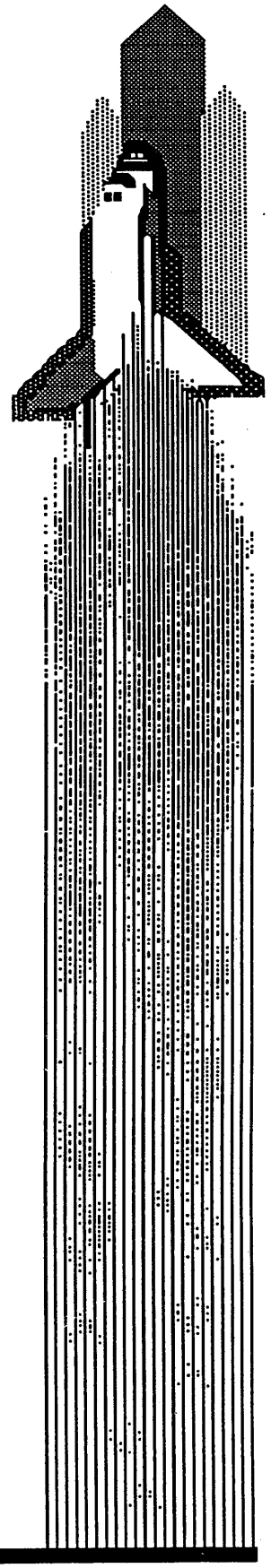
JSC-25826

LESC-30231



Space Shuttle

Photographic and Television Analysis Project

STS-49 Final Report

June 19 , 1992

NASA

National Aeronautics and Space Administration

Lyndon B. Johnson Space Center
Houston, Texas 77058

Subsystem name : Launch and Landing Photography STS - 49
WUC : V

Task No.	Task	Completed JSC	Completed RI	Significant Findings/Comments (Include report no. if off-nom.)
1.	Space Shuttle Launch & Landing Photography.(see 48 hr. report)			LESC-30231 JSC-25826 1) A flexing of the base heat shield was seen during SSME ignition (cameras E-19, E-20, E-76, E-77). Engineers from the MER were shown this event and concluded that some motion was present. Review of previous missions (STS-33) showed flexing of the base heat shield. The preleminary conclusion is that the observed flexing is not mission specific. Attempts to quantify the deflections and determine a frequency of vibration from the photography are being made. A timeline to relate the base heat shield motion to SSME bell motion will be made. A hypothesis is that the motion is caused by pressure waves from the main engines. 2) Orange vapor (possibly free burning hydrogen) was seen to rise toward the base of the vertical stabilizer just prior to SSME ignition. The vapor was slightly more extensive than had been noted on previous missions. No follow up action has been requested. 3) On cameras E-52 and E-54, a tumbling piece of debris was noted on the underside of the Orbiter near the TPS at liftoff. The debris was first seen 36.3 feet from the tip of the Orbiter nose. This event was reviewed with a JSC engineer and it was concluded that the debris was not a piece of Orbiter tile but probably ice from the LO2 feedline. Post landing inspection is believed to have confirmed that this debris was not a tile piece.

Subsystem Evaluation Complete

JSC Subsystem Mgr. (Signature and Date)

RI Subsystem Mgr. (Signature and Date)

Subsystem name : Launch and Landing Photography
WUC : V

STS - 49

Task No.	Task	Completed JSC	Completed RI	Significant Findings/Comments (Include report no. if off-nom.)
1.	Space Shuttle Launch & Landing			4) A light, meduim sized piece of rectangular debris was seen to fall past the right inboard elevon at liftoff (cameras E-5, E-6, E-25). Analysis indicated that the debris was probably ice from the ET LO2 feedline. 5) Other launch events noted include: base heat shield erosion; flares in the SSME exhaust plume after liftoff; slight body flap motion; recirculation; pad, flame duct and umbilical debris. These events have been seen on previous missions. No follow up analysis is expected. 6) An orbital debris impact was seen in photo S49-35-19. The impact occured on flight day 8 on window one. At this time, no photographic analysis requirements have been identified. 7) No anomalous events were detected from the landing films and videos. The drag chute deployment appeared as expected. The following were noted in the post landing video views: TPS damage just aft of the Orbiter nose cap RCC; a small segment of the aft payload bay door seal appeared misaligned; a tile on the base heat shield appeared damaged; streaks on the TPS were seen forward of the hydrogen umbilical. Small debris was seen on the ground underneath the Orbiter. A task is in progress to analyze the drag chute deployment events identified by JSC-ES62 and EG-311.

Subsystem Evaluation Complete

JSC Subsystem Mgr.
(Signature and Date)

RI Subsystem Mgr.
(Signature and Date)

Change of Shift Monday Night MAY 11

1) Forgot Theresa's film. Someone will have to get from building 8.

2) Chris will be in about 10 AM.

3) Steve and Theresa work on Task 13 - Rectangular debris Characterization (Films E30, 5 & E6)

4) Brian and Ranjit work on Task 14 - Base heat shield motion

5) Need to study white spot seen on E-34 FRAME 2891 and debris seen on frame 1371 Camera E52 (see MOVIES)
Are these two events related?

MAY 10 SUNDAY NIGHT

1) GREG Katnik called. Asked us to screen E-19, 20, 23, 24 for base heat shield flexing. Brian and I looked at these films. They are on Dave's table.

Saw some slight motion at the base of SSME # 2 and 3 where the base heat shield molds on to the SSME's. (E19, E20) Motion is slight when compared to the movement of the SSME's at start up.

E-23 and E24 - basically saw no motion (these are the close up views). The RTV "grid" in view appears to "wave" slightly at start up but this appearance is probably due to light changes, smoke, camera vibration, etc...

→ ① Look at Camera E-76 film carefully for base heat shield flexing.

② Look at E 19, 20, 23, 24 to see what you think

③ Look at Previous missions; (1st launch views of OV-102, 103, 104, 99 etc.. to see if can see (New tiles may make flexing more obvious) This will be a long term task since film will be hard to dig up.

OVER →

→ DOWNLINK TAPE OF SATELLITE RENDEVOUS IS ON DAVES TABLE IF NEEDED.

May 9th (Saturday Night)

Change of Shift notes for Sunday Morning:

1) The "white spot" seen on Camera E-34 (See Monica) may or may not be anything of Note. Check the Underside of the orbiter tiles on the night side "real close" to see if we can get a better idea what we are looking at..
(May be related to "tile spacer" debris)

ZJ

February 5, 1995

Video Mensuration of STS-63 R1U RCS Jet Characteristics

At the request of the MER Manager, the Image Science & Analysis Group conducted an analysis of Shuttle video downlink to estimate the size, count, and velocity of Nitrogen Tetroxide particles ("snowballs") leaking from the R1U RCS thruster. A similar analysis was conducted on the R4U leak on STS-42. It is assumed that the provided video is of PLB Camera D, an MLA-type monochrome camera at 30 frames per second. The provided video sequence runs from approximately 035:02:54:50 GMT to 035:03:05:00 GMT.

Particle Size Estimate

The largest particle seen while the vertical stabilizer was in the field of view (reference time 03:01:40:428) was estimated to be approximately 13 inches in diameter. However, the blooming of the video causes distortions that increase the apparent size of the particle. By way of comparison, a piece of downlink video from today's mission highlights (no timing available) was analyzed. This video (with less blooming distortions) showed a greatly reduced leak rate, with the largest particle being approximately 8 inches in size.

Particle Count Estimate

Given the available time, it was not possible to estimate the number of snowballs in the field of the view. Although the analysis would be hampered by the quality of the video, it is estimated the particle count could be determined with approximately five hours of analysis time.

Particle Velocity Estimate

The most accurate values of velocity (though not perhaps the highest values) occur at the edge of the leak dispersion cone since, at that point, there is only one plane of motion relative to the filed of view. During one of the bursts of oxidizer from the R1U jet, the maximum velocity was estimated to be 13.5 feet per second (reference time 03:01:43:459).

The accuracy of the analysis was hampered by the quality of the video, the amount of time the camera was held in a fixed position, and the amount of fixed hardware (i.e., the Orbiter) in the field of view. Blooming of the MLA view of the vertical stabilizer made it difficult to define scaling points. In addition, in some cases, it was difficult to distinguish the lighting of the cities on the Earth in the background from the oxidizer snowballs in the foreground.

Mike Gaunce, X35153
Lead, Image Science & Analysis Group

Space Shuttle Photographic and Television Analysis Project

STS-49 Final Report

Project Work Order - J5-PT2

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Acknowledgements

This document is a team effort by the Space Shuttle Photo/TV Analysis Project personnel. Jack Hartman/Lockheed Engineering and Sciences Company (LESC) has written much of the body of the document as well as being responsible for the organization and final preparation of the document. David Pitts/NASA/JSC, Christine Dailey, Jon Disler, Brian Gastineau, Mike Snyder, Ranjit Bhaskar, Steve Israel, Clyde Sapp, and Brett Pickin/LESC have contributed various sections and along with Jack Hartman, have done the screening and analysis activities that are documented in this report. Hollie Harless/LESC has done the bulk of the data entry essential to documenting screening and task status and has typed the report with the aid of Teresa Morris, Shannon Harris, and Nga Truong/LESC. Paul Armitage/LESC has maintained and improved the data bases used to present the screening and task information. Lorelei Lohrli-Kirk of Rockwell/Downey was an invaluable member of the screening team during the STS-49 mission. Questions about the contents of this document should be directed to David Pitts/NASA/SN5/713-483-5066 or Jack Hartman/LESC/C23/713-483-5337.

1.0 OV-105 STS-49 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 section 6.0, Appendix A, Engineering Photographic Screening Disposition Forms. Daily reports which summarize each day's screening and analysis activities submitted to the Mission Evaluation Room (MER) and the Mission Management Team (MMT) are presented in Section 6.0, Appendix B, Daily Reports to Mission Management.

1.1.1 Pre-Launch ET Hydrogen Tanking and Screening Analysis (Task #8)

(Cameras OTV-109, OTV-150, OTV-152, OTV-160, OTV-161, OTV-162, OTV-163, OTV-165 and OTV-166)

Mission Evaluation Room (MER) engineering views were screened real-time during fueling of the external tank (ET) commencing approximately 8 hours prior to launch.

The usual vapors and water drops were noted during tanking. Also, a small amount of frost was noted on the LH2 17" line and baggie at the orbiter. No anomalies were detected. (See Appendix D, Task #8, STS-49 ET Tanking Screening.)

1.1.2 Launch

The STS-49 launch of Endeavour occurred on Pad B at 23 hours 40 minutes 00.029 seconds UTC on May 7, 1992 (day 128) as seen on camera E-009. SRB separation occurred at 23 hours 42 minutes 07.281 seconds UTC as seen on KTV-13. On launch day, 23 videos out of 23 expected were screened. Following launch day, 61 out of 63 expected launch films were reviewed.

One potential inflight anomaly was reported. An unusual flexing of the orbiter base heat shield was seen at SSME ignition. This event is described further in Section 6.0, Appendix D, Task #14, Characterize Base Heat Shield Motion at SSME start-up.

DTO-0312 (photography of the external tank after separation) was attempted using the orbiter umbilical well cameras (method 1). These films were reviewed for anomalies at SRB separation and external tank separation. Due to the time of day/low light level, no photography was obtained from the 35mm camera in the right umbilical well and only SRB separation was obtained from the 16mm camera in the left umbilical well. The crew reported that no handheld photography was taken of the external tank (method 2) due to the attitude of the orbiter.

1.1.3 Landing

The landing of STS-49 occurred on runway 22 at Edwards Air Force Base as expected. Nine videos of the Orbiter's approach and landing were received including an infrared view of the Orbiter's landing and NASA Select. Right main gear touchdown was at 20 hours 57 minutes 38.182 UTC on May 16, 1992 as seen on camera DTV-3. Left main gear touchdown was at 20 hours 57 minutes 38.215 seconds UTC as seen on camera DTV-3. Nose gear touchdown occurred at 20 hours 57 minutes 49.091 seconds UTC as seen on DTV-4. Wheel stop was at approximately 20 hours 58 minutes 35.072 seconds UTC as seen on DTV-1.

Video and Film List
STS-49
Launch Film & Video

Item Number	Expected	Received	Screened	Personnel
EX001	05/10/92	05/11/92	05/11/92	JH,MS,SI,LK,CD
EX004	05/12/92	05/11/92	05/11/92	JH,MS,SI,LK,CD
E001	05/08/92	05/09/92	05/09/92	JH,MS,SI,LK
E002	05/08/92	05/09/92	05/09/92	JH,MS,SI,LK,CD
E003	05/08/92	05/09/92	05/09/92	JH,MS,SI,LK,CD
E004	05/08/92	05/09/92	05/09/92	JH,MS,SI,LK,CD
E005	05/08/92	05/09/92	05/09/92	JH,MS,SI,LK,CD
E006	05/08/92	05/09/92	05/09/92	JH,MS,SI,LK,CD
E007	05/09/92	05/10/92	05/10/92	JH,MS,SI,LK
E008	05/09/92	05/10/92	05/10/92	JH,MS,SI,LK,CD
E009	05/08/92	05/09/92	05/09/92	JH,MS,SI,LK,CD
E010	05/09/92	05/10/92	05/10/92	JH,MS,SI,LK,CD
E011	05/09/92	05/10/92	05/10/92	JH,MS,SI,LK,CD
E012	05/08/92	05/09/92	05/09/92	JH,MS,SI,LK,CD
E013	05/09/92	05/10/92	05/10/92	JH,MS,SI,LK,CD
E014	05/09/92	05/10/92	05/10/92	JH,MS,SI,LK,CD
E015	05/08/92	05/09/92	05/09/92	JH,MS,SI,LK,CD
E016	05/08/92	05/09/92	05/09/92	JH,MS,SI,LK,CD
E017	05/08/92	05/09/92	05/09/92	JH,MS,SI,LK,CD
E018	05/08/92	05/09/92	05/09/92	JH,MS,SI,LK,CD
E019	05/08/92	05/09/92	05/09/92	JH,MS,SI,LK,CD
E020	05/08/92	05/09/92	05/09/92	JD,RB,BG,CD
E021	05/12/92	/ /	/ /	Not received
E022	05/12/92	/ /	/ /	Not received
E023	05/09/92	05/10/92	05/10/92	JH,MS,SI,LK,CD
E024	05/09/92	05/10/92	05/10/92	JH,MS,SI,LK,CD
E025	05/08/92	05/09/92	05/09/92	JD,RB,BG,LK,CD
E026	05/08/92	05/09/92	05/09/92	JD,RB,BG,LK,CD
E027	05/10/92	05/11/92	05/11/92	JH,MS,SI,LK,CD
E028	05/10/92	05/11/92	05/11/92	JH,MS,SI,LK,CD
E030	05/09/92	05/10/92	05/10/92	JH,MS,SI,LK,CD
E031	05/10/92	05/10/92	05/10/92	JH,MS,SI,LK,CD,JD
E033	05/10/92	05/11/92	05/11/92	JH,MS,SI,LK,CD
E034	05/08/92	05/09/92	05/09/92	JD,RB,BG,LK,CD
E035	05/08/92	05/09/92	05/09/92	JD,RB,BG,LK,CD
E036	05/08/92	05/09/92	05/09/92	JD,RB,BG,LK,CD
E040	05/08/92	05/09/92	05/09/92	JD,RB,BG,LK,CD
E041	05/10/92	05/11/92	05/11/92	JH,MS,SI,LK,CD
E042	05/10/92	05/11/92	05/11/92	JH,MS,SI,LK,CD
E050	05/10/92	05/11/92	05/11/92	JH,MS,SI,LK,CD
E052	05/10/92	05/11/92	05/11/92	JD,CD,RB,LK
E054	05/09/92	05/10/92	05/10/92	JD,CD,RB,BG,LK
E057	05/10/92	05/11/92	05/11/92	JD,CD,RB,BG,LK
E059	05/09/92	05/10/92	05/10/92	JD,CD,RB,BG,LK
E060	05/10/92	05/11/92	05/11/92	JD,CD,RB,BG,LK
E062	05/07/92	05/11/92	05/11/92	JD,CD,RB,BG,LK
E063	05/10/92	05/11/92	05/11/92	JD,CD,RB,BG,LK

Table 1

Video and Film List
STS-49
Launch Film & Video

Item Number	Expected	Received	Screened	Personnel
E065	05/07/92	05/11/92	05/11/92	JH,MS,SI,LK,CD
E076	05/10/92	05/11/92	05/11/92	JH,MS,SI,LK,CD
E077	05/12/92	05/13/92	05/13/92	JD,BG,MS
E079	05/07/92	05/13/92	05/13/92	JD,BG,MS
E204	05/10/92	05/11/92	05/11/92	JD,CD,RB,BG,LK
E205	05/10/92	05/11/92	05/11/92	JD,CD,RB,LK
E207	05/09/92	05/10/92	05/10/92	JD,CD,BG,RB,LK
E208	05/09/92	05/10/92	05/10/92	JH,MS,SI,LK,CD,JD
E211	05/10/92	05/11/92	05/11/92	JD,CD,RB,BG,LK
E212	05/09/92	05/10/92	05/10/92	JH,MS,SI,LK,CD,JD
E213	05/09/92	05/10/92	05/10/92	JH,MS,SI,LK,CD,JD
E218	05/10/92	05/11/92	05/11/92	JH,MS,SI,LK,CD
E220	05/09/92	05/10/92	05/10/92	JH,MS,SI,LK,CD,JD
E222	05/09/92	05/10/92	05/10/92	JH,MS,SI,LK,CD
E223	05/09/92	05/10/92	05/10/92	JH,MS,SI,LK,CD
E224	05/09/92	05/10/92	05/10/92	JH,MS,SI,LK,CD
UMBL1	05/07/92	05/20/92	05/20/92	JD,JH,GG,CK,JD
ET207	05/07/92	05/08/92	05/08/92	JD,RB,BG
ET208	05/07/92	05/08/92	05/08/92	JD,RB,BG
ET212	05/07/92	05/08/92	05/08/92	JD,RB,BG
ET213	05/07/92	05/08/92	05/08/92	JD,RB,BG
ET204	05/07/92	05/08/92	05/08/92	JD,RB,BG
KTV2	05/07/92	05/07/92	05/07/92	JH,CD,MS,SI,DP
KTV5	05/07/92	05/07/92	05/07/92	JH,CD,MS,SI,DP
KTV11	05/07/92	05/07/92	05/07/92	JH,MS,SI
KTV13	05/07/92	05/07/92	05/07/92	JH,MS,SI,CD
KTV4B	05/07/92	05/07/92	05/07/92	JH,CD,MS,SI,DP
KTV7B	05/07/92	05/07/92	05/07/92	JH,MS,SI
KTV21B	05/07/92	05/07/92	05/07/92	JH,MS,SI
OTV109	05/07/92	05/07/92	05/07/92	JH,CD,MS,SI,GG
OTV141	05/07/92	05/07/92	05/07/92	JH,CD,MS,SI,GG
OTV148	05/07/92	05/07/92	05/07/92	JH,CD,MS,SI
OTV149	05/07/92	05/07/92	05/07/92	JH,CD,MS,SI,GG
OTV151	05/07/92	05/07/92	05/07/92	JH,CD,MS,SI,GG
OTV154	05/07/92	05/07/92	05/07/92	JH,CD,MS,SI,GG
OTV160	05/07/92	05/07/92	05/07/92	JH,CD,MS,SI,GG
OTV161	05/07/92	05/07/92	05/07/92	JH,CD,MS,SI,GG
OTV163	05/07/92	05/07/92	05/07/92	JH,CD,MS,SI,GG
OTV171	05/07/92	05/07/92	05/07/92	JH,MS,MS,SI
OTV170	05/07/92	05/07/92	05/07/92	JH,CD,MS,SI,GG

Table 1 continued

Video and Film List
STS-49
Landing Film & Video

Item Number	Expected	Received	Screened	Personnel
EXTRA #2	05/16/92	05/22/92	05/22/92	SI,BG,BP
EXTRA #1	05/16/92	05/22/92	05/22/92	SI,BG,BP
E1001A	05/17/92	05/20/92	05/20/92	JD,JK,SI,JH
E1001	05/17/92	05/20/92	05/20/92	JD,JK,GG,SI,JH
E1002A	05/17/92	05/20/92	05/20/92	JH,CS,SI
E1002	05/17/92	05/20/92	05/20/92	SI,JH
E1003A	05/17/92	05/20/92	05/21/92	SI,JH,JK
E1007A	05/16/92	05/20/92	05/22/92	SI,BG,BP
E1008	05/17/92	05/20/92	05/20/92	JK,JD,SI,JH
E1009	05/17/92	05/21/92	05/21/92	JH,JK,SI
E1010	05/17/92	05/21/92	05/21/92	JH,SI
E1011	05/17/92	05/21/92	05/21/92	JH,SI
E1012	05/17/92	05/21/92	05/20/92	JH,SI,JK
E1017	05/17/92	05/21/92	05/21/92	JH,SI
E1019	05/17/92	/ /	/ /	Not received
E1024	05/17/92	/ /	/ /	Not received
E1027	05/17/92	05/21/92	05/21/92	JH,SI
E1027A	05/16/92	05/22/92	05/22/92	SI,BG,BP
DTV1	05/16/92	05/16/92	05/16/92	JD,RB,BG,CS
DTV2	05/16/92	05/15/92	05/16/92	JD,RB,BG,CS
DTV3	05/16/92	05/16/92	05/16/92	JD,RB,BG,CS
DTV4	05/16/92	05/15/92	05/16/92	JD,RB,BG,CS
IR	05/16/92	05/16/92	05/16/92	JD,RB,BG,CS
LRO	05/16/92	05/16/92	05/16/92	JD,RB,BG,CS
NASA SEL	05/16/92	05/16/92	05/16/92	JD,RB,BG,CS
SBEV	05/16/92	05/16/92	05/16/92	JD,RB,BG,CS
VLRO	05/16/92	05/16/92	05/16/92	JD,RB,BG,CS

Table 2

1.0 OV-105 STS-49 Film/Video Screening and Timing Summary

Sixteen unprocessed films arrived at JSC May 18, 1992. After these films were processed and screened for anomalies. Dryden has reported that the cameras at position 3L (Runway 22, 5000 foot mark, left side) did not operate due to a generator failure.

Good video coverage of the drag chute deploy was obtained. Drag chute deployment occurred as expected. The following drag chute event times were acquired from DTV-4. The first sighting of the pilot chute deploy was at 20:57:49.291 UTC. The drag chute was seen to inflate in the reefed configuration at 20:57:52.261 UTC. The drag chute was seen to fully open at 20:57:55.297. The drag chute was released at 20:58:17.520 UTC. Photographic analysis of the drag chute deployment is reported in Appendix D, Task #10, Drag Chute Performance Analysis.

Nine on orbit images of INTELSAT from the Electronic Still Camera (ESC) were used to aid in the INTELSAT recovery. The Assembly of Space Station by EVA Methods (ASEM) activity was monitored but due to problems with the Ku band antenna, only a minimum of data was received. Twenty-six onboard tapes of the ASEM event were requested and are currently being screened.

Ten Mavica prints of the post landing inspection of the Orbiter were transmitted to JSC from Dryden. The debris hit to the tile(s) on the right side of the Orbiter nose was visible in the Mavica views. The Mavica post landing views were forwarded to the MER manager.

No anomalous events were detected from the landing videos or films. However, the following items were noted during the post-landing inspection video views:

TPS damage was noted on the right side of the vehicle just aft of the Orbiter nose cap RCC; a small segment of the aft port payload bay door seal appeared misaligned; a tile on the base heat shield showed signs of damage; and streaks on the TPS were seen forward of the hydrogen umbilical. A half inch long 10-32 Torx head screw and a 3/4 inch long segment of a Jo-bolt were seen on the ground during the screening of the orbiter post landing videos.

1.2 Timing Activities

Film from cameras E-076, E-079, E-204, E-212, E-218, E-220, E-1008 and E-1027 were used to time events of interest for the STS-49 mission. Film timing was determined from encoded film edge timing marks (IRIG-B). Cameras EX-004, E-002, E-003, E-008, E-009, E-010, E-011, E-012, E-013, E-052, E-054, E-059, E-211, E-224 and E-1002A had in-frame digital timing and was used to time specific mission events during the initial screening of each camera. Section 6.0, Appendix C, STS-49 Timing Data Report contains a detailed listing of 22 items of interest that were timed using IRIG-B timing. Several of these events were timed to determine if the same event occurred on more than one camera.

Also summarized in Appendix C are the operations of eight film cameras relative to the camera offsets used in timing and actual determined frame rates.

2.0 Summary of Significant Events Analysis

2.1 Debris

2.1.1 Debris near the Time of SSME Ignition

2.1.1.1 Umbilical Ice Debris
(Cameras E-001, E-002, E-004, E-005, E-006, E-017, E-018, E-019, E-024, E-026, E-031, E-033, E-034, E-050, E-065, E-076, E-077 and E-079)

The amount of ice debris from the LO2 and LH2 TSM T-0 umbilicals and the ET/Orbiter umbilicals was noted as normal on the MLP cameras. No follow up action has been requested.

2.1.2 Debris near the Time of SRB Ignition

2.1.2.1 SRB Holddown Post (HDP) Debris
(Cameras EX-004, E-011 and E-012)

On camera E-012, debris originated from the HDP M-5 shoe area. On camera EX-004, two pieces of dark debris (possibly epon shim or putty material as suggested by Rockwell-Downey) were noted between the SLV and HDP M-5 shoe at liftoff. A white tag was noted to the right of HDP M-7 at SSME ignition on camera E-011. No SRB holddown post stud hang ups were seen on any STS-49 mission films. No follow up action has been requested.

2.1.2.2 Debris near Vertical Stabilizer
(Cameras E-003 and E-020)

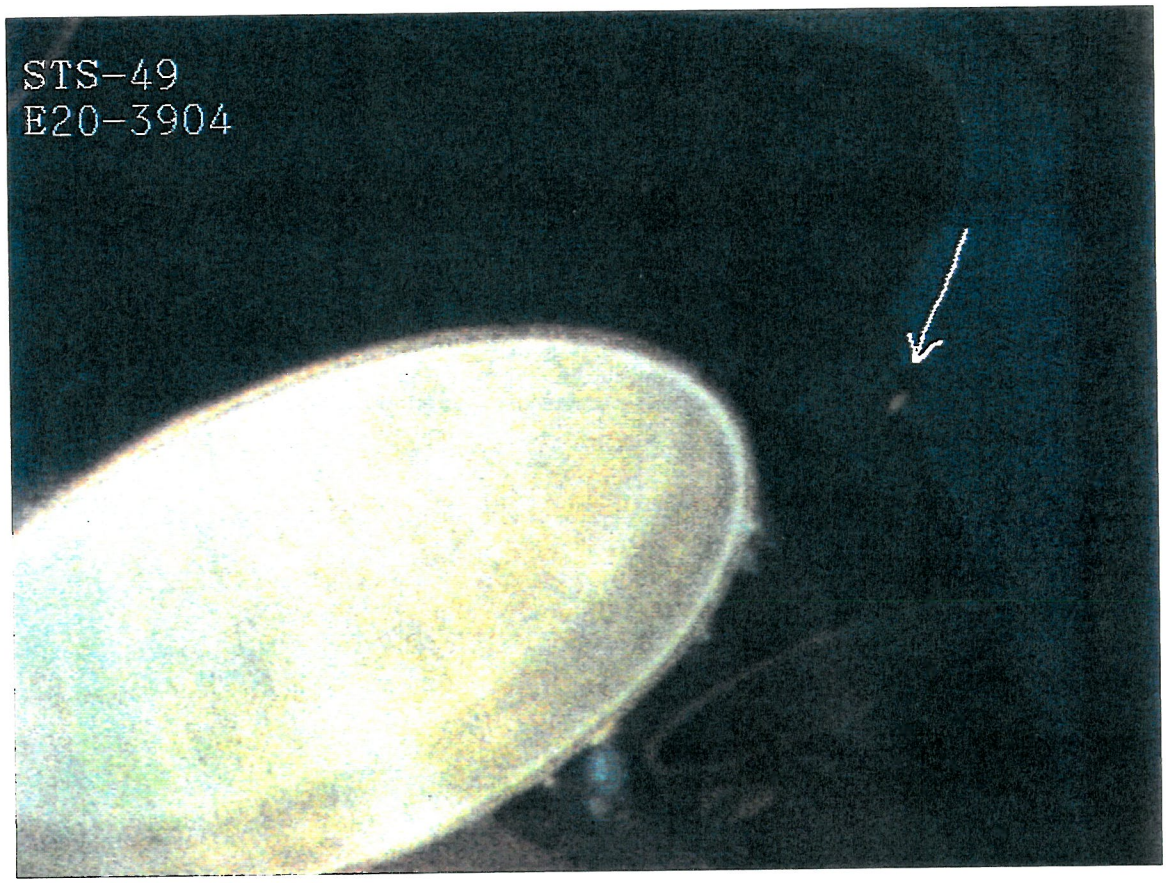

Figure 2.1.2.2 Debris near Vertical Stabilizer

A single piece of debris (dark on one side, light on the other) appeared on the right side of the FOV near the vertical stabilizer and fell aft into the SSME plume at liftoff. This debris is shown in figure 2.1.2.2. The event was shown to the TPS subsystem manager. No follow up action has been requested.

2.1.2.3 Flame Duct Debris
(Task #7)
(Cameras E-007, E-008, E-009, E-010, E-011, E-012, E-014 and E-062)

Since all the flame duct debris pieces were very small and the trajectories of these objects were very short or very difficult to see, Task #7, Velocity Measurements of SRB Duct Debris will not be performed this mission. (See Section 6.0, Appendix D.)

2.1.3 Debris after Liftoff

2.1.3.1 Tumbling Debris seen on Underside of Orbiter
(Task #16)
(Cameras E-052, E-054, and E-079)

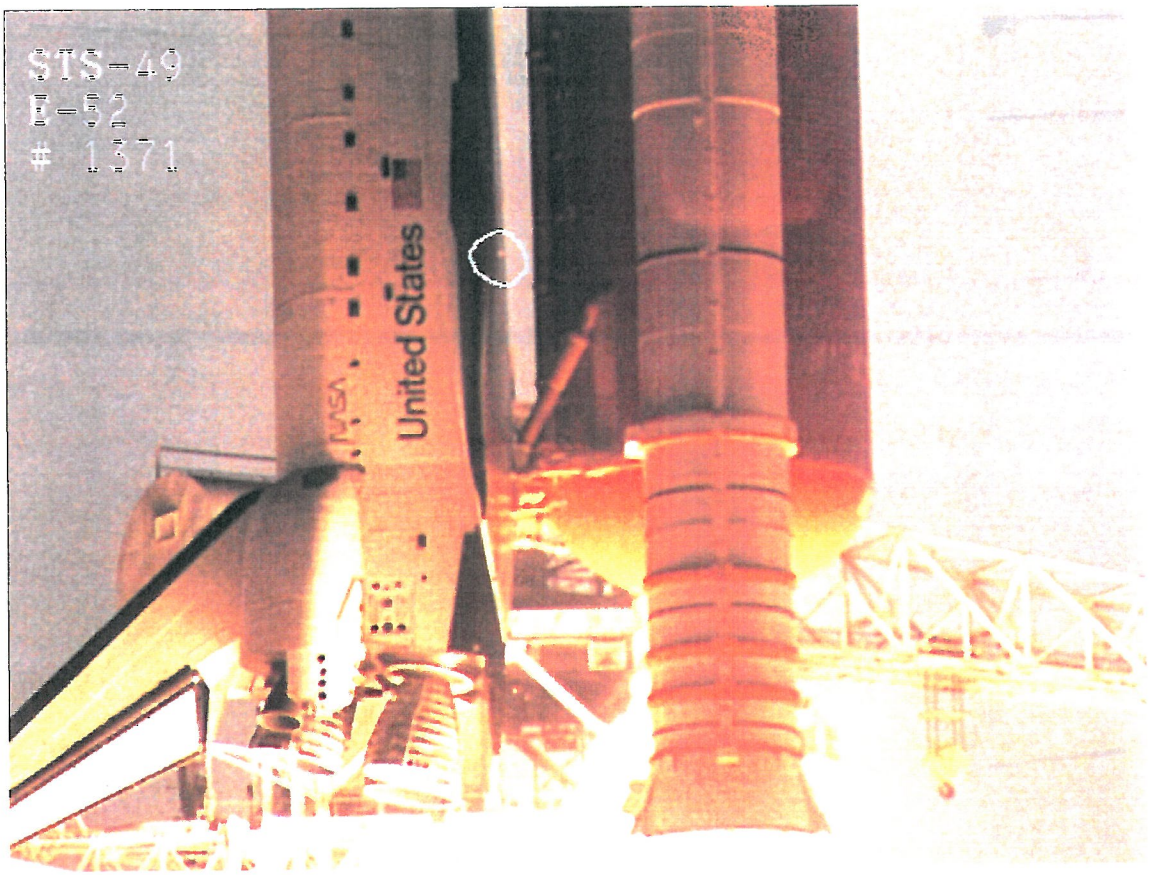

Figure 2.1.3.1 Tumbling Debris seen on Underside of Orbiter

A tumbling piece of debris (dark on one side, light on the other), first noted on the underside of the orbiter at mid-fuselage, fell aft during tower clear. This debris is depicted in figure 2.1.3.1. The distance from the tip of the orbiter nose to the position that the debris was first seen was measured to be 36.3 feet (or 74.5 feet above the orbiter umbilical area). This means that the debris source would have to have been at this position or further forward along the orbiter x-axis. The actual source could not be determined visually from either cameras E-052 or E-054. (The LO2 feedline on the ET or the ET/Orbiter forward attach are both possible debris sources for this event as reported verbally by KSC. See Section 6.0, Appendix D, Task #16, Determine source of Debris on Underside of Orbiter at Mid Fuselage.)

A white piece of debris was seen on camera E-079 moving from left to right across the ET LO2 feedline and then falling aft along the LO2 feed line at liftoff. This event was reviewed with a JSC

engineer and it was concluded that the debris was unlikely to be a piece of orbiter tile. Also the post landing debris assessment report did not indicate a potential tile source for this debris.

