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Direct Simulation Monte Carlo Prediction Of On-Orbit Contaminant Deposit Levels For HALOE

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ABSTRACT

A three-dimensional version of the direct simulation Monte Carlo method is adapted to assess the contamination environment surrounding a highly detailed model of the Upper Atmosphere Research Satellite. Emphasis is placed on simulating a realistic, worst-case set of flowfield and surface conditions and geometric orientations for the satellite in order to estimate an upper limit for the cumulative level of volatile organic molecular deposits at the aperture of the Halogen Occultation Experiment (HALOE). Results pertaining to satellite environment are presented regarding contaminant cloud structure, cloud composition, and statistics of simulated molecules impinging on the HALOE aperture, along with data related to code performance. Using procedures developed in standard contamination analyses, along with many worst-case assumptions, the cumulative upper-limit level of volatile organic deposits on the HALOE aperture over the instrument's 35-month nominal data collection period is estimated at about 13,350Å.

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NOMENCLATURE

CCM	Coarse Cartesian Mesh
CLAES	Cryogenic Limb Array Etalon Spectrometer
CO_2	carbon dioxide
DSMC	direct simulation Monte Carlo
FCM	Fine Cartesian Mesh
FNUM	ratio of real to simulated molecules
GMW	gram molecular weight
HALOE	Halogen Occultation Experiment
HGA	High Gain Antenna
IM	Instrument Module
LDEF	Long Duration Exposure Facility
MLI	Multi-Layered Insulation
MMS	Multi-mission Modular Spacecraft
Ne	neon
NEPS	Nadir Energetic Particle Spectrometer
O	monatomic oxygen
SP	Solar Panel
SI	International System of metric units
SSPP	Solar/Stellar Positioning Platform
SWF	species weighting factor
T	absolute temperature [K]
UARS	Upper Atmosphere Research Satellite
V_x, V_y, V_z	directed velocities
X, Y, Z	coordinate directions
ZEPS	Zenith Energetic Particle Spectrometer
l	length scale [Å]
n	number density [m^{-3}]
t	relative temperature [°C]
Δt	time increment [sec]
Ω	solid angle [steradians]
α	HALOE azimuth angle

β	angle describing UARS-Sun relationship
θ	HALOE elevation angle
τ	period $[min]$
$\dot{\phi}$	mass flux rate $[gm/cm^2/sec]$
ω	exponent in power-law viscosity-temperature relationship

Subscripts:

j	species index
s	satellite condition
ss	steady state condition
∞	freestream condition

1.0 INTRODUCTION

The Upper Atmosphere Research Satellite (UARS) was designed to collect data on various aspects of Earth's upper atmosphere to help characterize global atmospheric changes that are thought to be occurring. Figure 1 depicts the UARS model used in this investigation. One instrument carried on board the currently-operational satellite is the NASA Langley Halogen Occultation Experiment (HALOE). During each sunrise and sunset experienced by the satellite, the HALOE instrument peers at the Sun through the atmosphere and measures solar infrared energy absorption over a range of wavelengths. With this information, vertical distributions for concentrations of trace gases such as HF, HCl, and O_3 are deduced.[1]

In order to obtain precise measurements, HALOE optical surfaces must be kept extremely clean. Experience shows that even minute amounts of contamination can seriously degrade the spectral transmissivity and reflectivity of optical surfaces.[2] Although atmospheric density is extremely low at the satellite orbit altitude of $600km$, there are many potential sources of contamination contained on board UARS itself, ranging from light gases to heavy, long-chain polymers. Volatiles outgassed from certain materials used in satellite construction, gases vented from the interior of the satellite and cryogenically-cooled experiments, and effluents exhausted from attitude thrusters, all contribute to a gas cloud that envelops the vehicle.

Previous analyses have indicated that the cumulative level of deposits on critical HALOE optical surfaces over its nominal 35 months of operation could exceed maximum acceptable levels by over an order of magnitude.[3] While UARS instrument managers specified a goal of no more than 100Å of cumulative deposits at the HALOE aperture, analyses predicted for its original set of orientations that it would receive about 32,170Å.[3] A recommended change adopted in stowing positions for HALOE reduced that estimate to about 6188Å.[3] These analyses utilized SPACE2[4] and MOLFLUX,[5] which are standard engineering codes developed for estimating fluxes on target surfaces due to outgassing. These codes either assume no intermolecular collisions within the gas cloud or employ first-collision theory.

Because of the important effect of contamination on the success of the HALOE data collection effort, detailed characteristics of the gas cloud in the vicinity of the HALOE aperture are needed to accurately estimate incident contaminant fluxes and to help define criteria for optimal operation of the instrument. In order to facilitate this goal, a study of the contamination environment surrounding UARS was performed using the direct simulation Monte Carlo (DSMC) technique.[6,7]

This report describes details of the investigation, emphasizing methods used and assessment of input data and assumptions. First, a discussion of issues important to satellite contamination is presented, followed by a general description of the DSMC method and preprocessors specifically developed to handle various necessary input conditions and geometric orientations required for the investigation. This discussion is then followed by a description of specific data pertinent to contamination of the HALOE instrument on board UARS. Results include simulated flowfield species number density maps describing the overall gaseous environment surrounding UARS, and statistical details regarding the fluxes intercepted at the HALOE aperture. Also, results regarding predictions of cumulative contaminant deposit levels are presented and interpreted, and code performance statistics are mentioned.

2.0 CONTAMINATION ISSUES

Satellites tend to surround themselves with their own artificial atmosphere through surface outgassing, equipment venting, and attitude thruster firing. This artificial atmosphere typically has very low density, and its overall distribution is usually anisotropic and non-Maxwellian. It is composed of species having a wide range of molecular weights, including massive, long-chain, volatile organic compounds, and is characterized by a wide range of concentrations, with some important species present only at trace levels.

The molecular flux of contaminants incident on a spacecraft surface has traditionally been subdivided into two categories: direct and return flux. Freestream or outgassing molecules directly impinging on a critical target surface that may have encountered prior collisions with other surfaces, but no intermolecular collisions with other gas species, belong to the direct flux. Outgassing molecules having undergone intermolecular collisions before reaching the target surface belong to the return flux. Direct flux computation is relatively straightforward for diffuse surfaces (geometric viewfactors or particle tracing), but return flux computation, which requires an integrated knowledge about the contaminant cloud structure and collision physics, is intrinsically more complex. It also requires that a relatively large computational domain surround the satellite to ensure that the simulation satisfactorily accounts for virtually all molecules which can return to the vehicle surface, regardless of how far they ventured away from the satellite before being scattered back.

The physics involved in contamination processes, such as surface desorption, reflection, absorption, adsorption, etc. are very complex. The experimental database is presently insufficient to devise accurate models to simulate mechanisms such as surface outgassing (flux magnitude as a function of surface temperature and material composition, emitted angular velocity distribution, and species composition), surface deposition and polymerization (effects of ultraviolet radiation, atmospheric monatomic oxygen flux, and surface material), and surface reflection (momentum and energy accommodation, reflected angular velocity distribution). Reliable estimates of the contamination environment surrounding future spacecraft will therefore require improving the present state of knowledge. The molecule-based DSMC algorithm is readily amenable to incorporate new physical models as these become available. DSMC could therefore be used to evaluate these models and foster new research in this field.

3.0 NUMERICAL TOOLS

In this section, the method used to investigate HALOE on-orbit instrument contamination is presented, along with preprocessing routines developed to assimilate data concerning geometric configurations and outgassing required to provide detailed simulations. First, a general description of the DSMC method is presented, followed by a brief presentation describing the various preprocessing routines used, many of which have been specifically developed to handle outgassing emission data.

3.1 DSMC METHOD

The direct simulation Monte Carlo method has been steadily gaining acceptance as an approach to solving problems related to fluid dynamics when the effects of rarefaction become important and the gaseous medium no longer behaves as a continuum.[8] In contrast to the approach of Computational Fluid Dynamics (CFD), where the gas is treated as a continuum mathematical fluid, macroscopic flowfield properties are calculated based on the interactions of many thousands or millions of particles that behave as molecules at the microscopic level.[8]

In the DSMC method, the simulated flowfield volume is discretized into a network of subcells, and the ensemble of particles constituting the gas is allowed to develop in time, where time is discretized into small increments over which the processes of molecular collisions and molecular motion are decoupled. The subcells are used to help identify nearest-neighbor prospective collision partners. The flowfield evolves in time from an initial, specified configuration, and once it reaches steady state, cumulative statistics on the gas are kept by the computer for small numbers of subcells grouped together to form cells. By specifying the intermolecular potential governing the behavior of collisions between the simulated molecules, or "particles," and by using concepts of kinetic theory and statistical mechanics to sample the flowfield at the subcell or cell level, one can establish macroscopic flowfield characteristics.

Although the true intermolecular potential for most interactions are unknown, a number of simple models are available which give reasonably accurate macroscopic behavior. The potential commonly used in contemporary DSMC applications is the Variable Hard Sphere (VHS) model.[8] In this model, the hard-sphere assumption of uniform, isotropic scattering is retained, but collision cross-sections become proportional to the relative velocities between molecules.[8] The VHS model has been employed in this investigation.

The DSMC outgassing model has been widely used in other applications,[9,10] and is assumed to be valid in this investigation. It assumes that molecules of an outgassing species are emitted from specified surfaces at given rates, with velocities sampled from a drifting Maxwellian velocity distribution at a given temperature.

The DSMC code used in the present study was devised by Bird[11] and modified by Rault.[6,7,12] High computational efficiency is achieved with this code through the use of an unstructured cell network overlaid on a cubic Cartesian subcell mesh. Two levels of subcells are employed in this particular code. A fine scale mesh (FCM) is used to resolve high flowfield gradients that often occur near windward-side surfaces, and a coarser mesh (CCM) is used farther away to conserve computational resources and to improve statistically-based calculations in regions where overall density levels are low. The individual subcells at the FCM level are referred to as "pixels." When available, comparisons between results generated with this code and experimental measurements regarding surface and flowfield properties for flows around a wide variety of vehicles have yielded excellent agreement.[12,13] The code has recently been optimized for vector architecture supercomputers, and has been complemented with a set of utilities for diagnosis, preprocessing, postprocessing, and grid adaptation.[12] Grid adaptation of the cell network with respect to certain variables can enhance resolution of flowfield phenomena as well as surface fluxes.

Special coding has been developed to collect information regarding particles striking the HALOE aperture. Such data include particle velocity, position where the aperture plane has been struck, species type, etc. In order to distinguish molecules belonging to the direct flux or the return flux, a parameter has been added to the run code to store the number of surface and intermolecular collisions each particle encounters prior to reaching the aperture. An additional parameter, storing information identifying the originating surfaces of these outgassed molecules, helps indicate which surfaces dominated the influence of volatile species fluxes at the aperture plane.

A novel additional capability featured in this simulation is the introduction of a parallel processing technique to separate the flowfield into two domains. This option allows higher resolution in the inner domain, combined with a larger outer domain for computing return flux, than would be possible if the resources of only a single computer were available. Implementation of this technique is discussed further in Section 4.2.

3.2 PREPROCESSOR ROUTINES

3.2.1 Geometry Definition

To define and input the inherently complex geometry of typical satellites, the interactive three-dimensional CAD preprocessor developed by Rault is used.[6,7] This preprocessing utility relies on the fact that even a very complex body geometry can be decomposed into a series of simple geometric primitives, such as spheres, cylinders, planes, etc. or portions thereof.[6,7] The current set of 16 basic primitives is presented in Table 1. UARS is modeled using 385 of these primitive subelements, and the resulting geometric model is displayed in Fig. 1. Also shown in the figure is the relative coordinate system used in this investigation, and details of the HALOE instrument in Figs. 1b-1d. As described in Ref. 6, properties of these subelements are entered into the preprocessor code through an input file. Typical input data are presented in Table 2. After listing data associated with the overall configuration of the flowfield volume, a series of fields describe the type of each subelement, its dimensions, location, and orientation. Since the DSMC code assumes SI units, use of any other system requires conversion using the "scale" factor. In Table 2, lengths had been measured and entered in inches, requiring "scale" to be set to 0.0254.

Other entries displayed in Table 2 also require further explanation. Certain types of geometric elements can be completely described by quadratic functions. These elements are categorized under "quadrics," and are handled analytically by the DSMC code. Other planar surfaces, such as rings and disks, where limits cannot adequately be described by quadrics, are simply referred to as "planes," and are stored as a number of points with high resolution. This resolution must be higher than that used to discretize the surfaces for incorporation into the DSMC code for high fidelity.[11,12] In this study, these two groups encompassed all types of subelements used. In other studies, nonplanar surfaces of arbitrary complexity are defined in similar fashion to the rings and disks used here.[12]

Since subassemblies or components constituting the satellite are represented in the code by groups of geometric subelements, these subelements may be linked by a common "component number." Defining a unique color to represent each component number can be useful in geometry visualization to highlight or otherwise distinguish individual components. References to "limit planes" in Table 2 pertain to the fact that these surfaces are discretized within the DSMC framework and replaced by small cubes.[11] Along certain edges where surfaces should intersect, small gaps may occur as a result of the discretization process. This problem occurs most frequently where surfaces intersect at oblique angles. Since the flowfield cell network is built up in layers from surfaces, these gaps will allow the interior to be filled with flowfield cells, which consumes computational resources and may lead to confusing errors.[12] Limit plane displacement lengthens or widens the original subelement to eliminate those gaps. Finally, the entry fields identified as "F3I limits" refer to a subordinate volume contained within the flowfield where the particular subelement lies. This information is used to speed up the discretization process by telling the code to check for a particular surface only within that subvolume instead of searching the entire flowfield.

Dimensions and locations for various facets of the UARS satellite have been obtained from engineering drawings provided by HALOE instrument managers, and a complete listing of the data entered for the baseline geometric representation is presented in Table 3. Code has been developed to alter subassemblies of the geometric UARS model by taking the baseline geometry file listed in Table 3, and rotating the required subelements about a given axis at a given point. The input files for cases studied are displayed in Table 4, and the output resembles Table 3, except that values for the affected subelements have been duly altered.

3.2.2 Outgassing Inputs

Code has been developed to process information pertaining to individual outgassing surfaces for incorporation into the general DSMC run code. These input files include subelement-level information pertaining to the outgassing flux at a given reference temperature, and the molar composition of the outgassing flux. Table 5 is an example of typical outgassing information, and Table 6 is a reproduction of the input file for outgassing information used in this investigation. The values listed before each outgassing rate are species mole fractions for each of the six species modeled.

The preprocessor code contains enough flexibility to process information on whether or not an individual subelement is composed of several regions outgassing different species at different rates. This capability has been used to create vent sources on certain surfaces of the Instrument Module (IM) by superimposing vent locations, flux rates, and gas constituents on existing larger elements. An example is illustrated in the data fields associated with the first geometric element in Table 6. Since outgassing rates are strongly dependent on surface temperature, additional coding has been developed to assign a unique value to each satellite surface. A listing of subelement-level temperatures in °C is presented in Table 7.

3.2.3 Vent Plume Modeling

In addition to outgassing information, a preprocessing routine for handling jet-like vent plumes from sonic orifices has been developed. Whereas effluents outgassed from surfaces and exiting most vents diffuse into the flowfield with modeled velocity distributions resembling drifting Maxwellian distributions at $T_{surface}$, "jet" sources represent relatively high mass flux rates exiting small orifices as choked, uniform flow at a supplied exit temperature T_{exit}. The data necessary to recreate such sources are shown in Table 8.

3.2.4 Global Resolution

Finally, Table 9 lists inputs used by the DSMC code in order to initialize the overall simulation. Some of the input variables are simply switches used to tailor the code to the problem at hand with respect to where high grid resolution is needed, sizing maximum lengths for Fortran arrays, information required for setting reasonable estimates for DSMC simulation parameters, flow direction with respect to the body, and the like.[12]

4.0 APPLICATION TO UARS/HALOE CONTAMINATION

4.1 UARS/HALOE DESCRIPTION

UARS was placed in orbit in September 1991 to probe Earth's upper atmosphere and characterize global atmospheric changes which are thought to be taking place. It operates at a roughly circular $600km$ altitude orbit with a 96-minute period (τ). Depicted in Fig. 1, UARS is about $10.3m$ long, $5.9m$ high, $3.2m$ wide, and its solar panel (SP) measures $13.3m$ by $3.3m$.

Several instruments have been mounted on the Instrument Module (IM), including HALOE, (an occultation viewing radiometer that requires part per million signal precision and characterization[1]), the Cryogenic Limb Array Etalon Spectrometer (CLAES), and the Nadir and Zenith Energetic Particle Spectrometers (NEPS and ZEPS). The High Gain Antenna (HGA) receives signals from UARS mission controllers, and the Solar/Stellar Positioning Platform (SSPP) assists in navigating the satellite. The Multi-mission Modular Spacecraft (MMS) is used to periodically boost or maneuver the satellite in accordance with mission guidelines.

UARS is designed to always keep the side with HALOE and the SP facing the Sun when it is over the horizon, but HALOE only takes measurements during sunrise and sunset, which occur once every period. At other times, whether the Sun is above or below the horizon, HALOE is stowed facing away from the freestream direction and the bulk of the satellite. Even though HALOE's stowed position has been chosen to minimize contamination from surface outgassing, it will periodically have substantial viewfactors from the continuously-rotating solar panel.

4.2 PARALLEL CODE SCHEME

As described in Section 3.1, the flowfield has been separated into two domains in order to increase grid resolution near the satellite and to create a large outer domain for computing return flux. Figure 2 shows a schematic representation of the computing arrangement. A different processor computes the solution in each domain independently, and Parallel Virtual Machine software from Oak Ridge National Laboratories has been implemented to allow the processors to communicate data between one another.[14]

The potential utility of this parallel routine software has been demonstrated even though an outer domain was not considered necessary for the scope of this particular investigation. Although the effect of return flux on HALOE is deemed insignificant, this feature could be useful in other contamination studies (at lower altitudes, for instance), where the far-field effect could play a more significant role. In this investigation, the inner domain takes on the shape of a right parallelepiped with dimensions slightly larger than the maximum dimensions of UARS, and the outer domain is a cube. During a given timestep Δt, particles reaching or passing through the interface boundary separating the domains are moved to the boundary, and information required by the other processor for these entering particles is stored in a buffer. Data include particle position and velocity information, remaining fraction of Δt, individual species codes, and individual tag parameters. The buffer file is transmitted as a message to the other processor once each timestep.

It is reasoned advantageous to size the domains using the following equation:

$$\frac{FNUM_i}{FNUM_o} = \frac{\Delta t_i}{\Delta t_o} = \frac{V_i}{V_o} \propto \left(\frac{l_i}{l_o}\right)^3 . \tag{1}$$

Concentrating on the first equality in Eq. (1), the need to clone or remove particles at the interfaces to ensure correct transmitted species flux levels is obviated. The second equality is an attempt to achieve roughly equal numbers of particles in each domain, a desirable feature which could result in roughly equal processor loadings under certain circumstances. One compromise inherent in Eq. (1) requires finding suitable timesteps for the different domains, such that when adequate temporal resolution in the inner domain is obtained, particles do not travel too quickly through the outer domain. Of course, shorter timesteps translate into longer run times.

4.3 SPECIES WEIGHTING FACTORS

Due to the large variation in species concentrations within a contaminant cloud, "species weighting factors" (*SWF*) have been implemented to artificially enhance minor species concentrations. Important species, such as the organic volatiles most likely to deposit and remain on critical surfaces, are usually present in trace amounts, and statistical sample sizes concerning these molecules would therefore be inadequate without the use of these weighting factors. The DSMC code has been modified by artificially increasing the outgassing flux of trace species by a species weighting factor, which in effect enables one to specify species-dependent values of *FNUM* to obtain reasonable numbers of each representative simulated species within the flowfield for better statistical property measurement. The only aspects of the simulation affected by this artifice are collision rates and quantities associated with flowfield sampling. These aspects may be accounted for by reducing bimolecular collision probabilities and cumulative species sampling summations by the same factors within the code.

The conditions under which *SWF*'s may be applied should be considered carefully, since mean free path lengths of trace species may be artificially increased when intermolecular collisions become important. Such an approximation is not considered a problem for the simulated UARS/HALOE environment.

5.0 COMPUTATIONAL CONDITIONS

This section describes details concerning the application of the tools mentioned above to the analysis of the UARS/HALOE contamination environment. First is a description of the geometric configurations that were considered to provide realistic worst-case estimates for deposits at the HALOE aperture, followed by assumed freestream and outgassing conditions.

5.1 GEOMETRIC CONSIDERATIONS

5.1.1 Configurations

For the set of assumptions associated with this approach, a realistic, conservative estimate for the cumulative level of contaminants deposited at the HALOE aperture must recognize that certain instruments rotate with respect to the rest of UARS over time. The solar panel (SP) continuously tracks the Sun, and the Solar/Stellar Positioning Platform (SSPP) undergoes limited movement as it alternately tracks the Sun and certain stars. HALOE faces the Sun during sunrise and sunset every 96-minute orbital period. Otherwise, it is stowed facing away from the freestream direction with severely restricted views of the rest of the satellite.[3] Three different configurations have been chosen, representing a realistic worst case set of orientations. Two of these represent the beginning and end of the HALOE data collection period considered most deleterious with respect to contamination, and one represents the instrument in its stowed position after this data collection period.

Since the direct flux of outgassed molecules intercepted by a target surface is strongly dependent on the solid angle Ω subtended by the originating surfaces within the target's line of sight (viewfactor), cases have been chosen where HALOE collects data facing the $-X$–direction (toward the Multi-mission Modular Spacecraft (MMS)). In this orientation, viewfactors subtended by the SP and the bulk of the satellite are maximized. In addition, since both the SP and HALOE track the Sun during HALOE data collection periods, the SP presents a large frontal area to the oncoming freestream, which could potentially contribute to increased overall number flux levels at the HALOE aperture. Movement of the SSPP has been ignored.

The angle between the HALOE aperture normal and the UARS body axis during data collection periods is equal to β, the angle between the Earth-Sun line and the plane of the satellite orbit.[3] Angle β also plays a role in outgassing, since satellite surface temperatures are directly proportional to local surface inclination with respect to the Sun. For this particular orbit ($0° \leq \beta \leq 80°$), temperatures of influential surfaces are generally maximized when $\beta = 80°$. One important exception is that trends for the SP surface temperatures run counter to the other objects. Due to the glancing angle it makes with the Sun at $\beta = 80°$, SP surface temperatures, and hence its outgassing rates, are minimized there. Conversely, SP surface temperatures are maximized when $\beta = 0°$. The large SP surface area and its orientation with respect to HALOE make it a formidable influence on the latter's contamination environment. Another influential factor is that although the temperatures of the many influential outgassing surfaces are minimized at $\beta = 0°$, their viewfactors are maximized with respect to HALOE for this orientation.

The three sets of geometric orientations studied in this investigation are listed below in expected descending order of severity. Angle α represents azimuth angle with respect to the UARS X axis, and θ represents elevation. Case 1 assumed $\alpha = -180°$ and $\theta = 6°$ (end of sunrise data collection period); Case 2 assumed $\alpha = -180°$ and $\theta = -23.6°$ (beginning of sunrise data collection period); and Case 3 assumed $\alpha = 45°$ and $\theta = -25°$ (stow position immediately prior to $\beta = 0°$ sunset data collection period). Views of the geometric configurations for these cases are depicted in Fig. 1. Note that the SP location in Fig. 1c lies behind the HALOE aperture plane. The visual absence of that large, relatively high-temperature, outgassing object nearby should have a significant impact on the Case 2 contamination environment.

During each orbit at $\beta = 0°$, HALOE collects data for a maximum total of 15 minutes (7.5 min. during each sunrise and sunset), and is stowed during the remainder of that period. Assuming that only the volatile species accumulate on critical optical surfaces, the average mass flux rate $\bar{\dot{\phi}}$ per orbit per species j may be estimated by

$$\bar{\dot{\phi}}_{j,\text{sunrise}} = \frac{\dot{\phi}_j|_{\theta=6°} + \dot{\phi}_j|_{\theta=-23.6°}}{2}, \tag{2}$$

$$\bar{\dot{\phi}}_{j,\text{orbit}} = \left(\frac{\tau_{\text{sunrise}}}{\tau_{\text{orbit}}}\right)\bar{\dot{\phi}}_{j,\text{sunrise}} + \left(\frac{\tau_{\text{sunset}}}{\tau_{\text{orbit}}}\right)\bar{\dot{\phi}}_{j,\text{sunset}} + \left(\frac{\tau_{\text{stow}}}{\tau_{\text{orbit}}}\right)\dot{\phi}_{j,\text{stow}}. \tag{3}$$

In Eq. (2), linear behavior of $\dot{\phi}_j$ is assumed between the two cases, and in Eq. (3) for conservative estimates, $\bar{\dot{\phi}}_{j,\text{sunset}} = \bar{\dot{\phi}}_{j,\text{sunrise}}$, even though satellite IM-area viewfactors are lower for sunset viewing periods.

The probability that a contaminant molecule adheres to a critical surface is determined by its "sticking coefficient," a probabilistic parameter dependent on the combined effects of individual contaminant/surface material pairing, energy differences between contaminant molecules and the surface, and photopolymerization,[15] among other things. Multiplying Eq. (3) by the number of orbits in the 35-month nominal HALOE lifespan and the area of the HALOE aperture, an upper bound for the total mass accumulated for each species may be calculated, assuming a sticking coefficient of unity. Neglecting the effects of highly-reactive O atomic flux on removing these deposits, such an assumption may be valid during data collection periods due to photopolymerization of volatile compounds on optical surfaces, but may considerably overestimate the mass accumulated while HALOE is stowed facing away from the Sun. Assuming values for the mass and volume associated with each species, one can make a crude estimate for the depth of deposits at the aperture for each species. The total thickness becomes the summation of the contributions from each species.

5.1.2 DSMC Resolution

Figure 3 illustrates representative cross-sections of the inner domain cell network used for the present study after grid adaptation. Figure 3b shows the extent of the solar panel along with the rest of the vehicle. The body geometry is discretized and stored at the FCM level. Each element is characterized by a wetted surface area and a set of normal direction cosines. Figure 4 shows an XY-planar slice through the discretized geometry using a diagnosis utility developed for use with the DSMC code. In Fig. 4, pixels representing the surface are displayed along with outward direction cosines. Additionally, information on different levels of subcells surrounding the geometry can be represented. To simulate the UARS geometry, about 85,000 pixels have been used (pixel dimension $\approx 5.0cm$), and the inner domain computational grid is composed of 35,000 cells. All outgassing and venting particles enter the flowfield from positions adjacent to the center of the pixel face closest to the outward normal of the outgassing pixel, about 0.2 percent the distance represented by a pixel length scale inside the flowfield volume. This has been done to eliminate position round-off error. These particles are given velocity components sampled from a drifting Maxwellian at the local outgassing surface temperature.

5.2 FREESTREAM PARAMETERS

Assumed ambient conditions at the satellite operating altitude of $600km$ consisted of 100 percent atomic oxygen (O) at a nominal number density n_∞ of 6×10^{12} molecules/m^3.[16] At this altitude, the density may vary from this standard in either direction by roughly an order of magnitude due to solar activity. In addition, solar activity can cause appreciable helium concentrations to develop at this altitude. For conservative calculations, assuming 100 percent O maximizes its presence, and since O is highly corrosive to certain satellite materials, and may actually reduce the cumulative level of deposits on critical optical surfaces, instrument managers may be interested in its interactions with the satellite. Of course, ambient collision rates are affected by number density and species constituency,[17] however, using a single species to represent the freestream simplifies the simulation process, and it happens that UARS is operating in a period of low solar activity. These reasons may make the assumed level for n_∞ somewhat conservative. The assumed satellite orbital velocity V_s is 7500 m/sec.

5.3 OUTGASSING SPECIES, FLUX RATES, & TEMPERATURES

5.3.1 Outgassing Species

In preliminary calculations,[6] two ficticious outgassing species were fabricated for demonstration purposes. One, with a gram molecular weight (*GMW*) of 200, was emitted from all outgassing surfaces. The other, with *GMW* = 100, was emitted only from the Instrument Module (IM) vent, located above the CLAES experiment.[6] The *GMW*'s are similar to those used in standard industry contamination codes, and are associated with heavy, volatile, organic compounds.[5]

Further investigation into likely types of outgassing materials covering UARS focused on four different items. These were: Mylar, used in the Multi-Layered Insulation (MLI) covering most of the satellite; Chemglaze Z306, a black paint covering portions of some instruments (as well as the interior of HALOE); S/13G/LO-V10, a white paint covering portions of some instruments as well as the back side of the SP; and adhesives possibly used to affix components to the front of the SP. A report investigating the types and mass fractions of volatile components outgassing from these materials at different temperatures identified compounds such as alkanes, alcohols, organic acids, and aldehydes.[18] Many components remained unidentified; however, taking the highest mass-fraction species identified for the materials listed above, a ficticious molecule with *GMW* close to each calculated average has been generated. Moreover, a ficticious species associated with venting from internally-carried components has been created. The *GMW* assumed for this material is 100, following standard contamination procedures.[5] Values describing each of these species and their outgassing rates are listed in Table 10.

Collision cross-sections for these species ratioed to that for monatomic oxygen have been assumed to scale with the 2/3 power of the associated mass ratio (see Table 10).[17] The mean viscosity-temperature power-law exponent ω is assumed to be 0.75, a value associated with O, and no chemistry has been considered. This information is contained within the input gas species file used by the DSMC code, which is presented in Table 11. Due to lack of information, it is not clear how well the collision dynamics of heavy, long-chain, polyatomic organic molecules are modeled by these assumptions, but since temperatures are moderate and density levels are extremely low, collision rates are assumed to be negligible.

All surfaces reflected particles diffusely, although evidence suggests incomplete momentum and energy accommodation better represent certain surfaces exposed to the vacuum of space for extended periods.[19] Such behavior could affect the statistics of true fluxes encountered at the instrument aperture.

5.3.2 Mass Flux Rates

Measured mass flux rates associated with materials covering the instruments and subassemblies have been obtained from Ref. 3, which lists data taken from a month-long bakeout test performed at NASA Goddard Space Flight Center on the completed UARS satellite at 100 °C. In that report, rates were assumed for units lacking measured data. It was noted that the rate associated with MLI covering the satellite bus varied from a high initial level to a lower, constant level by the end of the test. In this study the lower, constant value was assumed, since the HALOE aperture remained closed for the first month in orbit as a precautionary measure against the initial, transient levels of MLI outgassing. Unfortunately, no information was given on the relative location of instruments measuring these rates with respect to the satellite, and some subassemblies feature surfaces sporting more than one type of covering. Since only one rate was listed per unit, such information had to be supplemented through judicious interpretation of photographs depicting various UARS subcomponents to determine what surfaces were covered with which material. These photographs were supplied by HALOE instrument managers and personnel at Goddard Space Flight Center. The mass flux rates for surfaces and coatings deduced from Ref. 3 are presented in Table 10.

In addition to outgassing surfaces, other gas-emitting sources have been modeled. The CLAES experiment is cryogenically cooled by gases contained in two separate reservoirs.[20–22] One reservoir contains Ne, the other CO_2. After cooling the instrument, these gases are expelled through vents. The CO_2 vent is located at the exit of a 1 *in*-diameter tube intersecting the CLAES shield plate, with direction cosines for the exit plane normal as (-.49, .64, .59) in the X, Y, Z coordinate system indicated in Fig. 1. The Ne vent is located at the end of a short, 2 *in*-diameter tube at the $+Z$-most section of the CLAES smaller cylinder, directed downward. The flow from these vent exits is assumed to be choked at an estimated temperature of $T_{exit} = 207K$.[22] Mass flow rates for the CO_2 and Ne vents have been estimated at 3.65 and $8.39 mg/sec$, respectively. In this study, these sources have been modeled using the jet-like vent plume routines for sonic orifices mentioned above. Calculated outgassing rates for the CLAES vents are listed in Table 10.

Other vents, such as the IM vent, MLI blanket vents, and those associated with the MMS, released effluents at much lower flux rates, and have been modeled as regular surface-temperature dependent outgassing surfaces. Assumed *GMW*'s and outgassing rates associated with these vents are listed in Table 10.

5.3.3 Temperature Variation

Mass flux rates given in Ref. 3 for the bakeout test have been adjusted to reflect levels associated with realistic operating temperatures through use of the following empirical relationship, formulated to characterize generic mass flux behavior of polymeric materials on Skylab[4,5] (t in °C):

$$\frac{\dot{\phi}_j(t)}{\dot{\phi}_j(t = 100\ °C)} = \exp\left(\frac{t - 100}{29}\right). \qquad (4)$$

This formula has been used to adjust all volatile organic compound outgassing rates. Although actual material outgassing rates probably deviate from Eq. (4), this formula is the only one available for use in this investigation. Surface temperatures associated with various components have been estimated using data contained within Ref. 3, with one exception. UARS instrument managers provided solar panel operating temperatures which were measured in orbit. For $\beta = 0°$, SP temperatures oscillate on orbit between -60°C and 30°C. The maximum SP temperature has been assumed for all cases, and values for other subassembly surfaces are listed in Table 7.

5.3.4 Species Weighting Factors

Upon commencement of the first DSMC computations, problems were encountered obtaining volatile fluxes at the HALOE aperture, because the outgassing rates associated with those species created flowfield number density levels orders of magnitude lower than those associated with the freestream and the CLAES vent species.[7] In a single timestep, about 3300 simulated monatomic oxygen molecules would enter the upstream boundary (area $\cong 110m^2$), 30 simulated volatile, organic molecules of all types outgassed from the satellite (surface area $\cong 230m^2$), and 200,000 particles exited the CLAES vents (total vent exit area = $2.5\times10^{-3}m^2$). The number flux of volatiles in the inner domain is therefore about two billionths of that for the CLAES vent species. Thus, by adjusting computational resources to adequately simulate the dominant CO_2 and Ne environment, keeping the computational size of the simulation large enough to simulate $\sim 10^6$ particles, the simulation would completely lose track of the volatile species whose development was the motivation for engaging in this investigation.

The solution adopted has been to implement the species weighting factors discussed in Section 4.3. First, a simulation was run without the contributions of the CLAES vents in order to assess the ratio of volatile, organic species number density levels to the freestream. Another simulation included CLAES vent contributions in order to determine those density levels relative to those from the freestream as well. With information on the relative species number density levels, simulated fluxes of the various species have been altered using arbitrary SWF's in order to obtain roughly equal orders of magnitude for numbers of each simulated species in the computational volume. The weighting factors used for O, Ne, CO_2, and the volatile, organic species with GMW = 100, 150, and 200 are 40, 1, 1, 10^3, 10^4, and 5×10^3, respectively.

5.4 CODE SETUP

The methodology adopted for this study is to initially run the code for each set of conditions in a free molecule (collisionless) mode. Due to the large size of the satellite and the low thermal velocity of the heavy outgassing molecules, the approach to steady state is slow ($N_{ss} \cong 10^4\Delta t$, where $\Delta t \approx 7\mu$sec). Figure 5 shows the number of particles in the inner and outer domains versus number of elapsed timesteps. Depending on the type of problem being studied, the region where the curves flatten out may mark the onset of steady state. (While this rule-of-thumb may usually be adequate for measuring surface quantities, it is no panacea. For example, wakes behind bodies evolve over a long period of time without perceptible change in overall density levels.) Since exploratory calculations[6,7] demonstrated that the global level of collisions was very low, the simulation is initially run in free molecule mode to reach an approximate steady state more quickly than if intermolecular collisions were allowed. After grid adaptation, each adapted cell contains roughly the same number of molecules (about 10 for the inner domain), as shown in Fig. 6. The code is then run with intermolecular collisions until a new steady state is reached. Subsequently, molecules incident on the HALOE aperture are counted, sampled, and written to a data file.

For the inner domain, high spatial resolution is necessary, since UARS is very complex and quite large ($\sim 10m$), and the HALOE aperture is only $22.9cm$ ($9\,in$) in diameter. At the CCM level, the inner domain is composed of $74\times46\times104$ equal subdivisions of $15.1cm$ on a side. Each FCM subcell consisted of pixels having lengths three times smaller than the CCM level, resulting in a surface resolution of $5.0cm$. Since overall density levels are lower in the outer domain, the physical domain could be simulated with much coarser resolution. The outer domain is a cube measuring $21.2m$ on a side, composed of $70\times70\times70$ subcells at the CCM level, with each FCM subcell having resolution equal to the CCM level.

6.0 RESULTS AND DISCUSSION

The wealth of information obtainable within a DSMC simulation will clearly be demonstrated in this section, as surface flux information is obtained along with flowfield behavior within the three-dimensional solution volume. First species number density contour maps will be presented, describing concentration levels surrounding the satellite, followed by results characterizing the fluxes incident on the HALOE aperture. The latter includes statistics concerning prior collisions, velocity distribution functions, and mass flux rates associated with simulated molecules impinging upon the aperture. This last item is manipulated to obtain a cumulative contamination deposit level. Finally, this cumulative level is compared to that of Ref. 3, and some code performance measurements are presented.

6.1 SPECIES NUMBER DENSITY

Figures 7-15 depict number density contour maps for each of the six gaseous species in the entire simulated flowfield surrounding UARS, ratioed to the freestream ambient number density, $n_{O,\infty}$ using a $\log_{10}$ scale. This information is presented in two planes that capture information concerning the majority of the flowfield physics in the three-dimensional volume. One plane runs longitudinally, parallel to the main body axis, while the other runs normal to it and the freestream direction.

For the first set of figures concerning Case 1 (Figs. 7-12), a longitudinal solution plane has been chosen that runs through the vehicle coincident with its main body axis (X-axis), while the transverse solution plane coincides with the streamwise location of the center of the CLAES Ne vent in order to capture a cross-section of the plume emanating from it. These planes have been picked to present the overall physical environment. For the remainder of these number density maps, planes have been chosen that better reflect the environment in the vicinity of the HALOE instrument.

The black outline surrounding UARS denotes the boundary separating inner and outer domains. While contributions of each species are presented separately, they co-exist simultaneously within the simulation.

6.1.1 Case 1

In Figs. 7a and 7b, contours for freestream species monatomic oxygen are presented for Case 1. In Fig. 7a, an expected buildup of O is observed on UARS windward side components. However, in initial DSMC calculations omitting the CLAES vents,[6] and in subsequent calculations prior to grid adaptation, when intermolecular collisions have been disallowed, the maximum density level peaked at about 25 times the freestream level on the cylindrical face of the MMS.[6] After grid adaptation and allowing intermolecular collisions to occur, the maximum density ratio there becomes roughly 50 times the freestream level. It seems apparent that this density level increase is due to interaction of the freestream with the gases emitted from the CLAES vents. Even though the global level of intermolecular collisions is low (about 130 collisions per timestep over 740,000 simulated molecules), the CLAES vent plumes create an effectively larger frontal area for UARS with respect to the freestream and scatter O out of the streamwise direction. An advantage of presenting these maps with a logarthmic scale is that the diminished levels of O in the wake of the vehicle are clearly evident. Figure 7b depicts the same set of contours viewed from the opposite side of the domain. The large, dark parallelogram jutting out from behind the transverse plane is the SP, canted 6° upward for this case.

In Figs. 8 and 9, number density contour maps are depicted for CLAES Ne and CO_2 vent gases. In Fig. 8a, the plume developing from the Ne vent exit is clearly captured. In the transverse plane, one can observe a sizable amount of upward scattering although the vent is pointed directly downward. This is likely the result of diffuse surface scattering from surfaces of the CLAES experiment, due to its proximity to the Ne vent. Figure 8b reveals that very little of the Ne plume extends into the $-Z$ regions. In Figs. 9a and 9b, the plume associated with the CO_2 vent is also clearly defined, although its axis is directed at oblique angles to both the streamwise and transverse planes.

In Figs. 10-12, number density contour maps are presented for the outgassing species. In Figs. 10a and 10b, the entire vehicle is surrounded by outgassing of species with *GMW* = 100. The streamwise plane contour map above UARS is dominated by outgassing from the IM vent (located just above CLAES on the $+Z$ side of the satellite bus and angled 45° upward), although much of the concentration extending in front of the satellite is due to outgassing of adhesive material from the cell side of the SP (see Fig. 10b). The minor contribution to the flowfield from surfaces outgassing Chemglaze Z306 is shown in Figs. 11a and 11b (*GMW* = 150). These clouds originate chiefly from surfaces located on NEPS and ZEPS, although the interior of HALOE outgasses this material through its aperture. In Figs. 12a and 12b, *GMW* = 200 concentrations are presented. In the streamwise plane, the highest density levels are found near the HGA dish, although most of the outgassed material originates from the back side of the SP (Fig. 12b).

Results for this identical case are shown using two other planes that better depict the HALOE environment. The HALOE instrument is located in the center of each figure. In Fig. 13a, a buildup of O is clearly seen in front of HALOE and its mount. One also notices that the highest levels are found before the SP as it plows through the rarefied atmosphere. In Fig. 13b, even though the vast majority of Ne is directed downward on UARS' other side, there is a slight presence of that species in the vicinity of HALOE through a combination of surface and intermolecular collisions. As for CO_2, in comparing streamwise plane results for Fig. 13c with Fig. 9b, where the former is displaced approximately $1m$ closer to HALOE than the latter in Fig. 9b, density levels for that species have abated by roughly an order of magnitude. No CO_2 flux was detected at the HALOE aperture.

Comparing streamwise planes from Fig. 13d with Fig. 10b for the *GMW* = 100 material, it becomes clear that the influence of the IM vent is greatly diminished over that $1m$ separation distance, and the local flowfield is dominated by the influence of the SP. In Fig. 13e, the contribution of the *GMW* = 150 material is globally quite minor, yet there is a relatively high concentration of it at the HALOE aperture, thanks to its own contribution. Finally, the concentrations of *GMW* = 200 material at the aperture are shown in Fig. 13f to be about an order of magnitude higher than for the previous figure, which is a consequence of the high concentrations of this material from the back side of the solar panel and the $-Z$ side of the Instrument Module.

6.1.2 Case 2

Planes chosen to represent the Case 2 flowfield solution (Figs. 14a-14f) are identical to those depicted in the last subsection, emphasizing the HALOE environment. The number density contour maps for this case are similar to those presented in the preceeding two paragraphs. Besides the obvious repositioning of the SP and the HALOE instrument (-23° inclination versus 6° above), the most striking difference is in the map for the *GMW* = 200 material (Fig. 14f vs. Fig. 13f). The difference in SP inclination accounts for a dramatic decrease of this material in the vicinity of HALOE.

