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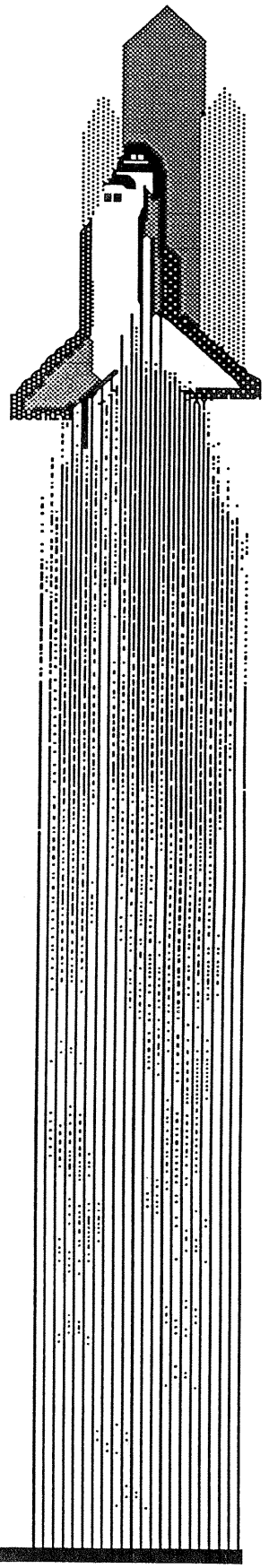

Space Shuttle

Photographic and Television Analysis Project

STS-45 Final Report

May 11, 1992

NASA
National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas 77058

JSC-25796

LESC-30200

Space Shuttle Photographic and Television Analysis Project

STS-45 Final Report

Project Work Order - J5-PT2

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1.0 OV-104 STS-45 Film/Video Screening and Timing Summary

1.1 Screening Activities

All films and videos screened by project analysts are summarized in Tables 1 and 2. Screening information has been tabulated and is presented in Appendix A.

1.1.1 Pre-Launch ET Hydrogen Tanking and Screening Analysis (Task #8)
(Cameras OTV-009, OTV-054, OTV-057, OTV-063 and OTV-064)

Mission Evaluation Room (MER) engineering views were screened real-time during fueling of the External Tank (ET) LO2 and LH2 compartments beginning approximately 8 hours prior to launch.

The usual vapors and water drops were noted during tanking. Ice was visible on top of the 17 inch line at the Orbiter/ET interface forty-three minutes after tanking began. The Mission Evaluation Room (MER) reported a high LO2 leak indication approximately one hour into the tanking procedure, but the readings came back down to normal limits. No anomalies were detected. See Appendix D Task #8 for details.

1.1.2 Launch

The STS-45 launch of Atlantis occurred on Pad A at 13 hours 13 minutes 40.000 seconds UTC on March 24, 1992 (day 84) as seen on camera E-012. SRB separation occurred at 13 hours 15 minutes 48.128 seconds UTC as seen on E-212.

On launch day, 23 videos (out of 23 expected) were screened. Following launch day, 60 of 61 expected launch films were reviewed.

There were two potential inflight anomalies on STS-45: the ET venting observed by the astronauts just after ET separation and the RCC damage to the Orbiter wing.

DTO-312 (photography of the external tank after separation) was performed on STS-45. Thirty-eight frames of the external tank were acquired by the astronauts using the handheld Hasselblad camera with a 250mm lens. These images showed the closest views of the ET after separation of any mission to date. However, only the first picture on the roll showed the aft LH2 umbilical venting reported by the crew. This venting observed by the astronauts was also acquired by the 16mm Arriflex handheld motion picture camera with a 100mm lens. The intertank venting reported by the crew was only acquired on frame 31 of the Hasselblad imagery.

1.1.3 Landing

OV-104 (Atlantis) landed on runway 33 at the Kennedy Space Center on April 2, 1992. Sixteen videos of the Orbiter's approach and landing were received along with NASA Select. All of the following times were obtained from camera KTV-33. Right main gear touchdown was at 11 hours 23 minutes 04.988 seconds UTC. Left main gear touchdown was at 11 hours 23 minutes 05.121 seconds UTC. Nose wheel touchdown occurred at 11 hours 23 minutes 13.596 seconds UTC. Wheel stop was at approximately 11 hours 23 minutes 24.020 seconds UTC. Seven landing films were received and screened (on April 8, 1992).

Video and Film List
STS-45
Launch Film & Video

Item Number	Expected	Received	Screened	Personnel
EX001	03/27/92	03/27/92	03/27/92	CD,MS,SI,CS,LK
EX004	03/29/92	03/30/92	03/31/92	JD,BG
E001	03/25/92	03/25/92	03/25/92	CD,MS,CS,SI,LK
E002	03/25/92	03/25/92	03/25/92	CD,MS,SI,CS,LK
E003	03/25/92	03/25/92	03/25/92	CD,MS,SI,CS,LK
E004	03/25/92	03/25/92	03/25/92	CD,MS,SI,CS,LK
E005	03/25/92	03/25/92	03/25/92	CD,MS,SI,CS,LK
E006	03/25/92	03/25/92	03/25/92	CD,MS,SI,CS,LK,WG,DM
E007	03/26/92	03/26/92	03/27/92	JD,RB,BG,LK
E008	03/26/92	03/26/92	03/27/92	JD,RB,BG,LK
E009	03/25/92	03/25/92	03/25/92	CD,MS,SI,CS,LK,WG,DM
E010	03/26/92	03/26/92	03/27/92	JD,RB,BG,LK
E011	03/26/92	03/26/92	03/27/92	JD,RB,BG,LK
E012	03/25/92	03/25/92	03/25/92	CD,MS,SI,CS,LK,WG,DM
E013	03/26/92	03/26/92	03/27/92	JD,RB,BG,LK
E014	03/26/92	03/26/92	03/27/92	JD,RB,BG,LK
E015	03/25/92	03/25/92	03/25/92	CD,MS,SI,CS,LK,RB
E016	03/25/92	03/25/92	03/25/92	CD,MS,SI,CS,LK
E017	03/25/92	03/25/92	03/25/92	CD,MS,SI,CS,LK
E018	03/25/92	03/25/92	03/25/92	CD,MS,SI,CS,LK
E019	03/25/92	03/25/92	03/25/92	CD,MS,SI,CS,LK
E020	03/25/92	03/25/92	03/26/92	JD,RB,BG,LK
E023	03/26/92	03/26/92	03/27/92	JD,RB,BG,LK
E024	03/26/92	03/26/92	03/27/92	JD,RB,BG,LK
E025	03/25/92	03/25/92	03/26/92	JD,RB,BG,LK
E026	03/25/92	03/25/92	03/26/92	JD,RB,BG,LK
E027	03/27/92	03/27/92	03/27/92	CS,MS,SI,CS,LK
E028	03/27/92	03/27/92	03/27/92	CD,MS,SI,CS,LK
E030	03/26/92	03/26/92	03/27/92	JD,RB,BG,LK
E031	03/27/92	03/26/92	03/27/92	JD,RB,BG,LK
E033	03/27/92	03/27/92	03/27/92	CD,MS,SI,CS,LK
E034	03/25/92	03/25/92	03/26/92	JD,RB,BG,LK
E035	03/25/92	03/25/92	03/26/92	JD,RB,BG,LK
E036	03/25/92	03/25/92	03/26/92	JD,RB,BG,LK
E040	03/25/92	03/25/92	03/26/92	JD,RB,BG,LK
E041	03/27/92	03/27/92	03/27/92	CD,MS,SI,CS,LK
E042	03/27/92	03/27/92	03/27/92	CD,MS,SI,CS,LK
E050	03/27/92	03/27/92	03/27/92	CD,MS,SI,CS,LK,DM
E052	03/27/92	03/27/92	03/27/92	CD,MS,SI,CS,LK
E054	03/26/92	03/26/92	03/26/92	MS,SI,CS,LK,JDV
E057	03/27/92	03/27/92	03/27/92	CD,MS,SI,CS,LK
E059	03/26/92	03/26/92	03/26/92	CD,MS,SI,CS,LK,JDV
E060	03/27/92	03/27/92	03/27/92	CD,MS,SI,CS,LK
E062	03/24/92	03/27/92	03/27/92	CD,MS,SI,CS,LK,GG
E063	03/27/92	03/27/92	03/27/92	CD,MS,SI,CS,LK,GG
E065	03/27/92	03/27/92	03/27/92	CD,MS,SI,CS,LK
E076	03/27/92	03/27/92	03/27/92	CD,MS,SI,CS,LK,GG

Table 1

Video and Film List
STS-45
Launch Film & Video

Item Number	Expected	Received	Screened	Personnel
E077	03/29/92	03/27/92	03/27/92	CD,MS,SI,CS,LK,GG,DM
E079	03/27/92	03/27/92	03/27/92	CD,MS,SI,CS,LK
E204	03/27/92	03/27/92	03/27/92	CD,MS,SI,CS,LK,DM
E205	03/27/92	03/27/92	03/27/92	CD,MS,SI,CS,LK
E207	03/26/92	03/26/92	03/26/92	CD,MS,SI,CS,LK,JDV
E208	03/26/92	03/26/92	03/26/92	CD,MS,SI,CS,LK
E211	03/27/92	03/27/92	03/27/92	CD,MS,SI,CS,LK,DM
E212	03/26/92	03/26/92	03/26/92	CD,MS,SI,CS,LK,BP
E213	03/26/92	03/26/92	03/26/92	CD,MS,SI,CS,LK
E218	03/27/92	03/27/92	03/27/92	CD,MS,SI,CS,LK,DM
E220	03/26/92	/ /	/ /	Not received
E222	03/26/92	03/26/92	03/26/92	CD,MS,SI,CS,LK
E223	03/26/92	03/26/92	03/27/92	JD,RB,BG,LK
E224	03/26/92	03/26/92	03/27/92	JD,RB,BG,LK
ET207	03/24/92	03/24/92	03/24/92	JD,MS,SI
ET208	03/24/92	03/24/92	03/24/92	JD,MS,SI
ET212	03/24/92	03/24/92	03/24/92	JD,MS,SI
ET213	03/24/92	03/24/92	03/24/92	JD,MS,SI
ET204	03/24/92	03/24/92	03/24/92	JD,MS,SI
KTV2	03/24/92	03/24/92	03/24/92	CD,RB,CS,BG,JW,FB
KTV5	03/24/92	03/24/92	03/24/92	CD,RB,CS,BG,JW
KTV11	03/24/92	03/24/92	03/24/92	RB,CS,BG
KTV13	03/24/92	03/24/92	03/24/92	CD,RB,CS,BG
KTV4A	03/24/92	03/24/92	03/24/92	CD,CS,RB,BG,FB,JW
KTV7A	03/24/92	03/24/92	03/24/92	CD,RB,CS,BG
KTV21A	03/24/92	03/24/92	03/24/92	CD,RB,CS,BG
OTV009	03/24/92	03/24/92	03/24/92	CD,RB,CS,BG,MS
OTV041	03/24/92	03/24/92	03/24/92	CD,RB,CS,BG
OTV048	03/24/92	03/24/92	03/24/92	CD,CS,RB,BG
OTV049	03/24/92	03/24/92	03/24/92	CD,CS,RB,BG
OTV051	03/24/92	03/24/92	03/24/92	CD,CS,RB,BG
OTV054	03/24/92	03/24/92	03/24/92	CD,CS,RB,BG
OTV060	03/24/92	03/24/92	03/24/92	CD,CS,RB,BG
OTV061	03/24/92	03/24/92	03/24/92	CD,CS,RB,BG,GG,JW,FB
OTV063	03/24/92	03/24/92	03/24/92	CD,RB,CS,BG,GG,JW,FB
OTV071	03/24/92	03/24/92	03/24/92	CD,RB,CS,BG,JW,FB
OTV070	03/24/92	03/24/92	03/24/92	CD,RB,CS,BG,FB,JW

Table 1 - Continued

Video and Film List
STS-45
Landing Film & Video

Item Number	Expected	Received	Screened	Personnel
EL002	04/02/92	04/07/92	04/08/92	MS,JD
EL004	04/02/92	04/07/92	04/08/92	MS,JD
EL008	04/02/92	04/07/92	04/08/92	MS,JD
EL011	04/02/92	04/07/92	04/08/92	MS,JD
EL005	04/02/92	04/07/92	04/08/92	JD,MS
EL003	04/02/92	04/07/92	04/08/92	JD,MS
EL009	04/02/92	04/07/92	04/08/92	JD,MS
EL030	04/02/92	04/07/92	04/08/92	JD,MS
EL031	04/02/92	04/07/92	04/08/92	JD,MS
M005	04/02/92	04/07/92	04/08/92	JD,MS
IR1	04/02/92	04/02/92	04/02/92	JH,MS,SI
IR2	04/02/92	04/02/92	04/02/92	JH,MS,SI
IR3	04/02/92	04/02/92	04/02/92	JH,MS,SI
IR4	04/02/92	04/02/92	04/02/92	JH,MS,SI
KTV1L	04/02/92	04/02/92	04/02/92	JH,CS,SI,MS
KTV5L	04/02/92	04/02/92	04/02/92	JH,CS,SI,MS
KTV6L	04/02/92	04/02/92	04/02/92	JH,CS,SI,MS
KTV11L	04/02/92	04/02/92	04/02/92	JH,CS,SI,MS
KTV12L	04/02/92	04/02/92	04/02/92	JH,CS,SI,MS
KTV13L	04/02/92	04/02/92	04/02/92	JH,SI,MS
KTV15L	04/02/92	04/02/92	04/02/92	JH,SI,MS
KTV16L	04/02/92	04/02/92	04/02/92	JH,MS,SI
KTV20L	04/02/92	04/02/92	04/02/92	JH,SI,MS
KTV33L	04/02/92	04/02/92	04/02/92	JH,SI,MS
SDIO1	04/02/92	04/02/92	04/02/92	JH,MS,SI
SDIO2	04/02/92	04/02/92	04/02/92	JH,MS,SI

Table 2

1.0 OV-104 STS-45 Film/Video Screening and Timing Summary

No major anomalies were noted in any of the approach, landing and rollout video views screened. However, damage to the RCC on the leading edge of the right wing and nose area was discovered during the post landing inspection.

1.2 Timing Activities

Film from cameras E-204, E-205, E-212 and E-222 were used to time events of interest for the STS-45 mission. Film timing was determined from encoded film edge timing marks except on the cameras which had in-frame Light Emitting Diode (LED) numbers available which were E-002, E-003, E-010, E-011, E-012, E-013, E-052, E-054, E-057, E-058, E-059, E-211, E-222, and E-224.

Appendix C contains a detailed listing of the 7 items of interest that were timed. Several of these events were timed to determine if the same event was being seen on more than one camera.

Also summarized in Appendix C are the operations of 4 film cameras relative to the timing encoded, total frames exposed, camera offsets, actual determined frame rates and problems encountered.

2.0 Summary of Significant Events Analysis

2.1 Debris

2.1.1 Debris near the Time of SSME Ignition

2.1.1.1 LH2 and LO2 Umbilical Disconnect Debris

(Cameras E-005, E-006, E-019, E-020, E-025, E-026, E-031, E-040, E-052, E-076, OTV-009, OTV-054, OTV-063)

Normal ice debris was noted falling from both the LH2 and LO2 umbilical disconnect areas at SSME ignition through liftoff. There was less ice falling from the umbilical areas than has been seen on previous missions. None of the debris appeared to strike the vehicle.

2.1.1.2 Rope-like Debris from Right RCS R4D

(Cameras E-002, E-003, E-015, E-017)

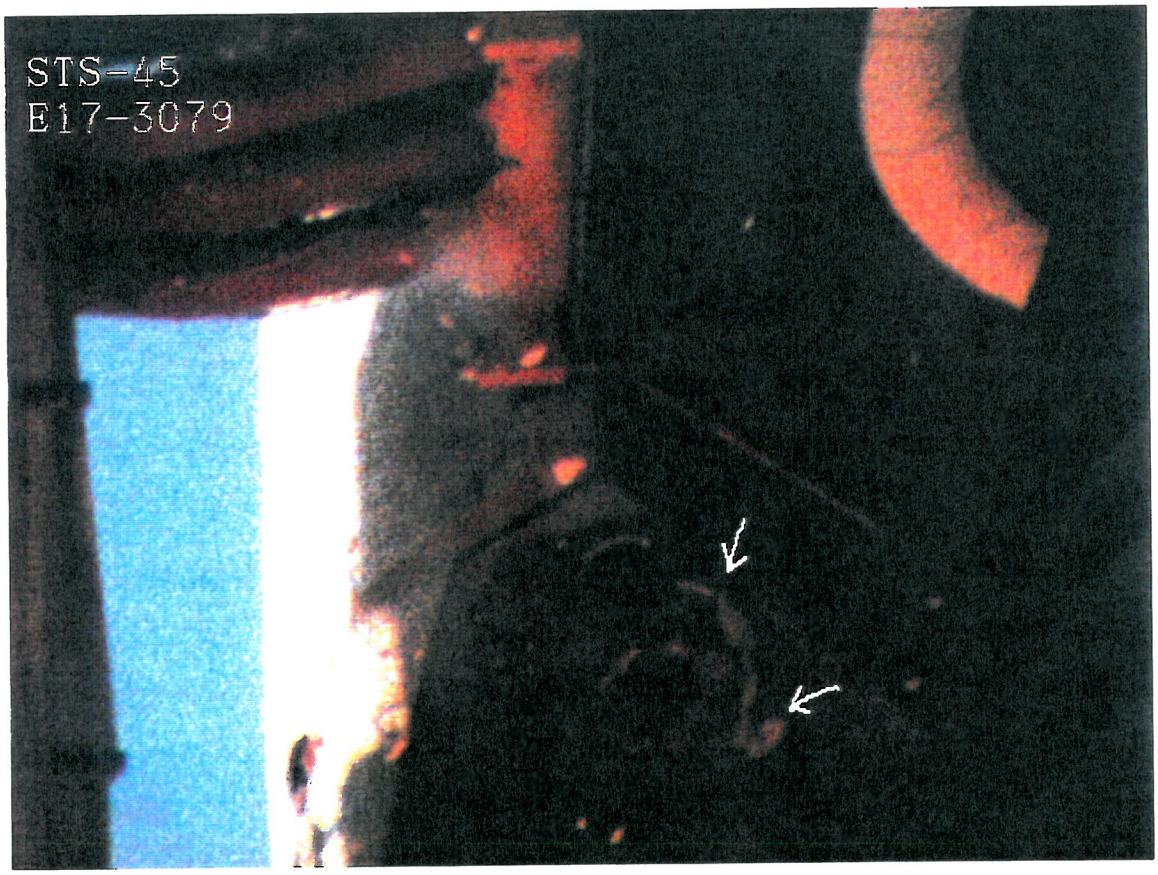


Figure 2.1.1.2 Rope-like Debris Seen near Port RCS at Liftoff

A single, thin rope-like piece of dark debris originated from behind the right RCS (port) stinger and fell aft at liftoff. The debris was identified by KSC to be a bead of RTV adhesive used to bond the RCS paper cover to the thruster at R4D. KSC reported that this event has been seen before. No follow-up analysis has been requested.

2.1.2 Debris near the Time of SRB Ignition

2.1.2.1 SRB Flame Duct Debris (Task #7)
(Cameras EX-001, E-001, E-007, E-008, E-010, E-011, E-013, E-015, E-025, E-027 and E-028, OTV-054)

As on previous missions, several pieces of debris were noted originating from the SRB flame ducts near the holddown posts during and after SRB ignition.

On camera E-014, a long rope-like piece of debris was seen near the LSRB HDP M-8 at liftoff. This appeared to be excess rope used to tie down the water baffles at the flame duct.

On camera E-026, a flat piece of dark debris first seen north of the SRBs, traveled south past the LSRB and under the left wing during liftoff. See Figure 2.1.2.1.

On camera E-025, multiple small pieces of white debris (possibly from flame duct) traveled from the aft end of the ET/SRB area toward the LO2 TSM at liftoff.

Several small, light-colored pieces of debris fell aft along the right side of the ET at liftoff as seen on camera OTV-054.

Velocity measurements were made on two fast-moving pieces of debris that traveled from the LSRB flame duct toward the RSRB. The trajectory of these pieces were digitized on a Film Motion Analyzer. One of these particles was seen to exit the flame duct area just after SRB ignition and the other was observed as the SRB cleared the MLP. The maximum velocity of these particles was calculated to be 89 feet per second.

None of the observed debris appeared to strike the orbiter.

Plots of velocity versus time are located in Appendix D Task #7.

Several films were reviewed to determine if individual pieces of debris could be seen by more than one camera. If this were true, a phototheodolite solution of the trajectory of the debris could then be calculated. However, none of the observed flame duct debris satisfied the restrictions of the phototheodolite solution. No follow-up action has been requested.

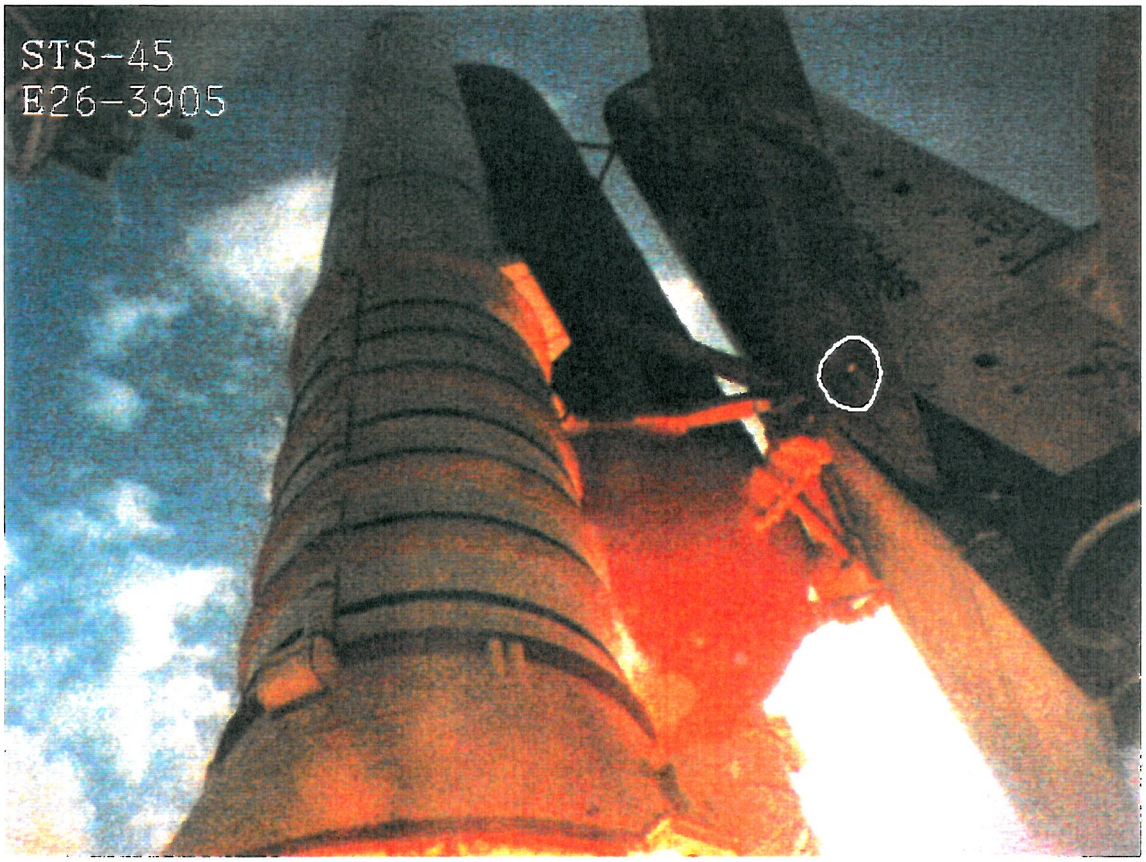


Figure 2.1.2.1 Debris Seen at Base of SRBs During Liftoff

On camera E-026, a shiny, flat piece of debris appeared at the base of the SRBs and moved south under the left inboard elevon during liftoff. The debris did not appear to strike the vehicle. No follow-up action has been requested.

2.1.2.2 Debris from SRB HDPs M-5, M-7, M-8
(Cameras E-007, E-011, E-014, E-016, E-028 and EX-004)

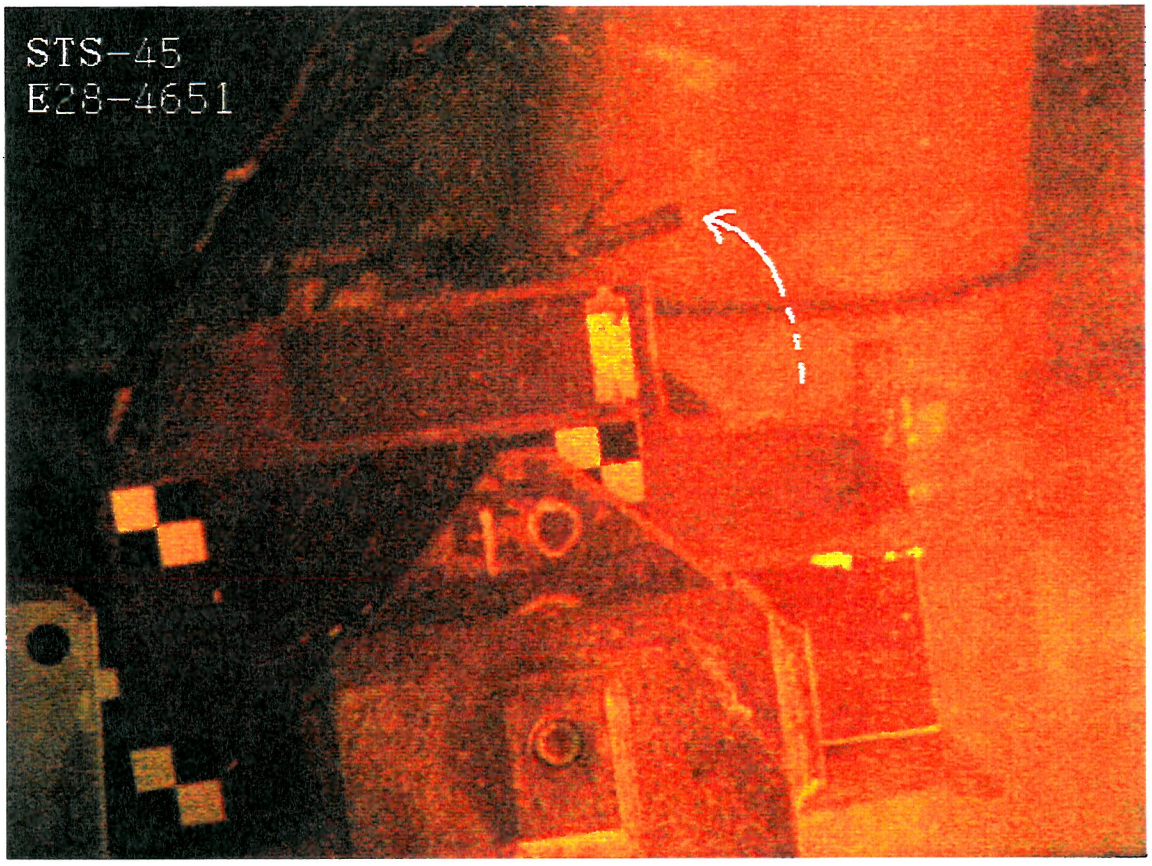


Figure 2.1.2.2 Dark Debris from LSRB Stud Hole at HDP M-7

A single piece of dark debris originated from the LSRB stud hole at HDP M-7 and fell aft after liftoff. See Figure 2.1.2.2. The debris was estimated to be 3 x 0.5 inches in size. This event was seen on cameras E-016, E-011 and E-028.

On camera EX-004, several small pieces of dark debris appeared to originate from the LSRB HDP M-5 area after PIC firing as the foot lifted off the holddown post shoe.

None of the above debris appeared to strike the vehicle. No follow up analysis of the debris seen near the holddown posts has been requested.

2.1.2.3 Epon Shim Material from RSRB Aft Skirt Foot at HDP M-4 during Liftoff

(Cameras E-007, E-011, E-014, E-016, E-028 and EX-004)

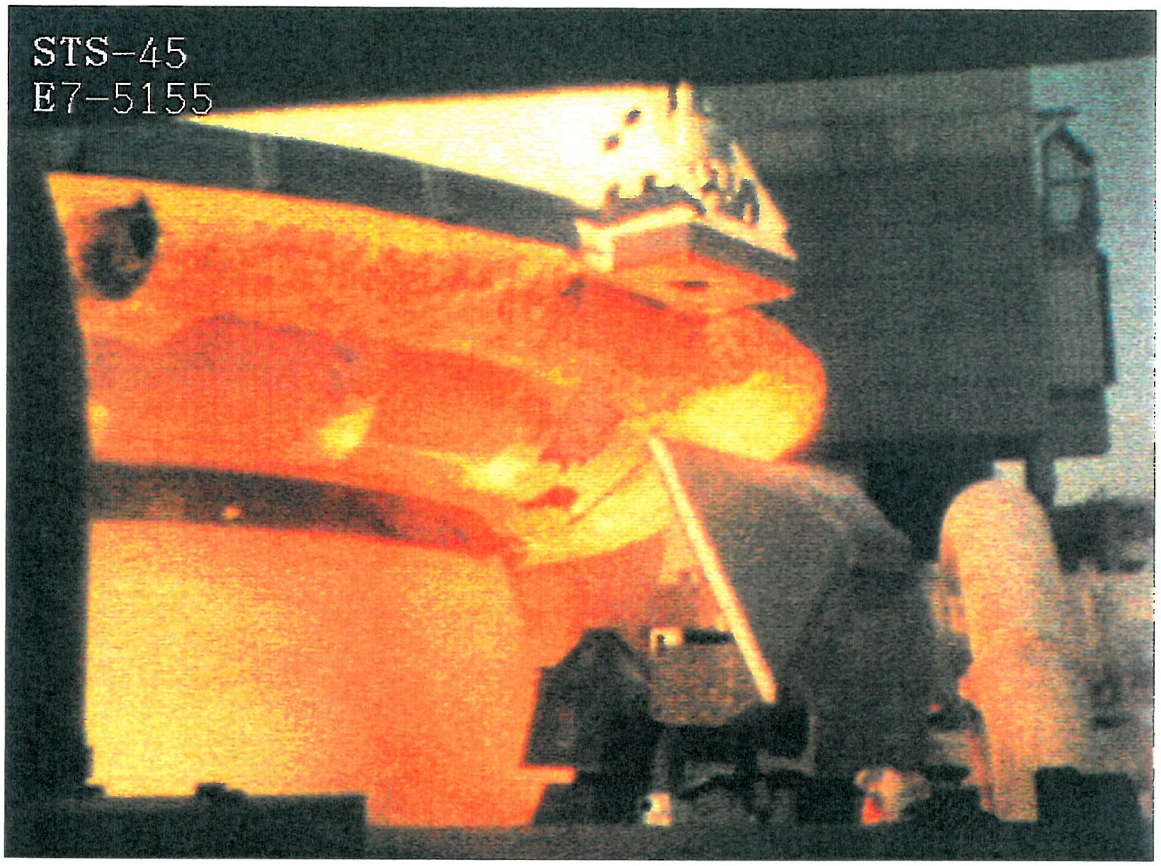


Figure 2.1.2.3 Epon Shim Material from RSRB Aft Skirt Foot at Liftoff

On camera E-007, epon shim material detached from the RSRB aft skirt foot at HDP M-4 and fell into the flame duct at liftoff. See Figure 2.1.2.3. Loose shim material was previously seen on STS-38 at the same holddown post. No follow up analysis of this event has been requested.

2.1.3 Debris after Liftoff

Multiple pieces of debris were seen falling aft of the SLV from liftoff through ascent on the launch tracking views. Most of the debris sightings were probably RCS paper or ice from the ET/Orbiter umbilicals. The debris did not appear to strike the vehicle. No follow-up analysis has been requested.

2.1.3.1 SLV Debris at Tower Clear through Roll Maneuver *(Cameras E-040, KTV-4A)*

Several pieces of white debris were seen in the exhaust plume just after tower clear on camera E-040. On camera KTV-4A, a light-colored piece of debris, first seen near the base of the vertical stabilizer, fell aft of the vehicle just after roll maneuver. The debris did not appear to strike the vehicle. No follow-up analysis has been requested.

2.1.3.2 Orange Debris from near LO2 Umbilical at 23.7 seconds MET *(Cameras E-212, E-213, E-222)*

On cameras E-212, E-213 and E-222, a single piece of orange debris appeared to originate from the LO2 umbilical area. The debris became entrained in the recirculation flow and fell aft at 23.674 seconds.

2.1.3.3 White Debris near SSME #1 at 31.3 seconds MET
(Camera E-212, E-213, E-222, ET-212 and OTV-054)

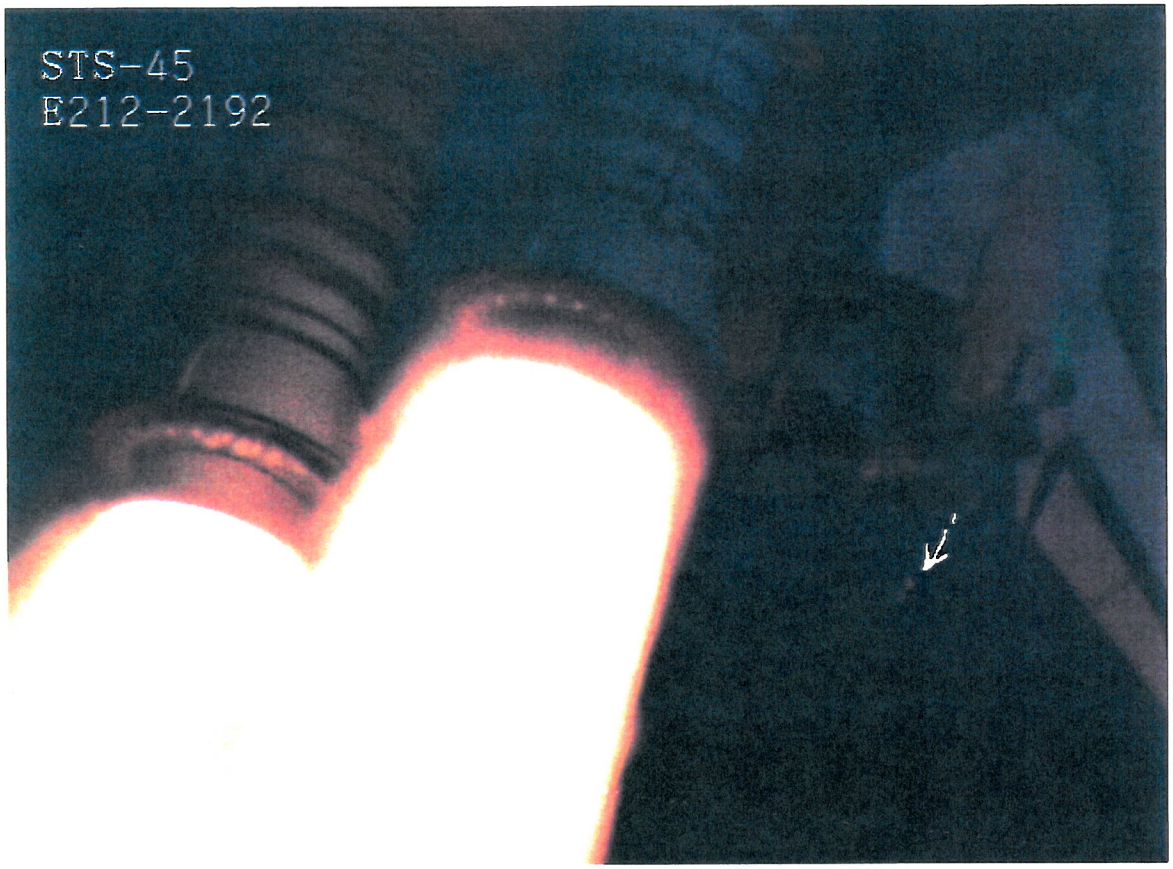


Figure 2.1.3.3 White Debris behind SSME #1 Fell Aft and Split into Two Pieces at 31.277 seconds MET

A single large piece of white debris, first noted behind SSME #1, fell aft and appeared to split into two pieces at approximately 31.277 seconds MET. See Figure 2.1.3.3. KSC believed that this debris was part of the closeout blanket patch material found near the pad after launch.

2.1.3.4 Orange Debris Aft of LSRB at 71 seconds MET
(Camera E-212)

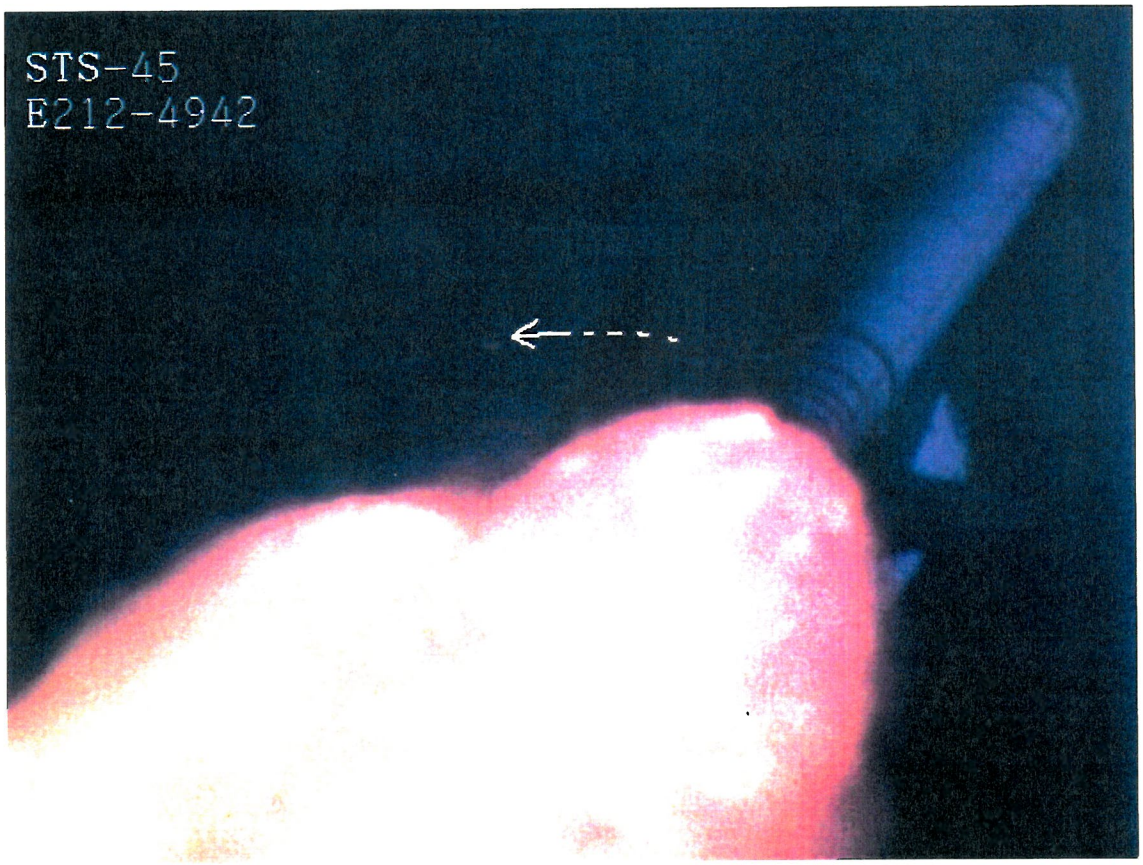


Figure 2.1.3.4 Orange Debris from Tail End of LSRB Fell Aft at 71 seconds MET

A single piece of orange debris originated near the tail end of the LSRB and fell aft at approximately 71 seconds MET.

None of the above-mentioned debris appeared to strike the vehicle. Debris falling aft of the SLV after liftoff has been seen on films and videos from previous missions. Most of this type of debris has been attributed to ice or RCS paper. No further analysis has been requested.

2.2 MLP Events

2.2.1 Uncovered RCS Nozzles
(Camera E-017)

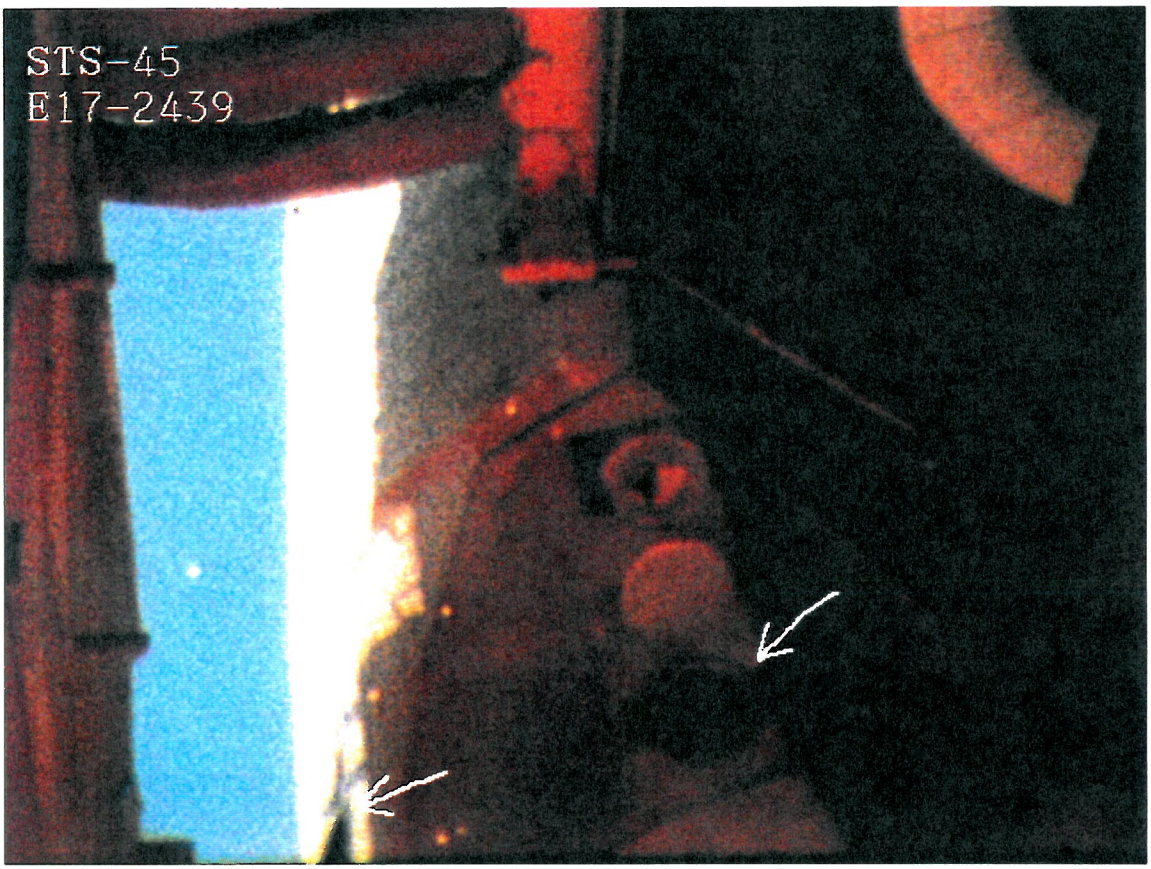


Figure 2.2.1 RCS Ports R3D and R3R were Uncovered Prior to SSME Startup

RCS ports R3D and R3R were not covered with butcher paper prior to the time of launch. KSC reported that the butcher paper fell off after the March 22 tanking attempt. A waiver from having to replace the paper was issued to KSC. No follow-up analysis has been requested.

2.2.2 Water Leak in MLP J-Pipes
(Camera E-010, E-011 and E-016)

A continuous water leak was noted from different sections of the MLP J-pipes both prior to and after SSME ignition. A similar event was last seen on STS-37. No follow-up analysis has been requested.

2.2.3 Vapor at LH2 Umbilical Prior to SSME Ignition
(Camera OTV-009)

On OTV-009, a slight vapor was noted at the top of the LH2 umbilical prior to ignition. A review of videos from earlier missions revealed that this event has occurred before. In fact, there appeared to be less vapor seen at the umbilicals on STS-45 than on some earlier missions. No follow-up analysis has been requested.

2.2.4 Base Heat Shield Erosion
(Cameras E-019 and E-020)

On camera E-020, TPS erosion was seen at the base of the left OMS nozzle at SSME ignition. On camera E-019, slight base heat shield erosion was noted between SSMEs #1 and #3 at liftoff. Base heat shield erosion has been seen on films from most of the previous missions since reflight. No follow-up analysis has been requested.

2.2.5 RSRB HDP M-4 Bolt Hang-up
(Camera E-007)

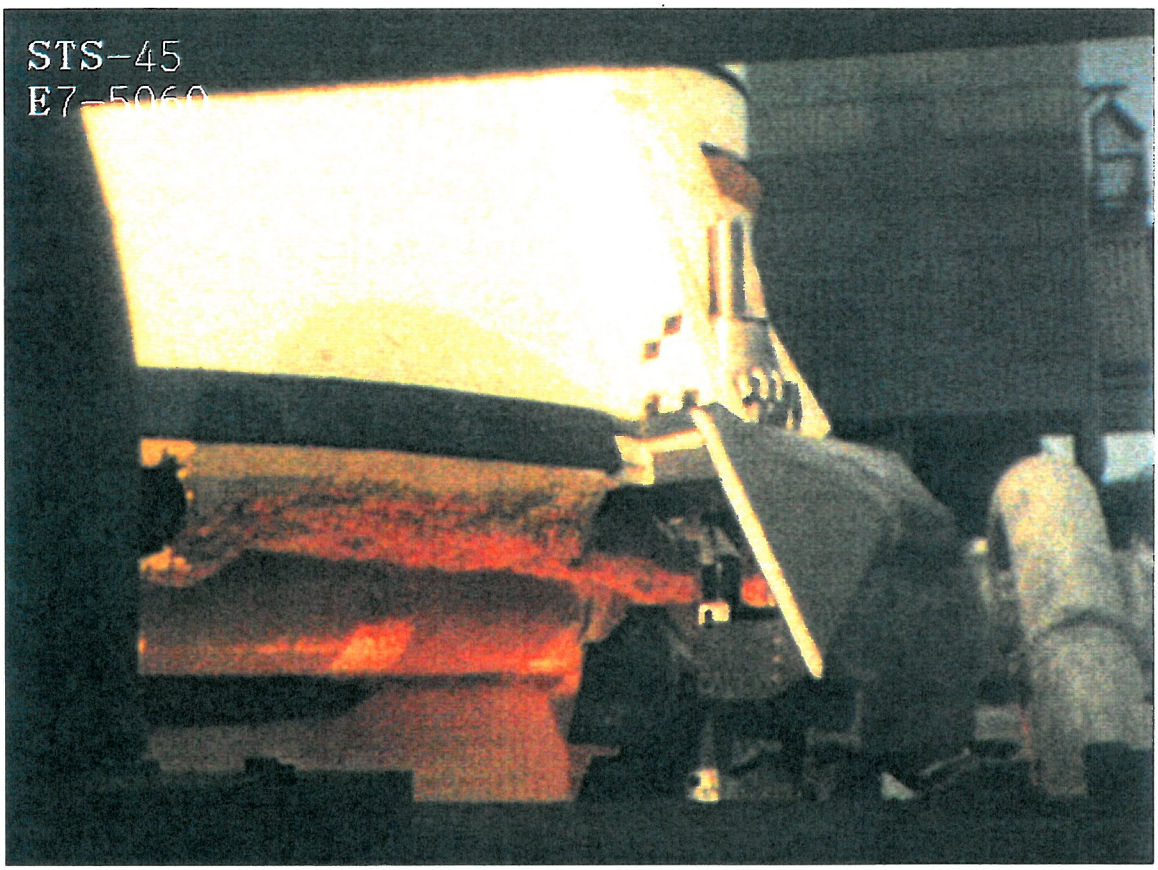


Figure 2.2.5 Bolt Hang-up at RSRB HDP M-4 During Liftoff

A bolt hang-up was noted at the RSRB HDP M-4. The bolt appeared to bend during liftoff until the aft skirt foot released it, causing the bolt to spring back to a vertical position. See Figure 2.2.5. A review of previous occurrences of bolt hang-ups since reflight was conducted. Note that earlier hang-ups have all been at different holddown posts.

MISSION	LOCATION OF HANG-UP
STS-34	RSRB holddown post M-2
STS-33	RSRB holddown post M-3
STS-39	RSRB holddown post M-1 (slight)
STS-43	LSRB holddown post M-7
STS-45	RSRB holddown post M-4

2.2.6 LSRB Firing Cable Remained Attached at Liftoff
(Cameras E-013)

An HDP M-6 firing (PIC) cable remained attached to the LSRB during liftoff. This event was seen with a RSRB firing cable on STS-37 and two LSRB firing cables on STS-39. No follow-up analysis has been requested.

2.3 Ascent Events

2.3.1 White Flashes in SSME Plume after Roll Maneuver
(Cameras E-052, E-054, E-057, E-213 and E-222)

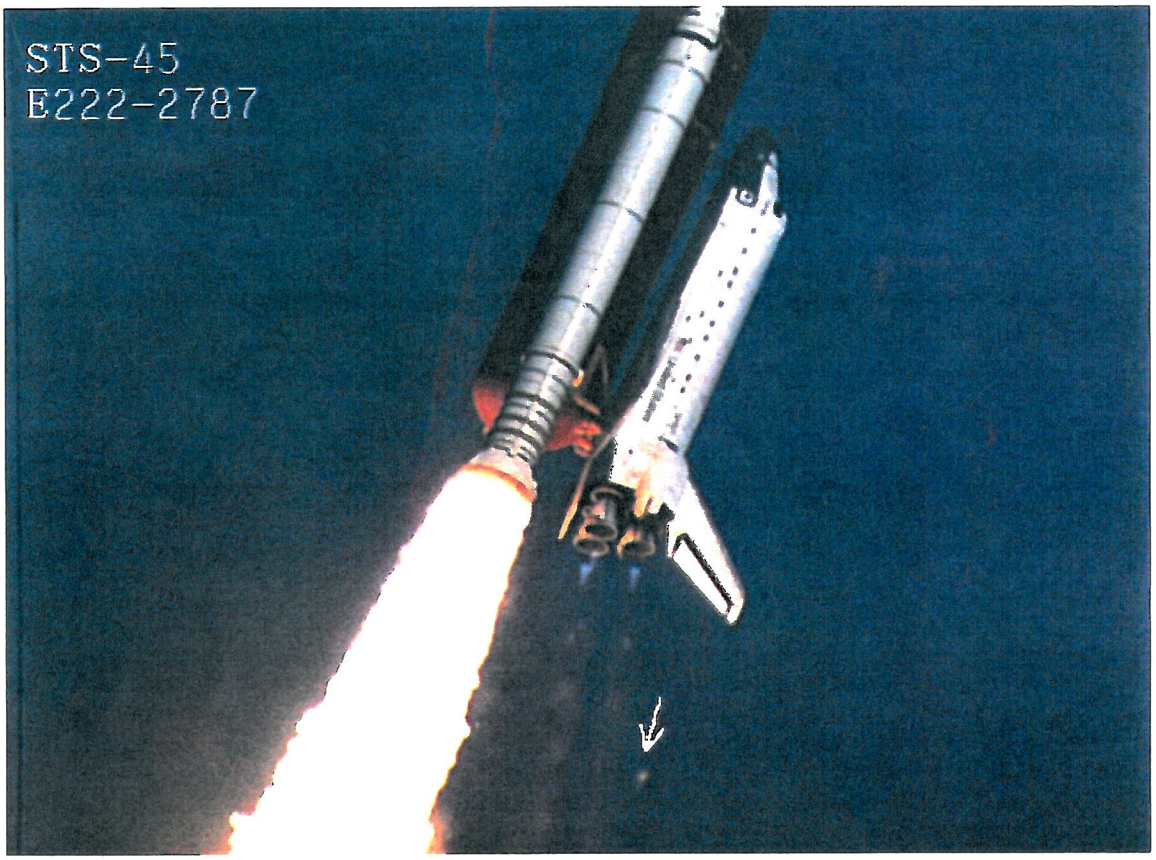


Figure 2.3.1 Flash in SSME Exhaust Plume just after Roll Maneuver

Several white flashes were visible in the SSME plume just after roll maneuver. These flashes were seen from approximately 15 seconds MET through about 27 seconds MET. This event has been noted on previous missions during this time frame. No follow up analysis has been requested.

2.3.2 Flares in SSME Plume
(Camera E-222)

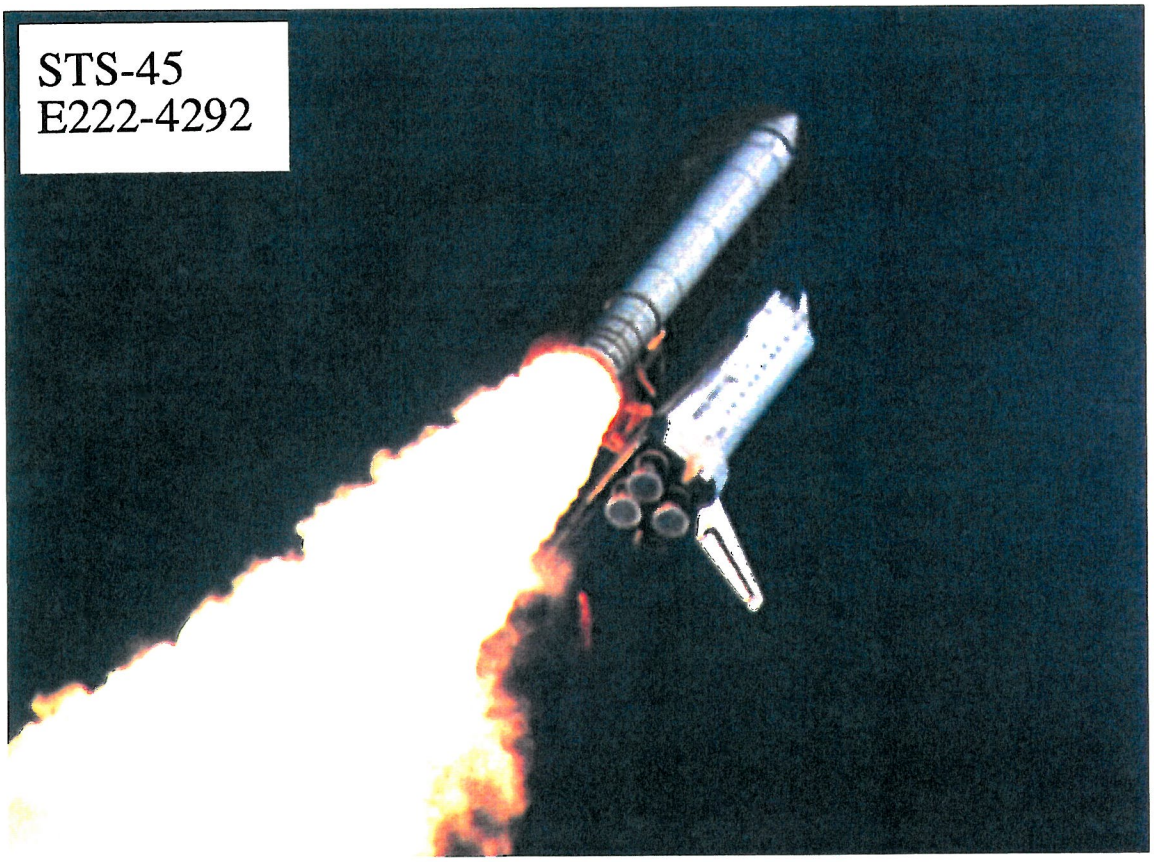


Figure 2.3.2 Flare in SSME Exhaust Plume at 38.334 seconds MET

Two flares were noted in the SSME exhaust plume at 20.006 and 38.334 seconds MET on camera E-222. See Figure 2.3.3. Flares in the SSME exhaust plume have been seen on previous missions. No follow up analysis has been requested.

2.3.3 Body Flap Motion during Ascent (Task #4)
(Camera E-207)

Slight body flap motion was seen on E-207. When only slight motion is seen, attempted measurement of the displacement would be too inaccurate to generate useful results. In addition, the 180" lens used on the camera (E-207) showing the best view of the event was not of a high enough resolution to accurately quantify the motion.

Apparent body flap motion has been seen on most of the missions since reflight. This event will continue to be tracked on future missions.

2.3.4 Recirculation (Task #1)
(Camera E-205)

The recirculation or expansion of burning gases at the aft end of the SLV prior to SRB separation has been seen on nearly all of the previous missions. This event was conspicuously absent on most of the tracker camera films from STS-45 (due mostly to mission inclination). Only one camera showed even a slight amount of recirculation on this mission. Recirculation was first observed at 92 seconds MET and the end was noted at 111 seconds MET on Camera E-205. The time frame for this observed event is similar to those from previous missions.

See Appendix D Task #1 for a summary of recirculation start and stop times for all missions since reflight.

2.3.5 Linear Optical Effect
(Cameras ET-207, E-205 and E-207)

On camera ET-207, a small white spot was seen to move quickly away from the SSME area at approximately 106 seconds MET.

On camera E-207, multiple linear optical distortions were noted.

The linear optical effect has been seen on previous missions and is thought to be associated with the atmospheric refraction generated by SLV shock waves.

2.3.6 Orange Pulses in SRB Plume Before SRB Separation (Task #9)

(Cameras KTV-4A, KTV-5, KTV-13, ET-204, ET-207, ET-208, ET-212, E-204, E-205, E-207, E-208, E-212, E-218 and E-223)

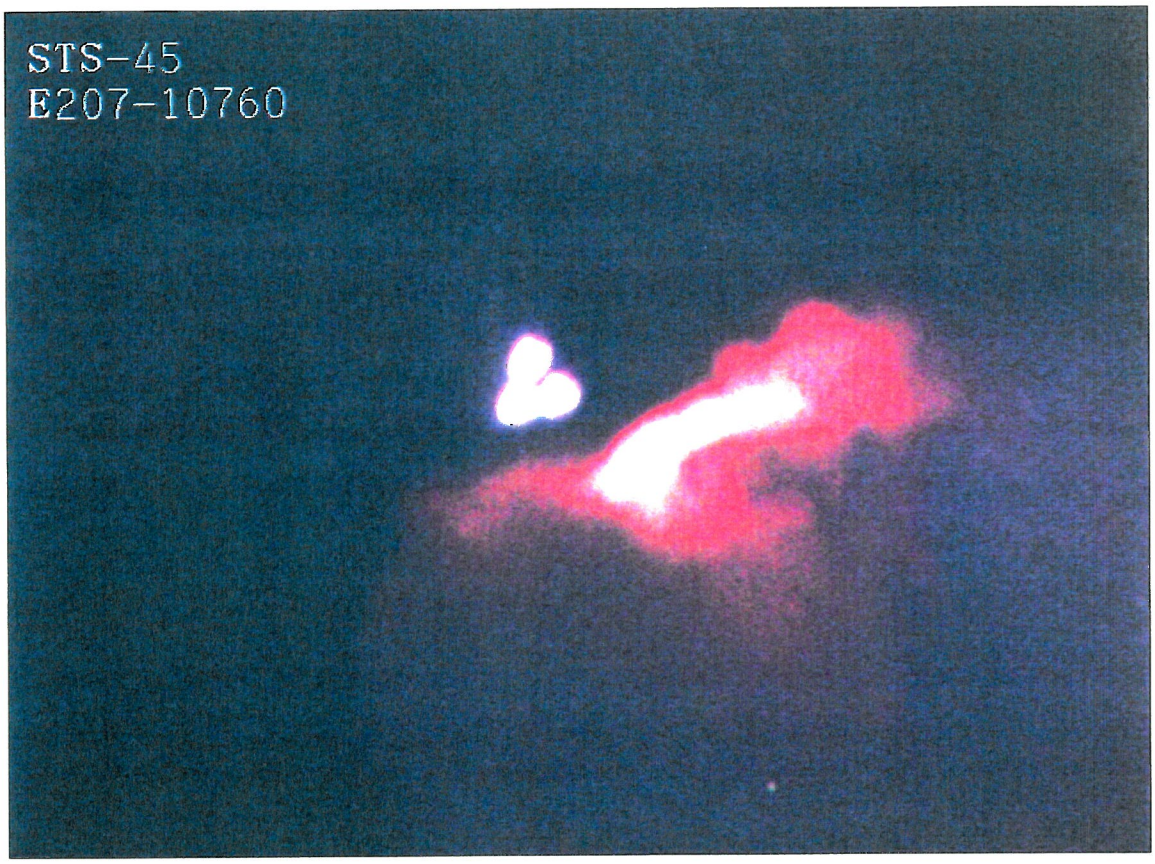


Figure 2.3.6 Orange Pulse in LSRB Exhaust Plume Prior to Normal Plume Brightening

An orange pulse was noted in the LSRB plume between 117.62 and 118.02 seconds MET on several tracker cameras. See Figure 2.3.8. On cameras E-204, E-205, E-207, E-218 and E-223, three separate orange pulses were noted in the SRB exhaust prior to normal plume brightening.

A similar event was seen on STS-42. Frames preceding normal plume brightening on STS-45 were digitized and analyzed and then compared to those from STS-42. The objective was to characterize similarities between the two events. The analysis focused on the relative mean intensity and area of the SRB plume with respect to time. Results indicated that while minor pulses occurred on STS-42, they were of much lower intensities than STS-45.

2.4 On Orbit

2.4.1 Onboard Hasselblad ET Analysis - DT0-312 (Task #6); *(Photographs 45-71-01 thru 45-71-38)*

Thirty-eight 70mm Hasselblad photographs of the ET were taken on STS-45. The exposure and focus for nearly all of the photographs were excellent. The data back was turned on and timing information was available. These images show the closest views of the ET after separation of any mission to date.

All measurements were taken with an analog Nikon Shadowgraph and an Optronics Coscan. Both the LSRB and RSRB BSM burn scars on the O-give of the ET were visible. Nine divots in the LH2 intertank interface were noted. The largest of these measured 27.8 inches. The combination of high resolution imagery, good lighting conditions, excellent focus and valid timing data allowed a quantitative determination of the movement of the ET relative to the Orbiter. The rotation and translation rates, along with the separation velocity, are discussed in section 2.4.2 of the report.

2.4.2 ET Venting Analysis (Task #10)

The crew of STS-45 reported the appearance of venting from the ET aft umbilical and intertank areas during the time period following ET separation. Both the 70mm Hasselblad and the 16mm Arriflex motion picture camera were used to record images of the ET. Analysis of the handheld 70mm Hasselblad still camera and the 16mm Arriflex motion picture camera indicated the presence of vapor at the aft umbilical area. One Hasselblad frame (no. 45-71-031) appeared to show some intertank venting.

A review of the two earlier missions on which the ET contained similar amounts of excess propellant was conducted. No handheld photography or umbilical well films were taken on STS-8. Only the 35mm umbilical well film was available on STS-61C. Over the time period where the ET was in the field of view, there was no evidence of either the intertank or aft umbilical venting on STS-61C.

Analysis to correlate crew observed events to the actual photographs and film was implemented. An estimated timeline monitoring the sequence of events was generated and was included as Figure 2.4.2 (A).

All thirty-eight frames from the 70mm Hasselblad camera have been enlarged and printed. Twenty frames from the 16mm Arriflex were also enlarged and printed. In addition, selected images from both cameras have been digitized and processed on the VDAS System to enhance the observed venting. The Arriflex film sequence which showed the ET at full zoom was also converted from film to video. These images were registered, thresholded and pseudocolored to emphasize the venting seen at the aft umbilical area. No intertank venting was observed in this enhanced video.

The 70mm Hasselblads were taken over a period of 9 minutes, 24 seconds starting at approximately three and a half minutes after ET separation. Standard calculations of distance from the ET to the Orbiter and their relative velocity were performed. Knowing the focal length of the camera (250mm), the actual diameter of the ET (333 inches) and the ratio of the film frame size to the actual field of view, the Orbiter/ET distance was calculated over several frames. At frame 1, this distance was 554 meters (See Figure 2.4.2 (B); at frame 38, the distance was calculated as 3272 meters. An average Orbiter/ET distance was also computed for the time frame when the 16mm Arriflex motion picture film showed the

STS-45 ET VENTING STUDY

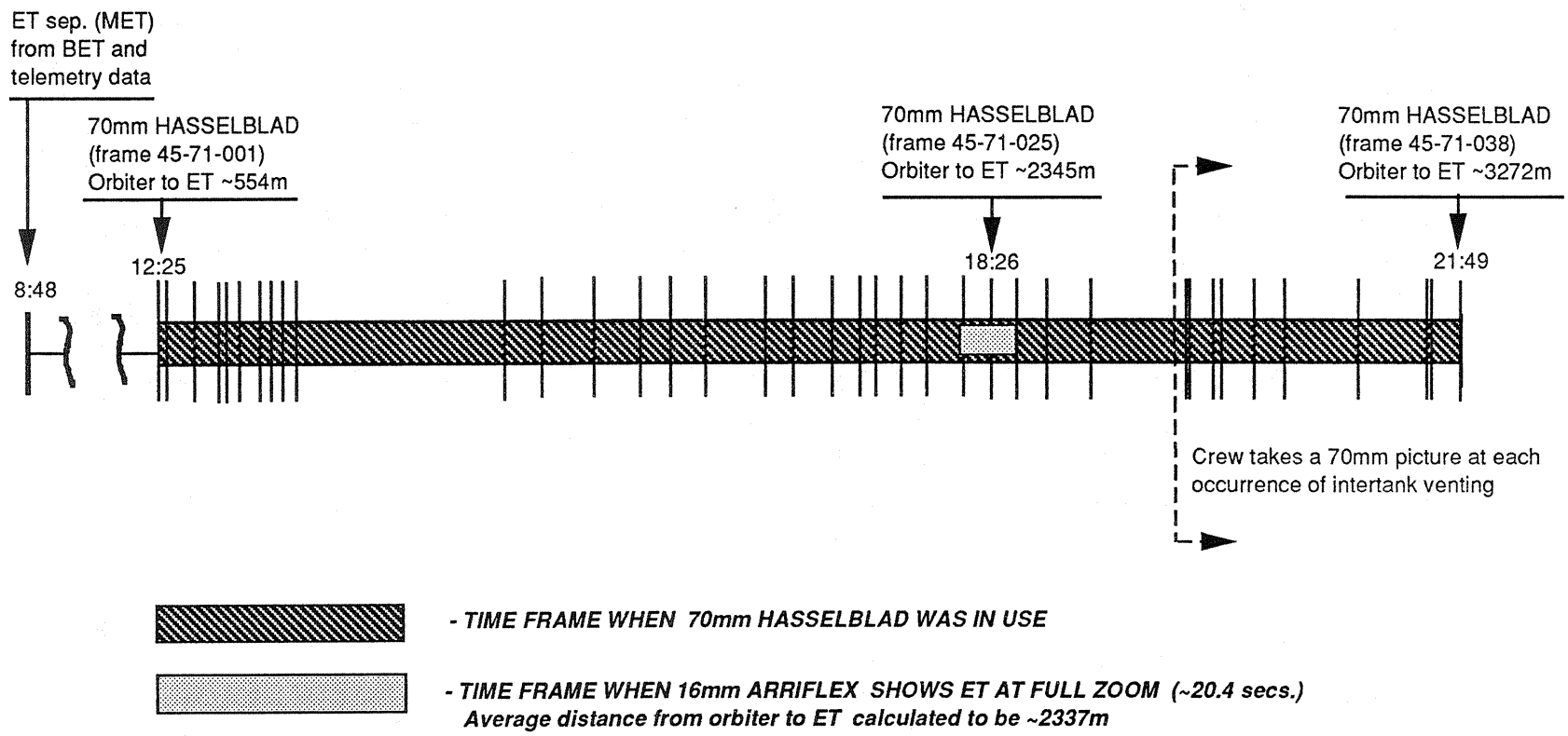


Figure 2.4.2 (A) ET Venting Study Timeline

ET at full zoom (a period of approximately 20 seconds). This average measure of the distance was calculated to be 2337 meters. This implies an overlap of as many as three Hasselblad frames (nos. 24, 25 and 26).

The aft umbilical venting angle was measured on five different digitized frames of the 16mm Arriflex motion picture film and was found to be varying between 51° and 86°. See Figure 2.4.2 (C). While the intertank venting was only captured on one frame of the Hasselblad film, this venting angle appears to agree with crew estimates of 90° to 150°. See Figure 2.4.2 (D). The actual measured angle on frame no. 45-71-031 was appxoximately 100°.

The tumble rate of the ET was calculated to be about 0.2°/second over the first seven minutes of photographic coverage and 2.7°/second over the final two minutes. This increase in the tumble rate appears to correspond with the crew's first observations of the intertank venting.

The rotation rate was calculated to be about 0.7°/second over the first minute of coverage. A maximum rotation rate of 3.0°/second occurred between the eight and nine minute mark of photographic coverage. This again appears to imply that the intertank venting reported by the crew did indeed affect the motion of the ET. See Figure 2.4.2 (E)

A CAD overlay of the ET was placed on the first frame of the 70mm Hasselblad sequence in order to locate the source of the aft umbilical venting. The best estimate of the projected origin was determined to be the LH2 umbilical area. Given limitations in the field of view of the photograph and the CAD system, the vent source could not be traced to a specific line.

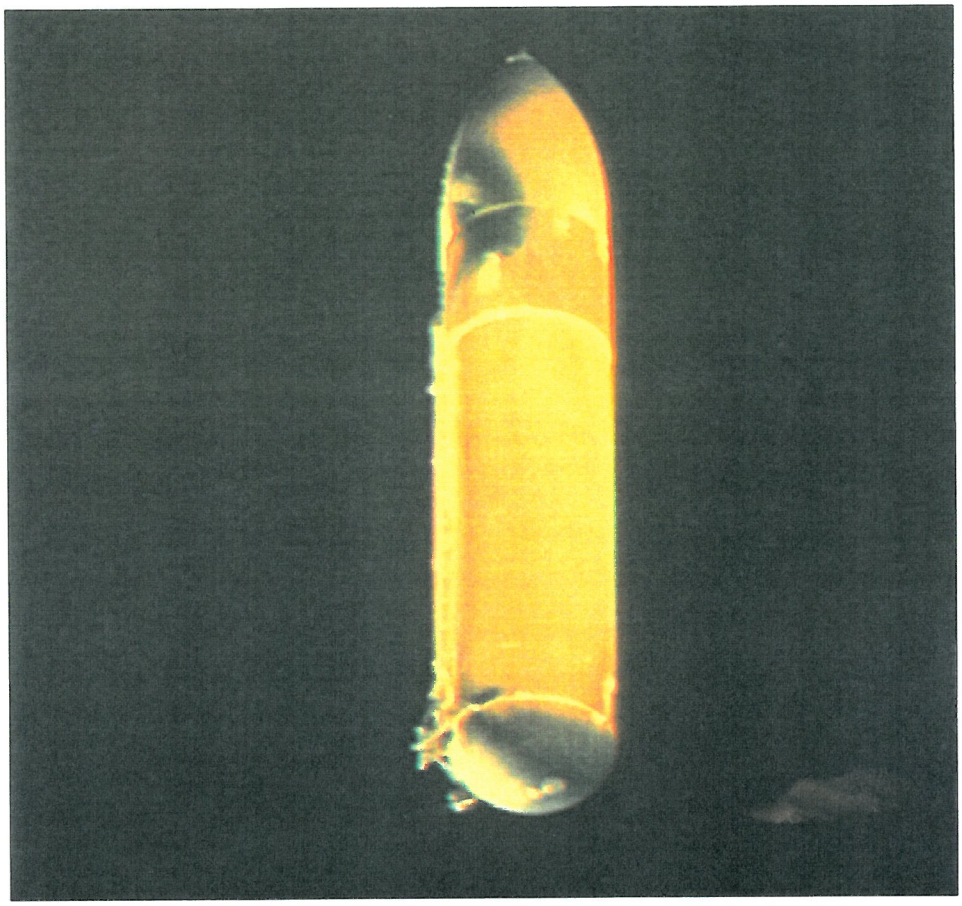


Figure 2.4.2 (B) **Earliest View of External Tank at 12 minutes, 25 seconds MET**
(70mm Hasselblad Frame No. 45-71-001)

The first Hasselblad image of the External Tank was taken from a calculated distance of approximately 554 meters. This is the earliest that the ET has been photographed and was the only Hasselblad image on which the aft umbilical venting could be seen, probably due to a combination of factors: Orbiter to ET distance; camera shutter speed; and exposure time. (Film type was Kodak color positive 5017.) Note that this view also clearly shows the burn scars on the O-give and four divots along the LH2 intertank interface. Reference the timeline in Figure 2.4.1 (A) for the observed sequence of events.

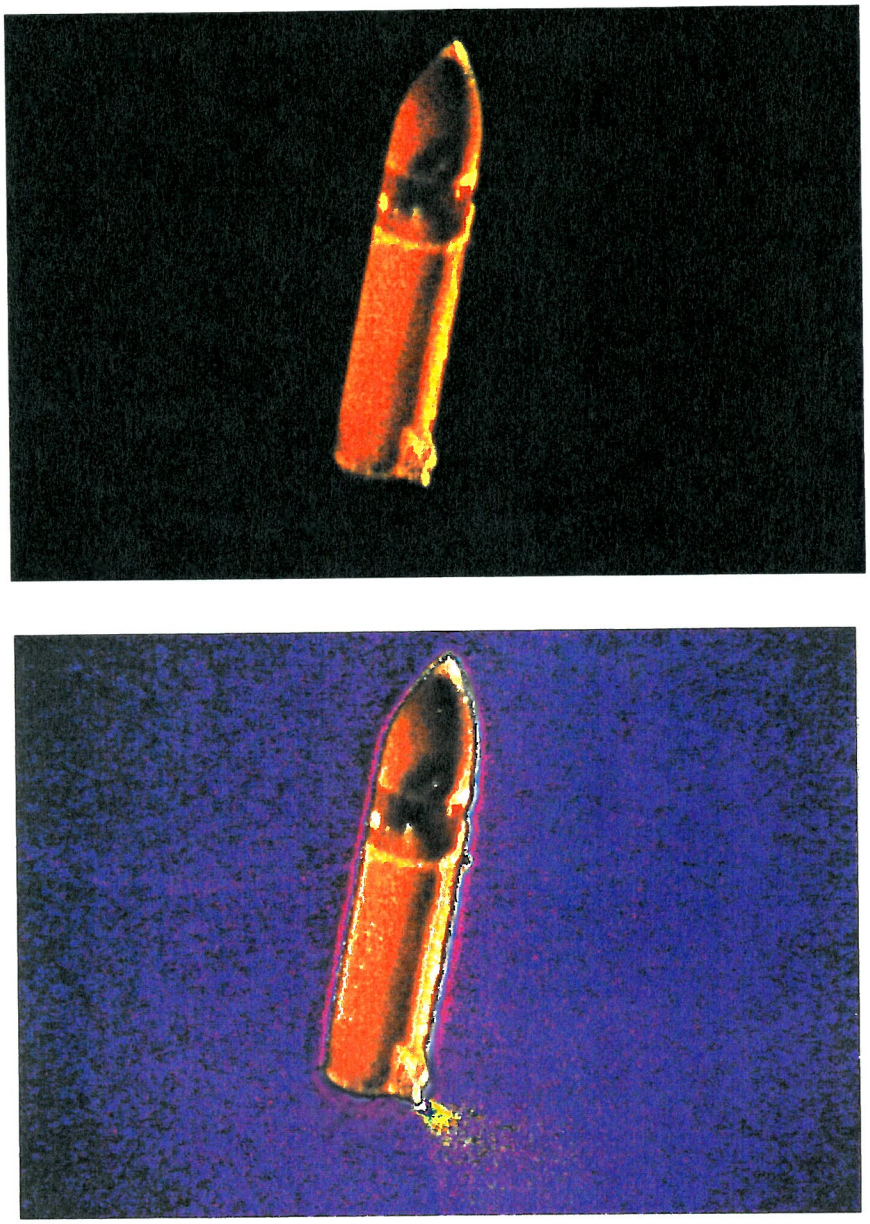


Figure 2.4.2 (C) **Venting Observed from Aft Umbilical Areas at Approximately 18 minutes, 30 seconds MET** *(16mm Arriflex Frame F510 - 1323)*

These images of the same frame show venting from the aft umbilical area as seen by the 16mm Arriflex motion picture camera. The top image shows the original frame, while the lower one emphasizes the venting with pseudo-color. While the External Tank was within the field of view at full zoom (a period of approximately 20 seconds), the aft umbilical venting appeared as three distinct pulses. An enhanced film-to-video conversion of this sequence of images showed the actual venting to be continuous. No intertank venting was observed on this film.

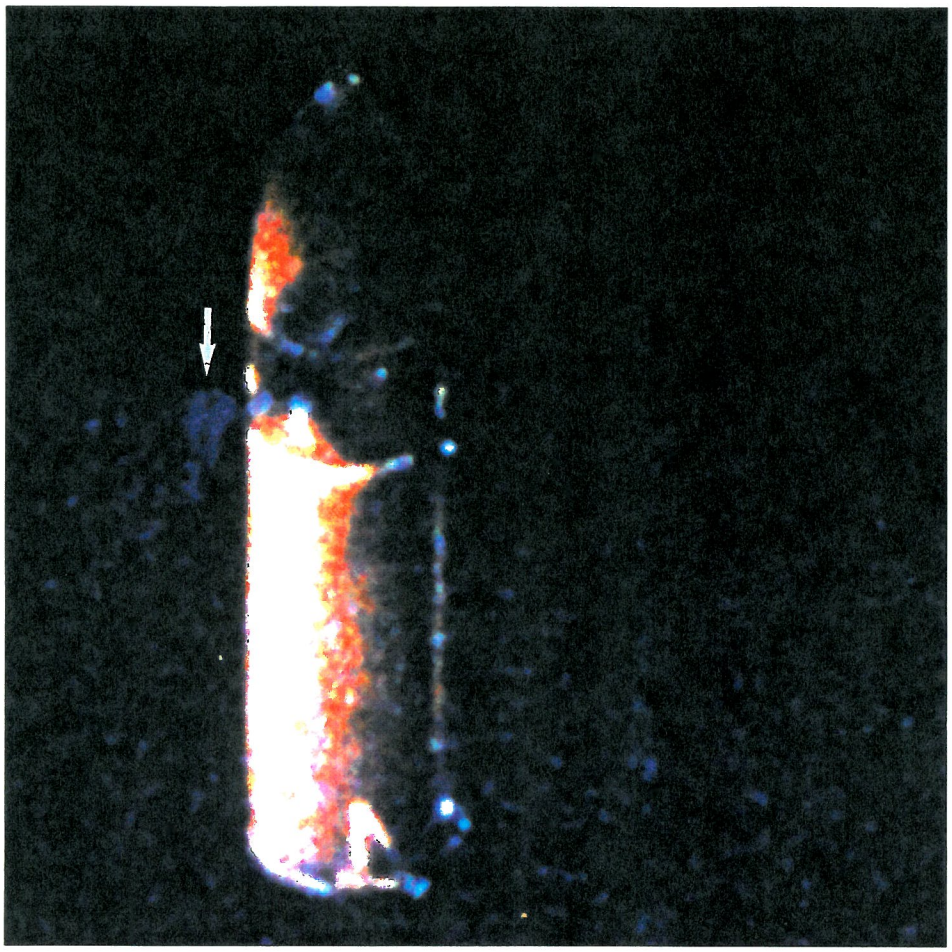
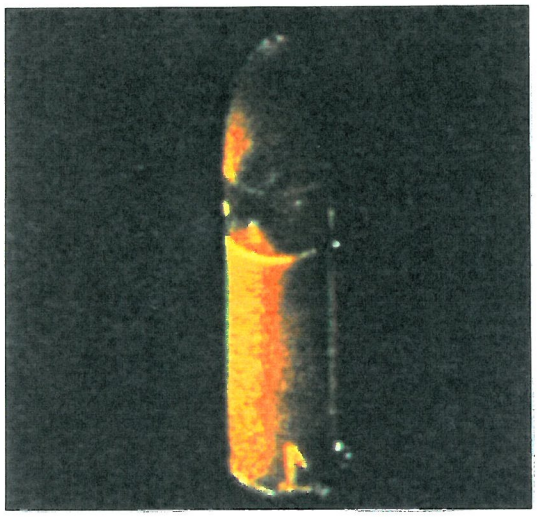


Figure 2.4.2 (D) **Intertank Venting seen at 20 minutes, 2 seconds MET**
(70mm Hasselblad Frame No. 45-71-031)

Processing enhancements to the 70mm Hasselblad imagery revealed one frame where the intertank venting reported by the astronauts was visible. The frame appeared to show the projected source as being in the vicinity of the intertank umbilical carrier plate area. Crew estimates of the venting cone angle varied between 90° and 150°. The intertank venting may have been the reason that the ET rotation rate seemed to change substantially during this period of time. See Figure 2.4.2 (E) for more detail.



Frame 45-71-031
20 minutes, 2 seconds MET

Frame 45-71-034
20 minutes, 32 seconds MET

Frame 45-71-035
21 minutes, 4 seconds MET

Frame 45-71-036
21 minutes, 34 seconds MET

Figure 2.4.2 (E) **Sequence of Four Images Showing Change in the Rotation Rate of the ET at 21 minutes MET**
(70mm Hasselblad Frame Nos. 45-71-031, 034, 035, 036)

Calculated rotation rates of the External Tank appeared to vary while the last ten Hasselblad frames were shot. This sequence of photographs compares the rotational position of the ET as a function of time. The intertank venting seen by the crew may have been a factor in this observed change of the ET rotational velocity. Assuming that the Orbiter's motion stayed relatively constant with respect to the External Tank, the ET also appeared to be wobbling (in a direction normal to the field of view) over this sequence of frames. Reference Appendix D Task #10 for details.

2.5 Landing Events

2.5.1 SSME #3 Beta Blanket Tear

The post-landing inspection of the Orbiter showed tears in the SSME #3 beta blanket. Similar damage had been seen on the SSME #2 beta blanket on STS-39. This event is not considered anomalous.

2.5.2 Damage to RCC on Right Wing and Nose Area (Task #11)

The post-landing inspection of the Orbiter revealed damage to the lower right nose area (tile nos. V070-39015-211 and V070-39015-212) and to the RCC panel #10 near the leading edge of the right wing. A review of launch tracker films E-052, E-054, E-057, E-059, E-205 and E-207 and all the landing videos was conducted to determine whether or not the damage could have been attributed to a previously seen event. No apparent debris source was seen on the films that might have led to the damage. Figure 2.5.2 (A) shows a general view of the damaged areas. Figure 2.5.2 (B) shows detailed views of the RCC damage.

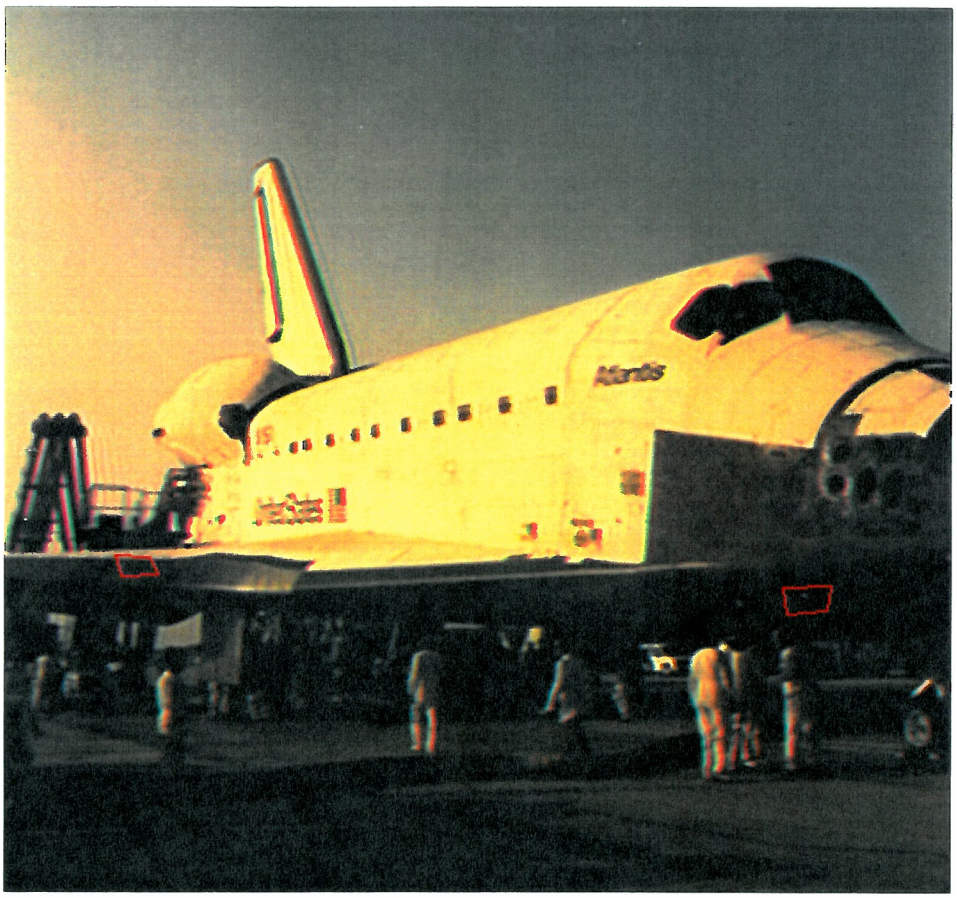
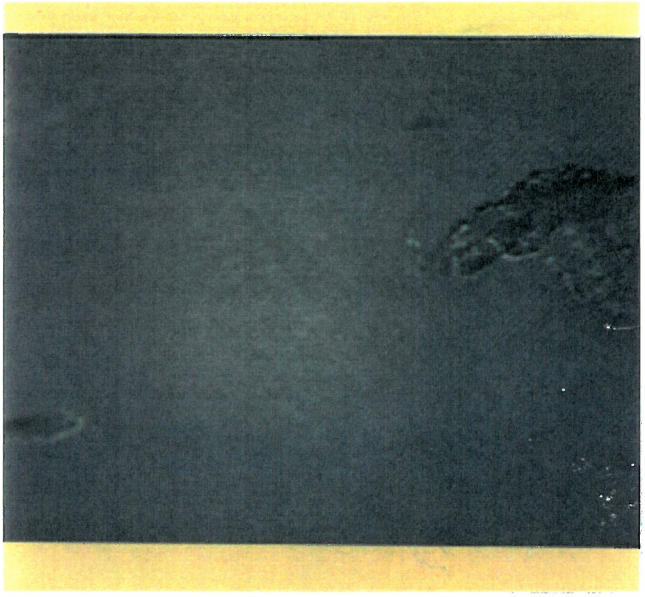
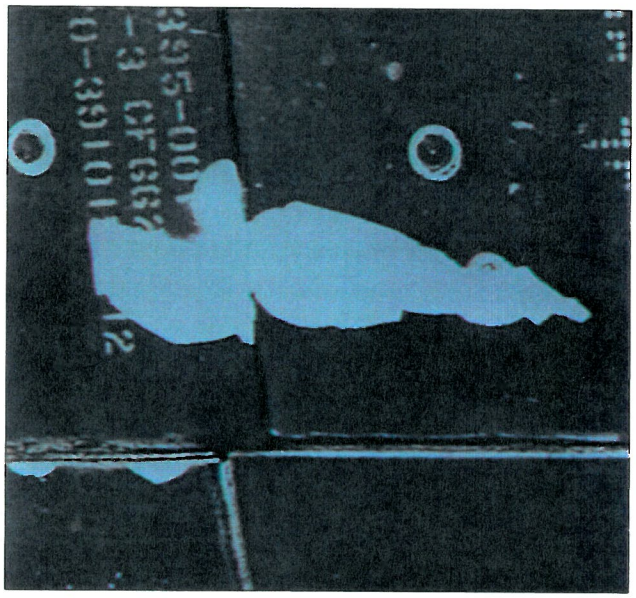


Figure 2.5.2 (A) Tile Damage Locations on the Orbiter

This photograph taken during the post-landing inspection of the Orbiter shows a general view of the area where RCC damage was seen. See Figure 2.5.2 (B) for more detailed views of the damage.



Right Wing Damage



Nose Area Damage

Figure 2.5.2 (B) RCC Damage to the Orbiter Right Wing and Nose Area

The photographs in Figure 2.5.2 (B) show the extent of the damage on both the leading edge of the right wing and the underside of the nose area. The strike on the lower right side of the Orbiter (Tile # V070-39015-211) was analyzed. A section of the black outer layer of the tile was pressed into the white inner layer from some object striking the tile; however, no residue was found in the cavity.

Post-retrieval inspection of the SRBs also revealed two areas of damage on the aft skirt area of the RSRB.

No definitive sources of debris that might have caused damage were identified from the tracker camera films at either launch or landing.

2.5.3 Debris in Umbilical Well Doors

The post-landing inspection of the Orbiter also revealed a pyro detonator booster located in the right ET door aft hinge cavity along with smaller metal debris. The problem report generated by this event is located in Appendix H.

2.5.4 Landing Sink Rate Analysis (Task #3)

2.5.4.1 Landing Sink Rate Analysis Using Film *(Camera E-1001)*

Camera EL-009 was used to determine the main landing gear sink rate. This particular view showed the aft side of the orbiter from the end of the runway. A point on the top and bottom of the right main landing gear was chosen for each frame. Four points were also chosen at the left and right edges of the runway for the first and last frames. These were digitized to detect any significant camera motion. Raw data was corrected for the vertical change in scale at each frame. The wheel position was computed and a linear regression was applied on the normalized vertical distance vs. time data to determine actual sink rate. This rate was determined to be 2.0 ft/sec.

Nose gear touchdown was determined using camera ML-005. Points on top of both the left and right main landing gear (used for scale and to eliminate camera motion) as well as a point on the nose wheel were digitized for each frame. Raw data was corrected for the vertical change in scale at each frame using the known distance between the two main landing gear wheels. The nose wheel position was computed and a linear regression was applied on the normalized vertical distance vs. time data to determine actual sink rate. This rate was determined to be 2.9 ft/sec.

See Appendix D Task #3 for details.

2.5.4.2 Landing Sink Rate Analysis Using Video *(Camera KTV-33)*

Data from camera KTV-33 was used to determine the sink rate of the main gear. An area near the nose gear was used as a reference scale. The position of the main gear as a function of time was found by taking the difference between the raw vertical positions of the main landing gear and the edge of the runway with the same X coordinate over 32 frames. Using the scale as a function of time, these differences were converted to feet. A least squares regression line was calculated from the data and the slope was used as the average sink rate. This rate was found to be 1.0 ft/sec.

The sink rate for the nose gear was also calculated using 32 frames digitized from camera KTV-33. A linear regression of the data was calculated in the same manner as above. The slope of this line was used as the sink rate and was found to be 3.0 feet per second.

See Appendix D Task #3 for details.

Results from the film analysis are considered better than video because of the higher spatial resolution. The quantization error inherent in the use of the video makes this analysis insufficient to meet the 0.1 feet per second precision required by the OMSRB.RCNSD500002DV51.P.001.

2.6 Other Normal Events

Other events seen on the STS-45 launch views that have been seen on previous shuttle flights include:

Overpressure wave during SRB ignition, debris in the exhaust cloud on the MLP after liftoff, vapor from both SRBs' stiffener rings, ET aft dome outgassing, charring of the ET aft dome, ice and vapor from the T-0 umbilical disconnects, and SRB plume brightening prior to SRB separation.

3.0 General Product Evaluation

3.1 Launch Video

Twenty-three of twenty-three launch videos expected were received. The Public Affairs Office replays were received approximately 20 minutes after launch. The first set of engineering replays were received approximately one hour after launch. The second set of replays were received approximately six and a half hours after launch.

The film to video conversion test was not scheduled for STS-45.

Correct timing was received with all videos.

A detailed assessment of the quality of the videos follows. Note that unless otherwise stated, the focus and exposure were good and if a camera number is not mentioned, there were no problems.

ET-204: Soft focus noted.

ET-208: Soft focus noted.

ET-213: Video signal distortion hindered analysis. Exposure was slightly dark.

KTV-2: Video interference noted throughout.

KTV-4A: Exposure varied from light to dark. Variable focus noted.

KTV-5: Camera vibration noted. Video dropout noted at 084:13:14:42.690 UTC. Variable focus noted.

KTV-13: Video breakup noted for 13 frames at 084:13:17:15 UTC.

KTV-21A: Slight camera vibration noted.

OTV-048: A rolling horizontal band noted

OTV-049: Variable exposure noted.

OTV-054: Horizontal banding hampered view.

OTV-061: Water drops on lens noted.

3.2 Launch Film

Sixty launch films arrived out of sixty-one expected. A detailed assessment of the film quality follows. Note that unless otherwise stated, the focus and exposure were good and if a camera number is not mentioned, there were no problems. E-002, E-003, E-008, E-010, E-011, E-012, E-013, E-052, E-054, E-057, E-059, E-211, E-222 and E-224 had digital timing. E-207 did not have timing.

E-002: Water spots were noted on lens. Camera vibration was noted. Periodic dig was seen on lower left edge of film.

E-003: Digital timing was faint. Camera vibration was noted. Periodic dig was seen on lower left edge of film.

E-004: Edge of camera housing noted on left side of FOV. Camera vibration was noted. Periodic dig was seen on lower left edge of film.

E-005: Camera vibration noted.

E-006: Timing marks were very faint.

E-008: Film too dark for analysis until after liftoff. Water drops were noted on lens.

E-009: Film ended prior to PIC firing. Internal lens reflection was noted.

E-011: Digital timing was faint.

E-012: Digital timing was faint.

E-013: Digital timing was faint.

E-017: Water spots were noted on lens.

E-023: Heavy haze hampered analysis. Timing marks were faint.

E-024: Haze seen after ROFI emission hampered analysis. Scratch noted in center of film.

E-025: Water drops were noted on lens. Periodic dig was seen on lower left edge of film.

E-026: Periodic dig was seen on lower left edge of film.

E-027: Focus was soft.

E-028: Camera vibration was noted.

E-033: Water spots were noted on lens. Digs were seen on film.

E-034: Film runs short and ends early.

E-035: FSS deluge water obscured view of umbilical area.

E-036: FSS deluge water hampered view.

E-040: FSS deluge water hampered view.

E-050: Timing marks were faint.

E-052: Camera vibration was noted. Digs were seen on film.

E-054: No first frame identifier. Glare from SRB plume noted. Water spots were noted on lens. Digs were seen on film.

E-057: Digs were seen on film.

E-059: No first frame identifier. Tracking did not correspond to OTV-048. Glare from SSME and SRB plumes noted. Water spots were noted on lens. Digs and streaks were seen on film.

E-079: Focus was soft.

E-204: Film had low contrast. Blue streaks were noted on right side of film.

E-205: Exposure was dark.

E-207: Digs were seen on film.

E-208: Numerous small digs were seen on film.

E-211: Focus was soft. Film had low contrast. Tracking appeared erratic. Processing stains were seen in middle of film. Emulsion scratch by-product seen at lower center of FOV.

E-212: Numerous digs were seen on film. Blue streaks were noted on right side of film.

E-222: Digs were seen on film.

E-223: Focus was soft (and hindered analysis). Major digs and scratches throughout film.