2.1.3.2 Rectangular Piece of Debris from above LO2 Umbilical Area (Task #13)

(Cameras E-005, E-006, and E-025)

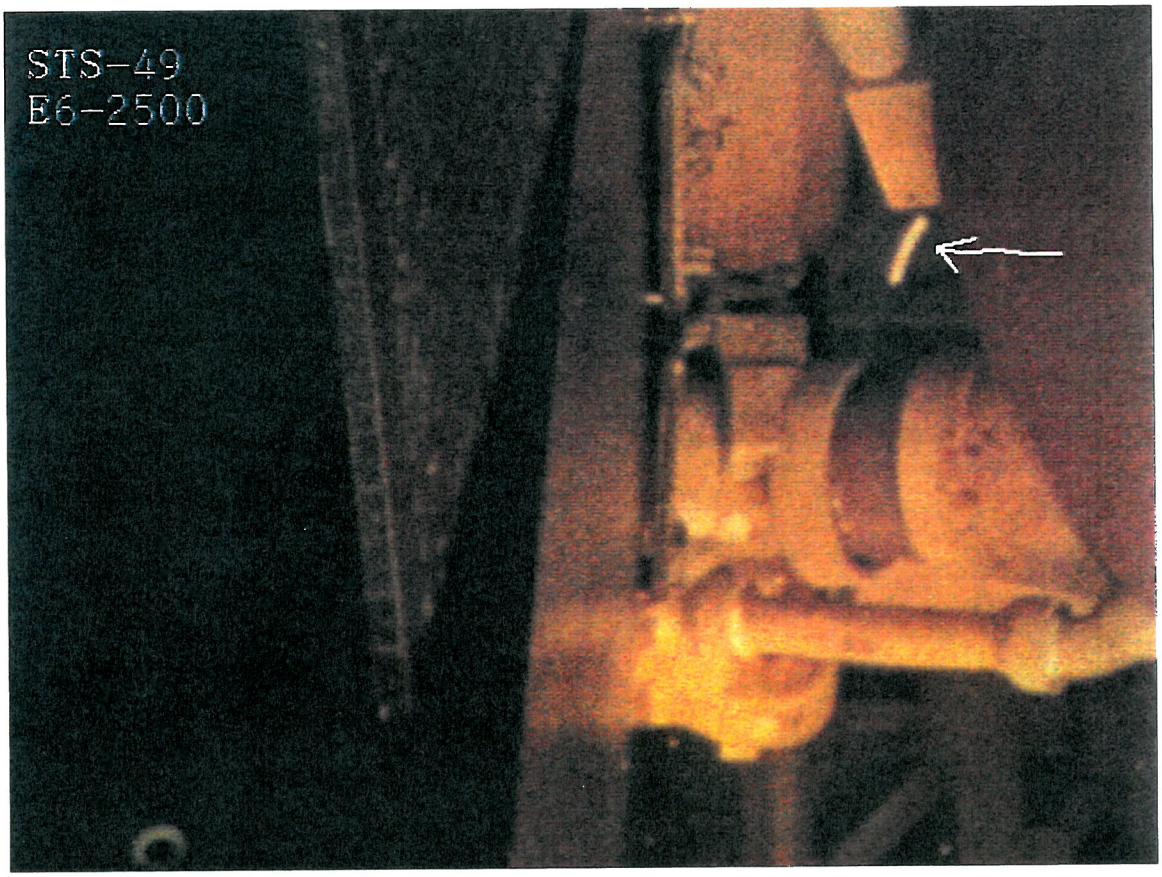

Figure 2.1.3.2 Rectangular Piece of Debris from Above LO2 Umbilical Area

A light, medium-sized piece of rectangular debris along with two other pieces of debris were seen originating from above and outboard of the LO2 umbilicals on cameras E-005, E-006 and E-025. See figure 2.1.3.2. This debris fell aft past the right inboard elevon at liftoff. Analysis indicated that the debris was probably ice from the LO2 feedline on the external tank. See Section 6.0, Appendix D, Task #13, Rectangular Debris Characterization.

2.1.3.3 Two White Pieces of Debris in front of Right Outboard Elevon *(Camera E-077)*

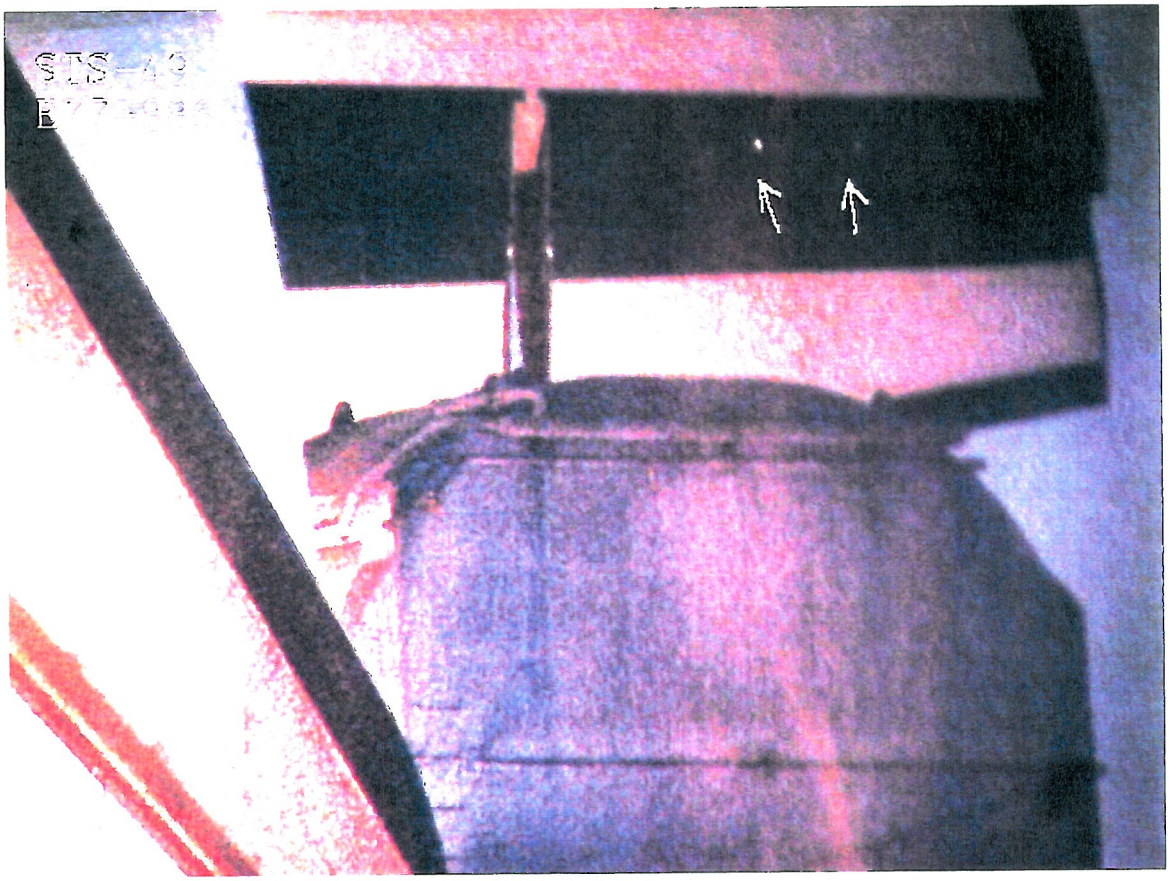

Figure 2.1.3.3 Two White Pieces of Debris in front of Right Outboard Elevon

Two small pieces of white debris were seen falling aft of the edge of the right outboard elevon at liftoff on camera E-077 as seen in figure 2.1.3.3. No follow up action has been requested.

2.1.3.4 Debris from above LH2 Umbilical and from Aft Strut
(Cameras E-031 and OTV-109)

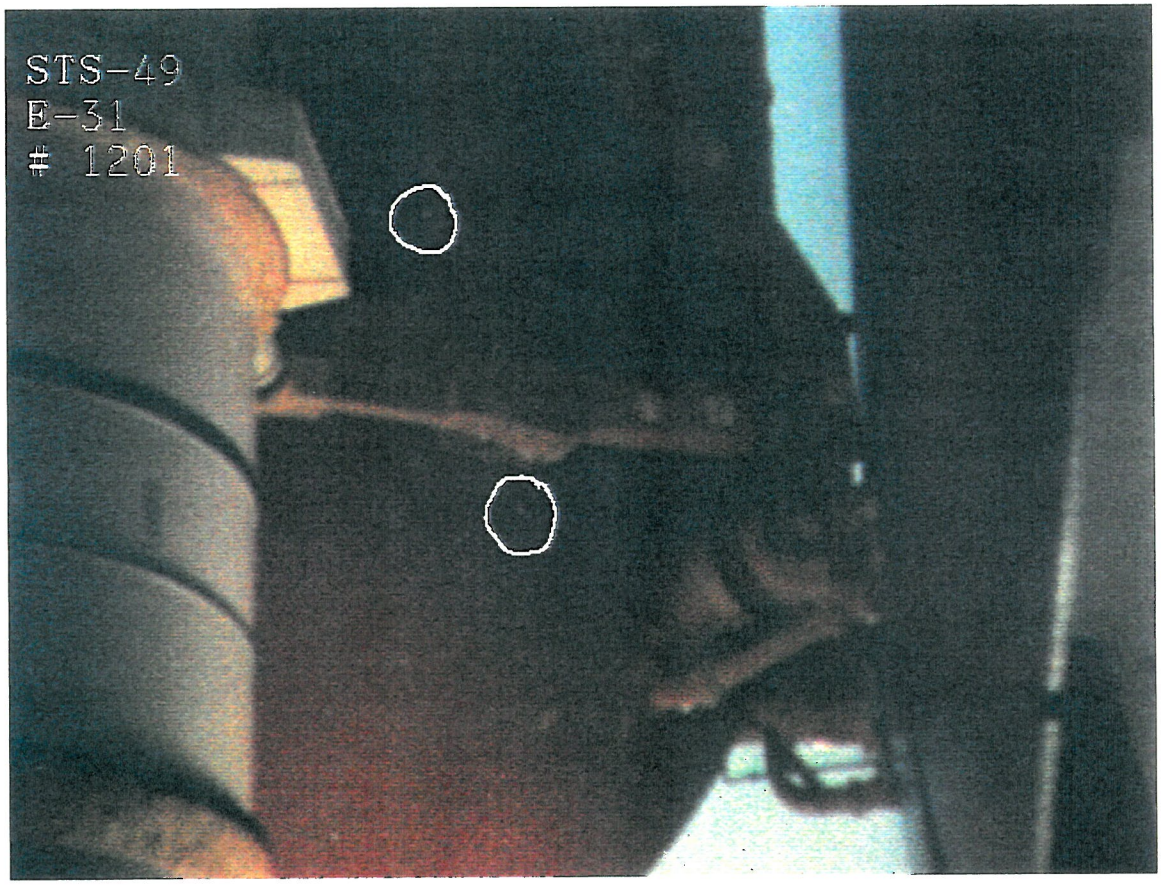

Figure 2.1.3.4 **Debris from above LH2 Umbilical (top circle); Debris from Aft Strut (lower circle).**

White debris (possibly ice) originated from the the ET side of the aft attach strut and fell toward the pad at liftoff as seen on OTV-109 and E-031. See figure 2.1.3.4.

Debris falling aft of the SLV after liftoff was similar to that seen on previous mission's film and videos. The timing of selected debris events is presented in Section 6.0, Appendix C, STS-49 Timing Data Report.

None of the debris described above was seen to strike the launch vehicle. No further analysis has been requested.

2.2 MLP Events

2.2.1 Base Heat Shield Flexing
(Task #14)
(Cameras E-019, E-020, E-076 and E-077)

Flexing (characterized by an up and down motion) was noted in the base heat shield from cameras E-076, E-077, E-019, and E-020. The flexing occurred at approximately T -4.6 seconds and ended just after all SSMEs had finished starting up at about T -2.9 seconds MET. Note that the flexing in the base heat shield was seen in the area between the SSMEs.

In order to see if the base heat shield flexing as seen on STS-49 was unique to OV-105, previous mission films were screened. Base heat shield flexing was detected on STS-51J (first flight of OV-104), STS-33, STS-48, STS-45, and STS-49 FRF. According to KSC, base heat shield flexing was also observed on the STS-1 FRF (SSME test firing for first flight of OV-102), STS-6 (FRF1 and FRF2) and STS-6 (first flight of OV-099), STS-14 (slightly evident), and STS-28 FRF. According to Rockwell - Downey base heat shield flexing was also seen on STS-41D, STS-51F, and STS-51J FRF.

Since base heat shield flexing has been seen on previous vehicles it is not unique to OV-105 and may be a normal occurrence.

An analysis was conducted to measure the amount of up an down motion exhibited in the base heat shield flexing by using film from camera E-076. Three separate analysts determined distances from a point on the base heat shield to a control point on the base of the vertical stabilizer over the same 200 frames for which maximum base heat shield movement was observed. The average of the distances from the three analysts was then used to determine the best estimate of the "true" distance for each frame. The distances between successive extreme points were measured and the maximum peak to peak displacement was found to be 1.06 inches with a 95% confidence range of between .24 to 1.88 inches. Note that the overall distance between the base heat shield and the point on the vertical stabilizer increases about 2 inches over the last one second and this is thought to be due to the twang caused by SSME start-up.

The frequencies of the oscillations seen in the base heat shield flexing were measured and two high frequency peaks were detected at 25 Hz. and 41 Hz.

The displacement of a point on the base heat shield was also measured with respect to the X and Y axes of the camera (note that the Y axis of the camera is essentially the same as the orbiter's X axis and the X axis of the camera is at a 30 degree angle to the orbiter's Y axis). The maximum peak to peak displacements are approximately 1.3 inches for each axis with a 95% confidence interval for the Y displacement of between 0.4 and 2.3 inches and for the X displacement the 95% confidence interval is between 0.3 and 2.2 inches.

MSFC conducted an analysis of the base heat shield flexing and found that the maximum displacement in the orbiter X and Y axes was approximately one inch. The MSFC preliminary report is included in Section 6.0, Appendix D, Task #14, Characterize Base Heat Shield Motion at SSME start-up.

A frequency analysis was conducted on the X and Y displacements and no dominant high frequencies were detected, implying that the base heat shield flexing is occurring randomly. This

result contradicts the finding of apparently strong peaks using the control point to base heat shield distance data. Since the distance data incorporates both X and Y displacements, it could be showing that peaks in the X and Y combine to create stronger peaks in the distance data.

MSFC also conducted a frequency analysis and found no dominant frequencies. MSFC concluded that the flexing was essentially random.

2.2.2 Base Heat Erosion
(Cameras E-019, E-023 and E-024)

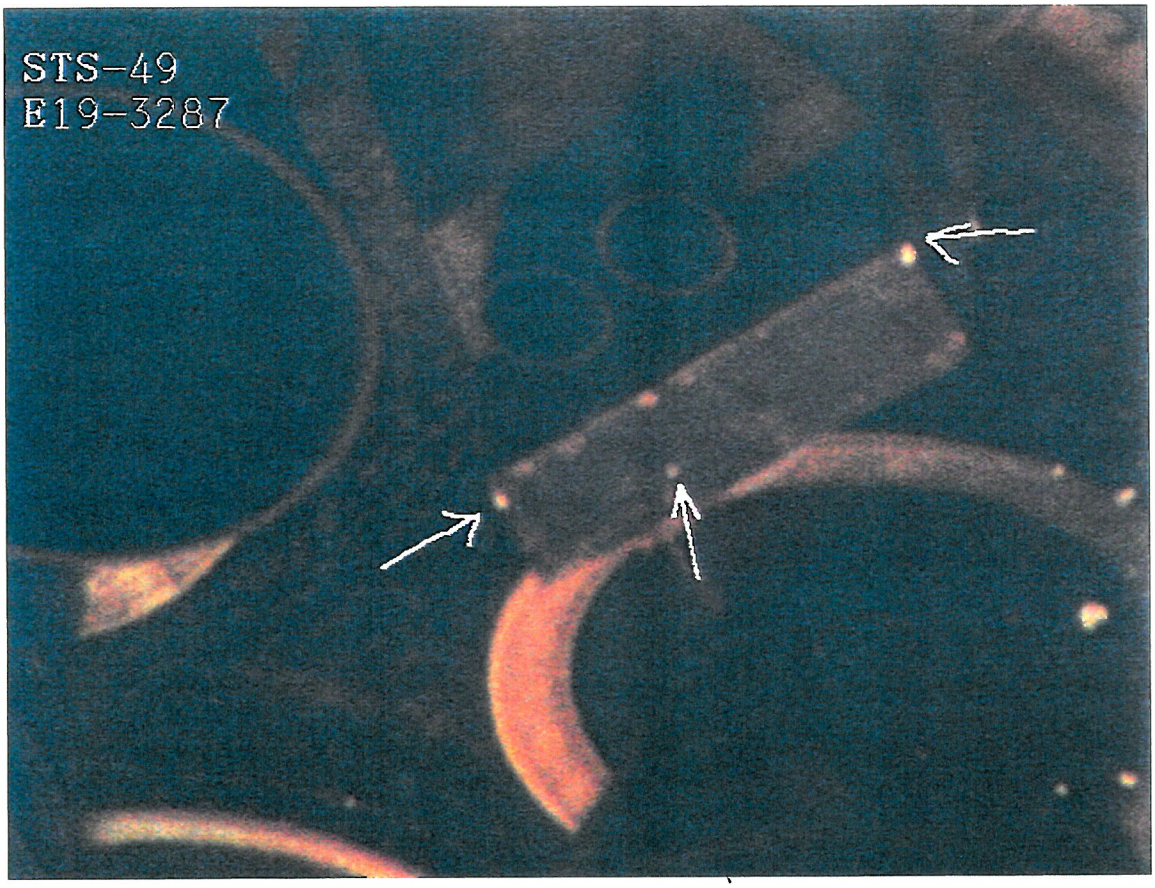

Figure 2.2.2 Base Heat Shield Deterioration on the Base of the Right RCS Stinger

Base heat shield erosion (three chips) was noted on cameras E-019, E-023 and E-024 on the right RCS stinger and at least seven small chips were noted on the base heat shield and left RCS stinger base at SSME start up as seen in figure 2.2.1.2. No further analysis has been requested.

2.2.3 Orange Vapor (Possible Free Burning Hydrogen)
(Cameras OTV-170, E-001, E-002, E-003, E-005, E-016, E-018, E-019, E-020, E-036 and E-077)

Orange vapor (possibly free-burning hydrogen) was seen to rise toward the base of the vertical stabilizer just prior to SSME ignition. This vapor appeared to be similar to other missions with winds from the north. No further analysis has been requested.

2.2.4 Flashes in SSME Plumes
(Cameras E-003 and E-005)

Multiple flashes were seen in the SSME #1, #2 and #3 exhaust plumes after SSME start-up while the vehicle was still on the pad. These flashes have been seen on previous missions. No further analysis has been requested.

2.3 Ascent Events

2.3.1 White Spot on Underside of Orbiter TPS at Liftoff
(Camera E-034)

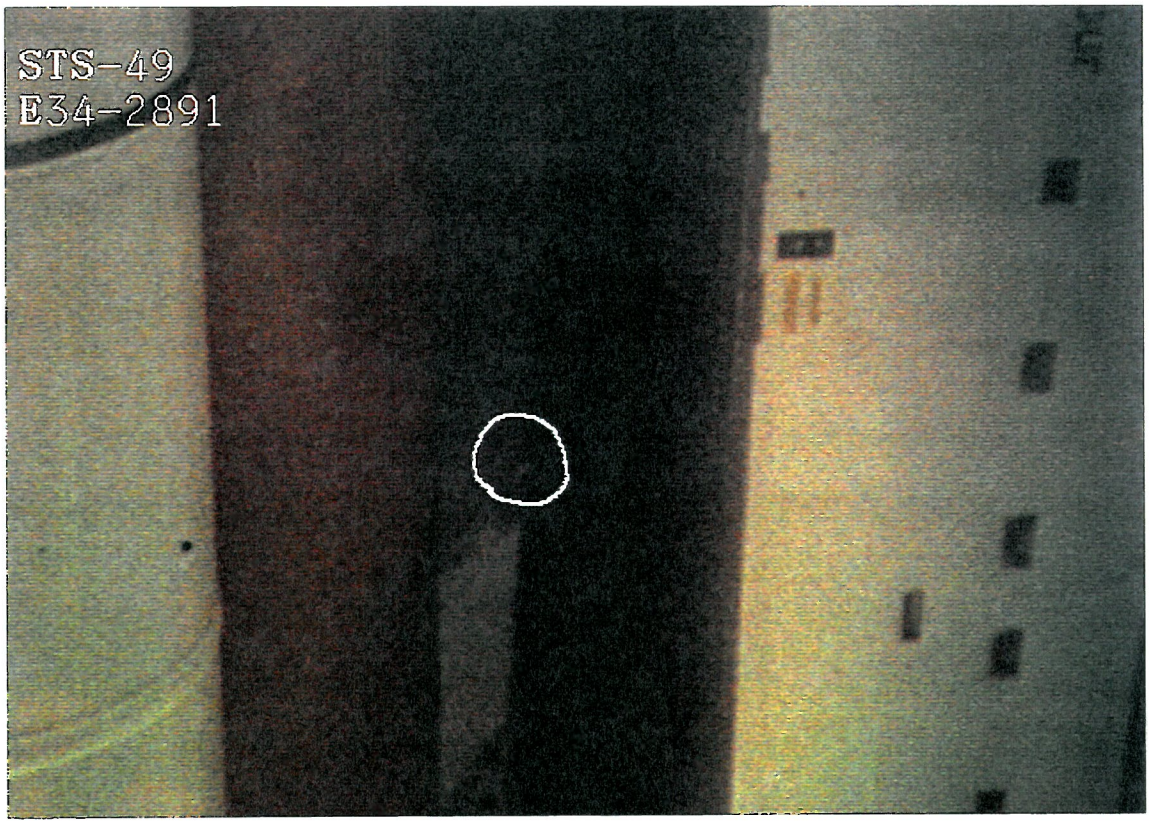

Figure 2.3.1 White Spot on Underside of Orbiter TPS at Liftoff

A white spot was noted on the underside of the Orbiter (approximately at mid-fuselage on the right side) at liftoff and appeared to be on the orbiter TPS. See figure 2.3.1. This white spot was not seen from any other launch views. Inspections of the orbiter after landing did not show the spot. No further analysis has been requested.

2.3.2 Brightening in SRB Plume
(Cameras ET-212 and E-204)

A small area near the upper right corner of the SRB plume appeared to brighten intermittently between 45 and 87 seconds MET. This was noted on camera ET-212.

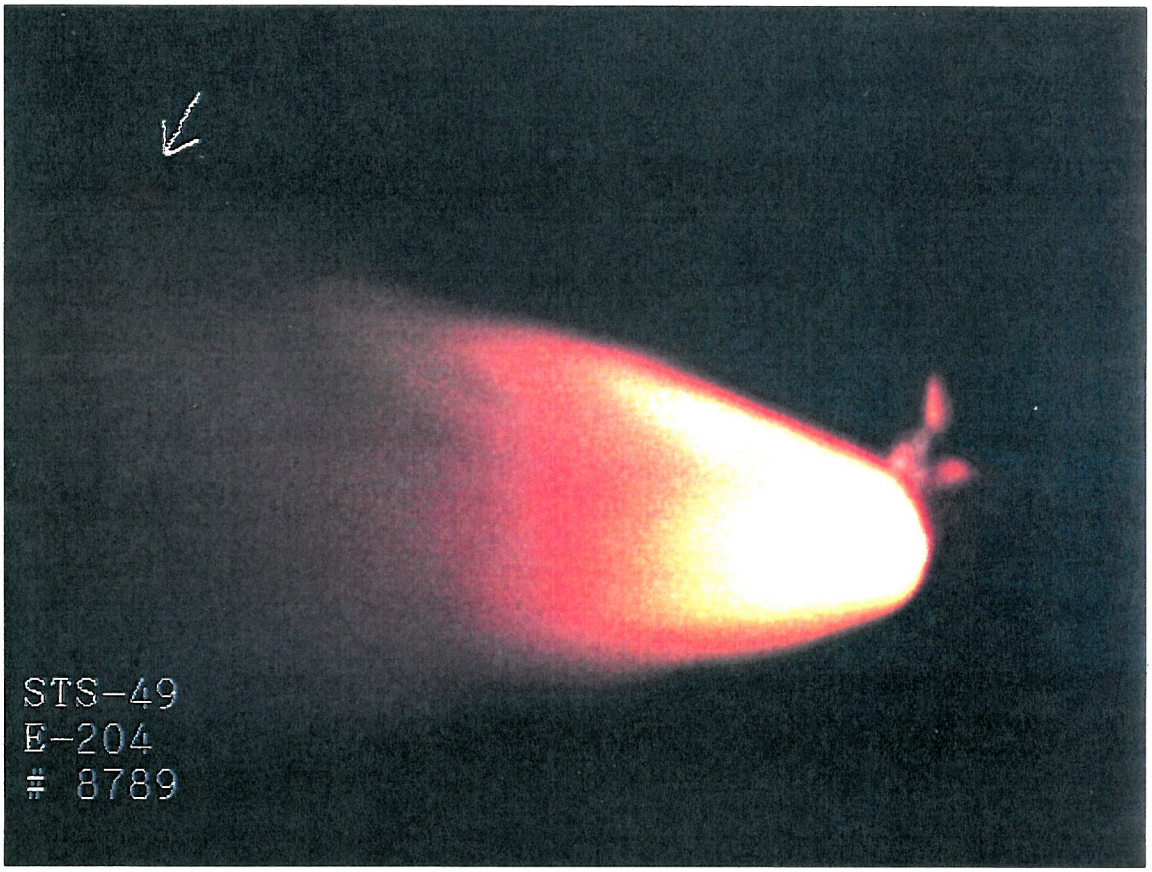

Figure 2.3.2 Bright Orange Area in SRB Plume

A bright orange area was observed at 121 seconds MET in the SRB plume several vehicles lengths below the vehicle as seen in figure 2.3.2. This bright area may have been the result of slag at tailoff prior to SRB separation.

2.3.3 Flares in SSME Plume

(Task #12)
(Cameras KTV-5, E-208, E-212, E-218 and E-220)

Figure 2.3.3 Orange Discoloration in SSME Plume

Up to five separate flares were seen in the SSME exhaust plume after liftoff on the long range trackers including a single flare that was noted on camera ET-212 near the SSME #1 plume at 48 seconds MET. Flares during this time period have been seen on several earlier missions and no further analysis has been requested.

Twenty-six orange discolorations (possibly flares) were noted in the SSME plumes beginning at 84 seconds MET (See Section 6.0, Appendix D, Task #12, Flare in SSME plume starting at 84 seconds MET) and continuing through SRB separation. Figure 2.3.3 is an example of one of the twenty-six orange discolorations. This event occurred at 118.7 seconds MET. The first of these orange discolorations coincided with a large increase in the SSME #2 high pressure fuel pump temperature reported by the MER. (It was later reported by the MER that this high pressure report was a sensor failure, not an actual high temperature condition.) Normal recirculation seen on camera ET-212 between 91 and 106 seconds MET was compared to the events seen on KTV-5. Since STS-33 was also launched from Pad 39B at a similar inclination angle and launch time, KTV-5 was reviewed for similar discolorations and did not show the same flare event; however color distortions were present on STS-33 KTV-5 view of the SLV at about the same viewing angles.

The STS-49 D2 tape of KTV-5 was screened at the JSC Imagery Operations Office/JL5 in order to get a better view of the discolorations in slow motion. JL5 reported that camera KTV-5 had a four line vertical jitter that was introduced at the time of recording at launch and it was impossible to remove. The view of the sensor "lag" on the D2 was very apparent. It is believed that the discoloration events were, at a minimum, exaggerated by the sensor lag making them appear so distinctive. Similar discolorations were not seen on other cameras. The conclusion was that the discolorations on KTV-5 were due to vertical jitter. No further analysis was requested.

2.3.4 Body Flap Motion
(Task #4)
(Cameras E-017, E-212 and E-220)

Slight body flap motion was seen on camera E-017 prior to liftoff. Slight body flap motion was also seen on camera films E-212 and E-220 after liftoff. Body flap motion has been seen on previous mission films and the magnitude of the body flap motion seen on the STS-49 views was not sufficient to warrant further analysis. See Section 6.0, Appendix D, Task #4, Body Flap Analysis.

2.3.5 Recirculation
(Task #1)
(Cameras ET-212, E-204, E-212 and E-218)

Recirculation prior to SRB separation was seen on long range cameras ET-212, E-204, E-212 and E-218. 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. For STS-49, the start of recirculation was observed at about 93 seconds MET and the end was noted at approximately 110 seconds MET on Camera E-212. Timing data for recirculation for STS-49 is presented below and a summary of recirculation for previous missions is presented in Section 6.0, Appendix D, Task #1, Recirculation Characterization. No further analysis has been requested.

Cameras on which recirculation was observed for STS-49

CAMERA	START (seconds MET)	STOP (seconds MET)
ET-212	91	106
E-204	---	---
*E-212	93	110
E-218	93	101

* BEST VIEW OF RECIRCULATION

NOTE: Intermittent LOV of the aft area of the SLV due to the exhaust plumes prevented acquisition of specific start and stop times for recirculation on camera E-204

2.3.6 Linear Optical Effect
(Camera E-205 and E-212)

On cameras E-205 and E-212, linear optical distortions were noted at 57 and 60 seconds MET. The time of occurrence of these and other events during ascent are presented in Section 6.0, Appendix C, STS-49 Timing Data Report. Linear optical effects have been seen on previous missions. No follow up action has been requested.

2.3.7 Umbilical Well Camera Analysis
(Camera UMBL1)

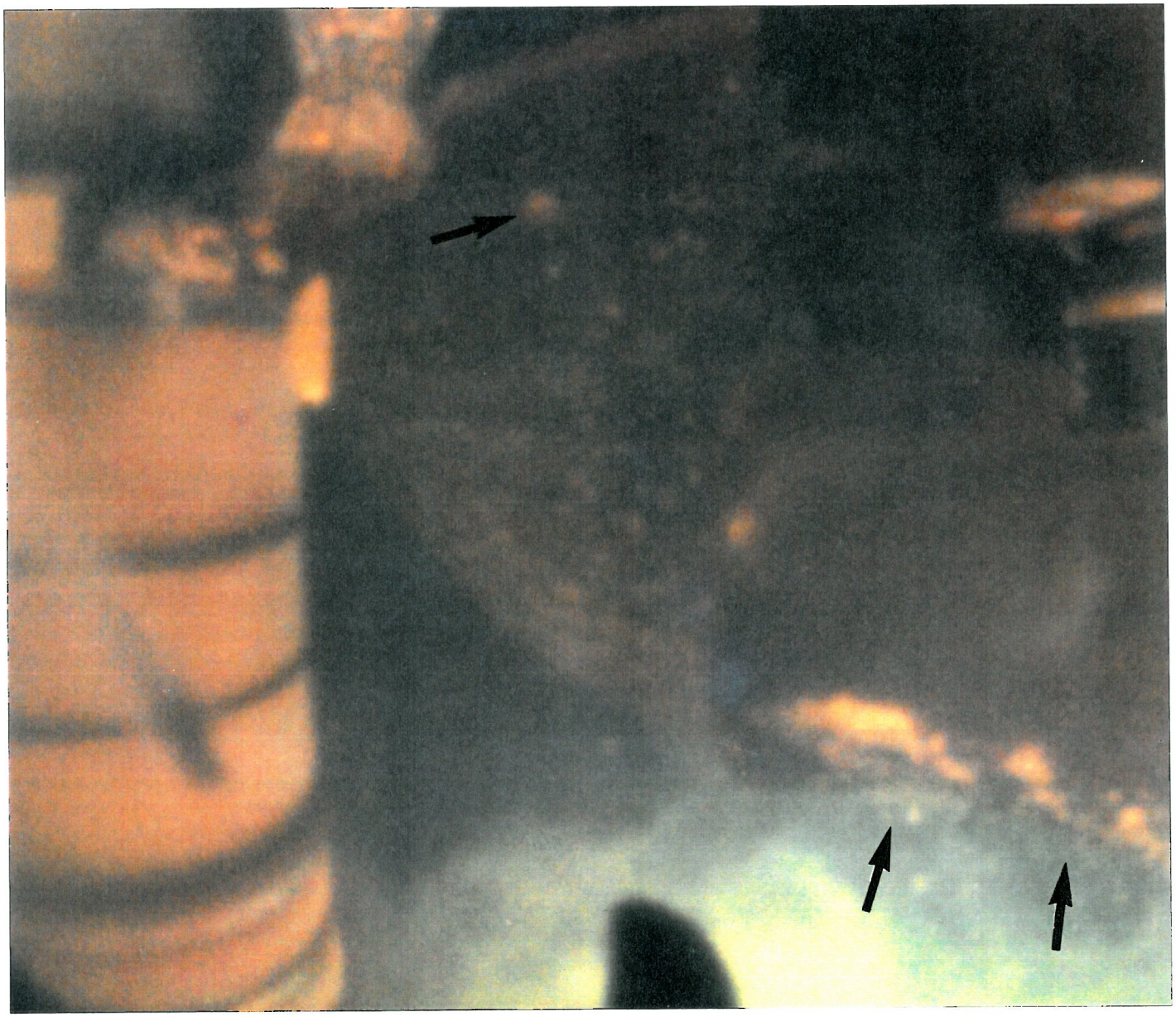

Figure 2.3.7 **Shallow Divot on ET Base TPS and White Linear Smear on Optical Plate**

A shallow divot on the ET base TPS near the left SRB attach and chipping of the LH2 electrical cable tray were noted on camera UMBL1. Also a white linear smear on the optical plate appears from left center to lower center of the FOV before SRB separation as seen on figure 2.3.7.

2.4 On Orbit

2.4.1 Analysis of Onboard Photography of the ET (DTO-0312)

Due to the lighting conditions and the attitude of the orbiter, no attempt was made by the STS-49 crew to acquire photography of the external tank after separation. (See Section 6.0, Appendix D, Task #6, ET Onboard Hasselblad Photo Analysis.)