6.1.3 Case 3

The general features presented in Figs. 15a through 15f are similar to the other two cases. Although the SP front face and HALOE no longer face the freestream, the SP rear face now opposes it. In Fig. 15a, the solar panel still impedes the motion of freestream O, but the position of the transverse planar solution cut reveals the wake behind it. In Fig. 15b, *Ne* is still present around HALOE, but HALOE's orientation 25° away from the body axis toward $-Z$ effectively shields its aperture from this gas. No *Ne* or CO_2 was detected at the aperture for this case (Figs. 15b and 15c).

Because the SP is roughly aligned with the $+X$ direction, the $GMW = 100$ contour density map in Fig. 15d shows a striking difference from the analogous Case 1 solution depicted in Fig. 13d above, where it is roughly aligned in the opposite direction. There is a reversal of which portions of the flowfield are densely and sparsely populated with this material. Even though HALOE is stowed, its viewfactor of the SP approaches that for Case 1 ($\Omega_{SP}|_{\text{Case 3}} = 0.412$ steradians versus $\Omega_{SP}|_{\text{Case 1}} = 0.527$ steradians). It will be shown shortly that in this configuration, there is still a surprisingly significant level of contaminant flux at the instrument aperture, mostly due to the SP. Fig. 15e shows the contribution from $GMW = 150$ material for this case, with local concentration maxima emanating from the HALOE aperture, NEPS, and ZEPS. Finally, in Fig. 15f, number density contours for the $GMW = 200$ material are presented, where once again, a reversal in high and low concentrations of this material are evident compared to Case 1 results in Fig. 13f.

6.2 CAPTURED MOLECULES–PRIOR COLLISIONS

There are a variety of statistics one can glean from simulated molecules striking the HALOE aperture. Two sets of information are presented in this section and the next. First, for each case, the history of each impinging simulated molecule is presented with respect to number of prior collisions it has suffered before reaching the aperture. Second, histograms are generated, representing the X, Y, and Z velocity probability distribution functions (PDF) for these same particles.

6.2.1 Case 1

In Figs. 16a-16c, plots are presented depicting the number of surface collisions prior to reaching the aperture for each species in each case. For Case 1, depicted in Fig. 16a, nearly 90 percent of O atoms reach the aperture directly from the freestream with no prior surface collisions. In contrast, all *Ne* atoms suffer at least two surface collisions before reaching this location. Outgassing molecules with $GMW = 100$ and 150 tend to encounter multiple surfaces before arrival, while most $GMW = 200$ material deposits directly from the back side of the SP and the $-Z$ side of the IM.

6.2.2 Case 2

In Fig. 16b, Case 2 collision history statistics for *O* are similar to those for Case 1. However, *Ne* atoms collected encountered at least five prior surface collisions before impinging on HALOE. This could be because the solar panel lies behind it in this run, and in its visual absence (zero viewfactor from the HALOE perspective), many other surfaces are required to facilitate the presence of neon. Again, outgassing molecules tend to encounter multiple reflections before arriving at the aperture, except for the $GMW = 200$ material. This material tends to collect from direct viewing of the $-Z$ side of the IM.

6.2.3 Case 3

Figure 16c shows that no *O* atoms directly encounter the aperture; most reflect once off the SP instead. Also, due to HALOE instrument orientation, no *Ne* is detected at all. $GMW = 100$ and 150 materials also tend to reflect once off the SP before impinging, but as in Case 1, $GMW = 200$ material emitted from the back side of the SP tends to arrive directly.

These figures do not reveal all information pertinent to *O*, whose distributions contain a rather long tail of multiply-reflected particles. The highest number recorded is 114 prior surface collisions for Case 1.

6.3 CAPTURED MOLECULES– VELOCITY PROBABILITY DISTRIBUTION FUNCTIONS

6.3.1 Case 1

Figure 17 depicts Case 1 histograms representing the X, Y, and Z PDF for particles striking the aperture. Only *Ne* contributes any return flux; all other species have been deposited as the result of direct flux. Beginning with the X, or streamwise direction in Fig. 17a, notice that PDF(V_x) for *O* is bimodal. One mode, a full Maxwellian distribution centered at $V_x = V_s$, represents molecules having suffered no previous surface collisions. The other mode, corresponding to a drifting Maxwellian distribution near $V_x = 0$, represents molecules having previously collided with the satellite at least once. Figure 17b shows PDF behavior for V_x near the origin for better detail. In this figure, the volatile outgassing species have a streamwise PDF corresponding to drifting Maxwellian distributions whose shapes differ from one another due to individual *GMW*'s. These distributions have been checked and compare favorably with theoretical calculations, but for clarity's sake the theoretical functions for PDF(V_x) have been omitted from the figure. However, the *Ne* distribution does not conform to any simple theoretical model because the majority of *Ne* samples had experienced intermolecular collisions. In Figs. 17c and 17d, probability density functions are presented for the Y and Z, or transverse, directions. The *O* distributions behave as expected, as they are dominated by contributions from the freestream mode, and compare quite well with theory. Due to the complicated nature of the geometric setup, no comparisons between these histograms and theoretical PDF's have been attempted in these directions.

6.3.2 Case 2

Figure 18 depicts Case 2 velocity PDF histograms. The X direction plot (Fig. 18a), generally appears similar to that for Case 1. However, the origin detail displayed in Fig. 18b shows that some portion of the flux has $V_x < 0$. Figs. 18c and 18d show that although O behaves as in Case 1, other species PDF's tend to be narrower and more peaked than in the previous case. This may be because overall viewfactors for HALOE are lower than Case 1, and impinging molecules come from a smaller, more select group of surfaces.

6.3.3 Case 3

In Case 3, there is no contribution from directly-impinging, freestream O atoms, so the distinct, bell-shaped Maxwellian mode associated with that species for Figs. 17a and 18a is not present in Fig. 19a. Although the mass flux associated with O still dominates the HALOE aperture environment, it is nearly two orders of magnitude lower than for the first two cases. The contribution from $GMW = 150$ molecules come entirely from the aperture itself, where emitted molecules reflect off the SP back towards HALOE. In Figs. 19b and 19c, most of the O flux has $V_y < 0$ and $V_z > 0$, indicating that it is constituted mostly from simulated atoms scattered downward and toward UARS from the SP, since that is the only assembly occupying $-Z$ space relative to HALOE.

6.4 MASS FLUX RATES

Individual species mass flux rates impinging on the HALOE aperture are presented in Table 12. Accuracy of these results rests heavily on the reliability of values for surface outgassing flux rates at the bakeout temperature, the use of Eq. (4) to adjust those rates for surface temperature, and the relative orientation and proximity of HALOE to the contributing surfaces. The rate for O has been subdivided into those atoms coming directly from the freestream and those having suffered prior surface collisions. Since a substantial portion of impinging Ne is attributed to return flux, while the rest reaches HALOE through surface collisions alone, two entries have been listed for Ne as well. Notice that fluxes from the outgassing species are orders of magnitude less than the others. Without using SWF's, much longer run times would be required to achieve a reasonable sample sizes—possibly by a factor of many thousand.

Tables 13a-13c relate the relative contributions of different surfaces to the mass flux rates presented in Table 12. The SP is the chief progenitor of the HALOE contamination environment for all three cases. This is because it apparently attains the highest temperatures of any surface expected on the satellite for $\beta = 0°$ (see Table 7), it is large, and it is located relatively near the HALOE aperture. The $-Z$ side of the IM (second largest contributor), also represents a large outgassing surface near HALOE, but its contributions are diminished because its outgassing rates are lower than those of the SP, and its surface normal does not oppose the HALOE aperture.

Flux rates for Case 2 are significantly less than Case 1 due to reduced viewfactors of the main contributing outgassing surfaces. Included in Tables 13a-13c are viewfactors ([solid angle Ω] = steradians out of 2π) of the SP and the $-Z$ side of the IM experienced by the HALOE aperture. Ironically, Case 3 demonstrates that while a stowed HALOE instrument is exposed to very little direct flux from the bulk of UARS, it is sometimes prone to relatively high viewfactors of the continuously-rotating SP, periodically enhancing the pernicious contamination environment surrounding HALOE.

Also enhancing this environment is a contribution from the Chemglaze–painted surfaces within its interior, whose effluents are allowed to escape out through the aperture. Some of these molecules strike other surfaces and return to the HALOE aperture, and are counted along with the other contaminants.

6.5 CUMULATIVE DEPOSIT LEVELS

Eqs. (2) and (3) may be used to estimate an upper-bound cumulative total level of deposits at the HALOE aperture. Assuming that only volatile, organic molecules accumulate (with a sticking coefficient of unity), and each occupies the space of a cube of length l, where l equals the particular species diameter listed in Table 10, a deposit depth of $\approx$ 3550Å is estimated. If standard contamination procedures are followed, and l = 10Å is assumed regardless of species diameter,[3] that estimate increases to $\approx$ 13,350Å. If the contribution HALOE receives while stowed is disregarded (sticking coefficient of zero), these estimates fall to $\approx$ 650Å and $\approx$ 2650Å, respectively.

Tables 14 and 15 show the species-level contributions from each run to the final, averaged estimates quoted above. It is interesting to observe how *GMW* factors into the second estimate described, which is a standard procedure in the contamination community.[3] A greater number of lighter *GMW* species molecules are required for a mass flux equal to that of a heavier *GMW* species. Since the deposit depth of contaminant molecules only depends on the number that accumulate, it becomes important to accurately assess the *GMW*'s of the accumulated molecules. Also, the true sticking coefficient is not known, and can be much less than unity under certain conditions (small gas/surface temperature differences, absence of direct sunlight, etc.).[15] Finally, the effects of scrubbing from the high monatomic oxygen flux on reducing the level of accumulants is not clear.

The effect of this predicted cumulative buildup on instrument performance is not clear. At this time, UARS has been in orbit for over two years, and the instrument has shown negligible loss in performance.

HALOE instrument managers have provided figures quantifying performance degradation in terms of signal strength attenuation for different species concentration measurements over the first year of operation. Signal voltages obtained over the first two months of operation were used to compute a standard expected signal voltage strength per channel, with instrument temperature corrections. Subsequent voltage strengths were measured and compared to the standard. Figures 20a and 20b show signal loss correlations for HF and HCl channel measurements, respectively. For initial standard voltages of $\approx$ 3.3 volts and $\approx$ 3.45 volts, after one year's operation, HF and HCl signal strengths have apparently been attenuated by 0.02 volts and 0.004 volts, respectively. This level of voltage attenuation is indicative of measurements made for the other channels used by HALOE as well. This may suggest that the concentrations of contaminants in the vicinity of the HALOE instrument have been overestimated in this as well as in previous studies, or that the effects of contamination from the types of outgassing materials carried on board UARS are relatively benign. Perhaps better understanding of volatile *GMW*'s, outgassing rates, temperature dependence on outgassing rates, gas/surface sticking coefficients, the cleansing effects of atomic oxygen, and light attenuation and scattering due to outgassing contaminants will come from the current examination of samples carried aboard the Long Duration Exposure Facility (LDEF).[23]

6.6 COMPARISON WITH PREVIOUS ANALYSES

It is difficult to make detailed comparisons with the results described in Ref. 3 for a number of reasons. First, in Ref. 3, the orientations of the SP and HALOE were decoupled. The SP cellside surface was pointed downward at HALOE, minimizing the distance between the two objects. Meanwhile, HALOE was allowed to assume various orientations associated with data collection periods as well as possible stow positions. In reality, HALOE would be stowed pointing away from the SP when its cell side faces downward. Second, the earlier contamination analyses[3] assumed a constant solar array surface temperature of 100 °*C*. This investigation benefitted from on-orbit data measured directly on the SP which indicate that $\beta = 0°$ surface temperatures are cyclic with each orbit over a range of -60 °*C* to 30 °*C*. For the 30 °*C* value used in this study, Eq. (4) predicts that the SP would outgas only 9 percent of the value expected at 100 °*C*. Third, the earlier analyses assumed only one outgassing species ($GMW = 100$) to relate cumulative depth to mass fluxes. Obscuring detailed comparisons further, the earlier analyses could not take into account the fact that after the Goddard bakeout test, MLI blankets covering the instrument module surface on the $-Z$ side had themselves been covered with panels of S/13G/LO-V10 (which outgasses at mass flux rates one to two orders of magnitude higher than MLI—see Table 10). This had the impact of increasing assumed flux levels from those surfaces to HALOE. Finally, the geometry used in Ref. 3 was somewhat less detailed than in the present study. Taking these differences into consideration, it seems that the results of this investigation tend to confirm those contained within Ref. 3 nevertheless.

6.7 CODE PERFORMANCE

The DSMC code is run simultaneously on two Sun SPARC 2 workstations with 64MBytes memory (RAM) each. Statistics concerning memory requirements, number of particles, weighting factor *FNUM*, timestep Δt, and overall computational volumes for the cases studied are listed in Table 16.

Regarding values for CPU time spent processing each region, it should be noted that *FNUM* and Δt could have been adjusted to create better load balancing between the inner and outer domain processors. This was not a major goal of the study, however.

Computational performance for simulations using particle methods is often measured in terms of average CPU time taken to process the state of an average particle per timestep. Using this metric, levels of approximately 29 μsec/particle/timestep and 44 μsec/particle/timestep have been obtained in the outer and inner domains, respectively, with the difference chiefly due to handling outgassing surfaces in the latter. This is a fairly exotic application for DSMC however, and it may be difficult to compare this performance estimate to other results in a straightforward, detailed manner.

7.0 CONCLUDING REMARKS

This report describes the development and application of a DSMC code to study contamination problems on satellites and estimate the effect of outgassing on sensitive instruments. Discussion is included on the development of a number of specially-developed preprocessor routines to incorporate detailed information regarding geometry, outgassing rates and temperature data, different types of outgassing sources, and the use of species weighting factors to enhance the statistical representation of important trace species. In estimating the amount of volatile organic molecular deposits collected at the HALOE aperture, special attention has been given to accurately account for outgassing species characteristics, surface temperatures, and geometric orientation of UARS subassemblies deemed critical to this endeavor. Using the best information available, and neglecting the scouring effects of monatomic oxygen, an upper bound on the cumulative contaminant deposition level at the HALOE aperture has been estimated at 13,350Å. If there is negligible tendency for volatile species to accumulate while HALOE is stored, this value falls to 2650Å. Notwithstanding consideration of important differences in geometric orientation, outgassing species weights and flux rates, and other specific influential input data, it appears that these results tend to confirm the earlier work described in Ref. 3.

Although the model for outgassing contained in DSMC has often been compared to other methods,[9,10,24] it could be instructive to make direct comparisons between results obtained using the DSMC method described in this report for a simple geometry over different ambient conditions with results from industry-standard codes and experimental data when they become available. Also, this study would benefit from better characterization of outgassing materials in terms of average molecular weights, mass flux rates, temperature dependence on mass flux rates, etc.

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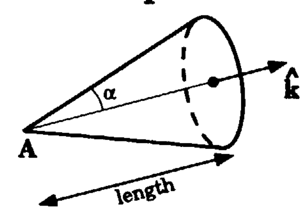
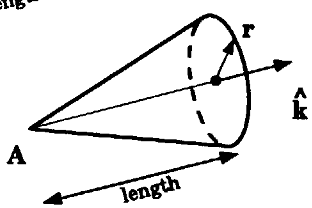
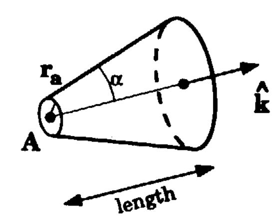
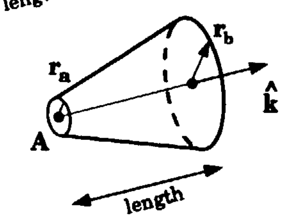
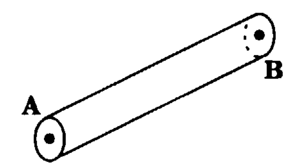
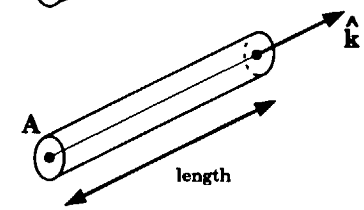
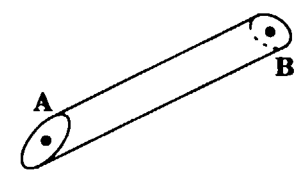
Table 1: Library of Geometric Primitives (5 pgs.)

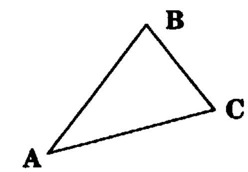
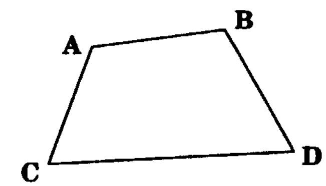
Geometry Definition for X Program: Cones

Name	Definition	Variables	Shape
ConeA	straight cone	half angle α apex **A** dir. cosine length	
ConeB	straight cone	apex **A** dir. cosine length exit radius	
ConeC	frustum	half angle α point **A** length dir. cosine radius at **A**	
ConeD	frustum	point **A** length dir. cosine radius at **A** radius at **B**	

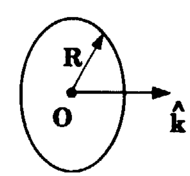
Geometry Definition for X Program: Cylinders

Name	Definition	Variables	Shape
CylinderA	straight cylinder	point **A** point **B** radius	
CylinderB	straight cylinder	point **A** radius dir. cosine length	
CylinderC	skewed cylinder	point **A** point **B** radius dir. cosine **A** dir. cosine **B**	

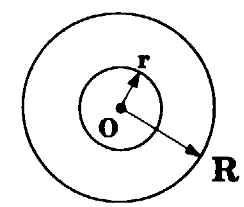
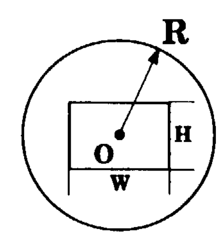
Geometry Definition for X Program: Plates

Name	Definition	Variables	Shape
PlateA	triangular plate	point **A** point **B** point **C**	
PlateB	four-sided plate (note order of successive pts.)	point **A** point **B** point **C** point **D**	

Disk

Name	Definition	Variables	Shape
Disk	circular disk	centerpoint dir. cosine radius **R**	

Geometry Definition for X Program: Rings

Name	Definition	Variables	Shape
RingA	concentric circular ring	centerpoint inner radius **r** outer radius **R** dir. cosine	
RingB	circular ring with centered rectangular hole	centerpoint radius **R** dir. cosine half height **H** / 2 half width **W** / 2	

Geometry Definition for X Program: Spheres

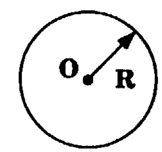
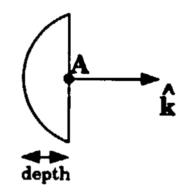
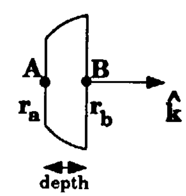
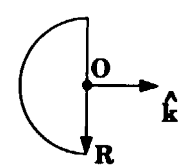
Name	Definition	Variables	Shape
SphereA	complete sphere	centerpoint radius **R**	
SphereC	portion of sphere	point **A** depth dir. cosine	
SphereD	spherical section (**A & B** same side as center)	point **A** depth dir. cosine radius at **A** radius at **B**	
SphereE	hemispherical cap	centerpoint dir. cosine radius **R**	

Table 2: Geometry Input Data Spreadsheet

Data	Description
27 347	no. of data planes, quadrics
0.0254	scale
100. 1. -20.	origin of axis
-80. 327. -100. 110. -515. 90.	parallelpiped around body
100. 1. -20.	center of gravity
10000. 300.	reference area and length
'Main block top plate ABCD1'	Quadric 1
1	component to which this quadric belongs
PlateB	
1	flow is outward, inward, or on both sides
3. 48.1 -42.5	pointA
218. 48.1 -42.5	pointB
3. 48.1 2.1	pointC
218. 48.1 2.1	pointD
100. 50. -20.	exterior point
0. 0. 0. 0.	displacement of limit planes (in pixels)

. . . .

Data	Description
'CLAES small cylinder'	Quadric 15
3	component to which this quadric belongs
CylinderA	
1	flow is outward, inward, or on both sides
64.5 2.7 30.6	pointA
97.1 2.7 30.6	pointB
20.0	radius
0. 0.	displacement of limit planes (in pixels)
0. 65. -30. 30. 0. 60.	F3I limits
'CLAES Ring'	Plane 1
3	component to which this quadric belongs
RingA	
64.5 2.7 30.6	pointA
1. 0. 0.	direction cosine perpendicular to plane
20.0	radius A
25.9	radius B
'CLAES small cap'	Quadric 16
3	component to which this quadric belongs
SphereE	
1	flow is outward, inward, or on both sides
97.1 2.7 30.6	pointA
-1. 0. 0.	direction cosine perpendicular to plane
20.0	radius
0.5	displacement of limit plane (in pixels)
64. 118. -20. 25. 0. 55.	F3I limits