3.3 Landing Video

Sixteen landing video replays (including four infrared views) were received from NASA Select approximately 3.5 hours after the landing of Atlantis on runway 33 at KSC. Correct timing was received with all videos except IR-1, IR-2, IR-3, IR-4, KTV-15, SDIO-1 and SDIO-2. (Main gear touchdown occurred at 11 hours, 23 minutes, 04.988 seconds UTC). A detailed assessment of the quality of the landing videos follows. Note that unless otherwise stated, the focus and exposure were good and if a camera is not mentioned, there were no problems associated with it.

IR-1: Even though this camera was designated as IR, it did not appear to be infrared. Focus was variable. Exposure was variable.

IR-2: Both radiometric and spatial resolution were limited. Several occurrences of horizontal distortion were noted. Focus was variable. Exposure was variable.

IR-4: Several occurrences of horizontal distortion were noted. Focus was variable. Exposure was variable.

KTV-5: Exposure was light.

KTV-11: Focus was variable. Exposure was light.

KTV-12: Camera tracking was erratic. Focus was variable.

KTV-13: Focus was variable. Exposure was variable.

KTV-16: Intermittent dropouts occurred throughout video. Focus was variable. Exposure was variable.

KTV-20: Exposure was variable.

3.4 Landing Film

Seven landing films were received and screened on April, 8, 1992. The following is a detailed description of the landing film quality for STS-45. Cameras EL0011 and M005 had digital timing. Note that if a camera is not mentioned, there were no problems noted with that camera. Unless otherwise mentioned, the focus, exposure, and timing were good.

EL003: Exposure was dark. Focus was soft.

EL005: Film was too dark for analysis. Timing marks were overexposed. Focus was soft.

EL009: FOV tilted slightly too low. No timing was present. Exposure was dark. Focus was soft.

EL011: No first frame identifier.

EL030: Exposure was dark. Focus was soft.

EL031: Exposure was dark. Focus was soft.

M005: Lower third of view obscured by object in foreground. Exposure was dark. Focus was soft.

4.0 Process Evaluation

All launch film deliveries and reviews went smoothly. Screening went smoothly for the second straight mission because a priority was put on screening 35mm films first. If the 35mm projector needed repair, then 16 mm films were screened while maintenance personnel were called to work on the broken projector. The electronic final report management system continues to be refined. Long-term improvements for the handling of task analysis data are being implemented.

A switch to Transponder 5 for replay of the first launch videos worked well but there was a slight confusion when we reconfigured our system in Bldg. 31 while Bldg. 8 was trying to make the change transparent. We need to let Bldg. 8 personnel handle the changes. Transponder 5 will be used on future missions for first launch replays.

Also, KSC transmits two video signals at landing while Dryden usually has only one.

5.0 References

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c. Martin Marietta Manned Space Systems (Michould Division), Space Shuttle External Tank (lightweight Model) Layout Drawings. Volume II, April 1983.

d. Johnson Space Center Space Shuttle Photographic and Television Analysis Project, STS-37 Final Report, May 10, 1991, LESC-29388, JSC-25042

e. Johnson Space Center Space Shuttle Photographic and Television Analysis Project, STS-39 Final Report, June 14, 1991, LESC-29453, JSC-25111

f. Johnson Space Center Space Shuttle Photographic and Television Analysis Project, STS-40 Final Report, August 9, 1991, LESC-29577, JSC-25162

g. Johnson Space Center Space Shuttle Photographic and Television Analysis Project, STS-43 Final Report, September 19, 1991, LESC-29714, JSC-25276

h. Johnson Space Center Space Shuttle Photographic and Television Analysis Project, STS-48 Final Report, November 7, 1991, LESC-29793, JSC-25362

i. Johnson Space Center Space Shuttle Photographic and Television Analysis Project, STS-44 Final Report, December 24, 1991, LESC-29973, JSC-25518

j. Johnson Space Center Space Shuttle Photographic and Television Analysis Project, STS-42 Final Report, March 2, 1992, LESC-30071, JSC-25667

k. Rockwell International, Space Transportation Systems Division, Operational Aerodynamic Data Book, Vol. 1, September 1985, STS85-0118, Volume 1.

l. Engineering Photographic Analysis Summary Report STS-42, Rockwell International; 92MA1052, March 2, 1992.

m. National Space Transportation System, Program Launch and Landing Photographic Engineering Evaluation, NSTS 08244, Lyndon B. Johnson Space Center Houston, Texas. October 14, 1988.

Engineering Photographic Screening Disposition Forms

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number EX001

Location:	MLP B13	Focus:	Good
Camera Type:	16DBM5	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	32mm	Timing:	Yes
FPS:	400	Date Received:	03/27/92
Timing:	A	Date Screened:	03/27/92
		Screened By:	CD,MS,SI,CS,LK

Film Quality

Orientation

View of Holddown shoe on Holddown M-1 to show shoe movement during period starting at SSME ignition thru liftoff.

Comments

Multiple pieces of white debris noted from behind the DCS area and passing thru FOV before liftoff
Frame 4360 - PIC firing noted
Multiple pieces of flame duct debris noted at liftoff
The left PIC firing cable was stretched further than the right cable at liftoff
Frame 4805 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number EX004

Location:	MLP B16	**Film Quality**	
Camera Type:	16DBM5	Focus:	Soft/Good
Film:	ECD 200'	FOV:	
Lens Focal Length:	32mm	Exposure:	Good
FPS:	400	Timing:	Yes
Timing:	A	Date Received:	03/30/92
		Date Screened:	03/31/92
		Screened By:	JD,BG

Orientation
View ofHolddown shoe on Holddown M-5 to show show movement during period starting at SSME ignition thru liftoff.

Comments
Frame 4162 - PIC firing
Frame 4312 - Instafoam debris noted near SRB flame duct to left of HDP M-5
Frame 4347 - Dark small pieces of debris noted from HDP M-5 DCS area as shoe lifts off foot
Frame 4358 - Small dark debris noted inside shoe at liftoff
Frame 4599 - LOV
Holddown post shoe rotation appeared similar to previous launch views
No anomalies detected

Film Quality Description
No first frame identifier - first frame used was image of HDP and SRB
Camera vibration noted at SSME ignition

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number ET204

Location:	PAFB PIGOR	Focus:	Soft
Camera Type:	TV/3000	FOV:	
Film:	1/2"	Exposure:	Good
Lens Focal Length:	120"	Timing:	Yes
FPS:		Date Received:	03/24/92
Timing:	B120	Date Screened:	03/24/92
		Screened By:	JD,MS,SI

Film Quality

Orientation

Video track of Launch Vehicle from acquisition to LOV. This item utilizes the acquisition lens. Continue track of ORB/ET during and after SRB separation. Do not track separated SRBs.
Local record on 1/2" MII. Requires IGIG B Mod (B120) on audio track #2.

Comments

Roll maneuver noted
084:13:14:14 - AOV
084:13:15:37.874 - Pulse noted in SRB plume
SRB plume brightening noted
084:13:15:48.117 - SRB separation noted
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number ET207

Location:	UCS-10 MIGOR	**Film Quality**	
Camera Type:	TV/3000	Focus:	Good
Film:	1/2" -	FOV:	
Lens Focal Length:	52"	Exposure:	Good
FPS:		Timing:	Yes
Timing:	B120	Date Received:	03/24/92
		Date Screened:	03/24/92
		Screened By:	JD,MS,SI

Orientation
Video track of entire vehicle from first acquisition to SRB separation.
After separation, track NORTH SRB to LOV.
Local Record on 1/2" MII. MII requires IRIG B. Mod. (B-120) on audio track #2.
This item utilizes the acquisition lens.

Comments
ET aft dome outgassing noted
Roll maneuver noted
084:13:15:26.133 - Small white spot moved quickly from SSME area away from the vehicle to the left of FOV
084:13:15:34.675, 084:13:15:36.843, 084:13:15:37.744- Three bright orange pulses noted in LSRB exhaust plume
084:13:15:40 - Start of SRB plume brightening noted
084:13:15:48.121 - SRB separation noted
No anomalies detected

Film Quality Description
Intermittent LOV due to clouds

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number ET208

Location:	C.B. DOAMS	Focus:	Good
Camera Type:	TV/750	FOV:	
Film:	1/2"	Exposure:	Soft
Lens Focal Length:	240"	Timing:	Yes
FPS:		Date Received:	03/24/92
Timing:	B120	Date Screened:	03/24/92
		Screened By:	JD,MS,SI

Film Quality

Orientation

Provide real-time video signal for transmission to JSC via BRRS. Track vehicle from AOV to LOV. Also local record on 1/2" MII.
Record IRIG B Mod (B120) on audio track #2.
Provide COLOR BARS at L-2 hrs. for KSC/TV.

Comments

084:13:14:24 - AOV
084:13:15:34.685, 084:13:15:37.888 - Orange pulses noted in LSRB plume
SRB plume brightening noted
084:13:15:48.132 - SRB separation noted
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number ET212

Location:	UCS-23 ATOTS	Focus:	Good
Camera Type:	TV/750	FOV:	
Film:	1/2"	Exposure:	Good
Lens Focal Length:	52"	Timing:	Yes
FPS:		Date Received:	03/24/92
Timing:	B120	Date Screened:	03/24/92
		Screened By:	JD,MS,SI

Film Quality

Orientation
Video track of Launch Vehicle from acquisition to LOV. This item utilizes the acquisition lens. After separation, camera will continue to track the ORB/ET. Provide real-time signal for transmission to LC-39 Press Site. Also local record on 1/2" MII. Record IRIG B Mod (B120) on audio track #2.
Provide COLOR BARS at L-2 hrs. for KSC/TV.

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Comments
Roll maneuver noted
084:13:14:11.355 - Small white piece of debris was seen above SSME #1 and traveled aft into exhaust plume (P)
084:13:15:34.972, 084:13:15:37.875 - Orange pulses noted in LSRB plume
SRB plume brightening noted
084:13:15:48.152 - SRB separation noted
No anomalies detected

Film Quality Description
Intermittent LOV due to clouds

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number ET213

Location:	UCS-12 MOTS	Focus:	Good
Camera Type:	TV/101	FOV:	
Film:	1/2"	Exposure:	Dark/Good
Lens Focal Length:	ZOOM	Timing:	Yes
FPS:		Date Received:	03/24/92
Timing:	B120	Date Screened:	03/24/92
		Screened By:	JD,MS,SI

Film Quality

Orientation

Manual Video track of Launch Vehicle from liftoff to T+50 secs or LOV, whichever occurs first. Committed for Range Safety. Remote tracker control from VABR. Provide video signal for transmission to RSDS. Also local record on 1/2" MII. Record IRIG B Mod (B120) on audio track #2.

Comments

Roll maneuver noted
SRB separation noted
No anomalies detected

Film Quality Description

Video signal distortion hampers analysis

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E001

Location:	MLP L1	**Film Quality**	
Camera Type:	16DBM4	Focus:	Good
Film:	ECD 200'	FOV:	
Lens Focal Length:	10MM	Exposure:	Good
FPS:	400	Timing:	Yes
Timing:	A	Date Received:	03/25/92
		Date Screened:	03/25/92
		Screened By:	CD,MS,CS,SI,LK

Orientation

Bottom 1/4 of launch vehicle with launch deck in extreme bottom of frame, during ignition and liftoff. To view for structural anomalies, thermal insulation failures, water patterns and possible debris.

Comments

Frame 4525 - A single piece of white debris noted moving from the LSRB area toward the RSRB at liftoff
Frame 5063 - A single piece of black debris noted passing from right to left thru the FOV close to the camera
Frame 5592 - LOV
Multiple pieces of rope-like debris noted in exhaust plume after vehicle passes TSM
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E002

Location:	MLP L4	Focus:	Good
Camera Type:	16PS	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	10MM	Timing:	Yes
FPS:	400	Date Received:	03/25/92
Timing:	B120	Date Screened:	03/25/92
		Screened By:	CD,MS,SI,CS,LK

Film Quality

Orientation
Bottom 1/4 of Launch Vehicle with launch deck in extreme bottom of frame during ignition and liftoff. To view for structural anomalies, thermal insulation failures, water patterns and possible debris.

Comments
084:13:13:37.19 (Frame 2696) - A thin dark rope-like piece of debris noted originating from behind right RCS stinger area and fell aft into SSME area (M)
084:13:13:38.173 (Frame 3091) - A white piece of debris noted passing between SSME #2 and #3 and fell aft into SSME plume
084:13:13:36-084:13:13:40.895 (Frame 4186) - Multiple pieces of white debris noted passing thru the FOV from right to left prior to and at liftoff, does not appear to strike the vehicle
Frame 5003 - LOV
No anomalies detected

Film Quality Description
Digital timing
Water spots on lens
Camera vibration
Periodic dig in left side of film

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E003

Location:	MLP L5	Focus:	Good
Camera Type:	16PS	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	10MM	Timing:	Yes
FPS:	400	Date Received:	03/25/92
Timing:	B120	Date Screened:	03/25/92
		Screened By:	CD,MS,SI,CS,LK

Film Quality

Orientation
Bottom 1/4 of Launch Vehicle with launch deck in extreme bottom of frame during ignition and liftoff. To view for structural anomalies, thermal insulation failures, water patterns and possible debris.

Comments
084:13:13:36.06 - A single thin dark rope-like piece of debris noted from behind SSME #1 and fell aft (similar event as seen on E002 at 37 seconds)
084:13:13:38.845 (Frame 3341) - A single piece of orange colored debris noted from the left RCS stinger area fell aft into SSME plume at SSME ignition
Multiple pieces of white debris (possibly ice) noted in SSME plume and fell aft after SSME ignition
Multiple pieces of white debris from SSME area fell aft after liftoff
Vapor from LSRB stiffener rings noted
084:13:13:42.55 - LOV
084:13:13:43.86 (Frame 5388) - Multiple pieces of dark debris noted in exhaust plume after vehicle clears the TSM

Film Quality Description
Faint digital timing
Camera vibration
Periodic digs on lower left edge of film

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E004

Location:	MLP L6	Focus:	Good
Camera Type:	16DBM4	FOV:	
Film:	ECD 200	Exposure:	Good
Lens Focal Length:	10MM	Timing:	Yes
FPS:	400	Date Received:	03/25/92
Timing:	A	Date Screened:	03/25/92
		Screened By:	CD,MS,SI,CS,LK

Film Quality

Orientation
Bottom 1/4 of Launch Vehicle with launch deck in extreme bottom of frame during ignition and liftoff. To view for structural anomalies, thermal insulation failures, water patterns and possible debris.

Comments
Frame 5609 - LOV
Multiple pieces of dark debris noted in exhaust plume after vehicle clears TSM
No anomalies detected

Film Quality Description
Edge of camera housing noted on left side of FOV
Periodic dig on lower left edge of film
Camera vibration

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E005

Location:	MLP L2	Focus:	Good
Camera Type:	16DBM5	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	10MM	Timing:	Yes
FPS:	400	Date Received:	03/25/92
Timing:	A	Date Screened:	03/25/92
		Screened By:	CD,MS,SI,CS,LK

Film Quality

Orientation
View underside of ORB to show URSI on Body Flap and surrounding area. Show entire Body Flap, but include as much insulation surfaces as possible. View for possible tile falloff.

Comments
Frame 2414 - A light piece of debris noted falling vertically in front of FSS
Frame 3363 - A single piece of thin debris noted falling vertically in front of the LSRB prior to liftoff, did not appear to strike the vehicle
Less than expected umbilical ice debris was noted
Multiple pieces of small white debris originated from ET/SRB area and fell aft. The debris traveled right to left thru FOV after SSME ignition and does not appear to strike the vehicle
Frame 4748 - LOV
No anomalies detected

Film Quality Description
Camera vibration

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E006

Location:	MLP L3	Focus:	Good
Camera Type:	16DBM5	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	25MM	Timing:	Yes
FPS:	200	Date Received:	03/25/92
Timing:	A	Date Screened:	03/25/92
		Screened By:	CD,MS,SI,CS,LK,WG,DM

Film Quality

Orientation
View ORB/ET LO2 fluid and electrical umbilical (EO-5) and lower portion of LO2 antigeyser line during ignition and liftoff. To show icing, leakage, insulation and structural failure.

Comments
Frame 1724 - Numerous pieces of small white debris originated between the ET and Orbiter at the umbilical level prior to liftoff, did not appear to strike the vehicle. Some of the debris appeared thin and flat. (M)
Multiple pieces of white debris passed thru the FOV from upper right to lower left at liftoff
Frame 1985 - Single flat dark piece of debris passed thru the FOV from top to left at liftoff (M)
Frame 2658 - LOV
No anomalies detected

Film Quality Description
Very faint timing marks

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E007

Location:	MLP B2	Focus:	Good
Camera Type:	16DBM4	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	10MM	Timing:	Yes
FPS:	400	Date Received:	03/26/92
Timing:	A	Date Screened:	03/27/92
		Screened By:	JD,RB,BG,LK

Film Quality

Orientation
View SRB Holdown Post M-4 during ignition and liftoff to show release and SRM nozzle clearance.

Comments
Water drops in view
Frame 4825 - ~PIC firing noted
Flame duct debris noted
Frame 5060 - Holddown post #4 bolt hang-up noted. Bolt appeared to spring back after aft skirt cleared bolt. (M)
Frame 5155 - Epon shim material detached from SRB aft skirt foot at holddown post #4 (M)
Frame 5301 - LOV
No anomalies detected

Film Quality Description
Digs in film

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E008

Location:	MLP B3	Focus:	Good
Camera Type:	16PS	FOV:	
Film:	ECD 200'	Exposure:	Dark
Lens Focal Length:	10MM	Timing:	Yes*
FPS:	400	Date Received:	03/26/92
Timing:	B120	Date Screened:	03/27/92
		Screened By:	JD,RB,BG,LK

Film Quality

Orientation
View SRB Holdown Post M-2 during ignition and liftoff to show release and SRM nozzle clearance.

Comments
Flame duct and water trough debris noted
13:13:41.392 (Frame 3990) - LOV
No anomalies detected

Film Quality Description
*digital timing
Water drops on lens
Too dark for analysis until after liftoff

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E009

Location:	MLP B4	Focus:	Soft
Camera Type:	16PS	FOV:	
Film:	ECD 200'	Exposure:	Dark
Lens Focal Length:	10mm	Timing:	No
FPS:	400	Date Received:	03/25/92
Timing:	B120	Date Screened:	03/25/92
		Screened By:	CD,MS,SI,CS,LK,WG,DM

Film Quality

Orientation
View SRB Holdown Post M-1 during ignition and liftoff to show release and SRM nozzle clearance.

Comments
Minor pad debris noted
No anomalies detected

Film Quality Description
Internal lens reflection
Film ended prior to PIC firing

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E010

Location:	MLP B5	Focus:	Good
Camera Type:	16PS	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	10mm	Timing:	Yes*
FPS:	400	Date Received:	03/26/92
Timing:	B120	Date Screened:	03/27/92
		Screened By:	JD,RB,BG,LK

Film Quality

Orientation
View SRB Holdown Post M-3 during ignition and liftoff to show release and SRM nozzle clearance.

Comments
PIC firing not visible
Leak in MLP J-pipe noted prior to liftoff
Flame duct debris noted
13:13:40.395 (Frame 3989) - Small dark piece of debris (probably throat plug material) fell into flame duct at liftoff.
13:13:41.005 (Frame 4236) - Rope like debris from flame duct noted at liftoff
13:13:41.005 (Frame 4236) - LOV
No anomalies detected

Film Quality Description
*Digital timing

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E011

Location:	MLP B7	Focus:	Good
Camera Type:	16PS	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	10mm	Timing:	Yes*
FPS:	400	Date Received:	03/26/92
Timing:	B120	Date Screened:	03/27/92
		Screened By:	JD,RB,BG,LK

Film Quality

Orientation
View SRB Holdown Post M-7 during ignition and liftoff to show release and SRM nozzle clearance.

Comments
Leak in MLP J-pipe noted prior to liftoff
Flame duct debris noted
13:13:40.009 (Frame 3830) - ~PIC firing noted
Normal pad debris noted
13:13:40.827 (Frame 4162) - Small dark piece of debris fell from foot area at holddown post #7 during liftoff.
13:13:40.948 (Frame 4211) - DCS debris noted falling from SRB aft skirt foot stud hole at Holddown post #7 at liftoff. (M)
13:13:41.039 (Frame 4248) - LOV
No anomalies detected

Film Quality Description
*Digital timing
Digital timing is light

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E012

Location:	MLP B8	Focus:	Soft
Camera Type:	16PS	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	10mm	Timing:	Yes
FPS:	400	Date Received:	03/25/92
Timing:	B120	Date Screened:	03/25/92
		Screened By:	CD,MS,SI,CS,LK,WG,DM

Film Quality

Orientation
View SRB Holdown Post M-5 during ignition and liftoff to show release and SRM nozzle clearance.

Comments
Minor pad debris noted throughout liftoff
084:13:13:40.00 (Frame 3841) - PIC firing noted
Multiple pieces of white debris passed thru the FOV at liftoff
Frame 4427 - LOV
Multiple pieces of dark debris noted in exhaust plume after liftoff
No anomalies detected

Film Quality Description
Faint digital timing

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E013

Location:	MLP B9	Focus:	Good
Camera Type:	16PS	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	10MM	Timing:	Yes*
FPS:	400	Date Received:	03/26/92
Timing:	B120	Date Screened:	03/27/92
		Screened By:	JD,RB,BG,LK

Film Quality

Orientation
View SRB Holdown Post M-6 during ignition and liftoff to show release and SRM nozzle clearance.

Comments
HPU exhaust noted
Normal pad debris noted
13:13:40.001 (Frame 3840) - PIC firing noted
Flame duct debris noted
13:13:40.888 (Frame 4198) - Holddown post #6 firing cable remain attached to LSRB during liftoff (M)
13:13:41.493 (Frame 4442) - LOV
No anomalies detected

Film Quality Description
*Digital timing
Digital timing is faint

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E014

Location:	MLP B10	**Film Quality**	
Camera Type:	16DBM4	Focus:	Good
Film:	ECD 200'	FOV:	
Lens Focal Length:	10MM	Exposure:	Good
FPS:	400	Timing:	Yes
Timing:	A	Date Received:	03/26/92
		Date Screened:	03/27/92
		Screened By:	JD,RB,BG,LK

Orientation
View SRB Holdown Post M-8 during ignition and liftoff to show release and SRM nozzle clearance.

Comments
Water drops in view
Frame 5199 - Long rope like debris in front of holddown post #M-8 at liftoff. (M)
Frame 5277 - Normal dark pad debris noted
Frame 5516 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E015

Location:	MLP B1	Focus:	Good
Camera Type:	16DBM4	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	15MM	Timing:	Yes
FPS:	400	Date Received:	03/25/92
Timing:	A	Date Screened:	03/25/92
		Screened By:	CD,MS,SI,CS,LK,RB

Film Quality

Orientation
SRM Nozzle on east SRB to show nozzle motion, holddown post clearance, gimble position and heat shield integrity.

Comments
Frame 3102 - A rope-like piece of debris noted in SSME area (may be similar event as seen on E002)
Frame 3986 - A single thin flat piece of debris fell in front of body flap at SSME ignition
Frame 4543 - Multiple pieces of flame trough debris noted exiting RSRB flame trough and then fell back into trough
Frame 4783 - Holddown post #3 doghouse appeared to close earlier than holddown post #4 doghouse (M)
Frame 4983 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E016

Location:	MLP B6	Focus:	Good
Camera Type:	16DBM4	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	15MM	Timing:	Yes
FPS:	400	Date Received:	03/25/92
Timing:	A	Date Screened:	03/25/92
		Screened By:	CD,MS,SI,CS,LK

Film Quality

Orientation

SRB Nozzle on west SRB to show nozzle motion, holddown post clearance, gimble position and heat shield integrity.

Comments

Leak in MLP J-pipe noted prior to SSME start-up
Debris noted near SSMEs during SSME ignition
Frame 4874 - Dark piece of debris noted from the DCS stud hole at holddown post M-7 (M)
Normal flame trough debris noted at LSRB ignition
Frame 5270 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E017

Location:	MLP 01	Focus:	Good
Camera Type:	16DBM4	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	10MM	Timing:	Yes
FPS:	400	Date Received:	03/25/92
Timing:	A	Date Screened:	03/25/92
		Screened By:	CD,MS,SI,CS,LK

Film Quality

Orientation
TSM Carrier disconnect and withdrawal during ignition and liftoff. View to include all visable portions of LO2 line for possible anomalies.

Comments
Frame 2439 - RCS jets R3D and R3R does not appear to be covered with butcher paper (M)
Frame 3079 - Rope-like debris noted from RCS jet R4D appears to be tape and is probably the rope-like debris seen on cameras E002 and E015 (M)
Numerous pieces of white debris noted to originate from the LO2 TSM prior to liftoff
Numerous pieces of white debris fell thru the FOV from top to bottom prior to and at liftoff, did not appear to strike the vehicle
Frame 5355 - LOV
No anomalies detected

Film Quality Description
Water spots on lens

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E018

Location:	MLP 04	Focus:	Good
Camera Type:	16DBM4	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	10MM	Timing:	Yes
FPS:	400	Date Received:	03/25/92
Timing:	A	Date Screened:	03/25/92
		Screened By:	CD,MS,SI,CS,LK

Film Quality

Orientation

TSM Carrier disconnect and withdrawal during ignition and liftoff. View to include all visable portions of LH2 line for possible anomalies.

Comments

White debris noted traveling from right to left thru the FOV at SSME ignition
Small white pieces of debris noted moving vertically in front of the elevon at SSME ignition
Ice debris noted falling from LH2 TSM at liftoff
Frame 5399 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E019

Location:	MLP 02	Focus:	Good
Camera Type:	16DBM4	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	10MM	Timing:	Yes
FPS:	400	Date Received:	03/25/92
Timing:	A	Date Screened:	03/25/92
		Screened By:	CD,MS,SI,CS,LK

Film Quality

Orientation
View inside of SSME Nozzles #1 and #3 and surrounding heat- shield during ignition and liftoff. For engine ignition evaluation and leakage surveillance.

Comments
RCS jet R3R does not appear to be covered with butcher paper
Frame 3043 - Slight base heat shield erosion noted between SSME #1 and #3
Rope-like debris noted from RCS jet R4D appears to be tape and is probably the same event as seen on cameras E002 and E015
White debris noted from LO2 TSM umbilical area at liftoff
White debris noted from LH2 TSM umbilical area at liftoff
Frame 5700 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E020

Location:	MLP 03	Focus:	Good
Camera Type:	16DBM4	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	10MM	Timing:	Yes
FPS:	400	Date Received:	03/25/92
Timing:	A	Date Screened:	03/26/92
		Screened By:	JD,RB,BG,LK

Film Quality

Orientation
View inside of SSME Nozzles #1 and #2 and surrounding heat- shield during ignition and liftoff.

Comments
Frame 2584 - TPS erosion at the base of the left OMS nozzle
RCS paper debris noted
Frame 4571 - TSM LH2 umbilical disconnect retracts
TSM ice debris noted
Frame 5301 - Several small white pieces of debris fell aft along upper surface of body flap just after liftoff. Does not appear to strike the vehicle.
Frame 5609 - LOV
No anomalies detected

-1 frame

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E023

Location:	MLP 02A	Focus:	Good
Camera Type:	16DBM4	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	25mm	Timing:	Yes
FPS:	400	Date Received:	03/26/92
Timing:	A	Date Screened:	03/27/92
		Screened By:	JD,RB,BG,LK

Film Quality

Orientation
View of OMS engine nozzle during ignition and liftoff.
To record nozzle structural integrity.
Power and timing with E19.

Comments
RCS paper debris noted
Possible base heat shield erosion noted
Frame 4602 - Small white debris (probably ice) from oxygen TSM noted at TSM disconnect
Frame 4983 - Multiple small white pieces of debris noted falling along right SRB after liftoff
Frame 5439 - LOV
No anomalies detected

Film Quality Description
Heavy haze hampered analysis
Timing marks are faint

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E024

Location:	MLP 03A	Focus:	Good
Camera Type:	16DBM4	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	25mm	Timing:	yes
FPS:	400	Date Received:	03/26/92
Timing:	A	Date Screened:	03/27/92
		Screened By:	JD,RB,BG,LK

Film Quality

Orientation

Comments
RCS paper debris noted
Frame 4892 - Several small white debris (probably ice) from LH2 TSM area noted at TSM disconnect through liftoff.
Frame 5287 - LOV
No anomalies detected

Film Quality Description
Scratch in center of film
Haze hampers analysis after ROFI emission

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E025

Location:	MLP B11*	Focus:	Good
Camera Type:	16DBM4	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	5.9mm	Timing:	Yes*
FPS:	400	Date Received:	03/25/92
Timing:	A	Date Screened:	03/26/92
		Screened By:	JD,RB,BG,LK

Film Quality

Orientation
View between ORB and ET/SRB during liftoff to show possible debris. *East Side

Comments
Frame 4151 - Multiple pieces of small white debris (possible umbilical ice debris) fell along body flap during liftoff.
Frame 3751 - Multiple small pieces of white debris (possible flame duct debris) traveled from right to left in FOV at liftoff. Does not appear to strike the vehicle.
Frame 4328 - Small white piece of debris first seen near RSRB moves from right to left and fell beneath the right elevon after liftoff. Does not appear to strike the vehicle.
Slight vapor off RSRB stiffener ring noted
Frame 4510 - LOV
No anomalies detected

Film Quality Description
Water drops on lens
Dig in film on left side of view
* Timing very faint

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E026

Location:	MLP B12*	**Film Quality**	
Camera Type:	16DBM4	Focus:	Good
Film:	ECD 200'	FOV:	
Lens Focal Length:	5.9mm	Exposure:	Good
FPS:	400	Timing:	Yes
Timing:	A	Date Received:	03/25/92
		Date Screened:	03/26/92
		Screened By:	JD,RB,BG,LK

Orientation
View between ORB and ET/SRB during liftoff to show possible debris. *West Side

Comments
GH2 vent line umbilical appeared to retract normally
FSS deluge water noted
Umbilical ice debris noted
Frame 3435-3762 - Medium size flat appearing piece of dark debris first seen North of LSRB moved South in front of LSRB and out of view below left outboard elevon at SRB ignition. Does not appear to strike the vehicle. Frame 3606 (M)
Frame 3937 - Flat appearing piece of debris (shiny on one side and dark on the other) first seen at base of SRBs traveled under left inboard elevon, moved South during liftoff. Did not appear to strike the vehicle.
Frame 4028- LOV
No anomalies detected

Film Quality Description
Dig in film on left side of view

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E027

Location:	MLP B2A	Focus:	Soft
Camera Type:	16DBM5	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	100mm	Timing:	Yes
FPS:	400	Date Received:	03/27/92
Timing:	A	Date Screened:	03/27/92
		Screened By:	CS,MS,SI,CS,LK

Film Quality

Orientation
View SRB Holddown shoe M-3 starting at SSME ignition and liftoff. To record shoe movement.

This item has start and timing paralleled with item E-7

Comments
Frame 4386 - PIC firing noted
Multiple pieces of flame duct debris noted at liftoff
Blast deflection shield appeared to operate normally
Frame 4667 - LOV

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E028

Location:	MLP B10A	Focus:	Good
Camera Type:	16DBM5	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	100mm	Timing:	Yes
FPS:	400	Date Received:	03/27/92
Timing:	A	Date Screened:	03/27/92
		Screened By:	CD,MS,SI,CS,LK

Film Quality

Orientation
View SRB Holddown shoe M-7 starting at SSME ignition and liftoff. To rccord shoe movement.

This item has start and timing paralleled with item E-14.

Comments
Frame 4309 - PIC firing noted
Multiple pieces of flame duct debris noted at liftoff
Frame 4651 - Dark debris (about 3 inches x 1/2 inch) noted falling from between shoe and foot area at liftoff (M)
No anomalies detected

Film Quality Description
Camera vibration

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E030

Location:	FSS-195' 19C	Focus:	Good
Camera Type:	16DBM5	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	15mm	Timing:	Yes
FPS:	400	Date Received:	03/26/92
Timing:	A	Date Screened:	03/27/92
		Screened By:	JD,RB,BG,LK

Film Quality

Orientation
View SRB secondary holes on MLP to show water bag reaction during ignition and liftoff.

Comments
FSS deluge water noted
Frame 5665 - LOV
No anomalies detected

Film Quality Description

Item Number E031

Location:	FSS-95' 9	Focus:	Good
Camera Type:	16DBM5	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	25mm	Timing:	Yes
FPS:	100	Date Received:	03/26/92
Timing:	B	Date Screened:	03/27/92
		Screened By:	JD,RB,BG,LK

Film Quality

Orientation
View ORB/ET LH2 Fluid and Electrical Umbilical (EO-4), LH2 feedline and tank pierce point during ignition and liftoff.
To view icing, leakage, insulation and structural failure.
Adjust ASA dial on AEC to agree with actual exposure reading at time of setup.
Set slew rate at approx. 2 F/stops per sec.

Comments
FSS deluge water noted
Frame 647 - Ice debris and vapor from LH2 umbilical noted
Elevon motion noted
Vapor off stiffener rings noted
Frame 1308 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E033

Location:	FSS-235' 23	Focus:	Good
Camera Type:	16DBM5	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	100mm*	Timing:	Yes
FPS:	200	Date Received:	03/27/92
Timing:	A	Date Screened:	03/27/92
		Screened By:	CD,MS,SI,CS,LK

Film Quality

Orientation
View ET GH2 Umbilical Vent Line Carrier and interfaces during ignition and liftoff. (Disconnect)
To view for icing and possible disconnect anomalies.
*Must use Schneider Lens.

Comments
Twang noted
Frame 1551 - GUCP retraction noted
Ice and vapor noted from GUCP area during twang and at disconnect
Light colored debris noted moving from the right of the LSRB and moving to the right at liftoff
Vapor noted from SRB stiffener rings
Frame 2386 - LOV
No anomalies detected

Film Quality Description
Water spots on lens
Digs on film

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E034

Location:	FSS-255' 25	Focus:	Good
Camera Type:	16DBM5	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	15mm	Timing:	Yes
FPS:	400	Date Received:	03/25/92
Timing:	A	Date Screened:	03/26/92
		Screened By:	JD,RB,BG,LK

Film Quality

Orientation
View ORB tiled surfaces (HRSI) on upper portion of Orbiter bottom. Include WIDE BLACK STRIPE ON SRB at bottom edge of frame. View during ignition and liftoff to show possible tile falloff and debris.

Comments
FSS deluge water noted
Frame 1434 - Film ends prior to SSME ignition
No anomalies detected

Film Quality Description
Film runs short and ends early

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E035

Location:	FSS-255' 25A	**Film Quality**	
Camera Type:	16DBM5	Focus:	Good
Film:	ECD 200'	FOV:	
Lens Focal Length:	15mm	Exposure:	Good
FPS:	400	Timing:	Yes
Timing:	A	Date Received:	03/25/92
		Date Screened:	03/26/92
		Screened By:	JD,RB,BG,LK

Orientation
View ORB tiled surfaces (HRSI) on MIDPORTION of Orbiter bottom. Include WIDE BLACK STRIPE ON SRB at TOP edge of frame. View during ignition and liftoff to show possible tile falloff and debris.

Comments
FSS deluge water noted
GH2 vent line umbilical appeared to retract normally
Frame 4476 - LOV
No anomalies detected

Film Quality Description
FSS deluge water obscures view of umbilical area

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E036

Location:	FSS-255' 25E	Focus:	Good
Camera Type:	16DBM5	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	15mm	Timing:	Yes
FPS:	400	Date Received:	03/25/92
Timing:	A	Date Screened:	03/26/92
		Screened By:	JD,RB,BG,LK

Film Quality

Orientation
View ORB tiled surfaces (HRSI) on lower portion of Orbiter bottom. Include left (west) wing-tip at bottom edge of frame. View during ignition and liftoff to show possible tile falloff and debris.

Comments
FSS deluge water noted
Frame 4339 - LOV
No anomalies detected

Film Quality Description
FSS deluge water hampered view

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E040

Location:	FSS-275' 27C	Focus:	Good
Camera Type:	16DBM5	FOV:	
Film:	ECD 200'	Exposure:	Good/Dark
Lens Focal Length:	10mm	Timing:	Yes
FPS:	400	Date Received:	03/25/92
Timing:	A	Date Screened:	03/26/92
		Screened By:	JD,RB,BG,LK

Film Quality

Orientation
Tip of ET in center of frame. (Horiz. and vert.)
To show tiled surfaces of Orbiter passing thru frame, and
any possible falling debris.

Comments
Twang noted
FSS deluge water noted
Slight ET aft dome outgassing noted
Vapor off both SRB stiffener rings noted
Frame 4579 - Small white piece of debris below ET Orbiter umbilical
noted during liftoff.
Frame 4954- LOV
Frame 4954, 5506 - Multiple pieces of debris noted in exhaust plume
after liftoff
No anomalies detected

Film Quality Description
FSS deluge water hampers view

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E041

Location:	FSS-255' 25D	Focus:	Good
Camera Type:	16DBM5	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	10mm*	Timing:	Yes
FPS:	400	Date Received:	03/27/92
Timing:	A	Date Screened:	03/27/92
		Screened By:	CD,MS,SI,CS,LK

Film Quality

Orientation
View of GH2 Vent Line during rotation. Place Vent Line in top of frame and include bottom level of Vent Line structure in bottom of frame.To show clearance between structure and SRB aft skirt.

Lens with f/ in top position. Adjust ASA dial on AEC to agree with actual exposure meter (ASA 125) at time of setup.
Slew rate set at 2-3 f/stops per second.
RAISED PLATFORM, EAST SIDE.

Comments
FSS deluge water noted
GH2 vent arm appeared to retract normally
MLP deluge water activated after liftoff
Several dark pieces of debris (near camera) noted falling thru scene after liftoff
Debris noted in exhaust plume
Frame 4263 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E042

Location:	FSS-185' 18	Focus:	Good
Camera Type:	16DBM5	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	50mm	Timing:	Yes
FPS:	400	Date Received:	03/27/92
Timing:	A	Date Screened:	03/27/92
		Screened By:	CD,MS,SI,CS,LK

Film Quality

Orientation
View of GH2 Vent Line structure to show Vent Line during final portion of drop, deceleration phase, and latchback.
To view for possible anomalies.

Access from 175' level of FSS.
Adjust ASA dial on AEC to agree with exposure meter (ASA 125)of overall scene at time of setup.Do not attempt to allow for reading inside of Vent Line structure.
Set slew rate for 2-3 f/stops per second.

Comments
FSS deluge water noted
GH2 vent arm retraction appeared normal
Dark pieces of debris noted falling thru scene at liftoff
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E050

Location:	39-1 17	Focus:	Good
Camera Type:	16DBM5	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	8"	Timing:	Yes
FPS:	400	Date Received:	03/27/92
Timing:	A	Date Screened:	03/27/92
		Screened By:	CD,MS,SI,CS,LK,DM

Film Quality

Orientation

Comments
FSS deluge water noted
Frame 4212 - ~ GUCP retraction noted. Vent arm retraction appeared normal
Vapor off LSRB stiffener rings noted
Frame 5806 - LOV
No anomalies detected

Film Quality Description
Faint timing marks

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E052

Location:	39-2 T1	Focus:	Good
Camera Type:	35PS	FOV:	
Film:	ECD 400'	Exposure:	Good
Lens Focal Length:	200mm	Timing:	Yes
FPS:	100	Date Received:	03/27/92
Timing:	B120	Date Screened:	03/27/92
		Screened By:	CD,MS,SI,CS,LK

Film Quality

Orientation

Remote tracking coverage of lower one-half of Launch Vehicle including MLP Deck. Interval of coverage from ignition to 1200 ft. View to record vehicle motion, structural integrity and engine operation during early flight.

Comments

MLP deluge water noted
GH2 vent line drop noted
Vapor off SRB stiffener rings noted
Debris noted falling from ET/Orbiter umbilical area after tower clear and before roll maneuver
ET aft dome outgassing and charring noted
Roll maneuver noted
Numerous pieces of debris noted in SSME plume during and after roll maneuver
084:13:13:52-084:13:14:05 - Multiple white flashes noted in SSME plume
Atmospheric bow waves noted
084:13:14:19 - LOV due to exhaust plume
No anomalies detected

Film Quality Description

Digital timing
Digs in film
Camera vibration

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E054

Location:	39-2 T4	Focus:	Good
Camera Type:	35PS	FOV:	
Film:	ECD 400'	Exposure:	Good
Lens Focal Length:	152mm	Timing:	Yes
FPS:	100	Date Received:	03/26/92
Timing:	B120	Date Screened:	03/26/92
		Screened By:	MS,SI,CS,LK,JDV

Film Quality

Orientation
Remote tracking coverage of upper one-third of Launch Vehicle.
Interval of coverage from ignition to 1200 ft.
View to record vehicle motion, structural integrity
and engine operation during early flight. Also to show possible
debris.

Comments
FSS deluge water noted
Twang noted
GH2 vent line drop noted
Roll maneuver noted
ET aft dome outgassing and charring noted
Numerous pieces of debris noted in SSME plume during and after roll
maneuver
084:13:13:55-084:13:14:05 - Multiple white flashes noted in SSME plume
084:13:14:00.940 - Four small orange pieces of debris (possibly RCS
paper) noted in SSME plume
Atmospheric bow waves noted in plume
LOV due to exhaust plume
No anomalies detected

Film Quality Description
No first frame identifier - last frame with eights used
Digital timing
Digs in film
Water spots on lens
Glare from SRB plume

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E057

Location:	39-6 T1	Focus:	Good
Camera Type:	35PS	FOV:	
Film:	ECD 400'	Exposure:	Good
Lens Focal Length:	200mm	Timing:	Yes
FPS:	100	Date Received:	03/27/92
Timing:	B120	Date Screened:	03/27/92
		Screened By:	CD,MS,SI,CS,LK

Film Quality

Orientation
Remote tracking coverage of lower one-half of Launch Vehicle including MLP Deck. Interval of coverage from ignition to 1200 ft.. View to record vehicle motion, structural integrity and engine operation during early flight.

Comments
FSS deluge water noted
MLP deluge water activated after liftoff
Vapor off SRB stiffener rings noted
ET aft dome outgassing and charring noted
Charring of RSRB stiffener rings (inboard) noted
Multiple pieces of debris noted from SSME plume
084:13:13:51 - White debris (probably ice) noted falling along the body flap
084:13:13:53.217 - Small white debris noted from LSRB area and fell aft
084:13:13:56-084:13:14:03 - Multiple white flashes noted in SSME plume
Atmospheric bow waves noted
084:13:14:11 - LOV due to clouds
No anomalies detected

Film Quality Description
Digital timing
Digs in film

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E059

Location:	39-6 T4	**Film Quality**	
Camera Type:	35PS	Focus:	Good
Film:	ECD 400'	FOV:	
Lens Focal Length:	200mm	Exposure:	Good
FPS:	100	Timing:	Yes
Timing:	B120	Date Received:	03/26/92
		Date Screened:	03/26/92
		Screened By:	CD,MS,SI,CS,LK,JDV

Orientation

Remote tracking coverage of upper one-half of Launch Vehicle.
Interval of coverage from ignition to 1200 ft.
View to record vehicle motion, structural integrity and engine operation during early flight. Also to show possible debris.

Comments

Roll maneuver noted
Atmospheric bow waves noted in plume
084:13:14:14.332 - LOV
No anomalies detected

Film Quality Description

No first frame identifier - last frame with eights used
Digital timing
Tracking did not correspond with OTV048
Digs and streaks on film
Water spots on lens
Glare from SSME and SRB plumes

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E060

Location:	39-1 11	**Film Quality**	
Camera Type:	35Mit	Focus:	Good
Film:	ECD 400'	FOV:	
Lens Focal Length:	100mm	Exposure:	Good
FPS:	96	Timing:	Yes
Timing:	B	Date Received:	03/27/92
		Date Screened:	03/27/92
		Screened By:	CD,MS,SI,CS,LK

Orientation
View of entire Launch Vehicle during ignition and liftoff.
View for structural surveillance and starting sequence.

Comments
FSS deluge water noted
Twang noted
GH2 vent arm retraction appeared normal
Frame 1012 - LOV
No anomalies detected

Film Quality Description

Item Number E062

Location:	39-3 09	**Film Quality**	
Camera Type:	35Mit	Focus:	Good
Film:	ECD 400'	FOV:	
Lens Focal Length:	100mm	Exposure:	Good
FPS:	96	Timing:	Yes
Timing:	B	Date Received:	03/27/92
		Date Screened:	03/27/92
		Screened By:	CD,MS,SI,CS,LK,GG

Orientation
View of entire Launch Vehicle during ignition and liftoff. View for structural surveillance and starting sequence.

Comments
Vapor off SRB stiffener rings noted
Frame 1369 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E063

		Film Quality	
Location:	39-4 09	Focus:	Good
Camera Type:	35Mit	FOV:	
Film:	ECD 400'	Exposure:	Good
Lens Focal Length:	100mm	Timing:	Yes
FPS:	96	Date Received:	03/27/92
Timing:	B	Date Screened:	03/27/92
		Screened By:	CD,MS,SI,CS,LK,GG

Orientation
View of entire Launch Vehicle during ignition and liftoff.
View for structural surveillance and starting sequence.

Comments
Twang noted
Vapor off SRB stiffener rings noted
Acoustic waves noted
Frame 1380 - LOV
No anomalies detected

Film Quality Description

Item Number E065

		Film Quality	
Location:	39-2 04	Focus:	Good
Camera Type:	16DBM5	FOV:	
Film:	ECD 400'	Exposure:	Good
Lens Focal Length:	20"	Timing:	Yes
FPS:	100	Date Received:	03/27/92
Timing:	B	Date Screened:	03/27/92
		Screened By:	CD,MS,SI,CS,LK

Orientation
Surveillance type view of LO2 feedline at entrance to ET intertank area, during ignition and liftoff. Include last sliding support prior to lines entering the intertank area.View to record TPS/Feedline Assembly
COMMITTED FOR DAYLIGHT LAUNCHES ONLY

Comments
Twang noted
Frame 1387 - Numerous pieces of white debris noted falling aft along the body flap after liftoff
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
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Item Number E076

Location:	39-3 03	**Film Quality**	
Camera Type:	35Mit	Focus:	Good
Film:	ECD 400'	FOV:	
Lens Focal Length:	20"	Exposure:	Good
FPS:	96	Timing:	Yes
Timing:	B	Date Received:	03/27/92
		Date Screened:	03/27/92
		Screened By:	CD,MS,SI,CS,LK,GG

Orientation

View of aft end of Orbiter and SSME's with MLP deck at bottom of frame. To show possible propulsion problems and free hydrogen burnoff system.

Comments

Normal RCS paper debris noted falling into SSME plume after SSME startup
LO2 carrier plate appeared to disconnect normally
Ice noted from LO2 TSM umbilical prior to and at disconnect
Frame 1034 - LOV
Acoustic waves noted
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E077

Location:	39-4 02	**Film Quality**	
Camera Type:	35Mit	Focus:	Good
Film:	ECD 400'	FOV:	
Lens Focal Length:	20"	Exposure:	Good
FPS:	96	Timing:	Yes
Timing:	B	Date Received:	03/27/92
		Date Screened:	03/27/92
		Screened By:	CD,MS,SI,CS,LK,GG,DM

Orientation

View of aft end of Orbiter and SSME's with MLP deck at bottom of frame. To show possible propulsion problems and free hydrogen burnoff system.

Comments

Frame 249 - Small flare noted near ROFI nozzle before SSME startup
LH2 carrier plate appeared to disconnect normally
Normal RCS paper debris noted falling into SSME plume after SSME startup
Debris noted from SRB area falling aft after liftoff
Frame 992 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
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Item Number E079

Location:	39-2 03	Focus:	Soft
Camera Type:	16DBM5	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	40"	Timing:	Yes
FPS:	100	Date Received:	03/27/92
Timing:	B	Date Screened:	03/27/92
		Screened By:	CD,MS,SI,CS,LK

Film Quality

Orientation

Surveillance type view of tip of ET in frame with FSS target in background to show deflection of ET tip. Also to show +Y ET GO2 Vent Louver and +Y Ogive TPS icing conditions at time of launch. Include black and white target on FSS at top edge of frame.

Comments

Frost and vapor noted on GOX vent
Twang noted
Two pieces of debris noted falling along ET LO2 feed line between Orbiter and ET at liftoff (one of the pieces connected up to a joint on the LO2 feed line)
Multiple pieces of white debris noted falling aft along the body flap after liftoff
Frame 1691 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
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Item Number E204

Location:	PAFB PIGOR	**Film Quality**	
Camera Type:	35Mit	Focus:	Soft
Film:	ECD 1000'	FOV:	
Lens Focal Length:	360"	Exposure:	*
FPS:	72	Timing:	Yes
Timing:	B	Date Received:	03/27/92
		Date Screened:	03/27/92
		Screened By:	CD,MS,SI,CS,LK,DM

Orientation

Track to view overall Launch Vehicle from acquisition to LOV. Continue track of ORB/ET during and after SRB separation. DO NOT TRACK SEPARATED SRB'S. Operational at 0-390 mins. Perform Pad checks at 0-375 mins and 0-25 mins. Central Computer will drive Theoretical Trajectories at 0-200 mins. and 0-130 mins. Provide on-track data from 0-10 mins. or termination of 0-25 min pad checks. Film run from AOV to LOV. Angle data committed for Range Safety from T-0 to T+50 secs. FIDUCIALS REQUIRED.

Comments

Charring of the ET aft dome noted
Frame 7863, Frame 8021, Frame 8090 - Three orange pulses noted in LSRB plume
SRB plume brightening noted
Frame 8815 - SRB separation noted
No anomalies detected

Film Quality Description

*Low contrast
Blue streaks on right side of film

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E205

Location:	SHILOH IFLOT	**Film Quality**	
Camera Type:	35Mit	Focus:	Good
Film:	ECD 1000'	FOV:	
Lens Focal Length:	200"	Exposure:	Dark
FPS:	72	Timing:	Yes
Timing:	B	Date Received:	03/27/92
		Date Screened:	03/27/92
		Screened By:	CD,MS,SI,CS,LK

Orientation

Track to view overall Launch Vehicle from acquisition to LOV. Continue track of ORB/ET during and after SRB separation. DO NOT TRACK SEPARATED SRB'S. View to record vehicle structural integrity. Focus on hyperfocal distance. Period of focus: T+25 sec. to inf.
FIDUCIALS REQUIRED.

Comments

Linear optical distortion noted
Frame 5008-Frame 5879 - Recirculation noted (T)
Three orange pulses noted in LSRB plume just prior to plume brightening
Frame 7253 - SRB separation noted
No anomalies detected

Film Quality Description

Intermittent LOV due to clouds

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E207

Location:	UCS 10 MIGOR	**Film Quality**	
Camera Type:	35Mit	Focus:	Good
Film:	ECD 1000'	FOV:	
Lens Focal Length:	180"	Exposure:	Dark
FPS:	96	Timing:	No
Timing:	B	Date Received:	03/26/92
		Date Screened:	03/26/92
		Screened By:	CD,MS,SI,CS,LK,JDV

Orientation
Primary FOV is rear of ORB and Body Flap until SRB separation.
After separation, track NORTH SRB to LOV.

PROVIDE ON-TRACK DATA TO MOTHER COMPUTER.
Film run from AOV of ORB to LOV of SRB. Operational at 0-390 mins. Perform pad checks at 0-375 mins and 0-25 mins. Central computer will drive Theoretical Trajectories at 0-200 mins and 0-130 mins. Provide on-track data from 0-10 mins or termination of 0-25 min Pad checks. Hot backup for Range Safety. FIDUCIALS REQUIRED.

Comments
Frame 3725 - Slight body flap motion noted
ET aft dome charring noted
Frame 4810, Frame 5215, Frame 9528, Frame 9547, Frame 10275 - Linear optical distortions noted
Frame 10452, Frame 10665, Frame 10760 (M) - Three orange pulses noted in LSRB exhaust plume
Frame 10544 - Orange pulse noted in RSRB plume
SRB plume brightening noted
Frame 11744 - SRB separation noted
No anomalies detected

Film Quality Description
Intermittent LOV due to clouds
Digs in film

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E208

Location:	C.B. DOAMS	**Film Quality**	
Camera Type:	35Mit	Focus:	Good
Film:	ECD 1000'	FOV:	
Lens Focal Length:	200"	Exposure:	Good
FPS:	48	Timing:	Yes
Timing:	B	Date Received:	03/26/92
		Date Screened:	03/26/92
		Screened By:	CD,MS,SI,CS,LK

Orientation

Track to view overall Launch Vehicle from acquisition to LOV. Continue track of ORB/ET during and after SRB separation. DO NOT TRACK SEPARATED SRB'S. PROVIDE ON-TRACK DATA TO MOTHER COMPUTER. Film run from first acquisition. Not committed for Range Safety.

FIDUCIALS REQUIRED.

FIXED FOCUS ON HYPERFOCAL DISTANCE.

Comments

ET aft dome charring noted
Frame 3699 - Orange pulse noted in LSRB exhaust plume
Frame 4171 - SRB separation noted
No anomalies detected

Film Quality Description

Intermittent LOV due to clouds after AOV
Numerous small digs on film

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E211

Location:	UCS-16 IFLOT	Focus:	Soft
Camera Type:	35PS	FOV:	
Film:	ECD 1000'	Exposure:	*
Lens Focal Length:	800mm	Timing:	Yes
FPS:	100	Date Received:	03/27/92
Timing:	B120	Date Screened:	03/27/92
		Screened By:	CD,MS,SI,CS,LK,DM

Film Quality

Orientation
Tracking: To show forward portion of Launch Vehicle from AOV to LOV.
Focus on hyperfocal distance. Period of focus: T-0 to LOV.

Comments
Roll maneuver noted
084:13:14:25 - LOV
084:13:15:49 - AOV
SRB separation noted
No anomalies detected

Film Quality Description
Digital timing
*Low contrast
Intermittent LOV due to clouds
Erratic tracking
Processing stains in middle of film
Emultion scratch by-product at lower center of FOV

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E212

Location:	UCS-23 ATOTS	**Film Quality**	
Camera Type:	35Mit	Focus:	Good
Film:	ECD 1000'	FOV:	
Lens Focal Length:	400"	Exposure:	Good
FPS:	64	Timing:	Yes
Timing:	B	Date Received:	03/26/92
		Date Screened:	03/26/92
		Screened By:	CD,MS,SI,CS,LK,BP

Orientation
Tracking: View of SRB Nozzles from AOV to LOV. To record Vehicle motion, structural integrity, and possible debris.

Operational at 0-390 mins. Perform pad checks at 0-375 mins and 0-25 mins. Central computer will drive Theoretical trajectories at 0-200 mins and 0-130 mins. Provide on-track data from 0-10 mins or termination of 0-25 min pad checks.

NOT COMMITTED FOR RANGE SAFETY

Comments
Roll maneuver noted
Frame 1219-Frame 1317 - Multiple pieces of light colored debris appeared near the SSMEs during roll maneuver and fell aft
Body flap motion noted
Frame 1708 - Single orange piece of debris noted from near LSRB nozzle area after roll maneuver. The debris traveled in an arc toward the SSME plume and fell aft into LSRB exhaust plume
Frame 2192 - Large light piece of debris noted from behind SSME #1 broke into two pieces and fell aft (M)
Charring of RSRB stiffener rings on inboard side noted
ET aft dome charring noted
Frame 4942 - Large orange piece of debris noted from the aft end of the LSRB and fell aft (M) (T)
Frame 7895 - Three orange pulses noted in LSRB exhaust plume
SRB plume brightening noted
Frame 8581 - SRB separation noted
Slag noted after SRB separation from both SRBs
No anomalies detected

Film Quality Description
Intermittent LOV due to clouds
Numerous digs in film
Blue streaks noted on right half of film

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E213

Location:	UCS-12 MOTS	Focus:	Good
Camera Type:	35Mit	FOV:	
Film:	ECD 400'	Exposure:	Good
Lens Focal Length:	800mm*	Timing:	Yes
FPS:	96	Date Received:	03/26/92
Timing:	B	Date Screened:	03/26/92
		Screened By:	CD,MS,SI,CS,LK

Film Quality

Orientation
Tracking: FORWARD portion of Launch Vehicle from AOV to LOV. To record possible debris. Focus on hyperfocal distance (1.6 mi). As image size decreases, include entire vehicle in frame.
FIDUCIALS REQUIRED.

*Nikkor lens

Comments
ET aft dome outgassing noted
Vapor off SRB stiffener rings noted
ET aft dome charring noted
Multiple pieces of light colored debris noted from the SSMEs and fell aft after roll maneuver
Frame 2402-Frame 2444 - A single piece of debris noted from behind the underside of the body flap and entrained in recirculation flow
Frame 2662 - White flashes noted in SSME plume after roll maneuver
Multiple pieces of small debris noted from SSME area and fell aft after roll maneuver
Frame 3113-Frame 3143 - Single white piece of debris noted from behind SSME #1 broke into two pieces and fell aft after roll maneuver
Frame 5143 - LOV due to exhaust plume
No anomalies detected

Film Quality Description
Blue streaks noted on film

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E218

Location:	UCS-26 IFLOT	**Film Quality**	
Camera Type:	35Mit	Focus:	Good
Film:	ECD 1000'	FOV:	
Lens Focal Length:	120"	Exposure:	Good
FPS:	96	Timing:	Yes
Timing:	B	Date Received:	03/27/92
		Date Screened:	03/27/92
		Screened By:	CD,MS,SI,CS,LK,DM

Orientation
Track entire Vehicle from AOV to LOV. To record vehicle motion, structural integrity, engine operation and possible debris. Focus on hyperfocal distance.

Comments
Charring of ET aft dome noted
Orange pulse noted in LSRB plume prior to plume brightening
Frame 10027 - SRB separation noted
No anomalies detected

Film Quality Description
Intermittent LOV due to clouds

Item Number E220

Location:	U247L116 IFLOT	**Film Quality**	
Camera Type:	35Mit	Focus:	
Film:	ECD 1000'	FOV:	
Lens Focal Length:	120"	Exposure:	
FPS:	96	Timing:	
Timing:	B	Date Received:	/ /
		Date Screened:	03/26/92
		Screened By:	

Orientation
Track FORWARD portion of Launch Vehicle from AOV to LOV. To record possible debris. Focus on Vehicle at active pad.
As image size decreases,include entire vehicle in frame.
39A= 5.49 st.mi.
Period of focus: T-0 to T+35 sec.

Comments
No run

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E222

Location:	S.BCH SITE IFLOT	Focus:	Good
Camera Type:	35PS	FOV:	
Film:	ECD 400'	Exposure:	Good
Lens Focal Length:	800mm	Timing:	Yes
FPS:	100	Date Received:	03/26/92
Timing:	B120	Date Screened:	03/26/92
		Screened By:	CD,MS,SI,CS,LK

Film Quality

Orientation
Tracking: Rear portion of Launch Vehicle from AOV to LOV. To record possible debris. Focus on Vehicle at active pad.
39A=2.46 st.mi. Period of focus: T-0 to T+50 secs.

Comments
Vapor off SRB stiffener rings noted
Roll maneuver noted
084:13:13:52-084:13:14:17.131 - Multiple pieces of white debris noted from SSME area and fell aft
084:13:13:55-084:13:14:06.695 - White flashes noted in SSME plume (Frame 2787) (M)
084:13:14:00.006 - Flare noted in SSME plume
084:13:14:03.674 - Single large piece of debris appeared to originate from the LO2 umbilical area and fell aft along the body flap and entrained in recirculation flow. The debris did not appear to strike the vehicle
084:13:14:11.277-084:13:14:11.595 - Single white piece of debris noted from behind SSME #1 broke into two pieces and fell aft
084:13:14:18.334 (Frame 4292) - Flare noted in SSME plume (M)
No anomalies detected

Film Quality Description
Digital Timing
Digs in film

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number E223

Location:	UCS-9 IFLOT	Focus:	Soft
Camera Type:	35Mit	FOV:	
Film:	ECD 1000'	Exposure:	Good
Lens Focal Length:	80"	Timing:	Yes
FPS:	96	Date Received:	03/26/92
Timing:	B	Date Screened:	03/27/92
		Screened By:	JD,RB,BG,LK

Film Quality

Orientation

Tracking: FORWARD portion of Launch Vehicle from AOV to LOV. To record possible debris. Focus on Vehicle at active pad.
39A=4.35 st.mi. Period of focus: T-0 to T+50 secs.
As image size decreases,include entire vehicle.

Comments

ET aft dome outgassing noted
Vapor off both SRB stiffener rings noted
Roll maneuver noted
Debris in SSME plume during roll maneuver
Intermittent LOV due to clouds
Charring of ET aft dome noted
Three orange pulses from the left SRB noted in SRB plume
Plume brightening noted
SRB separation noted
No anomalies detected

Film Quality Description

Viewed on Tokiwa projector
Major digs and scratches throughout film, soft focus hinders analysis

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Photo/TV Analysis Group Evaluation Report
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Item Number E224

Location:	UCS-16 IFLOT	Focus:	Good
Camera Type:	35PS	FOV:	
Film:	ECD 400'	Exposure:	Soft
Lens Focal Length:	800MM	Timing:	Yes*
FPS:	100	Date Received:	03/26/92
Timing:	B120	Date Screened:	03/27/92
		Screened By:	JD,RB,BG,LK

Film Quality

Orientation
Close-in tracking coverage to show AFT portion of Launch Vehicle from AOV to LOV. Focus on Launch Vehicle at Pad. View to record vehicle motion, structural integrity, and engine operation during early flight.
39A=3.31 st.mi.

Comments
Roll maneuver noted
Intermittent LOV due to clouds
Frame 4917 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number KTV2

Location:	SLF CONVOY	Focus:	Good
Camera Type:	RCA	FOV:	
Film:		Exposure:	Good
Lens Focal Length:	14X10	Timing:	Yes
FPS:	30	Date Received:	03/24/92
Timing:		Date Screened:	03/24/92
		Screened By:	CD,RB,CS,BG,JW,FB

Film Quality

Orientation
RCA TK76A FUJINON 14 X 10 ZOOM lens with a 2 X extender or a 30 x 26 lens with a 1.7 X extender. SRB exhaust.

Comments
Wind shear noted in plume
No anomalies detected

Film Quality Description
Interference noted throughout video

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number KTV4A

Location:	PAD A	Focus:	Variable
Camera Type:		FOV:	
Film:		Exposure:	Variable
Lens Focal Length:	30X26	Timing:	Yes
FPS:	30	Date Received:	03/24/92
Timing:		Date Screened:	03/24/92
		Screened By:	CD,CS,RB,BG,FB,JW

Film Quality

Orientation
RCA TK76B color camera.

Comments
Vapor off SRB stiffener rings noted
Overshoot of roll maneuver noted
084:13:14:11.425 - Light colored piece of debris first seen near base of vertical stabilizer appeared to fall aft of vehicle.
084:13:14:57.104 - Light colored debris fell from SRB plume
084:13:14:58.572 - Puff noted near SRB plume
084:13:15:37.878 - Pulse in SRB plume behind left SRB noted
084:13:15:41.381 - ~ Start of expected SRB plume brightening
084:13:15:48.155 - SRB separation noted

Film Quality Description
Cloud cover hampered viewing

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number KTV5

Location:	VAB ROOF	**Film Quality**	
Camera Type:	RCA	Focus:	Variable
Film:		FOV:	
Lens Focal Length:	30X26	Exposure:	Good
FPS:	30	Timing:	Yes
Timing:		Date Received:	03/24/92
		Date Screened:	03/24/92
		Screened By:	CD,RB,CS,BG,JW

Orientation

RCA TK760B color camera SCHNEIDER 30 X 26 lens with a 1.7 X extender and 900 feet of camera cable. Viewed from southwest. Prior to liftoff past SRB separation.

Comments

084:13:15:37.878 - Pulse in SRB plume behind the left SRB noted
084:13:15:48.155 - SRB separation noted

Film Quality Description

Camera vibration noted
084:13:14:42.690 - Video dropout
Hazy

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number KTV7A

Location:	PAD A	Focus:	Good
Camera Type:		FOV:	
Film:		Exposure:	Good
Lens Focal Length:	14X10	Timing:	Yes
FPS:	10	Date Received:	03/24/92
Timing:		Date Screened:	03/24/92
		Screened By:	CD,RB,CS,BG

Film Quality

Orientation
RCA RK76B Camera with AC Power Pack and FUJINON 14 X 10 ZOOM lens with a 2 X extender. This camera is located at the Launch Pad perimeter camera site 2 (CS-2) on a remotely controlled mount to provide a profile view for prelaunch and liftoff. View from east.

Comments
084:13:13:40 - ~Liftoff
Two birds in FOV
No anomalies detected

Film Quality Description

Item Number KTV11

Location:	TV TOWER 1	Focus:	Good
Camera Type:	RCA	FOV:	
Film:		Exposure:	Good
Lens Focal Length:		Timing:	Yes
FPS:	30	Date Received:	03/24/92
Timing:		Date Screened:	03/24/92
		Screened By:	RB,CS,BG

Film Quality

Orientation
From the north TV tower # 7 at SLF. RCA TK76B color camera, w/ a 2X extender and a 1.7X teleconverter.

Comments
Wind shear noted
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
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Item Number KTV13

Location:	COCOA BEA.	**Film Quality**	
Camera Type:	RCA	Focus:	Good
Film:		FOV:	
Lens Focal Length:		Exposure:	Good
FPS:	30	Timing:	Yes
Timing:		Date Received:	03/24/92
		Date Screened:	03/24/92
		Screened By:	CD,RB,CS,BG

Orientation
RCA TK710 provides coverage after loss of view from KSC cameras.

Comments
084:13:14:23.866 - Video starts
084:13:15:37.706-084:13:15:38.140 - Pulse in SRB plume behind the left SRB noted
084:13:15:41 - ~SRB plume brightening noted
084:13:15:48.117 - SRB separation noted
Slag after SRB separation noted

Film Quality Description
084:13:17:15 - video breakup (~13 frames)
Hazy

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number KTV21A

		Film Quality	
Location:	S. OF PADA	Focus:	Good
Camera Type:		FOV:	
Film:		Exposure:	Variable
Lens Focal Length:		Timing:	Yes
FPS:	30	Date Received:	03/24/92
Timing:		Date Screened:	03/24/92
		Screened By:	CD,RB,CS,BG

Orientation
View from south liftoff past SRB separation.

Comments
Vapor off stiffener rings noted
Roll maneuver noted
Wind shear in SRB plume noted
084:13:14:44.283 - Vehicle became obscured by SRB plume
No anomalies detected

Film Quality Description
Slight camera vibration noted

Item Number OTV061

		Film Quality	
Location:	Pad A FSS 255	Focus:	Good
Camera Type:	Video	FOV:	
Film:		Exposure:	Good
Lens Focal Length:		Timing:	Yes
FPS:	30	Date Received:	03/24/92
Timing:		Date Screened:	03/24/92
		Screened By:	CD,CS,RB,BG,GG,JW,FB

Orientation
ET scan (color) fire surveillance - left SRB and TPS on left side of Orbiter as vehicle moves through scene.

Comments
FSS deluge water noted
Twang noted
No anomalies detected

Film Quality Description
Water drops on lens noted

Photo/TV Analysis Group Evaluation Report
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Item Number OTV063

Film Quality

Location:	Pad A FSS 155	Focus:	Good
Camera Type:	Video	FOV:	
Film:		Exposure:	Good
Lens Focal Length:		Timing:	Yes
FPS:	30	Date Received:	03/24/92
Timing:		Date Screened:	03/24/92
		Screened By:	CD,RB,CS,BG,GG,JW,FB

Orientation
Lower third of vehicle left SRB - left side of Orbiter and external and external tank attach point with Orbiter.

Comments
084:13:13.40.131 - Liftoff
FSS deluge water noted
084:13:13:31.689 - Fast moving light colored debris fell along left wing prior to SSME ignition
Light colored debris fell from umbilicals. Did not appear to strike the vehicle.
No anomalies detected

Film Quality Description
Strong winds and FSS deluge water hampered view

Item Number OTV070

Film Quality

Location:	SE Pad A	Focus:	Good
Camera Type:	Video	FOV:	
Film:		Exposure:	Good
Lens Focal Length:		Timing:	yes
FPS:	30	Date Received:	03/24/92
Timing:		Date Screened:	03/24/92
		Screened By:	CD,RB,CS,BG,FB,JW

Orientation
Fire surveillance (color) south east field close up of SSMEs at ignition.

Comments
White debris from the oxygen TSM area noted
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number OTV071

Location:	SW Pad A	**Film Quality**	
Camera Type:	Video	Focus:	Good
Film:		FOV:	
Lens Focal Length:		Exposure:	Good
FPS:	30	Timing:	Yes
Timing:		Date Received:	03/24/92
		Date Screened:	03/24/92
		Screened By:	CD,RB,CS,BG,JW,FB

Orientation
Fire surveillance (color) fixed service structure on left and water tower on right full vehicle. View from southwest.

Comments
Light colored pieces of debris seen below vertical stabilizer.
Appeared to originate from behind the tail.
No anomalies detected

Film Quality Description

Item Number OTV009

Location:	Pad A FSS 95	**Film Quality**	
Camera Type:	Video	Focus:	Good
Film:		FOV:	
Lens Focal Length:		Exposure:	Good
FPS:		Timing:	Yes
Timing:		Date Received:	03/24/92
		Date Screened:	03/24/92
		Screened By:	CD,RB,CS,BG,MS

Orientation
Left side of vehicle. Orbiter ET interface and TPS. East side.

Comments
Slight vapor at top of LH2 umbilical noted
084:13:13:36.260 - Ice noted falling from umbilical
FSS deluge water noted
No anomalies detected

Film Quality Description
Deluge water hampers analysis

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number OTV041

Location:	39A-2	**Film Quality**	
Camera Type:	Video	Focus:	Good
Film:		FOV:	
Lens Focal Length:		Exposure:	Good
FPS:	30	Timing:	Yes
Timing:		Date Received:	03/24/92
		Date Screened:	03/24/92
		Screened By:	CD,RB,CS,BG

Orientation

Upper portion of vehicle on pad. Short range tracker. Black and white video.

Comments

Roll maneuver noted
084:13:14:13 - Vehicle obscured by SRB plume
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
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Item Number OTV048

Location:	39A-6	**Film Quality**	
Camera Type:	Video	Focus:	Good
Film:		FOV:	
Lens Focal Length:		Exposure:	Good
FPS:	30	Timing:	Yes
Timing:		Date Received:	03/24/92
		Date Screened:	03/24/92
		Screened By:	CD,CS,RB,BG

Orientation
Goertz track video. Black and white video. Looks at upper part of vehicle from northwest. Photo tracker Boresight.

Comments
084:13:13:40 - ~Liftoff
ET aft dome outgassing noted
Roll maneuver noted
084:13:13:47 - Sun reflection off right SRB during roll maneuver noted
084:13:14:06 - Atmospheric bow wave noted
084:13:14:07 - Vehicle obscured by SRB plume
No anomalies detected

Film Quality Description
Rolling horizontal banding noted

Photo/TV Analysis Group Evaluation Report
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Item Number OTV049

		Film Quality	
Location:	Pad A MLP 0	Focus:	Variable
Camera Type:	Video	FOV:	
Film:		Exposure:	Good
Lens Focal Length:		Timing:	Yes
FPS:		Date Received:	03/24/92
Timing:		Date Screened:	03/24/92
		Screened By:	CD,CS,RB,BG

Orientation
T-0 LO2 umbilical disconnect. Left side of 1-E.

Comments
No anomalies detected

Film Quality Description
Horizontal banding noted

Item Number OTV051

		Film Quality	
Location:	Pad A MLP	Focus:	Good
Camera Type:	Video	FOV:	
Film:		Exposure:	Good
Lens Focal Length:		Timing:	Yes
FPS:		Date Received:	03/24/92
Timing:		Date Screened:	03/24/92
		Screened By:	CD,CS,RB,BG

Orientation
LO2 AFT umbilical interface, APU exhaust No. 3 & main engine area.
Side 1-East.

Comments
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
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Item Number OTV054

Location:	Pad A MLP	**Film Quality**	
Camera Type:	Video	Focus:	Good
Film:		FOV:	
Lens Focal Length:		Exposure:	Good
FPS:		Timing:	Yes
Timing:		Date Received:	03/24/92
		Date Screened:	03/24/92
		Screened By:	CD,CS,RB,BG

Orientation
MLP side 4, 0-ft. level. Orbiter to ET interface underside of Orbiter wind and TPS.

Comments
Several small light colored pieces of debris noted from the ET area
Several small light colored pieces of debris fell from umbilical area
No anomalies detected

Film Quality Description
Horizontal banding hampers viewing

Item Number OTV060

Location:	Pad A	**Film Quality**	
Camera Type:	Video	Focus:	Good
Film:		FOV:	
Lens Focal Length:		Exposure:	Good
FPS:		Timing:	Yes
Timing:		Date Received:	03/24/92
		Date Screened:	03/24/92
		Screened By:	CD,CS,RB,BG

Orientation
LOX vent arm hood seals (color) water tower- View from north east SRB attach points stiffener rings field joints and factory joints visible. Good view of north side of vehicle and tail as it moves through scene at liftoff.

Comments
Twang noted
GH2 vent arm retracts normally
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number EL002

Location:	SITE C S. TWR	Focus:	Good
Camera Type:	35PS	FOV:	
Film:	ECD	Exposure:	Good
Lens Focal Length:	135mm	Timing:	Yes
FPS:	48	Date Received:	04/07/92
Timing:	B	Date Screened:	04/08/92
		Screened By:	MS,JD

Film Quality

Orientation

Tracking coverage of ORB landing. Acquire during final approach. Start camera at L-15 sec. and run thru wheel-stop. View for possible contingency, also for elevon and speed-brake positions. Use Range type cable, edge timing only.
View of right side of vehicle.

Comments

Frame 275 - Wheel doors open
Frame 739 - Contrail off right wing (tip) at runway threshold
Bright area noted on right wing leading edge during landing flare (probably light reflection)
Frame 1123 - ~ Main gear touchdown
Nose wheel touchdown obscured by vegetation
Frame 3800 - ~ Wheel stop
Frame 4270 - End of film
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number EL004

Location:	SITE F N. TWR.	**Film Quality**	
Camera Type:	35PS	Focus:	Soft
Film:	ECD	FOV:	
Lens Focal Length:	135mm	Exposure:	Good
FPS:	48	Timing:	Yes
Timing:	B	Date Received:	04/07/92
		Date Screened:	04/08/92
		Screened By:	MS,JD

Orientation

Tracking coverage of ORB landing. Acquire during final approach. Start camera at L-15 sec. and run thru wheel-stop. View for possible contingency, also for elevon and speed-brake positions. Use Range type cable, edge timing only.
View of left side of vehicle.

Comments

Frame 968 - ~ Main gear touchdown
Nose gear touchdown to far away to verify frame number
Frame 3736 - Wheel stop
APU venting noted after wheel stop
Frame 6045 - End of film
No anomalies detected

Film Quality Description

Haze obscures view at longer ranges
Dig in film
Scratches in left side of view - caused by projector

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number EL008

		Film Quality	
Location:	SITE 4 S.END	Focus:	Good
Camera Type:	35PS	FOV:	
Film:	ECD	Exposure:	Good/Dark
Lens Focal Length:	105mm	Timing:	Yes
FPS:	100	Date Received:	04/07/92
Timing:	B	Date Screened:	04/08/92
		Screened By:	MS,JD

Orientation

View looking SOUTH to record landing gear deployment. Locate camera on runway centerline and at elevation of 15 degrees. Use Range type cable, edge timing only.

REMOTE START 1

Orbiter passes overhead.

Comments

Frame 849 - LOV
Frame 932 - Contrail off left wing tip
View of underside of left wing, left fuselage and left landing gear as Orbiter passes overhead
Underside is too dark to see tiles
Frame 971 - LOV
No anomalies detected

Film Quality Description

No first frame identifier - first white frame used as first frame

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Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number EL011

Location:	SITE E IFLOT	Focus:	Good
Camera Type:	35PS	FOV:	
Film:	ECD 400'	Exposure:	Good
Lens Focal Length:	135mm	Timing:	Yes
FPS:	48	Date Received:	04/07/92
Timing:	B	Date Screened:	04/08/92
		Screened By:	MS,JD

Film Quality

Orientation
Tracking coverage of ORB landing. Acquire during final approach. Start camera at L-15 sec. and run thru wheel-stop. View for possible contingency, also for elevon and speed-brake positions. View of left side of vehicle.

Comments
11:23:05.050 (Frame 860) - Right main gear touchdown
11:23:05.243 (Frame 869) - Left main gear touchdown
11:23:13.702 (Frame 1262) - Nose gear touchdown
11:24:01.702 (Frame 3492) - ~ Wheel stop
11:24:16.742 (Frame 4192 - Last frame
No anomalies detected

Film Quality Description
Digital timing
Last 888888 used for first frame identifier

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number EL005

Location:	SITE F N. TWR.	**Film Quality**	
Camera Type:	16PS	Focus:	Soft
Film:	ECD	FOV:	
Lens Focal Length:	75mm	Exposure:	Dark
FPS:	48	Timing:	*
Timing:	B	Date Received:	04/07/92
		Date Screened:	04/08/92
		Screened By:	JD,MS

Orientation

Tracking coverage of ORB landing. Acquire during final approach. Start camera at L-15 sec. and run thru wheel-stop. View for possible contingency, also for elevon and speed-brake positions. Use Range type cable, edge timing only.
View of left side of vehicle.

Comments

Frame 3838 - ~ Wheel stop
No anomalies detected

Film Quality Description

Film too dark for useful analysis
*Timing marks, if present, are overexposed

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number EL003

Location:	SITE C S. TWR	Focus:	Soft
Camera Type:	16PS	FOV:	
Film:	ECD 400'	Exposure:	Dark
Lens Focal Length:	75mm	Timing:	Yes
FPS:	48	Date Received:	04/07/92
Timing:	B	Date Screened:	04/08/92
		Screened By:	JD,MS

Film Quality

Orientation

Tracking coverage of ORB landing. Acquire during final approach. Start camera at L-15 sec. and run thru wheel-stop. View for possible contingency, also for elevon and speed-brake positions.

USE RANGE TYPE CABLE, EDGE TIMING ONLY.

Comments

Frame 237 - ~ Wheel doors open
Main gear touchdown obscured by vegetation
Nose wheel touchdown obscured by vegetation
Frame 3651 - ~ Wheel stop
Frame 3787 - End of film
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number EL009

Location:	SITE 4 S.END	Focus:	Soft
Camera Type:	16MIT	FOV:	
Film:	ECD 400'	Exposure:	Dark
Lens Focal Length:	12"	Timing:	No
FPS:	96	Date Received:	04/07/92
Timing:	B+1K	Date Screened:	04/08/92
		Screened By:	JD,MS

Film Quality

Orientation
Camera located on runway centerline. Level camera with spirit-level. Provide view looking NORTH to cover nose gear and main gear tracking during touchdown and rollout. Also to view elevon and speed-brake positions.

Remote start 2

Comments
Frame 1268 - AOV
Frame 1544 - Contrail off left wing tip prior to touchdown
Frame 1677 - Right main gear touchdown
Frame 1688 - Left main gear touchdown
Frame 2043 - Vaporous cloud over forward portion of right wing (possible contrail or dust)
Frame 2456 - Apparent vapor trail at back of both wings after main gear touchdown. Could be dust cloud from runway
No anomalies detected

Film Quality Description
Camera FOV tilted slightly low

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number EL030

Film Quality

Location:	UCS-9 IFLOT	Focus:	Soft
Camera Type:	16MIT	FOV:	
Film:	ECD	Exposure:	Dark
Lens Focal Length:	40"	Timing:	Yes
FPS:	48	Date Received:	04/07/92
Timing:	B+1K	Date Screened:	04/08/92
		Screened By:	JD,MS

Orientation
Tracking coverage of ORB during final approach for landing to LOV. Do not start camera before L-4 min. In event of crew ejection, continue track of vehicle.
View of right side of vehicle.

Comments
Frame 4278 - AOV
Frame 7350 - LOV
Frame 7461 - Bird in foreground
Frame 10,057 - End of film
No anomalies detected

Film Quality Description
View very dark, hindering analysis

Item Number EL031

Film Quality

Location:	UCS-3 IFLOT	Focus:	Soft
Camera Type:	16MIT	FOV:	
Film:	ECD	Exposure:	Dark
Lens Focal Length:	40"	Timing:	Yes
FPS:	48	Date Received:	04/07/92
Timing:	B+1K	Date Screened:	04/08/92
		Screened By:	JD,MS

Orientation
Tracking coverage of ORB during final approach for landing to LOV. Do not start camera before L-4 min. In event of crew ejection, continue track of vehicle.
View of right side of vehicle.

Comments
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number IR1

		Film Quality	
Location:	Midfield	Focus:	Variable
Camera Type:		FOV:	
Film:		Exposure:	Variable
Lens Focal Length:		Timing:	No
FPS:		Date Received:	04/02/92
Timing:		Date Screened:	04/02/92
		Screened By:	JH,MS,SI

Orientation
Left side of vehicle.

Comments
HAC noted
LOV prior to touchdown
No anomalies detected

Film Quality Description
View does not appear to be IR

Item Number IR2

		Film Quality	
Location:	Midfield	Focus:	Good
Camera Type:		FOV:	
Film:		Exposure:	Good
Lens Focal Length:		Timing:	Yes*
FPS:		Date Received:	04/02/92
Timing:		Date Screened:	04/02/92
		Screened By:	JH,MS,SI

Orientation
Left side of vehicle.

Comments
Bright spot noted behind nose cap on underside of the vehicle
HAC noted
093:11:22:41 - LOV prior to touchdown
No anomalies detected

Film Quality Description
In-frame timing

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number IR3

Location:	Site B	**Film Quality**	
Camera Type:		Focus:	Variable
Film:		FOV:	
Lens Focal Length:		Exposure:	Variable
FPS:		Timing:	No
Timing:		Date Received:	04/02/92
		Date Screened:	04/02/92
		Screened By:	JH,MS,SI

Orientation
Bionetics video. Eastside of SLF. Right side of vehicle.
IR camera

Comments
HAC noted
Wheels down noted
Main gear touchdown noted
APU venting noted
Nose gear touchdown noted
No anomalies detected

Film Quality Description
Low radiometric and spatial resolution
Horizontal video distortion (possibly during lens change)

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number IR4

Film Quality

Location:	Site E	Focus:	Variable
Camera Type:		FOV:	
Film:		Exposure:	Variable
Lens Focal Length:		Timing:	No
FPS:		Date Received:	04/02/92
Timing:		Date Screened:	04/02/92
		Screened By:	JH,MS,SI

Orientation
Bionetics video. Westside of SLF. Left side of vehicle.
IR camera

Comments
Contrail noted behind vehicle during descent
Wheels down noted
Main gear touchdown noted
Nose gear touchdown noted
APU venting noted
Wheel stop noted
No anomalies detected

Film Quality Description
Horizontal video distortion (possibly during lens change)

Item Number KTV1L

Film Quality

Location:	Mobile	Focus:	Good
Camera Type:		FOV:	
Film:		Exposure:	Good
Lens Focal Length:		Timing:	Yes
FPS:		Date Received:	04/02/92
Timing:		Date Screened:	04/02/92
		Screened By:	JH,CS,SI,MS

Orientation
Mobile TV Van in convoy at SLF

Comments
Video started after wheel stop approximately 3 minutes after touchdown.

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number KTV5L

Location:	VAB Video	Focus:	Good
Camera Type:		FOV:	
Film:		Exposure:	Light
Lens Focal Length:	30x26	Timing:	Yes
FPS:		Date Received:	04/02/92
Timing:		Date Screened:	04/02/92
		Screened By:	JH,CS,SI,MS

Film Quality

Orientation
RCA TK760B color camera, Schneider 30x26 lens with a 1.7x extender.
Right side of vehicle.

Comments
Low contrast due to fog hampers ananlysis
093:11:23:04 - ~ Main gear touchdown
Nose gear touchdown and wheel stop were unable to be determined
No anomalies detected

Film Quality Description

Item Number KTV6L

Location:	MDD Video	Focus:	Good
Camera Type:		FOV:	
Film:		Exposure:	Good
Lens Focal Length:	14x10	Timing:	Yes
FPS:		Date Received:	04/02/92
Timing:		Date Screened:	04/02/92
		Screened By:	JH,CS,SI,MS

Film Quality

Orientation
RCA TK76B color camera. 14x10 Fujinon lens. Right side of vehicle.

Comments
093:11:23:05.088 - Main gear touchdown noted
093:11:23:13.597 - ~ Nose gear touchdown noted
093:11:24:00 - Wheel stop
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number KTV11L

		Film Quality	
Location:	Tower #1 Video	Focus:	Variable
Camera Type:		FOV:	
Film:		Exposure:	Light
Lens Focal Length:	14x10	Timing:	Yes
FPS:	30	Date Received:	04/02/92
Timing:		Date Screened:	04/02/92
		Screened By:	JH,CS,SI,MS

Orientation
RCA TK6B color camera. 14x10 Fujinon zoom lens with a 2x extender and a 1.7x teleconverter. Right side of vehicle.

Comments
Main gear and nose gear touchdown were obscured by vegetation
093:11:23:59.608 - Wheel stop
No anomalies detected

Film Quality Description

Item Number KTV12L

		Film Quality	
Location:		Focus:	Variable
Camera Type:		FOV:	
Film:		Exposure:	Good
Lens Focal Length:		Timing:	Yes
FPS:		Date Received:	04/02/92
Timing:		Date Screened:	04/02/92
		Screened By:	JH,CS,SI,MS

Orientation
Right side of vehicle.

Comments
HAC noted
093:11:22:35.718 - LOV before touchdown
No anomalies detected

Film Quality Description
Erratic tracking

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number KTV13L

Film Quality

Location:		Focus:	Variable
Camera Type:		FOV:	
Film:		Exposure:	Variable
Lens Focal Length:		Timing:	Yes
FPS:		Date Received:	04/02/92
Timing:		Date Screened:	04/02/92
		Screened By:	JH,SI,MS

Orientation
Left side of vehicle.

Comments
093:11:17:39.011 - Condensation noted from vertical stabilizer
093:11:20:18 - Wing-tip vorticies noted
HAC noted
093:11:22:10 - LOV prior to touchdown
No anomalies detected

Film Quality Description

Item Number KTV15L

Film Quality

Location:		Focus:	Good
Camera Type:		FOV:	
Film:		Exposure:	Good
Lens Focal Length:		Timing:	No
FPS:		Date Received:	04/02/92
Timing:		Date Screened:	04/02/92
		Screened By:	JH,SI,MS

Orientation
Left side of vehicle.

Comments
Vehicle acquired after touchdown
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number KTV16L

		Film Quality	
Location:		Focus:	Variable
Camera Type:		FOV:	
Film:		Exposure:	Variable
Lens Focal Length:		Timing:	Yes
FPS:		Date Received:	04/02/92
Timing:		Date Screened:	04/02/92
		Screened By:	JH,MS,SI

Orientation
Left side of vehicle.

Comments
093:11:23:05.257 - Main gear touchdown noted
Nose gear was unable to be determined
Wheel stop noted
No anomalies detected

Film Quality Description
Intermittent video dropout

Item Number KTV20L

		Film Quality	
Location:		Focus:	Good
Camera Type:		FOV:	
Film:		Exposure:	Variable
Lens Focal Length:		Timing:	Yes
FPS:		Date Received:	04/02/92
Timing:		Date Screened:	04/02/92
		Screened By:	JH,SI,MS

Orientation
Right side of vehicle.

Comments
093:11:22:42.989 - LOV due to fog before touchdown
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number KTV33L

Film Quality

Location:		Focus:	Good
Camera Type:		FOV:	
Film:		Exposure:	Good
Lens Focal Length:		Timing:	Yes
FPS:		Date Received:	04/02/92
Timing:		Date Screened:	04/02/92
		Screened By:	JH,SI,MS

Orientation
Right side of vehicle.

Comments
093:11:23:04.988 - Right main gear touchdown noted
093:11:23:04.988 - Wing-tip vorticies noted
093:11:23:05.121 - Left main gear touchdown noted
093:11:23:13.596 - Nose gear touchdown noted
093:11:24:02 - Wheel stop noted
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number M005

Location:		**Film Quality**	
Camera Type:	16mm	Focus:	Soft
Film:		FOV:	
Lens Focal Length:		Exposure:	Dark
FPS:		Timing:	Yes*
Timing:		Date Received:	04/07/92
		Date Screened:	04/08/92
		Screened By:	JD,MS

Orientation
Tracking of Orbiter landing sink rate. 15 feet vertical distance from runway. Right side of vehicle.

Comments
11:23:01.001 (Frame 2320) - Contrail off right wing tip visible as Orbiter crosses runway threshold
11:23:04.910 (Frame 2709) - ~ Main gear touchdown
Frame 3585 - Three dark objects move up in front of right wing and go above Orbiter at nose wheel touchdown. Did not appear to strike the vehicle. Objects may be in foreground
11:23:13.711 (Frame 3585) - Nose gear touchdown
White mark noted on right wing glove during rollout
Frame 7897 - End of film prior to wheel stop
No anomalies detected

Film Quality Description
*Digital
Lower 1/3 of view obscured by object in foreground

Photo/TV Analysis Group Evaluation Report
STS-45
04/23/92

Item Number SDIO1

Location:	South	**Film Quality**	
Camera Type:		Focus:	Good
Film:		FOV:	
Lens Focal Length:		Exposure:	Good
FPS:		Timing:	No
Timing:		Date Received:	04/02/92
		Date Screened:	04/02/92
		Screened By:	JH,MS,SI

Orientation
Left side of vehicle.

Comments
LOV prior to touchdown
No anomalies detected

Film Quality Description
SDIO/ISTEF

Item Number SDIO2

		Film Quality	
Location:		Focus:	Good
Camera Type:		FOV:	
Film:		Exposure:	Good
Lens Focal Length:		Timing:	No
FPS:		Date Received:	04/02/92
Timing:		Date Screened:	04/02/92
		Screened By:	JH,MS,SI

Orientation
Left side of vehicle.
IR camera

Comments
Bright spot noted below and behind nose cap on underneath side of vehicle
HAC noted
LOV prior to touchdown

Film Quality Description
SDIO/ISTEF

Daily Reports to Mission Management

STS-45
JSC Photo/TV Analysis Report
18:30 CST March 24, 1992

The STS-45 launch of Atlantis occurred on March 24th, 1992 at 84:13:13:40.131 UTC as seen on Camera OTV063. SRB separation occurred at 84:13:15:48.155 UTC as seen on KTV4A.

On launch day, 23 of 23 expected videos were received and screened. Twenty 16mm films are expected on Wednesday.

While performing DTO 312 the astronauts observed an anomalous spewing of O2 or H2 from the external tank intertank area. Questions were formulated concerning the ET venting observation and sent to the crew to gain more information. (See attached transcripts). Tracking videos were reviewed specifically to determine if any anomaly could be seen in the intertank area on ascent. No venting or vapors were detected on the external tank forward of the aft dome from the tracking views. Known features of the external tank such as an access door could be misinterpreted at long distances to possibly be vapor. However, comparison with views from closer range indicated that these features were known ET structures.

The following items merit mentioning but are not considered anomalous:

Cameras KTV4A, KTV5A, KTV13, ET-204, ET-207, ET-208, ET-212 - A pulse was noted in the SRB plume from 117.62 to 118.02 secs. MET (~10 secs. prior to SRB separation). (On camera ET-207 three separate pulse events were noted.) A similar event with less intensity was seen on STS-42. An initial comparison with the plume discoloration event seen on STS-39, at approximately the same time, was made, but it has not been established to what degree the two events may be related.

Camera KTV4A - A light colored piece of debris, first seen near the base of the vertical stabilizer, fell aft of the vehicle just after the roll maneuver.
A light colored piece of debris fell from the SRB plume at 30 secs. MET.
A puff was noted near the SRB plume at 78 secs. MET.

Camera OTV009 - A slight vapor at the top of the LH2 umbilical was noted prior to SSME ignition.

Camera OTV054 - Several small light colored pieces of debris fell aft along the right side of ET at liftoff.

Camera ET-212 - A small piece of white debris was seen above SSME #1 and traveled aft into the SRB exhaust plume.

Camera ET-207 - A small white spot was seen to move quickly away from the SSME area at approximately 106 seconds MET.

Other normal events observed included: ice debris from ET umbilical areas; ice debris from LO2 TSM; SRB slag noted after SRB separation; RCS paper debris; indication of wind shear in SRB plume; overshoot of roll maneuver; atmospheric bow wave noted at 26 secs. MET

STS-45 Day 1 Film
JSC Photo/TV Analysis Report
00:30 CST March 26, 1992

On Wednesday, twenty of twenty 16mm films arrived. A total of 13 16mm and twenty videos have been screened to date. Ten 16 mm and ten 35 mm films are expected on Wednesday, March 26.

The following items merit mentioning but are not considered anomalous:

Camera E16 - A single dark piece of debris (DCS) originated from the stud hole at HDP #7 and fell aft after liftoff.

Camera E2, E15, E17 - A single, thin, dark, rope-like piece of debris originated from behind the right RCS stinger and fell aft into the SSME area prior to liftoff. The debris was identified as tape from RCS R4D.

Camera E3 - A single, thin, dark, rope-like piece of debris originated from behind SSME #1 and fell aft prior to liftoff. This event is similar to the event observed on camera E2.

Camera E5 - There appeared to be less ice debris from the umbilicals than expected at SSME start-up.

Camera E19 - Slight base heat shield erosion was noted between the SSME #1 and #3 beta blankets at liftoff.

Other normal events observed included: normal pad debris which does not strike the vehicle both in and out of the exhaust plume throughout launch, multiple pieces of RCS paper entering the SSME plume at SSME start-up, MLP deluge water, ice debris originating from the umbilical area, normal flame trough debris, normal vapor from TSM carrier plates at T-0.

STS-45
JSC Photo/TV Analysis
00:30 CST, Friday, March 27, 1992

On March 26, 1992, nineteen of twenty expected launch films arrived. To date a total of twenty-three videos, twenty 16 mm and seven 35 mm films have been screened. On Friday, March 26, nine 16 mm films and ten 35 mm films are expected to arrive at JSC for screening.

The following items merit mentioning but are not considered anomalous:

Camera E20 - TPS erosion was noted at the base of the left OMS nozzle at SSME ignition.

Camera E26 - A flat piece of dark debris, first seen north of the SRBs at liftoff, traveled south past the LSRB, under the left wing and exited the FOV on the right side.

Camera E26 - A shiny, flat piece of debris appeared at the base of the SRBs and moved south under the left inboard elevon during liftoff.

Camera E25 - Multiple small pieces of white debris (possibly from flame duct) traveled from the aft end of the ET/SRB area toward LO2 TSM at liftoff.

Camera E40 - A small white piece of debris originally seen below ET/Orbiter umbilicals fell aft at liftoff.

Camera E40 - Multiple pieces of white debris were seen in the exhaust plume after tower clear.

Camera E207, E208, E212 - Three orange pulses were noted in the LSRB exhaust plume prior to plume brightening. These pulses were also observed on launch videos at approximately 117 seconds MET.

Camera E212, E213, E222 - A single, orange piece of debris appeared to originate from the LO2 umbilical and became entrained in the recirculation flow and fell aft at approximately 23.674 seconds MET.

Camera E212, E213, E222 - A single, large, white piece of debris was noted behind SSME #1, fell aft and appeared to split into two pieces at approximately 31.277 seconds MET. This event appears to be the one the KSC film day 2 report calls, "...likely the two pieces of SSME closeout blanket patch material found near the pad after launch."