2.4.2 Electronic Still Camera

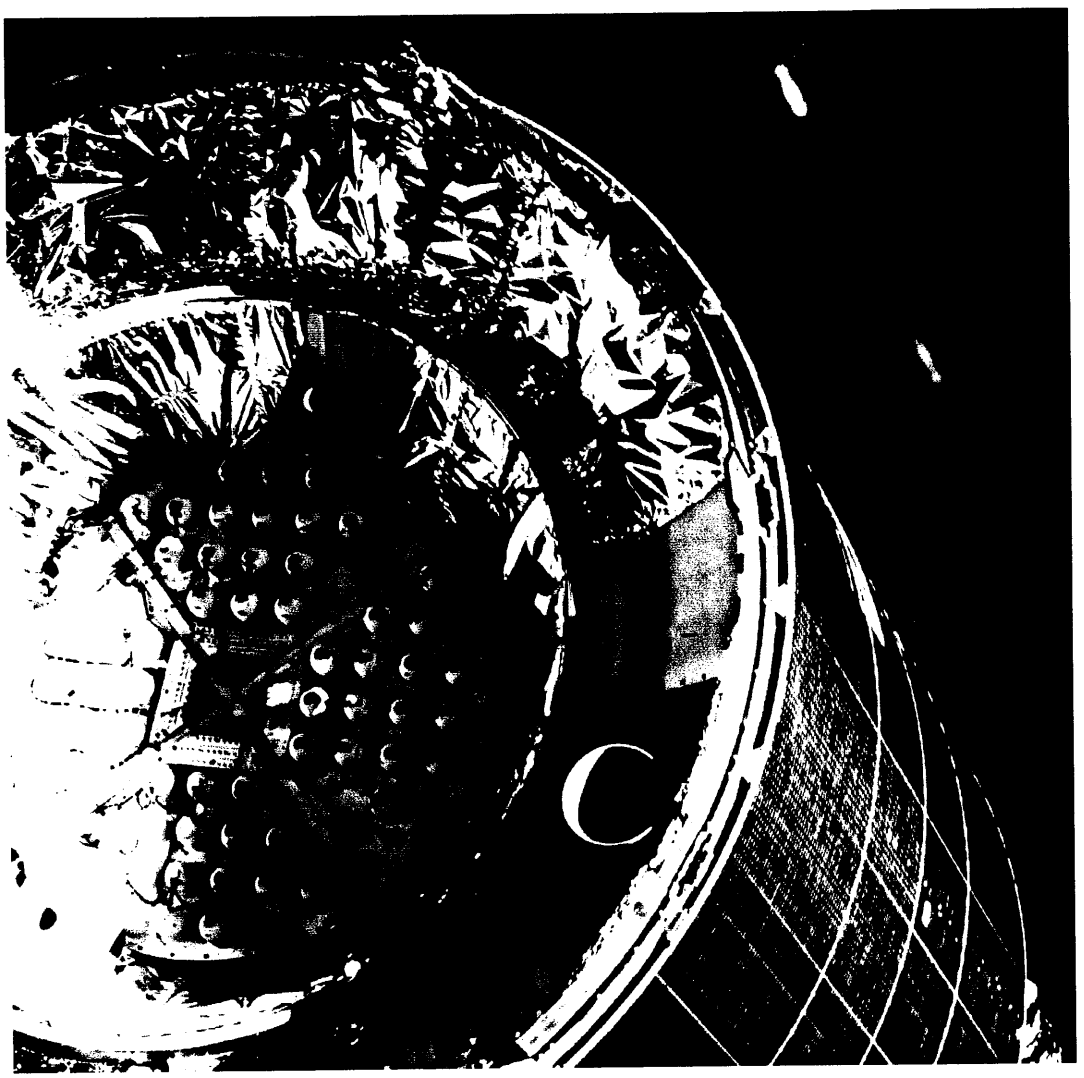

Figure 2.4.2 (A) Enhanced ESC Downlinked Image of INTELSAT

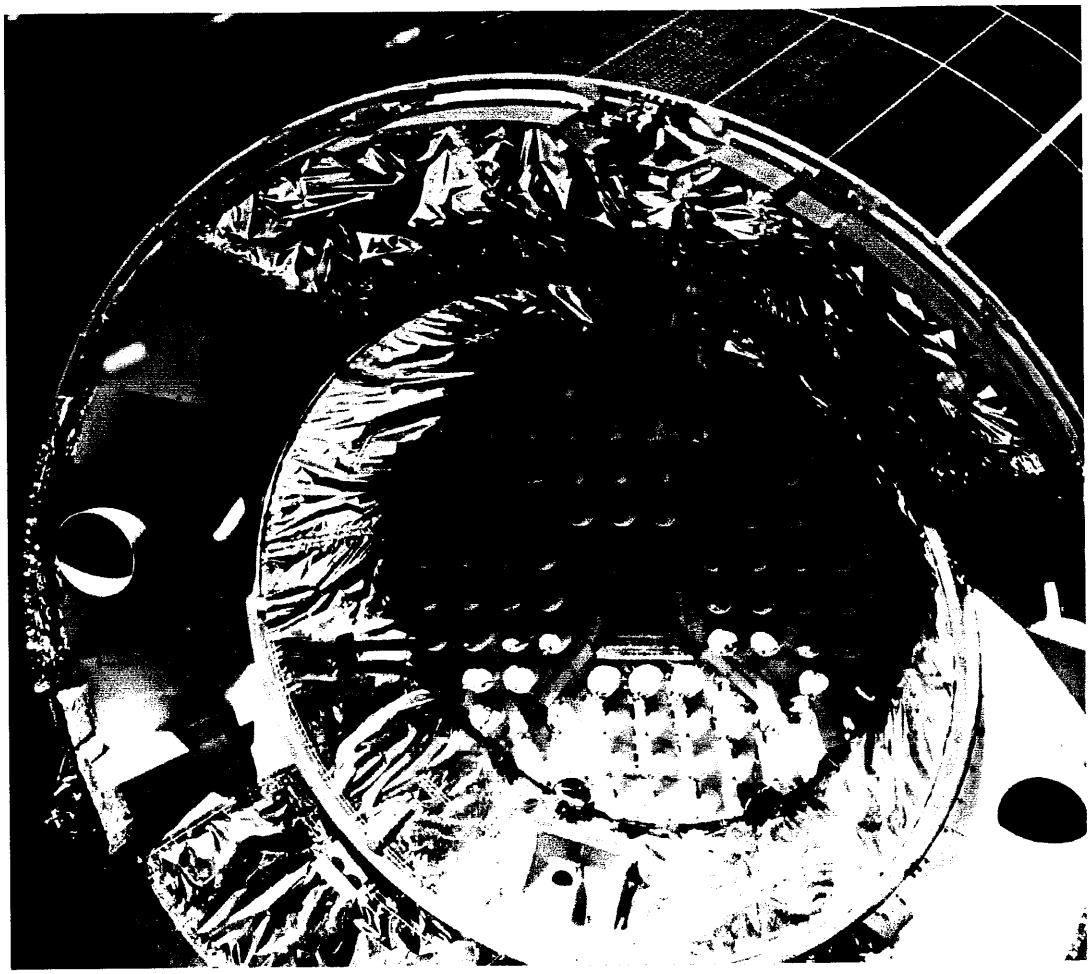

Figure 2.4.2 (B) Enhanced ESC Downlinked Image of INTELSAT

Electronic still camera (ESC) downlinked images from Endeavour of the INTELSAT prior to capture were enlarged, enhanced, and examined for sharp edges. No sharp edges that could have affected the astronauts retrieval of the satellite were noted. Figure 2.4.2(A) is a histogram equalization of one image of INTELSAT and figure 2.4.2(B) is an intensity mapping plus 90 degrees rotation of another ESC image. (See Section 6.0, Appendix D, Task #15, INTEL Satellite Enhancements.)

2.4.3 Assembly of Space Station by EVA Methods (ASEM) (Task #11)

The Assembly of Structures by EVA Methods (ASEM) was performed during STS-49. Due to the additional space walks required to retrieve and repair INTELSAT, ASEM activities were substantially reduced. PTAP personnel screened these activities in real-time to gather information for future analysis and to serve as support in case of a contingency. However, less than ten percent of the crew's EVA activities were downlinked live. Two video feeds were continuously recorded on the Orbiter during the course of these activities and they will be screened at a later date to help determine positions and rates of the RMS arm, assembly structures and crew propulsion devices.

Two preliminary findings from the initial screening were: difficulty identifying the astronauts if they were more than 30 feet away from the camera (the identification bands on the suits were not easily discernable) and a general problem with audio quality (higher frequency voices were harder to understand). Detailed notes on the initial screening can be found in Section 6.0, Appendix D, Task #11, ASEM Evaluation.

2.4.4 Orbital Debris Impact on Window W1

Figure 2.4.4 Orbital Debris Impact on Window W1

An orbital debris impact was noted by the STS-49 crew on flight day 8 in the upper right hand corner of window W1 as viewed from the commander's seat. The size of the dark star burst was described as the size of a 50 cent piece. The photograph displayed in figure 2.4.4 was made during the post-landing inspection and shows a white material covering the window that is the residual for SRB separation motors. Commander Brandenstein suggested that the dark star burst is due to the cleaning(removal) of the SRB plume residual by the debris impact. An estimate has been made that the strike occurred one inch from the edge of the window and the center of the star burst is approximately 1/16 to 1/32 of a inch in size.

2.5 Landing Events

2.5.1 Landing Sink Rate Analysis

2.5.1.1 Landing Sink Rate Analysis Using Film

Camera E-1008 film was used to determine the sink rate of the main gear and the nose gear. The vertical stabilizer was used as a scale. Data were gathered from approximately 1 second prior to landing through touchdown. Four points on every other frame over a period of 100 frames were digitized. These points consisted of the bottom of the left main gear, a point on the runway immediately below the wheel and the top and bottom of the vertical stabilizer (as a scaling reference). The raw data were corrected for the vertical change in scale at each frame. The distance between the bottom of the wheel and the runway was computed and a linear regression was applied on this normalized vertical distance vs. time data to determine the actual sink rate. This rate was determined to be 2.0 ft/sec.

Nose gear touchdown occurred 11 seconds after main gear touchdown. Again, data were gathered for approximately 1 second just prior to nose gear touchdown. Three points on every other frame over a period of 96 frames were digitized (also from Camera E-1008). These points consisted of the top and bottom of the right nose gear wheel (as a scaling reference) and a point on the runway immediately below the wheel. The raw data were corrected for the vertical change in scale at each frame. A linear regression was performed on this normalized vertical distance vs. time data. The slope of this line was used as the sink rate of the nose gear and found to be 2.8 ft/sec. Graphs depicting the above data can be seen in Section 6.0, Appendix D, Task #3, Determine Sink Rate from Video/Film.

2.5.1.2 Landing Sink Rate Analysis Using Video

Data from TV-4 was used to determine the sink rate of the main gear and the nose gear. A vertical section of tile of known length on the right side of the orbiter was used as a reference scale. The vertical position of the main gear 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 a one second period. Using the scale calculated from the known vertical reference, these differences were converted to feet. The same method was used to determine the vertical position of the nose gear. A least squares regression line was calculated from the data and the slope was used as the average sink rate. The sink rate for the main gear was determined to be 1.08 feet per second and 2.81 for the nose gear. Graphics depicting the above data may be found in Section 6.0, Appendix D, Task #3, Determine Sink Rate from Video/Film.

2.5.2 Drag Chute

2.5.2.1 Uplock Shear Pin
(Task #9)

PTAP analysts were requested to attempt to determine if the appropriate shear pin was used during installation of the drag chute into the Endeavour using the assembly video tapes. After carefully screening the tapes for scenes which displayed the shear pin, it was determined that there was insufficient information due to shadows and video resolution in the video tapes to make the determination requested. See Section 6.0, Appendix D, Task #9, Uplock Shear Pin Identification.

2.5.2.2 Drag Chute Performance
(Task #10)

Figure 2.5.2.2 Chute Inflated in Reefed Configuration

Figure 2.5.2.2 depicts just one of many stages of the drag chute deployment. The various stages are drag chute initiation, pilot chute inflation, bag release, chute inflation in reefed configuration, disreefing initiation, full chute inflation and chute release. The analysis of the drag chute deployment and its effect upon the vehicle is still being performed as of the writing of this report and a separate report will be generated describing the results of this analysis upon completion. (See Section 6.0, Appendix D, Task #10, Drag Chute Performance Analysis.)

2.5.3 Post-Landing Inspection of Damage to the Orbiter

Although the launch and landing films indicated that STS-49 was an unusually clean mission, eleven hits greater than one inch were found by KSC on the orbiter during the post-landing inspection. Several of these hits included TPS damage on the right side of the orbiter nose and the

base heat shield. A small segment of the aft port payload bay door seal appeared misaligned. Streaks were noted on the TPS forward of the hydrogen umbilical.

2.5.4 Post-Landing Inspection of Debris Found on Runway

A half inch screw and a small green cylindrical object were seen on the ground during the post-landing inspection.

2.6 Other Normal Events

Other normal events observed included: normal pad debris; SRB flame duct debris; RCS paper debris; white debris (probably ice) from the ET/Orbiter, TSM umbilical areas and the GUCP disconnect during liftoff; left inboard elevon motion was noted during liftoff; ET aft dome out gassing and charring; vapor off SRB stiffener rings; condensation vapor trails off both wings after tower clear; white flashes in the SSME plume throughout the roll maneuver; indication of wind shear in the SRB plume; atmospheric bow waves; SRB exhaust plume brightening at tail off; and slag noted after SRB separation. No further analysis has been requested for any of these events.

3.0 General Product Evaluation

3.1 Launch Video

Twenty-three launch videos, out of twenty-three expected, were received. The Public Affairs Office replays were received a few minutes after launch. The first set of engineering replays were received approximately 30 minutes after launch. The second set of replays were received approximately 6 hours after launch.

The film to video conversion test was not scheduled for STS-49.

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.

OTV-141: Variable exposure noted after launch. Internal lens reflection noted.

OTV-148: Variable exposure noted. Internal lens reflection noted.

OTV-151: Variable exposure noted.

OTV-154: Horizontal banding noted at liftoff.

OTV-160: Camera vibration noted.

OTV-161: Video breakup noted after launch. Internal lens reflection noted.

ET-204: Soft focus noted. Exposure varied from dark to good. Intermittent LOV due to clouds and tracking noted. The slate for the next video, ET-207, appeared in the middle of the view during screening at 128:23:41:55.851-128:25:41:58.554 UTC.

ET-208: Momentary error in timing signal noted at approximately 128:23:41:15 UTC.

ET-213: Variable exposure noted. Red, blue and green horizontal color bands noted throughout video. Ghosting of the image noted after roll maneuver.

KTV-5: Variable focus noted. Video breakup noted at liftoff through 128:23:40:20.330 UTC.

KTV-7B: Dark exposure noted.

KTV-13: Variable focus noted. Variable exposure noted. Internal lens reflection noted.

3.2 Launch Film

Sixty-one launch films arrived out of sixty-three expected. A detailed assessment of the film quality follows. Note that unless otherwise stated, the focus and exposure was good and if a camera number is not mentioned, there were no problems.

EX-001: Camera vibration was noted. The exposure was dark. Shoe is not completely in FOV.

EX-004: Camera vibration was noted. The exposure was dark. Shoe is not completely in FOV.

E-001: The exposure was dark. Edge of camera housing noted in right side of FOV.

E-002: Camera vibration was noted.

E-003: Camera vibration was noted. The exposure was dark.

E-004: Camera vibration was noted. The exposure was dark.

E-005: Camera vibration was noted. The exposure was too dark to see umbilicals prior to SSME ignition.

E-006: The dark exposure hindered analysis.

E-007: The exposure was dark.

E-008: Camera vibration was noted.

E-009: Camera vibration was noted. The exposure was dark.

E-010: The exposure was dark.

E-011: The exposure was dark.

E-012: Camera vibration was noted. The exposure was dark. Timing was lost at 23:39:56.282.

E-013: Camera vibration was noted. The exposure was dark.

E-014: The exposure was dark.

E-015: The exposure was dark.

E-016: The exposure was dark.

E-017: The exposure was dark.

E-018: The exposure was dark.

E-019: Digs were noted in film. The exposure was dark. Timing marks bleed into image area at liftoff.

E-020: The exposure was variable.

E-023: Camera vibration was noted. The exposure was dark.

E-024: The exposure was dark.

E-025: The exposure was variable.

E-026: Digs were noted in film. The dark exposure hampered analysis.

E-027: Camera vibration was noted. The exposure was dark. Targets on shoe obscured by exhaust from SRB ignition.

E-028: Camera vibration was noted. Targets for shoe rotation not in FOV.

E-030: Camera vibration was noted. The exposure was dark. Yellow film exposures noted on both sides of frame just above lower sproket holes.

E-031: The focus was soft.

E-033: The focus was soft.

E-036: The exposure was dark.

E-040: The focus was soft.

E-042: The exposure was dark. Camera was positioned too high in relationship to the GUCP. Timing marks were on very edge of film.

E-050: The exposure was good/dark.

E-052: Internal lens reflection noted.

E-059: The exposure was good/dark.

E-062: No timing.

E-065: The exposure was dark.

E-079: The exposure was dark.

E-204: The focus was soft.

E-205: The exposure was dark.

E-211: Digs were noted in film.

E-212: Digs were noted in film.

E-213: Digs were noted in film. Film ended prior to SRB separation.

E-220: Digs were noted in film.

3.3 Landing Video

Nine landing video replays were received from NASA Select approximately 2.5 hours after the landing of Endeavour on runway 22 at Edwards Air Force Base. (Main gear touchdown occurred at 20 hours, 57 minutes, 38.215 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.

DTV-1: Thermal distortions noted at the beginning of the film.

DTV-3: During the drag chute deployment there was a momentary loss of focus. At 137:20:58:06.107 UTC time was lost and the time for wheel stop could not be determined.

IR: Timing on the film was invalid.

LRO: Camera tracking was erratic.

SBEV: No timing.

VLRO: No timing. Analysis was hampered by soft focus.

3.4 Landing Film

Sixteen landing films were received and screened. The following is a detailed description of the landing film quality for STS-49. Note that if a camera is not mentioned, there were no problems noted with the camera. Unless otherwise mentioned, the focus, exposures, and timing were good.

E1001A: Fiducials were not lit. White digs noted throughout beginning of film. No IRIG timing.

E1001: No timing. Thermal distortions noted throughout film.

E1002A Faint digital timing marks. Digital timing is incorrect. Thermal distortions noted throughout film.

E1002: No timing.

E1003A: No timing. Thermal distortions noted throughout film.

E1007A: No timing.

E1008: Thermal distortion noted at main gear touchdown. No offset was found on film.

E1009: No timing. The focus was soft. Thermal distortions noted throughout film.

E1010: Faint digital timing marks. Thermal distortions noted throughout film.

E1011: No timing. The focus was very soft because of an apparent shutter problem.

E1012: No offset was found on film.

E1017: No timing. No first frame identifier.

E1027: The focus was soft due to thermal distortions noted throughout film.

E1027A: No timing.

EXTRA #1: No first frame identifier. Digital timing is incorrect.

EXTRA #2: No first frame identifier.

4.0 Process Evaluation

All launch film deliveries and reviews went smoothly. Several problems were incurred in screening of the 35mm film in Building 8. The 35mm analyzer died the first time that it was powered up. This unit was down approximately 24 hours for repairs requiring screeners to use an alternate 35mm projector that does not have freeze-frame capabilities. After repairs were made, no further problems were incurred with the 35mm analyzer. The alternate 35mm projector frequently overheated causing a breaker to trip on the power outlet being used. Some time was spent in trying to locate the circuit breaker for this outlet. (It was later determined that the breaker was in a locked area in another portion of Building 8.)

5.0 References

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

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

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

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

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

j. Johnson Space Center Space Shuttle Photographic and Television Analysis Project, STS-45 Final Report, May 11, 1992, LESC-30200, JSC-25796

k. Johnson Space Center Space Shuttle Photographic and Television Analysis Project, STS-49 FRF Final Report, May 5, 1992, LESC-30230, JSC-25825

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

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

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Engineering Photographic Screening Disposition Forms

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number EX001

Location:	MLP B13	Focus:	Good
Camera Type:	16DBM5	FOV:	*
Film:	ECD 200'	Exposure:	Dark
Lens Focal Length:	32mm	Timing:	Yes
FPS:	400	Date Received:	05/11/92
Timing:	A	Date Screened:	05/11/92
		Screened By:	JH,MS,SI,LK,CD

Film Quality

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

Comments
Frame 3758 - Small thin piece of debris fell from top of view in front of shoe, struck MLP and rebounded out of FOV
Minor pad debris noted during SSME ignition
Slight rocking of the shoe noted at liftoff
Frame 5506 - LOV
No anomalies detected

Film Quality Description
*Shoe is not completely in FOV
Camera vibration at SSME ignition

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number EX004

Location:	MLP B16	**Film Quality**	
Camera Type:	16DBM5	Focus:	Good
Film:	ECD 200'	FOV:	*
Lens Focal Length:	32mm	Exposure:	Dark
FPS:	400	Timing:	Yes
Timing:	A	Date Received:	05/11/92
		Date Screened:	05/11/92
		Screened By:	JH,MS,SI,LK,CD

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

Comments
Minor pad debris noted during SSME ignition
Slight rocking of shoe noted at liftoff
Frame 3950 - Two dark pieces of debris fell from behind the left side of M-5 and into flame duct area at liftoff
Frame 4000 - Two pieces of debris (possibly shim material or putty) noted in shoe area at liftoff
Frame 4069 - LOV
No anomalies detected

Film Quality Description
*Shoe is not completely in FOV
Camera vibration at SSME ignition

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number ET204

Location:	PAFB PIGOR	Focus:	Soft
Camera Type:	TV/3000	FOV:	
Film:	1/2"	Exposure:	Dark/Good
Lens Focal Length:	120"	Timing:	Yes
FPS:		Date Received:	05/08/92
Timing:	B120	Date Screened:	05/08/92
		Screened By:	JD,RB,BG

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
128:23:40:07.008 - AOV
Intermittent LOV due to clouds
128:23:41:54.483 - AOV
128:23:42:07.263 - -SRB separation
128:23:42:12 - LOV
No anomalies detected

Film Quality Description
Intermittent LOV due to clouds and tracking
Incorrect ET-207 slate in middle of view -
128:23:41:55.851-128:25:41:58.554

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

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:	05/08/92
		Date Screened:	05/08/92
		Screened By:	JD,RB,BG

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

128:23:40:00.711 - ~Liftoff
Vapor off both stiffener rings noted
ET aft dome outgassing noted
Roll maneuver noted
128:23:40:15.559 - Contrail off right wing just after roll maneuver noted
128:23:40:16.393 - LOV
128:23:40:40.351 - AOV
Plume brightening noted
128:23:42:07.271 - SRB separation noted
128:23:42:53.450 - LOV of Orbiter
128:23:43:48.606 - LOV of SRB
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-49
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Item Number ET208

Location:	C.B. DOAMS	**Focus:**	Good
Camera Type:	TV/750	**FOV:**	
Film:	1/2"	**Exposure:**	Good
Lens Focal Length:	240"	**Timing:**	Yes
FPS:		**Date Received:**	05/08/92
Timing:	B120	**Date Screened:**	05/08/92
		Screened By:	JD,RB,BG

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
128:23:40:41.475 - AOV
128:23:40:53.987 - LOV
128:23:41:16.910 - AOV
128:23:41:30.557 - LOV
128:23:42:04.225 - AOV
128:23:42:07.261 - ~SRB separation noted
128:23:42:55 - LOV
No anomalies detected

Film Quality Description
Momentary time error at ~128:23:41:15

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number ET212

Location:	UCS-23 ATOTS	Focus:	Good
Camera Type:	TV/750	FOV:	
Film:	1/2"	Exposure:	Good
Lens Focal Length:	60"	Timing:	Yes
FPS:		Date Received:	05/08/92
Timing:	B120	Date Screened:	05/08/92
		Screened By:	JD,RB,BG

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.

.

Comments

128:23:40:10.403 - AOV
Roll maneuver noted
128:23:40:45.739-128:23:41:17.537 - A small area above upper right corner of SRB plume appears to brighten intermittently
123:23:40:47.973 - Flare noted near SSME #1 exhaust plume (P)
Intermittent LOV due to clouds
128:23:41:28.048 - AOV
128:23:41:31.485 - ~Start of recirculation
128:23:41:45.766 - ~End of recirculation
128:23:41:55.209 - Normal plume brightening noted
128:23:42:07.254 - ~SRB separation
128:23:42:18.932 - Multiple pieces of slag noted after SRB separation
128:23:42:27.841 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number ET213

Location:	UCS-7 MOTS	**Film Quality**	
Camera Type:	TV/101	Focus:	Good
Film:	1/2"	FOV:	
Lens Focal Length:	ZOOM	Exposure:	Variable
FPS:		Timing:	Yes
Timing:	B120	Date Received:	05/08/92
		Date Screened:	05/08/92
		Screened By:	JD,RB,BG

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
128:23:40:00.467 - -Liftoff
Roll maneuver noted
128:23:40:16.116 - LOV
128:23:40:31.464 - AOV
128:23:42:13.300 - LOV
No anomalies detected

Film Quality Description
Red, blue and green horizontal color bands noted throughout video
Ghost image noted after roll maneuver

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E001

Location:	MLP L1	Focus:	Good
Camera Type:	16DBM4	FOV:	
Film:	ECD 200'	Exposure:	Dark
Lens Focal Length:	10MM	Timing:	Yes
FPS:	400	Date Received:	05/09/92
Timing:	A	Date Screened:	05/09/92
		Screened By:	JH,MS,SI,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 2095 - Orange vapor originated from SSME area at SSME ignition
Single white piece of debris fell aft near body flap after SSME ignition, debris does not appear to strike the vehicle
Several pieces of white debris appeared to originate from the LH2 umbilical and fell aft after liftoff
Frame 5307 - LOV
No anomalies detected

Film Quality Description
Camera housing noted in right side of FOV

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

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:	05/09/92
Timing:	B120	Date Screened:	05/09/92
		Screened By:	JH,MS,SI,LK,CD

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
View of drag chute assembly cover appeared normal
23:39:54.895 - Free burning hydrogen noted above SSMEs at SSME startup
Multiple pieces of white debris (probably RCS paper) noted at SSME ignition
Vapor noted from RSRB stiffener rings
23:40:00.705 - A piece of dark debris originated from the LO2 TSM prior to liftoff
23:40:01.042 - A piece of dark debris appeared to origitnate from the fourth plant joint on the RSRB and fell through the FOV in front of the LO2 TSM at liftoff
Several pieces of white debris (probably ice) originated from LO2 umbilical at liftoff
23:40:02.465 - LOV
Multiple pieces of debris noted in exhaust plume after vehicle leaves FOV
No anomalies detected

Film Quality Description
*Digital timing
Camera vibration

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E003

Location:	MLP L5	Focus:	Good
Camera Type:	16PS	FOV:	
Film:	ECD 200'	Exposure:	Dark
Lens Focal Length:	10MM	Timing:	Yes*
FPS:	400	Date Received:	05/09/92
Timing:	B120	Date Screened:	05/09/92
		Screened By:	JH,MS,SI,LK,CD

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
Free burning hydrogen noted above SSMEs at SSME startup
Multiple pieces of RCS paper debris noted after SSME ignition
23:39:58.534 (Frame 3192) - Light piece of debris appeared from right side of FOV near vertical stabilizer and fell aft into SSME plume
23:40:00.539 (Frame 4007) - Flash noted in SSME #2
23:40:00.798 (Frame 4112) - Faint flash noted in SSME #1
Vapor noted from LH2 disconnect at liftoff
Vapor noted from LSRB stiffener rings
23:40:02.217 - LOV
Several pieces of pad debris noted after liftoff
No anomalies detected

Film Quality Description
*Digital timing
Camera vibration at liftoff

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E004

Location:	MLP L6	Focus:	Good
Camera Type:	16DBM4	FOV:	
Film:	ECD 200	Exposure:	Dark
Lens Focal Length:	10MM	Timing:	Yes
FPS:	400	Date Received:	05/09/92
Timing:	A	Date Screened:	05/09/92
		Screened By:	JH,MS,SI,LK,CD

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
FSS deluge water noted
Vapor noted from SRB stiffener rings
Single piece of white debris appeared to originate from SSME area and fell aft at liftoff
Frame 4770 - White debris (possibly from LO2 umbilical area) traveled aft near right outboard elevon at liftoff
Frame 4887 - Large white piece of debris originated near left outboard elevon and fell aft
MLP deluge water noted after liftoff
Frame 5429 - LOV
Several pieces of pad debris noted after liftoff
No anomalies detected

Film Quality Description
Edge of camera housing in right side of FOV
Camera vibration at liftoff

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E005

Location:	MLP L2	Focus:	Good
Camera Type:	16DBM5	FOV:	
Film:	ECD 200'	Exposure:	Dark
Lens Focal Length:	10MM	Timing:	Yes
FPS:	400	Date Received:	05/09/92
Timing:	A	Date Screened:	05/09/92
		Screened By:	JH,MS,SI,LK,CD

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 2307 - Free burning hydrogen noted above SSME #3 rim
Multiple pieces of white debris fell aft along body flap
Frame 3168, Frame 3561, Frame 3721, Frame 3888 - Multiple flashes noted from SSME #3 rim
Frame 4697 - Small piece of white debris noted between TSM and SSME area and fell aft after liftoff
Frame 4782 - Light, rectangular, medium size piece of debris noted from above LO2 umbilical area (origin unknown) and fell along right inboard elevon just after liftoff, debris does not appear to strike the vehicle (M)
Several pieces of debris noted in exhaust plume
Frame 5262 - LOV
No anomalies detected

Film Quality Description
Too dark to see umbilicals prior to SSME ignition
Camera vibration at SSME ignition

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E006

Location:	MLP L3	Focus:	Good
Camera Type:	16DBM5	FOV:	
Film:	ECD 200'	Exposure:	Dark
Lens Focal Length:	25MM	Timing:	Yes
FPS:	200	Date Received:	05/09/92
Timing:	A	Date Screened:	05/09/92
		Screened By:	JH,MS,SI,LK,CD

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 2500 - Light medium sized, rectangular piece of debris fell from above the LO2 umbilical area and fell aft, does not appear to strike the vehicle, approximately 4" long (also on camera E5) (M)
Multiple pieces of debris (probably ice) fell from the LH2 umbilical area during SSME startup and liftoff
Slight motion of right inboard elevon noted at liftoff
Frame 2647 - LOV
No anomalies detected

Film Quality Description
Dark exposure hindered analysis

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E007

Location:	MLP B2	Focus:	Good
Camera Type:	16DBM4	FOV:	
Film:	ECD 200'	Exposure:	Dark
Lens Focal Length:	10MM	Timing:	Yes
FPS:	400	Date Received:	05/10/92
Timing:	A	Date Screened:	05/10/92
		Screened By:	JH,MS,SI,LK

Film Quality

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

Comments
Frame 5013 - PIC firing noted
A piece of water trough rope debris noted flapping at liftoff
Frame 5423 - LOV
Multiple pieces of dark debris noted exiting the flame duct after liftoff, debris does not appear to strike the vehicle
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E008

Location:	MLP B3	Focus:	Good
Camera Type:	16PS	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	10MM	Timing:	Yes*
FPS:	400	Date Received:	05/10/92
Timing:	B120	Date Screened:	05/10/92
		Screened By:	JH,MS,SI,LK,CD

Film Quality

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

Comments
A piece of dark debris fell through right side of FOV prior to SSME startup
23:40:00.023 - - PIC firing noted
23:40:00.506 - A small animal ejected from flame duct and traveled through FOV at liftoff, debris does not appear to strike the aft skirt
23:40:00.715 - A single dark piece of debris noted entering flame duct after liftoff
23:40:01.119 - LOV
No anomalies detected

Film Quality Description
*Digital timing
Camera vibration noted after SSME ignition

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E009

Location:	MLP B4	Focus:	Good
Camera Type:	16PS	FOV:	
Film:	ECD 200'	Exposure:	Dark
Lens Focal Length:	10mm	Timing:	Yes*
FPS:	400	Date Received:	05/09/92
Timing:	B120	Date Screened:	05/09/92
		Screened By:	JH,MS,SI,LK,CD

Film Quality

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

Comments
Several dark objects/debris appeared very close to the camera during SSME ignition
23:40:00.029 - PIC firing noted
Several small (black, orange, white) pieces of flame duct debris were noted at SRB ignition
23:40:01.200 (Frame 4217) - LOV
No anomalies detected

Film Quality Description
*Digital timing
Camera vibration noted at SSME startup

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E010

Location:	MLP B5	**Focus:**	Good
Camera Type:	16PS	**FOV:**	
Film:	ECD 200'	**Exposure:**	Dark
Lens Focal Length:	10mm	**Timing:**	Yes*
FPS:	400	**Date Received:**	05/10/92
Timing:	B120	**Date Screened:**	05/10/92
		Screened By:	JH,MS,SI,LK,CD

Film Quality

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

Comments
Multiple dark, flat pieces of debris noted fluttering through FOV at SSME startup
FSS deluge water noted
23:40:00.021 - ~ PIC firing noted
Multiple pieces of debris noted exiting SRB flame duct at SRB ignition, debris does not appear to strike the vehicle
23:40:01.049 - LOV
No anomalies detected

Film Quality Description
*Digital timing

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E011

Location:	MLP B7	**Focus:**	Good
Camera Type:	16PS	**FOV:**	
Film:	ECD 200'	**Exposure:**	Dark
Lens Focal Length:	10mm	**Timing:**	Yes*
FPS:	400	**Date Received:**	05/10/92
Timing:	B120	**Date Screened:**	05/10/92
		Screened By:	JH,MS,SI,LK,CD

Film Quality

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

Comments
Multiple dark, flat pieces of debris noted fluttering through FOV at SSME startup
A white tag noted flapping to the right of HDP M-7 at SSME ignition
23:40:00.042 - ~ PIC firing noted
23:40:00.193 - Single medium size piece of debris noted exiting flame duct at liftoff
Numerous small pieces of flame duct debris noted at liftoff
Rippling of the thermal curtain noted at liftoff
Several pieces of pad debris noted after liftoff, debris does not appear to strike the vehicle
23:40:01.027 - LOV
No anomalies detected

Film Quality Description
*Digital timing

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E012

Location:	MLP B8	Focus:	Good
Camera Type:	16PS	FOV:	
Film:	ECD 200'	Exposure:	Dark
Lens Focal Length:	10mm	Timing:	Yes*
FPS:	400	Date Received:	05/09/92
Timing:	B120	Date Screened:	05/09/92
		Screened By:	JH,MS,SI,LK,CD

Film Quality

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

Comments
Normal pad debris noted at SSME ignition
Dirty deluge water noted in FOV
Frame 3773 - PIC firing noted
Multiple pieces of dark debris fell into flame trough area, debris originated from HDP/shoe area
Small chunk of instafoam noted at liftoff
Frame 4233 - White paper debris noted after liftoff, traveled through FOV from right to left
Frame 4233 - LOV
No anomalies detected

Film Quality Description
*Digital timing
Camera vibration noted at SSME startup
23:39:56.282 (Frame 2275) - Timing lost

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E013

Location:	MLP B9	Focus:	Good
Camera Type:	16PS	FOV:	
Film:	ECD 200'	Exposure:	Dark
Lens Focal Length:	10MM	Timing:	Yes*
FPS:	400	Date Received:	05/10/92
Timing:	B120	Date Screened:	05/10/92
		Screened By:	JH,MS,SI,LK,CD

Film Quality

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

Comments
Dirty FSS deluge water noted
23:40:01.240 - LOV
No anomalies detected

Film Quality Description
*Digital timing
Camera vibration at SSME ignition
FSS deluge water hampered analysis and obscured view of PIC firing

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Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E014

Location:	MLP B10	**Focus:**	Good
Camera Type:	16DBM4	**FOV:**	
Film:	ECD 200'	**Exposure:**	Dark
Lens Focal Length:	10MM	**Timing:**	Yes
FPS:	400	**Date Received:**	05/10/92
Timing:	A	**Date Screened:**	05/10/92
		Screened By:	JH,MS,SI,LK,CD

Film Quality

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

Comments
FSS deluge water noted
Multiple dark, flat pieces of debris noted fluttering through FOV at SSME startup
Frame 5080 - PIC firing noted
Multiple pieces of flame duct debris noted at liftoff
Frame 5483 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E015

