Sect 0.0 FINITE ELEMENT MODEL DESCRIPTION

0.0 Finite Element Model Description

Introduction

A finite element model of the AMS-02 payload was built to determine both the dynamic and static loads for all major structural components that make up the total payload. The model was built using both FEMAP 8.0 and MSC/NASTRAN. The actual dynamic and static analysis is performed using MSC/NASTRAN version 2001. The model is currently maintained on the ecf system at NASA/JSC. The actual directory where the model is currently located is shown in this report.

Most of the current stress analysis for the USS-02 and the Vacuum Case is based on the AMS-02 model version 6-02 and 6-02a. The USS-02 Center Body Joint and the Primary Sill Trunnion Joint analysis was done using the 11-02 AMS-02 model. A new loads comparison is performed each time that a new model is released to determine if there needs to be any revisions to the current stress analysis. Model updates are sent out with each new model release detailing the changes made from the previous version.

The final assessment of the loads for the VAR will be performed at a later time. The VLA load factors are expected to be lower than the design load factors.

Model Description

The full AMS-02 Model version 6-02a along with some sub components are shown in Figures 0.0-1 and 0.0-7. The element ranges and types are listed in Table 0.0-1 through Table 0.0- 7. The important locations in the model are the five trunnion attach locations, vacuum case to USS-02 attachments and the ISS-PAS attachment locations to the International Space Station truss segment. Various other attachments locations for the experiment components are represented in the model as well. The key interface locations are shown on Table 0.0-8.

The AMS-02 payload currently has an Orbiter manifest weight of 14809 lbs. The AMS-02 6-02a math model weighs 14997 lbs. The distribution of the mass is shown in Table 0.0-9 through Table 0.0-12 .

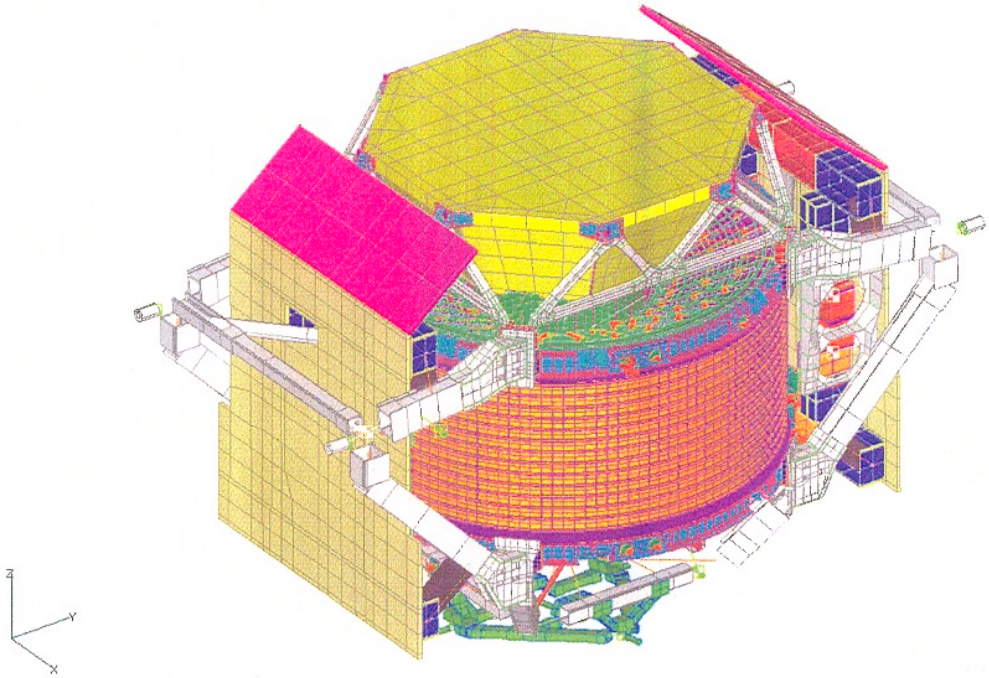

Figure 0.0-1: AMS-02 Model 6-02a

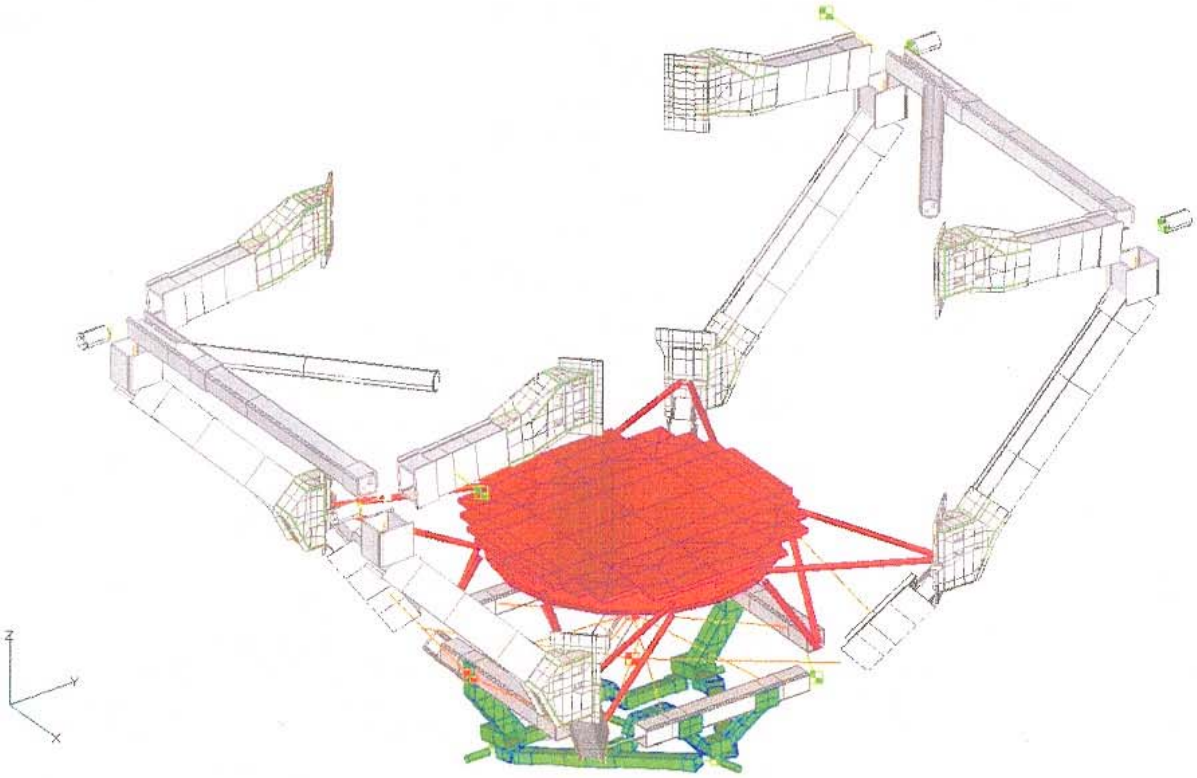

Figure 0.0-2: USS-02 with Payload Attach System (PAS) and Lower Time of Flight

Model Location and File Description

All of the different releases of the AMS-02 loads model are located on the ecf system at JSC. The directory location is:

