambeck, The Compleat Traidsman, General Research Corporation
IM-711/2, September 1968.

[2] R.L. Stone, A Dynamic Storage Allocation System for Fortran Programs,
General Research Corporation IMR-1249, January 1970.

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lists. Routines are provided in the package to enable the programmer to search lists and access any dataset once the data structure is known. This allows the model designer to put together extremely complex data structures without making use of large arrays.

The above program libraries are used primarily in the systems modules and in the physics interface structure of the code. The physics modules have been left in standard Fortran, with a few minor exceptions to allow for communications between subroutines, so that these routines can be individually transferred to the user community.

2.1.3 Computational Flow

A simplified view of the computational flow of the radar version[1] of the program is shown in Fig. 2.3. The systems modules are shown at the top of the figure, and the physics modules at the bottom.

The systems model is made up of an attack generation event, which initializes the ambient atmosphere and magnetic field models and sets up the attack by calling launch and impact events; a radar event, which performs the radar function of search, verification, track initiation, and track; and a radar signal processing event, which computes all propagation losses along a line-of-sight, and filters the radar returns to point the radar for the next "look".

The physics model consists of a burst event which creates the initial burst parameters, two update events to update the low-altitude and high-altitude phenomenology, and an interpolation routine to interpolate the physics data at times specified in the input or at times specified by the systems calculations.[2] In addition, there is a point properties

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[1] See Volumes 20 & 21-1 for the communications and optical systems model, respectively.

[2] Many of the physics variables are updated on a periodic basis and their values stored for only two widely spaced times, to reduce computation time. The data is then interpolated for times intermediate to the stored times.
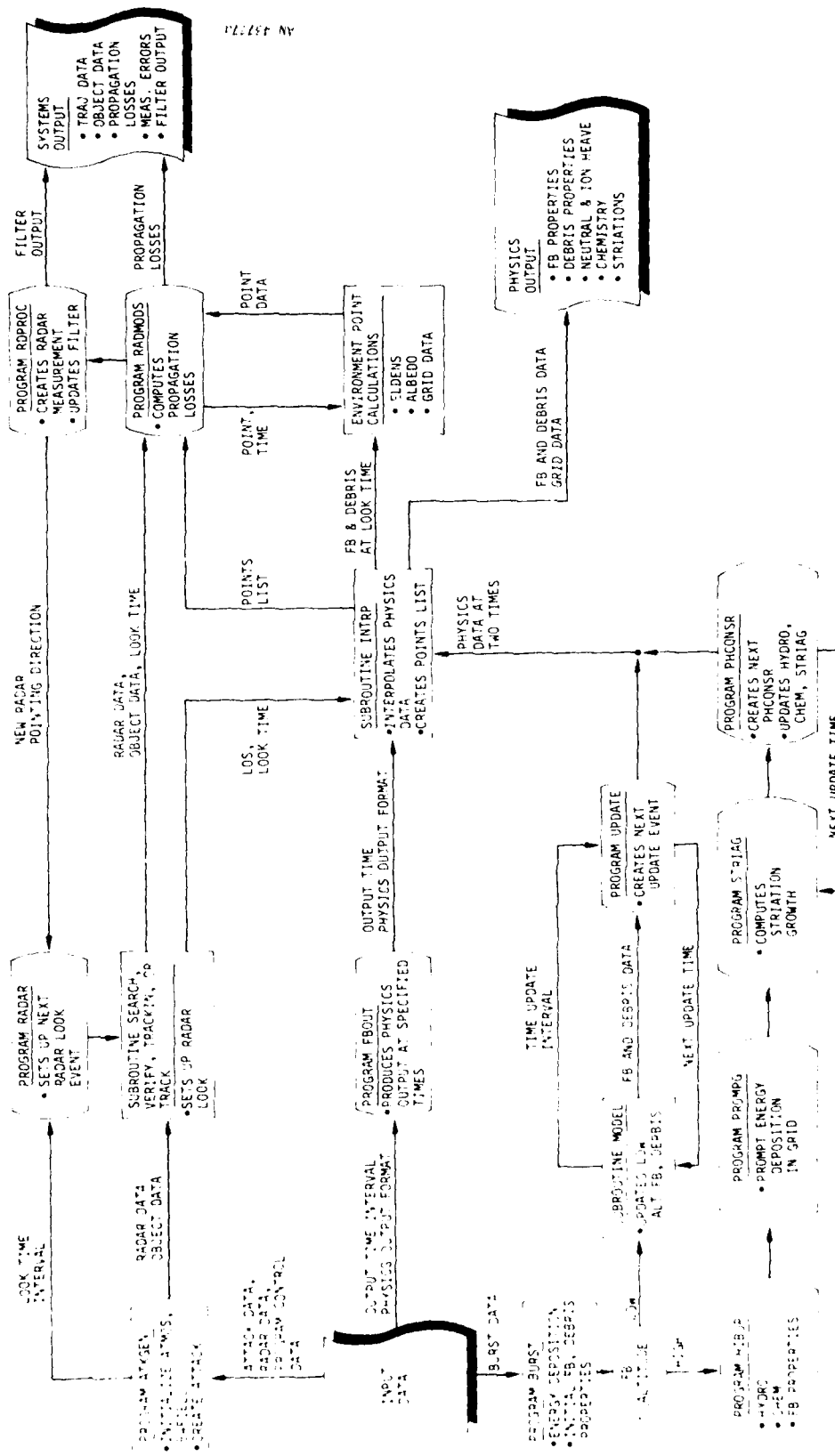
Figure 2.3. ROSCOE Basic Data Flow

routine which provides physical data at specified points as requested for propagation calculations.

Output occurs in two ways: (1) specific physics and system data can be output at program termination, and/or (2) individual data and some special printer plots of specific physics data can be output as they are produced within the program. These output options can be set up in the input deck.

2.2 THE SYSTEM MODEL

As mentioned above, the system model consists of a generalized framework from which the user can design his particular system simulation. Some very general system applications models have been provided as examples; including, radar track and discrimination, optical surveillance and satellite communications.

Each of these system applications models are structured in the same way. Each starts with the attack generation event to initialize the ambient atmospheric properties and to create the attack if appropriate. This is followed by one or more events which perform the signal generating, processing and output functions.

As an example, the three major modules or "events" which make up the radar track simulation are attack generation, radar, and signal processing. A brief description of these modules is given below. For further details on the radar system models see Volume 4. The reader is referred to Volumes 20 and 21-1 for descriptions of the satellite communications and optical surveillance system models, respectively.

2.2.1 Attack Generation

The attack generation module consists of a general attack generator, some initialization routines, and a set of object observable models. The attack generator is basically derived from the GRC BAG 14 code.[1]

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[1] L.R. Ford and T.O. Sullivan, <u>An Overview of BAG XIV: A Simulation for Hardsite Defense</u>, General Research Corporation IMR-1484, March 1971.

The input consists of a set of launch points and impact points, a set of object types, and the number of objects of each type. Object types are tied to the launch points, and the number of objects of a given type and the timing of the attack are tied to the impact points. Thus by merely ordering the launch point and impact point lists properly, one can generate complicated attacks.

Initialization of the ambient atmosphere, the geomagnetic field, and the high-altitude grid[1] (if appropriate) are also performed in this module. Initial ambient atmospheric properties (solar flux, time of day and year, etc.) are set up by a call to the ambient atmosphere subroutine with an appropriate initialization flag. A dipole magnetic field is fitted to a central battlespace[2] location specified in the input. Grid initialization sets up the physical dimensions and orientation of the high-altitude grid and battlespace region. It also calls the ambient atmosphere and ionospheric routines, and assigns appropriate ambient properties to each grid cell. If striation calculations are desired, a magnetic grid region (a gridded plane normal to the magnetic field at the center of the grid) is also established.

Object observables models are used to identify each object type. Models can be specified for ballistic coefficient, radar cross section, wake radar cross section, tumbling dynamics, and radar cross section sheathing. There are a number of options available for each model. For example, the ballistic coefficient can be modeled as a constant, computed from a cone-aerodynamics model, or imput as a tabular function of altitude.

2.2.2 Radar

Scope. The radar model basically represents a phased-array tracker, specified by the characteristics shown in Table 2.1.

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[1] For altitudes above about 90 km, the battlespace is divided into as many as 1300 cells. Atmospheric and ionospheric properties of the disturbed environment are computed at cell centers and interpolated in time and space.

[2] "Battlespace", as used here, refers to the spatial extent of the nuclear environment.

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The search/detection/verification procedure uses a search sector that is limited in angular extent by input values of elevation and azimuth, and has a range-height transition which defines its range limit (i.e., it is limited by either range or altitude). The search sector is also assumed to have an inner boundary in range (see Fig. 2.4).

TABLE 2.1

FEATURES OF THE RADAR MODEL

Multiple Faces

Search Sector (with H, R, A, E limits)

Antenna Patterns

    Mainlobe plus constant sidelobe

    Mainlobe plus tapered sidelobe

Range Gating

Monopulse

Range Marking

    Peak Signal

    Split-gate

Waveforms

    Rectangular

    Frequency modulated (chirped) pulse

Waveform Dispersion

Measurement Errors

    Bias

    Random
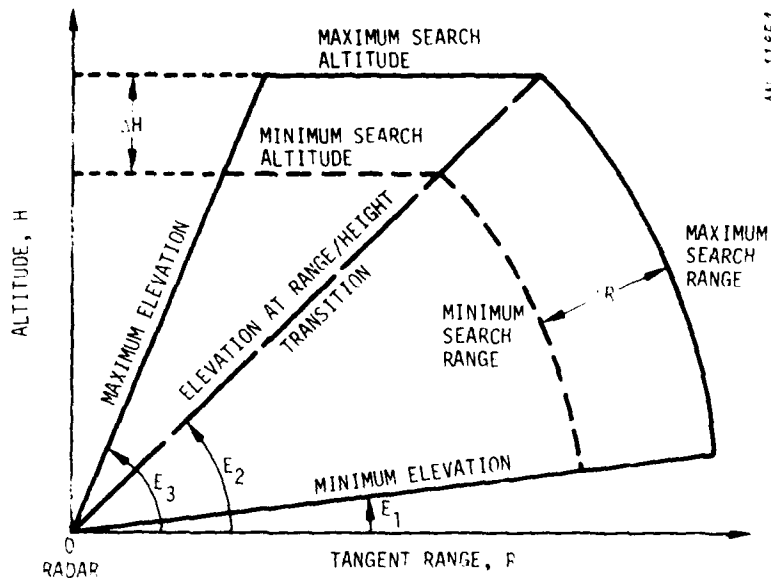
Figure 2.4. Vertical Slice Through Search Sector With
Range-Height Transition

Several different antenna patterns can be modeled, including a main-
lobe-plus-constant-sidelobe model (where the mainlobe is assumed to have
the form (sin x)/x), and a mainlobe-plus-tapered-sidelobe model.

Range gating is performed at each radar "look", based on the filter
estimate of the target position, to determine when the target is lost due
to refraction or poor prediction.

For the track function, a monopulse system is modeled for angle
tracking, and a range marking system is used for range tracking. A
split-gate range marking system is used in track, while a simple peak-
signal model is used during search.

Two simple waveforms are available: a rectangular pulse and a
chirped pulse. They can be used for either search or track.

Finally, a waveform dispersion model is incorporated in the code, as are bias and random measurement errors (see Vol. 4 for details).

Radar Event Logic. A simplified view of the radar event logic is shown in Fig. 2.5. It consists of five main events: initialization, search, verification, track initiation, and track. This scheme is representative of a generalized BMD radar system.

Each block in the figure represents one pulse by the radar in an attempt to put an object into track. Note that after each pulse the ratio of the signal-to-noise-plus-clutter is tested against a threshold value to see if the next event can be processed. If the test fails while in search or verification, a subsequent search pulse is made. If a failure occurs after one track initiation pulse, a second track initiation pulse is attempted before returning to search. Finally, if the threshold test fails while in track, additional track pulses are attempted until a successful pulse is received, or the total unsuccessful track time exceeds a threshold (an input) and then the object is classified as "lost". Note that two successful track initiation pulses are required in order to put an object into track (i.e., establish a track file for the object/sensor pair).

2.2.3 Signal Processing

General Features. The signal-to-noise-plus-clutter ratio is computed from the following equation:

$$\frac{S}{N+C} = (S/N)_T (R_o/R)^4 \frac{F_T F_R \sigma \cos^2 \theta}{L_2 L_D L_F [1 + (T_X/T_N) + (C/N_N)]}$$

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S/(N + C) = SIGNAL-TO-NOISE-PLUS-CLUTTER
RATIO
RAE = RANGE, AZIMUTH, AND ELEVATION

UPDATE
TRACK FILTER

YES

TARGET IN
RANGE GATE
?

NO

LOST TARGET

YES

NEXT TRACK
PULSE
$(t_t = t_t + T_t)$

YES

S/(N+C) >
THRESH
?

NO

TIME
SINCE LAST
TRACK > TMAX
?

NO
$(t_t = t_t + T_t)$

INITIALIZATION

• PROJECT TARGET TO
EDGE OF SECTOR

• FIND RADAR FACE

TRACK $(t_t = t_1 + T_t)$

• MAKE MEASUREMENT

• SET RANGE GATE

• COMPUTE S/(N+C) & RAE

SEARCH $(t_s = T_o)$

• MAKE MEASUREMENT
WITH RANDOM BEAM
POINTING ERROR

• COMPUTE S/(N+C), RAE

YES

NO
$(t_s = t_s + T_s)$

S/(N+C) >
THRESH
?

TWO
SUCCESSFUL
PULSES
?

NO $(t_1 = t_1 + T_t)$

YES

YES

VERIFICATION $(t_v = t_s + T_v)$

• USE APPARENT TARGET
POSITION FROM SEARCH

• COMPUTE S/(N+C), RAE

$(t_s = t_s + T_s)$

NO

NO

TARGET IN
RANGE GATE
?

YES

NO
$(t_s = t_s + T_s)$

S/(N+C) >
THRESH
?

YES

I=1?

NO

S/(N+C) >
THRESH
?

YES
$(t_1 = t_1 + T_t)$

COMPUTE TARGET
VELOCITY:

$$\dot{R}_v = \frac{R_v - R_s}{T_v}$$

TRACK INIT. $(t_1 = t_v + T_t)$

• COMPUTE EST. RANGE

$R_e \quad R_v + \dot{R}_v T_t$

• SET RANGE GATE

• COMPUTE S/(N+C), RAE

Figure 2.5. Radar Event Logic

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where L_2 = two-way absorption loss factor

L_D = dispersive loss

L_F = Faraday rotation loss

T_X = noise temperature, °K

T_N = system noise temperature, °K

C/N_N = clutter-to-noise ratio

θ = off-boresight angle

F_T, F_R = off-beam-axis gains for transmit and receive

σ = radar cross section of target, cm^2

R_o = range (cm) at which threshold is achieved on a one-square-centimeter target

R = range to the target, cm

$(S/N)_T$ = signal-to-noise ratio threshold

The measured target position is determined as shown in Fig. 2.6. First, the actual target position is corrupted by refraction to yield a refracted target location. Then the apparent target position is computed by considering the monopulse return and any multiple images that may occur due to multipath effects. Finally, radar measurement errors are added to the apparent target coordinates to yield the measured target location.

Signal Processing Logic. The signal processing logic, illustrated in Fig. 2.7, carries out the determination of signal-to-noise-plus-clutter ratio and measured target location in the following series of steps. The simplest factors are computed first so that, if the target signal is below threshold, the more complicated factors need not be computed.

ACTUAL
TARGET
POSITION
(RAE)

→

```
┌─────────────┐
│ COMPUTE     │
│ REFRACTION  │
│ ERRORS      │
└─────────────┘
```

REFRACTED
TARGET
COORDINATES
$(RAE)_R$

→

```
┌──────────────────────┐
│ COMPUTE APPARENT     │
│ TARGET COORDINATES   │
│ DUE TO MONOPULSE,    │
│ MULTIPATH            │
└──────────────────────┘
```

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APPARENT
TARGET
COORDINATES
$(RAE)_A$

MEASURED
TARGET
COORDINATES
$(RAE)_M$

←

```
┌──────────────────────┐
│ ADD RADAR MEASUREMENT│
│ ERRORS TO APPARENT   │
│ TARGET COORDINATES   │
└──────────────────────┘
```
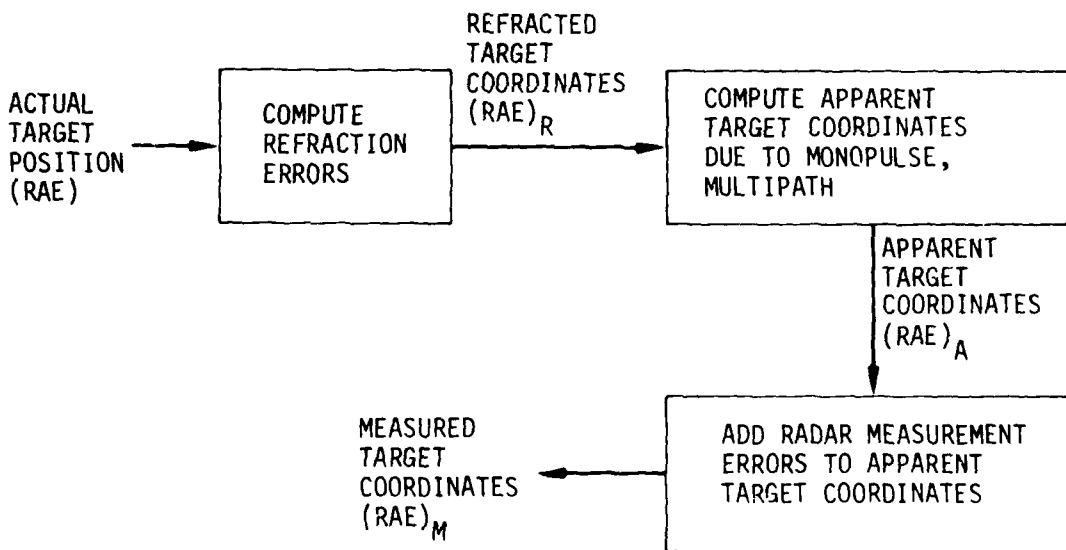
Figure 2.6.   Generation of the Measured Target Coordinates

SET UP LIST OF
TARGETS WHICH MAY
CONTRIBUTE TO SIGNAL

ABSORPTION
- COMPUTE THRESHOLD LOSS
  FACTOR (L_m)
- COMPUTE 2-WAY ABSORPTION
  LOSS ALONG PATH (L_2)

$L_2 > L_m$?

YES → LOW SIGNAL, RETURN

NO

NOISE
- SYSTEM NOISE TEMPERATURE = T_N
- THRESHOLD NOISE TEMPERATURE = $T_m = T_N (L_m-1)$
- COMPUTE EFFECTIVE OUTSIDE
  NOISE TEMPERATURE (T_X)

$T_X > T_m$?

YES

NO

$L_2 (1 + \frac{T_X}{T_N}) > L_m$?

YES

NO

REFRACTION (H > 60 km)
- COMPUTE REFRACTION ERRORS
  AND REFRACTED TARGET
  COORDINATES
- CALCULATE INTEGRATED
  ELECTRON DENSITY AND
  DISPERSIVE LOSS (L_D)
- CALCULATE FARADAY ROTATION
  ANGLE AND LOSS (L_F)

$L_2 L_D L_F (1 + \frac{T_X}{T_N}) > L_m$?

NO

YES → LOW SIGNAL, RETURN

TRACK SUCCESSFUL-- UPDATE
FILTER, NEXT MEASUREMENT

YES

MEASUREMENT
WITHIN FIELD OF VIEW
AND RANGE GATE
?

NO → LOST TARGET, RETURN

YES

MEASURED COORDINATES
- COMPUTE MEASURED
  COORDINATES OF TARGET
  AND ERROR SIGMAS

YES

$\frac{S}{N+C} > $ THRESHOLD ?

NO → LOW SIGNAL, RETURN

APPARENT TARGET COORDINATES
- COMPUTE APPARENT COORDINATES
  --MONOPULSE, FALSE IMAGES

CLUTTER
- COMPUTE FIREBALL AND
  DUST CLOUD CLUTTER (C)
  IN RANGE CELL

MULTIPATH (H < 60 km)
- FIND ALL FALSE TARGET
  IMAGES THAT MAY CONTRIBUTE

YES

ANY
TARGETS IN
25 dB BEAMWIDTH
?

NO

YES

ANY
TARGETS IN
RANGE GATE
?

NO → LOST TARGET, RETURN

Figure 2.7.   Radar Signal Processing Logic

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1. A list of targets which may contribute to the signal return at this look time is set up by considering a region somewhat larger than the range cell and beamwidth.

2. A threshold loss factor (L_m) which just cancels the incremental target signal above threshold is computed and the two-way absorption loss (L_2) is computed. If the loss (L_2) is greater than the threshold (L_m), processing is terminated and a message signifying the type of failure is returned.

3. Next, the effective outside noise temperature (T_X) is computed and tested against the system noise temperature (T_N). If $T_N > T_X$, the sum of the absorption and noise losses is checked against the threshold loss factor (L_m).

4. If the threshold is not exceeded, refraction due to both gross effects and scintillation is computed and the refracted target coordinates are returned. Losses due to dispersion and Faraday rotation (if a linearly polarized radar signal is used) are also computed. All losses are combined and tested against the threshold. If the target signal is still above threshold, additional tests are made to insure that the refracted target position is in the range gate and 25 dB beamwidth.

5. Next, multipath and clutter are computed to generate the apparent target coordinates.

6. If the signal-to-noise-plus-clutter ratio is still above the threshold, the measurement errors are then added to form the measured target coordinates. At this point, a check is made to determine whether the target is still in the field of view and within the range gate.

7. If it is, a successful track pulse has been made; the data is filtered and a new predicted RV position is created. This information is used to point the radar for the next "look."

Tracking Filter. ROSCOE uses a fully coupled Kalman filter[1] operating with seven state variables (three components of position, three components of velocity, and ballistic coefficient). The input data to the filter may be two-dimensional measurements (e.g., angles-only from an optical sensor), three-dimensional measurements (e.g., R,u,v from a radar), four-dimensional measurements (e.g., $R,u,v,\dot{R}$), or any other suitable set. Any convenient measurement coordinate system can be used; in the present version, all radar measurements are made in radar face coordinates (R,u,v).

An option for exponential memory decay of past measurements is also available. A two-stage scheme for defining the filter decay time constant is used. The user inputs an altitude H_τ, and two values of the decay constant τ_1 and τ_2. The filter uses τ_1 when the target is above H_τ and τ_2 when the target is below H_τ.

The ROSCOE filter weights the input data in accordance with the estimated measurement error sigmas, but does not apply any special weighting based on assumed environmental conditions. There currently is no provision for "turning off" the filter in response to nuclear bursts.

2.3 THE PHYSICS MODEL

The physics model is divided into two main modules, due to the different treatment given low-altitude and high-altitude phenomenology, plus some general ambient environment routines. A brief description of these modules is given below. See Ref. 2 for a more thorough discussion.

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[1] E.R. Buley, Evaluation of MSR Tactical Tracking Filter, July 1971 (unpublished).

[2] J. Ise, A Summary of the ROSCOE Physics Models, General Research Corporation Contract Report (in preparation).

2.3.1 The Ambient Environment

The ambient environment module consists of these major parts:

1. Ambient atmosphere, which returns the state properties of pressure, density, temperature, and scale height and the concentrations of some major species (N_2, O_2, O, He, Ar, CO_2).

2. Minor neutral species, which returns species concentrations for N, NO, $O_2(^1\Delta)$, O_3, NO_2, H_2O, H, OH, HO_2, CO, N_2O, and some excited states.

3. Ambient ionosphere, which returns the effective total ion production rate (Q), the positive atomic ion density, the various positive molecular ion densities, and the electron temperature.

4. Ambient magnetic field, which fits a dipole field to the local magnetic field at a specified central battlespace location and returns magnetic dipole field strength and direction.

2.3.2 The Low-Altitude Model

The low-altitude model encompasses the altitudes from ground to about 90 km. At these altitudes, energy deposition from nuclear bursts tends to be confined to regions near the burst point by the high air density. Thus the properties of the fireball and its immediate surroundings are calculated in detail at each update time, and fireball interactions are considered, but properties in the intervening "continuum" region are treated on a point-by-point basis (when required by the system model), since they may or may not be affected by the bursts.

Fireball Model. The ROSCOE low-altitude fireball model is a "phenomenological" model (as in RANC)[1], in that fireball properties are computed using equations based on physical principles and test data. A number of improvements to the RANC models have been made, including: (1) a tapering

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[1] RANC IV, Computer Simulation of Radar Propagation in a Nuclear Environment, Vol. I, "Computational Models," July 1970 (unpublished).

temperature profile from the fireball edge rather than the RANC step-function profile; (2) inclusion of ground-reflected shocks and shock interactions from other fireballs; and (3) multiburst effects, which can result in the merging of two or more bursts into a new one.

The tapering temperature profile has been modeled by first finding the 500°K temperature contour surrounding the fireball shortly after burst (from 2-D hydrodynamic model runs) to define an outer limit of a warm air region (see fig. 2.8). This warm air region is referred to as the "vortex" region, since it is assumed that the vortex motion (if any) that is generated as the fireball rises will be enclosed in this region. It is further assumed for the chemistry calculations that air within this region is thoroughly mixed, that is, particle motion is not followed.

Two kinds of fireball merges can occur. The first is a "hydromerge" where two fireballs are driven together by their hydrodynamic motion to form a larger single fireball. The second type of merge is termed a "radmerge" or radiation merge. In this case, a new burst occurs within an existing one so that the old fireball is given a new pulse of radiation.

Energy Deposition. The principal sources of energy emitted from a low-altitude burst are prompt radiation, thermal radiation, and delayed radiation sources. The prompt radiation sources include neutrons, X-rays, and gammas, and are assumed to deposit an impulse of energy near the burst point that modifies the initial concentrations of electrons, ions, and neutral species.