Location:	MLP B1	**Film Quality**	
Camera Type:	16DBM4	Focus:	Good
Film:	ECD 200'	FOV:	
Lens Focal Length:	15MM	Exposure:	Dark
FPS:	400	Timing:	Yes
Timing:	A	Date Received:	05/09/92
		Date Screened:	05/09/92
		Screened By:	JH,MS,SI,LK,CD

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

Comments
Frame 2262 - Icicle noted at SSME startup on SSME #3 rim and fell (also noted on E5)
Numerous pieces of white debris noted falling in front of body flap
Several small dark pieces of debris noted from flame duct area at SRB ignition
Frame 4847 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E016

Film Quality

Location:	MLP B6	Focus:	Good
Camera Type:	16DBM4	FOV:	
Film:	ECD 200'	Exposure:	Dark
Lens Focal Length:	15MM	Timing:	Yes
FPS:	400	Date Received:	05/09/92
Timing:	A	Date Screened:	05/09/92
		Screened By:	JH,MS,SI,LK,CD

Orientation

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

Comments

Orange vapor noted curling above SSME #2 rim at SSME ignition
RCS paper debris noted
White debris noted falling from top of FOV in front of body flap at SSME ignition
Frame 4875 - White debris fell from the top of FOV into the flame duct after liftoff
Frame 5022 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E017

Location:	MLP 01	**Focus:**	Good
Camera Type:	16DBM4	**FOV:**	
Film:	ECD	**Exposure:**	Dark
Lens Focal Length:	10MM	**Timing:**	Yes
FPS:	200	**Date Received:**	05/09/92
Timing:	A	**Date Screened:**	05/09/92
		Screened By:	JH,MS,SI,LK,CD

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

FSS deluge water noted
Body flap motion and right inboard elevon motion noted
Multiple pieces of ice noted from LO2 TSM starting at SSME ignition
Frame 2337 - LH2 TSM carrier plate disconnect
Frame 2394 - Small piece of white debris noted falling from the LH2 TSM umbilicals after disconnect
Frame 2770 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E018

Location:	MLP 04	Focus:	Good
Camera Type:	16DBM4	FOV:	
Film:	ECD 200'	Exposure:	Dark
Lens Focal Length:	10MM	Timing:	Yes
FPS:	400	Date Received:	05/09/92
Timing:	A	Date Screened:	05/09/92
		Screened By:	JH,MS,SI,LK,CD

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

RCS paper debris noted at SSME startup
Orange vapor noted above SSME #2 rim at SSME ignition
Multiple pieces of white debris noted from LO2 TSM umbilicals and carrier plate starting at SSME ignition
Frame 4454 - LO2 carrier plate disconnect
Body flap and elevon motion vibration noted
Frame 5109 - Plastic noted flapping from LO2 TSM door after liftoff
Frame 5211 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E019

Location:	MLP 02	Focus:	Good
Camera Type:	16DBM4	FOV:	
Film:	ECD 200'	Exposure:	Dark
Lens Focal Length:	10MM	Timing:	Yes
FPS:	400	Date Received:	05/09/92
Timing:	A	Date Screened:	05/09/92
		Screened By:	JH,MS,SI,LK,CD

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
Ice buildup noted on SSME #3 vent nozzles prior to SSME ignition
Free burning hydrogen noted at SSME startup
RCS paper debris noted
Multiple pieces of ice debris noted from LO2 TSM area at SSME startup
Frame 2599, Frame 2634, Frame 3287 (M) - Three chips appeared on right RCS stinger base noted from acoustical vibration
Frame 4651 - White debris noted from behind LO2 TSM area and fell aft past SSME #3
Drag chute cover appeared normal
Frame 5455 - LOV
No anomalies detected
-1 frame

Film Quality Description
Scratch noted on right side of film at liftoff
Timing marks bleeds into image area at liftoff

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E020

Location:	MLP 03	Focus:	Good
Camera Type:	16DBM4	FOV:	
Film:	ECD 200'	Exposure:	Variable
Lens Focal Length:	10MM	Timing:	Yes
FPS:	400	Date Received:	05/09/92
Timing:	A	Date Screened:	05/09/92
		Screened By:	JD,RB,BG,CD

Film Quality

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

Comments
Free burning hydrogen noted above SSMEs
Frame 3904 - A piece of debris, light on one side dark on the other, appeared from right side of the FOV near vertical stabilizer and fell aft into SSME plume (also seen on E3) (M)
RCS paper debris noted
FSS deluge water noted
Frame 5344 - LOV
Several pieces of debris noted in exhaust plume after liftoff
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E023

Location:	MLP 02A	**Film Quality**	
Camera Type:	16DBM4	Focus:	Good
Film:	ECD 200'	FOV:	
Lens Focal Length:	25mm	Exposure:	Dark
FPS:	400	Timing:	Yes
Timing:	A	Date Received:	05/10/92
		Date Screened:	05/10/92
		Screened By:	JH,MS,SI,LK,CD

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

Comments
Ice buildup on SSME #1 vent nozzle
RCS paper debris noted
Frame 2259, Frame 2581 - At least seven small chips noted on base heat shield and left RCS stinger base at SSME startup
Multiple pieces of white debris (probably ice) and vapor noted from LO2 TSM umbilical at liftoff
Frame 5143 - LOV
No anomalies detected

Film Quality Description
Camera vibration at SSME ignition

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E024

Location:	MLP 03A	Focus:	Good
Camera Type:	16DBM4	FOV:	
Film:	ECD 200'	Exposure:	Dark
Lens Focal Length:	25mm	Timing:	Yes
FPS:	400	Date Received:	05/10/92
Timing:	A	Date Screened:	05/10/92
		Screened By:	JH,MS,SI,LK,CD

Film Quality

Orientation

Comments
Frame 2073 - Free burning hydrogen noted above the OMS nozzle
Slight motion of OMS nozzle at SSME startup
RCS paper debris noted
FSS deluge water noted
Frame 2728 - At least seven small chips noted on base heat shield and left RCS stinger base at SSME startup
Ice and vapor noted from LH2 TSM umbilical at liftoff
Plastic noted flapping from LH2 TSM door
Frame 4766 - LOV
No anomalies detected

Film Quality Description
FSS water on lens hampered analysis

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E025

Location:	MLP B11*	**Focus:**	Good
Camera Type:	16DBM4	**FOV:**	
Film:	ECD 200'	**Exposure:**	Variable
Lens Focal Length:	5.9mm	**Timing:**	Yes
FPS:	400	**Date Received:**	05/09/92
Timing:	A	**Date Screened:**	05/09/92
		Screened By:	JD,RB,BG,LK,CD

Film Quality

Orientation

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

Comments

Several pieces of white debris (probably ice) noted falling aft along body flap at SSME ignition
Frame 3946 - Light medium sized, rectangular piece of debris noted above and outboard of the LO2 umbilical, (also seen on Cameras E5 and E6) along with two other pieces fell aft past the right inboard elevon at liftoff
Frame 4835 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E026

Location:	MLP B12*	Focus:	Good
Camera Type:	16DBM4	FOV:	
Film:	ECD 200'	Exposure:	Dark
Lens Focal Length:	5.9mm	Timing:	Yes
FPS:	400	Date Received:	05/09/92
Timing:	A	Date Screened:	05/09/92
		Screened By:	JD,RB,BG,LK,CD

Film Quality

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

Comments
Dark objects (possibly FSS deluge water drops) noted moving past Orbiter throughout film
White debris (probably ice) noted falling along body flap at SSME ignition
Small white piece of debris noted falling from ET side of umbilicals at liftoff
Frame 4121 - LOV
No anomalies detected
-1 frame

Film Quality Description
Persistent white scratch noted on left side of film
Dark exposure hampered anlaysis

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E027

Location:	MLP B2A	Focus:	Good
Camera Type:	16DBM5	FOV:	
Film:	ECD 200'	Exposure:	Dark
Lens Focal Length:	100mm	Timing:	Yes
FPS:	400	Date Received:	05/11/92
Timing:	A	Date Screened:	05/11/92
		Screened By:	JH,MS,SI,LK,CD

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 5305 - Multiple pieces of light colored debris noted entering SRB flame duct at liftoff
Frame 5440 - Two pieces of dark debris (insects) noted in shoe area at liftoff
Blast cover appeared to operate normal
No anomalies detected

Film Quality Description
Camera vibration at SSME ignition
Targets on shoe obscured by exhaust from SRB ignition

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

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:	05/11/92
Timing:	A	Date Screened:	05/11/92
		Screened By:	JH,MS,SI,LK,CD

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
FSS deluge water noted
Normal pad debris noted at SRB ignition
Rippling in thermal curtain noted at liftoff
Frame 4887 - LOV
Blast deflection shield appeared to operate normal
No anomalies detected

Film Quality Description
*Targets for shoe rotation not in FOV
Camera vibration at SSME ignition

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E030

Location:	FSS-195' 20C	**Focus:**	Good
Camera Type:	16DBM5	**FOV:**	
Film:	ECD 200'	**Exposure:**	Dark
Lens Focal Length:	15mm	**Timing:**	Yes
FPS:	400	**Date Received:**	05/10/92
Timing:	A	**Date Screened:**	05/10/92
		Screened By:	JH,MS,SI,LK,CD

Film Quality

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

Comments
Frame 1827 - Free burning hydrogen noted at SSME startup, vapor does not appear underneath body flap
White debris from ET/Orbiter umbilicals after SSME ignition
Frame 3865 - SRB ignition noted
FSS deluge water noted
Frame 4365 - MLP deluge water noted
Frame 4868 - LOV
No anomalies detected

Film Quality Description
Camera vibration
Yellow film exposures noted on both sides of frame just above lower sprocket holes - possibly produced during processing

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Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E031

Location:	FSS-95' 10	Focus:	Soft
Camera Type:	16DBM5	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	25mm	Timing:	Yes
FPS:	100	Date Received:	05/10/92
Timing:	B	Date Screened:	05/10/92
		Screened By:	JH,MS,SI,LK,CD,JD

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. USE ASA 100 ON METER.
Set slew rate at approx. 2 F/stops per sec.

Comments
Multiple pieces of white debris noted from ET/Orbiter umbilicals at SSME startup, debris does not appear to strike the vehicle
Slight left outboard and inboard elevon motion noted
Frame 1201 - A single white piece of debris originated from left aft attach strut on the ET and fell aft at liftoff (as seen on OTV109) (M)
Frame 1201 - A single piece of white debris fell through FOV near ET at liftoff (M)
FSS deluge water noted
A single piece of dark debris noted fluttering in lower right of FOV after liftoff, debris does not appear to strike the vehicle
Frame 1472 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E033

Location:	FSS-235' 24	Focus:	Soft
Camera Type:	16DBM5	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	100mm*	Timing:	Yes
FPS:	200	Date Received:	05/11/92
Timing:	A	Date Screened:	05/11/92
		Screened By:	JH,MS,SI,LK,CD

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
FSS deluge water noted
Twang noted
Multiple pieces of ice noted falling from GUCP prior to retraction
Frame 1560 - GUCP retraction noted
Multiple pieces of ice debris and vapor noted from GUCP at retraction
Frame 1812 - Frost noted just below intertank area on ET at liftoff
Frame 2029 - Bright spots (possibly reflection) noted below plant joint on forward center segment on SRB
Dirty deluge water noted on SRB
Frame 2353 - LOV
No anomalies detected

Film Quality Description
FSS deluge water hampered anlaysis

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E034

Location:	FSS-255' 26	Focus:	Good
Camera Type:	16DBM5	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	15mm	Timing:	Yes
FPS:	300	Date Received:	05/09/92
Timing:	A	Date Screened:	05/09/92
		Screened By:	JD,RB,BG,LK,CD

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
Twang noted
Frame 2127 - ~ GUCP retraction noted
Ice debris noted at GUCP disconnect
FSS deluge water noted
Frame 2891 - Small white spot noted on underside of Orbiter at liftoff (M)
Frame 3325 - LOV
No anomalies detected

Film Quality Description
FSS deluge water obstructs view after liftoff

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E035

Location:	FSS-255' 26A	**Film Quality**	
Camera Type:	16DBM5	Focus:	Good
Film:	ECD 200'	FOV:	
Lens Focal Length:	15mm	Exposure:	Good
FPS:	300	Timing:	Yes
Timing:	A	Date Received:	05/09/92
		Date Screened:	05/09/92
		Screened By:	JD,RB,BG,LK,CD

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
GUCP retraction noted
Frame 3340 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E036

Location:	FSS-255' 26E	**Focus:**	Good
Camera Type:	16DBM5	**FOV:**	
Film:	ECD 200'	**Exposure:**	Dark
Lens Focal Length:	15mm	**Timing:**	Yes
FPS:	300	**Date Received:**	05/09/92
Timing:	A	**Date Screened:**	05/09/92
		Screened By:	JD,RB,BG,LK,CD

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

Free burning hydrogen noted
FSS deluge water noted
LH2 TSM carrier plate disconnect noted
Frame 3292 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E040

Location:	FSS-275' 28B	**Focus:**	Soft
Camera Type:	16DBM5	**FOV:**	
Film:	ECD 200'	**Exposure:**	Good
Lens Focal Length:	10mm	**Timing:**	Yes
FPS:	300	**Date Received:**	05/09/92
Timing:	A	**Date Screened:**	05/09/92
		Screened By:	JD,RB,BG,LK,CD

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

Frost noted on louvers
Twang noted
Frame 3799 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E041

Location:	FSS-255' 26D	Focus:	Good
Camera Type:	16DBM5	FOV:	
Film:	ECD 200'	Exposure:	Good
Lens Focal Length:	10mm*	Timing:	Yes
FPS:	300	Date Received:	05/11/92
Timing:	A	Date Screened:	05/11/92
		Screened By:	JH,MS,SI,LK,CD

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
GUCP retraction appeared normal
MLP deluge water noted
Frame 3328 - LOV
Debris noted in exhaust plume after vehicle cleared tower
No anomalies detected

Film Quality Description
FSS deluge water hampered anlaysis

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E042

Location:	FSS-185' 20	Focus:	Good
Camera Type:	16DBM5	FOV:	*
Film:	ECD 200'	Exposure:	Dark
Lens Focal Length:	50mm	Timing:	Yes**
FPS:	300	Date Received:	05/11/92
Timing:	A	Date Screened:	05/11/92
		Screened By:	JH,MS,SI,LK,CD

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
Bird noted flying behind FSS prior to liftoff
GUCP did not appear to rebound
Multiple pieces of dark debris noted in exhaust plume after liftoff
No anomalies detected

Film Quality Description
*Camera positioned too high in relationship to GUCP
**Timing marks on very edge of film (almost off of edge of film)

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E050

Location:	39-1 17	Focus:	Good
Camera Type:	16DBM5	FOV:	
Film:	ECD 200'	Exposure:	Dark/Good
Lens Focal Length:	8"	Timing:	Yes
FPS:	60	Date Received:	05/11/92
Timing:	B	Date Screened:	05/11/92
		Screened By:	JH,MS,SI,LK,CD

Film Quality

Orientation
Overall view of GH2 Vent Line including hinge and ET interface during ignition and liftoff. (Rotation.)
To view for possible anomalies during rotation and latchback.

Comments
FSS deluge water noted
Twang noted
GUCP retraction and latchback appeared normal, GUCP did not appear to rebound
Small white piece of ice noted falling along the side of LSRB after disconnect
Frame 5733 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E052

Location:	39-2 T1	Focus:	cood
Camera Type:	35PS	FOV:	
Film:	ECD 400'	Exposure:	Good
Lens Focal Length:	200mm	Timing:	*Yes
FPS:	100	Date Received:	05/11/92
Timing:	B120	Date Screened:	05/11/92
		Screened By:	JD,CD,RB,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
23:40:04.622 (Frame 1371) - Flashing piece of debris (light on one side, dark on the other) first seen on the underside of the Orbiter at mid fuselage falls aft during tower clear. (M)
RCS paper debris at tower clear noted
Drag chute compartment appears normal during ascent
23:40:05 - Light debris (probably RCS paper) noted aft of the vehicle in SSME plumes
White flashes in plume through roll maneuver
23:40:13.2 - Vapor trails off both wings
23:40:16.017 - LOV due to clouds
No anomalies detected

Film Quality Description
Internal reflection noted
*Digital timing

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E054

Film Quality

Location:	39-2 T4	Focus:	Good
Camera Type:	35PS	FOV:	
Film:	ECD 400'	Exposure:	Good
Lens Focal Length:	200mm	Timing:	*Yes
FPS:	100	Date Received:	05/10/92
Timing:	B120	Date Screened:	05/10/92
		Screened By:	JD,CD,RB,BG,LK

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

Twang noted
Reflection off pilot's window noted
Forward RCS paper still intact as vehicle entered clouds
23:40:16 - LOV
23:40:53 - End of film
No anomalies detected

Film Quality Description

*In frame timing

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E057

Location:	39-6 T1	**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:	05/11/92
		Date Screened:	05/11/92
		Screened By:	JD,CD,RB,BG,LK

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
23:40:01.330 - One piece of light colored debris falls aft of right outboard elevon at liftoff
23:40:04.547 - Two small light colored pieces of debris (one by the right inboard elevon, the other by the left side of the body flap) fell aft into the plume
23:40:05.999 - Small light colored piece of debris falls past right inboard elevon and falls aft at tower clear
Light colored debris aft of vertical stabilizer and the SSMEs noted at tower clear
Atmospheric bow waves noted
Vapor trails off right wing tip noted
White flashes in SSME plume noted
23:40:17.518 - LOV
23:40:46.640 - End of film
No anomalies detected

Film Quality Description
Most of view is obscured due to clouds after roll maneuver

Photo/TV Analysis Group Evaluation Report
STS-49
06/19/92

Item Number E059

Location:	39-6 T4	**Focus:**	Good
Camera Type:	35PS	**FOV:**	
Film:	ECD 400'	**Exposure:**	Dark/Good
Lens Focal Length:	200	**Timing:**	*Yes
FPS:	100	**Date Received:**	05/10/92
Timing:	B120	**Date Screened:**	05/10/92
		Screened By:	JD,CD,RB,BG,LK

Film Quality

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
ET aft dome outgassing noted
Charring of the ET aft dome noted
Atmospheric bow waves noted
23:40:15 - Vapor off right wing noted
23:40:16.5 - Vehicle enters cloud
23:40:53 - End of film
No anomalies detected

Film Quality Description
*Digital timing

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

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:	No
Timing:	B	Date Received:	05/11/92
		Date Screened:	05/11/92
		Screened By:	JD,CD,RB,BG,LK

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

Comments
FSS deluge water noted
GH2 Vent arm retraction appeared to operate normally
ET aft dome outgassing noted
Frame 1352 - LOV
No anomalies detected

+1 frame

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E062

Location:	39-3 09	Focus:	Good
Camera Type:	35Mit	FOV:	
Film:	ECD 400'	Exposure:	Good
Lens Focal Length:	100mm	Timing:	No
FPS:	96	Date Received:	05/11/92
Timing:	B	Date Screened:	05/11/92
		Screened By:	JD,CD,RB,BG,LK

Film Quality

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

Comments
FSS deluge water noted
Vapor cloud from TSM disconnect noted
Frame 1070 - SRB flame duct debris to the right of the RSRB noted
Vapor off both SRB stiffener rings noted
Small light colored piece of debris seen falling aft of body flap
Small light colored piece of debris seen falling aft of right inboard elevon
Frame 1432 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E063

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:**	05/11/92
Timing:	B	**Date Screened:**	05/11/92
		Screened By:	JD,CD,RB,BG,LK

Film Quality

Orientation

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

Comments

Vapor from T-0 disconnect noted
Frame 1272 - LOV
No anomalies detected

-1 frame

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E065

Film Quality

Location:		Focus:	Good
Camera Type:		FOV:	
Film:		Exposure:	Dark
Lens Focal Length:		Timing:	Yes
FPS:		Date Received:	05/11/92
Timing:		Date Screened:	05/11/92
		Screened By:	JH,MS,SI,LK,CD

Orientation

Comments

Twang noted
Multiple pieces of white debris (probably ice) noted falling along body flap, debris appeared to originate from ET/Orbiter umbilicals
Vapor from SRB stiffener rings noted
Frame 1470 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E076

Location:	39-3 03	Focus:	Good
Camera Type:	35Mit	FOV:	
Film:	ECD 400'	Exposure:	Good
Lens Focal Length:	20"	Timing:	Yes
FPS:	96	Date Received:	05/11/92
Timing:	B	Date Screened:	05/11/92
		Screened By:	JH,MS,SI,LK,CD

Film Quality

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 268 - Free burning hydrogen noted above SSMEs (M)
Multiple pieces of white debris (probably ice) noted falling from LO2 TSM at SSME ignition
RCS paper debris noted
Frame 378 - Flexing of the base heat shield noted at SSME ignition
Frame 630 - Flash noted in SSME #3
Vapor noted from LO2 TSM at disconnect
Frame 986 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E077

Location:	39-4 02	**Focus:**	Good
Camera Type:	35Mit	**FOV:**	
Film:	ECD 400'	**Exposure:**	Good
Lens Focal Length:	20"	**Timing:**	Yes
FPS:	96	**Date Received:**	05/13/92
Timing:	B	**Date Screened:**	05/13/92
		Screened By:	JD,BG,MS

Film Quality

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
Orange vapor (possibly free burning hydrogen) noted at SSME start-up and extends above SSME #1 bell.
Normal ice debris from LH2 TSM umbilical noted
Frame 452 - Flexing of the base heat shield noted at start-up
Frame 589 - RCS paper noted
Frame 743 - Light colored piece of debris falls from behind the vertical stabilizer into the SSME plume.
Frame 886 - Two small white spots (one large) noted on right SSME outboard elevon on dark surface. (M)
Frame 904 - Small white pieces of debris aft of SSME #2 seen at liftoff
Frame 914 - Two small pieces of white debris seen to fall from edge of right inboard elevon.
Frame 981 - LOV

Film Quality Description
Water drops on lens

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E079

Location:	39-2 03	Focus:	Good
Camera Type:	16DBM5	FOV:	
Film:	ECD 200'	Exposure:	Dark
Lens Focal Length:	40"	Timing:	Yes
FPS:	100	Date Received:	05/13/92
Timing:	B	Date Screened:	05/13/92
		Screened By:	JD,BG,MS

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
Twang noted
Frame 1612-1644 - White piece of debris moves from left to right across LO2 feedline.
Frame 1677-1743 - White piece of debris seen falling along LOx line at liftoff
Frame 1749 - Ice debris from umbilicals noted at liftoff
Frame 1757 - LOV
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E204

Location:	PAFB PIGOR	Focus:	Soft
Camera Type:	35Mit	FOV:	
Film:	ECD 1000'	Exposure:	Dark
Lens Focal Length:	360"	Timing:	Yes
FPS:	72	Date Received:	05/11/92
Timing:	B	Date Screened:	05/11/92
		Screened By:	JD,CD,RB,BG,LK

Film Quality

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

Frame 8402 - Recirculation noted
Frame 8789 - Orange flare noted in the Orbiter side of the SRB plume (T) (M)
Plume brightening noted
Frame 9204 - SRB separation noted
No anomalies detected

-2 frames

Film Quality Description

Almost entire launch sequence obscured by clouds

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E205

Location:	SHILOH IFLOT	**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:	05/11/92
		Date Screened:	05/11/92
		Screened By:	JD,CD,RB,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

Acquisition of vehicle after roll maneuver
Charring of ET aft dome noted
Frame 1726- Linear optical effect noted (T)
Light and dark puffs in SRB plume noted just prior to SRB plume brightening
Plume brightening noted
Frame 4442 - SRB separation noted
Slag from the SRB nozzles noted after SRB separation noted
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E207

Location:	UCS 10 MIGOR	Focus:	Good
Camera Type:	35Mit	FOV:	
Film:	ECD 1000'	Exposure:	Good
Lens Focal Length:	180"	Timing:	Yes
FPS:	96	Date Received:	05/10/92
Timing:	B	Date Screened:	05/10/92
		Screened By:	JD,CD,BG,RB,LK

Film Quality

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
Vapor from SRB stiffener rings noted
ET aft dome outgassing noted
Frame 1545 - Vapor off right wing noted
Charring of ET aft dome noted
Frame 6944 - Debris noted coming out of top of Orbiter side of plume
Plume brightening noted
Frame 12024 - SRB separation noted
Frame 13000 - Slag noted during SRB separation
No anomalies detected

Film Quality Description
Intermittent LOV due to clouds

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E208

Location:	C.B. DOAMS	**Film Quality**	
Camera Type:	35Mit	Focus:	Variable
Film:	ECD 1000'	FOV:	
Lens Focal Length:	200"	Exposure:	Good
FPS:	48	Timing:	Yes
Timing:	B	Date Received:	05/10/92
		Date Screened:	05/10/92
		Screened By:	JH,MS,SI,LK,CD,JD

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

Intermittent LOV due to clouds and tracking
Possible flare noted in SSME plume (noted in normal time frame)
SRB separation noted
No anomalies detected

Film Quality Description

Viewed on Tokiwa projector
Clouds hampered analysis

Photo/TV Analysis Group Evaluation Report
STS-49
06/19/92

Item Number E211

Location:	UCS-16 IFLOT	Focus:	Good
Camera Type:	35PS	FOV:	
Film:	ECD 1000'	Exposure:	Good
Lens Focal Length:	800mm	Timing:	*Yes
FPS:	100	Date Received:	05/11/92
Timing:	B120	Date Screened:	05/11/92
		Screened By:	JD,CD,RB,BG,LK

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
23:40:05 - Light colored debris noted IN SSME plume through roll maneuver
Vapor trail off left wing noted during roll maneuver
23:40:16.5 - LOV due to clouds
23:40:21.6 - AOV
Bow waves noted
Charring of ET aft dome noted
23:40:42.9 - Intermittent LOV due to clouds throughout remainder of film
23:41:30 - End of film
No anomalies detected

Film Quality Description
Three persistent yellow streaks in center of film throughout film
Cloud cover obscured view after roll maneuver
*Digital timing

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

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:	05/10/92
		Date Screened:	05/10/92
		Screened By:	JH,MS,SI,LK,CD,JD

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
Frame 220 - Vapor trails noted off both wings
Intermittent LOV due to clouds
ET aft dome outgassing and charring noted
Frame 2011 - Flare in SSME plume noted
Frame 3016 - Body flap motion noted
Charring of the SRB stiffener rings noted
Frame 3099, 3258 - Linear optical distortions noted
Frame 5179 - Small bright orange puff at edge of SRB plume
Frame 6172 - White pulses in SSME engines at 9 o'clock position
Frames 5441-6600 - Recirculation noted (T)
Pulsing of the plume noted prior to SRB plume brightening
SRB plume brightening noted
Frame 7719 - SRB separation noted
Slag noted after SRB separation
No anomalies detected

Film Quality Description
Viewed on Tokiwa projector
Clouds hampered analysis
Digs in film

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E213

Location:	UCS-7 MOTS	Focus:	Good
Camera Type:	35Mit	FOV:	
Film:	ECD 400'	Exposure:	Good
Lens Focal Length:	800mm*	Timing:	Yes
FPS:	96	Date Received:	05/10/92
Timing:	B	Date Screened:	05/10/92
		Screened By:	JH,MS,SI,LK,CD,JD

Film Quality

Orientation

Tracking: REAR 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
Frame 427 - Small white piece of debris noted falling aft from right stinger area into SSME plumes just after tower clear
Vapor noted from SRB stiffener rings
Roll maneuver noted
Condensation noted on left wing tip
Charring of ET aft dome noted
No anomalies detected

Film Quality Description

Viewed on Tokiwa projector
Digs in film
Film ended before SRB separation
Intermittent LOV due to clouds

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E218

Location:	UCS-26 IFLOT	Focus:	Good
Camera Type:	35Mit	FOV:	
Film:	ECD 1000'	Exposure:	Good
Lens Focal Length:	120"	Timing:	Yes
FPS:	96	Date Received:	05/11/92
Timing:	B	Date Screened:	05/11/92
		Screened By:	JH,MS,SI,LK,CD

Film Quality

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

Comments
Vapor off SRB stiffener rings noted
Roll maneuver noted
White flashes noted in SSME plume
Frame 1595 - Vapor trail noted off left wing
Frame 2372, Frame 2395 - Multiple pieces of white debris noted in SSME exhaust plume
Frame 3605 - A white piece of debris fell from behind the vertical stabilizer and into the SSME plume
Frame 3836, Frame 5006 - Flares noted in SSME plume
Charring of ET aft dome noted
Frame 8360-9067 - Recirculation noted (T)
SRB plume brightening noted
Frame 11309 - SRB separation noted (Frames 11309-11423 - possible forward LSRB BSM appeared to fire longer than expected)
Slag noted after SRB separation
No anomalies detected
+1 frame

Film Quality Description
Intermittent LOV due to clouds

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E220

Location:	UCS 15 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:	05/10/92
		Date Screened:	05/10/92
		Screened By:	JH,MS,SI,LK,CD,JD

Orientation

Track REAR 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.
39B=13618 yrd 7.74 mi
Period of focus: T-0 to T+35 sec.

Comments

Vapor from SRB stiffener rings noted
Roll maneuver noted
Frame 1350 - Vapor trails noted off both wing tips at roll maneuver
Vehicle enters clouds at end of roll maneuver
Frame 3197 (One piece of debris), Frame 3468 (Three or more pieces), Frame 3619 (Three or more pieces) - Several pieces of debris (possible RCS paper) noted from base of vertical stabilizer area and fell aft in SSME plume after roll maneuver
Frame 2938 (From SSME #1), Frame 2940 (From SSME #2 or #3), Frame 4098 (From SSME #1), Frame 5053 (From SSME #1) - Flares noted in SSME plume
Body flap motion noted
Frame 3732 - Large orange flare noted in SSME #1
Frame 5762 - Puffs on edge of SRB exhaust plume well aft of exhaust
Frame 12162 - ~SRB separation
Frame 11363 - SRB plume brightening noted
No anomalies detected

Film Quality Description

Viewed on Tokiwa projector
Liftoff obscured by exhaust plume
Yellow cast of film at liftoff
Digs in film
*Vehicle not centered in FOV
View of SRB separation not noted due to misalignment of vehicle in FOV

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E222

Location:	N.BCH SITE IFLOT	Focus:	Good
Camera Type:	35PS	FOV:	
Film:	ECD 400'	Exposure:	Good
Lens Focal Length:	800mm	Timing:	Yes
FPS:	100	Date Received:	05/10/92
Timing:	B120	Date Screened:	05/10/92
		Screened By:	JH,MS,SI,LK,CD

Film Quality

Orientation

Tracking: Rear portion of Launch Vehicle from AOV to LOV. To record possible debris. Focus on Vehicle at active pad.
39B=3416 yrds 1.94 mi Period of focus: T-0 to T+50 secs.

Comments

Free burning hydrogen noted at SSME startup
Vapor from LO2 TSM disconnect noted
Vapor noted from SRB stiffener rings
Debris noted from vertical stabilizer area and fell aft prior to roll maneuver
Vapor trails noted off wing tips at roll maneuver
Roll maneuver noted
Intermittent LOV due to clouds
Charring of ET aft dome noted
No anomalies detected

Film Quality Description

Film ran short
Clouds hampered analysis

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E223

Film Quality

Location:	UCS-9 IFLOT	Focus:	Good
Camera Type:	35Mit	FOV:	*
Film:	ECD 1000'	Exposure:	Good
Lens Focal Length:	80"	Timing:	Yes
FPS:	96	Date Received:	05/10/92
Timing:	B	Date Screened:	05/10/92
		Screened By:	JH,MS,SI,LK,CD

Orientation

Tracking: FORWARD portion of Launch Vehicle from AOV to LOV. To record possible debris. Focus on Vehicle at active pad.
39B=4824. Period of focus: T-0 to T+50 secs.
As image size decreases,include entire vehicle.

Comments

GUCP retration appeared normal
ET aft dome outgassing noted
Roll maneuver noted
Intermittent LOV due to clouds (actually view of vehicle is 15 or 20 seconds)
Multiple pieces of debris (probably RCS paper) noted
No anomalies detected

Film Quality Description

Viewed on Tokiwa projector
Internal lens reflection
Yellow cast of film at roll maneuver
Clouds hampered analysis
*Tracking of vehicle was not according to PADD (the center portion of the vehicle was tracked instead of the forward portion)

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E224

Location:	UCS 6 IFLOT	**Film Quality**	
Camera Type:	35PS	Focus:	Good
Film:	ECD 400'	FOV:	
Lens Focal Length:	800MM	Exposure:	Good
FPS:	100	Timing:	Yes*
Timing:	B120	Date Received:	05/10/92
		Date Screened:	05/10/92
		Screened By:	JH,MS,SI,LK,CD

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.
39B=5636 yrds

Comments

Debris noted falling into SRB plume at liftoff
Vapor off SRB stiffener rings noted
Roll maneuver noted
ET aft dome outgassing noted
Vapor trails noted off both wing tips
23:40:16-23:40:21 - Intermittent LOV due to clouds
Charring of the ET aft dome noted
Bow waves noted
23:40:42 - LOV due to clouds
No anomalies detected

Film Quality Description

Viewed on Tokiwa projector
*Digital timing
23:41:00.847 - Film ran short

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

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:	05/07/92
Timing:		Date Screened:	05/07/92
		Screened By:	JH,CD,MS,SI,DP

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
Shearing of the plume noted
No anomalies detected

Film Quality Description

Item Number KTV4B

Location:	IFLOT	Focus:	Good
Camera Type:	RCA	FOV:	
Film:		Exposure:	Good
Lens Focal Length:	30X26	Timing:	Yes
FPS:	30	Date Received:	05/07/92
Timing:		Date Screened:	05/07/92
		Screened By:	JH,CD,MS,SI,DP

Film Quality

Orientation
RCA TK76B color camera.

Comments
No anomalies detected

Film Quality Description

STS-42
Quick Look Study of RCS R4U Leak

Assumptions
It was assumed during the analysis that the imagery used originated from the forward left payload bay camera (camera A), that the video frame rate was the standard 30 frames per second, that the particle cloud and ejecta (snowballs) originated from the R4U RCS jet, that the reflective intensity of the particle cloud was directly proportional to the particle density, and that the particle cone was symmetric about a central axis perpendicular to the Orbiter XY plane. It was also assumed that the section of the available data chosen for analysis was representative of the event.

Summary of Assumptions
- Imagery source = PB cam A (forward left)
- Frame rate = 30 frames/sec (standard video)
- Particle & ejecta source = RCS R4U
- Reflective intensity of the particle cloud proportional to particle density
- Cone is symmetric about a central axis

Disclaimers
No estimates of precision are available at this time
No corrections were made for optical lens distortions

Input Data
A representative section of the available video was chosen which contained 800 frames (approximately 27 seconds) of consecutive video, during which the camera direction and focal length remained unchanged. The quality of the input video was not ideal. If a more exacting study is required, it is recommended that we use the master tape as the data source.

Analysis Techniques
800 frames of video were digitized at a rate of 30 frames per second and at a resolution of 512x512x8 bits and stored onto a Vicom Real-Time Digital Disk. All positional and photometric measurements were performed on the digitized images using a Vicom IP8500 image processing system. A detailed description of the analysis techniques will be available upon request at a later date.