Camera E212 - A single, orange piece of debris originated from the aft end of the LSRB and fell aft at approximately 71 seconds MET.

Camera E17 - RCS jet R3D and R3R were not covered with butcher paper at the time of launch. From a conversation with KSC, it was determined that the butcher paper fell off after the Sunday night's tanking attempt. KSC received a waiver from having to replace the butcher paper.

None of the above-mentioned debris appeared to strike the vehicle.

Other observed events included: several small pieces of umbilical ice debris, vapor off SRB stiffener rings, ET aft dome outgassing and charring, atmospheric bow waves, slight body flap motion, linear optical distortions, charring of the RSRB stiffener rings on the inboard side, flares in SSME plume, slag in SRB exhaust after SRB separation.

STS-45
JSC Photo/TV Analysis
00:30 CST, Saturday, March 28, 1992

On March 27, 1992, twenty of nineteen expected launch films arrived. To date a total of twenty-three videos, thirty-nine 16mm and twenty 35mm films have been screened. On Tuesday, March 31, the final three 16mm films will be screened.

Camera E7 - A bolt hang-up was noted at the RSRB HDP M-4. (The bolt appeared to bend during liftoff until the aft skirt foot released it, causing the bolt to spring back to a vertical position.)

The following items merit mentioning but are not considered anomalous:

Camera E7 - Epon shim material detached from the RSRB aft skirt foot at HDP M-4 and fell into the flame duct at liftoff.

Camera E11 - DCS debris was noted near the LSRB aft skirt foot stud hole at HDP M-7 at liftoff.

Camera E13 - An HDP M-6 firing cable remained attached to the LSRB during liftoff.

Camera E223, E204 , E205, E218 - Three orange pulses were noted in the LSRB plume prior to normal plume brightening. This event was noted previously on E207, E208, E212, KTV4A, KTV5A, KTV13, ET204, ET207, ET208 and ET212.

Camera E14 - A long rope-like piece of debris was seen near the LSRB HDP M-8 at liftoff and did not appear to strike the SLV.

Camera E10, E11 - A continuous water leak was noted in the MLP J-pipes.

Camera E11, E28 - On HDP M-7, a dark piece of debris, about 3 x .5 inches, fell from the foot area towards the shoe at liftoff.

Other normal events:

ET aft dome outgassing. Vapor off stiffener rings. RCS paper debris noted. Flame duct debris noted. Normal pad debris noted. Plume brightening noted. Recirculation noted. Linear optical distortion noted.

STS 45
JSC Photo TV Analysis Report
10:00 CST, Tuesday, March 31, 1992

On Monday, March 30, 1992, one of one expected launch films arrived. To date a total of twenty three videos, forty 16 mm and twenty 35 mm films have been screened.

The following items merit mentioning but are not considered anomalous:

Camera EX4 - Several small pieces of dark debris appeared to originate from the vicinity of HDP #M-5 after PIC firing as the shoe lifted off the holddown post foot. A small dark piece of debris was seen inside the holddown post shoe at liftoff. The holddown post shoe rotation appeared similar to that seen on previous missions.

STS-45 Landing
JSC Photo/TV Analysis Report
16:00 CST, April 2, 1992

Sixteen landing video were received approximately 3 hours after landing. Landing of STS-45 occurred on runway 33 at the Kennedy Space Center. Right main gear touchdown was at 11 hours 23 minutes 04.988 seconds UTC on April 2 (day of year 93) as seen from KTV-33. Left main gear touchdown was at 11 hours 23 minutes
05.121 seconds UTC as seen from KTV-33. Nose wheel touchdown occurred at 11 hours 23 minutes 13.596 seconds UTC as seen from KTV-33. Wheel stop was at approximately 11 hours 23 minutes 24.02 seconds UTC as seen on KTV-33.

A bright spot was noted behind the nose cap on the underside of the orbiter during decent on the IR-2 and SDIO-2 cameras. Condensation was noted from the vertical stabilizer on IR-4 at 11 hours 17 minutes 39.011 seconds UTC. Vortices were noted from both wing-tips on KTV-33 and KTV-13 at 11 hours 23 minutes 04.988 seconds ITC.

No anomalies were detected.

STS-45 Timing Data Report

STS-45 TIMING REPORT

After the photography from the Engineering and Tracking Cameras were screened for events of interest for the STS-45 Launch; frame counts were noted. These events were located on the 16mm and 35mm photography and timed from the encoded film edge timing and digital timing marks. The following are the events of interest per camera and their associated times. (It should be noted that the times have been corrected for camera offset.) A camera offset was found on all rolls of photography stated in this report.

Camera E204 (35mm)

Item of Interest	Frame #	Start Time	Stop Time
Orange pulses in LSRB plume	7863 8021 8090	084:13:15:34.602 084:13:15:36.841 084:13:15:37.823	
Timing IRIG B		Total Frames 15029	

Camera E205 (35mm)

Item of Interest	Frame #	Start Time	Stop Time
Recirculation	5008 to 5879	084:13:15:17.534	084:13:15:29.407
Timing IRIG B		Total Frames 13175	

Camera E212 (35mm)

Item of Interest	Frame #	Start Time	Stop Time
Large orange piece of debris from aft end of LSRB	4942	084:13:14:53.064	
SRB separation	8581	084:13:15:48.128	
Timing Digital		Total Frames 15410	

Camera E222 (35mm)

Item of Interest	Frame #	Start Time	Stop Time
White flashes in SSME plume		084:13:13:55	084:13:14:06
Flare in SSME plume	4292	084:13:14:00.006 084:13:14:18.334	
Single large piece of debris originated from the LO2 umbilical area and fell along the body flap		084:13:14:03.674	

Single white piece of debris from behind SSME #1 broke into two pieces	084:13:14:11.277	084:13:14:11.595
Timing IRIG B	Total Frames 6195	

CAMERA OFFSETS AND SPEEDS

Camera	Offset (mm)	Film Speed (fps) Begin	End
E204 (35mm)	301	70	70
E205 (35mm)	304	73	74
E212 (35mm)	292	66	67
E222 (35mm)	Digital Timing	100	101

Analysis Tasks and Summary of Analysis of Visual Events

Photo/TV Analysis Group Request Form
STS-45
04/30/92

Task Number --> 1

Request Date : 10/16/91
Completion Date : 04/20/92

Requestor : B. Rosenbaum
Phone : 483-9006
Mail Code : EP

Analyst Name	Phone Number	Assignment
Team		Screen & Document
		Analysis & Reporting

Task Title

Recirculation Characterization

Objectives

Hypothesis

Reporting

Analysis Strategy

1) Note start/stop time (frames) on all video and film cameras where recirculation is visible (produce a table to send to B. Rosenbaum). Use image processing techniques as necessary to characterize the recirculation.
   * Determine color of recirculation.
2) Document results

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
1

Title : Recirculation Characterization

Analysts : R. Bhaskar
Date : 04/20/92

Camera Number :
Frame Number :
GMT :

Requestor : B. Rosenbaum
Phone : 483-9006
Mail Code : EP

Description of Analysis

See attached

Image Analysis Tools & Techniques

RECIRCULATION BY MISSION

MISSION	START (sec MET)	STOP (sec MET)	BEST VIEW
STS-26	92	112	E204
STS-27	95	---	E205
STS-29	92	112	E208
STS-30	95	---	E204,E206
STS-28	94	104	E205
STS-34	95	---	E204
STS-33	95	112	E206
STS-32	100	109	E204,E206
STS-36	93	103	E207
STS-31	91	108	E206
STS-41	91	112	E206
STS-38	94	110	n/a
STS-35	92	107	E212
STS-37	92	107	E204
STS-39	92	101	E205
STS-40	---	---	---
STS-43	94	110	E204
STS-48	91	108	E205
STS-44	95	113	E204
STS-42	92	111	E205
STS-45	97	109	E205

NOTES: **No recirculation was observed on STS-40. Intermittent cloud cover prevented acquisition of specific stop times for recirculation on STS-27, STS-30 and STS-34.**

Best view chosen by duration and clarity of event on films.

Photo/TV Analysis Group Request Form
STS-45
04/30/92

Task Number --> 2

Request Date : 10/16/91
Completion Date : 03/30/92

Requestor : D. Pitts
Phone : 483-5066
Mail Code : SN5

Analyst Name	Phone Number	Assignment
Team		

Task Title

Check Effect of Snychronizers on IRIG Time Transmission

Objectives

Hypothesis

Reporting

Analysis Strategy

1) Check known events with time recorded on video
   A) SRB Separation
   B) Main Gear Landing
   C) Wheel Stop
   D) Etc.
2) Determine if there is time difference. If there is, does a pattern exist?
3) Document results and send to TV Working Group through D. Pitts.

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
2

Title : Check Effect of Snychronizers on IRIG Time Transmission

Analysts :
Date : 03/30/92

Camera Number :
Frame Number :
GMT :

Requestor : D. Pitts
Phone : 483-5066
Mail Code : SN5

Description of Analysis

IRIG time appeared to be snychronized with the incoming video.

Image Analysis Tools & Techniques

Photo/TV Analysis Group Request Form
STS-45
04/30/92

Task Number --> 3

Request Date : 10/16/91
Completion Date : 04/30/92

Requestor : D. Hamilton
Phone : 483-8885
Mail Code : ES421

Analyst Name	Phone Number	Assignment
R. Bhaskar	244-5322	Video Sink Rate
S. Israel	244-5106	Two Camera Sink Rate

Task Title

Determine Sink Rate from Video/Film

Objectives

Hypothesis

Reporting

Analysis Strategy

1) Choose video for analysis
2) Use D. Pitts sink rate analysis techniques
3) Document results
4) Report results to D. Hamilton/ES421
5) Choose film or films to determine sink rate using the film analyzers and appropriate software.
6) Report results to D. Hamilton at 483-8885

Summary of Analysis of Visual Events
STS-45
04/28/92

Task Number
3

Title : Determine Sink Rate from Video/Film

Analysts : J. Hartman
Date : 04/24/92

Camera Number : KTV33
Frame Number :
GMT :

Requestor : D. Hamilton
Phone : 483-8885
Mail Code : ES421

Description of Analysis

See attached

Image Analysis Tools & Techniques

RTMOV

STS-45: Video Sink Rate Analysis Summary

Sink rate analysis for STS-45 was performed using video camera TV-33.

TV-33 Main gear

Four points per frame consisting of:

Y1) a right angle corner of a row of black tile on the right side of the orbiter nose at a known location.
Y2) another known location of tile directly below Y1 at a known distance.
Y3) the center of the wheel assembly of the right main gear.
Y4) a stationary point on the runway directly below the wheel assembly which was used as a vertical reference.

Points Y1 and Y2 were used for scaling and points Y3 and Y4 were used determine the position of the wheel above the runway.

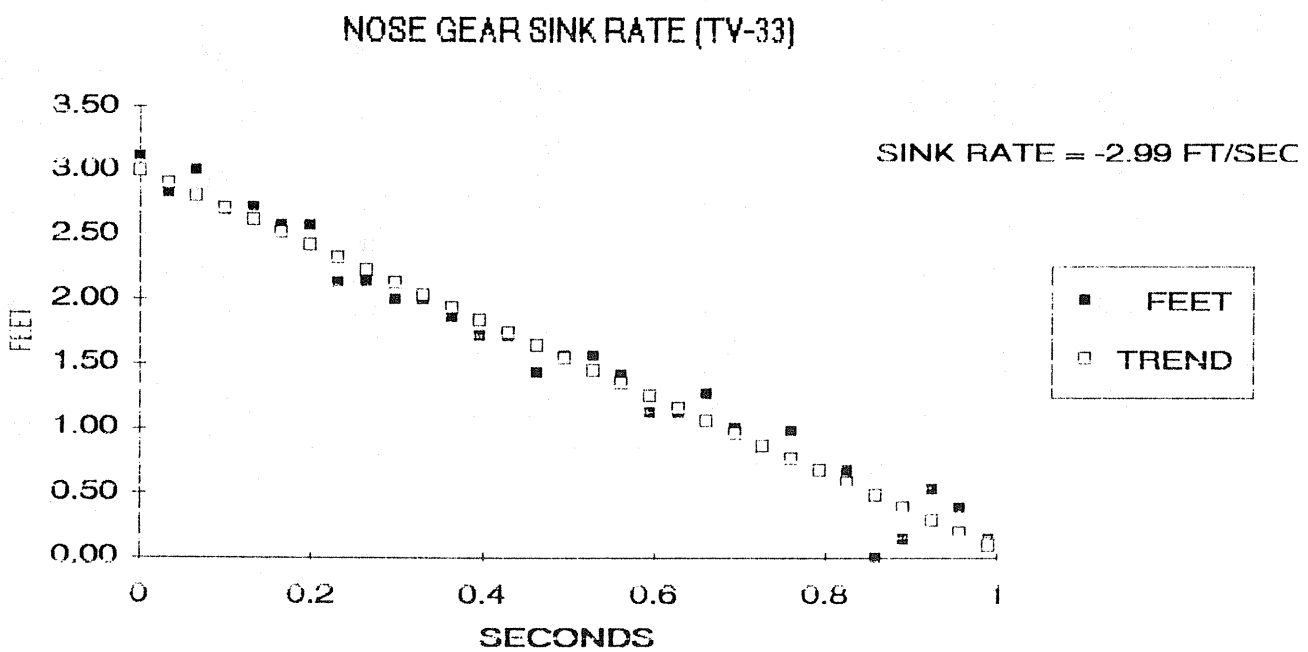
TV-33 Nose gear

Four points per frame consisting of:

Y1) a right angle corner of a row of black tile on the right side of the orbiter nose at a known location.
Y2) another known location of tile directly below Y1 at a known distance.
Y3) the center of the wheel assembly of the right main gear.
Y4) a stationary point on the runway directly below the wheel assembly which was used as a vertical reference.

Points Y1 and Y2 were used for scaling and points Y3 and Y4 were used determine the position of the wheel above the runway.

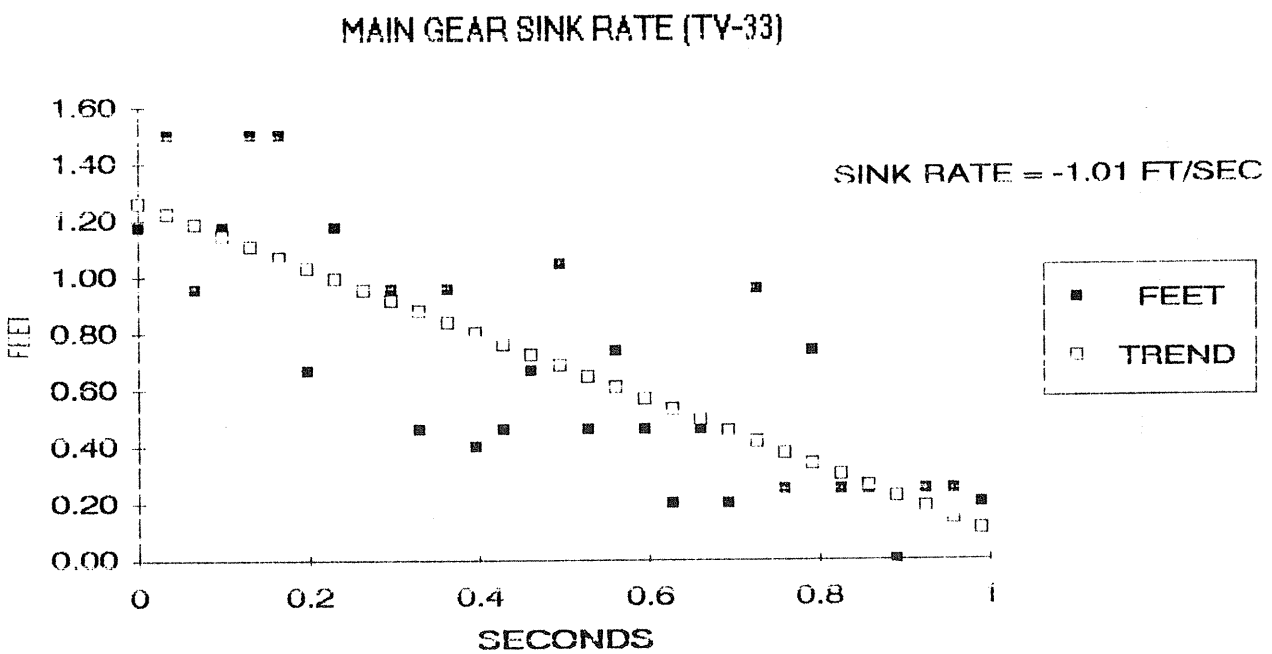
The video sink rate for the right main gear was determined to be 1.02 feet per second and the sink rate for the nose wheel was determined to be 2.99 feet per second for STS-45.


NOSE GEAR SINK RATE (TV-33)
SINK RATE = -2.99 FT/SEC
FEET
TREND
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
FEET
0
0.2
0.4
0.6
0.8
1
SECONDS

NOSE WHEEL

Y1	Y2	Y3	Y4	FRAME #	REL REF	REL DIST	SEC	FEET
256	220	168	123	395	36	45	0	3.11
254	218	165	122	396	36	43	0.033	2.83
253	218	165	122	397	35	43	0.066	3.00
253	217	165	123	398	36	42	0.099	2.69
253	218	165	124	399	35	41	0.132	2.72
251	216	163	123	400	35	40	0.165	2.57
249	214	162	122	401	35	40	0.198	2.57
248	211	160	121	402	37	39	0.231	2.13
248	212	160	122	403	36	38	0.264	2.14
247	212	158	122	404	35	36	0.297	2.00
246	211	158	122	405	35	36	0.33	2.00
245	210	157	122	406	35	35	0.363	1.86
244	208	156	121	407	36	35	0.396	1.72
243	207	156	121	408	36	35	0.429	1.72
243	208	155	123	409	35	32	0.462	1.43
242	208	154	122	410	34	32	0.495	1.57
240	206	153	121	411	34	32	0.528	1.57
239	205	152	121	412	34	31	0.561	1.42
239	205	151	122	413	34	29	0.594	1.12
238	204	151	122	414	34	29	0.627	1.12
238	204	151	121	415	34	30	0.66	1.27
237	202	150	121	416	35	29	0.693	1.00
236	201	149	121	417	35	28	0.726	0.86
236	202	149	121	418	34	28	0.759	0.98
235	201	147	121	419	34	26	0.792	0.68
234	200	147	121	420	34	26	0.825	0.68
234	199	143	121	421	35	22	0.858	0.00
233	198	143	120	422	35	23	0.891	0.15
232	198	146	121	423	34	25	0.924	0.54
231	197	144	120	424	34	24	0.957	0.39
230	195	143	120	425	35	23	0.99	0.15
	NOSE WHEEL			SINK RATE		-2.99		FT/SEC

TREND
3.00
2.90
2.81
2.71
2.61
2.52
2.42
2.32
2.23
2.13
2.03
1.94
1.84
1.74
1.65
1.55
1.45
1.36
1.26
1.16
1.06
0.97
0.87
0.77
0.68
0.58
0.48
0.39
0.29
0.19
0.10


MAIN GEAR SINK RATE (TV-33)
SINK RATE = -1.01 FT/SEC
FEET
TREND
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
FEET
0
0.2
0.4
0.6
0.8
1
SECONDS

RT. MAIN WHEEL

Y1	Y2	Y3	Y4	FRAME #	REL REF	REL DIST	SEC	FEET
351	328	250	217	137	23	33	0	1.17
351	329	250	217	138	22	33	0.033	1.50
351	328	249	217	139	23	32	0.066	0.96
351	328	249	216	140	23	33	0.099	1.17
350	328	249	216	141	22	33	0.132	1.50
350	328	249	216	142	22	33	0.165	1.50
351	327	249	217	143	24	32	0.198	0.67
351	328	249	216	144	23	33	0.231	1.17
351	328	248	216	145	23	32	0.264	0.96
350	327	248	216	146	23	32	0.297	0.96
351	327	247	216	147	24	31	0.33	0.46
350	327	247	215	148	23	32	0.363	0.96
351	326	247	215	149	25	32	0.396	0.40
351	327	247	216	150	24	31	0.429	0.46
351	327	247	215	151	24	32	0.462	0.67
350	328	246	215	152	22	31	0.495	1.05
350	326	246	215	153	24	31	0.528	0.46
350	327	246	215	154	23	31	0.561	0.74
350	326	245	214	155	24	31	0.594	0.46
350	325	245	214	156	25	31	0.627	0.20
350	326	246	215	157	24	31	0.66	0.46
351	326	246	215	158	25	31	0.693	0.20
349	326	245	213	159	23	32	0.726	0.96
349	325	244	214	160	24	30	0.759	0.25
349	326	245	214	161	23	31	0.792	0.74
350	326	244	214	162	24	30	0.825	0.25
349	325	243	213	163	24	30	0.858	0.25
349	324	243	213	164	25	30	0.891	0.00
349	325	243	213	165	24	30	0.924	0.25
349	325	243	213	166	24	30	0.957	0.25
349	324	243	212	167	25	31	0.99	0.20
	RT. MAIN WHEEL			-1.01652		FT/SEC		

TREND
1.26
1.22
1.18
1.15
1.11
1.07
1.03
0.99
0.95
0.91
0.88
0.84
0.80
0.76
0.72
0.68
0.65
0.61
0.57
0.53
0.49
0.45
0.41
0.38
0.34
0.30
0.26
0.22
0.18
0.15
0.11

TS-45 NOSE WHEEL SINK RATE RAW DATA

RAME # 395 093:11:23:12.68
RAME # 425 093:11:23:13.69

X,	Y,	VALUE,	FRAME #
206,	256,	152,	395
205,	220,	126,	395
267,	168,	82,	395
267,	123,	100,	395
205,	254,	137,	396
205,	218,	102,	396
266,	165,	74,	396
266,	122,	105,	396
204,	253,	116,	397
203,	218,	108,	397
264,	165,	71,	397
264,	122,	113,	397
201,	253,	132,	398
201,	217,	122,	398
262,	165,	67,	398
262,	123,	105,	398
199,	253,	133,	399
199,	218,	99,	399
259,	165,	73,	399
259,	124,	102,	399
197,	251,	118,	400
196,	216,	109,	400
257,	163,	74,	400
257,	123,	102,	400
196,	249,	115,	401
195,	214,	97,	401
255,	162,	77,	401
255,	122,	95,	401
195,	248,	131,	402
194,	211,	105,	402
253,	160,	71,	402
253,	121,	107,	402
193,	248,	138,	403
192,	212,	105,	403
252,	160,	76,	403
252,	122,	101,	403
193,	247,	113,	404
192,	212,	103,	404
251,	158,	69,	404
251,	122,	100,	404
193,	246,	114,	405
192,	211,	95,	405
251,	158,	72,	405
251,	122,	99,	405
193,	245,	113,	406
192,	210,	97,	406
251,	157,	69,	406
251,	122,	94,	406
193,	244,	139,	407
191,	208,	93,	407
250,	156,	72,	407
250,	121,	101,	407
192,	243,	126,	408
191,	207,	104,	408
249,	156,	68,	408
249,	121,	103,	408
191,	243,	97,	409

190,	208,	105,	409
249,	155,	63,	409
249,	123,	98,	409
188,	242,	134,	410
187,	208,	93,	410
246,	154,	69,	410
246,	122,	95,	410
185,	240,	114,	411
183,	206,	99,	411
243,	153,	66,	411
243,	121,	105,	411
183,	239,	102,	412
181,	205,	99,	412
241,	152,	73,	412
241,	121,	105,	412
181,	239,	114,	413
179,	205,	98,	413
239,	151,	72,	413
239,	122,	100,	413
178,	238,	107,	414
176,	204,	97,	414
236,	151,	67,	414
236,	122,	102,	414
178,	238,	138,	415
176,	204,	103,	415
234,	151,	64,	415
234,	121,	110,	415
178,	237,	116,	416
176,	202,	92,	416
234,	150,	64,	416
234,	121,	108,	416
178,	236,	124,	417
176,	201,	96,	417
234,	149,	68,	417
234,	121,	105,	417
179,	236,	139,	418
177,	202,	108,	418
235,	149,	66,	418
235,	121,	106,	418
180,	235,	123,	419
178,	201,	88,	419
236,	147,	64,	419
236,	121,	109,	419
180,	234,	136,	420
178,	200,	95,	420
236,	147,	61,	420
236,	121,	107,	420
179,	234,	143,	421
178,	199,	88,	421
235,	143,	54,	421
235,	121,	108,	421
179,	233,	127,	422
178,	198,	87,	422
236,	143,	54,	422
236,	120,	111,	422
179,	232,	128,	423
177,	198,	82,	423
236,	146,	72,	423
236,	121,	104,	423
177,	231,	130,	424
176,	197,	87,	424
234,	144,	67,	424
234,	120,	105,	424

179,	230,	139,	425
176,	195,	80,	425
234,	143,	67,	425
234,	120,	107,	425

TS-45 RT. WHEEL SINK RATE RAW DATA

RAME # 137 093:11:23:04.08
RAME # 167 093:11:23:05.08

X,	Y,	VALUE,	FRAME #
183,	351,	150,	137
184,	328,	128,	137
151,	250,	86,	137
151,	217,	103,	137
183,	351,	145,	138
184,	329,	126,	138
151,	250,	92,	138
151,	217,	105,	138
185,	351,	148,	139
186,	328,	127,	139
153,	249,	90,	139
153,	217,	115,	139
184,	351,	146,	140
185,	328,	127,	140
152,	249,	89,	140
152,	216,	94,	140
184,	350,	137,	141
184,	328,	138,	141
151,	249,	89,	141
151,	216,	102,	141
184,	350,	139,	142
184,	328,	143,	142
152,	249,	94,	142
152,	216,	95,	142
185,	351,	147,	143
185,	327,	129,	143
152,	249,	87,	143
152,	217,	109,	143
182,	351,	149,	144
183,	328,	123,	144
149,	249,	87,	144
149,	216,	107,	144
182,	351,	149,	145
182,	328,	130,	145
149,	248,	90,	145
149,	216,	104,	145
182,	350,	133,	146
182,	327,	129,	146
149,	248,	92,	146
149,	216,	107,	146
182,	351,	145,	147
182,	327,	125,	147
149,	247,	96,	147
149,	216,	112,	147
182,	350,	142,	148
182,	327,	123,	148
149,	247,	91,	148
149,	215,	101,	148
181,	351,	150,	149
181,	326,	119,	149
147,	247,	86,	149
147,	215,	105,	149
179,	351,	154,	150
179,	327,	139,	150
146,	247,	87,	150
146,	216,	115,	150
179,	351,	147,	151

179,	327,	132,	151
146,	247,	88,	151
146,	215,	103,	151
178,	350,	134,	152
179,	328,	121,	152
145,	246,	94,	152
145,	215,	95,	152
178,	350,	136,	153
178,	326,	126,	153
145,	246,	90,	153
145,	215,	102,	153
179,	350,	139,	154
179,	327,	130,	154
146,	246,	92,	154
146,	215,	97,	154
179,	350,	153,	155
180,	326,	130,	155
146,	245,	88,	155
146,	214,	92,	155
181,	350,	147,	156
181,	325,	122,	156
147,	245,	90,	156
147,	214,	90,	156
181,	350,	138,	157
181,	326,	129,	157
147,	246,	90,	157
147,	215,	106,	157
180,	351,	153,	158
180,	326,	125,	158
147,	246,	89,	158
147,	215,	96,	158
180,	349,	133,	159
180,	326,	130,	159
146,	245,	86,	159
146,	213,	80,	159
180,	349,	141,	160
180,	325,	122,	160
145,	244,	87,	160
145,	214,	97,	160
181,	349,	116,	161
181,	326,	126,	161
146,	245,	87,	161
146,	214,	113,	161
181,	350,	144,	162
181,	326,	132,	162
146,	244,	87,	162
146,	214,	108,	162
182,	349,	137,	163
182,	325,	123,	163
146,	243,	90,	163
146,	213,	99,	163
182,	349,	144,	164
183,	324,	114,	164
147,	243,	87,	164
147,	213,	99,	164
182,	349,	148,	165
182,	325,	136,	165
147,	243,	84,	165
147,	213,	107,	165
181,	349,	145,	166
181,	325,	134,	166
146,	243,	86,	166
146,	213,	112,	166

182,	349,	144,	167
181,	324,	136,	167
146,	243,	92,	167
146,	212,	96,	167

Summary of Analysis of Visual Events
STS-45
04/28/92

Task Number
3.01

Title : Determine Sink Rate from Video/Film

Analysts : M. Snyder
Date : 04/24/92

Camera Number : EL009
Frame Number : *
GMT :

Requestor : D. Hamilton
Phone : 483-8885
Mail Code : ES421

Description of Analysis

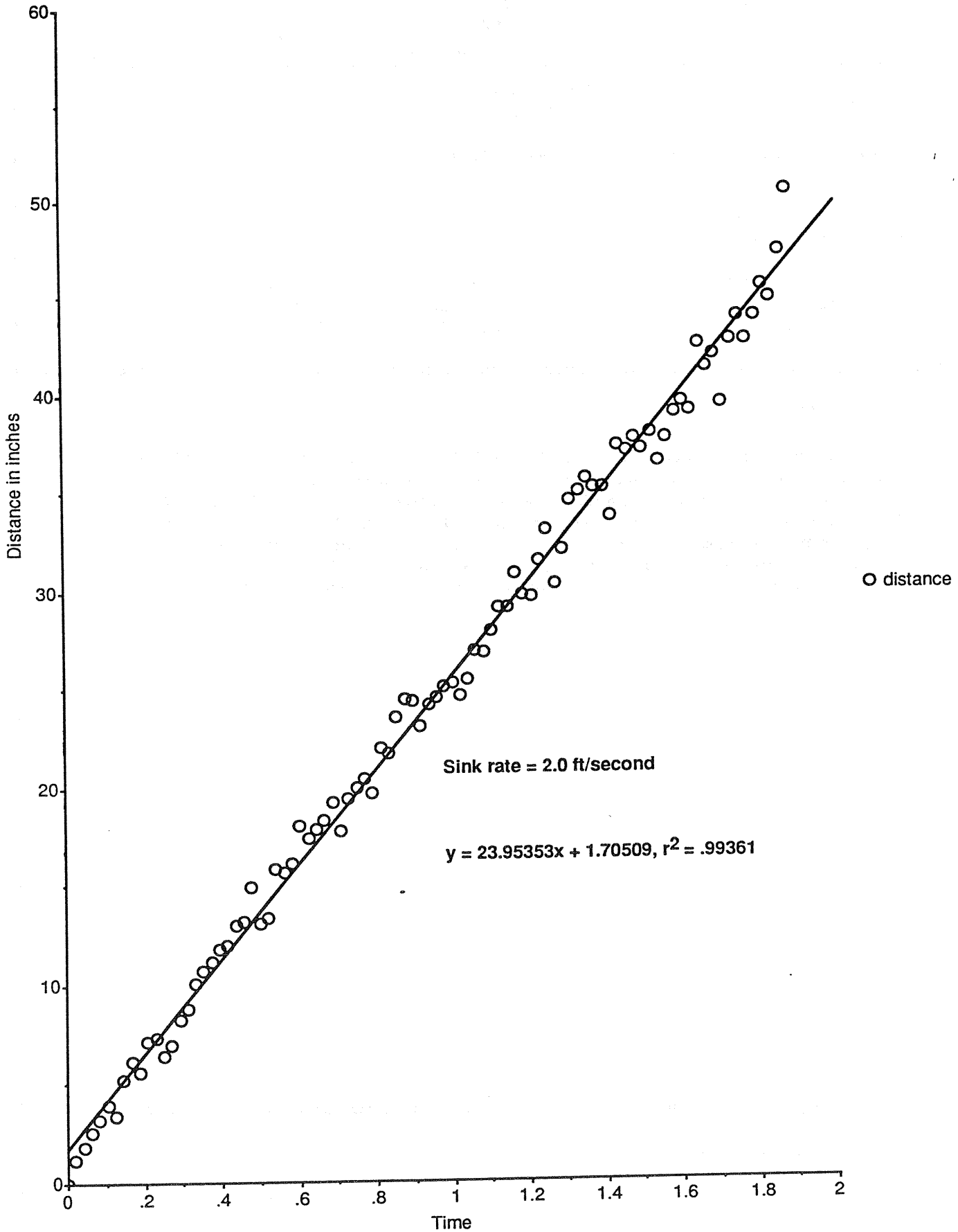
*1500-1680

Every other frames from frame 1500 to 1680 on film EL009 were used to determine the main landing gear sink rate. A point on the top and bottom of the right main landing gear was chosen for each frame. The PAST software was used to digitize the points and the data was stored in [snyder.sts45]main_gear.log. The last four points were the left and right edges of the runway for frames 1680 and 1500. These frames were digitized to see if there was significant camera motion from frame 1500 to 1680.

Image Analysis Tools & Techniques

Viewed films on FMA

Main Landing Gear Sink rate Film



Spreadsheet for Main Gear Sink rate analysis from Film

Frame	Time	Xtop	Ytop	Xbottom	Ybottom	Ydif	scale_in_pix	top__fram1_dst
1500	0	277.66	225.96001	277.23999	211.34	14.62001	3.04377357	0
1502	0.02083333	277.22	225.58	276.95999	211.16	14.42	3.08599168	1.172707698
1504	0.04166667	276.29999	225.38	276.06	211.06	14.32	3.1075419	1.802405377
1506	0.0625	276.67999	225.16	276.42001	211.2	13.96	3.18767908	2.550175143
1508	0.08333333	276.12	224.94	275.84	210.64	14.3	3.11188811	3.174156993
1510	0.10416667	276.5	224.72	275.92001	210.86	13.86	3.21067821	3.981273088
1512	0.125	275.89999	224.88	275.44	210.82001	14.05999	3.16500936	3.418241763
1514	0.14583333	275.28	224.34	275.01999	210.56	13.78	3.22931785	5.231527213
1516	0.16666667	274.54001	224.06	274.5	210.24001	13.81999	3.21997339	6.117981634
1518	0.1875	274.64001	224.25999	274.64001	210.64	13.61999	3.26725644	5.554401288
1520	0.20833333	274.48001	223.78	273.56	210.25999	13.52001	3.29141768	7.175323465
1522	0.22916667	273.95999	223.67999	273.28	209.86	13.81999	3.21997339	7.34160372
1524	0.25	273.76001	223.98	273.22	210.28	13.7	3.24817518	6.431419343
1526	0.27083333	273.42001	223.8	273.26001	210.03999	13.76001	3.23400928	6.98549238
1528	0.29166667	273.38	223.44	272.95999	209.8	13.64	3.26246334	8.221440249
1530	0.3125	272.76001	223.25999	271.89999	209.64	13.61999	3.26725644	8.821657725
1532	0.33333333	272.29999	222.88	272.23999	209.32001	13.55999	3.28171333	10.10770989
1534	0.35416667	271.88	222.7	271.82001	209.22	13.48	3.30118694	10.76190245
1536	0.375	271.88	222.60001	271.48001	209.2	13.40001	3.32089304	11.15820063
1538	0.39583333	271.67999	222.34	271.28	208.67999	13.66001	3.25768429	11.79284971
1540	0.41666667	271.34	222.24001	271.29999	208.44	13.80001	3.22463534	11.99564348
1542	0.4375	271.17999	222.02	270.51999	208.56	13.46	3.30609212	13.02603603
1544	0.45833333	271	221.94	270.92001	208.36	13.58	3.27687776	13.17308137
1546	0.47916667	271.06	221.42	270.51999	207.88	13.54	3.28655835	14.92100775
1548	0.5	270.72	221.88	270.48001	208.08	13.8	3.22463768	13.15655399
1550	0.52083333	270.10001	221.78	270.42001	207.89999	13.88001	3.20604956	13.40131924
1552	0.54166667	269.95999	221.17999	269.98001	207.74001	13.43998	3.31101683	15.82672668
1554	0.5625	269.84	221.24001	269.66	207.86	13.38001	3.32585701	15.69804507
1556	0.58333333	269.78	221.16	269.5	207.89999	13.26001	3.35595524	16.1086187
1558	0.60416667	268.84	220.66	268.62	207.60001	13.05999	3.4073533	18.05900655
1560	0.625	268.23999	220.82001	268.35999	207.67999	13.14002	3.38660063	17.40712723
1562	0.64583333	268.32001	220.84	268.51999	208.10001	12.73999	3.49293838	17.88387942
1564	0.66666667	267.76001	220.44	267.72	207.03999	13.40001	3.32089304	18.33136281
1566	0.6875	268.06	220.32001	268	207.3	13.02001	3.41781612	19.27648289
1568	0.70833333	267.95999	220.92	268.01999	208.32001	12.59999	3.53174883	17.80004944
1570	0.72916667	267.64001	220.28	267.38	207.25999	13.02001	3.41781612	19.41322971
1572	0.75	267.16	220.02	267.23999	206.8	13.22	3.36611195	19.99473865
1574	0.77083333	267.07999	220.03999	266.82001	207.17999	12.86	3.46034215	20.48529471
1576	0.79166667	266.92001	220.17999	266.72	207.14	13.03999	3.4125793	19.72477663
1578	0.8125	266.88	219.60001	266.17999	206.72	12.88001	3.45496626	21.97358542
1580	0.83333333	266.14001	219.88	266.10001	207.44	12.44	3.57717042	21.74923191
1582	0.85416667	265.92001	219.42	266.17999	207.06	12.36	3.60032362	23.54615251
1584	0.875	265.73999	219.08	265.70001	206.60001	12.47999	3.56570799	24.5321066
1586	0.89583333	265.70001	219.2	265.12	206.88	12.32	3.61201299	24.41724391
1588	0.91666667	264.95999	219.46001	264.89999	206.94	12.52001	3.55431026	23.10301669
1590	0.9375	265.35999	219.16	265.22	206.66	12.5	3.56	24.2080356
1592	0.95833333	264.95999	219.03999	264.94	206.52	12.51999	3.55431594	24.59593738
1594	0.97916667	264.39999	218.94	264.20001	206.52	12.42	3.58293076	25.15220974
1596	1	264.54001	218.84	264.14001	206.32001	12.51999	3.55431594	25.30676502
1598	1.02083333	264.28	218.96001	263.82001	206.36	12.60001	3.53174323	24.7222026
1600	1.04166667	263.88	218.74001	263.82001	206.14	12.60001	3.53174323	25.49918611
1602	1.0625	263.85999	218.48	263.44	206.14	12.34	3.60615883	26.97410413
1604	1.08333333	263.82001	218.48	263.51999	206.10001	12.37999	3.59451017	26.88697204
1606	1.10416667	263.85999	218.24001	263.23999	205.98	12.26001	3.62968709	28.02118432
1608	1.125	263.29999	217.96001	262.67999	205.75999	12.20002	3.647535	29.18028003
1610	1.14583333	262.73999	217.84	262.20001	205.46001	12.37999	3.59451017	29.18745855
1612	1.16666667	262.84	217.58	262.76001	205.52	12.06	3.68988391	30.9212641
1614	1.1875	262.79999	217.86	262.26001	205.78	12.08	3.68377483	29.838613
1616	1.20833333	262.42001	217.75999	261.54001	205.5	12.25999	3.62969301	29.76355527
1618	1.22916667	261.78	217.48	261.54001	205.52	11.96	3.72073579	31.55187667
1620	1.25	261.54001	217.14	261.62	205.3	11.84	3.75844595	33.14953083

1622	1.27083333	262.10001	217.7	261.60001	205.60001	12.09999	3.67768899	30.37774783
1624	1.29166667	261.84	217.38	261.29999	205.48	11.9	3.7394958	32.08491134
1626	1.3125	261.28	216.84	260.73999	205.12	11.72	3.79692833	34.62802432
1628	1.33333333	261.23999	216.74001	260.70001	205.02	11.72001	3.79692509	35.00764931
1630	1.35416667	260.85999	216.86	260.56	205.52	11.34	3.92416226	35.70991578
1632	1.375	260.44	216.60001	259.98001	204.78	11.82001	3.76480223	35.23854887
1634	1.39583333	259.89999	216.58	260	204.74001	11.83999	3.75844912	35.25429033
1636	1.41666667	259.54001	216.7	259.60001	204.5	12.2	3.64754098	33.77626598
1638	1.4375	259.72	216.17999	259.12	204.52	11.65999	3.81646983	37.32515122
1640	1.45833333	259.54001	216.06	259.12	204.17999	11.88001	3.74578809	37.08333958
1642	1.47916667	259.10001	216.03999	259.23999	204.32001	11.71998	3.79693481	37.66566922
1644	1.5	259.48001	215.98	259.17999	204.03999	11.94001	3.72696505	37.1951485
1646	1.52083333	258.84	215.86	258.92001	204.02	11.84	3.75844595	37.96034164
1648	1.54166667	259.06	216	258.98001	203.86	12.14	3.66556837	36.50909761
1650	1.5625	258.72	215.7	258.44	203.60001	12.09999	3.67768899	37.73312581
1652	1.58333333	258.07999	215.53999	258.28	203.64	11.89999	3.73949894	38.96565375
1654	1.60416667	257.84	215.46001	258.07999	203.64	11.82001	3.76480223	39.53042341
1656	1.625	257.78	215.56	257.79999	203.72	11.84	3.75844595	39.08787542
1658	1.64583333	257.64001	215.03999	258.16	203.60001	11.43998	3.88986694	42.47742479
1660	1.66666667	257.51999	215.16	257.12	203.52	11.64	3.82302405	41.28869802
1662	1.6875	257.73999	214.92	257.12	203.2	11.72	3.79692833	41.91812671
1664	1.70833333	257.72	215.22	257.14001	203.10001	12.11999	3.67162019	39.43323757
1666	1.72916667	257.60001	214.7	257.20001	202.96001	11.73999	3.79046319	42.68065348
1668	1.75	256.39999	214.58	256.26001	203.03999	11.54001	3.85614917	43.88301613
1670	1.77083333	256.10001	214.82001	256.06	203.2	11.62001	3.82960084	42.6617533
1672	1.79166667	256.57999	214.48	255.74001	202.82001	11.65999	3.81646983	43.81311176
1674	1.8125	256.29999	214.44	256	203.16	11.28	3.94503546	45.44684796
1676	1.83333333	255.94	214.42	255.44	202.96001	11.45999	3.88307494	44.81072366
1678	1.85416667	255.16	214.12	255.24001	202.94	11.18	3.980322	47.12705233
1680	1.875	255.56	213.92	254.7	203.25999	10.66001	4.17448014	50.26078259

Sink rate in/sec	
23.95	
Sink rate ft/sec	
1.996	

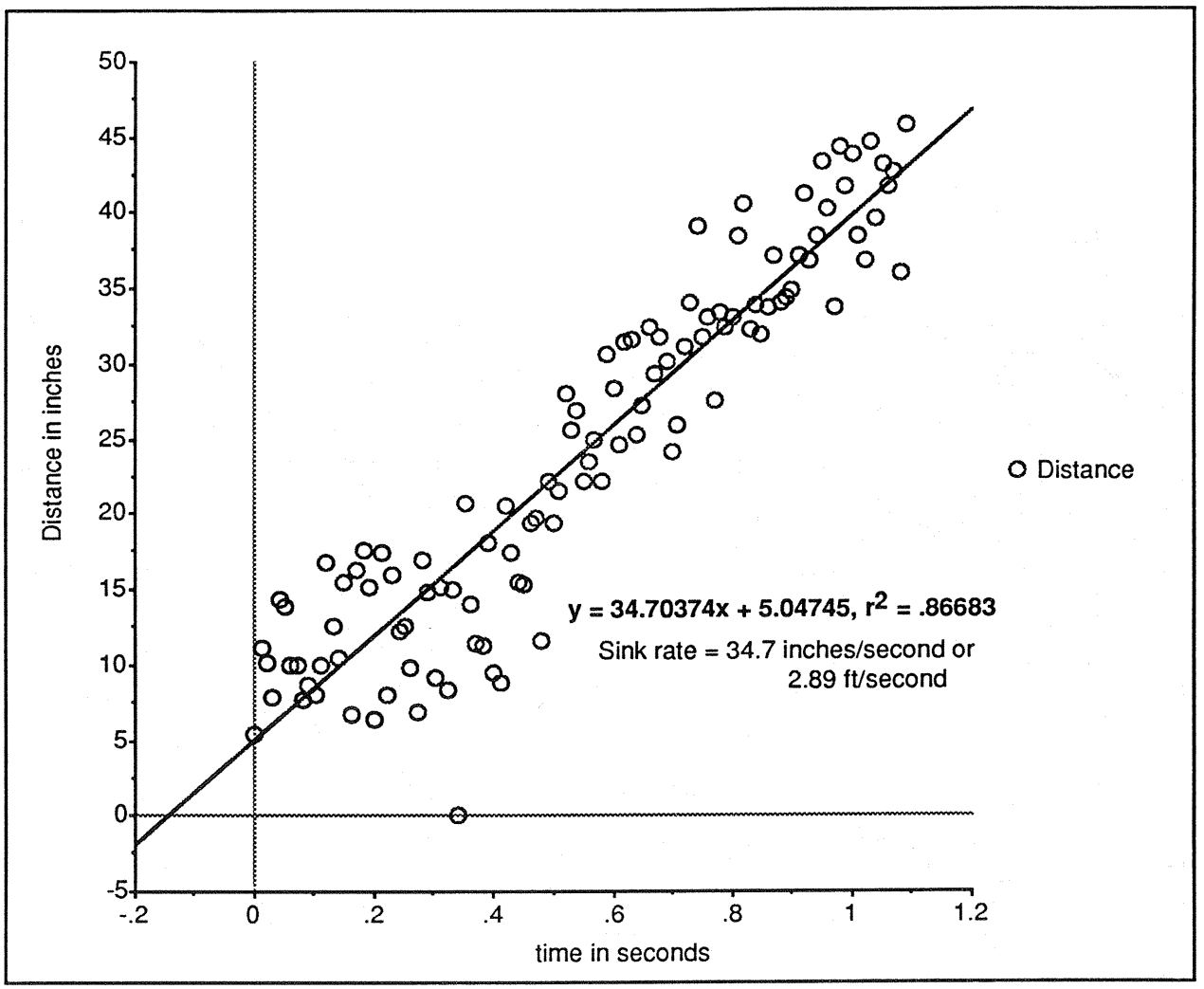
Frames 1500 to 1680 from Film EL-09 were used to determine the main landing gear sink rate. This camera was located at the end of the runway and viewed the back of the orbiter at landing. Since the camera did not appear to move significantly, no reference was used to compensate for camera motion. The first frame (1500) was used as the 0 reference point and the top and bottom of the right right main landing gear wheel was used as the target point on the orbiter to determine sink rate. In the analysis only the y or vertical positions of the wheel were used. The pixel location of the top of the wheel was subtracted from the reference frame and then scaled using the known diameter of the main wheel. This gave a distance between each frame and the reference frame.

The time between each frame was 1/48 seconds since the camera speed was 96 frames per second and every other frame was sampled. The time for each frame was also determined in reference to the first frame, so frame 1 was time 0 and each subsequent frame was incremented by 1/48 seconds.

With the time of each frame and the distance of each frame from the reference frame, the sink rate was determined using simple least squares regression. Using the time(in seconds) as the independent variable and distance from the reference (in inches) as the dependent variable the slope of the resulting regression line was found to be 23.9535 in/sec or 1.996 ft/sec. This slope was then assummed to be the main landing gear sink rate.

The variables in the spreadsheet are: **Frame** (frame number on 16mm E-09 film), **Time** (time in seconds from first or reference frame), **Xtop** (x coordinate of top of rt. rt. main wheel), **Ytop** (y coordinate of top of wheel), **Xbottom** (x coordinate of bottom of wheel), **Ybottom** (y coordinate of bottom of wheel), **Ydif** (distance in pixels from top to bottom of wheel), **Scale_in_pix** (scale in inches per pixel using a wheel diameter of 44.5 inches), **Top_frame_dst** (Distance in inches from the reference frame to each frame).

Nose Wheel Sink rate



Frame	time	Xback1	Yback1	Xback2	Yback2	Xnose	Ynose	Ynorm	scale	Ynorm_inches	Ynorm_cal	sinkrate inches
3505	1.09	165.98	165.86	181.36	165.6	177	167.1	1.24001	17.683	21.9268231	45.770573	34.70373582
3506	1.08	165.92	165.92	181.58	165.86	177	166.62	0.7	17.369	12.158276	36.002026	sinkrate ft
3507	1.07	166	166	181.56	165.54	177.1	167.08	1.08	17.473	18.8709325	42.714682	2.891977985
3508	1.06	166.06	166.16	181.64	165.92	177.06	167.18	1.01999	17.456	17.8051585	41.648908	
3509	1.05	165.88	166.28	181.7	165.78	177.18	167.4	1.11999	17.185	19.2468547	43.090605	
3510	1.04	166.06	166.14	181.6	165.84	177.06	167.04	0.89999	17.5	15.749776	39.593526	
3511	1.03	166.32	166.12	181.82	166.04	177.24	167.3	1.18	17.548	20.7068209	44.550571	
3512	1.02	166.02	166.02	181.48	165.88	177.16	166.76	0.73999	17.593	13.0186952	36.862445	
3513	1.01	166.24	166.26	181.88	165.96	176.84	167.1	0.84002	17.388	14.6063663	38.450116	
3514	1	166.04	166.06	181.84	165.94	177.3	167.22	1.16	17.215	19.9690317	43.812782	
3515	0.99	166.18	166.18	181.96	166.12	177.4	167.22	1.04001	17.237	17.9265093	41.770259	
3516	0.98	166.24	166.2	181.42	166.18	177.14	167.34	1.14	17.918	20.4268732	44.270623	
3517	0.97	166.28	166.44	181.76	165.92	177.44	167	0.56	17.561	9.83425269	33.678003	
3518	0.96	166.1	166.26	181.72	166.06	177.32	167.2	0.94001	17.412	16.3676011	40.211351	
3519	0.95	166.08	166.12	181.76	166.04	177.12	167.24	1.12001	17.347	19.4285044	43.272254	
3520	0.94	166.42	166.12	182.04	165.7	177.38	166.96	0.84001	17.407	14.6222993	38.466049	
3521	0.93	166.3	166.04	181.9	165.86	177.2	166.78	0.74001	17.435	12.901888	36.745638	
3522	0.92	166.32	165.9	181.92	165.92	177.52	166.9	1	17.436	17.4358943	41.279644	
3523	0.91	166.26	166.26	181.8	166.04	177.28	167.02	0.76001	17.501	13.3012789	37.145029	
3524	0.9	166.34	166.18	182.12	165.84	177.54	166.82	0.64002	17.233	11.0294707	34.873221	
3525	0.89	166.6	166.38	182.12	166.06	177.82	166.98	0.6	17.522	10.5132362	34.356986	
3526	0.88	166.24	166.32	182.1	166.14	177.18	166.92	0.59999	17.149	10.2892036	34.132953	
3527	0.87	166.34	166.26	182.34	165.96	177.24	167.04	0.78	16.997	13.2576701	37.10142	
3528	0.86	166.32	166.26	182.28	166.1	177.62	166.84	0.58001	17.042	9.88439184	33.728142	
3529	0.85	166.7	166.26	182.06	166.14	177.44	166.72	0.46001	17.708	8.14576187	31.989512	
3530	0.84	166.32	166.48	182.14	166.18	177.64	167.06	0.58	17.19	9.97040073	33.814151	
3531	0.83	166.5	166.68	182	166.62	177.64	167.16	0.48001	17.548	8.4233382	32.267088	
3532	0.82	166.64	166.22	182.22	166.42	177.46	167.18	0.95999	17.457	16.7583933	40.602143	
3533	0.81	166.5	166.26	182.08	166.38	177.64	167.1	0.84002	17.458	14.6648692	38.508619	
3534	0.8	166.42	166.46	182.36	166.32	178.04	167	0.53999	17.063	9.21402856	33.057778	
3535	0.79	166.44	166.46	182.22	166.3	177.9	166.96	0.5	17.236	8.61806139	32.461811	
3536	0.78	166.72	166.46	182.54	166.38	177.98	167.02	0.55999	17.193	9.6280296	33.471779	
3537	0.77	166.62	166.54	182.5	166.26	177.74	166.76	0.22	17.126	3.76767633	27.611426	
3538	0.76	166.46	166.5	182.38	166.54	177.76	167.04	0.53999	17.085	9.22593649	33.069686	
3539	0.75	166.5	166.58	182.38	166.62	178.14	167.04	0.45999	17.128	7.87889692	31.722647	
3540	0.74	166.56	166.28	182.3	166.26	177.9	167.16	0.88	17.281	15.2071033	39.050853	
3541	0.73	166.56	166.52	182.58	166.42	177.62	167.12	0.6	16.978	10.1870674	34.030817	
3542	0.72	166.62	166.24	182.42	165.82	177.8	166.66	0.41999	17.209	7.22765445	31.071404	
3543	0.71	166.72	166.48	182.54	166.26	177.88	166.6	0.12001	17.192	2.06318486	25.906935	
3544	0.7	166.78	166.62	182.48	166.46	177.98	166.64	0.02	17.324	0.34647883	24.190229	

3545	0.69	167	166.54	182.4	166.5	177.78	166.9	0.36	17.662	6.35842425	30.202174
3546	0.68	166.78	166.54	182.44	166.4	177.96	167	0.46001	17.368	7.98963731	31.833387
3547	0.67	166.64	166.68	182.38	166.72	177.8	167	0.32001	17.281	5.53001517	29.373765
3548	0.66	166.64	166.64	182.38	166.72	177.58	167.14	0.5	17.281	8.64029501	32.484045
3549	0.65	166.48	166.8	182.36	166.64	177.8	167	0.2	17.128	3.42551883	27.269269
3550	0.64	166.52	166.78	182.04	166.6	177.9	166.86	0.08	17.525	1.40196848	25.245718
3551	0.63	166.52	166.4	182	166.38	177.78	166.84	0.44001	17.571	7.73143541	31.575185
3552	0.62	166.64	166.4	182.52	166.18	177.48	166.84	0.44001	17.127	7.53597206	31.379722
3553	0.61	166.68	166.78	182.26	166.78	177.72	166.82	0.04001	17.458	0.69850578	24.542256
3554	0.6	166.4	166.64	182.14	166.62	177.94	166.9	0.25999	17.281	4.49283215	28.336582
3555	0.59	166.32	166.66	182.22	166.74	178	167.06	0.4	17.107	6.84268497	30.686435
3556	0.58	166.26	166.7	182.04	166.56	177.96	166.6	-0.1	17.236	-1.7234607	22.120289
3557	0.57	166.08	166.72	182.02	166.72	177.64	166.78	0.06	17.064	1.0238394	24.867589
3558	0.56	166.66	166.68	181.9	166.28	177.84	166.66	-0.02	17.842	-0.3566543	23.487096
3559	0.55	166.56	166.62	182.2	166.42	177.96	166.52	-0.1	17.39	-1.7389883	22.104762
3560	0.54	166.22	166.2	182.58	166.2	178.04	166.38	0.18	16.626	2.99266504	26.836415
3561	0.53	166.44	166.28	182.2	166.14	177.94	166.38	0.1	17.258	1.72582023	25.56957
3562	0.52	166.5	166.34	182.38	166.2	177.78	166.58	0.24	17.128	4.11067149	27.954421
3563	0.51	166.52	166.7	182.54	166.46	177.82	166.56	-0.14	16.977	-2.3767635	21.466986
3564	0.5	166.22	167.02	182.38	166.44	177.84	166.76	-0.26	16.821	-4.3735899	19.47016
3565	0.49	166.42	166.88	182.32	166.46	177.56	166.78	-0.1	17.101	-1.7100943	22.133656
3566	0.48	166.36	166.88	182.32	166.36	177.56	166.16	-0.72	17.034	-12.264161	11.579589
3567	0.47	166.34	166.88	182.18	166.5	177.46	166.64	-0.24	17.167	-4.1200293	19.723721
3568	0.46	166.1	167	182.22	166.6	178.02	166.74	-0.26	16.868	-4.3855809	19.458169
3569	0.45	166.26	167.04	182.14	166.84	177.48	166.54	-0.5	17.127	-8.5635473	15.280203
3570	0.44	166.14	166.74	182.46	166.2	177.46	166.24	-0.5	16.658	-8.32877	15.51498
3571	0.43	165.98	166.64	182.1	166.36	177.62	166.26	-0.38	16.871	-6.4111084	17.432641
3572	0.42	166.02	166.42	182.4	166.32	177.72	166.22	-0.2	16.605	-3.3210635	20.522686
3573	0.41	166	166.88	181.98	166.68	177.84	166	-0.88	17.02	-14.97755	8.8661996
3574	0.4	166.4	166.5	182.36	166.12	177.32	165.66	-0.84	17.038	-14.311724	9.5320254
3575	0.39	166.18	166.64	182.2	166.28	177.62	166.3	-0.34	16.974	-5.7713234	18.072426
3576	0.38	166.3	166.56	182.26	166.32	177.96	165.82	-0.74	17.041	-12.609941	11.233809
3577	0.37	165.92	166.66	182.6	166.28	177.64	165.9	-0.76	16.303	-12.390226	11.453524
3578	0.36	166.3	166.48	182.34	166.44	177.86	165.9	-0.58	16.958	-9.8355505	14.008199
3579	0.35	166.36	166.44	182.04	166.3	177.6	166.26	-0.18	17.346	-3.1225	20.72125
3580	0.34	166.38	166.66	182.12	166.38	177.32	165.28	-1.38	17.278	-23.84375	0
3581	0.33	166	166.64	181.94	166.26	177.74	166.12	-0.52	17.059	-8.8707543	14.972996
3582	0.32	165.88	166.96	182.04	166.56	177.92	166.04	-0.92	16.827	-15.480753	8.362997
3583	0.31	166.18	166.58	181.86	166.76	177.76	166.08	-0.5	17.346	-8.6728925	15.170857
3584	0.3	166.06	166.7	182.32	166.38	177.64	165.82	-0.88	16.725	-14.717761	9.1259889
3585	0.29	166.04	166.8	182.32	166.56	177.52	166.26	-0.54	16.706	-9.0212888	14.822461

3586	0.28	166.22	166.5	182.08	166.34	177.8	166.1	-0.4	17.149	-6.8595047	16.984245	
3587	0.27	165.88	166.76	182.22	166.42	177.48	165.74	-1.02	16.643	-16.975185	6.8685648	
3588	0.26	166	166.84	181.94	166.46	177.28	166.02	-0.82	17.059	-13.988498	9.8552523	
3589	0.25	165.84	166.86	181.82	166.76	177.38	166.2	-0.66	17.021	-11.233816	12.609934	
3590	0.24	166.1	166.82	182.04	166.34	177.34	166.14	-0.68	17.056	-11.598441	12.245309	
3591	0.23	166.18	166.82	181.96	166.88	177.54	166.36	-0.46	17.237	-7.9291291	15.914621	
3592	0.22	166.1	166.92	182.2	166.54	177.84	165.98	-0.94	16.89	-15.876333	7.9674164	
3593	0.21	165.8	166.38	182.02	166.36	177.4	166	-0.38	16.769	-6.3723749	17.471375	
3594	0.2	166.04	166.9	181.92	166.4	177.68	165.88	-1.02	17.12	-17.462197	6.381553	
3595	0.19	166.12	166.66	181.86	166.36	177.24	166.16	-0.5	17.278	-8.6388376	15.204912	
3596	0.18	165.84	166.46	181.7	166.24	177.26	166.1	-0.36	17.148	-6.1734288	17.670321	
3597	0.17	166.1	166.36	182.16	166.04	177.84	165.92	-0.44	16.933	-7.4505805	16.393169	
3598	0.16	166.14	166.52	182.38	166.22	177.14	165.5	-1.02	16.746	-17.08083	6.7629202	
3599	0.15	166.18	166.32	182.44	166.04	177.18	165.82	-0.5	16.726	-8.3628385	15.480911	
3600	0.14	165.84	166.94	182.02	166.62	177.72	166.14	-0.8	16.808	-13.446073	10.397677	
3601	0.13	166.1	166.9	181.98	166.74	177.8	166.24	-0.66	17.128	-11.303877	12.539873	
3602	0.12	166.16	166.62	182.26	166.44	177.4	166.2	-0.42	16.893	-7.0952132	16.748537	
3603	0.11	165.98	166.76	181.96	166.42	177.18	165.94	-0.82	17.017	-13.95411	9.8896399	
3604	0.1	165.66	166.74	181.8	166.2	177.84	165.8	-0.94	16.843	-15.832697	8.0110528	
3605	0.09	165.82	166.58	182.26	166.54	177.68	165.66	-0.92	16.545	-15.221385	8.6223652	
3606	0.08	166.1	166.92	182.28	166.58	177.7	165.96	-0.96	16.807	-16.134722	7.7090274	
3607	0.07	166.28	166.88	182.36	166.66	177.7	166.06	-0.82	16.914	-13.869349	9.9744011	
3608	0.06	166.2	166.94	181.96	166.48	177.68	166.14	-0.8	17.252	-13.80122	10.04253	
3609	0.05	166.04	166.8	181.9	166.5	177.88	166.22	-0.58	17.147	-9.9452575	13.898492	
3610	0.04	165.82	166.76	181.98	166.38	177.96	166.2	-0.56	16.827	-9.4229754	14.420774	
3611	0.03	165.92	166.82	182.24	166.66	177.64	165.86	-0.96	16.666	-15.999388	7.844362	
3612	0.02	166.7	166.72	182.2	166.86	177.76	165.94	-0.78	17.548	-13.687184	10.156566	
3613	0.01	166.36	166.66	182.6	166.6	177.86	165.9	-0.76	16.749	-12.729137	11.114613	
3614	0	166.14	166.8	182.34	166.44	177.68	165.7	-1.1	16.786	-18.464577	5.3791726	
										min_ynorm		
										-23.84375		

Frames 3505 to 3614 from Film ML-005 were used to determine the nose wheel sink rate. Three points were digitized for each frame. The first point was the top of the right main landing gear wheel, the second point was the top of the left main wheel, and the third point was the top of the nose wheel. The main landing gear wheels were used to scale each frame (they are 272 inches apart) and were also used to remove camera motion. The vertical position of the nose wheel was subtracted from the vertical position of the top of the right main wheel (which served as a reference point in the vertical dimension, since the main wheels had already touched down.) to give the normalized vertical position of the nose wheel. After scaling to convert vertical position of the nose wheel to inches, the normalized vertical position was also scaled by subtracting the minimum vertical position from each frame so that the minimum value was 0.

The time between each frame was .01 seconds since the camera speed was 100 frames per second.
With the time of each frame and the distance of the nose wheel from the main landing wheel reference point, the sink rate was determined using simple least squares regression. Using the time(in seconds) as the independent variable and distance from the reference (in inches) as the dependent variable the slope of the resulting regression line was found to be 34.7 in/sec or 2.89 ft/sec. This slope was then assummed to be the main landing gear sink rate.

The variables in the spreadsheet are: **Frame** (frame number on 16mm ML-005 film), **Time** (time in seconds), **Xback1** (x coordinate of top of rt. main wheel), **Yback1** (y coordinate of top of back wheel), **Xback2** (x coordinate of left main wheel), **Yback2** (y coordinate of left main wheel), **Xnose** (x coordinate of top of nose wheel), **Ynose** (Y coordinate of top of nose wheel), **Ynorm**(vertical distance in pixels from rt main wheel to nose wheel), **Scale** (scale in inches per pixel using distance between main wheels = 272 inches), **Ynorm_inches** (Distance in inches from the vertical position of the rt. main wheel to the nose wheel), **Ynorm_cal** (Vertical distance from nose wheel to rt main wheel scaled from 0 to max).,
sinkrate in (sink rate in inches/second using linest function), **sinkrate ft** (sink rate in ft/second), **min_ynorm** (minimum of the Ynorm_inches values).

Photo/TV Analysis Group Request Form
STS-45
04/30/92

Task Number --> 4

Request Date : 10/16/91
Completion Date : 03/31/92

Requestor : Debris Team
Phone : 483-0684
Mail Code :

Analyst Name	Phone Number	Assignment
M. Snyder	483-5171	Data Analysis
H. Harless/T. Morris	483-9143	Data Measurements
Team		Screening & Documentation

Task Title

Body Flap Analysis

Objectives

Hypothesis

Reporting

Analysis Strategy

1) Screen films E-207, E-221, E-222, E-223, and others which may show motion of the body flap.
2) Note times/frames in which movement occurs
3) Measure motion - amplitude and frequency
4) Characterize and document motion
5) Report to appropriate Level II and MER personnel

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
4

Title : Body Flap Analysis

Analysts : M. Snyder
Date : 03/31/92

Camera Number : E207
Frame Number :
GMT :

Requestor : Debris Team
Phone : 483-0684
Mail Code :

Description of Analysis

Slight body flap motion was seen on E207. Since there was only very slight body flap motion noted in this mission, a detailed analysis of body flap motion would not be appropriate. Body flap motion is difficult to measure even when there is much greater apparent motion than was seen in this mission. When only slight body flap motion is seen measurement of body flap displacement would be too inaccurate for useful results.

Image Analysis Tools & Techniques

Viewed films of FMA

Photo/TV Analysis Group Request Form
STS-45
04/30/92

Task Number --> 5

Request Date : 10/16/91
Completion Date : 03/26/92

Requestor : Debris Team
Phone : 483-0684
Mail Code : WC13

Analyst Name	Phone Number	Assignment
J. Disler	483-5182	

Task Title

Umbilical Well Camera Analysis

Objectives

Hypothesis

Reporting

Analysis Strategy

1) Screen photography for anomalies
2) Enhance photography for analysis
3) Analyze and document results

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
5

Title : Umbilical Well Camera Analysis

Analysts :
Date : 03/26/92

Camera Number :
Frame Number :
GMT :

Requestor : Debris Team
Phone : 483-0684
Mail Code : WC13

Description of Analysis

Not available this mission

Image Analysis Tools & Techniques

Photo/TV Analysis Group Request Form
STS-45
04/30/92

Task Number --> 6

Request Date : 10/16/91
Completion Date : 04/03/92

Requestor : Debris Team
Phone : 483-0684
Mail Code : WC13

Analyst Name	Phone Number	Assignment
Jon Disler	483-5182	Coordination
Team	483-5182	

Task Title

ET Onboard Hasselblad Photo Analysis

Objectives

Hypothesis

Reporting

Analysis Strategy

1) Determine resolution and distance of ET from shuttle
2) Determine size of debris flying with ET. Note other characteristics if possible.
3) Investigate to see if any anomalies exist?
4) Investigate results
5) Talk to Astronauts
6) In screening, try to determine rate and direction of tumbling
7) Compare to umbilical well cameras
8) Digitize

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
6

Title : ET Onboard Hasselblad Photo Analysis

Analysts : B. Gastineau,M. Snyder,R. Bhaskar
Date : 04/03/92

Camera Number :
Frame Number :
GMT :

Requestor : Debris Team
Phone : 483-0684
Mail Code : WC13

Description of Analysis

See attached

Image Analysis Tools & Techniques

frame id	gmt	el. tim	/ lt of l	description	signif. obs
45-71-001	13:26:07	0	rt side	good focus , good exposure	1. divots 1,2, 3,4 lh2 intertank interface
					2. ET aftdome charring, RSRB sep. burn scar
					3. ring of light colored SOFI above ET aftdome
					4. charring above aftdome180 deg. from LO2 feed line
					5. dark linear feature along ET above right aft strut
45-71-002	13:26:11	4	rt side	good focus , good exposure	#1, 2, 3, 4,5
45-71-003	13:26:22	15	rt + 30	good focus , good exposure	#2, 3, 4, 5
					divots 2 3, 4,
					white debris on left of FOV
45-71-004	13:26:33	26	rt +30	good focus, good exposure	#2, 3, 4
					divots 2 3, 4,
					white debris below ET
45-71-005	13:26:37	30	rt + 45	good focus , good exposure	#2, 3 ,4
					divots 2, 3, 4
					white debris below and to right of ET
45-71-006	13:26:42	35	rt + 45	good focus , good exposure	#2, 3, 4
					divots 2, 3, 4
					white debris below and to right of ET

45-71-007	13:26:51	44	rt + 45	fair focus, dark exposure	#2, 4		
					divots 3, 4		
45-71-008	13:26:56	49	rt + 45	good focus, dark exposure	#2, 4		
					divots 2, 3, 4		
45-71-009	13:27:01	54	rt + 45	good focus , good exposure	#3, 4		
					slight amt. of RSRB burn scar		
					divots 2, 3, 4		
45-71-010	13:27:07	60	rt + 60	good focus , good exposure	#3, 4		
				slight image smear	slight amt. of RSRB burn scar		
					divots 2, 3, 4 on LH2 intertank interface		
					white debris below and to left of ET		
45-71-011	13:28:37	150	lt -75	good focus , good exposure	# 4		
					6. ET aftdome charring		
					7. LSRB sep. burn scar		
					(3) white objects: above; above right; below right		
45-71-012	13:28:53	166	lt - 60	good focus , good exposure	#4, 6, 7		
					(1) white object to the right of ET		
45-71-013	13:29:16	189	lt - 60	good focus , dark exposure	#6, 7		
					(1) white object below ET		
45-71-014	13:29:36	209	lt - 60	soft focus, dark exposure	too dark for analysis		
45-71-015	13:29:49	222	lt - 60	good focus , exposure var	#6, 7		

45-71-016	13:30:04	237	lt - 60	soft focus, good exposure	#6, 7		
					soft focus hampers analysis		
45-17-017	13:30:30	263	lt - 45	good focus , good exposure	#6, 7		
					8. dark linear feature along ET above left aft strut		
					divots 5, 6, 7, 8 on LH2 intertank interface		
45-71-018	13:30:42	275	lt - 45	good focus , good exposure	#6, 7, 8		
					divots ~6, 8 on LH2 intertank interface		
45-71-019	13:30:59	292	lt - 30	good focus , good exposure	#6, 7, 8		
					divots ~6, 8 on LH2 intertank interface		
45-71-020	13:31:10	303	l t	good focus , good exposure	#7, 8		
					divots ~6, 8 on LH2 intertank interface		
45-71-021	13:31:18	311	l t	good focus , good exposure	#7, 8		
					divots ~6, 8 on LH2 intertank interface		
45-71-022	13:31:29	322	l t	good focus , good exposure	#7, 8		
					divot ~8 on LH2 intertank interface		
					white debris to left of ET intertank		
45-71-023	13:31:40	333	l t	good focus , good exposure	#7, 8		

					divots 5, 6, 7, 8 on LH2 intertank interface
					white debris on ogive
45-71-024	13:31:56	349	lt +15	good focus , good exposure	#7, 8
					divots 6, 7 on LH2 intertank interface
					white debris to right of ogive
					white debris appears at left of FOV
45-71-025	13:32:08	361	lt + 15	good focus , good exposure	#7, 8
					divots 6, 7 on LH2 intertank interface
					white debris still visible at left of FOV
45-71-026	13:32:19	372	lt+15	good focus , good exposure	#7, 8
					divots 6, 7, 8 on LH2 intertank interface
					white debris still visible at left of FOV
45-71-027	13:32:32	385	lt + 15	good focus , good exposure	#7, 8
					divots 7, 8 on LH2 intertank interface
					white debris still visible at left of FOV
					small, white debris at left of FOV
45-71-028	13:32:51	404	lt + 15	good focus , good exposure	#7, 8
					divots 6, 7, 8 on LH2 intertank interface
					white debris still visible at left of FOV
					small, white debris below and to the left of FOV
45-71-029	13:33:32	445	lt + 30	soft focus, dark exposure	#7
					white debris still visible at left of FOV
					dark exposure hampers analysis

45-71-030	13:33:34	447	lt + 45	good focus , dark exposure	#7		
					divots 7, 8 on LH2 intertank interface		
					white debris still visible at left of FOV		
					dark exposure hampers analysis		
45-71-031	13:33:44	457	lt + 45	soft focus, dark exposure	#7		
					divots 7, 8 on LH2 intertank interface		
					white debris still visible at left of FOV		
					dark exposure hampers analysis		
45-71-032	13:33:47	460	lt + 45	good focus , dark exposure	white debris still visible at left of FOV		
					dark exposure hampers analysis		
45-71-33	13:34:01	474	lt + 45	good focus , dark exposure	#7		
					divots 7, 8 on LH2 intertank interface		
					white debris still visible at left of FOV		
45-71-34	13:34:14	487	lt + 45	good focus , good exposure	#7		
					divots 7, 8, 9 on LH2 intertank interface		
					white debris still visible at left of FOV		
45-71-35	13:34:46	519	rt - 30	good focus , good exposure	#2, 6		
					divot 1 on LH2 intertank interface		
					white debris visible now above and to left of FOV		
45-71-36	13:35:16	549	rt - 15	good focus , dark exposure	dark exposure hampers analysis		
					white debris visible now above ET		
45-71-37	13:35:18	551	rt - 15	good focus , exposure var	dark exposure hampers analysis		

45-71-38	13:35:31	564	rt - 15	good focus , exposure var	dark exposure hampers analysis	
					white debris visible now above and to right of FOV	

STS-45
16mm Arriflex motion camera
File Roll No. F-510 (zero frame)

Brian Gastineau, Mike Snyder, Ranjit Bhaskar
3/3/92, 3/6/92, 3/7/92

Frame	**402**	acquisition of ET
		intermittent loss of ET (camera being zoomed in)
Frame	**1075-1190**	white debris moving across FOV in front of the intertank (from left aft strut side)
Frame	**1086-1200**	vapor from (hydrogen) umbilical area noted
		small white objects noted in vapor cone throughout the time periods when vapor is visible
Frame	**1259-1422**	vapor from (hydrogen) umbilical area noted
Frame	**1260-1385**	small white object moves across FOV between ET and camera
Frame	**1457-1586**	vapor from (hydrogen) umbilical area noted

FILM QUALITY

Nicks and scratches on film

Summary of Analysis of Visual Events
STS-45
05/06/92

Task Number
6.01

Title : ET Onboard Hasselblad Photo Analysis

Analysts : C. Dailey
Date : 04/10/92

Camera Number :
Frame Number :
GMT :

Requestor : Debris Team
Phone : 483-0684
Mail Code : WC13

Description of Analysis

Attached is the debrief questions and astronauts answers for DTO-312.

Image Analysis Tools & Techniques

April 10, 1992

STS 45 DTO-312 DEBRIEF QUESTIONS

ASTRONAUTS INVOLVED IN DTO-312 QUESTIONING:
Dave - Dave Leestma
Kathy - Kathy Sullivan
Charlie - Charlie Bolden
Mike - Mike Foale

PLEASE NOTE THAT RECORDED RESPONSES WERE NOT VERBATIM.

Who took the pictures?

Dave Leestma took the first 7 or 8 Hasselblads. Mike Foale took the last 30 or so pictures. Kathy Sullivan operated the 16mm Arriflex motion picture camera.

Did you have any problems getting set up to take the pictures?

Dave - No real problems, but it took time to set up for the pictures. Had to remove the window shade and it was difficult to stuff and had no where to attach it.

Could you readily acquire the ET visually?

Dave - Yes.

Were the existing lighting conditions a problem? About what you expected?

Good sun angle.

Did the crew know that we want to get pictures of as many sides of the tank as possible? (particularly the areas that are prone toward having divots like the bipod area)

Dave - No. We did not really know what you wanted. Charlie - From what I remember the DTO brief was mostly about F/stops. The best time for training would be before integrated training - some 6 to 8 weeks ... Brian says 16 weeks. Dave - We need to know three things from the DTO brief ... 1, what you wanted (?) ... 2, camera settings ...3, what specifics are you looking for in the pictures. Kathy - The only brief I remember was a small subset in the intense camera "thrash" we received. General comment was that the DTO merits its own sit down session.

Did you note any debris near the ET? Can you comment on the relative size, shape, appearance or distance of the debris?

NOT ADDRESSED

Have you seen any of the pictures that were taken? Do the ET photos appear similar to the way the ET appeared visually?

Dave - Yes. The one thing that stands out is that the venting was clearly visible. I'm surprised we didn't see it in the pictures (REF: Hasselblad Pictures). The venting was clearly distinct by eye. The last ten pictures on the Hasselblad should show intertank venting. They were taken to correspond with the intertank venting.

Could you see the separation burn on the ogive of the ET?

NOT ADDRESSED

Were any "divots" in the ET TPS visible?

NOT ADDRESSED

Was preflight training / preparation adequate to perform the DTO?

REFERENCE EARLIER QUESTION ABOUT WHAT WAS REQUIRED

Timing is important to some of our analyses. Could you comment on the method you use to remember to turn on the data recording back?

Dave - There was grey tape on the eye piece with a note that said "TURN ON DATABACK IMMEDIATELY".

Which type of film was used to take the 16mm pictures?

Kathy - ASA 100 daylight film ... and I did have the orange filter on.

When was the 16mm film taken in relationship to the 70mm film?

Dave - About 5 minutes after the 70mm were started.

Did you change position of the camera while taking the 70mm pictures?

Dave - I took the first shots ... we later changed from window 8 to 7. The 16mm film was taken looking out window 8.

Did you zoom all the way in on the 16mm pictures of the venting?

Kathy - The first few seconds I zoomed full out wide ... the rest of the time I zoomed in tight - all the way.

ET Venting Observation Questions:

1. How long after ET/Orbiter separation was the tank observed?

2. When was venting from the aft umbilical first observed (after ET separation)? How long after the start of the observation period did the venting begin? From the intertank? How long did it continue?

Mike - Approximately 25 minutes.

3. Estimate size/configuration of the vapor cloud from the intertank and how did it it change with time?

Dave - The intertank venting occurred as large 120 degree cone-shaped puffs (Mike says 150 degrees +), no periodic nature. We only saw it after about five minutes [no reference]. Mike - The last 10 frames, I tried to take a picture every time I saw the intertank venting. That should at least give you a time frame for the event.

4. Where on the intertank was the vapor cloud originating?

Mike - It appeared to be coming from the lower intertank ring this could have been perspective.

5. The comment Brian made inferred that the venting from the intertank was periodic; could you give an estimate of the vent cycle time and periodic cloud formation?

REFERENCE EARLIER QUESTION ABOUT INTERTANK VENTING

6. Could you describe the intertank venting area relative to the bipod or LO2 feedline fairing?

REFERENCE EARLIER QUESTION ABOUT INTERTANK VENTING

7. Did either venting location appear to cause thrust effects? Rolling (about the longitudinal axis) ? Was the ET rolling noticeably during the GH2 (intertank are) venting period? Tumbling (about the Y axis) ? Did the ET appear to be tumbling slowly or not at all?

Dave - I think the intertank venting probably did. You could see the ET tumble - slowly.

8. Did ET/Orbiter separation feel normal?

NOT ADDRESSED

9. Did you record the observations to tape? Were observations and comments correlated with the mission clock?

NOT ADDRESSED

10. What gave the impression that the tank was about to explode?

Dave - I guess it was because I hadn't seen the ET that close and when we saw it venting from both the aft end and these huge puffs from the intertank, my first reaction was that it was about to ....

Other Comments:

The Arriflex camera is not trivial to get set up. This was done by astronauts with previous flight experience. The reason they didn't get more pictures is that Kathy had gone back to the aft deck to do some other work and when they got the camera back on the flight deck, the switch wouldn't work.

The crew recommended using the camcorder rather than the Arriflex and having it stowed in A16 or A17 locker in a ready to use configuration. (We will follow up on this suggestion with the JSC Photo Working Group to determine feasibility.)

The astronauts volunteered to develop an observation timeline to go with the photo timeline. That will be faxed out after our Friday April 17 meeting with them.

Photo/TV Analysis Group Request Form
STS-45
05/06/92

Task Number --> 7

Request Date : 10/16/91
Completion Date : 04/15/92

Requestor : Debris Team
Phone : 483-1137
Mail Code : WC

Analyst Name	Phone Number	Assignment
S. Israel	244-5106	Data Collection
H. Harless/T. Morris	483-9143	Data Collection
Team		Screen & Document

Task Title

Velocity Measurements of SRB Duct Debris

Objectives

1.) Determine actual speed (scalar value) of a piece of debris

2.) Single camera solution will yield minimum value. (No information about velocity along optic axis. Direction of viewing.

Hypothesis

Most of the velocity will be described by change of position parallel to the cameras focal plane. Therefore velocity and speed can be determined as the first derivative of position.

Reporting

Document results in Final Report

Analysis Strategy

1) Look at Pad cameras for pieces of debris to study velocity coming from the SRB flame duct.
2) Choose several candidates at various times
3) Measure movement on film analyzers
4) Calculate velocities
5) Report to Debris Team

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
7

Title : Velocity Measurements of SRB Duct Debris

Analysts : S. Israel
Date : 03/30/92

Camera Number : E1,E15
Frame Number :
GMT :

Requestor : Debris Team
Phone : 483-1137
Mail Code : WC

Description of Analysis

Camera E1 Frame 4433
Highest position of debris x=205.6 y=150.4
Corresponds to 2nd from aft uncorked SRB stiffener ring

1. Digitized debris using 16mm FMA
2. Digitized SRBs to scale from FMA coordinates into real world coordinates
3. Analyzed data to determine initial velocity and observe if external forces are acting on debris other than gravity

Image Analysis Tools & Techniques

X=Xo+Vot+1/2gt2

Summary of Analysis of Visual Events
STS-45
05/06/92

Task Number
7.01

Title : Velocity Measurements of SRB Duct Debris

Analysts : S. Israel
Date : 03/30/92

Camera Number : E1,E15
Frame Number : 4433->
GMT :

Requestor : Debris Team
Phone : 483-1137
Mail Code : WC

Description of Analysis

1. Digitized spatial information using 16mm film motion analyzer
2. Digitized SRBs to scale FMA units to actual positions
3. Analyzed data to determine initial velocity and observe if external forces are acting on debris in addition to gravity

Image Analysis Tools & Techniques

-36.54	34.00	0.44	12.42	-13.35	11.94
-36.92	33.78	0.45	12.34	-13.49	11.87
-37.12	33.22	0.45	12.14	-13.56	11.67
-37.62	32.86	0.46	12.01	-13.75	11.54
-38.12	32.66	0.46	11.93	-13.93	11.47
-38.58	32.56	0.47	11.90	-14.10	11.44
-38.80	32.34	0.47	11.82	-14.18	11.36
-38.72	31.98	0.48	11.69	-14.15	11.23

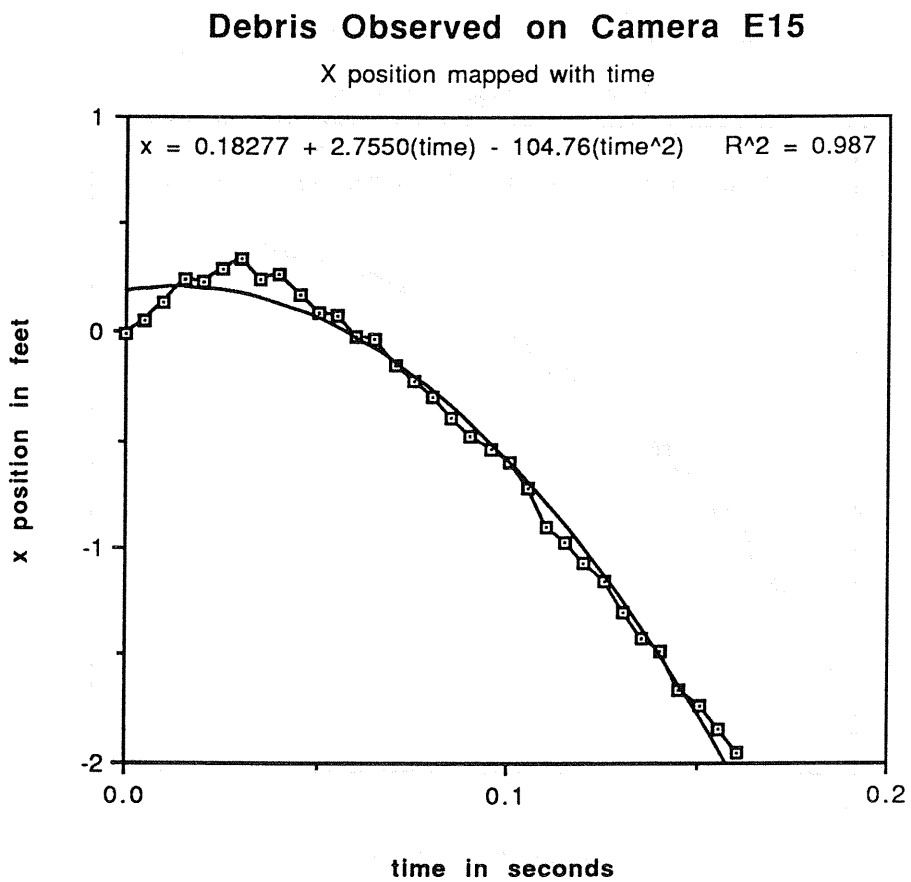
Debris Data from Camera E15

x pos. fma	y pos fma	time	y pos. real	x pos. real
-0.18	6.44	0.00	0.61	-0.02
0.50	13.88	0.01	1.32	0.05
1.42	19.76	0.01	1.88	0.13
2.50	24.94	0.02	2.37	0.24
2.42	29.98	0.02	2.85	0.23
3.02	34.86	0.03	3.31	0.29
3.56	38.62	0.03	3.67	0.34
2.50	42.40	0.04	4.02	0.24
2.78	46.24	0.04	4.39	0.26
1.84	49.00	0.05	4.65	0.17
0.90	52.30	0.05	4.96	0.09
0.72	54.60	0.06	5.18	0.07
-0.26	57.50	0.06	5.46	-0.02
-0.34	59.82	0.07	5.68	-0.03
-1.60	62.24	0.07	5.91	-0.15
-2.38	64.56	0.08	6.13	-0.23
-3.16	65.92	0.08	6.26	-0.30
-4.24	67.98	0.09	6.45	-0.40
-5.12	69.64	0.09	6.61	-0.49
-5.66	71.06	0.10	6.74	-0.54
-6.38	73.60	0.10	6.98	-0.61
-7.66	74.72	0.11	7.09	-0.73
-9.54	76.50	0.11	7.26	-0.91
-10.28	77.62	0.12	7.37	-0.98
-11.34	79.08	0.12	7.50	-1.08
-12.24	80.08	0.13	7.60	-1.16
-13.66	80.00	0.13	7.59	-1.30
-15.02	81.16	0.14	7.70	-1.43
-15.62	82.14	0.14	7.80	-1.48
-17.54	83.16	0.15	7.89	-1.66
-18.30	83.60	0.15	7.93	-1.74
-19.40	84.54	0.16	8.02	-1.84
-20.54	85.56	0.16	8.12	-1.95

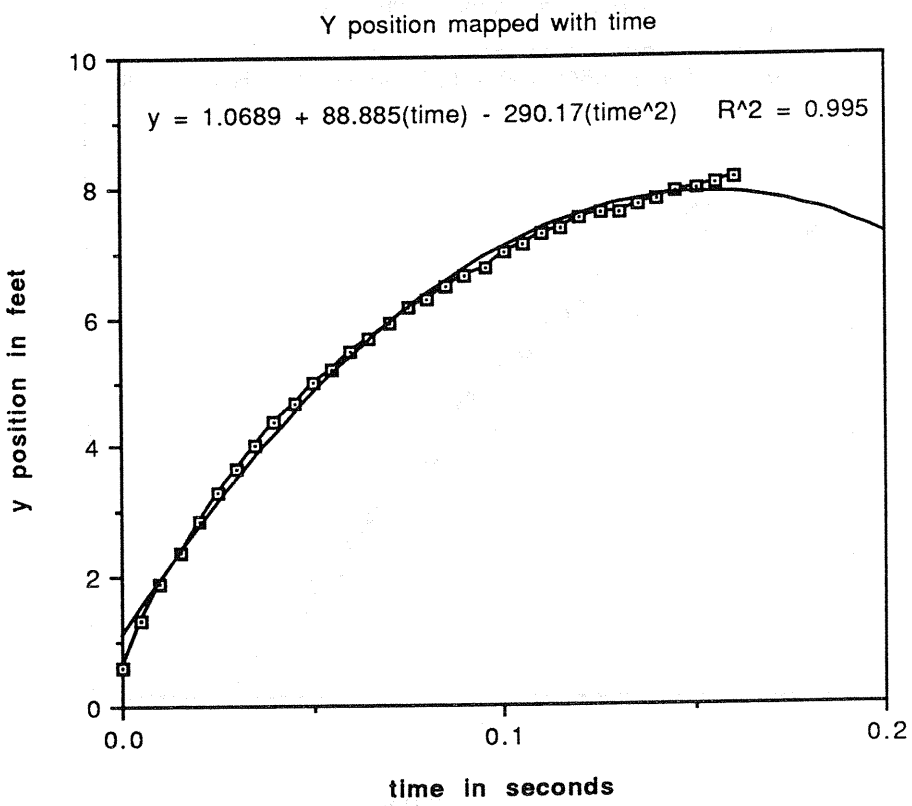
-16.96	34.16	0.21	12.48	-6.20	12.00
-17.44	34.46	0.22	12.59	-6.37	12.10
-17.84	34.76	0.22	12.70	-6.52	12.21
-18.06	34.70	0.23	12.68	-6.60	12.19
-18.68	34.84	0.23	12.73	-6.83	12.24
-18.96	35.38	0.24	12.93	-6.93	12.43
-19.36	35.62	0.24	13.02	-7.07	12.51
-20.06	35.58	0.25	13.00	-7.33	12.50
-20.36	35.60	0.25	13.01	-7.44	12.50
-20.88	35.78	0.26	13.07	-7.63	12.57
-21.36	36.32	0.26	13.27	-7.80	12.76
-21.84	36.32	0.27	13.27	-7.98	12.76
-22.26	36.18	0.27	13.22	-8.13	12.71
-22.54	36.06	0.28	13.18	-8.24	12.67
-23.14	36.30	0.28	13.26	-8.46	12.75
-23.58	36.40	0.29	13.30	-8.62	12.79
-23.96	36.28	0.29	13.26	-8.75	12.74
-24.50	36.42	0.30	13.31	-8.95	12.79
-25.04	36.68	0.30	13.40	-9.15	12.88
-25.50	36.96	0.31	13.51	-9.32	12.98
-25.76	36.84	0.31	13.46	-9.41	12.94
-26.44	36.26	0.32	13.25	-9.66	12.74
-26.62	36.12	0.32	13.20	-9.73	12.69
-27.38	36.34	0.33	13.28	-10.00	12.76
-27.86	36.56	0.33	13.36	-10.18	12.84
-27.82	36.90	0.34	13.48	-10.17	12.96
-27.92	36.90	0.34	13.48	-10.20	12.96
-28.30	36.84	0.35	13.46	-10.34	12.94
-29.16	36.24	0.35	13.24	-10.66	12.73
-29.84	36.18	0.36	13.22	-10.90	12.71
-30.94	36.36	0.36	13.29	-11.31	12.77
-30.60	36.42	0.37	13.31	-11.18	12.79
-30.50	36.06	0.37	13.18	-11.14	12.67
-30.90	36.24	0.38	13.24	-11.29	12.73
-31.66	35.96	0.38	13.14	-11.57	12.63
-32.30	35.50	0.39	12.97	-11.80	12.47
-33.06	35.26	0.39	12.88	-12.08	12.39
-33.18	35.44	0.40	12.95	-12.12	12.45
-33.08	35.22	0.40	12.87	-12.09	12.37
-33.48	35.28	0.41	12.89	-12.23	12.39
-34.28	34.94	0.41	12.77	-12.53	12.27
-34.90	34.56	0.42	12.63	-12.75	12.14
-35.26	34.60	0.42	12.64	-12.88	12.15
-35.46	34.28	0.43	12.53	-12.96	12.04
-35.72	33.90	0.43	12.39	-13.05	11.91
-36.04	34.02	0.44	12.43	-13.17	11.95

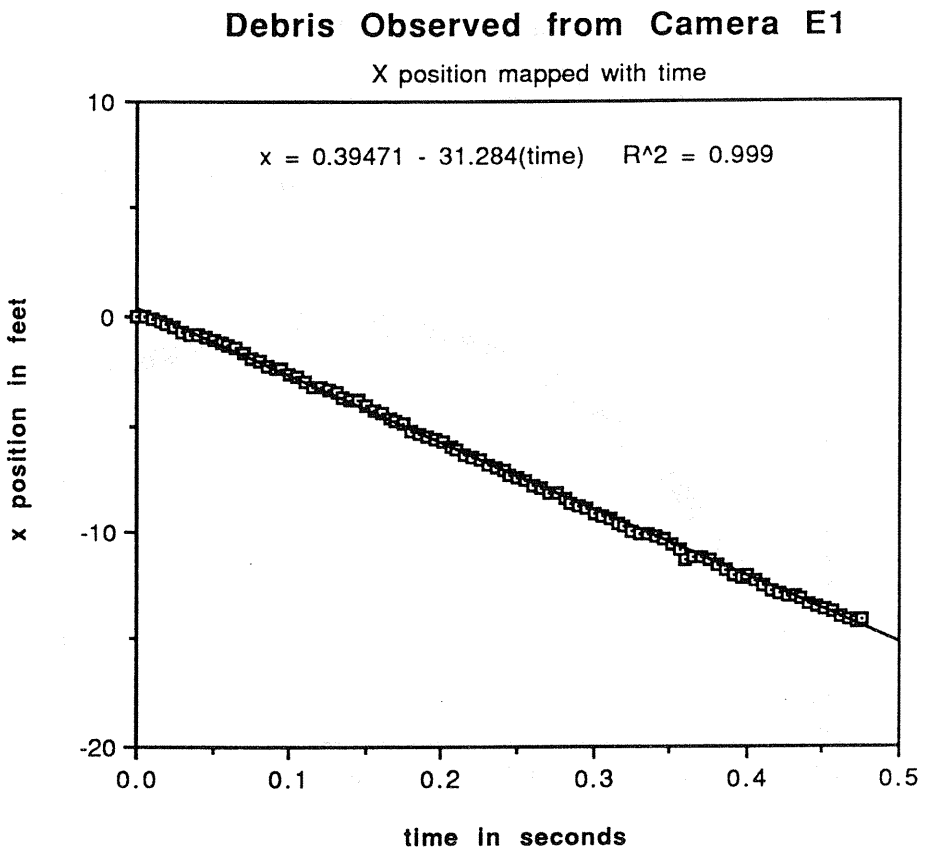
Debris Data from Camera E1

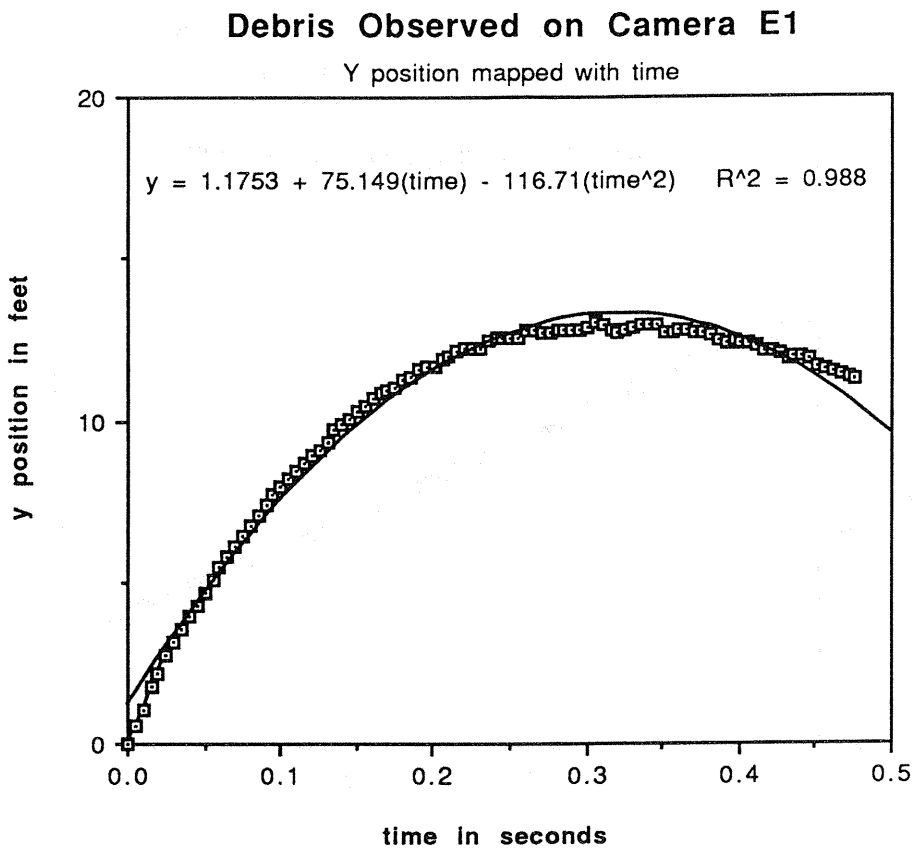
x pos. fma	y pos fma	time	y pos. real	x pos. real	y pos*cos(ele.)
0.00	0.00	0.00	0.00	0.00	0.00
-0.14	1.68	0.01	0.61	-0.05	0.59
-0.40	3.06	0.01	1.12	-0.15	1.07
-0.68	4.98	0.02	1.82	-0.25	1.75
-1.14	6.22	0.02	2.27	-0.42	2.18
-1.46	7.72	0.03	2.82	-0.53	2.71
-1.88	8.88	0.03	3.24	-0.69	3.12
-2.38	10.04	0.04	3.67	-0.87	3.53
-2.42	11.12	0.04	4.06	-0.88	3.91
-2.64	12.20	0.05	4.46	-0.96	4.29
-2.84	13.34	0.05	4.87	-1.04	4.69
-3.34	14.42	0.06	5.27	-1.22	5.07
-3.62	15.46	0.06	5.65	-1.32	5.43
-4.02	16.52	0.07	6.04	-1.47	5.80
-4.62	17.48	0.07	6.39	-1.69	6.14
-5.28	18.38	0.08	6.72	-1.93	6.46
-5.58	19.28	0.08	7.04	-2.04	6.77
-6.18	20.18	0.09	7.37	-2.26	7.09
-6.72	21.00	0.09	7.67	-2.46	7.38
-6.70	21.88	0.10	7.99	-2.45	7.69
-7.14	22.62	0.10	8.27	-2.61	7.95
-7.70	23.34	0.11	8.53	-2.81	8.20
-8.20	24.04	0.11	8.78	-3.00	8.44
-8.78	24.70	0.12	9.03	-3.21	8.68
-8.98	25.28	0.12	9.24	-3.28	8.88
-9.22	25.86	0.13	9.45	-3.37	9.08
-9.64	26.48	0.13	9.68	-3.52	9.30
-10.16	27.56	0.14	10.07	-3.71	9.68
-10.48	28.18	0.14	10.30	-3.83	9.90
-10.50	28.54	0.15	10.43	-3.84	10.02
-11.14	29.16	0.15	10.66	-4.07	10.24
-11.88	29.72	0.16	10.86	-4.34	10.44
-12.24	30.30	0.16	11.07	-4.47	10.64
-12.76	30.84	0.17	11.27	-4.66	10.83
-13.14	31.08	0.17	11.36	-4.80	10.92
-13.62	31.42	0.18	11.48	-4.98	11.04
-14.50	32.00	0.18	11.69	-5.30	11.24
-14.70	32.22	0.19	11.77	-5.37	11.32
-15.12	32.84	0.19	12.00	-5.52	11.54
-15.58	33.18	0.20	12.12	-5.69	11.65
-15.98	33.26	0.20	12.15	-5.84	11.68
-16.54	33.78	0.21	12.34	-6.04	11.87


Debris Observed on Camera E15
X position mapped with time
x = 0.18277 + 2.7550(time) - 104.76(time^2)
R^2 = 0.987
1
0
-1
-2
0.0
0.1
0.2
x position in feet
time in seconds

Debris Observed on Camera E15




Debris Observed from Camera E1
X position mapped with time
x = 0.39471 - 31.284(time) R^2 = 0.999
10
0
-10
-20
x position in feet
0.0
0.1
0.2
0.3
0.4
0.5
time in seconds


Debris Observed on Camera E1
Y position mapped with time
y = 1.1753 + 75.149(time) - 116.71(time^2)
R^2 = 0.988
y position in feet
20
10
0
0.0
0.1
0.2
0.3
0.4
0.5
time in seconds

Photo/TV Analysis Group Request Form
STS-45
04/30/92

Task Number --> 8

Request Date : 10/16/91
Completion Date : 03/24/92

Requestor : Troy Welch
Phone : 483-3335
Mail Code : VF

Analyst Name	Phone Number	Assignment
Team		Screen & Report

Task Title

STS-45 ET Tanking Screening

Objectives

Hypothesis

Reporting

Analysis Strategy

1) Screen and tape the first 3 hours of ET tanking for STS-45.
2) Review MER and PAO views during real time to identify any anomalies.
3) Report to MER

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
8

Title : STS-45 ET Tanking Screening

Analysts : J. Disler and S. Israel
Date : 03/23/92

Camera Number :
Frame Number :
GMT :

Requestor : Troy Welch
Phone : 483-3335
Mail Code : VF

Description of Analysis

See attached

Image Analysis Tools & Techniques

STS-45 TANKING TIMELINE (SCRUB)

At 22:00 CST the tanking telecon was held. At 22:35 CST we were notified by the MER that there is a go for tanking inspite of the forecast 80 percent chance of a no go for launch due to weather.