The major contributors to delayed radiation are neutrons, gammas, and betas. Delayed gammas are deposited outside the fireball. Beta particles can be deposited in a sheath region outside the fireball or in a field-aligned tube (Fig. 2.9). Separate equations are used to determine the beta energy deposited at the various points shown. The sources are summed if the point falls within more than one region (such as point 4).
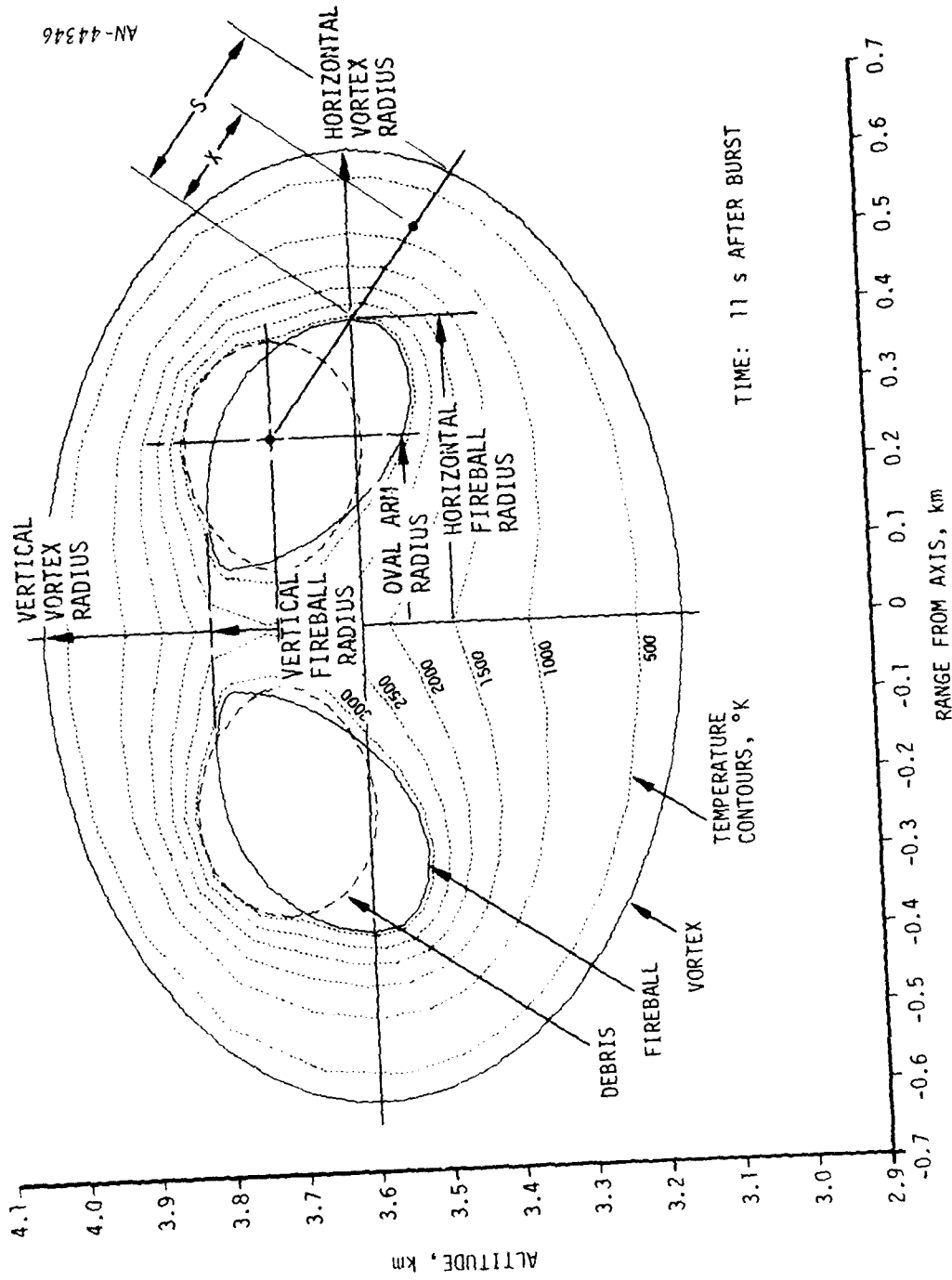
Figure 2.8. ROSCOE Low-Altitude Fireball Example
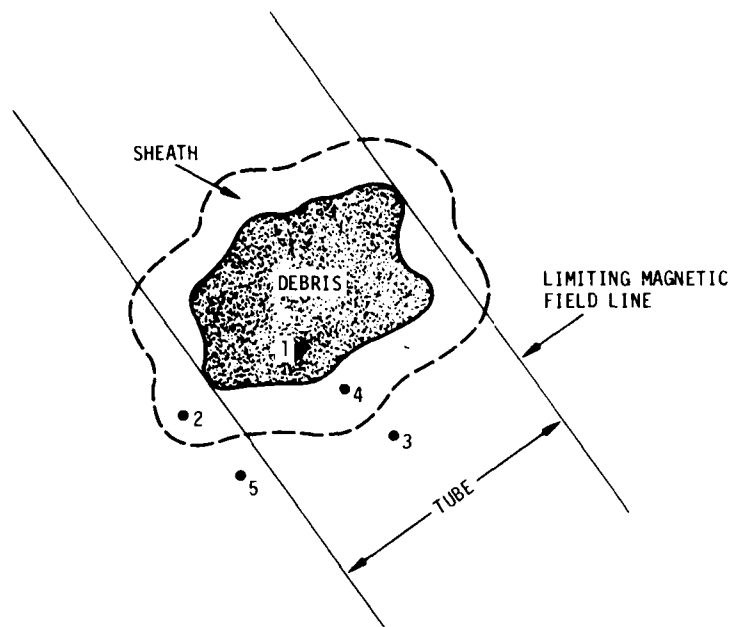
Figure 2.9.   ROSCOE Low-Altitude Beta Deposition Regions

The effect of the total delayed radiation reaching a point is deter-
mined by summing the energy reaching the point from each burst that
occurred prior to the calculation time.

Low-Altitude Chemistry. As mentioned above, air chemistry in the
low-altitude module is treated on a point-by-point basis depending on
where the point lies with respect to the fireball regions. Four different
chemistry regions are considered (Fig. 2.10). A heated-region chemistry
routine is used for points inside the vortex where the current tempera-
ture is above 500°K and the temperature at burst time was above 2000°K.
Recall that although there may be vortex motion in this region, no air
motion is considered for the purposes of chemistry calculations.

For points outside the vortex region (termed the "continuum"), a
continuum-region chemistry package is called. If the calculation point
lies within a few vortex radii of the vortex edge, where an air particle
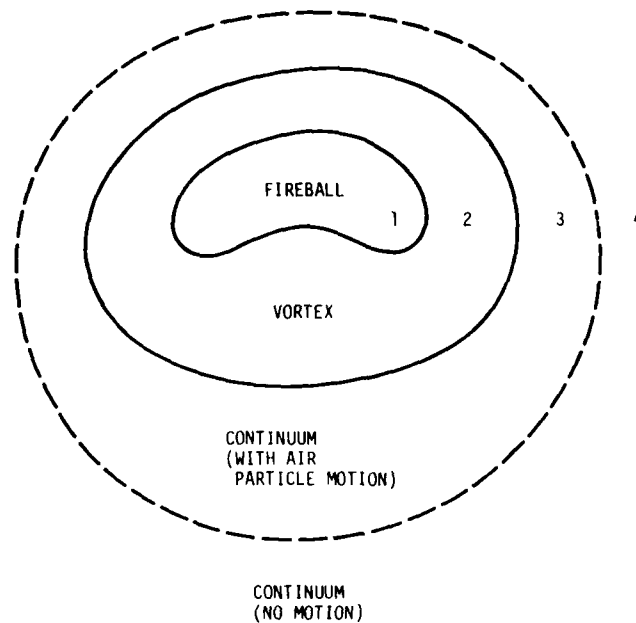
Figure 2.10.   ROSCOE Low-Altitude Chemistry Regions

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may have been swept up with the fireball, the air particle motion history can be traced to refine the chemistry calculations.   This calculation can be time-consuming if there are many closely spaced bursts, so it has been made a program input option.

2.3.3   The High-Altitude Model

The high-altitude model extends from about 90 km up.   Here, because of the more rarefied atmosphere, nuclear effects can be widespread.   As a result, the high-altitude battlespace is gridded so that air motion and chemistry can be computed in a time-ordered fashion for the entire region. Because there can be many cells in the grid (a maximum of 1300 is currently allowed for) and there are a large number of physical properties to track (currently 33), the grid is updated only periodically and inter- polation is used for intermediate times.   Update time steps are short immediately after a burst, and longer at later times.[1]

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[1] Time steps of 1, 2, 7, 20, 30, 30,...(seconds) are currently used.

Fireball Model. The high-altitude fireball model is essentially the RANC IV model,[1] with some modifications to account for multiburst effects. For example, fireballs born in the grid after a previous burst will be initialized using the disturbed region properties carried in the grid rather than ambient properties.

Fireballs which are formed below the grid and rise into it are currently treated as low-altitude fireballs; that is, their characteristics are still computed by the low-altitude fireball model and the motion of the grid is ignored.

Energy Deposition and Chemistry. At high altitudes, the prompt energy deposition can be widespread. A large module of the code is devoted to depositing the energy from a burst into each cell of the grid. A grid chemistry routine uses the energy deposition to modify the initial ambient concentrations of electrons, ions, and neutral species, and then integrates these properties forward in time to the specified time intervals.

To account for delayed energy deposition at a point, a second chemistry routine is used. The procedure for determining the air chemistry at a point in space and time is to first interpolate the grid properties to obtain the modified air chemistry due to prompt effects, and second (using this set of properties as input) modify the properties again to account for delayed effects.

To obtain the electron density at a point inside a fireball region, the heated-region chemistry routine mentioned earlier must also be called. Then the electron density is set equal to the maximum of either that obtained from the grid chemistry calculation or the heated-region result.

Figure 2.11 is a flow diagram showing the logic described above.

---

[1] RANC IV, Computer Simulation of Radar Propagation in a Nuclear Environment, Vol. ʼ, "Computational Models," July 1970 (unpublished).

COMPUTE AMBIENT
PROPERTIES AT
POINT

CALL ATMOS

START

VARIABLES

ENE = ELECTRON DENSITY
TEMP = TEMPERATURE
RHO = DENSITY

SUBSCRIPTS

A--AMBIENT
G--GRID
HR--HEATED REGION
Q--EQUILIBRIUM

SET PROPERTIES
TO AMBIENT

ENE = 0
TEMP = $TEMP_A$
RHOP = RHO_A

LOW

ALTITUDE
OF
POINT
?

HIGH

SET PROPERTIES
TO AMBIENT

ENE = ENE_A
TEMP = $TEMP_A$
RHOP = RHO_A

CALL NEXT
LOW ALTITUDE
FIREBALL

CALL NEXT
HIGH ALTITUDE
FIREBALL

STOP

YES

KFLAG = 1

YES

LIST
EMPTY
?

NO

LIST
EMPTY
?

YES

INTERPOLATE
GRID FOR:

ENE_G, RHO_G, $TEMP_G$

NO

NO

COMPUTE CONTINUUM
CHEMISTRY

CALL CHEMD

POINT
INSIDE
VORTEX
?

NO

POINT
INSIDE
FIREBALL
?

NO

COMPUTE DELAYED
ENERGY DEPOSITION
IN GRID

CALL DEDEP

STOP

YES

YES

TX > 500
AND
TXO > 2000
?

NO

COMPUTE DELAYED
ENERGY DEPOSITION

CALL DEDEP

DELAYED
ENERGY
LARGE
?

NO

STOP

YES

YES

COMPUTE DELAYED
ENERGY DEPOSITION

CALL DEDEP
KFLAG = 1

COMPUTE HEATED
REGION CHEMISTRY

CALL CHEMHR

INTERPOLATE
GRID FOR
CHEMISTRY
PROPERTIES

COMPUTE HEATED
REGION CHEMISTRY

CALL CHEMHR

NO

ENE_{HR} = ENE
?

COMPUTE EQUILIBRIUM
CHEMISTRY AFTER
DEPOSITION

CALL CHEMQ

YES

ENE = ENE_{HR}
TEMP = $TEMP_{HR}$
RHO = RHO_{HR}

ENE_{HR} = ENE
?

NO

ENE_G = ENE_Q
ENE
?

NO

YES

ENE = ENE_{HR}
TEMP = $TEMP_{HR}$
RHO = RHO_{HR}

YES

ENE = ENE_G
ENE
RHO = RHO_G
TEMP = $TEMP_G$

Figure 2.11.   ROSCOE Chemistry Calling Logic

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Heave Model. A one-dimensional, Lagrangian hydrocode is used to predict particle motion in the grid region. This is done by constructing a grid of tubes at the grid bottom altitude that extends along lines radiating from the center of the earth. One-dimensional air motion in the radial direction is computed for each tube independently as energy is deposited and the air is heated. The tubes can be divided into as many as 18 cells, with cell heights determined from input. Currently, the ROSCOE code uses a cell height which varies with scale height; that is, a finer grid is used at lower altitudes.

A rezoning capability is available as an input option. This allows tubes to be rezoned after significant motion and stretching of cell boundaries has occurred (recall that Lagrangian equations of motion are used, so that cell boundaries are allowed to expand upward as the air is heaved). Rezoning occurs when the top boundary of the uppermost cell in a tube reaches an input altitude ($\sim$650-750 km). The tube is then rezoned by interpolating the data in the existing cells back to the original set of cell boundaries.

Striation Model. A separate ion heave model for predicting striation growth is also available in the code. For this calculation, a plane is set up normal to the magnetic field at a point in the center of the grid. This plane is then divided into a number of rectangles (the number being determined by an input variable), and field-aligned tubes are constructed. The striation routine then interpolates electron density and velocity data from the grid at a number of points along these field-aligned tubes to generate the data base needed for the striation growth and decay computations. A measure of the striation strength is then computed and stored for each rectangular cell in the magnetic planar grid.

The resultant striation fraction (that is, the striation magnitude relative to the background) is then interpolated to find values for each cell in the heave grid, assuming that this striation fraction is constant along field lines.

3   USING ROSCOE

This section of the manual describes the basic program structure, the input data required to run ROSCOE, how the data is to be prepared for input to the program, and the output the program produces.

3.1   PROGRAM ORGANIZATION

The ROSCOE program has been written with two primary objectives in mind. First, ROSCOE must be flexible, both for use and change. It is an all-altitude code, and as such must have the flexibility to provide for many different kinds of scenarios. Second, it must be structured in a modular fashion, so that the effort involved in making changes is minimized. ROSCOE is intended to be a framework within which new phenomenology or systems models can be input with a minimum of effort.

To satisfy these objectives, an event-based structure has been used, in which separate types of calculations are separated into operational overlays, each with its own event. In addition, a modular database structure using the Dynamic Storage Allocation[1] system is used. This allows the database to be placed in a tree structure similar to the code subroutine structure, and separates it from the code so that modules can be replaced without disturbing data interfaces. Finally, a system for structuring the code at run-time (i.e., the capability of selecting alternative models from a large program library) is used so that new or alternative models with similar input/output requirements can be selected for a particular run.

3.1.1   Computational Flow and Storage Organization

The computational flow of the program in its simplest form is shown in Fig. 3.1. The program is an event-type model which internally constructs and updates an event list, orders the events in time, and processes them sequentially. Program termination occurs when there are no more events to be processed.

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[1] R.L. Stone, A Dynamic Storage Allocation System for Fortran Programs, General Research Corporation IMR-1249, January 1970.

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START

```
        │
        ▼
┌─────────────────┐
│  READ ALL DATA  │
└─────────────────┘
        │
        ▼
┌─────────────────┐   NO    ┌─────────────┐
│ FIND EARLIEST   │  MORE   │ OUTPUT ALL  │
│ EVENT ON EVENT  │────────▶│ SUMMARY DATA│
│ LIST            │         └─────────────┘
└─────────────────┘              │
        │                        ▼
        ▼                       STOP
┌─────────────────┐
│ CALL OVERLAY TO │
│ PROCESS EVENT   │
└─────────────────┘
        │
        ▼
┌─────────────────┐
│ DELETE EVENT    │
│ FROM EVENT LIST │
└─────────────────┘
```

AN-36140
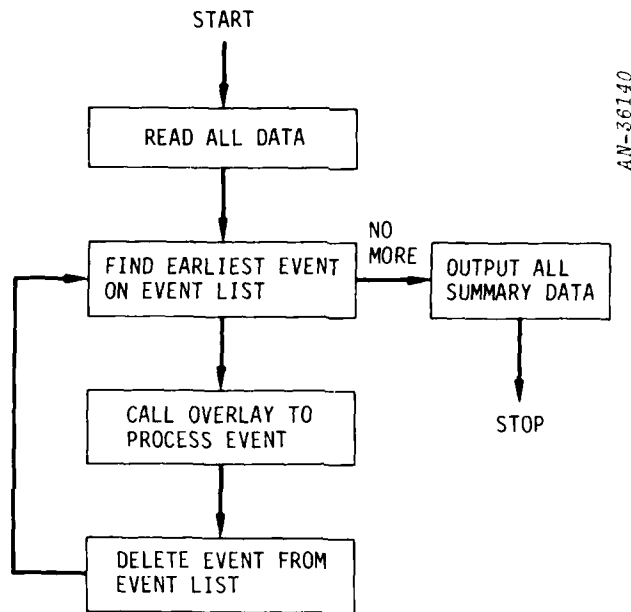
Figure 3.1. ROSCOE Computation Flow

Figure 3.2 shows the ROSCOE storage organization. The (0,0) over-
lay contains the main program and the processing routines for dynamic
storage allocation (DSA). A block of blank common is reserved for storage
of datasets, with a provision for spilling datasets not currently in use
onto a random-access storage device.

Overlays (1,0) and (2,0) contain the input and output routines,
respectively, and overlay (3,0) the event processor. The lowest level
of overlays, (3,1) through (3,32), contain the system and physics modules,
each corresponding to a separate event type.

3.1.2 Event Structure

Figure 3.3 is a more detailed look at the event overlays. The
event processor accesses events in a time-ordered fashion, as described
above. Several of these events are set up in the data deck, including
the attack generation event, the burst events, the stop event, the

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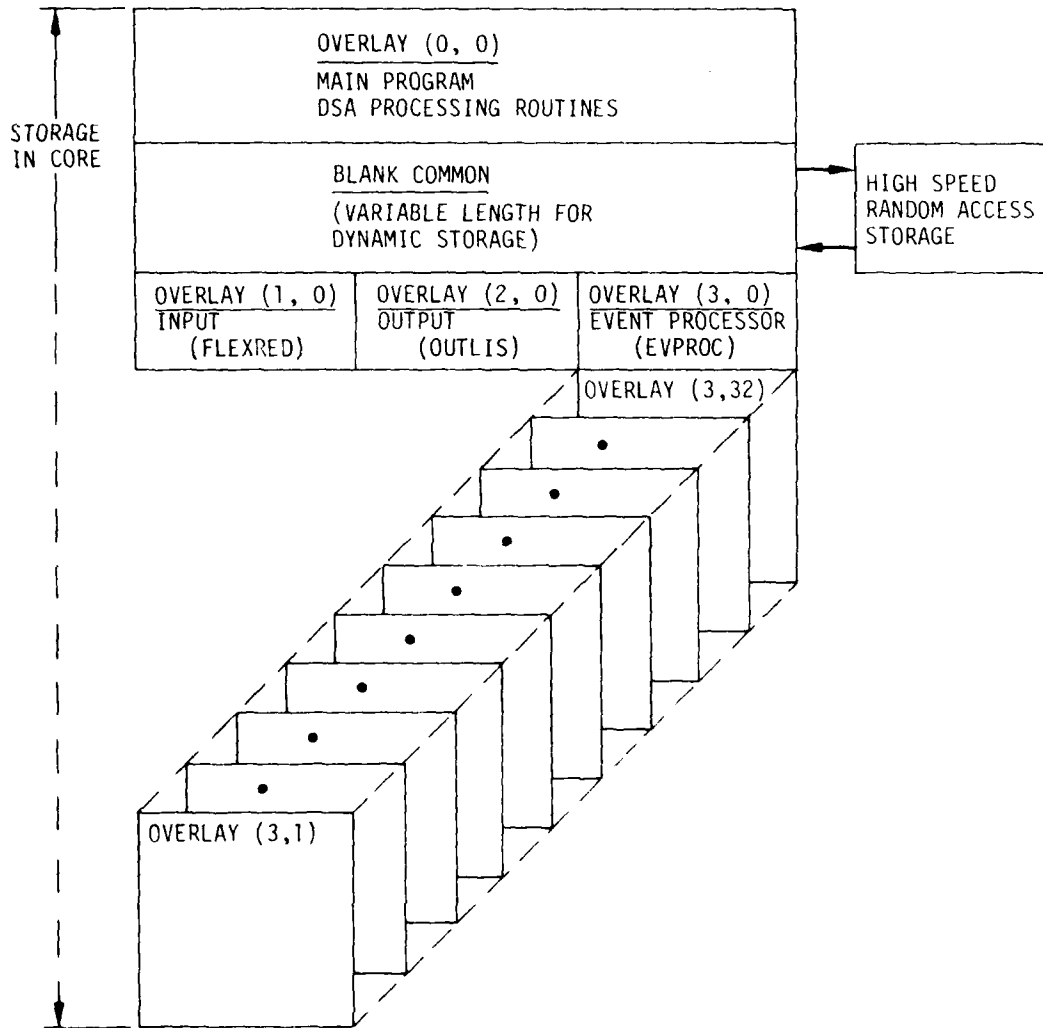
Figure 3.2. ROSCOE Storage Organization
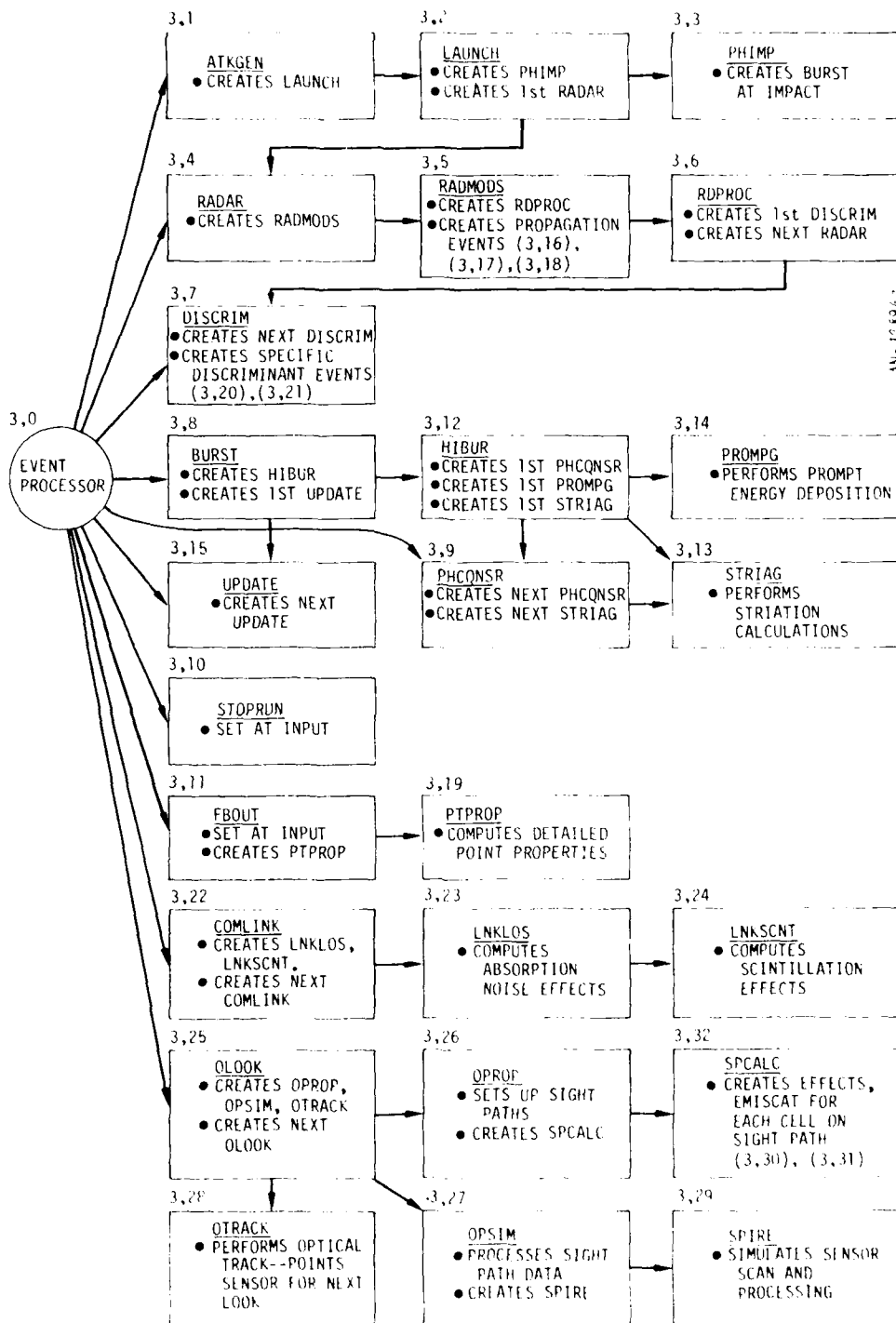
Figure 3.3. ROSCOE Event Structure

communications event, the optics look event, and the environment output
event. Others are created by preceding events. For example, the attack
generation event creates launch and impact events based on input data.
The first radar event (and possibly optics look event) for an object/
sensor pair is created by the launch event. The radar event then creates,
in succession, the radar propagation events (3,5), (3,16), (3,17), and
(3,18), the signal processing event (3,6), and the first discrimination
event (3,7), if desired.

The burst event creates the first low-altitude update event (3,15)
or a high-altitude burst event (3,12). The high-altitude burst event in
turn creates the first high-altitude update event (3,9), the prompt energy
deposition event (3,14), and a striation event (3,13). Subsequent physics
update events are created within PHCQNSR (3,19) for high-altitude updat-
ing, and UPDATE (3,15) for low-altitude updating.

3.1.3 Data Base Organization

There are several ways in which data is transmitted and stored in
ROSCOE. First, for very large blocks of data (such as the high-altitude
grid data), routines are used to read and write blocks of words directly
to peripheral storage. Second, for smaller data blocks internal to spe-
cific phenomenology modules, standard labeled common blocks are used so
that these modules can be transferred efficiently from ROSCOE to users
more familiar with this type of programming. Finally, for small data
blocks used in the systems portion of the code and some of the physics
interface structure, a data structure based on the Dynamic Storage Allo-
cation[1] system is used. The first two means of handling data are well
known, but the DSA system is less standard and deserves fuller discussion.

The original intent of the DSA system was to provide a system of
utility routines for data management so that the programmer who was
using the system saw the machine as having an infinate "virtual memory"

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[1] R.L. Stone, A Dynamic Storage Allocation System for Fortran Programs,
General Research Corporation IMR-1249, January 1970.

for data storage. Rather than the usual organization of data into large multiply-dimensioned arrays, which are accessed by means of indexing and searched by means of the Fortran DO-loop, data in the DSA mode of operation is organized into individual datasets, which are relatively short (the maximum length tends to be a few tens of words), and which are organized into lists. System subroutines are then provided to enable the programmer to search a given list, to access a dataset whose identity is known, and in general to perform all the operations on datasets that can be performed on the more standard dimensioned arrays. Two new kinds of data words have been defined: the List Header Variable (LHV), and the Data Set Pointer (DSP), which serve the functions, respectively, of identifying a list, thus enabling the program to access its members, and of identifying an individual dataset, thus enabling the program to access that dataset.

This capability allows the model designer to put together extremely complex data structures without making use of large arrays. For example, the dataset describing an event such as a radar track pulse would contain pointers to a list of the radar's faces (for a multi-faced array), and to a radar type dataset which contains power, frequency, angular limits, and the like, which are common to several radars. Generally this radar-type dataset does not tell how many radars are of this type--perhaps none are, perhaps all but one, or perhaps all of them. Thus a simulation is possible in which all radars are different, all the same, or any mixture. The actual scenario being simulated is determined by the data structure, which is in turn input via a DSA subroutine (FLEXRED)[7] which is designed for the input of complex DSA structures. Thus, the programmer is relieved of the necessity of setting up the data structure--this is done at execution time as part of the data input process; data items may be added or deleted, and the data organization changed, without having to make any changes in the code.

Figure 3.4 shows a portion of the DSA data base structure. Each dataset is identified by a two-character mnemonic. For example, the "basic" dataset is identified by the letter and number B0. Each event

[1] J.A. Bardens and L.R. Ford, FLEXRED Users Manual, General Research Corporation RM-1447, August 1972.

Figure 3.4. Dataset Structure
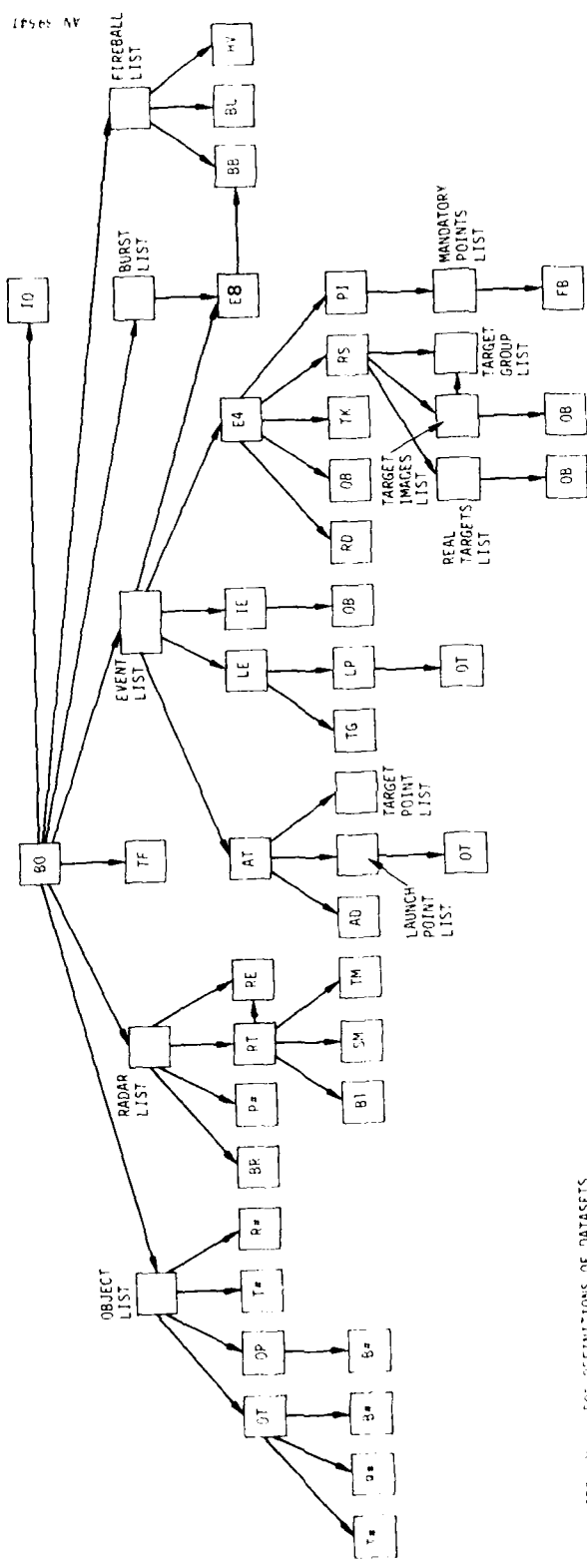
SEE 3.L.3 FOR DEFINITIONS OF DATASETS.