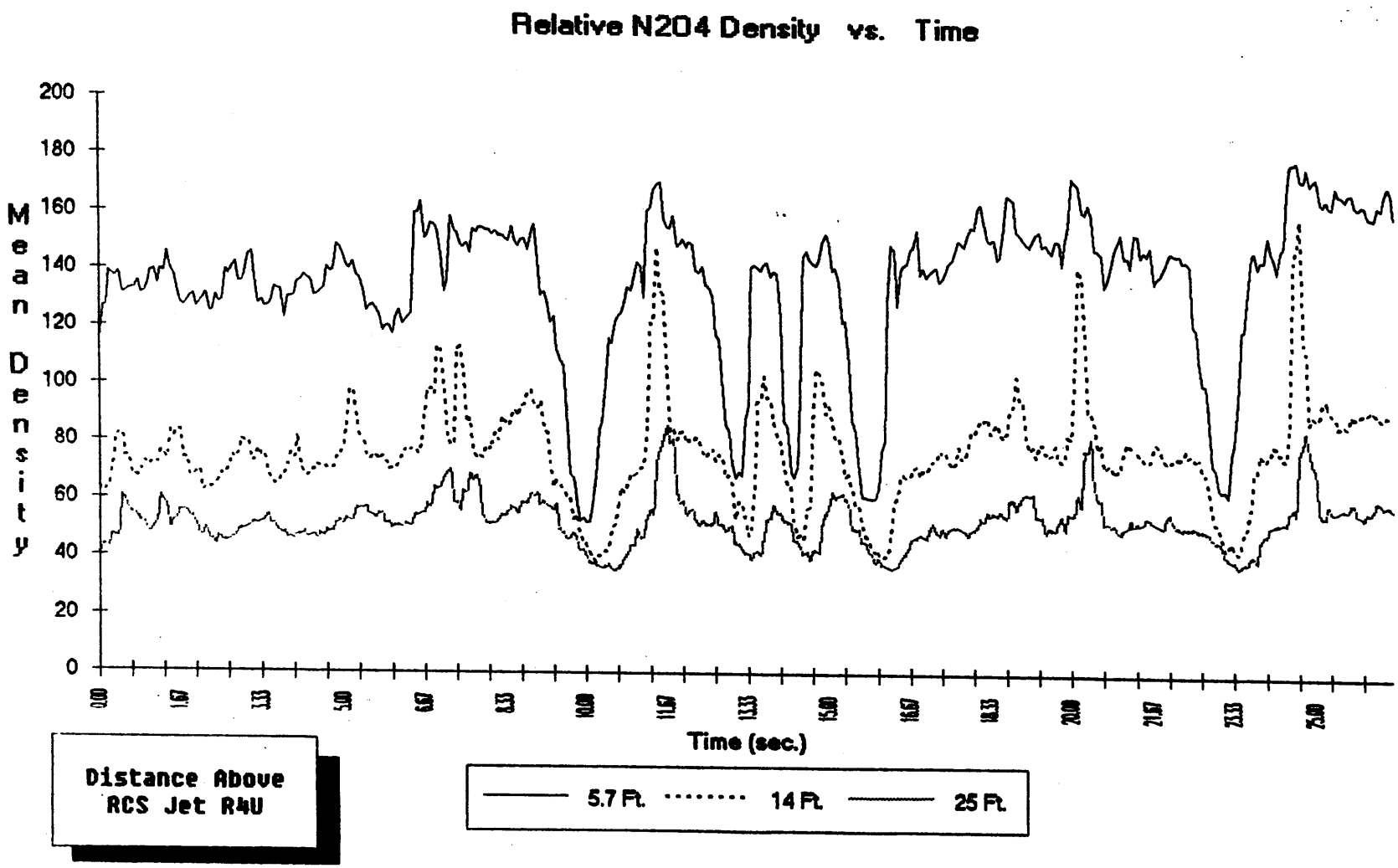
Results of Quick Look Analysis

Cone description
Angle = 51.7 deg. (see Cone & Viewing Geometry illustration)

Particle velocities
It was decided that the best way to determine the velocity of the particle discharge was to measure the velocity of the leading edge of the occasional pulse in the RCS plume. Two separate pulses were measured with velocities of 34.8 ft/sec and 31.9 ft/sec.

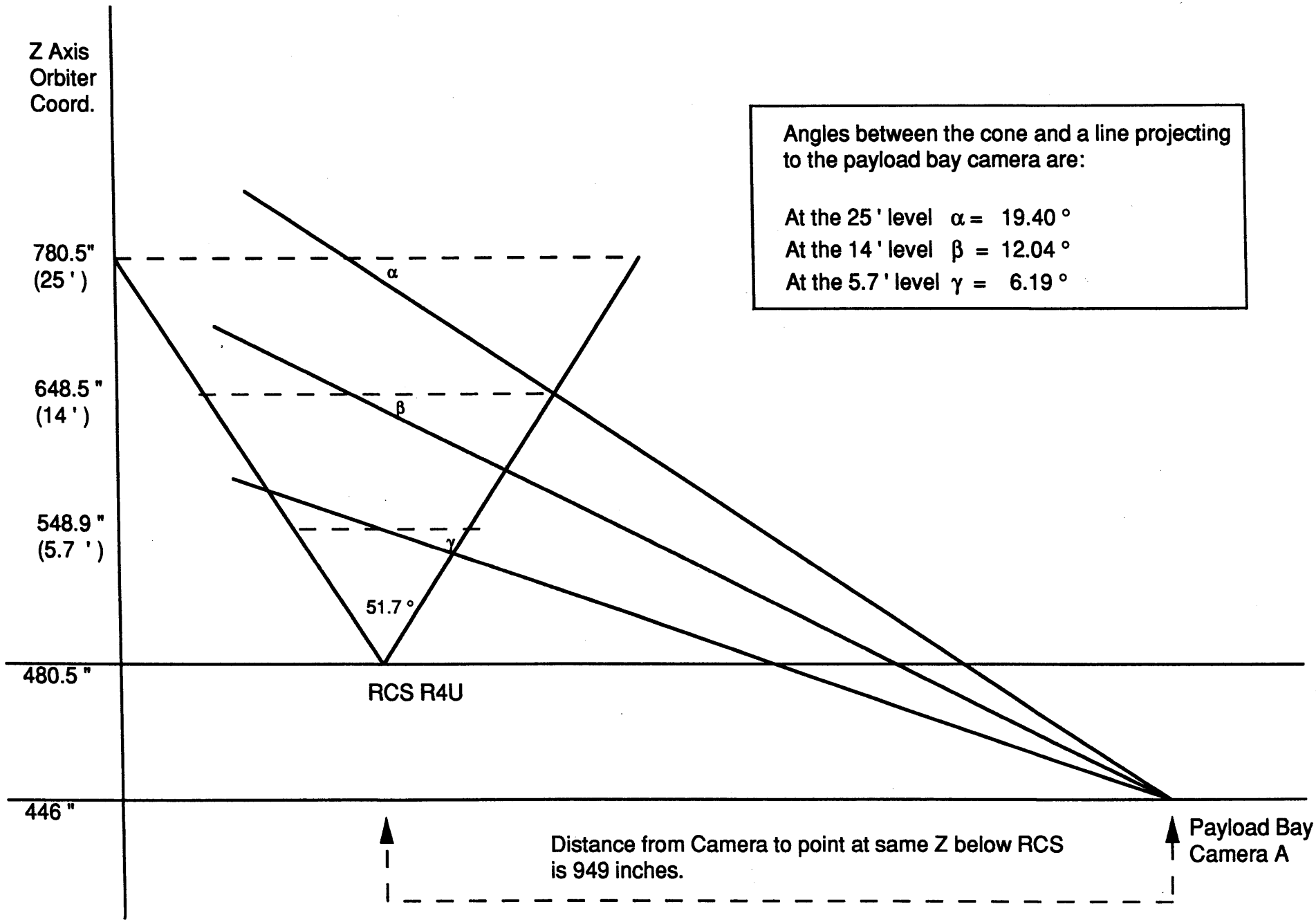
moment in time. The following table summarizes the minimum, maximum, and average values obtained in this fashion. The graph depicting the entire data set gives a more complete impression of the density variance.

	5.7 Ft.	14 Ft.	25 Ft.
Average	135.779	77.29397	52.89067
Max	181.1875	160.407	86.02299
Min	52.48438	38.88372	35.81226


Relative N2O4 Density vs. Time
Mean Density
200
180
160
140
120
100
80
60
40
20
0
0.00
1.67
3.33
5.00
6.67
8.33
10.00
11.67
13.33
15.00
16.67
18.33
20.00
21.67
23.33
25.00
Time (sec.)
Distance Above RCS Jet R4U
5.7 Ft.
14 Ft.
25 Ft.

Cone and Viewing Geometry

(Not to scale)



Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number KTV5

Location:	VAB ROOF	Focus:	Variable
Camera Type:	RCA	FOV:	
Film:		Exposure:	Good
Lens Focal Length:	30X26	Timing:	Yes
FPS:	30	Date Received:	05/07/92
Timing:		Date Screened:	05/07/92
		Screened By:	JH,CD,MS,SI,DP

Film Quality

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
Intermittent LOV due to clouds
*128:23:41:24.427, *128:23:41:24.761, *128:23:41:25.128,
*128:23:41.25.261, 128:23:41:26.529, 128:23:41:30.900,
128:23:41:32.135, 128:23:41:57.193, 128:23:41:58.628,
128:23:41:55.925, 128:23:41:56.326, 128:23:41:56.760,
128:23:41:57.861, 128:23:41:57.994, 128:23:41:58.161,
128:23:42:06.269, 128:23:42:07.037, 128:23:42:09.873,
128:23:42:12.876, 123:23:42:13.443, 128:23:42:13.710,
128:23:42:18.515; 128:23:42:18.982, 128:23:42:20.316,
128:23:42:20.984, 128:23:42:22.085 - Flares noted in SSME plume
*Filament effect
Quit due to degragation of video.
128:23:42:07.270 - SRB separation noted
No anomalies detected

Film Quality Description
Internal lens reflection
Video breakup from liftoff through 128:23:40:20.330

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Item Number KTV7B

Location:	E. OF PAD REMOTED	**Film Quality**	
Camera Type:	RCA	Focus:	Good
Film:		FOV:	
Lens Focal Length:	14X10	Exposure:	Dark
FPS:	30	Timing:	Yes
Timing:		Date Received:	05/07/92
		Date Screened:	05/07/92
		Screened By:	JH,MS,SI

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
128:23:40:06.149 - LOV
No anomalies detected

Film Quality Description

Item Number KTV11

Location:	TV TOWER 1	**Film Quality**	
Camera Type:	RCA	Focus:	Good
Film:		FOV:	
Lens Focal Length:		Exposure:	Good
FPS:	30	Timing:	Yes
Timing:		Date Received:	05/07/92
		Date Screened:	05/07/92
		Screened By:	JH,MS,SI

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

Comments
Vehicle passed through cloud layer
Shearing of the plume noted
Clouds obscured view of vehicle
No anomalies detected

Film Quality Description

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Item Number KTV13

Location:	COCOA BEA.	**Film Quality**	
Camera Type:	RCA	Focus:	Variable
Film:		FOV:	
Lens Focal Length:		Exposure:	Variable
FPS:	30	Timing:	Yes
Timing:		Date Received:	05/07/92
		Date Screened:	05/07/92
		Screened By:	JH,MS,SI,CD

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

Comments
128:23:41:17.364 - AOV
Intermittent LOV due to clouds
128:23:42:07.281 - SRB separation noted
No anomalies detected

Film Quality Description
Internal lens reflection

Item Number KTV21B

Location:	S. OF PAD UCS-15	**Film Quality**	
Camera Type:		Focus:	Good
Film:		FOV:	
Lens Focal Length:		Exposure:	Good
FPS:	30	Timing:	Yes
Timing:		Date Received:	05/07/92
		Date Screened:	05/07/92
		Screened By:	JH,MS,SI

Orientation
View from south liftoff past SRB separation.

Comments
Roll maneuver noted
Intermittent LOV due to clouds
128:23:42:07.254 - SRB separation noted
No anomalies noted

Film Quality Description

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Item Number OTV109

Location:	PAD B FSS- 120	**Film Quality**	
Camera Type:		Focus:	Good
Film:		FOV:	
Lens Focal Length:		Exposure:	Good
FPS:		Timing:	Yes
Timing:		Date Received:	05/07/92
		Date Screened:	05/07/92
		Screened By:	JH,CD,MS,SI,GG

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

Comments
Vapor noted from 4" line
Ice noted accumulating at the bottom of the electrical cable tray near vent
Water noted dropping off the 4" line near the ET
Deluge water noted
Slight motion of the left inboard elevon noted
White debris noted from the ET side of the aft attach strut
Ice debris noted from ET/Orbiter umbilicals
Piece of white debris noted from an unknown origin fell from above ET aft strut, does not strike the vehicle
No anomalies detected

Film Quality Description

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Item Number OTV141

Location:	Pad B Cam. Site 2	Focus:	Good
Camera Type:		FOV:	
Film:		Exposure:	Variable
Lens Focal Length:		Timing:	Yes
FPS:	30	Date Received:	05/07/92
Timing:		Date Screened:	05/07/92
		Screened By:	JH,CD,MS,SI,GG

Film Quality

Orientation
Perimeter camera site 2. Boresight camera for photographic tracking mount.

Comments
Twang noted
Roll maneuver noted
128:23:40:18 - LOV
No anomalies detected

Film Quality Description
Variable exposure after launch hampers analysis
Internal lens reflection

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Item Number OTV148

Location:	Pad B Cam. Site 6	**Film Quality**	
Camera Type:		Focus:	Good
Film:		FOV:	
Lens Focal Length:		Exposure:	Variable
FPS:	30	Timing:	Yes
Timing:		Date Received:	05/07/92
		Date Screened:	05/07/92
		Screened By:	JH,CD,MS,SI

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

Comments
Deluge water noted
Twang noted
Roll maneuver noted
Bow waves noted
128:23:40:20 - LOV
No anomalies detected

Film Quality Description
Internal lens reflection

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Item Number OTV149

Location:	PAD B MLP	**Focus:**	Good
Camera Type:	VIDEO	**FOV:**	
Film:		**Exposure:**	Good
Lens Focal Length:		**Timing:**	Yes
FPS:		**Date Received:**	05/07/92
Timing:		**Date Screened:**	05/07/92
		Screened By:	JH,CD,MS,SI,GG

Film Quality

Orientation
View of overall launch vehicle during ignition and liftoff. MLP 0-ft. level, side 1, east end of blast shield: LOX TSM/Orbiter interface. (fixed view). TIMING ON ORIGINAL.

Comments
128:23:39:57.086 - Multiple pieces of white debris originate from the LO2 TSM carrier plate at liftoff
Vapor noted from LO2 carrier plate at disconnect
128:23:40:02.191 - Several dark pieces of debris appeared from below body flap and fell past the right side of the LSRB
No anomalies detected

Film Quality Description

Item Number OTV151

Location:	PAD B MLP	**Focus:**	Good
Camera Type:	VIDEO	**FOV:**	
Film:		**Exposure:**	Variable
Lens Focal Length:		**Timing:**	Yes
FPS:		**Date Received:**	05/07/92
Timing:		**Date Screened:**	05/07/92
		Screened By:	JH,CD,MS,SI,GG

Film Quality

Orientation
Side 1 -East. LO2 aft umbilical interface, APU exhaust no. 3 and main engine area.

Comments
Ice noted on SSME #1 and #2 vent nozzles
No anomalies detected

Film Quality Description

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Item Number OTV154

Location:	PAD B MLP	**Film Quality**	
Camera Type:	Video	Focus:	Good
Film:		FOV:	
Lens Focal Length:		Exposure:	Good
FPS:		Timing:	Yes
Timing:		Date Received:	05/07/92
		Date Screened:	05/07/92
		Screened By:	JH,CD,MS,SI,GG

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

Comments
Several pieces of white debris fell from LH2 umbilical area
Several pieces of white debris fell from LO2 umbilical area
128:23:39:57.697 - Medium size piece of white debris originated from inside FSS structure and strikes another piece of FSS structure and fell aft, does not appear to strike the vehilce
128:23:39:59.689 - Single piece of white debris originated from the umbilical area, traveled from right to left through the FOV and fell below right inboard elevon, debris does not appear to strike the vehicle
128:23:40:01.591 - Single fast moving white piece of debris noted falling aft of the vehicle after liftoff, debris does not appear to strike the vehicle
No anomalies detected

Film Quality Description
Horizontal banding at liftoff

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Item Number OTV160

Location:	PAD B	**Focus:**	Good
Camera Type:		**FOV:**	
Film:		**Exposure:**	Good
Lens Focal Length:		**Timing:**	Yes
FPS:	30	**Date Received:**	05/07/92
Timing:		**Date Screened:**	05/07/92
		Screened By:	JH,CD,MS,SI,GG

Film Quality

Orientation

Color - Lox vent arm hood seals water tower - Pad B view from northeast SRB attach points stiffener rings field joints and factory field visible. Good view of north side of vehicle and tail as it moves through scene at liftoff. Pad B STRUT on H20 TWR-97'.

Comments

Twang noted
No anomalies detected

Film Quality Description

View of top of the oxygen tank and nose cone
Camera vibration

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Item Number OTV161

Location:	PAD B	Focus:	Good
Camera Type:		FOV:	
Film:		Exposure:	Good
Lens Focal Length:		Timing:	Yes
FPS:	30	Date Received:	05/07/92
Timing:		Date Screened:	05/07/92
		Screened By:	JH,CD,MS,SI,GG

Film Quality

Orientation
Color - ET Scan Fire Surveillance - left SRB and TPS on left side of orbiter as vehicle moves through scene. Pad B FSS-255'.

Comments
Frost noted on louvers
FSS deluge water noted
Twang noted
No anomalies detected

Film Quality Description
Video breakup after launch
Internal lens reflection

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Item Number OTV163

Location:	PAD B	**Film Quality**	
Camera Type:		Focus:	Good
Film:		FOV:	
Lens Focal Length:		Exposure:	Good
FPS:	30	Timing:	Yes
Timing:		Date Received:	05/07/92
		Date Screened:	05/07/92
		Screened By:	JH,CD,MS,SI,GG

Orientation
Lower third of vehicle left SRB - Left side of orbiter and external tank attach point with orbiter Pad B FSS-160'. ET scan, fire surveillance (color).

Comments
Small white debris (ice) noted from umbilicals
Deluge water noted
128:23:40:00.156 - Liftoff
128:23:39:58.654 - White piece of debris is entrained in the flow and appeared to move toward the Orbiter, does not appear to strike the vehicle
No anomalies detected

Film Quality Description

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Item Number OTV170

Location:	PAD B	**Film Quality**	
Camera Type:		Focus:	Good
Film:		FOV:	
Lens Focal Length:		Exposure:	Good
FPS:	30	Timing:	Yes
Timing:		Date Received:	05/07/92
		Date Screened:	05/07/92
		Screened By:	JH,CD,MS,SI,GG

Orientation
Color - Fire surveillance southeast field close up of SSME's at ignition. Pad B W. SE of MLP.

Comments
Ice noted on SSME vent nozzles
128:23:39:55.985 - Free burning hydrogen noted around vertical stabilizer at SSME ignition
Slight vertical stabilizer motion noted at SSME ignition
White vapor cloud noted at LH2 TSM carrier plate disconnect
Normal small white pieces of debris (probably ice and paper) noted at SSME ignition
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
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Item Number OTV171

Location:	PAD B	**Focus:**	Good
Camera Type:		**FOV:**	
Film:		**Exposure:**	Good
Lens Focal Length:		**Timing:**	Yes
FPS:	30	**Date Received:**	05/07/92
Timing:		**Date Screened:**	05/07/92
		Screened By:	JH,MS,MS,SI

Film Quality

Orientation

Color - Fire surveillance fixed service structure on left and water tower on right full vehicle. View from southwest.

Comments

Vehicle obscured by exhaust plume at launch
128:23:40:06.863 - LOV
No anomalies detected

Film Quality Description

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Item Number DTV1

Location:	MOBILE VAN	**Film Quality**	
Camera Type:	IKEGAMI	Focus:	Good
Film:		FOV:	
Lens Focal Length:	ZOOM	Exposure:	Good
FPS:		Timing:	Yes
Timing:		Date Received:	05/16/92
		Date Screened:	05/16/92
		Screened By:	JD,RB,BG,CS

Orientation
Right side of vehicle.

Comments
137:20:57:20.364 - Wheel doors begin to open
137:20:57:38.182 - -Main gear touchdown
137:20:57:49.092 - -Nose touchdown
137:20:57:49.459 - First sighting of drogue chute
137:20:57:52.296 - Chute partially opened
137:20:57:55.198 - Chute fully opened
137:20:58:17.521 - Chute release
137:20:58:35.072 - Wheel stop
No anomalies detected

Film Quality Description
Thermal distortions at beginning of view

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Item Number DTV2

Location:	MOBILE VAN	**Film Quality**	
Camera Type:	IKEGAMI	Focus:	Good
Film:		FOV:	
Lens Focal Length:	13X9	Exposure:	Good
FPS:		Timing:	Yes
Timing:		Date Received:	05/15/92
		Date Screened:	05/16/92
		Screened By:	JD,RB,BG,CS

Orientation

Right side of vehicle station near threshold of runway.

Comments

137:20:57:20.464 - ~Wheel doors begin to open
137:20:57:38.348 - ~Main gear touchdown
137:20:57:48.859 - ~Nose gear touchdown
137:20:57:49.793 - First sighting of drogue chute
137:20:57:52.296 - Chute partially opened
137:20:57:55.132 - Chute fully opened
137:20:58:17.387 - Chute release
Videos ends before wheel stop
No anomalies detected

Film Quality Description

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Item Number DTV3

Location:	MOBILE VAN	**Film Quality**	
Camera Type:	IKEGAMI	Focus:	Good
Film:		FOV:	
Lens Focal Length:	13X9	Exposure:	Good
FPS:		Timing:	Yes
Timing:		Date Received:	05/16/92
		Date Screened:	05/16/92
		Screened By:	JD,RB,BG,CS

Orientation
Left side of vehicle station near threshold of runway.

Comments
137:20:57:20.831 - ~Wheel doors begin to open
137:20:57:38.182 - Right main gear touchdown
137:20:57:38.215 - Left Main gear touchdown
137:20:57:49.092 - ~Nose gear touchdown
137:20:57:49.459 - First sighting of drogue chute
137:20:57:52.362 - Chute partially opened
137:20:57:55.265 - Chute fully opened
137:20:58:17.588 - ~Chute release
Wheel stop noted
No anomalies detected

Film Quality Description
Momentary loss of focus during drag chute deploy
At 137:20:58:06.107 time was lost and wheel stop was not able to be determined

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Item Number DTV4

Location:	MOBILE VAN	**Film Quality**	
Camera Type:	IKEGAMI	Focus:	Good
Film:		FOV:	
Lens Focal Length:		Exposure:	Good
FPS:		Timing:	Yes
Timing:		Date Received:	05/15/92
		Date Screened:	05/16/92
		Screened By:	JD,RB,BG,CS

Orientation
Left side of vehicle.

Comments
137:20:57:20.396 - Wheel doors begin to open
137:20:57:38.180 - Right main gear touchdown
137:20:57:38.214 - Left main gear touchdown
137:20:57:49.091 - Nose gear touchdown
137:20:57:49.291 - First sighting of drogue chute
137:20:57:52.261 - Chute partially opened
137:20:57:55.297 - Chute fully opened
137:20:58:17.520 - Chute release
Wheel stop noted
No anomalies detected

Film Quality Description

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Item Number EXTRA #2

Location:		**Film Quality**	
Camera Type:		Focus:	Good
Film:		FOV:	
Lens Focal Length:		Exposure:	Good
FPS:	200	Timing:	No
Timing:		Date Received:	05/22/92
		Date Screened:	05/22/92
		Screened By:	SI,BG,BP

Orientation

Comments
Frame 369 - Main gear touchdown noted
Film ends prior to nose gear touchdown
No anomalies detected

Film Quality Description
A #2 was placed at frame #1 for first frame identifier

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Item Number EXTRA #1

Location:		**Film Quality**	
Camera Type:		Focus:	Good
Film:		FOV:	
Lens Focal Length:		Exposure:	Good
FPS:	200	Timing:	Yes
Timing:		Date Received:	05/22/92
		Date Screened:	05/22/92
		Screened By:	SI,BG,BP

Orientation

Comments
Film starts after touchdown
13:57:47.017 - Nose gear touchdown noted
13:57:49.203 - Drag chute initiation noted
Pilot chute inflation noted
Initiation of bag release noted
Chute inflation in reefed configuration noted
13:58:17.313 - Full chute inflation noted (partial observation of disreefing initiation noted)
No anomalies detected

Film Quality Description
A #2 was placed on the first frame for identification

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Item Number E1001A

Location:	1R
Camera Type:	Photo
Film:	
Lens Focal Length:	14"
FPS:	100
Timing:	

Film Quality

Focus:	Good
FOV:	
Exposure:	Good
Timing:	Yes
Date Received:	05/20/92
Date Screened:	05/20/92
Screened By:	JD,JK,SI,JH

Orientation

Comments
Frame 2501 - Right main gear touchdown
Frame 2502- Left main gear touchdown
Frame 3582- Nose gear touchdown
Drag chute initiation noted
Pilot chute noted
Bag release noted
Chute inflation noted
Chute disreefing noted
Full chute inflation noted
Frame 6387 - Main chute release
Frame 8170 - Wheel stop
No anomalies detected

Film Quality Description
Fiducials are not lit
White specs throughout beginning of film

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Item Number E1001

Location:	1L	Focus:	Good
Camera Type:		FOV:	
Film:	ECD	Exposure:	Good
Lens Focal Length:	6"	Timing:	No
FPS:	200	Date Received:	05/20/92
Timing:	B	Date Screened:	05/20/92
		Screened By:	JD,JK,GG,SI,JH

Film Quality

Orientation
Head on (750' offset) of orbiter touchdown to rollout.

Comments
Main gear touchdown noted
Nose gear touchdown noted
Drag chute initiation noted
Several birds noted flying thru FOV between Orbiter and camera. Did not appear to strike the vehcile
Frame 11324 - Main chute release noted
Wheel stop noted
No anomalies detected

Film Quality Description
Thermal distortions throughout film noted
The following events were not observed because they occured outside the FOV:
Pilot chute inflation
Bag release
Chute inflation in reefed configuration
Disreefing initiation
Full chute inflation (disreefing completion)

Photo/TV Analysis Group Evaluation Report
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Item Number E1002A

Location:	1R	Focus:	Good
Camera Type:	Photo	FOV:	
Film:		Exposure:	Good
Lens Focal Length:	20"	Timing:	Yes*
FPS:	200	Date Received:	05/20/92
Timing:		Date Screened:	05/20/92
		Screened By:	JH,CS,SI

Film Quality

Orientation

Comments
57:46.98? (Frame 1270) - Nose gear touchdown noted
Pilot chute noted
Drag chute door noted
Sabot noted
54.74? (Frame 2390) - - Start of dereefing noted
55.22? (Frame 2485) - - End of dereefing noted
58:17.36? (Frame 6793) - - Chute separation from vehicle noted
Riser does not appear to strike the vehicle after separation
58:34.87? (Frame 10200) - - Wheel stop noted
No anomalies detected

Film Quality Description
Film appeared grainy
Thermal distortions noted throughout film
Film started after main gear touchdown
*Faint digital timing
Initiation of drag chute sequence obscured by vehicle

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Item Number E1002

Location:	1L	**Film Quality**	
Camera Type:		Focus:	Good
Film:	ECN	FOV:	
Lens Focal Length:	4"	Exposure:	Good
FPS:	24	Timing:	No
Timing:		Date Received:	05/20/92
		Date Screened:	05/20/92
		Screened By:	SI,JH

Orientation
Head on view (750' offset) of orbiter touchdown to rollout.

Comments
Doors open noted
Main gear touchdown noted
Nose gear touchdown noted
Drag chute initiation noted
Pilot chute initiation noted
Bag release noted
Chute inflation in reefed configuration noted
Disreefing initiation noted
Full chute inflation noted (Disreefing completion)
Chute release noted
Wheel stop noted
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
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Item Number E1003A

Location:	1R	Focus:	Good
Camera Type:	Photo	FOV:	
Film:		Exposure:	Good
Lens Focal Length:	4"	Timing:	No
FPS:	24	Date Received:	05/20/92
Timing:		Date Screened:	05/21/92
		Screened By:	SI,JH,JK

Film Quality

Orientation

Comments
HAC noted
Doors open noted
Frame 5783 - Main gear touchdown noted
Nose gear touchdown noted
Drag chute initiation obscured by vehicle
Pilot chute initiation noted
Bag release noted
Chute inflation in reefed configuration noted
Disreefing initiation noted
Full chute inflation noted (disreefing completion)
Frame 6765 - Chute release noted
Wheels stop noted
No anomalies detected

Film Quality Description
Thermal distortions noted throughout film

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E1007A

Location:		**Film Quality**	
Camera Type:		Focus:	Good
Film:		FOV:	
Lens Focal Length:		Exposure:	Good
FPS:	50	Timing:	No
Timing:		Date Received:	05/20/92
		Date Screened:	05/22/92
		Screened By:	SI,BG,BP

Orientation

Comments
Frame 10011 - Main gear touchdown noted
Frame 10629 - Drag chute initiation noted
Pilot chute inflation noted
Pilot chute/Sabot/motar cover are in view
Initiation of bag release noted
Chute inflation in reefed configuration
Disreefing initiation noted
Full chute inflation (disreefing completion)
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-49
06/08/92

Item Number E1008

Location:	3R	Focus:	Good
Camera Type:	PHOTOS	FOV:	
Film:	VND	Exposure:	Good
Lens Focal Length:	14"	Timing:	Yes
FPS:	100	Date Received:	05/20/92
Timing:	B	Date Screened:	05/20/92
		Screened By:	JK,JD,SI,JH

Film Quality

Orientation
Right side of orbiter.
Orbiter main landing gear down and touchdown.

Comments
Frame 4069 - Beginning of wheels down noted
Frame 5883 - Right main gear touchdown noted
Frame 5885 - Left main gear touchdown noted
Frame 6997 - Nose gear touchdown noted
Frame 7014 - Initiation of chute deploy noted (initiation of door separation)
Frame 7021 - Chute door and sabot/pilot chute deploy noted (M)
Frame 7048 - Pilot chute/riser line feedout noted (M)
Frame 7113 - Main chute extraction noted (frame 7117-M)
Frame 7139, 7160 - Continuation of riser line deploy (2-M)
Frame 7191 - Peak of riser line feedout noted (M)
Frame 7593 - Beginning of disreefing
Frame 7630 - Main chute full inflation
Frame 8887 - Reflection noted between SSME #1 and #3 during rollout before chute release
Parachute release is obscured by parachute
Frame 11414 - ~Wheel stop
No anomalies detected

+1 frame

Film Quality Description
Thermal distortion noted at main gear touchdown
The following events were not observed because they occured outside the FOV:
Pilot chute inflation
Bag release
Chute inflation in reefed configuration
Minor distortion due to heating at beginning of landing

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E1009

Location:	3R	Focus:	Soft
Camera Type:		FOV:	
Film:	ECN	Exposure:	Good
Lens Focal Length:	4"	Timing:	No
FPS:	24	Date Received:	05/21/92
Timing:		Date Screened:	05/21/92
		Screened By:	JH,JK,SI

Film Quality

Orientation
Orbiter touch down to rollout.

Comments
HAC noted
Doors open noted
Frame 8994 - Main gear touchdown noted
Nose gear touchdown noted
Frame 9545 - Drag chute initiation noted
Frame 9627 - Peak of riser line feedout noted (M)
Disreefing initiation noted
Full chute inflation noted (disreefing completion)
Chute release obscured by chute canopy
Wheel stop noted
No anomalies detected

Film Quality Description
Thermal distortions throughout film
The following were not seen because they were out of the FOV:
Pilot chute inflation
Bag release
Chute inflation in reefed configuration

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E1010

Location:	3R	Focus:	Good
Camera Type:		FOV:	
Film:	VNF	Exposure:	Good
Lens Focal Length:	10"	Timing:	*Yes
FPS:	200	Date Received:	05/21/92
Timing:		Date Screened:	05/21/92
		Screened By:	JH,SI

Film Quality

Orientation
Orbiter touch down to rollout. Right side of the vehicle.

Comments
Frame 7073 - Beginning of doors open
Frame 10701 - Right main gear touchdown noted
Frame 10703 - Left main gear touchdown noted
Frame 14127 - Disreefing initiation noted
Frame 14210 - Full chute inflation (disreefing completion)
Film ended prior to chute release
No anomalies detected

Film Quality Description
*Timing marks very faint
Thermal distortions throughout film
These events were not seen because they occured outside the FOV or the film ended:
Nose gear touchdown
Drag chute initiation
Pilot chute inflation
Bag release
Chute inflation in reefed configuration
Chute release
Wheel stop

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E1011

Location:	4R	**Film Quality**	
Camera Type:		Focus:	*Very soft
Film:	VNF	FOV:	
Lens Focal Length:	75mm	Exposure:	Good
FPS:	24	Timing:	No
Timing:		Date Received:	05/21/92
		Date Screened:	05/21/92
		Screened By:	JH,SI

Orientation
Left side of orbiter.
Orbiter touchdown to rollout.

Comments
Main gear touchdown noted
Nose gear touchdown noted
Drag chute initiation noted
Chute release obscured by chute canopy
Wheel stop noted
No anomalies detected

Film Quality Description
*Focus is very soft because of apparent shutter problem
The following items were not seen because they were out of the FOV:
Pilot chute initiation
Bag release
Chute inflation in reefed configuration
Disreefing initiation
Full chute inflation (disreefing completion)

This film is not usable for analysis

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E1012

Location:	4R	Focus:	Good
Camera Type:		FOV:	
Film:	ECN	Exposure:	Good
Lens Focal Length:	150MM	Timing:	Yes
FPS:	24	Date Received:	05/21/92
Timing:		Date Screened:	05/20/92
		Screened By:	JH,SI,JK

Film Quality

Orientation
Left side of orbiter.
Orbiter landing to rollout.