Table 3: Input Data Listing—Geometric Model (29 pgs.)

```
30   355          Number of data planes, quadrics
0.0254            scale
100.    1.    -20.                  Origin of axis
-80.  327.  -100.  150.  -530.  70.  Parallel'ped around body
100.    0.    -20.                  Center of gravity
10000.   300.                       Reference area and length

'Main block top plate ABDC0'        Quadric 1
1                                      Component no.
PlateB
1                                   flow on ext., int. or both
  3.     48.1   -42.5               pointA: actual point A0
218.0    48.1   -42.5               pointB: actual point B0
  3.     48.1     2.1               pointC: actual point D0
218.0    48.1     2.1               pointD: actual point C0
100.     50.    -20.                Exterior point
 0.       0.      0.      0.         limit plane disp. (in pixels)

'Main block side Zmax DCHG0'        Quadric 2
1                                      Component no.
PlateB
1                                   flow on ext., int. or both
  3.     48.1     2.1               pointA: actual point D0
218.0    48.1     2.1               pointB: actual point C0
  3.    -30.2     2.1               pointC: actual point H0
218.0   -30.2     2.1               pointD: actual point G0
100.      0.     10.                Exterior point
 0.       0.      0.      0.         limit plane disp. (in pixels)

'Main block side Zmin ABEF0'        Quadric 3
1                                      Component no.
PlateB
1                                   flow on ext., int. or both
  3.     48.1   -42.5               pointA: actual point A0
218.0    48.1   -42.5               pointB: actual point B0
  3.    -30.2   -42.5               pointC: actual point E0
218.0   -30.2   -42.5               pointD: actual point F0
100.      0.    -50.                Exterior point
 0.       0.      0.      0.         limit plane disp. (in pixels)

'Main block bottom EIHJ0'           Quadric 4
1                                      Component no.
PlateB
1                                   flow on ext., int. or both
  3.    -30.2   -42.5               pointA: actual point E0
 49.3   -30.2   -42.5               pointB: actual point I0
  3.    -30.2     2.1               pointC: actual point H0
 49.3   -30.2     2.1               pointD: actual point J0
100.    -50.    -20.                Exterior point
 0.       0.      0.      0.         limit plane disp. (in pixels)

'Main block Xmin ADEH0'             Quadric 5
1                                      Component no.
PlateB
1                                   flow on ext., int. or both
  3.     48.1   -42.5               pointA: actual point A0
  3.     48.1     2.1               pointB: actual point D0
  3.     32.2   -42.5               pointC: actual point E00
  3.     32.2     2.1               pointD: actual point H00
-50.      0.    -20.                Exterior point
 0.       0.      0.      0.         limit plane disp. (in pixels)

'Main block Xmax BCFG0'             Quadric 6
1                                      Component no.
PlateB
1                                   flow on ext., int. or both
218.0    48.1   -42.5               pointA: actual point B0
218.0    48.1     2.1               pointB: actual point C0
218.0   -30.2   -42.5               pointC: actual point F0
218.0   -30.2     2.1               pointD: actual point G0
250.      0.    -20.                Exterior point
 0.       0.      0.      0.         limit plane disp. (in pixels)

'Front small plate Xmin ABDC1'      Quadric 7
2                                      Component no.
PlateB
1                                   flow on ext., int. or both
 -3.     32.2   -43.0               pointA: actual point A1
 -3.     32.2    28.7               pointB: actual point B1
 -3.    -32.2   -43.0               pointC: actual point D1
 -3.    -32.2    28.7               pointD: actual point C1
-10.      0.    -20.                Exterior point
 0.       0.      0.      0.         limit plane disp. (in pixels)

'Front small plate Xmax EFHG1'      Quadric 8
2                                      Component no.
PlateB
1                                   flow on ext., int. or both
  3.     32.2   -43.0               pointA: actual point E1
  3.     32.2    28.7               pointB: actual point F1
  3.    -32.2   -43.0               pointC: actual point H1
  3.    -32.2    28.7               pointD: actual point G1
 10.      0.    -20.                Exterior point
 0.       0.      0.      0.         limit plane disp. (in pixels)

'Front small plate Ymin DHCG1'      Quadric 9
2                                      Component no.
PlateB
1                                   flow on ext., int. or both
 -3.    -32.2   -43.0               pointA: actual point D1
  3.    -32.2   -43.0               pointC: actual point H1
 -3.    -32.2    28.7               pointC: actual point C1
  3.    -32.2    28.7               pointD: actual point G1
 0.     -50.    -20.                Exterior point
 0.       0.      0.      0.         limit plane disp. (in pixels)

'Front small plate Ymax ABEF1'      Quadric 10
2                                      Component no.
PlateB
1                                   flow on ext., int. or both
 -3.     32.2   -43.0               pointA: actual point A1
 -3.     32.2    28.7               pointB: actual point B1
  3.     32.2   -43.0               pointC: actual point E1
  3.     32.2    28.7               pointD: actual point F1
 0.      50.    -20.                Exterior point
 0.       0.      0.      0.         limit plane disp. (in pixels)

'Front small plate Zmin AEDH1'      Quadric 11
2                                      Component no.
PlateB
1                                   flow on ext., int. or both
 -3.     32.2   -43.0               pointA: actual point A1
  3.     32.2   -43.0               pointB: actual point E1
 -3.    -32.2   -43.0               pointC: actual point D1
  3.    -32.2   -43.0               pointD: actual point H1
 0.       0.    -50.                Exterior point
 0.       0.      0.      0.         limit plane disp. (in pixels)

'Front small plate Zmax BFCG1'      Quadric 12
2                                      Component no.
PlateB
1                                   flow on ext., int. or both
 -3.     32.2    28.7               pointA: actual point B1
  3.     32.2    28.7               pointB: actual point F1
 -3.    -32.2    28.7               pointC: actual point C1
  3.    -32.2    28.7               pointD: actual point G1
 0.       0.     50.                Exterior point
 0.       0.      0.      0.         limit plane disp. (in pixels)
```

```
'CLAES big cap'                    Quadric 13
3                                     Component no.
SphereE
1                                  flow on ext., int. or both
 30.0      2.7    30.6             pointA
 1.        0.      0.              dircos
 25.9                              radius
 0.5                                limit plane disp. (in pixels)
 0.   30.0   -30.0   30.0   0.0   60.0  F3I limits

'CLAES fat cylindrical part'       Quadric 14
3                                     Component no.
CylinderA
1                                  flow on ext., int. or both
 30.0     2.7    30.6              pointA
 64.5     2.7    30.6              pointB
 25.9                              radius
 0.       0.                        limit plane disp. (in pixels)
 0.   65.0   -30.0   30.0   0.0   60.0  F3I limits

'CLAES small cylindrical part'     Quadric 15
3                                     Component no.
CylinderA
1                                  flow on ext., int. or both
 64.5     2.7    30.6              pointA
 97.1     2.7    30.6              pointB
 20.0                              radius
 0.       0.                        limit plane disp. (in pixels)
64.  118.0  -20.0   30.0   0.   55.  F3I limits

'CLAES Ring'                       Plane 1
3                                     Component no.
RingA
 64.5     2.7    30.6              pointA
 1.       0.      0.               direction cosine normal to disk
 20.0                              radius1
 25.9                              radius2

'CLAES small cap'                  Quadric 16
3                                     Component no.
SphereE
1                                  flow on ext., int. or both
 97.1     2.7    30.6              pointA
-1.       0.      0.               dircos
 20.0                              radius
 0.5                                limit plane disp. (in pixels)
64.  118.0  -20.   25.0   0.   55.  F3I limits

'CLAES shield plate'               Quadric 17
3                                     Component no.
PlateB
0                                  flow on ext., int. or both
  7.8     33.1     2.1             pointA: actual point A2
127.8     33.1     2.1             pointB: actual point B2
  7.8     33.1    37.0             pointD: actual point D2
127.8     33.1    37.0             pointC: actual point C2
100.      50.    -20.              Exterior point
 0.       0.      0.      0.        limit plane disp. (in pixels)

'Battery package ABCD3'            Quadric 18
4                                     Component no.
PlateB
1                                  flow on ext., int. or both
-58.3   -28.0     0.               pointA: actual point A3
 -3.    -28.0     0.               pointB: actual point B3
-58.3   -39.2    21.5              pointC: actual point C3
 -3.    -39.2    21.5              pointD: actual point D3
-50.    -45.     10.               Exterior point
 0.       0.      0.      0.        limit plane disp. (in pixels)

'Battery package CDEF3'            Quadric 19
4                                     Component no.
PlateB
1                                  flow on ext., int. or both
-58.3   -39.2    21.5              pointA: actual point C3
 -3.    -39.2    21.5              pointB: actual point D3
-58.3     2.7    44.6              pointC: actual point E3
 -3.      2.7    44.6              pointD: actual point F3
-50.    -20.     60.               Exterior point
 0.       0.      0.      0.        limit plane disp. (in pixels)

'Battery package EFGH3'            Quadric 20
4                                     Component no.
PlateB
1                                  flow on ext., int. or both
-58.3     2.7    44.6              pointA: actual point E3
 -3.      2.7    44.6              pointB: actual point F3
-58.3    14.6    23.6              pointC: actual point G3
 -3.     14.6    23.6              pointD: actual point H3
-50.     10.0    50.0              Exterior point
 0.       0.      0.     -1.        limit plane disp. (in pixels)

'Battery package GHIJ3'            Quadric 21
4                                     Component no.
PlateB
1                                  flow on ext., int. or both
-58.3    14.6    23.6              pointA: actual point G3
 -3.     14.6    23.6              pointB: actual point H3
-58.3    39.8    23.6              pointC: actual point I3
 -3.     39.8    23.6              pointD: actual point J3
-50.     25.0    30.0              Exterior point
 0.       0.      0.      0.        limit plane disp. (in pixels)

'Battery package IJKL3'            Quadric 22
4                                     Component no.
PlateB
1                                  flow on ext., int. or both
-58.3    39.8    23.6              pointA: actual point I3
 -3.     39.8    23.6              pointB: actual point J3
-58.3    39.8   -23.6              pointC: actual point K3
 -3.     39.8   -23.6              pointD: actual point L3
-50.     50.0     0.0              Exterior point
 0.       0.      0.      0.        limit plane disp. (in pixels)

'Battery package KLMN3'            Quadric 23
4                                     Component no.
PlateB
1                                  flow on ext., int. or both
-58.3    39.8   -23.6              pointA: actual point K3
 -3.     39.8   -23.6              pointB: actual point L3
-58.3    14.5   -23.6              pointC: actual point M3
 -3.     14.5   -23.6              pointD: actual point N3
-50.     20.0   -30.0              Exterior point
 0.       0.      0.      0.        limit plane disp. (in pixels)

'Battery package MNOP3'            Quadric 24
4                                     Component no.
PlateB
1                                  flow on ext., int. or both
-58.3    14.5   -23.6              pointA: actual point M3
 -3.     14.5   -23.6              pointB: actual point N3
-58.3     0.0   -43.5              pointC: actual point O3
 -3.      0.0   -43.5              pointD: actual point P3
-50.     10.0   -50.0              Exterior point
-1.       0.      0.      0.        limit plane disp. (in pixels)

'Battery package OPQR3'            Quadric 25
```

```
4                                       Component no.
PlateB
1                                      flow on ext., int. or both
-58.3     0.0   -43.5                  pointA: actual point O3
 -3.      0.0   -43.5                  pointB: actual point P3
-58.3   -40.3   -21.0                  pointC: actual point Q3
 -3.    -40.3   -21.0                  pointD: actual point R3
-50.    -20.0   -50.0                  Exterior point
 0.      0.      0.      0.             limit plane disp. (in pixels)

'Battery package QRAB3'                Quadric 26
4                                        Component no.
PlateB
1                                      flow on ext., int. or both
-58.3   -40.3   -21.0                  pointA: actual point Q3
 -3.    -40.3   -21.0                  pointB: actual point R3
-58.3   -28.0    0.                    pointC: actual point A3
 -3.    -28.0    0.                    pointD: actual point B3
-50.    -50.0   -10.0                  Exterior point
 0.      0.      0.      0.             limit plane disp. (in pixels)

'Battery package side AGCE3 lower X'     Quadric 27
4                                        Component no.
PlateB
1                                      flow on ext., int. or both
-58.3   -28.0    0.                    pointA: actual point A3
-58.3    14.6   23.6                   pointB: actual point G3
-58.3   -39.2   21.5                   pointC: actual point C3
-58.3     2.7   44.6                   pointD: actual point E3
-100.     0.0    0.0                   Exterior point
 0.      0.      0.      0.             limit plane disp. (in pixels)

'Battery package side GIMK3 lower X'     Quadric 28
4                                        Component no.
PlateB
1                                      flow on ext., int. or both
-58.3    14.6   23.6                   pointA: actual point G3
-58.3    39.8   23.6                   pointB: actual point I3
-58.3    14.5   -23.6                  pointC: actual point M3
-58.3    39.8   -23.6                  pointD: actual point K3
-100.     0.0    0.0                   Exterior point
 0.      0.      0.      0.             limit plane disp. (in pixels)

'Battery package side MOAQ3 lower X'     Quadric 29
4                                        Component no.
PlateB
1                                      flow on ext., int. or both
-58.3    14.5   -23.6                  pointA: actual point M3
-58.3     0.0   -43.5                  pointB: actual point O3
-58.3   -28.0    0.                    pointC: actual point A3
-58.3   -40.3   -21.0                  pointD: actual point Q3
-100.     0.0    0.0                   Exterior point
 0.      0.      0.      0.             limit plane disp. (in pixels)

'Battery package side BDHF3 higher X'    Quadric 30
4                                        Component no.
PlateB
1                                      flow on ext., int. or both
 -3.    -28.0    0.                    pointA: actual point B3
 -3.    -39.2   21.5                   pointB: actual point D3
 -3.     14.6   23.6                   pointC: actual point H3
 -3.      2.7   44.6                   pointD: actual point F3
100.      0.0    0.0                   Exterior point
 0.      0.      0.      0.             limit plane disp. (in pixels)

'Battery package side HJNL3 higher X'    Quadric 31
4                                        Component no.
PlateB
1                                      flow on ext., int. or both
 -3.     14.6   23.6                   pointA: actual point H3
 -3.     39.8   23.6                   pointB: actual point J3
 -3.     14.5   -23.6                  pointC: actual point N3
 -3.     39.8   -23.6                  pointD: actual point L3
100.      0.0    0.0                   Exterior point
 0.      0.      0.      0.             limit plane disp. (in pixels)

'Battery package side NPBR3 higher X'    Quadric 32
4                                        Component no.
PlateB
1                                      flow on ext., int. or both
 -3.     14.5   -23.6                  pointA: actual point N3
 -3.      0.0   -43.5                  pointB: actual point P3
 -3.    -28.0    0.                    pointC: actual point B3
 -3.    -40.3   -21.0                  pointD: actual point R3
100.      0.0    0.0                   Exterior point
 0.      0.      0.      0.             limit plane disp. (in pixels)

'Battery package side AGM3 lower X'      Quadric 33
4                                        Component no.
PlateA
1                                      flow on ext., int. or both
-58.3   -28.0    0.                    pointA: actual point A3
-58.3    14.6   23.6                   pointB: actual point G3
-58.3    14.5   -23.6                  pointC: actual point M3
-100.     0.0    0.0                   Exterior point
 0.      0.      0.      0.             limit plane disp. (in pixels)

'Battery Cylindrical MMS'              Quadric 34
5                                        Component no.
CylinderB
1                                      flow on ext., int. or both
-58.3    0.      0.                    pointA
 25.0                                  radius
-1.      0.      0.                    dircos
 21.1                                  Rlength
 0.      0.                             limit plane disp. (in pixels)
-80.0  -55.0  -25.0  25.0  -25.0  25.0   F3I limits

'Battery MMS plane bottom'             Plane 2
5                                        Component no.
Disk
-79.4    0.      0.                    pointA
-1.      0.      0.                    direction cosine normal to disk
 25.0                                  radius

'HALOE mount ABC4'                     Quadric 35
6                                        Component no.
PlateA
0                                      flow on ext., int. or both
171.4    30.8   -42.5                  pointA: actual point A4
171.4   -30.2   -42.5                  pointB: actual point B4
136.3   -23.6   -66.9                  pointC: actual point C4
150.      0.0   -80.0                  Exterior point
 0.      0.      0.      0.             limit plane disp. (in pixels)

'HALOE mount ACD4'                     Quadric 36
6                                        Component no.
PlateA
1                                      flow on ext., int. or both
250.0     0.8   -80.0                  pointA: actual point A4
251.0     0.0   -81.0                  pointB: actual point C4
252.0     0.8   -80.0                  pointC: actual point D4
251.      1.0   -81.0                  Exterior point
 0.      1.      0.      0.             limit plane disp. (in pixels)

'HALOE mount CDE4'                     Quadric 37
6                                        Component no.
PlateA
```

```
0                                       flow on ext., int. or both
136.3   -23.6   -66.9                   pointA: actual point C4
101.2    30.8   -42.5                   pointB: actual point D4
101.2   -30.2   -42.5                   pointC: actual point E4
150.      0.0   -80.0                   Exterior point
 0.       0.      0.      0.             limit plane disp. (in pixels)

'HALOE mount BCE4'                      Quadric 38
6                                          Component no.
PlateA
0                                       flow on ext., int. or both
171.4   -30.2   -42.5                   pointA: actual point B4
136.3   -23.6   -66.9                   pointB: actual point C4
101.2   -30.2   -42.5                   pointC: actual point E4
150.    -40.0   -50.0                   Exterior point
 0.       0.      0.      0.             limit plane disp. (in pixels)

'NEPS ABCD5'                            Quadric 39
7                                          Component no.
PlateB
1                                       flow on ext., int. or both
  83.7  -38.7   -17.6                   pointA: actual point A5
  59.4  -38.7   -17.6                   pointB: actual point B5
  79.6  -73.2   -15.9                   pointC: actual point C5
  63.7  -73.2   -15.9                   pointD: actual point D5
 70.    -60.    -30.                    Exterior point
 0.       0.      0.      0.             limit plane disp. (in pixels)

'NEPS BFDH5'                            Quadric 40
7                                          Component no.
PlateB
1                                       flow on ext., int. or both
  59.4  -38.7  -17.6                    pointA: actual point B5
  59.4  -38.7    1.4                    pointB: actual point F5
  63.7  -73.2  -15.9                    pointC: actual point D5
  63.7  -73.2   -2.1                    pointD: actual point H5
 50.    -60.    -30.                    Exterior point
 0.       0.      0.      0.             limit plane disp. (in pixels)

'NEPS FEHG5'                            Quadric 41
7                                          Component no.
PlateB
1                                       flow on ext., int. or both
  59.4  -38.7     1.4                   pointA: actual point F5
  83.7  -38.7     1.4                   pointB: actual point E5
  63.7  -73.2    -2.1                   pointC: actual point H5
  79.6  -73.2    -2.1                   pointD: actual point G5
 70.    -60.     10.                    Exterior point
 0.       0.      0.      0.             limit plane disp. (in pixels)

'NEPS EAGC5'                            Quadric 42
7                                          Component no.
PlateB
1                                       flow on ext., int. or both
  83.7  -38.7     1.4                   pointA: actual point E5
  83.7  -38.7   -17.6                   pointB: actual point A5
  79.6  -73.2    -2.1                   pointC: actual point G5
  79.6  -73.2   -15.9                   pointD: actual point C5
100.    -60.    -10.                    Exterior point
 0.       0.      0.      0.             limit plane disp. (in pixels)

'NEPS JLIK5'                            Quadric 43
7                                          Component no.
PlateB
1                                       flow on ext., int. or both
  79.6  -83.5   -15.9                   pointA: actual point J5
  79.6  -83.5    -2.1                   pointB: actual point L5
  63.7  -83.5   -15.9                   pointC: actual point I5
  63.7  -83.5    -2.1                   pointD: actual point K5

100.    -90.    -10.                    Exterior point
 0.       0.      0.      0.             limit plane disp. (in pixels)

'Thin box under main block ABCD6'       Quadric 44
8                                          Component no.
PlateB
1                                       flow on ext., int. or both
  49.3  -30.2   -25.5                   pointA: actual point A6
  49.3  -30.2   -42.5                   pointB: actual point B6
  49.3  -38.7   -25.5                   pointC: actual point C6
  49.3  -38.7   -42.5                   pointD: actual point D6
  0.    -35.    -20.                    Exterior point
 0.       0.      0.      0.             limit plane disp. (in pixels)

'Thin box under main block CDGH6'       Quadric 45
8                                          Component no.
PlateB
1                                       flow on ext., int. or both
  49.3  -38.7     2.1                   pointA: actual point C6
  49.3  -38.7   -42.5                   pointB: actual point D6
 176.3  -38.7     2.1                   pointC: actual point G6
 176.3  -38.7   -42.5                   pointD: actual point H6
100.    -50.    -20.                    Exterior point
 0.       0.      0.      0.             limit plane disp. (in pixels)

'Thin box under main block DHBF6'       Quadric 46
8                                          Component no.
PlateB
1                                       flow on ext., int. or both
  49.3  -38.7   -42.5                   pointA: actual point D6
 176.3  -38.7   -42.5                   pointB: actual point H6
  49.3  -30.2   -42.5                   pointC: actual point B6
 176.3  -30.2   -42.5                   pointD: actual point F6
  0.    -35.    -50.                    Exterior point
 0.       0.      0.      0.             limit plane disp. (in pixels)

'Thin box under main block EAGC6'       Quadric 47
8                                          Component no.
PlateB
1                                       flow on ext., int. or both
 176.3  -30.2     2.1                   pointA: actual point E6
  49.3  -30.2     2.1                   pointB: actual point A6
 176.3  -38.7     2.1                   pointC: actual point G6
  49.3  -38.7     2.1                   pointD: actual point C6
100.    -35.     10.                    Exterior point
 0.       0.      0.      0.             limit plane disp. (in pixels)

'Box under main block AECG7'            Quadric 48
9                                          Component no.
PlateB
1                                       flow on ext., int. or both
 176.3  -30.2     2.1                   pointA: actual point A7
 218.0  -30.2     2.1                   pointB: actual point E7
 176.3  -51.0     2.1                   pointC: actual point C7
 218.0  -51.0     2.1                   pointD: actual point G7
200.    -35.     10.                    Exterior point
 0.       0.      0.      0.             limit plane disp. (in pixels)

'Box under main block EFGH7'            Quadric 49
9                                          Component no.
PlateB
1                                       flow on ext., int. or both
 218.0  -30.2     2.1                   pointA: actual point E7
 218.0  -30.2   -42.5                   pointB: actual point F7
 218.0  -51.0     2.1                   pointC: actual point G7
 218.0  -51.0   -42.5                   pointD: actual point H7
250.    -35.    -20.                    Exterior point
 0.       0.      0.      0.             limit plane disp. (in pixels)
```

```
'Box under main block BFDH7'           Quadric 50
9                                         Component no.
PlateB
1                                      flow on ext., int. or both
 176.3  -30.2   -42.5                  pointA: actual point B7
 218.0  -30.2   -42.5                  pointB: actual point F7
 176.3  -51.0   -42.5                  pointC: actual point D7
 218.0  -51.0   -42.5                  pointD: actual point H7
250.    -35.    -50.                   Exterior point
 0.      0.      0.      0.             limit plane disp. (in pixels)

'Box under main block IJCD7'           Quadric 51
9                                         Component no.
PlateB
1                                      flow on ext., int. or both
 176.3  -38.7     2.1                  pointA: actual point I7
 176.3  -38.7   -42.5                  pointB: actual point J7
 176.3  -51.0     2.1                  pointC: actual point C7
 176.3  -51.0   -42.5                  pointD: actual point D7
150.    -45.    -20.                   Exterior point
 0.      0.      0.      0.             limit plane disp. (in pixels)

'Box under main block CGDH7'           Quadric 52
9                                         Component no.
PlateB
1                                      flow on ext., int. or both
 176.3  -51.0     2.1                  pointC: actual point C7
 218.0  -51.0     2.1                  pointG: actual point G7
 176.3  -51.0   -42.5                  pointD: actual point D7
 218.0  -51.0   -42.5                  pointH: actual point H7
200.    -60.    -20.                   Exterior point
 0.      0.      0.      0.             limit plane disp. (in pixels)

'HRDI interferometer ABCD8'            Quadric 53
10                                        Component no.
PlateB
1                                      flow on ext., int. or both
 123.3  -38.7     6.1                  pointA: actual point A8
 123.3  -38.7   -40.4                  pointB: actual point B8
 123.3  -61.4     6.1                  pointC: actual point C8
 123.3  -61.4   -40.4                  pointD: actual point D8
150.    -50.    -20.                   Exterior point
 0.      0.      0.      0.             limit plane disp. (in pixels)

'HRDI interferometer BFDH8'            Quadric 54
10                                        Component no.
PlateB
1                                      flow on ext., int. or both
 123.3  -38.7   -40.4                  pointA: actual point B8
 104.7  -38.7   -40.4                  pointB: actual point F8
 123.3  -61.4   -40.4                  pointC: actual point D8
 104.7  -61.4   -40.4                  pointD: actual point H8
110.    -50.    -50.                   Exterior point
 0.      0.      0.      0.             limit plane disp. (in pixels)

'HRDI interferometer HGFE8'            Quadric 55
10                                        Component no.
PlateB
1                                      flow on ext., int. or both
 104.7  -61.4   -40.4                  pointA: actual point H8
 104.7  -61.4     6.1                  pointB: actual point G8
 104.7  -38.7   -40.4                  pointC: actual point F8
 104.7  -38.7     6.1                  pointD: actual point E8
100.    -50.    -20.                   Exterior point
 0.      0.      0.      0.             limit plane disp. (in pixels)

'HRDI interferometer AECG8'            Quadric 56
10                                        Component no.
PlateB
1                                      flow on ext., int. or both
 123.3  -38.7     6.1                  pointA: actual point A8
 104.7  -38.7     6.1                  pointB: actual point E8
 123.3  -61.4     6.1                  pointC: actual point C8
 104.7  -61.4     6.1                  pointD: actual point G8
110.    -50.     10.                   Exterior point
 0.      0.      0.      0.             limit plane disp. (in pixels)

'HRDI interferometer AEJI8'            Quadric 57
10                                        Component no.
PlateB
1                                      flow on ext., int. or both
 123.3  -38.7     6.1                  pointA: actual point A8
 104.7  -38.7     6.1                  pointB: actual point E8
 123.3  -38.7     2.3                  pointC: actual point J8
 104.7  -38.7     2.3                  pointD: actual point I8
110.    -30.      4.                   Exterior point
 0.      0.      0.      0.             limit plane disp. (in pixels)

'HRDI interferometer CDGH8'            Quadric 58
10                                        Component no.
PlateB
1                                      flow on ext., int. or both
 123.3  -61.4     6.1                  pointA: actual point C8
 123.3  -61.4   -40.4                  pointB: actual point D8
 104.7  -61.4     6.1                  pointC: actual point G8
 104.7  -61.4   -40.4                  pointD: actual point H8
110.    -70.    -20.                   Exterior point
 0.      0.      0.      0.             limit plane disp. (in pixels)

'cylindrical truss #1 at X = 0.'       Quadric 59
11                                        Component no.
CylinderA
1                                      flow on ext., int. or both
  0.    -32.2     0.                   pointA
  0.    -94.0     0.                   pointB
 1.5                                   radius
 0.      0.                             limit plane disp. (in pixels)
-2.0   2.0   -100.0    -30.0  -2.0     2.0  F3I limits

'cylindrical truss #2 at X = 0.'       Quadric 60
11                                        Component no.
CylinderA
1                                      flow on ext., int. or both
  0.    -30.9   -40.2                  pointA
  0.    -94.0     0.                   pointB
 1.5                                   radius
 0.      0.                             limit plane disp. (in pixels)
-2.0   2.0   -100.0    -30.0  -45.0    2.0  F3I limits

'cylindrical truss #3 at X = 0.'       Quadric 61
11                                        Component no.
CylinderA
1                                      flow on ext., int. or both
  0.      0.    -43.0                  pointA
  0.      0.    -94.0                  pointB
 1.5                                   radius
 0.      0.                             limit plane disp. (in pixels)
-2.0   2.0   -2.0   2.0   -100.0       -30.0  F3I limits

'cylindrical truss #4 at X = 0.'       Quadric 62
11                                        Component no.
CylinderA
1                                      flow on ext., int. or both
  0.     29.4   -41.7                  pointA
  0.      0.    -94.0                  pointB
 1.5                                   radius
 0.      0.                             limit plane disp. (in pixels)
-2.0   2.0   -10.0   40.0   -100.0     -30.0  F3I limits
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```
'cylindrical truss #5 at X = 0.'     Quadric 63
11                                      Component no.
CylinderA
1                                    flow on ext., int. or both
  0.     32.2     0.                 pointA
  0.     94.0     0.                 pointB
 1.5                                 radius
 0.       0.                          limit plane disp. (in pixels)
-2.0   2.0    30.0     100.0  -2.0   2.0  F3I limits

'cylindrical truss #6 at X = 0.'     Quadric 64
11                                      Component no.
CylinderA
1                                    flow on ext., int. or both
  0.     31.0   -37.8                pointA
  0.     94.0     0.                 pointB
 1.5                                 radius
 0.       0.                          limit plane disp. (in pixels)
-2.0   2.0    30.0     100.0  -50.0  10.0  F3I limits

'Sphere junctn betwn trusses 1-2(X=0)'  Quadric 65
11                                      Component no.
SphereA
1                                    flow on ext., int. or both
  0.    -94.0     0.                 pointA
 5.0                                 radius

'Sphere junctn betwn trusses 3-4(X=0)'  Quadric 66
11                                      Component no.
SphereA
1                                    flow on ext., int. or both
  0.      0.    -94.0                pointA
 5.0                                 radius

'Sphere junctn betwn trusses 5-6(X=0)'  Quadric 67
11                                      Component no.
SphereA
1                                    flow on ext., int. or both
  0.     94.0     0.                 pointA
 5.0                                 radius

'left-hand HGA-end box AFDI10'       Quadric 68
12                                      Component no.
PlateB
1                                    flow on ext., int. or both
 218.0   31.1    18.6                pointA: actual point A10
 218.0   31.1     2.1                pointB: actual point F10
 218.0  -30.2    18.6                pointC: actual point D10
 218.0  -30.2     2.1                pointD: actual point I10
200.     35.     25.                 Exterior point
 0.       0.      0.       0.         limit plane disp. (in pixels)

'left-hand HGA-end box ABDE10'       Quadric 69
12                                      Component no.
PlateB
1                                    flow on ext., int. or both
 218.0   31.1    18.6                pointA: actual point A10
 232.5   31.1    18.6                pointB: actual point B10
 218.0  -30.2    18.6                pointC: actual point D10
 225.5  -30.2    18.6                pointD: actual point E10
220.     15.     25.                 Exterior point
 0.       0.      0.       0.         limit plane disp. (in pixels)

'left-hand HGA-end box BCE10'        Quadric 70
12                                      Component no.
PlateA
1                                    flow on ext., int. or both
 232.5   31.1    18.6                pointA: actual point B10
 256.9   19.6    18.6                pointB: actual point C10
 225.5  -30.2    18.6                pointC: actual point E10
250.     15.     25.                 Exterior point
 0.       0.      0.       0.         limit plane disp. (in pixels)

'left/right-hand HGA-end box ABFG10' Quadric 71
12                                      Component no.
PlateB
1                                    flow on ext., int. or both
 218.0   31.1    18.6                pointA: actual point A10
 232.5   31.1    18.6                pointB: actual point B10
 218.0   31.1   -42.5                pointC: actual point G11
 232.5   31.1   -42.5                pointD: actual point H11
220.     50.      0.                 Exterior point
 0.       0.      0.       0.         limit plane disp. (in pixels)

'left/right-hand HGA-end box BCGH10' Quadric 72
12                                      Component no.
PlateB
1                                    flow on ext., int. or both
 232.5   31.1    18.6                pointA: actual point B10
 256.9   19.6    18.6                pointB: actual point C10
 232.5   31.1   -42.5                pointC: actual point H11
 256.9   19.6   -42.5                pointD: actual point I11
250.     75.      0.                 Exterior point
 0.       0.      0.       0.         limit plane disp. (in pixels)

'left-hand HGA-end box CHEJ10'       Quadric 73
12                                      Component no.
PlateB
1                                    flow on ext., int. or both
 256.9   19.6    18.6                pointA: actual point C10
 256.9   19.6     2.1                pointB: actual point H10
 225.5  -30.2    18.6                pointC: actual point E10
 225.5  -30.2     2.1                pointD: actual point J10
260.    -30.     25.                 Exterior point
 0.       0.      0.       0.         limit plane disp. (in pixels)

'left/right-hand HGA-end box DEIJ10' Quadric 74
12                                      Component no.
PlateB
1                                    flow on ext., int. or both
 218.0  -30.2    18.6                pointA: actual point D10
 225.5  -30.2    18.6                pointB: actual point E10
 218.0  -30.2   -42.5                pointC: actual point J11
 225.5  -30.2   -42.5                pointD: actual point K11
220.    -50.      0.                 Exterior point
 0.       0.      0.       0.         limit plane disp. (in pixels)

'right-hand HGA-end box GHJK11'      Quadric 75
12                                      Component no.
PlateB
1                                    flow on ext., int. or both
 218.0   31.1   -42.5                pointA: actual point G11
 232.5   31.1   -42.5                pointB: actual point H11
 218.0  -30.2   -42.5                pointC: actual point J11
 225.5  -30.2   -42.5                pointD: actual point K11
220.      0.    -50.                 Exterior point
 0.       0.      0.       0.         limit plane disp. (in pixels)

'right-hand HGA-end box CEF11'       Quadric 76
12                                      Component no.
PlateA
1                                    flow on ext., int. or both
 256.9   19.6     2.1                pointA: actual point C11
 225.5  -30.2     2.1                pointB: actual point E11
 256.9  -15.9     2.1                pointC: actual point F11
250.     35.     25.                 Exterior point
 0.       0.      0.       0.         limit plane disp. (in pixels)
```

```
'right-hand HGA-end box HIKL11'     Quadric 77
12                                     Component no.
PlateB
1                                   flow on ext., int. or both
  232.5   31.1   -42.5              pointA: actual point H11
  256.9   19.6   -42.5              pointB: actual point I11
  225.5  -30.2   -42.5              pointC: actual point K11
  256.9  -15.9   -42.5              pointD: actual point L11
 250.      0.    -75.               Exterior point
  0.       0.      0.       0.       limit plane disp. (in pixels)

'right-hand HGA-end box CIFL11'     Quadric 78
12                                     Component no.
PlateB
1                                   flow on ext., int. or both
  256.9   19.6     2.1              pointA: actual point C11
  256.9   19.6   -42.5              pointB: actual point I11
  256.9  -15.9     2.1              pointC: actual point F11
  256.9  -15.9   -42.5              pointD: actual point L11
 270.     35.     25.               Exterior point
  0.       0.     -2.       0.       limit plane disp. (in pixels)

'right-hand HGA-end box EFKL11'     Quadric 79
12                                     Component no.
PlateB
1                                   flow on ext., int. or both
  225.5  -30.2     2.1              pointA: actual point E11
  256.9  -15.9     2.1              pointB: actual point F11
  225.5  -30.2   -42.5              pointC: actual point K11
  256.9  -15.9   -42.5              pointD: actual point L11
 270.    -50.      0.               Exterior point
  0.       0.      0.       0.       limit plane disp. (in pixels)

'HGA-end nose box CIMN11'           Quadric 80
12                                     Component no.
PlateB
1                                   flow on ext., int. or both
  256.9   19.6     2.1              pointA: actual point C11
  256.9   19.6   -42.5              pointB: actual point I11
  275.9   38.4   -11.4              pointC: actual point M11
  275.9   38.4   -18.7              pointD: actual point N11
 200.     50.      0.               Exterior point
  0.       0.      0.       0.       limit plane disp. (in pixels)

'HGA-end nose box MNFL11'           Quadric 81
12                                     Component no.
PlateB
1                                   flow on ext., int. or both
  275.9   38.4   -11.4              pointA: actual point M11
  275.9   38.4   -18.7              pointB: actual point N11
  256.9  -15.9     2.1              pointC: actual point F11
  256.9  -15.9   -42.5              pointD: actual point L11
 300.    -50.      0.               Exterior point
  0.       0.      0.       0.       limit plane disp. (in pixels)

'HGA-end nose box CMF11'            Quadric 82
12                                     Component no.
PlateA
1                                   flow on ext., int. or both
  256.9   19.6     2.1              pointA: actual point C11
  275.9   38.4   -11.4              pointB: actual point M11
  256.9  -15.9     2.1              pointC: actual point F11
 300.     35.     50.               Exterior point
  0.       0.      0.       0.       limit plane disp. (in pixels)

'HGA-end nose box INL11'            Quadric 83
12                                     Component no.
PlateA
1                                   flow on ext., int. or both
  256.9   19.6   -42.5              pointA: actual point I11
  275.9   38.4   -18.7              pointB: actual point N11
  256.9  -15.9   -42.5              pointC: actual point L11
 300.    -35.    -75.               Exterior point
  0.      -1.      0.       0.       limit plane disp. (in pixels)

'solar panel mount ABCD12'          Quadric 84
13                                     Component no.
PlateB
1                                   flow on ext., int. or both
  142.4   64.5   -42.5              pointA: actual point A12
  129.7   64.5   -42.5              pointB: actual point B12
  142.4   48.1   -42.5              pointC: actual point C12
  129.7   48.1   -42.5              pointD: actual point D12
 135.     50.    -70.               Exterior point
  0.       0.      0.       0.      limit plane disp. (in pixels)

'solar panel mount EFGH12'          Quadric 85
13                                     Component no.
PlateB
1                                   flow on ext., int. or both
  142.4   64.5     2.1              pointA: actual point E12
  129.7   64.5     2.1              pointB: actual point F12
  142.4   48.1     2.1              pointC: actual point G12
  129.7   48.1     2.1              pointD: actual point H12
 135.     50.     70.               Exterior point
  0.       0.      1.       0.      limit plane disp. (in pixels)

'solar panel mount AECG12'          Quadric 86
13                                     Component no.
PlateB
1                                   flow on ext., int. or both
  142.4   64.5   -42.5              pointA: actual point A12
  142.4   64.5     2.1              pointB: actual point E12
  142.4   48.1   -42.5              pointC: actual point C12
  142.4   48.1     2.1              pointD: actual point G12
 200.     70.      0.               Exterior point
  0.       0.      0.       0.      limit plane disp. (in pixels)

'solar panel mount BFDH12'          Quadric 87
13                                     Component no.
PlateB
1                                   flow on ext., int. or both
  129.7   64.5   -42.5              pointA: actual point B12
  129.7   64.5     2.1              pointB: actual point F12
  129.7   48.1   -42.5              pointC: actual point D12
  129.7   48.1     2.1              pointD: actual point H12
 100.     70.      0.               Exterior point
  0.       0.      0.       0.      limit plane disp. (in pixels)

'solar panel mount ABEF12'          Quadric 88
13                                     Component no.
PlateB
1                                   flow on ext., int. or both
  142.4   64.5   -42.5              pointA: actual point A12
  129.7   64.5   -42.5              pointB: actual point B12
  142.4   64.5     2.1              pointC: actual point E12
  129.7   64.5     2.1              pointD: actual point F12
 135.     70.      0.               Exterior point
  0.       0.      0.       0.      limit plane disp. (in pixels)

'solar panel support IJ12'          Quadric 89
13                                     Component no.
CylinderA
1                                   flow on ext., int. or both
  136.1   56.3   -42.5              pointA
  136.1   56.3   -55.5              pointB
  3.5                               radius
```

```
 0.       0.                              limit plane disp. (in pixels)
100.  150.  40.   80.   -70.   0.        F3I limits

'solar panel support J12'                Quadric 90
13                                          Component no.
SphereE
1                                        flow on ext., int. or both
 136.1   56.3   -55.5                    pointA
 0.       0.      1.                     dircos
 3.5                                     radius
 0.                                       limit plane disp. (in pixels)
100.  150.   0.  70.0  -100.   0.        F3I limits

'solar panel support JK12'               Quadric 91
13                                          Component no.
CylinderA
1                                        flow on ext., int. or both
 136.1   56.3   -55.5                    pointA
 136.1  105.79  -70.63                   pointB
 2.4                                     radius
 0.       0.                              limit plane disp. (in pixels)
80.  185.   0.  110.   -100. -50.        F3I limits

'solar panel support JL12'               Quadric 92
13                                          Component no.
CylinderA
1                                        flow on ext., int. or both
 136.1   56.3   -55.5                    pointA
 106.28 105.79  -70.63                   pointB
 1.4                                     radius
 0.       0.                              limit plane disp. (in pixels)
 70.  200.  -5.  120.  -100. -50.        F3I limits

'solar panel support JM12'               Quadric 93
13                                          Component no.
CylinderA
1                                        flow on ext., int. or both
 136.1   56.3   -55.5                    pointA
 165.92 105.79  -70.63                   pointB
 1.4                                     radius
 0.       0.                              limit plane disp. (in pixels)
 70.  200.  -5.  120.  -100. -50.        F3I limits

'solar panel, NOPQ12'                    Quadric 94
13                                          Component no.
PlateB
0                                        flow on ext., int. or both
 200.5  105.79  -70.63                   pointA: actual point N12
  71.7  105.79  -70.63                   pointB: actual point O12
 200.5  -34.55 -529.66                   pointC: actual point P12
  71.7  -34.55 -529.66                   pointD: actual point Q12
150.    100.   -150.                     Exterior point
 0.       0.      0.      0.              limit plane disp. (in pixels)

'solar panel support RS12'               Quadric 95
13                                          Component no.
CylinderA
1                                        flow on ext., int. or both
 106.28 105.79  -70.63                   pointA
 165.92 105.79  -70.63                   pointB
 2.4                                     radius
 0.       0.                              limit plane disp. (in pixels)
 70.  200.  -5.  120.  -100. -50.        F3I limits

'solar panel support R12'                Quadric 96
13                                          Component no.
SphereE
1                                        flow on ext., int. or both
 106.28 105.79  -70.63                   pointA
```

```
 1.       0.      0.                     dircos
 2.4                                     radius
 0.                                       limit plane disp. (in pixels)
 70.  200.  -5.  120.  -100.   0.        F3I limits

'solar panel support S12'                Quadric 97
13                                          Component no.
SphereE
1                                        flow on ext., int. or both
 165.92 105.79  -70.63                   pointA
-1.       0.      0.                     dircos
 2.4                                     radius
 0.                                       limit plane disp. (in pixels)
 70.  200.  -5.  120.  -100.   0.        F3I limits

'HRDI telescope mount AB13'              Quadric 98
14                                          Component no.
CylinderA
1                                        flow on ext., int. or both
 136.3  -38.7    -7.2                    pointA
 136.3  -42.7    -7.2                    pointB
  8.                                     radius
 0.       0.                              limit plane disp. (in pixels)
100.  150.  -80.   0.   -20.  20.        F3I limits

'HRDI telescope mount BC13'              Quadric 99
14                                          Component no.
ConeD
 1                                       flow on ext., int. or both
 136.3  -54.6    -7.2                    pointA
  4.2                                    radiusA
  8.                                     radiusB
  11.9                                   Rlength
 0.       1.      0.                     dircos
 0.5     -0.5                             limit plane disp. (in pixels)
100.  150.   -80.  0.   -20.  20.        F3I limits

'HRDI telescope mount FGJK13'            Quadric 100
14                                          Component no.
PlateB
1                                        flow on ext., int. or both
 132.1  -54.6     0.7                    pointA: actual point F13
 140.5  -54.6     0.7                    pointB: actual point G13
 132.1  -54.6   -15.1                    pointC: actual point J13
 140.5  -54.6   -15.1                    pointD: actual point K13
135.     70.      0.                     Exterior point
 0.       0.      0.      0.              limit plane disp. (in pixels)

'HRDI telescope mount HILM13'            Quadric 101
14                                          Component no.
PlateB
1                                        flow on ext., int. or both
 132.1  -55.6     0.7                    pointA: actual point H13
 140.5  -55.6     0.7                    pointB: actual point I13
 132.1  -55.6   -15.1                    pointC: actual point L13
 140.5  -55.6   -15.1                    pointD: actual point M13
135.    -70.      0.                     Exterior point
 0.       0.      0.      0.              limit plane disp. (in pixels)

'HRDI telescope mount FGHI13'            Quadric 102
14                                          Component no.
PlateB
1                                        flow on ext., int. or both
 132.1  -54.6     0.7                    pointA: actual point F13
 140.5  -54.6     0.7                    pointB: actual point G13
 132.1  -55.6     0.7                    pointC: actual point H13
 140.5  -55.6     0.7                    pointD: actual point I13
135.    -55.      5.                     Exterior point
 0.       0.      0.      0.              limit plane disp. (in pixels)
```

```
'HRDI telescope mount JKLM13'       Quadric 103
14                                     Component no.
PlateB
1                                   flow on ext., int. or both
 132.1  -54.6   -15.1               pointA: actual point J13
 140.5  -54.6   -15.1               pointB: actual point K13
 132.1  -55.6   -15.1               pointC: actual point L13
 140.5  -55.6   -15.1               pointD: actual point M13
135.    -55.    -20.                Exterior point
 0.       0.      0.      0.         limit plane disp. (in pixels)

'HRDI telescope mount GIKM13'       Quadric 104
14                                     Component no.
PlateB
1                                   flow on ext., int. or both
 140.5  -54.6     0.7               pointA: actual point G13
 140.5  -55.6     0.7               pointB: actual point I13
 140.5  -54.6   -15.1               pointC: actual point K13
 140.5  -55.6   -15.1               pointD: actual point M13
150.    -55.    -20.                Exterior point
 0.       0.      0.      0.         limit plane disp. (in pixels)

'HRDI telescope mount FHJL13'       Quadric 105
14                                     Component no.
PlateB
1                                   flow on ext., int. or both
 132.1  -54.6     0.7               pointA: actual point F13
 132.1  -55.6     0.7               pointB: actual point H13
 132.1  -54.6   -15.1               pointC: actual point J13
 132.1  -55.6   -15.1               pointD: actual point L13
100.    -55.    -20.                Exterior point
 0.       0.      0.      0.         limit plane disp. (in pixels)

'HRDI telescope mount HIRS13'       Quadric 106
14                                     Component no.
PlateB
1                                   flow on ext., int. or both
 132.1  -55.6     0.7               pointA: actual point H13
 140.5  -55.6     0.7               pointB: actual point I13
 133.8  -71.3     0.7               pointC: actual point R13
 138.8  -71.3     0.7               pointD: actual point S13
135.    -70.     10.                Exterior point
 0.       0.      0.      0.         limit plane disp. (in pixels)

'HRDI telescope mount NOTU13'       Quadric 107
14                                     Component no.
PlateB
1                                   flow on ext., int. or both
 132.1  -55.6    -1.3               pointA: actual point N13
 140.5  -55.6    -1.3               pointB: actual point O13
 133.8  -71.3    -1.3               pointC: actual point T13
 138.8  -71.3    -1.3               pointD: actual point U13
135.    -70     -10.0               Exterior point
 0.       0.      0.      0.         limit plane disp. (in pixels)

'HRDI telescope mount IOSU13'       Quadric 108
14                                     Component no.
PlateB
1                                   flow on ext., int. or both
 140.5  -55.6     0.7               pointA: actual point I13
 140.5  -55.6    -1.3               pointB: actual point O13
 138.8  -71.3     0.7               pointC: actual point S13
 138.8  -71.3    -1.3               pointD: actual point U13
150.    -70.      0.                Exterior point
 0.       0.      0.      0.         limit plane disp. (in pixels)

'HRDI telescope mount HNRT13'       Quadric 109
14                                     Component no.
```

```
PlateB
1                                   flow on ext., int. or both
 132.1  -55.6     0.7               pointA: actual point H13
 132.1  -55.6    -1.3               pointB: actual point N13
 133.8  -71.3     0.7               pointC: actual point R13
 133.8  -71.3    -1.3               pointD: actual point T13
100.    -70.      0.                Exterior point
 0.       0.      0.      0.         limit plane disp. (in pixels)

'HRDI telescope mount RSTU13'       Quadric 110
14                                     Component no.
PlateB
1                                   flow on ext., int. or both
 133.8  -71.3     0.7               pointA: actual point R13
 138.8  -71.3     0.7               pointB: actual point S13
 133.8  -71.3    -1.3               pointC: actual point T13
 138.8  -71.3    -1.3               pointD: actual point U13
135.    -90.      0.                Exterior point
 0.       0.      0.      0.         limit plane disp. (in pixels)

'HRDI telescope mount knob'         Quadric 111
14                                     Component no.
CylinderA
1                                   flow on ext., int. or both
 136.3  -71.3    -1.3               pointA
 136.3  -71.3     3.7               pointB
 3.5                                radius
 0.       0.                         limit plane disp. (in pixels)
100.  150.  -80.   0.  -20.  20.    F3I limits

'HRDI telescope mount knob'         Plane 3
14                                     Component no.
Disk
 136.3  -71.3    -1.3               pointA
 0.       0.     -1.                direction cosine normal to disk
 3.5                                radius

'HRDI telescope mount knob'         Plane 4
14                                     Component no.
Disk
 136.3  -71.3     3.7               pointA
 0.       0.      1.                direction cosine normal to disk
 3.5                                radius

'HRDI telescope mount PQVW13'       Quadric 112
14                                     Component no.
PlateB
1                                   flow on ext., int. or both
 132.1  -55.6   -13.1               pointA: actual point P13
 140.5  -55.6   -13.1               pointB: actual point Q13
 133.8  -71.3   -13.1               pointC: actual point V13
 138.8  -71.3   -13.1               pointD: actual point W13
135.    -70.      0.                Exterior point
 0.       0.      0.      0.         limit plane disp. (in pixels)

'HRDI telescope mount LMXY13'       Quadric 113
14                                     Component no.
PlateB
1                                   flow on ext., int. or both
 132.1  -55.6   -15.1               pointA: actual point L13
 140.5  -55.6   -15.1               pointB: actual point M13
 133.8  -71.3   -15.1               pointC: actual point X13
 138.8  -71.3   -15.1               pointD: actual point Y13
135.    -70.    -50.                Exterior point
 0.       0.      0.      0.         limit plane disp. (in pixels)

'HRDI telescope mount QMWY13'       Quadric 114
14                                     Component no.
PlateB
```

```
1                                   flow on ext., int. or both
 140.5  -55.6    -13.1              pointA: actual point Q13
 140.5  -55.6    -15.1              pointB: actual point M13
 138.8  -71.3    -13.1              pointC: actual point W13
 138.8  -71.3    -15.1              pointD: actual point Y13
170.    -70.    -10.                Exterior point
 0.      0.      0.      0.          limit plane disp. (in pixels)

'HRDI telescope mount PLVX13'       Quadric 115
14                                     Component no.
PlateB
1                                   flow on ext., int. or both
 132.1  -55.6    -13.1              pointA: actual point P13
 132.1  -55.6    -15.1              pointB: actual point L13
 133.8  -71.3    -13.1              pointC: actual point V13
 133.8  -71.3    -15.1              pointD: actual point X13
100.    -70.    -10.                Exterior point
 0.      0.      0.      0.          limit plane disp. (in pixels)

'HRDI telescope mount VWXY13'       Quadric 116
14                                     Component no.
PlateB
1                                   flow on ext., int. or both
 133.8  -71.3    -13.1              pointA: actual point V13
 138.8  -71.3    -13.1              pointB: actual point W13
 133.8  -71.3    -15.1              pointC: actual point X13
 138.8  -71.3    -15.1              pointD: actual point Y13
100.   -100.    -10.                Exterior point
 0.      0.      0.      0.          limit plane disp. (in pixels)

'HRDI telescope mount knob'         Quadric 117
14                                     Component no.
CylinderA
1                                   flow on ext., int. or both
 136.3  -71.3    -13.1              pointC: actual point T13
 136.3  -71.3    -18.1              pointD: actual point U13
 3.5                                radius
 0.      0.                          limit plane disp. (in pixels)
100.  150.  -80.   0.   -20.  20.   F3I limits

'HRDI telescope mount knob'         Plane 5
14                                     Component no.
Disk
 136.3  -71.3    -18.1              pointA
 0.      0.      -1.                direction cosine normal to disk
 3.5                                radius

'HRDI telescope mount knob'         Plane 6
14                                     Component no.
Disk
 136.3  -71.3    -13.1              pointA
 0.      0.      1.                 direction cosine normal to disk
 3.5                                radius

'HRDI telescope DE13'               Quadric 118
14                                     Component no.
CylinderA
1                                   flow on ext., int. or both
 144.7  -63.988  -7.2               pointA
 127.9  -78.7    -7.2               pointB
  4.0                               radius
 0.      0.                          limit plane disp. (in pixels)
100.  150.  -80.   0.   -20.  20.   F3I limits

'HRDI telescope D13'                Plane 7
14                                     Component no.
Disk
 144.7  -63.988  -7.2               pointA
 0.7523   0.6588    0.              dircos
```

```
 4.0                                radius

'HRDI telescope E13'                Plane 8
14                                     Component no.
Disk
 127.9  -78.7    -7.2               pointA
-0.7523  -0.6588    0.              dircos
 4.0                                radius

'HRDI telescope box abcd13'         Quadric 119
14                                     Component no.
PlateB
1                                   flow on ext., int. or both
 133.0  -74.3   -11.2               pointA: actual point a13
 133.0  -74.3    -3.2               pointB: actual point b13
 137.6  -79.6   -11.2               pointC: actual point c13
 137.6  -79.6    -3.2               pointD: actual point d13
100.    -85.     0.                 Exterior point
 0.      0.      0.      0.          limit plane disp. (in pixels)

'HRDI telescope box efgh13'         Quadric 120
14                                     Component no.
PlateB
1                                   flow on ext., int. or both
 143.3  -65.3   -11.2               pointA: actual point e13
 143.3  -65.3    -3.2               pointB: actual point f13
 147.9  -70.6   -11.2               pointC: actual point g13
 147.9  -70.6    -3.2               pointD: actual point h13
200.    -50.     0.                 Exterior point
 0.      0.      0.      0.          limit plane disp. (in pixels)

'HRDI telescope box aceg13'         Quadric 121
14                                     Component no.
PlateB
1                                   flow on ext., int. or both
 133.0  -74.3   -11.2               pointA: actual point a13
 137.6  -79.6   -11.2               pointB: actual point c13
 143.3  -65.3   -11.2               pointC: actual point e13
 147.9  -70.6   -11.2               pointD: actual point g13
200.    -50.    -20.                Exterior point
 0.      0.      0.      0.          limit plane disp. (in pixels)

'HRDI telescope box bdfh13'         Quadric 122
14                                     Component no.
PlateB
1                                   flow on ext., int. or both
 133.0  -74.3    -3.2               pointA: actual point b13
 137.6  -79.6    -3.2               pointB: actual point d13
 143.3  -65.3    -3.2               pointC: actual point f13
 147.9  -70.6    -3.2               pointD: actual point h13
200.    -50.     20.                Exterior point
 0.      0.      0.      0.          limit plane disp. (in pixels)

'HRDI telescope box cdgh13'         Quadric 123
14                                     Component no.
PlateB
1                                   flow on ext., int. or both
 137.6  -79.6   -11.2               pointA: actual point c13
 137.6  -79.6    -3.2               pointB: actual point d13
 147.9  -70.6   -11.2               pointC: actual point g13
 147.9  -70.6    -3.2               pointD: actual point h13
200.   -250.     0.                 Exterior point
 0.      0.      0.      0.          limit plane disp. (in pixels)

'SSPP box ABCD14'                   Quadric 124
15                                     Component no.
PlateB
1                                   flow on ext., int. or both
 276.3   39.2   -61.0               pointA: actual point A14
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 276.3    39.2    -93.8             pointB: actual point B14
 276.3    -7.2    -61.0             pointC: actual point C14
 276.3    -7.2    -93.8             pointD: actual point D14
300.      35.     -80.              Exterior point
 0.        0.       0.       0.      limit plane disp. (in pixels)

'SSPP box EFGH14'                   Quadric 125
15                                     Component no.
PlateB
1                                   flow on ext., int. or both
 230.3    39.2    -61.0             pointA: actual point E14
 230.3    39.2    -93.8             pointB: actual point F14
 230.3    -7.2    -61.0             pointC: actual point G14
 230.3    -7.2    -93.8             pointD: actual point H14
200.      35.     -80.              Exterior point
 0.        0.       0.       0.      limit plane disp. (in pixels)

'SSPP box ABEF14'                   Quadric 126
15                                     Component no.
PlateB
1                                   flow on ext., int. or both
 276.3    39.2    -61.0             pointA: actual point A14
 276.3    39.2    -93.8             pointB: actual point B14
 230.3    39.2    -61.0             pointC: actual point E14
 230.3    39.2    -93.8             pointD: actual point F14
250.      50.     -80.              Exterior point
 0.        0.       0.       0.      limit plane disp. (in pixels)

'SSPP box CDGH14'                   Quadric 127
15                                     Component no.
PlateB
1                                   flow on ext., int. or both
 276.3    -7.2    -61.0             pointA: actual point C14
 276.3    -7.2    -93.8             pointB: actual point D14
 230.3    -7.2    -61.0             pointC: actual point G14
 230.3    -7.2    -93.8             pointD: actual point H14
250.     -20.     -80.              Exterior point
 0.        0.       0.       0.      limit plane disp. (in pixels)

'SSPP box BFDH14'                   Quadric 128
15                                     Component no.
PlateB
1                                   flow on ext., int. or both
 276.3    39.2    -93.8             pointA: actual point B14
 230.3    39.2    -93.8             pointB: actual point F14
 276.3    -7.2    -93.8             pointC: actual point D14
 230.3    -7.2    -93.8             pointD: actual point H14
250.     -20.    -150.              Exterior point
 0.        0.       0.       0.      limit plane disp. (in pixels)

'SSPP box AECG14'                   Quadric 129
15                                     Component no.
PlateB
1                                   flow on ext., int. or both
 276.3    39.2    -61.0             pointA: actual point A14
 230.3    39.2    -61.0             pointB: actual point E14
 276.3    -7.2    -61.0             pointC: actual point C14
 230.3    -7.2    -61.0             pointD: actual point G14
250.     -20.     -20.              Exterior point
 0.        0.       0.       0.      limit plane disp. (in pixels)

'ISAMS box ABCD15'                  Quadric 130
16                                     Component no.
PlateB
1                                   flow on ext., int. or both
  19.8   -30.2     11.6             pointA: actual point A15
  49.3   -30.2     11.6             pointB: actual point B15
  19.8   -38.7     11.6             pointC: actual point C15
  49.3   -38.7     11.6             pointD: actual point D15
```

```
 90.     -20.      80.              Exterior point
  0.       0.       0.       0.      limit plane disp. (in pixels)

'ISAMS box EFGH15'                  Quadric 131
16                                     Component no.
PlateB
1                                   flow on ext., int. or both
  19.8   -30.2    -25.5             pointA: actual point E15
  49.3   -30.2    -25.5             pointB: actual point F15
  19.8   -38.7    -25.5             pointC: actual point G15
  49.3   -38.7    -25.5             pointD: actual point H15
 90.     -20.     -80.              Exterior point
  0.       0.       0.       0.      limit plane disp. (in pixels)

'ISAMS box BFDH15'                  Quadric 132
16                                     Component no.
PlateB
1                                   flow on ext., int. or both
  49.3   -30.2     11.6             pointA: actual point B15
  49.3   -30.2      2.1             pointB: actual point F15
  49.3   -38.7     11.6             pointC: actual point D15
  49.3   -38.7      2.1             pointD: actual point H15
 80.     -30.       0.              Exterior point
  0.       0.       0.       0.      limit plane disp. (in pixels)

'ISAMS box ABEF15'                  Quadric 133
16                                     Component no.
PlateB
1                                   flow on ext., int. or both
  19.8   -30.2     11.6             pointA: actual point A15
  49.3   -30.2     11.6             pointB: actual point B15
  19.8   -30.2      2.1             pointC: actual point E15
  49.3   -30.2      2.1             pointD: actual point F15
 90.     -20.      80.              Exterior point
  0.       0.       0.       0.      limit plane disp. (in pixels)

'ISAMS box AKEM15'                  Quadric 134
16                                     Component no.
PlateB
1                                   flow on ext., int. or both
  19.8   -30.2     11.6             pointA: actual point A15
  19.8   -76.2     11.6             pointB: actual point K15
  19.8   -30.2    -25.5             pointC: actual point E15
  19.8   -76.2    -25.5             pointD: actual point M15
  0.     -80.       0.              Exterior point
  0.       0.       0.       0.      limit plane disp. (in pixels)

'ISAMS box CDKL15'                  Quadric 135
16                                     Component no.
PlateB
1                                   flow on ext., int. or both
  19.8   -38.7     11.6             pointA: actual point C15
  44.8   -38.7     11.6             pointB: actual point D15
  19.8   -76.2     11.6             pointC: actual point K15
  44.8   -76.2     11.6             pointD: actual point L15
 50.     -20.      80.              Exterior point
  0.       0.       0.       0.      limit plane disp. (in pixels)

'ISAMS box GHMN15'                  Quadric 136
16                                     Component no.
PlateB
1                                   flow on ext., int. or both
  19.8   -38.7    -25.5             pointA: actual point G15
  44.8   -38.7    -25.5             pointB: actual point H15
  19.8   -76.2    -25.5             pointC: actual point M15
  44.8   -76.2    -25.5             pointD: actual point N15
 50.     -20.     -80.              Exterior point
  0.       0.       0.       0.      limit plane disp. (in pixels)
```

```
'ISAMS box KLMN15'                      Quadric 137
16                                         Component no.
PlateB
1                                       flow on ext., int. or both
  19.8  -76.2    11.6                   pointA: actual point K15
  44.8  -76.2    11.6                   pointB: actual point L15
  19.8  -76.2   -25.5                   pointC: actual point M15
  44.8  -76.2   -25.5                   pointD: actual point N15
 50.   -100.      0.                    Exterior point
 0.       0.      0.      0.             limit plane disp. (in pixels)

'ISAMS box IJPR15'                      Quadric 138
16                                         Component no.
PlateB
1                                       flow on ext., int. or both
  57.3  -38.7    11.6                   pointA: actual point I15
  57.3  -38.7   -25.5                   pointB: actual point J15
  57.3  -61.2    11.6                   pointC: actual point P15
  57.3  -61.2   -25.5                   pointD: actual point R15
100.   -100.      0.                    Exterior point
 0.       0.      0.      0.             limit plane disp. (in pixels)

'ISAMS box DHIJ15'                      Quadric 139
16                                         Component no.
PlateB
1                                       flow on ext., int. or both
  49.3  -38.7    11.6                   pointA: actual point D15
  49.3  -38.7     2.1                   pointB: actual point H15
  57.3  -38.7    11.6                   pointC: actual point I15
  57.3  -38.7     2.1                   pointD: actual point J15
100.      0.      0.                    Exterior point
 0.       0.      1.      0.             limit plane disp. (in pixels)

'HGA antenna AB16'                      Quadric 140
17                                         Component no.
CylinderA
1                                       flow on ext., int. or both
 279.7   40.4    -3.7                   pointA
 279.7   40.4   -18.7                   pointB
 2.8                                    radius
 0.       0.                             limit plane disp. (in pixels)
250.  300.  0.    60.   -30.  20.       F3I limits

'HGA antenna A16'                       Quadric 141
17                                         Component no.
SphereE
1                                       flow on ext., int. or both
 279.7   40.4    -3.7                   pointA
 0.       0.     -1.                    dircos
 2.8                                    radius
 0.                                      limit plane disp. (in pixels)
250.  300.   0.   60.   -30.  20.       F3I limits

'HGA antenna B16'                       Plane 9
17                                         Component no.
Disk
 279.7   40.4   -18.7                   pointA
 0.       0.     -1.                    dircos
 2.8                                    radius

'HGA antenna CD16'                      Quadric 142
17                                         Component no.
CylinderA
1                                       flow on ext., int. or both
 278.7   40.4     2.7                   pointA
 301.5   40.4     2.7                   pointB
 4.6                                    radius
 0.       0.                             limit plane disp. (in pixels)
250.  350.  0.    60.   0.   20.        F3I limits
```

```
'HGA antenna C16'                       Plane 10
17                                         Component no.
Disk
 278.7   40.4     2.7                   pointA
-1.       0.      0.                    dircos
 4.6                                    radius

'HGA antenna D16'                       Quadric 143
17                                         Component no.
SphereE
1                                       flow on ext., int. or both
 301.5   40.4     2.7                   pointA
-1.       0.      0.                    dircos
 4.6                                    radius
 0.                                      limit plane disp. (in pixels)
250.  350.   0.   60.   0.    20.       F3I limits

'HGA antenna DE16'                      Quadric 144
17                                         Component no.
CylinderA
1                                       flow on ext., int. or both
 301.5   40.4     2.7                   pointA
 301.5   60.4     2.7                   pointB
 2.5                                    radius
 0.       0.                             limit plane disp. (in pixels)
250.  350.  0.   100.   0.    20.       F3I limits

'HGA antenna E16'                       Quadric 145
17                                         Component no.
SphereC
0                                       flow on ext., int. or both
 301.5   71.4     2.7                   pointA
 0.       1.      0.                    dircos
11.                                     depth
25.5                                    radius
 0.                                      limit plane disp. (in pixels)
250.  400.   0.  100.  -50.  50.        F3I limits

'CLAES lower mount, ABC17'              Quadric 146
18                                         Component no.
PlateA
1                                       flow on ext., int. or both
 102.4  -29.2     2.1                   pointA: actual point A17
  41.9  -29.2     2.1                   pointB: actual point B17
 63.2   -26.2    33.4                   pointC: actual point C17
100.    -35.     50.                    Exterior point
 0.       0.      0.      0.             limit plane disp. (in pixels)

'CLAES lower mount, DEF17'              Quadric 147
18                                         Component no.
PlateA
1                                       flow on ext., int. or both
 102.4  -26.2     2.1                   pointA: actual point D17
  41.9  -26.2     2.1                   pointB: actual point E17
 63.2   -23.2    33.4                   pointC: actual point F17
100.    -20.     50.                    Exterior point
 0.       0.      0.      0.             limit plane disp. (in pixels)

'CLAES lower mount, ACDF17'             Quadric 148
18                                         Component no.
PlateB
1                                       flow on ext., int. or both
 102.4  -29.2     2.1                   pointA: actual point A17
 63.2   -26.2    33.4                   pointB: actual point C17
 102.4  -26.2     2.1                   pointC: actual point D17
 63.2   -23.2    33.4                   pointD: actual point F17
100.    -30.     50.                    Exterior point
 0.       0.      0.      0.             limit plane disp. (in pixels)
```

```
'CLAES lower mount, BCEF17'          Quadric 149
18                                      Component no.
PlateB
1                                    flow on ext., int. or both
 41.9  -29.2     2.1                 pointA: actual point B17
 63.2  -26.2    33.4                 pointB: actual point C17
 41.9  -26.2     2.1                 pointC: actual point E17
 63.2  -23.2    33.4                 pointD: actual point F17
 0.    -30.     50.                  Exterior point
 0.      0.      0.      0.           limit plane disp. (in pixels)

'CLAES upper mount, GHI17'           Quadric 150
18                                      Component no.
PlateA
1                                    flow on ext., int. or both
 102.4   29.0     2.1                pointA: actual point G17
  41.9   29.0     2.1                pointB: actual point H17
 63.2    29.0    33.4                pointC: actual point I17
100.    -35.     50.                 Exterior point
 0.       0.      0.      0.          limit plane disp. (in pixels)

'CLAES upper mount, JKL17'           Quadric 151
18                                      Component no.
PlateA
1                                    flow on ext., int. or both
 102.4   32.0     2.1                pointA: actual point J17
  41.9   32.0     2.1                pointB: actual point K17
 63.2    32.0    33.4                pointC: actual point L17
100.     50.     50.                 Exterior point
 0.       0.      0.      0.          limit plane disp. (in pixels)

'CLAES upper mount, GIJL17'          Quadric 152
18                                      Component no.
PlateB
1                                    flow on ext., int. or both
 102.4   29.0     2.1                pointA: actual point G17
 63.2    29.0    33.4                pointB: actual point I17
 102.4   32.0     2.1                pointC: actual point J17
 63.2    32.0    33.4                pointD: actual point L17
100.    -30.     50.                 Exterior point
 0.       0.      0.     -0.5         limit plane disp. (in pixels)

'CLAES upper mount, HIKL17'          Quadric 153
18                                      Component no.
PlateB
1                                    flow on ext., int. or both
  41.9   29.0     2.1                pointA: actual point H17
 63.2    29.0    33.4                pointB: actual point I17
  41.9   32.0     2.1                pointC: actual point K17
 63.2    32.0    33.4                pointD: actual point L17
 50.   -100.     50.                 Exterior point
 0.       0.      0.     -0.5         limit plane disp. (in pixels)

'WINDII base, ABCD18'                Quadric 154
19                                      Component no.
PlateB
1                                    flow on ext., int. or both
 130.8    0.      2.1                pointA: actual point A18
 167.4    0.      2.1                pointB: actual point B18
 130.8    0.     27.3                pointC: actual point C18
 167.4    0.     27.3                pointD: actual point D18
200.    100.     50.                 Exterior point
 0.       0.      0.      0.          limit plane disp. (in pixels)

'WINDII base, OPQR18'                Quadric 155
19                                      Component no.
PlateB
1                                    flow on ext., int. or both
 173.8  -30.2     9.3                pointA: actual point O18
 173.8  -30.2     2.1                pointB: actual point P18
 123.8  -30.2     9.3                pointC: actual point Q18
 123.8  -30.2     2.1                pointD: actual point R18
200.   -100.     50.                 Exterior point
 2.       2.      2.      2.          limit plane disp. (in pixels)

'WINDII base, DBOP18'                Quadric 156
19                                      Component no.
PlateB
1                                    flow on ext., int. or both
 167.4    0.     27.3                pointA: actual point D18
 167.4    0.      2.1                pointB: actual point B18
 173.8  -30.2     9.3                pointC: actual point O18
 173.8  -30.2     2.1                pointD: actual point P18
200.    100.     50.                 Exterior point
 2.       2.      2.      2.          limit plane disp. (in pixels)

'WINDII base, ACRQ18'                Quadric 157
19                                      Component no.
PlateB
1                                    flow on ext., int. or both
 130.8    0.      2.1                pointA: actual point A18
 130.8    0.     27.3                pointB: actual point C18
 123.8  -30.2     2.1                pointC: actual point R18
 123.8  -30.2     9.3                pointD: actual point Q18
100.    100.     50.                 Exterior point
 2.       2.      2.      2.          limit plane disp. (in pixels)

'WINDII base, DFO18'                 Quadric 158
19                                      Component no.
PlateA
1                                    flow on ext., int. or both
 167.4    0.     27.3                pointA: actual point D18
 167.4  -22.8    27.3                pointB: actual point F18
 173.8  -30.2     9.3                pointC: actual point O18
200.     50.     50.                 Exterior point
 2.       2.      2.      0.          limit plane disp. (in pixels)

'WINDII base, CEQ18'                 Quadric 159
19                                      Component no.
PlateA
1                                    flow on ext., int. or both
 130.8    0.     27.3                pointA: actual point C18
 130.8  -22.8    27.3                pointB: actual point E18
 123.8  -30.2     9.3                pointC: actual point Q18
100.     50.     50.                 Exterior point
 2.       2.      2.      0.          limit plane disp. (in pixels)

'WINDII base, FNO18'                 Quadric 160
19                                      Component no.
PlateA
1                                    flow on ext., int. or both
 167.4  -22.8    27.3                pointA: actual point F18
 162.0  -36.4    21.8                pointB: actual point N18
 173.8  -30.2     9.3                pointC: actual point O18
200.    -50.     50.                 Exterior point
 2.       2.      2.      0.          limit plane disp. (in pixels)

'WINDII base, EMQ18'                 Quadric 161
19                                      Component no.
PlateA
1                                    flow on ext., int. or both
 130.8  -22.8    27.3                pointA: actual point E18
 136.0  -36.4    21.8                pointB: actual point M18
 123.8  -30.2     9.3                pointC: actual point Q18
100.    -50.     50.                 Exterior point
 2.       2.      2.      0.          limit plane disp. (in pixels)
```