The following cameras were broadcast during tanking: 003, 009, 054, 057, 063, 064, 071.

The sequence of events were:

083/05:00:xx GMT, Started recorders when cameras began cycling. Tanking starts.

05:05:xx GMT, Minor venting was seen originating on camera view 063 beneath the 17 inch feedline on the orbiter side. On camera 009 the vapors can be seen coming from a vent.

05:21:xx GMT, Vapors appear to be increasing in intensity. Possible ice was visible above the LH2 umbilical disconnect at the interface of the feedline and the orbiter (top of baggy).

05:52:xx GMT, Liquid drops seen falling from beneath the 4 inch line on camera view 063. Liquid drops also seen coming from top of view above LH2 17 inch line on same view. Camera 009, liquid drops were seen coming from the LH2 17 inch flange on the orbiter side.

06:06:xx GMT, Start recording second set of tapes.

06:15:xx GMT, Camera view 054 zoomed in (oxygen side). Slightly out of focus.

06:30:xx GMT, the MER information line reported leaks in both the LH2 and LO2 systems at the beginning of tanking. The tanking flow has been stopped. No decision has been made on when to commence tanking again. The launch for March 23, 1992, looks doubtful.

06:48:xx GMT, On camera 063, a large amount of vapor was seen moving horizontally from south to north across bottom of view. Vapor was coming from under body flap.

06:50:xx GMT, On all cameras, liquid drops were seen falling from the 4 inch line on the ET side, the 17 inch flange on the orbiter side, and a large amount vapors were noted in the LH2 umbilical area. The ice noted earlier appears to have melted.

07:09:xx GMT, Start recording third set of tapes.

07:14:xx GMT, On camera 054, the view was zoomed in on a very large amount of vapor. Vapor seen from under the body flap moves upward toward umbilical area on the camera 054 view.

07:42:xx GMT, At T-3:00 hours and holding Bob Sieck announced the scrub of the STS-45 launch for March 23. There is still a possibility that STS-45 will launch on March 24, 1992. Stokes McMillan from the MER called and said that leak testing will continue for the next several hours and would like us to continue recording.

08:02:xx GMT, Trouble shooting will continue until 07:00am CST. Both the hydrogen and oxygen leaks were reported to be in the SSME aft engine compartment. The oxygen leak was measured at 600 ppm and the hydrogen leak measured at 700 ppm. The normal leak detected is approximately 50 ppm. The cause of the leaks has not been determined. The LH2 tank is approximately one third full.

08:11:xx GMT, Start recording fourth set of tapes.

08:16:xx GMT, The oxygen tank is being drained. The engineers feel that the oxygen leak can be explained. The cause of the hydrogen leaks are not known.

08:45:xx GMT, On camera 063, an unusual wet appearing area was noted on the orbiter tiles directly beneath the electric cable tray on the LH2 side. On camera 009 ice was seen on the LH2 umbilical vents.

09:00:xx GMT, The hydrogen tank will be detanked in the morning after the leak tests are completed.

09:07:xx GMT, Returning to a fast fill on liquid hydrogen in the same configuration that the leak first occurred. The test to isolate the elements from each of the three main engines did not help. Camera 009 showed a large amount of ice on the umbilical/orbiter interface.

09:15:xx GMT, Start recording fifth set of tapes.

09:33:xx GMT, The vehicle does not leak in the original tanking configuration where it was first found. The engineers are assessing the data. Liquid oxygen continues to be offloaded.

09:44:xx GMT, Discussions continue on leaks. The vehicle is not leaking. Both leaks cannot be explained. May be temperature related. No assurance if they tried to tank again that the leaks would not reoccur.

09:51:xx GMT, Trouble shooting no longer providing information. They have decided to start detanking the hydrogen. A decision on a 24 hour turn around has not been made. Probably will be announced at the 09:00 am CST press conference.

10:00:xx GMT, Commentary from shuttle launch control has been concluded. The MER no longer requires our support this evening. The MER expects that the next tanking attempt will be tomorrow night (March 24, 1992)

March 23, 1992

STS-45 TANKING TIMELINE (TRY #2)

At 21:30 CST, the tanking telecon was held. At 22:15 CST, we were notified by the MER that there is a go for tanking.

The following cameras were broadcast during tanking: 009, 054, 057, 063, 064.

The sequence of events were:

084/04:34:xx GMT, Started recorders when cameras began cycling. Tanking started. No vapors were visible.

04:35:xx GMT, Camera 054, a slight vapor was visible at the upper portion of view near ET/Orbiter attach strut.

04:44:xx GMT, On camera 063, vapor visible below the 17 inch line and above the 4 inch recirculation line. Also seen on camera views 009 and 064.

04:047:xx GMT On camera 064, normal vapor was seen exiting the purge port on the 17" vent line (orbiter side).

05:05:xx GMT, Vapors continue beneath the 17 inch feedline and above the 4 inch line. The amount of vapors noted up to this time were significantly less than on last nights scrub tanking.

05:17:xx GMT, On camera 009 zoomed in view, ice was visible on top of the 17 inch line at the orbiter interface.

05:36:xx GMT, Start recording second set of tapes.

05:37:xx GMT, MER reports that the LOX fill went well. There was a high LO2 leak indication but the readings came back down to normal limits. The LH2 fast fill has been started with no indications of any problems.

05:47:xx GMT, Liquid drops from the 4 inch recirculation line on the orbiter side were noted.

06:04:xx GMT, MER reports that they are well within the LH2 fast fill and that the detected leaks are relatively small. Everything looks good for launch tomorrow with respect to the ET.

06:08:xx GMT, On cameras 009, 063, and 064, liquid drops were seen from the 17 inch flange on the external tank side.

06:40:xx GMT, Start recording third set of tapes.

07:00:xx GMT, MER reports that the ET tanking is complete. The LH2 and LO2 fueling was normal with only minor leakage. No orbiter anomalies are in work.

There is a go for a 7 am CST launch tomorrow March 24, 1992. The only question is the weather at the TAL abort sites.

07:20:xx GMT, The MER has been notified that we have shut down until 12:00 GMT March 24, 1992.

Photo/TV Analysis Group Request Form
STS-45
04/30/92

Task Number --> 9

Request Date : 03/24/92
Completion Date : 03/30/92

Requestor : D. Pitts
Phone : 483-5066
Mail Code : SN5

Analyst Name	Phone Number	Assignment
Clyde Sapp	483-5141	

Task Title

Characterize pulse in SRB plume at 084:13:15:37.706

Objectives

To describe the visual parameters of a pulse in the SRB plume.

Hypothesis

Reporting

Analysis Strategy

Note time of occurrence in relationship to plume brightening and SRB separation
Note length of time of occurrence
Characterize change in area of plume
Characterize brightening of occurrence

TV13*, TV4, TV5
Compare against STS-42 KTV13 and STS-39 plume brightening

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
9

Title : Characterize pulse in SRB plume at 084:13:15:37.706

Analysts : Steve Israel
Date : 03/24/92

Camera Number : *
Frame Number :
GMT :

Requestor : D. Pitts
Phone : 483-5066
Mail Code : SN5

Description of Analysis

Reviewed long range trackers and KTV13 from STS-39.
STS-39 occurred a hour earlier than STS-45 and much of the color information is lost. STS-39 was a 57 degree mission.
The STS-39 Final report was read and the events noted were observed during screening on 3/24/92. However, the pulsing observed during the screening of STS-45 were not present.
Reviewed KTV13 from STS-42 (also a 57 degree mission). Screening this video a minor pulse was noted an object analysis will follow.

Image Analysis Tools & Techniques

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
9.01

Title : Characterize pulse in SRB plume at 084:13:15:37.706

Analysts : Clyde Sapp
Date : 03/24/92

Camera Number : KTV13
Frame Number :
GMT :

Requestor : D. Pitts
Phone : 483-5066
Mail Code : SN5

Description of Analysis

Digitized sequence to VOL 0 on RTDD
Frame 432 corresponds to beginning of event [084:13:15:37.756] SRB separation occurs on Frame 744, and corresponds to time 15:48.166
Will save frames 422 to 456 with prefix of PULS.
Will use region of 0< x <511, 37< y <480 to get rid of timing and video clutter.
Will use cut off value of 160 to discriminate plume from background.
Wrote program EVAL.COM which performs histogram of plume for each frame. Wrote BAT.COM to submit as batch file and divert output to RAW_EVAL.TXT.

Image Analysis Tools & Techniques

Downloaded RAW_EVAL.TXT to PC to graph results.
Used MS Word to convert to a usable format.
Graphed results in MS Excel

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
9.02

Title : Characterize pulse in SRB plume at 084:13:15:37.706

Analysts : Clyde Sapp
Date : 03/24/92

Camera Number : KTV13
Frame Number :
GMT :

Requestor : D. Pitts
Phone : 483-5066
Mail Code : SN5

Description of Analysis

Decided that event needed to be tied to SRB separation to give it some reference point. Saving frames 457-745 to disk to analyze in same fashion.

Image Analysis Tools & Techniques

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
9.03

Title : Characterize pulse in SRB plume at 084:13:15:37.706

Analysts : Clyde Sapp
Date : 03/24/92

Camera Number : KTV13
Frame Number :
GMT :

Requestor : D. Pitts
Phone : 483-5066
Mail Code : SN5

Description of Analysis

Summary: Digitized and analyzed a total of 324 frames. All images and data are stored in [STS.LAUNCH.KTV13]. Image names are PULSnnn.PIC (where 'nnn' ranges from 422 to 745).
Produced two graphs. One is relative mean brightness vs. time, and the other is relative area vs. time.

Image Analysis Tools & Techniques

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
9.04

Title : Characterize pulse in SRB plume at 084:13:15:37.706

Analysts : C. Sapp
Date : 03/30/92

Camera Number : KTV13
Frame Number :
GMT :

Requestor : D. Pitts
Phone : 483-5066
Mail Code : SN5

Description of Analysis

Saving frames 300 to 421 from RTDD to RA60 prefix = "PULS"
This will account for the 122 frames prior to largest pulse in plume, to determine whether we can see the two smaller pulses which preceded it. Created EVAL3.COM program to perform analysis, and BAT3.COM to submit as a batch job and direct output from EVAL3 to a log file.
PULS300.PIC corresponds to VTC = 084:13:15:33.352
SRB sep occurs at VTC = 084:13:15:48.150 (Frame 743)

Image Analysis Tools & Techniques

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
9.05

Title : Characterize pulse in SRB plume at 084:13:15:37.706

Analysts : C. Sapp
Date : 03/30/92

Camera Number : KTV13
Frame Number :
GMT :

Requestor : D. Pitts
Phone : 483-5066
Mail Code : SN5

Description of Analysis

AOV=Frame 209 = GMT=22:14:54:26.643
SRB sep=Frame 637 = GMT=22:14:54:40.923
Will save frames 209-639
Prefix = PULSB
Forces to save images to USER1:[STS.PLUM42] due to insufficient space on STS-45 RA-60.
Created EVAL42.COM and BAT42.COM to perform analysis on the 431 images. Output file named RAW_EVAL42.TXT, placed on mission disk. Imported file to PC. Formatted data with MSWord, then graphed results using MSExcel.

Image Analysis Tools & Techniques

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
9.06

Title : Characterize pulse in SRB plume at 084:13:15:37.706

Analysts : C. Sapp
Date : 03/30/92

Camera Number : KTV13
Frame Number :
GMT :

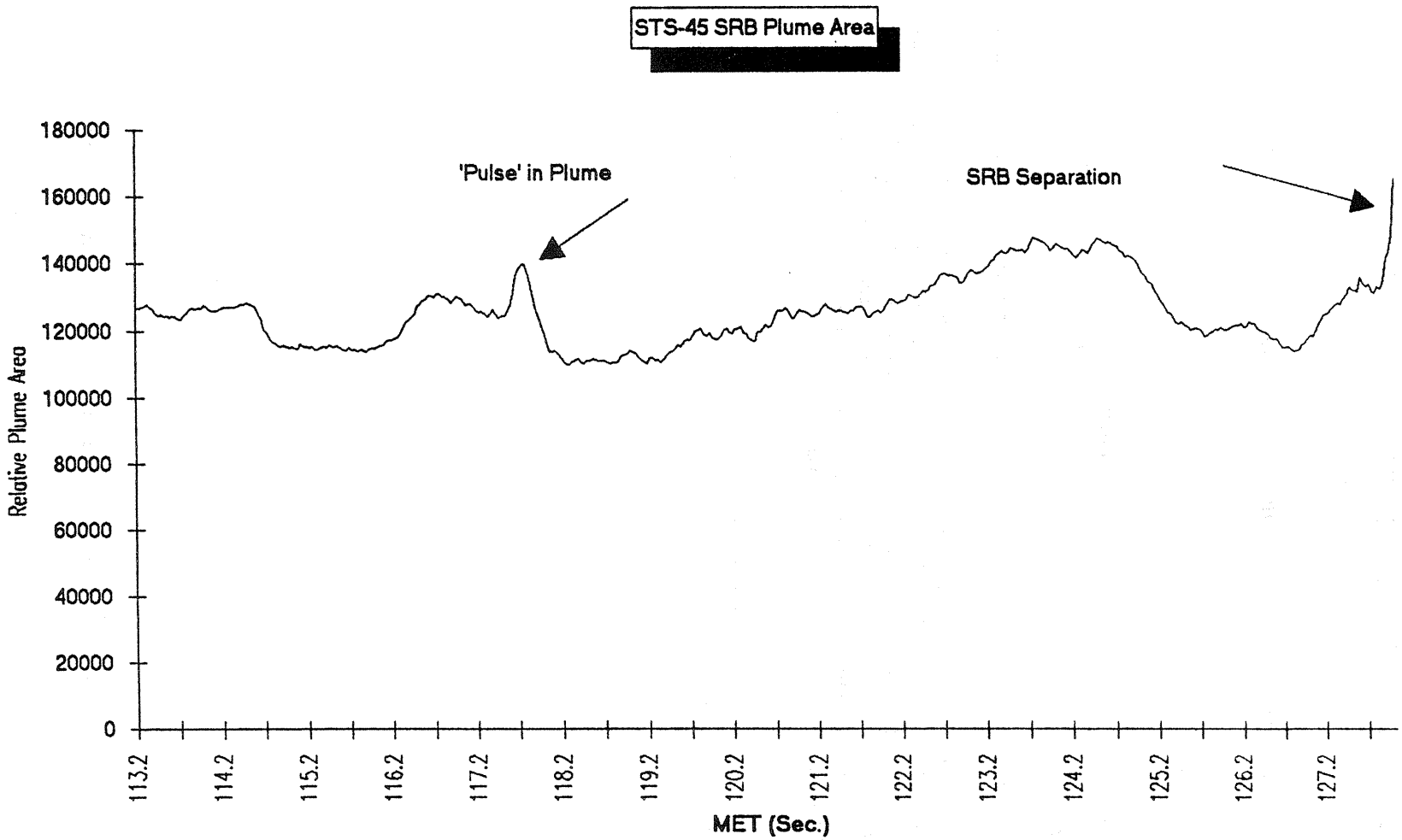
Requestor : D. Pitts
Phone : 483-5066
Mail Code : SN5

Description of Analysis

Summary: Frames preceding SRB separation on mission STS-45 and frames preceding SRB separation on mission STS-42 were digitized and analyzed using procedures developed specifically for this task. The camera used for both missions was KTV13. The analysis focused on the relative mean intensity and the relative area of the SRB plumes vs. time. The data collection was performed on VDAS, and on a PC. (Graphs attached)

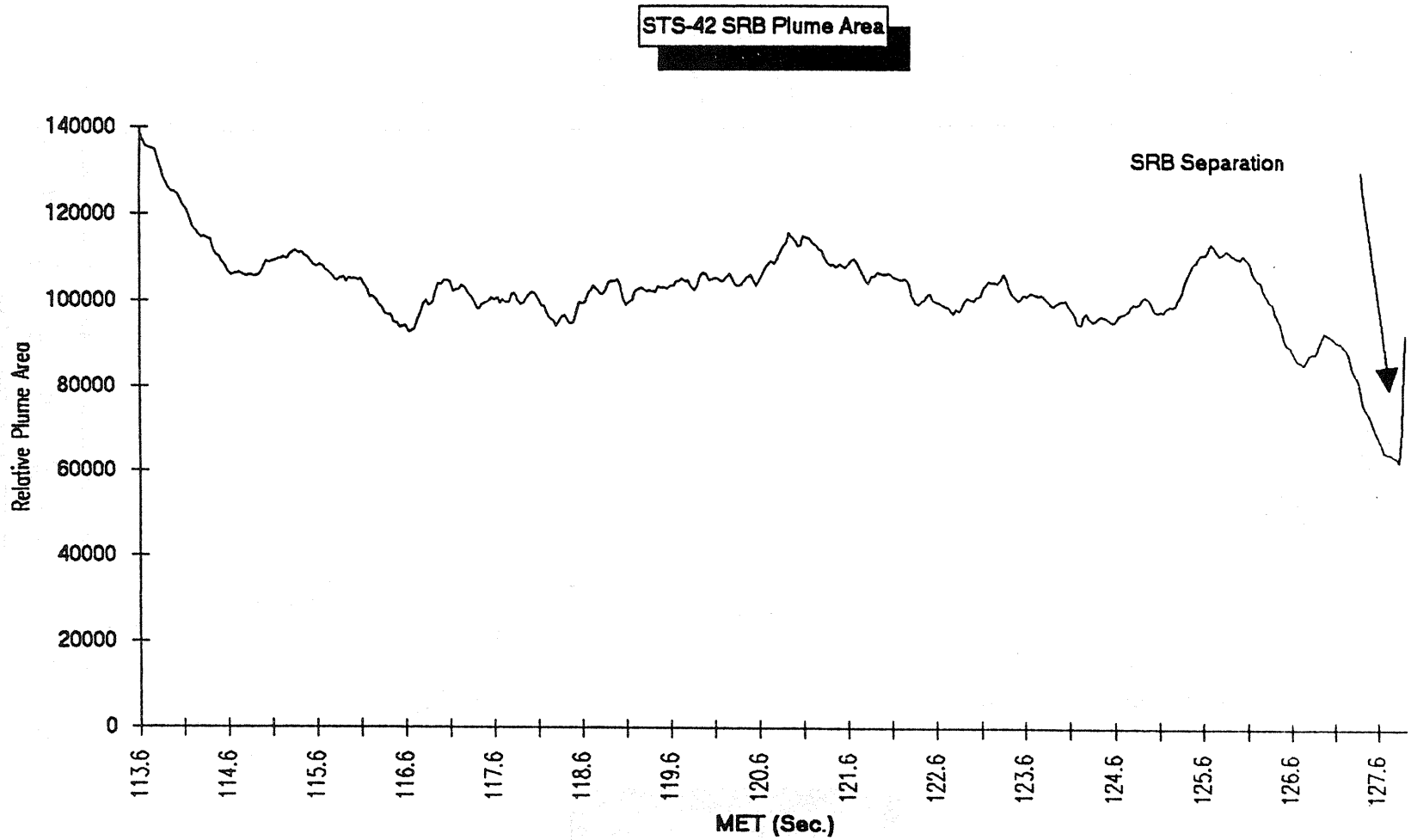
Conclusion: There appears to be minor pulses in the SRB plume on STS-42, but nowhere near the intensity of the large pulse on STS-45.

Image Analysis Tools & Techniques



Plume Characterization - Camera KTV-13

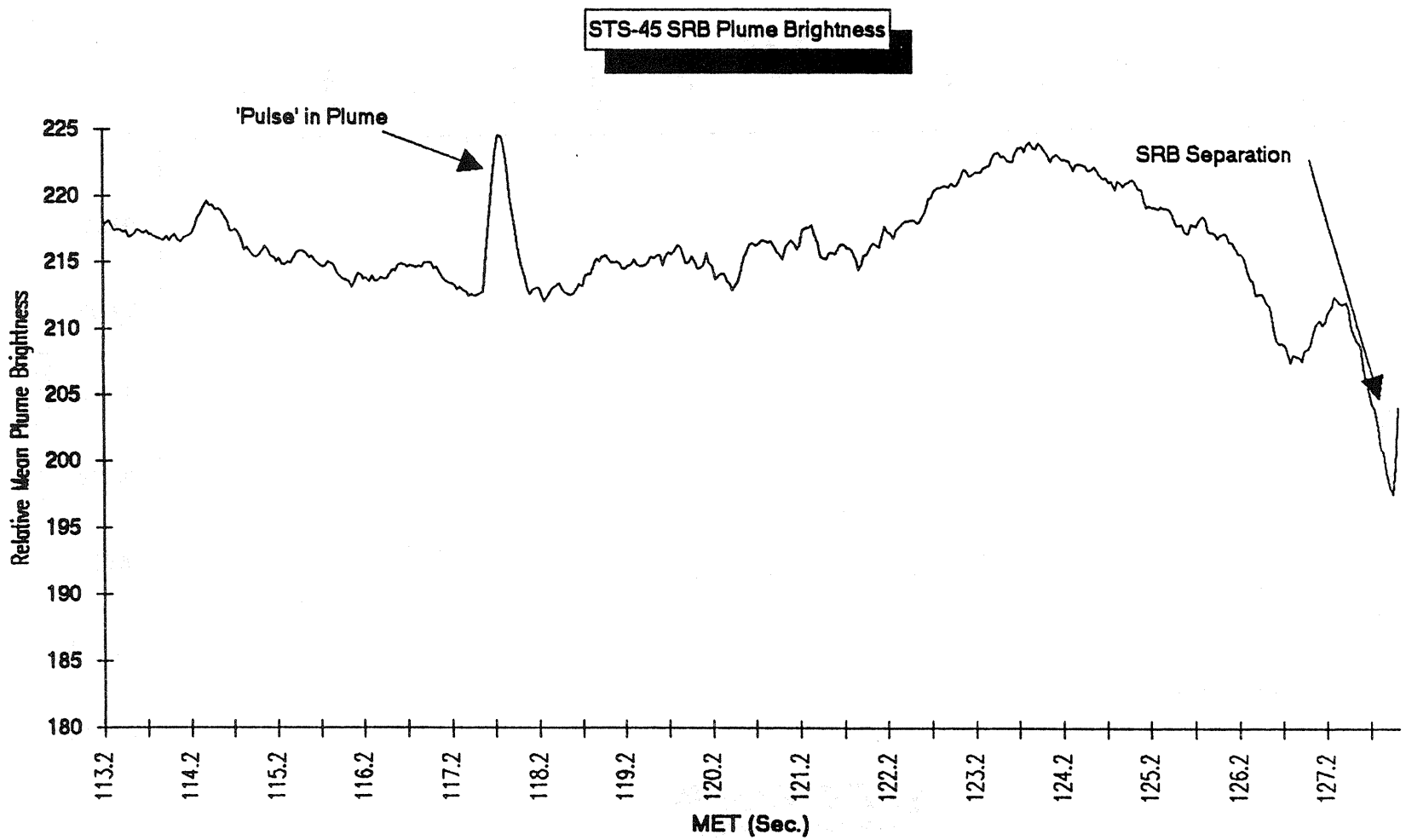
STS-45, Task #9



Camera KTV13, C.A.Sapp: Analyst

U.S. Gov't

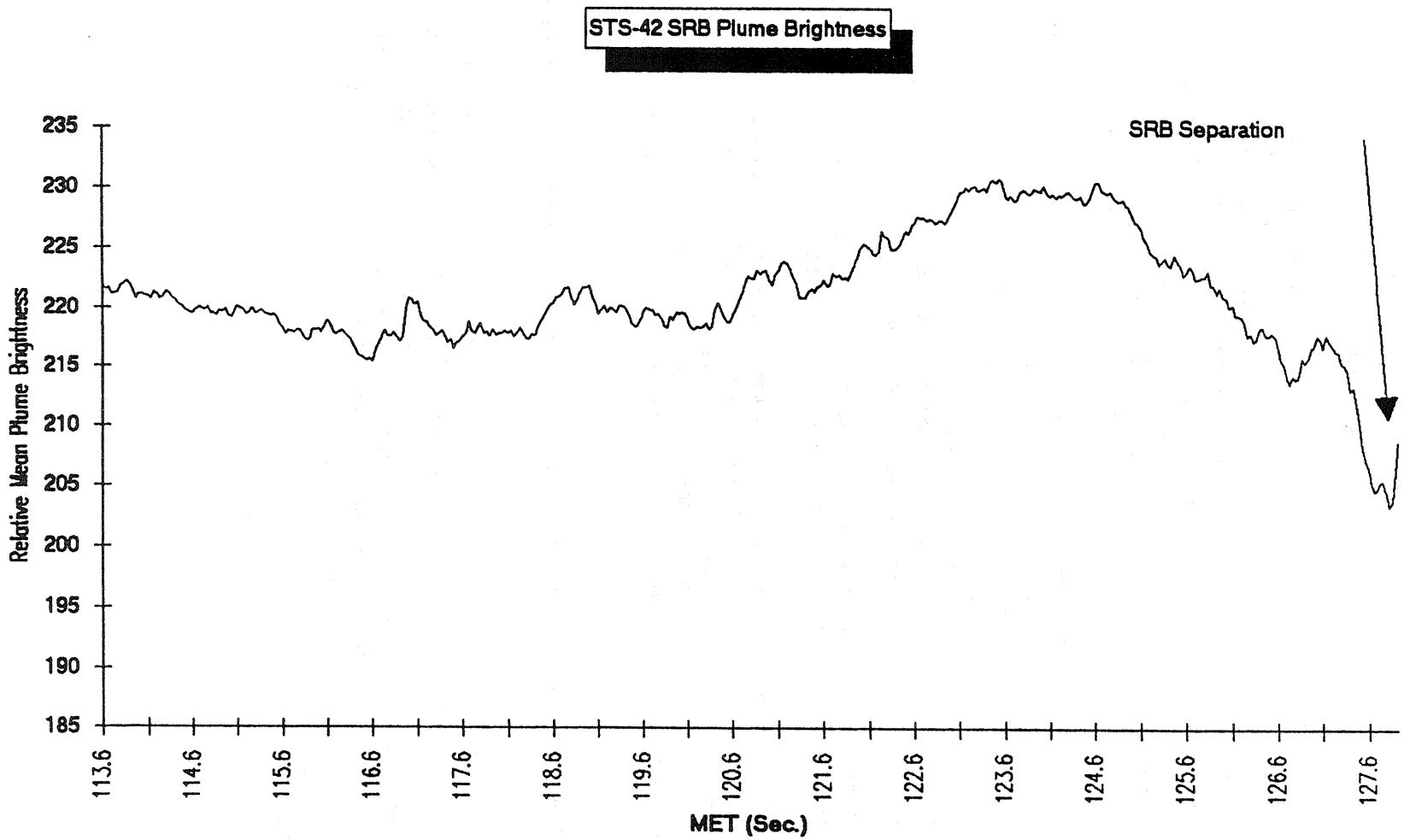
STS-45 Task #9



Plume Characterization, Camera KTV-13

U.S. Gov't

STS-45, Task #9



Camera KTV13, C.A.Sapp : Analyst

D77

Photo/TV Analysis Group Request Form
STS-45
04/30/92

Task Number --> 10

Request Date : 03/24/92
Completion Date : 04/28/92

Requestor : Dave Pitts
Phone : 483-5066
Mail Code : SN5

Analyst Name	Phone Number	Assignment
Jon Disler	483-5182	Coordination
Team		

Task Title

Review films, videos and photography of ET after separation

Objectives

1. To identify any signs of possible intertank vapor reported by the crew.
2. Determine whether vapor-like events seen by the STS-45 astronauts on the intertank area of the ET were visible on earlier missions.
3. Understand what Dave Leestma observed on STS-45 ET DTO-312.

Hypothesis

Large amounts of residual LOX liquid hydrogen may cause venting after separation.

Reporting

Analysis Strategy

1. Review launch videos and film specifically for signs of vapor in the intertank. Use CADs as necessary to identify structures on the intertank and distinguish them from possible suspected vapor. (John Young saw possible vapor on the second set of replays from a south position and saw on the upper left side of the tank about the 2 o'clock position.)
Refer to Task #6
2. See attached for Task 10 Actions

5/6/92

STS-45 DTO-0312 ET VENTING PHOTO ANALYSIS

TASK 10

ACTION	ACTIONEE	CLOSED
1. Complete 70 mm and 16mm screening sheets	Israel/Snyder/Gastineau	4/15/92
1.1 70 mm	Israel	
1.2 16mm	Gastineau/Snyder	5/5/92
Select 16mm prints and submit photo order to bldg. 8	Gastineau	5/5/92
1.3 Type up and send out on distribution		
1.4 Screen 70mm film for any signs of venting		
1.5 Screen 16mm film in detail for any signs of venting in intertank		
2. Obtain 70mm data back offsets from Earth Obs.	Hartman	4/7/92
3. Submit photo order for enlarged prints of all 70 mm images (38 frames)	Gastineau	4/7/92
4. Screen test prints in building 8 for correct enlargement prior to distribution to other centers	Disler	4/3/92
5. Understand motion of ET prior to and during venting. Does venting cause ET to roll or tumble? Use 16mm film.	Isreal/Gastineau	5/5/92

ACTION		ACTIONEE	CLOSED
6.	Measure angle of venting	Sapp	5/5/92
7.	Put in photo order for film to video conversion (3/4 and 1/2 ") of 16mm film Work with bldg. 8 to get good views.	Bhaskar	4/7/92
8.	Determine solar position relative to ET and Orbiter at separation and time of venting.	Hartman	5/5/92
9.	Calculate distance of ET from Orbiter	Israel	5/5/92
10	Prepare CAD overlays to determine which umbilical is venting. Use 70 mm and 16 mm films.	Sapp/Gastineau	5/5/92
11	Construct timeline of observed venting. Compare orientation of 70 mm and 16mm.	Snyder/Bhaskar	4/15/92
12.	Determine how far venting spay extends out from ET. What was ET distance from orbiter at that time.? Determine rate/velocity of spewing. Use film to video conversion.	Snyder	5/5/92
13.	What type of film was used for 16mm camera:? Astronaut debrief	Dailey	5/5/92

ACTION	ACTIONEE	CLOSED
14. When was 16 mm film taken in relation to 70 mm film. Astronaut debrief.	Dailey	4/15/92
15. Was 16 mm zoomed all the way out? Astronaut debrief	Dailey	4/15/92
16 Digitize 6 hasselblad views that were sent out on distribution Digitize from prints initially. Digitize from film masters on the side	Harless/Morris. Hartman.	4/15/92 film masters not relevant
17. Digitize ET closeout pictures and register CAD.	Gastineau	4/15/92
18. 16 mm Mag. 61 File # 510, research lens size, film size, shutter speed, frame rate used to photo ET venting	Disler	5/5/92
19. Review STS-8 (OV-99) and STS-61C (OV-102) ET umbilical views and handheld views of ET for possible venting or other anomalies.	Disler	4/15/92
20. Make comparison time line of when previous mission handheld photography was taken compared to times for STS-45 photographs	Bhaskar	4/15/92
21. (38) Print ready to be enlarged. Review.	Disler	5/5/92

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
10

Title : Review films, videos and photography of ET after separation

Analysts : Chris Dailey
Date : 03/24/92

Camera Number :
Frame Number :
GMT :

Requestor : Dave Pitts
Phone : 483-5066
Mail Code : SN5

Description of Analysis

In reply to questions about possible vapor in the intertank by the MER and John Young a review of all tracking cameras (ET204, ET207, ET208, ET212, ET213) and TV4 to specifically view the intertank area was completed. Where the intertank was clearly visible all the color differences could be explained as parts of the ET structure. On out-of-focus pictures some structures could still be identified but any interpretation of vapor on these views would be tenuous at best and the other clearer views do not show vapor in the intertank.

Image Analysis Tools & Techniques

U.S. Gov't

STS-45 Air to Ground 1 Voice Transcript

March 24, 1992

= GMT 084/18:03

CAPCOM: Sounds good Bryan.

ATLANTIS: Okay, there is one other thing that wasn't part of the debris but we would like to tell you a little bit about what Dave described from the tank when they were doing the ET photo DTO.

CAPCOM: Okay we are ready to copy.

ATLANTIS: Okay, as they had it in sight and they were watching it, Dave described what he saw was a ..... what was probably O2 or H2, it was spewing out and periodically out of the inner tank area and it gave Dave the impression that the thing was going to explode at any moment. We never did see that, of course, but he said he had never seen anything like that before.

LEESTMA

CAPCOM: Okay, we copy that.

QUESTIONS SENT TO FLIGHT DIRECTOR
ABOUT ET VENTING

TO: Lee Briscoe

SUBJ: Post Separation DTO 312 Anomaly
Liquid/Vapor from ET Intertank area

FROM: Mark Holderman
SSP/WC

1. Did the liquid/vapor come from a single point from the Inter tank or was it released from multiple sources.

2. Could you identify a location in relation to the Forward Bipod Yoke.

3. Confirm if the liquid/vapor was in the vicinity of the LO2 feedline.

4. Confirm that the liquid/vapor was not in the vicinity of the 17" disconnects.

5. Compare the size of the plume of the liquid/vapor in relation to the diameter/length of the ET.

6. Estimate of rate-of-growth of the plume/vapor cloud

7. How was the ET illuminated: Front, Back or Side

8. Describe the aspect view of the ET as the plume/vapor cloud first became evident (relative to the DTO crewmember). How long after separation was the ET first viewed?

9. Was there a discernable tumble/rotation noticeable. Any estimate of the rate?

U.S. Gov't

QUESTIONS SENT TO ASTRONAUTS
ABOUT ET VENTING

REVIEW COPY

MSG 005B - RED FD2 INFORMATION
PAGE 1 OF 1, 32 LINES THIS PAGE

A spectacular launch for the pride of the fleet! Everyone on the ground is looking forward to a busy day of science activity. Due to late launch, sunrise/sunset times have shifted approximately 1.5 minutes earlier.

For Dave, the ground would like some words concerning his ET observations:

(1) When & how far away was tank when venting observed? (If can estimate seconds from ET sep or distance directly, how much of FOV did ET take up?) Lens used? Did you get only stills or any camcorder?

(2) Can you better describe location of venting in intertank area - with respect to Bipod, ET attach pts, feedline, etc.

(3) The comment Brian made inferred that the venting was "periodic". Could you give an estimate of vent cycle?

(4) Was any discoloration on the tank & was it tumbling?

(5) Any other pertinent data you can provide.

For future waste H2O dumps, MCC will TMBU nozzle temp limits (pre & post dump). Atlantis has an erratic waste H2O Qty Ducer so MCC will enable waste tank Qty FDA prior to a dump and re-inhibit it post-dump. The TK Qty lower limit will remain at 6% for entire mission.

END OF PAGE 1 OF 1, MSG 005B

U.S. Gov't

STS-45 Air to Ground Conversation Between the CAPCOM and Astronaut Dave Leestma

CAPCOM

O.K. we have some SPAN people wondering about exactly what you saw at ET separation..... about the venting you saw. Message 5B should be in the tags tray after you get a chance to read that message if you want to respond to it people down here would be glad to hear what you have to say.

DAVE LEESTMA

..... Mike and I watched it the venting that we first saw was occurring out of the 17 inch line. We could not tell if it was the LO2 or the LH2 side. It appeared that the disconnect on the ET side did not close. And it was venting almost continuously out of the 17 inch line, one or the other. As it went away from us. About 5 minutes after we viewed it going away from us we started noticed some pulsing of a very large vent from the intertank area. We could not tell exactly where around on the tank it was. But large vent was occurring in the intertank area it would pulse it would only vent for about one second. Then it wouldn't vent for awhile and it wasn't regular it was kinda intermittent. But the venting was large enough to make Mike and I both believe that the tank was already coming apart it was about ready to totally disintegrate. We are trying to get some 16mm at the time but I don't think we ever did get some 16mm. We did get stills now whether we got stills of the actual intertank venting I'm not sure. We will just have to wait and see when we get the film back. It was all done with a 250mm lens on the Hasselblad.

CAPCOM

O.K Dave we copy that. Thanks for the extra work.

CAPCOM later

I have another question for Dave if he is still on the loop.....
Can you tell us the degree to which the tank was tumbling?

DAVE LEESTMA

The tank was not tumbling at a very high rate at all which was kind of unusual for what we were seeing although it may not have been ah it may not have been venting a whole lot of material it is just that you could see it. It came out in a cone angle kinda like a RCS type firing and a cone angle of about ...120 degrees 60 degrees either side of where the vent was coming out.

CAPCOM

O.K copy that. One final question.
Any unusual discoloration on the tank compare to what you have seen in the past?

DAVE LEESTMA

No I did not notice any unusual discoloration at all it had the usual dark areas where from the heating of ascent but there was nothing unusual about what we saw.

CAPCOM

O.K. before we talked to you they were talking about the possibility of an LH2 vent valve periodically cracking open and they will take what you have told us and put that together with what they were thinking and see if that theory still holds.....

Summary of Analysis of Visual Events
STS-45
05/06/92

Task Number
10.01

Title : Review films, videos and photography of ET after separation

Analysts : J. Disler and R. Bhaskar
Date : 03/25/92

Camera Number :
Frame Number :
GMT :

Requestor : Dave Pitts
Phone : 483-5066
Mail Code : SN5

Description of Analysis

Compile list showing missions that viewed ET with the umbilical well cameras.
-Preliminary list already compiled

View videos of ET umbilical well camera scenes (3/25/92)
-Tapes #178 and #179 (of 16mm and 35mm umbilical well camera views from STS-1, STS-2, STS-3, STS-4, and STS-5) were re-screened. Nothing in the views appeared to look like vapor. Ice debris was noted for some time beyond actual ET separation, but it appeared to originate from the Orbiter umbilical area.

Review DTO-312 photography from previous missions

Image Analysis Tools & Techniques

Video Stack

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
10.02

Title : Review films, videos and photography of ET after separation

Analysts : R. Bhaskar
Date : 03/26/92

Camera Number : *
Frame Number :
GMT :

Requestor : Dave Pitts
Phone : 483-5066
Mail Code : SN5

Description of Analysis

* STS-61C umbilical camera

The purpose of this analysis was to compare the events during ET separation on STS-45 to events during ET separation during STS-8 and STS-61C. It was proposed that the venting observed on STS-45 was done to the unusually large margin of propellant left in the tank at separation. STS-8 and STS-61C also had large amounts of propellant left in the tank.

No umbilical well films or handheld photography was taken during STS-8.

The imagery obtained during STS-61C included on 35mm umbilical well camera. STS-61C showed ice on and near the ET hydrogen umbilical. No features were located which might indicate venting. All views were of the Orbiter side of the ET. No views were available of the vent near the GH2 vent line umbilical.

Image Analysis Tools & Techniques

16mm UMBILICAL CAMERA USAGE

FLIGHT	FILL ROLL #	CAMERA LENS SIZE	SLATE START	BURP START	SRB START	ET START	STOP	COMMENTS
STS-1	B-947	5mm		00:00	24:10	85:30	298:17	
STS-1	B-948	10mm	00:00	NONE	19:19	67:17	408:26	
STS-1	B-949	5mm	00:00	16:38	27:12	88:36	503:37	
STS-2	C-150	5mm	00:00	28:15	129:21	190:35	605:11	three burbs
STS-2	C-151	10mm	00:00	5:12	90:03	166:14	578:12	two burbs
STS-3	C-301	10mm			00:00	61:14	154:12	
STS-3	C-301	5mm			00:00	61:01	218:33	
STS-4	C-404	10mm			00:00	61:16	473:38	
STS-4	C-404	5mm			00:00	61:31	475:16	
STS-5	C-522	5mm		00:00	17:28	79:03	495:02	
STS-28	E-542	10mm		00:00	10:39	19:33		camera jam
STS-28	E-542	5mm		00:00	5:19	57:29	472:37	
STS-32	E-699	5mm			00:00	51:29	497:10	
STS-32	E-700	10mm			00:00	50:31	465:20	
STS-35	F-022	5mm						
STS-35		10mm						no run fuse
STS-40		5mm						no run film break
STS-40	F-216	10mm			00:00	51:30	462:18	
STS-49								
STS-49								
STS-50								
STS-50								
STS-47								
STS-47								
STS-52								
STS-52								

NOTE: Frame count is given in feet and frames. example 24:10 is 24 feet and 10 frames
16mm is 40 frames per foot
Camera speed is 240 frames per second

U.S. Gov't

TABLE III. NORAD FLIGHT MEASUREMENTS OF ET RUPTURE ALTITUDE

FLIGHT ID	DATE OF LAUNCH	RUPTURE ALT. (KFT)	FLIGHT ID	DATE OF LAUNCH	RUPTURE ALT. (KFT)
STS-1	APR. 12, 1981	N/A	51-B	APR. 19, 1985	220
STS-2	NOV. 12, 1981	255	51-G	JUN. 17, 1985	233
STS-3	MAR. 22, 1982	235	51-F	JUL. 29, 1985	211
STS-4	JUN. 27, 1982	228	51-I	AUG. 27, 1985	232
STS-5	NOV. 11, 1982	236	51-J	OCT. 3, 1985	230
STS-6	APR. 4, 1983	237	61-A	OCT. 30, 1985	N/A
STS-7	JUN. 18, 1983	233*	61-B	NOV. 26, 1985	231
STS-8	AUG. 30, 1983	241	61-C	JAN. 12, 1986	239
STS-9	NOV. 28, 1983	N/A	STS-26	SEP. 29, 1988	231
41-B	FEB. 3, 1984	231	STS-27	DEC. 2, 1988	238
41-C	APR. 6, 1984	246	STS-29	MAR. 13, 1989	240
41-D	AUG. 30, 1984	245	STS-30	MAY 4, 1989	243*
41-G	OCT. 5, 1984	N/A	STS-28	AUG. 8, 1989	220
51-A	NOV. 8, 1984	226	STS-34	OCT. 18, 1989	245*
51-C	JAN. 24, 1985	239	STS-33	NOV. 22, 1989	241*
51-D	APR. 12, 1985	N/A			

MEAN - ALL FLIGHTS	234.8
MEAN - T/V OPERATIVE	233.8
MEAN - T/V INOPERATIVE	240.5

* TUMBLE VALVE INOPERATIVE; ALL OTHER FLIGHTS TUMBLE VALVE OPERATIVE

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
10.03

Title : Review films, videos and photography of ET after separation

Analysts : B. Gastineau
Date : 03/25/92

Camera Number :
Frame Number :
GMT :

Requestor : Dave Pitts
Phone : 483-5066
Mail Code : SN5

Description of Analysis

Launch replays were reviewed in an attempt to locate features on the ET intertank which could be associated with the venting discovered on the ET by the astronauts during completion of DTO-312. All features located were either 1) the antenae structure on the Orbiter side of the ET, 2) the access door underside of the ET, or 3) undiscernable from the previous 2 features from video. Cameras reviewed included KTV2, KTV4, KTV5, KTV11, KTV13, KTV21A, OTV41, OTV48, ET204, ET207, ET208, ET212, ET213. A frame was digitized from KTV4A (KTV4A_PAD.PIC) showing the antenae structure. Closeout photos offering better views of both structures will be digitized upon receipt in preparation of Hasselblad analysis.

Image Analysis Tools & Techniques

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
10.04

Title : Review films, videos and photography of ET after separation

Analysts : B. Gastineau
Date : 03/30/92

Camera Number :
Frame Number :
GMT :

Requestor : Dave Pitts
Phone : 483-5066
Mail Code : SN5

Description of Analysis

STS-45 closeout photographs were digitized in preparation for the ET venting study expected when STS-45 ET photographs are delivered to JSC after landing. Four pictures were digitized and placed on the STS-45 disk in the directory [STS.LAUNCH.ET_CLOSEOUT].

KSC-392C-1470_32.pic - GUCP umbilical
KSC-392C-1501_03.pic - underside of ET
KSC-392C-818_06.pic - Orbiter side of ET intertank
KSC-392C-818_08.pic - ET/Orbiter umbilical

Image Analysis Tools & Techniques

Eikonix Digitizer

Summary of Analysis of Visual Events
STS-45
04/08/92

Task Number
10.05

Title : Review films, videos and photography of ET after separation

Analysts : C. Sapp
Date : 04/03/92

Camera Number : 16MM
Frame Number :
GMT :

Requestor : Dave Pitts
Phone : 483-5066
Mail Code : SN5

Description of Analysis

Using mavica prints
A = (104,355) to (316,343)
B = (289,488) to (324,350)
using profile

$$ma = \frac{355-343}{104-316} = -0.0566$$

$$mf = \frac{488-350}{289-324} = -3.94286$$

$$<AB = \tan -1 \frac{(mb-ma)}{(1+ma\ mb)}$$

$$= \tan -1 (-3.17717)$$

$$<AB = 72.53$$

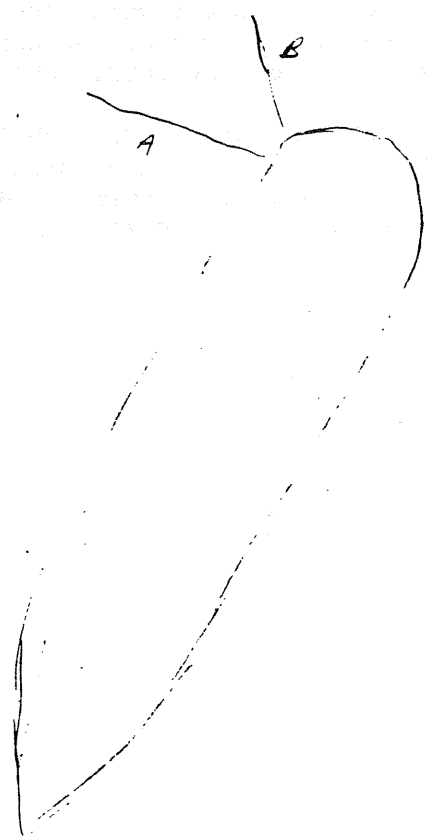


Image Analysis Tools & Techniques

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
10.06

Title : Review films, videos and photography of ET after separation

Analysts : J. Disler, B. Gastineau
Date : 03/30/92

Camera Number : **
Frame Number :
GMT :

Requestor : Dave Pitts
Phone : 483-5066
Mail Code : SN5

Description of Analysis

**Umbilical well films from:
STS-28 (16mm w/5mm lens)
STS-32 (16mm w/10mm lens)
STS-40 (16mm w/10mm lens)

Umbilical well films from STS-28, STS-32, and STS-40 were reviewed in an attempt to locate possible venting during these missions with the following results:

STS-28: Vapors seen at purge (immediately before ET separation)

STS-32: Vapors and ice seen at purge

STS-40: Vapors and ice seen at purge. Ice debris seen throughout ET separation

No evidence of venting from either the intertank or umbilical areas was noted.

Image Analysis Tools & Techniques

16mm film motion analyzer

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
10.07

Title : Review films, videos and photography of ET after separation

Analysts : R. Bhaskar
Date : 04/07/92

Camera Number : *
Frame Number :
GMT :

Requestor : Dave Pitts
Phone : 483-5066
Mail Code : SN5

Description of Analysis

*16mm Arriflex onboard

Digitized points on 16mm film where ET is clearly visible and at a constant focal length:
a. points along either side of the upper intertank interface were digitized: this measure should correspond to 333 inches (actual diameter of tank).
b. calculate distance to ET using the measured length of the ET on film, the actual length of the ET and the lens focal length (~100mm)
c. calculate relative velocity using change in diameter relative to change in time (camera frame rate=24fps)

a. Scale: film/fma = 0.00138
inches/fmau = 0.0395

b. H=(f/S)
frame 1075: H=(3.937/4.4512e-5)=88448in.=2246.6m
frame 1565: H=(3.937/4.1069e-5)=95863in.=2434.9m

c. V=(del-x/del-t)=((2434.9m - 2246.6m)/(20.42 secs.))=9.23m/sec.

Image Analysis Tools & Techniques

Shadowgraph
film motion analyzer
PAST software
EXCEL software

STS-45 16mm Arriflex Film

focal length (in.)
3.937

fmau	inches	inches/unit
211.93	8.366	0.0394753
292.92	11.575	0.03951591

fr. size (fma)	fr. size (film)	scale
211.93	0.2931	0.001383
292.92	0.4042	0.0013799

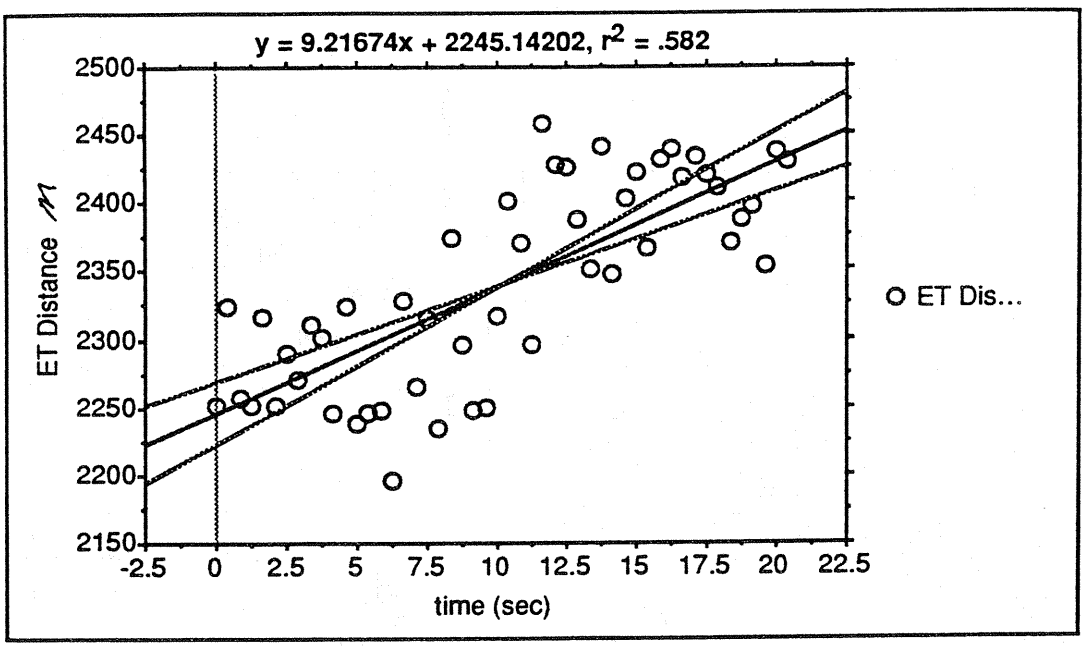
ET frames	fps of film	total distance (m)
490	24	188.34

elapsed secs.
20.42

average distance to ET - 16mm film (in meters)	vel (m/s)
2336.97	9.23

U.S. Gov't

Plot of regression line for ET distance on 16mm Film



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Statistics for ET distance on 16mm Film

Simple Regression X 1 : time (sec) Y 1 : ET Distance

Count:	R:	R-squared:	Adj. R-squared:	RMS Residual:
50	.76289	.582	.57329	47.9349

Analysis of Variance Table

Source	DF:	Sum Squares:	Mean Square:	F-test:
REGRESSION	1	153563.25749	153563.25749	66.83187
RESIDUAL	48	110292.23077	2297.75481	p = .0001
TOTAL	49	263855.48827		

No Residual Statistics Computed

Simple Regression X 1 : time (sec) Y 1 : ET Distance

Beta Coefficient Table

Variable:	Coefficient:	Std. Err.:	Std. Coeff.:	t-Value:	Probability:
INTERCEPT	2245.14202				
SLOPE	9.21674	1.12742	.76289	8.17508	.0001

Confidence Intervals Table

Variable:	95% Lower:	95% Upper:	90% Lower:	90% Upper:
MEAN (X,Y)	2325.59807	2352.8611	2327.85859	2350.60059
SLOPE	6.94968	11.4838	7.32563	11.10785

U.S. Gov't

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
10.08

Title : Review films, videos and photography of ET after separation

Analysts : R. Bhaskar
Date : 04/09/92

Camera Number :
Frame Number :
GMT :

Requestor : Dave Pitts
Phone : 483-5066
Mail Code : SN5

Description of Analysis

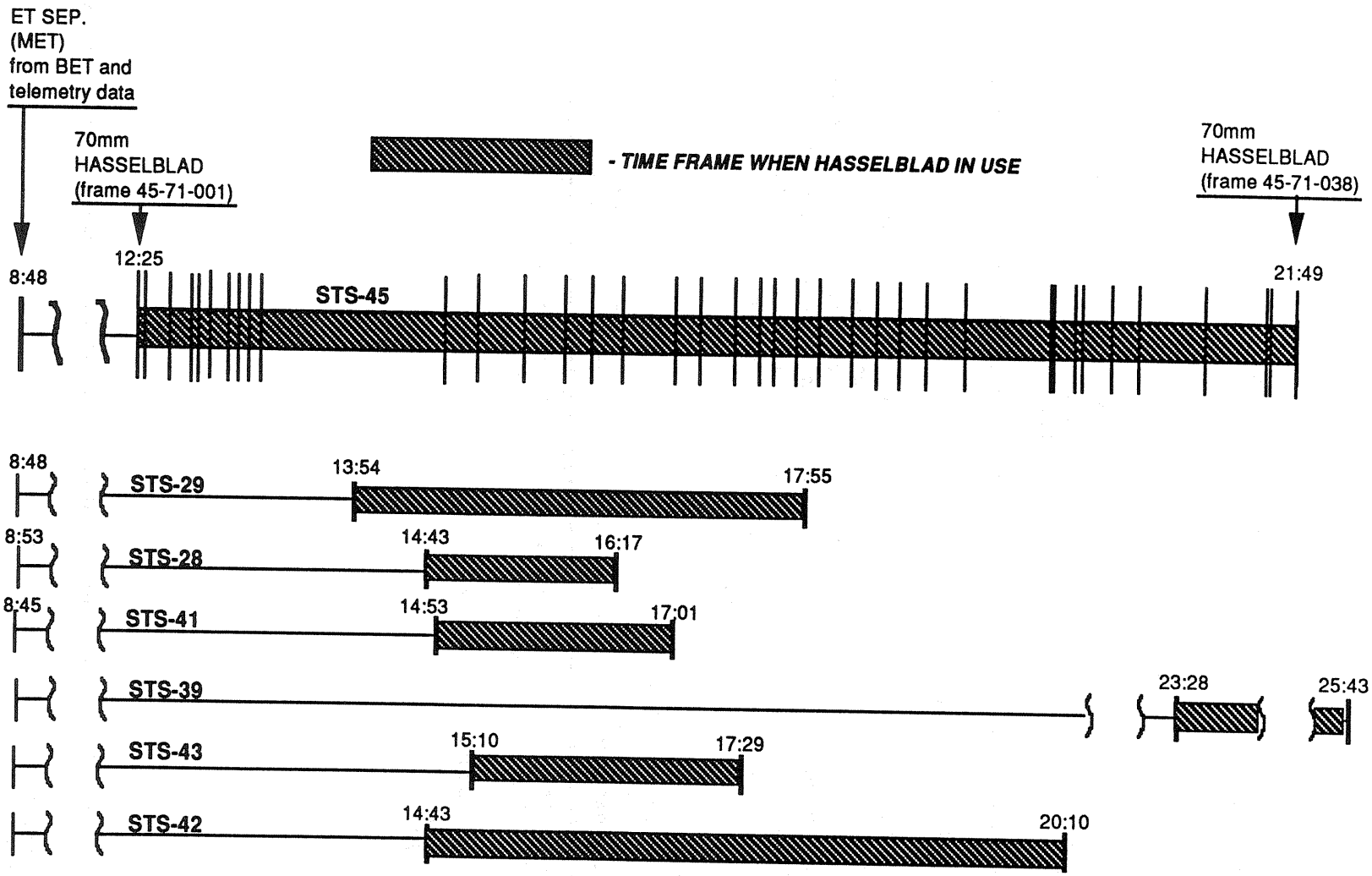
-Compile list showing missions that viewed ET with the umbilical well cameras [3/25/92]. Preliminary list already compiled. Since reflight, STS-28, STS-32, and STS-40.
-View videos of ET umbilical well cameras scenes [3/25/92]. Tapes #178 and 179 (of 16mm and 35mm umbilical well camera views from STS-1, STS-2, STS-3, STS-4 and STS-5) were re-screened. Nothing in the views appeared to look like vapor. Ice debris was ntoed for some time beyond actual ET separation, but it appeared to originate from the Orbiter.
-Review DTO-312 Hasselblad photography from previous missions [4/8/92]. Obtain start/stop times of Hasselblad images from prior missions (all UTC times)
STS-51I: launch @ ?
STS-51J: launch @ ?
STS-26: launch@15:37:00; ET Sep n/a; no timing on Hasselblads (?)
STS-27: launch@14:34:00; ET Sep n/a; no timing on Hasselblads (?)
STS-29: launch @ 14:57:00; ET Sep@~15:05:48; frame 1 @ 15:10:54 to frame 100 @ 15:14:55
STS-28: launch @ 12:37:00; ET Sep@~12:45:53; frame 1 @ 12:51:43 to frame 14 @ 12:53:17
STS-34: launch @ 16:53:40; ET Sep@~17:02:30; no timing on Hasselblads
STS-41: launch @ 11:47:15; ET Sep@~11:56:00; frame 1 @ 12:02:08 to frame 27 @ 12:04:16
STS-35: launch @ 06:49:01; ET Sep n/a; no timing on Hasselblads
STS-37: launch @ 14:22:45; ET Sep n/a; no timing on Hasselblads
STS-39: launch @ 11:33:14; ET Sep n/a; frame 1 @ 11:56:42 to frame 10 @ 11:58:57
STS-40: launch @ 13:24:51; ET Sep @~13:33:40; no timing on Hasselblads
STS-43: launch @ 15:02:00; ET Sep n/a; frame 1 @ 15:17:10 to frame 17 @ 15:19:29

Image Analysis Tools & Techniques

STS-42: launch @ 14:52:33; ET Sep n/a; frame 1 @ 15:07:16 to frame 30 @ 15:12:43

Video Stack

HASSELBLAD PHOTO TIMELINE



Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
10.09

Title : Review films, videos and photography of ET after separation

Analysts : C. Sapp,B. Gastineau
Date : 04/15/92

Camera Number : *
Frame Number :
GMT :

Requestor : Dave Pitts
Phone : 483-5066
Mail Code : SN5

Description of Analysis

*STS-45-71-001 & 16mm #1323

CADs were registered to 2 digitized images of the External Tank after separation. One frame was from the 70mm Hasselblad still camera and the other frame was from the 16mm Arriflex motion camera. The frames were then analyzed for an indication of the origin of the vapor. Results from both images indicated that the vapor originated from the LH2 umbilical of the ET. The image from the 70mm camera was overexposed to show the vapor.

File storage:
STS-45 disk [STS.LAUNCH]
[HASSELBLAD]S4571001.2 - regular digitization of Hasselblad image
[HASSELBLAD]S4571001.3 - overexposed digitization of Hasselblad image
[HASSELBLAD]S457100_2.TRN - CAD registration information for Reg3D
[16MM]F1323A.DAT - regular digitization of Arriflex image
[16MM]F1323A.TRN - CAD registration information for Reg3D

External tank coordinates of origin of vapor:
70mm - (2072,-77,604)
16mm - (2078,-53,605)

Image Analysis Tools & Techniques

Eikonix Digitizer
Reg3D Software

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
10.10

Title : Review films, videos and photography of ET after separation

Analysts : R. Bhaskar
Date : 04/09/92

Camera Number :
Frame Number :
GMT :

Requestor : Dave Pitts
Phone : 483-5066
Mail Code : SN5

Description of Analysis

-Plot each 70mm Hasselblad photo on timeline

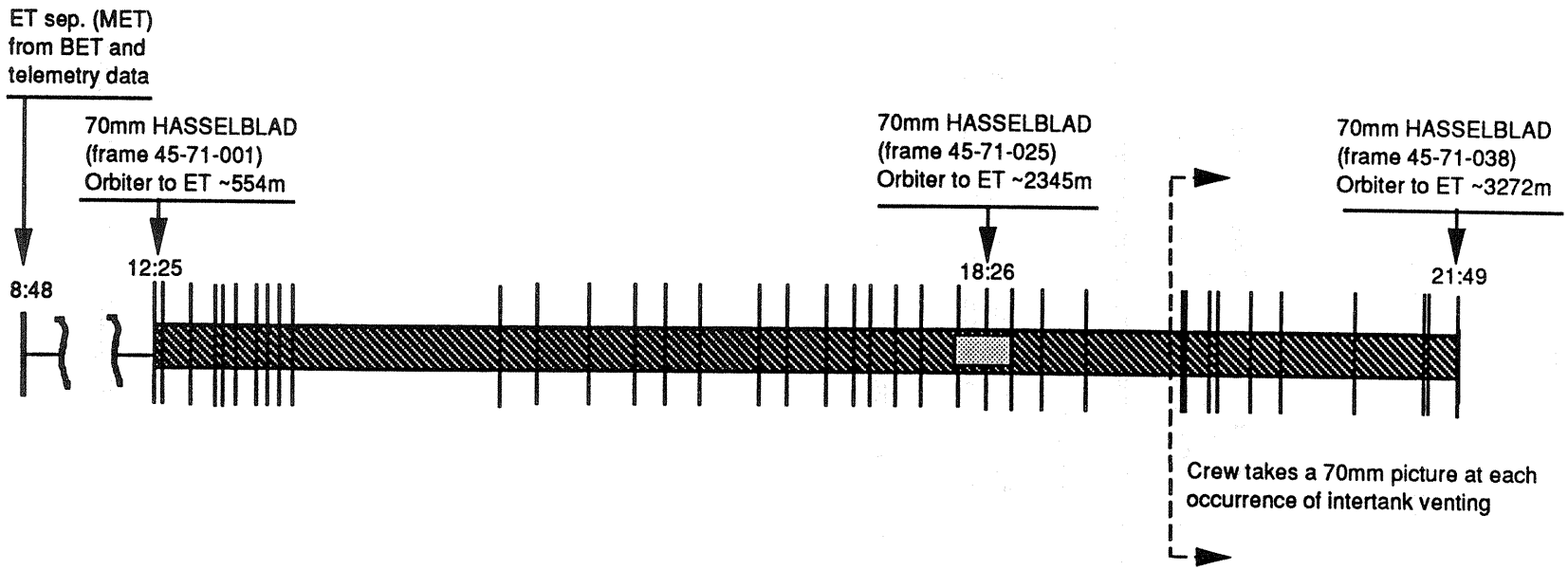
-From measures of the diameter of the ET (see prior task), calculate approximate average distance between the Orbiter and the ET as seen on the 16mm Arriflex film

-Plot approximate timeframe of Arriflex use on timeline

Image Analysis Tools & Techniques

Excel Software

STS-45 ET VENTING STUDY



- TIME FRAME WHEN 70mm HASSELBLAD IN USE

- TIME FRAME WHEN 16mm ARRIFLEX SHOWS ET AT FULL ZOOM (~20.4 secs.)
Average distance from orbiter to ET calculated to be ~2337m

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
10.11

Title : Review films, videos and photography of ET after separation

Analysts : B. Gastineau
Date : 04/10/92

Camera Number : *
Frame Number : **
GMT :

Requestor : Dave Pitts
Phone : 483-5066
Mail Code : SN5

Description of Analysis

*16mm Arriflex ET separation
**1080-1545 (increments of 5)

The purpose of this analysis was to quantify the rotation of the ET from the 16mm films. It was hoped that this information would be helpful in determining the flow rate of the venting observed coming from the liquid hydrogen umbilical view.

Stars in the field of view for the time interval under consideration were used to establish a coordinate system to eliminate any apparent motion of the ET due to camera rotation. A Fortran program was written which determined
1) the angle (alpha) between the vector made by the stars and the vector (in 2 dimensions) made by the Et/
2) the angle (alpha) between the projection plane and the vector (in 3 dimensions) made by the ET. This measurement is made by comparing the foreshortening of the length of the ET to the known length.
3) the angle (gamma) relating the relative rotation about the ET's major axis. This measurement was made relating the movement of a feature on the tank around the circumference of the tank.

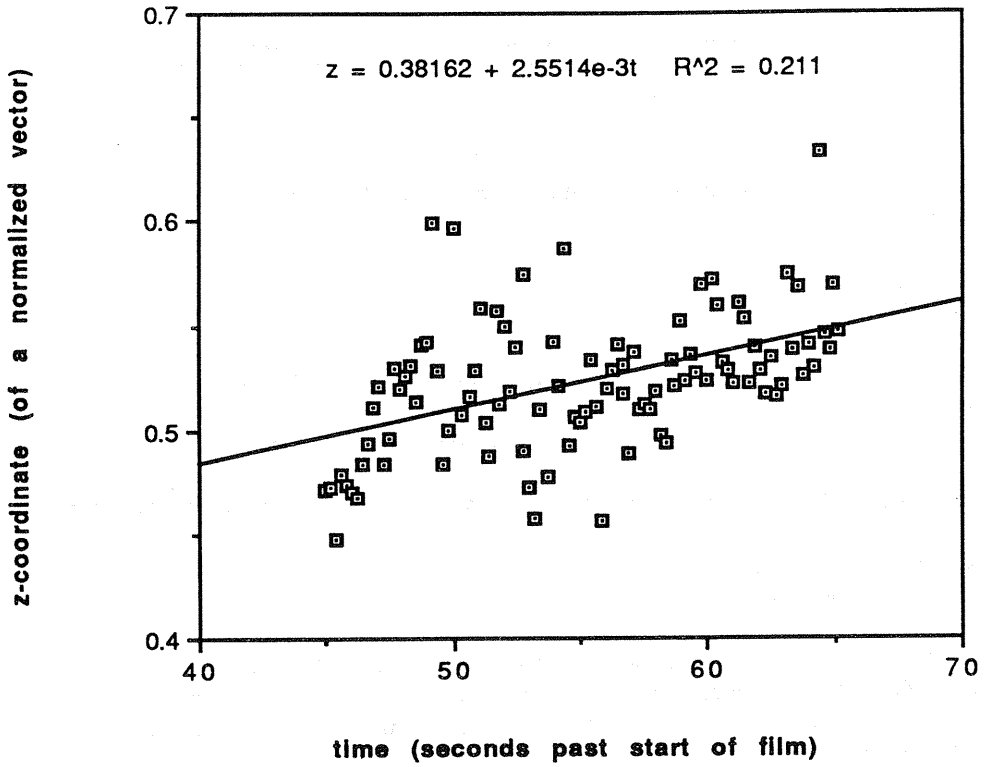
Alpha and beta were then used to construct a unit vector for each frame measured. The derivative of this unit vector with respect to time was taken to indicate angular velocity (called tumble rate). The derivative of gamma was used to determine the rate of spin of the ET around its own axis. The data was not useful in determining any angular acceleration which could be related back to a force applied by the venting.

The results of this analysis indicated a tumble rate of 0.010 rad/sec (0.58 deg/sec) for the approximately 20 seconds when the ET is captured by the film.

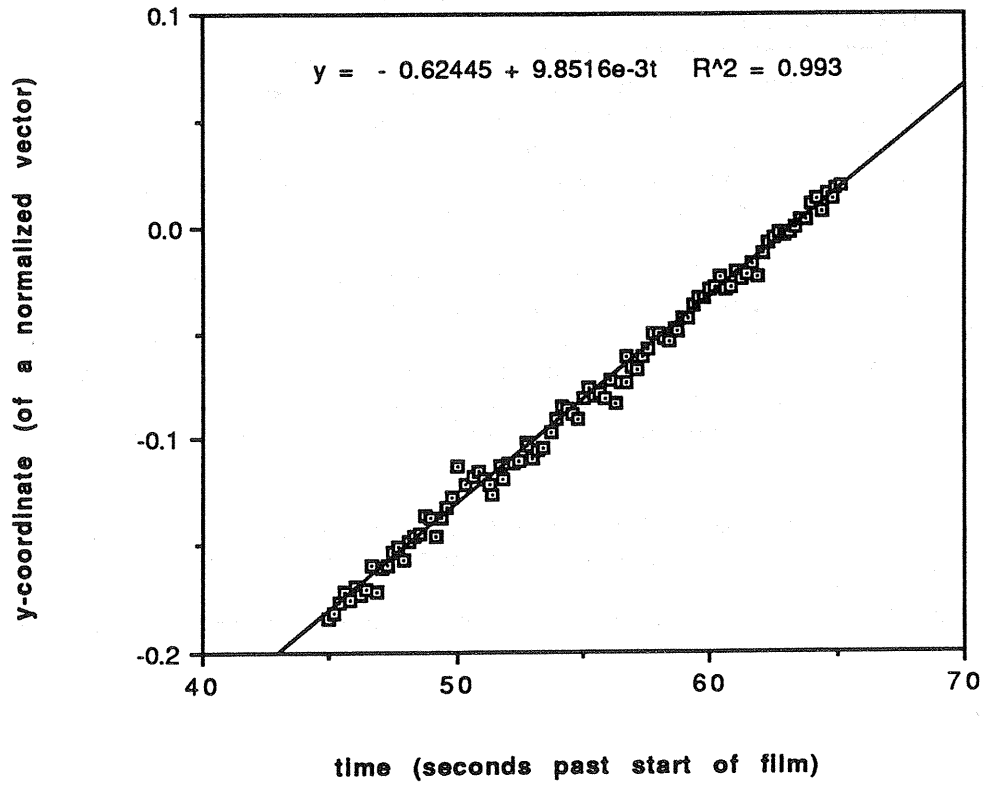
Image Analysis Tools & Techniques

16mm Film Motion Analyzer
Past Software
Cricket Graph

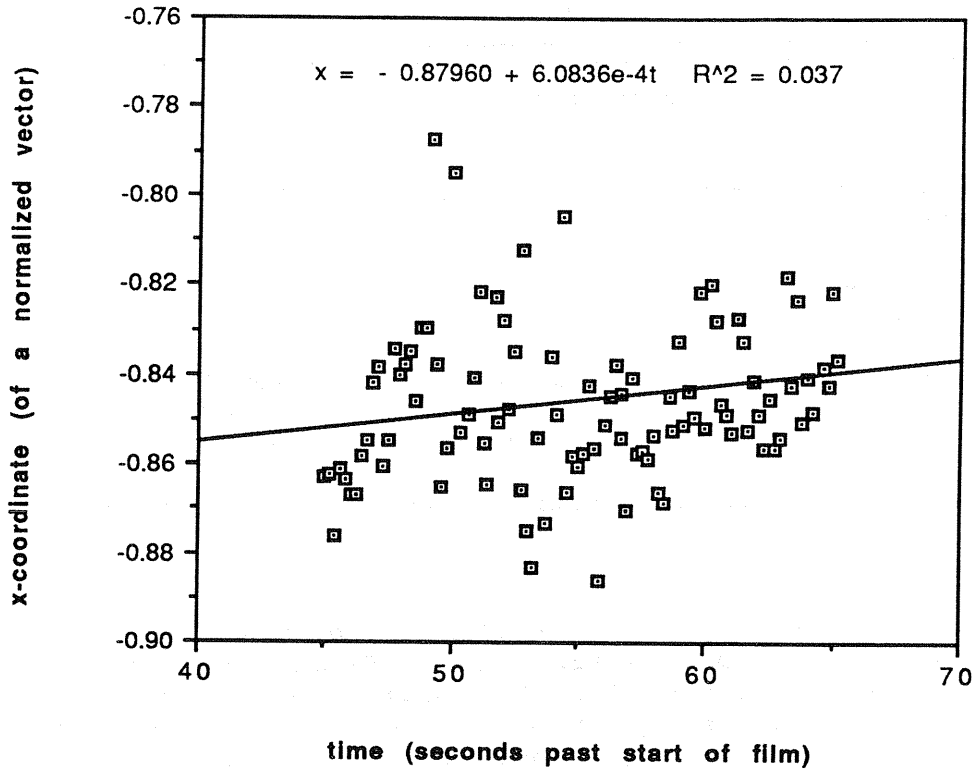
z-coordinate of ET unit pointing vector versus time (STS-45 - 16mm Arriflex)



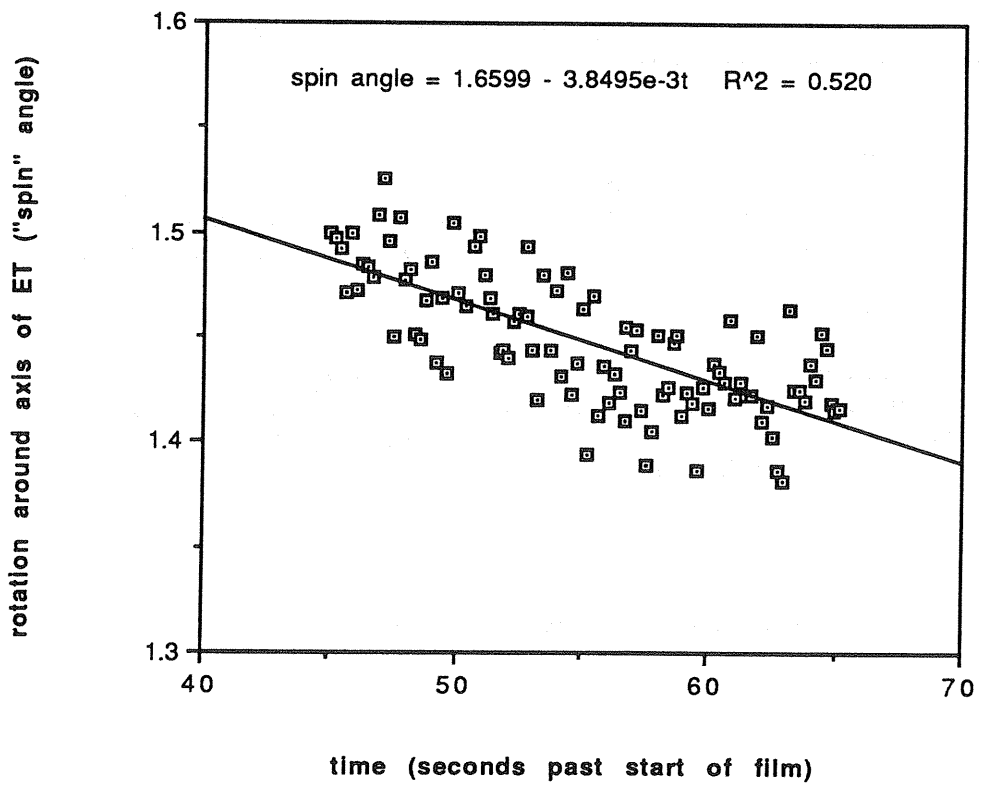
y-coordinate of ET unit pointing vector versus time (STS-45 - 16mm Arriflex)



x-coordinate of ET unit pointing vector versus time (STS-45 - 16mm Arriflex)



Spin angle versus time (STS-45 - 16mm Arriflex)



Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
10.12

Title : Review films, videos and photography of ET after separation

Analysts : B. Gastineau
Date : 04/20/92

Camera Number : *
Frame Number :
GMT :

Requestor : Dave Pitts
Phone : 483-5066
Mail Code : SN5

Description of Analysis

*STS-45-71-001

The overexposed frame 45-71-001 showed the point of origin of the vapor to be behind the visible portion of the LH2 umbilical. The Reg3D software was temporarily changed to extract the 3-dimensional information from the farthest point of the CAD instead of the nearest point. The result of this analysis indicated the point of origin of the venting to have the coordinates (2069,-63,608). The only positional information available from External Tank drawings were a center of 17" line x-coordinate of 2072. With crude scaling methods, the center of 17" line y-coordinate was determined to be -60.5. Indications from this analysis are that the venting does originate from the 17" line of the LH2 umbilical. The accuracy of this analysis is questionable due to the actual point of origin not being visible and possible 3D CAD imperfections.

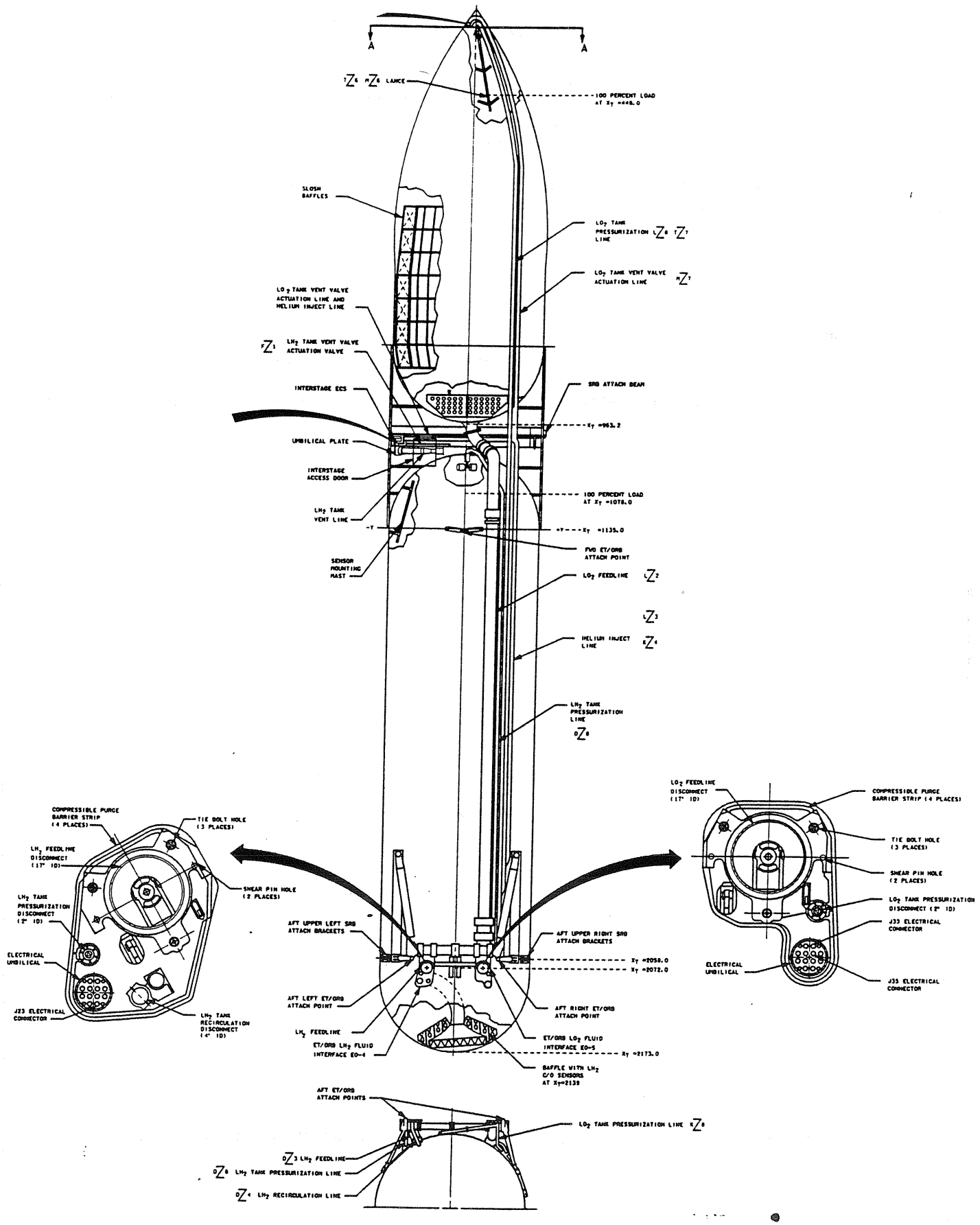
File storage:
STS-45 disk [STS.LAUNCH]
[HASSELBLAD]S4571001.2 - regular digitization of Hasselblad image
[HASSELBLAD]S4571001.3 - overexposed digitization of Hasselblad image
[HASSELBLAD]S4571001_2.TRN - CAD registration information for Reg3D

All coordinates in inches

Crude approximation of center of 17" line y-coordinate consisted of scaling by attached drawing of the external tank diameter (331.2 inches) to the distance of the center of the LH2 17" line to the center line of the external tank

Image Analysis Tools & Techniques

Eikonix Digitizer
Reg3D Software


A
A
LANCE
100 PERCENT LOAD AT X_T =448.0
SLOSH BAFFLES
LO_2 TANK PRESSURIZATION LINE
LO_2 TANK VENT VALVE ACTUATION LINE
LO_2 TANK VENT VALVE ACTUATION LINE AND HELIUM INJECT LINE
LH_2 TANK VENT VALVE ACTUATION VALVE
INTERSTAGE ECS
SRB ATTACH BEAM
X_T =963.2
UMBILICAL PLATE
INTERSTAGE ACCESS DOOR
100 PERCENT LOAD AT X_T =1078.0
LH_2 TANK VENT LINE
X_T =1135.0
FWD ET/ORB ATTACH POINT
SENSOR MOUNTING MAST
LO_2 FEEDLINE
HELIUM INJECT LINE
LH_2 TANK PRESSURIZATION LINE
COMPRESSIBLE PURGE BARRIER STRIP (4 PLACES)
TIE BOLT HOLE (3 PLACES)
LH_2 FEEDLINE DISCONNECT (17" ID)
SHEAR PIN HOLE (2 PLACES)
LH_2 TANK PRESSURIZATION DISCONNECT (2" ID)
ELECTRICAL UMBILICAL
J23 ELECTRICAL CONNECTOR
LH_2 TANK RECIRCULATION DISCONNECT (4" ID)
LO_2 FEEDLINE DISCONNECT (17" ID)
COMPRESSIBLE PURGE BARRIER STRIP (4 PLACES)
TIE BOLT HOLE (3 PLACES)
SHEAR PIN HOLE (2 PLACES)
LO_2 TANK PRESSURIZATION DISCONNECT (2" ID)
J33 ELECTRICAL CONNECTOR
ELECTRICAL UMBILICAL
J35 ELECTRICAL CONNECTOR
AFT UPPER LEFT SRB ATTACH BRACKETS
AFT UPPER RIGHT SRB ATTACH BRACKETS
X_T =2050.0
X_T =2072.0
AFT LEFT ET/ORB ATTACH POINT
AFT RIGHT ET/ORB ATTACH POINT
LH_2 FEEDLINE
ET/ORB LO_2 FLUID INTERFACE EO-5
ET/ORB LH_2 FLUID INTERFACE EO-4
X_T =2173.0
BAFFLE WITH LH_2 C/O SENSORS AT X_T=2139
AFT ET/ORB ATTACH POINTS
LO_2 TANK PRESSURIZATION LINE
LH_2 FEEDLINE
LH_2 TANK PRESSURIZATION LINE
LH_2 RECIRCULATION LINE

U.S. Gov't

Summary of Analysis of Visual Events
STS-45
04/23/92

Task Number
10.13

Title : Review films, videos and photography of ET after separation

Analysts : S. Israel
Date : 04/03/92

Camera Number :
Frame Number :
GMT :

Requestor : Dave Pitts
Phone : 483-5066
Mail Code : SN5

Description of Analysis

See attached

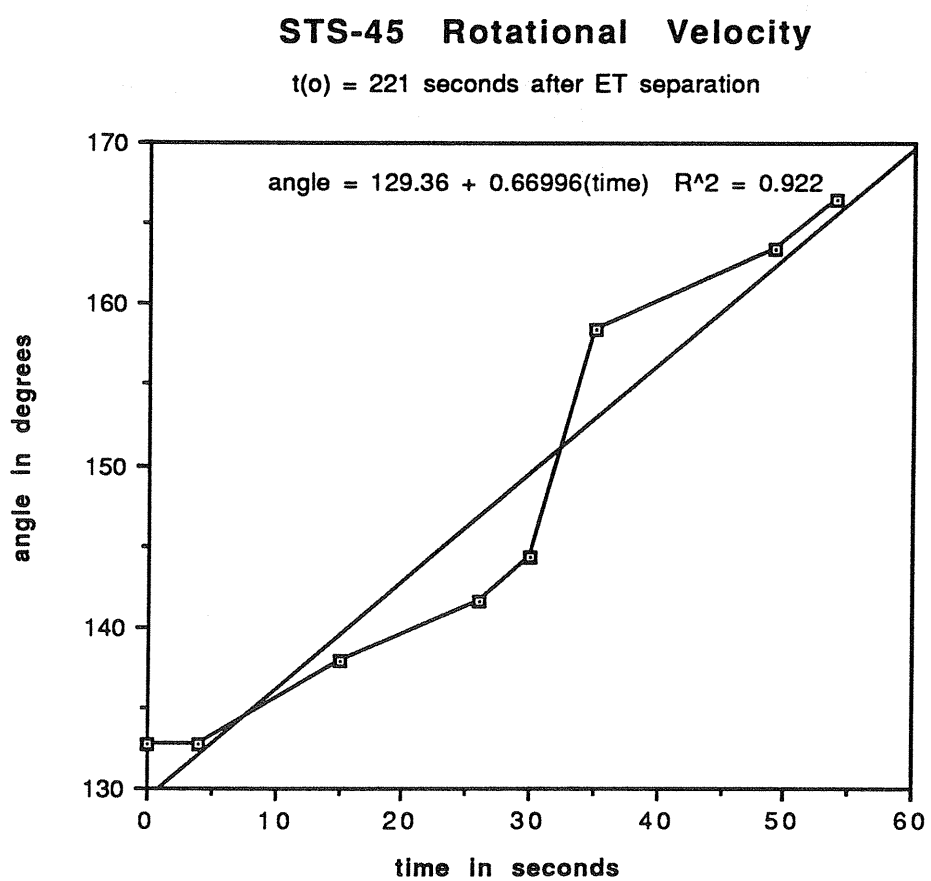
Image Analysis Tools & Techniques

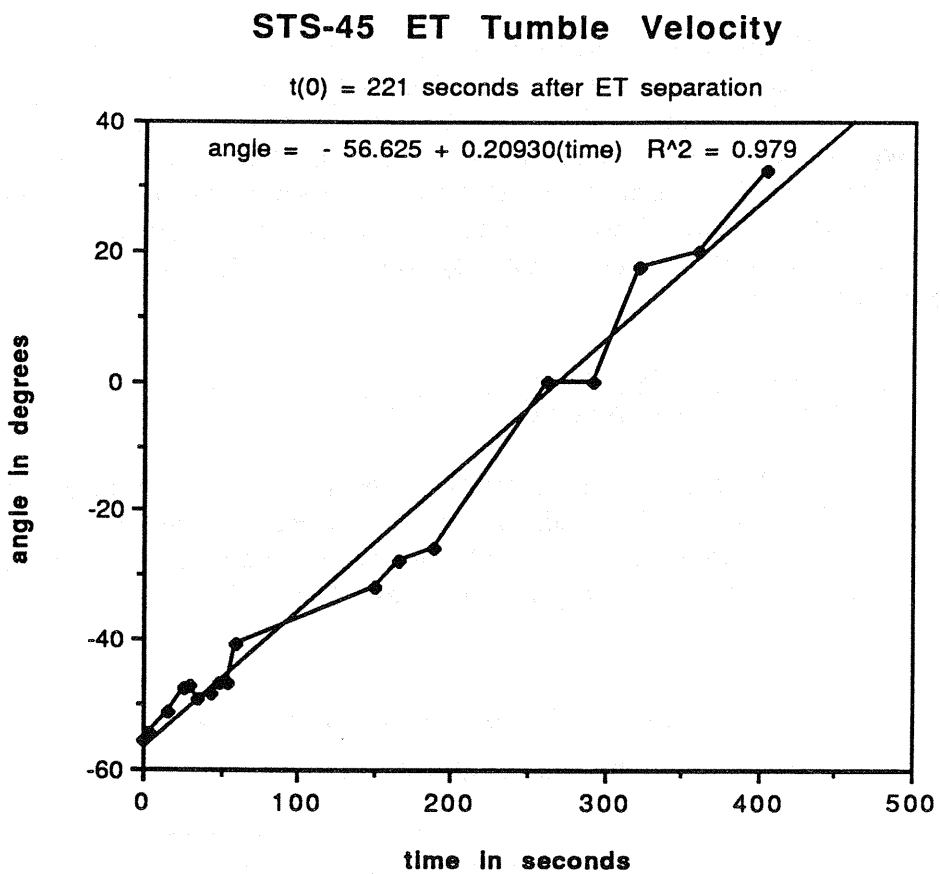
Task #10 ET Onboard Hasselblad Photographic Analysis DTO-0312

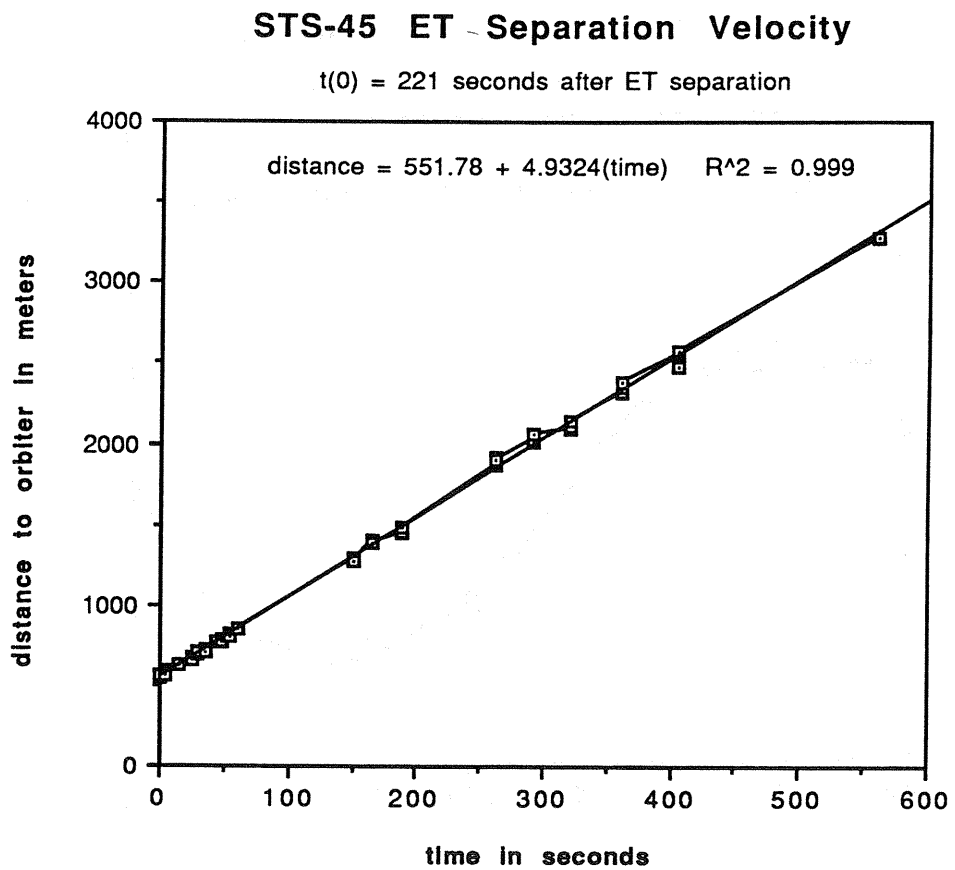
The goal of the ET analysis is to determine the sizes of the possible anomalies including divots and sizes of the burn scars on the surface of the ET. The spatial information was created by using a Nikon Shadowgraph and a Optronics Coscan at JSC. The Shadowgraph has a least count for measurements of 1000th of an inch and the Coscan has a least count of 1 μm in two degrees of freedom (x and y direction) and the process is fully manual. Sizes were computed by determining the distance between the extreme edges along the major diagonal of an object of interest. Distances were calculated as:

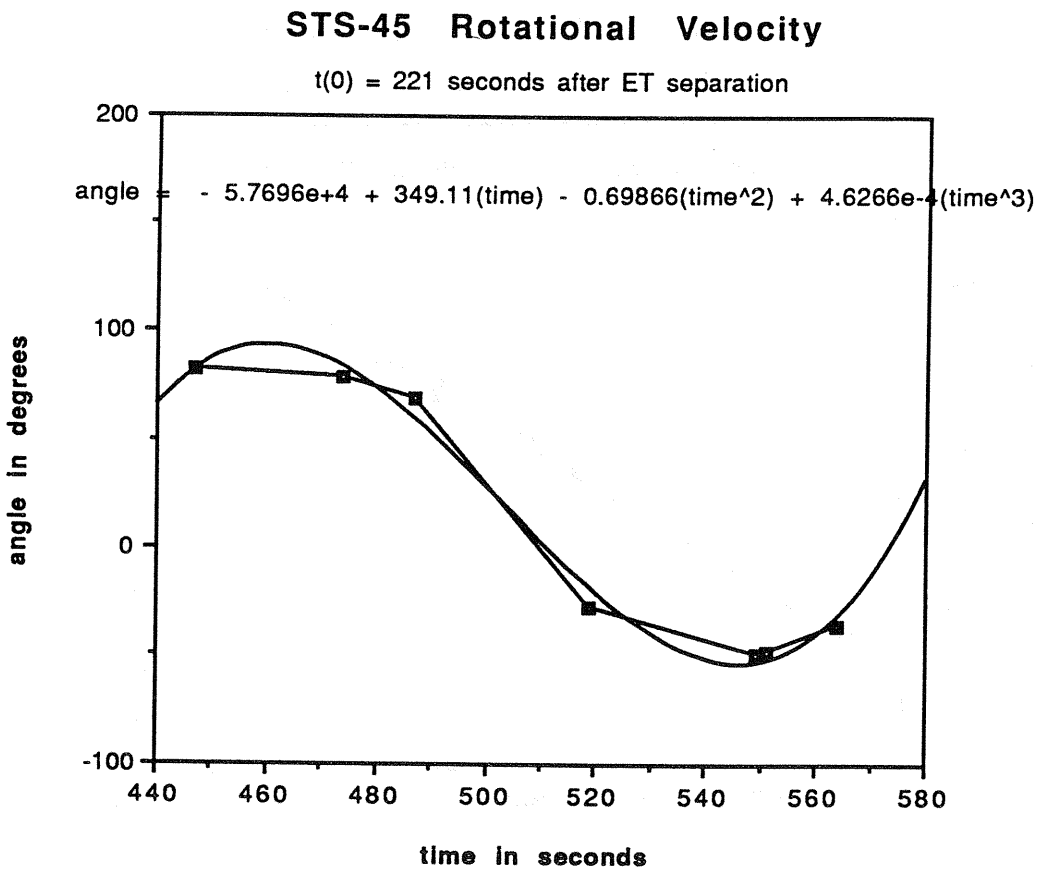
$$\text{calculated distance} = \frac{\text{measured size - divot}}{\text{measured diameter ET}} * \text{actual diameter ET}$$

Rotational velocity was calculated as the ratio between the distance between a divot on the LH2 intertank interface and the diameter at the LH2 intertank interface. The tumble velocity was calculated at the angle between actual distance between the LH2 intertank interface and the aft attach ring and the calculated distance.