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has a corresponding dataset; for example, the burst event dataset is denoted by E8. Every dataset is tied to the basic dataset along with some important lists such as the object list, the radar list, and the burst list. Datasets containing more detailed information, such as object type, radar type, and weapon type information, emanate from these main datasets and lists.

With the above data base tree structure, any subroutine having the basic dataset can access lower-level information by use of the pointers and list headers.

3.2   PROGRAM INPUT/OUTPUT

Flexible input/output routines (FLEXRED, SIMPLFY and OUTLIS) designed to be used with DSA have been incorporated in ROSCOE. The use of the FLEXRED routine allows one to build quite complicated data structures, while OUTLIS allows the creation of output lists, printer plots, or Calcomp plots through data input at run time.

SIMPLFY is a much simpler input scheme than FLEXRED. It allows most problems to be run but with some limitations on the number of items (objects, sensors, bursts) considered. It was written for the casual ROSCOE user and is documented in a separate report.[1]

To explain the usefulness of FLEXRED and OUTLIS, descriptions of the use of these routines are given below. These discussions are followed by a description of the specific ROSCOE inputs.

Sample output form the code is given in Volume 2.

3.2.1   FLEXRED

3.2.1.1   Inputs of "Traditional Data"

This section describes the options open to the user in inputting

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[1] J. Baltes and J. Garbarino, A Simplified ROSCOE Input Scheme
General Research Corporation, December 1979.

data of a standard FORTRAN type (fixed point, floating point, or Hollerith). Also, the automatic scaling and coordinate transformation features are described.

FLEXRED places input data words consecutively into whatever dataset it is processing until it is given a command to do otherwise. That is, it will build up a dataset until told to start a new dataset or some other command occurs which stops construction of the current dataset. Thus it builds datasets linearly by default.

A FLEXRED input card is divided into eight 10-column fields. The last of these (71-80) is generally reserved for instructions to FLEXRED, i.e., a card type identifier. All data fields start in the fifth field (41-50) except when the amount of data on the card (the TABLE and the VECTOR cards) requires use of the fourth field as well. All fields to the left of the first-used data field are free for user comments and descriptive matter.

Automatic Unit Conversion and the SCALE Card. The internal units assumed by FLEXRED are MKS units; its geographical coordinate system is earth-fixed cartesian; its angles are measured in radians. Automatic unit conversion is provided for many of the commoner units; in addition, the user may define or redefine his own units by means of the SCALE card.[1] Table 3.1 lists the built-in units which will be recognized by the system. Input values identified by the characters in the "unit name" column will be multiplied by the associated factor to effect the conversion to the MKS-radians internal units. Note that DB (or DBSM) and INT (or INTEGER) do not, properly speaking, represent scaling factors, but rather built-in functions.

The user may expand or edit the list of "standard" units shown in Table 3.1 by means of the SCALE card.

The SCALE card (see Fig. 3.5) is used to define scaling factors other than those provided by the system. It may also be used to redefine

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[1] In ROSCOE, internal calculations are in CGS units; thus a set of SCALE cards are used to convert from normal FLEXRED units.

TABLE 3.1

UNIT NAMES RECOGNIZED BY FLEXRED

Unit Name	Unit	Factor for Conversion to MKS-Radians
DEG	degrees	0.01745329252
FT	feet	0.3048006
PSF	pounds per square foot	4.88240
KM	kilometers	1000.0
NMI	nautical miles	1853.25
LB	pounds	0.453592
G	gravity	9.80665
KFT	kilofeet	304.8006
M	meters	*
MRAD	milliradians	0.001
SEC	seconds	*
DB or DBSM [+]	decibel referred to 1 square meter	$xDB \rightarrow 10^{x/10}$
INT or INTEGER		Fixed point input--converted from floating point

---

[*] M and SEC are provided for the user's convenience in documenting his input deck; they do not cause any conversion and may be omitted.

[+] DBSM cannot be used correctly in the current version of ROSCOE since internal units are in the CGS system; however, DB, which is inherently dimensionless, remains legitimate.

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values for system-provided scaling constants (except for DB, DBSM, and INT or INTEGER, due to their unique status as functions). Columns 1-40 are reserved for user comments, the alphabetic name of the unit is defined starting in 41, the numerical scaling factor in the field 51-60, and the word SCALE starting in 71. The example shown in Fig. 3.5 would ensure that input data identified as PER-CENT would be converted to statistical probability values by a factor of 0.01.

```
CONVERT PERCENT INTO PROBABILITY        PER-CENT  0.01    !              SCALE
```
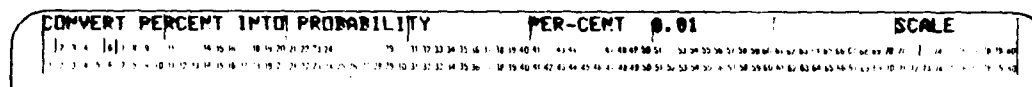
Figure 3.5. Example of a SCALE Card

The SCALE card may appear anywhere in the data deck, provided that it appears prior to the first use of the defined unit.

Primary Data Input, Tables, and Vectors. Numeric data may be entered into a dataset either singly, in pairs using the TABLE card, or in triples using the VECTOR card. Data is always stored in floating point format, unless INT or INTEGER is used in the unit-name field, or unless the data is recognized as Hollerith (see "Hollerith Data Input"). An example is given in Fig. 3.6.

It is important to remember that the words of a particular dataset are filled sequentially, so that a VECTOR card, for example, fills three of them. A similar remark applies to the geographical inputs discussed under "Geographical and Related Inputs."

The data input format is somewhat freer than standard FORTRAN rules: Blanks act as delimiters for the data field, and decimal points need not be punched after whole numbers. A few examples will make this clear, as in Fig. 3.7.

Note that the 10-character field is processed from left to right. This discussion applies to all numeric data fields used by FLEXRED.

Figure 3.6.   Examples of Numeric Input

PUNCHED (COLUMNS)										PRODUCES
1	2	3	4	5	6	7	8	9	10	
		-	3							-3.0
		5	.	7	E	3		5		5.7×10^3
		-	3	8	7	5				-3875.0
		-		5	.	7				0.0[*]
+	1	5	.	5						15.5
										0.0[**]
	.	7	2	3						.723

[*] The minus is accepted as a valid numeric character, but the
following blank terminates the field, causing interpretation
as 0.0.

[**] An all-blank field is interpreted as 0.0.

Figure 3.7.   Sample Data Values

If a dataset requires several consecutive zero words, perhaps to be used later by the program, these may be provided by the ZEROS card. Columns 41-50 contain a number (the number of words of zeros desired) and the word ZEROS appears in column 71-80. For example, the card shown in Fig. 3.8 will produce 10 consecutive zero words in the dataset containing it.

Geographical and Related Inputs. A series of card types is provided for automatic conversion of geographical inputs, and for inputs relative to a prescribed geographical location.

The coordinate system used internally is earth-centered earth-fixed Cartesian with the North Pole lying on the positive z-axis and the point where the Greenwich meridian crosses the equator lying on the positive x-axis. The right-handed system is completed by a y-axis which points out into the Indian Ocean. Longitude is reckoned positive to the East and negative to the West, which makes it conform to the customary convention for the θ of spherical coordinates. Altitude is measured from a sea-level radius of 6,375,180.0 meters.

The fundamental geographical position input card is the GEOGR card. Its format is seen in Fig. 3.9. Columns 1-40 are for user comments; 41-50
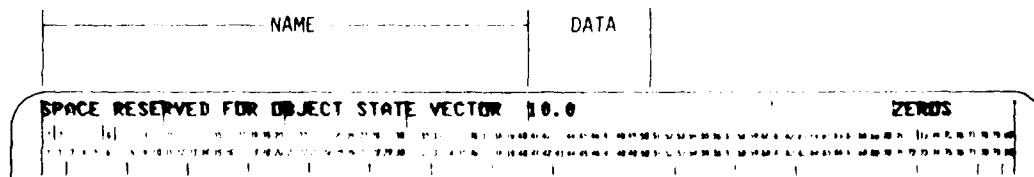
Figure 3.8. The ZEROS Card