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'WINDII base, HFN18'                 Quadric 162
19                                      Component no.
PlateA
1                                    flow on ext., int. or both
 157.9  -22.8    27.3                pointA: actual point H18
 167.4  -22.8    27.3                pointB: actual point F18
 162.0  -36.4    21.8                pointC: actual point N18
200.    -50.    100.                 Exterior point
 2.       2.      2.      0.          limit plane disp. (in pixels)

'WINDII base, GEM18'                 Quadric 163
19                                      Component no.
PlateA
1                                    flow on ext., int. or both
 140.4  -22.8    27.3                pointA: actual point G18
 130.8  -22.8    27.3                pointB: actual point E18
 136.0  -36.4    21.8                pointC: actual point M18
100.    -50.    100.                 Exterior point
 2.       2.      2.      0.          limit plane disp. (in pixels)

'WINDII base, CDEF18'                Quadric 164
19                                      Component no.
PlateB
1                                    flow on ext., int. or both
 130.8    0.     27.3                pointA: actual point C18
 167.4    0.     27.3                pointB: actual point D18
 130.8  -22.8    27.3                pointC: actual point E18
 167.4  -22.8    27.3                pointD: actual point F18
200.    -10.     50.                 Exterior point
 2.       2.      2.      2.          limit plane disp. (in pixels)

'WINDII base, MNQO18'                Quadric 165
19                                      Component no.
PlateB
1                                    flow on ext., int. or both
 136.0  -36.4    21.8                pointA: actual point M18
 162.0  -36.4    21.8                pointB: actual point N18
 123.8  -30.2     9.3                pointC: actual point Q18
 173.8  -30.2     9.3                pointD: actual point O18
200.   -100.     50.                 Exterior point
 2.       2.      2.      2.          limit plane disp. (in pixels)

'WINDII base, MNKL18'                Quadric 166
19                                      Component no.
PlateB
1                                    flow on ext., int. or both
 136.0  -36.4    21.8                pointA: actual point M18
 162.0  -36.4    21.8                pointB: actual point N18
 119.7  -45.0    46.4                pointC: actual point K18
 179.7  -45.0    46.4                pointD: actual point L18
200.   -100.      0.                 Exterior point
 2.       2.      2.      2.          limit plane disp. (in pixels)

'WINDII base, GHIJ18'                Quadric 167
19                                      Component no.
PlateB
1                                    flow on ext., int. or both
 140.4  -22.8    27.3                pointA: actual point G18
 157.9  -22.8    27.3                pointB: actual point H18
 124.9  -31.9    46.4                pointC: actual point I18
 173.4  -31.9    46.4                pointD: actual point J18
200.    100.     50.                 Exterior point
 2.       2.      2.      2.          limit plane disp. (in pixels)

'WINDII base, IJKL18'                Quadric 168
19                                      Component no.
PlateB
1                                    flow on ext., int. or both
 124.9  -31.9    46.4                pointA: actual point I18
 173.4  -31.9    46.4                pointB: actual point J18
 119.7  -45.0    46.4                pointC: actual point K18
 179.7  -45.0    46.4                pointD: actual point L18
200.    -40.     80.                 Exterior point
 0.       0.      0.      0.          limit plane disp. (in pixels)

'WINDII base, HJNL18'                Quadric 169
19                                      Component no.
PlateB
1                                    flow on ext., int. or both
 157.9  -22.8    27.3                pointA: actual point H18
 173.4  -31.9    46.4                pointB: actual point J18
 162.0  -36.4    21.8                pointC: actual point N18
 179.7  -45.0    46.4                pointD: actual point L18
200.    100.     50.                 Exterior point
 2.       2.      2.      2.          limit plane disp. (in pixels)

'WINDII base, IGKM18'                Quadric 170
19                                      Component no.
PlateB
1                                    flow on ext., int. or both
 124.9  -31.9    46.4                pointA: actual point I18
 140.4  -22.8    27.3                pointB: actual point G18
 119.7  -45.0    46.4                pointC: actual point K18
 136.0  -36.4    21.8                pointD: actual point M18
100.    100.     50.                 Exterior point
 2.       2.      2.      2.          limit plane disp. (in pixels)

'PEM-AXIS base, ABCD19'              Quadric 171
20                                      Component no.
PlateB
1                                    flow on ext., int. or both
 269.8  -34.6    36.4                pointA: actual point A19
 247.1  -34.6    36.4                pointB: actual point B19
 263.9  -34.6    16.8                pointC: actual point C19
 253.0  -34.6    16.8                pointD: actual point D19
250.    -50.     50.                 Exterior point
 0.       0.      0.      0.          limit plane disp. (in pixels)

'PEM-AXIS base, EFGH19'              Quadric 172
20                                      Component no.
PlateB
1                                    flow on ext., int. or both
 269.8  -32.3    36.4                pointA: actual point E19
 247.1  -32.3    36.4                pointB: actual point F19
 263.9  -32.3    16.8                pointC: actual point G19
 253.0  -32.3    16.8                pointD: actual point H19
250.     50.     50.                 Exterior point
 0.       0.      0.      0.          limit plane disp. (in pixels)

'PEM-AXIS base, AECG19'              Quadric 173
20                                      Component no.
PlateB
1                                    flow on ext., int. or both
 269.8  -34.6    36.4                pointA: actual point A19
 269.8  -32.3    36.4                pointB: actual point E19
 263.9  -34.6    16.8                pointC: actual point C19
 263.9  -32.3    16.8                pointD: actual point G19
300.    -30.     20.                 Exterior point
 0.       0.      0.      0.          limit plane disp. (in pixels)

'PEM-AXIS base, BFDH19'              Quadric 174
20                                      Component no.
PlateB
1                                    flow on ext., int. or both
 247.1  -34.6    36.4                pointA: actual point B19
 247.1  -32.3    36.4                pointB: actual point F19
 253.0  -34.6    16.8                pointC: actual point D19
 253.0  -32.3    16.8                pointD: actual point H19
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200.    -30.     20.                      Exterior point
  0.      0.      0.      0.               limit plane disp. (in pixels)

'PEM-AXIS base, CDGH19'                   Quadric 175
20                                           Component no.
PlateB
1                                         flow on ext., int. or both
 263.9  -34.6    16.8                     pointA: actual point C19
 253.0  -34.6    16.8                     pointB: actual point D19
 263.9  -32.3    16.8                     pointC: actual point G19
 253.0  -32.3    16.8                     pointD: actual point H19
250.    -30.      0.                      Exterior point
  0.      0.      0.      0.               limit plane disp. (in pixels)

'PEM-AXIS base, AEBF19'                   Quadric 176
20                                           Component no.
PlateB
1                                         flow on ext., int. or both
 269.8  -34.6    36.4                     pointA: actual point A19
 269.8  -32.3    36.4                     pointB: actual point E19
 247.1  -34.6    36.4                     pointC: actual point B19
 247.1  -32.3    36.4                     pointD: actual point F19
250.    -30.     50.                      Exterior point
  0.      0.      0.      0.               limit plane disp. (in pixels)

'PEM-AXIS base, KLMN19'                   Quadric 177
20                                           Component no.
PlateB
1                                         flow on ext., int. or both
 253.0  -34.6    31.5                     pointA: actual point K19
 263.9  -34.6    31.5                     pointB: actual point L19
 253.0  -48.3    31.5                     pointC: actual point M19
 263.9  -48.3    31.5                     pointD: actual point N19
260.    -40.     50.                      Exterior point
  0.      0.      0.      0.               limit plane disp. (in pixels)

'PEM-AXIS base, OPQR19'                   Quadric 178
20                                           Component no.
PlateB
1                                         flow on ext., int. or both
 253.0  -34.6    20.9                     pointA: actual point O19
 263.9  -34.6    20.9                     pointB: actual point P19
 253.0  -48.3    20.9                     pointC: actual point Q19
 263.9  -48.3    20.9                     pointD: actual point R19
250.    -40.      0.                      Exterior point
  0.      0.      0.      0.               limit plane disp. (in pixels)

'PEM-AXIS base, KOMQ19'                   Quadric 179
20                                           Component no.
PlateB
1                                         flow on ext., int. or both
 253.0  -34.6    31.5                     pointA: actual point K19
 253.0  -34.6    20.9                     pointB: actual point O19
 253.0  -48.3    31.5                     pointC: actual point M19
 253.0  -48.3    20.9                     pointD: actual point Q19
200.    -60.     30.                      Exterior point
  0.      0.      0.      0.               limit plane disp. (in pixels)

'PEM-AXIS base, LPNR19'                   Quadric 180
20                                           Component no.
PlateB
1                                         flow on ext., int. or both
 263.9  -34.6    31.5                     pointA: actual point L19
 263.9  -34.6    20.9                     pointB: actual point P19
 263.9  -48.3    31.5                     pointC: actual point N19
 263.9  -48.3    20.9                     pointD: actual point R19
300.    -60.     30.                      Exterior point
  0.      0.      0.      0.               limit plane disp. (in pixels)
```

```
'PEM-AXIS base, MNQR19'                   Quadric 181
20                                           Component no.
PlateB
1                                         flow on ext., int. or both
 253.0  -48.3    31.5                     pointA: actual point M19
 263.9  -48.3    31.5                     pointB: actual point N19
 253.0  -48.3    20.9                     pointC: actual point Q19
 263.9  -48.3    20.9                     pointD: actual point R19
250.    -60.     30.                      Exterior point
  0.      0.      0.      0.               limit plane disp. (in pixels)

'PEM-AXIS antenna JI19'                   Quadric 182
20                                           Component no.
ConeD
0                                         flow on ext., int. or both
 258.3  -44.4    38.8                     pointA
  6.3                                     radiusA
 12.3                                     radiusB
  15.2                                    Rlength
  0.      0.5     0.866                   dircos
  0.      0.                               limit plane disp. (in pixels)
200.  300.   -80.   0.    0.    80.       F3I limits

'PEM-AXIS antenna J19'                    Plane 11
20                                           Component no.
Disk
 258.3  -44.4    38.8                     pointA
  0.      0.5     0.866                   dircos
  6.3                                     radius

'PEM-AXIS base, ST19'                     Quadric 183
20                                           Component no.
CylinderA
1                                         flow on ext., int. or both
 255.8   19.6    10.4                     pointA
 258.3  -33.0    26.6                     pointB
  2.                                      radius
  0.     -0.5                              limit plane disp. (in pixels)
200.  300. -50.   50.   0.    50.         F3I limits

'PEM-ZEPS base, ABC20'                       Quadric 184
21                                           Component no.
PlateA
1                                         flow on ext., int. or both
   5.9   48.1   -42.5                     pointA: actual point A20
  28.7   48.1   -51.4                     pointB: actual point B20
  42.8   48.1   -42.5                     pointC: actual point C20
 30.    100.    -50.                      Exterior point
  0.      0.      0.      0.               limit plane disp. (in pixels)

'PEM-ZEPS base, ABD20'                    Quadric 185
21                                           Component no.
PlateA
1                                         flow on ext., int. or both
   5.9   48.1   -42.5                     pointA: actual point A20
  28.7   48.1   -51.4                     pointB: actual point B20
   5.9   36.4   -42.5                     pointC: actual point D20
 10.     50.   -100.                      Exterior point
  0.      0.      0.      0.               limit plane disp. (in pixels)

'PEM-ZEPS base, BCE20'                    Quadric 186
21                                           Component no.
PlateA
1                                         flow on ext., int. or both
  28.7   48.1   -51.4                     pointA: actual point B20
  42.8   48.1   -42.5                     pointB: actual point C20
  42.8   36.4   -42.5                     pointC: actual point E20
 80.     50.   -100.                      Exterior point
  0.      0.      0.      0.               limit plane disp. (in pixels)
```

```
'PEM-ZEPS base, BDE20'             Quadric 187
21                                     Component no.
PlateA
1                                   flow on ext., int. or both
  28.7   48.1   -51.4               pointA: actual point B20
   5.9   36.4   -42.5               pointB: actual point D20
  42.8   36.4   -42.5               pointC: actual point E20
 40.      0.   -100.                Exterior point
  0.      0.      0.      0.         limit plane disp. (in pixels)

'PEM-ZEPS base, FG20'              Quadric 188
21                                     Component no.
CylinderA
1                                   flow on ext., int. or both
  27.3   48.1   -39.8               pointA
  27.3   55.1   -39.8               pointB
 10.                                radius
  0.      0.                         limit plane disp. (in pixels)
   0.   50.   0.   80.   -90.   0.  F3I limits

'PEM-ZEPS base, G20'               Plane 12
21                                     Component no.
RingA
  27.3   55.1   -39.8               pointA
  0.      1.      0.                dircos
  2.8                               radius1
 10.0                               radius2

'PEM-ZEPS box HIJK20'              Quadric 189
21                                     Component no.
PlateB
1                                   flow on ext., int. or both
  30.7  150.0   -55.1               pointA: actual point H20
  41.2  150.0   -36.9               pointB: actual point I20
  13.0  150.0   -43.7               pointC: actual point J20
  24.3  150.0   -26.2               pointD: actual point K20
100.    200.      0.                Exterior point
  0.      0.      0.      0.         limit plane disp. (in pixels)

'PEM-ZEPS box LMNO20'              Quadric 190
21                                     Component no.
PlateB
1                                   flow on ext., int. or both
  30.7  138.6   -55.1               pointA: actual point L20
  41.2  138.6   -36.9               pointB: actual point M20
  13.0  138.6   -43.7               pointC: actual point N20
  24.3  138.6   -26.2               pointD: actual point O20
100.     50.      0.                Exterior point
  0.      0.      0.      0.         limit plane disp. (in pixels)

'PEM-ZEPS box JKNO20'              Quadric 191
21                                     Component no.
PlateB
1                                   flow on ext., int. or both
  13.0  150.0   -43.7               pointA: actual point J20
  24.3  150.0   -26.2               pointB: actual point K20
  13.0  138.6   -43.7               pointC: actual point N20
  24.3  138.6   -26.2               pointD: actual point O20
  0.    100.      0.                Exterior point
  0.      0.      0.      0.         limit plane disp. (in pixels)

'PEM-ZEPS box HJLN20'              Quadric 192
21                                     Component no.
PlateB
1                                   flow on ext., int. or both
  30.7  150.0   -55.1               pointA: actual point H20
  13.0  150.0   -43.7               pointB: actual point J20
  30.7  138.6   -55.1               pointC: actual point L20
  13.0  138.6   -43.7               pointD: actual point N20
  0.    100.    -50.                Exterior point
  0.      0.      0.      0.         limit plane disp. (in pixels)

'PEM-ZEPS box HILM20'              Quadric 193
21                                     Component no.
PlateB
1                                   flow on ext., int. or both
  30.7  150.0   -55.1               pointA: actual point H20
  41.2  150.0   -36.9               pointB: actual point I20
  30.7  138.6   -55.1               pointC: actual point L20
  41.2  138.6   -36.9               pointD: actual point M20
100.    100.    -50.                Exterior point
  0.      0.      0.      0.         limit plane disp. (in pixels)

'PEM-ZEPS box IKMO20'              Quadric 194
21                                     Component no.
PlateB
1                                   flow on ext., int. or both
  41.2  150.0   -36.9               pointA: actual point I20
  24.3  150.0   -26.2               pointB: actual point K20
  41.2  138.6   -36.9               pointC: actual point M20
  24.3  138.6   -26.2               pointD: actual point O20
100.    100.      0.                Exterior point
  0.      0.      0.      0.         limit plane disp. (in pixels)

'PEM-ZEPS shaft (approx.) PQ20'    Quadric 195
21                                     Component no.
CylinderA
1                                   flow on ext., int. or both
  27.1  138.6   -40.65              pointA
  27.1   55.1   -40.65              pointB
  2.8                               radius
  0.      0.                         limit plane disp. (in pixels)
  0.   100.   50.   150.   -50.   -30.   F3I limits

'MLS gizmo box ABCD21'             Quadric 196
22                                     Component no.
PlateB
1                                   flow on ext., int. or both
 175.2   73.7    20.0               pointA: actual point A21
 217.0   73.7    20.0               pointB: actual point B21
 175.2   48.1    20.0               pointC: actual point C21
 217.0   48.1    20.0               pointD: actual point D21
200.     50.     40.                Exterior point
  0.      0.      0.      0.         limit plane disp. (in pixels)

'MLS gizmo box EFGH21'             Quadric 197
22                                     Component no.
PlateB
1                                   flow on ext., int. or both
 175.2   73.7     2.1               pointA: actual point E21
 217.0   73.7     2.1               pointB: actual point F21
 175.2   48.1     2.1               pointC: actual point G21
 217.0   48.1     2.1               pointD: actual point H21
200.     50.    -40.                Exterior point
  0.      0.      0.      0.         limit plane disp. (in pixels)

'MLS gizmo box EFAB21'             Quadric 198
22                                     Component no.
PlateB
1                                   flow on ext., int. or both
 175.2   73.7     2.1               pointA: actual point E21
 217.0   73.7     2.1               pointB: actual point F21
 175.2   73.7    20.0               pointC: actual point A21
 217.0   73.7    20.0               pointD: actual point B21
200.    100.      0.                Exterior point
  0.      0.      0.      0.         limit plane disp. (in pixels)
```

```
'MLS gizmo box BFDH21'          Quadric 199
22                                  Component no.
PlateB
1                                flow on ext., int. or both
 217.0   73.7    20.0            pointA: actual point B21
 217.0   73.7     2.1            pointB: actual point F21
 217.0   48.1    20.0            pointC: actual point D21
 217.0   48.1     2.1            pointD: actual point H21
250.     50.     40.             Exterior point
 0.      0.      0.      0.       limit plane disp. (in pixels)

'MLS gizmo box AECG21'          Quadric 200
22                                  Component no.
PlateB
1                                flow on ext., int. or both
 175.2   73.7    20.0            pointA: actual point A21
 175.2   73.7     2.1            pointB: actual point E21
 175.2   48.1    20.0            pointC: actual point C21
 175.2   48.1     2.1            pointD: actual point G21
100.     50.    -40.             Exterior point
 0.      0.      0.      0.       limit plane disp. (in pixels)

'MLS gizmo box CDGH21'          Quadric 201
22                                  Component no.
PlateB
1                                flow on ext., int. or both
 175.2   48.1    20.0            pointA: actual point C21
 217.0   48.1    20.0            pointB: actual point D21
 175.2   48.1     2.1            pointC: actual point G21
 217.0   48.1     2.1            pointD: actual point H21
250.    -50.     40.             Exterior point
 0.      0.      0.      0.       limit plane disp. (in pixels)

'MLS box behind antenna IJKL21'         Quadric 202
22                                  Component no.
PlateB
1                                flow on ext., int. or both
 172.7   29.1     9.5            pointA: actual point I21
 218.0   29.1     9.5            pointB: actual point J21
 172.7    3.2     9.5            pointC: actual point K21
 218.0    3.2     9.5            pointD: actual point L21
250.    -50.     40.             Exterior point
 0.      0.      0.      0.       limit plane disp. (in pixels)

'MLS box behind antenna JNLP21'         Quadric 203
22                                  Component no.
PlateB
1                                flow on ext., int. or both
 218.0   29.1     9.5            pointA: actual point J21
 218.0   29.1     2.1            pointB: actual point N21
 218.0    3.2     9.5            pointC: actual point L21
 218.0    3.2     2.1            pointD: actual point P21
250.     30.     40.             Exterior point
 0.      0.      0.      0.       limit plane disp. (in pixels)

'MLS box behind antenna KOLP21'         Quadric 204
22                                  Component no.
PlateB
1                                flow on ext., int. or both
 172.7    3.2     9.5            pointA: actual point K21
 172.7    3.2     2.1            pointB: actual point O21
 218.0    3.2     9.5            pointC: actual point L21
 218.0    3.2     2.1            pointD: actual point P21
250.     0.      0.              Exterior point
 0.      0.      0.      0.       limit plane disp. (in pixels)

'MLS box behind antenna IJMN21'         Quadric 205
22                                  Component no.
PlateB
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1                                         flow on ext., int. or both
 172.7   29.1     9.5                     pointA: actual point I21
 218.0   29.1     9.5                     pointB: actual point J21
 172.7   29.1     2.1                     pointC: actual point M21
 218.0   29.1     2.1                     pointD: actual point N21
250.     50.     40.                      Exterior point
 0.      0.      0.       0.               limit plane disp. (in pixels)

'MLS cylinder QR21'                   Quadric 206
22                                        Component no.
CylinderA
1                                         flow on ext., int. or both
 172.7   24.5    16.0                     pointA
 218.0   24.5    16.0                     pointB
 5.9                                      radius
 0.      0.                                limit plane disp. (in pixels)
150.   250.   0.    50.       0.   40.    F3I limits

'MLS cylinder end'                        Plane 13
22                                           Component no.
Disk
 218.0   24.5    16.0                     pointA
 1.      0.      0.                       direction cosine normal to disk
 5.9                                      radius

'MLS LHS box ABCD22'                   Quadric 207
22                                           Component no.
PlateB
1                                         flow on ext., int. or both
 150.4   44.1    35.3                     pointA: actual point A22
 172.7   44.1    35.3                     pointB: actual point B22
 150.4    3.2    35.3                     pointC: actual point C22
 172.7    3.2    35.3                     pointD: actual point D22
200.     50.     40.                      Exterior point
 0.      0.      0.       0.               limit plane disp. (in pixels)

'MLS LHS box ABEF22'                   Quadric 208
22                                           Component no.
PlateB
1                                         flow on ext., int. or both
 150.4   44.1    35.3                     pointA: actual point A22
 172.7   44.1    35.3                     pointB: actual point B22
 150.4   44.1    21.4                     pointC: actual point E22
 172.7   44.1    21.4                     pointD: actual point F22
200.     50.     40.                      Exterior point
 0.      0.      0.       0.               limit plane disp. (in pixels)

'MLS LHS box CDGH22'                   Quadric 209
22                                           Component no.
PlateB
1                                         flow on ext., int. or both
 150.4    3.2    35.3                     pointA: actual point C22
 172.7    3.2    35.3                     pointB: actual point D22
 150.4    3.2    21.4                     pointC: actual point G22
 172.7    3.2    21.4                     pointD: actual point H22
200.    -10.     40.                      Exterior point
 0.      0.      0.       0.               limit plane disp. (in pixels)

'MLS LHS box BFDH22'                   Quadric 210
22                                           Component no.
PlateB
1                                         flow on ext., int. or both
 172.7   44.1    35.3                     pointA: actual point B22
 172.7   44.1    21.4                     pointB: actual point F22
 172.7    3.2    35.3                     pointC: actual point D22
 172.7    3.2    21.4                     pointD: actual point H22
200.    -10.     40.                      Exterior point
 0.      0.      0.       0.               limit plane disp. (in pixels)
```

```
'MLS LHS box AECG22'                Quadric 211
22                                       Component no.
PlateB
1                                      flow on ext., int. or both
 150.4   44.1    35.3                  pointA: actual point A22
 150.4   44.1    21.4                  pointB: actual point E22
 150.4    3.2    35.3                  pointC: actual point C22
 150.4    3.2    21.4                  pointD: actual point G22
100.    -10.     40.                   Exterior point
 0.       0.      0.       0.           limit plane disp. (in pixels)

'MLS LHS box EFIJ22'                Quadric 212
22                                       Component no.
PlateB
1                                      flow on ext., int. or both
 150.4   44.1    21.4                  pointA: actual point E22
 172.7   44.1    21.4                  pointB: actual point F22
 150.4   29.1    21.4                  pointC: actual point I22
 172.7   29.1    21.4                  pointD: actual point J22
200.     50.      0.                   Exterior point
 0.       0.      0.       0.           limit plane disp. (in pixels)

'MLS LHS box IJQK22'                Quadric 213
22                                       Component no.
PlateB
1                                      flow on ext., int. or both
 150.4   29.1    21.4                  pointA: actual point I22
 172.7   29.1    21.4                  pointB: actual point J22
 169.3   29.1     9.5                  pointC: actual point Q22
 172.7   29.1     9.5                  pointD: actual point K22
200.     50.      0.                   Exterior point
 0.       0.      0.       0.           limit plane disp. (in pixels)

'MLS LHS box GHRL22'                Quadric 214
22                                       Component no.
PlateB
1                                      flow on ext., int. or both
 150.4    3.2    21.4                  pointA: actual point G22
 172.7    3.2    21.4                  pointB: actual point H22
 169.3    3.2     9.5                  pointC: actual point R22
 172.7    3.2     9.5                  pointD: actual point L22
200.    -50.      0.                   Exterior point
 0.       0.      0.       0.           limit plane disp. (in pixels)

'MLS LHS box JKHL22'                Quadric 215
22                                       Component no.
PlateB
1                                      flow on ext., int. or both
 172.7   29.1    21.4                  pointA: actual point J22
 172.7   29.1     9.5                  pointB: actual point K22
 172.7    3.2    21.4                  pointC: actual point H22
 172.7    3.2     9.5                  pointD: actual point L22
200.    -50.      0.                   Exterior point
 0.       0.      0.       0.           limit plane disp. (in pixels)

'MLS LHS box IQGR22'                Quadric 216
22                                       Component no.
PlateB
1                                      flow on ext., int. or both
 150.4   29.1    21.4                  pointA: actual point I22
 169.3   29.1     9.5                  pointB: actual point Q22
 150.4    3.2    21.4                  pointC: actual point G22
 169.3    3.2     9.5                  pointD: actual point R22
100.    -50.      0.                   Exterior point
 0.       0.      0.       0.           limit plane disp. (in pixels)

'MLS LHS box QKOM22'                Quadric 217
22                                       Component no.
PlateB
1                                      flow on ext., int. or both
 169.3   29.1     9.5                  pointA: actual point Q22
 172.7   29.1     9.5                  pointB: actual point K22
 169.3   29.1     2.1                  pointC: actual point O22
 172.7   29.1     2.1                  pointD: actual point M22
100.     50.      0.                   Exterior point
 0.       0.      0.       0.           limit plane disp. (in pixels)

'MLS LHS box RLPN22'                Quadric 218
22                                       Component no.
PlateB
1                                      flow on ext., int. or both
 169.3    3.2     9.5                  pointA: actual point R22
 172.7    3.2     9.5                  pointB: actual point L22
 169.3    3.2     2.1                  pointC: actual point P22
 172.7    3.2     2.1                  pointD: actual point N22
100.    -50.      0.                   Exterior point
 0.       0.      0.       0.           limit plane disp. (in pixels)

'MLS LHS box QORP22'                Quadric 219
22                                       Component no.
PlateB
1                                      flow on ext., int. or both
 169.3   29.1     9.5                  pointA: actual point Q22
 169.3   29.1     2.1                  pointB: actual point O22
 169.3    3.2     9.5                  pointC: actual point R22
 169.3    3.2     2.1                  pointD: actual point P22
100.    -50.      0.                   Exterior point
 0.       0.      0.       0.           limit plane disp. (in pixels)

'MLS large antenna BCDE24'          Quadric 220
22                                       Component no.
PlateB
1                                      flow on ext., int. or both
 185.0   15.9    26.9                  pointA: actual point B24
 217.3   15.9    34.8                  pointB: actual point C24
 186.1   29.8    33.7                  pointC: actual point D24
 216.3   29.8    41.0                  pointD: actual point E24
200.     50.    100.                   Exterior point
 0.       0.      0.       0.           limit plane disp. (in pixels)

'MLS large antenna DEHI24'          Quadric 221
22                                       Component no.
PlateB
1                                      flow on ext., int. or both
 186.1   29.8    33.7                  pointA: actual point D24
 216.3   29.8    41.0                  pointB: actual point E24
 190.6   37.3    38.7                  pointC: actual point H24
 210.7   37.3    44.0                  pointD: actual point I24
200.     50.    100.                   Exterior point
 0.       0.      0.       0.           limit plane disp. (in pixels)

'MLS large antenna HIL24'           Quadric 222
22                                       Component no.
PlateA
1                                      flow on ext., int. or both
 190.6   37.3    38.7                  pointA: actual point H24
 210.7   37.3    44.0                  pointB: actual point I24
 200.2   42.3    46.2                  pointC: actual point L24
200.     50.    100.                   Exterior point
 0.       0.      0.       0.           limit plane disp. (in pixels)

'MLS large antenna BCFG24'          Quadric 223
22                                       Component no.
PlateB
1                                      flow on ext., int. or both
 185.0   15.9    26.9                  pointA: actual point B24
 217.3   15.9    34.8                  pointB: actual point C24
 186.1    5.5    23.2                  pointC: actual point F24
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 216.3    5.5    30.5            pointD: actual point G24
200.     50.    100.             Exterior point
 0.       0.      0.      0.      limit plane disp. (in pixels)

'MLS large antenna FGJK24'      Quadric 224
22                                   Component no.
PlateB
1                                 flow on ext., int. or both
 186.1    5.5    23.2            pointA: actual point F24
 216.3    5.5    30.5            pointB: actual point G24
 189.5   -6.1    20.9            pointC: actual point J24
 213.9   -6.1    26.8            pointD: actual point K24
200.     50.    100.             Exterior point
 0.       0.      0.      0.      limit plane disp. (in pixels)

'MLS large antenna JKM24'       Quadric 225
22                                   Component no.
PlateA
1                                 flow on ext., int. or both
 189.5   -6.1    20.9            pointA: actual point J24
 213.9   -6.1    26.8            pointB: actual point K24
 201.6  -16.8    21.1            pointC: actual point M24
200.     50.    100.             Exterior point
 0.       0.      0.      0.      limit plane disp. (in pixels)

'MLS large antenna BCDE24'       Back face    Quadric 226
22                                  Component no.
PlateB
1                                 flow on ext., int. or both
 185.0   16.4    24.2            pointA: actual point B24
 217.3   16.4    32.1            pointB: actual point C24
 186.1   30.7    32.0            pointC: actual point D24
 216.3   30.7    38.3            pointD: actual point E24
200.     50.   -100.             Exterior point
 0.       0.      0.      0.      limit plane disp. (in pixels)

'MLS large antenna DEHI24'       Back face    Quadric 227
22                                  Component no.
PlateB
1                                 flow on ext., int. or both
 186.1   30.7    32.0            pointA: actual point D24
 216.3   30.7    38.3            pointB: actual point E24
 190.6   38.4    36.0            pointC: actual point H24
 210.7   38.4    41.3            pointD: actual point I24
200.     50.   -100.             Exterior point
 0.       0.      0.      0.      limit plane disp. (in pixels)

'MLS large antenna HIL24'        Back face    Quadric 228
22                                  Component no.
PlateA
1                                 flow on ext., int. or both
 190.6   38.4    36.0            pointA: actual point H24
 210.7   38.4    41.3            pointB: actual point I24
 200.2   43.6    43.5            pointC: actual point L24
200.     50.   -100.             Exterior point
 0.       0.      0.      0.      limit plane disp. (in pixels)

'MLS large antenna BCFG24'       Back face    Quadric 229
22                                  Component no.
PlateB
1                                 flow on ext., int. or both
 185.0   16.4    24.2            pointA: actual point B24
 217.3   16.4    32.1            pointB: actual point C24
 186.1    5.7    20.5            pointC: actual point F24
 216.3    5.7    27.8            pointD: actual point G24
200.     50.   -100.             Exterior point
 0.       0.      0.      0.      limit plane disp. (in pixels)

'MLS large antenna FGJK24'       Back face    Quadric 230
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22                                   Component no.
PlateB
1                                 flow on ext., int. or both
 186.1    5.7    20.5            pointA: actual point F24
 216.3    5.7    27.8            pointB: actual point G24
 189.5   -6.3    18.2            pointC: actual point J24
 213.9   -6.3    24.1            pointD: actual point K24
200.     50.   -100.             Exterior point
 0.       0.      0.      0.      limit plane disp. (in pixels)

'MLS large antenna JKM24'        Back face    Quadric 231
22                                  Component no.
PlateA
1                                 flow on ext., int. or both
 189.5   -6.3    18.2            pointA: actual point J24
 213.9   -6.3    24.1            pointB: actual point K24
 201.6  -17.3    18.4            pointC: actual point M24
200.     50.   -100.             Exterior point
 0.       0.      0.      0.      limit plane disp. (in pixels)

'MLS large antenna CCEE24'      Quadric 232
22                                   Component no.
PlateB
1                                 flow on ext., int. or both
 217.3   15.9    34.8            pointA: actual point C24
 217.3   16.4    32.1            pointB: actual point C24
 216.3   29.8    41.0            pointC: actual point E24
 216.3   30.7    38.3            pointD: actual point E24
250.     15.     40.             Exterior point
 0.       0.      0.      0.      limit plane disp. (in pixels)

'MLS large antenna EEII24'      Quadric 233
22                                   Component no.
PlateB
1                                 flow on ext., int. or both
 216.3   29.8    41.0            pointA: actual point E24
 216.3   30.7    38.3            pointB: actual point E24
 210.7   37.3    44.0            pointC: actual point I24
 210.7   38.4    41.3            pointD: actual point I24
250.     30.     40.             Exterior point
 0.       0.      0.      0.      limit plane disp. (in pixels)

'MLS large antenna BBDD24'      Quadric 234
22                                   Component no.
PlateB
1                                 flow on ext., int. or both
 185.0   15.9    26.9            pointA: actual point B24
 185.0   16.4    24.2            pointB: actual point B24
 186.1   29.8    33.7            pointC: actual point D24
 186.1   30.7    32.0            pointD: actual point D24
100.     15.     40.             Exterior point
 0.       0.      0.      0.      limit plane disp. (in pixels)