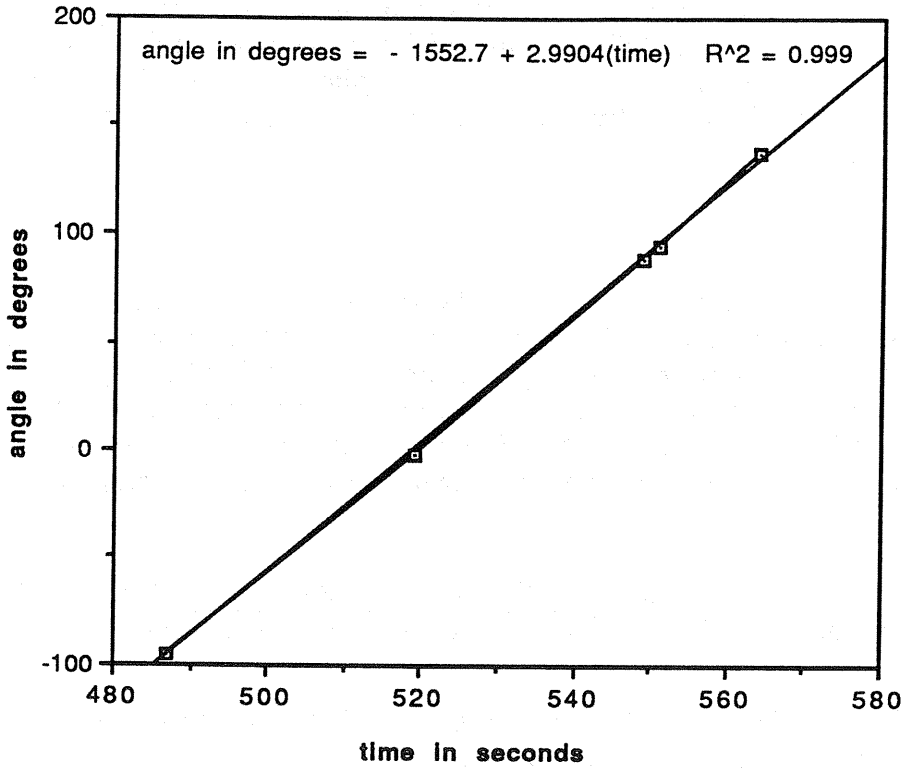

STS-45 ET Tumble Velocity
t(0) = 221 seconds after ET separation
angle = - 56.625 + 0.20930(time) R^2 = 0.979
angle in degrees
time in seconds
40
20
0
-20
-40
-60
0
100
200
300
400
500


STS-45 ET Separation Velocity
t(0) = 221 seconds after ET separation
distance = 551.78 + 4.9324(time) R^2 = 0.999
distance to orbiter in meters
4000
3000
2000
1000
0
0
100
200
300
400
500
600
time in seconds


STS-45 Rotational Velocity
t(0) = 221 seconds after ET separation
angle = - 5.7696e+4 + 349.11(time) - 0.69866(time^2) + 4.6266e-4(time^3)
200
100
0
-100
angle in degrees
440
460
480
500
520
540
560
580
time in seconds

STS-45 Tumbling Rate Frames 45-71-31 thru 38

t(0) = 221 seconds after ET separation



The following are the procedures for determining the rotational and tumbling velocity of the ET using 70 mm photography.

All measurements were obtained from an Optronics Coscan or Nikon Shadowgraph monocomparator using the 70 mm Hasselblad second generation transparencies. Dave Leestma has confirmed that Mike Foale and he maintained a fairly constant orientation with respect to the flight deck during the photography. Therefore, the tumbling observed in the photography corresponds to the actual ET tumbling with respect to the Orbiter.

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Tumbling Velocity

Tumbling is considered the rotation of the ET about the y-z axes. The tumbling is observed as a foreshortening of the ET and the rotation about the optic axis. Over the first 60 seconds, the dominant tumbling motion was foreshortening ET. The foreshortening was calculated by finding the edges of the diameter at the LH2 intertank interface and the diameter at the aftdome interface. The actual distance between these two rings is known so the angle from parallel to the image plane of the camera was determined as:

$$\frac{\text{average diameter of ET (image)}}{\text{actual diameter of ET}} = \frac{\text{distance between diameters (image)}}{\cos(\theta)\text{*actual distance between diamters}}$$

Over the last $1\frac{1}{2}$ minutes, the dominant tumbling was cause by rotation about the optic axis. Tumbling about the optic axis was difficult to determine since the edges of the frame were not visible. To determine the orientation of the ET, a line was drawn between the corresponding sprockets and along the x axis of the ET. The angle between these two lines was then determined with a protractor. The velocity was determined to be the change in orientation with respect to time.

Rotational Velocity

The rotational velocity was determined by tracking a divot along the diameter of the ET as it passed through the field of view. Velocity then, is just the change in the angle over time. The divots located on the LH2 intertank interface were targeted since the edge of the ET normal to the intertank interface could be determined. The relative angle was determine by the following:

$$\Theta = \text{acos}\left[\frac{\text{distance between the divot and the right edge}}{\text{(diameter of the ET)/2}}\right]$$

	frame	position	rotation angle	relative time	tumble angle
1			degrees	seconds	degrees
2	45-71-30	aft attach	81.656	447.000	
3	45-71-33	aft attach	78.567	474.000	
4	45-71-34	aft attach	68.717	487.000	-95.000
5	45-71-35	aft attach	-27.196	519.000	-2.000
6	45-71-36	aft attach	-49.271	549.000	87.500
7	45-71-37	aft attach	-48.607	551.000	93.500
8	45-71-38	lh2 int.int.		564.000	137.000

U.S. Gov't

	frame	relative time	object	x1	y1	x2	y2
1				in microns	in microns	in microns	in microns
2	45-71-001	0.000	aft attach	-17350.000	22.000	-21152.000	-458.000
3		0.000	lh2 int.int.	-20423.000	-8742.000	-16731.000	-8743.000
4	45-71-002	4.000	lo2 int.int.	7326.000	-8780.000	3796.000	-9327.000
5		4.000	lh2 int. int.	-3455.000	-6766.000	-7118.000	-6570.000
6		4.000	aft attach	6133.000	1751.000	2468.000	1281.000
7	45-71-003	15.000	aft attach	-4939.000	14323.000	-8298.000	14057.000
8		15.000	lh2 int.int.	-8223.000	6990.000	-4850.000	6923.000
9	45-71-004	26.000	lo2 int.int.	-11483.000	687.000	-14564.000	787.000
10		26.000	lo2 int. int.	-11321.000	2605.000	-14428.000	2836.000
11		26.000	aft attach	-14005.000	9213.000	-10819.000	9006.000
12	45-71-005	30.000	aft attach	0.000	0.000	-2967.000	816.000
13		30.000	lh2 int. int.	-4383.000	-5247.000	-1443.000	-5932.000
14		30.000	lo2 int.int.	-1907.000	-7808.000	-4828.000	-7192.000
15	45-71-006	35.000	lo2 int.int.	1118.000	2722.000	4022.000	2582.000
16		35.000	lh2 int.int.	4090.000	4138.000	1192.000	4447.000
17		35.000	aft attach	4436.000	10262.000	1490.000	10532.000
18	45-71-007	44.000	lh2 int.int	558.000	3804.000	3267.000	3522.000
19		44.000	aft attach	4190.000	9074.000	1456.000	9360.000
20	45-71-008	49.000	lh2 int.int.	-658.000	6331.000	1983.000	6047.000
21		49.000	aft attach	2566.000	11418.000	-133.000	11685.000
22	45-71-009	54.000	lh2 int.int.	1653.000	3392.000	4215.000	3156.000
23		54.000	aft attach	4754.000	8348.000	2140.000	8582.000
24	45-71-010	60.000	lh2 int.int.	951.000	3316.000	3402.000	2926.000
25		60.000	aft attach	3772.000	8150.000	1321.000	8388.000
26	45-71-011	150.000	lh2 int.int.	1980.000	1952.000	3577.000	1648.000
27		150.000	aft attach	4263.000	5371.000	2662.000	5754.000
28	45-71-012	166.000	lo2 int.int.	1102.000	399.000	2611.000	399.000
29		166.000	lh2 int.int.	2662.000	1379.000	1143.000	1461.000
30		166.000	aft attach	1283.000	5144.000	2801.000	5091.000

U.S. Gov't

	photo distance	to orbiter	frame	rotation angle
1	in microns	in meters		degrees
2	3832.180	548.474	45-71-001	132.663
3	3692.000	569.298		
4	3572.129	588.403	45-71-002	132.792
5	3668.240	572.986		
6	3695.014	568.834		
7	3369.516	623.784	45-71-003	137.932
8	3373.665	623.017		
9	3082.622	681.838	45-71-004	141.525
10	3115.575	674.627		
11	3192.717	658.326		
12	3077.165	683.048	45-71-005	144.326
13	3018.746	696.266		
14	2985.247	704.079		
15	2907.373	722.938	45-71-006	158.390
16	2914.427	721.188		
17	2958.347	710.481		
18	2723.638	771.707	45-71-007	
19	2748.918	764.610		
20	2656.226	791.292	45-71-008	163.489
21	2712.174	774.969		
22	2572.847	816.936	45-71-009	166.487
23	2624.453	800.872		
24	2481.834	846.894	45-71-010	
25	2462.528	853.533		
26	1625.677	1292.908	45-71-011	
27	1646.174	1276.809		
28	1509.000	1392.876	45-71-012	
29	1521.212	1381.695		
30	1518.925	1383.775		

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				Steve Israel - Mail Code C-23			
				Lockheed Engineering and Sciences Company			
				2400 NASA RD1			
				Houston, Texas 77058			
				713-244-5106			
frame id	**gmt**	**position**	**x1**	**y1**	**x2**	**y2**	**length um**
			microns	microns	microns	microns	microns
45-71-001	13:26:05	aft attach	-17350	22	-21152	-458	3832.18006
		lh2 int.int.	-20423	-8742	-16731	-8743	3692.00014
		divot 2	-17493	-9696	-17737	-9696	244
		divot 1	-17099	-9299	-17064	-9400	106.892469
		divot 3	-17798	-9782	-18002	-9782	204
		divot 4	-18337	-9885	-18435	-9777	145.835524
45-71-002	13:26:09	lo2 int.int.	7326	-8780	3796	-9327	3572.12948
		aft attach	6133	-1751	2468	1281	4756.60057
		lh2 int. int.	3455	-6766	7118	-6570	3668.24004
		divot 2	6186	-7588	6403	-7534	223.617978
45-71-003	13:26:20	aft attach	-4939	14323	-8298	14057	3369.51584
		lh2 int.int.	-8223	6990	-4850	6923	3373.66537
		divot 2	-5418	6025	-5587	6025	169
45-71-004	13:26:31	lo2 int.int.	-11483	687	-14564	787	3082.62242
		aft attach	-14005	9213	-10819	9006	3192.71749
		lh2 int. int.	-11321	2605	-14428	2836	3115.57539
		divot 2	-11771	1810	-11941	1787	171.548827
45-71-005	13:26:35	aft attach	0	0	-2967	816	3077.16509
		lh2 int. int.	-4383	-5247	-1443	-5932	3018.7456
		divot 2	-1939	-6578	-2087	-6622	154.402073
		lo2 int.int.	-1907	-7808	-4828	-7192	2985.24656
45-71-006	13:26:40	lo2 int.int.	1118	2722	4022	2582	2907.3727
		aft attach	4436	10262	1490	10532	2958.34684
		lh2 int.int.	4090	4138	1192	4447	2914.42704
		divot 2	3834	3761	3710	3716	131.91285
45-71-007	13:26:49	aft attach	4190	9074	1456	9360	2748.91833
		lh2 int.int	558	3804	3267	3522	2723.63819
45-71-008	13:26:54	aft attach	2566	11418	-133	11685	2712.1744
		lh2 int.int.	-658	6331	1983	6047	2656.22608
		divot 2	1836	5743	1771	5709	73.3552997
45-71-009	13:26:59	aft attach	4754	8348	2140	8582	2624.4527

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		lh2 int.int.	1653	3392	4215	3156	2572.84667
		divot 2	4109	2916	4063	2867	67.2086304
45-71-010	13:27:05	aft attach	3772	8150	1321	8388	2462.52817
		lh2 int.int.	951	3316	3402	2926	2481.8342
45-71-011	13:28:35	aft attach	4263	5371	2662	5754	1646.17435
		lh2 int.int.	1980	1952	3577	1648	1625.67678
45-71-012	13:28:51	lo2 int.int.	1102	399	2611	399	1509
		aft attach	1283	5144	2801	5091	1518.92495
		lh2 int.int.	2662	1379	1143	1461	1521.21169
		"------- microns above inches below ---------					
			inches	inches	inches	inches	inches
45-71-013	13:29:14	lo2 int.int.	0.4727	0.3142	0.5276	0.29815	0.05719801
		aft attach	0.5676	0.47525	0.51375	0.491	0.05610602
		lh2 int.int.	0.5367	0.3406	0.4821	0.3542	0.05626829
		access door l.	0.5059	0.32495			
45-71-014	13:29:34						
45-71-015	13:29:47						
45-71-016	13:30:02						
45-17-017	13:30:28	lo2 int.int.	0.3811	0.6409	0.3613	0.6807	0.04445312
		aft attach	0.52325	0.70905	0.50415	0.7485	0.0438305
		lh2 int.int.	0.4118	0.6566	0.39345	0.69595	0.04341826
		access door	0.39685	0.66165			
		divot 5	0.40705	0.66875	0.405	0.66875	0.00205
		divot 6	0.4049	0.6729	0.4039	0.6722	0.00122066
		divot 7	0.40325	0.67645	0.40135	0.6756	0.00208147
		divot 8	0.4004	0.6796	0.39895	0.683	0.00369628
45-71-018	13:30:40						
45-71-019	13:30:57	lo2 int.int.	0.587	0.3559	0.56365	0.3894	0.0408347
		aft attach	0.7078	0.4378	0.68605	0.4715	0.04010926
		lh2 int.int.	0.61415	0.37365	0.5906	0.4074	0.04115416
		access door l.	0.60135	0.37505			

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45-71-020	13:31:08						
45-71-021	13:31:16						
45-71-022	13:31:27	lo2 int.int.	0.7979	0.3208	0.7793	0.3558	0.03963534
		aft attach	0.9136	0.3873	0.8948	0.42125	0.03880776
		lh2 int.int.	0.82465	0.33685	0.8048	0.3709	0.03941351
		access door l.	0.8143	0.33795			
45-71-023	13:31:38						
45-71-024	13:31:54						
45-71-025	13:32:06	lo2 int.int.	0.2879	0.25095	0.27785	0.28525	0.03574203
		aft attach	0.3999	0.281	0.3924	0.315	0.03481738
		lh2 int.int.	0.3132	0.2577	0.3033	0.2916	0.035316
		access door l.	0.30575	0.2594			
45-71-026	13:32:17						
45-71-027	13:32:30						
45-71-028	13:32:49	lo2 int.int.	0.3319	0.2887	0.33065	0.3211	0.0324241
		aft attach	0.4294	0.2948	0.4304	0.3269	0.03211557
		lh2 int.int.	0.354	0.28975	0.3535	0.32315	0.03340374
		access door l.	0.3491	0.2926			
		lh2 int.int. +1	0.4947	0.311	0.49515	0.34355	0.03255311
		divot 9	0.50255	0.3284	0.50085	0.3284	0.0017
45-71-029	13:33:30						

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45-71-030	13:33:32	aft attach	0.3554	0.23807	0.3652	0.2683	0.03177881
		far sup	0.3685	0.26187			0.54547653
45-71-031	13:33:42						
45-71-032	13:33:45						
45-71-33	13:33:59	aft attach	0.3166	0.28967	0.3415	0.30785	0.03083054
		far sup	0.3397	0.29847			1.25581896
45-71-34	13:34:12	aft attach	0.3056	0.2635	0.33795	0.26605	0.03245035
		far sup	0.32612	0.261			0.88016176
45-71-35	13:34:44	aft attach	0.3446	0.2895	0.3458	0.3152	0.025728
		near sup	0.32552	0.306			1.55124113
		far sup	0.3453	0.318			0.07392295
45-71-36	13:35:14	aft attach	0.3909	0.3205	0.4154	0.3229	0.02461727
		hudaucallit	0.3928	0.3209			0.3998316
		near sup	0.4054	0.32402			0.91961697
45-71-37	13:35:16	aft attach	0.3909	0.16487	0.4164	0.16132	0.02574592
		hudaucallit	0.39222	0.16425			0.33819259
		near sup	0.40675	0.16585			0.90611656
45-71-38	13:35:29	lh2 int.int.	0.2095	0.1751	0.19205	0.1934	0.02528621
		aft attach	0.7569	0.15597	0.7747	0.13615	0.02663968
		hudaucallit	0.76072	0.15675			0.36383772

U.S. Gov't

Summary of Analysis of Visual Events
STS-45
04/23/92

Task Number
10.14

Title : Review films, videos and photography of ET after separation

Analysts : C. Sapp
Date : 04/15/92

Camera Number :
Frame Number :
GMT :

Requestor : Dave Pitts
Phone : 483-5066
Mail Code : SN5

Description of Analysis

Five frames were used in determining the angle of the cone of vapor emitting from the umbilical area. The frames used were 1142, 1323, 1342, 1500, & 1520 from the Arriflex 16mm film. All except for 1323 were digitized from prints. Frame 1323 was a Mavica image taken during the initial screening of the film.

In each case, the method used was to use the 'rubber band' cursor in PROFIL to define an edge of the cone. This was a somewhat subjective way to define the edge of the cone, but in almost every case, the grain size of the image was large enough to prevent a more objective means (i.e. the edge of the cone was jagged, requiring a human eye to integrate it into a straight line). Both sides of the cone were defined in this way, and the endpoints of the cursor line segment noted on paper.

The endpoints were then entered into a spreadsheet in Microsoft Excel, and the angle between the line segments calculated using the formal

<AB=Tan-1(Mb-Ma/1+MaMb) where Ma=slope of line A=Xb-Xa/Yb-Ya

The average of the angles measured was 71.1 deg. The maximum angle measured was 86.6 and the minimum was 58.4 deg.

Image Analysis Tools & Techniques

Summary of Analysis of Visual Events
STS-45
04/23/92

Task Number
10.15

Title : Review films, videos and photography of ET after separation

Analysts : M. Snyder
Date : 04/20/92

Camera Number :
Frame Number :
GMT :

Requestor : Dave Pitts
Phone : 483-5066
Mail Code : SN5

Description of Analysis

A 16mm frame from the onboard film showing ET venting was digitized on the Eikonix digitizer and then transferred to the MAC for analysis. The image contrast was enhanced using PhotoShop and it was discovered that the vapor from the vent area had the best contrast in the green channel. The green channel was saved as a separate image and opened using NIH IMAGE. In NIH Image the extent of the vapor was measured. The length of the top edge of the vapor cone was approximately 412 inches, while the length of the bottom cone edge was app. 439 inches. (The width of the ET was used for scale.)

The 2 dimensional area extent of the vapor was measured using a histogram of the area outlined by the vapor. Since all nonzero pixels in this area were considered part of the vapor cloud, the size of the vapor cloud in pixels was (total number of pixels - the number of zero valued pixels). After scaling, the area of the vapor cloud in 2d was: 81,237 sq. inches or 564 sq. ft.

Image Analysis Tools & Techniques

Viewed films on FMA

Summary of Analysis of Visual Events
STS-45
04/29/92

Task Number
10.16

Title : Review films, videos and photography of ET after separation

Analysts : J. Hartman
Date : 04/27/92

Camera Number :
Frame Number :
GMT :

Requestor : Dave Pitts
Phone : 483-5066
Mail Code : SN5

Description of Analysis

Determine solar position relative to ET and Orbiter at separation and time of venting.

See attachment from Ed Brown, RSOC Ground Navigation. (The ASCII file SUNANGLE.045 which was mentioned in page two of the attachment has been placed on Disk STS45[STS.LAUNCH.SUN_ANGLE].)

Image Analysis Tools & Techniques

ET-44

PERFORMANCE

ON

STS-45

CONTENTS GENERATED BY
ROCKWELL INTERNATIONAL SPACE SYSTEMS
DIVISION

MARCH 24, 1992

STS-45 / ET-44 Performance Summary

Loading/Detank, 03/23/92

- No ET OMRSD or LCC violations
- No ET Anomalies
- Nominal system performance during loadings

Loading/launch, 03/24/92

- No OMRSD or LCC violations
- All objectives satisfied during loading/flight
- Nominal system performance during loading/flight

Issue

After separation the flight crew reported continuous venting from vicinity of ET/Orbiter disconnects. Also reported a pulsating venting from the intertank area.

STS-45 , ET-44 Performance Summary

Discussion:

Disconnect: There are five valves in the ET/Orb disconnect area.

- 17" LO2 Disconnect
- 17" LH2 Disconnect
- 4" LH2 Recirculation Line Disconnect
- 2" GH2 Pressurization Line Disconnect
- 2" GO2 Pressurization Line Disconnect

All of the valves are furnished as GFP by the Orbiter as part of the two disconnect assemblies.

It is unlikely that the 17" feedline valves were open for two reasons.

- The thrust of an open 17" valve would have caused the ET to tumble at a high rate. The crew report was that "The tank was <u>not</u> tumbling at a very high rate."
- The ET 17" valve has to be closed for the Orbiter valve to close. The position indicators on the Orbiter showed it's valves to be closed.

The 4-inch recirculation valve on the Orbiter also reported closed within the maximum travel time. It is mechanically coupled to the ET half which has a spring back-up.

The 2-inch pressurization valves are spring loaded and close when the disconnect separates.

STS-45 / ET-44 Performance Summary

Disconnect:

Conclusion:

Although the 17" and 4" valves were closed they could have been leaking, due to improper seating, with no way to verify. The allowable leakage from the 17" LH2 valve is 5,000 scims so it is possible that the crew only saw this allowable leakage.

The condition of the 2" valves after separation is unknown. A possible source of the vapors noted could have been the LH2 trapped between the tank and orbiter 17" flapper valves. At separation this hydrogen freezes into ice crystals, a fact noted by the umbilical cameras on orbiter 102 on a number of flights.

TS-45 / ET-44 Performance Summary

Intertank:

The fact that this flight did not have a tumble valve, had among the highest LH2 residuals, and the DTO resulted in the orbiter being very close to the tank after separation would indicate that the crew may have been observing normal cycling of the ET relief valve. The tank, pre- burnout, is maintained at 32-34 psia and the relief valve opens at 35 psia. Gas and entrained liquid, would exit the vent and relief valve duct at the intertank skin in a pulsing pattern, forming a core of ice crystals visible from the orbiter. Both of Astronaut Leestma's previous flights were with ET's with active tumble valve; on a tumbling tank the centrifugal force would have maintained the propellant in the cold back end. The LH2 tank wall temperature at the forward end is near 0° F. The back end is at LH2 temp, so a tumbling tank would vent much later than a non-tumbling tank where the natural deceleration "g" forces would have thrown the propellant forward onto the warm surfaces.

Conclusion:

This was a normal venting event aggravated by:

- Non-tumbling tank
- High LH2 residuals
- Close, and early, observation by crew

STS-45 / ET-44 Performance Summary

ET Separation & Rupture / Breakup

- Radar report from Bermuda confirmed, as expected, ET-53 did not tumble.
- Impact point based on simulated trajectory using telemetry data before separation showed impact estimate within predicted footprint.
- Velocity at MECO was 6 ft/sec below predicted value (typical for Direct Orbital Insertion (DOI) missions).
- Predicted post flight ET intact impact point was approximately 115N.M. uprange from the preflight predicted impact point.

ET intact impact point	Preflight	Post Flight
Latitude	41.37 Deg S	42.74 Deg S
Longitude	153.18 Deg W	154.99 Deg W

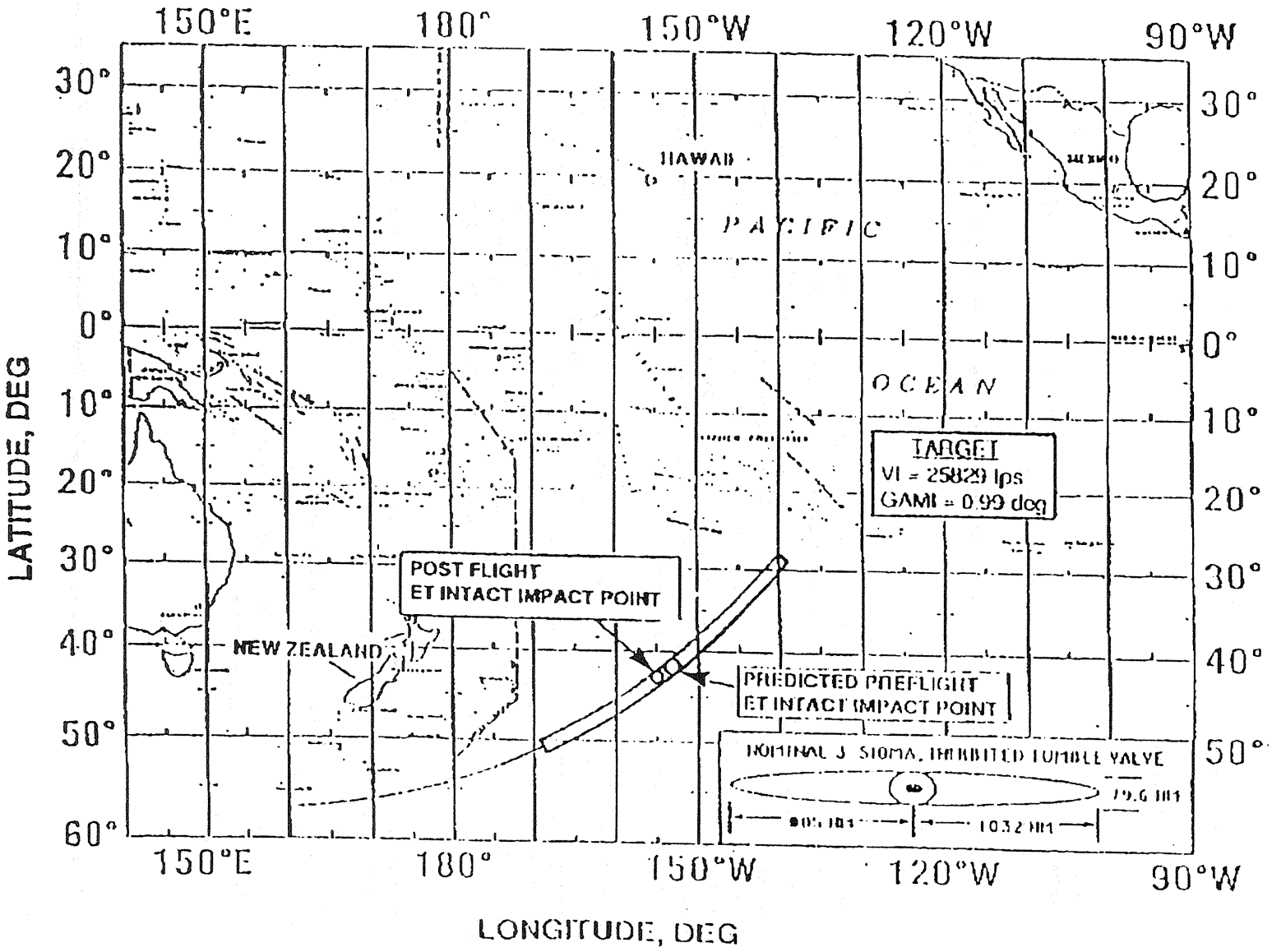
- ET-44 Rupture/Breakup estimates not available at this time.

D132

-6

STS-45/ET-44 NOMINAL IMPACT AREA

3/24/92



MARTIN MARIETTA
MANNED SPACE SYSTEMS

-7

TOTAL PAGE.08

Summary of Analysis of Visual Events
STS-45
04/29/92

Task Number
10.17

Title : Review films, videos and photography of ET after separation

Analysts : B. Gastineau
Date : 04/28/92

Camera Number : *
Frame Number : **
GMT :

Requestor : Dave Pitts
Phone : 483-5066
Mail Code : SN5

Description of Analysis

*70mm Hasselblad
**S45-71-031

The purpose of this analysis was to determine the coordinate around the external tank where the intertank venting was visible from enhanced images. It was hoped that the venting could be located directly to the GUCP (Ground Umbilical Connection Plate). A CAD was registered to the ET. The venting was not seen to originate from one point but was seen along a range of the side of the intertank. Coordinates were determined from the image which bounded the length along which the cloud was visible.

The measured x-station (along major length of ET) was found to range from 1061.3 to 1137.7 (inches). The x-stations which abound the GUCP are 1002.6 to 1027.7. A check of the acquired data was done by measuring the coordinates of the GUCP. The x-stations of the GUCP were measure to range from 1002.2 to 1047.7. The discrepancy at the large end is possibly due to the poor contrast or possible markings of the area around the GUCP.

The failure of the ranges to overlap is probably due to the effect of foreshortening in the image.
File Storage:
STS 45 disk -- [STS.LAUNCH.HASSELBLAD]
S45-71-031.PIC -- digitized image of frame
S45-71-031.TRN -- CAD registration data
INTERTANK.CAD -- positional information from Reg3D (prior to correction for coordinate system)

Image Analysis Tools & Techniques

Reg3D

4/16/92

To: Jack Hartman, Lockheed
From: Ed Brown, RSOC Ground Navigation

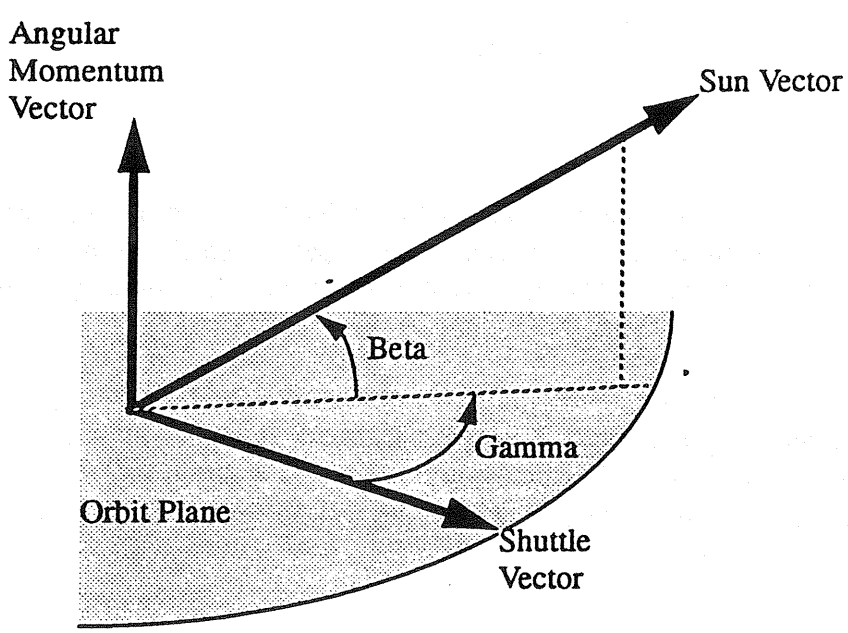
Subject: Sun Angle Data During STS-45 ET-Sep Period

This memo is in response to your request for sun angle data during the External Tank Separation period of STS-45. You were interested in the angle at which the sun was shining on the ET, presumably as seen from the Shuttle. Sun angles are easily computed for the Shuttle, whose attitude and orbital parameters are available for the period in question. That information is presented here. Similar information for the ET is not easily computed, and is not included in these results. However, the approximate ET sun angle can be backed out of the Shuttle information, assuming that the position of the ET with respect to the Shuttle is known. This can be approximated if it is known which window the crew members used to observe the ET.

Sun angles can be computed with respect to the center of the earth, or with respect to the Shuttle body axes, as described below.

Earth Centered - The Beta angle is the most commonly used earth-centered sun angle. The relative position of the sun with respect to the Shuttle can be fully characterized by the addition of a second parameter, which I've called the "gamma" angle. These angles are depicted in Figure 1, below.

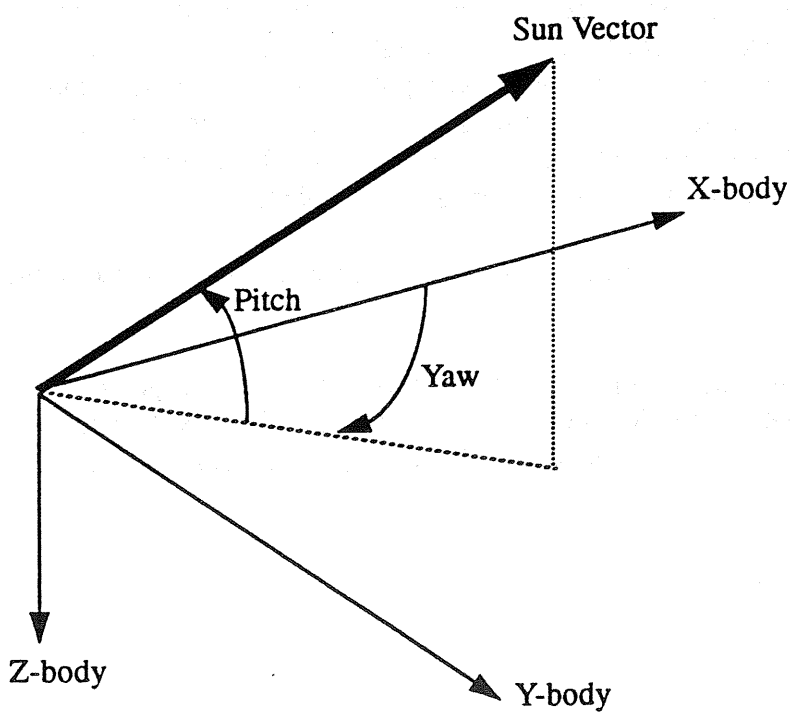
Figure 1 - Sun Beta and Gamma Angles



For this system, the Shuttle and ET sun angles are essentially identical, since their positions differ by no more than a few miles. In the figure above, the Shuttle is heading toward and "under" the sun. Earth-centered sun angles follow a gamma-beta sequence.

Body Centered - Position with respect to the Shuttle body axes is described in terms of "look angles", as shown in Figure 2.

Figure 2 - Sun Look Angles



Look angles follow a yaw-pitch sequence, and basically describe the direction of sunlight with respect to the Shuttle structure. In the figure, the sun would appear to be ahead of, above, and to the right of the Shuttle. This information can be used to determine the ET sun angles, as mentioned above.

The accompanying floppy disk contains an ASCII listing of both sets of sun angles, along with the Shuttle LVLH attitudes (following a pitch, yaw, roll sequence), at approximately one-second intervals from launch through OMS-2. ET Sep was commanded at about 529 seconds MET, which probably marks the beginning of the period of interest. Information for this study was obtained from Shuttle telemetry data.

Photo/TV Analysis Group Request Form
STS-45
05/06/92

Task Number --> 11

Request Date : 04/03/92
Completion Date : 05/01/92

Requestor : Larry Williams
Phone :
Mail Code :

Analyst Name	Phone Number	Assignment
Jack Hartman		

Task Title

Right Wing RCC Damage

Objectives

To determine if a debris source for this damage can be identified.

Hypothesis

Reporting

Analysis Strategy

1. Review screening sheets.
2. Ask for new E207 (too dark and no timing).
3. Review ET207 and E205.
4. Review closeout photography and post landing photography
5. Review landing replays
6. Review E52, E54, E57, E59
7. Digitize ice debris photo
8. Digitize post landing photo of nose strike and RCC area and overlay with CAD
9. Digitize enlargement of post landing photo of RCC damage area. Determine Orbiter coordinates of damage on RCC

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
11

Title : Right Wing RCC Damage

Analysts : Jack Hartman
Date : 04/03/92

Camera Number :
Frame Number :
GMT :

Requestor : Larry Williams
Phone :
Mail Code :

Description of Analysis

Part I.

Five attempts were made to call Nancy Pope to request another E207 film, however no answer. Will keep trying.

Part II.

All the STS-45 screening sheet were reviewed for possible sources of "dings" on Right Wing RCC. The only possible (very small possiblity) source that may have been noted in the screening sheets is E025, Frame 4328" small white piece of debris first seen near RSRB moves from right to left and fell beneath the right elevon after liftoff. All other comments were too general, too low in relation to RCC area, or on leftside of vehicle.

Image Analysis Tools & Techniques

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
11.01

Title : Right Wing RCC Damage

Analysts : J. Hartman
Date : 04/08/92

Camera Number : TV13
Frame Number :
GMT :

Requestor : Larry Williams
Phone :
Mail Code :

Description of Analysis

The landing video replays were reviewed again for a possible source for the right wing RCC damage. The only item noted that might be a possible source was found on: TV13 - 093:11:18:39.238
There appears to be a white stream of "vapor" flowing from the rear of the right wing/vertical stabilizer area. This could possible be debris flowing over and away from the wing. It couldalso be normal condensation.

See attached D-Scan print.

A new copy of E207 was requested from KSC, Ed Kolher (4/6/92)

Image Analysis Tools & Techniques

GRAB

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
11.02

Title : Right Wing RCC Damage

Analysts : J. Hartman
Date : 04/06/92

Camera Number :
Frame Number :
GMT :

Requestor : Larry Williams
Phone :
Mail Code :

Description of Analysis

All of the photographs of the Orbiter which were placed in the "STS-45 Closeout Photography" book were scrutinized for possible pre-launch divots. No divots or marks were noted on any of the pre-launch photographs.

Image Analysis Tools & Techniques

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
11.03

Title : Right Wing RCC Damage

Analysts : J. Hartman
Date : 04/09/92

Camera Number : ET207
Frame Number :
GMT :

Requestor : Larry Williams
Phone :
Mail Code :

Description of Analysis

Upon re-screening ET207, the following was noted which was not previously mentioned:

On ET207 a bright spot was noted moving from about the SSME area forward along the right side of the vehicle (apparent motion) at 084:13:15:25.988.

Also two bright spots appeared to move forward from the SSME area along the right side of the vehicle at 084:13:15:32.803

Image Analysis Tools & Techniques

RTMOV

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
11.04

Title : Right Wing RCC Damage

Analysts : J. Hartman
Date : 04/10/92

Camera Number : *
Frame Number :
GMT :

Requestor : Larry Williams
Phone :
Mail Code :

Description of Analysis

*E207 and E205

A new roll of E207 was received from KSC and it was re-screened for possible sources of debris which may have produced the damage to the right wing RCC. No sources were noted from this camera. (It was note that camera still has no timing.) It was noted that two linear optical effects occured close to and prior to SRB separation. These were probably the bright spots noted traveling up the right side ofthe vehicle on ET207.

Also E205 was re-screened for possible debris sources. None were found.

Image Analysis Tools & Techniques

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
11.05

Title : Right Wing RCC Damage

Analysts : J. Hartman
Date : 04/13/92

Camera Number :
Frame Number :
GMT :

Requestor : Larry Williams
Phone :
Mail Code :

Description of Analysis

All the screening notes for STS-45 landing photography were received for possible debris sources. None were noted.

Two photographs were digitized to try to determine the position of the RCC damage and the lower right nose strike. (It was determined from Greg Katnik/KSC that the hit occured on tile V070-39015-211 & 212). One photo was the Orbiter on the pad (KSC-392C-1501.05). The other was the Orbiter after rollout (KSC-392C-1677.15).

Image Analysis Tools & Techniques

Digitized
Reg3D

Summary of Analysis of Visual Events
STS-45
04/20/92

Task Number
11.06

Title : Right Wing RCC Damage

Analysts : J. Hartman
Date : 04/16/92

Camera Number :
Frame Number :
GMT :

Requestor : Larry Williams
Phone :
Mail Code :

Description of Analysis

Photograph KSC-392C-1677.15 was digitized as large as possible whithout breaking up into grain of the photograph. This image was placed on STS45:
[STS.LANDING.ROLLOUT]RCC_AREA.PIC

No evidence of a debris hit on the RCC can be determined from this image.

Using Orbiter coordinates a rough determination of the location of RCC #10 was made on KSC-392C-1677.15 with CAD overlay.

Image Analysis Tools & Techniques

Digitize
20 (Zoom)

Summary of Analysis of Visual Events
STS-45
05/06/92

Task Number
11.07

Title : Right Wing RCC Damage

Analysts : J. Hartman
Date : 04/30/92

Camera Number : *
Frame Number :
GMT :

Requestor : Larry Williams
Phone :
Mail Code :

Description of Analysis

*E52, E54, E57, E59

The following cameras for STS45 were re-screened for a possible debris source which may have caused the RCC #10 panel damage and/or then lower nose strike.

E52 - View of the right side of Orbiter, lower 1/3 of stack.
(Frames 0-2333)
E54 - View of the right side of Orbiter, upper 1/3 of stack.
(Frames 0-2700)
E57 - View from the NW side of pad, lower 1/3 of stack.
(Frames 0-2475)
E59 - View from the NW side of pad, upper 1/3 of stack.
(Frames 0-2800)

Results: No debris was able to be found during launch through roll maneuver which may have caused either the RCC #10 damage of the lower right nose strike.

Image Analysis Tools & Techniques

SUMMARY FOR
STS-45
TASK #11

All screening notes for both the launch and landing videos, engineering cameras and tracking cameras for STS-45 were reviewed for possible sources of debris which may have caused damage to the right RCC during STS-45. All close out photography that was sent to SN15 was also reviewed. Landing videos for STS-45 were also re-screened and Cameras E-205 and E-207 were re-reviewed.

No debris was noted on any of the above cameras which may have caused damage to the right wing RCC. The only item that was noted on any of the above media which may have resulted from a debris strike was a "white vapor trail" noted from the rear edge of the right wing at 093:11:18:39.238 prior to landing. This was noted on TV-13.

Two photographs (One was an Ice Debris Team picture taken of the vehicle just prior to launch and the other was a post rollout picture.) were digitized and a CAD was overlaid on each photo in an attempt to determine the location of the RCC strikes and the strike on the lower right nose area. Information from Greg Katnik/KSC stated that the lower right nose strike was on tile V070-39015-211 (Also adjacent tile #212 was hit.) and the RCC damage was on the -Z side of the tenth RCC panel for the upper (forward) part of the wing. It can be see from photograph KSC-392-1625.03 that the debris traveled from forward to aft. This rules out the possibility that the RCC strike caused the lower right nose strike. (There may be some possibility that the lower nose strike may have caused the RCC damage; however, it should be noted that the strike area on tiles #211 and #212 is below the RCC damage area on the Orbiter.) It was determined from the photograph of the Orbiter after landing and the CAD overlay that the strike on the lower right side of the nose is at X 390.58, Y 67.266, Z 299.95 in the Orbiter coordinate system.

In conclusion, no source of the debris has been found for the right wing RCC damage or the lower right nose damage.

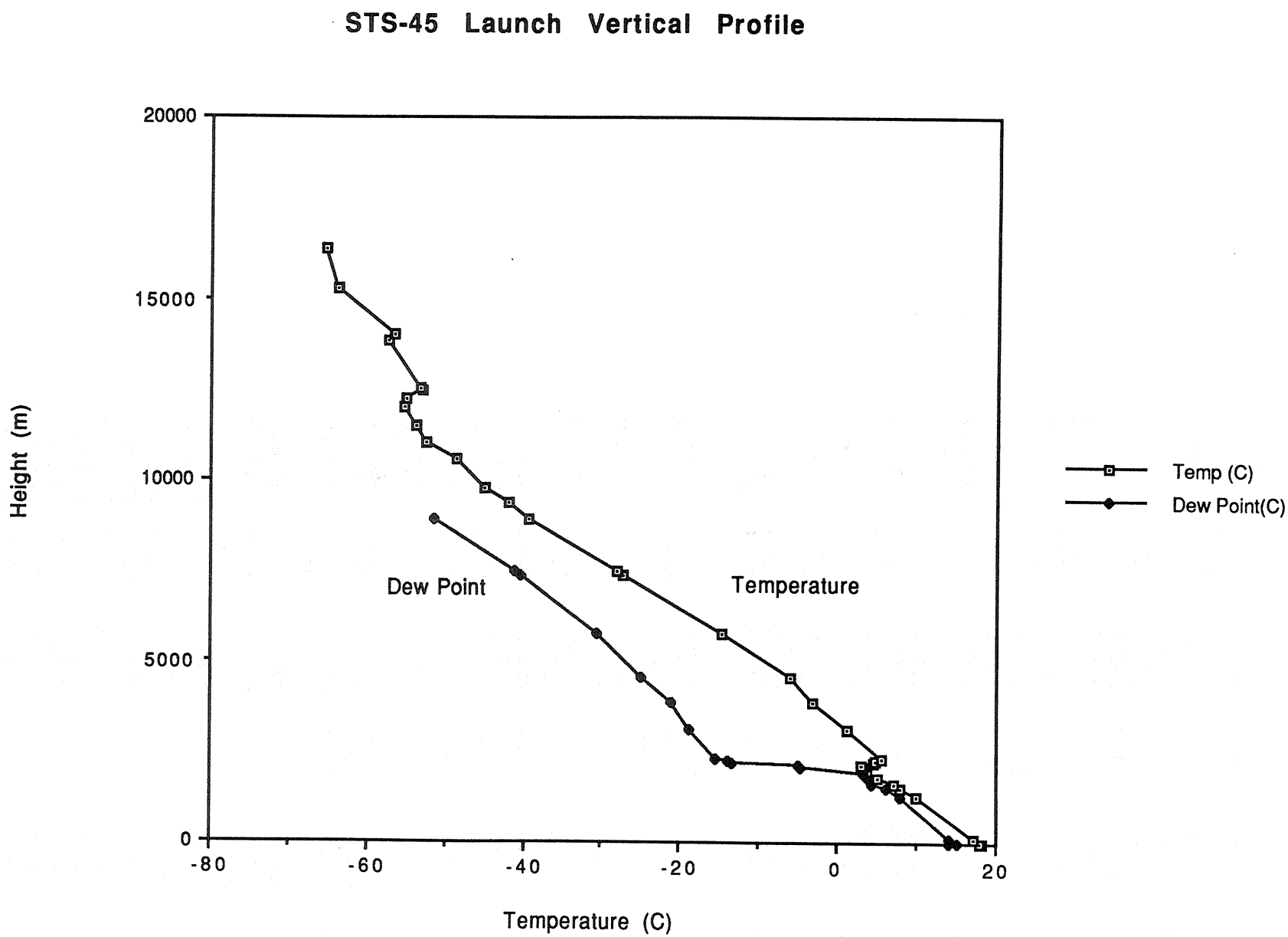
Rawinsonde Data

STATION: 74794 DAY/TIME: 92084 120000 LAT/LONG: 284666 805500

LEVEL	TEMP	DEW PT	DIR	SPEED	HEIGHT
1016.0	18.2	15.0	20.0	5.1	3.0
1014.0	18.0	14.1	18.8	5.7	19.9
1000.0	17.2	14.2	10.0	9.7	139.1
878.0	10.0	7.8	82.3	5.6	1238.2
850.0	8.0	6.1	100.0	4.6	1507.3
841.0	7.2	4.4	91.5	-12147.2	1595.3
822.0	5.2	3.7	73.3	-38097.5	1783.0
809.0	3.8	3.2	60.7	-56088.6	1913.2
795.0	3.4	-4.6	47.0	-75710.4	2055.1
788.0	3.0	-5.0	40.1	-85628.4	2126.9
782.0	4.6	-13.4	34.0	-94214.5	2189.0
778.0	4.9	-14.0	30.0	-99999.0	2230.8
769.0	5.6	-15.4	17.8	-88922.3	2325.8
700.0	1.2	-18.8	280.0	12.3	3088.2
636.0	-3.1	-21.1	278.5	16.3	3853.5
582.0	-5.9	-24.9	277.2	20.0	4552.3
500.0	-14.7	-30.7	275.0	26.2	5722.5
400.0	-27.3	-40.3	275.0	37.0	7371.6
394.0	-28.1	-41.1	274.7	37.6	7480.3
322.0	-39.5	-51.5	271.2	44.8	8895.7
300.0	-41.9		270.0	47.3	9377.7
284.0	-45.1		273.0	47.1	9746.5
250.0	-48.7		280.0	46.8	10591.8
233.0	-52.5		280.0	49.1	11051.1
217.0	-53.7		280.0	51.4	11509.8
200.0	-55.3		280.0	54.0	12032.4
194.0	-55.1		280.0	53.3	12226.9
193.0	-55.1		280.0	53.2	12259.9
187.0	-53.1		280.0	52.4	12462.6
185.0	-53.3		280.0	52.2	12531.9
150.0	-57.3		280.0	47.3	13870.6
147.0	-56.7		279.2	46.8	13998.6
120.0	-63.9		271.7	42.1	15264.3
100.0	-65.3		265.0	38.0	16378.4

PARCEL: DEW PT.= 285.5 POT. TEMP= 294.8 EQUIV.POT.TEMP= 321.5 MIX= 9.9
PRECIP.WATER=21.16 CONV.TEMP= 21.0 FCST MAX= 23.0 LIFTED INDEX= .7
TOTALS= 43.5 EQUIL.PRES.= 356.5 K-INDEX= 8.8 SWEAT INDEX=142.0

	Pressure(mb)	Temp (C)	Dew Point(C)	Wind Direction	Wind SPD(kts)	Height (m)
1	1016.000	18.200	15.000	20.000	5.100	0.000
2	1014.000	18.000	14.100	18.800	5.700	19.900
3	1000.000	17.200	14.200	10.000	9.700	139.100
4	878.000	10.000	7.800	82.300	5.600	1238.200
5	850.000	8.000	6.100	100.000	4.600	1507.300
6	841.000	7.200	4.400	91.500		1595.300
7	822.000	5.200	3.700	73.300		1783.000
8	809.000	3.800	3.200	60.700		1913.200
9	795.000	3.400	-4.600	47.000		2055.100
10	788.000	3.000	-5.000	40.100		2126.900
11	782.000	4.600	-13.400	34.000		2189.000
12	778.000	4.900	-14.000	30.000		2230.800
13	769.000	5.600	-15.400	17.800		2325.800
14	700.000	1.200	-18.800	280.000	12.300	3088.200
15	636.000	-3.100	-21.100	278.500	16.300	3853.500
16	582.000	-5.900	-24.900	277.200	20.000	4552.300
17	500.000	-14.700	-30.700	275.000	26.200	5722.500
18	400.000	-27.300	-40.300	275.000	37.000	7371.600
19	394.000	-28.100	-41.100	274.700	37.600	7480.300
20	322.000	-39.500	-51.500	271.200	44.800	8895.700
21	300.000	-41.900		270.000	47.300	9377.700
22	284.000	-45.100		273.000	47.100	9746.500
23	250.000	-48.700		280.000	46.800	10591.800
24	233.000	-52.500		280.000	49.100	11051.100
25	217.000	-53.700		280.000	51.400	11509.800
26	200.000	-55.300		280.000	54.000	12032.400
27	194.000	-55.100		280.000	53.300	12226.900
28	193.000	-55.100		280.000	53.200	12259.900
29	187.000	-53.100		280.000	52.400	12462.600
30	185.000	-53.300		280.000	52.200	12531.900
31	150.000	-57.300		280.000	47.300	13870.600
32	147.000	-56.700		279.200	46.800	13998.600
33	120.000	-63.900		271.700	42.100	15264.300
34	100.000	-65.300		265.000	38.000	16378.400


STS-45 Launch Vertical Profile
20000
15000
10000
5000
0
Height (m)
-80
-60
-40
-20
0
20
Temperature (C)
Dew Point
Temperature
Temp (C)
Dew Point(C)

FILE GID OPEN ON WINDOW 0

.UL LIST 74794 09:00:00 DAY=92093

STATION: 74794 DAY/TIME: 92093 90000 LAT/LONG: 284666 805500

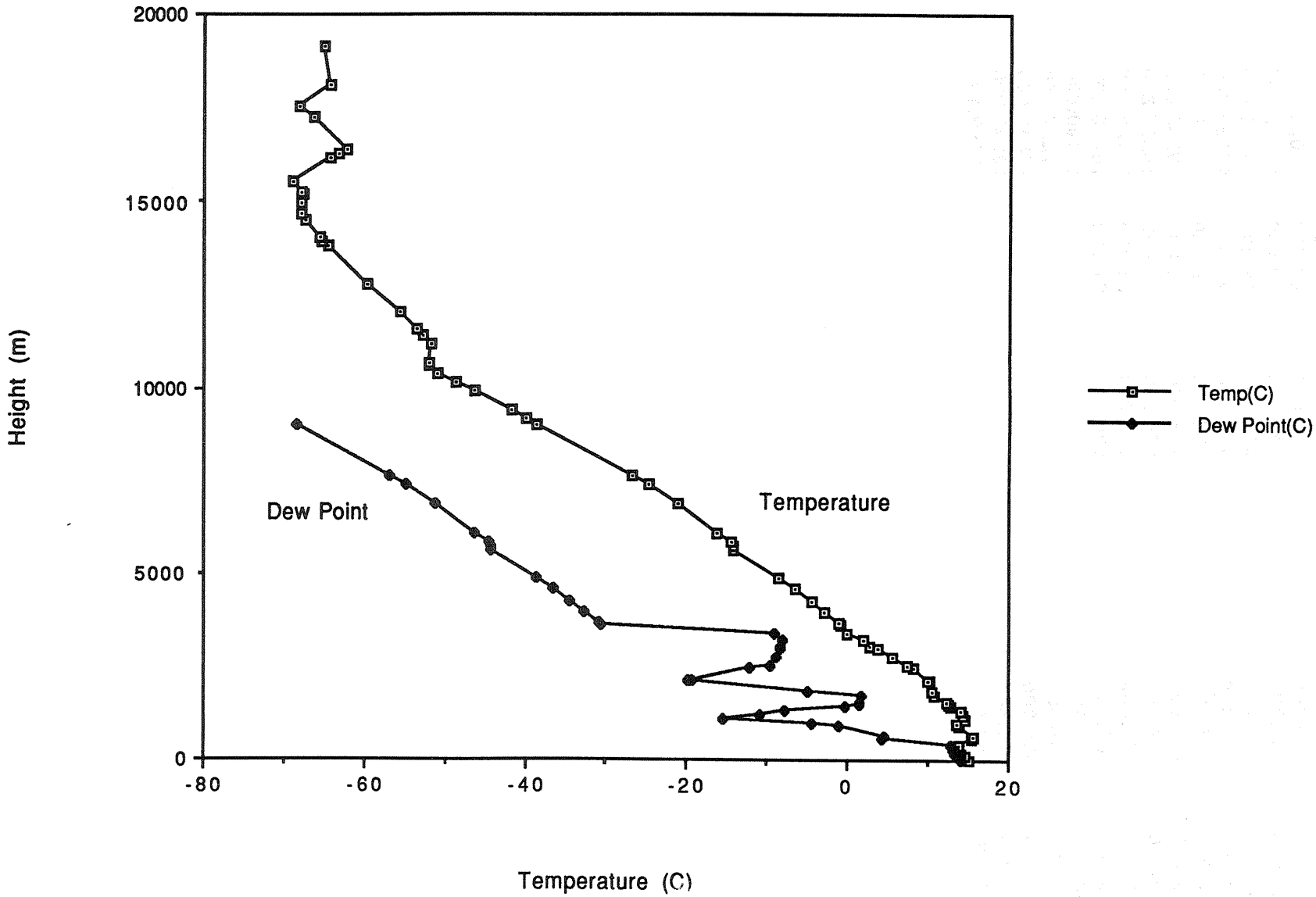
LEVEL	TEMP	DEW PT	DIR	SPEED	HEIGHT
1010.0	15.0	14.1	310.0	4.6	3.0
1000.0	14.6	13.8	300.0	8.2	87.5
987.0	14.0	13.3	302.6	11.4	198.3
980.0	13.8	13.2	304.0	13.1	258.5
974.7	13.8	13.0	305.0	14.4	304.0
965.0	13.8	12.7	306.4	14.0	389.0
942.0	15.4	4.4	309.7	12.9	593.3
940.3	15.5	4.5	310.0	12.8	609.0
937.0	15.6	4.6	309.5	12.5	638.5
907.0	13.9	-1.0	305.0	9.7	914.0
906.0	13.8	-1.2	304.0	9.8	923.1
899.0	13.6	-4.4	296.5	10.6	988.4
886.0	14.6	-15.4	282.4	12.0	1111.2
874.7	14.4	-10.9	270.0	13.3	1219.0
867.0	14.2	-7.8	270.0	13.8	1294.0
850.0	12.8	-.2	270.0	14.9	1460.7
847.0	12.6	1.6	270.0	15.1	1490.4
843.6	12.3	1.6	270.0	15.4	1524.0
826.0	10.8	1.8	270.0	16.6	1700.6
813.4	10.6	-4.9	270.0	17.4	1829.0
786.0	10.2	-19.8	270.0	18.9	2113.9
784.1	10.1	-19.3	270.0	19.0	2134.0
755.7	8.1	-12.1	265.0	20.5	2439.0
746.0	7.4	-9.6	265.0	20.9	2545.9
728.2	5.7	-8.9	265.0	21.6	2743.0
709.0	3.8	-8.2	268.4	22.3	2962.0
700.0	2.8	-8.2	270.0	22.6	3065.7
690.0	2.0	-8.0	272.0	22.7	3182.1
672.0	.0	-9.0	275.6	22.9	3394.8
654.0	-.7	-30.7	279.2	23.1	3612.0
650.2	-1.0	-31.0	280.0	23.1	3658.0
625.6	-2.8	-32.8	280.0	23.6	3963.0
601.9	-4.5	-34.5	280.0	25.2	4268.0
577.0	-6.5	-36.5	280.0	26.0	4601.6
556.7	-8.6	-38.6	280.0	26.7	4878.0
506.0	-14.3	-44.3	275.5	29.5	5612.6
500.0	-14.3	-44.3	275.0	29.8	5703.1
492.0	-14.5	-44.5	275.0	30.4	5825.4
474.5	-16.2	-46.2	275.0	31.8	6097.0
426.0	-21.1	-51.1	271.8	34.1	6903.2
400.0	-24.7	-54.7	270.0	35.4	7365.0
385.8	-26.9	-56.9	270.0	35.4	7621.0
318.0	-38.5	-68.5	270.0	39.6	8988.7
310.8	-39.8		270.0	40.1	9146.0
300.0	-41.7		270.0	42.1	9386.6
278.0	-46.3		270.0	43.2	9898.0
268.0	-48.7		270.0	43.7	10140.2
259.0	-50.9		270.0	44.2	10363.7
250.0	-51.9		270.0	44.7	10593.5
247.1	-51.9		275.0	45.2	10670.0
229.0	-51.7		275.0	48.0	11162.6
221.0	-52.8		275.0	49.3	11391.2
214.4	-53.6		275.0	48.8	11585.0
200.0	-55.7		275.0	47.8	12033.2
176.8	-59.6		275.0	49.3	12804.0
150.0	-64.7		270.0	47.8	13828.3
148.0	-65.3		270.0	47.8	13910.2
145.2	-65.7		270.0	47.8	14024.0
134.0	-67.3		273.6	48.2	14512.4

```
    130.0   -67.9            275.0    47.8  14939.0
    124.8   -67.8            275.0    47.8  14939.0
    120.0   -67.7            275.0    46.5  15176.6
    118.7   -67.9            275.0    46.2  15243.0
    113.0   -68.9            276.6    41.4  15537.3
    102.0   -64.2            280.0    31.3  16158.0
    100.0   -63.3            280.0    27.2  16278.8
     98.2   -62.3                          16390.8
     85.5   -66.5                          17237.9
     81.3   -68.3                          17541.5
     74.3   -64.3                          18087.2
     62.3   -65.1                          19163.1
 PARCEL: DEW PT.= 281.9 POT. TEMP= 291.1 EQUIV.POT.TEMP= 312.1 MIX=  7.8
 PRECIP.WATER=15.24 CONV.TEMP= 33.1 FCST MAX=    .0 LIFTED INDEX=  6.6
 TOTALS= 41.2 EQUIL.PRES.= 577.2 K-INDEX= 15.9 SWEAT INDEX=115.9
UL      --  DONE
TFILE CLOSE
```

	Pressure(mb)	Temp(C)	Dew Point(C)	Wind Direction	Wind SPD(kts)	Height(m)
1	1010.000	15.000	14.100	310.000	4.600	3.000
2	1000.000	14.600	13.800	300.000	8.200	87.500
3	987.000	14.000	13.300	302.600	11.400	198.300
4	980.000	13.800	13.200	304.000	13.100	258.500
5	974.700	13.800	13.000	305.000	14.400	304.000
6	965.000	13.800	12.700	306.400	14.000	389.000
7	942.000	15.400	4.400	309.700	12.900	593.300
8	940.300	15.500	4.500	310.000	12.800	609.000
9	937.000	15.600	4.600	309.500	12.500	638.500
10	907.000	13.900	-1.000	305.000	9.700	914.000
11	906.000	13.800	-1.200	304.000	9.800	923.100
12	899.000	13.600	-4.400	296.500	10.600	988.400
13	886.000	14.600	-15.400	282.400	12.000	1111.200
14	874.700	14.400	-10.900	270.000	13.300	1219.000
15	867.000	14.200	-7.800	270.000	13.800	1294.000
16	850.000	12.800	-0.200	270.000	14.900	1460.700
17	847.000	12.600	1.600	270.000	15.100	1490.400
18	843.600	12.300	1.600	270.000	15.400	1524.000
19	826.000	10.800	1.800	270.000	16.600	1700.600
20	813.400	10.600	-4.900	270.000	17.400	1829.000
21	786.000	10.200	-19.800	270.000	18.900	2113.900
22	784.100	10.100	-19.300	270.000	19.000	2134.000
23	755.700	8.100	-12.100	265.000	20.500	2439.000
24	746.000	7.400	-9.600	265.000	20.900	2545.900
25	728.200	5.700	-8.900	265.000	21.600	2743.000
26	709.000	3.800	-8.200	268.400	22.300	2962.000
27	700.000	2.800	-8.200	270.000	22.600	3065.700
28	690.000	2.000	-8.000	272.000	22.700	3182.100
29	672.000	0.000	-9.000	275.600	22.900	3394.800
30	654.000	-0.700	-30.700	279.200	23.100	3612.000
31	650.200	-1.000	-31.000	280.000	23.100	3658.000
32	625.600	-2.800	-32.800	280.000	23.600	3963.000
33	601.900	-4.500	-34.500	280.000	25.200	4268.000
34	577.000	-6.500	-36.500	280.000	26.000	4601.600
35	556.700	-8.600	-38.600	280.000	26.700	4878.000
36	506.000	-14.300	-44.300	275.500	29.500	5612.600
37	500.000	-14.300	-44.300	275.000	29.800	5703.100
38	492.000	-14.500	-44.500	275.000	30.400	5825.400
39	474.500	-16.200	-46.200	275.000	31.800	6097.000
40	426.000	-21.100	-51.100	271.800	34.100	6903.200
41	400.000	-24.700	-54.700	270.000	35.400	7365.000
42	385.800	-26.900	-56.900	270.000	35.400	7621.000
43	318.000	-38.500	-68.500	270.000	39.600	8988.700
44	310.800	-39.800		270.000	40.100	9146.000
45	300.000	-41.700		270.000	42.100	9386.600
46	278.000	-46.300		270.000	43.200	9898.000
47	268.000	-48.700		270.000	43.700	10140.200
48	259.000	-50.900		270.000	44.200	10363.700
49	250.000	-51.900		270.000	44.700	10593.500
50	247.100	-51.900		275.000	45.200	10670.000
51	229.000	-51.700		275.000	48.000	11162.600
52	221.000	-52.800		275.000	49.300	11391.200
53	214.400	-53.600		275.000	48.800	11585.000
54	200.000	-55.700		275.000	47.800	12033.200
55	176.800	-59.600		275.000	49.300	12804.000
56	150.000	-64.700		270.000	47.800	13828.300

	Pressure(mb)	Temp(C)	Dew Point(C)	Wind Direction	Wind SPD(kts)	Height(m)
7	148.000	-65.300		270.000	47.800	13910.200
3	145.200	-65.700		270.000	47.800	14024.000
59	134.000	-67.300		273.600	48.200	14512.400
60	130.000	-67.900		275.000	48.300	14695.000
61	124.800	-67.800		275.000	47.800	14939.000
62	120.000	-67.700		275.000	46.500	15176.600
63	118.700	-67.900		275.000	46.200	15243.000
64	113.000	-68.900		276.600	41.400	15537.300
65	102.000	-64.200		280.000	31.300	16158.000
66	100.000	-63.300		280.000	27.200	16278.800
67	98.200	-62.300				16390.800
68	85.500	-66.500				17237.900
69	81.300	-68.300				17541.500
70	74.300	-64.300				18087.200
71	62.300	-65.100				19163.100

STS-45 Landing Vertical Sounding



STS-45 Day of Launch First Stage Trajectory Data

NOMINAL DISPLAY DATA FOR STS-45 CYCLE FLT
AERODYNAMIC SUMMARY

TIME (SEC)	MACH (ND)	ALPHA (DEG)	BETA (DEG)	BANK (DEG)	DYN PRESS (PSF)	QALPHA (PSF-DEG)	QBETA (PSF-DEG)	VE (FPS)	GAME (DEG)	AZE (DEG)	VI (FPS)	GAMI (DEG)	AZI (DEG)	SURFACE RANGE (NM)
.00	.00	90.00	-50.18	.12	.0	0.	0.	0.	.366	63.39	1341.	.000	90.00	.0
.96	.01	7.69	-.91	-6.51	.1	1.	0.	11.	82.803	.63	1341.	.475	89.94	.0
1.92	.03	7.37	-.34	-2.58	.9	7.	0.	28.	82.414	.19	1341.	1.188	89.84	.0
2.88	.04	7.32	-.32	-2.48	2.4	18.	-1.	45.	82.242	.03	1341.	1.915	89.74	.0
3.84	.06	7.16	-.37	-3.04	4.6	33.	-2.	63.	82.372	-.18	1342.	2.664	89.64	.0
4.80	.07	6.93	-.45	-3.76	7.7	53.	-3.	81.	82.562	-.33	1343.	3.441	89.55	.0
5.76	.09	6.68	-.53	-4.57	11.7	78.	-6.	100.	82.758	-.45	1344.	4.250	89.46	.0
6.72	.11	6.43	-.61	-5.38	16.8	108.	-10.	120.	82.951	-.49	1346.	5.088	89.37	.0
7.68	.13	6.19	-.70	-6.27	22.8	141.	-16.	141.	83.115	-.62	1348.	5.947	89.28	.0
8.64	.14	6.20	-1.10	-6.25	30.0	186.	-33.	162.	83.230	-1.57	1350.	6.824	89.19	.0
9.60	.16	6.64	-1.70	.73	38.2	253.	-65.	183.	83.439	-.86	1353.	7.714	89.11	.0
10.56	.18	7.55	-2.16	17.75	47.4	358.	-102.	204.	83.809	3.92	1358.	8.605	89.06	.0
11.52	.20	8.50	-2.06	46.57	57.6	490.	-119.	226.	84.053	15.43	1366.	9.479	89.04	.0
12.48	.22	8.89	-1.65	80.91	68.9	612.	-114.	248.	83.647	30.44	1377.	10.319	89.00	.0
13.44	.24	8.73	-1.41	111.22	81.1	709.	-114.	271.	82.452	42.21	1391.	11.122	88.89	.0
14.40	.26	8.30	-1.38	134.05	94.5	785.	-130.	294.	80.742	48.74	1407.	11.889	88.70	.0
15.36	.28	7.76	-1.56	151.53	109.1	846.	-170.	317.	78.798	51.37	1424.	12.622	88.41	.0
16.32	.30	7.22	-1.89	166.13	124.8	901.	-236.	341.	76.797	51.63	1442.	13.329	88.02	.1
17.28	.33	6.76	-2.40	179.25	141.8	959.	-340.	366.	74.844	50.46	1459.	14.016	87.53	.1
18.24	.35	6.21	-2.90	-170.04	160.1	994.	-465.	392.	73.004	48.26	1477.	14.695	86.94	.1
19.20	.37	5.07	-3.15	-165.30	179.7	911.	-566.	418.	71.388	45.78	1493.	15.379	86.30	.1
20.16	.40	3.43	-2.96	-166.39	200.7	689.	-594.	445.	70.023	43.62	1509.	16.075	85.65	.1
21.12	.42	1.69	-2.26	-171.01	223.0	376.	-503.	472.	68.860	42.13	1525.	16.771	85.04	.1
22.08	.44	-.09	-1.29	-175.73	245.6	-22.	-316.	499.	67.836	41.18	1543.	17.433	84.48	.2
23.04	.47	-1.67	-.03	-179.95	268.3	-447.	-9.	526.	67.028	40.67	1560.	18.072	83.98	.2
24.00	.49	-2.83	1.17	176.44	290.7	-823.	341.	552.	66.397	40.60	1577.	18.687	83.56	.2
24.96	.52	-3.62	1.80	174.53	312.8	-1133.	564.	577.	65.919	40.78	1595.	19.283	83.20	.3
25.92	.54	-4.03	1.79	174.35	334.7	-1349.	599.	602.	65.532	40.92	1612.	19.863	82.86	.3
26.88	.56	-4.05	1.56	174.84	356.3	-1444.	558.	626.	65.174	41.00	1629.	20.423	82.53	.4
27.84	.58	-3.97	1.27	175.46	377.4	-1497.	479.	651.	64.795	41.00	1646.	20.956	82.18	.4
28.80	.60	-4.03	1.06	175.90	397.5	-1603.	421.	674.	64.404	40.95	1663.	21.450	81.83	.4
29.76	.62	-4.09	.92	176.10	415.8	-1701.	384.	697.	63.992	40.85	1679.	21.892	81.47	.5
30.72	.64	-4.16	.87	176.15	432.7	-1799.	375.	718.	63.562	40.75	1695.	22.290	81.12	.5
31.68	.66	-4.27	.85	176.13	449.2	-1920.	384.	739.	63.139	40.63	1712.	22.671	80.76	.6
32.64	.68	-4.44	.88	176.07	465.4	-2068.	408.	761.	62.748	40.52	1728.	23.042	80.41	.6
33.60	.71	-4.49	.89	176.02	481.0	-2158.	426.	782.	62.374	40.40	1744.	23.401	80.07	.7
34.56	.73	-4.44	.89	175.96	496.2	-2201.	442.	802.	62.008	40.28	1760.	23.746	79.72	.8
35.52	.75	-4.31	.87	175.93	510.8	-2202.	444.	823.	61.632	40.16	1776.	24.074	79.38	.8
36.48	.77	-4.20	.85	175.93	524.7	-2203.	444.	844.	61.253	40.03	1792.	24.386	79.02	.9
37.44	.79	-4.09	.80	176.01	537.8	-2201.	429.	865.	60.865	39.89	1809.	24.682	78.66	.9
38.40	.81	-4.07	.75	176.15	550.3	-2241.	415.	885.	60.476	39.74	1825.	24.965	78.30	1.0
39.36	.83	-4.12	.69	176.31	562.1	-2315.	389.	906.	60.093	39.59	1842.	25.237	77.94	1.1

NOMINAL DISPLAY DATA FOR STS-45 CYCLE FLT
AERODYNAMIC SUMMARY

TIME (SEC)	MACH (ND)	ALPHA (DEG)	BETA (DEG)	BANK (DEG)	DYN PRESS (PSF)	QALPHA (PSF-DEG)	QBETA (PSF-DEG)	VE (FPS)	GAME (DEG)	AZE (DEG)	VI (FPS)	GAMI (DEG)	AZI (DEG)	SURFACE RANGE (NM)
40.32	.85	-4.19	.64	176.47	573.1	-2400.	368.	926.	59.729	39.43	1858.	25.501	77.58	1.2
41.28	.87	-4.19	.60	176.61	583.2	-2444.	348.	947.	59.374	39.26	1875.	25.756	77.22	1.2
42.24	.89	-4.22	.60	176.76	592.6	-2501.	356.	967.	59.027	39.09	1891.	26.002	76.87	1.3
43.20	.91	-4.23	.60	176.81	601.2	-2541.	362.	987.	58.688	38.93	1908.	26.240	76.51	1.4
44.16	.93	-4.28	.63	176.81	609.0	-2608.	381.	1008.	58.360	38.77	1924.	26.471	76.16	1.5
45.12	.95	-4.35	.65	176.77	615.9	-2678.	401.	1028.	58.040	38.61	1941.	26.693	75.81	1.6
46.08	.97	-4.45	.70	176.71	622.0	-2768.	433.	1048.	57.736	38.46	1957.	26.911	75.47	1.6
47.04	.99	-4.52	.72	176.65	627.2	-2832.	452.	1068.	57.446	38.30	1974.	27.124	75.13	1.7
48.00	1.02	-4.58	.74	176.57	631.3	-2890.	468.	1087.	57.164	38.16	1990.	27.326	74.80	1.8
48.96	1.04	-4.62	.74	176.46	634.3	-2933.	470.	1106.	56.890	38.01	2006.	27.517	74.47	1.9
49.92	1.06	-4.67	.75	176.43	636.3	-2974.	480.	1125.	56.624	37.86	2022.	27.700	74.15	2.0
50.88	1.08	-4.72	.77	176.47	637.7	-3012.	490.	1144.	56.363	37.71	2037.	27.877	73.84	2.1
51.84	1.10	-4.76	.79	176.61	638.5	-3040.	504.	1163.	56.112	37.58	2053.	28.053	73.52	2.2
52.80	1.12	-4.76	.80	176.75	639.0	-3039.	512.	1183.	55.861	37.45	2069.	28.227	73.20	2.3
53.76	1.15	-4.71	.80	176.79	639.3	-3014.	514.	1202.	55.605	37.30	2086.	28.398	72.88	2.4
54.72	1.17	-4.71	.83	176.83	639.4	-3010.	530.	1223.	55.344	37.16	2103.	28.568	72.54	2.5
55.68	1.20	-4.73	.87	176.86	639.5	-3027.	559.	1244.	55.086	37.01	2121.	28.742	72.20	2.6
56.64	1.22	-4.80	.93	176.88	639.3	-3069.	597.	1266.	54.838	36.87	2139.	28.921	71.86	2.7
57.60	1.25	-4.84	.98	176.79	638.8	-3093.	626.	1288.	54.600	36.73	2158.	29.106	71.51	2.9
58.56	1.28	-4.82	1.00	176.71	637.9	-3073.	640.	1311.	54.371	36.59	2178.	29.297	71.16	3.0
59.52	1.31	-4.75	.99	176.66	636.7	-3023.	632.	1335.	54.142	36.44	2198.	29.490	70.80	3.1
60.48	1.34	-4.72	.98	176.71	634.9	-2995.	624.	1360.	53.915	36.29	2219.	29.685	70.43	3.2
61.44	1.37	-4.73	.96	176.80	632.4	-2992.	605.	1385.	53.693	36.13	2241.	29.884	70.06	3.4
62.40	1.40	-4.77	.94	176.92	629.3	-3005.	592.	1412.	53.485	35.98	2263.	30.093	69.68	3.5
63.36	1.43	-4.79	.95	177.04	626.3	-2998.	594.	1440.	53.304	35.82	2287.	30.330	69.30	3.6
64.32	1.47	-4.80	.93	177.24	623.8	-2995.	581.	1471.	53.153	35.67	2312.	30.596	68.90	3.8
65.28	1.51	-4.76	.91	177.51	621.6	-2958.	565.	1503.	53.028	35.51	2339.	30.888	68.50	3.9
66.24	1.55	-4.67	.94	177.70	619.2	-2889.	584.	1538.	52.918	35.37	2368.	31.197	68.09	4.0
67.20	1.59	-4.54	.91	177.89	616.6	-2801.	561.	1573.	52.806	35.23	2398.	31.503	67.67	4.2
68.16	1.63	-4.23	.88	177.98	613.6	-2596.	537.	1610.	52.684	35.10	2429.	31.801	67.25	4.3
69.12	1.68	-3.79	.87	177.96	609.8	-2308.	532.	1647.	52.532	34.97	2461.	32.080	66.82	4.5
70.08	1.73	-3.38	.84	177.97	605.7	-2045.	508.	1685.	52.352	34.85	2495.	32.338	66.37	4.7
71.04	1.78	-2.96	.85	177.91	600.6	-1778.	511.	1725.	52.142	34.74	2530.	32.574	65.92	4.8
72.00	1.83	-2.61	.88	177.78	594.6	-1550.	522.	1766.	51.908	34.64	2566.	32.788	65.45	5.0
72.96	1.88	-2.28	.91	177.62	587.5	-1339.	537.	1807.	51.649	34.56	2603.	32.981	64.99	5.2
73.92	1.93	-1.92	.95	177.44	579.1	-1114.	552.	1850.	51.369	34.49	2642.	33.152	64.52	5.3
74.88	1.98	-1.54	.96	177.29	569.3	-874.	547.	1894.	51.061	34.43	2683.	33.298	64.04	5.5
75.84	2.04	-1.15	.95	177.14	558.2	-639.	530.	1938.	50.729	34.39	2725.	33.419	63.56	5.7
76.80	2.09	-.78	.94	177.05	546.2	-424.	513.	1984.	50.374	34.36	2768.	33.516	63.08	5.9
77.76	2.14	-.36	.92	177.05	532.6	-192.	492.	2031.	49.996	34.35	2812.	33.587	62.61	6.1
78.72	2.19	.09	.91	177.10	516.9	45.	469.	2079.	49.593	34.35	2858.	33.628	62.13	6.3
79.68	2.24	.53	.90	177.17	499.5	265.	448.	2126.	49.166	34.35	2904.	33.640	61.66	6.5

NOMINAL DISPLAY DATA FOR STS-45 CYCLE FLT
AERODYNAMIC SUMMARY

TIME (SEC)	MACH (ND)	ALPHA (DEG)	BETA (DEG)	BANK (DEG)	DYN PRESS (PSF)	QALPHA (PSF-DEG)	QBETA (PSF-DEG)	VE (FPS)	GAME (DEG)	AZE (DEG)	VI (FPS)	GAMI (DEG)	AZI (DEG)	SURFACE RANGE (NM)
80.64	2.29	1.00	.92	177.21	481.2	482.	442.	2175.	48.721	34.38	2951.	33.623	61.20	6.8
81.60	2.33	1.50	.97	177.25	462.8	696.	450.	2224.	48.254	34.41	3000.	33.578	60.74	7.0
82.56	2.38	1.84	1.01	177.26	444.4	817.	451.	2273.	47.768	34.45	3049.	33.506	60.29	7.2
83.52	2.43	2.00	1.06	177.24	426.0	853.	452.	2323.	47.279	34.50	3098.	33.419	59.86	7.5
84.48	2.47	2.13	1.09	177.26	407.7	867.	443.	2372.	46.790	34.56	3148.	33.317	59.43	7.7
85.44	2.52	2.22	1.12	177.30	389.7	864.	436.	2423.	46.303	34.61	3199.	33.205	59.02	8.0
86.40	2.56	2.19	1.14	177.37	372.5	816.	426.	2473.	45.818	34.67	3250.	33.083	58.62	8.2
87.36	2.61	2.06	1.16	177.42	355.9	732.	413.	2524.	45.346	34.73	3301.	32.957	58.23	8.5
88.32	2.66	1.94	1.19	177.46	339.6	660.	404.	2575.	44.887	34.79	3352.	32.829	57.86	8.8
89.28	2.70	1.89	1.23	177.47	323.3	611.	398.	2625.	44.437	34.85	3403.	32.696	57.50	9.1
90.24	2.75	1.88	1.28	177.48	307.6	579.	393.	2676.	43.995	34.91	3454.	32.560	57.16	9.4
91.20	2.79	1.93	1.31	177.49	292.3	564.	384.	2728.	43.559	34.96	3506.	32.419	56.82	9.7
92.16	2.84	2.00	1.33	177.51	277.5	554.	369.	2780.	43.125	35.02	3559.	32.273	56.48	10.0
93.12	2.89	2.03	1.33	177.57	263.1	535.	349.	2832.	42.695	35.08	3612.	32.123	56.16	10.3
94.08	2.93	2.04	1.30	177.67	249.3	508.	323.	2885.	42.271	35.13	3665.	31.970	55.84	10.7
95.04	2.98	2.07	1.27	177.81	235.7	487.	299.	2938.	41.853	35.18	3719.	31.813	55.52	11.0
96.00	3.02	2.17	1.26	177.91	221.8	481.	279.	2992.	41.440	35.22	3773.	31.653	55.22	11.3
96.96	3.06	2.19	1.29	177.99	208.9	458.	270.	3045.	41.034	35.26	3827.	31.490	54.92	11.7
97.92	3.10	2.17	1.34	178.03	197.0	427.	264.	3098.	40.635	35.31	3881.	31.325	54.64	12.1
98.88	3.15	2.13	1.36	178.06	185.4	395.	253.	3152.	40.243	35.35	3935.	31.160	54.36	12.4
99.84	3.19	2.11	1.37	178.10	174.3	368.	239.	3205.	39.857	35.38	3989.	30.993	54.08	12.8
100.80	3.23	2.10	1.38	178.15	163.5	343.	226.	3259.	39.477	35.42	4044.	30.825	53.82	13.2
101.76	3.26	2.08	1.39	178.19	153.2	319.	213.	3313.	39.103	35.45	4098.	30.655	53.56	13.6
102.72	3.30	2.07	1.40	178.24	143.6	297.	201.	3367.	38.735	35.48	4153.	30.484	53.30	14.0
103.68	3.34	2.03	1.39	178.33	134.7	274.	187.	3420.	38.372	35.51	4207.	30.312	53.06	14.4
104.64	3.38	2.01	1.35	178.45	126.3	253.	171.	3474.	38.015	35.54	4261.	30.138	52.82	14.9
105.60	3.42	1.98	1.29	178.59	118.3	235.	152.	3527.	37.663	35.56	4314.	29.963	52.59	15.3
106.56	3.46	1.97	1.21	178.74	110.7	218.	134.	3579.	37.316	35.58	4368.	29.787	52.36	15.7
107.52	3.50	1.96	1.12	178.88	103.6	203.	116.	3632.	36.973	35.60	4421.	29.610	52.14	16.2
108.48	3.54	1.97	1.02	179.05	96.9	190.	99.	3685.	36.634	35.62	4474.	29.432	51.92	16.6
109.44	3.58	1.97	.93	179.22	90.6	179.	84.	3738.	36.299	35.63	4528.	29.254	51.70	17.1
110.40	3.62	1.98	.87	179.34	84.8	168.	74.	3790.	35.969	35.64	4580.	29.074	51.49	17.6
111.36	3.65	1.96	.88	179.42	79.2	155.	70.	3839.	35.644	35.65	4631.	28.891	51.30	18.1
112.32	3.68	1.94	.92	179.43	73.8	143.	68.	3886.	35.327	35.66	4678.	28.707	51.11	18.6
113.28	3.71	2.04	.95	179.40	68.6	140.	65.	3928.	35.018	35.67	4721.	28.518	50.95	19.1
114.24	3.73	2.20	.98	179.36	63.5	140.	62.	3963.	34.715	35.68	4757.	28.323	50.81	19.6
115.20	3.74	2.38	1.01	179.36	58.6	139.	59.	3992.	34.418	35.69	4787.	28.121	50.69	20.1
116.16	3.75	2.53	1.06	179.41	54.1	137.	57.	4016.	34.125	35.70	4812.	27.914	50.59	20.6
117.12	3.76	2.72	1.09	179.45	49.9	135.	54.	4037.	33.836	35.71	4835.	27.706	50.50	21.1
118.08	3.77	2.97	1.12	179.50	45.9	137.	51.	4055.	33.548	35.72	4854.	27.493	50.42	21.7
119.04	3.77	3.14	1.15	179.55	42.3	133.	49.	4071.	33.261	35.72	4872.	27.278	50.34	22.2
120.00	3.77	3.11	1.19	179.59	39.0	121.	46.	4085.	32.975	35.73	4887.	27.060	50.27	22.7

NOMINAL DISPLAY DATA FOR STS-45 CYCLE FLT
AERODYNAMIC SUMMARY

TIME (SEC)	MACH (ND)	ALPHA (DEG)	BETA (DEG)	BANK (DEG)	DYN PRESS (PSF)	QALPHA (PSF-DEG)	QBETA (PSF-DEG)	VE (FPS)	GAME (DEG)	AZE (DEG)	VI (FPS)	GAMI (DEG)	AZI (DEG)	SURFACE RANGE (NM)
120.96	3.78	2.91	1.23	179.63	35.9	104.	44.	4097.	32.694	35.74	4901.	26.844	50.21	23.3
121.92	3.78	2.61	1.27	179.66	33.1	87.	42.	4108.	32.417	35.75	4914.	26.629	50.15	23.8
122.88	3.78	2.30	1.32	179.68	30.6	70.	40.	4118.	32.143	35.76	4925.	26.415	50.10	24.4
123.84	3.79	1.97	1.37	179.69	28.3	56.	39.	4127.	31.874	35.77	4935.	26.203	50.05	24.9
124.80	3.79	1.66	1.42	179.73	26.1	43.	37.	4135.	31.607	35.78	4945.	25.992	50.00	25.5
125.48	3.79	1.45	1.45	179.72	24.7	36.	36.	4141.	31.419	35.78	4952.	25.843	49.97	25.8
SRB SEP AT 125.48 SEC														
125.48	3.79	1.45	1.45	179.72	24.7	36.	36.	4141.	31.419	35.78	4952.	25.843	49.97	25.8
126.08	3.80	1.83	1.48	179.69	23.6	43.	35.	4149.	31.261	35.79	4961.	25.722	49.93	26.2
127.04	3.80	1.68	1.61	179.98	21.9	37.	35.	4162.	30.994	35.80	4975.	25.516	49.87	26.7
128.00	3.82	1.21	1.72	-179.75	20.3	24.	35.	4175.	30.734	35.81	4989.	25.316	49.82	27.3
128.96	3.83	.82	1.79	-179.59	18.9	16.	34.	4188.	30.477	35.82	5004.	25.118	49.76	27.9
129.92	3.84	.39	1.83	-179.52	17.6	7.	32.	4201.	30.225	35.84	5019.	24.925	49.71	28.4
130.88	3.85	.07	1.87	-179.48	16.4	1.	31.	4215.	29.976	35.85	5034.	24.733	49.66	29.0
131.84	3.87	-.19	1.90	-179.45	15.2	-3.	29.	4229.	29.727	35.86	5048.	24.541	49.61	29.6
132.80	3.88	-.35	1.86	-179.45	14.2	-5.	26.	4242.	29.486	35.88	5063.	24.356	49.56	30.2
133.76	3.90	.50	1.39	-179.37	13.3	7.	18.	4256.	29.244	35.89	5079.	24.169	49.51	30.7
134.72	3.92	2.09	.53	-179.04	12.4	26.	7.	4271.	28.989	35.90	5094.	23.973	49.45	31.3
135.68	3.93	3.61	-.32	-178.58	11.6	42.	-4.	4286.	28.721	35.90	5110.	23.767	49.38	31.9
136.64	3.95	4.77	-.91	-178.18	10.8	52.	-10.	4301.	28.443	35.89	5126.	23.552	49.31	32.5
137.60	3.96	5.45	-1.20	-177.96	10.1	55.	-12.	4316.	28.159	35.87	5142.	23.332	49.23	33.1
138.56	3.98	5.75	-1.29	-177.84	9.4	54.	-12.	4332.	27.871	35.86	5159.	23.110	49.16	33.7
139.52	4.00	5.59	-1.25	-177.77	8.8	49.	-11.	4347.	27.585	35.85	5176.	22.889	49.08	34.3
140.48	4.01	5.29	-1.13	-177.83	8.2	44.	-9.	4363.	27.303	35.83	5193.	22.670	49.00	34.9
141.44	4.03	4.95	-.99	-177.98	7.7	38.	-8.	4379.	27.023	35.82	5210.	22.454	48.93	35.5
142.40	4.05	4.67	-.89	-178.13	7.2	34.	-6.	4396.	26.747	35.81	5227.	22.240	48.86	36.1
143.36	4.07	4.52	-.86	-178.28	6.8	31.	-6.	4412.	26.473	35.81	5244.	22.027	48.79	36.7
144.32	4.09	4.42	-.86	-178.44	6.3	28.	-5.	4429.	26.200	35.80	5262.	21.815	48.72	37.3
145.28	4.11	4.36	-.91	-178.55	5.9	26.	-5.	4446.	25.928	35.79	5280.	21.603	48.64	38.0
146.24	4.13	4.26	-.98	-178.66	5.6	24.	-5.	4463.	25.657	35.78	5298.	21.393	48.57	38.6
147.20	4.16	4.11	-1.05	-178.77	5.2	22.	-6.	4480.	25.388	35.77	5316.	21.183	48.50	39.2
148.16	4.18	3.93	-1.12	-178.88	4.9	19.	-5.	4498.	25.120	35.76	5334.	20.975	48.43	39.9
149.12	4.21	3.73	-1.18	-178.98	4.6	17.	-5.	4515.	24.854	35.75	5352.	20.768	48.36	40.5
150.08	4.25	3.54	-1.24	-179.08	4.4	15.	-5.	4533.	24.590	35.74	5371.	20.562	48.29	41.1
151.04	4.28	3.35	-1.29	-179.15	4.1	14.	-5.	4551.	24.328	35.73	5390.	20.357	48.22	41.8
152.00	4.31	3.19	-1.33	-179.18	3.9	12.	-5.	4569.	24.068	35.72	5408.	20.154	48.15	42.4
152.96	4.35	3.05	-1.35	-179.23	3.7	11.	-5.	4588.	23.809	35.71	5427.	19.951	48.08	43.1
153.92	4.39	2.90	-1.36	-179.27	3.5	10.	-5.	4606.	23.551	35.70	5447.	19.750	48.02	43.8
154.88	4.43	2.75	-1.37	-179.30	3.3	9.	-4.	4625.	23.295	35.69	5466.	19.549	47.95	44.4
155.84	4.47	2.60	-1.37	-179.35	3.1	8.	-4.	4644.	23.041	35.68	5485.	19.350	47.88	45.1
156.80	4.52	2.44	-1.38	-179.39	2.9	7.	-4.	4663.	22.788	35.67	5505.	19.151	47.81	45.7
157.76	4.57	2.26	-1.38	-179.42	2.8	6.	-4.	4682.	22.537	35.66	5525.	18.954	47.75	46.4