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```
|————————————— NAME ———————————| ALTITUDE, |EAST      | NORTH     |
|                              | km        |LONGITUDE,| LATITUDE, |
|                              |           |deg       | deg       |
| DENVER, COLORADO  |       |    1.6093    -104.989  39.749    GEOGR |
```

Figure 3.9.   GEOGR Card

---

contain the altitude in kilometers; 51-60 the longitude in degrees; 61-70
the latitude in degrees; and the word GEOGR starts in column 71.

Conversion to the fundamental Cartesian coordinates is accomplished
automatically, units being governed by the current values of scaling
associated with KM and DEG.

There are four additional cards which define geometrical inputs
relative to the last previously read GEOGR card. These require a little
preliminary discussion and definition. In Fig. 3.10, G denotes the
location of the last GEOGR point, and the pictured plane is the tangent
plane at G . Another location, P , may then be defined by specifying
its location relative to G , e.g., by its range, azimuth, and elevation
as seen from G . It should be noted that "azimuth" is measured counter-
clockwise from East (θ of plane polar coordinates).

The four "relative to GEOGR" cards are shown in Table 3.2. Columns
1-40 are free for user comments.

Although the POLAR and RADAR cards appear at first glance to be the
same, the reader should note that the vector returned for POLAR is mea-
sured from G (see Fig. 3.10), whereas for RADAR the vector returned is
measured from the center of the earth, C.
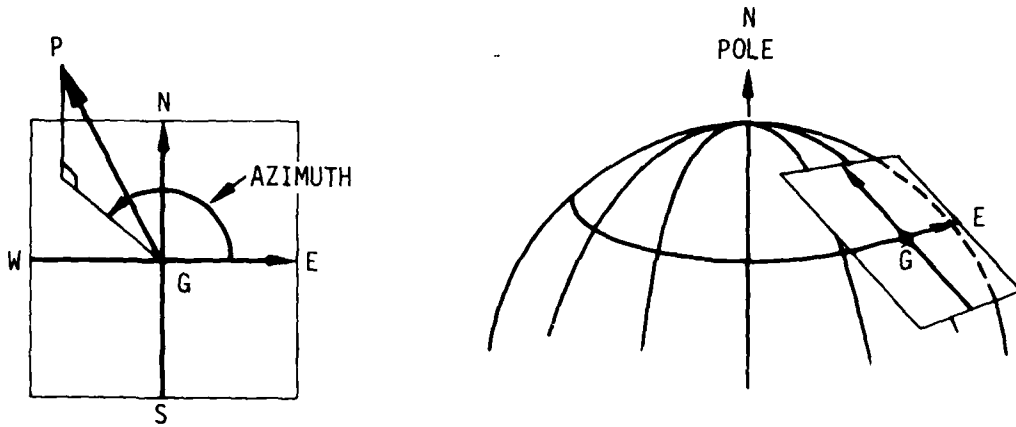
Figure 3.10. The Local Coordinate System

TABLE 3.2

THE "RELATIVE" CARDS

Card Name (Column 71)	Column 41	Column 51	Column 61	Cartesian Vector Stored Within Dataset Being Processed
POLAR	Vector length, km	Azimuth, deg	Elevation, deg	$\overrightarrow{GP}$
RADAR	Slant range, km	Azimuth, deg	Elevation, deg	$\overrightarrow{CP}$
LOCAL	Ground range, km	Azimuth, deg	Altitude, km	$\overrightarrow{CP}$
LOCXYZ	East, km	North, km	Distance (km) above tangent plane	$\overrightarrow{CP}$

Examples are given in Fig. 3.11. The POLAR vector is typically a short vector, such as a direction or a velocity, described in locally defined reference terms, whereas the RADAR, LOCAL, and LOCXYZ vectors are typically position vectors measured in the earth-centered system.

Hollerith Data Input. When using the single-word data input option, the input data in columns 41-50 will be treated as Hollerith data and read in A10 format whenever FLEXRED is not able to identify it as a number

NAME	LENGTH OF VECTOR, km	LOCAL AZIMUTH, deg	LOCAL ELEVATION, deg
VELOCITY OF EAST-BOUND CAR IN DENVER	0.015	-5.0	-3.0	POLAR

NAME	SLANT RANGE, km	LOCAL AZIMUTH, deg	LOCAL ELEVATION, deg
MOUNTAIN PEAK SOUTH OF DENVER	15.0	-87.0	20.0	RADAR

NAME	GROUND RANGE, km	LOCAL AZIMUTH, deg	ALTITUDE, km
MOUNTAIN PEAK WEST OF DENVER	20.0	173.0	3.5	LOCAL

NAME	EAST, km	NORTH, km	ALTITUDE, km
MOUNTAIN PEAK NORTH-EAST OF DENVER	15.	15.	4.	LOCXYZ

Figure 3.11. Examples of the "Relative" Cards. (These examples assume that the last-read GEOGR card was that of Fig. 3.9.)

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according to the rules illustrated in Fig. 3.7. An example is shown in Fig. 3.12.

The FORMAT Card. This card allows the user to read in quantities of data from cards in his own format. This card has two forms (see Fig. 3.13). The program assumes that the number of cards is one unless it can identify some number different from 1 in the field of columns 21-30.

Figure 3.12. Example of Hollerith Input

Figure 3.13. The FORMAT Card

Once a FORMAT card has been identified and the number of cards (n) and the number of words (m) have been defined, the program reads m words from the next n cards using the standard Fortran format provided in field 41-70. It will then read a second batch of m words from the next succeeding n cards, and so on. This flow of data is terminated by a card with END DATA beginning in column 1.

In the examples shown in Fig. 3.14, 25 words will be read by the first format and 12 words will be read by the second.

It should be noted that when the FORMAT card is used, the numerical inputs are generated strictly by FORTRAN conversion rules. That is, the conventions of Fig. 3.7 do not apply, and illegal punches will cause premature program termination.

CARDS ARE TO BE READ FROM BOTTOM TO TOP

Figure 3.14. Use of FORMAT Card

3.2.1.2 Structuring of the Data System

A data structure for a DSA-based program consists of datasets and lists of datasets. (A list is a collection of datasets which are logically associated in some manner. The word "file" is sometimes used synonymously with "list.") Associated with each dataset and list is a data word (the dataset pointer, DSP, in the case of a dataset and the list header variable, LHV, in the case of a list) which allows the user to obtain access to the contents of the dataset or list.

The FLEXRED program provides a method for creating both datasets and lists, and for storing as data both the DSP word addresses and the LHVs associated with them.

Structuring of Datasets. A dataset is defined by a BEG SET card. The dataset is identified (for FLEXRED purposes only) by the first 40 characters on the BEG SET card. It contains data in the amounts and in the order specified by ensuing data cards in sequence, terminated by an END SET card or by the beginning of another dataset or list (a BEG SET or a BEG LIST card).

The example in Fig. 3.15 defines a dataset with seven words in it. It has an identification for FLEXRED purposes which is:

DATASET NUMBER 1. THIS CARD DEFINES A SA

and which may be used later to refer to the dataset.

Once a dataset has been created, it may then be used in three different ways.

1. The DSP word address of the dataset may be stored as a piece of data in another dataset. This is done by means of the RFFER card. The dataset may then be accessed by a call to DSA subroutine INDWRD or

Figure 3.15. A Sample Dataset Containing Seven Words of Data

INDWRL. Figure 3.16 shows an example, where a dataset is defined containing one data word, which is the DSP word address of the dataset defined in Fig. 3.15. The effect of the REFER option here is to place a pointer to one dataset within another.

2. A copy of the complete dataset may be incorporated as part of another dataset. This is done by means of the INSERT card. Figure 3.17 shows the construction of an eight-word dataset containing the combined data of the datasets of Figs. 3.15 and 3.16.

3. The dataset may be added to a list. This is also done by means of the REFER card, as discussed below.

Structuring of Lists. A list is defined by a BEG LIST card. The list is identified (for FLEXRED purposes only) by the first 40 characters on the BEG LIST card. Datasets appear on the list in the exact

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Figure 3.16. Use of the REFER Card to Produce a DSP Word Address

Figure 3.17. Use of the INSERT Card to Produce Composite Datasets

order specified by the ensuing REFER cards in sequence, and the list is
terminated by an END LIST card or by the beginning of another list or
dataset (a BEG SET or a BEG LIST card).

The example in Fig. 3.18 defines a list with three datasets on it
(the first and third happen to be the same dataset--this is not an error,
as the datasets on a list are not required to be distinct). The identifi-
cation of this list for FLEXRED purposes is

LIST OF SOME OF THE DATASETS PREVIOUSLY

which may be used later to refer to the list.

Once a list has been created, it may then be used in two different
ways.

CARDS ARE TO BE READ FROM BOTTOM TO TOP

Figure 3.18. A Sample List Containing Three Datasets

1. Its list header variable (LHV) may be stored as a piece of data in some dataset. This is done by using the REFER card, with the list name on it. An example will be seen in Fig. 3.19 where a one-word dataset has been created whose contents are the LHV for the list defined in Fig. 3.18.

2. A copy of it may be incorporated as part of another list. This is done by means of the INSERT card. Figure 3.20 shows the construction of a list containing six datasets (counting repetitions, of course) formed from the list of Fig. 3.18 by using the INSERT card.

The uses of the REFER and INSERT cards are summarized in Table 3.3. It should be noted again that the order of presentation of the data is only important during the definition of a list or dataset. The lists and datasets themselves may appear in any order and need not have appeared prior to their use on a REFER or INSERT card. Use of the INSERT card, however, may lead to a logical paradox (such as INSERTing an entity into

CARDS ARE TO BE READ FROM BOTTOM TO TOP

Figure 3.19. Example of LHV Stored in a Dataset

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Figure 3.20. Use of the INSERT Card for List Definition

TABLE 3.3

SUMMARY OF STRUCTURE CARDS

Card Type	Entity Named on Card	Entity Inside Which Data on Card is Placed	Result
REFER	Dataset	Dataset	One data word, the DSP word address
REFER	Dataset	List	Places dataset on list
REFER	List	Dataset	One data word, the LHV
INSERT	Dataset	Dataset	Copies data from named set into new set
INSERT	List	List	Copies list from named list into new list
(Anything Else)			Diagnostic--fatal error

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itself). FLEXRED will identify this (and more complicated variants) as
an error and return a diagnostic. The REFER card is subject to no such
logical difficulties and may be used anywhere.

The Basic Dataset. We have discussed the construction of indivi-
dual datasets and lists. It is necessary to communicate or interface this
entire data structure built by data cards with the user's program. This
is done via the basic dataset, through which it must be possible to reach
all data entered by FLEXRED. The basic dataset is locked into position
by FLEXRED and its dataset index returned through its calling sequence.

Any one dataset may be defined as the basic dataset, through the
use of the BASIC card, as shown in Fig. 3.21. The basic datas t provides
the means to reach all other entities read during the FLEXRED run, and
any entities not accessible directly or indirectly through the basic
dataset are destroyed.

The basic dataset can provide access to entities in several ways.
Values can be entered directly in the basic dataset, or DSP words or LHV
words may be entered in the basic dataset which point to other datasets
or lists. A chain of reference may be built up in which datasets and
lists which are immediately referred to in the basic set point in turn to
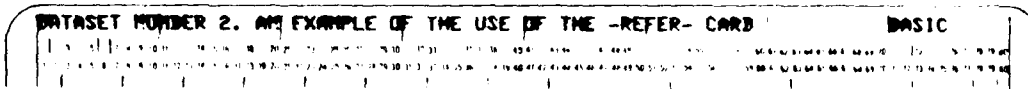
Figure 3.21. Example of the BASIC Card

other datasets and lists. Thus, any variable entered through FLEXRED has to be linked either directly or through a chain of DSP and LHV words to some variable in the basic dataset.

3.2.1.3 Formatting and Comments

A card whose first character is an asterisk is a comment card of some sort in the data deck. If columns 71-80 are blank or contain something other than PRINT, BOX, or BOX PAGE, the card will be skipped and ignored by FLEXRED. This allows the user to intersperse his data deck with comments of a technical nature (which may assist in modifying the data deck) without having them appear to clutter up the output.

If the word PRINT occurs starting in column 71, then the contents of columns 1-70 appear on the output as a single line. If the word BOX occurs starting in 71, then the contents of columns 1-70 appear inside a box composed of asterisks. (Consecutive BOX cards produce only one box, containing multiple lines of output.) Finally BOX PAGE produces a box, and a skip to the top of a new page. Figure 3.22 shows some samples of these cards.

3.2.2 OUTLIS

The purpose of this routine is to perform general-purpose output for lists of data which have been previously generated internally by the ROSCOE simulation. These data take the form of lists of datasets (the so-called output datasets) which are constructed from time to time within the program while it is running. Each dataset on such an output list (of which there may be more than one) is presumed to be of the same form. That is to say, each dataset must be of the same length, and contain values of the same variable. In addition, the contents of each such dataset are presumed to be known to the user, who must decide how he wants the output to be formatted, scaled, and graphed or printed.

Four different types of output are currently provided for in subroutine OUTLIS: (1) a state-vector form of output based on the STOUT

Figure 3.22. Sample Formatting Cards

subroutine of the TRAID system, which includes provision for some coordi-
nate conversions; (2) a columnar form of output which is based on the
OUTCOL subroutine of the TRAID system, but which has additional capabili-
ties such as automatic scaling of the output variables; (3) a graphical
form of output using the printer as a rudimentary plotter, based on the
SETPLOT routine of the TRAID system; and (4) a Calcomp plotter output capa-
bility with automatic axis scaling, based on Calcomp-supplied software.
The user may select any combination of these at run time by means of data
inputs which define "format" datasets which are interpreted in combination
with the lists of output data to provide flexible output in a readable
form. These four types of output will now be discussed in greater detail.

3.2.2.1 State Variable Output Formatting

In this form of output, it is assumed that the data on the output
list is a series of ten-word datasets corresponding to the standard TRAID
state vector, composed of time, followed by the nine components of position,

velocity, and acceleration. These will be output according to the capabilities of subroutine STOUT of the TRAID system.

The structure of the format dataset which implements the state variable output capability is:

Word	Contents
1	STOUT (a single Hollerith constant)
2	An integer code word, described below
3-10	The (Hollerith) title to be used at the head of the output array

The OUTLIS program detects the Hollerith constant, STOUT, and proceeds with the state vector form of output.

The integer code word consists of six independent digits (in base-10 notation) which are decoded by the same program and serve to control the type of output which is desired. These digits are, reading from left to right in the code word: KF, KN, KI, KP, KV, and KA. Their use is as shown in Table 3.4.

This output routine does, however, assume that the state vectors provided to it in the datasets on the data output list are in an appropriate coordinate system to begin with. As indicated in the table, for KP = 1 the form is assumed to be in rectangular coordinates, whereas for KP = 2, 3, or 4 , the form is assumed to be space polar.

3.2.2.2 Columnar Data Output

In this form of output, it is assumed that the data on the output list is a series of datasets (of no prescribed length) with identical structure. Each dataset will represent a single "line" of output in a tabular format. The user may select which column on the output sheet that particular data word will be printed in, how it should be scaled, and what the column heading should be.

TABLE 3.4

COMPONENTS OF THE CODE WORD IN STATE VARIABLE FORM OF DATA OUTPUT

KF	Format control for number printout
KF = 0	F10.3 conversion
KF = 1	E11.2 conversion

KN	Name output control
KN = 0	Names not printed
KN = 1	Names printed for each line

KI	Identification control (leftmost printed column)
KI = 0	None
KI = 1	State vector entry 1 as time
KI = 2	State vector entry 1 as Hollerith ID
KI = 3	State vector index number in array of states

KP	Position printout control
KP = 1	Rectangular coordinates (x, y, z)
KP = 2	Polar coordinates (r, θ, ϕ)
KP = 3	Radar coordinates (range, azimuth, elevation)
KP = 4	Geocentric coordinates (altitude, longitude, latitude)

Above values plus 5: positions labeled as "Reference Position"

All vectors in array must be in rectangular coordinates for output with KP = 1, and in polar coordinates for output with KP = 2, 3, or 4.

If the integer code word is negative, position output is deleted and the index KP defines the coordinate system used for the velocity and acceleration printouts below.

KV	Velocity printout control
KV = 0	Velocity printout deleted
KV = 1	Rates of position coordinates ($\dot{x}$, $\dot{y}$, $\dot{z}$ or $\dot{r}$, $\dot{\theta}$, $\dot{\phi}$, etc. depending on the choice of KP)
KV = 2	Rectangular velocity components ($\dot{x}$, $\dot{y}$, $\dot{z}$ or $\dot{r}$, $r\dot{\theta} \cos \phi$, $r\dot{\phi}$, etc.)
KV = 3	Polar velocity components (velocity magnitude, azimuth, elevation)
KV = 5	Polar coordinates of radar boresight, stored in velocity components of state

Above values plus 5: components 5 to 7 of state are scaled and labeled as position deviations

KA	Acceleration printout control
KA = 0	Acceleration printout deleted
KA = 1	Second derivatives of position coordinates ($\ddot{x}$, $\ddot{y}$, $\ddot{z}$, etc.)
KA = 2	Rectangular acceleration components
KA = 3	Polar acceleration vector (magnitude, azimuth, elevation)
KA = 4	Acceleration relative to velocity (magnitude, component parallel to velocity, component perpendicular to velocity)

Above values plus 5: components 8 to 10 of state are scaled and labeled as velocity deviations

The structure of the format dataset which implements the columnar output format is:

Word	Contents
1	OUTCOL (a single Hollerith constant)
2-9	The Hollerith title to be used at the head of the output array
10	An integer code word, described below
11	10-character top line of column heading
12	10-character middle line of column heading
13	10-character bottom line of column heading
14	Numerical scale factor to be applied to each data item in the column
15-19	Same data as 10-14 for another column
20-24	Same data as 10-14 for another column; and so on for as many columns as output is desired for

The code word (thought of as a decimal integer) is a positional composite of four other words; it is of the form NNPCF, composed of the integers, reading from left to right, NN, P, C, and F. These have the following meanings to the output routine:

NN = the index, within the output dataset, of the data item for which this is an output instruction.

P = the "page" on which this column of output is to be placed; P = 0 is the "first" page, P = 1 the second, and so on to P = 9 . The word "page" means output array, rather than physical page of printout.

C = the column on that page in which the output is to appear. There are ten 12-character columns on a page of computer printout; they are numbered 1, 2, 3, 4, 5, 6, 7, 8, 9, and 0, reading from left to right.

F = the output format (in the FORTRAN sense) under which the words in this column are to be printed. The possible codes range from 1 through 9 inclusive; their meanings are shown in Table 3.5.

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TABLE 3.5

CORRESPONDENCE BETWEEN DIGITAL CODES AND FORTRAN
FORMATS IN COLUMNAR FORM OF OUTPUT

Code Digit	Format
1	E12.4
2	E11.2
3	F11.6
4	F11.3
5	F10.0
6	I8
7	I10
8	Ø12
9	A10

It may be noted that there is no requirement that a column be printed only once; typically in time-series data the time column is printed once on each "page" of output. If one inadvertently specifies two different outputs for the same page/column pair, the latest one in the format dataset will govern.

Mention should be made here of a special input card which is recognized by FLEXRED and will allow the easy specification of the five-word segment of the format dataset corresponding to a particular output column. This is the OUTCOL card. Because of its specialized nature, its discussion was deferred until here. It is identified by FLEXRED by means of the word OUTCOL punched starting in column 71. The code word is punched in field 31-40; the top, middle, and bottom lines of the column heading are punched in fields 41-50, 51-60, and 61-70, respectively. If the word punched in 61-70 as the bottom line of the column heading is left-justified and recognizable by FLEXRED as being a scaling factor with which it is familiar, it will automatically define the correct scale factor and

store it in the format dataset for OUTLIS to use later. If the word is
unrecognizable, on the other hand, FLEXRED will assume that this column
is to be unscaled, and will put in a 1.0 for a scale factor.

Figure 3.23 shows a sample OUTCOL card. It will be noted that this
is an instruction to OUTLIS to take the second word in each successive
output dataset (NN = 02) and print it in the fourth column (C = 4) of the
first output array (P = 0), after scaling it into nautical miles (i.e.,
after dividing by 1853.25), using a FORTRAN F11.3 format (F = 4). The
resulting output will look like the following:

                    ALTITUDE
                    OF BURST
                 NMI
                       50.357
                      126.780
                      etc.

3.2.2.3 Printer Graphic Form of Output

In this form of output, it is assumed that the data on the output
list is a series of datasets (of no prescribed length) with identical
structure. The user may select in turn pairs of data words which are to
be plotted against each other, using the line printer as a gross plotting

---
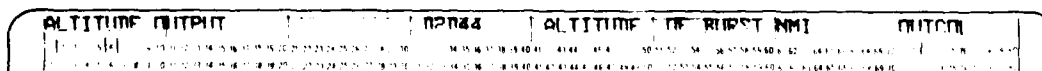
Figure 3.23. A Sample OUTCOL Card

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mechanism. This form of output does not allow for any scaling of the data, and the axis scaling is quite crude. It is designed primarily to obtain a rapid overview of the joint variation of two variables, rather than a polished output.

The structure of the format dataset which implements the graphical output format is:

Word	Contents
1	GRAPH (a single Hollerith constant)
2-9	The Hollerith title to be used at the head of the graph
10	Index (integer) in the output dataset of the data word to be graphed along the x-axis
11	Index (integer) in the output dataset of the data word to be graphed along the y-axis
12-21	Another title and pair of indices as in 2-11 for another graph from the same serial list of datasets
22-31	Another such definition; and so on

No axis labels are provided for, and axis scaling is automatically chosen to include all the data points within the plot field. This output method is extremely rapid, but suffers from low resolution.

3.2.2.4 Calcomp Plotter Form of Output

In this form of output it is assumed that the data on the output list is a series of datasets (of no prescribed length) with identical structure. The user may select in turn pairs of data words which are to be plotted against each other by a Calcomp plotter (or some other plotting device for which the appropriate software has been written).

This graphical output allows the user to specify a title for the graph, individual labels for the x-axis and y-axis, and scaling for the variables to be plotted along each axis. The program will then select appropriate scaling parameters so that the tick marks on the axes are at

convenient values, and so that the plotted graph "fills the field." The
structure of the format dataset which implements the Calcomp output for-
mat is:

Word	Contents
1	CALCOMP (a single Hollerith constant)
2-9	The Hollerith title to be used at the head of the graph
10	Index (integer) in the output dataset of the data word to be plotted along the x-axis
11-12	Two-word Hollerith label for the x-axis
13	One-word Hollerith scaling factor name describing the units to be used along the x-axis
14	The value of the scaling factor associated with the units defined in 13
15	(intentionally blank)
16-21	Equivalent to words 10-15, but now defining the y-axis and its structure
22-41	Same as 2-21, but for a second graph to be constructed from the same sequential list of data arrays
42-61	Same as above; and so on

It should be noted here that words 10 through 14 (and all later
sequences) are designed so that they may be read in by FLEXRED on a single
OUTCOL input card, allowing FLEXRED to provide the value of the scaling
factor automatically if its Hollerith name is one which it has learned
to recognize. The use of these cards, and their format, are the same as
in Sec. 3.2.2.2, where they were used to input and scale columnar data.

The routines in this Calcomp package are all Fortran except for
two system subroutines, PLOTS and PLOT. Since these routines will have
to be replaced when moving ROSCOE to another facility, they will be
briefly described as to function. The presumption is that the associated
plotter has a 10 × 13-inch plotting field.

PLOTS. Within a program which is to use the plotter, this routine must be the first to be called. It initializes various parameters and the position of the pen at the edge of the graph paper. The pen will be up. This point is defined as the origin (0.,0.) until it is redefined by a termination call to PLOT.

PLOT (X, Y, IC). This routine's calling sequence gives the following instructions.

X = abscissa in inches

Y = ordinate in inches

IC = control of pen

3--lift the pen

2--lower the pen

1--leave the pen as it is

If IC is negative, the pen will be positioned as above and the current plot will terminate at coordinate X,Y. This position on the paper is then defined as (0.,0.) for the next plot.

Thus PLOT moves the pen from the current position to (X,Y) with the pen up or down depending upon IC.

3.2.3 ROSCOE Inputs

From the preceding discussions, one can begin to perceive the flexibility built into the input/output structure of ROSCOE. Once the dataset structure is understood,[1] very simple or extremely complex data packages can be pieced together, depending on how the program is to be used.

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[1] Volume 3 presents a complete programmer's notebook of all ROSCOE datasets and definitions of all variables in those datasets.

In this section, we will go through an example data deck in some detail to illustrate the use of the FLEXRED/OUTLIS structure. We start with a review of the dataset "tree" structure concept as it relates to ROSCOE specifically.

3.2.3.1 The "Tree" Structure Concept

As discussed in the description of FLEXRED above, the dataset structure ("tree" structure) starts with a dataset termed the BASIC dataset. All other datasets either created in the input deck or created later within the code are tied to this basic dataset either directly or indirectly through other datasets and lists. Thus to create a ROSCOE data deck, one starts with the ROSCOE basic dataset and begins constructing the tree structure required for his particular job.

An example of such a tree structure is shown in Fig. 3.24. The ROSCOE basic dataset contains these items:

Event List

Function -- a list of the events that will be processed in a time ordered fashion within the program.

Options -- The user should always specify an attack generation event (since it initializes the ambient atmosphere and magnetic field) and a stop event to terminate execution. He then has the option of setting up an attack, that is, inputing an attack type dataset, a launch point list and target point list. Other optional events would be burst events (as many as he desires) each pointing to a bomb type dataset; an environment output event to produce specific phenomonelogy data at points in nuclear disturbed regions; a satellite communications event (see Vol. 20); or an optional surveillance event (see Vol. 21-1). Note that the attack generation event creates radar look events for each object/sensor pair at the radar acquisition range(s) internally.
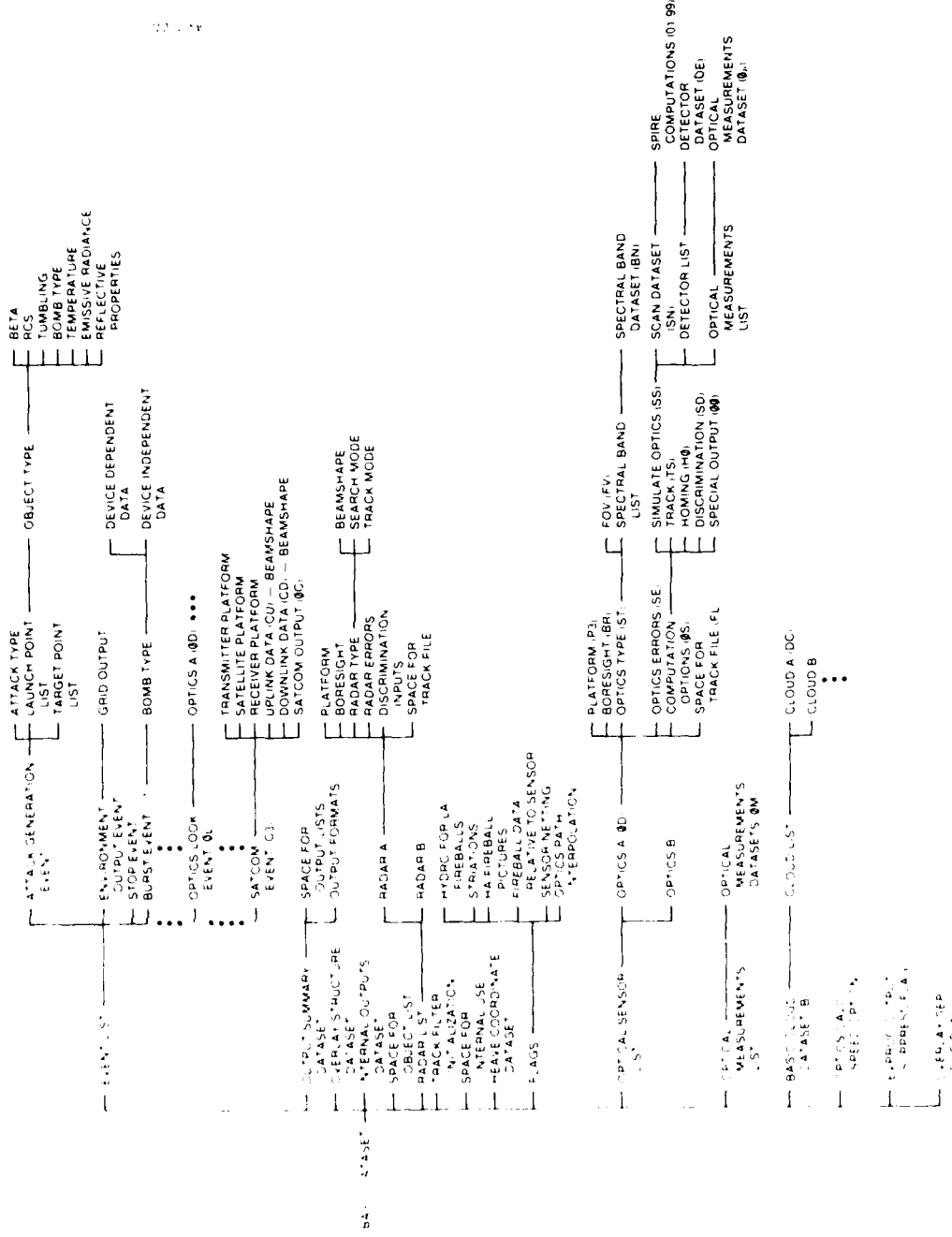
Figure 3.24. ROSCOE Dataset Organization

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Output Summary Dataset

Function -- to provide lists and format datasets for preparation
of summary output within the program.

Options -- The user satisfied with the form of the outputs
provided can leave this dataset string as it is.
The user who would like the data in a different
format (or printer plot output of any two items)
can merely add additional format datasets to the
format lists provided. The user who would like
additional output can add new format lists and
insert a new code to generate these data internally.

Overlay Structure Dataset

Function -- ROSCOE is intended to be a programming system
rather than a code. This dataset allows for
the addition of replacement overlays at input
time.

Options -- If the programmer/user would like to use a
program module of his own to replace one in the
code, he can add the routines to the program
library structure and specify that the appropriate
event number call his overlay. This will require
changing the appropriate overlay in the program
structure (STRUCT) file. (Note that a comparable
option exists at the subroutine level. The user can
replace an existing subroutine with his own by giving
it a different deck name with an entry name correspond-
ing to the ROSCOE deck. He should then replace the
original INSERT, old deck with his INSERT, new deck in
the STRUCT file).

Internal Outputs Dataset

Function -- Provides for internal debug outputs. Write statements
have been inserted in each event of the code to provide
important data as they are computed.

Options — By inputting the Hollerith flag "NO" the debug output
is suppressed for that event. A "YES" flag turns on
the output for that event. The casual user should
probably ignore the debug print.

Space for Object List

Function — To leave space for the object list created in the
attack generation event.

Options — Alternatively, one could input an object list rather
than generate it within the attack generation event.
In this case he would need the object states at an
appropriate engagement time from some other program
and would have to input the dataset string associated
with each object (i.e., object type, beta, RCS, tumbling
and bomb type datasets), and also a radar look event
for each object on the event list.

Radar List

Function — Lists all radar sensors to be used in this engagement.

Options — There are no limitations on the number of radars that
can be input (although large numbers will overload
the dynamic storage system and considerable CP time
will be spent allocating storage). For each radar, the
dataset string shown must be entered.

Track Filter Initialization

Function — A dataset to provide initialization paramaters for
the Kalman filter used.

Options — None, unless the user would like to use his own filter.

Space for Lists

Function — There are a number of spaces allocated here for internal
storage of lists (bursts, fireballs at different times
and altitude regimes, etc.).

Options — None. These should not be changed.

Heave Coordinate Dataset

Function -- Provides a description of the grid region desired for high altitude nuclear engagements.

Options -- If a zero card is entered, a grid region will not be generated. This will be the case where the user is only interested in low-altitude (<90 km) detonations. If a <u>REFER</u> card is entered here, then a heave coordinate dataset should be entered somewhere in the input stream.

Flags

Function -- A number of flags are supplied to allow the user the option of simulating specific phenomenology, or providing additional output.

Options -- A "NO" flag means the item will not be computed; a "YES" entry means that it will be computed. The flags are:

(1) Hydro around low-altitude fireballs--factors in the motion of air particles around low-altitude fireballs for chemistry calculations. This calculation can be time consuming for large numbers of multi-burst calculations. Its importance is a function of the geometry of the ray path intersections with the disturbed regions. Probably should be used for a limited set of ray paths rather than in a complete tracking simulation.

(2) Striation calculations--this flag allows for the calculation of striations in the high-altitude grid region. It is important for high yield detonations, and for times longer than a few tens of seconds after burst.

(3) Printer plots of HA fireballs--this option allows the user to get printer plot pictures of all high-

altitude fireballs and the beta tubes eminating from them. These plots require little computation time so the default has been set to "YES" in the standard decks provided.

(4) FB data relative to radar--this option provides the position and extent of all low-altitude fireballs relative to each radar specified. It also provides the clutter contribution to the radar from each fireball.

(5) Sensor Netting--an option which allows all sensor data to be netted. The alternative is that each sensor operates autonommously.

(6) Optics Path Interpolation--allows for time interpolation of optics propagation data. The path integrations can be time consuming so for large FOV applications which require many paths or for large attack engagements this option should be used.

Optical Sensor List

Function -- Lists all optical sensors to be used in this engagement.

Options -- There are no inherent limitations on the number of optical sensors or sensor types that can be specified.

Optical Measurements List

Function -- Contains a list of optical measurement datasets which contain measured position coordinates of a target relative to the sensor boresight, the magnitude of the signal, etc.

Options -- These are created internally so a zero card should be used in the input deck to leave space for it.

Basic Cloud Dataset

Function -- Allows for the treatment of natural clouds in the optics calculation.

Options -- The user either inputs a "zero" card (no clouds) or card which refers to a basic cloud dataset which appears later in the input stream.

Optics Calculation Speed Option

Function -- To allow the user an option on computation speed.

Options -- The user inputs either "fast" or "slow". The default value is "slow". The "fast" option allows for run times to be reduced by about one-half, but does not produce the fidelity which the "slow" option affords.

EVPROC Output Suppression Play

Function -- Allows the user to suppress a standard printout which shows the ordering of events as they are processed and the computation time expended.

Options -- User inputs either "1.0" or "0". The default is 1.0, which enables the printout.

Overlay Separate File Flag

Function -- A flag to direct the code to use separate files for each overlay, which allows considerable savings in "ID" time changes.

Options -- "ID" or "0" should be input. Default is "ID" which directs the code to use the separate files.

3.2.3.2 Sample Data Deck

For our own studies at GRC, we have found it convenient to set up a large complex data package from which many variations can be run. The data deck includes five high-altitude bursts , a UHF radar model, a communications satellite and ground receivers, and a SWIR surveillance sensor on a synchronous satellite.

The deck is saved as a CDC UPDATE[1] file so that the deck can be edited and updated to run different problems. A listing of this UPDATE file is given in Appendix A. A description of the cards contained in the file follows.

1. <u>Title and Initialization</u>. (Data .2 – Data .5)

Data .2 and Data .3 are used for titling the output. Data .4 sets the earth rotation to on or off with input of YES or NO, respectively. Data .5 provides a starting point for the random number generator (used in structuring random RV attacks). Note that these first four cards, which are required, do not follow the FLEXRED format --FLEXRED formats are used for all other inputs.

2. <u>Scale Factors</u>. (Data .6 – Data .32)

As mentioned in the FLEXRED description, the user can specify scale factors so that inputs can be scaled properly to internal units (CGS for ROSCOE). Note the unusual set required to convert to range in centimeters on a one-square-centimeter target (Data .27 – Data .29). The scale factor (K) required to convert km on one-square-meter to cm on one-square-cm is derived as follows:

$$S/N \propto \left(\frac{R_{MKS}}{R} \right)^4 \sigma$$

where R_{MKS} = range in km on a one-square-meter target

so that R_{MKS} has the units $km/m^{1/2}$. Thus

$$K = \left(\frac{km}{m^{1/2}} \right) \frac{(10^5 \text{ cm/km})}{(10^2 \text{ cm/m})^{1/2}}$$

$$= 10^4$$

---

[1]UPDATE is a CDC software package for maintaining source libraries by use of flexible editing features.

3.   Basic Dataset. (Data .33 - Data .63)

As mentioned earlier, the basic dataset is the primary element
in the data structure from which all other datasets and lists
emanate. The ROSCOE basic dataset has a fixed structure containing
those variables described above in Sec. 3.2.3.1.

The datasets and lists referred to in the basic dataset by
REFER cards follow in the input stream.

4.   Instructions for Internal Outputs. (Data .64 - Data .97)

This dataset establishes the debug output flags for each
event. Note that the first card (card 65) must have the exact
wording specified on the REFER card in the basic dataset and must
have BEG SET starting in column 71.

5.   Overlay Structure Type Dataset. (Data .98 - Data .131)

This dataset sets up the overlay calling structure by event.
The purpose of this dataset is to allow for alternate overlays to
be constructed and substituted for the existing ones.

6.   Miscellaneous Datasets for Summary Output. (Data .132 - Data .440)

Output Summary Dataset. (Data .132 - Data .164)

This dataset provides space for the output lists that will be
filled during program execution (the system output list, and the
physics output lists designated as BO, F1, F2, F3, F4, D1, BE, CO,
OC, OS and OP--see Volume 3 for definitions), and sets up pointers
to the format lists which follow in the input stream.

Format Lists. (Data .165 - Data .200)

The format lists for each of the output types (trajectory
output, track measurement errors, etc.) can contain any number of
output format datasets for tabular output, printer plots, or Calcomp
plots. Each separate output type must be defined by a dataset, however.

In the current example, a single tabular output format dataset
is used for each systems and physics output.

<u>Individual Output Instructions</u>. (Data .201 – Data .440)

The individual output format datasets are given in this block
of inputs. The format datasets all have the "columnar" form
described in Sec. 3.2.2.2. The first card is a dataset descriptor
which must correspond to a card image on one of the output format
lists. The next card defines the type of output to be used--defined
by the work OUTCOL in column 41. The third card is a title card
for the tabular output. The title is punched in columns 1-71, and
the work TITLE must be punched starting in column 71.

The next set of cards (up to ten) define the output data by
column. The cards are punched as follows:

Columns 1-30:   A description of the variable.

Columns 31-40:   The code word as described in Sec. 3.2.2.2.

Columns 41-70:   Descriptors which are printed at the top of
                  each column. The first field of ten is
                  printed on the first line, the second on the
                  second line, and the third on the third line.
                  The data may be scaled to any convenient units
                  by using the third field for the unit name
                  of a previously defined scale factor. In
                  this case, the scale factor must be left-
                  justified to distinguish it from a label.

Columns 71-80:   The word OUTCOL.

7.   <u>Event List</u>. (Data .441 – Data .459)

The event list must contain an attack generation event to
initialize the atmospheric, ionospheric, and magnetic field models,
and a stop event to terminate program execution; however, no other
events are mandatory. The user can specify any number of burst
events or an environment output event if desired. All events
specified must have a dataset somewhere in the input stream, however.

8. Attack Generation and Battlespace Initialization.
(Data .460 - Data .512)

This block of data contains those datasets associated with
the attack generation event and general problem initialization.

Attack Generation Event. (Data .461 - Data .466

The attack generation event consists of the event type variable
(1 in this case), a dummy event time, and pointers to the attack
type dataset, the launch point list, and the target point list.

Attack Type Dataset. (Data .468 - Data .482)

Only a uniform attack (RVs spaced uniformly in time) can be
specified at present; however, other attack types could be added
easily. Other inputs include: a day or night specification (which
is currently overridden in the initialization portion of the
atmospheric model), the attack date (day, month, year) and time of
day (zone time at the burst location), an approximate battlespace
center location for the magnetic dipole fit, an initialization
flag used internally which should be set to zero, and four parameters
to describe the terrain for optics calculations (see Volume 7).

Launch Point List and Datasets. (Data .483 - Data .495)

Any number of launch points can be put on the launch point
list. Recall that each launch point has an object type associated
with it, so that object types are mixed by mixing launch points.

In the example, only one launch point (THE LAUCHOU LAUNCHERY)
is listed. The launch point dataset contains the launch point
name (LAUCHOU), the location of the launch point, pointers to the
booster and object types, the number of boosters available at
this launch point (or of this type), and space for an internally
used variable.

Target Point List and Datasets. (Data .496 - Data .512)

The target point list also can have any number of targets
listed. Arrival sequence is determined by the order of the target

list and the corresponding order of the launch point list. For the first target point, the program selects the first launch point (and object type) and constructs a trajectory between the points. For subsequent objects on this target or other target points, any remaining boosters at the first launch point are used until these are exhausted; then the second and succeeding launch points are used.

Only one target point is specified in the example--BUFFALO, NEW YORK. The target point dataset includes a target name, BUFFALO, the target location, the number of boosters on target, the arrival time (at the target) of the first RV, the delta time between arrivals of successive RVs, the standard deviation in arrival time (if any), the CEP about the impact location, a mode indicator for the trajectory type desired, a trajectory descriptor, and space for a target output array. The following options are available for describing the trajectory:

Mode	Trajectory Descriptor Input
1	Flight time
2	Excess flight time (above minimum-energy orbit)
3	Speed at launch (inertial)
4	Velocity-elevation angle at launch (inertial)
5	Speed at launch (relative to ground)
6	Velocity-elevation angle at launch (relative to ground)

System Output List. (Data .513 - Data .518)

This list contains output datasets for each radar/object pair. The list is created internally when the RV trajectory generation option is used to drive the radar look event logic (i.e., radar look events are created as RVs enter the radar fields of view and output datasets are created to hold the measurement data). However, if the user bypasses the RV trajectory generation by inputting object states directly and putting a radar look event on the event list then he must also set up a system output dataset for each radar/object pair.

High Altitude Heave Grid. (Data .519 - Data .540)

A grided region is used to model the high altitude (>90 km) disturbed regions. A reference location for the center of the region is input first (Data .520 - Data .521). This is followed by the heave coordinate dataset which contains the specifications for the size and orientation of the grid.

Data entries for the bottom altitude, the heave coordinate center (may be relative to the reference position given above), the angular cell widths,[1] the number of vertical cells, the number of columns in the positive and negative x- and y- directions,[2] and the azimuth of the x-axis (measured positive in the clockwise direction from north) must be specified. (The specification MAGNETIC aligns the negative x-axis with magnetic North.) In addition, the number of cells (NMCEL $\leq$ 100) used in the magnetic grid for striation calculations is specified if striations are computed. This input variable is followed by initialization inputs for the two times at which grid data is saved, a space for an internal flag (IXPLD), flags for turning on energy check calculations (INCHK) and rezoning the grid cells in a column (IRZN), space for the cell heights (used internally), and the altitude (HMAX) at which a column should be rezoned. The energy check and rezoning calculations are actuated by setting the flags equal to 1.; otherwise, zeros should be entered as shown.

Placement and size of the heave grid relative to bursts is important. For some situations, experimentation may be required. In general, grid cell dimensions should be set so that at least four or five cells are contained within the initial fireball region. Differences will also appear due to placement of bursts within grid

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[1] Cell widths in the x- and y- directions are measured in geocentric angular units.

[2] The code allows a maximum of 1300 cells. There can be as many as 18 vertical cells and 20 columns along the x-axis and 20 columns along the y-axis. For example, a grid of 10 x 10 x 13 in the x-y-z directions can be modeled.

cells (at cell edges compared to cell centers); this is a natural consequence of the granularity of the grid calculations.

Note that the number and size of the cells should be made large enough to cover the battlespace of interest. For points outside (i.e., below the bottom, above the top cell center, and outside the bounding tubes), ambient properties are assumed.

9. Object Data. (Data .541 – Data .623)

Object data can be input in two ways. The user can imput either object coordinates directly (suitable for endo-atmospheric problems) or the object trajectory by using the launch point and target point lists described above. In the second case, the user can ignore these and skip to the booster type and object type datasets below.

Object Datasets. (Data .542 – Data .579)

In the example data deck, spaces have been allocated for two objects. To use these, the user should change these "zeros" cards to "refer" cards. The object datasets (Data .545 – Data .552 and Data .564 – Data .569) contain the following data:

Card 1   Beg Set card (name must correspond to name
                referred to on object list)

Card 2   Object name (user selected)

Card 3   Pointer to object type dataset

Card 4   Pointer to object position dataset

Card 5   An internal flag

Card 6   Pointer to radar cross section dataset

Card 7   Pointer to object tumbling model dataset

Card 8   Space for track file associated with this object

The object position datasets (Data .553 – Data .563 and Data .572 – Data .579) contain ten spaces for orbital element storage internally, the reentry time for the object (not used in this mode), the state

of the object (time, position, velocity, acceleration) which the user specifies, a pointer to the ballistic coefficient dataset and space for a beta multiplier for modification of the beta table (not used in this mode and internally set otherwise).

Booster type data is entered when booster plume tracking with an optical sensor is to be performed or when a full object trajectory from launch point to impact point is desired. The booster dataset contains a user selected name ("PLUME" in the example), a reference to the launch point associated with this booster, and a booster stage list.

A two stage booster is given in the sample deck. Inputs for each stage include fuel type (either "SOLID" or "LIQUID"), thrust, initial weight, final weight, nozzle area, burn time, the integration step size for trajectory calculations, the aerodynamic reference area, and a table of axial coefficients versus Mach number.

Object Type Data. (Data .613 - Data .619)

The object type is described by an object name (OVERSHOE in this example), a pointer to a ballistic coefficient dataset, the reentry altitude where drag should start, a pointer to the radar cross section for this object, a pointer to the bomb type, and a pointer to the tumbling model.

Ballistic Coefficient Dataset. (Data .621 - Data .623)

The ballistic coefficient (beta) can be modeled with a constant (model type = 1), with a beta/altitude table (model type = 2), or using a cone-aerodynamic model (model type = 3). The datasets corresponding to these models are B4, BT, and B3, respectively (see Vol. 3).

The object ballistic coefficient in this case is modeled as a constant. The dataset for this model contains the model type (1.0), and the ballistic coefficient.

10. Radar Event and Radar Datasets. (Data .624 - Data .759)

There are a large number of radar inputs, beginning with the radar look event and radar list. The user can elect to set up his own initial radar event by putting the event on the event list and entering the object data as described above, or he can merely input a radar list and use the trajectory generation option (must input launch points and target points as described above) in which case the program sets up radar lo·ks for each object as it enters each radar field-of-view. Note that in the sample data deck provision is allowed for either option; that is, a radar event is entered on the event list (although with a large event time) and launch point/targets point lists are entered (except that the number of objects is set to zero). Thus the sample deck can be used in either case by either inputting the desired radar lock event time or inputting one or mare objects on the launch and target point datasets.

Radar Event Dataset. (Data .625 - Data .634)

The radar event dataset consists of the event type (4.0, which should not be changed), the event time (user specifies), pointers to the radar and object used in this event, and eleven additional parameters that are either internally generated or should not be changed.

Radar List and Radar Datasets. (Data .635 - Data .645)

In the current example, a single radar is specified, called RADAR B. The RADAR B dataset contains a name (RAD/B), pointers to platform, boresight, radar type, radar errors, and discrimination input datasets, and space for a track file list used internally.

Boresight Dataset. (Data .649 - Data .652)

The boresight dataset contains Hollerith flags indicating whether a face can acquire the target followed by the boresight vector. In the example, only one radar fare is specified which can acquire. Note that the boresight vector is specified in polar coordinates relative to the geographic coordinates (GEOR card 647) just above it.

Radar Errors. (Data .654 - Data .661)

Fixed and signal-to-noise-dependent errors in range, azimuth, and elevation for the two faces are input in the form shown. Bias errors for the three measurements can also be input if known. Zeros have been entered for bias errors in the example.

Discrimination Input Dataset. (Data .663 - Data .673)

Discrimination inputs consist of the discrimination type (either WBL, wide-bandwidth length, or FFL, fine-frequency length), the body length, the time interval for discrimination pulses, the altitude below which fine-frequency length measurements cannot be made, the total time during which discrimination pulses will be sent, a range limit beyond which wide-bandwidth length measurements cannot be made, and the noise bandwidth.

Radar Type Data. (Data .675 - Data .687)

Radar type data consists of a radar name, a Hollerith flag for beam stacking, pointers to datasets (radar errors, transmit beam-shape, receive beamshape, search mode parameters, and track mode parameters), the radar frequency, the effective noise temperature,[1] the radar horizon limit, the off-boresight angle limit, and a Hollerith flag indicating antenna polarization.

Search Mode Parameters. (Data .690 - Data .708)

Separate radar parameters are given for the search/verification and the track-initiation/track functions. The search/verification parameters define the search sector plus the other characteristics shown in the example. The last card is an integer flag which allows successive search pulses to be processed. When the flag is set to 1, the track logic is bypassed.

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[1] The total effective noise temperature as used here includes the sum of the system temperature and effective receiver noise temperature, which is equivalent to the noise figure times the system (room) temperature.

Radar Platform Dataset.   (Data .711 - Data .713)

The radar may be placed on a number of different types of platforms (ground-based, satellite, airborne). These are designated by inputting the Hollerith names FIXED, ORBITAL, or CIRCULAR, with a set of state parameters appropriate to that model (see the P1, P2, P3 datasets in Vol. 3). For the fixed platform used in this example, only a position need be specified.

Track Filter Initialization.   (Data .715 - Data .728)

The "ad hoc dataset for tracker initialization" contains a track filter beta multiplier term for initialization, the decay constants, and altitude for setting up exponential memory decay (if desired), initial values for the beta multiplier sigma and beta dot terms, and a pointer to the defense "guessed" beta table which follows in the input stream.

Transmit Beam Shape Model.   (Data .730 - Data .737)

The name of the model type is specified first. Options include: CONSTANT for a mainlobe-plus-constant-sidelobe model, and TAPERED for tapered angle sidelobes. Other inputs include the beamshape (CIRCULAR or ELLIPTICAL), the beamwidth, the half beamwidth in sine space, a second input for half beamwidth in the vertical direction when an elliptical beamshape is used, the near-in angular sidelobe level, and a space for internal storage.

Track Mode Parameters Dataset.   (Data .739 - Data .751)

The radar parameters used for the track initiation and track functions are shown next. Most of these parameters are well defined, with the exception of the range gate parameters. The range gate width at any time is given by

$$W = \begin{cases} W1 & \text{for track initiation} \\ W2 = K1 + K2\sigma_{RP} & \text{for track} \end{cases}$$

where K1 and K2 are inputs, and σ_{RP} is the deviation in the predicted target output by the filter.

Radar Cross Section Dataset. (Data .752 - Data .754)

The object radar cross section dataset is the next set of cards in the data stream. Here a moael specification must be made from among the four model types allowed:

Type	Model
1	Constant
2	Table interpolation of RCS with aspect
3	Tank-like objects
4	RV and decoy model

Datasets R1, R2, R3 and R4 correspond to these model types. For type 1, which is used here, the user merely inputs the RCS. For the other types, the user is referred to the datasets R2, R3, and R4 in Vol. 3.

Tumbling Model. (Data .755 - Data .756)

There are three tumbling models available: type 1--object oriented along the current velocity vector; type 2--body oriented along its initial reentry velocity vector; and type 3--a stochastic model which allows the object to tumble at a given rate to some stabilization altitude. Datasets for these three models (T1, T2 and T3, respectively) are given in Vol. 3 of this report.

The tumbling model for the object in this example is Model type 1, where the body axis is aligned with the velocity vector. With this model, no other inputs are required.

Receive Beam Shape Model. (Data .757 - Data .759)

The transmit and receive beamshape models are assumed to be identical. Thus we merely insert the transmit beamshape model here using the INSERT card.

11. Communication Event Datasets. (Data .760 - Data .842)

The satellite communications model can be run by putting a communication event dataset on the event list, and then satisfying the data input requirements that emanate from this dataset. These

include: (1) the uplink dataset, which defines the parameters for
the uplink transmitter-receiver pair; (2) the downlink dataset,
which contains similar parameters for the downlink; (3) the trans-
mitter platform dataset, which gives the position of the ground
transmitter; (4) the satellite platform dataset, which gives the
satellite starting position and orbital parameters (if desired);
and (5) the receiver platform dataset, which gives the position of
the ground receiver.

Communication Event Dataset. (Data .761 - Data .779)

A communication event has been input on the event list in the
sample data deck. To enable the computation of this event the
user should change the event time to be consistent with the burst
times and other events being processed. Events will be processed at
the time interval input by the user (set to 30 sec. in the sample
deck). Other input options relating to the type of communication
system simulated are described in Vol. 20.

Uplink and Downlink Datasets. (Data .780 - Data .830)

The user can change any of the input variables in the uplink
and downlink datasets to model his particular system with the ex-
ception of the "zeros" card at the end of the datasets.

Transmitter, Receivers, and Satellite Platform Datasets.
(Data .831 - Data .842)

The transmitter and receiver datasets are generally input
as fixed ground platforms. The satellite platform can be input as
fixed in space (as in the sample deck) or specified as following
an orbit (see the P2 and P3 dataset descriptions in Vol. 3)

12. **Optical Sensor Event and Optics Data.** (Data .843 - Data .998)

Two types of optics problems can be simulated in ROSCOE--(1)
a surveillance problem where the sensor is pointed at some reference
location, or (2) a track problem where a booster plume, aircraft
plume, or fireball is tracked. In the first case, the user puts
an optics look event in the event list and supplies the first look
time and the reference point for the look direction. In the

second case, the user inputs the booster model and the burnout position.

Both types of problems are set up in the sample deck. The following sections describe how to turn them on and the calculation options allowed in each case.

Optics Look Event. (Data .844 - Data .851)

An optics look event has been inserted on the event list. To enable its computation, the user must change the event time. The look event will be set up using the optical sensor and reference position "referred" to on the next two cards of the dataset. All other inputs should be set as shown in the sample deck.

Cloud Data. (Data .852 - Data .872)

Two types of cloud modeling are allowed: (1) a deterministic model, where the user inputs the location and size of each cloud; and (2) a statistical model which allows for some average cloud statistics to be included in the optics calculation.

Clouds are modeled by putting a basic cloud dataset pointer in the basic dataset (change card 60 from ZEROS to REFER) and entering a basic cloud dataset as shown in the sample deck. The inputs for this dataset are: (1) model type (1 for statistical clouds and 0 for deterministic clouds); (2) number of deterministic clouds; (3) cloud list header (change ZEROS to REFER to enter deterministic cloud list); and (4) pointer to the statistical cloud dataset.

For statistical cloud modeling options (model number and layer number), the user is referred to Vol.24 describing this model. For deterministic clouds, the user enters a REFER card on the cloud list for each cloud he wishes to model and follows this with a cloud dataset describing the position and size of each cloud. A single cloud (CLOUDA) is included in the sample deck as an example.

The cloud index should be set to consecutively higher numbers if additional deterministic clouds are added. The cloud type parameters should be left as is since only one cloud type is currently provided for in the code.

Optical Sensor Data. (Data .873 - Data .873)

The optical sensor data begins with a sensor list. One sensor is shown in the sample deck. The optical sensor dataset includes these cards:

Card 1 -- Beg Set Card (dataset descriptor must be consistent with descriptor on sensor list).

Card 2 -- Name (user supplied).

Card 3 -- Optics type (options include TRACK and SURVEILNCE as described above).

Card 4 -- Optics calculation type (optics inclued--POINTS, which means only single line-of-sight calculations will be performed; or FOV, which means a set of lines-of-sight will be computed so that a focal plane representation of the scene can be constructed and scanned (see Vol. 33); or LOCAL, which sets up the focal plane representation as above but limits the scanning to regions about specific objects.

Card 5 -- Object types (used with LOCAL above--options are TARGETS, FIREBALLS or ALL).

Card 6-9-- Pointers to the boresight, platform, optics type and optics noise datasets.

Card 10 -- Spaces for optics options (by changing this card to a REFER the simulate optics and track simulations events can be enabled).

Card 11 -- Internal Space for a trackfile.

Card 12 -- Pointer to the optics grid dataset.

Card 13 -- Internal space for list of paths within FOV.

The optics noise, boresight and platform datasets follow in
the sample deck (Data .889 - Data .903). They are self-explana-
tory with the exception of the acquisition flag in the boresight
dataset. This parameter either allows (enter YES) or does not
allow (enter NO) the optical sensor to initiate a trackfile on
its own. If acquisition is not allowed, it is assumed a radar
has been entered and acquisition and trackfile initiation will be
performed by the radar sensor.

Optics Type Data. (Data .905 - Data .934)

Optics type data consists of an optics type dataset describ-
ing the sensor (number of detectors, blur diameter, NEFD, frame
time. etc.), a wavelength band list, and a field-of-view dataset.

There are a number of options allowed for entering wavelength
bands. First, the user can specify any number of wavelength bands
he is interested in by putting them on the wavelength band list
and entering a wavelength band dataset for each of them. In the
wavelength band datasets, he can enter the end points of the band
in length units (first two entries as shown in the sample deck), or
he can enter the end points of the band in wave numbers (cm^{-1}). The
last entry in the dataset can be set to zero, meaning no further
subdivision of the band is desired; or the user can enter a list
header variable to a band interval list to further subdivide the
band (in which case he must enter the list and band interval data-
sets--see Vol. 3 for a description of these datasets); or the user
can enter an integer describing the number of intervals the band
should be divided into. Emission and scattering calculations are
performed within the code for every band interval specified. Out-
puts of the radiance along a path at each band interval and the
band integrated radiance are then provided.

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The field-of-view of the sensor is described by setting the azimuth and elevation extent. These inputs must be limited to values not greater than 100 detector diameters. The last two inputs in this dataset are used to set baffle limits for a sensor. The first entry refers to the altitude below which the sensor cannot pick up a target. The second constraint is for upward looking sensors where an angle above the horizon is specified.

Optics Calculations. (Data .935 – Data .962)

Two types of optical sensor processing calculations can be simulated. The first is for the surveillance sensor application, where a field-of-view representation is computed, and a simulation of the scanning motion over the field-of-view is conducted. The second is a track simulation using the optical sensor. The processing calculations are enabled by setting up the simulate optics or track simulation event dataset pointers in the optics options dataset (i.e., making these REFER cards), and setting the event times accordingly.

Options allowed in the simulate optics event include a model type specification in which the user can select a built-in model (SURVEIL-01) or input his own (GENERAL). If the user inputs his own model, he must designate the scan pattern type (either CIRCULAR or LINEAR) and input a list header variable for the SPIRE computation list (change ZEROS card to REFER). The only other option allowed is for the plots entry. Here the user can specify whether he wants printer plot outputs of the sensor focal plane representation. The options are: OBJECTS--which produces contour plots for individual objects plus a composite plot; YES--produces only the composite plot; or NO--produces no contour plots but sets up the focal plane data for scanning and processing calculations.

For the track simulation event the user must specify the event time, the track interval, and the initial standard deviation in range used for track initialization in the case where the optical sensor is allowed to perform acquisition.

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SPIRE Sensor processing Blocks. (Data .964 - Data .998)

As mentioned above, the user can input his own sensor scanning and processing model. The model is described in ROSCOE Vol. 21. An example set of processing blocks are shown in the sample deck. This set allows scanning of the focal plane, the addition of detector noise to the scanned output, Gaussian smoothing of the data stream output, and differencing and thresholding of the data for target identification.

13.   Burst and Weapon Type Data. (Data .999 - Data .1174)

Burst Event Datasets. (Data .1002 - Data .1029)

The burst event datasets have the form: event type, event time, burst position, and a pointer to the weapon type dataset. Burst altitudes must be greater than zero. Five burst events are shown in the sample data deck, each pointing to a separate weapon type (note--these bursts could also point to same weapon type dataset if that were desired).

Weapon Type Dataset. (Data .1032 - Data .1174)

The weapon type dataset contains a weapon name (BOMB-1 for example), yield and yield fractions, weapon mass and mass fractions, and pointers to the device-dependent energy spectrum data and the device-independent energy spectrum data.

The remainder of this section of the data deck consists of the various spectrum data for a nominal weapon. Other weapon characteristics can be specified in a similar manner. Two sets of special weapon characteristics are given in Ref. 1.

14.   Environment Output Event. (Data .1175 - Data .1191)

This event directs the program to create specific physics outputs at specified times. The dataset contains the event type,

---

[1] W.S. Knapp, Weapon Output, Energy Deposition and Atmospheric Chemistry Models for ROSCOE, Vol. 2, "Weapon Output and Energy Deposition Models," December 1974 (unpublished).

the event time, the type of output desired, the number of points at
which output is desired, the time interval between calculations,
the end print time, the radar frequency for these calculations (if appro-
priate), a pointer to a grid output data set, and a space for internal storage.

The event types can be specified as FIREBALL, which means that
a single point within a low-altitude fireball or on its surface
will be used to compute electron densities, temperatures, and
clutter albedos; or as NONE, VORTEX, CONTINUUM, or ALL, which
would produce point data at the number of points specified in
any or all of these regions along a horizontal line from the center
of a low-altitude fireball. In addition, the user can specify
the event type as HA-FIREBAL to get electron densities along a
vertical line through a high-altitude fireball.

The environment output event prints at a minimum (when the
type is NONE) the fireball and debris properties corresponding to
formats F1, F2, F3, F4, and D1. The other output types (FIREBALL,
VORTEX, CONTINUUM, ALL, HA-FIREBAL) also provide the chemistry and
albedo data given in the CO format dataset.

An example of the use of grid output dataset is shown in
cards 1187-1191 of the sample data package. The grid output data-
set is designed to provide contour plot output at selected cross
sections of the grid. The variable "type" defines the location
where the grid cut is made; in the example, the type is FIREBALL,
indicating that a cut through the center of the fireball will be
made; otherwise the type should be input as OTHER and the second
variable, "index" will be used to define the index of the cell in
the x- or y- direction to be used. The "kind of output" can be RHO
for mass density contour plots, NE for electron density plots, STRI
for striation fraction plots, ALL for all of the above, or NONE
for none of them.

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15. <u>Stop Event</u>. (Data .1192 – Data .1194)

The stop event terminates program execution at the time specified.

APPENDIX A

ROSCOE DATA PACKAGE