'MLS large antenna DDHH24'      Quadric 235
22                                   Component no.
PlateB
1                                 flow on ext., int. or both
 186.1   29.8    33.7            pointA: actual point D24
 186.1   30.7    32.0            pointB: actual point D24
 190.6   37.3    38.7            pointC: actual point H24
 190.6   38.4    36.0            pointD: actual point H24
100.     30.     40.             Exterior point
 0.       0.      0.      0.      limit plane disp. (in pixels)

'MLS large antenna CCGG24'      Quadric 236
22                                   Component no.
PlateB
1                                 flow on ext., int. or both
 217.3   15.9    34.8            pointA: actual point C24
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 217.3   16.4    32.1               pointB: actual point C24
 216.3    5.5    30.5               pointC: actual point G24
 216.3    5.7    27.8               pointD: actual point G24
250.     15.     40.                Exterior point
 0.       0.      0.       0.        limit plane disp. (in pixels)

'MLS large antenna GGKK24'        Quadric 237
22                                     Component no.
PlateB
1                                   flow on ext., int. or both
 216.3    5.5    30.5               pointA: actual point G24
 216.3    5.7    27.8               pointB: actual point G24
 213.9   -6.1    26.8               pointC: actual point K24
 213.9   -6.3    24.1               pointD: actual point K24
250.      0.     40.                Exterior point
 0.       0.      0.       0.        limit plane disp. (in pixels)

'MLS large antenna BBFF24'        Quadric 238
22                                     Component no.
PlateB
1                                   flow on ext., int. or both
 185.0   15.9    26.9               pointA: actual point B24
 185.0   16.4    24.2               pointB: actual point B24
 186.1    5.5    23.2               pointC: actual point F24
 186.1    5.7    20.5               pointD: actual point F24
100.     15.     40.                Exterior point
 0.       0.      0.       0.        limit plane disp. (in pixels)

'MLS large antenna FFJJ24'        Quadric 239
22                                     Component no.
PlateB
1                                   flow on ext., int. or both
 186.1    5.5    23.2               pointA: actual point F24
 186.1    5.7    20.5               pointB: actual point F24
 189.5   -6.1    20.9               pointC: actual point J24
 189.5   -6.3    18.2               pointD: actual point J24
100.      0.     40.                Exterior point
 0.       0.      0.       0.        limit plane disp. (in pixels)

'MLS large antenna IILL24'        Quadric 240
22                                     Component no.
PlateB
1                                   flow on ext., int. or both
 210.7   37.3    44.0               pointA: actual point I24
 210.7   38.4    41.3               pointB: actual point I24
 200.2   42.3    46.2               pointC: actual point L24
 200.2   43.6    43.5               pointD: actual point L24
250.     40.     40.                Exterior point
 0.       0.      0.       0.        limit plane disp. (in pixels)

'MLS large antenna KKMM24'        Quadric 241
22                                     Component no.
PlateB
1                                   flow on ext., int. or both
 213.9   -6.1    26.8               pointA: actual point K24
 213.9   -6.3    24.1               pointB: actual point K24
 201.6  -16.8    21.1               pointC: actual point M24
 201.6  -17.3    18.4               pointD: actual point M24
250.    -20.     40.                Exterior point
 0.       0.      0.       0.        limit plane disp. (in pixels)

'MLS large antenna HHLL24'        Quadric 242
22                                     Component no.
PlateB
1                                   flow on ext., int. or both
 190.6   37.3    38.7               pointA: actual point H24
 190.6   38.4    36.0               pointB: actual point H24
 200.2   42.3    46.2               pointC: actual point L24
 200.2   43.6    43.5               pointD: actual point L24
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100.     40.     40.                Exterior point
 0.       0.      0.       0.        limit plane disp. (in pixels)

'MLS large antenna JJMM24'        Quadric 243
22                                     Component no.
PlateB
1                                   flow on ext., int. or both
 189.5   -6.1    20.9               pointA: actual point J24
 189.5   -6.3    18.2               pointB: actual point J24
 201.6  -16.8    21.1               pointC: actual point M24
 201.6  -17.3    18.4               pointD: actual point M24
100.    -20.     40.                Exterior point
 0.       0.      0.       0.        limit plane disp. (in pixels)

'MLS small antenna OPQR24'        Quadric 244
22                                     Component no.
PlateB
1                                   flow on ext., int. or both
 174.7    4.6    53.5               pointA: actual point O24
 183.8    4.6    55.7               pointB: actual point P24
 175.6    9.1    54.9               pointC: actual point Q24
 182.9    9.1    57.1               pointD: actual point R24
200.      0.    100.                Exterior point
 0.       0.      0.       0.        limit plane disp. (in pixels)

'MLS small antenna QRU24'         Quadric 245
22                                     Component no.
PlateA
1                                   flow on ext., int. or both
 175.6    9.1    54.9               pointA: actual point Q24
 182.9    9.1    57.1               pointB: actual point R24
 179.25  13.7    57.8               pointC: actual point U24
200.      0.    100.                Exterior point
 0.       0.      0.       0.        limit plane disp. (in pixels)

'MLS small antenna OPQR24'          back plate   Quadric 246
22                                     Component no.
PlateB
1                                   flow on ext., int. or both
 174.7    4.7    50.8               pointA: actual point O24
 183.8    4.7    53.0               pointB: actual point P24
 175.6    9.4    52.2               pointC: actual point Q24
 182.9    9.4    54.4               pointD: actual point R24
200.      0.   -100.                Exterior point
 0.       0.      0.       0.        limit plane disp. (in pixels)

'MLS small antenna QRU24'           back plate   Quadric 247
22                                     Component no.
PlateA
1                                   flow on ext., int. or both
 175.6    9.4    52.2               pointA: actual point Q24
 182.9    9.4    54.4               pointB: actual point R24
 179.25  14.1    55.1               pointC: actual point U24
200.      0.   -100.                Exterior point
 0.       0.      0.       0.        limit plane disp. (in pixels)

'MLS small antenna OPST24'        Quadric 248
22                                     Component no.
PlateB
1                                   flow on ext., int. or both
 174.7    4.6    53.5               pointA: actual point O24
 183.8    4.6    55.7               pointB: actual point P24
 175.6    0.     52.1               pointC: actual point S24
 182.9    0.     54.3               pointD: actual point T24
200.      0.    100.                Exterior point
 0.       0.      0.       0.        limit plane disp. (in pixels)

'MLS small antenna STV24'         Quadric 249
22                                     Component no.
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PlateA
1                                  flow on ext., int. or both
 175.6    0.      52.1             pointA: actual point S24
 182.9    0.      54.3             pointB: actual point T24
 179.25  -4.6     51.0             pointC: actual point V24
200.      0.     100.              Exterior point
 0.       0.      0.      0.        limit plane disp. (in pixels)

'MLS small antenna OPST24'         back plate   Quadric 250
22                                    Component no.
PlateB
1                                  flow on ext., int. or both
 174.7    4.7     50.8             pointA: actual point O24
 183.8    4.7     53.0             pointB: actual point P24
 175.6    0.      49.4             pointC: actual point S24
 182.9    0.      51.6             pointD: actual point T24
200.      0.    -100.              Exterior point
 0.       0.      0.      0.        limit plane disp. (in pixels)

'MLS small antenna STV24'          back plate    Quadric 251
22                                    Component no.
PlateA
1                                  flow on ext., int. or both
 175.6    0.      49.4             pointA: actual point S24
 182.9    0.      51.6             pointB: actual point T24
 179.25  -4.7     48.3             pointC: actual point V24
200.      0.    -100.              Exterior point
 0.       0.      0.      0.        limit plane disp. (in pixels)

'MLS small antenna PPRR24'         Quadric 252
22                                    Component no.
PlateB
1                                  flow on ext., int. or both
 183.8    4.6     55.7             pointA: actual point P24
 183.8    4.7     53.0             pointB: actual point P24
 182.9    9.1     57.1             pointC: actual point R24
 182.9    9.4     54.4             pointD: actual point R24
200.      0.      50.              Exterior point
 0.       0.      0.      0.        limit plane disp. (in pixels)

'MLS small antenna PPTT24'         Quadric 253
22                                    Component no.
PlateB
1                                  flow on ext., int. or both
 183.8    4.6     55.7             pointA: actual point P24
 183.8    4.7     53.0             pointB: actual point P24
 182.9    0.      54.3             pointC: actual point T24
 182.9    0.      51.6             pointD: actual point T24
200.      0.      50.              Exterior point
 0.       0.      0.      0.        limit plane disp. (in pixels)

'MLS small antenna RRUU24'         Quadric 254
22                                    Component no.
PlateB
1                                  flow on ext., int. or both
 182.9    9.1     57.1             pointA: actual point R24
 182.9    9.4     54.4             pointB: actual point R24
 179.25  13.7     57.8             pointC: actual point U24
 179.25  14.1     55.1             pointD: actual point U24
200.     50.      50.              Exterior point
 0.       0.      0.      0.        limit plane disp. (in pixels)

'MLS small antenna TTVV24'         Quadric 255
22                                    Component no.
PlateB
1                                  flow on ext., int. or both
 182.9    0.      54.3             pointA: actual point T24
 182.9    0.      51.6             pointB: actual point T24
 179.25  -4.6     51.0             pointC: actual point V24
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 179.25  -4.7     48.3             pointD: actual point V24
200.    -50.      50.              Exterior point
 0.       0.      0.      0.        limit plane disp. (in pixels)

'MLS small antenna OOQQ24'         Quadric 256
22                                    Component no.
PlateB
1                                  flow on ext., int. or both
 174.7    4.6     53.5             pointA: actual point O24
 174.7    4.7     50.8             pointB: actual point O24
 175.6    9.1     54.9             pointC: actual point Q24
 175.6    9.4     52.2             pointD: actual point Q24
100.      0.      50.              Exterior point
 0.       0.      0.      0.        limit plane disp. (in pixels)

'MLS small antenna OOSS24'         Quadric 257
22                                    Component no.
PlateB
1                                  flow on ext., int. or both
 174.7    4.6     53.5             pointA: actual point O24
 174.7    4.7     50.8             pointB: actual point O24
 175.6    0.      52.1             pointC: actual point S24
 175.6    0.      49.4             pointD: actual point S24
100.      0.      50.              Exterior point
 0.       0.      0.      0.        limit plane disp. (in pixels)

'MLS small antenna QQUU24'         Quadric 258
22                                    Component no.
PlateB
1                                  flow on ext., int. or both
 179.25  13.7     57.8             pointA: actual point U24
 179.25  14.1     55.1             pointB: actual point U24
 175.6    9.1     54.9             pointC: actual point Q24
 175.6    9.4     52.2             pointD: actual point Q24
100.     50.      50.              Exterior point
 0.       0.      0.      0.        limit plane disp. (in pixels)

'MLS small antenna SSVV24'         Quadric 259
22                                    Component no.
PlateB
1                                  flow on ext., int. or both
 175.6    0.      52.1             pointA: actual point S24
 175.6    0.      49.4             pointB: actual point S24
 179.25  -4.6     51.0             pointC: actual point V24
 179.25  -4.7     48.3             pointD: actual point V24
100.    -50.      50.              Exterior point
 0.       0.      0.      0.        limit plane disp. (in pixels)

'MLS antenna arm, RHS ABCD25'      Quadric 260
22                                    Component no.
PlateB
0                                  flow on ext., int. or both
 218.0   19.7     30.9             pointA: actual point A25
 218.0   30.4     16.0             pointB: actual point B25
 218.0   10.3     30.9             pointC: actual point C25
 218.0   18.6     16.0             pointD: actual point D25
250.      0.      50.              Exterior point
 0.       0.      0.      0.        limit plane disp. (in pixels)

'MLS antenna arm, RHS EF25'        Quadric 261
22                                    Component no.
CylinderA
1                                  flow on ext., int. or both
 218.0   15.0     30.9             pointA
 226.8   15.0     30.9             pointB
 4.8                               radius
 0.       0.                        limit plane disp. (in pixels)
200. 300.  0.   50.  0.   100.     F3I limits
```

```
'MLS antenna arm, RHS E25'          Plane 14
22                                     Component no.
Disk
 218.0    15.0     30.9             pointA
-1.        0.       0.              direction cosine normal to disk
 4.8                                radius

'MLS antenna arm, RHS F25'          Plane 15
22                                     Component no.
Disk
 226.8    15.0     30.9             pointA
 1.        0.       0.              direction cosine normal to disk
 4.8                                radius

'MLS antenna arm, back GH25'     Quadric 262
22                                     Component no.
CylinderA
1                                   flow on ext., int. or both
 183.1    30.7     27.7             pointA
 216.3    30.7     35.3             pointB
 2.                                 radius
 0.        0.                        limit plane disp. (in pixels)
150. 300.  0.    50.  0.  50.       F3I limits

'MLS antenna arm, back IJ25'     Quadric 263
22                                     Component no.
CylinderA
1                                   flow on ext., int. or both
 183.1     5.7     16.8             pointA
 216.3     5.7     24.8             pointB
 2.                                 radius
 0.        0.                        limit plane disp. (in pixels)
150. 300.  0.    50.  0.  50.       F3I limits

'MLS antenna arm, back H25'      Quadric 264
22                                     Component no.
SphereE
1                                   flow on ext., int. or both
 216.3    30.7     35.3             pointA
-.98247   0.       -.18643          dircos
 2.                                 radius
 0.                                  limit plane disp. (in pixels)
200.  250.   0.   20.    0.   50.   F3I limits

'MLS antenna arm, back J25'      Quadric 265
22                                     Component no.
SphereE
1                                   flow on ext., int. or both
 216.3     5.7     24.8             pointA
-.98247   0.       -.18643          dircos
 2.                                 radius
 0.                                  limit plane disp. (in pixels)
200.  250.   0.   20.    0.   50.   F3I limits

'MLS antenna arm, back G25'      Quadric 266
22                                     Component no.
SphereA
1                                   flow on ext., int. or both
 183.1    30.7     27.7             pointA
 3.                                 radius

'MLS antenna arm, back I25'      Quadric 267
22                                     Component no.
SphereA
1                                   flow on ext., int. or both
 183.1     5.7     16.8             pointA
 3.                                 radius

'MLS antenna arm, between GK25'  Quadric 268
22                                     Component no.
CylinderA
1                                   flow on ext., int. or both
 183.1    30.7     27.7             pointA
 172.5     9.1     57.0             pointB
 2.                                 radius
 0.        0.                        limit plane disp. (in pixels)
150. 300.  0.    50.  0.   100.     F3I limits

'MLS antenna arm, between IL25'  Quadric 269
22                                     Component no.
CylinderA
1                                   flow on ext., int. or both
 183.1     5.7     16.8             pointA
 172.5     0.      54.2             pointB
 2.                                 radius
 0.        0.                        limit plane disp. (in pixels)
150. 300.  0.    50.  0.   100.     F3I limits

'MLS antenna arm, side K25'      Quadric 270
22                                     Component no.
SphereA
1                                   flow on ext., int. or both
 172.5     9.1     57.0             pointA
 3.                                 radius

'MLS antenna arm, side L25'      Quadric 271
22                                     Component no.
SphereA
1                                   flow on ext., int. or both
 172.5     0.      54.2             pointA
 3.                                 radius

'HGA-side bracework AB23'        Quadric 272
23                                     Component no.
CylinderA
1                                   flow on ext., int. or both
 221.0    31.1      0.              pointA
 221.0    94.0      0.              pointB
 1.5                                radius
 0.        0.                        limit plane disp. (in pixels)
150.  250.  0.   100.  -100.  100.  F3I limits

'HGA-side bracework CB23'        Quadric 273
23                                     Component no.
CylinderA
1                                   flow on ext., int. or both
 221.0    29.6    -41.0             pointA
 221.0    94.0      0.              pointB
 1.5                                radius
 0.        0.                        limit plane disp. (in pixels)
150.  250.  0.   100.  -100.  100.  F3I limits

'HGA-side bracework EB23'        Quadric 274
23                                     Component no.
CylinderA
1                                   flow on ext., int. or both
 255.4    18.6      0.              pointA
 221.0    94.0      0.              pointB
 1.5                                radius
 0.        0.                        limit plane disp. (in pixels)
150.  300.  0.   100.  -100.  100.  F3I limits

'HGA-side bracework GB23'        Quadric 275
23                                     Component no.
CylinderA
1                                   flow on ext., int. or both
 255.4    18.1    -41.0             pointA
 221.0    94.0      0.              pointB
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```
 1.5                                      radius
 0.        0.                              limit plane disp. (in pixels)
150.  300.  0.   100.  -100.  100.        F3I limits

'HGA-side bracework IJ23'               Quadric 276
23                                           Component no.
CylinderA
1                                         flow on ext., int. or both
 221.0  -30.2      0.                     pointA
 221.0  -94.0      0.                     pointB
 1.5                                      radius
 0.        0.                              limit plane disp. (in pixels)
150.  250.  -100.  0.  -100.  100.        F3I limits

'HGA-side bracework KJ23'               Quadric 277
23                                           Component no.
CylinderA
1                                         flow on ext., int. or both
 221.0  -28.7   -41.0                     pointA
 221.0  -94.0      0.                     pointB
 1.5                                      radius
 0.        0.                              limit plane disp. (in pixels)
150.  250.  -100.  0.  -100.  100.        F3I limits

'HGA-side bracework MJ23'               Quadric 278
23                                           Component no.
CylinderA
1                                         flow on ext., int. or both
 255.4  -14.4   -41.0                     pointA
 221.0  -94.0      0.                     pointB
 1.5                                      radius
 0.        0.                              limit plane disp. (in pixels)
150.  300.  -100.  0.  -100.  100.        F3I limits

'HGA-side bracework OJ23'               Quadric 279
23                                           Component no.
CylinderA
1                                         flow on ext., int. or both
 255.4  -14.4      0.                     pointA
 221.0  -94.0      0.                     pointB
 1.5                                      radius
 0.        0.                              limit plane disp. (in pixels)
150.  300.  -100.  0.  -100.  100.        F3I limits

'HGA-side bracework QR23'               Quadric 280
23                                           Component no.
CylinderA
1                                         flow on ext., int. or both
 221.0   29.6   -41.0                     pointA
 221.0    0.    -94.0                     pointB
 1.5                                      radius
 0.5       0.                              limit plane disp. (in pixels)
150. 300.  -100. 100.  -100.  100.        F3I limits

'HGA-side bracework SR23'               Quadric 281
23                                           Component no.
CylinderA
1                                         flow on ext., int. or both
 221.0  -28.6   -41.0                     pointA
 221.0    0.    -94.0                     pointB
 1.5                                      radius
 0.5       0.                              limit plane disp. (in pixels)
150. 300.  -100. 100.  -100.  100.        F3I limits

'Sphere junctn B23'                     Quadric 282
23                                           Component no.
SphereA
1                                         flow on ext., int. or both
221.0    94.0      0.                     pointA
```

```
 5.0                                      radius

'Sphere junctn J23'                     Quadric 283
23                                           Component no.
SphereA
1                                         flow on ext., int. or both
221.0   -94.0      0.                     pointA
 5.0                                      radius

'Sphere junctn R23'                     Quadric 284
23                                           Component no.
SphereA
1                                         flow on ext., int. or both
221.0     0.    -94.0                     pointA
 5.0                                      radius

'Dish above CLAES'                        Plane 16
24                                           Component no.
Disk
  97.5    47.8    15.0                    pointA
 0.      0.8706   0.4921                  direction cosine normal to disk
11.4                                      radius

'Thrusters, AC26'                       Quadric 285
25                                           Component no.
ConeA
0                                         flow on ext., int. or both
 -39.9   27.1    23.6                     pointA
-.66446   0.34202  .66446                 dircos
 14.0                                     Cone half angle
 21.0                                     Rlength
 0.        0.                              limit plane disp. (in pixels)
-90.   0.  0.   90.  0.  50.              F3I limits

'Thrusters, BD26'                       Quadric 286
25                                           Component no.
ConeA
0                                         flow on ext., int. or both
 -21.4   27.1    23.6                     pointA
 .66446   0.34202  .66446                 dircos
 14.0                                     Cone half angle
 21.0                                     Rlength
 0.        0.                              limit plane disp. (in pixels)
-50.  50.  0.   90.  0.  50.              F3I limits

'HALOE mount A27'                         Plane 17
26                                           Component no.
Disk
136.3    -23.8   -60.0                    pointA
 0.        1.      0.                     direction cosine normal to disk
 10.6                                     radius

'HALOE mount AB27'                      Quadric 287
26                                           Component no.
CylinderA
1                                         flow on ext., int. or both
136.3    -23.8   -60.0                    pointA
136.3    -26.7   -60.0                    pointB
 10.6                                     radius
 0.        0.                              limit plane disp. (in pixels)
100.  150.  -50.  0.  -100.  -50.         F3I limits

'HALOE mount B27'                         Plane 18
26                                           Component no.
RingA
136.3    -26.7   -60.0                    pointA
 0.       -1.      0.                     direction cosine normal to disk
  6.7                                     radius1
 10.6                                     radius2
```

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'HALOE mount BC27'                  Quadric 288
26                                      Component no.
CylinderA
1                                     flow on ext., int. or both
136.3   -26.7   -60.0                 pointA
136.3   -28.7   -60.0                 pointB
 6.7                                 radius
 0.      0.                            limit plane disp. (in pixels)
100.  150.  -50.  0.  -100.  -50.     F3I limits

'HALOE mount C27'                     Plane 19
26                                      Component no.
RingA
136.3   -28.7   -60.0                 pointA
 0.      -1.      0.                  direction cosine normal to disk
  5.0                                 radius1
  6.7                                 radius2

'HALOE mount CD27'                  Quadric 289
26                                      Component no.
ConeD
 1                                     flow on ext., int. or both
136.3   -33.3   -60.0                 pointA
  2.8                                 radiusA
  5.0                                 radiusB
  4.6                                 Rlength
 0.       1.      0.                  dircos
 0.       0.                           limit plane disp. (in pixels)
100.  150.  -50.  0.  -100.  -50.     F3I limits

'HALOE mount D27'                     Plane 20
26                                      Component no.
RingA
136.3   -33.3   -60.0                 pointA
 0.       1.      0.                  direction cosine normal to disk
  4.6                                 radius1
  5.0                                 radius2

'HALOE mount DE27'                  Quadric 290
26                                      Component no.
CylinderA
1                                     flow on ext., int. or both
136.3   -33.3   -60.0                 pointA
136.3   -41.0   -60.0                 pointB
  5.0                                 radius
 0.       0.                           limit plane disp. (in pixels)
100.  150.  -50.  0.  -100.  -50.     F3I limits

'HALOE mount E27'                     Plane 21
26                                      Component no.
Disk
136.3   -41.0   -60.0                 pointA
 0.      -1.      0.                  direction cosine normal to disk
  5.0                                 radius

'HALOE mount FGHI27'                Quadric 291
26                                      Component no.
PlateB
1                                     flow on ext., int. or both
141.3   -34.4   -53.2                 pointA:  actual point F27
141.3   -34.4   -60.0                 pointB:  actual point G27
141.3   -40.6   -53.2                 pointC:  actual point H27
141.3   -40.6   -60.0                 pointD:  actual point I27
250.    -50.    -50.                  Exterior point
 0.       0.      0.       0.          limit plane disp. (in pixels)

'HALOE mount JKLM27'                Quadric 292
26                                      Component no.
PlateB
1                                     flow on ext., int. or both
131.3   -34.4   -53.2                 pointA:  actual point J27
131.3   -34.4   -60.0                 pointB:  actual point K27
131.3   -40.6   -53.2                 pointC:  actual point L27
131.3   -40.6   -60.0                 pointD:  actual point M27
 50.    -50.    -50.                  Exterior point
 0.       0.      0.       0.          limit plane disp. (in pixels)

'HALOE mount FGJK27'                Quadric 293
26                                      Component no.
PlateB
1                                     flow on ext., int. or both
141.3   -34.4   -53.2                 pointA:  actual point F27
141.3   -34.4   -60.0                 pointB:  actual point G27
131.3   -34.4   -53.2                 pointC:  actual point J27
131.3   -34.4   -60.0                 pointD:  actual point K27
150.      0.    -50.                  Exterior point
 0.       0.      0.       0.          limit plane disp. (in pixels)

'HALOE mount HILM27'                Quadric 294
26                                      Component no.
PlateB
1                                     flow on ext., int. or both
141.3   -40.6   -53.2                 pointA:  actual point H27
141.3   -40.6   -60.0                 pointB:  actual point I27
131.3   -40.6   -53.2                 pointC:  actual point L27
131.3   -40.6   -60.0                 pointD:  actual point M27
150.    -50.    -50.                  Exterior point
 0.       0.      0.       0.          limit plane disp. (in pixels)

'HALOE mount FNJR27'                Quadric 295
26                                      Component no.
PlateB
1                                     flow on ext., int. or both
141.3   -34.4   -53.2                 pointA:  actual point F27
141.3   -38.8   -49.4                 pointB:  actual point N27
131.3   -34.4   -53.2                 pointC:  actual point J27
131.3   -38.8   -49.4                 pointD:  actual point R27
150.      0.    -50.                  Exterior point
 0.       0.     -0.5      0.          limit plane disp. (in pixels)

'HALOE mount NFPQ27'                Quadric 296
26                                      Component no.
PlateB
1                                     flow on ext., int. or both
141.3   -38.8   -49.4                 pointA:  actual point N27
141.3   -34.4   -53.2                 pointB:  actual point F27
141.3   -50.5   -49.4                 pointC:  actual point P27
141.3   -50.5   -53.2                 pointD:  actual point Q27
250.    -50.    -50.                  Exterior point
 0.       0.      0.       0.          limit plane disp. (in pixels)

'HALOE mount RJTU27'                Quadric 297
26                                      Component no.
PlateB
1                                     flow on ext., int. or both
131.3   -38.8   -49.4                 pointA:  actual point R27
131.3   -34.4   -53.2                 pointB:  actual point J27
131.3   -50.5   -49.4                 pointC:  actual point T27
131.3   -50.5   -53.2                 pointD:  actual point U27
 50.    -50.    -50.                  Exterior point
 0.       0.      0.       0.          limit plane disp. (in pixels)

'HALOE mount HLQU27'                Quadric 298
26                                      Component no.
PlateB
1                                     flow on ext., int. or both
141.3   -40.6   -53.2                 pointA:  actual point H27
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131.3   -40.6   -53.2                    pointB:  actual point L27
141.3   -50.5   -53.2                    pointC:  actual point Q27
131.3   -50.5   -53.2                    pointD:  actual point U27
150.    -50.   -100.                     Exterior point
 0.      0.      0.       0.              limit plane disp. (in pixels)

'HALOE mount NRPT27'                    Quadric 299
26                                           Component no.
PlateB
1                                        flow on ext., int. or both
141.3   -38.8   -49.4                    pointA:  actual point N27
131.3   -38.8   -49.4                    pointB:  actual point R27
141.3   -50.5   -49.4                    pointC:  actual point P27
131.3   -50.5   -49.4                    pointD:  actual point T27
250.    -50.      0.                     Exterior point
 0.      0.      0.       0.              limit plane disp. (in pixels)

'HALOE mount VW27'                      Quadric 300
26                                           Component no.
CylinderA
1                                        flow on ext., int. or both
136.3   -50.5   -49.4                    pointA
136.3   -50.5   -56.3                    pointB
  5.0                                    radius
 0.      0.                               limit plane disp. (in pixels)
100.  160.  -80.  0.   -80.  -30.        F3I limits

'HALOE mount V27'                        Plane 22
26                                          Component no.
RingA
136.3   -50.5   -49.4                    pointA
 0.      0.     -1.                      direction cosine normal to disk
  1.1                                    radius1
  5.0                                    radius2

'HALOE mount VX27'                      Quadric 301
26                                           Component no.
CylinderA
1                                        flow on ext., int. or both
136.3   -50.5   -49.4                    pointA
136.3   -50.5   -47.4                    pointB
  1.1                                    radius
 0.      0.                               limit plane disp. (in pixels)
100.  160.  -80.  0.   -80.  -30.        F3I limits

'HALOE mount X27'                        Plane 23
26                                          Component no.
Disk
136.3   -50.5   -47.4                    pointA
 0.      0.     -1.                      direction cosine normal to disk
  1.1                                    radius

'HALOE box ABCD28'                      Quadric 302
26                                           Component no.
PlateB
1                                        flow on ext., int. or both
147.6   -52.7   -66.7                    pointA:  actual point A28
121.0   -52.7   -66.7                    pointB:  actual point B28
147.6   -55.4   -66.7                    pointC:  actual point C28
121.0   -55.4   -66.7                    pointD:  actual point D28
150.    -50.   -100.                     Exterior point
 0.      0.      0.       0.              limit plane disp. (in pixels)

'HALOE box GHIJ28'                      Quadric 303
26                                           Component no.
PlateB
1                                        flow on ext., int. or both
147.6   -52.7   -56.3                    pointA:  actual point G28
121.0   -52.7   -56.3                    pointB:  actual point H28
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147.6   -55.4   -56.3                    pointC:  actual point I28
121.0   -55.4   -56.3                    pointD:  actual point J28
150.    -50.      0.                     Exterior point
 0.      0.      0.       0.              limit plane disp. (in pixels)

'HALOE box BDHJ28'                      Quadric 304
26                                           Component no.
PlateB
1                                        flow on ext., int. or both
121.0   -52.7   -66.7                    pointA:  actual point B28
121.0   -55.4   -66.7                    pointB:  actual point D28
121.0   -52.7   -56.3                    pointC:  actual point H28
121.0   -55.4   -56.3                    pointD:  actual point J28
 50.    -50.   -100.                     Exterior point
 0.      0.      0.       0.              limit plane disp. (in pixels)

'HALOE box CDEF28'                      Quadric 305
26                                           Component no.
PlateB
1                                        flow on ext., int. or both
147.6   -55.4   -66.7                    pointA:  actual point C28
121.0   -55.4   -66.7                    pointB:  actual point D28
145.0   -61.8   -66.7                    pointC:  actual point E28
133.8   -61.8   -66.7                    pointD:  actual point F28
150.    -50.   -100.                     Exterior point
 0.      0.      0.       0.              limit plane disp. (in pixels)

'HALOE box IJKL28'                      Quadric 306
26                                           Component no.
PlateB
1                                        flow on ext., int. or both
147.6   -55.4   -56.3                    pointA:  actual point I28
121.0   -55.4   -56.3                    pointB:  actual point J28
145.0   -61.8   -56.3                    pointC:  actual point K28
133.8   -61.8   -56.3                    pointD:  actual point L28
150.    -50.      0.                     Exterior point
 0.      0.      0.       0.              limit plane disp. (in pixels)

'HALOE box CEIK28'                      Quadric 307
26                                           Component no.
PlateB
1                                        flow on ext., int. or both
147.6   -55.4   -66.7                    pointA:  actual point C28
145.0   -61.8   -66.7                    pointB:  actual point E28
147.6   -55.4   -56.3                    pointC:  actual point I28
145.0   -61.8   -56.3                    pointD:  actual point K28
200.   -100.      0.                     Exterior point
 0.      0.      0.       0.              limit plane disp. (in pixels)

'HALOE box EFKL28'                      Quadric 308
26                                           Component no.
PlateB
1                                        flow on ext., int. or both
145.0   -61.8   -66.7                    pointA:  actual point E28
133.8   -61.8   -66.7                    pointB:  actual point F28
145.0   -61.8   -56.3                    pointC:  actual point K28
133.8   -61.8   -56.3                    pointD:  actual point L28
150.   -100.      0.                     Exterior point
 0.      0.      0.       0.              limit plane disp. (in pixels)

'HALOE box DFJL28'                      Quadric 309
26                                           Component no.
PlateB
1                                        flow on ext., int. or both
121.0   -55.4   -66.7                    pointA:  actual point D28
133.8   -61.8   -66.7                    pointB:  actual point F28
121.0   -55.4   -56.3                    pointC:  actual point J28
133.8   -61.8   -56.3                    pointD:  actual point L28
 50.   -100.      0.                     Exterior point
```

```
 0.      0.      0.      0.      limit plane disp. (in pixels)

'HALOE box MNOP28'               Quadric 310
26                                   Component no.
PlateB
0                                 flow on ext., int. or both
147.6   -41.3   -49.4             pointA:  actual point M28
147.6   -41.3   -68.7             pointB:  actual point N28
147.6   -55.4   -49.4             pointC:  actual point O28
147.6   -55.4   -68.7             pointD:  actual point P28
 50.   -100.      0.              Exterior point
 0.      0.      0.      0.        limit plane disp. (in pixels)

'HALOE box QRST28'               Quadric 311
26                                   Component no.
PlateB
1                                 flow on ext., int. or both
152.7   -43.7   -56.3             pointA:  actual point Q28
152.7   -43.7   -66.7             pointB:  actual point R28
152.7   -55.4   -56.3             pointC:  actual point S28
152.7   -55.4   -66.7             pointD:  actual point T28
200.   -100.    -50.              Exterior point
 0.      0.      0.      0.        limit plane disp. (in pixels)

'HALOE box QRUV28'               Quadric 312
26                                   Component no.
PlateB
1                                 flow on ext., int. or both
152.7   -43.7   -56.3             pointA:  actual point Q28
152.7   -43.7   -66.7             pointB:  actual point R28
147.6   -43.7   -56.3             pointC:  actual point U28
147.6   -43.7   -66.7             pointD:  actual point V28
200.      0.    -50.              Exterior point
 0.      0.      0.      0.        limit plane disp. (in pixels)

'HALOE box STWX28'               Quadric 313
26                                   Component no.
PlateB
1                                 flow on ext., int. or both
152.7   -55.4   -56.3             pointA:  actual point S28
152.7   -55.4   -66.7             pointB:  actual point T28
147.6   -55.4   -56.3             pointC:  actual point W28
147.6   -55.4   -66.7             pointD:  actual point X28
200.   -100.    -50.              Exterior point
 0.      0.      0.      0.        limit plane disp. (in pixels)

'HALOE box RVTX28'               Quadric 314
26                                   Component no.
PlateB
1                                 flow on ext., int. or both
152.7   -43.7   -66.7             pointA:  actual point R28
147.6   -43.7   -66.7             pointB:  actual point V28
152.7   -55.4   -66.7             pointC:  actual point T28
147.6   -55.4   -66.7             pointD:  actual point X28
200.    -50.   -100.              Exterior point
 0.      0.      0.      0.        limit plane disp. (in pixels)

'HALOE box QUSW28'               Quadric 315
26                                   Component no.
PlateB
1                                 flow on ext., int. or both
152.7   -43.7   -56.3             pointA:  actual point Q28
147.6   -43.7   -56.3             pointB:  actual point U28
152.7   -55.4   -56.3             pointC:  actual point S28
147.6   -55.4   -56.3             pointD:  actual point W28
200.    -50.      0.              Exterior point
 0.      0.      0.      0.        limit plane disp. (in pixels)

'HALOE box ABCD29'               Quadric 316
26                                   Component no.
PlateB
1                                 flow on ext., int. or both
147.6   -43.7   -66.7             pointA:  actual point A29
131.3   -43.7   -66.7             pointB:  actual point B29
147.6   -52.7   -66.7             pointC:  actual point C29
131.3   -52.7   -66.7             pointD:  actual point D29
150.    -50.   -100.              Exterior point
 0.      0.      0.      0.        limit plane disp. (in pixels)

'HALOE box EFGH29'               Quadric 317
26                                   Component no.
PlateB
1                                 flow on ext., int. or both
147.6   -43.7   -56.3             pointA:  actual point E29
131.3   -43.7   -56.3             pointB:  actual point F29
147.6   -52.7   -56.3             pointC:  actual point G29
131.3   -52.7   -56.3             pointD:  actual point H29
150.    -50.      0.              Exterior point
 0.      0.      0.      0.        limit plane disp. (in pixels)

'HALOE box ABEF29'               Quadric 318
26                                   Component no.
PlateB
1                                 flow on ext., int. or both
147.6   -43.7   -66.7             pointA:  actual point A29
131.3   -43.7   -66.7             pointB:  actual point B29
147.6   -43.7   -56.3             pointC:  actual point E29
131.3   -43.7   -56.3             pointD:  actual point F29
150.      0.    -50.              Exterior point
 0.      0.      0.      0.        limit plane disp. (in pixels)

'HALOE box BDFH29'               Quadric 319
26                                   Component no.
PlateB
1                                 flow on ext., int. or both
131.3   -43.7   -66.7             pointA:  actual point B29
131.3   -52.7   -66.7             pointB:  actual point D29
131.3   -43.7   -56.3             pointC:  actual point F29
131.3   -52.7   -56.3             pointD:  actual point H29
 50.    -50.    -50.              Exterior point
 0.      0.      0.      0.        limit plane disp. (in pixels)

'HALOE box DHLM29'               Quadric 320
26                                   Component no.
PlateB
1                                 flow on ext., int. or both
131.3   -52.7   -66.7             pointA:  actual point D29
131.3   -52.7   -56.3             pointB:  actual point H29
121.0   -52.7   -66.7             pointC:  actual point L29
121.0   -52.7   -56.3             pointD:  actual point M29
150.      0.    -50.              Exterior point
 0.      0.      0.      0.        limit plane disp. (in pixels)

'HALOE cover IJ29'               Quadric 321
26                                   Component no.
ConeA
 1                                flow on ext., int. or both
 145.65 -48.0   -64.9             pointA
-1.      0.      0.               dircos
 25.                              Cone half angle
 9.65                             Rlength
 0.      0.                        limit plane disp. (in pixels)
110.  160.  -70.  -30.  -80.  -40.   F3I limits

'HALOE cover JK29'               Quadric 322
26                                   Component no.
CylinderA
1                                 flow on ext., int. or both
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```
136.0   -48.0   -64.9                     pointA
121.0   -48.0   -64.9                     pointB
  4.5                                     radius (4.5)
 0.       0.                               limit plane disp. (in pixels)
110.  160.  -70.  -30.  -80.  -40.        F3I limits

'HALOE aperture K29'                      Plane 24
26                                           Component no.
Disk
121.0   -48.0   -64.9                     pointA
-1.       0.      0.                      direction cosine normal to disk
  4.5                                     radius

'HALOE sun-sensor NOPQ29'                       Quadric 323
26                                           Component no.
PlateB
1                                         flow on ext., int. or both
121.0   -45.1   -60.7                     pointA:  actual point N29
121.0   -45.1   -57.9                     pointB:  actual point O29
121.0   -51.0   -60.7                     pointC:  actual point P29
121.0   -51.0   -57.9                     pointD:  actual point Q29
100.    -50.    -50.                      Exterior point
 0.       0.      0.       0.              limit plane disp. (in pixels)

'HALOE sun-sensor NORS29'                       Quadric 324
26                                           Component no.
PlateB
1                                         flow on ext., int. or both
121.0   -45.1   -60.7                     pointA:  actual point N29
121.0   -45.1   -57.9                     pointB:  actual point O29
131.3   -45.1   -60.7                     pointC:  actual point R29
131.3   -45.1   -57.9                     pointD:  actual point S29
130.      0.    -50.                      Exterior point
 0.       0.      0.       0.              limit plane disp. (in pixels)

'HALOE sun-sensor PQTU29'                       Quadric 325
26                                           Component no.
PlateB
1                                         flow on ext., int. or both
121.0   -51.0   -60.7                     pointA:  actual point P29
121.0   -51.0   -57.9                     pointB:  actual point Q29
131.3   -51.0   -60.7                     pointC:  actual point T29
131.3   -51.0   -57.9                     pointD:  actual point U29
130.    -90.    -50.                      Exterior point
 0.       0.      0.       0.              limit plane disp. (in pixels)

'HALOE sun-sensor NRPT29'                       Quadric 326
26                                           Component no.
PlateB
1                                         flow on ext., int. or both
121.0   -45.1   -60.7                     pointA:  actual point N29
131.3   -45.1   -60.7                     pointB:  actual point R29
121.0   -51.0   -60.7                     pointC:  actual point P29
131.3   -51.0   -60.7                     pointD:  actual point T29
130.    -50.   -100.                      Exterior point
 0.       0.      0.       0.              limit plane disp. (in pixels)

'HALOE sun-sensor OSQU29'                       Quadric 327
26                                           Component no.
PlateB
1                                         flow on ext., int. or both
121.0   -45.1   -57.9                     pointA:  actual point O29
131.3   -45.1   -57.9                     pointB:  actual point S29
121.0   -51.0   -57.9                     pointC:  actual point Q29
131.3   -51.0   -57.9                     pointD:  actual point U29
130.    -50.      0.                      Exterior point
 0.       0.      0.       0.              limit plane disp. (in pixels)

'HALOE aperture cover L29'                Plane 25
26                                           Component no.
Disk
125.5   -50.25  -68.80                    pointA
 0.     -0.5     -0.86603                 direction cosine normal to disk
  4.5                                     radius

'SSPP support'                            Quadric 328
15                                           Component no.
CylinderA
1                                         flow on ext., int. or both
 253.3   16.0   -61.0                     pointA
 253.3   16.0   -42.5                     pointB
  3.4                                     radius
 0.       0.                               limit plane disp. (in pixels)
200.  300.  10.   20.   -80. -20.         F3I limits

'ISAMS box DIOP15'                        Quadric 329
16                                           Component no.
PlateB
1                                         flow on ext., int. or both
  44.8  -38.7    11.6                     pointA: actual point D15
  57.3  -38.7    11.6                     pointB: actual point I15
  44.8  -61.2    11.6                     pointC: actual point O15
  57.3  -61.2    11.6                     pointD: actual point P15
 50.    -50.     80.                      Exterior point
 0.       0.      0.       0.              limit plane disp. (in pixels)

'ISAMS box HJQR15'                        Quadric 330
16                                           Component no.
PlateB
1                                         flow on ext., int. or both
  44.8  -38.7   -25.5                     pointA: actual point H15
  57.3  -38.7   -25.5                     pointB: actual point J15
  44.8  -61.2   -25.5                     pointC: actual point Q15
  57.3  -61.2   -25.5                     pointD: actual point R15
 50.    -50.    -80.                      Exterior point
 0.       0.      0.       0.              limit plane disp. (in pixels)

'ISAMS box OPST15'                        Quadric 331
16                                           Component no.
PlateB
1                                         flow on ext., int. or both
  44.8  -61.2    11.6                     pointA: actual point O15
  57.3  -61.2    11.6                     pointB: actual point P15
  44.8  -76.2     7.8                     pointC: actual point S15
  57.3  -76.2     7.8                     pointD: actual point T15
 50.    -70.     80.                      Exterior point
 0.       0.      0.       0.              limit plane disp. (in pixels)

'ISAMS box QRUV15'                        Quadric 332
16                                           Component no.
PlateB
1                                         flow on ext., int. or both
  44.8  -61.2   -25.5                     pointA: actual point Q15
  57.3  -61.2   -25.5                     pointB: actual point R15
  44.8  -76.2   -21.7                     pointC: actual point U15
  57.3  -76.2   -21.7                     pointD: actual point V15
 50.    -70.    -80.                      Exterior point
 0.       0.      0.       0.              limit plane disp. (in pixels)

'ISAMS box STWX15'                        Quadric 333
16                                           Component no.
PlateB
0                                         flow on ext., int. or both
  44.8  -76.2     7.8                     pointA: actual point S15
  57.3  -76.2     7.8                     pointB: actual point T15
  44.8  -91.2    11.6                     pointC: actual point O15
  57.3  -91.2    11.6                     pointD: actual point P15
 50.    -80.     80.                      Exterior point
```

```
 0.       0.       0.       0.          limit plane disp. (in pixels)

'ISAMS box UVYZ15'                     Quadric 334
16                                        Component no.
PlateB
0                                       flow on ext., int. or both
  44.8  -76.2   -21.7                   pointA: actual point U15
  57.3  -76.2   -21.7                   pointB: actual point V15
  44.8  -91.2   -25.5                   pointC: actual point Y15
  57.3  -91.2   -25.5                   pointD: actual point Z15
 50.    -80.    -80.                    Exterior point
 0.       0.       0.       0.          limit plane disp. (in pixels)

'ISAMS box PRTV15'                     Quadric 335
16                                        Component no.
PlateB
1                                       flow on ext., int. or both
  57.3  -61.2    11.6                   pointA: actual point P15
  57.3  -61.2   -25.5                   pointB: actual point R15
  57.3  -76.2     7.8                   pointC: actual point T15
  57.3  -76.2   -21.7                   pointD: actual point V15
150.    -70.      0.                    Exterior point
 0.       0.       0.       0.          limit plane disp. (in pixels)

'ISAMS box SUTV15'                     Quadric 336
16                                        Component no.
PlateB
1                                       flow on ext., int. or both
  44.8  -76.2     7.8                   pointA: actual point S15
  44.8  -76.2   -21.7                   pointB: actual point U15
  57.3  -76.2     7.8                   pointC: actual point T15
  57.3  -76.2   -21.7                   pointD: actual point V15
 50.   -150.      0.                    Exterior point
 0.       0.       0.       0.          limit plane disp. (in pixels)

'ISAMS box OLS15'                      Quadric 337
16                                        Component no.
PlateA
1                                       flow on ext., int. or both
  44.8  -61.2    11.6                   pointA: actual point O15
  44.8  -76.2    11.6                   pointB: actual point L15
  44.8  -76.2     7.8                   pointC: actual point S15
150.    -80.      0.                    Exterior point
 0.       0.       0.       0.          limit plane disp. (in pixels)

'ISAMS box QNU15'                      Quadric 338
16                                        Component no.
PlateA
1                                       flow on ext., int. or both
  44.8  -61.2   -25.5                   pointA: actual point Q15
  44.8  -76.2   -25.5                   pointB: actual point N15
  44.8  -76.2   -21.7                   pointC: actual point U15
150.    -80.      0.                    Exterior point
 0.       0.       0.       0.          limit plane disp. (in pixels)

'NEPS DCIJ15'                          Quadric 339
7                                         Component no.
PlateB
1                                       flow on ext., int. or both
  63.7  -73.2   -15.9                   pointA: actual point D15
  79.6  -73.2   -15.9                   pointB: actual point C15
  63.7  -83.5   -15.9                   pointC: actual point I15
  79.6  -83.5   -15.9                   pointD: actual point J15
 70.    -80.    -50.                    Exterior point
 0.       0.       0.       0.          limit plane disp. (in pixels)

'NEPS HGKL15'                          Quadric 340
7                                         Component no.
PlateB
```

```
1                                       flow on ext., int. or both
  63.7  -73.2    -2.1                   pointA: actual point H15
  79.6  -73.2    -2.1                   pointB: actual point G15
  63.7  -83.5    -2.1                   pointC: actual point K15
  79.6  -83.5    -2.1                   pointD: actual point L15
 70.    -80.      0.                    Exterior point
 0.       0.       0.       0.          limit plane disp. (in pixels)

'NEPS CGJL15'                          Quadric 341
7                                         Component no.
PlateB
1                                       flow on ext., int. or both
  79.6  -73.2   -15.9                   pointA: actual point C15
  79.6  -73.2    -2.1                   pointB: actual point G15
  79.6  -83.5   -15.9                   pointC: actual point J15
  79.6  -83.5    -2.1                   pointD: actual point L15
100.    -80.    -10.                    Exterior point
 0.       0.       0.       0.          limit plane disp. (in pixels)

'NEPS DHIK15'                          Quadric 342
7                                         Component no.
PlateB
1                                       flow on ext., int. or both
  63.7  -73.2   -15.9                   pointA: actual point D15
  63.7  -73.2    -2.1                   pointB: actual point H15
  63.7  -83.5   -15.9                   pointC: actual point I15
  63.7  -83.5    -2.1                   pointD: actual point K15
 50.    -80.    -10.                    Exterior point
 0.       0.       0.       0.          limit plane disp. (in pixels)

'Dish above CLAES'                     Plane 26 (back face)
24                                        Component no.
Disk
  97.5   46.0    14.0                   pointA
 0.    -0.8706  -0.4921                 direction cosine normal to disk
11.4                                    radius

'Dish above CLAES'                     Quadric 343
24                                        Component no.
CylinderA
1                                       flow on ext., int. or both
  97.5   47.8    15.0                   pointA
  97.5   46.0    14.0                   pointB
 11.4                                   radius
 0.      0.                             limit plane disp. (in pixels)
 50.  150.  30.   70.   0.   30.        F3I limits

'PEM-AXIS antenna J19'                 Plane 27 (back face)
20                                        Component no.
Disk
 258.3  -45.4    37.068                 pointA
 0.      -0.5    -0.866                 dircos
 6.3                                    radius

'PEM-AXIS antenna ??19'                Quadric 344
20                                        Component no.
CylinderA
1                                       flow on ext., int. or both
 258.3  -44.4    38.8                   pointA
 258.3  -45.4    37.068                 pointB
 6.3                                    radius
 0.      0.                             limit plane disp. (in pixels)
200.  300.  -60.  -30.   20.   50.      F3I limits

'HRDI telescope box abef13'            Quadric 345
14                                        Component no.
PlateB
1                                       flow on ext., int. or both
 133.0  -74.3   -11.2                   pointA: actual point a13
```

```
 133.0  -74.3    -3.2                 pointB: actual point b13
 143.3  -65.3   -11.2                 pointC: actual point e13
 143.3  -65.3    -3.2                 pointD: actual point f13
 120.   -40.    -10.                  Exterior point
 0.       0.      0.       0.          limit plane disp. (in pixels)

'HALOE mount GIKM27'                 Quadric 346
26                                       Component no.
PlateB
1                                     flow on ext., int. or both
141.3   -34.4   -60.0                 pointA:  actual point G27
141.3   -40.6   -60.0                 pointB:  actual point I27
131.3   -34.4   -60.0                 pointC:  actual point K27
131.3   -40.6   -60.0                 pointD:  actual point M27
135.    -36.    -90.                  Exterior point
 0.       0.      0.       0.          limit plane disp. (in pixels)

'HALOE mount PQTU27'                 Quadric 347
26                                       Component no.
PlateB
1                                     flow on ext., int. or both
141.3   -50.5   -49.4                 pointA:  actual point P27
141.3   -50.5   -53.2                 pointB:  actual point Q27
131.3   -50.5   -49.4                 pointC:  actual point T27
131.3   -50.5   -53.2                 pointD:  actual point U27
135.    -70.    -50.                  Exterior point
 0.       0.      0.       0.          limit plane disp. (in pixels)

'CLAES Neon vent A30'                Plane 28
27                                       Component no.
Disk
  71.0     2.7     53.0               pointA
 0.        1.       0.                dircos
 1.0                                  radius

'CLAES Neon vent AB30'               Quadric 348
27                                       Component no.
CylinderA
1                                     flow on ext., int. or both
  71.0     2.7     53.0               pointA
  71.0     1.7     53.0               pointB
 1.0                                  radius
 0.        0.                          limit plane disp. (in pixels)
 60.   80.  -10.    10.    40.    60.  F3I limits

'CLAES Neon vent B30'                Plane 29
27                                       Component no.
Disk
  71.0     1.7     53.0               pointB
 0.       -1.       0.                dircos
 1.0                                  radius

'CLAES CO2 vent CD30'                Quadric 349
27                                       Component no.
CylinderC
1                                     flow on ext., int. or both
 67.8      33.1     23.0              pointC
 65.092    36.635   26.228            pointD
 0.5                                  radius
 0.        -1.      0.                dircosC
-0.6428    0.5868   0.4924            dircosD
 0.        0.                          limit plane disp. (in pixels)
 50.  100.   0.    50.    0.    50.   F3I limits

'CLAES CO2 vent D30'                 Plane 30
27                                       Component no.
Disk
 65.092    36.635   26.228            pointD
-0.6428    0.5868   0.4924            dircosD
```

```
 0.5                                  radius

'IM vent ABEF31'                     Quadric 350
28                                       Component no.
PlateB
1                                     flow on ext., int. or both
 12.0     45.1     2.1                pointA:  actual point A31
 60.0     45.1     2.1                pointB:  actual point B31
 12.0     44.1     3.1                pointC:  actual point E31
 60.0     44.1     3.1                pointD:  actual point F31
 40.      70.      5.                 Exterior point
 0.        0.      0.       0.         limit plane disp. (in pixels)

'IM vent CDEF31'                     Quadric 351
28                                       Component no.
PlateB
1                                     flow on ext., int. or both
 12.0     43.1     2.1                pointA:  actual point C31
 60.0     43.1     2.1                pointB:  actual point D31
 12.0     44.1     3.1                pointC:  actual point E31
 60.0     44.1     3.1                pointD:  actual point F31
 40.     -70.      5.                 Exterior point
 0.        0.      0.       0.         limit plane disp. (in pixels)

'IM vent ACE31'                      Quadric 352
28                                       Component no.
PlateA
1                                     flow on ext., int. or both
 12.0     45.1     2.1                pointA:  actual point A31
 12.0     43.1     2.1                pointB:  actual point C31
 12.0     44.1     3.1                pointC:  actual point E31
-100.      0.0     0.0                Exterior point
 0.        0.      0.       0.         limit plane disp. (in pixels)

'IM vent BDF31'                      Quadric 353
28                                       Component no.
PlateA
1                                     flow on ext., int. or both
 60.0     45.1     2.1                pointA:  actual point B31
 60.0     43.1     2.1                pointB:  actual point D31
 60.0     44.1     3.1                pointC:  actual point F31
 100.      0.0     0.0                Exterior point
 0.        0.      0.       0.         limit plane disp. (in pixels)

'HALOE mount ACFG4'                  Quadric 354
4                                        Component no.
PlateB
0                                     flow on ext., int. or both
171.4     30.8    -42.5               pointA: actual point A4
136.3    -23.6    -66.9               pointB: actual point C4
171.4     30.8    -42.25              pointC: actual point F4
136.3    -23.6    -66.65              pointD: actual point G4
136.       0.     -50.                Exterior point
 0.        0.      0.       0.         limit plane disp. (in pixels)

'HALOE mount CDGH4'                  Quadric 355
4                                        Component no.
PlateB
0                                     flow on ext., int. or both
136.3    -23.6    -66.9               pointA: actual point C4
101.2     30.8    -42.5               pointB: actual point D4
136.3    -23.6    -66.65              pointC: actual point G4
101.2     30.8    -42.25              pointD: actual point H4
136.       0.     -50.                Exterior point
 0.        0.      0.       0.         limit plane disp. (in pixels)
```