/hsm/bsommer/ams/bulk/(*insert model version here*)

Model 6-02a is found in the directory /hsm/bsommer/ams/bulk/6-02a/ and contains the following files:

cord.dat	coordinate systems for nonlinear straps, USS-02, and Vacuum Case models
ip-uss-springs.dat	CBUSH elements that connect the vacuum case to the USS-02 at 10 locations, the lower USS-02 to the lower Vacuum Case Joint and the TRD to the upper Vacuum Case Joint.
ip-vc-springs.dat	CBUSH elements that connect the vacuum case to the interface plates.
magassy.dat	Magnet with full Helium Tank
magassyslosh.dat	Magnet with half full Helium Tank
magassyempty.dat	Magnet with empty Helium Tank
mpc2.dat - mpc8.dat	Magnet strap, Helium Tank and Vacuum Case connectivity equations for sub cases 2 through 8.
nlstraps.dat	nonlinear strap grids, elements, materials, property and temperature cards.
oc-vc-springs.dat	Vacuum Case Support Rings attachment to the Conical Flanges and Outer Cylinder.
parame.dat	Model parameters with empty Helium Tank center of gravity (CG) location
paramhf.dat	Model parameters with half-full Helium Tank CG location
pramf.dat	Model parameters with full Helium Tank CG location
preload.dat	strap preload force cards
radiators.dat	WAKE and RAM radiator model
spc1.dat – spc8.dat	Model constraints for sub cases 1 thru 8.
trd.dat	Transition Radiation Detector (TRD) model
trdgas.dat	TRD Gas Supply Model
uss.dat	USS-02 model
vc.dat	Vacuum Case Model

Table 0.0-1: USS-02 Finite Element Numbering

USS-02		
Component	**Element Range**	**Element Type**
Upper Trunnion Bridge, Main Cross Section	1101-1112	CBEAM
Upper Trunnion Bridge, Upper VC Joint Insert	1117-1120	CBEAM
Upper Trunnion Bridge, Sill Joint Insert	1113-1116	CBEAM
Lower Trunnion Bridge, Main Cross Section	1201-1212	CBEAM
Lower Trunnion Bridge, Lower VC Joint Insert	1213-1216	CBEAM
Lower Trunnion Bride Elbow, Upper	1217-1220	CBEAM
Lower Trunnion Bride Elbow, Lower	1221-1224	CBEAM
Keel 4x4x1/4 7075 Tubes	1301-1303	CBEAM
Keel, Centerbody Stubs	1305-1306	CBEAM
Keel, Trunnion Joint Stubs	1307-1308	CBEAM
Trunnions	1401-1405	CBEAM
Lower Centerbody 4x4x1/4	1501-1517	CBEAM
Lower Diagonal Corner FLANGE BOX Beams	1601-1620	CBEAM
Lower USS to Upper USS joints	1605 1610 1615 1620	CBEAM
RBE's for Lower Centerbody Joints	1621-1624	RBE2
Sill Bridge 4x4x1/4,	1701-1704	CBEAM
Sill Bracket	1705-1706	CBEAM
Diagional Sill Bracket, I Section	1707-1709	CBEAM
Diagional Sill Bracket, Tube Section	1711-1712	CBEAM
Horizontal Diagonal Strut	1801-1804	CBEAM
RBE END A Upper Trunnioin Beridge to Upper VC JOINT	2001-2004	RBE2
RBE END B Upper Trunnioin Beridge to Upper VC JOINT	2011-2014	RBE2
RBE END A LOWER VC JOINT	2021-2024	RBE2
RBE END B LOWER VC JOINT	2031-2034	RBE2
UPPER VC JOINTS	3001-4304	CQUAD4, CTRIA3, CBAR
LOWER VC JOINTS	4401-5420	CQUAD4, CTRIA3, CBAR
RBE END B of LTB BEAM TO LOWER VC JT	2021-2024	RBE2
RBE END A of LTB BEAM TO LOWER VC JT	2031-2034	RBE3
RBE LOWER DIAGONAL BEAM TO LOWER VC JT	2041-2044	RBE4
MASSES	2101-2131	
Mass-Primary Block	2101-2102	CONM2
Mass-Secondary Block	2103-2104	CONM2
Joint Mass, 3#, upper VC interface	4305-4308	CONM2
Joint Mass, 3#, Lower VC interface	4309-4312	CONM2
Joint mass, 26#, Keel	2111	CONM2
Joint Mass, 54#, RICH/ECAL, forward	2112-2113	CONM2
Joint Mass, 45.55#, RICH/ECAL, aft	2114-2115	CONM2
Fastener Mass, 7#, lower diagonal	2124-2127	CONM2
Joint Mass, 3#,End Fittings for Diag. Strut	2120-2123	CONM2