NOMINAL DISPLAY DATA FOR STS-45 CYCLE FLT
AERODYNAMIC SUMMARY

TIME (SEC)	MACH (ND)	ALPHA (DEG)	BETA (DEG)	BANK (DEG)	DYN PRESS (PSF)	QALPHA (PSF-DEG)	QBETA (PSF-DEG)	VE (FPS)	GAME (DEG)	AZE (DEG)	VI (FPS)	GAMI (DEG)	AZI (DEG)	SURFACE RANGE (NM)
158.72	4.62	2.09	-1.39	-179.45	2.6	6.	-4.	4701.	22.288	35.65	5545.	18.758	47.68	47.1
159.68	4.67	1.91	-1.39	-179.49	2.5	5.	-3.	4721.	22.041	35.64	5565.	18.564	47.62	47.8
160.64	4.71	1.74	-1.39	-179.53	2.3	4.	-3.	4741.	21.796	35.63	5585.	18.371	47.55	48.5
161.60	4.74	1.57	-1.39	-179.56	2.2	3.	-3.	4761.	21.552	35.63	5606.	18.179	47.49	49.2
162.56	4.78	1.42	-1.39	-179.58	2.1	3.	-3.	4781.	21.310	35.62	5626.	17.988	47.42	49.9
163.52	4.81	1.26	-1.39	-179.58	1.9	2.	-3.	4801.	21.070	35.61	5647.	17.798	47.36	50.5
164.48	4.85	1.07	-1.42	-179.54	1.8	2.	-3.	4821.	20.832	35.60	5668.	17.609	47.30	51.2
165.44	4.89	.89	-1.45	-179.52	1.7	1.	-2.	4842.	20.596	35.60	5689.	17.422	47.23	52.0
166.40	4.93	.70	-1.49	-179.51	1.6	1.	-2.	4863.	20.361	35.59	5710.	17.236	47.17	52.7
167.36	4.97	.52	-1.52	-179.52	1.5	1.	-2.	4884.	20.128	35.59	5732.	17.051	47.11	53.4
168.32	5.02	.35	-1.55	-179.53	1.4	0.	-2.	4905.	19.897	35.58	5753.	16.868	47.05	54.1
169.28	5.06	.17	-1.58	-179.54	1.3	0.	-2.	4926.	19.668	35.57	5775.	16.686	46.99	54.8
170.24	5.10	-.01	-1.62	-179.53	1.2	0.	-2.	4948.	19.441	35.57	5797.	16.505	46.93	55.5
171.20	5.14	-.17	-1.65	-179.50	1.1	0.	-2.	4969.	19.215	35.56	5819.	16.325	46.87	56.3
172.16	5.19	-.34	-1.68	-179.46	1.0	0.	-2.	4991.	18.992	35.56	5841.	16.147	46.82	57.0
173.12	5.23	-.50	-1.71	-179.43	1.0	0.	-2.	5013.	18.770	35.55	5863.	15.969	46.76	57.7
174.08	5.27	-.63	-1.69	-179.45	.9	-1.	-2.	5035.	18.550	35.55	5886.	15.793	46.70	58.5
175.04	5.30	-.77	-1.67	-179.49	.8	-1.	-1.	5058.	18.331	35.55	5908.	15.619	46.65	59.2
176.00	5.34	-.91	-1.64	-179.51	.8	-1.	-1.	5080.	18.115	35.54	5931.	15.445	46.59	60.0
176.96	5.38	-1.04	-1.62	-179.54	.7	-1.	-1.	5103.	17.900	35.54	5954.	15.273	46.53	60.7
177.92	5.41	-1.17	-1.59	-179.57	.7	-1.	-1.	5125.	17.687	35.54	5977.	15.102	46.48	61.5
178.88	5.45	-1.30	-1.58	-179.58	.6	-1.	-1.	5148.	17.476	35.53	6000.	14.932	46.42	62.3
179.84	5.49	-1.42	-1.55	-179.57	.6	-1.	-1.	5172.	17.266	35.53	6023.	14.764	46.37	63.0
180.80	5.53	-1.54	-1.53	-179.56	.6	-1.	-1.	5195.	17.059	35.53	6047.	14.597	46.32	63.8
181.76	5.56	-1.67	-1.52	-179.55	.5	-1.	-1.	5218.	16.853	35.53	6071.	14.431	46.26	64.6
182.72	5.60	-1.79	-1.49	-179.55	.5	-1.	-1.	5242.	16.649	35.52	6094.	14.266	46.21	65.4
183.68	5.64	-1.90	-1.47	-179.58	.5	-1.	-1.	5266.	16.446	35.52	6118.	14.102	46.16	66.1
184.64	5.68	-2.02	-1.46	-179.63	.4	-1.	-1.	5290.	16.246	35.52	6143.	13.940	46.11	66.9
185.60	5.72	-2.14	-1.44	-179.67	.4	-1.	-1.	5314.	16.047	35.52	6167.	13.779	46.05	67.7
186.56	5.76	-2.25	-1.42	-179.69	.4	-1.	-1.	5338.	15.850	35.52	6191.	13.619	46.00	68.5
187.52	5.80	-2.37	-1.41	-179.66	.4	-1.	-1.	5362.	15.654	35.51	6216.	13.460	45.95	69.3
188.48	5.84	-2.48	-1.39	-179.65	.3	-1.	0.	5387.	15.460	35.51	6241.	13.303	45.90	70.1
189.44	5.88	-2.59	-1.37	-179.64	.3	-1.	0.	5412.	15.268	35.51	6265.	13.147	45.85	71.0
190.40	5.92	-2.69	-1.35	-179.63	.3	-1.	0.	5436.	15.077	35.51	6290.	12.992	45.80	71.8
191.36	5.96	-2.80	-1.33	-179.63	.3	-1.	0.	5462.	14.889	35.51	6316.	12.838	45.76	72.6
192.32	6.00	-2.90	-1.32	-179.66	.3	-1.	0.	5487.	14.702	35.51	6341.	12.685	45.71	73.4
193.28	6.04	-3.01	-1.30	-179.69	.3	-1.	0.	5512.	14.516	35.51	6366.	12.534	45.66	74.2
194.24	6.08	-3.12	-1.28	-179.70	.2	-1.	0.	5538.	14.332	35.51	6392.	12.384	45.61	75.1
195.20	6.12	-3.21	-1.26	-179.71	.2	-1.	0.	5563.	14.150	35.51	6418.	12.235	45.56	75.9
196.16	6.17	-3.31	-1.26	-179.72	.2	-1.	0.	5589.	13.970	35.51	6444.	12.087	45.52	76.8
197.12	6.21	-3.41	-1.26	-179.71	.2	-1.	0.	5615.	13.791	35.51	6470.	11.940	45.47	77.6
198.08	6.25	-3.51	-1.26	-179.71	.2	-1.	0.	5641.	13.614	35.51	6496.	11.794	45.43	78.5

NOMINAL DISPLAY DATA FOR STS-45 CYCLE FLT
AERODYNAMIC SUMMARY

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199.04	6.29	-3.60	-1.24	-179.73	.2	-1.	0.	5667.	13.438	35.51	6522.	11.650	45.38	79.3
200.00	6.33	-3.70	-1.22	-179.75	.2	-1.	0.	5694.	13.264	35.51	6549.	11.507	45.33	80.2
200.96	6.38	-3.79	-1.20	-179.77	.2	-1.	0.	5720.	13.091	35.51	6575.	11.365	45.29	81.0
201.92	6.42	-3.88	-1.19	-179.78	.2	-1.	0.	5747.	12.920	35.51	6602.	11.224	45.24	81.9
202.88	6.47	-3.97	-1.17	-179.75	.1	-1.	0.	5774.	12.751	35.52	6629.	11.084	45.20	82.8
203.84	6.51	-4.05	-1.15	-179.74	.1	-1.	0.	5801.	12.583	35.52	6656.	10.946	45.16	83.7
204.80	6.55	-4.13	-1.13	-179.74	.1	-1.	0.	5828.	12.417	35.52	6683.	10.808	45.11	84.5
205.76	6.60	-4.22	-1.12	-179.75	.1	-1.	0.	5856.	12.252	35.52	6711.	10.672	45.07	85.4
206.72	6.64	-4.30	-1.10	-179.77	.1	-1.	0.	5883.	12.089	35.52	6738.	10.536	45.03	86.3
207.68	6.69	-4.38	-1.07	-179.81	.1	0.	0.	5911.	11.927	35.52	6766.	10.402	44.99	87.2
208.64	6.71	-4.47	-1.05	-179.83	.1	0.	0.	5938.	11.767	35.53	6793.	10.269	44.94	88.1
209.60	6.72	-4.54	-1.03	-179.83	.1	0.	0.	5966.	11.609	35.53	6821.	10.137	44.90	89.0
210.56	6.73	-4.62	-1.02	-179.80	.1	0.	0.	5994.	11.452	35.53	6849.	10.006	44.86	90.0
211.52	6.74	-4.69	-1.00	-179.79	.1	0.	0.	6023.	11.296	35.53	6878.	9.877	44.82	90.9
212.48	6.75	-4.77	-.99	-179.76	.1	0.	0.	6051.	11.142	35.54	6906.	9.748	44.78	91.8
213.44	6.76	-4.84	-.97	-179.74	.1	0.	0.	6080.	10.989	35.54	6935.	9.620	44.74	92.7
214.40	6.77	-4.91	-.97	-179.76	.1	0.	0.	6108.	10.838	35.54	6963.	9.494	44.70	93.6
215.36	6.78	-4.97	-.98	-179.80	.1	0.	0.	6137.	10.688	35.55	6992.	9.368	44.66	94.6
216.32	6.80	-5.04	-.98	-179.84	.1	0.	0.	6166.	10.539	35.55	7021.	9.244	44.62	95.5
217.28	6.81	-5.11	-.98	-179.87	.1	0.	0.	6195.	10.392	35.55	7050.	9.121	44.58	96.5
218.24	6.83	-5.17	-.97	-179.87	.1	0.	0.	6225.	10.247	35.55	7079.	8.999	44.54	97.4
219.20	6.84	-5.24	-.95	-179.85	.1	0.	0.	6254.	10.102	35.56	7109.	8.877	44.51	98.4
220.16	6.86	-5.30	-.93	-179.82	.1	0.	0.	6284.	9.959	35.56	7138.	8.757	44.47	99.3
221.12	6.88	-5.36	-.91	-179.80	.1	0.	0.	6313.	9.818	35.57	7168.	8.638	44.43	100.3
222.08	6.89	-5.41	-.89	-179.80	.0	0.	0.	6343.	9.678	35.57	7198.	8.520	44.39	101.3
223.04	6.91	-5.47	-.88	-179.81	.0	0.	0.	6373.	9.539	35.57	7228.	8.403	44.36	102.3
224.00	6.92	-5.53	-.86	-179.84	.0	0.	0.	6404.	9.401	35.58	7258.	8.287	44.32	103.2
224.96	6.94	-5.59	-.84	-179.86	.0	0.	0.	6434.	9.265	35.58	7288.	8.171	44.29	104.2
225.92	6.96	-5.64	-.83	-179.85	.0	0.	0.	6464.	9.130	35.59	7318.	8.057	44.25	105.2
226.88	6.97	-5.69	-.81	-179.85	.0	0.	0.	6495.	8.997	35.59	7349.	7.944	44.21	106.2
227.84	6.99	-5.74	-.80	-179.85	.0	0.	0.	6526.	8.865	35.60	7380.	7.832	44.18	107.2
228.80	7.01	-5.79	-.78	-179.87	.0	0.	0.	6557.	8.734	35.60	7410.	7.721	44.14	108.2
229.76	7.02	-5.84	-.77	-179.91	.0	0.	0.	6588.	8.604	35.61	7441.	7.611	44.11	109.2
230.72	7.04	-5.89	-.75	-179.92	.0	0.	0.	6619.	8.476	35.61	7473.	7.502	44.08	110.2
231.68	7.06	-5.94	-.75	-179.89	.0	0.	0.	6650.	8.349	35.62	7504.	7.394	44.04	111.3
232.64	7.08	-5.98	-.74	-179.87	.0	0.	0.	6682.	8.223	35.62	7535.	7.286	44.01	112.3
233.60	7.10	-6.02	-.73	-179.85	.0	0.	0.	6714.	8.098	35.63	7567.	7.180	43.98	113.3
234.56	7.13	-6.06	-.72	-179.86	.0	0.	0.	6746.	7.975	35.63	7598.	7.075	43.94	114.4
235.52	7.15	-6.11	-.70	-179.88	.0	0.	0.	6777.	7.853	35.64	7630.	6.970	43.91	115.4
236.48	7.16	-6.15	-.69	-179.92	.0	0.	0.	6810.	7.732	35.64	7662.	6.867	43.88	116.4
237.44	7.18	-6.19	-.68	-179.94	.0	0.	0.	6842.	7.612	35.65	7695.	6.764	43.85	117.5
238.40	7.20	-6.23	-.68	-179.91	.0	0.	0.	6874.	7.494	35.66	7727.	6.663	43.81	118.5

NOMINAL DISPLAY DATA FOR STS-45 CYCLE FLT
AERODYNAMIC SUMMARY

TIME (SEC)	MACH (ND)	ALPHA (DEG)	BETA (DEG)	BANK (DEG)	DYN PRESS (PSF)	QALPHA (PSF-DEG)	QBETA (PSF-DEG)	VE (FPS)	GAME (DEG)	AZE (DEG)	VI (FPS)	GAMI (DEG)	AZI (DEG)	SURFACE RANGE (NM)
239.36	7.21	-6.26	-.67	-179.90	.0	0.	0.	6907.	7.376	35.66	7759.	6.562	43.78	119.6
240.32	7.23	-6.30	-.66	-179.88	.0	0.	0.	6940.	7.260	35.67	7792.	6.463	43.75	120.7
241.28	7.24	-6.33	-.64	-179.86	.0	0.	0.	6973.	7.145	35.67	7825.	6.364	43.72	121.8
242.24	7.25	-6.37	-.63	-179.88	.0	0.	0.	7006.	7.031	35.68	7857.	6.266	43.69	122.8
243.20	7.26	-6.40	-.61	-179.91	.0	0.	0.	7039.	6.919	35.69	7890.	6.169	43.66	123.9
244.16	7.27	-6.43	-.60	-179.94	.0	0.	0.	7072.	6.807	35.69	7924.	6.073	43.63	125.0
245.12	7.29	-6.46	-.59	-179.96	.0	0.	0.	7106.	6.697	35.70	7957.	5.977	43.60	126.1
246.08	7.30	-6.49	-.59	-179.96	.0	0.	0.	7139.	6.588	35.71	7990.	5.883	43.57	127.2
247.04	7.31	-6.52	-.59	-179.93	.0	0.	0.	7173.	6.479	35.71	8024.	5.790	43.54	128.3
248.00	7.33	-6.54	-.58	-179.91	.0	0.	0.	7207.	6.372	35.72	8058.	5.697	43.51	129.4
248.96	7.34	-6.57	-.56	-179.88	.0	0.	0.	7241.	6.266	35.73	8092.	5.605	43.48	130.5
249.92	7.36	-6.59	-.55	-179.88	.0	0.	0.	7275.	6.161	35.73	8126.	5.514	43.46	131.7
250.88	7.37	-6.61	-.53	-179.92	.0	0.	0.	7310.	6.058	35.74	8160.	5.424	43.43	132.8
251.84	7.39	-6.64	-.51	-179.93	.0	0.	0.	7344.	5.955	35.75	8194.	5.335	43.40	133.9
252.80	7.41	-6.66	-.50	-179.95	.0	0.	0.	7379.	5.853	35.76	8229.	5.247	43.37	135.0
253.76	7.43	-6.69	-.49	-179.96	.0	0.	0.	7414.	5.753	35.76	8264.	5.159	43.34	136.2
254.72	7.44	-6.71	-.49	-179.95	.0	0.	0.	7449.	5.653	35.77	8299.	5.073	43.32	137.3
255.68	7.46	-6.72	-.48	-179.92	.0	0.	0.	7484.	5.555	35.78	8333.	4.987	43.29	138.5
256.64	7.48	-6.74	-.47	-179.91	.0	0.	0.	7519.	5.457	35.79	8369.	4.902	43.26	139.7
257.60	7.50	-6.76	-.45	-179.94	.0	0.	0.	7555.	5.361	35.80	8404.	4.818	43.24	140.8
258.56	7.52	-6.77	-.44	-179.97	.0	0.	0.	7590.	5.266	35.80	8439.	4.734	43.21	142.0
259.52	7.54	-6.79	-.43	-180.00	.0	0.	0.	7626.	5.171	35.81	8475.	4.652	43.19	143.2
260.48	7.55	-6.81	-.43	-179.99	.0	0.	0.	7662.	5.078	35.82	8511.	4.570	43.16	144.4
261.44	7.57	-6.82	-.43	-179.97	.0	0.	0.	7698.	4.985	35.83	8547.	4.489	43.14	145.5
262.40	7.59	-6.83	-.42	-179.95	.0	0.	0.	7734.	4.894	35.84	8583.	4.409	43.11	146.7
263.36	7.61	-6.84	-.40	-179.92	.0	0.	0.	7770.	4.804	35.85	8619.	4.330	43.09	147.9
264.32	7.63	-6.85	-.39	-179.91	.0	0.	0.	7807.	4.714	35.86	8655.	4.251	43.06	149.1
265.28	7.65	-6.86	-.38	-179.93	.0	0.	0.	7844.	4.626	35.86	8692.	4.174	43.04	150.4
266.24	7.67	-6.87	-.36	-179.97	.0	0.	0.	7881.	4.538	35.87	8728.	4.097	43.01	151.6
267.20	7.69	-6.88	-.35	-179.99	.0	0.	0.	7918.	4.451	35.88	8765.	4.020	42.99	152.8
268.16	7.71	-6.88	-.34	-179.99	.0	0.	0.	7955.	4.366	35.89	8802.	3.945	42.97	154.0
269.12	7.74	-6.89	-.33	-179.96	.0	0.	0.	7992.	4.281	35.90	8839.	3.870	42.94	155.3
270.08	7.76	-6.89	-.32	-179.94	.0	0.	0.	8029.	4.197	35.91	8877.	3.796	42.92	156.5
271.04	7.78	-6.90	-.31	-179.94	.0	0.	0.	8067.	4.115	35.92	8914.	3.723	42.90	157.7
272.00	7.80	-6.90	-.29	-179.95	.0	0.	0.	8105.	4.033	35.93	8952.	3.651	42.88	159.0
272.96	7.83	-6.91	-.28	-179.99	.0	0.	0.	8143.	3.951	35.94	8989.	3.579	42.85	160.3
273.92	7.85	-6.91	-.29	179.99	.0	0.	0.	8181.	3.871	35.95	9027.	3.508	42.83	161.5
274.88	7.88	-6.90	-.30	180.00	.0	0.	0.	8219.	3.792	35.96	9065.	3.438	42.81	162.8
275.84	7.91	-6.90	-.29	-179.98	.0	0.	0.	8258.	3.714	35.97	9104.	3.368	42.79	164.1
276.80	7.93	-6.90	-.28	-179.95	.0	0.	0.	8296.	3.636	35.98	9142.	3.299	42.77	165.4
277.76	7.96	-6.90	-.27	-179.93	.0	0.	0.	8335.	3.560	35.99	9181.	3.231	42.75	166.6
278.72	7.99	-6.90	-.25	-179.95	.0	0.	0.	8374.	3.484	36.00	9219.	3.164	42.73	167.9

NOMINAL DISPLAY DATA FOR STS-45 CYCLE FLT
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279.68	8.01	-6.90	-.23	-179.98	.0	0.	0.	8413.	3.409	36.01	9258.	3.097	42.71	169.2
280.64	8.04	-6.90	-.22	179.99	.0	0.	0.	8452.	3.335	36.02	9297.	3.031	42.69	170.5
281.60	8.06	-6.90	-.21	179.98	.0	0.	0.	8492.	3.261	36.03	9337.	2.966	42.67	171.9
282.56	8.09	-6.90	-.19	-179.99	.0	0.	0.	8531.	3.189	36.04	9376.	2.902	42.65	173.2
283.52	8.11	-6.90	-.19	-179.97	.0	0.	0.	8571.	3.118	36.05	9415.	2.838	42.63	174.5
284.48	8.14	-6.90	-.18	-179.95	.0	0.	0.	8611.	3.047	36.06	9455.	2.775	42.61	175.8
285.44	8.16	-6.89	-.16	-179.94	.0	0.	0.	8651.	2.977	36.07	9495.	2.712	42.59	177.2
286.40	8.18	-6.89	-.15	-179.96	.0	0.	0.	8691.	2.908	36.08	9535.	2.651	42.57	178.5
287.36	8.21	-6.88	-.14	-180.00	.0	0.	0.	8731.	2.840	36.10	9575.	2.590	42.55	179.9
288.32	8.23	-6.87	-.12	179.98	.0	0.	0.	8772.	2.773	36.11	9616.	2.530	42.53	181.2
289.28	8.25	-6.86	-.11	179.97	.0	0.	0.	8813.	2.707	36.12	9656.	2.470	42.51	182.6
290.24	8.27	-6.85	-.10	180.00	.0	0.	0.	8854.	2.641	36.13	9697.	2.411	42.50	184.0
291.20	8.29	-6.83	-.09	-179.98	.0	0.	0.	8895.	2.576	36.14	9738.	2.353	42.48	185.3
292.16	8.31	-6.82	-.08	-179.96	.0	0.	0.	8936.	2.512	36.15	9779.	2.295	42.46	186.7
293.12	8.33	-6.80	-.09	-179.95	.0	0.	0.	8977.	2.448	36.16	9820.	2.238	42.44	188.1
294.08	8.35	-6.79	-.10	-179.99	.0	0.	0.	9019.	2.385	36.18	9861.	2.182	42.43	189.5
295.04	8.37	-6.77	-.11	180.00	.0	0.	0.	9061.	2.324	36.19	9903.	2.126	42.41	190.9
296.00	8.39	-6.76	-.11	179.99	.0	0.	0.	9102.	2.262	36.20	9945.	2.071	42.39	192.3
296.96	8.41	-6.74	-.10	-179.99	.0	0.	0.	9145.	2.202	36.21	9987.	2.016	42.38	193.7
297.92	8.43	-6.72	-.08	-179.96	.0	0.	0.	9187.	2.142	36.22	10029.	1.962	42.36	195.2
298.88	8.45	-6.69	-.07	-179.95	.0	0.	0.	9229.	2.083	36.24	10071.	1.909	42.35	196.6
299.84	8.47	-6.68	-.05	-179.96	.0	0.	0.	9272.	2.025	36.25	10113.	1.857	42.33	198.0
300.80	8.49	-6.65	-.04	-179.99	.0	0.	0.	9315.	1.968	36.26	10156.	1.805	42.31	199.5
301.76	8.52	-6.64	-.02	-180.00	.0	0.	0.	9358.	1.911	36.27	10199.	1.753	42.30	200.9
302.72	8.54	-6.61	-.01	-180.00	.0	0.	0.	9401.	1.855	36.29	10242.	1.702	42.28	202.4
303.68	8.56	-6.59	.00	-179.99	.0	0.	0.	9444.	1.799	36.30	10285.	1.652	42.27	203.8
304.64	8.59	-6.57	.01	-179.98	.0	0.	0.	9487.	1.745	36.31	10328.	1.603	42.25	205.3
305.60	8.61	-6.55	.02	-179.96	.0	0.	0.	9531.	1.691	36.32	10372.	1.554	42.24	206.8
306.56	8.64	-6.52	.03	-179.97	.0	0.	0.	9575.	1.637	36.34	10415.	1.505	42.23	208.3
307.52	8.66	-6.50	.05	-180.00	.0	0.	0.	9619.	1.585	36.35	10459.	1.457	42.21	209.7
308.48	8.69	-6.47	.06	179.97	.0	0.	0.	9663.	1.533	36.36	10503.	1.410	42.20	211.2
309.44	8.72	-6.44	.08	179.96	.0	0.	0.	9708.	1.481	36.38	10548.	1.363	42.18	212.7
310.40	8.75	-6.42	.08	179.99	.0	0.	0.	9752.	1.431	36.39	10592.	1.317	42.17	214.3
311.36	8.77	-6.40	.08	-179.99	.0	0.	0.	9797.	1.381	36.40	10637.	1.272	42.16	215.8
312.32	8.80	-6.37	.08	-179.97	.0	0.	0.	9842.	1.332	36.42	10681.	1.227	42.15	217.3
313.28	8.83	-6.34	.08	-179.97	.0	0.	0.	9887.	1.283	36.43	10726.	1.183	42.13	218.8
314.24	8.86	-6.31	.08	-180.00	.0	0.	0.	9932.	1.235	36.44	10772.	1.139	42.12	220.4
315.20	8.89	-6.28	.08	179.97	.0	0.	0.	9978.	1.188	36.46	10817.	1.096	42.11	221.9
316.16	8.92	-6.25	.09	179.97	.0	0.	0.	10024.	1.141	36.47	10862.	1.053	42.10	223.5
317.12	8.95	-6.22	.10	-180.00	.0	0.	0.	10070.	1.095	36.49	10908.	1.011	42.08	225.0
318.08	8.99	-6.19	.11	-179.99	.0	0.	0.	10116.	1.050	36.50	10954.	.969	42.07	226.6
319.04	9.02	-6.16	.12	-179.97	.0	0.	0.	10162.	1.005	36.51	11000.	.928	42.06	228.2

NOMINAL DISPLAY DATA FOR STS-45 CYCLE FLT
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320.00	9.05	-6.13	.13	-179.96	.0	0.	0.	10208.	.961	36.53	11047.	.888	42.05	229.7
320.96	9.08	-6.10	.14	-179.98	.0	0.	0.	10255.	.917	36.54	11093.	.848	42.04	231.3
321.92	9.12	-6.07	.15	-180.00	.0	0.	0.	10302.	.874	36.56	11140.	.809	42.03	232.9
322.88	9.15	-6.03	.17	179.99	.0	0.	0.	10349.	.832	36.57	11187.	.770	42.02	234.5
323.84	9.18	-6.00	.17	179.99	.0	0.	0.	10396.	.791	36.59	11234.	.732	42.01	236.1
324.80	9.22	-5.97	.18	-179.99	.0	0.	0.	10444.	.750	36.60	11281.	.694	42.00	237.8
325.76	9.25	-5.94	.19	-179.97	.0	0.	0.	10491.	.709	36.62	11329.	.657	41.99	239.4
326.72	9.29	-5.91	.20	-179.97	.0	0.	0.	10539.	.669	36.63	11376.	.620	41.98	241.0
327.68	9.33	-5.87	.21	180.00	.0	0.	0.	10587.	.630	36.65	11424.	.584	41.97	242.7
328.64	9.36	-5.83	.20	179.97	.0	0.	0.	10635.	.592	36.66	11472.	.548	41.96	244.3
329.60	9.40	-5.80	.20	179.97	.0	0.	0.	10684.	.554	36.68	11521.	.513	41.95	246.0
330.56	9.44	-5.76	.21	-180.00	.0	0.	0.	10733.	.516	36.69	11569.	.479	41.94	247.6
331.52	9.47	-5.72	.22	-179.98	.0	0.	0.	10781.	.479	36.71	11618.	.445	41.93	249.3
332.48	9.51	-5.69	.23	-179.97	.0	0.	0.	10831.	.443	36.72	11667.	.411	41.92	251.0
333.44	9.55	-5.65	.24	-179.97	.0	0.	0.	10880.	.407	36.74	11716.	.378	41.91	252.6
334.40	9.59	-5.61	.25	-179.99	.0	0.	0.	10929.	.372	36.76	11765.	.346	41.90	254.3
335.36	9.63	-5.58	.26	179.99	.0	0.	0.	10979.	.338	36.77	11815.	.314	41.90	256.0
336.32	9.67	-5.54	.27	179.98	.0	0.	0.	11029.	.304	36.79	11865.	.282	41.89	257.7
337.28	9.71	-5.50	.28	179.99	.0	0.	0.	11079.	.270	36.80	11915.	.251	41.88	259.5
338.24	9.75	-5.46	.29	-179.99	.0	0.	0.	11129.	.238	36.82	11965.	.221	41.87	261.2
339.20	9.79	-5.42	.29	-179.96	.0	0.	0.	11180.	.205	36.84	12015.	.191	41.87	262.9
340.16	9.83	-5.38	.30	-179.94	.0	0.	0.	11231.	.174	36.85	12066.	.162	41.86	264.7
341.12	9.87	-5.34	.30	-179.96	.0	0.	0.	11282.	.142	36.87	12117.	.133	41.85	266.4
342.08	9.92	-5.30	.32	-179.98	.0	0.	0.	11333.	.112	36.89	12168.	.104	41.84	268.2
343.04	9.96	-5.26	.33	-180.00	.0	0.	0.	11384.	.082	36.90	12219.	.076	41.84	269.9
344.00	10.00	-5.22	.33	179.98	.0	0.	0.	11436.	.052	36.92	12271.	.049	41.83	271.7
344.96	10.05	-5.18	.32	179.97	.0	0.	0.	11488.	.023	36.94	12322.	.022	41.83	273.5
345.92	10.09	-5.14	.31	179.98	.0	0.	0.	11540.	-.005	36.95	12374.	-.005	41.82	275.3
346.88	10.13	-5.09	.31	-179.99	.0	0.	0.	11592.	-.033	36.97	12426.	-.031	41.81	277.1
347.84	10.18	-5.05	.32	-179.97	.0	0.	0.	11645.	-.061	36.99	12479.	-.057	41.81	278.9
348.80	10.23	-5.01	.34	-179.97	.0	0.	0.	11698.	-.088	37.00	12532.	-.082	41.80	280.7
349.76	10.27	-4.97	.35	-179.98	.0	0.	0.	11751.	-.114	37.02	12584.	-.106	41.80	282.5
350.72	10.32	-4.92	.36	179.99	.0	0.	0.	11804.	-.140	37.04	12638.	-.131	41.79	284.3
351.68	10.36	-4.87	.38	179.97	.0	0.	0.	11857.	-.165	37.06	12691.	-.154	41.79	286.2
352.64	10.41	-4.83	.38	179.98	.0	0.	0.	11911.	-.190	37.07	12744.	-.178	41.78	288.0
353.60	10.46	-4.79	.39	-180.00	.0	0.	0.	11965.	-.214	37.09	12798.	-.200	41.78	289.9
354.56	10.51	-4.74	.40	-179.98	.0	0.	0.	12019.	-.238	37.11	12852.	-.223	41.77	291.7
355.52	10.56	-4.70	.41	-179.97	.0	0.	0.	12074.	-.261	37.13	12907.	-.245	41.77	293.6
356.48	10.61	-4.65	.42	-179.98	.0	0.	0.	12128.	-.284	37.15	12961.	-.266	41.77	295.5
357.44	10.66	-4.60	.43	-180.00	.0	0.	0.	12183.	-.306	37.16	13016.	-.287	41.76	297.3
358.40	10.71	-4.56	.44	179.98	.0	0.	0.	12238.	-.328	37.18	13071.	-.307	41.76	299.2
359.36	10.76	-4.52	.45	179.96	.0	0.	0.	12294.	-.349	37.20	13126.	-.327	41.76	301.1

NOMINAL DISPLAY DATA FOR STS-45 CYCLE FLT
AERODYNAMIC SUMMARY

TIME (SEC)	MACH (ND)	ALPHA (DEG)	BETA (DEG)	BANK (DEG)	DYN PRESS (PSF)	QALPHA (PSF-DEG)	QBETA (PSF-DEG)	VE (FPS)	GAME (DEG)	AZE (DEG)	VI (FPS)	GAMI (DEG)	AZI (DEG)	SURFACE RANGE (NM)
360.32	10.81	-4.47	.45	179.99	.0	0.	0.	12349.	-.370	37.22	13182.	-.347	41.75	303.1
361.28	10.86	-4.42	.45	-179.99	.0	0.	0.	12405.	-.391	37.24	13238.	-.366	41.75	305.0
362.24	10.91	-4.37	.46	-179.97	.0	0.	0.	12461.	-.410	37.26	13294.	-.385	41.75	306.9
363.20	10.96	-4.33	.46	-179.96	.0	0.	0.	12518.	-.430	37.28	13350.	-.403	41.74	308.8
364.16	11.02	-4.28	.47	-179.98	.0	0.	0.	12574.	-.448	37.29	13407.	-.421	41.74	310.8
365.12	11.07	-4.24	.48	179.98	.0	0.	0.	12631.	-.467	37.31	13463.	-.438	41.74	312.8
366.08	11.12	-4.19	.48	179.96	.0	0.	0.	12688.	-.485	37.33	13520.	-.455	41.74	314.7
367.04	11.18	-4.14	.47	179.97	.0	0.	0.	12746.	-.502	37.35	13578.	-.471	41.74	316.7
368.00	11.23	-4.09	.47	180.00	.0	0.	0.	12804.	-.519	37.37	13635.	-.487	41.73	318.7
368.96	11.29	-4.04	.48	-179.97	.0	0.	0.	12862.	-.535	37.39	13693.	-.503	41.73	320.7
369.92	11.35	-4.00	.49	-179.96	.0	0.	0.	12920.	-.551	37.41	13751.	-.518	41.73	322.7
370.88	11.40	-3.95	.50	-179.97	.0	0.	0.	12978.	-.566	37.43	13810.	-.532	41.73	324.7
371.84	11.46	-3.90	.51	-179.99	.0	0.	0.	13037.	-.581	37.45	13868.	-.547	41.73	326.7
372.80	11.52	-3.85	.52	179.99	.0	0.	0.	13096.	-.596	37.47	13927.	-.560	41.73	328.7
373.76	11.57	-3.79	.53	179.98	.0	0.	0.	13155.	-.610	37.49	13986.	-.574	41.73	330.8
374.72	11.63	-3.74	.54	180.00	.0	0.	0.	13215.	-.624	37.51	14046.	-.587	41.73	332.8
375.68	11.69	-3.69	.55	-179.97	.0	0.	0.	13275.	-.637	37.53	14106.	-.599	41.73	334.9
376.64	11.75	-3.64	.56	-179.96	.0	0.	0.	13335.	-.649	37.55	14166.	-.611	41.73	336.9
377.60	11.81	-3.59	.56	-179.96	.0	0.	0.	13395.	-.662	37.57	14226.	-.623	41.73	339.0
378.56	11.87	-3.54	.57	-179.98	.0	0.	0.	13456.	-.673	37.59	14287.	-.634	41.73	341.1
379.52	11.93	-3.49	.58	180.00	.0	0.	0.	13517.	-.685	37.61	14348.	-.645	41.73	343.2
380.48	12.00	-3.43	.58	179.99	.0	0.	0.	13578.	-.696	37.63	14409.	-.655	41.73	345.3
381.44	12.06	-3.38	.59	180.00	.0	0.	0.	13640.	-.706	37.65	14470.	-.665	41.73	347.4
382.40	12.12	-3.35	.60	-179.97	.0	0.	0.	13702.	-.716	37.67	14532.	-.675	41.73	349.5
383.36	12.18	-3.30	.61	-179.95	.0	0.	0.	13764.	-.725	37.70	14594.	-.684	41.73	351.6
384.32	12.25	-3.27	.61	-179.94	.0	0.	0.	13826.	-.734	37.72	14656.	-.693	41.73	353.8
385.28	12.31	-3.23	.62	-179.95	.0	0.	0.	13889.	-.743	37.74	14719.	-.701	41.74	355.9
386.24	12.38	-3.18	.63	-179.99	.0	0.	0.	13952.	-.751	37.76	14782.	-.708	41.74	358.1
387.20	12.44	-3.14	.62	179.98	.0	0.	0.	14015.	-.758	37.78	14845.	-.716	41.74	360.3
388.16	12.51	-3.10	.61	179.96	.0	0.	0.	14079.	-.765	37.80	14909.	-.722	41.74	362.5
389.12	12.57	-3.05	.60	179.98	.0	0.	0.	14143.	-.771	37.82	14973.	-.729	41.75	364.6
390.08	12.64	-3.01	.61	-179.99	.0	0.	0.	14207.	-.777	37.85	15037.	-.735	41.75	366.8
391.04	12.71	-2.95	.62	-179.98	.0	0.	0.	14272.	-.783	37.87	15102.	-.740	41.75	369.1
392.00	12.78	-2.90	.63	-179.97	.0	0.	0.	14337.	-.788	37.89	15166.	-.745	41.75	371.3
392.96	12.84	-2.85	.65	-179.97	.0	0.	0.	14402.	-.793	37.91	15232.	-.750	41.76	373.5
393.92	12.91	-2.79	.66	-179.97	.0	0.	0.	14468.	-.797	37.94	15297.	-.754	41.76	375.7
394.88	12.98	-2.73	.66	-179.98	.0	0.	0.	14533.	-.801	37.96	15363.	-.758	41.76	378.0
395.84	13.05	-2.67	.67	-179.99	.0	0.	0.	14600.	-.805	37.98	15429.	-.761	41.77	380.3
396.80	13.12	-2.61	.69	-179.99	.0	0.	0.	14666.	-.808	38.00	15495.	-.764	41.77	382.5
397.76	13.20	-2.55	.70	-179.98	.0	0.	0.	14733.	-.810	38.03	15562.	-.767	41.78	384.8
398.72	13.27	-2.49	.70	-179.96	.0	0.	0.	14800.	-.813	38.05	15629.	-.770	41.78	387.1
399.68	13.34	-2.42	.70	-179.95	.0	0.	0.	14868.	-.815	38.07	15697.	-.772	41.79	389.4

NOMINAL DISPLAY DATA FOR STS-45 CYCLE FLT
AERODYNAMIC SUMMARY

TIME (SEC)	MACH (ND)	ALPHA (DEG)	BETA (DEG)	BANK (DEG)	DYN PRESS (PSF)	QALPHA (PSF-DEG)	QBETA (PSF-DEG)	VE (FPS)	GAME (DEG)	AZE (DEG)	VI (FPS)	GAMI (DEG)	AZI (DEG)	SURFACE RANGE (NM)
400.64	13.41	-2.35	.71	-179.96	.0	0.	0.	14936.	-.816	38.10	15765.	-.773	41.79	391.7
401.60	13.49	-2.29	.72	-180.00	.0	0.	0.	15004.	-.817	38.12	15833.	-.775	41.80	394.0
402.56	13.56	-2.23	.72	180.00	.0	0.	0.	15073.	-.818	38.14	15902.	-.776	41.80	396.4
403.52	13.64	-2.17	.72	-179.98	.0	0.	0.	15142.	-.819	38.17	15970.	-.776	41.81	398.7
404.48	13.71	-2.11	.73	-179.96	.0	0.	0.	15211.	-.819	38.19	16040.	-.777	41.81	401.1
405.44	13.79	-2.05	.74	-179.95	.0	0.	0.	15281.	-.818	38.21	16109.	-.776	41.82	403.4
406.40	13.87	-1.99	.75	-179.98	.0	0.	0.	15351.	-.818	38.24	16179.	-.776	41.82	405.8
407.36	13.94	-1.94	.76	179.99	.0	0.	0.	15421.	-.816	38.26	16250.	-.775	41.83	408.2
408.32	14.02	-1.88	.76	179.97	.0	0.	0.	15492.	-.815	38.29	16320.	-.774	41.84	410.6
409.28	14.10	-1.82	.75	179.99	.0	0.	0.	15563.	-.813	38.31	16392.	-.772	41.84	413.0
410.24	14.18	-1.76	.74	-179.98	.0	0.	0.	15635.	-.811	38.34	16463.	-.770	41.85	415.4
411.20	14.26	-1.70	.76	-179.98	.0	0.	0.	15707.	-.808	38.36	16535.	-.767	41.86	417.9
412.16	14.34	-1.65	.76	-179.98	.0	0.	0.	15779.	-.805	38.39	16607.	-.764	41.86	420.3
413.12	14.42	-1.59	.77	-179.99	.0	0.	0.	15852.	-.801	38.41	16680.	-.761	41.87	422.8
414.08	14.50	-1.54	.78	-179.99	.0	0.	0.	15925.	-.797	38.44	16753.	-.757	41.88	425.2
415.04	14.58	-1.48	.79	-180.00	.0	0.	0.	15998.	-.793	38.46	16826.	-.754	41.89	427.7
416.00	14.67	-1.42	.80	-180.00	.0	0.	0.	16072.	-.788	38.49	16900.	-.749	41.89	430.2
416.96	14.75	-1.36	.81	-179.99	.0	0.	0.	16146.	-.783	38.51	16975.	-.744	41.90	432.7
417.92	14.83	-1.30	.81	-179.98	.0	0.	0.	16221.	-.777	38.54	17049.	-.739	41.91	435.2
418.88	14.92	-1.24	.82	-179.98	.0	0.	0.	16296.	-.771	38.56	17124.	-.734	41.92	437.8
419.84	15.00	-1.18	.82	-179.98	.0	0.	0.	16372.	-.765	38.59	17200.	-.728	41.93	440.3
420.80	15.09	-1.12	.82	-179.99	.0	0.	0.	16448.	-.758	38.62	17276.	-.722	41.94	442.8
421.76	15.17	-1.07	.83	-179.99	.0	0.	0.	16524.	-.751	38.64	17352.	-.715	41.94	445.4
422.72	15.26	-1.01	.84	-179.97	.0	0.	0.	16601.	-.743	38.67	17429.	-.708	41.95	448.0
423.68	15.35	-.95	.85	-179.94	.0	0.	0.	16678.	-.735	38.70	17506.	-.701	41.96	450.5
424.64	15.43	-.89	.85	-179.95	.0	0.	0.	16756.	-.727	38.72	17584.	-.693	41.97	453.1
425.60	15.52	-.83	.86	-179.99	.0	0.	0.	16834.	-.718	38.75	17662.	-.685	41.98	455.8
426.56	15.61	-.78	.87	179.99	.0	0.	0.	16913.	-.709	38.78	17740.	-.676	41.99	458.4
427.52	15.70	-.73	.88	179.97	.0	0.	0.	16992.	-.700	38.80	17819.	-.667	42.00	461.0
428.48	15.79	-.69	.89	179.99	.0	0.	0.	17071.	-.690	38.83	17899.	-.658	42.01	463.6
429.44	15.87	-.65	.89	-179.98	.0	0.	0.	17151.	-.680	38.86	17979.	-.648	42.03	466.3
430.40	15.96	-.63	.89	-179.96	.0	0.	0.	17232.	-.669	38.89	18059.	-.638	42.04	469.0
431.36	16.05	-.59	.90	-179.96	.0	0.	0.	17312.	-.657	38.91	18140.	-.627	42.05	471.7
432.32	16.14	-.55	.91	-179.97	.0	0.	0.	17394.	-.645	38.94	18221.	-.616	42.06	474.4
433.28	16.23	-.50	.92	-179.99	.0	0.	0.	17476.	-.633	38.97	18303.	-.604	42.07	477.1
434.24	16.32	-.44	.92	179.99	.0	0.	0.	17558.	-.620	39.00	18385.	-.592	42.08	479.8
435.20	16.41	-.39	.91	179.98	.0	0.	0.	17641.	-.607	39.03	18468.	-.580	42.09	482.5
436.16	16.50	-.33	.89	179.98	.0	0.	0.	17724.	-.593	39.06	18552.	-.567	42.11	485.3
437.12	16.59	-.27	.88	-179.99	.0	0.	0.	17808.	-.579	39.08	18635.	-.554	42.12	488.0
438.08	16.68	-.21	.88	-179.99	.0	0.	0.	17892.	-.565	39.11	18720.	-.540	42.13	490.8
439.04	16.77	-.15	.90	-179.97	.0	0.	0.	17977.	-.550	39.14	18804.	-.526	42.14	493.6
440.00	16.86	-.10	.91	-179.96	.0	0.	0.	18062.	-.535	39.17	18890.	-.512	42.16	496.4

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440.96	16.95	-.04	.93	-179.97	.0	0.	0.	18148.	-.520	39.20	18976.	-.497	42.17	499.2
441.92	17.05	.03	.94	-179.99	.0	0.	0.	18235.	-.504	39.23	19062.	-.482	42.18	502.0
442.88	17.14	.09	.95	179.98	.0	0.	0.	18322.	-.488	39.26	19149.	-.467	42.20	504.8
443.84	17.23	.15	.96	179.98	.0	0.	0.	18409.	-.472	39.29	19237.	-.452	42.21	507.7
444.80	17.32	.22	.97	-180.00	.0	0.	0.	18497.	-.455	39.32	19325.	-.436	42.23	510.6
445.76	17.41	.28	.98	-179.98	.0	0.	0.	18586.	-.438	39.35	19413.	-.419	42.24	513.4
446.72	17.50	.35	.99	-179.97	.0	0.	0.	18675.	-.420	39.38	19503.	-.403	42.25	516.3
447.68	17.59	.41	1.00	-179.97	.0	0.	0.	18765.	-.403	39.41	19592.	-.386	42.27	519.2
448.64	17.69	.46	1.01	-179.97	.0	0.	0.	18855.	-.385	39.44	19682.	-.369	42.28	522.2
449.60	17.78	.51	1.02	-180.00	.0	0.	0.	18945.	-.367	39.47	19772.	-.352	42.30	525.1
450.56	17.87	.56	1.03	179.98	.0	0.	0.	19035.	-.349	39.50	19862.	-.335	42.32	528.0
451.52	17.96	.59	1.03	179.96	.0	0.	0.	19125.	-.332	39.54	19952.	-.318	42.33	531.0
452.48	18.05	.62	1.03	179.96	.0	0.	0.	19214.	-.314	39.57	20041.	-.301	42.35	534.0
453.44	18.13	.65	1.04	179.96	.0	0.	0.	19304.	-.295	39.60	20131.	-.283	42.37	537.0
454.40	18.22	.67	1.05	179.99	.0	0.	0.	19394.	-.277	39.63	20221.	-.266	42.38	540.0
455.36	18.31	.71	1.05	-179.99	.0	0.	0.	19484.	-.259	39.66	20311.	-.248	42.40	543.0
456.32	18.40	.68	1.05	180.00	.0	0.	0.	19574.	-.241	39.69	20401.	-.231	42.42	546.0
457.28	18.49	.67	1.03	-179.98	.0	0.	0.	19664.	-.220	39.73	20491.	-.211	42.43	549.1
458.24	18.57	.80	1.01	-179.94	.0	0.	0.	19754.	-.201	39.76	20581.	-.193	42.45	552.1
459.20	18.66	.96	1.00	-179.95	.0	0.	0.	19844.	-.182	39.79	20671.	-.175	42.47	555.2
460.16	18.75	1.05	.99	-179.96	.0	0.	0.	19934.	-.163	39.82	20762.	-.157	42.49	558.3
461.12	18.83	1.13	1.00	-179.98	.0	0.	0.	20025.	-.145	39.86	20852.	-.139	42.51	561.4
462.08	18.92	1.16	1.02	-179.98	.0	0.	0.	20115.	-.126	39.89	20943.	-.121	42.53	564.5
463.04	19.00	1.19	1.03	-180.00	.0	0.	0.	20205.	-.108	39.92	21032.	-.104	42.54	567.7
464.00	19.08	1.20	1.05	179.99	.0	0.	0.	20295.	-.089	39.96	21122.	-.086	42.56	570.8
464.96	19.17	1.20	1.06	179.97	.0	0.	0.	20385.	-.070	39.99	21212.	-.067	42.58	574.0
465.92	19.25	1.21	1.08	179.97	.0	0.	0.	20475.	-.051	40.02	21302.	-.049	42.60	577.1
466.88	19.33	1.22	1.10	179.98	.0	0.	0.	20565.	-.031	40.06	21392.	-.030	42.62	580.3
467.84	19.41	1.25	1.13	-180.00	.0	0.	0.	20655.	-.012	40.09	21482.	-.011	42.64	583.5
468.80	19.49	1.28	1.17	-179.99	.0	0.	0.	20745.	.008	40.12	21573.	.008	42.67	586.7
469.76	19.57	1.32	1.21	180.00	.0	0.	0.	20836.	.028	40.16	21663.	.027	42.69	590.0
470.72	19.65	1.36	1.23	179.97	.0	0.	0.	20926.	.048	40.19	21753.	.046	42.71	593.2
471.68	19.73	1.38	1.25	179.94	.0	0.	0.	21016.	.068	40.23	21844.	.066	42.73	596.5
472.64	19.81	1.35	1.26	179.92	.0	0.	0.	21107.	.089	40.26	21934.	.085	42.75	599.7
473.60	19.88	1.30	1.27	179.91	.0	0.	0.	21197.	.110	40.30	22025.	.106	42.78	603.0
474.56	19.96	1.24	1.29	179.92	.0	0.	0.	21288.	.131	40.34	22115.	.126	42.80	606.3
475.52	20.03	1.20	1.30	179.95	.0	0.	0.	21378.	.153	40.37	22206.	.148	42.82	609.6
476.48	20.11	1.19	1.31	179.96	.0	0.	0.	21469.	.176	40.41	22297.	.169	42.85	613.0
477.44	20.18	1.19	1.33	179.95	.0	0.	0.	21559.	.198	40.44	22387.	.191	42.87	616.3
478.40	20.25	1.22	1.34	179.92	.0	0.	0.	21649.	.221	40.48	22477.	.212	42.89	619.7
479.36	20.32	1.27	1.34	179.88	.0	0.	0.	21739.	.243	40.52	22566.	.234	42.92	623.0
480.32	20.39	1.33	1.35	179.86	.0	0.	0.	21828.	.265	40.55	22656.	.256	42.94	626.4

NOMINAL DISPLAY DATA FOR STS-45 CYCLE FLT
AERODYNAMIC SUMMARY

TIME (SEC)	MACH (ND)	ALPHA (DEG)	BETA (DEG)	BANK (DEG)	DYN PRESS (PSF)	QALPHA (PSF-DEG)	QBETA (PSF-DEG)	VE (FPS)	GAME (DEG)	AZE (DEG)	VI (FPS)	GAMI (DEG)	AZI (DEG)	SURFACE RANGE (NM)
481.28	20.46	1.42	1.36	179.88	.0	0.	0.	21919.	.288	40.59	22747.	.278	42.97	629.8
482.24	20.52	1.53	1.37	179.91	.0	0.	0.	22010.	.311	40.63	22837.	.299	42.99	633.2
483.20	20.59	1.64	1.36	179.94	.0	0.	0.	22100.	.333	40.67	22928.	.321	43.02	636.6
484.16	20.65	1.75	1.36	179.96	.0	0.	0.	22190.	.354	40.70	23018.	.342	43.04	640.1
485.12	20.71	1.86	1.33	179.95	.0	0.	0.	22280.	.376	40.74	23108.	.362	43.07	643.5
486.08	20.77	1.96	1.30	179.91	.0	0.	0.	22370.	.397	40.78	23198.	.383	43.10	647.0
487.04	20.83	2.07	1.28	179.89	.0	0.	0.	22460.	.418	40.82	23288.	.403	43.12	650.5
488.00	20.89	2.16	1.26	179.87	.0	0.	0.	22550.	.439	40.85	23378.	.423	43.15	654.0
488.96	20.95	2.26	1.24	179.89	.0	0.	0.	22641.	.459	40.89	23469.	.443	43.17	657.5
489.92	21.00	2.36	1.23	179.92	.0	0.	0.	22732.	.480	40.93	23560.	.463	43.20	661.0
490.88	21.06	2.45	1.24	179.94	.0	0.	0.	22823.	.500	40.97	23651.	.483	43.23	664.5
491.84	21.11	2.51	1.25	179.95	.0	0.	0.	22913.	.520	41.01	23741.	.502	43.25	668.1
492.80	21.16	2.55	1.27	179.93	.0	0.	0.	23003.	.540	41.04	23831.	.521	43.28	671.7
493.76	21.21	2.54	1.28	179.90	.0	0.	0.	23093.	.560	41.08	23921.	.541	43.31	675.2
494.72	21.25	2.50	1.30	179.87	.0	0.	0.	23184.	.581	41.12	24012.	.561	43.34	678.8
495.68	21.30	2.45	1.32	179.87	.0	0.	0.	23275.	.602	41.16	24103.	.581	43.37	682.4
496.64	21.35	2.39	1.34	179.90	.0	0.	0.	23366.	.623	41.20	24194.	.602	43.39	686.0
497.60	21.39	2.36	1.36	179.92	.0	0.	0.	23456.	.645	41.24	24284.	.623	43.42	689.7
498.56	21.43	2.35	1.38	179.92	.0	0.	0.	23546.	.667	41.28	24375.	.644	43.45	693.3
499.52	21.47	2.36	1.39	179.92	.0	0.	0.	23637.	.689	41.32	24466.	.666	43.48	697.0
500.48	21.51	2.39	1.42	179.92	.0	0.	0.	23728.	.711	41.36	24557.	.687	43.51	700.7
501.44	21.55	2.42	1.44	179.91	.0	0.	0.	23819.	.734	41.40	24648.	.709	43.54	704.4
502.40	21.59	2.47	1.47	179.89	.0	0.	0.	23910.	.756	41.44	24739.	.731	43.57	708.1
503.36	21.63	2.52	1.49	179.88	.0	0.	0.	24000.	.778	41.48	24828.	.752	43.60	711.8
504.32	21.67	2.56	1.51	179.86	.0	0.	0.	24090.	.800	41.53	24919.	.773	43.64	715.5
505.28	21.70	2.60	1.52	179.87	.0	0.	0.	24181.	.822	41.57	25009.	.795	43.67	719.3
505.76	21.72	2.63	1.53	179.89	.0	0.	0.	24226.	.833	41.59	25055.	.805	43.68	721.1
506.56	21.75	2.67	1.52	179.91	.0	0.	0.	24302.	.851	41.62	25131.	.823	43.71	724.3
507.52	21.79	2.72	1.49	179.94	.0	0.	0.	24393.	.873	41.67	25222.	.844	43.74	728.1
508.48	21.82	2.77	1.45	179.95	.0	0.	0.	24481.	.894	41.71	25310.	.865	43.77	731.9
509.44	21.85	2.82	1.39	179.92	.0	0.	0.	24568.	.915	41.75	25397.	.885	43.81	735.7
510.40	21.88	2.88	1.34	179.90	.0	0.	0.	24655.	.935	41.79	25484.	.905	43.84	739.5
511.36	21.90	2.94	1.32	179.88	.0	0.	0.	24743.	.956	41.84	25572.	.925	43.87	743.3
512.32	21.93	3.03	1.32	179.86	.0	0.	0.	24831.	.977	41.88	25661.	.945	43.90	747.2
513.28	21.96	3.13	1.35	179.88	.0	0.	0.	24920.	.997	41.92	25750.	.965	43.94	751.0
514.24	21.95	3.23	1.38	179.88	.0	0.	0.	24970.	1.009	41.96	25800.	.976	43.97	754.9
515.20	21.91	3.23	1.37	179.81	.0	0.	0.	24986.	1.013	42.00	25815.	.980	44.01	758.8
516.16	21.87	3.19	1.35	179.71	.0	0.	0.	24991.	1.014	42.04	25820.	.982	44.04	762.6
517.12	21.82	3.13	1.32	179.61	.0	0.	0.	24994.	1.016	42.08	25824.	.983	44.08	766.5
518.08	21.77	3.06	1.28	179.50	.0	0.	0.	24997.	1.017	42.12	25827.	.984	44.12	770.4
519.04	21.72	2.99	1.24	179.38	.0	0.	0.	24999.	1.018	42.16	25829.	.986	44.16	774.3
520.00	21.67	2.92	1.19	179.25	.0	0.	0.	25000.	1.019	42.20	25830.	.987	44.19	778.2

NOMINAL DISPLAY DATA FOR STS-45 CYCLE FLT
AERODYNAMIC SUMMARY

TIME (SEC)	MACH (ND)	ALPHA (DEG)	BETA (DEG)	BANK (DEG)	DYN PRESS (PSF)	QALPHA (PSF-DEG)	QBETA (PSF-DEG)	VE (FPS)	GAME (DEG)	AZE (DEG)	VI (FPS)	GAMI (DEG)	AZI (DEG)	SURFACE RANGE (NM)
520.96	21.62	2.86	1.14	179.10	.0	0.	0.	25001.	1.020	42.24	25830.	.987	44.23	782.0
MECO	(THRUST=0)													
521.27	21.60	2.84	1.12	179.05	.0	0.	0.	25000.	1.020	42.25	25830.	.987	44.24	783.3

NOMINAL DISPLAY DATA FOR STS-45 CYCLE FLT
TRAJECTORY SUMMARY

TIME (SEC)	GEOD LATD (DEG)	LONG (DEG)	ALT (FT)	ALT RATE (FPS)	VE (FPS)	VI (FPS)	ROLL ANGLE (DEG)	PITCH ANGLE (DEG)	YAW ANGLE (DEG)	THRT LEVEL (%)	SENSED ACC (G)	TOTAL WT (LBS)	ET MPS WT (LBS)
.00	28.608	-80.604	-25.	0.	0.	1341.	.0	89.8	-37.7	100.	.25	4502076.	1597444.
.96	28.608	-80.604	-22.	11.	11.	1341.	.0	89.7	-38.9	100.	1.54	4481870.	1594451.
1.92	28.608	-80.604	-3.	28.	28.	1341.	.0	89.5	-39.7	100.	1.55	4456146.	1591458.
2.88	28.608	-80.604	32.	45.	45.	1341.	.0	89.4	-40.5	100.	1.56	4430434.	1588465.
3.84	28.608	-80.604	83.	62.	63.	1342.	.0	89.5	-42.2	100.	1.58	4404623.	1585472.
4.80	28.608	-80.604	152.	81.	81.	1343.	.0	89.6	-43.3	100.	1.61	4378658.	1582479.
5.76	28.609	-80.604	239.	100.	100.	1344.	.0	89.6	-43.3	100.	1.63	4352481.	1579486.
6.72	28.609	-80.604	344.	119.	120.	1346.	.0	89.6	-42.8	100.	1.65	4326103.	1576493.
7.68	28.609	-80.604	468.	140.	141.	1348.	.0	89.6	-41.7	100.	1.67	4299601.	1573500.
8.64	28.609	-80.604	612.	160.	162.	1350.	.0	89.5	14.8	100.	1.69	4273023.	1570507.
9.60	28.609	-80.604	776.	182.	183.	1353.	102.0	88.2	55.2	100.	1.70	4246380.	1567514.
10.56	28.609	-80.604	961.	203.	204.	1358.	117.5	85.6	57.6	100.	1.72	4219703.	1564521.
11.52	28.609	-80.604	1166.	225.	226.	1366.	129.3	82.4	51.9	100.	1.73	4193017.	1561528.
12.48	28.609	-80.604	1393.	247.	248.	1377.	138.7	79.4	44.2	100.	1.74	4166335.	1558535.
13.44	28.609	-80.604	1640.	268.	271.	1391.	146.1	76.7	35.7	100.	1.75	4139656.	1555542.
14.40	28.609	-80.604	1908.	290.	294.	1407.	152.6	74.5	27.6	100.	1.77	4112974.	1552549.
15.36	28.609	-80.604	2197.	311.	317.	1424.	159.0	72.5	19.7	100.	1.78	4086279.	1549556.
16.32	28.609	-80.604	2506.	332.	341.	1442.	165.7	70.8	12.2	100.	1.80	4059565.	1546563.
17.28	28.609	-80.603	2835.	354.	366.	1459.	172.8	69.5	4.8	100.	1.81	4032831.	1543570.
18.24	28.610	-80.603	3185.	375.	392.	1477.	179.5	68.6	-1.8	100.	1.83	4006079.	1540577.
19.20	28.610	-80.603	3555.	396.	418.	1493.	183.4	68.4	-5.8	100.	1.84	3979314.	1537584.
20.16	28.610	-80.603	3945.	418.	445.	1509.	184.0	68.7	-6.7	100.	1.86	3952541.	1534591.
21.12	28.610	-80.602	4358.	441.	472.	1525.	182.4	69.0	-5.3	97.	1.87	3925786.	1531614.
22.08	28.611	-80.602	4791.	463.	499.	1543.	180.8	69.6	-3.3	89.	1.84	3899306.	1528858.
23.04	28.611	-80.602	5246.	484.	526.	1560.	180.0	70.3	-.4	89.	1.83	3873216.	1526196.
24.00	28.611	-80.601	5721.	506.	552.	1577.	179.3	70.9	2.4	89.	1.81	3847547.	1523535.
24.96	28.612	-80.601	6217.	527.	577.	1595.	178.7	71.3	3.9	89.	1.80	3822264.	1520874.
25.92	28.612	-80.600	6733.	548.	602.	1612.	178.3	71.3	3.6	89.	1.79	3797321.	1518213.
26.88	28.613	-80.600	7269.	569.	626.	1629.	178.2	71.0	2.9	89.	1.78	3772684.	1515552.
27.84	28.613	-80.599	7825.	589.	651.	1646.	178.1	70.6	2.0	89.	1.78	3748331.	1512891.
28.80	28.614	-80.599	8400.	609.	674.	1663.	178.0	70.2	1.2	79.	1.73	3724385.	1510373.
29.76	28.615	-80.598	8994.	627.	697.	1679.	177.8	69.9	.6	70.	1.70	3700971.	1508144.
30.72	28.615	-80.597	9603.	644.	718.	1695.	177.7	69.6	.1	67.	1.68	3678002.	1506131.
31.68	28.616	-80.597	10229.	660.	739.	1712.	177.6	69.3	-.2	67.	1.68	3655272.	1504129.
32.64	28.617	-80.596	10871.	677.	761.	1728.	177.5	69.1	-.5	67.	1.67	3632768.	1502127.
33.60	28.617	-80.595	11529.	693.	782.	1744.	177.4	68.8	-.7	67.	1.67	3610479.	1500126.
34.56	28.618	-80.595	12202.	709.	802.	1760.	177.4	68.4	-1.0	67.	1.66	3588404.	1498124.
35.52	28.619	-80.594	12891.	725.	823.	1776.	177.3	67.9	-1.3	67.	1.66	3566534.	1496122.
36.48	28.620	-80.593	13595.	741.	844.	1792.	177.2	67.4	-1.7	67.	1.66	3544865.	1494121.
37.44	28.620	-80.592	14313.	756.	865.	1809.	177.2	67.0	-2.1	67.	1.66	3523391.	1492119.
38.40	28.621	-80.592	15047.	771.	885.	1825.	177.2	66.6	-2.5	67.	1.65	3502109.	1490117.
39.36	28.622	-80.591	15794.	786.	906.	1842.	177.2	66.3	-2.9	67.	1.65	3481019.	1488116.

NOMINAL DISPLAY DATA FOR STS-45 CYCLE FLT
TRAJECTORY SUMMARY

TIME (SEC)	GEOD LATD (DEG)	LONG (DEG)	ALT (FT)	ALT RATE (FPS)	VE (FPS)	VI (FPS)	ROLL ANGLE (DEG)	PITCH ANGLE (DEG)	YAW ANGLE (DEG)	THRT LEVEL (%)	SENSED ACC (G)	TOTAL WT (LBS)	ET MPS WT (LBS)
40.32	28.623	-80.590	16556.	801.	926.	1858.	177.3	66.0	-3.3	67.	1.65	3460121.	1486114.
41.28	28.624	-80.589	17332.	816.	947.	1875.	177.3	65.7	-3.7	67.	1.65	3439403.	1484112.
42.24	28.625	-80.588	18122.	830.	967.	1891.	177.5	65.4	-3.9	67.	1.65	3418845.	1482111.
43.20	28.626	-80.587	18926.	845.	987.	1908.	177.6	65.1	-4.2	67.	1.65	3398435.	1480109.
44.16	28.627	-80.586	19744.	859.	1008.	1924.	177.6	64.9	-4.4	67.	1.65	3378159.	1478107.
45.12	28.628	-80.585	20576.	873.	1028.	1941.	177.6	64.7	-4.7	67.	1.65	3358013.	1476105.
46.08	28.629	-80.584	21420.	887.	1048.	1957.	177.6	64.5	-4.9	67.	1.66	3337981.	1474104.
47.04	28.631	-80.583	22279.	901.	1068.	1974.	177.5	64.3	-5.1	67.	1.65	3318070.	1472102.
48.00	28.632	-80.582	23151.	915.	1087.	1990.	177.5	64.2	-5.3	67.	1.65	3298356.	1470100.
48.96	28.633	-80.581	24035.	928.	1106.	2006.	177.3	64.0	-5.6	67.	1.64	3278863.	1468099.
49.92	28.634	-80.580	24932.	941.	1125.	2022.	177.3	63.8	-5.9	67.	1.64	3259540.	1466097.
50.88	28.636	-80.579	25842.	954.	1144.	2037.	177.4	63.6	-6.1	67.	1.65	3240315.	1464095.
51.84	28.637	-80.577	26764.	967.	1163.	2053.	177.6	63.4	-6.3	67.	1.66	3221133.	1462094.
52.80	28.638	-80.576	27699.	980.	1183.	2069.	177.7	63.2	-6.5	67.	1.67	3201960.	1460092.
53.76	28.640	-80.575	28646.	994.	1202.	2086.	177.8	62.9	-6.8	67.	1.69	3182758.	1458090.
54.72	28.641	-80.574	29607.	1007.	1223.	2103.	177.9	62.6	-7.0	67.	1.71	3163491.	1456089.
55.68	28.643	-80.572	30580.	1022.	1244.	2121.	178.0	62.4	-7.2	67.	1.73	3144136.	1454087.
56.64	28.644	-80.571	31568.	1036.	1266.	2139.	178.1	62.2	-7.3	67.	1.76	3124691.	1452085.
57.60	28.646	-80.570	32570.	1052.	1288.	2158.	178.0	62.1	-7.5	67.	1.78	3105158.	1450084.
58.56	28.647	-80.569	33587.	1067.	1311.	2178.	178.0	61.8	-7.7	67.	1.80	3085537.	1448082.
59.52	28.649	-80.567	34620.	1084.	1335.	2198.	177.9	61.5	-8.0	67.	1.83	3065827.	1446080.
60.48	28.650	-80.566	35668.	1101.	1360.	2219.	177.9	61.2	-8.2	67.	1.85	3046028.	1444079.
61.44	28.652	-80.564	36733.	1118.	1385.	2241.	178.0	61.0	-8.5	67.	1.87	3026141.	1442077.
62.40	28.654	-80.563	37816.	1137.	1412.	2263.	178.1	60.9	-8.7	72.	1.92	3006130.	1440040.
63.36	28.656	-80.561	38916.	1157.	1440.	2287.	178.2	60.7	-8.8	81.	1.99	2985788.	1437751.
64.32	28.658	-80.560	40037.	1179.	1471.	2312.	178.4	60.5	-8.9	91.	2.06	2965090.	1435173.
65.28	28.660	-80.558	41180.	1203.	1503.	2339.	178.7	60.3	-8.8	101.	2.13	2944043.	1432307.
66.24	28.661	-80.557	42347.	1229.	1538.	2368.	178.9	60.0	-8.7	104.	2.17	2922703.	1429212.
67.20	28.663	-80.555	43540.	1255.	1573.	2398.	179.1	59.7	-8.5	104.	2.19	2901262.	1426097.
68.16	28.666	-80.553	44758.	1282.	1610.	2429.	179.1	59.1	-8.3	104.	2.22	2879740.	1422983.
69.12	28.668	-80.552	46002.	1310.	1647.	2461.	179.1	58.4	-8.0	104.	2.24	2858157.	1419869.
70.08	28.670	-80.550	47272.	1337.	1685.	2495.	179.1	57.7	-7.7	104.	2.27	2836521.	1416755.
71.04	28.672	-80.548	48568.	1364.	1725.	2530.	179.0	56.9	-7.3	104.	2.29	2814838.	1413641.
72.00	28.674	-80.546	49892.	1392.	1766.	2566.	178.9	56.2	-6.9	104.	2.32	2793106.	1410526.
72.96	28.677	-80.545	51241.	1420.	1807.	2603.	178.8	55.5	-6.5	104.	2.34	2771336.	1407412.
73.92	28.679	-80.543	52618.	1448.	1850.	2642.	178.6	54.7	-6.0	104.	2.37	2749532.	1404298.
74.88	28.682	-80.541	54021.	1476.	1894.	2683.	178.5	53.9	-5.6	104.	2.39	2727698.	1401184.
75.84	28.684	-80.539	55451.	1503.	1938.	2725.	178.3	53.0	-5.2	104.	2.41	2705845.	1398070.
76.80	28.687	-80.536	56907.	1531.	1984.	2768.	178.2	52.1	-4.8	104.	2.44	2683974.	1394956.
77.76	28.690	-80.534	58391.	1559.	2031.	2812.	178.2	51.2	-4.4	104.	2.45	2662108.	1391841.
78.72	28.693	-80.532	59900.	1586.	2079.	2858.	178.2	50.2	-4.0	104.	2.46	2640345.	1388727.
79.68	28.696	-80.530	61435.	1612.	2126.	2904.	178.2	49.2	-3.6	104.	2.46	2618781.	1385613.

NOMINAL DISPLAY DATA FOR STS-45 CYCLE FLT
TRAJECTORY SUMMARY

TIME (SEC)	GEOD LATD (DEG)	LONG (DEG)	ALT (FT)	ALT RATE (FPS)	VE (FPS)	VI (FPS)	ROLL ANGLE (DEG)	PITCH ANGLE (DEG)	YAW ANGLE (DEG)	THRT LEVEL (%)	SENSED ACC (G)	TOTAL WT (LBS)	ET MPS WT (LBS)
80.64	28.699	-80.527	62995.	1638.	2175.	2951.	178.3	48.1	-3.2	104.	2.46	2597409.	1382499.
81.60	28.702	-80.525	64579.	1662.	2224.	3000.	178.4	47.1	-2.8	104.	2.47	2576189.	1379385.
82.56	28.705	-80.522	66187.	1686.	2273.	3049.	178.4	46.2	-2.4	104.	2.47	2555113.	1376270.
83.52	28.709	-80.520	67817.	1710.	2323.	3098.	178.5	45.5	-2.2	104.	2.47	2534244.	1373156.
84.48	28.712	-80.517	69469.	1733.	2372.	3148.	178.5	44.8	-2.0	104.	2.47	2513595.	1370042.
85.44	28.716	-80.514	71144.	1756.	2423.	3199.	178.5	44.2	-1.8	104.	2.47	2493134.	1366928.
86.40	28.719	-80.511	72840.	1778.	2473.	3250.	178.6	43.7	-1.6	104.	2.47	2472871.	1363814.
87.36	28.723	-80.508	74557.	1800.	2524.	3301.	178.6	43.3	-1.5	104.	2.46	2452860.	1360700.
88.32	28.727	-80.505	76295.	1821.	2575.	3352.	178.7	43.0	-1.4	104.	2.44	2433143.	1357585.
89.28	28.731	-80.502	78054.	1843.	2625.	3403.	178.7	42.6	-1.3	104.	2.43	2413715.	1354471.
90.24	28.735	-80.499	79833.	1863.	2676.	3454.	178.8	42.1	-1.2	104.	2.44	2394480.	1351357.
91.20	28.739	-80.496	81632.	1884.	2728.	3506.	178.8	41.7	-1.1	104.	2.45	2375339.	1348243.
92.16	28.743	-80.492	83451.	1905.	2780.	3559.	178.8	41.2	-1.1	104.	2.46	2356279.	1345129.
93.12	28.748	-80.489	85289.	1925.	2832.	3612.	178.8	40.7	-1.1	104.	2.47	2337320.	1342014.
94.08	28.752	-80.485	87147.	1946.	2885.	3665.	178.9	40.3	-1.1	104.	2.47	2318498.	1338900.
95.04	28.757	-80.481	89025.	1966.	2938.	3719.	179.0	39.9	-1.2	104.	2.46	2299861.	1335786.
96.00	28.762	-80.478	90921.	1985.	2992.	3773.	179.1	39.5	-1.2	104.	2.45	2281455.	1332672.
96.96	28.767	-80.474	92836.	2004.	3045.	3827.	179.2	39.1	-1.2	104.	2.44	2263274.	1329558.
97.92	28.772	-80.470	94769.	2023.	3098.	3881.	179.2	38.8	-1.1	104.	2.44	2245274.	1326443.
98.88	28.777	-80.466	96720.	2042.	3152.	3935.	179.3	38.4	-1.2	104.	2.44	2227437.	1323329.
99.84	28.782	-80.461	98689.	2060.	3205.	3989.	179.3	38.1	-1.2	104.	2.44	2209765.	1320215.
100.80	28.787	-80.457	100675.	2078.	3259.	4044.	179.3	37.7	-1.2	104.	2.43	2192281.	1317101.
101.76	28.793	-80.453	102678.	2095.	3313.	4098.	179.3	37.4	-1.3	104.	2.42	2175001.	1313987.
102.72	28.798	-80.448	104698.	2113.	3367.	4153.	179.4	37.0	-1.3	104.	2.41	2157939.	1310873.
103.68	28.804	-80.444	106734.	2129.	3420.	4207.	179.5	36.7	-1.3	104.	2.40	2141124.	1307758.
104.64	28.810	-80.439	108786.	2146.	3474.	4261.	179.5	36.3	-1.4	104.	2.38	2124640.	1304644.
105.60	28.815	-80.434	110853.	2161.	3527.	4314.	179.6	36.0	-1.5	104.	2.36	2108500.	1301530.
106.56	28.821	-80.429	112935.	2176.	3579.	4368.	179.7	35.6	-1.6	104.	2.35	2092664.	1298416.
107.52	28.828	-80.424	115032.	2191.	3632.	4421.	179.7	35.3	-1.7	104.	2.34	2077081.	1295302.
108.48	28.834	-80.419	117142.	2205.	3685.	4474.	179.8	34.9	-1.8	104.	2.34	2061666.	1292187.
109.44	28.840	-80.414	119266.	2220.	3738.	4528.	179.9	34.6	-1.9	104.	2.33	2046407.	1289073.
110.40	28.847	-80.409	121403.	2233.	3790.	4580.	180.0	34.2	-2.0	104.	2.27	2031506.	1285959.
111.36	28.853	-80.403	123553.	2245.	3839.	4631.	180.1	33.9	-2.0	104.	2.19	2017202.	1282845.
112.32	28.860	-80.398	125712.	2254.	3886.	4678.	180.1	33.6	-2.0	104.	2.05	2003770.	1279731.
113.28	28.867	-80.392	127880.	2261.	3928.	4721.	180.1	33.2	-2.0	104.	1.84	1991655.	1276617.
114.24	28.874	-80.387	130053.	2264.	3963.	4757.	180.0	32.8	-1.9	104.	1.62	1981143.	1273502.
115.20	28.881	-80.381	132226.	2264.	3992.	4787.	180.1	32.3	-1.9	104.	1.44	1972082.	1270388.
116.16	28.888	-80.375	134398.	2261.	4016.	4812.	180.1	31.9	-1.9	104.	1.31	1964092.	1267274.
117.12	28.895	-80.369	136566.	2256.	4037.	4835.	180.2	31.4	-1.9	104.	1.21	1956964.	1264160.
118.08	28.902	-80.363	138728.	2249.	4055.	4854.	180.2	30.9	-1.8	104.	1.13	1950605.	1261046.
119.04	28.909	-80.358	140883.	2241.	4071.	4872.	180.3	30.5	-1.8	104.	1.05	1944900.	1257931.
120.00	28.916	-80.352	143030.	2231.	4085.	4887.	180.4	30.2	-1.8	104.	.98	1939797.	1254817.

NOMINAL DISPLAY DATA FOR STS-45 CYCLE FLT
TRAJECTORY SUMMARY

TIME (SEC)	GEOD LATD (DEG)	LONG (DEG)	ALT (FT)	ALT RATE (FPS)	VE (FPS)	VI (FPS)	ROLL ANGLE (DEG)	PITCH ANGLE (DEG)	YAW ANGLE (DEG)	THRT LEVEL (%)	SENSED ACC (G)	TOTAL WT (LBS)	ET MPS WT (LBS)
120.96	28.924	-80.346	145167.	2221.	4097.	4901.	180.4	30.2	-1.7	104.	.93	1935220.	1251703.
121.92	28.931	-80.340	147294.	2210.	4108.	4914.	180.5	30.2	-1.7	104.	.88	1931045.	1248589.
122.88	28.938	-80.334	149410.	2199.	4118.	4925.	180.5	30.3	-1.7	104.	.85	1927160.	1245475.
123.84	28.946	-80.327	151516.	2187.	4127.	4935.	180.5	30.3	-1.6	104.	.82	1923483.	1242361.
124.80	28.953	-80.321	153610.	2175.	4135.	4945.	180.6	30.4	-1.6	104.	.81	1919973.	1239246.
125.48	28.958	-80.317	155086.	2167.	4141.	4952.	180.6	30.4	-1.6	104.	.80	1917567.	1237040.
SRB SEP AT 125.48 SEC													
125.48	28.958	-80.317	155086.	2167.	4141.	4952.	180.6	30.4	-1.6	104.	.95	1539555.	1237040.
126.08	28.963	-80.313	156384.	2161.	4149.	4961.	180.6	29.9	-1.6	104.	.95	1537607.	1235094.
127.04	28.971	-80.307	158454.	2151.	4162.	4975.	180.9	29.8	-1.5	104.	.96	1534492.	1231980.
128.00	28.978	-80.301	160514.	2142.	4175.	4989.	181.3	30.0	-1.4	104.	.96	1531376.	1228866.
128.96	28.986	-80.294	162566.	2132.	4188.	5004.	181.5	30.2	-1.3	104.	.96	1528260.	1225752.
129.92	28.994	-80.288	164609.	2123.	4201.	5019.	181.6	30.3	-1.3	104.	.96	1525144.	1222637.
130.88	29.001	-80.282	166643.	2114.	4215.	5034.	181.6	30.4	-1.3	104.	.96	1522029.	1219523.
131.84	29.009	-80.275	168668.	2105.	4229.	5048.	181.7	30.4	-1.3	104.	.97	1518914.	1216409.
132.80	29.017	-80.269	170685.	2097.	4242.	5063.	181.6	30.3	-1.4	104.	.97	1515799.	1213295.
133.76	29.025	-80.263	172694.	2088.	4256.	5079.	181.4	29.3	-2.0	104.	.97	1512684.	1210181.
134.72	29.033	-80.256	174693.	2078.	4271.	5094.	181.2	27.4	-3.1	104.	.97	1509569.	1207066.
135.68	29.041	-80.249	176684.	2068.	4286.	5110.	181.2	25.6	-4.1	104.	.97	1506454.	1203952.
136.64	29.049	-80.243	178664.	2057.	4301.	5126.	181.3	24.2	-4.9	104.	.98	1503339.	1200838.
137.60	29.057	-80.236	180633.	2046.	4316.	5142.	181.3	23.3	-5.3	104.	.98	1500225.	1197724.
138.56	29.065	-80.230	182591.	2034.	4332.	5159.	181.4	22.7	-5.4	104.	.98	1497110.	1194610.
139.52	29.073	-80.223	184538.	2022.	4347.	5176.	181.5	22.6	-5.4	104.	.98	1493995.	1191496.
140.48	29.081	-80.216	186473.	2010.	4363.	5193.	181.5	22.6	-5.2	104.	.98	1490880.	1188381.
141.44	29.089	-80.209	188397.	1999.	4379.	5210.	181.4	22.7	-5.1	104.	.99	1487765.	1185267.
142.40	29.097	-80.203	190311.	1987.	4396.	5227.	181.4	22.7	-5.0	104.	.99	1484650.	1182153.
143.36	29.106	-80.196	192213.	1976.	4412.	5244.	181.2	22.6	-4.9	104.	.99	1481535.	1179039.
144.32	29.114	-80.189	194105.	1965.	4429.	5262.	181.1	22.4	-4.9	104.	.99	1478420.	1175925.
145.28	29.123	-80.182	195985.	1953.	4446.	5280.	181.0	22.3	-4.9	104.	1.00	1475305.	1172810.
146.24	29.131	-80.175	197854.	1942.	4463.	5298.	180.8	22.1	-4.9	104.	1.00	1472190.	1169696.
147.20	29.140	-80.168	199713.	1930.	4480.	5316.	180.7	22.0	-5.0	104.	1.00	1469075.	1166582.
148.16	29.148	-80.161	201560.	1919.	4498.	5334.	180.6	21.8	-5.0	104.	1.00	1465960.	1163468.
149.12	29.157	-80.154	203397.	1907.	4515.	5352.	180.4	21.8	-5.0	104.	1.00	1462846.	1160354.
150.08	29.166	-80.146	205222.	1896.	4533.	5371.	180.3	21.7	-5.1	104.	1.01	1459731.	1157239.
151.04	29.174	-80.139	207037.	1884.	4551.	5390.	180.2	21.6	-5.1	104.	1.01	1456616.	1154125.
152.00	29.183	-80.132	208840.	1873.	4569.	5408.	180.2	21.4	-5.1	104.	1.01	1453501.	1151011.
152.96	29.192	-80.125	210633.	1862.	4588.	5427.	180.2	21.3	-5.1	104.	1.01	1450386.	1147897.
153.92	29.201	-80.117	212414.	1850.	4606.	5447.	180.1	21.2	-5.1	104.	1.01	1447271.	1144783.
154.88	29.210	-80.110	214185.	1839.	4625.	5466.	180.1	21.1	-5.0	104.	1.02	1444156.	1141669.
155.84	29.219	-80.103	215945.	1827.	4644.	5485.	180.1	20.9	-5.0	104.	1.02	1441041.	1138554.
156.80	29.228	-80.095	217693.	1816.	4663.	5505.	180.0	20.8	-5.0	104.	1.02	1437926.	1135440.
157.76	29.237	-80.088	219431.	1805.	4682.	5525.	180.0	20.7	-5.0	104.	1.02	1434811.	1132326.

NOMINAL DISPLAY DATA FOR STS-45 CYCLE FLT
TRAJECTORY SUMMARY

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158.72	29.246	-80.080	221158.	1793.	4701.	5545.	180.0	20.6	-5.0	104.	1.03	1431696.	1129212.
159.68	29.256	-80.073	222874.	1782.	4721.	5565.	179.9	20.5	-4.9	104.	1.03	1428582.	1126098.
160.64	29.265	-80.065	224579.	1770.	4741.	5585.	179.9	20.5	-4.9	104.	1.03	1425467.	1122983.
161.60	29.274	-80.057	226273.	1759.	4761.	5606.	179.9	20.4	-4.9	104.	1.03	1422352.	1119869.
162.56	29.284	-80.050	227956.	1748.	4781.	5626.	179.9	20.2	-4.9	104.	1.03	1419237.	1116755.
163.52	29.293	-80.042	229628.	1736.	4801.	5647.	179.9	20.2	-4.8	104.	1.04	1416122.	1113641.
164.48	29.303	-80.034	231290.	1725.	4821.	5668.	179.9	20.1	-4.8	104.	1.04	1413007.	1110527.
165.44	29.312	-80.026	232940.	1714.	4842.	5689.	179.9	20.0	-4.8	104.	1.04	1409892.	1107413.
166.40	29.322	-80.018	234580.	1703.	4863.	5710.	179.9	19.9	-4.8	104.	1.04	1406777.	1104298.
167.36	29.332	-80.011	236209.	1691.	4884.	5732.	179.9	19.8	-4.7	104.	1.05	1403662.	1101184.
168.32	29.341	-80.003	237827.	1680.	4905.	5753.	179.9	19.7	-4.7	104.	1.05	1400547.	1098070.
169.28	29.351	-79.995	239435.	1669.	4926.	5775.	179.9	19.6	-4.7	104.	1.05	1397432.	1094956.
170.24	29.361	-79.986	241031.	1658.	4948.	5797.	179.9	19.5	-4.7	104.	1.05	1394317.	1091842.
171.20	29.371	-79.978	242617.	1646.	4969.	5819.	179.9	19.5	-4.7	104.	1.06	1391203.	1088727.
172.16	29.381	-79.970	244192.	1635.	4991.	5841.	180.0	19.4	-4.6	104.	1.06	1388088.	1085613.
173.12	29.391	-79.962	245757.	1624.	5013.	5863.	180.0	19.3	-4.6	104.	1.06	1384973.	1082499.
174.08	29.401	-79.954	247310.	1613.	5035.	5886.	180.0	19.2	-4.6	104.	1.06	1381858.	1079385.
175.04	29.411	-79.945	248853.	1602.	5058.	5908.	180.0	19.1	-4.6	104.	1.07	1378743.	1076271.
176.00	29.421	-79.937	250386.	1591.	5080.	5931.	179.9	19.0	-4.6	104.	1.07	1375628.	1073156.
176.96	29.432	-79.929	251907.	1580.	5103.	5954.	179.9	18.9	-4.5	104.	1.07	1372513.	1070042.
177.92	29.442	-79.920	253418.	1569.	5125.	5977.	179.9	18.9	-4.5	104.	1.07	1369398.	1066928.
178.88	29.452	-79.912	254919.	1558.	5148.	6000.	179.9	18.8	-4.5	104.	1.07	1366283.	1063814.
179.84	29.463	-79.903	256409.	1547.	5172.	6023.	179.9	18.7	-4.5	104.	1.08	1363168.	1060700.
180.80	29.473	-79.895	257888.	1536.	5195.	6047.	180.0	18.6	-4.5	104.	1.08	1360053.	1057586.
181.76	29.484	-79.886	259357.	1525.	5218.	6071.	180.0	18.5	-4.5	104.	1.08	1356939.	1054471.
182.72	29.495	-79.877	260815.	1514.	5242.	6094.	180.0	18.4	-4.4	104.	1.08	1353824.	1051357.
183.68	29.505	-79.869	262262.	1503.	5266.	6118.	180.0	18.4	-4.4	104.	1.09	1350709.	1048243.
184.64	29.516	-79.860	263699.	1492.	5290.	6143.	179.9	18.3	-4.4	104.	1.09	1347594.	1045129.
185.60	29.527	-79.851	265126.	1481.	5314.	6167.	179.9	18.2	-4.4	104.	1.09	1344479.	1042015.
186.56	29.538	-79.842	266542.	1470.	5338.	6191.	179.9	18.1	-4.4	104.	1.09	1341364.	1038900.
187.52	29.548	-79.833	267948.	1459.	5362.	6216.	179.9	18.0	-4.4	104.	1.10	1338249.	1035786.
188.48	29.559	-79.824	269343.	1448.	5387.	6241.	180.0	17.9	-4.4	104.	1.10	1335134.	1032672.
189.44	29.570	-79.815	270728.	1437.	5412.	6265.	180.0	17.9	-4.4	104.	1.10	1332019.	1029558.
190.40	29.582	-79.806	272102.	1426.	5436.	6290.	180.0	17.8	-4.3	104.	1.10	1328904.	1026444.
191.36	29.593	-79.797	273467.	1416.	5462.	6316.	180.0	17.7	-4.3	104.	1.11	1325789.	1023330.
192.32	29.604	-79.788	274820.	1405.	5487.	6341.	180.0	17.6	-4.3	104.	1.11	1322675.	1020215.
193.28	29.615	-79.779	276164.	1394.	5512.	6366.	180.0	17.5	-4.3	104.	1.11	1319560.	1017101.
194.24	29.627	-79.769	277497.	1383.	5538.	6392.	180.0	17.5	-4.3	104.	1.12	1316445.	1013987.
195.20	29.638	-79.760	278819.	1373.	5563.	6418.	180.0	17.4	-4.3	104.	1.12	1313330.	1010873.
196.16	29.649	-79.751	280132.	1362.	5589.	6444.	180.0	17.3	-4.3	104.	1.12	1310215.	1007759.
197.12	29.661	-79.741	281434.	1351.	5615.	6470.	180.0	17.2	-4.3	104.	1.12	1307100.	1004644.
198.08	29.673	-79.732	282726.	1341.	5641.	6496.	180.0	17.1	-4.3	104.	1.13	1303985.	1001530.

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TRAJECTORY SUMMARY

TIME (SEC)	GEOD LATD (DEG)	LONG (DEG)	ALT (FT)	ALT RATE (FPS)	VE (FPS)	VI (FPS)	ROLL ANGLE (DEG)	PITCH ANGLE (DEG)	YAW ANGLE (DEG)	THRT LEVEL (%)	SENSED ACC (G)	TOTAL WT (LBS)	ET MPS WT (LBS)
199.04	29.684	-79.722	284008.	1330.	5667.	6522.	180.0	17.0	-4.3	104.	1.13	1300870.	998416.
200.00	29.696	-79.713	285279.	1319.	5694.	6549.	180.0	17.0	-4.3	104.	1.13	1297755.	995302.
200.96	29.708	-79.703	286541.	1309.	5720.	6575.	179.9	16.9	-4.3	104.	1.13	1294640.	992188.
201.92	29.719	-79.694	287792.	1298.	5747.	6602.	179.9	16.8	-4.2	104.	1.14	1291525.	989074.
202.88	29.731	-79.684	289033.	1288.	5774.	6629.	180.0	16.7	-4.2	104.	1.14	1288410.	985959.
203.84	29.743	-79.674	290264.	1277.	5801.	6656.	180.0	16.6	-4.2	104.	1.14	1285296.	982845.
204.80	29.755	-79.664	291484.	1267.	5828.	6683.	180.0	16.6	-4.2	104.	1.15	1282181.	979731.
205.76	29.767	-79.654	292695.	1256.	5856.	6711.	180.0	16.5	-4.2	104.	1.15	1279066.	976617.
206.72	29.780	-79.644	293896.	1246.	5883.	6738.	180.0	16.4	-4.2	104.	1.15	1275951.	973503.
207.68	29.792	-79.634	295086.	1235.	5911.	6766.	180.0	16.3	-4.2	104.	1.15	1272836.	970388.
208.64	29.804	-79.624	296267.	1225.	5938.	6793.	179.9	16.2	-4.1	104.	1.16	1269721.	967274.
209.60	29.816	-79.614	297438.	1214.	5966.	6821.	180.0	16.2	-4.1	104.	1.16	1266606.	964160.
210.56	29.829	-79.604	298598.	1204.	5994.	6849.	180.0	16.1	-4.1	104.	1.16	1263491.	961046.
211.52	29.841	-79.594	299749.	1194.	6023.	6878.	180.0	16.0	-4.1	104.	1.17	1260376.	957932.
212.48	29.854	-79.583	300890.	1183.	6051.	6906.	180.0	15.9	-4.1	104.	1.17	1257261.	954817.
213.44	29.866	-79.573	302020.	1173.	6080.	6935.	180.1	15.8	-4.1	104.	1.17	1254146.	951703.
214.40	29.879	-79.563	303141.	1163.	6108.	6963.	180.1	15.7	-4.1	104.	1.17	1251032.	948589.
215.36	29.892	-79.552	304252.	1152.	6137.	6992.	180.0	15.7	-4.1	104.	1.18	1247917.	945475.
216.32	29.905	-79.542	305354.	1142.	6166.	7021.	180.0	15.6	-4.1	104.	1.18	1244802.	942361.
217.28	29.917	-79.531	306445.	1132.	6195.	7050.	179.9	15.5	-4.1	104.	1.18	1241687.	939247.
218.24	29.930	-79.521	307526.	1122.	6225.	7079.	179.9	15.4	-4.1	104.	1.19	1238572.	936132.
219.20	29.943	-79.510	308598.	1112.	6254.	7109.	180.0	15.3	-4.1	104.	1.19	1235457.	933018.
220.16	29.956	-79.499	309660.	1101.	6284.	7138.	180.0	15.3	-4.1	104.	1.19	1232342.	929904.
221.12	29.970	-79.489	310712.	1091.	6313.	7168.	180.0	15.2	-4.0	104.	1.19	1229227.	926790.
222.08	29.983	-79.478	311755.	1081.	6343.	7198.	180.1	15.1	-4.0	104.	1.20	1226112.	923676.
223.04	29.996	-79.467	312788.	1071.	6373.	7228.	180.0	15.0	-4.0	104.	1.20	1222997.	920561.
224.00	30.009	-79.456	313811.	1061.	6404.	7258.	180.0	14.9	-4.0	104.	1.20	1219882.	917447.
224.96	30.023	-79.445	314824.	1051.	6434.	7288.	180.0	14.9	-4.0	104.	1.21	1216767.	914333.
225.92	30.036	-79.434	315828.	1041.	6464.	7318.	180.0	14.8	-4.0	104.	1.21	1213653.	911219.
226.88	30.050	-79.423	316822.	1031.	6495.	7349.	180.0	14.7	-4.0	104.	1.21	1210538.	908105.
227.84	30.063	-79.411	317807.	1021.	6526.	7380.	180.0	14.6	-3.9	104.	1.22	1207423.	904991.
228.80	30.077	-79.400	318782.	1011.	6557.	7410.	180.0	14.5	-3.9	104.	1.22	1204308.	901876.
229.76	30.091	-79.389	319747.	1001.	6588.	7441.	180.0	14.4	-3.9	104.	1.22	1201193.	898762.
230.72	30.104	-79.377	320703.	991.	6619.	7473.	180.0	14.4	-3.9	104.	1.23	1198078.	895648.
231.68	30.118	-79.366	321650.	981.	6650.	7504.	180.0	14.3	-3.9	104.	1.23	1194963.	892534.
232.64	30.132	-79.355	322587.	971.	6682.	7535.	180.0	14.2	-3.9	104.	1.23	1191848.	889420.
233.60	30.146	-79.343	323514.	961.	6714.	7567.	180.0	14.1	-3.9	104.	1.24	1188733.	886305.
234.56	30.160	-79.331	324432.	952.	6746.	7598.	180.0	14.0	-3.9	104.	1.24	1185618.	883191.
235.52	30.174	-79.320	325341.	942.	6777.	7630.	180.0	14.0	-3.9	104.	1.24	1182503.	880077.
236.48	30.189	-79.308	326240.	932.	6810.	7662.	180.0	13.9	-3.9	104.	1.25	1179389.	876963.
237.44	30.203	-79.296	327130.	922.	6842.	7695.	180.0	13.8	-3.9	104.	1.25	1176274.	873849.
238.40	30.217	-79.284	328011.	913.	6874.	7727.	180.0	13.7	-3.8	104.	1.25	1173159.	870735.