Table 4: Input Data Listing—Subassembly Rotation Data

```
              Case 1 Rotation Data:


        HALOE rotation (theta = 6 deg)

28                      How many subelements?  (List follows)
325 326 327 328 329 330 331 332 333 334 335 336 337 338
339 340 341 342 343 344 345 346 347 348 349 350 351 352
6.                      Rot. angle from baseline geometry (deg)
136.3 -50.5 -56.3       Coords. of rotating origin
z                       Axis of rotation

--------------------------------------------------------------

        solar panel rotation (theta = 6 deg)

7                       How many subelements?  (List follows)
93 94 95 96 97 98 99
-84.                    Rot. angle from baseline geometry (deg)
136.1 56.3 -55.5        Coords. of rotating origin
z                       Axis of rotation

--------------------------------------------------------------
--------------------------------------------------------------



              Case 2 Rotation Data:


        HALOE rotation (theta = -23.6 deg)

28                      How many subelements?  (List follows)
325 326 327 328 329 330 331 332 333 334 335 336 337 338
339 340 341 342 343 344 345 346 347 348 349 350 351 352
-23.6                   Rot. angle from baseline geometry (deg)
136.3 -50.5 -56.3       Coords. of rotating origin
z                       Axis of rotation

--------------------------------------------------------------

        solar panel rotation (theta = -23.6 deg)

7                       How many subelements?  (List follows)
93 94 95 96 97 98 99
-113.6                  Rot. angle from baseline geometry (deg)
136.1 56.3 -55.5        Coords. of rotating origin
z                       Axis of rotation

--------------------------------------------------------------
--------------------------------------------------------------



              Case 3 Rotation Data:


        HALOE rotation (theta = -25 deg)

28                      How many subelements?  (List follows)
325 326 327 328 329 330 331 332 333 334 335 336 337 338
339 340 341 342 343 344 345 346 347 348 349 350 351 352
-25.                    Rot. angle from baseline geometry (deg)
136.3 -50.5 -56.3       Coords. of rotating origin
z                       Axis of rotation

--------------------------------------------------------------

        HALOE rotation (alpha = 45 deg)

43                      How many subelements?  (List follows)
312 313 314 315 316 317 318 319 320 321 322 323 324 325
326 327 328 329 330 331 332 333 334 335 336 337 338 339
340 341 342 343 344 345 346 347 348 349 350 351 352 373 374
135.                    Rot. angle from baseline geometry (deg)
136.3 -41.0 -60.0       Coords. of rotating origin
y                       Axis of rotation

--------------------------------------------------------------

        solar panel rotation (theta = 84 deg)

7                       How many subelements (List follows)
93 94 95 96 97 98 99
84.                     Rot. angle from baseline geometry (deg)
136.1 56.3 -55.5        Coords. of rotating origin
z                       Axis of rotation
```

Table 5: Typical Elemental Outgassing Data

Data	Description
'Main block top plate ABCD1'	Quadric 1
1	number of outgassing surfaces on object
PlateB	shape of outgassing surface
1 0	flow direction code, outgassing index, (0 if entire surface has one rate, or no. of defining points)
0. 1. 0.6264E+17 100.	mole fractions of outgassing species, total outgassing flux [molecules/m^2/sec], ref. temp. [°C]
'Main block side Zmax CDGH1'	Quadric 2
2	number of outgassing surfaces on object
PlateB	shape of outgassing surface #1, entire surface
1 0	flow direction code, outgassing index, (0 if entire surface has one rate, or no. of defining points)
0. 1. 0.6264E+17 100.	mole fractions of outgassing species, total outgassing flux [molecules/m^2/sec], ref. temp. [°C]
PlateB	shape of outgassing surface #2, vent above CLAES
1 4	flow direction code, outgassing index, (number of defining points)
1. 0. 0.7649E+20 100.	mole fractions of outgassing species, total outgassing flux [molecules/m^2/sec], ref. temp. [°C]
12. 43.1 2.1	pointA for vent
60. 43.1 2.1	pointB for vent
12. 45.1 2.1	pointC for vent
60. 45.1 2.1	pointD for vent

Table 6: Input Data Listing—Outgassing Information (19 pgs.)

```
'Main block top plate ABDC0'
3            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)
PlateB
1   4
0.  0.  0.  1.   0.   0.    7.35E+17   100.  outgas rate
(Number/m2/sec), ref temp(C)
   4.0   48.1   -42.25                  pointA   combined blanket vent
   4.0   48.1   -42.5                   pointB
  14.0   48.1   -42.25                  pointC
  14.0   48.1   -42.5                   pointD
PlateB
1   4
0.  0.  0.  1.   0.   0.    7.35E+17   100.  outgas rate
(Number/m2/sec), ref temp(C)
  53.0   48.1   -42.25                  pointA   combined blanket vent
  53.0   48.1   -42.5                   pointB
  63.0   48.1   -42.25                  pointC
  63.0   48.1   -42.5                   pointD

'Main block side Zmax DCHG0'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Main block side Zmin ABEF0'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  0.   0.   1.    1.62E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Main block bottom EIHJ0'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Main block Xmin ADEH0'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Main block Xmax BCFG0'
2            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)
PlateB
1   4
0.  0.  0.  1.   0.   0.    7.35E+17   100.  outgas rate
(Number/m2/sec), ref temp(C)
 218.0   43.1   -42.25                  pointA   combined blanket vent
 218.0   43.1   -42.5                   pointB
 218.0   33.1   -42.25                  pointC
 218.0   33.1   -42.5                   pointD

'Front small plate Xmin ABDC1'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Front small plate Xmax EFHG1'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Front small plate Ymin DHCG1'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Front small plate Ymax ABEF1'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Front small plate Zmin AEDH1'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Front small plate Zmax BFCG1'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'CLAES big cap'
1            Number of different outgassing surfaces on object
SphereE
1   0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'CLAES fat cylindrical part'
1            Number of different outgassing surfaces on object
CylinderA
1   0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'CLAES small cylindrical part'
1            Number of different outgassing surfaces on object
CylinderA
1   0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'CLAES Ring'
1            Number of different outgassing surfaces on object
RingA
1   0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'CLAES small cap'
```

```
1            Number of different outgassing surfaces on object
SphereE
1   0
0.  0.  0.  1.   0.   0.   4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'CLAES shield plate'
1            Number of different outgassing surfaces on object
PlateB
0   0
0.  0.  0.  0.   0.   1.   1.62E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)
0.  0.  0.  0.   0.   1.   1.62E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Battery package ABCD3'
2            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.   4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)
PlateB
1   4
0.  0.  0.  1.   0.   0.   7.35E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)
-31.12  -33.44   10.44              pointA   MPS vent
-30.18  -33.44   10.44              pointB
-31.12  -33.87   11.27              pointC
-30.18  -33.87   11.27              pointD

'Battery package CDEF3'
2            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.   4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)
PlateB
1   4
0.  0.  0.  1.   0.   0.   7.35E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)
-31.12  -28.28   27.52              pointA   MPS vent
-30.18  -28.28   27.52              pointB
-31.12  -29.10   27.07              pointC
-30.18  -29.10   27.07              pointD

'Battery package EFGH3'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.   4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Battery package GHIJ3'
3            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.   4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)
PlateB
1   4
0.  0.  0.  1.   0.   0.   2.21E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)
-31.12   27.67   23.6               pointA   ACS vent
-30.18   27.67   23.6               pointB
-31.12   26.73   23.6               pointC
-30.18   26.73   23.6               pointD
PlateB
1   4
0.  0.  0.  1.   0.   0.   2.21E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)
-15.47   27.67   23.6               pointA   ACS vent
-14.53   27.67   23.6               pointB
-15.47   26.73   23.6               pointC
-14.53   26.73   23.6               pointD

'Battery package IJKL3'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.   4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Battery package KLMN3'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.   4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Battery package MNOP3'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.   4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Battery package OPQR3'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.   4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Battery package QRAB3'
2            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.   4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)
PlateB
1   4
0.  0.  0.  1.   0.   0.   7.35E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)
-31.12  -34.00  -10.24              pointA   CDH vent
-30.18  -34.00  -10.24              pointB
-31.12  -34.47  -11.05              pointC
-30.18  -34.47  -11.05              pointD

'Battery package side AGCE3 lower X'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.   4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Battery package side GIMK3 lower X'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.   4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Battery package side MOAQ3 lower X'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.   4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)
```

```
'Battery package side BDHF3 higher X'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Battery package side HJNL3 higher X'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Battery package side NPBR3 higher X'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Battery package side AGM3 lower X'
1             Number of different outgassing surfaces on object
PlateA
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Battery Cylindrical MMS'
1             Number of different outgassing surfaces on object
CylinderB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Battery MMS plane bottom'
1             Number of different outgassing surfaces on object
Disk
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE mount ABC4'
1             Number of different outgassing surfaces on object
PlateA
0    0
0.  0.  0.  1.   0.   0.    1.62E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)
0.  0.  0.  1.   0.   0.    1.62E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE mount ACD4'
1             Number of different outgassing surfaces on object
PlateA
1    0
0.  0.  0.  1.   0.   0.    1.62E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE mount CDE4'
1             Number of different outgassing surfaces on object
PlateA
0    0
0.  0.  0.  1.   0.   0.    1.62E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)
0.  0.  0.  1.   0.   0.    1.62E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE mount BCE4'
1             Number of different outgassing surfaces on object
PlateA
0    0
0.  0.  0.  1.   0.   0.    1.62E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)
0.  0.  0.  1.   0.   0.    1.62E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)

'NEPS ABCD5'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'NEPS BFDH5'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'NEPS FEHG5'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'NEPS EAGC5'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'NEPS JLIK5'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  0.   1.   0.    3.09E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Thin box under main block ABCD6'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Thin box under main block CDGH6'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Thin box under main block DHBF6'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Thin box under main block EAGC6'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
```

```
(Number/m2/sec), ref temp(C)

'Box under main block AECG7'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Box under main block EFGH7'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Box under main block BFDH7'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Box under main block IJCD7'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Box under main block CGDH7'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI interferometer ABCD8'
0              Number of different outgassing surfaces on object

'HRDI interferometer BFDH8'
0              Number of different outgassing surfaces on object

'HRDI interferometer HGFE8'
0              Number of different outgassing surfaces on object

'HRDI interferometer AECG8'
0              Number of different outgassing surfaces on object

'HRDI interferometer AEJI8'
0              Number of different outgassing surfaces on object

'HRDI interferometer CDGH8'
0              Number of different outgassing surfaces on object

'cylindrical truss #1 at X = 0.'
1              Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'cylindrical truss #2 at X = 0.'
1              Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'cylindrical truss #3 at X = 0.'
1              Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'cylindrical truss #4 at X = 0.'
1              Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'cylindrical truss #5 at X = 0.'
1              Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'cylindrical truss #6 at X = 0.'
1              Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Sphere junctn betwn trusses 1-2(X=0)'
0              Number of different outgassing surfaces on object

'Sphere junctn betwn trusses 3-4(X=0)'
0              Number of different outgassing surfaces on object

'Sphere junctn betwn trusses 5-6(X=0)'
0              Number of different outgassing surfaces on object

'left-hand HGA-end box AFDI10'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'left-hand HGA-end box ABDE10'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'left-hand HGA-end box BCE10'
1              Number of different outgassing surfaces on object
PlateA
1    0
1.   0.   0.    3.62E+14   0.   0.   0.   100.  outgas rate
(Number/m2/sec), ref temp(C)

'left/right-hand HGA-end box ABFG10'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'left/right-hand HGA-end box BCGH10'
1              Number of different outgassing surfaces on object
PlateB
1    0
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0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'left-hand HGA-end box CHEJ10'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'left/right-hand HGA-end box DEIJ10'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'right-hand HGA-end box GHJK11'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'right-hand HGA-end box CEF11'
1              Number of different outgassing surfaces on object
PlateA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'right-hand HGA-end box HIKL11'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'right-hand HGA-end box CIFL11'
0              Number of different outgassing surfaces on object

'right-hand HGA-end box EFKL11'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HGA-end nose box CIMN11'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HGA-end nose box MNFL11'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HGA-end nose box CMF11'
1              Number of different outgassing surfaces on object
PlateA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HGA-end nose box INL11'
1              Number of different outgassing surfaces on object
PlateA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'solar panel mount ABCD12'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'solar panel mount EFGH12'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'solar panel mount AECG12'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'solar panel mount BFDH12'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'solar panel mount ABEF12'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'solar panel support IJ12'
1              Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'solar panel support J12'
1              Number of different outgassing surfaces on object
SphereE
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'solar panel support JK12'
1              Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'solar panel support JL12'
1              Number of different outgassing surfaces on object
CylinderC
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)
```

```
'solar panel support JM12'
1            Number of different outgassing surfaces on object
CylinderC
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'solar panel NOPQ12'
1            Number of different outgassing surfaces on object
PlateB
0    0
0.  0.  0.  1.   0.   0.    1.10E+16   100.  outgas rate
(Number/m2/sec), ref temp(C)
0.  0.  0.  0.   0.   1.    1.62E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)

'solar panel support RS12'
1            Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'solar panel support R12'
1            Number of different outgassing surfaces on object
SphereE
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'solar panel support S12'
1            Number of different outgassing surfaces on object
SphereE
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope mount AB13'
1            Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope mount BC13'
1            Number of different outgassing surfaces on object
ConeD
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope mount FGJK13'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope mount HILM13'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope mount FGHI13'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope mount JKLM13'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope mount GIKM13'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope mount FHJL13'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope mount HIRS13'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope mount NOTU13'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope mount IOSU13'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope mount HNRT13'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope mount RSTU13'
0            Number of different outgassing surfaces on object

'HRDI telescope mount knob'
1            Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope mount knob'
1            Number of different outgassing surfaces on object
Disk
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)
```

```
'HRDI telescope mount knob'
1            Number of different outgassing surfaces on object
Disk
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope mount PQVW13'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope mount LMXY13'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope mount QMWY13'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope mount PLVX13'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope mount VWXY13'
0            Number of different outgassing surfaces on object

'HRDI telescope mount knob'
1            Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope mount knob'
1            Number of different outgassing surfaces on object
Disk
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope mount knob'
1            Number of different outgassing surfaces on object
Disk
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope DE13'
1            Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope D13'
1            Number of different outgassing surfaces on object
Disk
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope E13'
1            Number of different outgassing surfaces on object
Disk
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope box abcd13'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope box efgh13'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope box aceg13'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope box bdfh13'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope box cdgh13'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'SSPP box ABCD14'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'SSPP box EFGH14'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'SSPP box ABEF14'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'SSPP box CDGH14'
```

```
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'SSPP box BFDH14'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'SSPP box AECG14'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'ISAMS box ABCD15'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'ISAMS box EFGH15'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'ISAMS box BFDH15'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'ISAMS box ABEF15'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'ISAMS box AKEM15'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'ISAMS box CDKL15'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'ISAMS box GHMN15'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'ISAMS box KLMN15'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'ISAMS box IJPR15'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'ISAMS box DHIJ15'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HGA antenna AB16'
1            Number of different outgassing surfaces on object
CylinderA
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HGA antenna A16'
1            Number of different outgassing surfaces on object
SphereE
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HGA antenna B16'
1            Number of different outgassing surfaces on object
Disk
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HGA antenna CD16'
1            Number of different outgassing surfaces on object
CylinderA
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HGA antenna C16'
1            Number of different outgassing surfaces on object
Disk
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HGA antenna D16'
1            Number of different outgassing surfaces on object
SphereE
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HGA antenna DE16'
1            Number of different outgassing surfaces on object
CylinderA
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)
```

```
'HGA antenna E16'
1            Number of different outgassing surfaces on object
SphereC
0    0
0.  0.  0.  0.   0.   1.    1.62E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)
0.  0.  0.  0.   0.   1.    1.62E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)

'CLAES lower mount, ABC17'
1            Number of different outgassing surfaces on object
PlateA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'CLAES lower mount, DEF17'
1            Number of different outgassing surfaces on object
PlateA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'CLAES lower mount, ACDF17'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'CLAES lower mount, BCEF17'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'CLAES upper mount, GHI17'
1            Number of different outgassing surfaces on object
PlateA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'CLAES upper mount, JKL17'
1            Number of different outgassing surfaces on object
PlateA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'CLAES upper mount, GIJL17'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'CLAES upper mount, HIKL17'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'WINDII base, ABCD18'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    2.61E+13   100.  outgas rate
(Number/m2/sec), ref temp(C)

'WINDII base, OPQR18'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    2.61E+13   100.  outgas rate
(Number/m2/sec), ref temp(C)

'WINDII base, DBOP18'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    2.61E+13   100.  outgas rate
(Number/m2/sec), ref temp(C)

'WINDII base, ACRQ18'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    2.61E+13   100.  outgas rate
(Number/m2/sec), ref temp(C)

'WINDII base, DFO18'
1            Number of different outgassing surfaces on object
PlateA
1    0
0.  0.  0.  1.   0.   0.    2.61E+13   100.  outgas rate
(Number/m2/sec), ref temp(C)

'WINDII base, CEQ18'
1            Number of different outgassing surfaces on object
PlateA
1    0
0.  0.  0.  1.   0.   0.    2.61E+13   100.  outgas rate
(Number/m2/sec), ref temp(C)

'WINDII base, FNO18'
1            Number of different outgassing surfaces on object
PlateA
1    0
0.  0.  0.  1.   0.   0.    2.61E+13   100.  outgas rate
(Number/m2/sec), ref temp(C)

'WINDII base, EMQ18'
1            Number of different outgassing surfaces on object
PlateA
1    0
0.  0.  0.  1.   0.   0.    2.61E+13   100.  outgas rate
(Number/m2/sec), ref temp(C)

'WINDII base, HFN18'
1            Number of different outgassing surfaces on object
PlateA
1    0
0.  0.  0.  1.   0.   0.    2.61E+13   100.  outgas rate
(Number/m2/sec), ref temp(C)

'WINDII base, GEM18'
1            Number of different outgassing surfaces on object
PlateA
1    0
0.  0.  0.  1.   0.   0.    2.61E+13   100.  outgas rate
(Number/m2/sec), ref temp(C)

'WINDII base, CDEF18'
1            Number of different outgassing surfaces on object
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PlateB
1    0
0.  0.  0.  1.   0.   0.    2.61E+13   100.  outgas rate
(Number/m2/sec), ref temp(C)

'WINDII base, MNQO18'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    2.61E+13   100.  outgas rate
(Number/m2/sec), ref temp(C)

'WINDII base, MNKL18'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    2.61E+13   100.  outgas rate
(Number/m2/sec), ref temp(C)

'WINDII base, GHIJ18'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    2.61E+13   100.  outgas rate
(Number/m2/sec), ref temp(C)

'WINDII base, IJKL18'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    2.61E+13   100.  outgas rate
(Number/m2/sec), ref temp(C)

'WINDII base, HJNL18'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    2.61E+13   100.  outgas rate
(Number/m2/sec), ref temp(C)

'WINDII base, IGKM18'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    2.61E+13   100.  outgas rate
(Number/m2/sec), ref temp(C)

'PEM-AXIS base, ABCD19'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'PEM-AXIS base, EFGH19'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'PEM-AXIS base, AECG19'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'PEM-AXIS base, BFDH19'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'PEM-AXIS base, CDGH19'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'PEM-AXIS base, AEBF19'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'PEM-AXIS base, KLMN19'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'PEM-AXIS base, OPQR19'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'PEM-AXIS base, KOMQ19'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'PEM-AXIS base, LPNR19'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'PEM-AXIS base, MNQR19'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'PEM-AXIS antenna JI19'
1            Number of different outgassing surfaces on object
ConeD
0    0
0.  0.  0.  0.   0.   1.    0.         100.  outgas rate
(Number/m2/sec), ref temp(C)
0.  0.  0.  0.   0.   1.    1.62E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)

'PEM-AXIS antenna J19'
1            Number of different outgassing surfaces on object
Disk
1    0
0.  0.  0.  0.   0.   1.    1.62E+15   100.  outgas rate
```

```
(Number/m2/sec), ref temp(C)

'PEM-AXIS base, ST19'
1            Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'PEM-ZEPS base, ABC20'
1            Number of different outgassing surfaces on object
PlateA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'PEM-ZEPS base, ABD20'
1            Number of different outgassing surfaces on object
PlateA
1    0
0.  0.  0.  1.   0.   0.    1.62E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)

'PEM-ZEPS base, BCE20'
1            Number of different outgassing surfaces on object
PlateA
1    0
0.  0.  0.  1.   0.   0.    1.62E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)

'PEM-ZEPS base, BDE20'
1            Number of different outgassing surfaces on object
PlateA
1    0
0.  0.  0.  1.   0.   0.    1.62E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)

'PEM-ZEPS base, FG20'
1            Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'PEM-ZEPS base, G20'
1            Number of different outgassing surfaces on object
RingA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'PEM-ZEPS box HIJK20'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  0.   1.   0.    3.09E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)

'PEM-ZEPS box LMNO20'
0            Number of different outgassing surfaces on object

'PEM-ZEPS box JKNO20'
0            Number of different outgassing surfaces on object

'PEM-ZEPS box HJLN20'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  0.   1.   0.    3.09E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)

'PEM-ZEPS box HILM20'
0            Number of different outgassing surfaces on object

'PEM-ZEPS box IKMO20'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  0.   1.   0.    3.09E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)

'PEM-ZEPS shaft (approx.) PQ20'
0            Number of different outgassing surfaces on object

'MLS gizmo box ABCD21'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS gizmo box EFGH21'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS gizmo box EFAB21'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS gizmo box BFDH21'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS gizmo box AECG21'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS gizmo box CDGH21'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS box behind antenna IJKL21'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS box behind antenna JNLP21'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
```

```
(Number/m2/sec), ref temp(C)

'MLS box behind antenna KOLP21'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS box behind antenna IJMN21'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS cylinder QR21'
1             Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS cylinder end'
1             Number of different outgassing surfaces on object
Disk
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS LHS box ABCD22'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS LHS box ABEF22'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS LHS box CDGH22'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS LHS box BFDH22'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS LHS box AECG22'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS LHS box EFIJ22'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS LHS box IJQK22'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS LHS box GHRL22'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS LHS box JKHL22'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS LHS box IQGR22'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS LHS box QKOM22'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS LHS box RLPN22'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS LHS box QORP22'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS large antenna BCDE24'
0             Number of different outgassing surfaces on object

'MLS large antenna DEHI24'
0             Number of different outgassing surfaces on object

'MLS large antenna HIL24'
0             Number of different outgassing surfaces on object

'MLS large antenna BCFG24'
0             Number of different outgassing surfaces on object

'MLS large antenna FGJK24'
0             Number of different outgassing surfaces on object

'MLS large antenna JKM24'
0             Number of different outgassing surfaces on object
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```
'MLS large antenna BCDE24'
1           Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS large antenna DEHI24'
1           Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS large antenna HIL24'
1           Number of different outgassing surfaces on object
PlateA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS large antenna BCFG24'
1           Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS large antenna FGJK24'
1           Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS large antenna JKM24'
1           Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS large antenna CCEE24'
1           Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS large antenna EEII24'
1           Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS large antenna BBDD24'
1           Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS large antenna DDHH24'
1           Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS large antenna CCGG24'
1           Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS large antenna GGKK24'
1           Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS large antenna BBFF24'
1           Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS large antenna FFJJ24'
1           Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS large antenna IILL24'
1           Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS large antenna KKMM24'
1           Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS large antenna HHLL24'
1           Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS large antenna JJMM24'
1           Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS small antenna OPQR24'
0           Number of different outgassing surfaces on object

'MLS small antenna QRU24'
0           Number of different outgassing surfaces on object

'MLS small antenna OPQR24'
1           Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
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```
(Number/m2/sec), ref temp(C)

'MLS small antenna QRU24'
1            Number of different outgassing surfaces on object
PlateA
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS small antenna OPST24'
0            Number of different outgassing surfaces on object

'MLS small antenna STV24'
0            Number of different outgassing surfaces on object

'MLS small antenna OPST24'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS small antenna STV24'
1            Number of different outgassing surfaces on object
PlateA
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS small antenna PPRR24'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS small antenna PPTT24'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS small antenna RRUU24'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS small antenna TTVV24'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS small antenna OOQQ24'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS small antenna OOSS24'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS small antenna QQUU24'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS small antenna SSVV24'
1            Number of different outgassing surfaces on object
PlateB
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS antenna arm, RHS ABCD25'
1            Number of different outgassing surfaces on object
PlateB
0   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS antenna arm, RHS EF25'
1            Number of different outgassing surfaces on object
CylinderA
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS antenna arm, RHS E25'
1            Number of different outgassing surfaces on object
Disk
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS antenna arm, RHS F25'
1            Number of different outgassing surfaces on object
Disk
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS antenna arm, back GH25'
1            Number of different outgassing surfaces on object
CylinderA
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS antenna arm, back IJ25'
1            Number of different outgassing surfaces on object
CylinderA
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS antenna arm, back H25'
1            Number of different outgassing surfaces on object
SphereE
1   0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS antenna arm, back J25'
1            Number of different outgassing surfaces on object
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SphereE
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS antenna arm, back G25'
1             Number of different outgassing surfaces on object
SphereA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS antenna arm, back I25'
1             Number of different outgassing surfaces on object
SphereA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS antenna arm, between GK25'
1             Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS antenna arm, between IL25'
1             Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS antenna arm, side K25'
1             Number of different outgassing surfaces on object
SphereA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'MLS antenna arm, side L25'
1             Number of different outgassing surfaces on object
SphereA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HGA-side bracework AB23'
1             Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HGA-side bracework CB23'
1             Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HGA-side bracework EB23'
1             Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HGA-side bracework GB23'
1             Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HGA-side bracework IJ23'
1             Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HGA-side bracework KJ23'
1             Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HGA-side bracework MJ23'
1             Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HGA-side bracework OJ23'
1             Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HGA-side bracework QR23'
1             Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HGA-side bracework SR23'
1             Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Sphere junctn B23'
0             Number of different outgassing surfaces on object

'Sphere junctn J23'
0             Number of different outgassing surfaces on object

'Sphere junctn R23'
0             Number of different outgassing surfaces on object

'Dish above CLAES'
0             Number of different outgassing surfaces on object

'Thrusters, AC26'
1             Number of different outgassing surfaces on object
ConeA
0    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)
0.  0.  0.  0.   1.   0.    3.09E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)
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'Thrusters, BD26'
1             Number of different outgassing surfaces on object
ConeA
0    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)
0.  0.  0.  0.   1.   0.    3.09E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE mount A27'
1             Number of different outgassing surfaces on object
Disk
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE mount AB27'
1             Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE mount B27'
1             Number of different outgassing surfaces on object
RingA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE mount BC27'
1             Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE mount C27'
1             Number of different outgassing surfaces on object
RingA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE mount CD27'
1             Number of different outgassing surfaces on object
ConeD
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE mount D27'
1             Number of different outgassing surfaces on object
RingA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE mount DE27'
1             Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE mount E27'
1             Number of different outgassing surfaces on object
Disk
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE mount FGHI27'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE mount JKLM27'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE mount FGJK27'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE mount HILM27'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE mount FNJR27'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE mount NFPQ27'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE mount RJTU27'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE mount HLQU27'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE mount NRPT27'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE mount VW27'
1             Number of different outgassing surfaces on object
CylinderA
```

```
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE mount V27'
1             Number of different outgassing surfaces on object
RingA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE mount VX27'
1             Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE mount X27'
1             Number of different outgassing surfaces on object
Disk
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE box ABCD28'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE box GHIJ28'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE box BDHJ28'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE box CDEF28'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE box IJKL28'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE box CEIK28'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE box EFKL28'
0             Number of different outgassing surfaces on object

'HALOE box DFJL28'
0             Number of different outgassing surfaces on object

'HALOE box MNOP28'
1             Number of different outgassing surfaces on object
PlateB
0    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE box QRST28'
0             Number of different outgassing surfaces on object

'HALOE box QRUV28'
0             Number of different outgassing surfaces on object

'HALOE box STWX28'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE box RVTX28'
0             Number of different outgassing surfaces on object

'HALOE box QUSW28'
0             Number of different outgassing surfaces on object

'HALOE box ABCD29'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE box EFGH29'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE box ABEF29'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE box BDFH29'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE box DHLM29'
1             Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE cover IJ29'
1             Number of different outgassing surfaces on object
```

```
ConeA
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE cover JK29'
1              Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE aperture K29'
1              Number of different outgassing surfaces on object
Disk
1    0
0.  0.  0.  0.   1.   0.    3.09E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE sun-sensor NOPQ29'
0              Number of different outgassing surfaces on object

'HALOE sun-sensor NORS29'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE sun-sensor PQTU29'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE sun-sensor NRPT29'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE sun-sensor OSQU29'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HALOE aperture cover L29'
0              Number of different outgassing surfaces on object

'SSPP support'
1              Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  1.   0.   0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'ISAMS box DIOP15'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'ISAMS box HJQR15'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'ISAMS box OPST15'
0              Number of different outgassing surfaces on object

'ISAMS box QRUV15'
0              Number of different outgassing surfaces on object

'ISAMS box STWX15'
1              Number of different outgassing surfaces on object
PlateB
0    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'ISAMS box UVYZ15'
1              Number of different outgassing surfaces on object
PlateB
0    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'ISAMS box PRTV15'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'ISAMS box SUTV15'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'ISAMS box OLS15'
1              Number of different outgassing surfaces on object
PlateA
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'ISAMS box QNU15'
1              Number of different outgassing surfaces on object
PlateA
1    0
0.  0.  0.  1.   0.   0.    4.17E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)

'NEPS DCIJ15'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  0.   1.   0.    3.09E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)

'NEPS HGKL15'
1              Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  0.   1.   0.    3.09E+15   100.  outgas rate
```

```
(Number/m2/sec), ref temp(C)

'NEPS CGJL15'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  0.  1.  0.    3.09E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)

'NEPS DHIK15'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  0.  1.  0.    3.09E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)

'Dish above CLAES'
0            Number of different outgassing surfaces on object

'Dish above CLAES'
0            Number of different outgassing surfaces on object

'PEM-AXIS antenna J19'
1            Number of different outgassing surfaces on object
Disk
1    0
0.  0.  0.  0.  0.  1.    1.62E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)

'PEM-AXIS antenna ??19'
1            Number of different outgassing surfaces on object
CylinderA
1    0
0.  0.  0.  0.  0.  1.    1.62E+15   100.  outgas rate
(Number/m2/sec), ref temp(C)

'HRDI telescope box abef13'
0            Number of different outgassing surfaces on object

'HALOE mount GIKM27'
0            Number of different outgassing surfaces on object

'HALOE mount PQTU27'
0            Number of different outgassing surfaces on object

'CLAES Neon vent A30'
0            Number of different outgassing surfaces on object

'CLAES Neon vent AB30'
0            Number of different outgassing surfaces on object

'CLAES Neon vent B30'
0            Number of different outgassing surfaces on object

'CLAES CO2 vent CD30'
0            Number of different outgassing surfaces on object

'CLAES CO2 vent D30'
0            Number of different outgassing surfaces on object

'IM vent ABEF31'
1            Number of different outgassing surfaces on object
PlateB
1    0
0.  0.  0.  1.  0.  0.    9.64E+18   100.  outgas rate
(Number/m2/sec), ref temp(C)

'IM vent CDEF31'
0            Number of different outgassing surfaces on object

'IM vent ACE31'
0            Number of different outgassing surfaces on object

'IM vent BDF31'
0            Number of different outgassing surfaces on object

'HALOE mount ACFG4'
2            Number of different outgassing surfaces on object
PlateB
0    0
0.  0.  0.  1.  0.  0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)
0.  0.  0.  1.  0.  0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)
PlateB
1    4
0.  0.  0.  1.  0.  0.    7.35E+17   100.  outgas rate
(Number/m2/sec), ref temp(C)
 140.36 -17.31  -63.83              pointA   HALOE blanket vent
 140.36 -17.31  -63.58              pointB
 137.82 -21.24  -65.59              pointC
 137.82 -21.24  -65.34              pointD

'HALOE mount CDGH4'
2            Number of different outgassing surfaces on object
PlateB
0    0
0.  0.  0.  1.  0.  0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)
0.  0.  0.  1.  0.  0.    3.62E+14   100.  outgas rate
(Number/m2/sec), ref temp(C)
PlateB
1    4
0.  0.  0.  1.  0.  0.    7.35E+17   100.  outgas rate
(Number/m2/sec), ref temp(C)
 132.24 -17.31  -63.83              pointA   HALOE blanket vent
 132.24 -17.31  -63.58              pointB
 134.78 -21.24  -65.59              pointC
 134.78 -21.24  -65.34              pointD
```