```
DATA    *DECK DATA
DATA    RGSCCE** NEW VERSION OF NUCLEAR PHENOMENOLOGY CODE*
DATA    02 TEST RUN FOR RGSCCE PROGRAM
DATA    IS EARTH ROTATING FOR THIS RUN                        YES
DATA    STARTING RANDOM NUMBER                                2.7192
DATA    * SCALE FACTORS USED IN RGSCCE DATA (STANDARD UNITS ARE CGS)   BOX PAGE
DATA    * SCALE FACTOR CHANGES TO CONVERT INTO CGS SYSTEM              PRINT
DATA    CONVERSION TO MHZ               MHZ    1000000.                SCALE
DATA    CONVERSION TO KHZ               KHZ    1000.                   SCALE
DATA    FRACTIONAL HOURS                HRS    1.0                     SCALE
DATA    KILOGRAM INPUTS                 KG     1000.0                  SCALE
DATA    GRAM INPUTS                     GT     1.0                     SCALE
DATA    CENTIMETER INPUTS              CM     1.0                      SCALE
DATA    * HERE WE REDEFINE THE APPROPRIATE SCALE FACTORS BUILT INTO FLEXRED   PRINT
DATA    FEET TO CENTIMETERS            FT     30.48006                 SCALE
DATA    PSF TO G/CM**2                 PSF    .0002405                 SCALE
DATA    KILOMETERS TO CENTIMETERS     KM     100000.0                  SCALE
DATA    NAUTICAL MILES TO CENTIMETERS NMI    185325.0                  SCALE
DATA    POUNDS TO GRAMS                LB     453.592                  SCALE
DATA    ACCELERATION UNITS             G      980.665                  SCALE
DATA    METERS TO CENTIMETERS          M      100.0                    SCALE
DATA    METERS**2 TO CENTIMETERS**2    MSQ    10000.0                  SCALE
DATA    KILOFEET TO CENTIMETERS        KFT    30480.06                 SCALE
DATA    MEGATON = THE FUNDAMENTAL YIELD UNIT   MT   1.0                SCALE
DATA    NAUTICAL MILES TO CENTIMETERS  NM    1.85E+05                  SCALE
DATA    KILOTONS TO MEGATONS           KT     .001                     SCALE
DATA    KILOMETERS ON SQUARE METERS    KMSQM  10000.0                  SCALE
DATA    NAUTICAL MILES RANGE ON 1 SQ. METER   NMSQM  1.85E4            SCALE
DATA    KILOFEET ON SQUARE METERS      KFSQM  3048.006                 SCALE
DATA    WATTS TO ERGS/SEC              WATTS  10000000.                SCALE
DATA    INCHES**2 TO CM**2             INSQ   6.4516                   SCALE
DATA    FT**2 TO CM**2                 FTSQ   929.0304                 SCALE
DATA    * THIS IS THE BASIC DATASET FOR RGSCCE                         BOX PAGE
DATA    RGSCCE BASIC DATA SET                                          BASIC
DATA    RGSCCE BASIC DATA SET                                          BEG SET
DATA    EVENT LIST
DATA    OUTPUT SUMMARY DATASET                                         REFER
DATA    OVERLAY STRUCTURE DATASET                                      REFER
DATA    INSTRUCTIONS FOR INTERNAL OUTPUTS      1.0                     REFER
DATA    SPACE FOR OBJECT LIST                  1.0                     ZEROS
DATA    SPACE FOR RADAR LIST                                           ZEROS
DATA    AD TCC DATA SET FOR TRACKEN INITIALIZATION                     REFER
DATA    SPACE FOR THE BURST LIST               1.0                     ZEROS
DATA    SPACE FOR FIREBALL LIST                1.0                     ZEROS
DATA    SPACE FOR =COAST=                      0.0
DATA    SPACE FOR =PRLIS= (LAMB)               0.0
DATA    SPACE FOR =PRLIS= (HEAVE)              0.0
DATA    SPACE FOR OFSET
DATA    SPACE FOR MAGNETIC FIELD DATASET       1.0                     ZEROS
DATA    HAVE COORDINATE DATASET                1.0                     ZEROS
DATA    SHOULD WE TURN ON MYOMC FOR LA FBS     NO                      REFER
DATA    DO YOU WANT STRIATION CALCULATIONS     YES
```

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```
DATA   DO YOU WANT PRINTER PLOTS OF MAFB-S           YES
DATA   SPACE FOR INTERNAL USE                        2.0
DATA   DO YOU WANT FB DATA RELATIVE TO RADAR         NO
DATA         SENSOR NETTING
DATA   DO YOU WANT TIME INTERPOLATION                NO
DATA   SPACE FOR OPTICAL SENSOR LIST                 1.0
DATA   SPACE FOR OPTICAL MEASUREMENTS                1.0
DATA   BASIC CLOUD DATASET                           1.0
DATA         OPTICS CALC SPEED OPTION                SLOW
DATA         EVPACC OUTPUT SUPPRESS FLAG             1.0
DATA         OVERLAY SEP, PILE FLAG                  1.0     INT
DATA   * FLAGS FOR TURNING ON DEBUG PRINTOUT BY OVERLAY      INT
DATA   INSTRUCTIONS FOR INTERNAL OUTPUTS
DATA   EVENT 1 OUTPUT                                NO
DATA   EVENT 2 OUTPUT                                NO
DATA   EVENT 3 OUTPUT                                NO
DATA   EVENT 4 OUTPUT                                NO
DATA   EVENT 5 OUTPUT                                NO
DATA   EVENT 6 OUTPUT                                NO
DATA   EVENT 7 OUTPUT                                NO
DATA   EVENT 8 OUTPUT                                NO
DATA   EVENT 9 OUTPUT                                NO
DATA   EVENT 10 OUTPUT                               NO
DATA   EVENT 11 OUTPUT                               NO
DATA   EVENT 12 OUTPUT                               NO
DATA   EVENT 13 OUTPUT                               NO
DATA   EVENT 14 OUTPUT                               NO
DATA   EVENT 15 OUTPUT                               NO
DATA   EVENT 16 OUTPUT                               NO
DATA   EVENT 17 OUTPUT                               NO
DATA   EVENT 18 OUTPUT                               NO
DATA   EVENT 19 OUTPUT                               NO
DATA   EVENT 20 OUTPUT                               NO
DATA   EVENT 21 OUTPUT                               NO
DATA   EVENT 22 OUTPUT                               NO
DATA   EVENT 23 OUTPUT                               NO
DATA   EVENT 24 OUTPUT                               NO
DATA   EVENT 25 OUTPUT                               NO
DATA   EVENT 26 OUTPUT                               NO
DATA   EVENT 27 OUTPUT                               NO
DATA   EVENT 28 OUTPUT                               NO
DATA   EVENT 29 OUTPUT                               NO
DATA   EVENT 30 OUTPUT                               NO
DATA   EVENT 31 OUTPUT                               NO
DATA   EVENT 32 OUTPUT                               NO
DATA   * OVERLAY CALLING STRUCTURE (ALTERNATE OVERLAYS CAN BE CALLED HERE)
DATA   OVERLAY STRUCTURE DATASET                     NO
DATA   EVENT 1 CALLS OVERLAY                         1.0     INT
DATA   EVENT 2 CALLS OVERLAY                         2.0     INT
DATA   EVENT 3 CALLS OVERLAY                         3.0     INT
DATA   EVENT 4 CALLS OVERLAY                         4.0     INT
DATA   EVENT 5 CALLS OVERLAY                         5.0     INT
```

```
DATA                    53  ◄
DATA                    54  ◄
DATA                    55  ◄
DATA                    56  ◄
DATA    ZEROS           57  ◄
DATA                    58  ◄
DATA                    59  ◄
DATA                    60  ◄
DATA    ZEROS           61  ◄
DATA    ZEROS           62  ◄
DATA    ZEROS           63  ◄
DATA                    64  ◄
DATA    BOX PAGE        65  ◄
DATA    BEG SET         66  ◄
DATA                    67  ◄
DATA                    68  ◄
DATA                    69  ◄
DATA                    70  ◄
DATA                    71  ◄
DATA                    72  ◄
DATA                    73  ◄
DATA                    74  ◄
DATA                    75  ◄
DATA                    76  ◄
DATA                    77  ◄
DATA                    78  ◄
DATA                    79  ◄
DATA                    80  ◄
DATA                    81  ◄
DATA                    82  ◄
DATA                    83  ◄
DATA                    84  ◄
DATA                    85  ◄
DATA                    86  ◄
DATA                    87  ◄
DATA                    88  ◄
DATA                    89  ◄
DATA                    90  ◄
DATA                    91  ◄
DATA                    92  ◄
DATA                    93  ◄
DATA                    94  ◄
DATA                    95  ◄
DATA                    96  ◄
DATA                    97  ◄
DATA                    98  ◄
DATA    BOX PAGE        99  ◄
DATA    BEG SET        100  ◄
DATA                   101  ◄
DATA                   102  ◄
DATA                   103  ◄
DATA                   104  ◄
```

```
DATA   EVENT  6 CALLS OVERLAY              6.0    INT
DATA   EVENT  7 CALLS OVERLAY              7.0    INT
DATA   EVENT  8 CALLS OVERLAY              8.0    INT
DATA   EVENT  9 CALLS OVERLAY              9.0    INT
DATA   EVENT 10 CALLS OVERLAY             10.0    INT
DATA   EVENT 11 CALLS OVERLAY             11.0    INT
DATA   EVENT 12 CALLS OVERLAY             12.0    INT
DATA   EVENT 13 CALLS OVERLAY             13.0    INT
DATA   EVENT 14 CALLS OVERLAY             14.0    INT
DATA   EVENT 15 CALLS OVERLAY             15.0    INT
DATA   EVENT 16 CALLS OVERLAY             16.0    INT
DATA   EVENT 17 CALLS OVERLAY             17.0    INT
DATA   EVENT 18 CALLS OVERLAY             18.0    INT
DATA   EVENT 19 CALLS OVERLAY             19.0    INT
DATA   EVENT 20 CALLS OVERLAY             20.0    INT
DATA   EVENT 21 CALLS OVERLAY             21.0    INT
DATA   EVENT 22 CALLS OVERLAY             22.0    INT
DATA   EVENT 23 CALLS OVERLAY             23.0    INT
DATA   EVENT 24 CALLS OVERLAY             24.0    INT
DATA   EVENT 25 CALLS OVERLAY             25.     INT
DATA   EVENT 26 CALLS OVERLAY             26.     INT
DATA   EVENT 27 CALLS OVERLAY             27.     INT
DATA   EVENT 28 CALLS OVERLAY             28.     INT
DATA   EVENT 29 CALLS OVERLAY             29.     INT
DATA   EVENT 30 CALLS OVERLAY             30.     INT
DATA   EVENT 31 CALLS OVERLAY             31.     INT
DATA   EVENT 32 CALLS OVERLAY             32.     INT
DATA   * OUTPUT DATASETS AND FORMATS (MAY BE CHANGED BY USER)
DATA   OUTPUT SUMMARY DATASET                            BCX PAGE       DATA 105
DATA   SYSTEM OUTPUT LIST                                BEG SET        DATA 106
DATA   TRAJECTORY OUTPUT FORMAT LIST                     REFER          DATA 107
DATA   TRACK MEAS, ERRORS FORMAT LIST                    REFER          DATA 108
DATA   TRACK FILE OUTPUT FORMAT LIST                     REFER          DATA 109
DATA   PROPAGATION OUTPUT FORMAT LIST                    REFER          DATA 110
DATA   DISCRIMINATION OUTPUT FORMAT LIST                 REFER          DATA 111
DATA   FIREBALL POSITION OUTPUT FORMAT LIST              REFER          DATA 112
DATA   BO OUTPUT LIST                        1.0         ZEROS          DATA 113
DATA   F1 OUTPUT LIST                        1.0         ZEROS          DATA 114
DATA   F2 OUTPUT LIST                        1.0         ZEROS          DATA 115
DATA   F3 OUTPUT LIST                        1.0         ZEROS          DATA 116
DATA   F4 OUTPUT LIST                        1.0         ZEROS          DATA 117
DATA   DI OUTPUT LIST                        1.0         ZEROS          DATA 118
DATA   BE OUTPUT LIST                        1.0         ZEROS          DATA 119
DATA   CO OUTPUT LIST                                    ZEROS          DATA 120
DATA   OM OUTPUT LIST                        1.0         ZEROS          DATA 121
DATA   CS OUTPUT LIST                        1.0         ZEROS          DATA 122
DATA   UP OUTPUT LIST                        1.0         ZEROS          DATA 123
DATA   OC OUTPUT LIST                        1.0         ZEROS          DATA 124
DATA   BO OUTPUT FORMAT LIST                             REFER          DATA 125
DATA   F1 OUTPUT FORMAT LIST                             REFER          DATA 126
DATA   F2 OUTPUT FORMAT LIST                             REFER          DATA 127
DATA   F3 OUTPUT FORMAT LIST                             REFER          DATA 128
                                                                        DATA 129
                                                                        DATA 130
                                                                        DATA 131
                                                                        DATA 132
                                                                        DATA 133
                                                                        DATA 134
                                                                        DATA 135
                                                                        DATA 136
                                                                        DATA 137
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                                                                        DATA 139
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                                                                        DATA 141
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                                                                        DATA 143
                                                                        DATA 144
                                                                        DATA 145
                                                                        DATA 146
                                                                        DATA 147
                                                                        DATA 148
                                                                        DATA 149
                                                                        DATA 150
                                                                        DATA 151
                                                                        DATA 152
                                                                        DATA 153
                                                                        DATA 154
                                                                        DATA 155
                                                                        DATA 156
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DATA    F4 OUTPUT FORMAT LIST
DATA    D1 OUTPUT FORMAT LIST
DATA    BE OUTPUT FORMAT LIST
DATA    CC OUTPUT FORMAT LIST
DATA    CM OUTPUT FORMAT LIST
DATA    CS OUTPUT FORMAT LIST
DATA    CP OUTPUT FORMAT LIST
DATA    CC OUTPUT FORMAT LIST
DATA    TRAJECTORY OUTPUT FORMAT LIST
DATA    TRAJECTORY OUTPUT FORMAT
DATA    TRACK MEAS. ERRORS FORMAT LIST
DATA    TRACK MEASUREMENT ERRORS FORMAT
DATA    TRACK FILE OUTPUT FORMAT LIST
DATA    TRACK FILE OUTPUT FORMAT
DATA    PROPAGATION OUTPUT FORMAT LIST
DATA    PROPAGATION OUTPUT FORMAT
DATA    DISCRIMINATION OUTPUT FORMAT LIST
DATA    DISCRIMINATION OUTPUT FORMAT
DATA    FIREBALL POSITION OUTPUT FORMAT LIST
DATA    FIREBALL POSITION OUTPUT FORMAT
DATA    BO OUTPUT FORMAT LIST
DATA    BO OUTPUT FORMAT DATASET
DATA    F1 OUTPUT FORMAT DATASET
DATA    F2 OUTPUT FORMAT LIST
DATA    F2 OUTPUT FORMAT DATASET
DATA    F3 OUTPUT FORMAT DATASET
DATA    F3 OUTPUT FORMAT LIST
DATA    F4 OUTPUT FORMAT LIST
DATA    F4 OUTPUT FORMAT DATASET
DATA    D1 OUTPUT FORMAT LIST
DATA    D1 OUTPUT FORMAT DATASET
DATA    BE OUTPUT FORMAT LIST
DATA    BE OUTPUT FORMAT DATASET
DATA    CC OUTPUT FORMAT LIST
DATA    CM OUTPUT FORMAT DATASET
DATA    CM OUTPUT FORMAT LIST
DATA    CS OUTPUT FORMAT LIST
DATA    CS OUTPUT FORMAT DATASET
DATA    CP OUTPUT FORMAT DATASET
DATA    CP OUTPUT FORMAT LIST
DATA    CC OUTPUT FORMAT LIST
DATA    CC OUTPUT FORMAT DATASET
DATA    * AND NCR FOR THE INDIVIDUAL OUTPUT INSTRUCTIONS
DATA    TRACK FILE OUTPUT FORMAT
DATA    TYPE OF OUTPUT REQUESTED
        TRACKING ERRORS          OUTCOL
                        01014.0   TIME OF OUTPUT SEC
DATA    TIME COLUMN
DATA    POSITION ERRORS  004024   ERRORS IN ALONG V M
DATA    POSITION ERRORS  03034    POSITION---PERP TO V M
DATA    POSITION ERRORS  02044    ----------ACROSS V M
```

```
REFER     DATA   157
REFER     DATA   158
REFER     DATA   159
REFER     DATA   160
REFER     DATA   161
REFER     DATA   162
REFER     DATA   163
REFER     DATA   164
BEG LIST  DATA   165
REFER     DATA   166
BEG LIST  DATA   167
REFER     DATA   168
BEG LIST  DATA   169
REFER     DATA   170
BEG LIST  DATA   171
REFER     DATA   172
BEG LIST  DATA   173
REFER     DATA   174
BEG LIST  DATA   175
REFER     DATA   176
BEG LIST  DATA   177
REFER     DATA   178
BEG LIST  DATA   179
REFER     DATA   180
BEG LIST  DATA   181
REFER     DATA   182
BEG LIST  DATA   183
REFER     DATA   184
BEG LIST  DATA   185
REFER     DATA   186
BEG LIST  DATA   187
REFER     DATA   188
BEG LIST  DATA   189
REFER     DATA   190
BEG LIST  DATA   191
REFER     DATA   192
BEG LIST  DATA   195
REFER     DATA   196
BEG LIST  DATA   197
REFER     DATA   198
BEG LIST  DATA   199
BEG LIST  DATA   200
REFER     FIX    1
PRINT     FIX    2
BEG SET   DATA   201
TITLE     DATA   202
OUTCOL    DATA   203
OUTCOL    DATA   204
OUTCOL    DATA   205
OUTCOL    DATA   206
                 207
                 208
```

```
DATA    VELOCITY ERRORS                    07054        ERRORS IN ALONG V M         OUTCOL    DATA 209
DATA    VELOCITY ERRORS                    06064        VELOCITY-- PERP TO VH       OUTCOL    DATA 210
DATA    VELOCITY ERRORS                    05074        --------- CROSS V M         OUTCOL    DATA 211
DATA    TARGET POSITION                    08084        APPARENT RANGE   M          OUTCOL    DATA 212
DATA    TARGET POSITION                    09094        TARGET  AZIMUTH  DEG        OUTCOL    DATA 213
DATA    TRAJECTORY OUTPUT FORMAT           10004        POSITION ELEVATION DEG      BEG SET   DATA 214
DATA    TYPE OF OUTPUT REQUESTED                                                              DATA 215
                      TRAJECTORY OUTPUT                 OUTCOL                                DATA 216
DATA    EVENT TYPE                         01014        TYPE   OF EVENT             TITLE     DATA 217
DATA    TIME OF OUTPUT                     02024        TIME  OF OUTPUT  SEC        OUTCOL    DATA 218
DATA    ALTITUDE                           03034        POSITION ALTITUDE M         OUTCOL    DATA 219
DATA    RANGE                              04044        DATA FOR  RANGE  M          OUTCOL    DATA 220
DATA    AZIMUTH                            05054        OBJECT AT AZIMUTH DEG       OUTCOL    DATA 221
DATA    ELEVATION                          06064        SPECIFIED ELEVATION DEG     OUTCOL    DATA 222
DATA    VELOCITY                           07074        TIME------ VELOCITY M       OUTCOL    DATA 223
DATA    SIGNAL TO NOISE                    08084        --------SIGNAL TO NOISE (DB) OUTCOL   DATA 224
DATA    NUMBER OF TARGETS                  09096        NUMBER OF TARGETS           OUTCOL    DATA 225
DATA    TRACK MEASUREMENT ERRORS FORMAT                                            OUTCOL    DATA 226
DATA    TYPE OF OUTPUT REQUESTED                                                   BEG SET   DATA 227
                      TRACK MEASUREMENT ERRORS          OUTCOL                                DATA 228
DATA    TIME OF OUTPUT                     01014        TIME   OF OUTPUT SEC        TITLE     DATA 229
DATA    PREDICTED RANGE                    02024        PREDICTED  RANGE  M         OUTCOL    DATA 230
DATA    PREDICTED AZIMUTH                  03034        PREDICTED AZIMUTH DEG       OUTCOL    DATA 231
DATA    PREDICTED ELEVATION               04044        PREDICTED ELEVATION DEG      OUTCOL    DATA 232
DATA    MEASURED RANGE                     05054        MEASURED  RANGE  M          OUTCOL    DATA 233
DATA    MEASURED AZIMUTH                   06064        MEASURED AZIMUTH DEG        OUTCOL    DATA 234
DATA    MEASURED ELEVATION                07074        MEASURED ELEVATION DEG      OUTCOL    DATA 235
DATA    RANDOM ERRORS                      08084        ERROR  RANGE  M             OUTCOL    DATA 236
DATA    RANDOM ERRORS                      09094        ERRORS--IN AZIMUTH DEG      OUTCOL    DATA 237
DATA    RANDOM ERRORS                      10004        HAS COORD ELEVATION DEG     OUTCOL    DATA 238
DATA    PROPAGATION OUTPUT FORMAT                                                  OUTCOL    DATA 239
DATA    TYPE OF OUTPUT REQUESTED                                                   BEG SET   DATA 240
                      PROPAGATION OUTPUT                OUTCOL                                DATA 241
DATA    TIME OF OUTPUT                     01014        TIME   OF OUTPUT SEC        TITLE     DATA 242
DATA    ABSORPTION FROM ALL SOURCES        02024        ABSORPTION FROM ALL SOURCES OUTCOL   DATA 243
DATA    THRES-HOLD ABSORPTION              03034        THRES-HOLD ABSORPTION       OUTCOL    DATA 244
DATA    NOISE TEMPERATURE                  04044        NOISE   TEMP                OUTCOL    DATA 245
DATA    NOISE POWER                        05052        NOISE   POWER               OUTCOL    DATA 246
DATA    CLUTTER POWER                      06062        CLUTTER POWER               OUTCOL    DATA 247
DATA    CLUTTER-TO-NOISE RATIO             06064        CLUTTER-TO-NOISE RATIO (DB) OUTCOL    DATA 248
DATA    DISPERSIVE LOSS                    13074        DISPERSIVE   LOSS           OUTCOL    DATA 249
DATA    FARADAY ROTATION LOSS              14004        FARADAY  ROTATION   LOSS    OUTCOL    DATA 250
DATA    FAILURE MODE                       15099        FAILURE   MODE              OUTCOL    DATA 251
DATA    TIME OF OUTPUT                     01114        TIME   OF OUTPUT SEC        OUTCOL    DATA 252
DATA    REFRACTION                         07134        BIAS  RANGE  M              OUTCOL    DATA 253
DATA    REFRACTION                         08144        REFRACTION AZIMUTH DEG      OUTCOL    DATA 254
DATA    REFRACTION                         09154        ERRORS  ELEVATION DEG       OUTCOL    DATA 255
DATA    REFRACTION                         10174        RANDOM  RANGE  M            OUTCOL    DATA 256
DATA    REFRACTION                         11184        RANDOM AZIMUTH  DEG         OUTCOL    DATA 257
DATA    REFRACTION                         12194        REFRACTION AZIMUTH DEG      OUTCOL    DATA 258
DATA    DISCRIMINATION OUTPUT FORMAT                    ERRORS ELEVATION DEG        OUTCOL    DATA 259
                                                                                   BEG SET   DATA 260
```