Table 0.0-1 cont. : USS-02 Finite Element Numbering

COMPONENT	ELEMENT RANGE	ELEMENT TYPE
PAS Fasteners	2135-2138	CONM2
Sill Joint Fasteners	2139-2142	CONM2
Contengcy Weight	4313-4332	CONM2
RBE2 Connection at Primary	1901-1902	RBE2
RBE2 Connection at Secondary	1903-1904	RBE2
RBE2 Connection at Keel	1905	RBE2
TRD and Upper TOF RBE 's to Upper VC Joint	65061-65064	RBE2
UPPER INTERFACE MPC's TO USS RBE'S	65101-65104	MPC
LOWER INTERFACE MPC's TO USS RBE'S	65111-65114	MPC
UPPER USS TO VC IP CBUSH ELEMENTS	66001-66006	CBUSH
LOWER VC JOINT TO IP CBUSH ELEMENTS	66011-66014	CBUSH
LOWER USS TO LOWER VC JOINT CBUSH ELEMENTS	66041-66044	CBUSH
TRD and Upper TOF Interface CBUSH ELEMENTS	66061-66064	CBUSH
Upper Interface Plate RBE to CBUSH nodes	65001-65006	
Lower Interface Plate RBE to CBUSH nodes	65011-65014	
Lower USS to Lower CBUSH Nodes	65041-65044	
Lower CBUSH elemnt to Lower VC Joint Nodes	65051-65054	
Upper VC Joint to CBUSH for TRD and Upper TOF	66061-66064	
Upper TOF and TRD to CBUSH Nodes	65071-65074	
Upper CBUSH element to MPC nodes	65021-65026	
Lower CBUSH element to MPC nodes	65031-65034	
Upper MPC to RBE to USS Nodes	65101-65106	
Lower MPC to RBE to USS Nodes	65111-65114	
ISS Integration Hardware		
PAS		
PAS Beams	9001-9027	CBEAM
PAS Front Attachment Bracket (PLATE & Beams)	9217 9155-9283	CBEAM, CQUAD4
PAS Back Attachment Members (PLATE & Beams)	9001-9283	CBEAM, CQUAD4
PAS Trunnions	9032-9034	CBEAM
PAS Capture Bar	9035-9036	CBEAM
PAS Lumped Mass	9309-9311	CONM2
PAS RBE's	9042-9048 9285-9288	RBE2
Mass - UMA and RBE	9101-9102	CONM2
Mass- EVA Panel/ Panel A	9153	CONM2
Mass - ISS Camera	9103	CONM2
Mass - ROEU and RBE	9104-9105	CONM2
Mass - Debree Shields	9106-9113	CONM2

Table 0.0-1 cont. : USS-02 Finite Element Numbering

COMPONENT	ELEMENT RANGE	ELEMENT TYPE
Mass- EVA Handrails	9313	CONM2
Mass - FGRF	9601	CONM2
Mass - PVGRF + Bracket Mass	9312, 9602	CONM2
Mass - Scuff Plates	9701-9704	CONM2