NOMINAL DISPLAY DATA FOR STS-45 CYCLE FLT
TRAJECTORY SUMMARY

TIME (SEC)	GEOD LATD (DEG)	LONG (DEG)	ALT (FT)	ALT RATE (FPS)	VE (FPS)	VI (FPS)	ROLL ANGLE (DEG)	PITCH ANGLE (DEG)	YAW ANGLE (DEG)	THRT LEVEL (%)	SENSED ACC (G)	TOTAL WT (LBS)	ET MPS WT (LBS)
239.36	30.232	-79.272	328882.	903.	6907.	7759.	180.0	13.6	-3.8	104.	1.25	1170044.	867620.
240.32	30.246	-79.260	329744.	893.	6940.	7792.	180.0	13.6	-3.8	104.	1.26	1166929.	864506.
241.28	30.261	-79.248	330597.	884.	6973.	7825.	180.1	13.5	-3.8	104.	1.26	1163814.	861392.
242.24	30.275	-79.236	331440.	874.	7006.	7857.	180.0	13.4	-3.8	104.	1.27	1160699.	858278.
243.20	30.290	-79.224	332275.	864.	7039.	7890.	180.0	13.3	-3.8	104.	1.27	1157584.	855164.
244.16	30.305	-79.212	333100.	855.	7072.	7924.	180.0	13.2	-3.8	104.	1.27	1154469.	852049.
245.12	30.320	-79.200	333915.	845.	7106.	7957.	180.0	13.2	-3.8	104.	1.28	1151354.	848935.
246.08	30.335	-79.187	334722.	836.	7139.	7990.	180.0	13.1	-3.8	104.	1.28	1148239.	845821.
247.04	30.350	-79.175	335520.	826.	7173.	8024.	180.0	13.0	-3.8	104.	1.28	1145124.	842707.
248.00	30.365	-79.162	336308.	817.	7207.	8058.	180.0	12.9	-3.8	104.	1.29	1142010.	839593.
248.96	30.380	-79.150	337088.	807.	7241.	8092.	180.1	12.8	-3.7	104.	1.29	1138895.	836478.
249.92	30.395	-79.137	337858.	798.	7275.	8126.	180.1	12.8	-3.7	104.	1.29	1135780.	833364.
250.88	30.410	-79.124	338619.	789.	7310.	8160.	180.0	12.7	-3.7	104.	1.30	1132665.	830250.
251.84	30.426	-79.112	339372.	779.	7344.	8194.	180.0	12.6	-3.7	104.	1.30	1129550.	827136.
252.80	30.441	-79.099	340115.	770.	7379.	8229.	180.0	12.5	-3.7	104.	1.30	1126435.	824022.
253.76	30.457	-79.086	340849.	761.	7414.	8264.	180.0	12.4	-3.7	104.	1.31	1123320.	820908.
254.72	30.472	-79.073	341575.	751.	7449.	8299.	180.0	12.4	-3.7	104.	1.31	1120205.	817793.
255.68	30.488	-79.060	342292.	742.	7484.	8333.	180.0	12.3	-3.7	104.	1.31	1117090.	814679.
256.64	30.503	-79.047	342999.	733.	7519.	8369.	180.0	12.2	-3.6	104.	1.32	1113975.	811565.
257.60	30.519	-79.034	343698.	724.	7555.	8404.	180.0	12.1	-3.6	104.	1.32	1110860.	808451.
258.56	30.535	-79.020	344388.	715.	7590.	8439.	180.0	12.0	-3.6	104.	1.33	1107746.	805337.
259.52	30.551	-79.007	345070.	705.	7626.	8475.	180.0	12.0	-3.6	104.	1.33	1104631.	802222.
260.48	30.567	-78.994	345742.	696.	7662.	8511.	180.0	11.9	-3.6	104.	1.33	1101516.	799108.
261.44	30.583	-78.980	346406.	687.	7698.	8547.	180.0	11.8	-3.6	104.	1.34	1098401.	795994.
262.40	30.599	-78.967	347061.	678.	7734.	8583.	180.0	11.7	-3.6	104.	1.34	1095286.	792880.
263.36	30.616	-78.953	347707.	669.	7770.	8619.	180.0	11.6	-3.6	104.	1.34	1092171.	789766.
264.32	30.632	-78.940	348345.	660.	7807.	8655.	180.1	11.6	-3.6	104.	1.35	1089056.	786652.
265.28	30.648	-78.926	348974.	651.	7844.	8692.	180.0	11.5	-3.6	104.	1.35	1085941.	783537.
266.24	30.665	-78.912	349595.	642.	7881.	8728.	180.0	11.4	-3.5	104.	1.36	1082826.	780423.
267.20	30.681	-78.898	350207.	633.	7918.	8765.	180.0	11.3	-3.5	104.	1.36	1079711.	777309.
268.16	30.698	-78.884	350810.	624.	7955.	8802.	180.0	11.3	-3.5	104.	1.36	1076596.	774195.
269.12	30.715	-78.870	351405.	616.	7992.	8839.	180.0	11.2	-3.5	104.	1.37	1073481.	771081.
270.08	30.732	-78.856	351992.	607.	8029.	8877.	180.0	11.1	-3.5	104.	1.37	1070367.	767966.
271.04	30.748	-78.842	352570.	598.	8067.	8914.	180.0	11.0	-3.5	104.	1.38	1067252.	764852.
272.00	30.765	-78.828	353139.	589.	8105.	8952.	180.0	10.9	-3.5	104.	1.38	1064137.	761738.
272.96	30.782	-78.814	353700.	581.	8143.	8989.	180.0	10.9	-3.5	104.	1.38	1061022.	758624.
273.92	30.800	-78.799	354253.	572.	8181.	9027.	180.0	10.8	-3.5	104.	1.39	1057907.	755510.
274.88	30.817	-78.785	354798.	563.	8219.	9065.	180.0	10.7	-3.5	104.	1.39	1054792.	752396.
275.84	30.834	-78.770	355334.	555.	8258.	9104.	180.0	10.6	-3.5	104.	1.40	1051677.	749281.
276.80	30.851	-78.756	355862.	546.	8296.	9142.	180.0	10.5	-3.5	104.	1.40	1048562.	746167.
277.76	30.869	-78.741	356381.	537.	8335.	9181.	180.1	10.5	-3.4	104.	1.40	1045447.	743053.
278.72	30.886	-78.726	356893.	529.	8374.	9219.	180.0	10.4	-3.4	104.	1.41	1042332.	739939.

NOMINAL DISPLAY DATA FOR STS-45 CYCLE FLT
TRAJECTORY SUMMARY

TIME (SEC)	GEOD LATD (DEG)	LONG (DEG)	ALT (FT)	ALT RATE (FPS)	VE (FPS)	VI (FPS)	ROLL ANGLE (DEG)	PITCH ANGLE (DEG)	YAW ANGLE (DEG)	THRT LEVEL (%)	SENSED ACC (G)	TOTAL WT (LBS)	ET MPS WT (LBS)
279.68	30.904	-78.711	357396.	520.	8413.	9258.	180.0	10.3	-3.4	104.	1.41	1039217.	736825.
280.64	30.921	-78.697	357891.	512.	8452.	9297.	180.0	10.2	-3.4	104.	1.42	1036103.	733710.
281.60	30.939	-78.682	358378.	503.	8492.	9337.	180.0	10.2	-3.4	104.	1.42	1032988.	730596.
282.56	30.957	-78.667	358857.	495.	8531.	9376.	180.0	10.1	-3.4	104.	1.43	1029873.	727482.
283.52	30.975	-78.651	359328.	487.	8571.	9415.	180.0	10.0	-3.4	104.	1.43	1026758.	724368.
284.48	30.993	-78.636	359791.	478.	8611.	9455.	180.0	9.9	-3.3	104.	1.43	1023643.	721254.
285.44	31.011	-78.621	360246.	470.	8651.	9495.	180.1	9.9	-3.3	104.	1.44	1020528.	718139.
286.40	31.029	-78.606	360693.	462.	8691.	9535.	180.0	9.8	-3.3	104.	1.44	1017413.	715025.
287.36	31.047	-78.590	361132.	454.	8731.	9575.	180.0	9.7	-3.3	104.	1.45	1014298.	711911.
288.32	31.066	-78.575	361563.	445.	8772.	9616.	180.0	9.6	-3.3	104.	1.45	1011183.	708797.
289.28	31.084	-78.559	361986.	437.	8813.	9656.	180.0	9.6	-3.3	104.	1.46	1008068.	705683.
290.24	31.103	-78.543	362401.	429.	8854.	9697.	180.0	9.5	-3.3	104.	1.46	1004953.	702569.
291.20	31.121	-78.528	362809.	421.	8895.	9738.	180.0	9.4	-3.3	104.	1.47	1001838.	699454.
292.16	31.140	-78.512	363209.	413.	8936.	9779.	180.0	9.3	-3.2	104.	1.47	998724.	696340.
293.12	31.159	-78.496	363601.	405.	8977.	9820.	180.0	9.2	-3.2	104.	1.47	995609.	693226.
294.08	31.177	-78.480	363986.	397.	9019.	9861.	180.0	9.2	-3.3	104.	1.48	992494.	690112.
295.04	31.196	-78.464	364363.	389.	9061.	9903.	180.0	9.1	-3.3	104.	1.48	989379.	686998.
296.00	31.215	-78.448	364732.	381.	9102.	9945.	180.0	9.0	-3.3	104.	1.49	986264.	683883.
296.96	31.234	-78.431	365094.	373.	9145.	9987.	180.0	8.9	-3.3	104.	1.49	983149.	680769.
297.92	31.254	-78.415	365448.	365.	9187.	10029.	180.0	8.9	-3.2	104.	1.50	980034.	677655.
298.88	31.273	-78.398	365795.	358.	9229.	10071.	180.1	8.8	-3.2	104.	1.50	976919.	674541.
299.84	31.292	-78.382	366134.	350.	9272.	10113.	180.0	8.7	-3.2	104.	1.51	973804.	671427.
300.80	31.312	-78.365	366466.	342.	9315.	10156.	180.0	8.6	-3.2	104.	1.51	970689.	668313.
301.76	31.331	-78.349	366790.	334.	9358.	10199.	180.0	8.6	-3.2	104.	1.52	967574.	665198.
302.72	31.351	-78.332	367107.	327.	9401.	10242.	180.0	8.5	-3.2	104.	1.52	964460.	662084.
303.68	31.370	-78.315	367417.	319.	9444.	10285.	180.0	8.4	-3.1	104.	1.53	961345.	658970.
304.64	31.390	-78.298	367720.	312.	9487.	10328.	180.0	8.3	-3.1	104.	1.53	958230.	655856.
305.60	31.410	-78.281	368015.	304.	9531.	10372.	180.0	8.2	-3.1	104.	1.54	955115.	652742.
306.56	31.430	-78.264	368303.	297.	9575.	10415.	180.0	8.2	-3.1	104.	1.54	952000.	649627.
307.52	31.450	-78.247	368583.	289.	9619.	10459.	180.0	8.1	-3.1	104.	1.55	948885.	646513.
308.48	31.470	-78.230	368857.	282.	9663.	10503.	180.0	8.0	-3.1	104.	1.55	945770.	643399.
309.44	31.490	-78.212	369123.	274.	9708.	10548.	180.0	7.9	-3.1	104.	1.56	942655.	640285.
310.40	31.511	-78.195	369383.	267.	9752.	10592.	180.0	7.9	-3.1	104.	1.56	939540.	637171.
311.36	31.531	-78.177	369635.	260.	9797.	10637.	180.0	7.8	-3.0	104.	1.57	936425.	634057.
312.32	31.551	-78.160	369881.	252.	9842.	10681.	180.0	7.7	-3.0	104.	1.57	933310.	630942.
313.28	31.572	-78.142	370119.	245.	9887.	10726.	180.0	7.6	-3.0	104.	1.58	930195.	627828.
314.24	31.593	-78.124	370351.	238.	9932.	10772.	180.0	7.5	-3.0	104.	1.58	927081.	624714.
315.20	31.613	-78.106	370575.	231.	9978.	10817.	180.0	7.5	-3.0	104.	1.59	923966.	621600.
316.16	31.634	-78.088	370793.	224.	10024.	10862.	180.0	7.4	-3.0	104.	1.59	920851.	618486.
317.12	31.655	-78.070	371004.	217.	10070.	10908.	180.0	7.3	-3.0	104.	1.60	917736.	615371.
318.08	31.676	-78.052	371208.	210.	10116.	10954.	180.0	7.2	-3.0	104.	1.61	914621.	612257.
319.04	31.697	-78.033	371406.	203.	10162.	11000.	180.0	7.2	-3.0	104.	1.61	911506.	609143.

NOMINAL DISPLAY DATA FOR STS-45 CYCLE FLT
TRAJECTORY SUMMARY

TIME (SEC)	GEOD LATD (DEG)	LONG (DEG)	ALT (FT)	ALT RATE (FPS)	VE (FPS)	VI (FPS)	ROLL ANGLE (DEG)	PITCH ANGLE (DEG)	YAW ANGLE (DEG)	THRT LEVEL (%)	SENSED ACC (G)	TOTAL WT (LBS)	ET MPS WT (LBS)
320.00	31.719	-78.015	371597.	196.	10208.	11047.	180.0	7.1	-3.0	104.	1.62	908391.	606029.
320.96	31.740	-77.997	371781.	189.	10255.	11093.	180.0	7.0	-3.0	104.	1.62	905276.	602915.
321.92	31.761	-77.978	371959.	182.	10302.	11140.	180.0	6.9	-2.9	104.	1.63	902161.	599800.
322.88	31.783	-77.959	372130.	175.	10349.	11187.	180.0	6.9	-2.9	104.	1.63	899046.	596686.
323.84	31.804	-77.941	372294.	169.	10396.	11234.	180.0	6.8	-2.9	104.	1.64	895931.	593572.
324.80	31.826	-77.922	372452.	162.	10444.	11281.	180.0	6.7	-2.9	104.	1.64	892817.	590458.
325.76	31.848	-77.903	372604.	155.	10491.	11329.	180.0	6.6	-2.9	104.	1.65	889702.	587344.
326.72	31.870	-77.884	372749.	149.	10539.	11376.	180.0	6.6	-2.9	104.	1.66	886587.	584230.
327.68	31.892	-77.865	372889.	142.	10587.	11424.	180.0	6.5	-2.9	104.	1.66	883472.	581115.
328.64	31.914	-77.845	373021.	135.	10635.	11472.	180.0	6.4	-2.9	104.	1.67	880357.	578001.
329.60	31.936	-77.826	373148.	129.	10684.	11521.	180.0	6.4	-2.9	104.	1.67	877242.	574887.
330.56	31.958	-77.807	373268.	123.	10733.	11569.	180.0	6.3	-2.9	104.	1.68	874127.	571773.
331.52	31.981	-77.787	373382.	116.	10781.	11618.	180.0	6.2	-2.9	104.	1.69	871012.	568659.
332.48	32.003	-77.767	373491.	110.	10831.	11667.	180.0	6.1	-2.8	104.	1.69	867897.	565544.
333.44	32.026	-77.748	373593.	104.	10880.	11716.	180.0	6.1	-2.8	104.	1.70	864782.	562430.
334.40	32.048	-77.728	373689.	97.	10929.	11765.	180.0	6.0	-2.8	104.	1.70	861667.	559316.
335.36	32.071	-77.708	373779.	91.	10979.	11815.	180.0	5.9	-2.8	104.	1.71	858552.	556202.
336.32	32.094	-77.688	373863.	85.	11029.	11865.	180.0	5.8	-2.8	104.	1.72	855438.	553088.
337.28	32.117	-77.668	373941.	79.	11079.	11915.	180.0	5.8	-2.8	104.	1.72	852323.	549974.
338.24	32.140	-77.647	374014.	73.	11129.	11965.	180.0	5.7	-2.8	104.	1.73	849208.	546859.
339.20	32.163	-77.627	374081.	67.	11180.	12015.	180.0	5.6	-2.8	104.	1.74	846093.	543745.
340.16	32.186	-77.606	374142.	61.	11231.	12066.	180.1	5.6	-2.7	104.	1.74	842978.	540631.
341.12	32.210	-77.586	374197.	55.	11282.	12117.	180.0	5.5	-2.7	104.	1.75	839863.	537517.
342.08	32.233	-77.565	374247.	50.	11333.	12168.	180.0	5.4	-2.7	104.	1.75	836748.	534403.
343.04	32.257	-77.544	374292.	44.	11384.	12219.	180.0	5.3	-2.7	104.	1.76	833633.	531288.
344.00	32.280	-77.523	374330.	38.	11436.	12271.	180.0	5.3	-2.7	104.	1.77	830518.	528174.
344.96	32.304	-77.502	374364.	32.	11488.	12322.	180.0	5.2	-2.7	104.	1.77	827403.	525060.
345.92	32.328	-77.481	374392.	27.	11540.	12374.	180.0	5.1	-2.7	104.	1.78	824288.	521946.
346.88	32.352	-77.460	374414.	21.	11592.	12426.	180.0	5.1	-2.7	104.	1.79	821174.	518832.
347.84	32.376	-77.439	374432.	16.	11645.	12479.	180.0	5.0	-2.7	104.	1.79	818059.	515718.
348.80	32.400	-77.417	374444.	10.	11698.	12532.	180.0	4.9	-2.7	104.	1.80	814944.	512603.
349.76	32.424	-77.396	374451.	5.	11751.	12584.	180.0	4.9	-2.7	104.	1.81	811829.	509489.
350.72	32.449	-77.374	374453.	0.	11804.	12638.	180.0	4.8	-2.6	104.	1.82	808714.	506375.
351.68	32.473	-77.352	374450.	-5.	11857.	12691.	180.0	4.7	-2.6	104.	1.82	805599.	503261.
352.64	32.498	-77.330	374442.	-11.	11911.	12744.	180.0	4.6	-2.6	104.	1.83	802484.	500147.
353.60	32.522	-77.308	374428.	-16.	11965.	12798.	180.0	4.6	-2.6	104.	1.84	799369.	497032.
354.56	32.547	-77.286	374410.	-21.	12019.	12852.	180.0	4.5	-2.6	104.	1.84	796254.	493918.
355.52	32.572	-77.264	374387.	-26.	12074.	12907.	180.0	4.4	-2.6	104.	1.85	793139.	490804.
356.48	32.597	-77.242	374360.	-31.	12128.	12961.	180.0	4.4	-2.6	104.	1.86	790024.	487690.
357.44	32.622	-77.219	374328.	-36.	12183.	13016.	180.0	4.3	-2.5	104.	1.87	786909.	484576.
358.40	32.647	-77.196	374291.	-40.	12238.	13071.	180.0	4.2	-2.5	104.	1.87	783795.	481461.
359.36	32.673	-77.174	374249.	-45.	12294.	13126.	180.0	4.2	-2.5	104.	1.88	780680.	478347.

NOMINAL DISPLAY DATA FOR STS-45 CYCLE FLT
TRAJECTORY SUMMARY

TIME (SEC)	GEOD LATD (DEG)	LONG (DEG)	ALT (FT)	ALT RATE (FPS)	VE (FPS)	VI (FPS)	ROLL ANGLE (DEG)	PITCH ANGLE (DEG)	YAW ANGLE (DEG)	THRT LEVEL (%)	SENSED ACC (G)	TOTAL WT (LBS)	ET MPS WT (LBS)
360.32	32.698	-77.151	374203.	-50.	12349.	13182.	180.0	4.1	-2.5	104.	1.89	777565.	475233.
361.28	32.724	-77.128	374152.	-54.	12405.	13238.	180.0	4.0	-2.5	104.	1.90	774450.	472119.
362.24	32.749	-77.105	374097.	-59.	12461.	13294.	180.0	4.0	-2.5	104.	1.90	771335.	469005.
363.20	32.775	-77.082	374038.	-63.	12518.	13350.	180.0	3.9	-2.5	104.	1.91	768220.	465891.
364.16	32.801	-77.058	373975.	-68.	12574.	13407.	180.0	3.8	-2.5	104.	1.92	765105.	462776.
365.12	32.827	-77.035	373907.	-72.	12631.	13463.	180.0	3.8	-2.5	104.	1.93	761990.	459662.
366.08	32.853	-77.011	373835.	-76.	12688.	13520.	180.0	3.7	-2.5	104.	1.93	758875.	456548.
367.04	32.879	-76.988	373759.	-81.	12746.	13578.	180.0	3.6	-2.5	104.	1.94	755760.	453434.
368.00	32.906	-76.964	373679.	-85.	12804.	13635.	180.0	3.6	-2.5	104.	1.95	752645.	450320.
368.96	32.932	-76.940	373595.	-89.	12862.	13693.	180.0	3.5	-2.4	104.	1.96	749531.	447205.
369.92	32.959	-76.916	373507.	-93.	12920.	13751.	180.0	3.4	-2.4	104.	1.97	746416.	444091.
370.88	32.985	-76.892	373416.	-97.	12978.	13810.	180.0	3.4	-2.4	104.	1.98	743301.	440977.
371.84	33.012	-76.867	373321.	-101.	13037.	13868.	180.0	3.3	-2.4	104.	1.98	740186.	437863.
372.80	33.039	-76.843	373222.	-104.	13096.	13927.	180.0	3.3	-2.4	104.	1.99	737071.	434749.
373.76	33.066	-76.818	373119.	-108.	13155.	13986.	180.0	3.2	-2.4	104.	2.00	733956.	431635.
374.72	33.093	-76.793	373013.	-112.	13215.	14046.	180.0	3.1	-2.4	104.	2.01	730841.	428520.
375.68	33.120	-76.769	372904.	-115.	13275.	14106.	180.0	3.1	-2.3	104.	2.02	727726.	425406.
376.64	33.148	-76.744	372791.	-119.	13335.	14166.	180.0	3.0	-2.3	104.	2.03	724611.	422292.
377.60	33.175	-76.719	372675.	-122.	13395.	14226.	180.0	2.9	-2.3	104.	2.04	721496.	419178.
378.56	33.203	-76.693	372556.	-125.	13456.	14287.	180.0	2.9	-2.3	104.	2.04	718381.	416064.
379.52	33.230	-76.668	372433.	-129.	13517.	14348.	180.0	2.8	-2.3	104.	2.05	715266.	412949.
380.48	33.258	-76.642	372308.	-132.	13578.	14409.	180.0	2.7	-2.3	104.	2.06	712152.	409835.
381.44	33.286	-76.617	372179.	-135.	13640.	14470.	180.0	2.7	-2.3	104.	2.07	709037.	406721.
382.40	33.314	-76.591	372048.	-138.	13702.	14532.	180.0	2.6	-2.3	104.	2.08	705922.	403607.
383.36	33.342	-76.565	371913.	-141.	13764.	14594.	180.0	2.6	-2.2	104.	2.09	702807.	400493.
384.32	33.370	-76.539	371776.	-143.	13826.	14656.	180.0	2.5	-2.2	104.	2.10	699692.	397378.
385.28	33.399	-76.513	371637.	-146.	13889.	14719.	180.0	2.5	-2.2	104.	2.11	696577.	394264.
386.24	33.427	-76.486	371495.	-149.	13952.	14782.	180.0	2.4	-2.2	104.	2.12	693462.	391150.
387.20	33.456	-76.460	371350.	-151.	14015.	14845.	180.0	2.4	-2.2	104.	2.13	690347.	388036.
388.16	33.485	-76.433	371203.	-154.	14079.	14909.	179.9	2.3	-2.2	104.	2.14	687232.	384922.
389.12	33.514	-76.407	371054.	-156.	14143.	14973.	180.0	2.3	-2.2	104.	2.15	684117.	381808.
390.08	33.543	-76.380	370903.	-158.	14207.	15037.	180.0	2.2	-2.2	104.	2.16	681002.	378693.
391.04	33.572	-76.353	370749.	-160.	14272.	15102.	180.0	2.2	-2.2	104.	2.17	677888.	375579.
392.00	33.601	-76.325	370594.	-162.	14337.	15166.	180.0	2.1	-2.2	104.	2.18	674773.	372465.
392.96	33.631	-76.298	370437.	-164.	14402.	15232.	180.0	2.1	-2.2	104.	2.19	671658.	369351.
393.92	33.660	-76.271	370278.	-166.	14468.	15297.	180.0	2.0	-2.1	104.	2.20	668543.	366237.
394.88	33.690	-76.243	370117.	-168.	14533.	15363.	180.0	1.9	-2.1	104.	2.21	665428.	363122.
395.84	33.719	-76.215	369954.	-169.	14600.	15429.	180.0	1.9	-2.1	104.	2.22	662313.	360008.
396.80	33.749	-76.187	369790.	-171.	14666.	15495.	180.0	1.8	-2.1	104.	2.23	659198.	356894.
397.76	33.779	-76.159	369625.	-172.	14733.	15562.	180.0	1.7	-2.1	104.	2.24	656083.	353780.
398.72	33.810	-76.131	369458.	-174.	14800.	15629.	180.0	1.7	-2.1	104.	2.25	652968.	350666.
399.68	33.840	-76.102	369290.	-175.	14868.	15697.	180.0	1.6	-2.1	104.	2.26	649853.	347552.

NOMINAL DISPLAY DATA FOR STS-45 CYCLE FLT
TRAJECTORY SUMMARY

TIME (SEC)	GEOD LATD (DEG)	LONG (DEG)	ALT (FT)	ALT RATE (FPS)	VE (FPS)	VI (FPS)	ROLL ANGLE (DEG)	PITCH ANGLE (DEG)	YAW ANGLE (DEG)	THRT LEVEL (%)	SENSED ACC (G)	TOTAL WT (LBS)	ET MPS WT (LBS)
400.64	33.870	-76.074	369121.	-176.	14936.	15765.	180.0	1.5	-2.1	104.	2.27	646738.	344437.
401.60	33.901	-76.045	368951.	-177.	15004.	15833.	180.0	1.5	-2.0	104.	2.28	643623.	341323.
402.56	33.931	-76.016	368779.	-178.	15073.	15902.	180.0	1.4	-2.0	104.	2.29	640509.	338209.
403.52	33.962	-75.987	368607.	-179.	15142.	15970.	180.0	1.4	-2.0	104.	2.30	637394.	335095.
404.48	33.993	-75.958	368434.	-180.	15211.	16040.	180.0	1.3	-2.0	104.	2.32	634279.	331981.
405.44	34.024	-75.929	368260.	-181.	15281.	16109.	180.0	1.2	-2.0	104.	2.33	631164.	328866.
406.40	34.055	-75.899	368085.	-182.	15351.	16179.	180.0	1.2	-2.0	104.	2.34	628049.	325752.
407.36	34.087	-75.870	367910.	-182.	15421.	16250.	180.0	1.1	-2.0	104.	2.35	624934.	322638.
408.32	34.118	-75.840	367734.	-182.	15492.	16320.	180.0	1.1	-2.0	104.	2.36	621819.	319524.
409.28	34.150	-75.810	367558.	-183.	15563.	16392.	180.0	1.0	-2.0	104.	2.37	618704.	316410.
410.24	34.181	-75.780	367382.	-183.	15635.	16463.	180.0	1.0	-2.0	104.	2.39	615589.	313296.
411.20	34.213	-75.749	367206.	-183.	15707.	16535.	180.0	.9	-1.9	104.	2.40	612474.	310181.
412.16	34.245	-75.719	367029.	-183.	15779.	16607.	180.0	.8	-1.9	104.	2.41	609359.	307067.
413.12	34.277	-75.688	366853.	-183.	15852.	16680.	180.0	.8	-1.9	104.	2.42	606245.	303953.
414.08	34.310	-75.657	366677.	-183.	15925.	16753.	180.0	.7	-1.9	104.	2.43	603130.	300839.
415.04	34.342	-75.626	366501.	-182.	15998.	16826.	180.0	.7	-1.9	104.	2.45	600015.	297725.
416.00	34.375	-75.595	366326.	-182.	16072.	16900.	180.0	.6	-1.9	104.	2.46	596900.	294610.
416.96	34.407	-75.564	366151.	-181.	16146.	16975.	180.0	.6	-1.9	104.	2.47	593785.	291496.
417.92	34.440	-75.532	365977.	-180.	16221.	17049.	180.0	.5	-1.9	104.	2.49	590670.	288382.
418.88	34.473	-75.500	365804.	-179.	16296.	17124.	180.0	.5	-1.8	104.	2.50	587555.	285268.
419.84	34.506	-75.469	365632.	-178.	16372.	17200.	180.0	.4	-1.8	104.	2.51	584440.	282154.
420.80	34.539	-75.437	365460.	-177.	16448.	17276.	180.0	.4	-1.8	104.	2.53	581325.	279039.
421.76	34.573	-75.404	365290.	-176.	16524.	17352.	180.0	.3	-1.8	104.	2.54	578210.	275925.
422.72	34.606	-75.372	365121.	-175.	16601.	17429.	180.0	.3	-1.8	104.	2.55	575095.	272811.
423.68	34.640	-75.339	364953.	-173.	16678.	17506.	180.0	.2	-1.8	104.	2.57	571981.	269697.
424.64	34.674	-75.306	364787.	-172.	16756.	17584.	180.0	.2	-1.8	104.	2.58	568866.	266583.
425.60	34.708	-75.273	364622.	-170.	16834.	17662.	180.0	.1	-1.8	104.	2.60	565751.	263469.
426.56	34.742	-75.240	364460.	-168.	16913.	17740.	180.0	.1	-1.7	104.	2.61	562636.	260354.
427.52	34.776	-75.207	364299.	-166.	16992.	17819.	180.0	.0	-1.7	104.	2.62	559521.	257240.
428.48	34.811	-75.173	364140.	-164.	17071.	17899.	180.0	360.0	-1.7	104.	2.64	556406.	254126.
429.44	34.845	-75.140	363983.	-161.	17151.	17979.	180.0	360.0	-1.7	104.	2.65	553291.	251012.
430.40	34.880	-75.106	363829.	-159.	17232.	18059.	180.0	360.0	-1.7	104.	2.67	550176.	247898.
431.36	34.915	-75.072	363677.	-156.	17312.	18140.	180.0	359.9	-1.7	104.	2.68	547061.	244783.
432.32	34.950	-75.037	363527.	-153.	17394.	18221.	180.0	359.9	-1.7	104.	2.70	543946.	241669.
433.28	34.985	-75.003	363381.	-150.	17476.	18303.	180.0	359.9	-1.6	104.	2.72	540831.	238555.
434.24	35.020	-74.968	363238.	-147.	17558.	18385.	180.0	359.8	-1.6	104.	2.73	537716.	235441.
435.20	35.055	-74.933	363097.	-144.	17641.	18468.	180.0	359.8	-1.7	104.	2.75	534602.	232327.
436.16	35.091	-74.898	362961.	-140.	17724.	18552.	180.0	359.7	-1.7	104.	2.76	531487.	229213.
437.12	35.127	-74.863	362827.	-136.	17808.	18635.	180.0	359.7	-1.7	104.	2.78	528372.	226098.
438.08	35.163	-74.827	362697.	-133.	17892.	18720.	180.0	359.6	-1.7	104.	2.80	525257.	222984.
439.04	35.199	-74.791	362571.	-129.	17977.	18804.	180.0	359.6	-1.6	104.	2.81	522142.	219870.
440.00	35.235	-74.755	362449.	-125.	18062.	18890.	180.0	359.6	-1.6	104.	2.83	519027.	216756.

NOMINAL DISPLAY DATA FOR STS-45 CYCLE FLT
TRAJECTORY SUMMARY

TIME (SEC)	GEOD LATD (DEG)	LONG (DEG)	ALT (FT)	ALT RATE (FPS)	VE (FPS)	VI (FPS)	ROLL ANGLE (DEG)	PITCH ANGLE (DEG)	YAW ANGLE (DEG)	THRT LEVEL (%)	SENSED ACC (G)	TOTAL WT (LBS)	ET MPS WT (LBS)
440.96	35.271	-74.719	362331.	-120.	18148.	18976.	180.0	359.5	-1.6	104.	2.85	515912.	213642.
441.92	35.308	-74.683	362216.	-116.	18235.	19062.	180.0	359.5	-1.6	104.	2.86	512797.	210527.
442.88	35.345	-74.646	362107.	-111.	18322.	19149.	180.0	359.4	-1.6	104.	2.88	509682.	207413.
443.84	35.382	-74.610	362002.	-106.	18409.	19237.	180.0	359.4	-1.5	104.	2.90	506567.	204299.
444.80	35.419	-74.573	361901.	-102.	18497.	19325.	180.0	359.3	-1.5	104.	2.92	503452.	201185.
445.76	35.456	-74.535	361805.	-96.	18586.	19413.	180.0	359.3	-1.5	104.	2.93	500338.	198071.
446.72	35.493	-74.498	361714.	-91.	18675.	19503.	180.0	359.2	-1.5	104.	2.95	497223.	194957.
447.68	35.531	-74.460	361628.	-86.	18765.	19592.	180.0	359.2	-1.5	104.	2.97	494108.	191842.
448.64	35.568	-74.422	361548.	-80.	18855.	19682.	180.0	359.2	-1.5	103.	2.96	491006.	188741.
449.60	35.606	-74.384	361472.	-75.	18945.	19772.	180.0	359.1	-1.4	103.	2.98	487921.	185658.
450.56	35.644	-74.346	361402.	-69.	19035.	19862.	180.0	359.1	-1.4	101.	2.94	484861.	182598.
451.52	35.682	-74.307	361338.	-64.	19125.	19952.	180.0	359.1	-1.4	101.	2.96	481837.	179574.
452.48	35.721	-74.268	361279.	-58.	19214.	20041.	179.9	359.1	-1.4	100.	2.95	478826.	176564.
453.44	35.759	-74.229	361225.	-52.	19304.	20131.	180.0	359.1	-1.4	100.	2.96	475832.	173571.
454.40	35.798	-74.190	361177.	-46.	19394.	20221.	180.0	359.1	-1.4	99.	2.95	472852.	170592.
455.36	35.836	-74.151	361135.	-40.	19484.	20311.	180.0	359.0	-1.4	99.	2.97	469888.	167629.
456.32	35.875	-74.111	361098.	-34.	19574.	20401.	180.0	359.1	-1.4	98.	2.96	466938.	164679.
457.28	35.915	-74.071	361068.	-27.	19664.	20491.	180.0	359.1	-1.4	98.	2.98	464005.	161747.
458.24	35.954	-74.031	361044.	-21.	19754.	20581.	180.1	359.0	-1.4	97.	2.97	461085.	158828.
459.20	35.993	-73.991	361026.	-14.	19844.	20671.	180.0	358.9	-1.4	97.	2.99	458182.	155925.
460.16	36.033	-73.950	361015.	-8.	19934.	20762.	180.0	358.8	-1.4	96.	2.97	455292.	153036.
461.12	36.073	-73.909	361010.	-2.	20025.	20852.	180.0	358.7	-1.4	96.	2.99	452419.	150164.
462.08	36.113	-73.868	361010.	5.	20115.	20943.	180.0	358.7	-1.4	94.	2.95	449570.	147316.
463.04	36.153	-73.827	361018.	12.	20205.	21032.	180.0	358.7	-1.3	94.	2.97	446758.	144504.
464.00	36.193	-73.785	361031.	18.	20295.	21122.	180.0	358.7	-1.3	93.	2.95	443959.	141706.
464.96	36.233	-73.743	361051.	25.	20385.	21212.	180.0	358.7	-1.3	93.	2.97	441176.	138924.
465.92	36.274	-73.701	361077.	32.	20475.	21302.	180.0	358.7	-1.3	92.	2.96	438407.	136156.
466.88	36.315	-73.659	361111.	39.	20565.	21392.	180.0	358.7	-1.2	92.	2.97	435655.	133404.
467.84	36.355	-73.616	361151.	46.	20655.	21482.	180.0	358.7	-1.2	91.	2.96	432916.	130666.
468.80	36.396	-73.574	361198.	54.	20745.	21573.	180.0	358.7	-1.2	91.	2.98	430194.	127945.
469.76	36.438	-73.531	361253.	61.	20836.	21663.	180.0	358.7	-1.1	90.	2.96	427485.	125236.
470.72	36.479	-73.487	361314.	69.	20926.	21753.	180.0	358.7	-1.1	90.	2.98	424793.	122545.
471.68	36.521	-73.444	361383.	77.	21016.	21844.	179.9	358.7	-1.1	89.	2.97	422114.	119867.
472.64	36.562	-73.400	361460.	84.	21107.	21934.	179.9	358.7	-1.0	89.	2.99	419452.	117206.
473.60	36.604	-73.356	361544.	93.	21197.	22025.	179.9	358.8	-1.0	88.	2.97	416804.	114558.
474.56	36.646	-73.312	361636.	101.	21288.	22115.	179.9	358.9	-1.0	88.	2.99	414172.	111927.
475.52	36.688	-73.268	361736.	110.	21378.	22206.	180.0	359.0	-1.0	87.	2.98	411553.	109309.
476.48	36.730	-73.223	361844.	118.	21469.	22297.	180.0	359.0	-1.0	87.	2.99	408951.	106708.
477.44	36.773	-73.178	361962.	127.	21559.	22387.	180.0	359.0	-.9	85.	2.94	406374.	104131.
478.40	36.815	-73.133	362087.	136.	21649.	22477.	179.9	359.0	-.9	85.	2.96	403832.	101590.
479.36	36.858	-73.087	362222.	145.	21739.	22566.	179.9	359.0	-.9	84.	2.95	401303.	99062.
480.32	36.901	-73.042	362365.	155.	21828.	22656.	179.9	358.9	-.9	84.	2.96	398792.	96551.

NOMINAL DISPLAY DATA FOR STS-45 CYCLE FLT
TRAJECTORY SUMMARY

TIME (SEC)	GEOD LATD (DEG)	LONG (DEG)	ALT (FT)	ALT RATE (FPS)	VE (FPS)	VI (FPS)	ROLL ANGLE (DEG)	PITCH ANGLE (DEG)	YAW ANGLE (DEG)	THRT LEVEL (%)	SENSED ACC (G)	TOTAL WT (LBS)	ET MPS WT (LBS)
481.28	36.944	-72.996	362517.	164.	21919.	22747.	179.9	358.9	-.9	84.	2.98	396280.	94040.
482.24	36.987	-72.950	362678.	173.	22010.	22837.	179.9	358.8	-.9	84.	3.00	393768.	91529.
483.20	37.031	-72.903	362848.	182.	22100.	22928.	179.9	358.7	-.9	82.	2.95	391281.	89042.
484.16	37.074	-72.857	363026.	192.	22190.	23018.	180.0	358.6	-.9	82.	2.97	388829.	86591.
485.12	37.118	-72.810	363213.	201.	22280.	23108.	180.0	358.5	-.9	81.	2.95	386391.	84154.
486.08	37.162	-72.762	363410.	210.	22370.	23198.	179.9	358.4	-.9	81.	2.97	383969.	81733.
487.04	37.206	-72.715	363614.	219.	22460.	23288.	179.9	358.4	-.9	80.	2.95	381560.	79325.
488.00	37.250	-72.667	363828.	228.	22550.	23378.	179.9	358.3	-.9	80.	2.97	379169.	76934.
488.96	37.294	-72.619	364050.	237.	22641.	23469.	179.9	358.2	-.9	80.	2.99	376777.	74543.
489.92	37.339	-72.571	364281.	246.	22732.	23560.	179.9	358.1	-.9	80.	3.00	374386.	72152.
490.88	37.383	-72.523	364520.	255.	22823.	23651.	180.0	358.1	-.9	78.	2.95	372018.	69785.
491.84	37.428	-72.474	364769.	264.	22913.	23741.	180.0	358.0	-.9	78.	2.97	369686.	67454.
492.80	37.473	-72.425	365025.	273.	23003.	23831.	179.9	358.0	-.9	77.	2.95	367367.	65136.
493.76	37.518	-72.376	365291.	282.	23093.	23921.	179.9	358.0	-.9	77.	2.96	365066.	62835.
494.72	37.563	-72.326	365565.	292.	23184.	24012.	179.9	358.1	-.8	77.	2.98	362764.	60534.
495.68	37.608	-72.277	365849.	301.	23275.	24103.	179.9	358.2	-.8	77.	3.00	360462.	58233.
496.64	37.654	-72.226	366142.	311.	23366.	24194.	179.9	358.2	-.8	75.	2.94	358184.	55956.
497.60	37.699	-72.176	366445.	321.	23456.	24284.	179.9	358.3	-.8	75.	2.96	355942.	53715.
498.56	37.745	-72.126	366757.	331.	23546.	24375.	179.9	358.3	-.7	75.	2.98	353701.	51474.
499.52	37.791	-72.075	367079.	342.	23637.	24466.	179.9	358.3	-.7	75.	3.00	351459.	49233.
500.48	37.837	-72.024	367412.	352.	23728.	24557.	179.9	358.3	-.7	74.	2.98	349230.	47005.
501.44	37.883	-71.972	367754.	363.	23819.	24648.	179.9	358.3	-.7	74.	3.00	347018.	44794.
502.40	37.930	-71.921	368107.	374.	23910.	24739.	179.9	358.3	-.6	72.	2.93	344830.	42606.
503.36	37.976	-71.869	368470.	384.	24000.	24828.	179.9	358.3	-.6	72.	2.95	342678.	40455.
504.32	38.023	-71.817	368843.	395.	24090.	24919.	179.9	358.2	-.6	72.	2.97	340526.	38304.
505.28	38.070	-71.764	369226.	406.	24181.	25009.	179.9	358.2	-.5	72.	2.99	338374.	36152.
505.76	38.093	-71.738	369422.	411.	24226.	25055.	179.9	358.2	-.5	72.	3.00	337298.	35077.
506.56	38.132	-71.694	369753.	420.	24302.	25131.	179.9	358.2	-.5	71.	2.97	335528.	33307.
507.52	38.179	-71.641	370161.	431.	24393.	25222.	180.0	358.2	-.6	71.	2.99	333406.	31186.
508.48	38.227	-71.588	370579.	442.	24481.	25310.	180.0	358.1	-.6	67.	2.84	331358.	29139.
509.44	38.274	-71.534	371007.	452.	24568.	25397.	179.9	358.1	-.6	67.	2.86	329356.	27138.
510.40	38.321	-71.480	371445.	463.	24655.	25484.	179.9	358.1	-.7	67.	2.87	327354.	25136.
511.36	38.369	-71.426	371893.	473.	24743.	25572.	179.9	358.0	-.7	67.	2.89	325351.	23134.
512.32	38.417	-71.371	372351.	484.	24831.	25661.	179.9	358.0	-.7	67.	2.91	323349.	21133.
513.28	38.465	-71.317	372820.	494.	24920.	25750.	179.9	357.9	-.7	67.	2.89	321347.	19131.
514.24	38.513	-71.262	373297.	500.	24970.	25800.	179.9	357.8	-.6	67.	.81	320202.	17988.
515.20	38.561	-71.207	373777.	502.	24986.	25815.	179.8	357.8	-.6	67.	.23	319836.	17621.
516.16	38.609	-71.152	374259.	503.	24991.	25820.	179.7	357.8	-.6	67.	.16	319715.	17502.
517.12	38.657	-71.096	374741.	504.	24994.	25824.	179.6	357.9	-.7	67.	.13	319616.	17403.
518.08	38.705	-71.041	375224.	504.	24997.	25827.	179.6	357.9	-.7	67.	.10	319537.	17325.
519.04	38.753	-70.986	375708.	505.	24999.	25829.	179.6	357.9	-.7	67.	.07	319479.	17267.
520.00	38.801	-70.930	376191.	505.	25000.	25830.	179.6	357.9	-.7	67.	.04	319441.	17230.

NOMINAL DISPLAY DATA FOR STS-45 CYCLE FLT
TRAJECTORY SUMMARY

TIME (SEC)	GEOD LATD (DEG)	LONG (DEG)	ALT (FT)	ALT RATE (FPS)	VE (FPS)	VI (FPS)	ROLL ANGLE (DEG)	PITCH ANGLE (DEG)	YAW ANGLE (DEG)	THRT LEVEL (%)	SENSED ACC (G)	TOTAL WT (LBS)	ET MPS WT (LBS)
520.96	38.849	-70.874	376676.	506.	25001.	25830.	179.6	357.9	-.7	67.	.01	319423.	17214.
MECO	(THRUST=0)												
521.27	38.864	-70.857	376830.	506.	25000.	25830.	179.6	357.9	-.7	67.	.00	319422.	17213.

@FREE 8.
I:002333 FREE complete.

@BRKPT PRINT$

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 1   ADINIT        =  +9.42E+01                    !V97U4306C

 3   ALIM1         =  +9.2000000E+01               !V97U4308C

 5   ALIM2         =  +9.47E+01                    !V97U4309C
 6
 7   ALL           =  +9.5500000E+01               !V97U4307C

 9   ALS1G         =  +5.0000000E+00               !V97U1402C
10   AZMTHL        =  38.34
11   CINT          =  +1.0E-02                     !V97U4418C
12   CPROP         =  +1.5E-01                     !V97U4419C
13   DTFCD         =  +3.20E-01
14   DTMAXX        =  +1.00E+20                    !V97U4369C
15   DTMINK        =  +6.871E+00                   !V97U4350C
16   DTMINN        =  +2.0E+00                     !V97U4370C
17   DTRD          =  +4.0000000E+01               !V97U4371C

19   DTTAIL(1)     =  +8.76E-01                    !V96U8335C
20   DTTAIL(2)     =  +8.71E-01                    !V96U8334C


23   EFMFED(1)     =  -9.75814135262D-01           !V97U5738C
24   EFMFED(4)     =  +2.18564609922D-01           !V97U5739C
25   EFMFED(7)     =  +4.03543208521D-03           !V97U5740C
26   EFMFED(2)     =  -2.18562792413D-01           !V97U5741C
27   EFMFED(5)     =  -9.75822479318D-01           !V97U5742C
28   EFMFED(8)     =  +8.91420341686D-04           !V97U5743C
29   EFMFED(3)     =  +4.13269828177D-03           !V97U5744C
30   EFMFED(6)     =  -1.21347352591D-05           !V97U5745C
31   EFMFED(9)     =  +9.99991460292D-01           !V97U5746C
32   EFPSW         =  .TRUE.                       !V99U7441C
33   EPSTP         =  +4.0E-02                     !V97U4381C
34   EPSX          =  +2.0E-02                     !V97U4380C
35   ETB           =  +5.0000000E+00               !V97U4382C
36   FTFACT        =  +9.98E-01                    !V97U4389C

38   FTFMIN        =  +6.5E-01                     !V97U4838C
39   FTOMS         =  +6.0000000E+03               !V97U4390C
40
41   FTRCS         =  +8.772E+02                   !V97U4391C

43   FTSSME        =  +4.7000000E+05               !V97U4392C

45   GAMD          =  +1.7732545E-02               !V97U4394C
46   GAMDN         =  +1.7732545E-02               !V97U4396C

48   GMTLRF        =  +0.0D+00                     !V99U7442C
49   IPRLNM        =  1                            !V99U7557C
50   KCMD          =  +100
51   KMAX          =  +104                         !V97U4424C
52   KMAX2         =  +109                         !V99U7107C
53   KMINAL        =  80                           !V99U7558C
54   KMIN          =  +67                          !V97U4425C
55   LTHRT         =  2                            !V99U7559C
56   LTHRTL        =  3                            !V99U7560C
57   NMAX          =  +1                           !V97U4445C
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ROCKWELL/COPIER
#77

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 59   NSEG          =  +10                          !V97U4447C1
 60   NSEG          =  +20                          !V97U4447C3
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 63   PHIG(2)       =  +1.00000000000E+00           !V97U4452C
 64   PHIG(3)       =  +1.00000000000E+00           !V97U4453C
 65   PHIG(4)       =  +1.00000000000E+00           !V97U4454C
 66   PHIG(5)       =  +1.00000000000E+00           !V97U4455C
 67   PHIG(6)       =  +1.00000000000E+00           !V97U4456C
 68   PHIG(7)       =  +1.00000000000E+00           !V97U4457C
 69   PHIG(8)       =  +1.00000000000E+00           !V97U4458C
 70   PHIG(9)       =  +1.00000000000E+00           !V97U4459C
 71   PHIG(10)      =  +1.00000000000E+00           !V97U4460C
 72   PHIG(11)      =  +1.00000000000E+00           !V97U4461C
 73   PHIG(12)      =  +1.00000000000E+00           !V97U4462C
 74   PHIG(13)      =  +1.00000000000E+00           !V97U4463C
 75   PHIG(14)      =  +1.00000000000E+00           !V97U4464C
 76   PHIG(15)      =  +1.00000000000E+00           !V97U4465C
 77   PHIG(1)       =  +0.00000000000E+00           !V97U4451C
 78   PHICMD        =  +3.141593E+00                !V97U4481C
 79   PHIDMX        =  +3.5E-02                     !V97U9003C

 81   PHI2ND        =  +3.141593E+00                !V97U4482C
 82   PIETAB(1)     =  +1.0E+01                     !V97U1667C
 83   PIETAB(2)     =  +1.0E+01                     !V97U1668C
 84   PIETAB(3)     =  +1.0E+01                     !V97U1669C
 85   PIETAB(4)     =  +1.0E+01                     !V97U1670C
 86   PIETAB(5)     =  +1.0E+01                     !V97U1671C
 87   PIETAB(6)     =  +1.43E+00                    !V97U1672C
 88   PIETAB(7)     =  +0.0E+00                     !V97U1673C
 89   PIETAB(8)     =  +0.0E+00                     !V97U1674C
 90   POETAB(1)     =  +9.0E+00                     !V97U1677C
 91   POETAB(2)     =  +9.0E+00                     !V97U1678C
 92   POETAB(3)     =  +1.5E+00                     !V97U1679C
 93   POETAB(4)     =  -5.0E+00                     !V97U1680C
 94   POETAB(5)     =  -5.0E+00                     !V97U1681C
 95   POETAB(6)     =  -5.0E+00                     !V97U1682C
 96   POETAB(7)     =  -2.5E+00                     !V97U1683C
 97   POETAB(8)     =  +0.0E+00                     !V97U1684C
 98   PPOLY2(1)     =  +0.00000000000E+00           !V97U4486C
 99   PPOLY2(2)     =  +1.27000000000E+02           !V97U4487C
100   PPOLY2(3)     =  +4.49000000000E+02           !V97U4488C
101   PPOLY2(4)     =  +4.77000000000E+02           !V97U4489C
102   PPOLY2(5)     =  +5.06000000000E+02           !V97U4490C
103   PPOLY2(6)     =  +5.34000000000E+02           !V97U4491C
104   PPOLY2(7)     =  +5.72000000000E+02           !V97U4492C
105   PPOLY2(8)     =  +5.98000000000E+02           !V97U4493C
106   PPOLY2(9)     =  +6.25000000000E+02           !V97U4494C
107   PPOLY2(10)    =  +6.58000000000E+02           !V97U4495C
108   PPOLY2(11)    =  +7.62000000000E+02           !V97U4496C
109   PPOLY2(12)    =  +9.32000000000E+02           !V97U4497C
110   PPOLY2(13)    =  +1.01500000000E+03           !V97U4498C
111   PPOLY2(14)    =  +1.23300000000E+03           !V97U4499C
112   PPOLY2(15)    =  +1.32500000000E+03           !V97U4500C
113   PPOLY2(16)    =  +1.45000000000E+03           !V97U4501C
114   PPOLY2(17)    =  +1.54000000000E+03           !V97U4502C
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115   PPOLY2(18)   =  +1.65000000000E+03        !V97U4503C
116   PPOLY2(19)   =  +1.76800000000E+03        !V97U4504C
117   PPOLY2(20)   =  +1.94200000000E+03        !V97U4505C
118   PPOLY2(21)   =  +2.08300000000E+03        !V97U4506C
119   PPOLY2(22)   =  +2.18100000000E+03        !V97U4507C
120   PPOLY2(23)   =  +2.26100000000E+03        !V97U4508C
121   PPOLY2(24)   =  +2.38200000000E+03        !V97U4509C
122   PPOLY2(25)   =  +2.71000000000E+03        !V97U4510C
123   PPOLY2(26)   =  +2.92700000000E+03        !V97U4511C
124   PPOLY2(27)   =  +3.03800000000E+03        !V97U4512C
125   PPOLY2(28)   =  +3.37200000000E+03        !V97U4513C
126   PPOLY2(29)   =  +3.70200000000E+03        !V97U4514C
127   PPOLY2(30)   =  +5.00000000000E+03        !V97U4515C
128   PSI(1)       =  +0.00000000000E+00        !V97U4516C
129   PSI(2)       =  +1.54260000000E-01        !V97U4520C
130   PSI(3)       =  +1.54260000000E-01        !V97U4524C
131   PSI(4)       =  +1.59720000000E-01        !V97U4528C
132   PSI(5)       =  +1.73360000000E-01        !V97U4532C
133   PSI(6)       =  +1.82600000000E-01        !V97U4536C
134   PSI(7)       =  +1.81450000000E-01        !V97U4540C
135   PSI(8)       =  +1.80670000000E-01        !V97U4544C
136   PSI(9)       =  +1.78470000000E-01        !V97U4548C
137   PSI(10)      =  +1.77030000000E-01        !V97U4552C
138   PSI(11)      =  +1.73860000000E-01        !V97U4556C
139   PSI(12)      =  +1.68540000000E-01        !V97U4560C
140   PSI(13)      =  +1.66080000000E-01        !V97U4564C
141   PSI(14)      =  +1.57860000000E-01        !V97U4568C
142   PSI(15)      =  +1.55110000000E-01        !V97U4572C
143   PSI(16)      =  +1.52230000000E-01        !V97U4576C
144   PSI(17)      =  +1.51600000000E-01        !V97U4580C
145   PSI(18)      =  +1.52620000000E-01        !V97U4584C
146   PSI(19)      =  +1.55280000000E-01        !V97U4588C
147   PSI(20)      =  +1.59870000000E-01        !V97U4592C
148   PSI(21)      =  +1.62300000000E-01        !V97U4596C
149   PSI(22)      =  +1.63320000000E-01        !V97U4600C
150   PSI(23)      =  +1.63780000000E-01        !V97U4604C
151   PSI(24)      =  +1.64030000000E-01        !V97U4608C
152   PSI(25)      =  +1.64000000000E-01        !V97U4612C
153   PSI(26)      =  +1.63170000000E-01        !V97U4616C
154   PSI(27)      =  +1.63260000000E-01        !V97U4620C
155   PSI(28)      =  +1.61810000000E-01        !V97U4624C
156   PSI(29)      =  +1.58880000000E-01        !V97U4628C
157   PSI(30)      =  +1.58880000000E-01        !V97U4632C
158   PTCHF        =  +6.00000000000E-03        !V99U7561C
159   PTCHFL       =  +4.00000000000E-03        !V99U7562C
160   PTCHP        =  +8.00000000000E-01        !V99U7563C
161   QPOLY(1)     =  +6.00000000000E+01        !V97U4640C
162   QPOLY(2)     =  +4.60000000000E+02        !V97U4641C
163   QPOLY(3)     =  +6.50000000000E+02        !V97U4642C
164   QPOLY(4)     =  +1.39500000000E+03        !V97U4643C
165   RDMAG        =  +2.1272079E+07            !V97U4647C
166   RDNOM        =  +2.1272079E+07            !V97U4645C
167   RHOMAG       =  +1.0000000E+00            !V97U4650C
168   SLOPEN       =  -1.616E-06                !V99U7443C
169   TAOA         =  +1.000E+03                !V97U4661C
170   TABORT       =  +1.0E+01                  !V98U7961C
171   TFAIL        =  +0.0E+00                  !V96U9384C
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ROCKWELL/COPIER
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THETT(1,1)   =  +4.14210000000E-01        !V97U4667C
THETT(2,1)   =  +3.10070000000E-01        !V97U4671C
THETT(3,1)   =  +3.10070000000E-01        !V97U4675C
THETT(4,1)   =  +3.14580000000E-01        !V97U4679C
THETT(5,1)   =  +3.17390000000E-01        !V97U4683C
THETT(6,1)   =  +3.19780000000E-01        !V97U4687C
THETT(7,1)   =  +3.20100000000E-01        !V97U4691C
THETT(8,1)   =  +3.17430000000E-01        !V97U4695C
THETT(9,1)   =  +3.15510000000E-01        !V97U4699C
THETT(10,1   =  +3.14840000000E-01        !V97U4703C
THETT(11,1   =  +3.06470000000E-01        !V97U4707C
THETT(12,1   =  +2.91270000000E-01        !V97U4711C
THETT(13,1   =  +2.85410000000E-01        !V97U4715C
THETT(14,1   =  +2.73290000000E-01        !V97U4719C
THETT(15,1   =  +2.68640000000E-01        !V97U4723C
THETT(16,1   =  +2.63880000000E-01        !V97U4727C
THETT(17,1   =  +2.60330000000E-01        !V97U4731C
THETT(18,1   =  +2.52800000000E-01        !V97U4735C
THETT(19,1   =  +2.42710000000E-01        !V97U4739C
THETT(20,1   =  +2.27210000000E-01        !V97U4743C
THETT(21,1   =  +2.14460000000E-01        !V97U4747C
THETT(22,1   =  +2.05550000000E-01        !V97U4751C
THETT(23,1   =  +2.01410000000E-01        !V97U4755C
THETT(24,1   =  +1.92510000000E-01        !V97U4759C
THETT(25,1   =  +1.76930000000E-01        !V97U4763C
THETT(26,1   =  +1.69050000000E-01        !V97U4767C
THETT(27,1   =  +1.65560000000E-01        !V97U4771C
THETT(28,1   =  +1.55280000000E-01        !V97U4775C
THETT(29,1   =  +1.45820000000E-01        !V97U4779C
THETT(30,1   =  +1.08210000000E-01        !V97U4783C
THETT(1,2)   =  +4.14200000000E-01        !V99U6401C
THETT(2,2)   =  +3.05800000000E-01        !V99U6402C
THETT(3,2)   =  +3.06800000000E-01        !V99U6403C
THETT(4,2)   =  +3.11900000000E-01        !V99U6404C
THETT(5,2)   =  +3.15400000000E-01        !V99U6405C
THETT(6,2)   =  +3.18300000000E-01        !V99U6406C
THETT(7,2)   =  +3.18700000000E-01        !V99U6407C
THETT(8,2)   =  +3.13600000000E-01        !V99U6408C
THETT(9,2)   =  +3.10000000000E-01        !V99U6409C
THETT(10,2   =  +3.10800000000E-01        !V99U6410C
THETT(11,2   =  +3.02400000000E-01        !V99U6411C
THETT(12,2   =  +2.92300000000E-01        !V99U6412C
THETT(13,2   =  +2.86400000000E-01        !V99U6413C
THETT(14,2   =  +2.71200000000E-01        !V99U6414C
THETT(15,2   =  +2.66400000000E-01        !V99U6415C
THETT(16,2   =  +2.61500000000E-01        !V99U6416C
THETT(17,2   =  +2.56800000000E-01        !V99U6417C
THETT(18,2   =  +2.48400000000E-01        !V99U6418C
THETT(19,2   =  +2.36600000000E-01        !V99U6419C
THETT(20,2   =  +2.20700000000E-01        !V99U6420C
THETT(21,2   =  +2.10300000000E-01        !V99U6421C
THETT(22,2   =  +2.03700000000E-01        !V99U6422C
THETT(23,2   =  +2.03200000000E-01        !V99U6423C
THETT(24,2   =  +1.97300000000E-01        !V99U6424C
THETT(25,2   =  +1.81900000000E-01        !V99U6425C
THETT(26,2   =  +1.76000000000E-01        !V99U6426C
THETT(27,2   =  +1.73300000000E-01        !V99U6427C
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229   THETT(28,2    =  +1.64400000000E-01          !V99U6428C
230   THETT(29,2    =  +1.55000000000E-01          !V99U6429C
231   THETT(30,2    =  +1.17300000000E-01          !V99U6430C
232   THETT(1,3)    =  +4.14200000000E-01          !V99U6431C
233   THETT(2,3)    =  +3.00100000000E-01          !V99U6432C
234   THETT(3,3)    =  +3.02500000000E-01          !V99U6433C
235   THETT(4,3)    =  +3.08400000000E-01          !V99U6434C
236   THETT(5,3)    =  +3.12700000000E-01          !V99U6435C
237   THETT(6,3)    =  +3.16400000000E-01          !V99U6436C
238   THETT(7,3)    =  +3.17700000000E-01          !V99U6437C
239   THETT(8,3)    =  +3.12900000000E-01          !V99U6438C
240   THETT(9,3)    =  +3.08700000000E-01          !V99U6439C
241   THETT(10,3    =  +3.09100000000E-01          !V99U6440C
242   THETT(11,3    =  +3.00000000000E-01          !V99U6441C
243   THETT(12,3    =  +2.89300000000E-01          !V99U6442C
244   THETT(13,3    =  +2.84000000000E-01          !V99U6443C
245   THETT(14,3    =  +2.71400000000E-01          !V99U6444C
246   THETT(15,3    =  +2.68700000000E-01          !V99U6445C
247   THETT(16,3    =  +2.66000000000E-01          !V99U6446C
248   THETT(17,3    =  +2.62400000000E-01          !V99U6447C
249   THETT(18,3    =  +2.55000000000E-01          !V99U6448C
250   THETT(19,3    =  +2.44500000000E-01          !V99U6449C
251   THETT(20,3    =  +2.29800000000E-01          !V99U6450C
252   THETT(21,3    =  +2.19900000000E-01          !V99U6451C
253   THETT(22,3    =  +2.12800000000E-01          !V99U6452C
254   THETT(23,3    =  +2.10700000000E-01          !V99U6453C
255   THETT(24,3    =  +2.04700000000E-01          !V99U6454C
256   THETT(25,3    =  +1.87000000000E-01          !V99U6455C
257   THETT(26,3    =  +1.80800000000E-01          !V99U6456C
258   THETT(27,3    =  +1.77800000000E-01          !V99U6457C
259   THETT(28,3    =  +1.68200000000E-01          !V99U6458C
260   THETT(29,3    =  +1.58700000000E-01          !V99U6459C
261   THETT(30,3    =  +1.21100000000E-01          !V99U6460C
262   THROTT(1)     =  +1.00000000000E+02          !V97U4808C
263   THROTT(2)     =  +8.90000000000E+01          !V97U4809C
264   THROTT(3)     =  +6.70000000000E+01          !V97U4810C
265   THROTT(4)     =  +1.04000000000E+02          !V97U4811C
266   THRTF         =  +2.64000000000E+03          !V99U7564C
267   THRTFL        =  +6.00000000000E+03          !V99U7565C
268   TLAG          =  +5.0000000E-01              !V97U4834C
269   TNZRFO(1)     =  -6.19000000000E-02          !V97U2138C
270   TNZRFO(2)     =  -5.70000000000E-02          !V97U2139C
271   TNZRFO(3)     =  -7.85000000000E-02          !V97U2140C
272   TNZRFO(4)     =  -1.23900000000E-01          !V97U2141C
273   TNZRFO(5)     =  -1.01900000000E-01          !V97U2142C
274   TNZRFO(6)     =  -1.27600000000E-01          !V97U2143C
275   TNZRFO(7)     =  -1.55700000000E-01          !V97U2144C
276   TNZRFO(8)     =  -1.98200000000E-01          !V97U2145C
277   TNZRFO(9)     =  -2.02400000000E-01          !V97U2146C
278   TNZRFO(10)    =  -1.97100000000E-01          !V97U2147C
279   TNZRFO(11)    =  -1.98200000000E-01          !V97U2148C
280   TNZRFO(12)    =  -2.10500000000E-01          !V97U2149C
281   TNZRFO(13)    =  -2.68800000000E-01          !V97U2150C
282   TNZRFO(14)    =  -2.19100000000E-01          !V97U2151C
283   TNZRFO(15)    =  -1.27900000000E-01          !V97U2152C
284   TNZRFO(16)    =  -1.17300000000E-01          !V97U2153C
285   TNZRFO(17)    =  -8.61000000000E-02          !V97U2154C
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ROCKWELL/COPIER
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286   TNZRFO(18)   =  -9.40000000000E-02        !V97U2155C
287   TNZRFO(19)   =  -1.22300000000E-01        !V97U2156C
288   TNZRFO(20)   =  -1.31400000000E-01        !V97U2157C
289   TREFAD       =  +1.98400000000E+01        !V99U7566C
290   TRIMDT       =  +1.2000000E+01            !V98U9809C
291   TSRPTO(1)    =  -3.37000000000E-01        !V97U1714C
292   TSRPTO(2)    =  -1.95000000000E-01        !V97U1715C
293   TSRPTO(3)    =  -4.59000000000E-01        !V97U1716C
294   TSRPTO(4)    =  -8.48000000000E-01        !V97U1717C
295   TSRPTO(5)    =  -6.25000000000E-01        !V97U1718C
296   TSRPTO(6)    =  -1.08700000000E+00        !V97U1719C
297   TSRPTO(7)    =  -1.21100000000E+00        !V97U1720C
298   TSRPTO(8)    =  -8.23000000000E-01        !V97U1721C
299   TSRPTO(9)    =  -9.06000000000E-01        !V97U1722C
300   TSRPTO(10)   =  -9.81000000000E-01        !V97U1723C
301   TSRPTO(11)   =  -1.02000000000E+00        !V97U1724C
302   TSRPTO(12)   =  -8.64000000000E-01        !V97U1725C
303   TSRPTO(13)   =  -9.52000000000E-01        !V97U1726C
304   TSRPTO(14)   =  -4.26000000000E-01        !V97U1727C
305   TSRPTO(15)   =  -4.05000000000E-02        !V97U1728C
306   TSRPTO(16)   =  +7.44000000000E-03        !V97U1729C
307   TSRPTO(17)   =  +9.05000000000E-02        !V97U1730C
308   TSRPTO(18)   =  +2.48000000000E-01        !V97U1731C
309   TSRPTO(19)   =  +6.55000000000E-01        !V97U1732C
310   TSRPTO(20)   =  +7.00000000000E-01        !V97U1733C
311   UYD(1)       =  +8.259191E-01             !V97U4413C
312   UYD(2)       =  -1.4569127E-01            !V97U4414C
313   UYD(3)       =  -5.4463903E-01            !V97U4415C
314   UYDNOM(1)    =  +8.259191E-01             !V96U9385C
315   UYDNOM(2)    =  -1.4569127E-01            !V96U9386C
316   UYDNOM(3)    =  -5.4463903E-01            !V96U9387C
317   VDMAG        =  +2.5829E+04               !V97U4828C
318   VDNOM        =  +2.5829E+04               !V97U4827C
319   VREFAD       =  +4.32540000000E+02        !V99U7567C
320   VREL20(1)    =  +0.0E+00                  !V97U2297C
321   VREL20(2)    =  +1.27000000000E+02        !V97U2298C
322   VREL20(3)    =  +5.06000000000E+02        !V97U2299C
323   VREL20(4)    =  +6.58000000000E+02        !V97U2300C
324   VREL20(5)    =  +7.40000000000E+02        !V97U2301C
325   VREL20(6)    =  +8.69000000000E+02        !V97U2302C
326   VREL20(7)    =  +9.73000000000E+02        !V97U2303C
327   VREL20(8)    =  +1.11500000000E+03        !V97U2304C
328   VREL20(9)    =  +1.15400000000E+03        !V97U2305C
329   VREL20(10)   =  +1.21200000000E+03        !V97U2306C
330   VREL20(11)   =  +1.27600000000E+03        !V97U2307C
331   VREL20(12)   =  +1.39000000000E+03        !V97U2308C
332   VREL20(13)   =  +1.50600000000E+03        !V97U2309C
333   VREL20(14)   =  +1.72800000000E+03        !V97U2310C
334   VREL20(15)   =  +2.03500000000E+03        !V97U2311C
335   VREL20(16)   =  +2.08300000000E+03        !V97U2312C
336   VREL20(17)   =  +2.28100000000E+03        !V97U2313C
337   VREL20(18)   =  +2.43300000000E+03        !V97U2314C
338   VREL20(19)   =  +3.37200000000E+03        !V97U2315C
339   VREL20(20)   =  +3.70200000000E+03        !V97U2316C
340   VRELT8(1)    =  +0.0E+00                  !V97U2276C
341   VRELT8(2)    =  +1.251E+03                !V97U2277C
342   VRELT8(3)    =  +1.416E+03                !V97U2278C
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ROCKWELL/COPIER

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VRELT8(4)     =  +1.624E+03                  !V97U2279C
VRELT8(5)     =  +1.748E+03                  !V97U2280C
VRELT8(6)     =  +2.289E+03                  !V97U2281C
VRELT8(7)     =  +2.4E+03                    !V97U2282C
VRELT8(8)     =  +2.512E+03                  !V97U2283C
VRHOPH        =  +5.7000000E+03              !V97U4823C
WLS1G         =  +1.5E+01                    !V97U2321C
XKDOT         =  +1.0000000E+01              !V97U4422C
XKMISS        =  +1.0E-02                    !V97U4831C

XMASS         =  +5.90590000000E+04          !V97U4429C1
XMASSL        =  +1.04790000000E+04          !V97U4432C
XMASST        =  +1.47620000000E+04          !V97U4436C
XMDDMS        =  +5.9542050E-01              !V97U4440C

XMDRCS        =  +1.0655714E-01              !V97U4441C
XMDSME        =  +3.2221560E+01              !V97U4442C
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ROCKWELL/COPIER
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LTQS RUNID: F8MCZ1 START: 11/15/91 17:48 TIME: 17:49
TRAJ PROC RUN 15 - SVDS ASCT 17 ADI OUTPUT

DOL ASCENT ADI-NOMINAL

TIME	THETA	HDOT	H
0:30	70	630	9K
0:50	64	941	25K
1:10	58	1332	47K
1:30	42	1854	79K
1:50	34	2220	121K

STAGING

VI	THETA	HDOT	H
6	19	1546	42NM
7	16	1135	50
8	13	816	55
9	11	559	58
10	9	349	60
12	6	42	62
14	3	-141	61
16	1	-217	61
18	0	-203	60
20	-1	-108	59
22	-1	38	59
24	-2	234	60
25830	-2	445	62

ROCKWELL/COPIER
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Launch Tracking Cameras Azimuth and Elevation Data

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
000	00:00:00.0	010	000000	+359.401	-000.151	00	T
084	13:12:58.0	010	002045	+359.401	-000.151	04	T
084	13:12:59.0	010	002045	+359.407	-000.151	04	T
084	13:13:00.0	010	002045	+359.401	-000.151	04	T
084	13:13:01.0	010	002045	+359.407	-000.151	04	T
084	13:13:02.0	010	002045	+359.409	-000.151	04	T
084	13:13:03.0	010	002045	+359.415	-000.151	04	T
084	13:13:04.0	010	002045	+359.407	-000.151	04	T
084	13:13:05.0	010	002045	+359.404	-000.151	04	T
084	13:13:06.0	010	002045	+359.398	-000.151	04	T
084	13:13:07.0	010	002045	+359.398	-000.151	04	T
084	13:13:08.0	010	002045	+359.398	-000.151	04	T
084	13:13:09.0	010	002045	+359.401	-000.151	04	T
084	13:13:10.0	010	002045	+359.404	-000.151	04	T
084	13:13:11.0	010	002045	+359.398	-000.146	04	T
084	13:13:12.0	010	002045	+359.407	-000.146	04	T
084	13:13:13.0	010	002045	+359.401	-000.146	04	T
084	13:13:14.0	010	002045	+359.401	-000.146	04	T
084	13:13:15.0	010	002045	+359.396	-000.148	04	T
084	13:13:16.0	010	002045	+359.407	-000.148	04	T
084	13:13:17.0	010	002045	+359.398	-000.148	04	T
084	13:13:18.0	010	002045	+359.401	-000.148	04	T
084	13:13:19.0	010	002045	+359.396	-000.148	04	T
084	13:13:20.0	010	002045	+359.404	-000.148	04	T
084	13:13:21.0	010	002045	+359.396	-000.148	04	T
084	13:13:22.0	010	002045	+359.407	-000.148	04	T
084	13:13:23.0	010	002045	+359.401	-000.148	04	T
084	13:13:24.0	010	002045	+359.412	-000.151	04	T
084	13:13:25.0	010	002045	+359.401	-000.151	04	T
084	13:13:26.0	010	002045	+359.409	-000.148	04	T
084	13:13:27.0	010	002045	+359.396	-000.148	04	T
084	13:13:28.0	010	002045	+359.409	-000.148	04	T
084	13:13:29.0	010	002045	+359.398	-000.148	04	T
084	13:13:30.0	010	002045	+359.407	-000.148	04	T
084	13:13:31.0	010	002045	+359.398	-000.148	04	T
084	13:13:32.0	010	002045	+359.407	-000.148	04	T
084	13:13:33.0	010	002045	+359.398	-000.148	04	T
084	13:13:34.0	010	002045	+359.404	-000.148	04	T
084	13:13:35.0	010	002045	+359.401	-000.146	04	T
084	13:13:36.0	010	002045	+359.404	-000.146	04	T
084	13:13:37.0	010	002045	+359.401	-000.146	04	T
084	13:13:38.0	010	002045	+359.407	-000.146	04	T
084	13:13:39.0	010	002045	+359.407	-000.146	04	T
084	13:13:40.0	010	002045	+359.407	-000.146	04	T
084	13:13:41.0	010	002045	+359.404	-000.146	04	T
084	13:13:42.0	010	002045	+359.409	-000.146	04	T
084	13:13:43.0	010	002045	+359.407	-000.146	04	T
084	13:13:44.0	010	002045	+359.396	-000.124	04	T
084	13:13:45.0	010	002045	+359.401	-000.093	04	T
084	13:13:46.0	010	002045	+359.401	-000.060	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
084	13:13:47.0	010	002045	+359.401	-000.014	04	T
084	13:13:48.0	010	002045	+359.409	+000.060	04	T
084	13:13:49.0	010	002045	+359.412	+000.126	04	T
084	13:13:50.0	010	002045	+359.412	+000.190	04	T
084	13:13:51.0	010	002045	+359.412	+000.261	04	T
084	13:13:52.0	010	002045	+359.404	+000.352	04	T
084	13:13:53.0	010	002045	+359.393	+000.445	04	T
084	13:13:54.0	010	002045	+359.393	+000.552	04	T
084	13:13:55.0	010	002045	+359.393	+000.676	04	T
084	13:13:56.0	010	002045	+359.404	+000.802	04	T
084	13:13:57.0	010	002045	+359.462	+000.953	04	T
084	13:13:58.0	010	002045	+359.492	+001.079	04	T
084	13:13:59.0	010	002045	+359.525	+001.228	04	T
084	13:14:00.0	010	002045	+359.566	+001.384	04	T
084	13:14:01.0	010	002045	+359.610	+001.555	04	T
084	13:14:02.0	010	002045	+359.654	+001.733	04	T
084	13:14:03.0	010	002045	+359.701	+001.898	04	T
084	13:14:04.0	010	002045	+359.758	+002.087	04	T
084	13:14:05.0	010	002045	+359.827	+002.291	04	T
084	13:14:06.0	010	002045	+359.876	+002.494	04	T
084	13:14:07.0	010	002045	+359.940	+002.705	04	T
084	13:14:08.0	010	002045	+000.038	+002.925	04	T
084	13:14:09.0	010	002045	+000.091	+003.112	04	
084	13:14:10.0	010	002045	+000.129	+003.238	04	
084	13:14:11.0	010	002045	+000.354	+003.628	04	
084	13:14:12.0	010	002045	+000.330	+004.018	04	
084	13:14:13.0	010	002045	+000.461	+004.191	04	
084	13:14:14.0	010	002045	+000.541	+004.449	04	
084	13:14:15.0	010	002045	+000.643	+004.705	04	T
084	13:14:16.0	010	002045	+000.711	+004.941	04	T
084	13:14:17.0	010	002045	+000.810	+005.216	04	T
084	13:14:18.0	010	002045	+000.934	+005.499	04	T
084	13:14:19.0	010	002045	+001.038	+005.782	04	T
084	13:14:20.0	010	002045	+001.148	+006.056	04	T
084	13:14:21.0	010	002045	+001.261	+006.350	04	T
084	13:14:22.0	010	002045	+001.384	+006.641	04	T
084	13:14:23.0	010	002045	+001.505	+006.946	04	T
084	13:14:24.0	010	002045	+001.626	+007.243	04	T
084	13:14:25.0	010	002045	+001.752	+007.537	04	T
084	13:14:26.0	010	002045	+001.884	+007.847	04	T
084	13:14:27.0	010	002045	+002.016	+008.144	04	T
084	13:14:28.0	010	002045	+002.145	+008.454	04	T
084	13:14:29.0	010	002045	+002.282	+008.773	04	T
084	13:14:30.0	010	002045	+002.422	+009.064	04	T
084	13:14:31.0	010	002045	+002.560	+009.388	04	T
084	13:14:32.0	010	002045	+002.697	+009.701	04	T
084	13:14:33.0	010	002045	+002.848	+010.022	04	T
084	13:14:34.0	010	002045	+002.994	+010.355	04	T
084	13:14:35.0	010	002045	+003.137	+010.643	04	T
084	13:14:36.0	010	002045	+003.285	+010.967	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	EMT	TRACK
084	13:14:37.0	010	002045	+003.436	+011.288	04	T
084	13:14:38.0	010	002045	+003.576	+011.615	04	T
084	13:14:39.0	010	002045	+003.730	+011.926	04	T
084	13:14:40.0	010	002045	+003.895	+012.242	04	T
084	13:14:41.0	010	002045	+004.035	+012.566	04	T
084	13:14:42.0	010	002045	+004.186	+012.887	04	T
084	13:14:43.0	010	002045	+004.356	+013.214	04	T
084	13:14:44.0	010	002045	+004.513	+013.524	04	T
084	13:14:45.0	010	002045	+004.669	+013.854	04	T
084	13:14:46.0	010	002045	+004.837	+014.172	04	T
084	13:14:47.0	010	002045	+004.993	+014.499	04	T
084	13:14:48.0	010	002045	+005.158	+014.840	04	T
084	13:14:49.0	010	002045	+005.337	+015.153	04	T
084	13:14:50.0	010	002045	+005.504	+015.491	04	T
084	13:14:51.0	010	002045	+005.672	+015.815	04	T
084	13:14:52.0	010	002045	+005.834	+016.153	04	T
084	13:14:53.0	010	002045	+005.999	+016.490	04	T
084	13:14:54.0	010	002045	+006.177	+016.806	04	T
084	13:14:55.0	010	002045	+006.353	+017.158	04	T
084	13:14:56.0	010	002045	+006.542	+017.485	04	T
084	13:14:57.0	010	002045	+006.735	+017.823	04	T
084	13:14:58.0	010	002045	+006.908	+018.141	04	T
084	13:14:59.0	010	002045	+007.089	+018.474	04	T
084	13:15:00.0	010	002045	+007.276	+018.806	04	T
084	13:15:01.0	010	002045	+007.482	+019.127	04	T
084	13:15:02.0	010	002045	+007.685	+019.454	04	T
084	13:15:03.0	010	002045	+007.877	+019.762	04	T
084	13:15:04.0	010	002045	+008.083	+020.086	04	T
084	13:15:05.0	010	002045	+008.292	+020.380	04	T
084	13:15:06.0	010	002045	+008.498	+020.690	04	T
084	13:15:07.0	010	002045	+008.709	+020.998	04	T
084	13:15:08.0	010	002045	+008.948	+021.267	04	T
084	13:15:09.0	010	002045	+009.168	+021.569	04	T
084	13:15:10.0	010	002045	+009.396	+021.844	04	T
084	13:15:11.0	010	002045	+009.619	+022.118	04	T
084	13:15:12.0	010	002045	+009.863	+022.387	04	T
084	13:15:13.0	010	002045	+010.099	+022.637	04	T
084	13:15:14.0	010	002045	+010.335	+022.893	04	T
084	13:15:15.0	010	002045	+010.572	+023.154	04	T
084	13:15:16.0	010	002045	+010.822	+023.387	04	T
084	13:15:17.0	010	002045	+011.069	+023.629	04	T
084	13:15:18.0	010	002045	+011.321	+023.868	04	T
084	13:15:19.0	010	002045	+011.566	+024.090	04	T
084	13:15:20.0	010	002045	+011.816	+024.288	04	T
084	13:15:21.0	010	002045	+012.063	+024.508	04	T
084	13:15:22.0	010	002045	+012.332	+024.711	04	T
084	13:15:23.0	010	002045	+012.585	+024.895	04	T
084	13:15:24.0	010	002045	+012.832	+025.085	04	T
084	13:15:25.0	010	002045	+013.079	+025.266	04	T
084	13:15:26.0	010	002045	+013.335	+025.444	04	T