Comments
Frame 1324 - Right main gear touchdown noted
Frame 1327 - Left main gear touchdown noted
Frame 3465 - Nose gear touchdown noted
Frame 3502 - - Initiation of chute deploy noted
Frame 3523 - Chute door, motar cap, and sabot/pilot chute deploy noted (M)
Frame 3707 - Start of deployment of drag chute with bag noted (M)
Frame 3757 - Riser line feedout noted (M)
Chute separation from vehicle noted. Separation obscured by chute
Frame 11833 - - Wheel stop noted
No anomalies detected

Film Quality Description
The following items occurred out of the camera's FOV: Pilot chute inflation, bag release, chute inflation in reefed configuration, disreefing initiation, full chute initiation (disreefing completion)

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E1017

Location:	5L	Focus:	Good
Camera Type:		FOV:	
Film:	ECN	Exposure:	Good
Lens Focal Length:	12-120	Timing:	*No
FPS:	24	Date Received:	05/21/92
Timing:		Date Screened:	05/21/92
		Screened By:	JH,SI

Film Quality

Orientation
View of right side of orbiter during approach and landing crew egress

Comments
Doors open noted
Frame 1442 - Right main gear touchdown noted
Frame 1443 - Left main gear touchdown noted
Frame 1703 - Nose gear touchdown noted
Frame 1709 - Drag chute initiation noted
Frame 1731 - Pilot chute inflation noted
Frame 1736 - Pilot chute/Sabot/motar cover are in view
Frame 1749 - Initiation of bag release noted
Frame 1784 - Chute inflation in reefed configuration
Frame 1842 - Disreefing initiation noted
Frame 1855 - Full chute inflation (disreefing completion)
Chute release obscured by canopy
Film ended before wheel stop
No anomalies detected

Film Quality Description
*No first frame identifier

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E1027

Location:	7R	Focus:	Soft
Camera Type:	16mm	FOV:	
Film:	ECD	Exposure:	Good
Lens Focal Length:	20"	Timing:	Yes
FPS:	200	Date Received:	05/21/92
Timing:	B	Date Screened:	05/21/92
		Screened By:	JH,SI

Film Quality

Orientation

Comments
AOV after main gear touchdown
Nose gear touchdown obscured by vegetation
Frame 2285 - Drag chute initiation noted
Frame 2474 - Pilot chute inflation noted
Frame 2631 - Bag release initiation noted
Frame 2926 - Chute inflation in reefed configuration noted
Frame 3418 - Disreefing initiation noted
Frame 3532 - Full chute inflation (disreefing completion)
Chute release obscured by chute canopy
Wheel stop noted
No anomalies detected

Film Quality Description
Focus is soft due to thermal distortions noted throughout film

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Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number E1027A

Location:	7R	**Film Quality**	
Camera Type:		Focus:	Good
Film:		FOV:	
Lens Focal Length:	10"	Exposure:	Good
FPS:	24	Timing:	No
Timing:		Date Received:	05/22/92
		Date Screened:	05/22/92
		Screened By:	SI,BG,BP

Orientation

Comments
Film starts after wheels down
Frame 313 - Main gear touchdown noted
Frame 591 - Drag chute initiation noted
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number IR

Location:
Camera Type:
Film:
Lens Focal Length:
FPS:
Timing:

Film Quality

Focus:	Good
FOV:	
Exposure:	Good
Timing:	*No
Date Received:	05/16/92
Date Screened:	05/16/92
Screened By:	JD,RB,BG,CS

Orientation

Comments
Main gear touchdown noted
Nose gear touchdown noted
First sighting of drogue chute noted
Chute partially opened
Chute fully opened
Chue release noted
Wheel stop noted
No anomalies detected

Film Quality Description
*Invalid timing or no timing
Excellent IR view of shuttle and drag chute

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number LRO

Location:
Camera Type:
Film:
Lens Focal Length:
FPS:
Timing:

Film Quality

Focus:	Variable
FOV:	
Exposure:	Good
Timing:	Yes
Date Received:	05/16/92
Date Screened:	05/16/92
Screened By:	JD,RB,BG,CS

Orientation
Long Range Optics
Left side of vehicle.

Comments
137:20:55:39.863 - AOV
137:20:57:20.363 - Wheel door begin to open
137:20:57:38.148 - Main gear touchdown
137:20:57:49.125 - First sighting of drouge chute
Rollout obscured by buildings
No anomalies detected

Film Quality Description
Jumpy tracking

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number NASA SEL

Film Quality

Location:		Focus:	Good
Camera Type:		FOV:	
Film:		Exposure:	Good
Lens Focal Length:		Timing:	Yes
FPS:		Date Received:	05/16/92
Timing:		Date Screened:	05/16/92
		Screened By:	JD,RB,BG,CS

Orientation
Landing view of both left and right side of vehicle.

Comments
137:20:53.00 - AOV. No timing until after AOV
Wheel doors begin to open
Main gear touchdown noted
Nose gear touchdown noted
First sighting of drogue chute noted
Chute partially opened
Chute fully opened
137:20:58:17.520 - Chute release noted
Wheel stop noted
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number SBEV

Location:
Camera Type:
Film:
Lens Focal Length:
FPS:
Timing:

Film Quality

Focus:	Good
FOV:	
Exposure:	Good
Timing:	No
Date Received:	05/16/92
Date Screened:	05/16/92
Screened By:	JD,RB,BG,CS

Orientation

Comments
Main gear touchdown noted
Nose gear touchdown
First sighting of drogue chute noted
Chute partially opened
Chute fully opened
Chute released noted
Wheel stop noted
No anomalies detected

Film Quality Description

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number UMBL1

		Film Quality	
Location:	Onboard	Focus:	Good
Camera Type:		FOV:	
Film:		Exposure:	Good
Lens Focal Length:	5mm	Timing:	Yes
FPS:		Date Received:	05/20/92
Timing:		Date Screened:	05/20/92
		Screened By:	JD,JH,GG,CK,JD

Orientation
Onboard umbilical well camera (left)

Comments
Multiple pieces of light colored debris appear throughout film and travel through FOV. Several pieces appear to originate from TPS ablating.
Frame 133 - Start of SRB separation sequence. Shallow divot on ET base TPS near left SRB attach. ET base charring noted. Chipping of LH2 umbilical base noted. Loose TPS also seen. Multiple small pieces of debris in view. Vapors beneath ET aft dome visible.
Frame 711 - White linear smear on optical plate appears from left center to lower center of FOV.
Frame 1011 - Left SRB separation noted
Frame 1034 - Large piece of white debris crosses FOV
Frame 1038 - ~SRB separation
SRB separation motors noted
Frame 1582 - Venting from LSRB BSM area noted (nose)
Frame 1897 - SRB out of view
Frame 2043 - Last frame of SRB separation sequence
No anomalies detected

Film Quality Description
No usable pictures of ET separation were taken due to night lighting conditions.

Photo/TV Analysis Group Evaluation Report
STS-49
06/05/92

Item Number VLRO

Location:
Camera Type:
Film:
Lens Focal Length:
FPS:
Timing:

Film Quality

Focus:	Soft
FOV:	
Exposure:	Good
Timing:	No
Date Received:	05/16/92
Date Screened:	05/16/92
Screened By:	JD,RB,BG,CS

Orientation

Comments
No anomalies detected

Film Quality Description
Analysis hampered by soft focus

Daily Reports to Mission Management

STS-49
JSC Photo/TV Analysis Report
05:00 CDT May 8, 1992

The STS-49 launch of Endeavour occurred on Thursday, May 7, 1992 at 23:40:00.156 UTC as seen on Camera OTV-163. SRB separation occurred at 23:42:07.281 UTC as seen on KTV-13.

On launch day, 23 of 23 expected videos were received and screened. Ten 16mm and ten 35 mm films are expected on Saturday.

Camera KTV-5 - Twenty-six orange discolorations (possibly flares) were noted in the SSME plumes beginning at 84 seconds MET and continuing through SRB separation. The first of these events coincided with a large increase in the SSME #2 high pressure fuel pump temperature reported by the MER. Normal recirculation seen on camera ET-212 between 91 and 106 seconds MET will be compared to the events seen on KTV-5. STS-33 was also launched from Pad 39B at a similar inclination angle and launch time. KTV-5 views from the two missions were compared to each other but the results proved to be inconclusive.

The following items are not considered anomalous but do merit mentioning:

Camera ET-212 - A single flare was noted near the SSME #1 plume at 48 seconds MET. Flares during this time period have been seen on several earlier missions.

Camera ET-212 - A small area near the upper right corner of the SRB plume appeared to brighten intermittently between 45 and 87 seconds MET. This event will be reviewed on the tracker camera films prior to landing.

Camera OTV-170 - Orange vapor (possibly free burning hydrogen) was noted around the vertical stabilizer at SSME ignition. This vapor appeared to be slightly more extensive than had been noted on previous missions.

Camera OTV-109 - White debris (possibly ice) originated from the the ET side of the aft attach strut and fell toward the pad at liftoff.

Other normal events observed included: recirculation; slag noted after SRB separation; indication of wind shear in the SRB plume and atmospheric bow waves.

STS-49
JSC Photo/TV Analysis Report
19:30 CDT May 9, 1992

On Saturday, twenty of twenty expected 16 mm films arrived. To date, a total of twenty 16mm films and 23 videos have been screened. Ten 16mm and ten 35mm films are expected on Sunday. Launch time for STS-49 was determined to be 23:40:00.029 as seen on Camera E9.

The following items merit metioning but are not considered anomalous:

Cameras E5, E6, E25 - A light, medium-sized piece of rectangular debris from above and outboard of the LO2 umbilicals (along with two other pieces) was seen to fall aft past the right inboard elevon at liftoff. This debris may have been a tile spacer.

Camera E34 - A white spot was noted on the underside of the Orbiter TPS (approximately at mid-fuselage on the right side) at liftoff. A better view of this apparent white spot will be searched for on films that will be screened on May 10th and 11th..

Camera E19 - Base heat shield erosion (three chips) was noted on the right RCS stinger after SSME ignition.

Cameras E1, E2, E3, E5, E16, E19, E20, E36 - Orange vapor (possibly free-burning hydrogen) was seen to rise toward the base of the vertical stabilizer just prior to SSME ignition. This is the same event that was seen on Camera OTV-170 as reported on the JSC launch day daily report from May 8th.

Cameras E3, E5 - Multiple flashes were seen in the SSME #1, #2 and #3 exhaust plumes after SSME startup while the vehicle was still on the pad.

Cameras E4, E5 - A single, small piece of white debris was noted falling aft from the SSME area at liftoff.

Cameras E3, E20 - Single piece of debris (dark on one side, light on the other) appeared on the right side of the FOV near the vertical stabilizer and fell aft into the SSME plume at liftoff.

None of the observed debris was seen to strike the vehicle.

Other normal debris events observed included: flame duct debris; pad debris;.RCS paper debris; white debris (probably ice) from the ET/Orbiter, TSM umbilical areas and the GUCP disconnect during liftoff. Also, slight body flap motion and left inboard elevon motion were noted during liftoff.

STS-49
JSC Photo/TV Analysis Report
23:30 CDT May 10, 1992

On Sunday, twenty of twenty expected films arrived. To date, a total of thirty 16mm films, ten 35mm films and 23 videos have been screened. Nine 16mm films and ten 35mm films are expected on Monday, May 11th.

The following items merit mentioning but are not considered anomalous:

Cameras E23, E24 - At least seven chips in the base heat shield tiles were noted at SSME startup. Base heat shield erosion was previously noted on Camera E19.

Camera E31 - A single piece of white debris originated from the left aft attach strut on the ET and fell aft at liftoff. Another piece of white debris fell through the FOV during this same time frame.

Cameras E24, E30 - Orange vapor (possibly free burning hydrogen) was seen above the OMS nozzle prior to SSME startup. This event was previously noted on Cameras E1, E2, E3, E5, E16, E19, E20, E36 and OTV-170.

Camera E207 - A single piece of light-colored debris was noted coming out of the Orbiter side of the SRB plume at 74 seconds MET.

Camera E213 - A small piece of white debris (possibly RCS paper) was noted falling aft from the right RCS stinger area into the SSME plumes just after tower clear.

None of the above debris appeared to strike the vehicle.

Other normal events observed included: normal flame duct debris; multiple pieces of dark MLP debris; vapor off both wings; atmospheric bow waves; two linear optical effects; multiple flares in the SSME plumes; apparent body flap motion; recirculation and slag noted after SRB separation.

Films E19, E20, E23 and E24 were reviewed for base heat shield flexing at the request of KSC. A slight amount of apparent motion was detected, but further analysis will be required.

STS-49
JSC Photo/TV Analysis Report
00:15 CDT May 12, 1992

On Monday, nineteen of nineteen expected films arrived. To date, a total of thirty-nine 16mm films, twenty 35mm films and twenty-three videos have been screened. One 35mm and three 16mm films are expected on Wednesday, May 13th.

Camera E76 - Flexing of the base heat shield was noted during SSME ignition. Engineers from the MER were shown this event and have concluded that some motion was present. A slight amount of base heat shield motion was also detected on E20. A quantitative analysis to measure both the magnitude and frequency of the base heat shield motion will be attempted. Correlation of this event with observed pressure waves and the SSME gimbaling will also be studied. A review of the E76 film from the STS-49 FRF indicated the presence of base heat shield flexing. The E76 films from STS-42 and STS-45 were reviewed for this same occurrence. The STS-45 film was difficult to interpret due to exhaust vapors obscuring the view. The view from the STS-42 film appeared inconclusive. Other missions with similar lighting conditions will also be examined for base heat shield motion.

The following items merit mentioning but are not considered anomalous:

Camera EX4 - Two pieces of dark debris (possibly epon shim or putty material) were noted between the SLV and HDP M-5 shoe at liftoff.

Camera E52 - A tumbling piece of debris (dark on one side, light on the other), first noted on the underside of the orbiter at mid-fuselage, fell aft during tower clear.

Other normal events observed included: SRB flame duct debris; RCS paper debris; atmospheric bow waves; condensation vapor trails off both wings after tower clear; flashes in the SSME plume throughout roll maneuver; recirculation and slag noted after SRB separation.

STS-49
JSC Photo/TV Analysis Report
16:15 CDT May 13, 1992

On Wednesday, two of two expected films arrived. To date, a total of forty 16mm films, twenty -one 35mm films and twenty-three videos have been screened. No more films are expected until after landing.

Camera E77 - Flexing of the base heat shield was again noted during SSME ignition. This event was also seen on E76, E19, and E20. Photo analysts and a JSC structures engineer reviewed films from previous missions. The preliminary conclusion is that the observed flexing is not mission specific. The main evidence for this came from a review of STS-33 (camera E-19), which showed flexing of the base heat shied. Rockwell-Downey has reported seeing the base heat shield motion on STS-51J films (the first flight of Atlantis) plus slight motion on STS-51F and STS-44.

Attempts to quantify the deflections and determine a frequency of vibration from the photography are being made. A timeline to relate the base heat shield motion to SSME bell motion will be made. Previous mission films will continue to be examined. A hypothesis is that the motion is caused by pressure waves from the main engines during SSME ignition.

The following items merit mentioning but are not considered anomalous:

Camera E77 - Two small pieces of white debris were seen falling from the edge of the right inboard elevon at liftoff.

Camera E79 - A white piece of debris was seen moving from left to right across the ET LO2 feedline and then falling aft along the LO2 feed line at liftoff. A task is in progress to determine if this debris is related to the debris seen falling aft along the orbiter fuselage under surface tiles at liftoff (Cameras E52 and E54).

Other normal events observed included: RCS paper debris, ice debris from the LH2 and LO2 umbilicals, and ice from the LO2 TSM.

JSC STS-49 Landing Day Report
May 16, 1992
21:30 CDT

Nine landing videos were received approximately 2.5 hours after landing. Landing of STS-49 occurred on runway 22 at Edwards Air Force Base. Right main gear touchdown was at 20 hours 57 minutes 38.182 seconds UTC on May 16 (day of year 137) as seen from DTV-3. Left main gear touchdown was at 20 hours 57 minutes 38.215 seconds UTC as seen from DTV-3. Nose wheel touchdown occurred at 20 hours 57 minutes 49.091 seconds UTC as seen from DTV-4. Wheel stop was at approximately 20 hours 58 minutes 35.072 seconds UTC as seen on DTV-1.

Good video coverage of the drag chute deploy was obtained. Drag chute deployment appeared as expected. The following drag chute event times were acquired from DTV-4. The first sighting of the drogue chute deploy was at 20 hours 57 minutes 49.291 seconds. The drag chute was seen to partially open at 20 hours 57 minutes 52.261 seconds. The drag chute was seen to fully open at 20 hours 57 minutes 55.297 seconds. The drag chute was released at 20 hours 58 minutes 17.520 seconds.

No anomalous events were detected from the landing videos. However, the following items were noted during the post-landing inspection video views: TPS damage was noted on the right side of the orbiter nose; a small segment of the aft port payload bay door seal appeared misaligned; a tile on the base heat shield showed signs of damage; and streaks on the TPS were seen forward of the hydrogen umbilical. A half inch screw and a small green cylindrical object were seen on the ground during the inspection.

STS-49 Timing Data Report

STS-49 TIMING REPORT

After the photography from the Engineering and Tracking Cameras were screened for events of interest for the STS-49 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.) Camera E1008 did not have an offset on the film.

Camera E76 (35mm)

Item of Interest	Frame #	Start Time	Stop Time
Base heat shield motion	320 to 484	128:23:39:55.357	128:23:39:57.103
Timing IRIG B		Total Frames 3595	

Camera E79 (16mm)

Item of Interest	Frame #	Start Time	Stop Time
Piece of debris noted moving left to right across LO2 feedline	1612 to 1644	128:23:40:03.262	128:23:40:03.569
Piece of debris noted falling along LOX line	1677 to 1743	128:23:40:03.900	128:23:40:04.538
Timing IRIG B		Total Frames 5216	

Camera E204 (35mm)

Item of Interest	Frame #	Start Time	Stop Time
Recirculation	8402	128:23:41:55.900	
Orange flare noted in the Orbiter side of the SRB plume	8789	128:23:42:01.375	
Timing IRIG B		Total Frames 15892	

Camera E212 (35mm)

Item of Interest	Frame #	Start Time	Stop Time
Flare in SSME plume	2011	128:23:40:40.775	
Body flap motion	2200 to 2500	128:23:40:43.649	128:23:40:48.203
	2840 to 3442	128:23:40:53.365	128:23:41:02.502
Linear optical distortions	3099 3258	128:23:40:57.307 128:23:40:59.711	

Recirculation	5441 to 6600	128:23:41:32.801	128:23:41:50.337
Timing IRIG B		Total Frames 9026	

Camera E218 (35mm)

Item of Interest	Frame #	Start Time	Stop Time
Recirculation	8360 to 9067	128:23:41:32.765	128:23:41:40.964
Timing IRIG B		Total Frames 14412	

Camera E220 (35mm)

Item of Interest	Frame #	Start Time	Stop Time
Orange flare in SSME #1	3732	128:23:40:40.777	
Debris noted at base of vertical stabilizer area and fell aft	3197 3468 3619	128:23:40:35.289 128:23:40:38.061 128:23:40:39.618	
Timing IRIG B		Total Frames 13808	

Camera E1008 (35mm)

Item of Interest	Frame #	Start Time	Stop Time
Right main gear touchdown	5883	137:20:57:38.145	
Left main gear touchdown	5885	137:20:57:38.165	
Nose gear touchdown	6997	137:20:57:49.045	
Drag chute initiation	7014	137:20:57:49.219	
Disreefing initiation	7593	137:20:57:54.900	
Full chute Inflation	7630	137:20:57:55.254	
Wheel stop	11414	137:20:58:32.310	
Timing IRIG B		Total Frames 13762	

Camera E1027 (16mm)

Item of Interest	Frame #	Start Time	Stop Time
Pilot chute inflation	2474	137:20:57:50.115	
Bag release	2631	137:20:57:50.902	
Refeed configuration	2926	137:20:57:52.348	
Timing IRIG B		Total Frames 5447	

CAMERA OFFSETS AND SPEEDS

Camera	Offset (mm)	Film Speed (fps) Begin	End
E76 (35mm)	300	94	94
E79 (16mm)	93	102	102
E204 (35mm)	305	70	70
E212 (35mm)	300	66	66
E218 (35mm)	310	87	87
E220 (35mm)	295	91	98
E1008 (35mm)	-152	102	102
E1027 (16mm)	193	201	203

Appendix D

Analysis Tasks and Summary of Analysis of Visual Events

Photo/TV Analysis Group Request Form
STS-49
06/12/92

Task Number --> 1

Request Date : 10/16/91
Completion Date : 06/09/92

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-49
06/12/92

Task Number
1

Title : Recirculation Characterization

Analysts : R. Bhaskar
Date : 06/09/92

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
STS-49	93	110	E212

NOTES: **No recirculation was observed on STS-40 films. 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-49
06/12/92

Task Number --> 2

Request Date : 10/16/91
Completion Date : 06/10/92

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-49
06/12/92

Task Number
2

Title : Check Effect of Snychronizers on IRIG Time Transmission

Analysts :
Date : 06/10/92

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-49
06/12/92

Task Number --> 3

Request Date : 10/16/91
Completion Date : 06/09/92

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

Analyst Name	Phone Number	Assignment
R. Bhaskar	244-5322	Video Sink Rater
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-49
06/09/92

Task Number
3

Title : Determine Sink Rate from Video/Film

Analysts : J. Hartman
Date : 05/19/92

Camera Number : KTV-4
Frame Number :
GMT :

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

Description of Analysis

See attached for data and results

Image Analysis Tools & Techniques

STS-49: Video Sink Rate Analysis Summary

Sink rate for STS-49 was performed using video camera TV-4.

TV-4 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 on 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 to determine the position of the main gear wheel above the runway.

TV-4 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 nose wheel.

Y4) A stationary point on the runway directly below the nose wheel assembly which was used as a vertical reference.

Points Y1 and Y2 were used for scaling and point s Y3 and Y4 were used to determine the position of the nose wheel above the runway.

Results: The video sink rate for the right main gear was determined to be 1.08 feet per second and the sink rate for the nose wheel was determinedto be 2.81 feet per second for STS-49.

MAIN GEAR DATA

FRAME #	Y1	Y2	Y3	Y4	REL REF	REF DIST
124	283	253	157	138	30	19
125	283	254	157	139	29	18
126	285	255	158	140	30	18
127	289	261	163	145	28	18
128	289	260	162	144	29	18
129	286	256	159	142	30	17
130	286	257	160	142	29	18
131	283	253	156	139	30	17
132	281	253	156	139	28	17
133	285	256	159	142	29	17
134	287	258	161	143	29	18
135	289	259	163	146	30	17
136	288	259	162	145	29	17
137	284	256	157	141	28	16
138	283	253	157	140	30	17
139	284	254	158	142	30	16
140	285	255	159	144	30	15
141	287	256	161	144	31	17
142	288	258	163	147	30	16
143	287	256	160	145	31	15
144	284	254	157	141	30	16
145	283	252	157	142	31	15
146	285	254	158	144	31	14
147	285	255	159	144	30	15
148	287	257	161	146	30	15
149	287	257	161	147	30	14
150	284	255	158	145	29	13
151	282	251	155	142	31	13
152	281	251	155	142	30	13
153	283	253	157	144	30	13
154	285	254	159	146	31	13
		MAIN GEAR SINK RATE			-1.08	FT/SEC

MAIN GEAR DATA

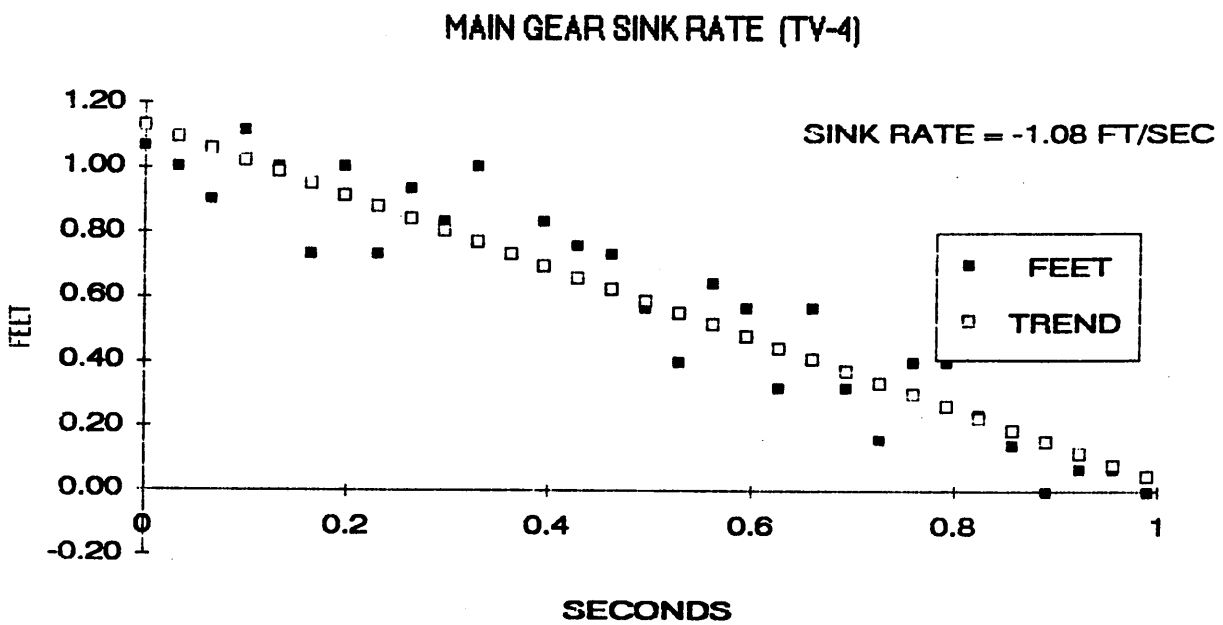
TIME	FEET	TREND
0	1.07	1.13
0.033	1.00	1.09
0.066	0.90	1.06
0.099	1.11	1.02
0.132	1.00	0.99
0.165	0.73	0.95
0.198	1.00	0.91
0.231	0.73	0.88
0.264	0.94	0.84
0.297	0.83	0.80
0.33	1.00	0.77
0.363	0.73	0.73
0.396	0.83	0.70
0.429	0.76	0.66
0.462	0.73	0.62
0.495	0.57	0.59
0.528	0.40	0.55
0.561	0.64	0.52
0.594	0.57	0.48
0.627	0.32	0.44
0.66	0.57	0.41
0.693	0.32	0.37
0.726	0.16	0.33
0.759	0.40	0.30
0.792	0.40	0.26
0.825	0.23	0.23
0.858	0.14	0.19
0.891	0.00	0.15
0.924	0.07	0.12
0.957	0.07	0.08
0.99	0.00	0.05

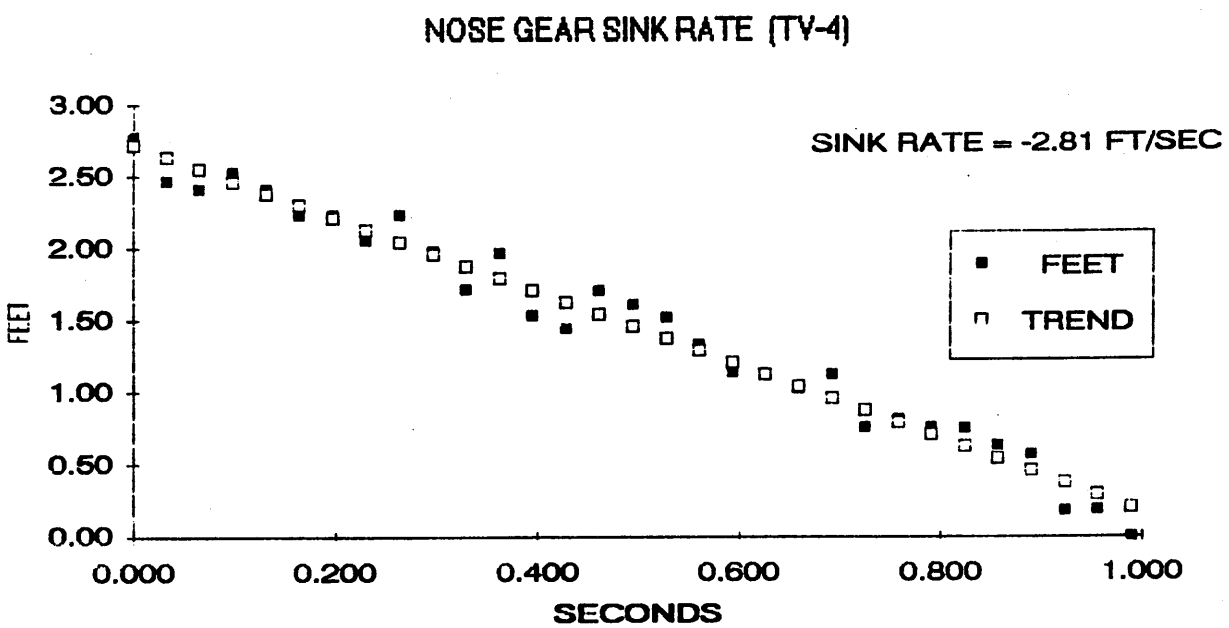
NOSE GEAR DATA

FRAME #	X 1	X2	Y1	Y2	Y3	Y4
451	369	366	239	211	170	149
452	373	369	240	211	171	151
453	379	375	239	211	170	151
454	383	379	239	212	172	153
455	388	384	240	212	172	153
456	390	386	238	210	170	152
457	392	388	238	210	170	152
458	394	390	238	210	170	153
459	397	393	238	210	171	153
460	400	396	238	211	171	155
461	403	400	238	210	170	155
462	407	402	237	210	171	155
463	410	407	238	210	171	157
464	417	414	237	210	170	157
465	424	420	236	210	171	157
466	429	425	235	208	170	156
467	430	426	232	206	168	155
468	429	425	231	205	166	154
469	425	421	230	204	166	155
470	425	420	231	205	167	156
471	426	422	234	209	170	160
472	428	423	236	210	172	161
473	428	424	237	211	172	163
474	428	423	238	213	174	165
475	428	424	239	213	175	166
476	434	429	238	212	174	165
477	438	434	238	213	174	166
478	441	437	238	212	174	166
479	443	438	238	212	173	167
480	442	438	238	212	173	167
481	443	439	238	212	173	168
	NOSE WHEEL SINK RATE			-2.81	FT/SEC	

NOSE GEAR DATA

REL REF	REL DIST	SEC	FEET	TREND
28.160	21	0.000	2.78	2.71
29.275	20	0.033	2.47	2.63
28.284	19	0.066	2.41	2.55
27.295	19	0.099	2.53	2.46
28.284	19	0.132	2.41	2.38
28.284	18	0.165	2.23	2.30
28.284	18	0.198	2.23	2.21
28.284	17	0.231	2.06	2.13
28.284	18	0.264	2.23	2.04
27.295	16	0.297	1.98	1.96
28.160	15	0.330	1.71	1.88
27.459	16	0.363	1.96	1.79
28.160	14	0.396	1.54	1.71
27.166	13	0.429	1.44	1.63
26.306	14	0.462	1.71	1.54
27.295	14	0.495	1.61	1.46
26.306	13	0.528	1.52	1.38
26.306	12	0.561	1.33	1.29
26.306	11	0.594	1.14	1.21
26.476	11	0.627	1.13	1.12
25.318	10	0.660	1.02	1.04
26.476	11	0.693	1.13	0.96
26.306	9	0.726	0.76	0.87
25.495	9	0.759	0.82	0.79
26.306	9	0.792	0.76	0.71
26.476	9	0.825	0.75	0.62
25.318	8	0.858	0.63	0.54
26.306	8	0.891	0.57	0.46
26.476	6	0.924	0.18	0.37
26.306	6	0.957	0.19	0.29
26.306	5	0.990	0.00	0.21


MAIN GEAR SINK RATE (TV-4)
SINK RATE = -1.08 FT/SEC
FEET
TREND
FEET
1.20
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
0
0.2
0.4
0.6
0.8
1
SECONDS


NOSE GEAR SINK RATE (TV-4)
SINK RATE = -2.81 FT/SEC
FEET
TREND
FEET
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0.000
0.200
0.400
0.600
0.800
1.000
SECONDS

RCN NO. SD0002	DATA REQUIREMENTS CHANGE NOTICE DV51 - ORB SINK RATE ANALYSIS	INTERNAL PROJ. CONT. NO. NUM2
OMRS FILE NO. IX/VOL V	RELATED PCIN/ECP/RCN/E.O. NO. NUM4	OTHER OMRS AFFECTED FILE NO'S. SYM1 SYM2	COLUMN AFFECTED REQ. SYM3 SPEC. SYM4 OTHER. SYM5

NUMBER	DESCRIPTION	MEAS/STIMU	SPECIFICATION	EFFECTIVITY/REMARKS/ REFERENCES/MISC.	RESP. FOR: IMP. (I) ANALY (A)
PRESENT	NONE				

NEW REVISION

DV51P.001

ORBITER IMPACT SINK RATE ANALYSIS

0-000
0-001
0-002
0-003
0-004 ANALYZE PHOTOGRAPHIC AND VIDEO DATA
0-005 OF THE DESCENDING ORBITER TO DETERMINE
0-006 IF THE LANDING IMPACT SINK RATE
0-007 EXCEEDS THE DESIGN CRITERIA FOR THE
0-008 ORBITER NOSE AND MAIN LANDING GEAR.
0-009
0-010
0-011
0-012

THE IMPACT SINK RATE SHALL NOT EXCEED THE GROSS VEHICLE WEIGHT AND GROSS WIND SPECIFICATIONS AS PER FIGURE 1

A:D06-1M/D08
B: ONE MINUTE BEFORE MAIN LANDING GEAR TOUCHDOWN TO WHEEL STOP.
C:

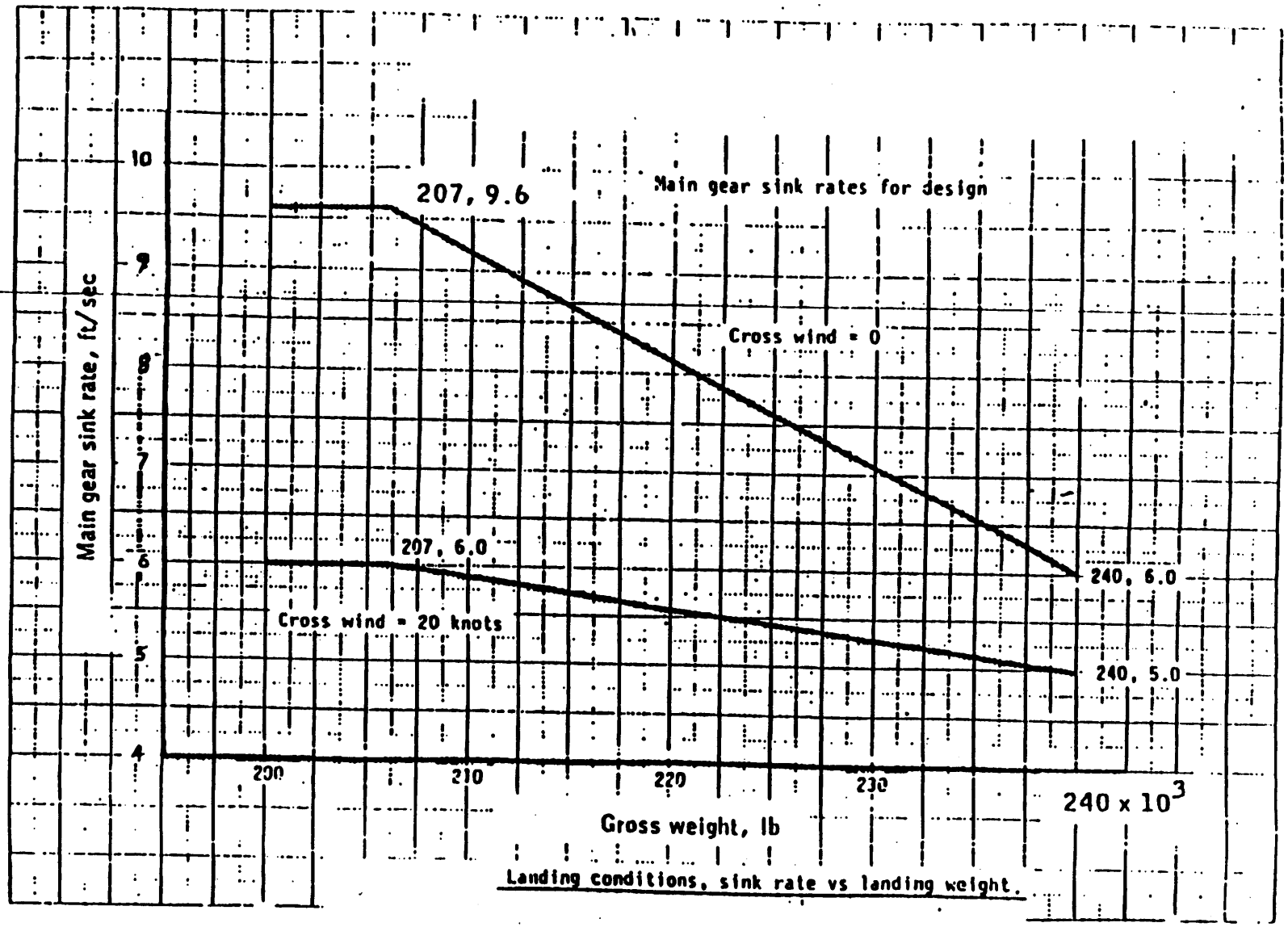
I-N/A
A-ORB PROJ

D: L&L PRD T49 (3120)

NAME	RESPONSE	JUSTIFICATION
NAM1	RES1	BASELINES ACCEPTABLE ORBITER LANDING SINK RATE VS ORBITER LANDING RATE FOR FILE IX. JSC CONTACT: DAVE HAMILTON, X8885 OR WALT GAYLOR, X6353.
NAM2	RES2	
NAM3	RES3	
NAM4	RES4	
NAM5	RES5	

REQUESTED BY RON JONES-RIC/DNY-03/08/88-X2642
APPROVED BY: DATE/CCBD NO.
LEVEL II SYM6

1



Landing conditions, sink rate vs landing weight.