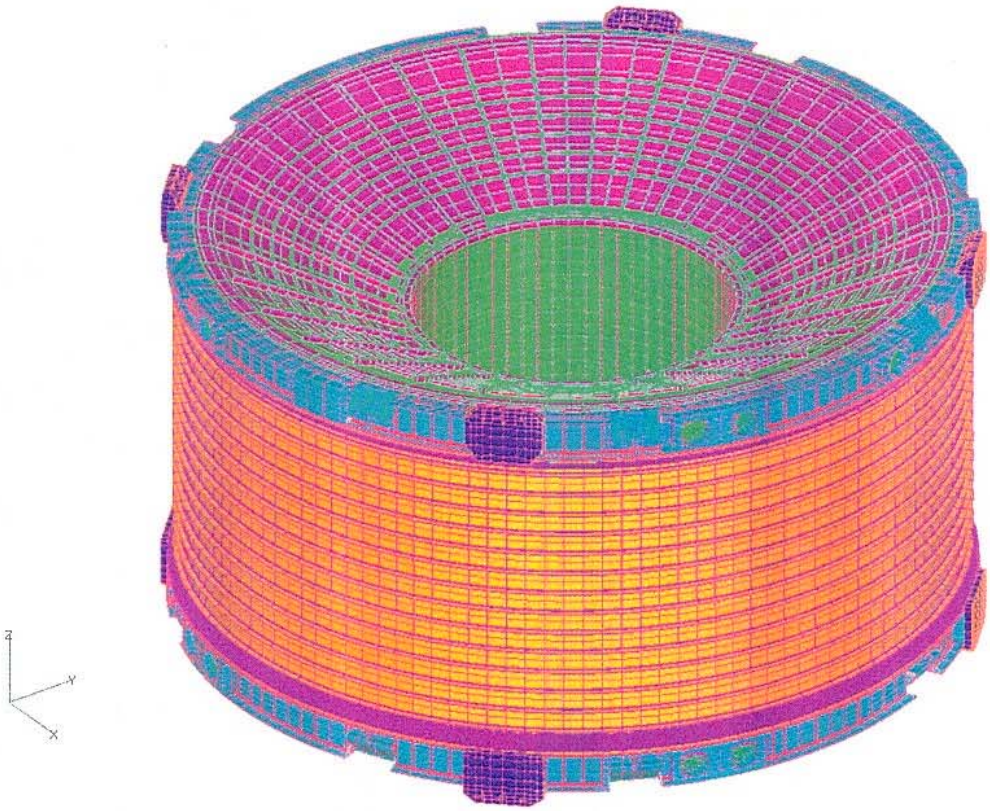

Figure 0.0-3: AMS -02 Vacuum Case Loads Model

Table 0.0-2: Vacuum Case Element Numbering

VACUUM CASE		
Component	Element Range	Element Type
UPPER FLANGE .08" PLATE	10001-11128	CQUAD4
UPPER FLANGE .5" PLATE	11129-11256	CQUAD4
UPPER FLANGE .736" PLATE	11257-11320	CQUAD4
UPPER FLANGE TPR .08"-.827" PLATE	11321-11328	CQUAD4
UPPER FLANGE .827 th PLATE	11329-11336	CQUAD4
UPPER FLANGE TPR .08"-.5" PLATE	11337-11400	CQUAD4
UPPER FLANGE 1.022"x.1" BEAM	11401-11976	CBEAM
UPPER FLANGE TPR .1" BEAM	11977-12041	CBEAM
UPPER FLANGE TPR .735"-.41" PLATE	12042-12049	CQUAD4
UPPER FLANGE TPR BOSS BEAM	12050-12081	CBEAM
UPPER FLANGE .174" PLATE	12082-12137	CQUAD4
UPPER FLANGE TPR .174"-.08" PLATE	12138-12193	CQUAD4
UPPER FLANGE 1ST STEP BEAM	12194-12249	CBEAM
UPPER FLANGE 2ND STEP BEAM	12250-12305	CBEAM
UPPER FLANGE INNER RADIUS BEAM	12306-12369	CBEAM
UPPER FLANGE MASSLESS BAR	12370-13319	CBAR
UPPER FLANGE CIRC. RIBS BEAM	13320-13703	CBEAM
UPPER FLANGE TRACKER RBE'S	13704-13743	RBE2
LOWER FLANGE .08" PLATE	70001-71128	CQUAD4
LOWER FLANGE .5" PLATE	71129-71256	CQUAD4
LOWER FLANGE .736" PLATE	71257-71320	CQUAD4
LOWER FLANGE TPR .08"-.827" PLATE	71321-71328	CQUAD4
LOWER FLANGE .827 th PLATE	71329-71336	CQUAD4
LOWER FLANGE TPR .08"-.5" PLATE	71337-71400	CQUAD4
LOWER FLANGE 1.022"x.1" BEAM	71401-71976	CBEAM
LOWER FLANGE TPR .1" BEAM	71977-72041	CBEAM
LOWER FLANGE TPR .735"-.41" PLATE	72042-72049	CQUAD4
LOWER FLANGE TPR BOSS BEAM	72050-72081	CBEAM
LOWER FLANGE .174" PLATE	72082-72137	CQUAD4
LOWER FLANGE TPR .174"-.08" PLATE	72138-72193	CQUAD4
LOWER FLANGE 1ST STEP BEAM	72194-72249	CBEAM
LOWER FLANGE 2ND STEP BEAM	72250-72305	CBEAM
LOWER FLANGE INNER RADIUS BEAM	72306-72369	CBEAM
LOWER FLANGE MASSLESS BAR	72370-73319	CBAR
LOWER FLANGE CIRC. RIBS	73320-73703	CBEAM
LOWER FLANGE TRACKER RBE'S	73704-73743	RBE2
UPPER IP 1" SOLID	13800-14391	CHEXA, CPENTA, CTETRA
LOWER IP 1" SOLID	14400-14999	CHEXA, CPENTA, CTETRA
OC .375" PLATE	16001-16512	CQUAD4
OC RING 1 0.250" PLATE	16513-16768	CQUAD4

Table 0.0-2: Vacuum Case Element Numbering Cont.

COMPONENT	ELEMENT RANGE	ELEMENT TYPE
OC RING 2 0.232" PLATE	16769-17024	CQUAD4
OC RING 3 0.213" PLATE	17025-17280	CQUAD4
OC RING 4 0.199" PLATE	17281-17536	CQUAD4
OC RING 5 0.187" PLATE	17537-17792	CQUAD4
OC RING 6 0.177" PLATE	17793-18048	CQUAD4
OC RING 7 0.169" PLATE	18049-18304	CQUAD4
OC RING 8 0.161" PLATE	18305-18560	CQUAD4
OC RING 9 0.154" PLATE	18561-18816	CQUAD4
OC RING 10 0.149" PLATE	18817-19072	CQUAD4
OC RING 11 0.148" PLATE	19073-19328	CQUAD4
OC RING 12 0.149" PLATE	19329-19584	CQUAD4
OC RING 13 0.156" PLATE	19585-19840	CQUAD4
OC RING 14 0.169" PLATE	19841-20096	CQUAD4
OC RING 15 0.196" PLATE	20097-20352	CQUAD4
OC FLANGE RADIUS BEAM	20353-20608	CBEAM
OC .365"x.353" BEAM	20609-20864	CBEAM
OC RIB 1 BEAM	20865-20992	CBEAM
OC RIB 2 BEAM	20993-21120	CBEAM
OC RIB 3 BEAM	21121-21248	CBEAM
OC RIB 4 BEAM	21249-21376	CBEAM
OC RIB 5 BEAM	21377-21504	CBEAM
OC RIB 6 BEAM	21505-21632	CBEAM
OC RIB 7 BEAM	21633-21760	CBEAM
OC RIB 8 BEAM	21761-21888	CBEAM
OC RIB 9 BEAM	21889-22016	CBEAM
OC RIB 10 BEAM	22017-22144	CBEAM
OC RIB 11 BEAM	22145-22272	CBEAM
OC RIB 12 BEAM	22273-22400	CBEAM
OC RIB 13 BEAM	22401-22528	CBEAM
OC RIB 14 BEAM	22529-22656	CBEAM
OC MASSLESS BAR	22657-26496	CBAR
IC .25" PLATE	27001-27128	CQUAD4
IC TPR .25"-.125" PLATE	27129-27256	CQUAD4
IC .125" PLATE	27257-28216	CQUAD4
IC MASSLESS BAR	28217-29432	CBAR
UPPER SR .25" PLATE	30001-31049	CQUAD4
UPPER SR .164" PLATE	31050-31607	CQUAD4
UPPER SR SOLID SECTION BEAM	31608-31643	CBEAM
UPPERSR .75" PLATE	31644-32376	CQUAD4
UPPER SR .25" RADIUS BEAM	32375-32531	CBEAM
UPPER SR .5" RADIUS BEAM	32532-32602	CBEAM
UPPER SR .50" PLATE	32603-32807	CQUAD4

Table 0.0-2: Vacuum Case Element Numbering Cont.