**** PTPD - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
084	13:15:27.0	010	002045	+013.596	+025.609	04	T
084	13:15:28.0	010	002045	+013.848	+025.752	04	T
084	13:15:29.0	010	002045	+014.101	+025.909	04	T
084	13:15:30.0	010	002045	+014.354	+026.057	04	T
084	13:15:31.0	010	002045	+014.612	+026.197	04	T
084	13:15:32.0	010	002045	+014.859	+026.326	04	T
084	13:15:33.0	010	002045	+015.106	+026.450	04	T
084	13:15:34.0	010	002045	+015.351	+026.573	04	T
084	13:15:35.0	010	002045	+015.606	+026.691	04	T
084	13:15:36.0	010	002045	+015.851	+026.796	04	T
084	13:15:37.0	010	002045	+016.081	+026.895	04	T
084	13:15:38.0	010	002045	+016.315	+026.991	04	T
084	13:15:39.0	010	002045	+016.545	+027.079	04	T
084	13:15:40.0	010	002045	+016.793	+027.158	04	T
084	13:15:41.0	010	002045	+017.029	+027.230	04	T
084	13:15:42.0	010	002045	+017.254	+027.301	04	T
084	13:15:43.0	010	002045	+017.463	+027.364	04	T
084	13:15:44.0	010	002045	+017.680	+027.427	04	T
084	13:15:45.0	010	002045	+017.894	+027.482	04	T
084	13:15:46.0	010	002045	+018.103	+027.532	04	T
084	13:15:47.0	010	002045	+018.309	+027.576	04	T
084	13:15:48.0	010	002045	+018.504	+027.614	04	T
084	13:15:49.0	010	002045	+018.707	+027.647	04	T
084	13:15:50.0	010	002045	+018.902	+027.680	04	T
084	13:15:51.0	010	002045	+019.097	+027.705	04	T
084	13:15:52.0	010	002045	+019.273	+027.729	04	T
084	13:15:53.0	010	002045	+019.460	+027.743	04	T
084	13:15:54.0	010	002045	+019.646	+027.757	04	T
084	13:15:55.0	010	002045	+019.819	+027.765	04	T
084	13:15:56.0	010	002045	+020.001	+027.776	04	T
084	13:15:57.0	010	002045	+020.168	+027.782	04	T
084	13:15:58.0	010	002045	+020.336	+027.782	04	T
084	13:15:59.0	010	002045	+020.503	+027.782	04	T
084	13:16:00.0	010	002045	+020.665	+027.782	04	T
084	13:16:01.0	010	002045	+020.833	+027.773	04	T
084	13:16:02.0	010	002045	+020.998	+027.754	04	T
084	13:16:03.0	010	002045	+021.146	+027.729	04	T
084	13:16:04.0	010	002045	+021.294	+027.708	04	T
084	13:16:05.0	010	002045	+021.451	+027.691	04	T
084	13:16:06.0	010	002045	+021.596	+027.661	04	T
084	13:16:07.0	010	002045	+021.742	+027.639	04	T
084	13:16:08.0	010	002045	+021.890	+027.606	04	T
084	13:16:09.0	010	002045	+022.033	+027.570	04	T
084	13:16:10.0	010	002045	+022.181	+027.532	04	T
084	13:16:11.0	010	002045	+022.327	+027.493	04	T
084	13:16:12.0	010	002045	+022.459	+027.452	04	T
084	13:16:13.0	010	002045	+022.580	+027.405	04	T
084	13:16:14.0	010	002045	+022.714	+027.361	04	T
084	13:16:15.0	010	002045	+022.846	+027.312	04	T
084	13:16:16.0	010	002045	+022.967	+027.263	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
084	13:16:17.0	010	002045	+023.102	+027.208	04	T
084	13:16:18.0	010	002045	+023.242	+027.166	04	T
084	13:16:19.0	010	002045	+023.365	+027.098	04	T
084	13:16:20.0	010	002045	+023.472	+027.048	04	T
084	13:16:21.0	010	002045	+023.590	+026.988	04	T
084	13:16:22.0	010	002045	+023.714	+026.925	04	T
084	13:16:23.0	010	002045	+023.824	+026.856	04	T
084	13:16:24.0	010	002045	+023.928	+026.790	04	T
084	13:16:25.0	010	002045	+024.041	+026.721	04	T
084	13:16:26.0	010	002045	+024.162	+026.656	04	T
084	13:16:27.0	010	002045	+024.269	+026.581	04	T
084	13:16:28.0	010	002045	+024.373	+026.510	04	T
084	13:16:29.0	010	002045	+024.486	+026.439	04	T
084	13:16:30.0	010	002045	+024.593	+026.359	04	T
084	13:16:31.0	010	002045	+024.692	+026.288	04	T
084	13:16:32.0	010	002045	+024.788	+026.216	04	T
084	13:16:33.0	010	002045	+024.884	+026.134	04	T
084	13:16:34.0	010	002045	+024.994	+026.062	04	T
084	13:16:35.0	010	002045	+025.093	+025.977	04	T
084	13:16:36.0	010	002045	+025.183	+025.895	04	T
084	13:16:37.0	010	002045	+025.277	+025.807	04	T
084	13:16:38.0	010	002045	+025.370	+025.722	04	T
084	13:16:39.0	010	002045	+025.475	+025.639	04	T
084	13:16:40.0	010	002045	+025.571	+025.557	04	T
084	13:16:41.0	010	002045	+025.653	+025.475	04	T
084	13:16:42.0	010	002045	+025.733	+025.381	04	T
084	13:16:43.0	010	002045	+025.821	+025.296	04	T
084	13:16:44.0	010	002045	+025.911	+025.200	04	T
084	13:16:45.0	010	002045	+025.996	+025.107	04	T
084	13:16:46.0	010	002045	+026.073	+025.019	04	T
084	13:16:47.0	010	002045	+026.158	+024.922	04	T
084	13:16:48.0	010	002045	+026.235	+024.818	04	T
084	13:16:49.0	010	002045	+026.320	+024.738	04	T
084	13:16:50.0	010	002045	+026.414	+024.648	04	T
084	13:16:51.0	010	002045	+026.491	+024.549	04	T
084	13:16:52.0	010	002045	+026.562	+024.453	04	T
084	13:16:53.0	010	002045	+026.636	+024.357	04	T
084	13:16:54.0	010	002045	+026.711	+024.258	04	T
084	13:16:55.0	010	002045	+026.787	+024.164	04	T
084	13:16:56.0	010	002045	+026.864	+024.071	04	T
084	13:16:57.0	010	002045	+026.936	+023.972	04	T
084	13:16:58.0	010	002045	+027.004	+023.868	04	T
084	13:16:59.0	010	002045	+027.076	+023.763	04	T
084	13:17:00.0	010	002045	+027.150	+023.665	04	T
084	13:17:01.0	010	002045	+027.221	+023.563	04	T
084	13:17:02.0	010	002045	+027.293	+023.459	04	T
084	13:17:03.0	010	002045	+027.361	+023.351	04	T
084	13:17:04.0	010	002045	+027.425	+023.258	04	T
084	13:17:05.0	010	002045	+027.488	+023.156	04	T
084	13:17:06.0	010	002045	+027.556	+023.063	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
084	13:17:07.0	010	002045	+027.633	+022.953	04	T
084	13:17:08.0	010	002045	+027.691	+022.852	04	T
084	13:17:09.0	010	002045	+027.749	+022.742	04	T
084	13:17:10.0	010	002045	+027.817	+022.632	04	T
084	13:17:11.0	010	002045	+027.881	+022.533	04	T
084	13:17:12.0	010	002045	+027.938	+022.434	04	T
084	13:17:13.0	010	002045	+027.999	+022.335	04	T
084	13:17:14.0	010	002045	+028.054	+022.223	04	T
084	13:17:15.0	010	002045	+028.117	+022.118	04	T
084	13:17:16.0	010	002045	+028.177	+022.014	04	T
084	13:17:17.0	010	002045	+028.235	+021.904	04	T
084	13:17:18.0	010	002045	+028.293	+021.794	04	T
084	13:17:19.0	010	002045	+028.347	+021.690	04	T
084	13:17:20.0	010	002045	+028.400	+021.594	04	T
084	13:17:21.0	010	002045	+028.460	+021.487	04	T
084	13:17:22.0	010	002045	+028.521	+021.368	04	T
084	13:17:23.0	010	002045	+028.570	+021.264	04	T
084	13:17:24.0	010	002045	+028.628	+021.146	04	T
084	13:17:25.0	010	002045	+028.683	+021.055	04	T
084	13:17:26.0	010	002045	+028.724	+020.945	04	T
084	13:17:27.0	010	002045	+028.776	+020.841	04	T
084	13:17:28.0	010	002045	+028.839	+020.720	04	T
084	13:17:29.0	010	002045	+028.894	+020.619	04	T
084	13:17:30.0	010	002045	+028.932	+020.506	04	T
084	13:17:31.0	010	002045	+028.976	+020.402	04	T
084	13:17:32.0	010	002045	+029.034	+020.292	04	T
084	13:17:33.0	010	002045	+029.089	+020.187	04	T
084	13:17:34.0	010	002045	+029.133	+020.083	04	T
084	13:17:35.0	010	002045	+029.174	+019.987	04	T
084	13:17:36.0	010	002045	+029.221	+019.861	04	T
084	13:17:37.0	010	002045	+029.270	+019.745	04	T
084	13:17:38.0	010	002045	+029.317	+019.644	04	T
084	13:17:39.0	010	002045	+029.361	+019.536	04	T
084	13:17:40.0	010	002045	+029.408	+019.429	04	T
084	13:17:41.0	010	002045	+029.454	+019.328	04	T
084	13:17:42.0	010	002045	+029.504	+019.218	04	T
084	13:17:43.0	010	002045	+029.545	+019.111	04	T
084	13:17:44.0	010	002045	+029.589	+018.995	04	T
084	13:17:45.0	010	002045	+029.633	+018.891	04	T
084	13:17:46.0	010	002045	+029.674	+018.784	04	T
084	13:17:47.0	010	002045	+029.710	+018.674	04	T
084	13:17:48.0	010	002045	+029.748	+018.572	04	T
084	13:17:49.0	010	002045	+029.795	+018.474	04	T
084	13:17:50.0	010	002045	+029.853	+018.366	04	T
084	13:17:51.0	010	002045	+029.888	+018.254	04	T
084	13:17:52.0	010	002045	+029.927	+018.133	04	T
084	13:17:53.0	010	002045	+029.968	+018.029	04	T
084	13:17:54.0	010	002045	+030.004	+017.924	04	T
084	13:17:55.0	010	002045	+030.045	+017.820	04	T
084	13:17:56.0	010	002045	+030.086	+017.726	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	EMT	TRACK
084	13:17:57.0	010	002045	+030.116	+017.611	04	T
084	13:17:58.0	010	002045	+030.149	+017.504	04	T
084	13:17:59.0	010	002045	+030.188	+017.394	04	T
084	13:18:00.0	010	002045	+030.232	+017.290	04	T
084	13:18:01.0	010	002045	+030.270	+017.183	04	T
084	13:18:02.0	010	002045	+030.303	+017.073	04	T
084	13:18:03.0	010	002045	+030.344	+016.982	04	T
084	13:18:04.0	010	002045	+030.369	+016.886	04	T
084	13:18:05.0	010	002045	+030.396	+016.751	04	T
084	13:18:06.0	010	002045	+030.451	+016.655	04	T
084	13:18:07.0	010	002045	+030.498	+016.548	04	T
084	13:18:08.0	010	002045	+030.523	+016.444	04	T
084	13:18:09.0	010	002045	+030.556	+016.348	04	T
084	13:18:10.0	010	002045	+030.591	+016.243	04	T
084	13:18:11.0	010	002045	+030.622	+016.142	04	T
084	13:18:12.0	010	002045	+030.663	+016.037	04	T
084	13:18:13.0	010	002045	+030.696	+015.930	04	T
084	13:18:14.0	010	002045	+030.721	+015.818	04	T
084	13:18:15.0	010	002045	+030.753	+015.724	04	T
084	13:18:16.0	010	002045	+030.792	+015.614	04	T
084	13:18:17.0	010	002045	+030.819	+015.510	04	T
084	13:18:18.0	010	002045	+030.855	+015.419	04	T
084	13:18:19.0	010	002045	+030.891	+015.323	04	T
084	13:18:20.0	010	002045	+030.918	+015.205	04	T
084	13:18:21.0	010	002045	+030.951	+015.109	04	T
084	13:18:22.0	010	002045	+030.979	+015.002	04	T
084	13:18:23.0	010	002045	+031.009	+014.897	04	T
084	13:18:24.0	010	002045	+031.039	+014.804	04	T
084	13:18:25.0	010	002045	+031.072	+014.702	04	T
084	13:18:26.0	010	002045	+031.102	+014.590	04	T
084	13:18:27.0	010	002045	+031.130	+014.491	04	T
084	13:18:28.0	010	002045	+031.160	+014.387	04	T
084	13:18:29.0	010	002045	+031.187	+014.290	04	T
084	13:18:30.0	010	002045	+031.220	+014.181	04	T
084	13:18:31.0	010	002045	+031.256	+014.082	04	T
084	13:18:32.0	010	002045	+031.281	+013.991	04	T
084	13:18:33.0	010	002045	+031.303	+013.903	04	T
084	13:18:34.0	010	002045	+031.336	+013.799	04	T
084	13:18:35.0	010	002045	+031.369	+013.697	04	T
084	13:18:36.0	010	002045	+031.391	+013.596	04	T
084	13:18:37.0	010	002045	+031.413	+013.491	04	T
084	13:18:38.0	010	002045	+031.443	+013.398	04	T
084	13:18:39.0	010	002045	+031.473	+013.302	04	T
084	13:18:40.0	010	002045	+031.498	+013.203	04	T
084	13:18:41.0	010	002045	+031.523	+013.120	04	T
084	13:18:42.0	010	002045	+031.550	+013.016	04	T
084	13:18:43.0	010	002045	+031.575	+012.914	04	T
084	13:18:44.0	010	002045	+031.605	+012.810	04	T
084	13:18:45.0	010	002045	+031.627	+012.717	04	T
084	13:18:46.0	010	002045	+031.654	+012.621	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
084	13:18:47.0	010	002045	+031.679	+012.516	04	T
084	13:18:48.0	010	002045	+031.704	+012.426	04	T
084	13:18:49.0	010	002045	+031.729	+012.343	04	T
084	13:18:50.0	010	002045	+031.759	+012.239	04	T
084	13:18:51.0	010	002045	+031.783	+012.140	04	T
084	13:18:52.0	010	002045	+031.803	+012.038	04	T
084	13:18:53.0	010	002045	+031.833	+011.942	04	T
084	13:18:54.0	010	002045	+031.863	+011.854	04	T
084	13:18:55.0	010	002045	+031.885	+011.766	04	T
084	13:18:56.0	010	002045	+031.902	+011.678	04	T
084	13:18:57.0	010	002045	+031.921	+011.585	04	T
084	13:18:58.0	010	002045	+031.951	+011.489	04	T
084	13:18:59.0	010	002045	+031.978	+011.396	04	T
084	13:19:00.0	010	002045	+031.998	+011.302	04	T
084	13:19:01.0	010	002045	+032.011	+011.209	04	T
084	13:19:02.0	010	002045	+032.033	+011.110	04	T
084	13:19:03.0	010	002045	+032.066	+011.025	04	T
084	13:19:04.0	010	002045	+032.094	+010.931	04	T
084	13:19:05.0	010	002045	+032.110	+010.844	04	T
084	13:19:06.0	010	002045	+032.121	+010.761	04	T
084	13:19:07.0	010	002045	+032.141	+010.668	04	T
084	13:19:08.0	010	002045	+032.173	+010.577	04	T
084	13:19:09.0	010	002045	+032.195	+010.481	04	T
084	13:19:10.0	010	002045	+032.217	+010.393	04	T
084	13:19:11.0	010	002045	+032.239	+010.302	04	T
084	13:19:12.0	010	002045	+032.259	+010.220	04	T
084	13:19:13.0	010	002045	+032.281	+010.127	04	T
084	13:19:14.0	010	002045	+032.303	+010.031	04	T
084	13:19:15.0	010	002045	+032.325	+009.937	04	T
084	13:19:16.0	010	002045	+032.349	+009.852	04	T
084	13:19:17.0	010	002045	+032.368	+009.764	04	T
084	13:19:18.0	010	002045	+032.382	+009.673	04	T
084	13:19:19.0	010	002045	+032.404	+009.586	04	T
084	13:19:20.0	010	002045	+032.429	+009.500	04	T
084	13:19:21.0	010	002045	+032.448	+009.424	04	T
084	13:19:22.0	010	002045	+032.465	+009.327	04	T
084	13:19:23.0	010	002045	+032.476	+009.248	04	T
084	13:19:24.0	010	002045	+032.492	+009.152	04	T
084	13:19:25.0	010	002045	+032.522	+009.061	04	T
084	13:19:26.0	010	002045	+032.550	+008.984	04	T
084	13:19:27.0	010	002045	+032.561	+008.891	04	T
084	13:19:28.0	010	002045	+032.569	+008.803	04	T
084	13:19:29.0	010	002045	+032.594	+008.721	04	T
084	13:19:30.0	010	002045	+032.621	+008.652	04	T
084	13:19:31.0	010	002045	+032.640	+008.564	04	T
084	13:19:32.0	010	002045	+032.660	+008.476	04	T
084	13:19:33.0	010	002045	+032.679	+008.396	04	T
084	13:19:34.0	010	002045	+032.698	+008.311	04	T
084	13:19:35.0	010	002045	+032.723	+008.226	04	T
084	13:19:36.0	010	002045	+032.739	+008.146	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	EMT	TRACK
084	13:19:37.0	010	002045	+032.753	+008.061	04	T
084	13:19:38.0	010	002045	+032.769	+007.982	04	T
084	13:19:39.0	010	002045	+032.789	+007.896	04	T
084	13:19:40.0	010	002045	+032.811	+007.828	04	T
084	13:19:41.0	010	002045	+032.827	+007.743	04	T
084	13:19:42.0	010	002045	+032.844	+007.655	04	T
084	13:19:43.0	010	002045	+032.866	+007.575	04	T
084	13:19:44.0	010	002045	+032.882	+007.495	04	T
084	13:19:45.0	010	002045	+032.899	+007.413	04	T
084	13:19:46.0	010	002045	+032.921	+007.333	04	T
084	13:19:47.0	010	002045	+032.943	+007.256	04	T
084	13:19:48.0	010	002045	+032.951	+007.177	04	T
084	13:19:49.0	010	002045	+032.956	+007.100	04	T
084	13:19:50.0	010	002045	+032.981	+007.020	04	T
084	13:19:51.0	010	002045	+033.008	+006.941	04	T
084	13:19:52.0	010	002045	+033.022	+006.855	04	T
084	13:19:53.0	010	002045	+033.033	+006.776	04	T
084	13:19:54.0	010	002045	+033.052	+006.699	04	T
084	13:19:55.0	010	002045	+033.069	+006.622	04	T
084	13:19:56.0	010	002045	+033.085	+006.542	04	T
084	13:19:57.0	010	002045	+033.102	+006.468	04	T
084	13:19:58.0	010	002045	+033.121	+006.391	04	T
084	13:19:59.0	010	002045	+033.143	+006.317	04	T
084	13:20:00.0	010	002045	+033.162	+006.240	04	T
084	13:20:01.0	010	002045	+033.176	+006.166	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
084	13:13:38.0	011	002045	+000.398	-000.058	04	*
084	13:13:39.0	011	002045	+000.398	-000.060	04	
084	13:13:40.0	011	002045	+000.393	-000.063	04	
084	13:13:41.0	011	002045	+000.393	-000.063	04	
084	13:13:42.0	011	002045	+000.401	-000.060	04	
084	13:13:43.0	011	002045	+000.393	-000.052	04	
084	13:13:44.0	011	002045	+000.382	-000.022	04	
084	13:13:45.0	011	002045	+000.387	+000.019	04	
084	13:13:46.0	011	002045	+000.382	+000.071	04	
084	13:13:47.0	011	002045	+000.387	+000.140	04	
084	13:13:48.0	011	002045	+000.404	+000.250	04	
084	13:13:49.0	011	002045	+000.404	+000.363	04	
084	13:13:50.0	011	002045	+000.390	+000.478	04	
084	13:13:51.0	011	002045	+000.390	+000.566	04	
084	13:13:52.0	011	002045	+000.393	+000.673	04	
084	13:13:53.0	011	002045	+000.401	+000.835	04	
084	13:13:54.0	011	002045	+000.390	+000.997	04	
084	13:13:55.0	011	002045	+000.412	+001.170	04	
084	13:13:56.0	011	002045	+000.442	+001.360	04	
084	13:13:57.0	011	002045	+000.478	+001.566	04	
084	13:13:58.0	011	002045	+000.522	+001.780	04	
084	13:13:59.0	011	002045	+000.591	+002.005	04	
084	13:14:00.0	011	002045	+000.634	+002.233	04	
084	13:14:01.0	011	002045	+000.678	+002.469	04	
084	13:14:02.0	011	002045	+000.753	+002.730	04	
084	13:14:03.0	011	002045	+000.843	+002.988	04	
084	13:14:04.0	011	002045	+000.931	+003.288	04	
084	13:14:05.0	011	002045	+001.005	+003.595	04	
084	13:14:06.0	011	002045	+001.099	+003.903	04	
084	13:14:07.0	011	002045	+001.198	+004.197	04	
084	13:14:08.0	011	002045	+001.305	+004.518	04	
084	13:14:09.0	011	002045	+001.420	+004.864	04	
084	13:14:10.0	011	002045	+001.524	+005.202	04	
084	13:14:11.0	011	002045	+001.640	+005.562	04	
084	13:14:12.0	011	002045	+001.733	+006.029	04	
084	13:14:13.0	011	002045	+001.901	+006.312	04	
084	13:14:14.0	011	002045	+002.027	+006.677	04	
084	13:14:15.0	011	002045	+002.167	+007.059	04	
084	13:14:16.0	011	002045	+002.324	+007.460	04	
084	13:14:17.0	011	002045	+002.461	+007.852	04	
084	13:14:18.0	011	002045	+002.617	+008.226	04	
084	13:14:19.0	011	002045	+002.760	+008.608	04	
084	13:14:20.0	011	002045	+002.922	+009.020	04	
084	13:14:21.0	011	002045	+003.062	+009.426	04	
084	13:14:22.0	011	002045	+003.197	+009.825	04	
084	13:14:23.0	011	002045	+003.384	+010.212	04	
084	13:14:24.0	011	002045	+003.593	+010.588	04	
084	13:14:25.0	011	002045	+003.744	+010.995	04	T
084	13:14:26.0	011	002045	+003.917	+011.409	04	T
084	13:14:27.0	011	002045	+004.095	+011.816	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
084	13:14:28.0	011	002045	+004.279	+012.231	04	T
084	13:14:29.0	011	002045	+004.463	+012.648	04	T
084	13:14:30.0	011	002045	+004.653	+013.065	04	T
084	13:14:31.0	011	002045	+004.842	+013.483	04	T
084	13:14:32.0	011	002045	+005.032	+013.898	04	T
084	13:14:33.0	011	002045	+005.224	+014.312	04	T
084	13:14:34.0	011	002045	+005.416	+014.724	04	T
084	13:14:35.0	011	002045	+005.614	+015.134	04	T
084	13:14:36.0	011	002045	+005.809	+015.537	04	T
084	13:14:37.0	011	002045	+006.004	+015.941	04	T
084	13:14:38.0	011	002045	+006.202	+016.348	04	T
084	13:14:39.0	011	002045	+006.405	+016.754	04	T
084	13:14:40.0	011	002045	+006.603	+017.158	04	T
084	13:14:41.0	011	002045	+006.801	+017.559	04	T
084	13:14:42.0	011	002045	+007.001	+017.957	04	T
084	13:14:43.0	011	002045	+007.207	+018.353	04	T
084	13:14:44.0	011	002045	+007.408	+018.745	04	T
084	13:14:45.0	011	002045	+007.611	+019.141	04	T
084	13:14:46.0	011	002045	+007.817	+019.539	04	T
084	13:14:47.0	011	002045	+008.026	+019.918	04	T
084	13:14:48.0	011	002045	+008.229	+020.300	04	T
084	13:14:49.0	011	002045	+008.435	+020.685	04	T
084	13:14:50.0	011	002045	+008.643	+021.072	04	T
084	13:14:51.0	011	002045	+008.849	+021.454	04	T
084	13:14:52.0	011	002045	+009.053	+021.833	04	T
084	13:14:53.0	011	002045	+009.264	+022.212	04	T
084	13:14:54.0	011	002045	+009.473	+022.588	04	T
084	13:14:55.0	011	002045	+009.690	+022.956	04	T
084	13:14:56.0	011	002045	+009.901	+023.324	04	T
084	13:14:57.0	011	002045	+010.121	+023.687	04	T
084	13:14:58.0	011	002045	+010.341	+024.041	04	T
084	13:14:59.0	011	002045	+010.561	+024.392	04	T
084	13:15:00.0	011	002045	+010.778	+024.738	04	T
084	13:15:01.0	011	002045	+011.008	+025.076	04	T
084	13:15:02.0	011	002045	+011.234	+025.406	04	T
084	13:15:03.0	011	002045	+011.464	+025.730	04	T
084	13:15:04.0	011	002045	+011.700	+026.046	04	T
084	13:15:05.0	011	002045	+011.939	+026.348	04	T
084	13:15:06.0	011	002045	+012.178	+026.645	04	T
084	13:15:07.0	011	002045	+012.423	+026.933	04	T
084	13:15:08.0	011	002045	+012.673	+027.213	04	T
084	13:15:09.0	011	002045	+012.920	+027.482	04	T
084	13:15:10.0	011	002045	+013.173	+027.740	04	T
084	13:15:11.0	011	002045	+013.428	+027.990	04	T
084	13:15:12.0	011	002045	+013.683	+028.232	04	T
084	13:15:13.0	011	002045	+013.936	+028.463	04	T
084	13:15:14.0	011	002045	+014.200	+028.683	04	T
084	13:15:15.0	011	002045	+014.458	+028.894	04	T
084	13:15:16.0	011	002045	+014.722	+029.097	04	T
084	13:15:17.0	011	002045	+014.983	+029.290	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
084	13:15:18.0	011	002045	+015.244	+029.476	04	T
084	13:15:19.0	011	002045	+015.507	+029.652	04	T
084	13:15:20.0	011	002045	+015.774	+029.817	04	T
084	13:15:21.0	011	002045	+016.035	+029.973	04	T
084	13:15:22.0	011	002045	+016.295	+030.125	04	T
084	13:15:23.0	011	002045	+016.562	+030.262	04	T
084	13:15:24.0	011	002045	+016.817	+030.394	04	T
084	13:15:25.0	011	002045	+017.078	+030.517	04	T
084	13:15:26.0	011	002045	+017.336	+030.633	04	T
084	13:15:27.0	011	002045	+017.589	+030.740	04	T
084	13:15:28.0	011	002045	+017.845	+030.839	04	T
084	13:15:29.0	011	002045	+018.103	+030.929	04	T
084	13:15:30.0	011	002045	+018.353	+031.014	04	T
084	13:15:31.0	011	002045	+018.594	+031.091	04	T
084	13:15:32.0	011	002045	+018.844	+031.160	04	T
084	13:15:33.0	011	002045	+019.083	+031.223	04	T
084	13:15:34.0	011	002045	+019.322	+031.281	04	T
084	13:15:35.0	011	002045	+019.564	+031.330	04	T
084	13:15:36.0	011	002045	+019.795	+031.374	04	T
084	13:15:37.0	011	002045	+020.020	+031.413	04	T
084	13:15:38.0	011	002045	+020.248	+031.443	04	T
084	13:15:39.0	011	002045	+020.476	+031.468	04	T
084	13:15:40.0	011	002045	+020.690	+031.487	04	T
084	13:15:41.0	011	002045	+020.901	+031.503	04	T
084	13:15:42.0	011	002045	+021.105	+031.514	04	T
084	13:15:43.0	011	002045	+021.308	+031.517	04	T
084	13:15:44.0	011	002045	+021.503	+031.520	04	T
084	13:15:45.0	011	002045	+021.695	+031.520	04	T
084	13:15:46.0	011	002045	+021.890	+031.512	04	T
084	13:15:47.0	011	002045	+022.074	+031.498	04	T
084	13:15:48.0	011	002045	+022.256	+031.476	04	T
084	13:15:49.0	011	002045	+022.431	+031.459	04	T
084	13:15:50.0	011	002045	+022.610	+031.437	04	T
084	13:15:51.0	011	002045	+022.780	+031.410	04	T
084	13:15:52.0	011	002045	+022.948	+031.382	04	T
084	13:15:53.0	011	002045	+023.107	+031.349	04	T
084	13:15:54.0	011	002045	+023.266	+031.311	04	T
084	13:15:55.0	011	002045	+023.423	+031.275	04	T
084	13:15:56.0	011	002045	+023.579	+031.237	04	T
084	13:15:57.0	011	002045	+023.739	+031.190	04	T
084	13:15:58.0	011	002045	+023.887	+031.146	04	T
084	13:15:59.0	011	002045	+024.030	+031.100	04	T
084	13:16:00.0	011	002045	+024.173	+031.050	04	T
084	13:16:01.0	011	002045	+024.313	+030.998	04	T
084	13:16:02.0	011	002045	+024.447	+030.940	04	T
084	13:16:03.0	011	002045	+024.582	+030.880	04	T
084	13:16:04.0	011	002045	+024.714	+030.817	04	T
084	13:16:05.0	011	002045	+024.846	+030.751	04	T
084	13:16:06.0	011	002045	+024.969	+030.685	04	T
084	13:16:07.0	011	002045	+025.096	+030.616	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
084	13:16:08.0	011	002045	+025.216	+030.545	04	T
084	13:16:09.0	011	002045	+025.334	+030.473	04	T
084	13:16:10.0	011	002045	+025.453	+030.396	04	T
084	13:16:11.0	011	002045	+025.571	+030.317	04	T
084	13:16:12.0	011	002045	+025.683	+030.240	04	T
084	13:16:13.0	011	002045	+025.796	+030.160	04	T
084	13:16:14.0	011	002045	+025.906	+030.075	04	T
084	13:16:15.0	011	002045	+026.013	+029.993	04	T
084	13:16:16.0	011	002045	+026.117	+029.908	04	T
084	13:16:17.0	011	002045	+026.222	+029.817	04	T
084	13:16:18.0	011	002045	+026.323	+029.729	04	T
084	13:16:19.0	011	002045	+026.422	+029.638	04	T
084	13:16:20.0	011	002045	+026.521	+029.548	04	T
084	13:16:21.0	011	002045	+026.617	+029.454	04	T
084	13:16:22.0	011	002045	+026.713	+029.358	04	T
084	13:16:23.0	011	002045	+026.804	+029.265	04	T
084	13:16:24.0	011	002045	+026.897	+029.166	04	T
084	13:16:25.0	011	002045	+026.988	+029.067	04	T
084	13:16:26.0	011	002045	+027.079	+028.968	04	T
084	13:16:27.0	011	002045	+027.166	+028.869	04	T
084	13:16:28.0	011	002045	+027.252	+028.768	04	T
084	13:16:29.0	011	002045	+027.334	+028.663	04	T
084	13:16:30.0	011	002045	+027.419	+028.559	04	T
084	13:16:31.0	011	002045	+027.499	+028.455	04	T
084	13:16:32.0	011	002045	+027.581	+028.350	04	T
084	13:16:33.0	011	002045	+027.661	+028.246	04	T
084	13:16:34.0	011	002045	+027.738	+028.139	04	T
084	13:16:35.0	011	002045	+027.815	+028.029	04	T
084	13:16:36.0	011	002045	+027.892	+027.922	04	T
084	13:16:37.0	011	002045	+027.966	+027.812	04	T
084	13:16:38.0	011	002045	+028.040	+027.702	04	T
084	13:16:39.0	011	002045	+028.114	+027.592	04	T
084	13:16:40.0	011	002045	+028.185	+027.480	04	T
084	13:16:41.0	011	002045	+028.254	+027.370	04	T
084	13:16:42.0	011	002045	+028.323	+027.257	04	T
084	13:16:43.0	011	002045	+028.391	+027.144	04	T
084	13:16:44.0	011	002045	+028.457	+027.029	04	T
084	13:16:45.0	011	002045	+028.523	+026.917	04	T
084	13:16:46.0	011	002045	+028.589	+026.801	04	T
084	13:16:47.0	011	002045	+028.655	+026.686	04	T
084	13:16:48.0	011	002045	+028.716	+026.570	04	T
084	13:16:49.0	011	002045	+028.779	+026.455	04	T
084	13:16:50.0	011	002045	+028.839	+026.337	04	T
084	13:16:51.0	011	002045	+028.900	+026.222	04	T
084	13:16:52.0	011	002045	+028.960	+026.104	04	T
084	13:16:53.0	011	002045	+029.020	+025.985	04	T
084	13:16:54.0	011	002045	+029.078	+025.870	04	T
084	13:16:55.0	011	002045	+029.136	+025.752	04	T
084	13:16:56.0	011	002045	+029.193	+025.634	04	T
084	13:16:57.0	011	002045	+029.251	+025.516	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
084	13:16:58.0	011	002045	+029.303	+025.398	04	T
084	13:16:59.0	011	002045	+029.358	+025.277	04	T
084	13:17:00.0	011	002045	+029.413	+025.159	04	T
084	13:17:01.0	011	002045	+029.465	+025.038	04	T
084	13:17:02.0	011	002045	+029.518	+024.920	04	T
084	13:17:03.0	011	002045	+029.567	+024.799	04	T
084	13:17:04.0	011	002045	+029.619	+024.678	04	T
084	13:17:05.0	011	002045	+029.669	+024.557	04	T
084	13:17:06.0	011	002045	+029.718	+024.439	04	T
084	13:17:07.0	011	002045	+029.767	+024.315	04	T
084	13:17:08.0	011	002045	+029.817	+024.197	04	T
084	13:17:09.0	011	002045	+029.864	+024.077	04	T
084	13:17:10.0	011	002045	+029.913	+023.956	04	T
084	13:17:11.0	011	002045	+029.957	+023.835	04	T
084	13:17:12.0	011	002045	+030.004	+023.714	04	T
084	13:17:13.0	011	002045	+030.050	+023.596	04	T
084	13:17:14.0	011	002045	+030.094	+023.472	04	T
084	13:17:15.0	011	002045	+030.141	+023.354	04	T
084	13:17:16.0	011	002045	+030.185	+023.231	04	T
084	13:17:17.0	011	002045	+030.226	+023.107	04	T
084	13:17:18.0	011	002045	+030.270	+022.986	04	T
084	13:17:19.0	011	002045	+030.311	+022.865	04	T
084	13:17:20.0	011	002045	+030.352	+022.744	04	T
084	13:17:21.0	011	002045	+030.394	+022.626	04	T
084	13:17:22.0	011	002045	+030.435	+022.505	04	T
084	13:17:23.0	011	002045	+030.476	+022.385	04	T
084	13:17:24.0	011	002045	+030.515	+022.264	04	T
084	13:17:25.0	011	002045	+030.556	+022.143	04	T
084	13:17:26.0	011	002045	+030.594	+022.022	04	T
084	13:17:27.0	011	002045	+030.633	+021.901	04	T
084	13:17:28.0	011	002045	+030.668	+021.780	04	T
084	13:17:29.0	011	002045	+030.710	+021.660	04	T
084	13:17:30.0	011	002045	+030.745	+021.539	04	T
084	13:17:31.0	011	002045	+030.784	+021.418	04	T
084	13:17:32.0	011	002045	+030.819	+021.300	04	T
084	13:17:33.0	011	002045	+030.855	+021.179	04	T
084	13:17:34.0	011	002045	+030.891	+021.061	04	T
084	13:17:35.0	011	002045	+030.927	+020.940	04	T
084	13:17:36.0	011	002045	+030.962	+020.822	04	T
084	13:17:37.0	011	002045	+030.995	+020.701	04	T
084	13:17:38.0	011	002045	+031.028	+020.583	04	T
084	13:17:39.0	011	002045	+031.064	+020.465	04	T
084	13:17:40.0	011	002045	+031.097	+020.344	04	T
084	13:17:41.0	011	002045	+031.130	+020.226	04	T
084	13:17:42.0	011	002045	+031.163	+020.105	04	T
084	13:17:43.0	011	002045	+031.196	+019.987	04	T
084	13:17:44.0	011	002045	+031.226	+019.869	04	T
084	13:17:45.0	011	002045	+031.259	+019.751	04	T
084	13:17:46.0	011	002045	+031.289	+019.633	04	T
084	13:17:47.0	011	002045	+031.319	+019.517	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
084	13:17:48.0	011	002045	+031.349	+019.399	04	T
084	13:17:49.0	011	002045	+031.382	+019.281	04	T
084	13:17:50.0	011	002045	+031.413	+019.166	04	T
084	13:17:51.0	011	002045	+031.443	+019.050	04	T
084	13:17:52.0	011	002045	+031.473	+018.932	04	T
084	13:17:53.0	011	002045	+031.501	+018.817	04	T
084	13:17:54.0	011	002045	+031.531	+018.699	04	T
084	13:17:55.0	011	002045	+031.555	+018.583	04	T
084	13:17:56.0	011	002045	+031.586	+018.468	04	T
084	13:17:57.0	011	002045	+031.616	+018.353	04	T
084	13:17:58.0	011	002045	+031.643	+018.237	04	T
084	13:17:59.0	011	002045	+031.674	+018.119	04	T
084	13:18:00.0	011	002045	+031.698	+018.007	04	T
084	13:18:01.0	011	002045	+031.726	+017.891	04	T
084	13:18:02.0	011	002045	+031.753	+017.779	04	T
084	13:18:03.0	011	002045	+031.781	+017.663	04	T
084	13:18:04.0	011	002045	+031.805	+017.551	04	T
084	13:18:05.0	011	002045	+031.833	+017.438	04	T
084	13:18:06.0	011	002045	+031.858	+017.325	04	T
084	13:18:07.0	011	002045	+031.882	+017.216	04	T
084	13:18:08.0	011	002045	+031.907	+017.097	04	T
084	13:18:09.0	011	002045	+031.935	+016.985	04	T
084	13:18:10.0	011	002045	+031.959	+016.872	04	T
084	13:18:11.0	011	002045	+031.984	+016.760	04	T
084	13:18:12.0	011	002045	+032.009	+016.650	04	T
084	13:18:13.0	011	002045	+032.033	+016.537	04	T
084	13:18:14.0	011	002045	+032.058	+016.427	04	T
084	13:18:15.0	011	002045	+032.080	+016.317	04	T
084	13:18:16.0	011	002045	+032.105	+016.208	04	T
084	13:18:17.0	011	002045	+032.127	+016.095	04	T
084	13:18:18.0	011	002045	+032.151	+015.985	04	T
084	13:18:19.0	011	002045	+032.176	+015.878	04	T
084	13:18:20.0	011	002045	+032.198	+015.768	04	T
084	13:18:21.0	011	002045	+032.220	+015.658	04	T
084	13:18:22.0	011	002045	+032.242	+015.551	04	T
084	13:18:23.0	011	002045	+032.267	+015.444	04	T
084	13:18:24.0	011	002045	+032.289	+015.334	04	T
084	13:18:25.0	011	002045	+032.311	+015.227	04	T
084	13:18:26.0	011	002045	+032.330	+015.120	04	T
084	13:18:27.0	011	002045	+032.352	+015.010	04	T
084	13:18:28.0	011	002045	+032.377	+014.906	04	T
084	13:18:29.0	011	002045	+032.399	+014.799	04	T
084	13:18:30.0	011	002045	+032.418	+014.691	04	T
084	13:18:31.0	011	002045	+032.440	+014.587	04	T
084	13:18:32.0	011	002045	+032.459	+014.483	04	T
084	13:18:33.0	011	002045	+032.478	+014.378	04	T
084	13:18:34.0	011	002045	+032.500	+014.271	04	T
084	13:18:35.0	011	002045	+032.520	+014.167	04	T
084	13:18:36.0	011	002045	+032.542	+014.062	04	T
084	13:18:37.0	011	002045	+032.561	+013.958	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	EMT	TRACK
084	13:18:38.0	011	002045	+032.580	+013.854	04	T
084	13:18:39.0	011	002045	+032.599	+013.749	04	T
084	13:18:40.0	011	002045	+032.618	+013.648	04	T
084	13:18:41.0	011	002045	+032.640	+013.546	04	T
084	13:18:42.0	011	002045	+032.660	+013.445	04	T
084	13:18:43.0	011	002045	+032.679	+013.340	04	T
084	13:18:44.0	011	002045	+032.698	+013.239	04	T
084	13:18:45.0	011	002045	+032.717	+013.137	04	T
084	13:18:46.0	011	002045	+032.737	+013.035	04	T
084	13:18:47.0	011	002045	+032.753	+012.936	04	
084	13:18:48.0	011	002045	+032.767	+012.838	04	
084	13:18:49.0	011	002045	+032.778	+012.744	04	
084	13:18:50.0	011	002045	+032.783	+012.645	04	
084	13:18:51.0	011	002045	+032.783	+012.544	04	
084	13:18:52.0	011	002045	+032.877	+012.431	04	
084	13:18:53.0	011	002045	+032.868	+012.340	04	
084	13:18:54.0	011	002045	+032.890	+012.247	04	
084	13:18:55.0	011	002045	+032.912	+012.151	04	
084	13:18:56.0	011	002045	+032.937	+012.049	04	
084	13:18:57.0	011	002045	+032.964	+011.942	04	
084	13:18:58.0	011	002045	+032.986	+011.819	04	
084	13:18:59.0	011	002045	+032.937	+011.764	04	
084	13:19:00.0	011	002045	+032.978	+011.673	04	
084	13:19:01.0	011	002045	+032.995	+011.574	04	
084	13:19:02.0	011	002045	+033.003	+011.470	04	
084	13:19:03.0	011	002045	+033.017	+011.363	04	
084	13:19:04.0	011	002045	+033.050	+011.247	04	
084	13:19:05.0	011	002045	+033.083	+011.140	04	
084	13:19:06.0	011	002045	+033.110	+011.085	04	
084	13:19:07.0	011	002045	+033.118	+010.989	04	

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	EMT	TRACK
084	13:13:36.0	272	002045	+149.282	+000.148	04	T
084	13:13:37.0	272	002045	+149.282	+000.148	04	T
084	13:13:38.0	272	002045	+149.282	+000.148	04	T
084	13:13:39.0	272	002045	+149.282	+000.148	04	T
084	13:13:40.0	272	002045	+149.282	+000.148	04	T
084	13:13:41.0	272	002045	+149.282	+000.148	04	T
084	13:13:42.0	272	002045	+149.282	+000.148	04	T
084	13:13:43.0	272	002045	+149.271	+000.236	04	T
084	13:13:44.0	272	002045	+149.271	+000.357	04	T
084	13:13:45.0	272	002045	+149.271	+000.445	04	T
084	13:13:46.0	272	002045	+149.249	+000.544	04	T
084	13:13:47.0	272	002045	+149.238	+000.687	04	T
084	13:13:48.0	272	002045	+149.227	+000.862	04	T
084	13:13:49.0	272	002045	+149.227	+001.093	04	T
084	13:13:50.0	272	002045	+149.205	+001.324	04	T
084	13:13:51.0	272	002045	+149.183	+001.609	04	T
084	13:13:52.0	272	002045	+149.183	+001.906	04	T
084	13:13:53.0	272	002045	+149.161	+002.247	04	T
084	13:13:54.0	272	002045	+149.128	+002.620	04	T
084	13:13:55.0	272	002045	+149.073	+003.027	04	T
084	13:13:56.0	272	002045	+149.008	+003.444	04	T
084	13:13:57.0	272	002045	+148.898	+003.897	04	T
084	13:13:58.0	272	002045	+148.766	+004.381	04	T
084	13:13:59.0	272	002045	+148.623	+004.897	04	T
084	13:14:00.0	272	002045	+148.447	+005.457	04	T
084	13:14:01.0	272	002045	+148.263	+006.029	04	T
084	13:14:02.0	272	002045	+148.033	+006.633	04	T
084	13:14:03.0	272	002045	+147.780	+007.281	04	T
084	13:14:04.0	272	002045	+147.516	+007.962	04	T
084	13:14:05.0	272	002045	+147.209	+008.665	04	T
084	13:14:06.0	272	002045	+146.901	+009.413	04	T
084	13:14:07.0	272	002045	+146.549	+010.182	04	T
084	13:14:08.0	272	002045	+146.187	+010.951	04	T
084	13:14:09.0	272	002045	+145.835	+011.632	04	T
084	13:14:10.0	272	002045	+145.824	+011.654	04	T
084	13:14:11.0	272	002045	+145.769	+011.698	04	
084	13:14:12.0	272	002045	+145.517	+013.324	04	
084	13:14:13.0	272	002045	+143.275	+014.598	04	
084	13:14:14.0	272	002045	+143.155	+016.674	04	
084	13:14:15.0	272	002045	+143.012	+017.281	04	
084	13:14:16.0	272	002045	+142.386	+018.270	04	
084	13:14:17.0	272	002045	+141.847	+019.314	04	
084	13:14:18.0	272	002045	+141.188	+020.248	04	
084	13:14:19.0	272	002045	+140.617	+021.160	04	
084	13:14:20.0	272	002045	+140.048	+022.137	04	T
084	13:14:21.0	272	002045	+139.378	+023.159	04	T
084	13:14:22.0	272	002045	+138.686	+024.181	04	T
084	13:14:23.0	272	002045	+137.961	+025.192	04	T
084	13:14:24.0	272	002045	+137.203	+026.249	04	T
084	13:14:25.0	272	002045	+136.434	+027.271	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
084	13:14:26.0	272	002045	+135.621	+028.315	04	T
084	13:14:27.0	272	002045	+134.786	+029.347	04	T
084	13:14:28.0	272	002045	+133.907	+030.391	04	T
084	13:14:29.0	272	002045	+133.020	+031.413	04	T
084	13:14:30.0	272	002045	+132.119	+032.412	04	T
084	13:14:31.0	272	002045	+131.174	+033.426	04	T
084	13:14:32.0	272	002045	+130.207	+034.426	04	T
084	13:14:33.0	272	002045	+129.207	+035.392	04	T
084	13:14:34.0	272	002045	+128.186	+036.359	04	T
084	13:14:35.0	272	002045	+127.120	+037.315	04	T
084	13:14:36.0	272	002045	+126.046	+038.249	04	T
084	13:14:37.0	272	002045	+124.937	+039.174	04	T
084	13:14:38.0	272	002045	+123.805	+040.064	04	T
084	13:14:39.0	272	002045	+122.651	+040.943	04	T
084	13:14:40.0	272	002045	+121.465	+041.811	04	T
084	13:14:41.0	272	002045	+120.245	+042.646	04	T
084	13:14:42.0	272	002045	+119.007	+043.448	04	T
084	13:14:43.0	272	002045	+117.732	+044.242	04	T
084	13:14:44.0	272	002045	+116.425	+044.000	04	T
084	13:14:45.0	272	002045	+115.096	+045.747	04	T
084	13:14:46.0	272	002045	+113.733	+046.472	04	T
084	13:14:47.0	272	002045	+112.360	+047.164	04	T
084	13:14:48.0	272	002045	+110.967	+047.834	04	T
084	13:14:49.0	272	002045	+109.528	+048.472	04	T
084	13:14:50.0	272	002045	+108.089	+049.087	04	T
084	13:14:51.0	272	002045	+106.617	+049.683	04	T
084	13:14:52.0	272	002045	+105.123	+050.254	04	T
084	13:14:53.0	272	002045	+103.596	+050.782	04	T
084	13:14:54.0	272	002045	+102.049	+051.287	04	T
084	13:14:55.0	272	002045	+100.489	+051.748	04	T
084	13:14:56.0	272	002045	+098.929	+052.188	04	T
084	13:14:57.0	272	002045	+097.347	+052.594	04	T
084	13:14:58.0	272	002045	+095.765	+052.968	04	T
084	13:14:59.0	272	002045	+094.150	+053.297	04	T
084	13:15:00.0	272	002045	+092.557	+053.605	04	T
084	13:15:01.0	272	002045	+090.942	+053.869	04	T
084	13:15:02.0	272	002045	+089.352	+054.099	04	T
084	13:15:03.0	272	002045	+087.748	+054.300	04	T
084	13:15:04.0	272	002045	+086.177	+054.454	04	T
084	13:15:05.0	272	002045	+084.606	+054.564	04	T
084	13:15:06.0	272	002045	+083.046	+054.662	04	T
084	13:15:07.0	272	002045	+081.519	+054.717	04	T
084	13:15:08.0	272	002045	+080.024	+054.739	04	T
084	13:15:09.0	272	002045	+078.541	+054.739	04	T
084	13:15:10.0	272	002045	+077.113	+054.704	04	T
084	13:15:11.0	272	002045	+075.696	+054.649	04	T
084	13:15:12.0	272	002045	+074.333	+054.528	04	T
084	13:15:13.0	272	002045	+073.026	+054.407	04	T
084	13:15:14.0	272	002045	+071.741	+054.264	04	T
084	13:15:15.0	272	002045	+070.488	+054.121	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
084	13:15:16.0	272	002045	+069.302	+053.946	04	T
084	13:15:17.0	272	002045	+068.145	+053.748	04	T
084	13:15:18.0	272	002045	+067.025	+053.550	04	T
084	13:15:19.0	272	002045	+065.915	+053.297	04	T
084	13:15:20.0	272	002045	+064.883	+053.089	04	T
084	13:15:21.0	272	002045	+063.905	+052.847	04	T
084	13:15:22.0	272	002045	+062.949	+052.605	04	T
084	13:15:23.0	272	002045	+062.015	+052.331	04	T
084	13:15:24.0	272	002045	+061.136	+052.064	04	T
084	13:15:25.0	272	002045	+060.257	+051.790	04	T
084	13:15:26.0	272	002045	+059.455	+051.504	04	T
084	13:15:27.0	272	002045	+058.664	+051.218	04	T
084	13:15:28.0	272	002045	+057.917	+050.911	04	T
084	13:15:29.0	272	002045	+057.189	+050.614	04	T
084	13:15:30.0	272	002045	+056.497	+050.317	04	T
084	13:15:31.0	272	002045	+055.816	+050.021	04	T
084	13:15:32.0	272	002045	+055.179	+049.724	04	T
084	13:15:33.0	272	002045	+054.575	+049.417	04	T
084	13:15:34.0	272	002045	+053.981	+049.106	04	T
084	13:15:35.0	272	002045	+053.421	+048.799	04	T
084	13:15:36.0	272	002045	+052.883	+048.491	04	T
084	13:15:37.0	272	002045	+052.355	+048.183	04	T
084	13:15:38.0	272	002045	+051.861	+047.876	04	T
084	13:15:39.0	272	002045	+051.400	+047.568	04	T
084	13:15:40.0	272	002045	+050.946	+047.271	04	T
084	13:15:41.0	272	002045	+050.507	+046.975	04	T
084	13:15:42.0	272	002045	+050.100	+046.689	04	T
084	13:15:43.0	272	002045	+049.705	+046.401	04	T
084	13:15:44.0	272	002045	+049.342	+046.115	04	T
084	13:15:45.0	272	002045	+048.969	+045.829	04	T
084	13:15:46.0	272	002045	+048.628	+045.544	04	T
084	13:15:47.0	272	002045	+048.299	+045.280	04	T
084	13:15:48.0	272	002045	+047.991	+045.016	04	T
084	13:15:49.0	272	002045	+047.683	+044.753	04	T
084	13:15:50.0	272	002045	+047.387	+044.489	04	T
084	13:15:51.0	272	002045	+047.112	+044.225	04	T
084	13:15:52.0	272	002045	+046.848	+043.962	04	T
084	13:15:53.0	272	002045	+046.585	+043.742	04	
084	13:15:54.0	272	002045	+046.321	+043.476	04	
084	13:15:55.0	272	002045	+046.090	+043.245	04	
084	13:15:56.0	272	002045	+045.871	+042.992	04	
084	13:15:57.0	272	002045	+045.648	+042.762	04	
084	13:15:58.0	272	002045	+045.439	+042.509	04	
084	13:15:59.0	272	002045	+045.231	+042.289	04	
084	13:16:00.0	272	002045	+045.044	+042.047	04	
084	13:16:01.0	272	002045	+044.857	+041.817	04	
084	13:16:02.0	272	002045	+044.659	+041.586	04	
084	13:16:03.0	272	002045	+044.484	+041.355	04	
084	13:16:04.0	272	002045	+044.308	+041.125	04	
084	13:16:05.0	272	002045	+044.154	+040.902	04	

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
084	13:16:06.0	272	002045	+044.011	+040.660	04	
084	13:16:07.0	272	002045	+043.857	+040.441	04	
084	13:16:08.0	272	002045	+043.704	+040.221	04	
084	13:16:09.0	272	002045	+043.561	+040.001	04	
084	13:16:10.0	272	002045	+043.418	+039.781	04	
084	13:16:11.0	272	002045	+043.286	+039.562	04	
084	13:16:12.0	272	002045	+043.154	+039.342	04	
084	13:16:13.0	272	002045	+043.022	+039.122	04	
084	13:16:14.0	272	002045	+042.902	+038.903	04	
084	13:16:15.0	272	002045	+042.770	+038.683	04	
084	13:16:16.0	272	002045	+042.671	+038.463	04	
084	13:16:17.0	272	002045	+042.539	+038.230	04	
084	13:16:18.0	272	002045	+042.429	+038.021	04	
084	13:16:19.0	272	002045	+042.330	+037.812	04	
084	13:16:20.0	272	002045	+042.229	+037.592	04	
084	13:16:21.0	272	002045	+042.130	+037.373	04	
084	13:16:22.0	272	002045	+042.031	+037.153	04	
084	13:16:23.0	272	002045	+041.932	+036.944	04	
084	13:16:24.0	272	002045	+041.833	+036.736	04	
084	13:16:25.0	272	002045	+041.745	+036.516	04	
084	13:16:26.0	272	002045	+041.657	+036.285	04	
084	13:16:27.0	272	002045	+041.581	+036.076	04	
084	13:16:28.0	272	002045	+041.493	+035.857	04	
084	13:16:29.0	272	002045	+041.405	+035.645	04	
084	13:16:30.0	272	002045	+041.328	+035.425	04	
084	13:16:31.0	272	002045	+041.262	+035.206	04	
084	13:16:32.0	272	002045	+041.174	+034.997	04	
084	13:16:33.0	272	002045	+041.097	+034.777	04	
084	13:16:34.0	272	002045	+041.031	+034.568	04	
084	13:16:35.0	272	002045	+040.954	+034.349	04	
084	13:16:36.0	272	002045	+040.877	+034.140	04	
084	13:16:37.0	272	002045	+040.822	+033.931	04	
084	13:16:38.0	272	002045	+040.746	+033.712	04	
084	13:16:39.0	272	002045	+040.691	+033.492	04	
084	13:16:40.0	272	002045	+040.625	+033.269	04	
084	13:16:41.0	272	002045	+040.559	+033.061	04	
084	13:16:42.0	272	002045	+040.504	+032.830	04	
084	13:16:43.0	272	002045	+040.427	+032.632	04	
084	13:16:44.0	272	002045	+040.383	+032.412	04	
084	13:16:45.0	272	002045	+040.328	+032.182	04	
084	13:16:46.0	272	002045	+040.273	+031.973	04	
084	13:16:47.0	272	002045	+040.218	+031.753	04	
084	13:16:48.0	272	002045	+040.163	+031.544	04	
084	13:16:49.0	272	002045	+040.108	+031.325	04	
084	13:16:50.0	272	002045	+040.042	+031.116	04	
084	13:16:51.0	272	002045	+039.998	+030.872	04	
084	13:16:52.0	272	002045	+039.952	+030.652	04	
084	13:16:53.0	272	002045	+039.908	+030.421	04	
084	13:16:54.0	272	002045	+039.864	+030.201	04	
084	13:16:55.0	272	002045	+039.809	+029.982	04	

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
084	13:16:56.0	272	002045	+039.765	+029.762	04	
084	13:16:57.0	272	002045	+039.721	+029.553	04	
084	13:16:58.0	272	002045	+039.677	+029.323	04	
084	13:16:59.0	272	002045	+039.622	+029.103	04	
084	13:17:00.0	272	002045	+039.578	+028.880	04	
084	13:17:01.0	272	002045	+039.545	+028.650	04	
084	13:17:02.0	272	002045	+039.501	+028.441	04	
084	13:17:03.0	272	002045	+039.457	+028.221	04	
084	13:17:04.0	272	002045	+039.413	+028.001	04	
084	13:17:05.0	272	002045	+039.370	+027.771	04	
084	13:17:06.0	272	002045	+039.337	+027.551	04	
084	13:17:07.0	272	002045	+039.293	+027.331	04	
084	13:17:08.0	272	002045	+039.260	+027.101	04	
084	13:17:09.0	272	002045	+039.227	+026.867	04	
084	13:17:10.0	272	002045	+039.194	+026.658	04	
084	13:17:11.0	272	002045	+039.150	+026.417	04	
084	13:17:12.0	272	002045	+039.117	+026.197	04	
084	13:17:13.0	272	002045	+039.084	+025.966	04	
084	13:17:14.0	272	002045	+039.051	+025.746	04	
084	13:17:15.0	272	002045	+039.018	+025.516	04	
084	13:17:16.0	272	002045	+038.985	+025.285	04	
084	13:17:17.0	272	002045	+038.952	+025.041	04	
084	13:17:18.0	272	002045	+038.919	+024.821	04	
084	13:17:19.0	272	002045	+038.886	+024.579	04	
084	13:17:20.0	272	002045	+038.864	+024.348	04	
084	13:17:21.0	272	002045	+038.831	+024.118	04	
084	13:17:22.0	272	002045	+038.798	+023.887	04	
084	13:17:23.0	272	002045	+038.765	+023.656	04	
084	13:17:24.0	272	002045	+038.732	+023.423	04	
084	13:17:25.0	272	002045	+038.710	+023.192	04	
084	13:17:26.0	272	002045	+038.699	+022.961	04	
084	13:17:27.0	272	002045	+038.677	+022.720	04	
084	13:17:28.0	272	002045	+038.633	+022.489	04	
084	13:17:29.0	272	002045	+038.611	+022.269	04	
084	13:17:30.0	272	002045	+038.578	+022.017	04	
084	13:17:31.0	272	002045	+038.557	+021.794	04	
084	13:17:32.0	272	002045	+038.535	+021.563	04	
084	13:17:33.0	272	002045	+038.502	+021.311	04	
084	13:17:34.0	272	002045	+038.477	+021.080	04	
084	13:17:35.0	272	002045	+038.444	+020.849	04	
084	13:17:36.0	272	002045	+038.422	+020.597	04	
084	13:17:37.0	272	002045	+038.400	+020.363	04	
084	13:17:38.0	272	002045	+038.389	+020.110	04	
084	13:17:39.0	272	002045	+038.367	+019.869	04	
084	13:17:40.0	272	002045	+038.345	+019.627	04	
084	13:17:41.0	272	002045	+038.312	+019.385	04	
084	13:17:42.0	272	002045	+038.301	+019.141	04	
084	13:17:43.0	272	002045	+038.279	+018.910	04	
084	13:17:44.0	272	002045	+038.257	+018.669	04	
084	13:17:45.0	272	002045	+038.235	+018.427	04	

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
084	13:17:46.0	272	002045	+038.213	+018.174	04	
084	13:17:47.0	272	002045	+038.180	+017.941	04	
084	13:17:48.0	272	002045	+038.169	+017.688	04	
084	13:17:49.0	272	002045	+038.147	+017.446	04	
084	13:17:50.0	272	002045	+038.136	+017.205	04	
084	13:17:51.0	272	002045	+038.114	+016.949	04	
084	13:17:52.0	272	002045	+038.092	+016.718	04	
084	13:17:53.0	272	002045	+038.070	+016.466	04	
084	13:17:54.0	272	002045	+038.059	+016.213	04	
084	13:17:55.0	272	002045	+038.037	+015.969	04	

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
084	13:13:37.0	291	002045	+339.239	+000.113	04	
084	13:13:38.0	291	002045	+339.236	+000.118	04	
084	13:13:39.0	291	002045	+339.244	+000.113	04	
084	13:13:40.0	291	002045	+339.225	+000.107	04	
084	13:13:41.0	291	002045	+339.236	+000.107	04	
084	13:13:42.0	291	002045	+339.247	+000.113	04	
084	13:13:43.0	291	002045	+339.244	+000.129	04	
084	13:13:44.0	291	002045	+339.217	+000.201	04	
084	13:13:45.0	291	002045	+339.222	+000.294	04	
084	13:13:46.0	291	002045	+339.225	+000.409	04	
084	13:13:47.0	291	002045	+339.236	+000.569	04	
084	13:13:48.0	291	002045	+339.291	+000.816	04	
084	13:13:49.0	291	002045	+339.288	+001.074	04	
084	13:13:50.0	291	002045	+339.250	+001.349	04	
084	13:13:51.0	291	002045	+339.291	+001.629	04	T
084	13:13:52.0	291	002045	+339.269	+001.868	04	T
084	13:13:53.0	291	002045	+339.294	+002.120	04	T
084	13:13:54.0	291	002045	+339.332	+002.472	04	T
084	13:13:55.0	291	002045	+339.370	+002.856	04	T
084	13:13:56.0	291	002045	+339.442	+003.279	04	T
084	13:13:57.0	291	002045	+339.535	+003.711	04	T
084	13:13:58.0	291	002045	+339.664	+004.202	04	T
084	13:13:59.0	291	002045	+339.796	+004.675	04	T
084	13:14:00.0	291	002045	+339.955	+005.205	04	T
084	13:14:01.0	291	002045	+340.142	+005.765	04	T
084	13:14:02.0	291	002045	+340.343	+006.350	04	T
084	13:14:03.0	291	002045	+340.568	+006.946	04	T
084	13:14:04.0	291	002045	+340.799	+007.592	04	T
084	13:14:05.0	291	002045	+341.057	+008.234	04	T
084	13:14:06.0	291	002045	+341.342	+008.899	04	T
084	13:14:07.0	291	002045	+341.634	+009.577	04	T
084	13:14:08.0	291	002045	+341.936	+010.283	04	T
084	13:14:09.0	291	002045	+342.260	+011.028	04	T
084	13:14:10.0	291	002045	+342.606	+011.766	04	T
084	13:14:11.0	291	002045	+342.952	+012.513	04	T
084	13:14:12.0	291	002045	+343.326	+013.282	04	T
084	13:14:13.0	291	002045	+343.710	+014.062	04	T
084	13:14:14.0	291	002045	+344.106	+014.818	04	T
084	13:14:15.0	291	002045	+344.518	+015.601	04	T
084	13:14:16.0	291	002045	+344.949	+016.419	04	T
084	13:14:17.0	291	002045	+345.380	+017.196	04	T
084	13:14:18.0	291	002045	+345.786	+017.963	04	T
084	13:14:19.0	291	002045	+346.262	+018.743	04	T
084	13:14:20.0	291	002045	+346.740	+019.512	04	T
084	13:14:21.0	291	002045	+347.223	+020.297	04	T
084	13:14:22.0	291	002045	+347.720	+021.069	04	T
084	13:14:23.0	291	002045	+348.283	+022.011	04	
084	13:14:24.0	291	002045	+348.827	+022.703	04	
084	13:14:25.0	291	002045	+349.275	+023.439	04	
084	13:14:26.0	291	002045	+349.763	+024.096	04	

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
084	13:14:27.0	291	002045	+350.239	+024.722	04	T
084	13:14:28.0	291	002045	+350.750	+025.431	04	T
084	13:14:29.0	291	002045	+351.266	+026.164	04	T
084	13:14:30.0	291	002045	+351.785	+026.829	04	T
084	13:14:31.0	291	002045	+352.359	+027.458	04	T
084	13:14:32.0	291	002045	+352.900	+028.070	04	T
084	13:14:33.0	291	002045	+353.551	+028.853	04	T
084	13:14:34.0	291	002045	+354.067	+029.463	04	
084	13:14:35.0	291	002045	+354.597	+030.053	04	
084	13:14:36.0	291	002045	+355.133	+030.602	04	
084	13:14:37.0	291	002045	+355.680	+031.113	04	
084	13:14:38.0	291	002045	+356.240	+031.627	04	
084	13:14:39.0	291	002045	+356.765	+032.162	04	
084	13:14:40.0	291	002045	+357.204	+032.640	04	
084	13:14:41.0	291	002045	+357.693	+033.085	04	
084	13:14:42.0	291	002045	+358.237	+033.571	04	T
084	13:14:43.0	291	002045	+358.767	+034.027	04	T
084	13:14:44.0	291	002045	+359.297	+034.467	04	T
084	13:14:45.0	291	002045	+359.816	+034.895	04	T
084	13:14:46.0	291	002045	+000.335	+035.310	04	T
084	13:14:47.0	291	002045	+000.838	+035.711	04	T
084	13:14:48.0	291	002045	+001.349	+036.120	04	T
084	13:14:49.0	291	002045	+001.848	+036.497	04	T
084	13:14:50.0	291	002045	+002.357	+036.862	04	T
084	13:14:51.0	291	002045	+002.854	+037.216	04	T
084	13:14:52.0	291	002045	+003.337	+037.554	04	T
084	13:14:53.0	291	002045	+003.818	+037.873	04	T
084	13:14:54.0	291	002045	+004.315	+038.191	04	T
084	13:14:55.0	291	002045	+004.801	+038.507	04	T
084	13:14:56.0	291	002045	+005.290	+038.798	04	T
084	13:14:57.0	291	002045	+005.757	+039.070	04	T
084	13:14:58.0	291	002045	+006.232	+039.323	04	T
084	13:14:59.0	291	002045	+006.718	+039.573	04	T
084	13:15:00.0	291	002045	+007.196	+039.812	04	T
084	13:15:01.0	291	002045	+007.655	+040.023	04	T
084	13:15:02.0	291	002045	+008.124	+040.226	04	T
084	13:15:03.0	291	002045	+008.575	+040.408	04	T
084	13:15:04.0	291	002045	+009.047	+040.578	04	T
084	13:15:05.0	291	002045	+009.528	+040.735	04	T
084	13:15:06.0	291	002045	+009.984	+040.872	04	T
084	13:15:07.0	291	002045	+010.443	+040.995	04	T
084	13:15:08.0	291	002045	+010.887	+041.100	04	T
084	13:15:09.0	291	002045	+011.341	+041.196	04	T
084	13:15:10.0	291	002045	+011.794	+041.278	04	T
084	13:15:11.0	291	002045	+012.242	+041.344	04	T
084	13:15:12.0	291	002045	+012.684	+041.402	04	T
084	13:15:13.0	291	002045	+013.137	+041.449	04	T
084	13:15:14.0	291	002045	+013.563	+041.482	04	T
084	13:15:15.0	291	002045	+013.988	+041.504	04	T
084	13:15:16.0	291	002045	+014.406	+041.515	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
084	13:15:17.0	291	002045	+014.832	+041.517	04	T
084	13:15:18.0	291	002045	+015.241	+041.512	04	T
084	13:15:19.0	291	002045	+015.647	+041.493	04	T
084	13:15:20.0	291	002045	+016.043	+041.465	04	T
084	13:15:21.0	291	002045	+016.441	+041.427	04	T
084	13:15:22.0	291	002045	+016.834	+041.385	04	T
084	13:15:23.0	291	002045	+017.216	+041.336	04	T
084	13:15:24.0	291	002045	+017.584	+041.278	04	T
084	13:15:25.0	291	002045	+017.954	+041.210	04	T
084	13:15:26.0	291	002045	+018.317	+041.136	04	T
084	13:15:27.0	291	002045	+018.666	+041.056	04	T
084	13:15:28.0	291	002045	+019.006	+040.974	04	T
084	13:15:29.0	291	002045	+019.352	+040.886	04	T
084	13:15:30.0	291	002045	+019.682	+040.789	04	T
084	13:15:31.0	291	002045	+020.009	+040.688	04	T
084	13:15:32.0	291	002045	+020.325	+040.586	04	T
084	13:15:33.0	291	002045	+020.635	+040.474	04	T
084	13:15:34.0	291	002045	+020.932	+040.364	04	T
084	13:15:35.0	291	002045	+021.228	+040.240	04	T
084	13:15:36.0	291	002045	+021.517	+040.119	04	T
084	13:15:37.0	291	002045	+021.797	+039.996	04	T
084	13:15:38.0	291	002045	+022.069	+039.867	04	T
084	13:15:39.0	291	002045	+022.332	+039.740	04	T
084	13:15:40.0	291	002045	+022.585	+039.608	04	T
084	13:15:41.0	291	002045	+022.835	+039.477	04	T
084	13:15:42.0	291	002045	+023.077	+039.345	04	T
084	13:15:43.0	291	002045	+023.307	+039.210	04	T
084	13:15:44.0	291	002045	+023.527	+039.070	04	T
084	13:15:45.0	291	002045	+023.744	+038.933	04	T
084	13:15:46.0	291	002045	+023.956	+038.795	04	T
084	13:15:47.0	291	002045	+024.159	+038.655	04	T
084	13:15:48.0	291	002045	+024.354	+038.515	04	T
084	13:15:49.0	291	002045	+024.546	+038.378	04	T
084	13:15:50.0	291	002045	+024.733	+038.238	04	T
084	13:15:51.0	291	002045	+024.911	+038.098	04	T
084	13:15:52.0	291	002045	+025.090	+037.961	04	T
084	13:15:53.0	291	002045	+025.260	+037.818	04	T
084	13:15:54.0	291	002045	+025.425	+037.675	04	T
084	13:15:55.0	291	002045	+025.584	+037.532	04	T
084	13:15:56.0	291	002045	+025.744	+037.395	04	T
084	13:15:57.0	291	002045	+025.900	+037.257	04	T
084	13:15:58.0	291	002045	+026.049	+037.117	04	T
084	13:15:59.0	291	002045	+026.194	+036.974	04	T
084	13:16:00.0	291	002045	+026.340	+036.834	04	T
084	13:16:01.0	291	002045	+026.477	+036.686	04	T
084	13:16:02.0	291	002045	+026.609	+036.538	04	T
084	13:16:03.0	291	002045	+026.741	+036.392	04	T
084	13:16:04.0	291	002045	+026.867	+036.244	04	T
084	13:16:05.0	291	002045	+026.991	+036.093	04	T
084	13:16:06.0	291	002045	+027.114	+035.945	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
084	13:16:07.0	291	002045	+027.238	+035.793	04	T
084	13:16:08.0	291	002045	+027.350	+035.645	04	T
084	13:16:09.0	291	002045	+027.460	+035.494	04	T
084	13:16:10.0	291	002045	+027.570	+035.346	04	T
084	13:16:11.0	291	002045	+027.680	+035.192	04	T
084	13:16:12.0	291	002045	+027.784	+035.035	04	T
084	13:16:13.0	291	002045	+027.889	+034.884	04	T
084	13:16:14.0	291	002045	+027.988	+034.731	04	T
084	13:16:15.0	291	002045	+028.087	+034.579	04	T
084	13:16:16.0	291	002045	+028.183	+034.428	04	T
084	13:16:17.0	291	002045	+028.279	+034.277	04	T
084	13:16:18.0	291	002045	+028.372	+034.124	04	T
084	13:16:19.0	291	002045	+028.460	+033.967	04	T
084	13:16:20.0	291	002045	+028.551	+033.813	04	T
084	13:16:21.0	291	002045	+028.636	+033.657	04	T
084	13:16:22.0	291	002045	+028.721	+033.503	04	T
084	13:16:23.0	291	002045	+028.801	+033.346	04	T
084	13:16:24.0	291	002045	+028.880	+033.192	04	T
084	13:16:25.0	291	002045	+028.963	+033.036	04	T
084	13:16:26.0	291	002045	+029.040	+032.877	04	T
084	13:16:27.0	291	002045	+029.117	+032.717	04	T
084	13:16:28.0	291	002045	+029.191	+032.561	04	T
084	13:16:29.0	291	002045	+029.268	+032.407	04	T
084	13:16:30.0	291	002045	+029.336	+032.253	04	T
084	13:16:31.0	291	002045	+029.408	+032.094	04	T
084	13:16:32.0	291	002045	+029.476	+031.943	04	T
084	13:16:33.0	291	002045	+029.545	+031.781	04	T
084	13:16:34.0	291	002045	+029.614	+031.627	04	T
084	13:16:35.0	291	002045	+029.677	+031.473	04	T
084	13:16:36.0	291	002045	+029.737	+031.319	04	T
084	13:16:37.0	291	002045	+029.800	+031.165	04	T
084	13:16:38.0	291	002045	+029.864	+031.006	04	T
084	13:16:39.0	291	002045	+029.921	+030.852	04	T
084	13:16:40.0	291	002045	+029.982	+030.696	04	T
084	13:16:41.0	291	002045	+030.042	+030.542	04	T
084	13:16:42.0	291	002045	+030.097	+030.385	04	T
084	13:16:43.0	291	002045	+030.157	+030.229	04	T
084	13:16:44.0	291	002045	+030.212	+030.070	04	T
084	13:16:45.0	291	002045	+030.267	+029.921	04	T
084	13:16:46.0	291	002045	+030.320	+029.767	04	T
084	13:16:47.0	291	002045	+030.374	+029.608	04	T
084	13:16:48.0	291	002045	+030.427	+029.454	04	T
084	13:16:49.0	291	002045	+030.479	+029.303	04	T
084	13:16:50.0	291	002045	+030.526	+029.158	04	T
084	13:16:51.0	291	002045	+030.569	+029.001	04	T
084	13:16:52.0	291	002045	+030.619	+028.847	04	T
084	13:16:53.0	291	002045	+030.666	+028.691	04	T
084	13:16:54.0	291	002045	+030.712	+028.534	04	T
084	13:16:55.0	291	002045	+030.762	+028.380	04	T
084	13:16:56.0	291	002045	+030.811	+028.229	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
084	13:16:57.0	291	002045	+030.852	+028.081	04	T
084	13:16:58.0	291	002045	+030.899	+027.930	04	T
084	13:16:59.0	291	002045	+030.940	+027.776	04	T
084	13:17:00.0	291	002045	+030.984	+027.622	04	T
084	13:17:01.0	291	002045	+031.028	+027.469	04	T
084	13:17:02.0	291	002045	+031.072	+027.320	04	T
084	13:17:03.0	291	002045	+031.108	+027.166	04	T
084	13:17:04.0	291	002045	+031.149	+027.018	04	T
084	13:17:05.0	291	002045	+031.185	+026.867	04	T
084	13:17:06.0	291	002045	+031.226	+026.719	04	T
084	13:17:07.0	291	002045	+031.264	+026.568	04	T
084	13:17:08.0	291	002045	+031.306	+026.417	04	T
084	13:17:09.0	291	002045	+031.341	+026.271	04	T
084	13:17:10.0	291	002045	+031.380	+026.123	04	T
084	13:17:11.0	291	002045	+031.415	+025.972	04	T
084	13:17:12.0	291	002045	+031.451	+025.826	04	T
084	13:17:13.0	291	002045	+031.487	+025.678	04	T
084	13:17:14.0	291	002045	+031.523	+025.529	04	T
084	13:17:15.0	291	002045	+031.555	+025.378	04	T
084	13:17:16.0	291	002045	+031.591	+025.233	04	T
084	13:17:17.0	291	002045	+031.621	+025.079	04	T
084	13:17:18.0	291	002045	+031.657	+024.933	04	T
084	13:17:19.0	291	002045	+031.687	+024.793	04	T
084	13:17:20.0	291	002045	+031.720	+024.651	04	T
084	13:17:21.0	291	002045	+031.753	+024.505	04	T
084	13:17:22.0	291	002045	+031.786	+024.359	04	T
084	13:17:23.0	291	002045	+031.819	+024.219	04	T
084	13:17:24.0	291	002045	+031.847	+024.071	04	T
084	13:17:25.0	291	002045	+031.877	+023.928	04	T
084	13:17:26.0	291	002045	+031.907	+023.783	04	T
084	13:17:27.0	291	002045	+031.935	+023.643	04	T
084	13:17:28.0	291	002045	+031.962	+023.505	04	T
084	13:17:29.0	291	002045	+031.995	+023.365	04	T
084	13:17:30.0	291	002045	+032.022	+023.222	04	T
084	13:17:31.0	291	002045	+032.053	+023.085	04	T
084	13:17:32.0	291	002045	+032.080	+022.942	04	T
084	13:17:33.0	291	002045	+032.105	+022.802	04	T
084	13:17:34.0	291	002045	+032.130	+022.659	04	T
084	13:17:35.0	291	002045	+032.160	+022.516	04	T
084	13:17:36.0	291	002045	+032.190	+022.379	04	T
084	13:17:37.0	291	002045	+032.215	+022.245	04	T
084	13:17:38.0	291	002045	+032.242	+022.102	04	T
084	13:17:39.0	291	002045	+032.267	+021.967	04	T
084	13:17:40.0	291	002045	+032.292	+021.835	04	T
084	13:17:41.0	291	002045	+032.316	+021.701	04	T
084	13:17:42.0	291	002045	+032.338	+021.563	04	T
084	13:17:43.0	291	002045	+032.363	+021.429	04	T
084	13:17:44.0	291	002045	+032.388	+021.294	04	T
084	13:17:45.0	291	002045	+032.410	+021.157	04	T
084	13:17:46.0	291	002045	+032.434	+021.022	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
084	13:17:47.0	291	002045	+032.456	+020.888	04	T
084	13:17:48.0	291	002045	+032.481	+020.753	04	T
084	13:17:49.0	291	002045	+032.503	+020.624	04	T
084	13:17:50.0	291	002045	+032.525	+020.492	04	T
084	13:17:51.0	291	002045	+032.550	+020.360	04	T
084	13:17:52.0	291	002045	+032.574	+020.226	04	T
084	13:17:53.0	291	002045	+032.596	+020.089	04	T
084	13:17:54.0	291	002045	+032.621	+019.957	04	T
084	13:17:55.0	291	002045	+032.638	+019.828	04	T
084	13:17:56.0	291	002045	+032.662	+019.698	04	T
084	13:17:57.0	291	002045	+032.684	+019.567	04	T
084	13:17:58.0	291	002045	+032.701	+019.440	04	T
084	13:17:59.0	291	002045	+032.720	+019.308	04	T
084	13:18:00.0	291	002045	+032.742	+019.179	04	T
084	13:18:01.0	291	002045	+032.761	+019.048	04	T
084	13:18:02.0	291	002045	+032.783	+018.921	04	T
084	13:18:03.0	291	002045	+032.802	+018.795	04	T
084	13:18:04.0	291	002045	+032.822	+018.669	04	T
084	13:18:05.0	291	002045	+032.841	+018.545	04	T
084	13:18:06.0	291	002045	+032.863	+018.419	04	T
084	13:18:07.0	291	002045	+032.877	+018.295	04	T
084	13:18:08.0	291	002045	+032.899	+018.171	04	T
084	13:18:09.0	291	002045	+032.915	+018.048	04	T
084	13:18:10.0	291	002045	+032.934	+017.919	04	T
084	13:18:11.0	291	002045	+032.951	+017.795	04	T
084	13:18:12.0	291	002045	+032.973	+017.666	04	T
084	13:18:13.0	291	002045	+032.989	+017.540	04	T
084	13:18:14.0	291	002045	+033.008	+017.419	04	T
084	13:18:15.0	291	002045	+033.025	+017.295	04	T
084	13:18:16.0	291	002045	+033.039	+017.177	04	T
084	13:18:17.0	291	002045	+033.061	+017.054	04	T
084	13:18:18.0	291	002045	+033.077	+016.938	04	T
084	13:18:19.0	291	002045	+033.094	+016.823	04	T
084	13:18:20.0	291	002045	+033.116	+016.702	04	T
084	13:18:21.0	291	002045	+033.129	+016.581	04	T
084	13:18:22.0	291	002045	+033.148	+016.463	04	T
084	13:18:23.0	291	002045	+033.162	+016.342	04	T
084	13:18:24.0	291	002045	+033.181	+016.227	04	T
084	13:18:25.0	291	002045	+033.198	+016.106	04	T
084	13:18:26.0	291	002045	+033.217	+015.985	04	T
084	13:18:27.0	291	002045	+033.231	+015.870	04	T
084	13:18:28.0	291	002045	+033.245	+015.754	04	T
084	13:18:29.0	291	002045	+033.264	+015.636	04	T
084	13:18:30.0	291	002045	+033.275	+015.524	04	T
084	13:18:31.0	291	002045	+033.291	+015.411	04	T
084	13:18:32.0	291	002045	+033.305	+015.296	04	T
084	13:18:33.0	291	002045	+033.322	+015.183	04	T
084	13:18:34.0	291	002045	+033.338	+015.065	04	T
084	13:18:35.0	291	002045	+033.354	+014.947	04	T
084	13:18:36.0	291	002045	+033.368	+014.834	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
084	13:18:37.0	291	002045	+033.382	+014.722	04	T
084	13:18:38.0	291	002045	+033.396	+014.609	04	T
084	13:18:39.0	291	002045	+033.412	+014.496	04	T
084	13:18:40.0	291	002045	+033.423	+014.389	04	T
084	13:18:41.0	291	002045	+033.440	+014.282	04	
084	13:18:42.0	291	002045	+033.453	+014.170	04	
084	13:18:43.0	291	002045	+033.467	+014.060	04	T
084	13:18:44.0	291	002045	+033.481	+013.947	04	T
084	13:18:45.0	291	002045	+033.495	+013.837	04	
084	13:18:46.0	291	002045	+033.508	+013.730	04	
084	13:18:47.0	291	002045	+033.522	+013.629	04	
084	13:18:48.0	291	002045	+033.536	+013.521	04	
084	13:18:49.0	291	002045	+033.552	+013.417	04	
084	13:18:50.0	291	002045	+033.566	+013.313	04	
084	13:18:51.0	291	002045	+033.580	+013.214	04	
084	13:18:52.0	291	002045	+033.599	+013.120	04	
084	13:18:53.0	291	002045	+033.613	+013.030	04	
084	13:18:54.0	291	002045	+033.624	+012.901	04	
084	13:18:55.0	291	002045	+033.626	+012.783	04	
084	13:18:56.0	291	002045	+033.643	+012.670	04	
084	13:18:57.0	291	002045	+033.651	+012.563	04	T
084	13:18:58.0	291	002045	+033.670	+012.461	04	T
084	13:18:59.0	291	002045	+033.684	+012.362	04	T
084	13:19:00.0	291	002045	+033.692	+012.258	04	T
084	13:19:01.0	291	002045	+033.709	+012.156	04	T
084	13:19:02.0	291	002045	+033.720	+012.049	04	T
084	13:19:03.0	291	002045	+033.734	+011.950	04	T
084	13:19:04.0	291	002045	+033.745	+011.843	04	T
084	13:19:05.0	291	002045	+033.758	+011.739	04	T
084	13:19:06.0	291	002045	+033.777	+011.643	04	T
084	13:19:07.0	291	002045	+033.788	+011.541	04	T
084	13:19:08.0	291	002045	+033.797	+011.442	04	T
084	13:19:09.0	291	002045	+033.808	+011.341	04	T
084	13:19:10.0	291	002045	+033.819	+011.242	04	T
084	13:19:11.0	291	002045	+033.830	+011.146	04	T
084	13:19:12.0	291	002045	+033.841	+011.044	04	
084	13:19:13.0	291	002045	+033.849	+010.934	04	
084	13:19:14.0	291	002045	+033.841	+010.805	04	
084	13:19:15.0	291	002045	+033.816	+010.662	04	
084	13:19:16.0	291	002045	+033.772	+010.506	04	

Landing Tracking Cameras Azimuth and Elevation Data had not been received as of the date of the printing of this document. When the data is received the data will be located in STS-45 mission files.

ORBITER/ET AFT ATTACH SEPARATION SYSTEM IFA

Lockheed
Space Operations Company

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COMPANY JSC

NUMBER OF PAGES SENT LEAD + 8

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LOCKHEED SPACE OPERATIONS COMPANY
1100 Lockheed Way
Titusville, Florida 32780, MS LSO·282

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FAX NO. 8·961·3645

n LSOC 142-2 (Rev. 7/00)

DACS TRACKING NUMBER
#0000189534#

919[redacted] 4-3-92

Kennedy Space Center/Vandenberg Air Force Base

[redacted] PROBLEM REPORT

☒ PROBLEM REPORT PY6- 215476

☐ DISCREPANCY REPORT

PAGE 1 OF

2. DETECTED DURING	3. WORK AREA	4. END ITEM CONTROL NUMBER
$0028	SLF / AFT / 330	PYR4-12-0150

5. WORK UNIT CODE	6. PART/PROG NAME	7. PART/PROG NO.	8. SER./REV NO.	9. QTY
	AFT ATTACH SEPARATION SYSTEM	V072-555215-005	N/A ~~STS 45~~	1 EA

10. FSCM/VENDOR	11. NHA/PN/TAPE/DISC ID.	12. STS #/EFF.	13. REPORTED BY (NAME/ORG)	14. DATE
03953/RI	V072-000002	046Y104	RICHARD JONES LSOC 17.22 x1-6121	4-3-92 0702

15. SOFTWARE PROBLEM LOCATOR

☐ DUMP ☐ TRANSLATOR OUTPUT DATE _____ TIME _____ ☐ LINE PRINTER OUTPUT ☐ COMPILER LISTING ☐ OTHER (SPECIFY

PRESS FIRMLY – ALL COPIES MUST BE LEGIBLE

16. ITEM	17. PROBLEM DESCRIPTION	17A. VALIDATION
1.	R/H AFT SEPARATION HOLE PLUGGER P/N V072-565254-003 JAMMED ON PYRO DETONATOR BOOSTER; HOLE PLUGGER DID NOT FULLY EXTEND.	LSOC 4-3-92

18. CRIT. SKILLS	19. ENG. CHANGE REQ.	20. CONSTRAINTS	21. CRIT	22. RESP ORG.
☐ YES ☒ NO ITEMS:	☐ YES ☐ NO ITEMS:	* ☒ YES ☐ NO TO: $0007 C.T.S.	1/3	17.22 PYR

23. WEIGHT REQD	24. RETEST REQD	25. HAZARDOUS OP	26. MR REQD	27. TIME/CYCLE	28. FRACTURE CRIT
☐ YES ☒ NO ITEMS:	☐ YES ☒ NO ITEMS:	☐ YES ☒ NO ITEMS:	☐ YES ☒ NO ITEMS:	☐ YES ☒ NO ITEMS:	☐ YES ☒ NO ITEMS:

29. ITEM	30. DISPOSITION/CAUSE/CORRECTIVE ACTION	31. TECH	CONTR QA	GOVT QA
	CRIT 1 HARDWARE INVOLVED IN THIS PR. SEE PAGE 2 FOR DISPO.			
	* LSOC/PYR [signature] 4-3-92			
	NASA/PYR [signature] 4/3/92			
	NOTE			
	HOLE PLUGGER WILL BE REMOVED FROM ORBITER & DECOMPRESSED PER OMI V5032 TASK 09, 12.			
	LO/PYR [signature] 4-3-92			
	NASA/PYR [signature] 4/3/92			

32. SYSTEM RESTORED (SIGNATURE)	DATE	33. FINAL ACCEP DATE

34. DATA CODE	36. REPL. S/N	36. RELATED REPORTS
V5521		

37. RC ACTION REQD	38. RC CONSTRAINT TO:	(SIGNATURE DATE)
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KSC FORM 2 161 (REV. 12/81)

ORIGINAL

H2

NASA
National Aeronautics and Space Administration
Kennedy Space Center

1. REPORT NUMBER
☐ INTERIM PROBLEM REPORT
☒ PROBLEM REPORT PV6-215476
☐ DISCREPANCY REPORT

PAGE 1A OF

DETECTED DURING 3/2/92	3. WORK AREA OPF-1/AFT/330	4. END ITEM CONTROL NUMBER PYR4-12-0150			
5. UNIT CODE JX-CO-090	6. PART/PROG NAME AFT ATTACH SEPARATION SYSTEM	7. PART/PROG NO. V072-555215-005	8. SER./REV NO. NA	9. QTY 1 EA.	
10. FSCM/VENDOR 03953/RI	11. NHA/PN/TAPE/DISC ID. V072-000002	12. BTS #/EFF. 046V104	13. REPORTED BY (NAME/ORG) RICHARD JONES LSOC 17-22 X1-6121	14. DATE 4-3-92 1730	

15. SOFTWARE PROBLEM LOCATOR
☐ DUMP ☐ TRANSLATOR OUTPUT DATE ____ TIME ____ ☐ LINE PRINTER OUTPUT ☐ COMPILER LISTING ☐ OTHER (SPECIFY)

16. ITEM	17. PROBLEM DESCRIPTION	17A. VALIDATION
2.	1 EA PYRO DETONATOR BOOSTER FOUND IN R/H ET DOOR AFT HINGE CAVITY, ALONG WITH SMALLER METAL DEBRIS.	G.D. Barnett 4/3/92

18. CRIT. SKILLS	19. ENG. CHANGE REQ.	20. CONSTRAINTS	21. CRIT	22. RESP ORG.
☐ YES ☐ NO ITEMS:	☐ YES ☐ NO ITEMS:	☒ YES ☐ NO TO: S0007 C.T.S LOPYR Richard Jones 4-3-92	1/3	17-22 PYR

23. WEIGHT REQD	24. RETEST REQD	25. HAZARDOUS OP	26. MR REQD	27. TIME/CYCLE	28. FRACTURE CRIT
☐ YES ☒ NO	☐ YES ☒ NO ITEMS:	☐ YES ☒ NO ITEMS:	☐ YES ☐ NO ITEMS:	☐ YES ☒ NO ITEMS:	☐ YES ☒ NO ITEMS:

30. DISPOSITION/CAUSE/CORRECTIVE ACTION

NOTE

CRIT 1 HARDWARE INVOLVED IN THIS PR.
PHOTOS TAKEN AND ATTACHED TO PR.

1. VISUALLY INSPECT RH ET DOOR AFT HINGE MECHANISM & CAVITY FOR ANY DAMAGE/DISCREPANCIES, RECORD RESULTS: no visual damage noted:
PYRO DEBRIS & DETONATOR PLUS PHOTOS TO PYRO ENG JONES
- FURTHER DISPO TO FOLLOW -

LSOC/PYR Richard Jones 4-3-92 NASA/PYR Jim Litam 4/3/92
LSOC/QE J. Wright 4-3-92 PTF TV-HSP-23

31. TECH	CONTR QA	GOVT QA
QW 4-3-92		

32. SYSTEM RESTORED (SIGNATURE)	DATE	33. FINAL ACCEP	DATE

DATA CODE	34. REPL. S/N	35. RELATED REPORTS
5 5 2 -		

RC ACTION REQD	36. RC CONSTRAINT TO:	(SIGNATURE DATE)
☐ YES ☐ NO ITEMS:	39. RC CLOSURE (SIGNATURE)	(DATE)

31 (REV. 6/91) PREVIOUS EDITIONS MAY BE USED

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NASA — USAF

Kennedy Space Center/Vandenberg Air Force Base

1. REPORT NUMBER
- [ ] INTERIM PROBLEM REPORT
- [x] PROBLEM REPORT PV6-215476
- [ ] DISCREPANCY REPORT

PAGE 1B OF

2. DETECTED DURING: V5032 TASK 07

3. WORK AREA: OPF 1/AFT/330

4. END ITEM CONTROL NUMBER: PYR4-12-0150

5. WORK UNIT CODE:

6. PART/PROG NAME: AFT ET ATTACH SEPARATION SYSTEM

7. PART/PROG NO.: V072-555215-005

8. SER./REV NO.: N/A

9. QTY: 1 EA.

10. FSCM/VENDOR: 03753/RI

11. NHA/PN/TAPE/DISC ID.: V072-000002

12. STS WEEK: 046V104

13. REPORTED BY (NAME/ORG): RICHARD JONES LSOC 17.22 X1-6121

14. DATE: 4.5.92 1700

15. SOFTWARE PROBLEM LOCATOR
- [ ] DUMP
- [ ] TRANSLATOR OUTPUT
- [ ] LINE PRINTER OUTPUT
- [ ] COMPILER LISTING
- [ ] OTHER (SPECIFY)

DATE ____ TIME ____

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16. ITEM

17. PROBLEM DESCRIPTION / 17A. VALIDATION

3. 1 EA NSI CONNECTOR BACKSHELL NOT RECOVERED FROM R/H AFT SEPARATION DEBRIS CONTAINER DURING V5032 AFT PYRO REMOVAL.

NOTE: RH AFT ATTACH AREA THOROUGHLY SEARCHED FOR MISSING BACKSHELL, AS WAS RH ET DOOR CAVITY. PART ~~WAS~~ IS ASSUMED LOST ON ORBIT AFTER ET SEPARATION PRIOR TO ET DOOR CLOSURE DUE TO JAMMED HOLE PLUGGER (REF PAGE 1). 4.5.92

18. CRIT. SKILLS: [ ] YES [x] NO ITEMS:

19. ENG CHANGE REQ.: [ ] YES [ ] NO ITEMS:

20. CONSTRAINTS: [x] YES [ ] NO TO: * S0007 C.T.S. 4.5.92

21. CRIT: 1/3

22. RESP ORG.: 17.22 PYR

23. WEIGHT REQD: [ ] YES [x] NO ITEMS:

24. RETEST REQD: [ ] YES [x] NO ITEMS:

25. HAZARDOUS OP: [ ] YES [x] NO ITEMS:

26. MR REQD: [ ] YES [x] NO ITEMS:

27. TIME/CYCLE: [ ] YES [x] NO ITEMS:

28. FRACTURE CRIT: [ ] YES [x] NO ITEMS:

29. ITEM

30. DISPOSITION/CAUSE/CORRECTIVE ACTION

NOTE

CRIT 1 HARDWARE INVOLVED IN THIS PR.
SEE PAGE 2 FOR DISPO.
4L0/PYR 4.5.92
NASA/PYR

31. TECH | CONTR QA | GOVT QA

32. SYSTEM RESTORED (SIGNATURE) DATE

33. FINAL ACCEP DATE

34. DATA CODE: 5 5 2

35. REPL. S/N

36. RELATED REPORTS

37. RC ACTION REQD: [ ] YES [ ] NO ITEMS

38. RC CONSTRAINT TO: (SIGNATURE DATE)

39. RC CLOSURE (SIGNATURE) (DATE)

RC FORM 2151 (REV. 12/81) ORIGINAL

DACS TRACKING NUMBER
#0000189535#

[redacted]EM REPORT

Kennedy Space Center/Vandenberg Air Force Base

☒ PROBLEM REPORT PVG-215477
☐ DISCREPANCY REPORT

4-3-92

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2. DETECTED DURING	3. WORK AREA	4. END ITEM CONTROL NUMBER		
S0229	SLF/AFT/330	PYR-4-12-0151		
5. WORK UNIT CODE	6. PART/PROG NAME	7. PART/PROG NO.	8. SER./REV NO.	9. QTY
	ET UMBILICAL SEPARATION SYSTEM	V072-565370-007	N/A	1 EA
10. FSCM/VENDOR	11. NHA/PN/TAPE/DISC ID	12. SYS R/EFF.	13. REPORTED BY (NAME/ORG)	14. DATE
03953/RI	V072-415200	046V104	RICHARD JONES LSOC 17-22 x1-6121	4-3-92 07 (ET)

15. SOFTWARE PROBLEM LOCATOR (201) RRJ 4-3-92 DATE _____ TIME _____

☐ DUMP ☐ TRANSLATOR OUTPUT ☐ LINE PRINTER OUTPUT ☐ COMPILER LISTING ☐ OTHER (SPECIFY)

16. ITEM	17. PROBLEM DESCRIPTION	17A. VALIDATION
1.	1 EA PYRO DETONATOR P/N SEB26100094-201, L/N JEH, S/N 00027 FOUND ON RUNWAY UNDER LO2 ET UMBILICAL AREA, AFT ET DOOR OPENING. PART OF NST CONNECTOR, COUPLING RING ONLY, MATED TO SUBJECT DETONATOR.	Gary H. Bell LSOC-QA 4-3-92

18. CRIT. SKILLS	19. ENG. CHANGE REQ	20. CONSTRAINTS	21. CRIT	22. RESP ORG.
☐ YES ☒ NO ITEMS:	☐ YES ☒ NO ITEMS:	* ☒ YES ☐ NO TO: $0007 C.T.S.	1/3	PYR 17-22
23. WEIGHT REQD	24. RETEST REQD	25. HAZARDOUS OP	26. MR REQD	27. TIME/CYCLE
☐ YES ☒ NO ITEMS:	☐ YES ☒ NO ITEMS:	☐ YES ☒ NO ITEMS:	☐ YES ☒ NO ITEMS:	☐ YES ☒ NO ITEMS:

28. FRACTURE CRIT ☐ YES ☒ NO ITEMS:

29. ITEM	30. DISPOSITION/CAUSE/CORRECTIVE ACTION	31. TECH	CONTR QA	GOVT QA
	CRIT 1 HARDWARE INVOLVED IN THIS PR. SEE PAGE 2 FOR DISPO.			
	* LSOC/PYR Richard Jones 4-3-92			
	NASA/PYR [illegible] 4/3/92			

32. SYSTEM RESTORED (SIGNATURE)	DATE	33. FINAL ACCEP	DATE

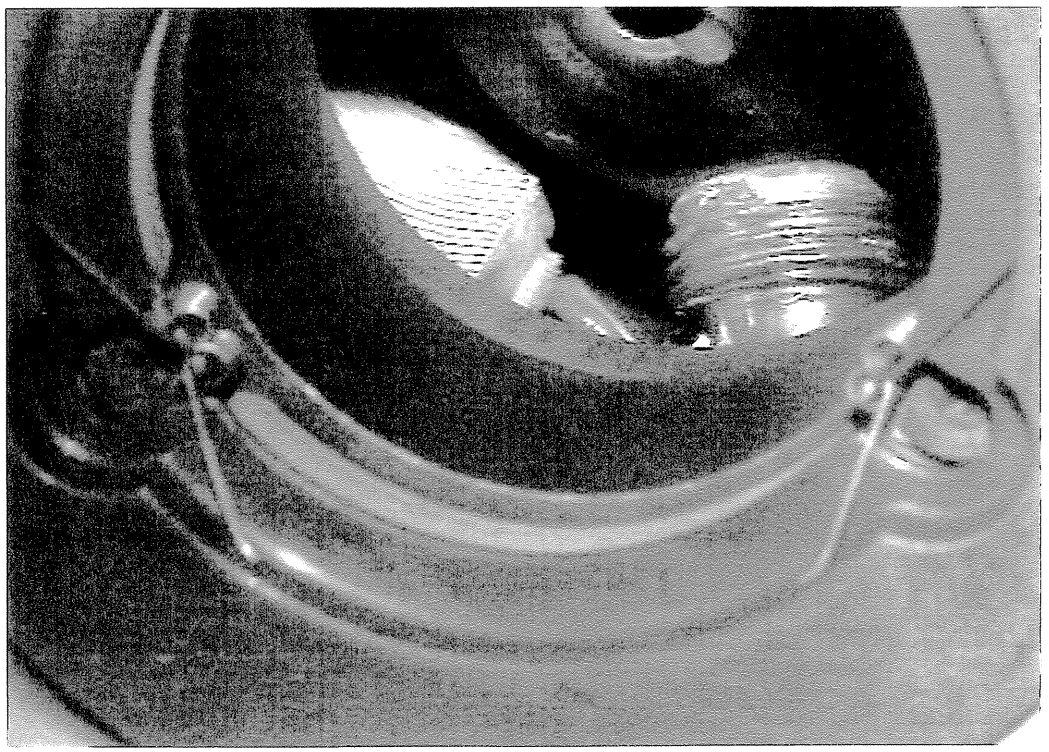
34. DATA CODE	35. REPL. S/N	36. RELATED REPORTS
V552 -		

37. RC ACTION REQD	38. RC CONSTRAINT TO:	(SIGNATURE DATE)
☐ YES ☒ NO ITEMS:	39. RC CLOSURE (SIGNATURE)	(DATE)

KSC FORM 2 151 (REV. 12/81)

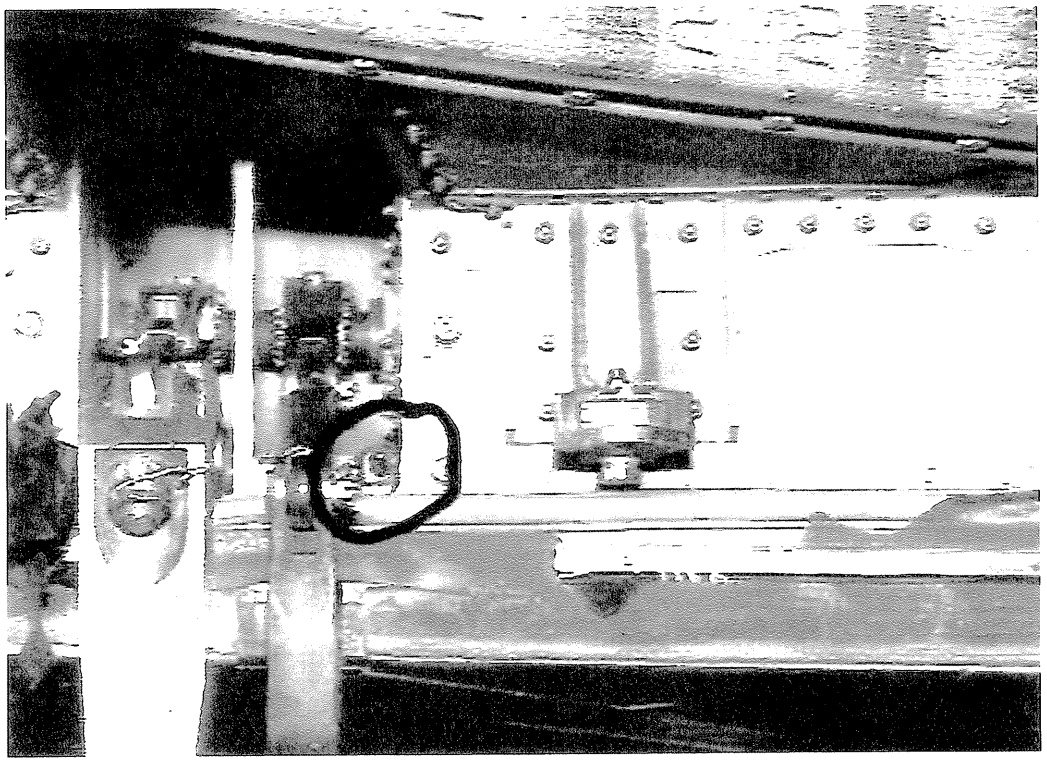
ORIGINAL

JAMMED DEBRIS CONTAINMENT SYSTEM



OV-104/11

AFT SEPARATION PYRO BOOSTER
FOUND IN LH ET DOOR HINGE CAVITY
(REF PR PYR4-1-0150, PAGE 1A)



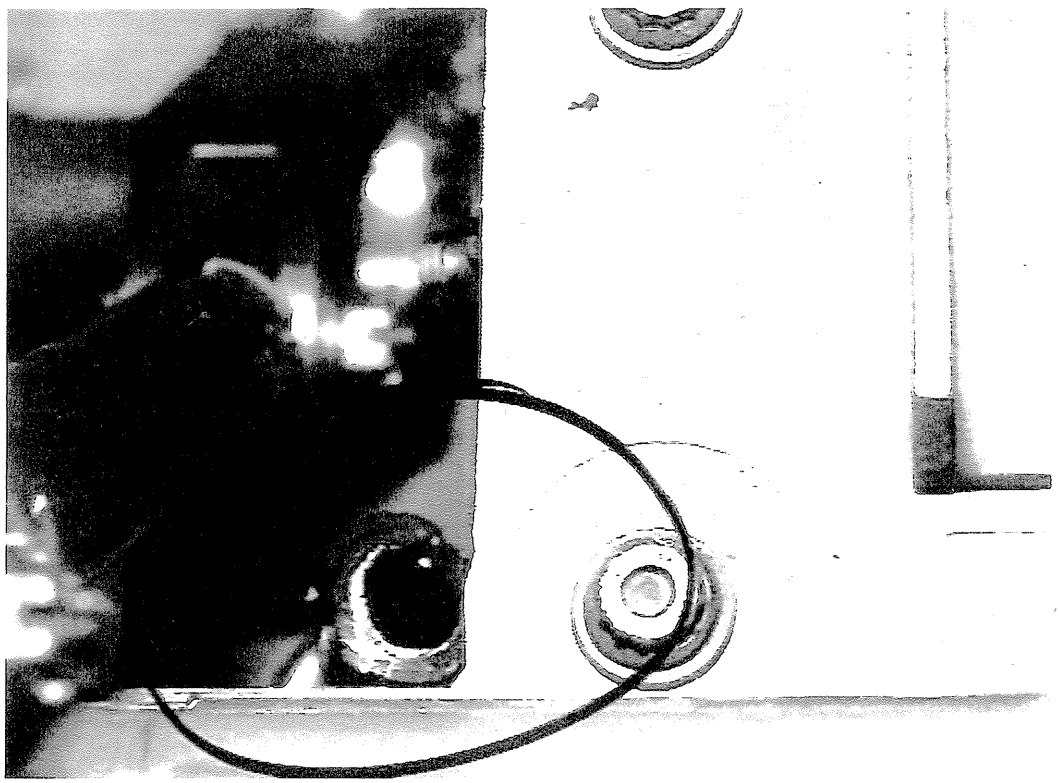
12

PYRO BOOSTER

FWD

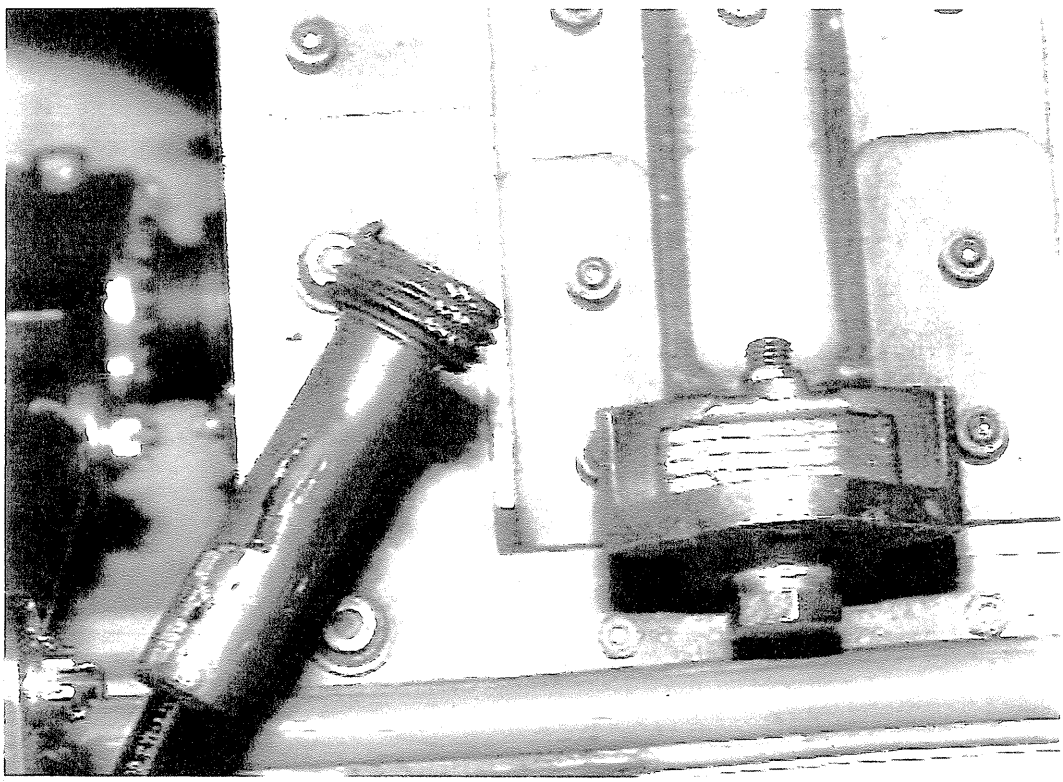
LH ET DOOR

CLOSEUP OF PREVIOUS PHOTO



PYRO BOOSTER

PYRO BOOSTER ON GOV'T BALL POINT PEN



ACRONYM LIST

Acronyn List

AFB	AIR FORCE BASE
BSM	BOOSTER SEPARATION MOTOR
CAD	COMPUTER AIDED DESIGN
CCD	CHARGED COUPLED DEVICE
DCS	DEBRIS CONTAINMENT SYSTEM
DOAMS	DISTANT OBJECT ATTITUDE MEASUREMENT SYSTEM
DTO	DETAILED TEST OBJECTIVE
DTV	DRYDEN TELEVISION
E	ENGINEERING
ECD	EASTMAN COLOR NEGATIVE/DAYLIGHT
EP	ENGINEERING PRINT
ET	EXTERNAL TANK
ET	ENGINEERING TELEVISION
FPS	FRAMES PER SECOND
FSS	FIXED SERVICE STRUCTURE
GH	GASEOUS HYDROGEN
GOX	GASEOUS OXYGEN
GMT	GREENWICH MEAN TIME
GUCP	GROUND UMBILICAL CARRIER PLATE
HSI	HUE, SATURATION, INTENSITY
IRIG	INTER RANGE INTRUMENTATION GROUP
JSC	JOHNSON SPACE CENTER
KSC	KENNEDY SPACE CENTER
KTV	KENNEDY TELEVISION
LED	LIGHT EMITTING DIODES
LESC	LOCKHEED ENGINEERING AND SCIENCES COMPANY
LHSRB	LEFT HAND SOLID ROCKET BOOSTER
LH	LIQUID HYDROGEN
LO	LIQUID OXYGEN
LOV	LOSS OF VIEW
LOX	LIQUID OXYGEN
LSRB	LEFT SOLID ROCKET BOOSTER
M	METERS
MECO	MAIN ENGINE CUT-OFF
MER	MISSION EVALUATION ROOM
MET	MISSION ELAPSED TIME
MLP	MOBIL LAUNCH PLATFORM
MMT	MISSION MANAGEMENT TEAM
MSFC	MARSHALL SPACE FLIGHT CENTER
NASA	NATIONAL AERONAUTICS & SPACE ADMINISTRATION
NORAD	NORTH AMERICAN AIR DEFENCE COMMAND
NSTS	NATIONAL SPACE TRANSPORTATION SYSTEM
OAMS	ORBITAL ATTITUDE AND MANEUVERING SYSTEM
OMRSD	OPERATION MAINTENANCE REQUIREMENTS AND SPECIFICATIONS DOCUMENT
OMS	ORBITAL MANEUVERING SUBSYSTEM
ORB	ORBITER
OTV	OPERATIONAL TELEVISION
OV	ORBITER VEHICLE
RCC	REINFORCED CARBON CARBON
PADD	PHOTOGRAPHIC ACQUISITION DISPOSITION DOCUMENT
PAL	PROTUBERANCE AIR LOAD
PAO	PUBLIC AFFAIRS OFFICE

RCS	REACTION CONTROL SYSTEM
RHSRB	RIGHT HAND SOLID ROCKET BOOSTER
ROFI	RADIALLY OUTWARD FIRE IGNITORS
ROTI	RECORDING OPTICAL TRACKING INSTRUMENT
RSRB	RIGHT SOLID ROCKET BOOSTER
RSS	ROTATING SERVICE STRUCTURE
SLV	SHUTTLE LAUNCH VEHICLE
SOFI	SPRAY ON FOAM INSULATION
SRB	SOLID ROCKET BOOSTER
SSME	SPACE SHUTTLE MAIN ENGINE
STS	SPACE TRANSPORTATION SYSTEM
T-0	LIFTOFF TIME
TPS	THERMAL PROTECTION SYSTEM
TSM	TAIL SERVICE MAST
TV	TELEVISION
UTC	COORDINATED UNIVERSAL TIME
VDAS	VIDEO DIGITAL ANALYSIS SYSTEM
VND	VIDEO NEWS DAYLIGHT FILM

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