ADDITIONAL REFERENCES

SUBMIT DATE

FIGURE NO. 1
RCN NO. SD 0002
APPRV: DATE:

SHUTTLE SINK RATE VELOCITIES SINCE REFLIGHT

MISSION	DATE	FILM main gear (fps)	FILM nose gear (fps)	VIDEO main gear (fps)	VIDEO nose gear (fps)	main gear to nose gear (seconds)	nose gear to wheel stop (seconds)
STS-26	10/3/88	n/a	n/a	n/a	n/a	10.1	39
STS-27	12/6/88	n/a	n/a	n/a	n/a	9.0	33
STS-29 *	3/18/89	n/a	n/a	n/a	1.8	12.0	40
STS-30	5/8/89	n/a	n/a	n/a	n/a	11.9	43
STS-28 *	8/13/89	n/a	n/a	1.1	7.3	8.3	39
STS-34 *	10/23/89	n/a	n/a	1.9	2.8	11.0	48
STS-33 *	11/27/89	n/a	n/a	4.1	2.4	10.3	37
STS-32 *	1/20/90	n/a	n/a	0.5	n/a	15.2	47
STS-36 *	3/4/90	1.5	3.5	2.4	2.6	13.2	47
STS-31	4/29/90	n/a	n/a	4.2	2.3	11.6	43
STS-41	10/10/90	1.3	2.3	0.8	2.0	12.6	37
STS-38	11/20/90	1.7	2.8	2.2	2.9	10.2	46
STS-35	12/17/90	too dark	too dark	1.5	2.5-3.0	13.5	45
STS-37	4/11/91	2.9	4.8	2.9	2.8	7.1	43
STS-39	5/6/91	3.4	2.4	3.1	2.3	12.5	43
STS-40	6/14/91	2.1	2.1	n/a	n/a	15.2	39
STS-43	8/11/91	2.2	2.5	n/a	n/a	11.0	48
STS-48	9/18/91	too dark	too dark	too dark	too dark		
STS-44	12/1/91	1.5	3.5	n/a	n/a	8.6	98
STS-42	1/29/92	3.9	3.2	5.3	2.1	9.6	49
STS-45	4/2/92	2.0	2.9	1.0	2.0	8.5	70
STS-49	5/16/92					10.9	46

* - Sink rate estimated from raw data

NOTE: Sink rate data obtained approximately 1 second prior to main gear and nose gear touchdown

Summary of Analysis of Visual Events
STS-49
06/09/92

Task Number
3.01

Title : Determine Sink Rate from Video/Film

Analysts : R. Bhaskar
Date : 06/09/92

Camera Number : E1008
Frame Number : *
GMT :

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

Description of Analysis

*5783-5883
6896-6996

Sink rate was calculated for both the main gear and nose gear from landing camera E1008 on Runway 22. The calculated frame rate of the film was found to be 102 frames per second (fps) as compared to the 100 fps shown on the PADD.

Main Gear:
Points were selected on the main gear and the runway and the vertical stabilizer was used as a scaling reference. These points were taken over a period of approximately 1 second just prior to touchdown. This data was then normalized and a best-fit line was drawn. The slope of this line was found to be 2.0 feet per second.

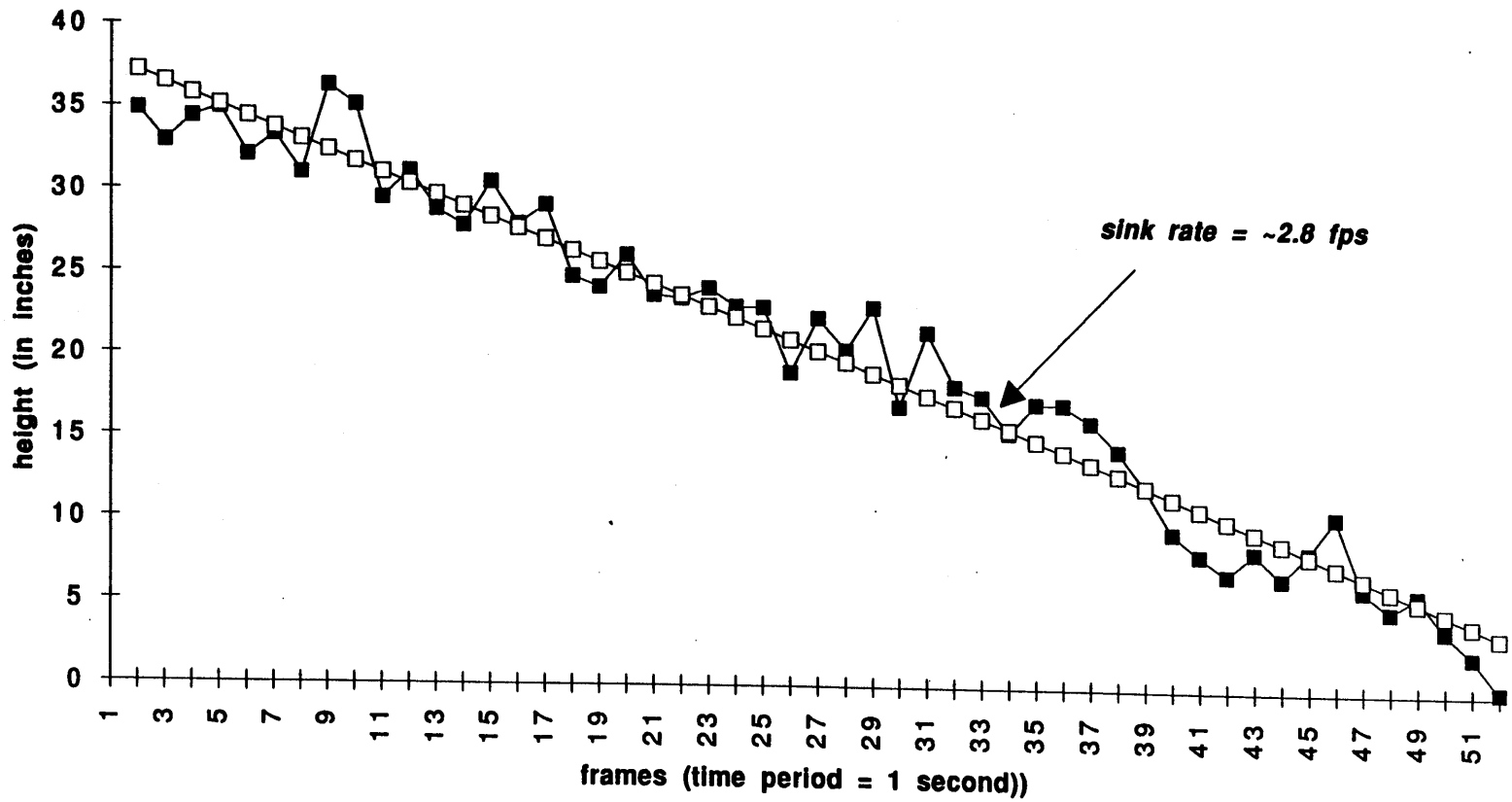
Nose Gear:
Points were selected on the nose gear and the runway and the nose wheel itself was used as a scaling reference. These points were taken over a period of approximately 1 second just prior to touchdown. This data was then normalized and a best-fit line was drawn. The slope of this line was found to be 2.8 feet per second.

Error:
Main gear measurement error was calculated to be ~+/-3 inches which implies a sink rate error to ~0.25 fps. No nose gear sink rate error was calculated.

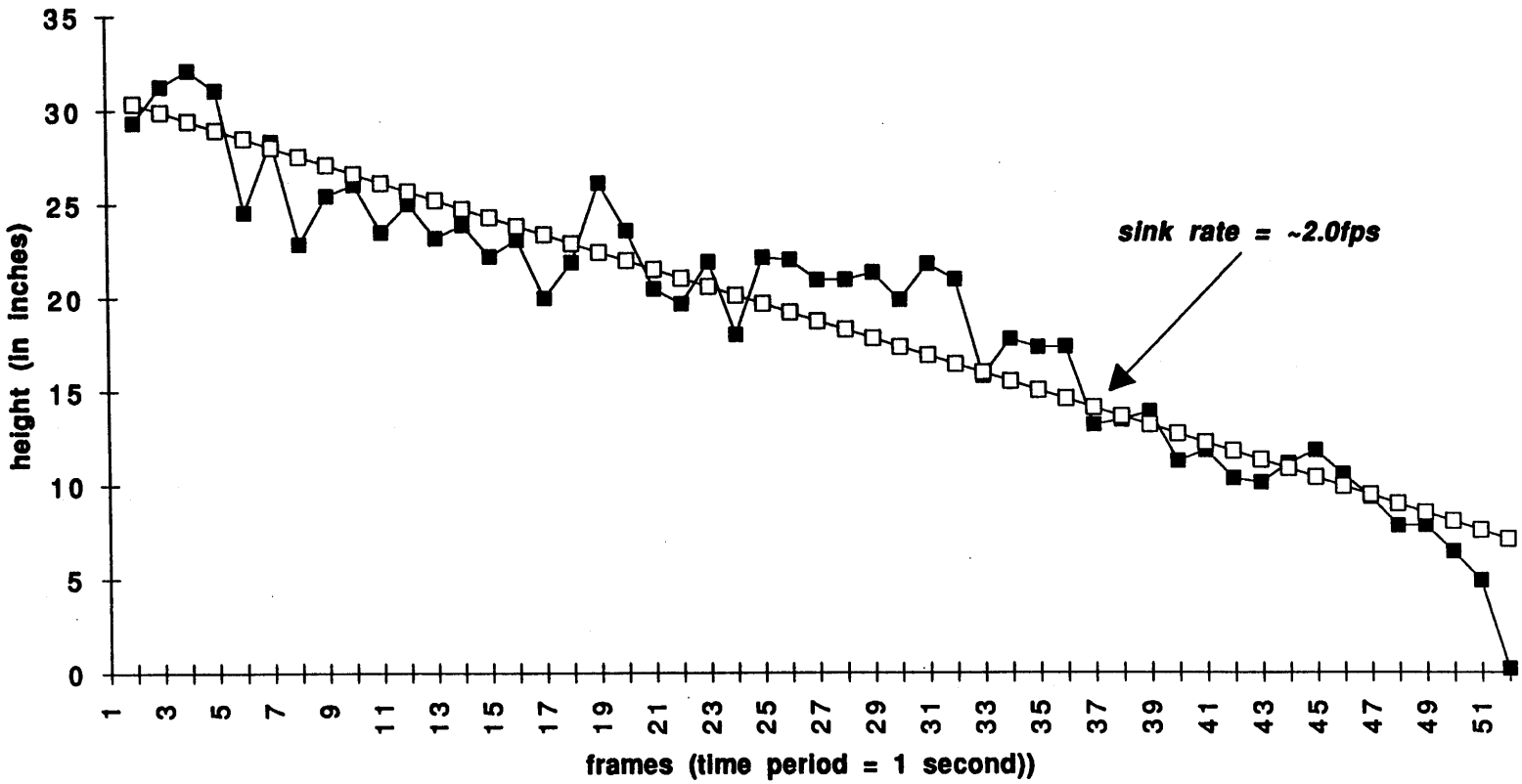
Image Analysis Tools & Techniques

Viewed films on FMA
Used PAST software to generate data
Used "modify_analyzer" routine to calculate distances between data points
Used EXCEL to plot points and create best-fit line (using "tend"

STS-49 NOSE GEAR SINK RATE



STS-49 MAIN GEAR SINK RATE



Photo/TV Analysis Group Request Form
STS-49
06/12/92

Task Number --> 4

Request Date : 10/16/91
Completion Date : 05/29/92

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-49
06/09/92

Task Number
4

Title : Body Flap Analysis

Analysts : M. Snyder
Date : 05/29/92

Camera Number : E-212
Frame Number :
GMT :

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

Description of Analysis

Body flap motion was seen on camera E-212 between the following frames:

2200-2500
2840-3442

The motion appeared about the same as previous missions. A great deal of atmospheric distortion was noticable (due mainly to plume motion and thermal effects). The SSME bells and SRB skirt also appeared to oscillate due to the atmospheric distortions.

Optical distortions noted at frame 3268 and 3098.

Image Analysis Tools & Techniques

Photo/TV Analysis Group Request Form
STS-49
06/12/92

Task Number --> 5

Request Date : 10/16/91
Completion Date : 06/10/92

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-49
06/15/92

Task Number
5

Title : Umbilical Well Camera Analysis

Analysts :
Date : 04/22/92

Camera Number :
Frame Number :
GMT :

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

Description of Analysis

Film was too dark for analysis.

Image Analysis Tools & Techniques

Photo/TV Analysis Group Request Form
STS-49
06/12/92

Task Number --> 6

Request Date : 10/16/91
Completion Date : 06/10/92

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-49
06/19/92

Task Number
6

Title : ET Onboard Hasselblad Photo Analysis

Analysts :
Date : 06/10/92

Camera Number :
Frame Number :
GMT :

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

Description of Analysis

ET Onboard Hasselblad Photo Analysis was not performed this mission.

Image Analysis Tools & Techniques

Photo/TV Analysis Group Request Form
STS-49
06/12/92

Task Number --> 7

Request Date : 10/16/91
Completion Date : 06/05/92

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 valve) 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-49
06/12/92

Task Number
7

Title : Velocity Measurements of SRB Duct Debris

Analysts : S. Israel
Date : 06/05/92

Camera Number :		**Requestor :**	Debris Team
Frame Number :		**Phone :**	483-1137
GMT :		**Mail Code :**	WC

Description of Analysis

Flame duct debris was seen on cameras E-7, E-8, E-9, E-10, E-11, E-12, E-14, and E-62. Since all the flame duct debris pieces were very small and the trajectories of these objects were very short or very difficult to see, velocity measurements will not be performed this mission.

Image Analysis Tools & Techniques

Photo/TV Analysis Group Request Form
STS-49
06/12/92

Task Number --> 8

Request Date : 10/16/91
Completion Date : 05/07/92

Requestor : Troy Welch
Phone : 483-3335
Mail Code : VF

Analyst Name	Phone Number	Assignment
Team		Screen & Report

Task Title

STS-49 ET Tanking Screening

Objectives

Hypothesis

Reporting

Analysis Strategy

1) Screen and tape the first 3 hours of ET tanking for STS-49
2) Review MER and PAO views during real time to identify any anomalies.
3) Report to MER

Summary of Analysis of Visual Events
STS-49
06/09/92

Task Number
8

Title : STS-49 ET Tanking Screening

Analysts : J. Hartman, R. Bhaskar
Date : 05/07/92

Camera Number :
Frame Number :
GMT :

Requestor : Troy Welch
Phone : 483-3335
Mail Code : VF

Description of Analysis

See attached for analysis

Image Analysis Tools & Techniques

STS-49 TANKING of OV-105 (Endeavour)
5/7/92

CAMERAS USED: 161, 152, 160, 163, 165, 166, 150, 162, 109

128:14:26:00	TANKING BEGINS ... CAMERA 161 SHOWS ET AREA CLOSEUPS
14:27-14:29:	Switching between first 9 cameras listed.
14:29	Camera 162 shows close-up view of ET hood (beanie cap).
14:30	Switching between 109 and 163 (views of LH2 umbilical area).
14:31	Camera 109 shows frost already on the umbilical at the Orbiter.
14:44:20	Both Cameras 109 and 163 show slight vapor rising from the top of the LH2 17" line.
14:47:45	Camera 163 zooming in and around umbilical area.
14:50	Camera 109 shows venting from both above and below the 17" line.
14:54	Vapors noted from purge port on 17" line (orbiter side).
14:55	Frost noted on baggie area on both Cameras 109 and 162.
14:58	Frost building up around cable tray connection to Orbiter.
15:03	Frost continues to build up around baggie material.
15:23	APPARENT HORIZONTAL JITTER OF THE VIDEO IS NOTED INTERMITTENTLY.
15:28	2ND SET OF TAPES ... Camera 109
15:50	Moisture droplets falling across field of view every 15-45 seconds from unknown source.
16:02	Frost continues to build up around baggie material.
16:05	Liquid drops noted falling from 4" recirculation line.
16:28	3RD SET OF TAPES ... Still Camera 109
16:57	Vapors from both top and bottom of 17" line appear to be reduced.
17:20	Called MER and they report they are in slow replenish mode and we are released from recording.
17:25	Switching between Cameras 143, 170, 171 (not pad views).

17:27 Tapes stopped. Launch is still a go ... weather forecast appears to be 50-50.

No anomalies or eventful occurrences were seen.

Photo/TV Analysis Group Request Form
STS-49
06/19/92

Task Number --> 9

Request Date : 04/24/92
Completion Date :

Requestor : John Kennedy
Phone : 483-8942
Mail Code : ES63

Analyst Name	Phone Number	Assignment
Clyde Sapp	483-5141	Lead

Task Title

Uplock Shear Pin Identification

Objectives

To determine the shape of the uplock shear pin which was installed on OV-105 on 2/10/92 and 2/11/92 in OPF Bay 1

Hypothesis

Two possible pins were installed. The shape of each pin is known.

Reporting

Analysis Strategy

1) Contact KSC (Denise Rosseau FTS-823-2090, in Chuck Brown's Group) to see if a higher quality video of T/0#-8450 (OTV) exists of "V5138 Drag Chute Install". She will also check for stills and motion picture footage.
2) Capture video and stills on RT disk
3) If acceptible image is found get drawings from John Kennedy and register to shear pin

No analysis was done on this task due to insufficient data.

Photo/TV Analysis Group Request Form
STS-49
06/10/92

Task Number --> 10

Request Date : 04/27/92
Completion Date :

Requestor : J. Kennedy
Phone : 483-8942
Mail Code : ES62

Analyst Name	Phone Number	Assignment
Clyde Sapp	483-5141	Lead
Steve Israel	244-5106	Analysis
Brian Gastineau	483-5167	Analysis

Task Title

Drag Chute Performance Analysis

Objectives

To assess velocities of the shuttle, angular and rotational motion of the chute, and deploy sequence.

Hypothesis

Reporting

Results should be available to R. Meyerson/O. Rodriguez in electronic form. Summary to J. Kennedy and other

Analysis Strategy

1) Screen videos/films to determine expected performance
   - Nose gear, main gear, wheel stop times
   - Track door
   - Time these events

2) Choose best views to:
   - Determine shuttle velocites/decelaration - horizontally prior to chute deploy (ground speed velocities through chute release)
   - Determine riser angle with reference degrees to the vehicle x-axis
   - Determine heading angles
   - Coning frequency
   - Determine the rate of rotation of the chute
   - Determine diameter of riser bundle and chute (not essential).
   - Determine riser shape and position at bag strip, post bag strip, and initial deploy.

3) Do analysis on views as necessary to find and check results

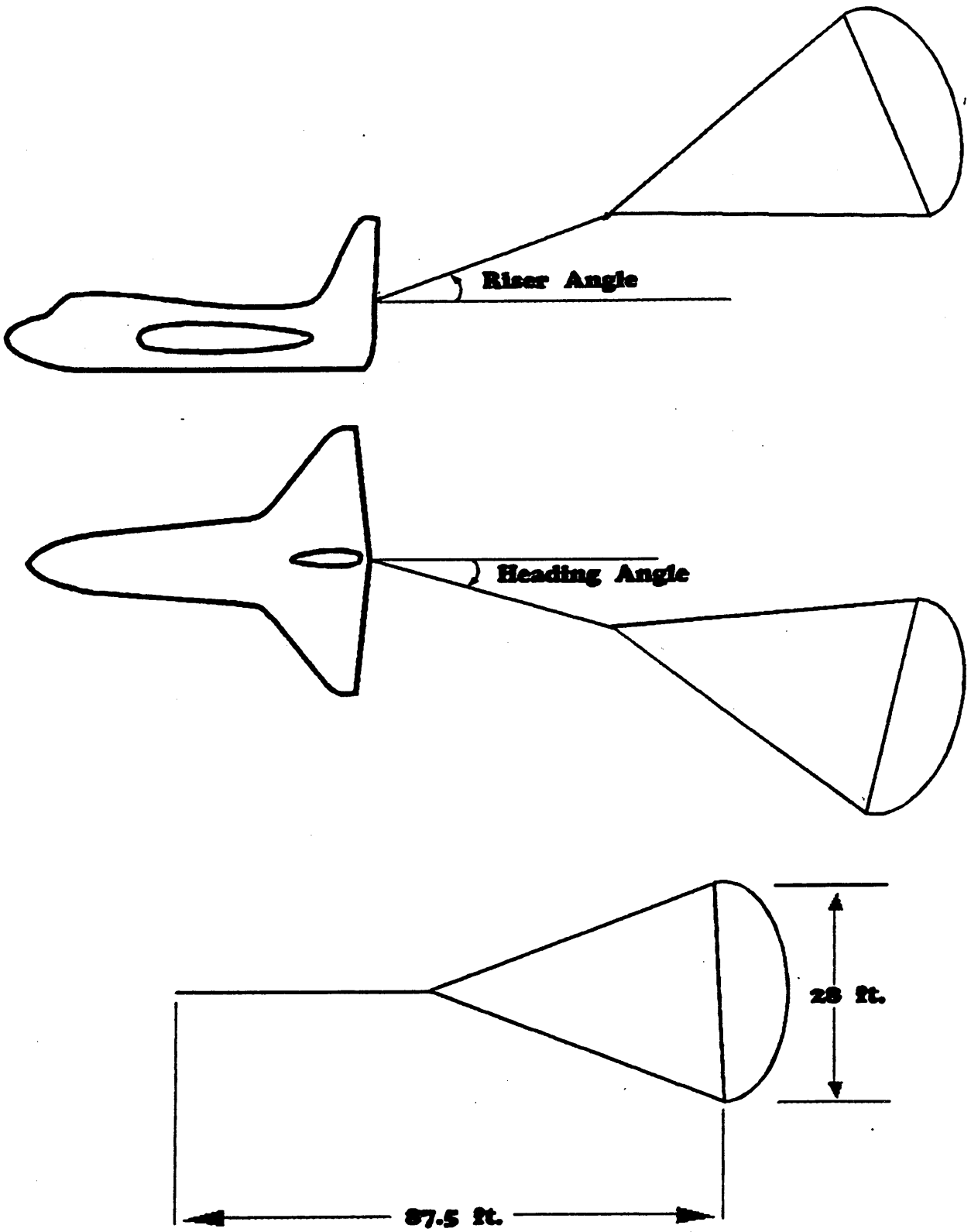
Photo/TV Analysis Group Request Form
STS-49
06/10/92

Task Number --> 10

Analysis Strategy

4) **Prepare results so they can be included in various models of chute performance**

STS Drag Chute



U.S. GOVT

Notes from Meeting with
Rob Meyerson (483-4629)
&
Oscar Rodriguez (333-7313)
May 19, 1992

- The initial requirement was to determine coning only through full chute inflation. That has been changed to include the entire timeline from chute deploy through chute release).
- The bag trajectory has become very low in priority. We can probably ignore it.
- Ignore the sabot trajectory. That is a predictable ballistic trajectory.
- During screening, we need to keep an eye out for the end of the riser striking the SSME when it is released from the Orbiter.
- Determine (in 3-D) the shape and position of the riser line at
  - bag strip (~ UTC 57:50.93)
  - post bag strip (~ UTC 57:51.061)
  - initial deploy (~ UTC 57:51.261)

Summary of Analysis of Visual Events
STS-49
06/09/92

Task Number
10

Title : Drag Chute Performance Analysis

Analysts : C.A. Sapp
Date : 05/17/92

Camera Number : KTV-3
Frame Number :
GMT :

Requestor : J. Kennedy
Phone : 483-8942
Mail Code : ES62

Description of Analysis

Digitized 800 frames to RTDD
Inflation of chute begins at from 150 (57:51:461)
Chute fully inflated (inpartial reef) at frame 174 (57:52.246)
unreefing begins at frame 254 (57:54.916)
Fully open at frame 366 (57:55.316)
(Note: Due to resolution problems, will probably be unable to use this view for rotation rates).

For determining coning frequency:

Will measure 1) left wing tip 2) right wing tip 3) top of vertical stabilizer and 4) center of chute

Saving frames 150 to 300 as the aerodynamics engineers expressed interest only in the dynamic portion of the chute deployment.

Allocated 16 image planes to MEM16 using MLOAD, loaded frames 150-165

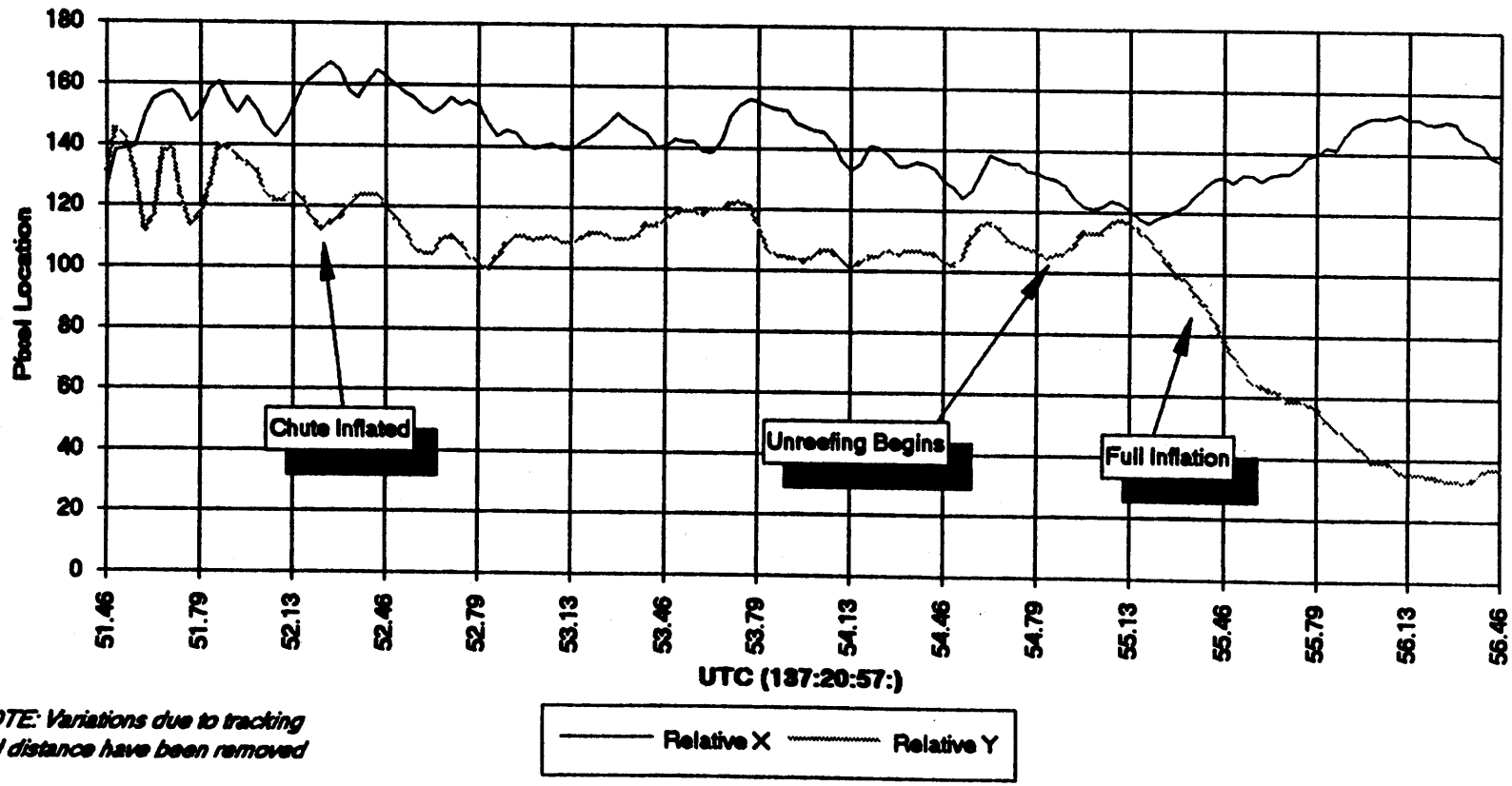
To simplify later processing, I am measuring all 16 frames of left wing tip, then all 16 frames of right wing tip, the tip of tail, then chute center.

Loading to memory, repeating some measures:
Chute 166-171 (repeated 10 frames)
172-187
188-203
204-219
220-235
236-251
252-267
268-283
284-299

Image Analysis Tools & Techniques

Image names CHUT150.PIC ... CHUT300.PIC

Relative Position of Chute Center



NOTE: Variations due to tracking and distance have been removed

Mission: STS-49 Task #10

JSC
Photo / Television
Analysis Project

	A	B	C	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	Wl	2		UTC (137:20:57:)		LW_x	LW_y	RW_x	RW_y	Tail_x	Tail_y	Chute_x	Chute_y	Ref_x	Ref_y	Ldist	Rdist	Tdist	Scale	Relative X	Relative Y
2	Wr	2		51.46		143	181	463	175	332	365	435	347	308.8	215.4	169	159	151	1	126.2	131.6
3	Wt	1		51.49		145	182	463	177	333	366	447	361	309.8	216.8	168	158	151	0.995	137.9	144.9
4				51.53		144	181	463	175	333	366	448	358	309.4	215.6	169	159	152	1	138.6	142.4
5				51.56		140	180	461	175	329	366	446	347	306.2	215.2	170	160	153	1.005	139.2	131.2
148				56.33		151	176	402	174	299	319	395	229	281	203.8	133	125	117	0.779	146.3	32.3
149				56.36		153	177	403	173	301	319	395	230	282.6	203.8	132	124	117	0.777	144.6	33.7
150				56.39		151	177	400	172	298	318	391	231	280	203.2	132	124	116	0.774	143.3	35.9
151				56.43		151	178	399	173	296	320	387	233	279.2	204.4	131	124	117	0.774	139.3	37.0
152				56.46		151	179	397	174	295	319	384	233	278.2	205	130	123	115	0.766	138.1	36.5
153																					
154																					
155																					
156																					
157																					

Many rows of unprinted data

Cell: A1
Note: Confidence weight factor for Left wing position.

Cell: G1
Note: X-Coord of tip of left wing

Cell: H1
Note: Y-Coord of tip of left wing

Cell: I1
Note: X-Coord of tip of right wing

Cell: J1
Note: Y-Coord of tip of right wing

Cell: K1
Note: X-Coord of tip of vertical stabilizer

Cell: L1
Note: Y-Coord of tip of vertical stabilizer

Cell: M1
Note: X-Coord for center of drag chute

Cell: N1
Note: y-Coord for center of drag chute

Cell: O1
Note: X-Coordinate of Reference point. (The reference point is defined as a weighted average of the three control points)

Cell: P1
Note: Y-Coordinate of Reference point. (The reference point is defined as a weighted average of the three control points)

Cell: Q1
Note: Distance of the Left wing tip from the reference point

Cell: R1
Note: Distance of the Right wing tip from the reference point

Cell: S1
Note: Distance of the tip of the tail from the reference point

Cell: T1
Note: Scale factor relative to the inital frame. Used in correcting for distance.

Cell: U1
Note: X-coordinate of the drag chute center with tracking and distance compensated.

Cell: V1
Note: Y-coordinate of the drag chute center with tracking and distance compensated.

Cell: A2
Note: Confidence weight factor for Right wing position.

Cell: A3
Note: Confidence weight factor for Vertical Stabilizer position.