COMPONENT	ELEMENT RANGE	ELEMENT TYPE
UPPER SR 1.859" PLATE	32808-33243	CQUAD4
UPPER SR OC BEAM FOR J SECTION	33244-33419	CBEAM
UPPER SR MASSLESS BAR	33420-33898	CBAR
UPPER SR PORT SIDE BEAMS	33899-33992	CBEAM
UPPER SR PORT TOP & BOTTOM BEAMS	33993-34024	CBEAM
UPPER SR POCKETS 0.375"	34025-34141	CQUAD4
LOWER SR .25" PLATE	34142-35234	CQUAD4
LOWER SR .164" PLATE	35235-35805	CQUAD4
LOWER SR SOLID SECTION BEAM	35806-35841	CBEAM
LOWER SR .75" PLATE	35842-36536	CQUAD4
LOWER SR .25" RADIUS BEAM	36537-36699	CBEAM
LOWER SR .5" RADIUS BEAM	36700-36764	CBEAM
LOWER SR 0.5" PLATE	36765-36962	CQUAD4
LOWER SR 1.859" PLATE	36963-37311	CQUAD4
LOWER SR OC BEAM FOR J SECTION	37312-37493	CBEAM
LOWER SR MASSLESS BAR	37494-37973	CBAR
LOWER SR PORT SIDE BEAMS	37974-38054	CBEAM
LOWER SR PORT TOP & BOTTOM BEAMS	38055-38083	CBEAM
LOWER SR POCKETS 0.375"	38084-38231	CQUAD4
CONM2 LUMPED MASS Upper SR	39001-39008	CONM2
CONM2 LUMPED MASS Lower SR	39009-39016	CONM2
Upper SR Fastener OC RBE's	39101-39228	RBE2
Lower SR Fastener OC RBE's	39301-39428	RBE2
Upper SR Fastener Flange RBE's	39501-39564	RBE2
Lower SR Fastener Flange RBE's	39601-39664	RBE2
Upper Flange to SR CBUSH Elements	39701-39764	CBUSH
Lower Flange to SR CBUSH Elements	39801-39864	CBUSH
Upper OC to SR CBUSH Elements	40001-40128	CBUSH
Lower OC to SR CBUSH Elements	40201-40328	CBUSH
UPPER SR RBE'S	60001-61054	RBE2
LOWER SR RBE'S unless otherwise noted	65115-65997	RBE2
UPPER FLANGE TO IC AND TRACKER STEP RBE'S	62083-62226	RBE2
LOWER FLANGE TO IC AND TRACKER STEP RBE'S	62227-62373	RBE2
UPPER VC TO INTERFACE SPRINGS RBE'S	62001-62004	RBE2
LOWER VC TO INTERFACE SPRINGS RBE'S	62011-62014	RBE2
UPPER INTERFACE SPRINGS TO IP RBE'S	63001-63004	RBE2
LOWER INTERFACE SPRINGS TO IP RBE'S	63011-63014	RBE2
UPPER VC TO IP CBUSH ELEMENTS	64001-64004	CBUSH
LOWER VC TO IP CBUSH ELEMENTS	64011-64014	CBUSH
CONTENGY MASS ON RINGS	64201-64216	CONM2
UPPER IP TO INTERFACE SPRINGS RBE'S	65001-65004	RBE2

Table 0.0-2: Vacuum Case Element Numbering Cont.

COMPONENT	ELEMENT RANGE	ELEMENT TYPE
Upper RBE Connection, Horizontal Diagonal Strut	65005-65006	RBE2
CONNECTION OF USS-02 TO VACUUM CASE		
LOWER IP TO INTERFACE SPRINGS RBE'S	65011-65014	RBE2
UPPER VC TO CBUSH Nodes	40001-40004	
LOWER VC TO CBUSH Nodes	40011-40014	
UPPER CUBSH TO IP Nodes	40101-40104	
LOWER CBUSH TO IP Nodes	40111-40114	
Top Flange Nodes	11001-12828	
Bottom Flange Nodes	12829-14659	
OC Nodes	15001-19480	
IC Nodes	20001-21281	
USS Interface Nodes	22001-22304	
Upper Support Ring Nodes	25001-28597	
Lower Support Ring Nodes	28601-32171	
Upper & LowerInterface Plate Nodes	37001-39136	
Magnet Interface Nodes	10101-10116	
Tracker Mass Nodes	10201-10216	
Upper Flange Fastener Nodes	32201-32264	
Upper Flange Contact to SR Nodes	32301-32364	
Upper Flange to Inner Cylinder Nodes	32401-32464	
Upper Flange Outer Tracker Diameter Nodes	32501-32564	
Lower Flange Fastener Nodes	32601-32664	
Lower Flange Contact to SR Nodes	32701-32764	
Lower Flange to Inner Cylinder Nodes	32801-32864	
Lower Flange Outer Tracker Diameter Nodes	32901-32964	
Upper OC Fastener to SR Nodes	33001-33128	
Upper OC Mid Rbe's to Upper SR Nodes	33201-33328	
Upper OC Inner Diameter to Upper SR Nodes	33401-33528	
Lower OC Fastener to SR Nodes	33601-33728	
Lower OC Mid Rbe's to Lower SR Nodes	33801-33928	
Lower OC Inner Diameter to Lower SR Nodes	34001-34127	
Upper SR Fastener to OC Nodes	35001-35128	
Lower SR Fastener to OC Nodes	35601-35728	
Upper SR Fastener to Flange Nodes	35801-35864	
Lower SR Fastener to Flange Nodes	35901-35964	
Upper SR Coincident Nodes for CBUSH OC	36001-36128	
Lower SR Coincident Nodes for CBUSH OC	36201-36328	
Upper SR Coincident Nodes for CBUSH to Flange	36401-36464	

Table 0.0-2: Vacuum Case Element Numbering Cont.

COMPONENT	ELEMENT RANGE	ELEMENT TYPE
Lower SR Coincident Nodes for CBUSH to Flange	36501-36564	
Joint Mass, 5#, horizontal diagonal lug	2109-2110	CONM2