Table 7: Input Data Listing—Surface Temperatures (3 pgs.)

```
-7     'Main block top plate ABDC0'
-22    'Main block side Zmax DCHG0'
-25    'Main block side Zmin ABEF0'
4      'Main block bottom EIHJ0'
7      'Main block Xmin ADEH0'
9      'Main block Xmax BCFG0'
7      'Front small plate Xmin ABDC1'
9      'Front small plate Xmax EFHG1'
4      'Front small plate Ymin DHCG1'
-7     'Front small plate Ymax ABEF1'
-25    'Front small plate Zmin AEDH1'
-22    'Front small plate Zmax BFCG1'
-34    'CLAES big cap'
-60    'CLAES fat cylindrical part'
-60    'CLAES small cylindrical part'
-60    'CLAES Ring'
-34    'CLAES small cap'
-7     'CLAES shield plate'
-76    'Battery package ABCD3'
11     'Battery package CDEF3'
-14    'Battery package EFGH3'
-55    'Battery package GHIJ3'
11     'Battery package IJKL3'
-32    'Battery package KLMN3'
-2     'Battery package MNOP3'
3      'Battery package OPQR3'
-39    'Battery package QRAB3'
-41    'Battery package side AGCE3 lower X'
-7     'Battery package side GIMK3 lower X'
-2     'Battery package side MOAQ3 lower X'
-37    'Battery package side BDHF3 higher X'
1      'Battery package side HJNL3 higher X'
3      'Battery package side NPBR3 higher X'
1      'Battery package side AGM3 lower X'
-75    'Battery Cylindrical MMS'
-64    'Battery MMS plane bottom'
-25    'HALOE mount ABC4'
-25    'HALOE mount ACD4'
-25    'HALOE mount CDE4'
-25    'HALOE mount BCE4'
-44    'NEPS ABCD5'
-8     'NEPS BFDH5'
-3     'NEPS FEHG5'
-28    'NEPS EAGC5'
6      'NEPS JLIK5'
7      'Thin box under main block ABCD6'
4      'Thin box under main block CDGH6'
-25    'Thin box under main block DHBF6'
-22    'Thin box under main block EAGC6'
-22    'Box under main block AECG7'
9      'Box under main block EFGH7'
-25    'Box under main block BFDH7'
7      'Box under main block IJCD7'
4      'Box under main block CGDH7'
-29    'HRDI interferometer ABCD8'
-45    'HRDI interferometer BFDH8'
14     'HRDI interferometer HGFE8'
-65    'HRDI interferometer AECG8'
-25    'HRDI interferometer AEJI8'
-15    'HRDI interferometer CDGH8'
4      'cylindrical truss #1 at X = 0.'
4      'cylindrical truss #2 at X = 0.'
-25    'cylindrical truss #3 at X = 0.'
-25    'cylindrical truss #4 at X = 0.'
-7     'cylindrical truss #5 at X = 0.'
-7     'cylindrical truss #6 at X = 0.'
4      'Sphere junctn betwn trusses 1-2(X=0)'
-25    'Sphere junctn betwn trusses 3-4(X=0)'
-7     'Sphere junctn betwn trusses 5-6(X=0)'
7      'left-hand HGA-end box AFDI10'
-22    'left-hand HGA-end box ABDE10'
-22    'left-hand HGA-end box BCE10'
-7     'left/right-hand HGA-end box ABFG10'
-7     'left/right-hand HGA-end box BCGH10'
9      'left-hand HGA-end box CHEJ10'
4      'left/right-hand HGA-end box DEIJ10'
-25    'right-hand HGA-end box GHJK11'
-22    'right-hand HGA-end box CEF11'
-25    'right-hand HGA-end box HIKL11'
9      'right-hand HGA-end box CIFL11'
4      'right-hand HGA-end box EFKL11'
9      'HGA-end nose box CIMN11'
9      'HGA-end nose box MNFL11'
9      'HGA-end nose box CMF11'
9      'HGA-end nose box INL11'
-25    'solar panel mount ABCD12'
-22    'solar panel mount EFGH12'
9      'solar panel mount AECG12'
7      'solar panel mount BFDH12'
-7     'solar panel mount ABEF12'
9      'solar panel support IJ12'
9      'solar panel support J12'
9      'solar panel support JK12'
9      'solar panel support JL12'
9      'solar panel support JM12'
30     'solar panel NOPQ12'
9      'solar panel support RS12'
9      'solar panel support R12'
9      'solar panel support S12'
4      'HRDI telescope mount AB13'
4      'HRDI telescope mount BC13'
4      'HRDI telescope mount FGJK13'
4      'HRDI telescope mount HILM13'
4      'HRDI telescope mount FGHI13'
4      'HRDI telescope mount JKLM13'
4      'HRDI telescope mount GIKM13'
4      'HRDI telescope mount FHJL13'
4      'HRDI telescope mount HIRS13'
4      'HRDI telescope mount NOTU13'
4      'HRDI telescope mount IOSU13'
4      'HRDI telescope mount HNRT13'
4      'HRDI telescope mount RSTU13'
-15    'HRDI telescope mount knob'
-15    'HRDI telescope mount knob'
-15    'HRDI telescope mount knob'
4      'HRDI telescope mount PQVW13'
4      'HRDI telescope mount LMXY13'
4      'HRDI telescope mount QMWY13'
4      'HRDI telescope mount PLVX13'
4      'HRDI telescope mount VWXY13'
-15    'HRDI telescope mount knob'
-15    'HRDI telescope mount knob'
-15    'HRDI telescope mount knob'
-35    'HRDI telescope DE13'
-34    'HRDI telescope D13'
-34    'HRDI telescope E13'
-35    'HRDI telescope box abcd13'
-35    'HRDI telescope box efgh13'
-35    'HRDI telescope box aceg13'
-35    'HRDI telescope box bdfh13'
-35    'HRDI telescope box cdgh13'
-72    'SSPP box ABCD14'
13     'SSPP box EFGH14'
-88    'SSPP box ABEF14'
-12    'SSPP box CDGH14'
50     'SSPP box BFDH14'
-11    'SSPP box AECG14'
-127   'ISAMS box ABCD15'
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-41   'ISAMS box EFGH15'
-9    'ISAMS box BFDH15'
-2    'ISAMS box ABEF15'
-18   'ISAMS box AKEM15'
-127  'ISAMS box CDKL15'
-41   'ISAMS box GHMN15'
-14   'ISAMS box KLMN15'
-9    'ISAMS box IJPR15'
-2    'ISAMS box DHIJ15'
9     'HGA antenna AB16'
9     'HGA antenna A16'
11    'HGA antenna B16'
13    'HGA antenna CD16'
13    'HGA antenna C16'
15    'HGA antenna D16'
17    'HGA antenna DE16'
20    'HGA antenna E16'
-22   'CLAES lower mount, ABC17'
-22   'CLAES lower mount, DEF17'
-22   'CLAES lower mount, ACDF17'
-22   'CLAES lower mount, BCEF17'
-22   'CLAES upper mount, GHI17'
-22   'CLAES upper mount, JKL17'
-22   'CLAES upper mount, GIJL17'
-22   'CLAES upper mount, HIKL17'
-9    'WINDII base, ABCD18'
-11   'WINDII base, OPQR18'
-24   'WINDII base, DBOP18'
-24   'WINDII base, ACRQ18'
-24   'WINDII base, DFO18'
-24   'WINDII base, CEQ18'
-24   'WINDII base, FNO18'
-24   'WINDII base, EMQ18'
-66   'WINDII base, HFN18'
-66   'WINDII base, GEM18'
-66   'WINDII base, CDEF18'
-11   'WINDII base, MNQO18'
-11   'WINDII base, MNKL18'
-35   'WINDII base, GHIJ18'
-79   'WINDII base, IJKL18'
-30   'WINDII base, HJNL18'
-9    'WINDII base, IGKM18'
-37   'PEM-AXIS base, ABCD19'
-37   'PEM-AXIS base, EFGH19'
-37   'PEM-AXIS base, AECG19'
-37   'PEM-AXIS base, BFDH19'
-37   'PEM-AXIS base, CDGH19'
-37   'PEM-AXIS base, AEBF19'
-37   'PEM-AXIS base, KLMN19'
-37   'PEM-AXIS base, OPQR19'
-37   'PEM-AXIS base, KOMQ19'
-37   'PEM-AXIS base, LPNR19'
-37   'PEM-AXIS base, MNQR19'
-37   'PEM-AXIS antenna JI19'
-43   'PEM-AXIS antenna J19'
-37   'PEM-AXIS base, ST19'
-7    'PEM-ZEPS base, ABC20'
-25   'PEM-ZEPS base, ABD20'
-25   'PEM-ZEPS base, BCE20'
-25   'PEM-ZEPS base, BDE20'
-25   'PEM-ZEPS base, FG20'
-7    'PEM-ZEPS base, G20'
-2    'PEM-ZEPS box HIJK20'
-9    'PEM-ZEPS box LMNO20'
-2    'PEM-ZEPS box JKNO20'
-7    'PEM-ZEPS box HJLN20'
-1    'PEM-ZEPS box HILM20'
-7    'PEM-ZEPS box IKMO20'
-7    'PEM-ZEPS shaft (approx.) PQ20'
```

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-85   'MLS gizmo box ABCD21'
-40   'MLS gizmo box EFGH21'
-32   'MLS gizmo box EFAB21'
-46   'MLS gizmo box BFDH21'
-45   'MLS gizmo box AECG21'
-66   'MLS gizmo box CDGH21'
-37   'MLS box behind antenna IJKL21'
-37   'MLS box behind antenna JNLP21'
-37   'MLS box behind antenna KOLP21'
-37   'MLS box behind antenna IJMN21'
-37   'MLS cylinder QR21'
-37   'MLS cylinder end'
-77   'MLS LHS box ABCD22'
-21   'MLS LHS box ABEF22'
-60   'MLS LHS box CDGH22'
-40   'MLS LHS box BFDH22'
-42   'MLS LHS box AECG22'
-37   'MLS LHS box EFIJ22'
-21   'MLS LHS box IJQK22'
-60   'MLS LHS box GHRL22'
-40   'MLS LHS box JKHL22'
-37   'MLS LHS box IQGR22'
-21   'MLS LHS box QKOM22'
-60   'MLS LHS box RLPN22'
-42   'MLS LHS box QORP22'
-28   'MLS large antenna BCDE24'
-28   'MLS large antenna DEHI24'
-28   'MLS large antenna HIL24'
-28   'MLS large antenna BCFG24'
-28   'MLS large antenna FGJK24'
-28   'MLS large antenna JKM24'
-37   'MLS large antenna BCDE24'
-37   'MLS large antenna DEHI24'
-37   'MLS large antenna HIL24'
-37   'MLS large antenna BCFG24'
-37   'MLS large antenna FGJK24'
-37   'MLS large antenna JKM24'
-32   'MLS large antenna CCEE24'
-32   'MLS large antenna EEII24'
-32   'MLS large antenna BBDD24'
-32   'MLS large antenna DDHH24'
-32   'MLS large antenna CCGG24'
-32   'MLS large antenna GGKK24'
-32   'MLS large antenna BBFF24'
-32   'MLS large antenna FFJJ24'
-32   'MLS large antenna IILL24'
-32   'MLS large antenna KKMM24'
-32   'MLS large antenna HHLL24'
-32   'MLS large antenna JJMM24'
-37   'MLS small antenna OPQR24'
-37   'MLS small antenna QRU24'
-28   'MLS small antenna OPQR24'
-28   'MLS small antenna QRU24'
-37   'MLS small antenna OPST24'
-37   'MLS small antenna STV24'
-28   'MLS small antenna OPST24'
-28   'MLS small antenna STV24'
-32   'MLS small antenna PPRR24'
-32   'MLS small antenna PPTT24'
-32   'MLS small antenna RRUU24'
-32   'MLS small antenna TTVV24'
-32   'MLS small antenna OOQQ24'
-32   'MLS small antenna OOSS24'
-32   'MLS small antenna QQUU24'
-32   'MLS small antenna SSVV24'
-28   'MLS antenna arm, RHS ABCD25'
-28   'MLS antenna arm, RHS EF25'
-28   'MLS antenna arm, RHS E25'
-28   'MLS antenna arm, RHS F25'
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-28   'MLS antenna arm, back GH25'
-28   'MLS antenna arm, back IJ25'
-28   'MLS antenna arm, back H25'
-28   'MLS antenna arm, back J25'
-28   'MLS antenna arm, back G25'
-28   'MLS antenna arm, back I25'
-28   'MLS antenna arm, between GK25'
-28   'MLS antenna arm, between IL25'
-28   'MLS antenna arm, side K25'
-28   'MLS antenna arm, side L25'
-7    'HGA-side bracework AB23'
-7    'HGA-side bracework CB23'
-7    'HGA-side bracework EB23'
-7    'HGA-side bracework GB23'
4     'HGA-side bracework IJ23'
4     'HGA-side bracework KJ23'
4     'HGA-side bracework MJ23'
4     'HGA-side bracework OJ23'
-25   'HGA-side bracework QR23'
-25   'HGA-side bracework SR23'
-7    'Sphere junctn B23'
4     'Sphere junctn J23'
-25   'Sphere junctn R23'
-7    'Dish above CLAES'
-55   'Thrusters, AC26'
-55   'Thrusters, BD26'
-27   'HALOE mount A27'
-27   'HALOE mount AB27'
-27   'HALOE mount B27'
-27   'HALOE mount BC27'
-27   'HALOE mount C27'
-27   'HALOE mount CD27'
-27   'HALOE mount D27'
-27   'HALOE mount DE27'
-27   'HALOE mount E27'
-24   'HALOE mount FGHI27'
-24   'HALOE mount JKLM27'
-24   'HALOE mount FGJK27'
-24   'HALOE mount HILM27'
-21   'HALOE mount FNJR27'
-21   'HALOE mount NFPQ27'
-21   'HALOE mount RJTU27'
-21   'HALOE mount HLQU27'
-21   'HALOE mount NRPT27'
-19   'HALOE mount VW27'
-19   'HALOE mount V27'
-19   'HALOE mount VX27'
-19   'HALOE mount X27'
-44   'HALOE box ABCD28'
-19   'HALOE box GHIJ28'
-17   'HALOE box BDHJ28'
-44   'HALOE box CDEF28'
-19   'HALOE box IJKL28'
-36   'HALOE box CEIK28'
-10   'HALOE box EFKL28'
-17   'HALOE box DFJL28'
-36   'HALOE box MNOP28'
-36   'HALOE box QRST28'
-9    'HALOE box QRUV28'
-10   'HALOE box STWX28'
-44   'HALOE box RVTX28'
-19   'HALOE box QUSW28'
-44   'HALOE box ABCD29'
-10   'HALOE box EFGH29'
-9    'HALOE box ABEF29'
-17   'HALOE box BDFH29'
-9    'HALOE box DHLM29'
-44   'HALOE cover IJ29'
-24   'HALOE cover JK29'
-44   'HALOE aperture K29'
-17   'HALOE sun-sensor NOPQ29'
-9    'HALOE sun-sensor NORS29'
-10   'HALOE sun-sensor PQTU29'
-44   'HALOE sun-sensor NRPT29'
-9    'HALOE sun-sensor OSQU29'
-44   'HALOE aperture cover L29'
-11   'SSPP support'
-127  'ISAMS box DIOP15'
-41   'ISAMS box HJQR15'
-127  'ISAMS box OPST15'
-41   'ISAMS box QRUV15'
-127  'ISAMS box STWX15'
-41   'ISAMS box UVYZ15'
-9    'ISAMS box PRTV15'
-14   'ISAMS box SUTV15'
-127  'ISAMS box OLS15'
-41   'ISAMS box QNU15'
-44   'NEPS DCIJ15'
-3    'NEPS HGKL15'
-28   'NEPS CGJL15'
-8    'NEPS DHIK15'
-7    'Dish above CLAES'
-7    'Dish above CLAES'
-37   'PEM-AXIS antenna J19'
-37   'PEM-AXIS antenna ??19'
-35   'HRDI telescope box abef13'
-21   'HALOE mount GIKM27'
-21   'HALOE mount PQTU27'
-66   'CLAES Neon vent A30'
-66   'CLAES Neon vent AB30'
-66   'CLAES Neon vent B30'
-66   'CLAES CO2 vent CD30'
-66   'CLAES CO2 vent D30'
-22   'IM vent ABEF31'
-22   'IM vent CDEF31'
-22   'IM vent ACE31'
-22   'IM vent BDF31'
-27   'HALOE mount ACFG4'
-27   'HALOE mount CDGH4'
```

Table 8: Typical Elemental Sonic Orifice Data

Data	Description
0.0254	scale
0. -1. 0.	jet direction cosine, *Ne* vent
71.0 1.7 53.0	jet center
1.	jet radius
3.28E+20	jet density [molecules/m^3]
377.	jet velocity [m/sec]
207.	jet exit temperature [K]
0. 1. 0. 0. 0. 0.	species fraction in jet
-0.4924 0.6428 0.5868	jet direction cosine, CO_2 vent
65.1 36.6 26.2	jet center
0.5	jet radius
4.04E+20	jet density [molecules/m^3]
244.	jet velocity [m/sec]
207.	jet exit temperature [K]
0. 0. 1. 0. 0. 0.	species fraction in jet

Table 9: Input Data Listing—General Preprocessor Input