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Description	Code	Statement	Label	DATA #
TYPE OF OUTPUT REQUESTED				
DISCRIMINATION OUTPUT		OUTCOL	TITLE	DATA 261
TYPE OF OUTPUT	01010	TYPE OF DISCRIM	OUTCOL	DATA 262
TYPE OF OUTPUT	02024	TIME OF OUTPUT SEC	OUTCOL	DATA 263
ESTIMATED LENGTH	03034	ESTIMATED LENGTH M	OUTCOL	DATA 264
DEVIATION IN LENGTH	04044	DEVIATION IN LENGTH M	OUTCOL	DATA 265
MEASUREMENT TYPE	05050	MEAS TYPE	OUTCOL	DATA 266
MINIMUM HCS	06061	MINIMUM HCS MSQ	OUTCOL	DATA 267
ONE-WAY ATTENUATION	07071	ONE-WAY ATTEN DB	OUTCOL	DATA 268
FIREBALL POSITION OUTPUT FORMAT				DATA 269
TYPE OF OUTPUT			BEG SET	DATA 270
				DATA 271
		FB COORDINATES RELATIVE TO RADAR		
		OUTCOL	TITLE	DATA 272
TYPE OF OUTPUT	01010	TYPE OF OUTPUT SEC	OUTCOL	DATA 273
FIREBALL INDEX	02026	FIREBALL INDEX	OUTCOL	DATA 274
FB RANGE	03034	FIREBALL RANGE M	OUTCOL	DATA 275
FB AZIMUTH	04044	FIREBALL AZIMUTH DEG	OUTCOL	DATA 276
FB ELEVATION	05054	FIREBALL ELEVATION DEG	OUTCOL	DATA 277
FB ANGULAR EXTENT	06064	FB ANGULAR EXTENT DEG	OUTCOL	DATA 278
FB RANGE EXTENT	07074	FB RANGE EXTENT M	OUTCOL	DATA 279
RANGE CELL	08084	RANGE CELL	OUTCOL	DATA 280
CLUTTER TO NOISE	09094	CLUTTER-TO-NOISE RATIO (DB)	OUTCOL	DATA 281
INCREMENTAL ABSORPTION	10002	ABSORPTION GRADIENT (DB/KM)	OUTCOL	DATA 282
BO OUTPUT FORMAT DATASET			BEG SET	DATA 283
TYPE OF OUTPUT				DATA 284
BURST PARAMETERS		OUTCOL	TITLE	DATA 285
TYPE OF OUTPUT	01010	TIME OF OUTPUT SEC	OUTCOL	DATA 286
TOTAL ENERGY	02022	TOTAL ENERGY (ERGS)	OUTCOL	DATA 287
FISSION ENERGY	03032	FISSION ENERGY (ERGS)	OUTCOL	DATA 288
BURST ALTITUDE	04044	BURST ALTITUDE KM	OUTCOL	DATA 289
BURST POINT DENSITY	05052	BURST PT. DENSITY (G/CC)	OUTCOL	DATA 290
BURST SCALE HEIGHT	06064	SCALE HEIGHT KM	OUTCOL	DATA 291
BURST POINT TEMP	07074	BURST PT. TEMP (DEG K)	OUTCOL	DATA 292
INITIAL FB RADIUS	08084	INITIAL RADIUS KM	OUTCOL	DATA 293
TIME TO REACH 3000K	09094	TIME TO REACH 3000K	OUTCOL	DATA 294
TIME TO REACH 2000K	10004	TIME TO REACH 2000K	OUTCOL	DATA 295
F1 OUTPUT FORMAT DATASET			BEG SET	DATA 296
TYPE OF OUTPUT				DATA 297
FIREBALL SET=1		OUTCOL	TITLE	DATA 298
TYPE OF OUTPUT	01010	TIME OF OUTPUT SEC	OUTCOL	DATA 299
FIREBALL INDEX	02026	FIREBALL INDEX NUMBER	OUTCOL	DATA 300
HORIZONTAL RADIUS	03034	HORIZONTAL RADIUS KM	OUTCOL	DATA 301
VERTICAL RADIUS	04044	VERTICAL RADIUS KM	OUTCOL	DATA 302
ALTITUDE	05054	CENTER ALTITUDE KM	OUTCOL	DATA 303
RISE RATE	06064	RISE RATE KM	OUTCOL	DATA 304
EXPANSION RATE	07074	EXPANSION RATE KM	OUTCOL	DATA 305
FIREBALL DENSITY	08082	FIREBALL DENSITY (G/CC)	OUTCOL	DATA 306
FIREBALL TEMP	09094	FIREBALL TEMP (DEG K)	OUTCOL	DATA 307
TIME SINCE BURST	10004	TIME SINCE BURST SEC	OUTCOL	DATA 308
F2 OUTPUT FORMAT DATASET			BEG SET	DATA 309
TYPE OF OUTPUT				DATA 310
FIREBALL SET=2		OUTCOL	TITLE	DATA 311
TIME OF OUTPUT	01010	TIME OF OUTPUT SEC	OUTCOL	DATA 312

Code	Field (left)	Field (center)	Units	Type		Line
02026	FIREBALL INDEX	FIREBALL INDEX NUMBER		OUTCOL	DATA	313
03034	MINIMUM ALTITUDE	MINIMUM ALTITUDE	KM	OUTCOL	DATA	314
04044	MAXIMUM ALTITUDE	MAXIMUM ALTITUDE	KM	OUTCOL	DATA	315
05054	TILT FROM VERTICAL	TILT FROM VERTICAL	DEG	OUTCOL	DATA	316
06064	AXIS ROTATION (C=0)	AXIS ROTATION	DEG	OUTCOL	DATA	317
07074	HOR VORTEX RADIUS	HOR VORTEX RADIUS	KM	OUTCOL	DATA	318
08084	VRT VORTEX RADIUS	VRT VORTEX RADIUS	KM	OUTCOL	DATA	319
09092	VORTEX VOLUME	VORTEX VOLUME	(CM3)	OUTCOL	DATA	320
10006	CHARACTERISTIC TIME	CHARACT. TIME	SEC	OUTCOL	DATA	321
				BEG SET	DATA	322
	F3 OUTPUT FORMAT DATASET	OUTCOL		TITLE	DATA	323
	TYPE OF OUTPUT					
01014	FIREBALL SET=3	TIME OF OUTPUT	SEC	OUTCOL	DATA	324
02026	TIME OF OUTPUT	FIREBALL INDEX	NUMBER	OUTCOL	DATA	325
03032	FIREBALL INDEX	X= COORDINATE	(CM)	OUTCOL	DATA	326
04042	X-COORDINATE	Y= COORDINATE	(CM)	OUTCOL	DATA	327
05052	Y-COORDINATE	Z= COORDINATE	(CM)	OUTCOL	DATA	328
06066	Z-COORDINATE	OVAL OF CASSINI	PARAMETER	OUTCOL	DATA	329
07074	OVAL OF CASSINI TERM	OVAL ARM RADIUS	KM	OUTCOL	DATA	330
08084	OVAL ARM RADIUS	VORTEX TEMP	(DEG-K)	OUTCOL	DATA	331
09096	VORTEX TEMP	FIREBALL KIND		OUTCOL	DATA	332
10006	FIREBALL KIND	MERGE ID INDEX		OUTCOL	DATA	333
	MERGE ID INDEX			BEG SET	DATA	334
	F4 OUTPUT FORMAT DATASET	OUTCOL		TITLE	DATA	335
	TYPE OF OUTPUT					
01014	FIREBALL SET=4	TIME OF OUTPUT	SEC	OUTCOL	DATA	336
02026	TIME OF OUTPUT	FIREBALL INDEX	NUMBER	OUTCOL	DATA	337
03032	FIREBALL INDEX	X= COORDINATE	(CM)	OUTCOL	DATA	338
04042	X-COORDINATE	Y= COORDINATE	(CM)	OUTCOL	DATA	339
05052	Y-COORDINATE	Z= COORDINATE	(CM)	OUTCOL	DATA	340
06066	Z-COORDINATE	GRID CELL INDEX	(X-DIR.)	OUTCOL	DATA	341
07078	CELL INDEX (X-DIR.)	GRID CELL INDEX	(Y-DIR.)	OUTCOL	DATA	342
08086	CELL INDEX (Y-DIR.)	GRID CELL INDEX	(Z-DIR.)	OUTCOL	DATA	343
09094	CELL INDEX (Z-DIR.)	FIREBALL REL. POS. IN CELL		OUTCOL	DATA	344
10006	FB REL. POS. IN CELL	FIREBALL KIND		OUTCOL	DATA	345
	FIREBALL KIND			BEG SET	DATA	346
	D1 OUTPUT FORMAT DATASET	OUTCOL		TITLE	DATA	347
	TYPE OF OUTPUT					
01014	DEBRIS PARAMETERS	TIME OF OUTPUT	SEC	OUTCOL	DATA	348
02026	TIME OF OUTPUT	FIREBALL INDEX	NUMBER	OUTCOL	DATA	349
03036	FIREBALL INDEX	DEBRIS INDEX	NUMBER	OUTCOL	DATA	350
04042	DEBRIS INDEX NUMBER	TOTAL ENERGY	(ERGS)	OUTCOL	DATA	351
05054	TOTAL ENERGY	DEBRIS ALTITUDE	KM	OUTCOL	DATA	352
06064	DEBRIS ALTITUDE	HORIZONTAL RADIUS	KM	OUTCOL	DATA	353
07074	HORIZONTAL RADIUS	VERTICAL RADIUS	KM	OUTCOL	DATA	354
08084	VERTICAL RADIUS	DEBRIS DISTRIB. PARAMETER		OUTCOL	DATA	355
09094	DEBRIS DISTRIBUTION,	EQUIVALENTSPH. RAD.	KM	OUTCOL	DATA	356
10002	EQUIVALENT SPH. RAD.	DEBRIS VOLUME	(CM3)	OUTCOL	DATA	357
	DEBRIS VOLUME			BEG SET	DATA	358
	BE OUTPUT FORMAT DATASET	OUTCOL		TITLE	DATA	359
	TYPE OF OUTPUT					
01014	BETA TUBE PARAMETERS	TIME OF OUTPUT	SEC	OUTCOL	DATA	360
	TIME OF OUTPUT					

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DATA   FIREBALL INDEX NUMBER   02026   FIREBALL  INDEX  NUMBER      OUTCOL   DATA   365
DATA   BETATUBE SHAPE          03039   BETATUBE  SHAPE              OUTCOL   DATA   366
DATA   INITIAL DIP ANGLE       04040   INITIAL  DIP ANGLE  DEG      OUTCOL   DATA   367
DATA   KINK ANGLE              05054   KINK ANGLE-HCM MCW1ZDEG      OUTCOL   DATA   368
DATA   KINK-BURST DISTANCE     06069   KINK-BURST DISTANCE  KM      OUTCOL   DATA   369
DATA   A-S RADIUS AT 85KM      07074   A-S RADIUS AT 85KM   KM      OUTCOL   DATA   370
DATA   E-M RADIUS AT 85KM      08084   E-M RADIUS AT 85KM   KM      OUTCOL   DATA   371
DATA   A-S RADIUS AT 60KM      09094   A-S RADIUS AT 60KM   KM      OUTCOL   DATA   372
DATA   E-M RADIUS AT 60KM      10004   E-M RADIUS AT 60KM   KM      BEG SET  DATA   373
DATA  CO OUTPUT FORMAT DATASET                                     TITLE    DATA   374
DATA   TYPE OF OUTPUT          01014   OUTCOL                       OUTCOL   DATA   375
DATA   DETAILED CHEMISTRY, REFLECTIVITY, AND ABSORPTION DATA       OUTCOL   DATA   376
DATA   TIME OF OUTPUT          02026   TIME  OF OUTPUT  SEC         OUTCOL   DATA   377
DATA   FIREBALL INDEX          03034   FIREBALL  INDEX   NUMBER     OUTCOL   DATA   378
DATA   ALTITUDE OF POINT       04044   ALTITUDE  OF POINT  KM       OUTCOL   DATA   379
DATA   RANGE FROM FB CENTER    05059   RANGE FROM FB CENTER  KM     OUTCOL   DATA   380
DATA   LOCATION OF POINT       06062   LOCATION  OF POINT           OUTCOL   DATA   381
DATA   ELECTRON DENSITY        07072   ELECTRON  DENSITY    (CM-3)  OUTCOL   DATA   382
DATA   POSITIVE ION DENSITY    08084   POSITIVE ION DENS.  (CM-3)   OUTCOL   DATA   383
DATA   TEMPERATURE AT POINT    09092   TEMP   AT POINT     (DEG-K)  OUTCOL   DATA   384
DATA   DENSITY AT POINT        09092   DENSITY  AT POINT   (GM/CC)  OUTCOL   DATA   385
DATA   ABSORPTION GRADIENT     10002   ABSORPTION GRADIENT (DB/KM)  BEG SET  DATA   386
DATA  DC OUTPUT FORMAT DATASET                                     TITLE    DATA   387
DATA   TYPE OF OUTPUT          01019   TYPE   OF OUTPUT             OUTCOL   DATA   388
DATA   COMMUNICATIONS OUTPUT                                       OUTCOL   DATA   389
DATA   TIME OF OUTPUT          02029   TIME   OF OUTPUT  SEC        OUTCOL   DATA   390
DATA   TIME OF OUTPUT          04034   UPLINK  LOSS    FACTOR       OUTCOL   DATA   391
DATA   UPLINK LOSS FACTOR      07041   UPLINK  SCINT,              OUTCOL   DATA   392
DATA   UPLINK SCINT,           07041   DOWNLINK  LOSS   FACTOR      OUTCOL   DATA   393
DATA   DOWNLINK LOSS FACTOR    12061   DOWNLINK  SCINT,            OUTCOL   DATA   394
DATA   DOWNLINK SCINT,         14071   PROB.   OF ERROR  SATELLITE  OUTCOL   DATA   395
DATA   PROB ERROR-SATELLITE    15081   PROB.   OF ERROR  GROUND     OUTCOL   DATA   396
DATA   PROB ERROR-GROUND       16091   PROB.   OF ERROR             OUTCOL   DATA   397
DATA   PROBABILITY OF ERROR    02114   TIME OF  OUTPUT  SEC         OUTCOL   DATA   398
DATA   TIME OF OUTPUT          19124   RANGE   S-FRCM-T  KM         OUTCOL   DATA   399
DATA   RANGE S-FROM-T          20134   AZIMUTH  S-FROM-T  DEG       OUTCOL   DATA   400
DATA   AZM B-FROM-T            21144   ELEVATION S-FROM-T  DEG      OUTCOL   DATA   401
DATA   ELV S-FROM-T            22164   RANGE   S-FROM-R  KM         OUTCOL   DATA   402
DATA   RANGE S-FROM-R          23174   AZIMUTH  S-FROM-R  DEG       OUTCOL   DATA   403
DATA   AZM S-FROM-R            24184   ELEVATION S-FROM-R  DEG      BEG SET  DATA   404
DATA   ELV S-FROM-R                                                TITLE    DATA   405
DATA  OM OUTPUT FORMAT DATASET                                     OUTCOL   DATA   406
DATA   TYPE OF OUTPUT          02014   TIME   OF OUTPUT  SEC        OUTCOL   DATA   407
DATA   OPTICAL MEASUREMENTS    04022   CENTRAL  WAVELENGTH-M        OUTCOL   DATA   408
DATA   TIME OF OUTPUT          10042   ACTUAL   AZIMUTH  (RADIANS)  OUTCOL   DATA   409
DATA   WAVELENGTH              11042   --COMOS   AZIMUTH  (RADIANS) OUTCOL   DATA   410
DATA   AZIMUTH                 06052   MEASURED  ELEVATION (RADIANS) OUTCOL  DATA   411
DATA   ELEVATION               07062   --COMOS   ELEVATION (RADIANS) OUTCOL  DATA   412
DATA   MEAS AZ                 07062   ESTIMATED AZIMUTH  (RADIANS) OUTCOL   DATA   413
DATA   MEAS EL                 08072   --COMOS   ELEVATION (RADIANS) OUTCOL   DATA   414
DATA   EST AZ                  09082                                         DATA   415
DATA   EST EL                                                               DATA   416
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DATA        IRRADIANCE                      15092   OUTCOL              IRRADIANCEAT SENSOR   (W/CM2)      DATA   417  ◄
DATA        SIGNAL-TO-NOISE                 19002   OUTCOL              SIGNAL- TO-NOISE        (DB)       DATA   418  ◄
DATA   US OUTPUT FORMAT DATASET                     BEG SET                                               DATA   419  ◄
DATA        TYPE OF OUTPUT                          TITLE           OUTCOL                                DATA   420  ◄
DATA        OPTICAL SAMPLES                 01013   OUTCOL                                                DATA   421  ◄
DATA        TIME OF OUTPUT                  02024   OUTCOL              TIME       OF OUTPUT SEC           DATA   422  ◄
DATA        DETECTOR                        03032   OUTCOL              DETECTOR   NUMBER                 DATA   423  ◄
DATA        WAVELENGTH                      04042   OUTCOL              CENTRAL    WAVELENGTHM            DATA   424  ◄
DATA        AZIMUTH                         05052   OUTCOL              AZIMUTH    OFF-BORE (RADIANS)     DATA   425  ◄
DATA        ELEVATION                       06062   OUTCOL              ELEVATION  OFF-BORE (RADIANS)     DATA   426  ◄
DATA        IRRADIANCE                      07072   OUTCOL              SCANNED    SIGNAL OUTPUT          DATA   427  ◄
DATA        NORMALIZED SIGNAL               09082   OUTCOL              NORMALIZED SIGNAL OUTPUT          DATA   428  ◄
DATA        FINAL SIGNAL                            OUTCOL              FINAL      SIGNAL OUTPUT          DATA   429  ◄
DATA        TARGET FLAG                     10099   OUTCOL              TARGET     DETECTION FLAG         DATA   430  ◄
DATA   OP OUTPUT FORMAT DATASET                     BEG SET                                               DATA   431  ◄
DATA        TYPE OF OUTPUT                          TITLE           OUTCOL                                DATA   432  ◄
DATA        INTEGRATED PATH DATA                    OUTCOL                                                DATA   433  ◄
DATA        TIME                            01014   OUTCOL              TIME       OF OUTPUT SEC           DATA   434  ◄
DATA        WAVELENGTH                      02022   OUTCOL              CENTRAL    WAVELENGTHM            DATA   435  ◄
DATA        AZIMUTH                         03032   OUTCOL              AZIMUTH    OFF-BORE (RADIANS)     DATA   436  ◄
DATA        ELEVATION                       04042   OUTCOL              ELEVATION  OFF-BORE (RADIANS)     DATA   437  ◄
DATA        RADIANCE                        05052   OUTCOL              RADIANCE  (PHOTONS/ S-SR-CM2)     DATA   438  ◄
DATA        INTEGRATED RADIANCE             07062   OUTCOL              INTEGRATED RADIANCE              DATA   439  ◄
DATA        SIGMA DUE TO STRCTR             08072   OUTCOL              SIGMA DUE TO STRCTR             DATA   440  ◄
DATA   *    THE EVENT LIST INCLUDING--              BCX PAGE                                              DATA   441  ◄
DATA   *    ATTACK GENERATION                       BCX                                                  DATA   442  ◄
DATA   *    RADAR                                   BCX                                                  DATA   443  ◄
DATA   *    COMMUNICATION                           BCX                                                  DATA   444  ◄
DATA   *    OPTICS                                  BCX                                                  DATA   445  ◄
DATA   *    BURSTS                                  BCX                                                  DATA   446  ◄
DATA   *    ENVIRONMENT OUTPUT                      BCX                                                  DATA   447  ◄
DATA   EVENT LIST                                   BEG LIST                                             DATA   448  ◄
DATA   ATTACK GENERATION DATASET                    REFER                                                DATA   449  ◄
DATA   RADAR EVENT                                  REFER                                                DATA   450  ◄
DATA   COMMUNICATIONS EVENT DATASET                 REFER                                                DATA   451  ◄
DATA   OPTICS LOCK EVENT                            REFER                                                DATA   452  ◄
DATA   BURST EVENT DATASET-1                        REFER                                                DATA   453  ◄
DATA   BURST EVENT DATASET-2                        REFER                                                DATA   454  ◄
DATA   BURST EVENT DATASET-3                        REFER                                                DATA   455  ◄
DATA   BURST EVENT DATASET-4                        REFER                                                DATA   456  ◄
DATA   BURST EVENT DATASET-5                        REFER                                                DATA   457  ◄
DATA   ENVIRONMENT OUTPUT EVENT                     REFER                                                DATA   458  ◄
DATA   STOP EVENT                                   REFER                                                DATA   459  ◄
DATA   *    THE ATTACK GENERATION EVENT INCLUDING INITIALIZATION --   BCX PAGE                           DATA   460  ◄
DATA   ATTACK GENERATION DATASET                    BEG SET                                              DATA   461  ◄
DATA        TYPE OF EVENT                   1,0     INT                                                  DATA   462  ◄
DATA        TYPE OF EVENT (DUMMY)          -5000.0  SEC                                                  DATA   463  ◄
DATA   ATTACK TYPE DATASET                          REFER                                                DATA   464  ◄
DATA   LAUNCH POINT LIST                            REFER                                                DATA   465  ◄
DATA   TARGET POINT LIST                            REFER                                                DATA   466  ◄
DATA   *    ATTACK TYPE DATASET                     BCX                                                  DATA   467  ◄
DATA   ATTACK TYPE DATASET                          BEG SET                                              DATA   468  ◄
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DATA    TYPE OF ATTACK TO BE GENERATED        UNIFORM
DATA    IS IT DAY OR NIGHT FOR B.O. CALCULS.  DAY
DATA    DAY OF ATTACK                         23          INT
DATA    MONTH OF ATTACK                       9           INT
DATA    YEAR OF ATTACK          (1900 AND----) 73         INT
DATA    TIME OF DAY                           15.45       HRS
DATA        REF ALT                           200.        KM
DATA        REF LAT                           47.75       DEG
DATA        REF LONG                          -79.33      DEG
DATA    INITIALIZATION FLAG                   0.          INT
DATA        REGION TYPE (1=RURAL)             1.          INT
DATA        VISABILITY (1=50KM)               1.          INT
DATA        MSM                               1.          INT
DATA        OD                                .01