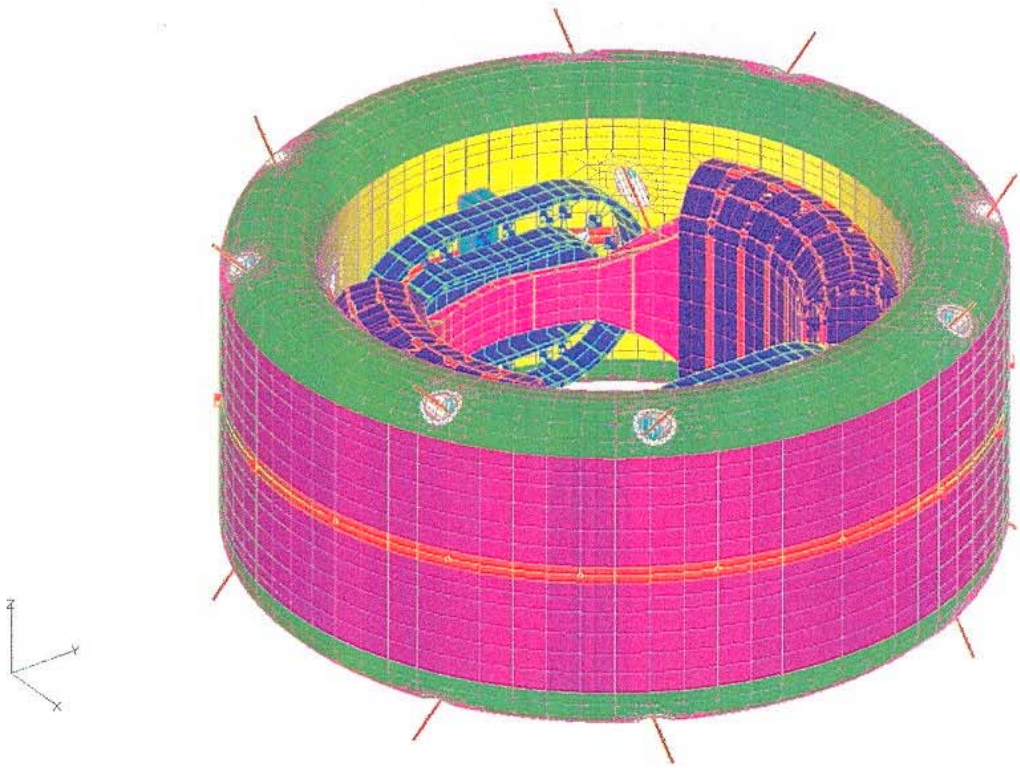

Figure 0.0-4: Magnet and He Tank Assembly

Table 0.0-3: Various Experiment Components Located in USS-02 and Vacuum Case Models

VARIOUS EXPERIMENT COMPONENTS		
Component	**Element Range**	**Element Type**
e-CAL, slotted connection modeled -	53001-53002	CONM2, RBE3
Tracker	54001-54016	CONM2
Tracker Cables	54201-54392	CONM2
ACC	54101-54108	CONM2
Electronics	57001-57008	CONM2
RICH	50001-50002	CONM2, RBE3
TOF, TRD ATTACHMENT	58001	CONM2, RBE3
TOF, BOTTOM HONEYCOMB, C CHANNELS	58002-58086	CBEAM
TOF, BOTTOM ATTACHMENT STRUTS	58087-58102	CBEAM
CAB	55003-55004	CONM2
Ther/Rad	56001-56013	CONM2
Magnet Avionics	59001-59027	CONM2
Magnet Avionics 20 lbs +RBE3	59028-59029	CONM2
Magnet Avionics 10 lbs+ RBE3's	59030-59033	CONM2
Magnet Avionics 5 lbs	59034-59041	CONM2
CVB	56109	CONM2
Cryo. Coolers	59051-59054	CONM2
Star Tracker	56116	CONM2
Lower WAKE and RAM Radiators with RBE's	56119-56122	CONM2, RBE3
Busbars, cabels, vent pump	56116	CONM2
TTCS	56112-56113	CONM2
Additional AMS Mass	56101-56108	CONM2

Table 0.0-4: Magnet and He Tank Element Numbering

MAGNET AND HE TANK		
Component	**Element Range**	**Element Type**
Straps	90001-90016	CROD
Strap connection to Magnet, RBE's	94163-94180	MPC
Magnet Elements	91001-99724	CBEAM, CQUAD4, CTIRA3
Magnet Contengency Weight	99801-99804	CONM2
He Tank Portion		
Outer Cylinder (OC) Plates	100001-100864	CQUAD4
OC Ribs	100865-101224	CBEAM
Inner Cylinder (IC) Plates	101225-102936	CQUAD4
IC Ribs	102937-103368	CBEAM
Top and Bottom Caps	103369-105552	CQUAD4, CTRIA3, CBAR
Strap Tubes	105553-109160	CQUAD4, CTRIA3, CBAR
Massless Bars	109161-112425	CBAR
Helium Mass	112426-112497	CONM2
Support Ring (SR) Beam	112498-112645	CBEAM
SR Plate	112646-112949	CQUAD4
SR Spokes	112950-112985	CBEAM
RBE3's for He Mass	112986-113057	RBE3
SR Lumped Mass	113061-113096	CONM2
Y Struts	114001-114002	CROD
He Tank Nodes	100001-107133	
Helium Nodes	112001-112072	
Magnet Attachment Nodes	100001-100108	

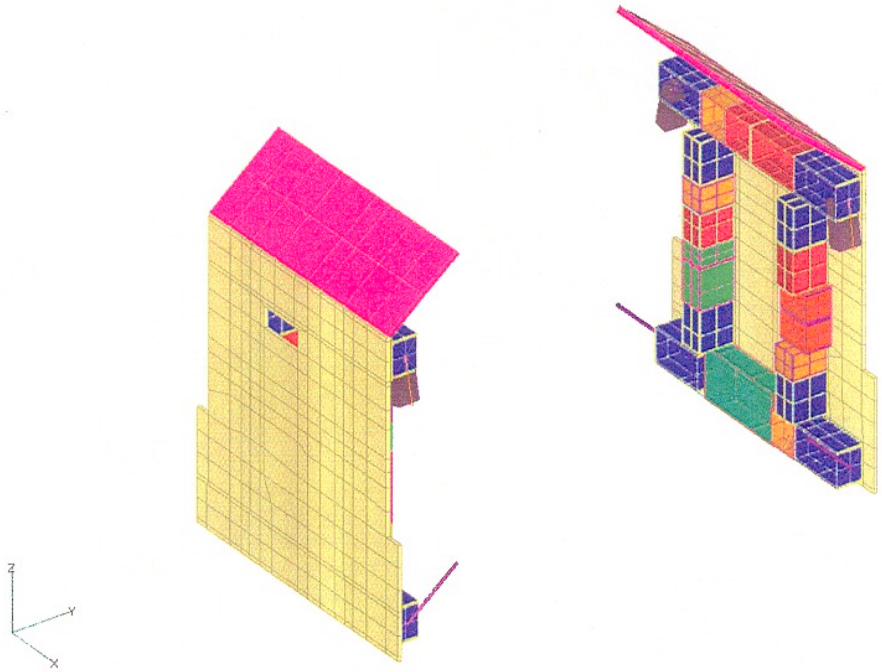

Figure 0.0-5: WAKE and RAM Radiator Model

WAKE AND RAM RADIATORS		
Component	**Element Range**	**Element Type**
WAKE Honeycomb	120001-120261	CQUAD4 (LAMINATE)
RAM Honeycomb	120301-120550	CQUAD4 (LAMINATE)
Crate Plate Elements	120601-121615	CQUAD4
Crate Beam Elements	120701-122322	CBEAM
Tracker Radiators	122401-122432	CQUAD4 (LAMINATE)
Mass Elements	122501-122543	CONM2
RBE's for Lower Centerbody Joints	122601-122928	RBE2
Radiator Nodes	120001-121952	