```
*-----data to model gas around UARS
*
*-----CONVENTION:
*-----GAS species # 1: O
*-----GAS species # 2: Ne
*-----GAS species # 3: CO_2
*-----GAS species # 4: outgas # 1 molecular mass = 100
*-----GAS species # 5: outgas # 2 molecular mass = 150
*-----GAS species # 6: outgas # 3 molecular mass = 200
*-----No Internal energy, no chemistry
*
***************************************************
*
*-----IRA = 1 means chemistry is on
      IRA = 0
*
*-----MNVT = maximum # of vibrational degrees of freedom in any species
      MNVT = 0
*
*     SP(1,L)= mass of a molecule of species L (Kg)
*     SP(2,L)= diameter of a molecule of species L at T = TREF (meter)
*
*     SP(3,L)= # of rotational deg. of freedom for species L
*     SP(4,L)= index K pointing to the table of SPRR for rot. rel. of L
*     IRROT(1)= switch for the # of collisions to relax rot. energy
*     SPRR(K,1)= # of collisions to relax rotational energy
*     SPRR(K,2)= polynomial coefficient: first order of temp
*     SPRR(K,3)= polynomial coefficient: second order of temp
*     SPRR(K,4)= polynomial coefficient: third order of temp
*
*     SP(5,1)= index M pointing to the table of SPRR for vib. rel. of L
*     IRVIB(1)= switch for the # of collisions to relax vib. energy
*     SPRR(M,1)= # of collisions to relax vibrational energy
*     SPRR(M,2)= polynomial coefficient: first order of temp
*     SPRR(M,3)= polynomial coefficient: second order of temp
*     SPRR(M,4)= polynomial coefficient: third order of temp
*     SP(6,L)= Vibrational temperature
*
      indexO   = 1
      indexNe  = 2
      indexCO2 = 3
      indexo1  = 4
      indexo2  = 5
      indexo3  = 6
*
      avogadro =  6.02252e+23
      boltzmann = 1.38054e-23
*
*-----counter for internal energy table
      itable = 0
*
*-----Monatomic Oxygen O
      n = indexO
      SP(1,n) = ( 16.0 * 1.e-3 ) / avogadro
      SP(2,n) = 3.0e-10
      SP(3,n) = 0.
      SP(4,n) = 0.
      SP(5,n) = 0.
      SP(6,n) = 0.
      SP(7,n) = 0.
      SP(8,n) = 0.
      SP(9,n) = 0.
*
*-----Neon Ne
      n = indexNe
      SP(1,n) = ( 20.179 * 1.e-3 ) / avogadro
      SP(2,n) = 2.72e-10
      SP(3,n) = 0.
      SP(4,n) = 0.
      SP(5,n) = 0.
      SP(6,n) = 0.
      SP(7,n) = 0.
      SP(8,n) = 0.
      SP(9,n) = 0.
*
*-----Carbon Dioxide CO_2
      n = indexCO2
      SP(1,n) = ( 44.01 * 1.e-3 ) / avogadro
      SP(2,n) = 5.41e-10
      SP(3,n) = 0.
      SP(4,n) = 0.
      SP(5,n) = 0.
      SP(6,n) = 0.
      SP(7,n) = 0.
      SP(8,n) = 0.
      SP(9,n) = 0.
*
*-----Outgassing gas # 1
      n = indexo1
      SP(1,n) = ( 100.0 * 1.e-3 ) / avogadro
      SP(2,n) = SP(2,indexO)*(SP(1,n)/SP(1,indexO))**.3333
      SP(3,n) = 0.
      SP(4,n) = 0.
      SP(5,n) = 0.
      SP(6,n) = 0.
      SP(7,n) = 0.
      SP(8,n) = 0.
      SP(9,n) = 0.
*
*-----Outgassing gas # 2
      n = indexo2
      SP(1,n) = ( 150.0 * 1.e-3 ) / avogadro
      SP(2,n) = SP(2,indexO)*(SP(1,n)/SP(1,indexO))**.3333
      SP(3,n) = 0.
      SP(4,n) = 0.
      SP(5,n) = 0.
      SP(6,n) = 0.
      SP(7,n) = 0.
      SP(8,n) = 0.
      SP(9,n) = 0.
*
*-----Outgassing gas # 3
      n = indexo3
      SP(1,n) = ( 200.0 * 1.e-3 ) / avogadro
      SP(2,n) = SP(2,indexO)*(SP(1,n)/SP(1,indexO))**.3333
      SP(3,n) = 0.
      SP(4,n) = 0.
      SP(5,n) = 0.
      SP(6,n) = 0.
      SP(7,n) = 0.
      SP(8,n) = 0.
      SP(9,n) = 0.
*
*-----max. no. of tables for rot. & vib. relaxation (SPRR)
      MRCFF= max(itable,1)
*
*-----Data for Tref, W, molecular diam.: from J. Moss
      Tref=300.
      W = 0.75
*
***************************************************
*
110   continue
```

Table 10: Outgassing Species Information

Species	*GMW*	d [Å]	Mass Flux Rates at 100°C [$gm/cm^2/sec$]
ficticious organic volatile species representing products from MLI	100	5.33	4.33×10^{-13} to 6.01×10^{-12}
ficticious organic volatile species representing products from solar array adhesives	100	5.33	1.83×10^{-10}
ficticious organic volatile species representing products from IM and MLI vents	100	5.33	1.60×10^{-7} (IM) 1.22×10^{-8} (MLI)
ficticious organic volatile species representing products from MMS vents	100	5.33	3.67×10^{-11} to 1.22×10^{-10}
ficticious organic volatile species representing products from Chemglaze Z306	150	6.33	7.70×10^{-11}
ficticious organic volatile species representing products from S/13G/LO-V10	200	6.96	4.30×10^{-11} to 5.39×10^{-11}
neon vented from CLAES experiment	20.18	2.72	$4.14\times10^{-4*}$
carbon dioxide vented from CLAES experiment	44.01	5.41	$7.20\times10^{-4*}$

* rate at operating temperature $T_{exit} = 207K$

Table 11: Gas Species Data

0	spatial resolution switch: body-0, gas-1
7.	max no. of Megabytes for body defn.
30000	ratio to compute mean no. of subcells/cell
0.5	ratio of cells near body
0	initially uniform freestream or vacuum
6	total no. of molecular species
2	no. of jet species (subset of total no. of species)
132	GAS?.FOR file (species-dependent gas info.)
7500.	free stream velocity
0.	angle of incidence alpha (deg)
0.	roll angle phi (deg)
6.e+12 1000.	freestream density, temp.
1. 0. 0. 0. 0. 0.	fraction of each species in freestream
300.	surface temp.
300.	mean expected temp. in flow
2 2 2 0 2 2	boundary conds. at -X, -Y, -Z, +X, +Y, +Z
1. 1. 1000.	safety factors for max no. of molecules, timestep, FNUM
20. 10. 10. 10. 10. 10.	clearances for -X, +X, -Y, +Y, -Z, +Z edges
350000	no. of subcells within computational domain
2	scale ratio between inner & outer domains
3. 0.28	anticipated density enhancements: peak, mean (used to estimate cell and subcell sizes)
1.	fraction of total volume to be used
2 50	no. of timesteps between sampling, no. of samples between saved states
2	parameter used to size pixel element arrays

C-2.

Table 12: Mass Flux Rates Intercepted at HALOE Aperture

Species	Mass Flux Rates $[gm/cm^2/sec]$		
	Case #1	Case #2	Case #3
monatomic oxygen from freestream distribution	1.2×10^{-10}	1.0×10^{-10}	$< 4.2\times10^{-14}$*
monatomic oxygen from surface-accommodated distribution	9.3×10^{-12}	7.5×10^{-12}	5.4×10^{-12}
neon vented from CLAES experiment (return flux)	1.9×10^{-11}	5.9×10^{-12}	$< 2.1\times10^{-12}$*
neon vented from CLAES experiment (direct flux)	1.3×10^{-11}	5.9×10^{-12}	$< 2.1\times10^{-12}$*
carbon dioxide vented from CLAES experiment	$< 5.8\times10^{-12}$*	$< 6.5\times10^{-12}$*	$< 4.6\times10^{-12}$*
ficticious organic volatile species representing all *GMW* = 100 materials	9.2×10^{-14}	1.8×10^{-13}	8.4×10^{-14}
ficticious organic volatile species representing *GMW* = 150 material	3.9×10^{-15}	1.1×10^{-14}	1.4×10^{-14}
ficticious organic volatile species representing *GMW* = 200 material	4.3×10^{-13}	1.8×10^{-14}	2.7×10^{-13}

* no samples collected

Table 13a: Subassembly Contributions to Cumulative Contaminant Deposition (Case #1)

Subassembly	Percent Contribution to Contaminant Flux		
	$GMW = 100$	$GMW = 150$	$GMW = 200$
Solar Panel (Ω = 0.527 steradians)	56	—	81
Instrument Module (Ω = 0.719 steradians)	13	—	19
HALOE	25	73	—
NEPS	3	27	—
ISAMS	3	—	—

Table 13b: Subassembly Contributions to Cumulative Contaminant Deposition (Case #2)

Subassembly	Percent Contribution to Contaminant Flux		
	$GMW = 100$	$GMW = 150$	$GMW = 200$
Solar Panel (Ω = 0 steradians)	92	—	—
Instrument Module (Ω = 0.292 steradians)	—	—	100
HALOE	8	80	—
NEPS	—	20	—

Table 13c: Subassembly Contributions to Cumulative Contaminant Deposition (Case #3)

Subassembly	Percent Contribution to Contaminant Flux		
	$GMW = 100$	$GMW = 150$	$GMW = 200$
Solar Panel (Ω = 0.412 steradians)	75	—	94
Instrument Module (Ω = 0.0354 steradians)	13	—	6
HALOE	12	100	—

Table 14: Cumulative Volatile Organic Contaminant Deposition at HALOE Aperture
(values based on d_O in parentheses)

Species	Cumulative Depth Over 35 Months [Å]		
	Case #1	Case #2	Case #3
ficticious organic volatile species representing all *GMW* = 100 materials	9496 (1602)	9787 (1652)	4663 (787)
ficticious organic volatile species representing *GMW* = 150 material	683 (173)	408 (103)	524 (133)
ficticious organic volatile species representing *GMW* = 200 material	13355 (4507)	489 (165)	7460 (2518)
total extrapolated accumulation per run	23534 (6282)	10684 (1920)	12647 (3438)

Table 15: Cumulative Volatile Organic Contaminant Deposition at HALOE Aperture—Arrival at Case-Averaged Total Deposition
(values based on d_O in parentheses)

Item	Amount Based On l = 10Å [Å]	Amount Based On d_O = 3.0Å [Å]
Average for runs #1 & #2	17109	(4101)
Avg. × (1 - τ_{stow}/τ_{orbit})	2673	(641)
Average for run #3	12647	(3438)
Avg. × τ_{stow}/τ_{orbit}	10671	(2901)
Case-averaged Total Deposition	13344	(3542)

Table 16: Simulation Set-Up and Performance

Item	Inner Domain	Outer Domain
Δt [sec]	1.35×10^{-5}	2.69×10^{-5}
FNUM	2.08×10^{13}	4.17×10^{13}
Volume [m^3]	11.21×6.97×15.75	21.20×21.20×21.20
CCM Resolution	74×46×104	70×70×70
FCM Resolution w/in CCM	3×3×3	1×1×1
No. of cells	34,900	7,530
No. of simulated molecules	329,000	404,000
Total CPU time [hrs]	191	150
Memory required [$Mbytes$]	60	40
Performance [$\mu sec/particle/\Delta t$]	44	29

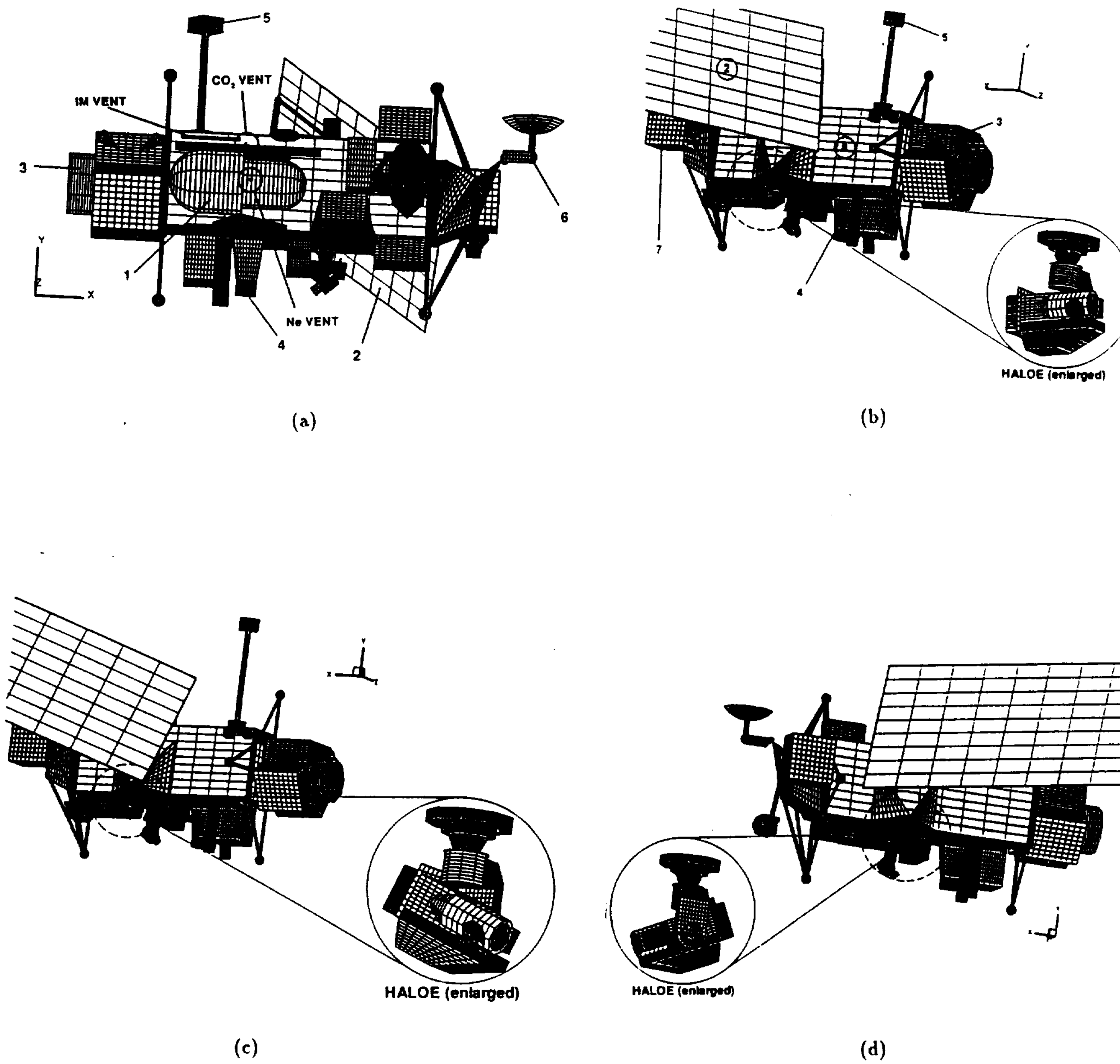


Figure 1. UARS model used in DSMC simulation: (a) +Z side, Case 1; (b) −Z side, Case 1; (c) −Z side, Case 2; (d) −Z side, Case 3. Key: 1-Cryogenic Limb Array Etalon Spectrometer (CLAES), 2-Solar panel (SP), 3-Multi-mission Modular Spacecraft (MMS), 4-Nadir Energetic Particle Spectrometer (NEPS), 5-Zenith Energetic Particle Spectrometer (ZEPS), 6-High Gain Antenna (HGA), 7-Solar/Stellar Positioning Platform (SSPP), and 8-Instrument Module (IM).

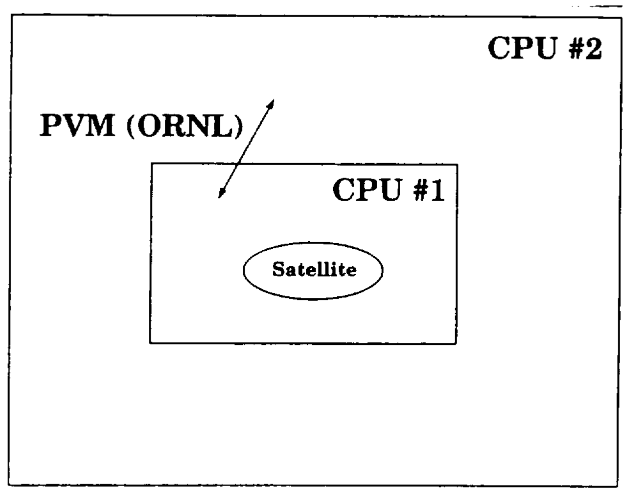
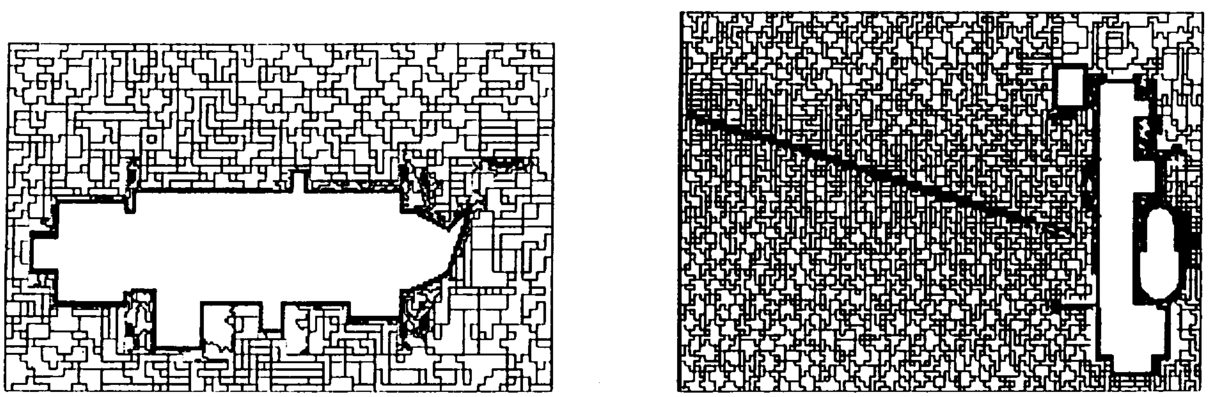


Figure 2. Schematic representation of computational flowfield volume used with parallelization routines.



(a) (b)

Figure 3. Representative cross-sections of computational grid for DSMC simulation; (a) inner domain at $Z = 0$, (b) inner domain at $Y = 0$.

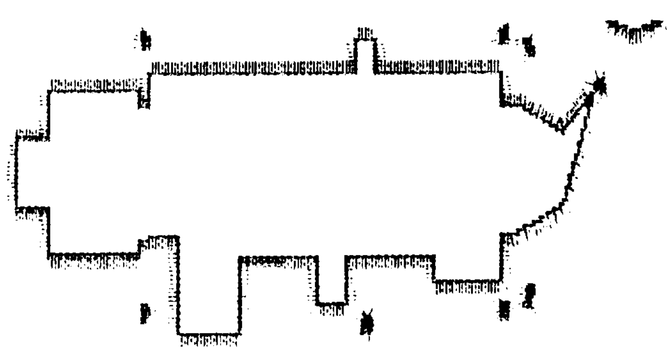


Figure 4. Representative cross-section of UARS geometric model discretized for incorporation into DSMC code. Outward-pointed normals included with surface pixel locations.

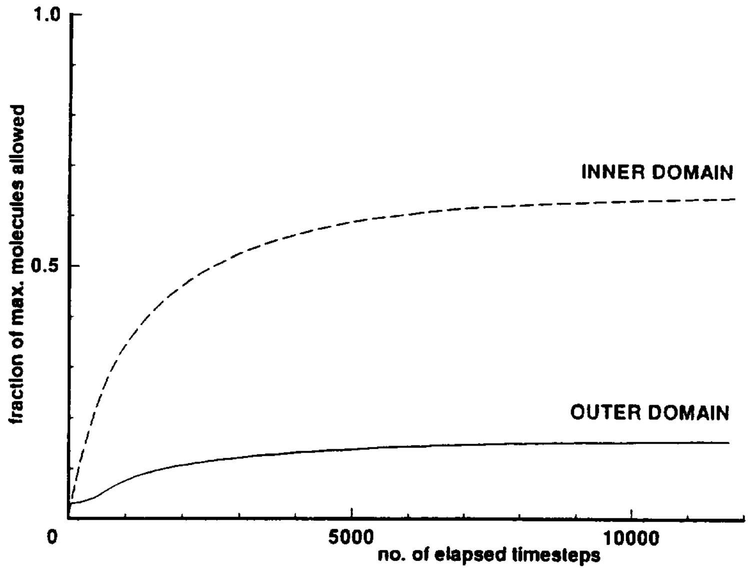


Figure 5. Typical behavior for number of particles per timestep versus simulated elapsed time as steady state is approached.

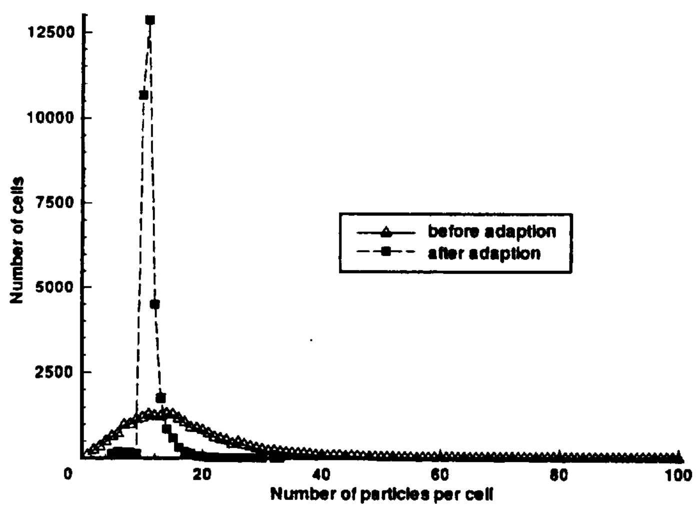
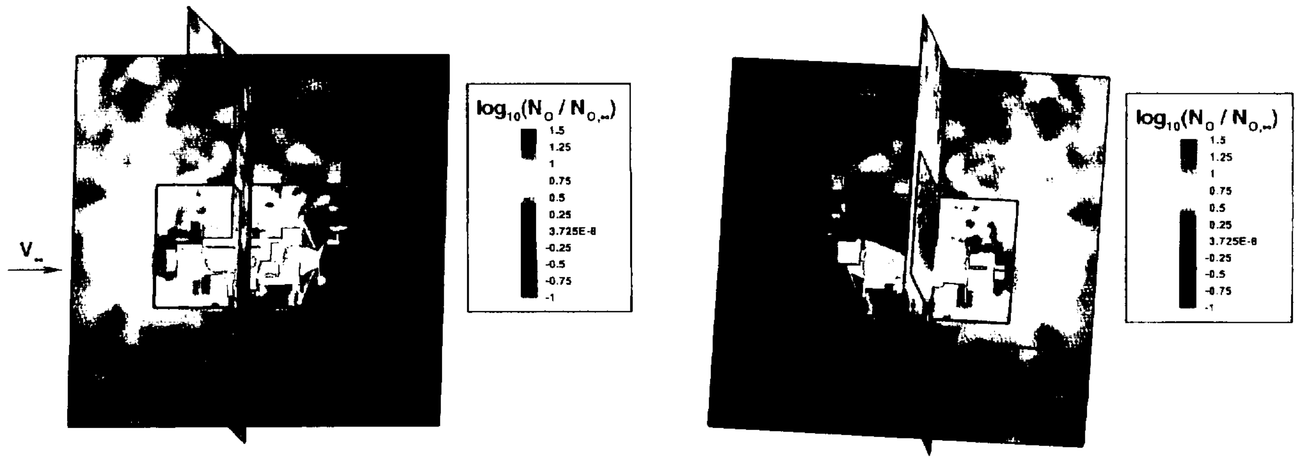
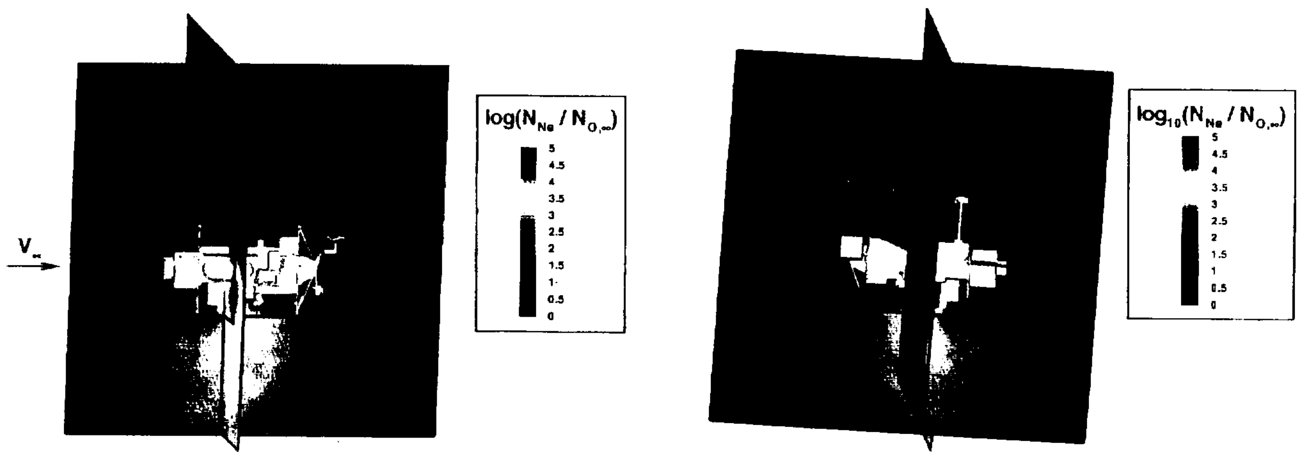


Figure 6. Typical distribution of particles per inner-domain cell before and after grid adaption.



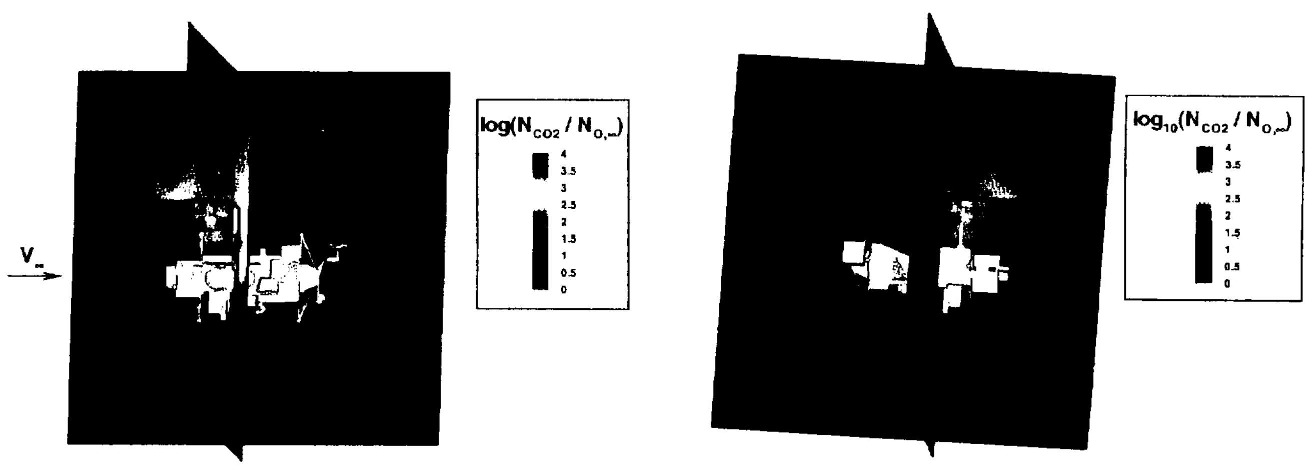
(a) (b)

Figure 7. Case 1 number density contours of freestream species O, logarithmic scale nondimensionalized by freestream number density $[O]_\infty$: (a) $+Z$ side, (b) $-Z$ side.



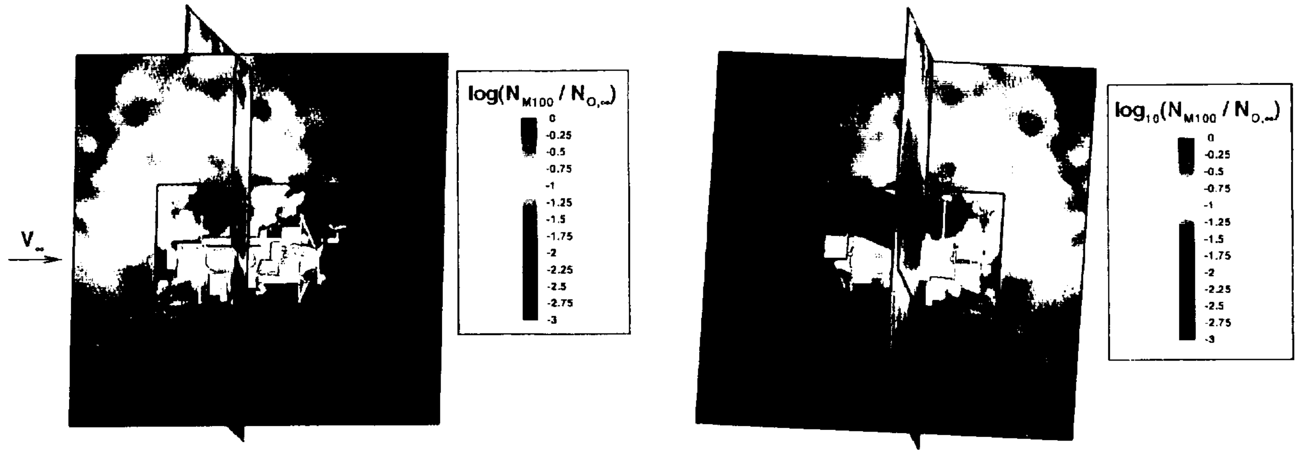
(a) (b)

Figure 8. Case 1 number density contours of neon, logarithmic scale nondimensionalized by $[O]_\infty$: (a) $+Z$ side, (b) $-Z$ side.



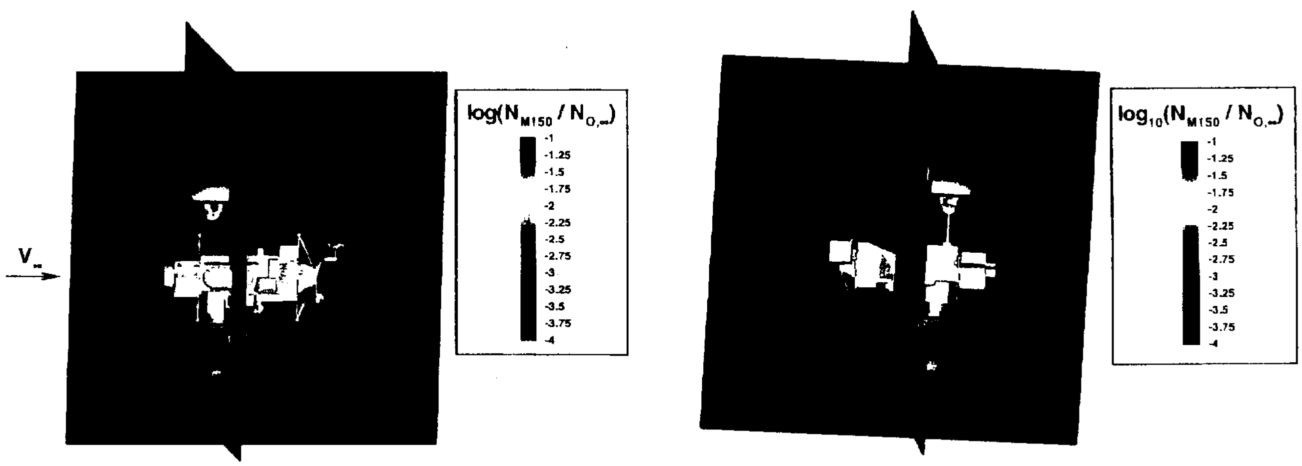
(a) (b)

Figure 9. Case 1 number density contours of carbon dioxide, logarithmic scale nondimensionalized by $[O]_\infty$: (a) $+Z$ side, (b) $-Z$ side.



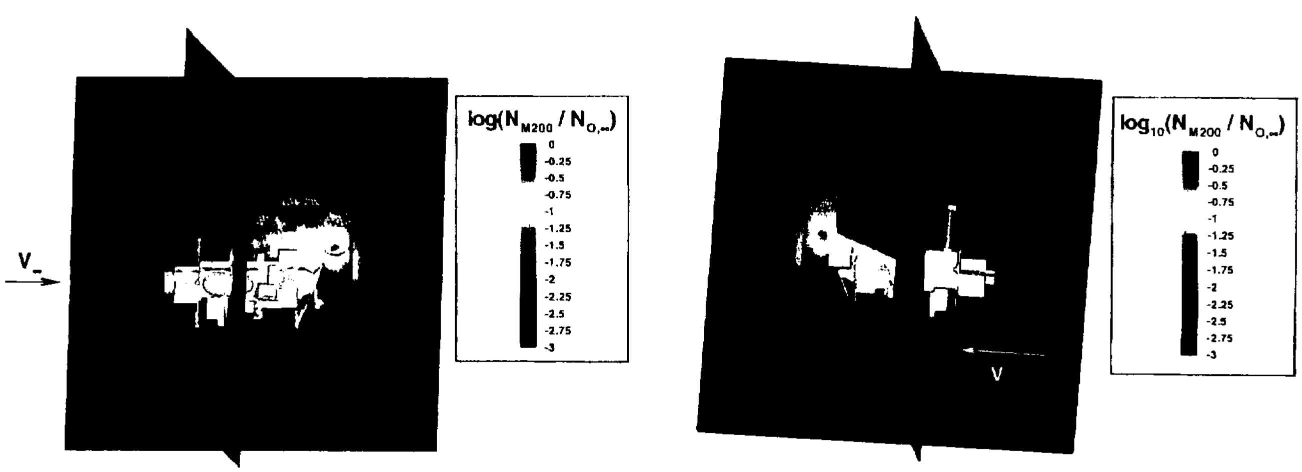
(a) (b)

Figure 10. Case 1 number density contours of *GMW* = 100 outgassing species, logarithmic scale nondimensionalized by $[O]_\infty$: (a) $+Z$ side, (b) $-Z$ side.



(b) (a)

Figure 11. Case 1 number density contours of *GMW* = 150 outgassing species, logarithmic scale nondimensionalized by $[O]_\infty$: (a) $+Z$ side, (b) $-Z$ side.



(a) (b)

Figure 12. Case 1 number density contours of *GMW* = 200 outgassing species, logarithmic scale nondimensionalized by $[O]_\infty$: (a) $+Z$ side, (b) $-Z$ side.

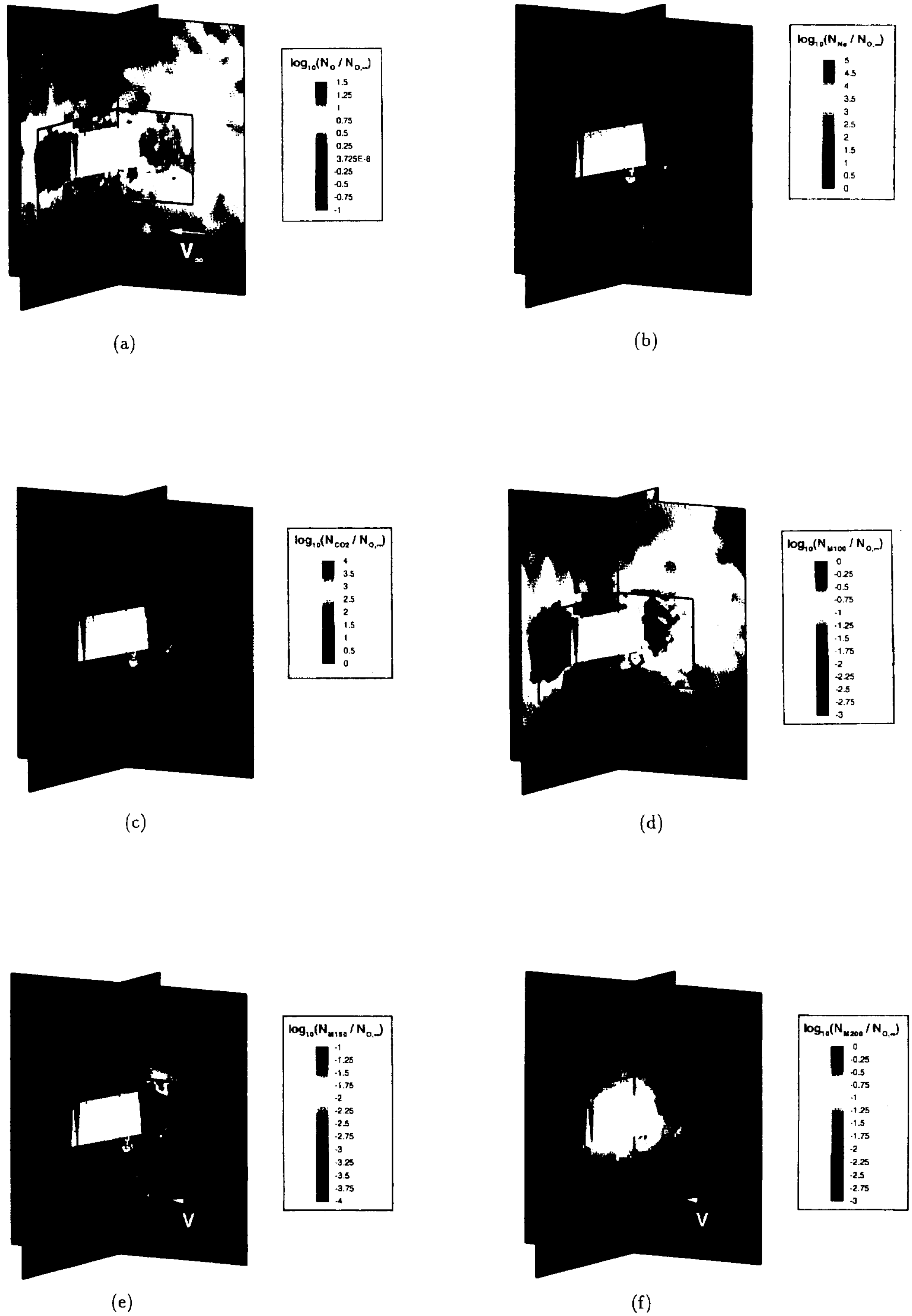


Figure 13. Case 1 species number density contour maps emphasizing the HALOE aperture environment. Logarithmic scale nondimensionalized by freestream number density $[O]_\infty$: (a) monatomic oxygen, (b) neon, (c) carbon dioxide, (d) *GMW* = 100 species, (e) *GMW* = 150 species, and (f) *GMW* = 200 species.

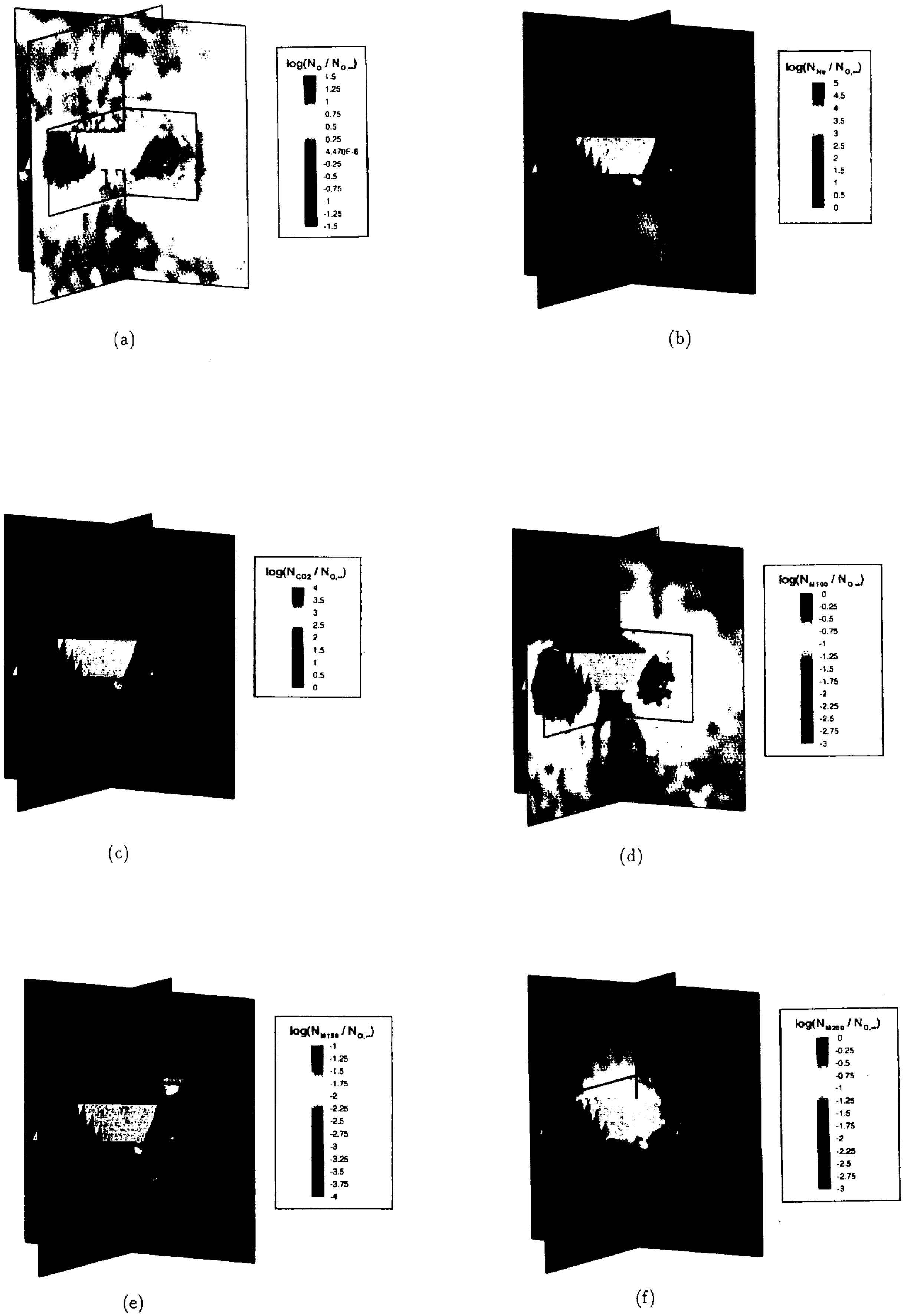


Figure 14. Case 2 species number density contour maps emphasizing the HALOE aperture environment. Logarithmic scale nondimensionalized by freestream number density $[O]_\infty$: (a) monatomic oxygen, (b) neon, (c) carbon dioxide, (d) *GMW* = 100 species, (e) *GMW* = 150 species, and (f) *GMW* = 200 species.

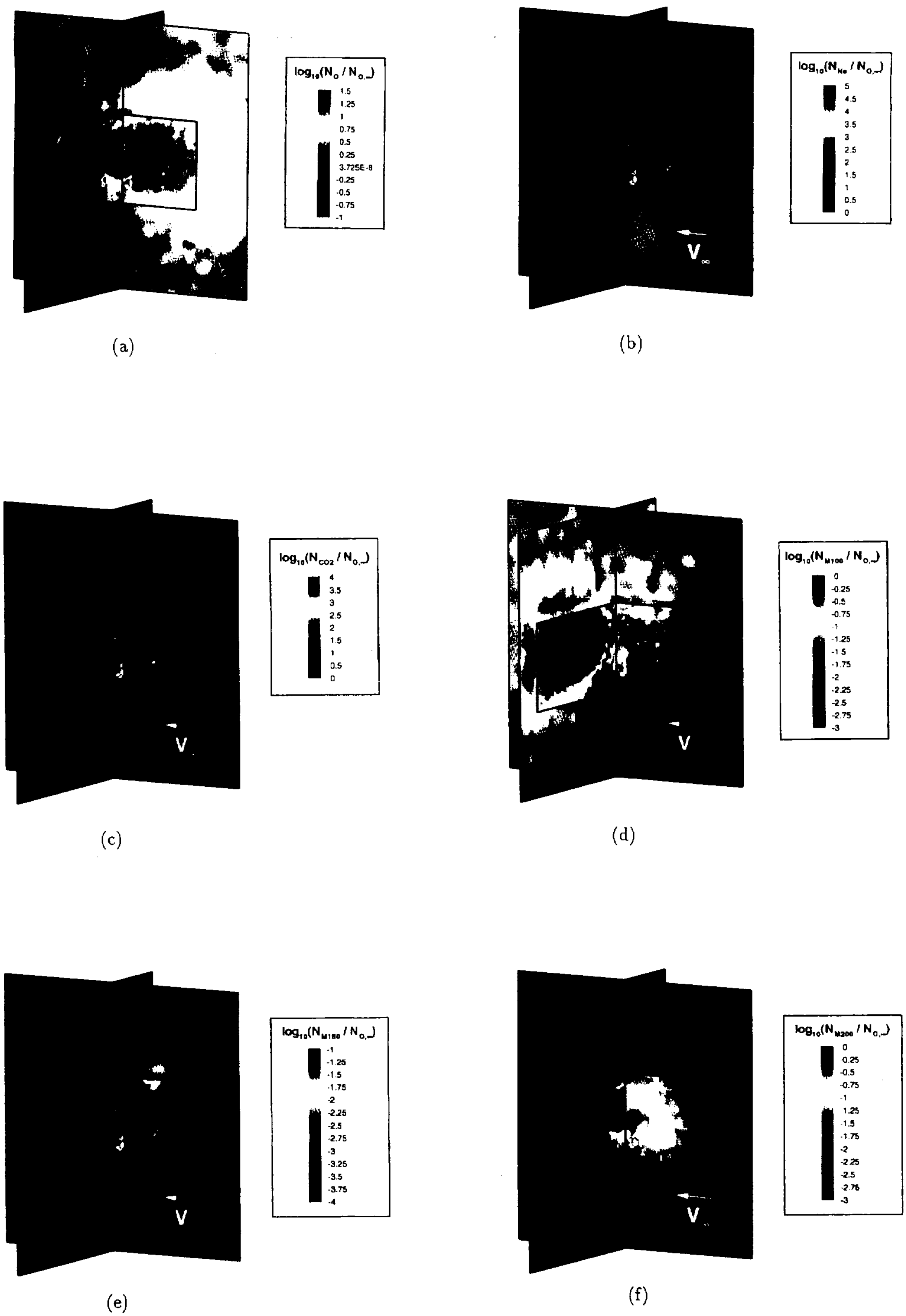


Figure 15. Case 3 species number density contour maps emphasizing the HALOE aperture environment. Logarithmic scale nondimensionalized by freestream number density $[O]_\infty$: (a) monatomic oxygen, (b) neon, (c) carbon dioxide, (d) *GMW* = 100 species, (e) *GMW* = 150 species, and (f) *GMW* = 200 species.

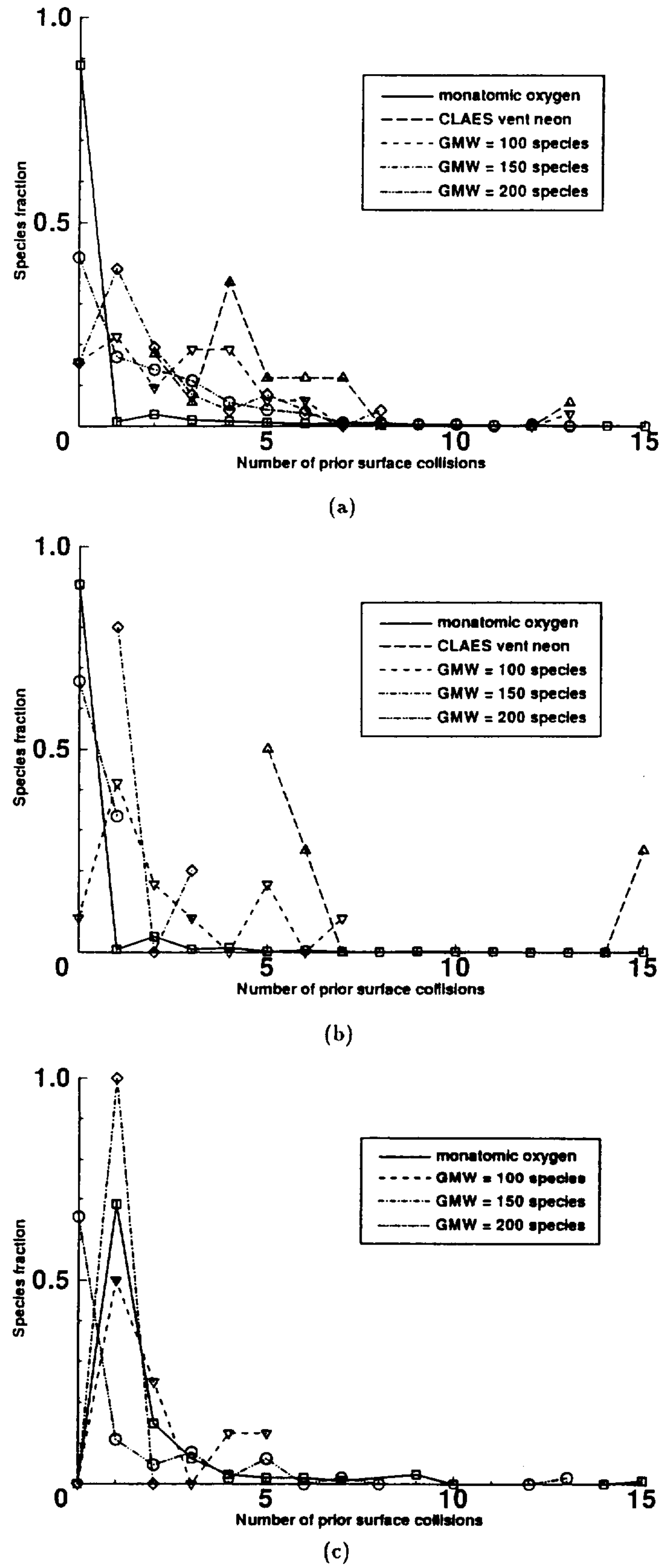


Figure 16. Number of surface collisions encountered by particles prior to striking the HALOE aperture: (a) Case 1, (b) Case 2, and (c) Case 3.

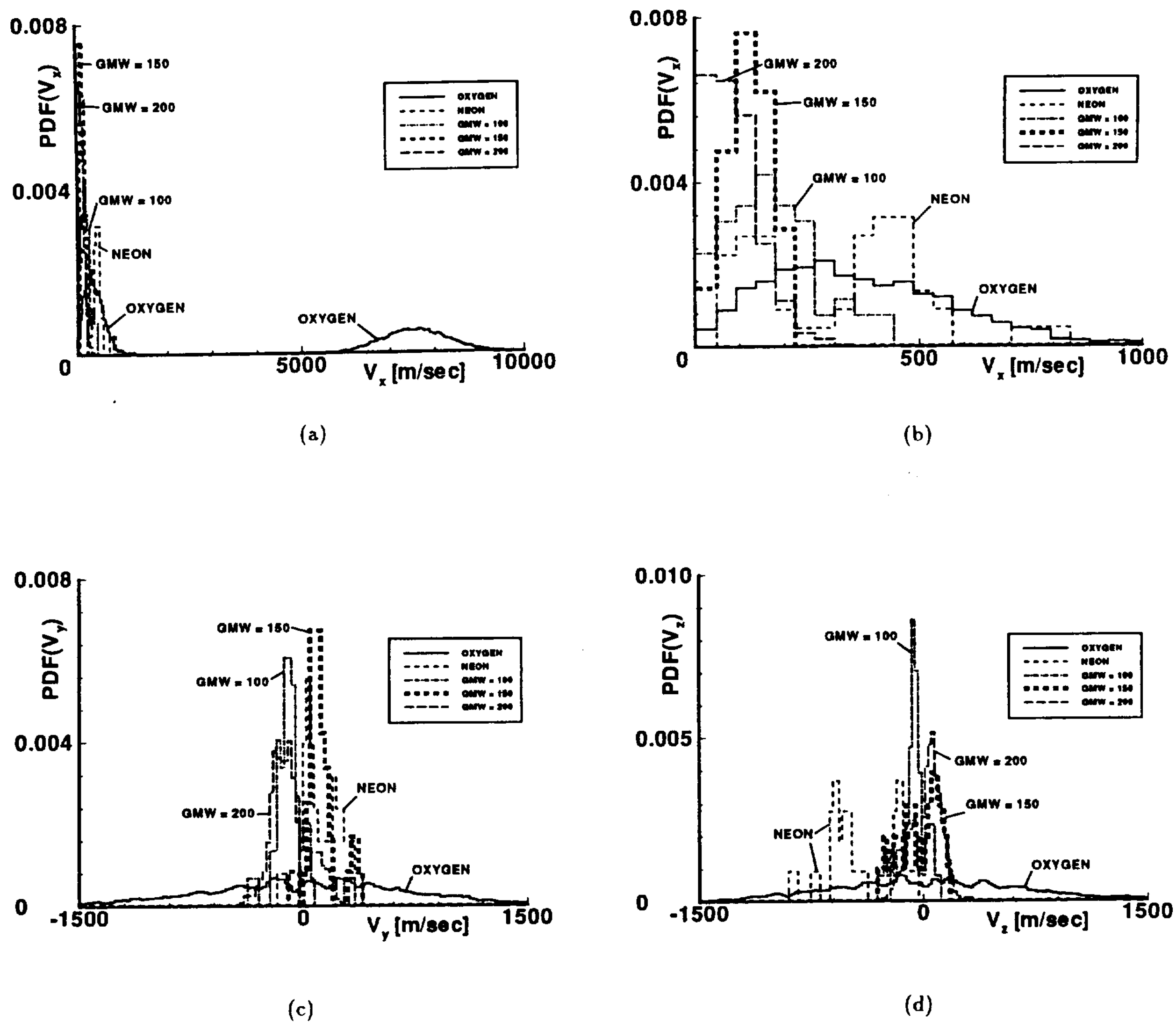


Figure 17. Case 1 histograms representing velocity distribution functions for particles striking the HALOE aperture: (a) X direction, (b) Y direction, (c) Z direction.

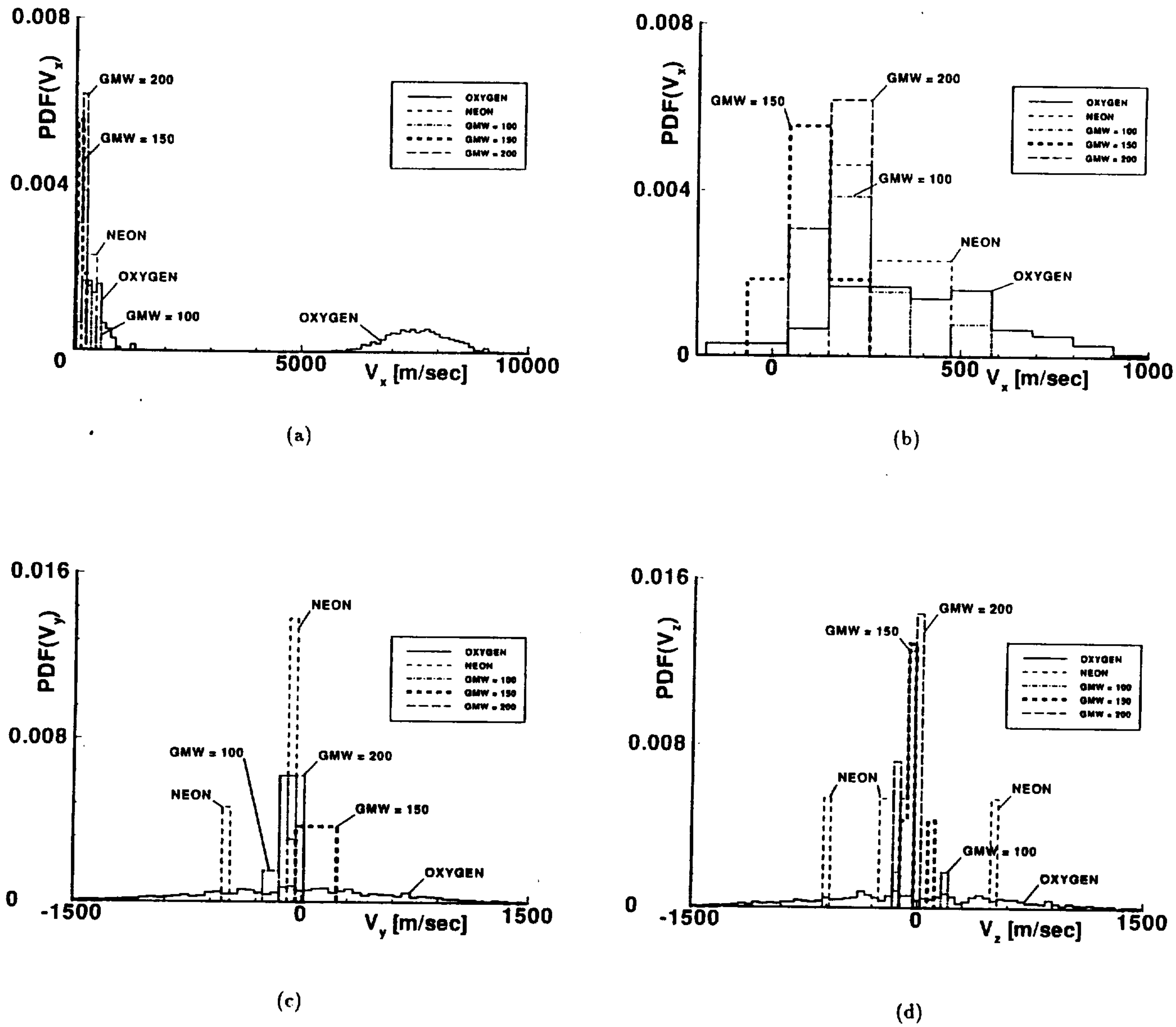


Figure 18. Case 2 histograms representing velocity distribution functions for particles striking the HALOE aperture: (a) *X* direction, (b) *Y* direction, (c) *Z* direction.

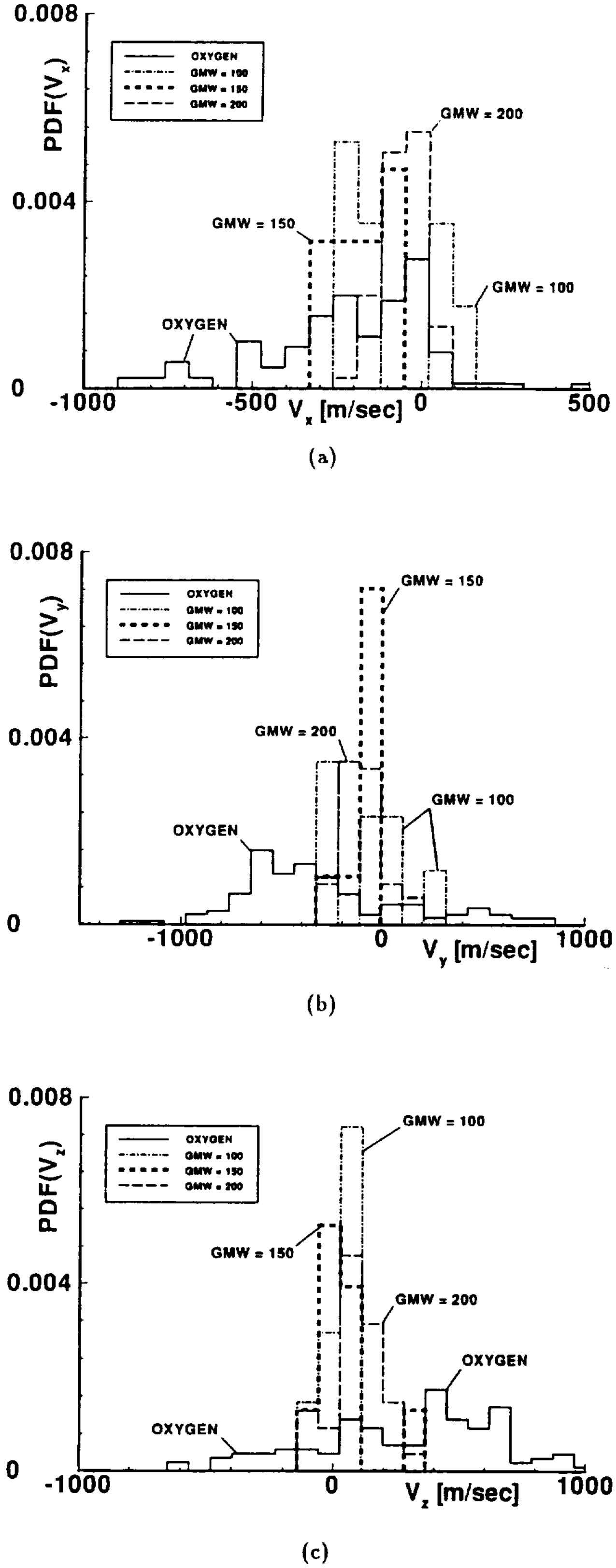
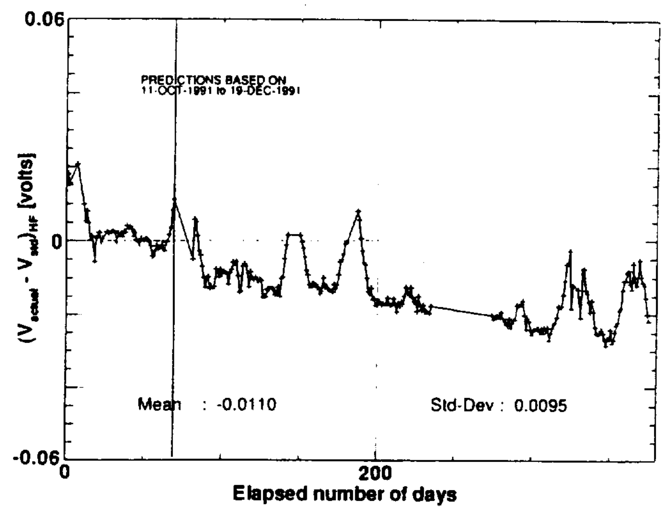
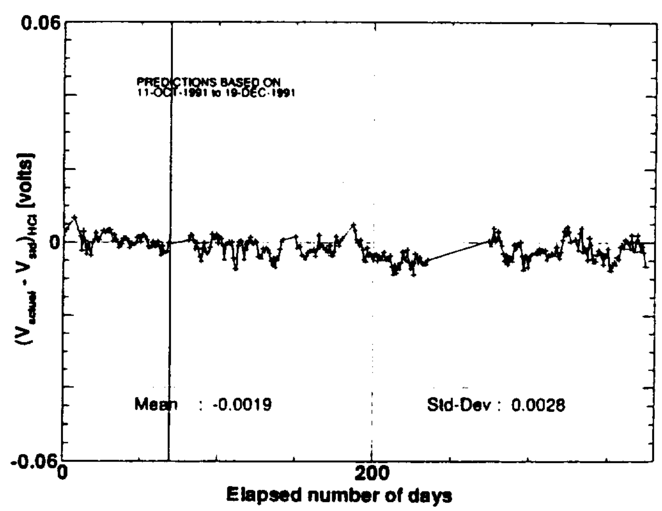


Figure 19. Case 3 histograms representing velocity distribution functions for particles striking the HALOE aperture: (a) X direction, (b) Y direction, (c) Z direction.



(a)



(b)

Figure 20. Actual HALOE signal attenuation measurements between October 11, 1991 and October 20, 1992 for (a) *HF* and (b) *HCl* species.

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13. ABSTRACT *(Maximum 200 words)*

A three-dimensional version of the direct simulation Monte Carlo method is adapted to assess the contamination environment surrounding a highly detailed model of the Upper Atmosphere Research Satellite. Emphasis is placed on simulating a realistic, worst-case set of flow field and surface conditions and geometric orientations for the satellite in order to estimate an upper limit for the cumulative level of volatile organic molecular deposits at the aperture of the Halogen Occultation Experiment. A detailed description of the adaptation of this solution method to the study the satellite's environment is also presented. Results pertaining to the satellite's environment are presented regarding contaminant cloud structure, cloud composition, and statistics of simulated molecules impinging on the target surface, along with data related to code performance. Using procedures developed in standard contamination analyses, along with many worst-case assumptions, the cumulative upper-limit level of volatile organic deposits on HALOE's aperture over the instrument's 35-month nominal data collection period is estimated at about 13,350 A.

14. SUBJECT TERMS
direct simulation Monte Carlo, outgassing, satellite contamination, direct flux, return flux, Upper Atmosphere Research Satellite (UARS), and Halogen Occultation Experiment (HALOE)

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