DATA    * THE LAUNCH POINTS                               BOX
DATA    LAUNCH POINT LIST                                 BEG LIST
DATA    THE LANCHOU LAUNCHERY                             REFER
DATA    * HEREWITH THE INDIVIDUAL LAUNCH POINTS THEMSELVES ===============  PRINT
DATA    REFERENCE FOR LAUNCH POINT                        BEG SET
DATA    COORD CENTER                          0.   -79.33  47.75   GEOGR
DATA    THE LANCHOU LAUNCHERY                 LANCHOU              BEG SET
DATA    NAME OF LAUNCH POINT                  0.    105.    36.    GEOGR
DATA    BOOSTER TYPE NO.1                                         REFER
DATA    OBJECT TYPE A                                             REFER
DATA        (INTERNALLY USED)                 0.0         INT
DATA        NUMBER OBJECTS                    0.0
DATA    * THE TARGET POINTS                               BOX
DATA    TARGET POINT LIST                                 BEG LIST
DATA    BUFFALO,NEW YORK                                  REFER
DATA    * THE INDIVIDUAL TARGET POINTS FOLLOW ===============  PRINT
DATA    REFERENCE FOR TARGET POINT                        BEG SET
DATA    COORD CENTER                          0.   -79.33  47.75   GEOGR
DATA    BUFFALO,NEW YORK                                  BEG SET
DATA    TARGET POINT NAME                     BUFFALO              LOCXYZ
DATA    TARGET PT                             0.    0.
DATA        NUMBER OBJECTS                    0.          INT
DATA        IMPACT TIME OF 1ST                2000.       SEC
DATA        DELTA TIME BETWEEN OBJECTS        20.         SEC
DATA    SIGMA OF ARRIVAL TIMES                0.0
DATA    C.E.P. OF IMPACT LOCATION            0.0
DATA    MODE INDICATOR (SEE RCRB2 IN TRAID)   4.0         INT
DATA        REENTRY ANGLE                     20.         DEG
DATA    SPACE FOR POINTER TO TARGET OUTPUT ARRAY 1.0              ZEROS
DATA    SYSTEM OUTPUT LIST                                        BEG LIST
DATA    SYSTEM OUTPUT DATASET                                     REFER
DATA    SYSTEM OUTPUT DATASET                                     BEG SET
DATA    OBJECT NAME                           OBJECT 1
DATA    RADAR NAME                            RAD/B                ZEROS
DATA    SPACES                                                    BOX
DATA    * SET UP WEAVE GRID                   0.0                  BEG SET
DATA    REFERENCE FOR WEAVE CENTER
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DATA   COORD CENTER                              0.          -79.33    47.75    GEOGR      DATA   521  ◄
DATA   WEAVE COORDINATE DATASET                                                 BEG SET    DATA   522  ◄
DATA      ALTITUDE OF SECTION                   90.          KM.                            DATA   523  ◄
DATA      WEAVE CENTER                          0.           0.        90.       LCCXYZ     DATA   524  ◄
DATA      ANGULAR CELL SIZE IN X                .02                                         DATA   525  ◄
DATA      ANGULAR CELL SIZE IN Y                .02          INT                            DATA   526  ◄
DATA      NO VERTICAL CELLS                     17.          INT                            DATA   527  ◄
DATA      NUMBER OF CELLS IN PCS, X-DIR.        3.           INT                            DATA   528  ◄
DATA      NUMBER OF CELLS IN NEG, X-DIR.        3.           INT                            DATA   529  ◄
DATA      NUMBER OF CELLS IN PCS, Y-DIR.        3.                                          DATA   530  ◄
DATA      NUMBER OF CELLS IN NEG, Y-DIR.        3.           INT                            DATA   531  ◄
DATA      AZIMUTH OF GRID ALIGNMENT             MAGNETIC                                    DATA   532  ◄
DATA      NUMBER OF CELLS IN MAG. GRID          36.          INT                            DATA   533  ◄
DATA      TIME AT LAST CALCULATION              -5000.       SEC                            DATA   534  ◄
DATA      TIME AT NEW CALCULATION               0.           SEC                            DATA   535  ◄
DATA      BURST FLAG (IXFLG)                    0.           INT                            DATA   536  ◄
DATA      ENERGY CHECK FLAG (IENCHK)            0.           INT                            DATA   537  ◄
DATA      REZONE FLAG (IRZN)                    0.           INT                            DATA   538  ◄
DATA      SPACE FOR CELL HEIGHTS                20.                     ZEROS     DATA   539  ◄
DATA      MAXIMUM ALTITUDE BEFORE REZONE        750.         KM                            DATA   540  ◄
DATA   *  OBJECT DEPENDENT DATA                                         BCX PAGE   DATA   541  ◄
DATA   *                                                                PRINT      DATA   542  ◄
DATA   OBJECT LIST                                                      BEG LIST   DATA   543  ◄
DATA   REF=OBJECT                                                       REFER      DATA   544  ◄
DATA   OBJECT=1                                                         BEG SET    DATA   545  ◄
DATA      NAME                                  OBJECT 1                            DATA   546  ◄
DATA   OBJECT TYPE A                                                    REFER      DATA   547  ◄
DATA   OBJECT POSITION                          ALIVE                   REFER      DATA   548  ◄
DATA      KFLG                                                                     DATA   549  ◄
DATA   RADAR CROSS SECTION DATASET                                      REFER      DATA   550  ◄
DATA   BODY AXIS ALONG VELOCITY TUMBLING MODEL                         REFER      DATA   551  ◄
DATA      FILE                                  1.0                     ZEROS      DATA   552  ◄
DATA   REFERENCE FOR OBJECT POSITION                                    BEG SET    DATA   553  ◄
DATA   COORD CENTER                             0.           -79.33    47.75    GEOGR     DATA   554  ◄
DATA   OBJECT POSITION                                                  BEG SET    DATA   555  ◄
DATA                                                                    ZEROS      DATA   556  ◄
DATA      STATE TIME                            10.          SEC                            DATA   557  ◄
DATA      STATE POSITION                        -10000.      SEC                            DATA   558  ◄
DATA      STATE VELOCITY                        99999.       50.        LCCXYZ     DATA   559  ◄
DATA      STATE ACCEL.                          0.           7.         -45.     PCLAR     DATA   560  ◄
DATA                                            0.           -90.       50.      LCCXYZ     DATA   561  ◄
DATA   COLUMBUS BOOSTER BETA TABLE              0.           0.         0.       LCCXYZ     DATA   562  ◄
DATA   BETA MULTIPLIER                                                  REFER      DATA   563  ◄
DATA   REF=OBJECT                               0.                                 DATA   564  ◄
DATA      NAME                                  REF                     BEG SET    DATA   565  ◄
DATA   OBJECT TYPE A                                                    REFER      DATA   566  ◄
DATA   REF OBJECT POSITION                      REF                     REFER      DATA   567  ◄
DATA      KFLG                                  ALIVE                              DATA   568  ◄
DATA      SPACES                                4.0                     ZEROS      DATA   569  ◄
DATA   REF. POSITION COORD. FOR LOCAL AXES                              BEG SET    DATA   570  ◄
DATA   COORD. CENTER                            0.           -79.33    47.75    GEOGR     DATA   571  ◄
DATA   REF OBJECT POSITION                                              BEG SET    DATA   572  ◄
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DATA                                    STATE TIME         10.        SEC              ZEROB      DATA   573  ◄
DATA                                    POSITION          -10000.     SEC              GEOGR      DATA   574  ◄
DATA                                    VELOCITY           0.    -79.33   47.75        ZEROS      DATA   575  ◄
DATA                                    ACCELERATION       1.0                         ZEROS      DATA   576  ◄
DATA                                    SPACES             2.0                         BCX        DATA   577  ◄
DATA        BOOSTER TYPE DATA                                                          BEG SET    DATA   578  ◄
DATA        BOOSTER TYPE NO.1                                                                     DATA   579  ◄
DATA          NAME                       PLUME                                                    DATA   580  ◄
DATA        THE LANCPCO LAUNCHERY                                                      REFER      DATA   581  ◄
DATA        BOOSTER STAGE LIST                                                         REFER      DATA   582  ◄
DATA        BOOSTER STAGE LIST                                                         BEG LIST   DATA   583  ◄
DATA          STAGE 1                                                                  REFER      DATA   584  ◄
DATA          STAGE 2                                                                  REFER      DATA   585  ◄
DATA          STAGE 2                                                                  BEG SET    DATA   586  ◄
DATA          FUEL TYPE         LIQUID                                                            DATA   587  ◄
DATA          THRUST            135000.    LB                                                     DATA   588  ◄
DATA          TI                20000.     LB                                          TABLE      DATA   589  ◄
DATA          TF                8000.      LB                                          TABLE      DATA   590  ◄
DATA          NOZA              2000.      INSQ                                        TABLE      DATA   591  ◄
DATA          TBURN             0.         SEC                                         BEG SET    DATA   592  ◄
DATA          TSTEP             5.         SEC                                                    DATA   593  ◄
DATA          REFA              35.        FTSQ                                                   DATA   594  ◄
DATA          CX-- PAIR1    .03           .5                                                      DATA   595  ◄
DATA          CX-- PAIR2    .136          1.0                                          TABLE      DATA   596  ◄
DATA          CX-- PAIR3    .068          3.0                                          TABLE      DATA   597  ◄
DATA                                                                                   TABLE      DATA   598  ◄
DATA        STAGE 1   FUEL TYPE         LIQUID                                         BEG SET    DATA   599  ◄
DATA          THRUST            110000.    LB                                                     DATA   600  ◄
DATA          TI                70000.     LB                                                     DATA   601  ◄
DATA          TF                45000.     LB                                          TABLE      DATA   602  ◄
DATA          NOZA              3000.      INSQ                                        TABLE      DATA   603  ◄
DATA          TBURN             0.         SEC                                         TABLE      DATA   604  ◄
DATA          TSTEP             1.         SEC                                         BCX        DATA   605  ◄
DATA          REFA              35.        FTSQ                                        BEG SET    DATA   606  ◄
DATA          CX-- PAIR1    .10           .5                                                      DATA   607  ◄
DATA          CX-- PAIR2    .19           1.0                                                     DATA   608  ◄
DATA          CX-- PAIR3    .11           3.0                                          REFER      DATA   609  ◄
DATA        OBJECT TYPE DATA                                                                      DATA   610  ◄
DATA        OBJECT TYPE A                                                              REFER      DATA   611  ◄
DATA        NAME OF OBJECT TYPE          OVERBMQE                                      ZEROS      DATA   612  ◄
DATA        COLUMBUS BOOSTER BETA TABLE                                                REFER      DATA   613  ◄
DATA        RE-ENTRY ALTITUDE (WHERE DRAG STARTS)  100.0   KM                          BCX        DATA   614  ◄
DATA        RADAR CROSS SECTION DATASET                                                BEG SET    DATA   615  ◄
DATA        SPACE FCH BCM3              1.0                                                       DATA   616  ◄
DATA        BODY AXIS ALONG VELOCITY TUMBLING MODEL                                               DATA   617  ◄
DATA        OBJECT TABULATED BETA                                                                 DATA   618  ◄
DATA        COLUMBUS BOOSTER BETA TABLE                                                           DATA   619  ◄
DATA          MODEL TYPE                            1.0       INT                                 DATA   620  ◄
DATA          BETA                                  1500.     PBF                                 DATA   621  ◄
DATA        THE RADAR EVENT AND RADAR DATASETS ..                                      BCX PAGE   DATA   622  ◄
DATA                                                                                              DATA   623  ◄
DATA                                                                                              DATA   624  ◄
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DATA    RADAR EVENT                                                          BEG SET    DATA    625
DATA        KTYPE                          4.0       INT                                DATA    626
DATA        TIME                           99999.    SEC                                DATA    627
DATA    RADAR B                                                              REFER      DATA    628
DATA    OBJECT-1                           1.0                               REFER      DATA    629
DATA        KTRACK                         INITIAL                           ZEROS      DATA    630
DATA        KFLAG                          2.0                                          DATA    631
DATA        SPACE                                                            ZEROS      DATA    632
DATA    SYSTEM OUTPUT DATASET                                                REFER      DATA    633
DATA        SPACE                          6.0                               ZEROS      DATA    634
DATA      * RADAR DATA                                                       BCX        DATA    635
DATA    RADAR LIST                                                           BEG LIST   DATA    636
DATA    RADAR B                                                              REFER      DATA    637
DATA    RADAR B                                                              BEG SET    DATA    638
DATA        NAME                           RAD/B                                        DATA    639
DATA    PLATFORM FOR RADAR                                                   REFER      DATA    640
DATA    BORESIGHT FOR RADAR B                                                REFER      DATA    641
DATA    RADAR TYPE DATA                                                      REFER      DATA    642
DATA    RADAR ERRORS                                                         REFER      DATA    643
DATA    DISCRIMINATION INPUT DATASET       1.0                               REFER      DATA    644
DATA    SPACE FOR TRACK FILE LIST HERE                                       ZEROS      DATA    645
DATA    GEOGRAPHICAL CENTER FOR LOCAL COORDINATE SYSTEM                      BEG SET    DATA    646
DATA    COORD CENTER                       0,       -79.33    47.75          GEOGR      DATA    647
DATA    * BORESIGHT ARRAY FOR PRECEDING RADAR ----------------------         PRINT      DATA    648
DATA    BORESIGHT FOR RADAR B                                                BEG SET    DATA    649
DATA        MAY FACE 1 ACQUIRE             YES                                          DATA    650
DATA        BORESIGHT                      1.0E-3    90,       25,           PCLAR      DATA    651
DATA    BORESIGHT FOR RADAR B                                                END SET    DATA    652
DATA    * RADAR ERROR LIST                                                   BCX        DATA    653
DATA    RADAR ERRORS                                                         BEG SET    DATA    654
DATA        FIXED ERRORS, R                500,      FT                                 DATA    655
DATA        FIXED ERRORS, A                .5        MRAD                               DATA    656
DATA        FIXED ERRORS, E                .8        MRAD                               DATA    657
DATA        S/N DEP, ERRORS, R             2400,     FT                                 DATA    658
DATA        S/N DEP, ERRORS, A             15,       MRAD                               DATA    659
DATA        S/N DEP, ERRORS, E             3.0       MRAD                               DATA    660
DATA        (SPACE FOR BIAS VALUES)                                          ZEROS      DATA    661
DATA      * DISCRIMINATION TYPE DATA                                         BCX        DATA    662
DATA    DISCRIMINATION INPUT DATASET                                         BEG SET    DATA    663
DATA        DISCRIMINANT                   FFL                                          DATA    664
DATA        MAX FREQUENCY                  575.0     MHZ                                DATA    665
DATA        MIN FREQUENCY                  450.0     MHZ                                DATA    666
DATA        LENGTH                         8,        FT                                 DATA    667
DATA        TIME INTERVAL                  1.0       SEC                                DATA    668
DATA        MFF                            100,      KM                                 DATA    669
DATA    TOTAL DISCRIMINATION TIME          100,      SEC                                DATA    670
DATA    RANGE LIMIT FOR DISCRIMINATION     100.0     KM                                 DATA    671
DATA        NOISE BANDWIDTH                10,       MHZ                                 DATA    672
DATA    SPACE FOR STATE VECTOR                                               ZEROS      DATA    673
DATA      * RADAR TYPE DATA                                                  BCX        DATA    674
DATA    RADAR TYPE DATA                                                      BEG SET    DATA    675
DATA    NAME                               MDLEST                                       DATA    676
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DATA   FLAG FOR BEAM STACKING              NONSTACKED                        DATA  677
DATA   RADAR ERRORS                                                          DATA  678
DATA   TRANSMIT BEAM SHAPE MODEL                                             DATA  679
DATA   RECEIVE BEAM SHAPE MODEL                                              DATA  680
DATA   SEARCH MODE PARAMETERS DATASET                         REFER         DATA  681
DATA   TRACK MODE PARAMETERS DATASET                          REFER         DATA  682
DATA     FREQUENCY                        450.0    MHZ        REFER         DATA  683
DATA     SYSTEM TEMPERATURE               720.0    DEG        REFER         DATA  684
DATA     HORIZON LIMIT                    2.       DEG        REFER         DATA  685
DATA     OFF BORESIGHT LIMIT              60.      DEG                      DATA  686
DATA   ANTENNA POLARIZATION               NONLINEAR                        DATA  687
DATA   *                                                      PRINT         DATA  688
DATA   *                                                      PRINT         DATA  689
DATA   SEARCH MODE PARAMETERS DATASET                         BEG SET       DATA  690
DATA     RANGE CV 150-M                   2500.    NMSQM                    DATA  691
DATA     THRESHOLD DET+VERIF              20.      DB                       DATA  692
DATA     DELAY FROM ACQ TO TRACK          .1       SEC                      DATA  693
DATA     FRAME RANDOMIZATION              NONRANDOM                         DATA  694
DATA     MAX DET ALT                      1800.    KM                       DATA  695
DATA     MIN DET ALT                      1.       KM                       DATA  696
DATA     MAX DET RANGE                    1800.    KM                       DATA  697
DATA     MIN DET RANGE                    1.       KM                       DATA  698
DATA     FRAME TIME                       1.0      SEC                      DATA  699
DATA     VERIFY PULSE                     1.0      SEC                      DATA  700
DATA     MIN ELEV                         2.       DEG                      DATA  701
DATA     UPPER ELEVATION                  85.      DEG                      DATA  702
DATA     SIDE HALF AZIMUTH                55.      DEG                      DATA  703
DATA     NOISE BANDWIDTH                  2.5      KHZ                      DATA  704
DATA     SIGNAL BANDWIDTH                 2.5      KHZ                      DATA  705
DATA     PULSE COMPRESSION                1.0                              DATA  706
DATA     RANGE SIDELOBE LEVEL             -30.     DB                       DATA  707
DATA     SEARCH FLAG                      1.0      INT                      DATA  708
DATA   REFERENCE FOR RADAR                                    BEG SET       DATA  709
DATA   COORD CENTER              0.   -79.33   47.75          GEOGR         DATA  710
DATA   PLATFORM FOR RADAR                                     BEG SET       DATA  711
DATA     TYPE                             FIXED               LOCXYZ        DATA  712
DATA     RADAR LOCATION          0.   0.                      PRINT         DATA  713
DATA                                                          BEG SET       DATA  714
DATA   * AD MOD DATA SET FOR TRACKER INITIALIZATION                        DATA  715
DATA     BETA MULTIPLIER                  0.0                              DATA  716
DATA     DECAY TIMES      TAU1            99999.                           DATA  717
DATA                      TAU2            99999.                           DATA  718
DATA                      M TAU           0.0                              DATA  719
DATA     BETA MULTIPLIER SIGMA START      500.0                           DATA  720
DATA     BETA DCT                         30.0                            DATA  721
DATA   GUESSED BETA TABLE                                     REFER         DATA  722
DATA   GUESSED BETA TABLE                                     BEG SET       DATA  723
DATA     TYPE                             2.0      INT                      DATA  724
DATA     NUMBER OF TABULAR ENTRIES        2.0      INT                      DATA  725
DATA     N-POINT INTERPOLATION FOR NB     2.0      INT                      DATA  726
DATA     TABULAR VALUES FOLLOW    10.0    1500.0   KM  PBF    TABLE         DATA  727
DATA                             50.0    1500.0   KM  PBF    TABLE         DATA  728
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DATA    * TRANSMIT BEAM SHAPE MODEL
DATA    NAME                              CONSTANT
DATA    SHAPE                             CIRCULAR
DATA      BEAM-IDTH                 DEG   1.5
DATA      HALF BEAM SINE SPACE            0.0
DATA    ELLIPTICAL HALF V VALUE
DATA      NEAR-IN ANGULAR SIDELOBE LEVEL  -30.
DATA      INTERNAL STORAGE          DB    1.0
DATA    TRACK MODE PARAMETERS DATASET
DATA      S/N THRESHOLD             DB    15.
DATA      MIN TRACK RANGE           KM    1.
DATA      RANGE GATE PARM, K1       KM    .5
DATA                           K2
DATA      TOTAL TIME BEFORE DROP TRACK  SEC  2.0
DATA      TRACK INT                 SEC   10.
DATA      RANGE ON 1 SQ-M           VMSGM 2500.
DATA      RANGE GATE                KM    1.
DATA      NOISE BANDWIDTH           KHZ   2.5
DATA      SIGNAL BANDWIDTH          KHZ   .3
DATA      PULSE COMPRESSION               120.
DATA    RANGE SIDE-LOBE LEVEL       DB    -30.
DATA    RADAR CROSS SECTION DATASET
DATA      MODEL TYPE                INT   1.0
DATA      KG3                       MSG   1.0
DATA    BODY AXIS ALONG VELOCITY TUMBLING MODEL
DATA      MODEL TYPE                INT   1.0
DATA    RECEIVE BEAM SHAPE MODEL
DATA    TRANSMIT BEAM SHAPE MODEL
DATA    RECEIVE BEAM SHAPE MODEL
DATA    * THE COMMUNICATIONS EVENT DATASETS --
DATA    COMMUNICATIONS EVENT DATASET
DATA      EVENT TYPE                INT   22.
DATA      EVENT TIME                SEC   99999.
DATA      TRANSMITTER PLATFORM DATASET
DATA      SATELLITE PLATFORM DATASET
DATA      RECEIVER PLATFORM DATASET
DATA      TIME STEP                 SEC   30.
DATA      TYPE MOD.                       DPSK
DATA      REGEN                          YES
DATA      COHERENT FSK                   NO
DATA      FULLY DET                      YES
DATA      CONSTANT ZETA                  .707
DATA      CYCER PLL                      FIRST
DATA      UPLINK DATASET
DATA      DOWNLINK DATASET
DATA    SPACE FOR INTERNAL CALCULATIONS
DATA      INITIAL VALUE FOR T1      SEC   0.0
DATA      INITIAL VALUE FOR T2      SEC   -10.
DATA    * SPACE FOR INTERNAL CALCULATIONS
DATA    UPLINK/DOWNLINK DATA              0.
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DATA   UPLINK DATASET   BEG SET   DATA   781
DATA   POWER   100.   WATTS   DATA   782
DATA   FREQ   8000.   MHZ   DATA   783
DATA   TRANS. GAIN   81.   DB   DATA   784
DATA   REC. GAIN   16.8   DB   DATA   785
DATA   TRANSMITTER LOSS FACTOR   2.5   DB   DATA   786
DATA   SYSTEM LINE LOSS FACTOR   0.5   DB   DATA   787
DATA   PHASED ARRAY TRANSMITTER   ?0   DATA   788
DATA   UPLINK XMTR AZIM ERROR   0.   DEG   DATA   789
DATA   PHASED ARRAY RECEIVER   0.   DEG   ZEROS   DATA   790
DATA   UPLINK XMTR ELEV ERROR   3.   DEG   DATA   791
DATA   SPACE FOR BORESIGHT VECTOR   ?0   DEG   DATA   792
DATA   PHASED ARRAY RECEIVER   0.   DEG   DATA   793
DATA   UPLINK RCVR AZIM ERROR   0.   DEG   ZEROS   DATA   794
DATA   UPLINK RCVR ELEV ERROR   0.   DEG   DATA   795
DATA   SPACE FOR BORESIGHT VECTOR   DATA   796
DATA   BIT PERIOD   1.0E-8   SEC   DATA   797
DATA   IF BANDWIDTH   125.   MHZ   DATA   798
DATA   BANDWIDTH FOR PLL   125.   MHZ   DATA   799
DATA   BEAMWIDTH   1.5   DEG   ZEROS   DATA   800
DATA   S/N THRESHOLD   15.   DB   DATA   801
DATA   SIDELOBE LEVEL   30.   DB   DATA   802
DATA   SPACE FOR BIT ERROR,PHASE ERROR ERR2.0   ZEROS   DATA   803
DATA   RECEIVER NOISE TEMPERATURE   720.   ZEROS   DATA   804
DATA   SPACE FOR NOISE FIGURE,TEMP   2.0   BEG SET   DATA   805
DATA   SPACES FOR INTERNAL CALCULATIONS   32.   DATA   806
DATA   DOWNLINK DATASET   DATA   807
DATA   POWER   20.   WATTS   DATA   808
DATA   FREQ   7400.   MHZ   DATA   809
DATA   REC. GAIN   33.2   DB   DATA   810
DATA   TRANSMITTER LOSS FACTOR   3.2   DB   DATA   811
DATA   SYSTEM LOSS FACTOR   0.5   DB   DATA   812
DATA   PHASE ARRAY TRANSMITTER   ?0   DATA   813
DATA   DNLINK XMTR AZIM ERROR   0.   DEG   DATA   814
DATA   DNLINK XMTR ELEV ERROR   3.   DEG   ZEROS   DATA   815
DATA   SPACE FOR BORESIGHT VECTOR   ?0   DEG   DATA   816
DATA   PHASED ARRAY RECEIVER   0.   DEG   DATA   817
DATA   DNLINK RCVR AZIM ERROR   0.   DEG   DATA   818
DATA   DNLINK RCVR ELEV ERROR   3.   DEG   ZEROS   DATA   819
DATA   SPACE FOR BORESIGHT VECTOR   DATA   820
DATA   BIT PERIOD   1.0E-8   SEC   DATA   821
DATA   IF BANDWIDTH   125.   MHZ   DATA   822
DATA   BANDWIDTH PLL   125.   MHZ   DATA   823
DATA   BEAMWIDTH   1.5   DEG   DATA   824
DATA   S/N THRESHOLD   15.   DB   ZEROS   DATA   825
DATA   SIDELOBE LEVEL   30.   DB   DATA   826
DATA   SPACE FOR BIT ERROR,PHASE ERROR ERR2.0   ZEROS   DATA   827
DATA   RECEIVER NOISE TEMPERATURE   200.   ZEROS   DATA   828
DATA   SPACE FOR NOISE FIGURE,TEMP   2.0   ZEROS   DATA   829
DATA   SPACES FOR INTERNAL CALCULATIONS   32.   BCX   DATA   830
DATA   G-GRND XMITTER,GROUND RECEIVER, AND SATELLITE POSITIONS BEG SET DATA   831
DATA   REF, PCS, FOR COMMUNICATIONS   DATA   832