Table 0.0-5: WAKE and RAM Radiator Loads Model Element Numbering

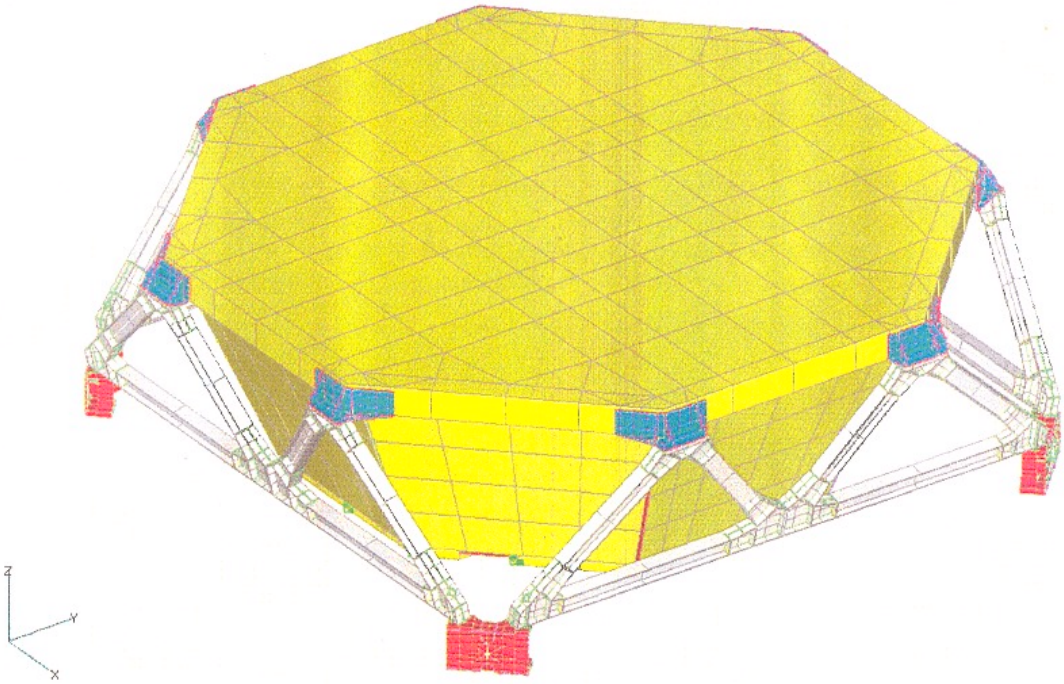

Figure 0.0-6: TRD Loads Model

Table 0.0-6: TRD Loads Model Element Numbering

TRD		
Component	**Element Range**	**Element Type**
M Structure Beams	130001-130048	CBEAM
M Structure Plates	130049-131648	CQUAD4
M Structure Massless Bars	131651-132726	CBAR
Top Bracket Plates	133001-133552	CBEAM
Top Bracket Bars	133561-132726	CBAR
Top Pannel CID 130001	133801-133976	CQUAD4 (LAMINATE)
Side Panel 1 CID 130003	134001-134024	CQUAD4 (LAMINATE)
Side Panel 2 CID 130004	134025-134040	CQUAD4 (LAMINATE)
Side Panel 3 CID 130005	134041-134064	CQUAD4 (LAMINATE)
Side Panel 4 CID 130006	134065-134080	CQUAD4 (LAMINATE)
Side Panel 5 CID 130007	134081-134104	CQUAD4 (LAMINATE)
Side Panel 6 CID 130008	134105-134120	CQUAD4 (LAMINATE)
Side Panel 7 CID 130008	134121-134144	CQUAD4 (LAMINATE)
Side Panel 8 CID 130010	134145-134160	CQUAD4 (LAMINATE)
Bottom Panel CID 130002	134201-134316	CQUAD4 (LAMINATE)
USS Interface RBE's	134651-134654	RBE2
Massless Bars for Octogon	134661-134692	CBAR
Other RBE's	134401-134640	RBE2
Corner Bracket Plates	136001-136416	CQUAD4, CTRIA3
Corner Bracket Bars	136421-136612	CBAR
Corner Bracket RBE's	136621-136644	RBE2
UTOF Interface RBE's	136651-136658	RBE2
Node ID's	130001-133271	
USS Interface Nodes	65061-65064	

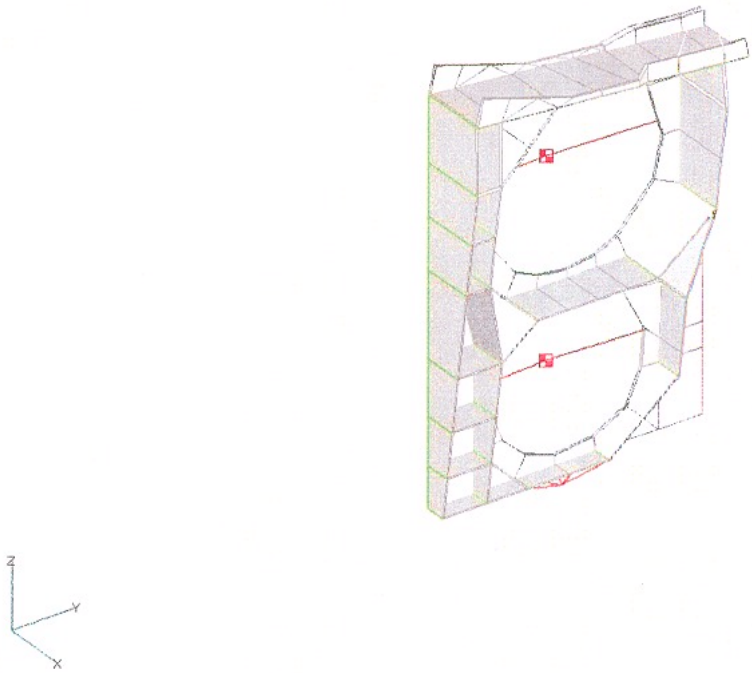

Figure 0.0-7: TRD Gas Supply Loads Model

TRD GAS SUPPLY		
Component	**Element Range**	**Element Type**
Sbox Plates, Bars, RBE's, Concentrated Masses	140001-140241	CQUAD4, CTRIA3, CBAR, RBE2, RBE3, CONM2