DATA	REFERENCE POSITION	0.	-79.33	47.75	GEOGR	DATA 831
DATA	TRANSMITTER PLATFORM DATASET				BEG SET	DATA 832
DATA	TYPE OF PLATFORM	FIXED				DATA 833
DATA	TRANS. POSITION	0.	0.	0.	LCCXYZ	DATA 834
DATA	RECEIVER PLATFORM DATASET				BEG SET	DATA 835
DATA	TYPE	FIXED				DATA 836
DATA	REC. POSITION	0.	0.	0.	LCCXYZ	DATA 837
DATA	SATELLITE PLATFORM DATASET				BEG SET	DATA 838
DATA	TYPE	FIXED				DATA 839
DATA	SAT. POSITION	0.	0.	35787.	LCCXYZ	DATA 840
DATA	* THE OPTICAL SENSOR EVENT AND OPTICS DATA --				BCX PAGE	DATA 841
DATA	OPTICS LOCK EVENT				BEG SET	DATA 842
DATA	TYPE	25.				DATA 843
DATA	TIME	99999.				DATA 844
DATA	OPTICAL SENSOR	INT			REFER	DATA 845
DATA	REF-OBJECT	SEC			REFER	DATA 846
DATA	SPACE				ZEROS	DATA 847
DATA	MFLAG	1.0				DATA 848
DATA		SET-UP				DATA 849
DATA	SPACE	1.0			ZEROS	DATA 850
DATA	* CLOUD DATA				BCX	DATA 851
DATA	BASIC CLOUD DATASET				BEG SET	DATA 852
DATA	MODEL TYPE	1.	INT			DATA 853
DATA	NUMBER OF CLOUDS	1.	INT			DATA 854
DATA	CLOUD LIST				ZEROS	DATA 855
DATA	STATISTICAL CLOUD DATASET				HEFEH	DATA 856
DATA	STATISTICAL CLOUD DATASET				BEG SET	DATA 857
DATA	MODEL NUMBER	1.	INT			DATA 858
DATA	LAYER PARAMETER	0.	INT			DATA 859
DATA	SPACES	90.			ZEROS	DATA 860
DATA	CLOUD LIST				BEG LIST	DATA 861
DATA	CLOUD A				REFER	DATA 862
DATA	CLOUD A				BEG SET	DATA 863
DATA	OBJECT TYPE	CLOUD				DATA 864
DATA	CLOUD INDEX	1.0	INT			DATA 865
DATA	CLOUD TYPE	1.0	INT			DATA 866
DATA	POSITION	0.	84.75	51.32	GEOGR	DATA 867
DATA	SEMI-MAJOR HORIZ. AXIS (A)	4.	KM			DATA 868
DATA	SEMI-INCH HORIZ. AXIS (B)	4.	KM			DATA 869
DATA	SEMI-MAJOR VERT. AXIS (C)	4.	KM			DATA 870
DATA	ORIENTATION (A +CCW FROM EAST)	0.	DEG			DATA 871
DATA	* OPTICAL SENSOR DATA				BCX	DATA 872
DATA	OPTICAL SENSOR LIST				BEG LIST	DATA 873
DATA	OPTICAL SENSOR				REFER	DATA 874
DATA	OPTICAL SENSOR				BEG SET	DATA 875
DATA	NAME	SCOPE				DATA 876
DATA	OPTICS TYPE	TRACK				DATA 877
DATA	OPTICS CALC TYPE	FOV				DATA 878
DATA	OBJECT TYPES	ALL				DATA 879
DATA	BORESIGHT				REFER	DATA 880
DATA	PLATFORM				REFER	DATA 881
DATA	OPTICS TYPE				REFER	DATA 882
DATA	OPTICS NOISE				REFER	DATA 883
DATA					REFER	DATA 884

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DATA   OPTICS OPTICS
DATA   TRACK FILE
DATA   OPTICS GRID
DATA   LIST OF PATHS
DATA   OPTICS NOISE
DATA       FIXED ERRORS, AZM        .01      MRAD                    ZEROS   DATA   885
DATA       FIXED ERRORS, ELV        .01      MRAD                    ZEROS   DATA   886
DATA       S/N DEP, ERRORS, AZM     1.       MRAD                    REFER   DATA   887
DATA       S/N DEP, ERRORS, ELV     2.0      MRAD                    ZEROS   DATA   888
DATA                                                                 BEG SET DATA   889
DATA   SPACE FOR BIAS ERRORS                                                 DATA   890
DATA   BORESIGHT                    YES                              ZEROS   DATA   891
DATA   ACQUISITION ALLOWED          3.0                              BEG SET DATA   892
DATA       BORESIGHT                0.                                       DATA   893
DATA       SIGMA                                                     ZEROS   DATA   894
DATA   DUMMY REF, PCS, FOR OPTICS SENSOR                                     DATA   895
DATA   REF, PCS, FOR OPTICS SENSOR  35787.   -79.33    47.75         BEG SET DATA   896
DATA   PLATFORM                                                      GEOGR   DATA   897
DATA       TYPE                     FIXED                            BEG SET DATA   898
DATA       SENSOR POSITION          35787.   -79.33    47.75         GEOGR   DATA   899
DATA   OPTICS TYPE DATA                                              BCX     DATA   900
DATA                                                                 BEG SET DATA   901
DATA   OPTICS TYPE                                                           DATA   902
DATA       NAME                     STANDARD                                 DATA   903
DATA       NUMBER OF DETECTORS      1.       INT                             DATA   904
DATA       DIAMETER                 2.7E-5                                   DATA   905
DATA       BLUR DIAMETER            2.7E-5                           ZEROS   DATA   906
DATA       REFD                     .5E-10                                   DATA   907
DATA       REFD BAND WIDTH          6000.                                    DATA   908
DATA       SPACE                    10.                                      DATA   909
DATA       FRAME TYPE               NO                                       DATA   910
DATA       RANDOM                   10.      SEC                             DATA   911
DATA       MIN UPDATE TIME          10.      SEC                     ZEROS   DATA   912
DATA       MAX UPDATE TIME          10.      SEC                             DATA   913
DATA   WAVELENGTH BAND LIST                                                  DATA   914
DATA   FIELD-OF-VIEW                                                         DATA   915
DATA   WAVELENGTH BAND LIST                                          REFER   DATA   916
DATA   WAVELENGTH BAND A            2.5E-6    M                      REFER   DATA   917
DATA   WAVELENGTH BAND A            2.6E-6    M                      BEG LIST DATA  918
DATA       LOW END                  3.0                              REFER   DATA   919
DATA       HIGH END                                                 BEG SET DATA   920
DATA       SPACES                                                            DATA   921
DATA   WAVELENGTH BAND B            2.6E-6    M                      ZEROS   DATA   922
DATA       LOW END                  2.7E-6    M                      BEG SET DATA   923
DATA       HIGH END                 3.0                                      DATA   924
DATA       SPACES                                                            DATA   925
DATA   FIELD-OF-VIEW                                                 ZEROS   DATA   926
DATA       TYPE                     SQUARE                           BEG SET DATA   927
DATA       AZIMUTH EXTENT           .8E-3                                    DATA   928
DATA       ELEVATION EXTENT         .8E-3                                    DATA   929
DATA       HBAF                     60.                                      DATA   930
DATA       ABAF                     6000.                                    DATA   931
DATA                                                                         DATA   932
DATA                                                                         DATA   933
DATA                                                                         DATA   934
DATA   *   OPTICS CALCULATIONS                                       BCX     DATA   935
DATA   *   OPTICS OPTICS                                             BEG SET DATA   936
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DATA   SIMULATE OPTICS
DATA   TRACK SIMULATION EVENT
DATA   SPACES
DATA   SIMULATE OPTICS
DATA     KTYPE                              1.0
DATA     TIME                              27.        INT
DATA     MODEL TYPE                     99999.        SEC
DATA     SCAN TYPE                     SURVEIL-01
DATA   OPTICAL SENSOR                  CIRCULAR
DATA     PLOTS                         OBJECTS
DATA     SPACE FOR IPP DATA                 1.0
DATA     SPIKE LIST                         1.0
DATA     SPACE FOR MEASUREMENT DATA         1.0
DATA   SPACE FOR LIST HEADER
DATA   OPTICS GRID
DATA     IFLAG                              0.        INT
DATA     DELTA AZIMUTH                    .4E-3
DATA     DELTA ELEVATION                  .4E-3
DATA   OPTICAL TRACK SIMULATION
DATA     KTYPE                             28.        INT
DATA     OPTICAL TRACK TIME             99999.        SEC
DATA   SPACE FOR SENSOR,OBJECT,TRACK FILE   3.0
DATA     TRACK INT                          1.        SEC
DATA   BORESIGHT
DATA     CAN THE SENSOR ACQUIRE        YES
DATA     INITAL RANGE ERROR                 1.0       KM
DATA     SPIRE SENSOR PROCESSING BLOCKS
DATA   SPIRE COMPUTATION LIST
DATA     BLOCK 2                            4.
DATA     BLOCK 3                            1.
DATA     BLOCK 4                        1.27E-3
DATA     BLOCK 5                          .8E-3
DATA     BLOCK 6
DATA     BLOCK 7
DATA     BLOCK 2
DATA   BLOCK 3   BLOCK TYPE (SCAN)          5.
DATA     FIRST BRANCH                       1.
DATA     BRANCH INTERVAL
DATA     PERIOD
DATA     SCAN LENGTH
DATA   BLOCK 4   BLOCK TYPE (DETECTOR NOISE)  6.
DATA     BRANCH                             1.
DATA                                    15000.
DATA                                        0.
DATA   BLOCK 5   BLOCK TYPE (GAUSSPO)
DATA     BRANCH                            19.
DATA     BANDPASS                           1.
DATA     W SIGMA                            1.
DATA   BLOCK 5   BLOCK TYPE (GAIN)
DATA     BRANCH
DATA     GAIN
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REFER     DATA   937
ZEROS     DATA   938
ZEROS     DATA   939
BEG SET   DATA   940
          DATA   941
          DATA   942
REFER     DATA   943
          DATA   944
ZEROS     DATA   945
ZEROS     DATA   946
ZEROS     DATA   947
ZEROS     DATA   948
BEG SET   DATA   949
          DATA   950
          DATA   951
BEG SET   DATA   952
          DATA   953
          DATA   954
ZEROS     DATA   955
          DATA   956
REFER     DATA   957
          DATA   958
BCX       DATA   959
BEG LIST  DATA   960
REFER     DATA   961
REFER     DATA   962
REFER     DATA   963
REFER     DATA   964
BEG SET   DATA   965
          DATA   966
          DATA   967
          DATA   968
BEG SET   DATA   969
          DATA   970
          DATA   971
BEG SET   DATA   972
          DATA   973
          DATA   974
          DATA   975
          DATA   976
          DATA   977
          DATA   978
          DATA   979
          DATA   980
          DATA   981
          DATA   982
          DATA   983
          DATA   984
          DATA   985
          DATA   986
          DATA   987
          DATA   988
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DATA                                                          DATA  989
DATA                                                          DATA  990
DATA                                                          DATA  991
DATA   BLOCK 6                                                DATA  992
DATA      BLOCK TYPE (GAIN)                                   DATA  993
DATA      BRANCH                    17.          BEG SET      DATA  994
DATA      GAIN                       1.                       DATA  995
DATA                                 1.                       DATA  996
DATA   BLOCK 7                                                DATA  997
DATA      BLOCK TYPE                26.          BEG SET      DATA  998
DATA      BRANCH                     1.,4E-3                  DATA  999
DATA      X-POSITION AT SCAN START   0.                       DATA 1000
DATA      Y-POSITION AT SCAN START 100.                       DATA 1001
DATA      THRESHOLD                               BCX PAGE    DATA 1002
DATA   * BURST DATA                              BEG SET      DATA 1003
DATA   BURST COORDINATE CENTER                   GEOGR       DATA 1004
DATA   COORD CENTER     0.   -79.33  47.75       BEG SET      DATA 1005
DATA   BURST EVENT DATASET-1                                  DATA 1006
DATA      EVENT TYPE     8.     INT              LCCXYZ       DATA 1007
DATA      TIME       99999.     SEC              REFER        DATA 1008
DATA      POSITION       0.      0.   200.       END SET      DATA 1009
DATA   BOMB-1                                    BEG SET      DATA 1010
DATA   BURST EVENT DATASET-1                                  DATA 1011
DATA   BURST EVENT DATASET-2                                  DATA 1012
DATA      EVENT TYPE     8.     INT              LCCXYZ       DATA 1013
DATA      TYPE       99999.     SEC              REFER        DATA 1014
DATA      POSITION       0.      0.   200.       END SET      DATA 1015
DATA   BOMB-2                                    BEG SET      DATA 1016
DATA   BURST EVENT DATASET-2                                  DATA 1017
DATA   BURST EVENT DATASET-3                                  DATA 1018
DATA      EVENT TYPE     8.     INT              LCCXYZ       DATA 1019
DATA      TYPE       99999.     SEC              REFER        DATA 1020
DATA      POSITION       0.      0.   200.       END SET      DATA 1021
DATA   BOMB-3                                    BEG SET      DATA 1022
DATA   BURST EVENT DATASET-3                                  DATA 1023
DATA   BURST EVENT DATASET-4                                  DATA 1024
DATA      EVENT TYPE     8.     INT              LCCXYZ       DATA 1025
DATA      TYPE       99999.     SEC              REFER        DATA 1026
DATA      POSITION       0.      0.   200.       BEG SET      DATA 1027
DATA   BOMB-4                                                 DATA 1028
DATA   BURST EVENT DATASET-5                                  DATA 1029
DATA      TYPE           8.     INT              LCCXYZ       DATA 1030
DATA      TIME       99999.     SEC              REFER        DATA 1031
DATA      POSITION       0.      0.   200.       BCX          DATA 1032
DATA   BOMB-5                                    PRINT        DATA 1033
DATA   * WEAPON TYPE DATA                        BEG SET      DATA 1034
DATA   BOMB-1                                                 DATA 1035
DATA      NAME       BOMB-1    MT                             DATA 1036
DATA      YIELD         1.0                                   DATA 1037
DATA      FFRAC          .50                                  DATA 1038
DATA      HFRAC          .24                                  DATA 1039
DATA      NFRAC          .01                                  DATA 1040
DATA      XFRAC          .75
DATA      THRPL NFRAC    .50
DATA      GFRAC         .001
```

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DATA        MASS                          1.5E6      GM
DATA        FRACTION ALUMINUM             0.05
DATA        SPACES                        2.0
DATA        FRACTION URANIUM              0.45
DATA    DEVICE DEPENDENT ENERGY SPECTRUM DATA =1
DATA    SPACE FOR ENERGY SPECTRUM DATA    1.0
DATA        BOMB=2
DATA        NAME                          BOMB=2
DATA        YIELD                         1.0        MT
DATA        FFRAC                         .10
DATA        MFRAC                         .24
DATA        NFRAC                         .01
DATA        XFRAC                         .75
DATA        THRPL NFRAC                   .50
DATA        GFRAC                         .001
DATA        MASS                          1.5E6      GM
DATA        FRACTION ALUMINUM             0.05
DATA        SPACES                        2.0
DATA        FRACTION URANIUM              0.45
DATA    DEVICE DEPENDENT ENERGY SPECTRUM DATA =2
DATA    SPACE FOR ENERGY SPECTRUM DATA    1.0
DATA        BOMB=3
DATA        NAME                          BOMB=3
DATA        YIELD                         1.0        MT
DATA        FFRAC                         .10
DATA        MFRAC                         .24
DATA        NFRAC                         .01
DATA        XFRAC                         .75
DATA        THRPL NFRAC                   .50
DATA        GFRAC                         .001
DATA        MASS                          1.5E6      GM
DATA        FRACTION ALUMINUM             0.05
DATA        SPACES                        2.0
DATA        FRACTION URANIUM              0.45
DATA    DEVICE DEPENDENT ENERGY SPECTRUM DATA =3
DATA    SPACE FOR ENERGY SPECTRUM DATA    1.0
DATA        BOMB=4
DATA        NAME                          BOMB=4
DATA        YIELD                         1.0        MT
DATA        FFRAC                         .10
DATA        MFRAC                         .24
DATA        NFRAC                         .01
DATA        XFRAC                         .75
DATA        THRPL NFRAC                   .50
DATA        GFRAC                         .001
DATA        MASS                          1.5E6      GM
DATA        FRACTION ALUMINUM             0.05
DATA        SPACES                        2.0
DATA        FRACTION URANIUM              0.45
DATA    DEVICE DEPENDENT ENERGY SPECTRUM DATA =4
DATA    SPACE FOR ENERGY SPECTRUM DATA    1.0
DATA        BOMB=5
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                ZEROS       GM       DATA        1041
                                     DATA        1042
                                     DATA        1043
                REFER                DATA        1044
                ZEROS                DATA        1045
                BEG SET              DATA        1046
                                     DATA        1047
                                     DATA        1048
                                     DATA        1049
                                     DATA        1050
                                     DATA        1051
                                     DATA        1052
                                     DATA        1053
                ZEROS       GM       DATA        1054
                                     DATA        1055
                                     DATA        1056
                REFER                DATA        1057
                ZEROS                DATA        1058
                BEG SET              DATA        1059
                                     DATA        1060
                                     DATA        1061
                                     DATA        1062
                                     DATA        1063
                                     DATA        1064
                                     DATA        1065
                                     DATA        1066
                                     DATA        1067
                ZEROS       GM       DATA        1068
                                     DATA        1069
                                     DATA        1070
                REFER                DATA        1071
                ZEROS                DATA        1072
                BEG SET              DATA        1073
                                     DATA        1074
                                     DATA        1075
                                     DATA        1076
                                     DATA        1077
                                     DATA        1078
                                     DATA        1079
                                     DATA        1080
                                     DATA        1081
                ZEROS       GM       DATA        1082
                                     DATA        1083
                                     DATA        1084
                REFER                DATA        1085
                ZEROS                DATA        1086
                BEG SET              DATA        1087
                                     DATA        1088
                                     DATA        1089
                                     DATA        1090
                                     DATA        1091
                                     DATA        1092
```

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DATA    AAPE                                              BOMB-5   DATA  1093 ◄
DATA    YIELD                                      1.0    MT       DATA  1094 ◄
DATA    FFRAC                                       .10            DATA  1095 ◄
DATA    MFRAC                                       .24            DATA  1096 ◄
DATA    NFRAC                                       .01            DATA  1097 ◄
DATA    XFRAC                                       .75            DATA  1098 ◄
DATA    THRML NFRAC                                 .50            DATA  1099 ◄
DATA    GFRAC                                      .001    GM      DATA  1100 ◄
DATA    MASS                                      1.5E6            DATA  1101 ◄
DATA    FRACTION ALUMINUM                          2.0            DATA  1102 ◄
DATA    SPACES                                     0.45            DATA  1103 ◄
DATA    FRACTION URANIUM                                  ZEROS    DATA  1104 ◄
DATA    DEVICE DEPENDENT ENERGY SPECTRUM DATA -5           REFER    DATA  1105 ◄
DATA    SPACE FOR ENERGY SPECTRUM DATA            1.0     ZEROS    DATA  1106 ◄
DATA    DEVICE DEPENDENT ENERGY SPECTRUM DATA -1           BEG SET  DATA  1107 ◄
DATA    FLAG FOR INITIALIZATION                   START            DATA  1108 ◄
DATA    NEUTRON WEAPON DEPENDENT DATA                      REFER    DATA  1109 ◄
DATA    GAMMA WEAPON DEPENDENT DATA                        REFER    DATA  1110 ◄
DATA    X-RAY WEAPON DEPENDENT DATASET1.0                  REFER    DATA  1111 ◄
DATA    SPACE FOR X-DATA                          1.0     ZEROS    DATA  1112 ◄
DATA    SPACE FOR N-DATA                          1.0     ZEROS    DATA  1113 ◄
DATA    SPACE FOR G-DATA                          1.0     ZEROS    DATA  1114 ◄
DATA    DEVICE DEPENDENT ENERGY SPECTRUM DATA -2           BEG SET  DATA  1115 ◄
DATA    FLAG                                      START            DATA  1116 ◄
DATA    NEUTRON WEAPON DEPENDENT DATA                      REFER    DATA  1117 ◄
DATA    GAMMA WEAPON DEPENDENT DATA                        REFER    DATA  1118 ◄
DATA    X-RAY WEAPON DEPENDENT DATASET1.0                  REFER    DATA  1119 ◄
DATA    SPACES                                             ZEROS    DATA  1120 ◄
DATA    DEVICE DEPENDENT ENERGY SPECTRUM DATA -3   3.0     BEG SET  DATA  1121 ◄
DATA    FLAG                                      START            DATA  1122 ◄
DATA    NEUTRON WEAPON DEPENDENT DATA                      REFER    DATA  1123 ◄
DATA    GAMMA WEAPON DEPENDENT DATA                        REFER    DATA  1124 ◄
DATA    X-RAY WEAPON DEPENDENT DATASET1.0                  REFER    DATA  1125 ◄
DATA    SPACES                                             ZEROS    DATA  1126 ◄
DATA    DEVICE DEPENDENT ENERGY SPECTRUM DATA -4   3.0     BEG SET  DATA  1127 ◄
DATA    FLAG                                      START            DATA  1128 ◄
DATA    NEUTRON WEAPON DEPENDENT DATA                      REFER    DATA  1129 ◄
DATA    GAMMA WEAPON DEPENDENT DATA                        REFER    DATA  1130 ◄
DATA    X-RAY WEAPON DEPENDENT DATASET1.0                  REFER    DATA  1131 ◄
DATA    SPACES                                             ZEROS    DATA  1132 ◄
DATA    DEVICE DEPENDENT ENERGY SPECTRUM DATA -5   3.0     BEG SET  DATA  1133 ◄
DATA    FLAG                                      START            DATA  1134 ◄
DATA    NEUTRON WEAPON DEPENDENT DATA                      REFER    DATA  1135 ◄
DATA    GAMMA WEAPON DEPENDENT DATA                        REFER    DATA  1136 ◄
DATA    X-RAY WEAPON DEPENDENT DATA                        REFER    DATA  1137 ◄
DATA    SPACES                                     3.0     ZEROS    DATA  1138 ◄
DATA    WEAPON DEPENDENT DATA FOR DEPOSITION CALCULATIONS  BCX PAGE DATA  1139 ◄
DATA    X-RAY WEAPON DEPENDENT DATASET0.5                  BEG SET  DATA  1140 ◄
DATA    SPECX         3.0      18.0    (7(E9.3,2X))        FORMAT   DATA  1141 ◄
DATA    2.820E-03, 1.040E-02, 9.100E-02, 1.740E-02, 4.710E-01, 2.360E-01, 9.040E-03,  DATA  1142 ◄
DATA    2.980E-06                                                   DATA  1143 ◄
DATA                                                                DATA  1144 ◄
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DATA      END DATA
DATA      X-RAY WEAPON DEPENDENT DATASET1,0                                      BEG SET          DATA  1145
DATA      SPECX         3,0    18,0        (7(E9,3,2X))                          FCHMAT           DATA  1146
DATA      3,810E-04, 2,440E-03, 1,640E-02, 4,170E-02, 2,230E-01, 4,710E-01, 2,360E-01,           DATA  1147
DATA      9,350E-03, 1,920E-04                                                                   DATA  1149
DATA      END DATA                                                                               DATA  1150
DATA      X-RAY WEAPON DEPENDENT DATASET2,0                                      BEG SET          DATA  1151
DATA      SPECX         3,0    18,0        (7(E9,3,2X))                          FCHMAT           DATA  1152
DATA      4,990E-05, 3,310E-04, 2,440E-03, 7,020E-03, 5,110E-02, 2,230E-01, 4,710E-01,           DATA  1153
DATA      1,910E-01, 4,510E-02, 8,110E-03, 1,240E-03, 1,710E-04                                  DATA  1154
DATA      END DATA                                                                               DATA  1155
DATA      NEUTRON WEAPON DEPENDENT DATA                                          BEG SET          DATA  1156
DATA      SPECN         3,0    18,0        (8(E8,2,2X))                          FCHMAT           DATA  1157
DATA      0,C1E-02, 2,00E-03, 2,40E-02, 1,22E-02, 3,65E-01, 1,02E-01, 8,50E-02, 6,20E-02,        DATA  1159
DATA      2,80E-02, 5,00E-03, 1,90E-02, 2,60E-02, 1,70E-02, 1,80E-02, 1,47E-02, 1,41E-02,        DATA  1160
DATA      2,50E-02, 7,06E-02                                                                     DATA  1161
DATA      END DATA                                                                               DATA  1162
DATA      GAMMA WEAPON DEPENDENT DATA                                            BEG SET          DATA  1163
DATA      SPECG         3,0    18,0        (8(E8,2,2X))                          FCHMAT           DATA  1164
DATA      3,06E-02, 1,30E-02, 8,16E-02, 6,87E-02, 1,77E-01, 1,4CE-01, 1,00E-01,                  DATA  1165
DATA      1,07E-01, 8,18E-02, 3,94E-02, 2,23E-02, 2,12E-02, 7,48E-03, 3,23E-03,                  DATA  1166
DATA      6,74E-04, 1,58E-04                                                                     DATA  1167
DATA      END DATA                                                                               DATA  1168
DATA      SPECD         3,0    18,0        (8(E8,2,2X))                          FC  T            DATA  1169
DATA      1,01E-03, 3,80E-03, 1,40E-02, 2,02E-02, 6,35E-02, 7,13E-02, 7,30E-02,                  DATA  1170
DATA      1,17E-01, 1,05E-01, 9,14E-02, 7,34E-02, 8,19E-02, 3,51E-03, 1,70E-02,                  DATA  1171
DATA      4,12E-02, 9,94E-04                                                                     DATA  1172
DATA      END DATA                                                                               DATA  1173
DATA   *  THE ENVIRONMENT OUTPUT AND STOP EVENTS **                              BCX PAGE         DATA  1174
DATA      ENVIRONMENT OUTPUT EVENT                                               BEG SET          DATA  1175
DATA         TYPE OF EVENT                    11,0       INT                                      DATA  1176
DATA         OUTPUT TIME                      99999.     SEC                                      DATA  1177
DATA         TYPE                             NONE                                                DATA  1179
DATA         NPTS                             1,0        INT                                      DATA  1180
DATA         OUTPUT TIME INT                  30.        SEC                                      DATA  1181
DATA         END PRINT TIME                   1751.      SEC                                      DATA  1182
DATA         FREQUENCY                        450.       MHZ                                      DATA  1183
DATA         EVENT INITIALIZATION FLAG        1,0        INT                                      DATA  1184
DATA      GRID OUTPUT DATASET                                                    REFER            DATA  1185
DATA      SPACE FOR INTERNAL STORAGE          1,0                                ZEROS            DATA  1186
DATA      GRID OUTPUT DATASET                                                    BEG SET          DATA  1187
DATA         TYPE                             FIREBALL                                            DATA  1188
DATA         INDEX                            1,         INT                                      DATA  1189
DATA         PLOT PARALLEL TO                 Y-AXIS                                              DATA  1190
DATA         KIND OF OUTPUT DESIRED           ALL                                                DATA  1191
DATA      STOP EVENT                                                             BEG SET          DATA  1192
DATA         TYPE OF EVENT                    10.        INT                                      DATA  1193
DATA         STOP TIME                        0.         SEC                                      DATA  1194
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