Table 0.0-7: TRD Gas Supply Model Numbering

Table 0.0-8: Key Interface Grid Locations

NODE ID	LOCATION
1	Primary Trunnion, Forward Starboard
2	Primary Trunnion, Forward Port
3	Secondary Trunnion, Aft Starboard
4	Secondary Trunnion, Aft Port
5	Keel Trunnion
65071-65074	TRD to Upper Vacuum Case Joint (USS-02 Side)
65061-65064	TRD to Upper Vacuum Case Joint (TRD Side)
40001-40004	Vacuum Case to Interface Plates (Vacuum Case Side)
40101-40104	Vacuum Case to Interface Plates (Interface Plate Side)
65101-65106	Interface Plate to Upper Vacuum Case Joint (Interface Plate Side)
65021-65026	Interface Plate to Upper Vacuum Case Joint (Spring Element)
65001-65006	Interface Plate to Upper Vacuum Case Joint (USS-02 Side)
65111-65114	Interface Plate to Lower Vacuum Case Joint (Interface Plate Side)
65031-65034	Interface Plate to Lower Vacuum Case Joint (Spring Element)
65011-65014	Interface Plate to Lower Vacuum Case Joint (USS-02 Side)
65051-65054	Lower USS-02 to Lower Vacuum Case Joint (Lower Vacuum Case Joint Side)
65041-65044	Lower USS-02 to Lower Vacuum Case Joint (Lower USS-02 Side)

Table 0.0-9: AMS-02 Experiment Weight

AMS EXPERIMENT WEIGHT	CONTROL WEIGHT (lbs)	MODEL 6-02 WEIGHT (lbs)	HOW WEIGHT IS MODELED
ANTICOINCIDENCE COUNTER (ACC) (w/ STRUCTURE TO VC)	117	117	Concentrated Mass Elements
TRACKER	403	403	Concentrated Mass Elements
TIME OF FLIGHT (TOF) (BOTH UPPER & LOWER)	525	525	RBEs, Concentrated Masses, Beam and Laminate Elements
TRANSITION RADIATION DETECTOR (TRD)	723	723	RBEs, Concentrated Masses, Beam, Bar, Laminate and Plate Elements
TRD GAS SUPPLY SYSTEM	258	258	RBEs, Concentrated Masses, Bar, Spring and Plate Elements
RING IMAGING CHERENKOV COUNTER (RICH)	406	406	RBE3, Concentrated Mass Elements
ELECTROMAGNETIC CALORIMETER (ECAL)	1407	1407	RBE3, Concentrated Mass Elements
ALL AVIONICS CRATES	1014	1177	RBE3, Concentrated Masses, Bar, Spring and Plate Elements
CRYOMAGNET SYSTEM	5196	5233	RBEs, Concentrated Masses, Bar, Spring and Plate Elements
THERMAL CONTROL SYSTEM (TCS)	686	554	RBEs, Concentrated Masses, Beam, Rod and Laminate Elements
CONTINGENCY	247	368	Concentrated Mass Elements
AMS EXPERIMENT HARDWARE TOTAL:	10982	11171	

Table 0.0-10: Space Shuttle Integration Hardware Weight

SPACE SHUTTLE INTEGRATION HARDWARE	CONTROL WEIGHT (lbs)	MODEL 6-02 WEIGHT (lbs)	HOW THE WEIGHT IS MODELED
UNIQUE SUPPORT STRUCTURE - 02 (USS-02)	1571	1602	RBEs, Beams, Bars, Plates Concentrated Mass Elements
CRYOMAGNET VACUUM CASE (VC)	1508	1598	RBEs, Beams, Bars, Plates, Solids Concentrated Mass Elements
BRACKETS, MISC. FASTENERS & HARDWARE, SAFETY WIRE	23	23	Concentrated Mass Elements
THERMAL BLANKETS	35	35	Concentrated Mass Elements
ADDITIONAL WEIGHT	121	0	
SHUTTLE INTEGRATION HARDWARE TOTAL:	3259	3258	

Table 0.0-11: ISS Integration Hardware Weight

ISS INTEGRATION HARDWARE	CONTROL WEIGHT (LBS)	MODEL 6-02 WEIGHT (LBS)	HOW THE WEIGHT IS MODELED
ISS PAS/UMA INTERFACE HARDWARE WITH CABLES	203	203	RBEs, Beams, Plates and Concentrated Mass Elements
GRAPPLE FIXTURES (1 FRGF & 1 PVGF) & BRACKETS	131	131	RBEs and Concentrated Mass Elements
MICROMETEORITE/ORBITAL DEBRIS (M/OD) SHIELDS & SUPPORTS	102	102	RBEs and Concentrated Mass Elements
EVA CONNECTOR PANEL, SCUFF PLATES & BRACKETS	55	55	RBEs and Concentrated Mass Elements
PAYLOAD DISCONNECT ASSEMBLY (PDA)	36	36	RBEs and Concentrated Mass Elements
EVA HANDRAILS & PORTABLE FOOT RESTRAINT (PFR) INTERFACE	16	16	RBEs and Concentrated Mass Elements
BERTHING CAMERA SYSTEM (BCS) WITH MOUNTING BRACKETS & CABLES	25	25	Concentrated Mass Element
ISS INTEGRATION HARDWARE TOTAL:	568	568	

Table 0.0-12: AMS-02 Total Weight Summary

TOTAL AMS-02 WEIGHT SUMMARY	CONTROL WEIGHT (LBS)	MODEL 6-02 WEIGHT (LBS)
AMS EXPERIMENT HARDWARE TOTAL:	525	525
SHUTTLE INTEGRATION HARDWARE TOTAL:	1571	1602
TOTAL EXPERIMENT & SHUTTLE INTEGRATION HARDWARE WEIGHT:	2096	2127
ISS INTEGRATION HARDWARE TOTAL:	36	36
TOTAL PAYLOAD WEIGHT:	14809	14997