STS-49 DRAG C. : SCREENING

CAMERA	LOCATION	TIMING	FRAME RATE	FOCAL LENGTH	MAIN GEAR TOUCHDOWN	NOSE GEAR TOUCHDOWN	DRAG CHUTE INITIATION	PILOT CHUTE INITIATION	BAG RELEASE
EXTRA #2	N/A	NO	200	N/A	NOTED - FRAME 369	FILM ENDS PRIOR TO NGT			
EXTRA #1	N/A	YES	200	N/A	FILM STARTS AFTER TOUCHDOWN	NOTED - 13:57:47.017	NOTED - 13:57:49.203	NOTED	NOTED
E1001A	1R	YES	100	14"	RIGHT - FRAME 2501; LEFT - FRAME 2502	NOTED - FRAME 3582	NOTED	NOTED	NOTED
E1001	1L	NO	200	6"	NOTED	NOTED	NOTED	WAS NOT NOTED	WAS NOT NOTED
E1002A	1R	YES - FAINT	200	20"	FILM STARTED AFTER M.G. TOUCHDOWN	NOTED - 57:46.98	OBSCURED BY VEHICLE	NOTED	
E1002	1L	NO	24	4"	NOTED	NOTED	NOTED	NOTED	NOTED
E1003A	1R	NO	24	4"	NOTED - FRAME 5783	NOTED	OBSCURED BY VEHICLE	NOTED	NOTED
E1007A	N/A	NO	50	N/A	NOTED - FRAME 10011		NOTED - FRAME 10629	NOTED	NOTED
E1008	3R	YES	100	14"	RIGHT - FRAME 5883; LEFT - FRAME 5885	NOTED - FRAME 6997	NOTED - FRAME 7014	NOTED - FRAME 7021	WAS NOT NOTED
E1009	3R	NO	24	4"	NOTED - FRAME 8994	NOTED	NOTED - FRAME 9545	WAS NOT NOTED	WAS NOT NOTED
E1010	3R	YES - FAINT	200	10"	RIGHT - FRAME 10701; LEFT - FRAME 10703	WAS NOT NOTED	WAS NOT NOTED	WAS NOT NOTED	WAS NOT NOTED
E1011	4R	NO	24	75 mm	NOTED	NOTED	NOTED	WAS NOT NOTED	WAS NOT NOTED
E1012	4R	YES	24	150 mm	RIGHT - FRAME 1324; LEFT - FRAME 1327	NOTED - FRAME 3465	NOTED - FRAME 3502	WAS NOT NOTED	WAS NOT NOTED
E1017	5R	NO	24	12-120 mm	RIGHT - FRAME 1442; LEFT - FRAME 1443	NOTED - FRAME 1703	NOTED - FRAME 1709	NOTED - FRAME 1731	NOTED - FRAME 1749
E1027	7R	YES	200	20"	AOV AFTER MAIN GEAR TOUCHDOWN	OBSCURED BY VEGETATION	NOTED - FRAME 2285	NOTED - FRAME 2474	NOTED - FRAME 2631
E1027A	7R	NO	24	10"	NOTED - FRAME 313		NOTED - FRAME 591		

STS-49 DRAG C E SCREENING

CHUTE INFLATION IN REEFED CONFIGURATION	DISREEFING INITIATION	FULL CHUTE INFLATION	CHUTE RELEASE	WHEEL STOP	CAMERA TYPE
					16 mm
NOTED	PARTIAL DISREEFING NOTED	NOTED - 13:58:17.313			16 mm
NOTED	NOTED	NOTED	NOTED - FRAME 6387	NOTED - FRAME 8170	35 mm
WAS NOT NOTED	WAS NOT NOTED	WAS NOT NOTED	NOTED - FRAME 11324	NOTED	16 mm
	NOTED - 54.74? (FRAME 2390)	NOTED - 55.22?	NOTED - 58:17.36?	NOTED - 58:34.87?	16 mm
NOTED	NOTED	NOTED	NOTED	NOTED	16 mm
NOTED	NOTED	NOTED	NOTED - FRAME 6765	NOTED	16 mm
NOTED	NOTED	NOTED			16 mm
WAS NOT NOTED	NOTED - FRAME 7593	NOTED - FRAME 7630	OBSCURED BY PARACHUTE	NOTED - FRAME 11414	35 mm
WAS NOT NOTED	NOTED	NOTED	OBSCURED BY CHUTE CANOPY	NOTED	16 mm
WAS NOT NOTED	NOTED - FRAME 14127	NOTED - FRAME 14210	WAS NOT NOTED	WAS NOT NOTED	16 mm
WAS NOT NOTED	WAS NOT NOTED	WAS NOT NOTED	OBSCURED BY CHUTE CANOPY	NOTED	16 mm
WAS NOT NOTED	WAS NOT NOTED	WAS NOT NOTED	NOTED - OBSCURED BY CHUTE	NOTED - FRAME 11833	16 mm
NOTED - FRAME 1784	NOTED - FRAME 1842	NOTED - FRAME 1855	OBSCURED BY CANOPY	FILM ENDED BEFORE WHEEL STOP	16 mm
NOTED - FRAME 2926	NOTED - FRAME 3418	NOTED - FRAME 3532	OBSCURED BY CHUTE CANOPY	NOTED	16 mm
					16 mm

TASK 10

Summary of Analysis of Visual Events
STS-49
06/15/92

Task Number
10.01

Title : Drag Chute Performance Analysis

Analysts : B. Pickin
Date : 05/29/92

Camera Number : E-1027
Frame Number :
GMT :

Requestor : J. Kennedy
Phone : 483-8942
Mail Code : ES62

Description of Analysis

Door was not visible in frames: 2298, 2322, 2346, 2350, 2383, 2386, 2402, 2406, 2408, 2412, 2422, 2434, 2466, 2486, 2490, 2494, 2506, 2510, 2546, 2570, 2574, 2573, 2582, 2594, 2634.

This analysis was between frames 2286 and 2642

Points collected were:
1. Right wing tip (back)
2. Top of the tail (back part)
3. Door

Image Analysis Tools & Techniques

Summary of Analysis of Visual Events
STS-49
06/09/92

Task Number
10.02

Title : Drag Chute Performance Analysis

Analysts : B. Pickin
Date : 06/03/92

Camera Number : E1001A
Frame Number :
GMT :

Requestor : J. Kennedy
Phone : 483-8942
Mail Code : ES62

Description of Analysis

Data collection of the riser and header angle. There area three files.

1 File S49E1001A_1.LOG: Starting frame 3839, Ending frame 4099
Frame 3943 has 2 entries (Pts. 131-140)
From frame 3839-3891 the points collected were: 1. Bottom of the Air Brake, 2. Top of the Air Brake, 3. Back of right wing tip, 4. Front left wing tip, 5. Riser pt.
From frame 3895-4099 the points collected were: 1. Bottom of the Air Brake, 2. Top of the Air Brake, 3. Top of tail-back tip, 4. Front left wing tip, 5. Riser pt.

2 File S49E1001A_2.LOG: Starting frame 4103, Ending frame 4199
(Bulb burnt out on frame 4135 so corner pts. were taken again)
Pts. collected: 1. Bottom of the Air Brake, 2. Top of the Air Brake, 3. Top of tail-brake, 4. Middle forward elliptical shaped RCS jet, 5. Left wing tip, 6. Riser pt.

3 File S49E1001A_3.LOG: Starting frame 4203, Ending frame 4687
Pts. collected: 1. Bottom of the Air Brake, 2. Top of the Air Brake, Back of right wing tip, 4. Middle forward elliptical shapped RCS jet, 5. Right back wing tip, 6. Riser pt.

The corner pts. were collected in this order:
1. Right bottom
2. Left bottom
3. Left top
4. Right Top

Files:
E1001A_1.LOG;1 - This corresponds to File 1
E1001A_2.LOG;1 - This cooresponds to File 2 and 3

Image Analysis Tools & Techniques

Summary of Analysis of Visual Events
STS-49
06/15/92

Task Number
10.03

Title : Drag Chute Performance Analysis

Analysts : B. Pickin
Date : 05/29/92

Camera Number : E-1002A
Frame Number :
GMT :

Requestor : J. Kennedy
Phone : 483-8942
Mail Code : ES62

Description of Analysis

Door was not in view because of the Orbiter in frames - 1333, 1345, 1349, 1397, 1457, 1465.

Door was not seen because it blended in with the background in frame 1621.

This analysis was between frames 1309 and 1351

Points collected were:
1. Front of the tail at the bottom
2. Back of the tail at the top
3. Door

Image Analysis Tools & Techniques

Summary of Analysis of Visual Events
STS-49
06/09/92

Task Number
10.04

Title : Drag Chute Performance Analysis

Analysts : B. Picken
Date : 06/01/92

Camera Number : E-1008
Frame Number :
GMT :

Requestor : J. Kennedy
Phone : 483-8942
Mail Code : ES62

Description of Analysis

Points collected for the riser angle are in PICKIN-STS-49 S49E1008_1.LOG and corner points are in E1008_1.LOG

There is an extra point on frame 7285. The number to be deleted is 45.

Starting frame - 7253
Ending frame - 8032

This collecting ended on frame 7412

Points collected are:

1. Stinger
2. Bottom of tail just above air brake
3. Left wing tip
4. Right main gear (center)
5. Riser point

Image Analysis Tools & Techniques

FIDUCIAL MARK ANALYSIS

	A	B	C	D	E	F	G	H	I
1	FIDUCIAL	X-COORD	Y-COORD	FRAME	CENTER OF	ROTATION	AVERAGE	CENTER	SLOPE
2					X	Y	X	Y	
3	BOTTOM	234.67999	95.44	7253	234.71001	219.1	234.732504	219.02	-0.001559
4	LEFT	67.94	219.36	7253					
5	TOP	234.86	349.01999	7253					
6	RIGHT	401.48001	218.84	7253					
7									
8	BOTTOM	234.58	94.96	7413	234.64	218.89			-0.0013766
9	LEFT	67.56	219.12	7413					
10	TOP	234.84	349.01999	7413					
11	RIGHT	401.72	218.66	7413					
12									
13	BOTTOM	237.82001	95.46	7417	234.64001	219.279995			0.02409497
14	LEFT	67.8	215.25999	7417					
15	TOP	231.38	349.17999	7417					
16	RIGHT	401.48001	223.3	7417					
17									
18	BOTTOM	237.86	95.24	8033	234.94001	218.810005			0.02391797
19	LEFT	68.12	214.82001	8033					
20	TOP	231.66	348.85999	8033					
21	RIGHT	401.76001	222.8	8033					

FIDUCIAL MARK ANALYSIS

	J	K	L	M	N
1	ANGLE	AVERAGE	ROTATION	DISTANCE	FRAME
2					
3	-0.089326			333.540415	7253
4					7253
5					7253
6		-0.0840992			7253
7					
8	-0.0788725			334.160317	7413
9					7413
10			1.45930437		7413
11					7413
12					
13	1.38027304			333.776858	7417
14					7417
15					7417
16		1.37520512			7417
17					
18	1.3701372			333.735429	8033
19					8033
20					8033
21					8033

FIDUCIAL MARK ANALYSIS

Cell: E1
Note: THESE POINTS ARE THE CENTERS OF ROTATION OF THE FILM PICTURE USING THE LEFT AND RIGHT FIDUCIAL POINTS.

Cell: G1
Note: THIS IS THE AVERAGE CENTER OF ROTATION OF THE FILM PICTURE USING THE DATA IN THE PREVIOUS COLUMNS.

Cell: I1
Note: THESE ARE THE SLOPES OF THE LINE CONNECTING THE LEFT AND RIGHT FIDUCIAL MARKS.

Cell: K1
Note: THESE ARE THE AVERAGE ANGLES (OF THE LINE CONNECTING THE LEFT AND RIGHT FIDUCIAL MARKS) FROM THE HORIZONTAL.(IN DEGREES)

Cell: L1
Note: THIS IS THE AMOUNT OF ROTATION OF THE FILM PICTURE FROM THE FIRST TO SECOND DATA COLLECTING SESSION.

Cell: M1
Note: THESE ARE THE DISTANCES BETWEEN THE LEFT AND RIGHT FIDUCIAL MARKS.

Cell: A3
Note: THESE POINTS WERE TAKEN AT THE BEGINNING OF THE FIRST DATA COLLECTION SESSION.

Cell: A8
Note: THESE POINTS WERE TAKEN AT THE END OF THE FIRST DATA COLLECTION SESSION.

Cell: A13
Note: THESE POINTS WERE TAKEN AT THE BEGINNING OF THE SECOND DATA COLLECTION SESSION.

Cell: A18
Note: THESE POINTS WERE TAKEN AT THE END OF THE SECOND DATA COLLECTION SESSION.

Summary of Analysis of Visual Events
STS-49
06/15/92

Task Number
10.05

Title : Drag Chute Performance Analysis

Analysts : B. Picken
Date : 06/02/92

Camera Number : E-1008
Frame Number :
GMT :

Requestor : J. Kennedy
Phone : 483-8942
Mail Code : ES62

Description of Analysis

Complete data file is in S49E1008_1.LOG;14
Fiducial mark data is in file E1008_1.LOG;2 for the first day
and E1008_2.LOG;3 for the second day .
Collected data from frame 7417 to frame 8033

edited:

inserted points	between points
235	231, 232
354	348, 349
355	344, 345
503	500, 501
742	740, 741

Deleted lines 756 and 777

Starting on frame 7457, the right main gear is no longer used. The right wing tip is now used in its place.

The zero point is still on frame 0.
On frame 7725, the 5th point was inserted from a new file because it was skipped during the original data collecting.

Image Analysis Tools & Techniques

Summary of Analysis of Visual Events
STS-49
06/09/92

Task Number
10.06

Title : Drag Chute Performance Analysis

Analysts : S. Harris
Date : 06/04/92

Camera Number : *
Frame Number :
GMT :

Requestor : J. Kennedy
Phone : 483-8942
Mail Code : ES62

Description of Analysis

*E1001A and E1008

Purpose was to find frame rate for both cameras E1001A & E1008 using frame numbers from right main gear touchdown and nose gear touchdown and their corresponding times.

E1001A - main gear touchdown - frame 2501 time 137:20:57:38.145
nose gear touchdown - frmae 3582 time 137:20:57:49.045
E1008 - main gear touchdown - frame 5883 time 137:20:57:38.145
nose gear touchdown - frame 6997 time 137:20:57:49.045

fps = number frames / length of time E1001A fps = 99 fps
E1008 fps = 102 fps

Next, determined timing for start and end frame numbers for both cameras.
E1001A - start frame 3839 time 137:20:57:51.641
end frame 4687 time 137:20:58:00.207
E1008 - start frame 7253 time 137:20:57:51.555
end frame 8033 time 137:20:57:59.202

time = start (end) frame - (frame with known time) + known time
fps

Image Analysis Tools & Techniques

Summary of Analysis of Visual Events
STS-49
06/09/92

Task Number
10.07

Title : Drag Chute Performance Analysis

Analysts : B. Pickin
Date : 06/04/92

Camera Number : E1008
Frame Number :
GMT :

Requestor : J. Kennedy
Phone : 483-8942
Mail Code : ES62

Description of Analysis

Used the fiducial marks to find the average center rotation, amount of rotation, and the distance between the left and right fiducial marks (to find out if it enlarged between data collecting sessions).

The picture was rotated 1.459 degrees (counter-clockwise). The average center of rotation was (234.73, 219.02). The picture was reduced by .03% which is well within acceptable error.

Image Analysis Tools & Techniques

Summary of Analysis of Visual Events
STS-49
06/09/92

Task Number
10.08

Title : Drag Chute Performance Analysis

Analysts : C. Sapp
Date : 06/08/92

Camera Number :
Frame Number :
GMT :

Requestor : J. Kennedy
Phone : 483-8942
Mail Code : ES62

Description of Analysis

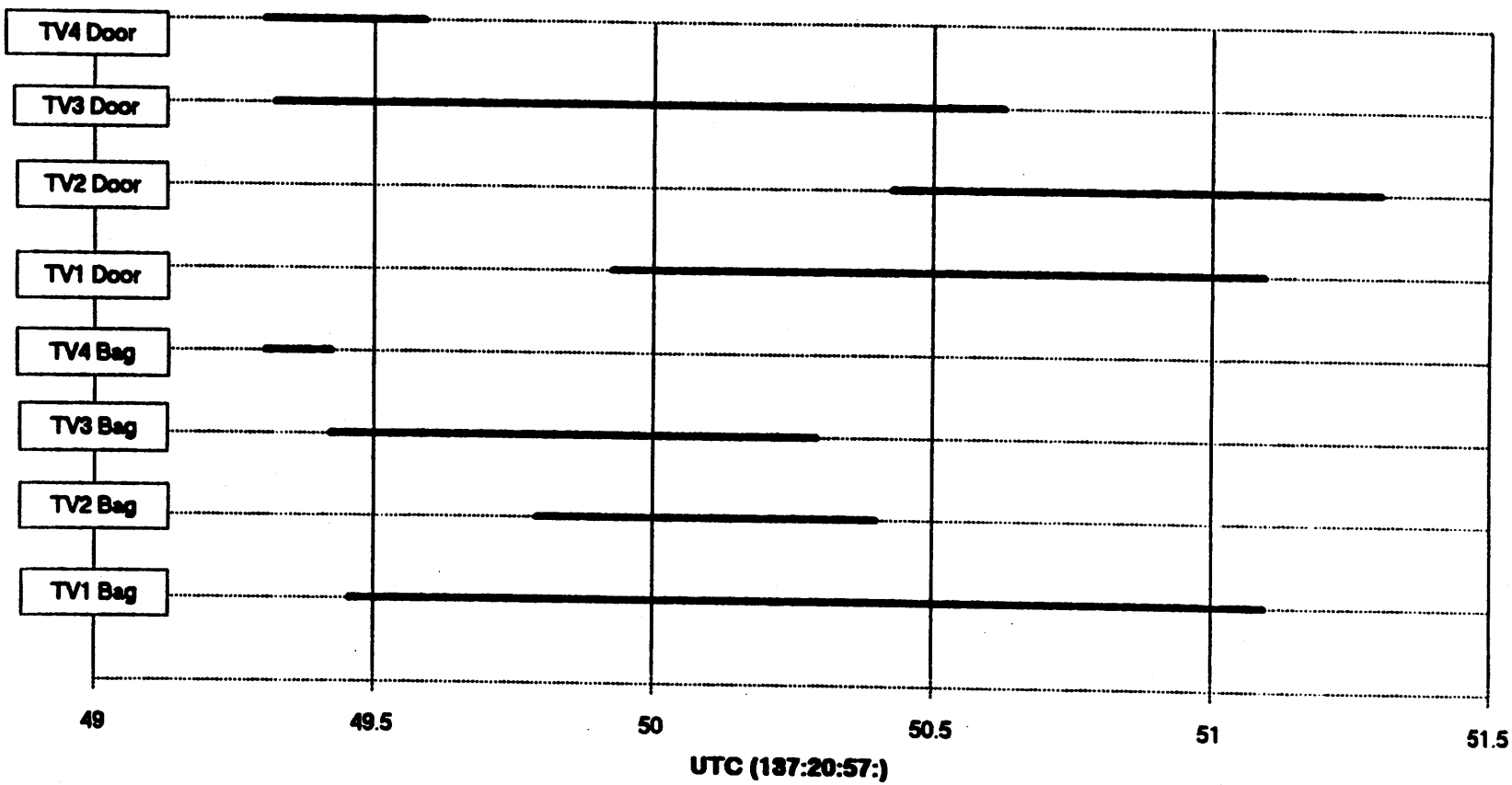
See attached

Image Analysis Tools & Techniques

BAG AND DOOR TRAJECTORIES

	BAG		DOOR	
	FIRST	LAST	FIRST	LAST
TV1	57:49.459	57:51.094	57:49.927	57:51.094
TV2	57:49.793	? Barely visible	57:50.427	? Difficult to see
TV3	57:49.426 Out of focus	57:50.294	57:49.326 Out of focus	57:50.627
TV4	57:49.307 Motion blur	57:49.425	57:49.307	57:49.592
LRO		INVALID TIME,	HARD TO SEE	
SBEV		INVALID	TIME	
IR		INVALID TIME,	HARD TO SEE	

Video Timeline of Drag Chute Door and Bag Visibility



Mission: STS-49

JSC
Photo / Television
Analysis Project

ROTATION AND ENLARGEMENT/REDUCTION ANALYSIS - E1001A

	A	B	C	D	I	J	M	O	P
1	CORNER	X-COORD.	Y-COORD.	FRAME	CENTER OF	ROTATION	ROTATION	DISTANCE	FRAME
2					X-COORD.	Y-COORD.	(IN DEGREES)	(PERCENTAGE)	
3	SESSION 1								
4									
5	RIGHT BOTTOM	402.29999	116.42	3839					3839
6	LEFT BOTTOM	67.46	116.4	3839					3839
7	LEFT TOP	67.76	321.29999	3839					3839
8	RIGHT TOP	402.23999	320.73999	3839					3839
9	RIGHT BOTTOM	402.17999	116.42	3839					3839
10	LEFT BOTTOM	67.42	116.42	3839					3839
11	LEFT TOP	67.56	321.01999	3839					3839
12	RIGHT TOP	402.14001	320.82001	3839					3839
13	RIGHT BOTTOM	402.32001	116.52	3839					3839
14	LEFT BOTTOM	67.52	116.24	3839					3839
15	LEFT TOP	67.74	321.17999	3839					3839
16	RIGHT TOP	402.12	320.92001	3839					3839
17	RIGHT BOTTOM	402.38	116.5	3839					3839
18	LEFT BOTTOM	67.42	116.38	3839					3839
19	LEFT TOP	67.68	321.10001	3839					3839
20	RIGHT TOP	402.07999	321.10001	3839					3839
21	RIGHT BOTTOM	401.76001	116.94	4099	234.819999	219.109998	0.05544385	-0.06033707	4099
22	LEFT BOTTOM	66.9	116.8	4099					4099
23	LEFT TOP	67.48	321.76001	4099					4099
24	RIGHT TOP	401.64001	321.29999	4099					4099
25	RIGHT BOTTOM	401.66	116.96	4099					4099
26	LEFT BOTTOM	66.94	116.78	4099					4099
27	LEFT TOP	67.6	321.85999	4099					4099
28	RIGHT TOP	401.66	321.39999	4099					4099
29	RIGHT BOTTOM	401.73999	116.9	4099					4099
30	LEFT BOTTOM	67	116.86	4099					4099
31	LEFT TOP	67.5	321.78	4099					4099
32	RIGHT TOP	401.76001	321.29999	4099					4099
33	RIGHT BOTTOM	401.85999	117.08	4099					4099

ROTATION AND ENLARGEMENT/REDUCTION ANALYSIS - E1001A

	A	B	C	D	I	J	M	O	P
34	LEFT BOTTOM	66.86	116.98	4099					4099
35	LEFT TOP	67.6	322.01999	4099					4099
36	RIGHT TOP	401.64001	321.35999	4099					4099
37									
38	SESSION 2								
39									
40	RIGHT BOTTOM	401.73999	116.8	4103	234.577498	219.214998	-0.0765615	0.022876569	4103
41	LEFT BOTTOM	66.92	116.38	4103					4103
42	LEFT TOP	67.14	321.23999	4103					4103
43	RIGHT TOP	401.54001	320.95999	4103					4103
44	RIGHT BOTTOM	401.73999	116.7	4103					4103
45	LEFT BOTTOM	66.84	116.4	4103					4103
46	LEFT TOP	67.28	321.22	4103					4103
47	RIGHT TOP	401.38	321.04001	4103					4103
48	RIGHT BOTTOM	401.76001	116.72	4103					4103
49	LEFT BOTTOM	67.08	116.4	4103					4103
50	LEFT TOP	67.28	321.22	4103					4103
51	RIGHT TOP	401.56	321.07999	4103					4103
52	RIGHT BOTTOM	401.89999	116.88	4103					4103
53	LEFT BOTTOM	67.02	116.52	4103					4103
54	LEFT TOP	67.2	321.35999	4103					4103
55	RIGHT TOP	401.48001	321.07999	4103					4103
56	RIGHT BOTTOM	401.84	117.16	4135	234.487499	219.18125	-0.0345414	0.076726962	4135
57	LEFT BOTTOM	66.96	116.7	4135					4135
58	LEFT TOP	66.94	321.60001	4135					4135
59	RIGHT TOP	401.70001	321.51999	4135					4135
60	RIGHT BOTTOM	401.92001	117.1	4135					4135
61	LEFT BOTTOM	66.86	116.66	4135					4135
62	LEFT TOP	67.02	321.56	4135					4135
63	RIGHT TOP	401.66	321.57999	4135					4135
64	RIGHT BOTTOM	401.98001	117.08	4135					4135
65	LEFT BOTTOM	66.94	116.5	4135					4135
66	LEFT TOP	67.12	321.60001	4135					4135

ROTATION AND ENLARGEMENT/REDUCTION ANALYSIS - E1001A

	A	B	C	D	I	J	M	O	P
67	RIGHT TOP	401.72	321.48001	4135					4135
68	RIGHT BOTTOM	402.01999	117.16	4135					4135
69	LEFT BOTTOM	66.9	116.52	4135					4135
70	LEFT TOP	66.92	321.5	4135					4135
71	RIGHT TOP	401.54001	321.56	4135					4135
72	RIGHT BOTTOM	402.12	116.66	4687	234.661001	219.083501	0.00410649	-0.06847767	4687
73	LEFT BOTTOM	67.4	116.22	4687					4687
74	LEFT TOP	67.58	321	4687					4687
75	RIGHT TOP	402.01999	321.07999	4687					4687
76	RIGHT BOTTOM	402.14001	116.68	4687					4687
77	LEFT BOTTOM	67.24	116.28	4687					4687
78	LEFT TOP	67.48	320.94	4687					4687
79	RIGHT TOP	402.04001	321.12	4687					4687
80	RIGHT BOTTOM	402.20001	116.56	4687					4687
81	LEFT BOTTOM	67.46	116.24	4687					4687
82	LEFT TOP	67.24	320.79999	4687					4687
83	RIGHT TOP	402.01999	321.07999	4687					4687
84	RIGHT BOTTOM	402.29999	116.7	4687					4687
85	LEFT BOTTOM	67.2	116.4	4687					4687
86	LEFT TOP	67.56	321.10001	4687					4687
87	RIGHT TOP	402.10001	321.10001	4687					4687
88	RIGHT BOTTOM	402.23999	116.7	4687					4687
89	LEFT BOTTOM	67.52	116.24	4687					4687
90	LEFT TOP	67.66	321.07999	4687					4687
91	RIGHT TOP	402	321.04001	4687					4687
92									
93				OVERALL	234.636499	219.147437	-0.0515526	-0.02921121	
94									
95					X-COORD.	Y-COORD.	(IN DEGREES)	(PERCENTAGE)	
96	CORNER	X-COORD.	Y-COORD.	FRAME	CENTER OF	ROTATION	ROTATION	DISTANCE	FRAME

ROTATION AND ENLARGEMENT/REDUCTION ANALYSIS - E1001A

Cell: I1
Note: THIS IS THE AVERAGE CENTER OF ROTATION.

Cell: M1
Note: THIS IS THE ROTATION BETWEEN THE BEGINNING AND END OF THE SESSION. POSITIVE ROTATION IS CLOCKWISE.

Cell: O1
Note: THESE ARE THE PERCENTAGES BY WHICH THE DIAGONAL WAS ENLARGED OR REDUCED. ENLARGING IS POSITIVE.

Cell: A3
Note: DURING THIS SESSION, FIVE POINTS WERE COLLECTED.

Cell: A5
Note: THESE POINTS WERE TAKEN AT THE BEGINNING OF THE DATA COLLECTION SESSION(ONE USING 5 POINTS.).

Cell: A21
Note: THESE POINTS WERE TAKEN AT THE END OF THE DATA COLLECTION SESSION(ONE USING 5 POINTS.).

Cell: A38
Note: DURING THIS SESSION, SIX POINTS WERE COLLECTED.

Cell: A40
Note: THESE POINTS WERE TAKEN AT THE BEGINNING OF THE DATA COLLECTION SESSION(ONE USING 6 POINTS.).

Cell: A56
Note: THESE POINTS WERE TAKEN AFTER THE BULB WAS REPLACED.

Cell: A76
Note: THESE POINTS WERE TAKEN AT THE END OF THE DATA COLLECTION SESSION(ONE USING 6 POINTS.).

Summary of Analysis of Visual Events
STS-49
06/09/92

Task Number
10.09

Title : Drag Chute Performance Analysis

Analysts : B. Pickin
Date : 06/08/92

Camera Number : E1001A
Frame Number :
GMT :

Requestor : J. Kennedy
Phone : 483-8942
Mail Code : ES62

Description of Analysis

Used the corner points to determine rotation and change in size of the film picutre.

Beginning of session 1 - End of session 1:
Center of rotation - x - 234.819999
y - 219.109998
Rotation was .055 degrees clockwise
Diagonal distance (top left to bottom right) was reduced by .06%

End of session 1 - Beginning of session 2:
Center of rotation - x - 234.577498
y - 219.214998
Rotation was .077 degrees counter-clockwise
Diagonal distance was enlarged by .023%

Beginning of session 2 - Bulb replacement:
Center of rotation - x - 234.487499
y - 219.18125
Rotation was .035 degrees counter-clockwise
Diagonal distance was enlarged by .077%

Bulb replacement - End of session 2:
Center of rotation - x - 234.661001
y - 219.083501
Rotation was .0041 degrees clockwise
Diagonal distance was reduced by .069%

Overall:
Center of rotation was x - 234.636499
y - 219.147437
Rotation was .052 degrees counter-clockwise
Diagonal distance was reduced by .029%

Image Analysis Tools & Techniques

Summary of Analysis of Visual Events
STS-49
06/15/92

Task Number
10.10

Title : Drag Chute Performance Analysis

Analysts : S. Harris
Date : 06/11/92

Camera Number : KTV-4
Frame Number :
GMT :

Requestor : J. Kennedy
Phone : 483-8942
Mail Code : ES62

Description of Analysis

Three KTV4 frames were digitized:
1) Bag strip:
a.(frameone_riser.dat) includes data for riser and first two points are coordinates on stabilizer.

b.(bagstripplacement_riser.dat) front main gear door the center of wheels.

c.(bagtail_riser.dat) outline of stabilizer.

2) Post Bag Strip:
a. (secondframe_riser.dat) data for riser,first two points are coordinates on stabilizer.

b. (postplacement_riser.dat) front main gear door, then center of wheels.

c. (posttail_riser.dat) outline of stabilizer.

3) Initial Deploy
a. (thirdframe_riser.dat) data for riser, first two points are coordinates on stabilizer.

b. (deployplacement_riser.dat) front main gear door, center of wheels.

c. (deploytail_riser.dat) outline of stabilizer.

Image Analysis Tools & Techniques

Summary of Analysis of Visual Events
STS-49
06/15/92

Task Number
10.11

Title : Drag Chute Performance Analysis

Analysts : B. Pickin
Date : 06/11/92

Camera Number : KTV-4
Frame Number :
GMT :

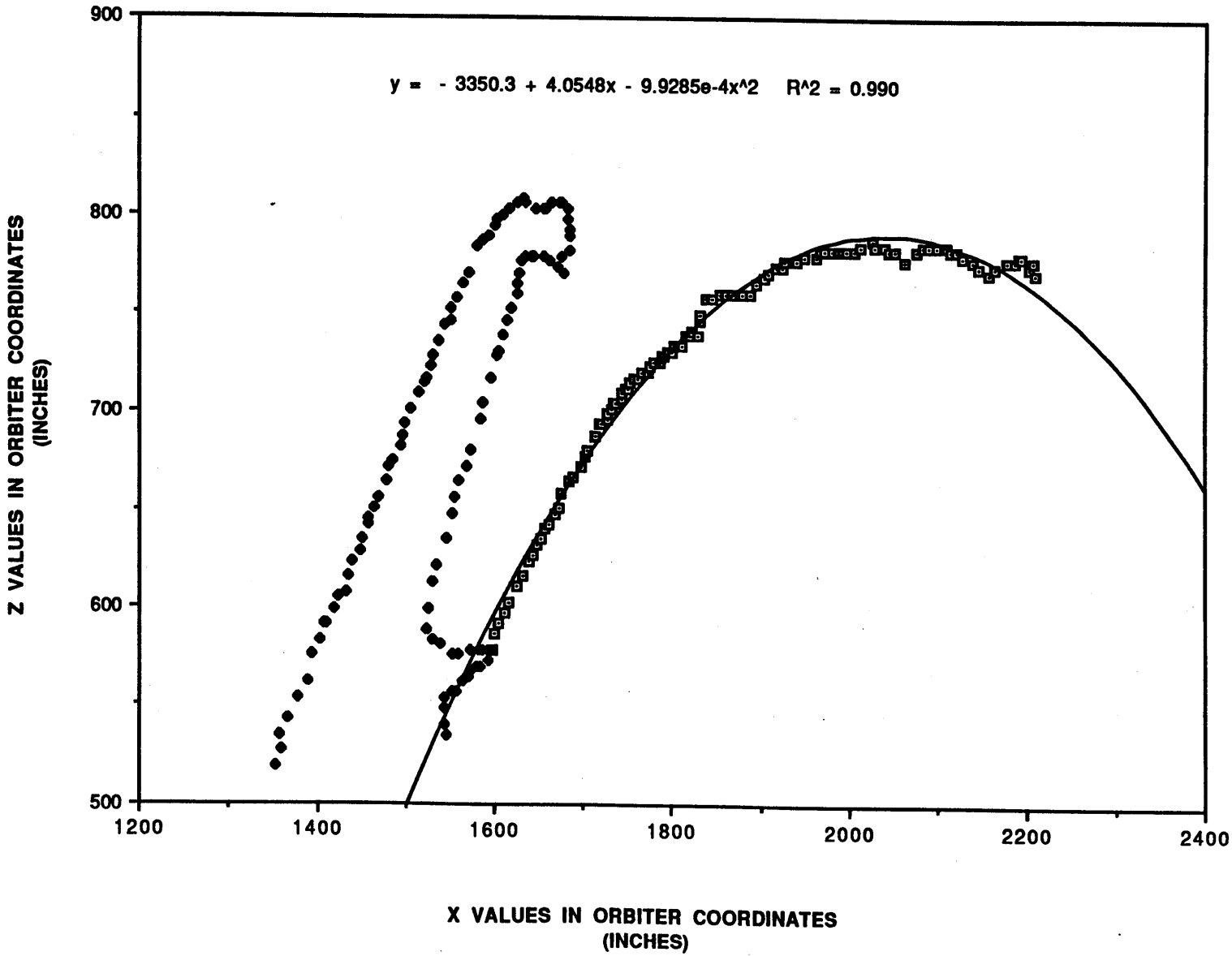
Requestor : J. Kennedy
Phone : 483-8942
Mail Code : ES62

Description of Analysis

Received frames that were digitized from KTV-4 and changed the data points from video units to Orbiter coordinates.

Image Analysis Tools & Techniques

RISER CURVATURE - BAG STRIP STAGE



RISER AND TAIL DATA - BAG STRIP STAGE

	A	B	C	D
1		COORDINATES	IN INCHES	
2				
3	RISER		TAIL	
4	X	Z	X	Z
5	1596.81	578	1594.13	578
6	1599.49	586.04	1674.53	779
7	1604.85	591.4	1545.89	535.12
8	1610.21	596.76	1543.21	540.48
9	1615.57	602.12	1543.21	548.52
10	1623.61	610.16	1543.21	553.88
11	1631.65	615.52	1551.25	556.56
12	1637.01	623.56	1556.61	556.56
13	1642.37	626.24	1561.97	561.92
14	1647.73	631.6	1570.01	564.6
15	1650.41	634.28	1572.69	567.28
16	1655.77	639.64	1578.05	569.96
17	1661.13	642.32	1583.41	569.96
18	1666.49	647.68	1591.45	572.64
19	1671.85	650.36	1591.45	578
20	1674.53	658.4	1591.45	578
21	1682.57	663.76	1586.09	578
22	1687.93	666.44	1580.73	578
23	1695.97	671.8	1572.69	578
24	1701.33	677.16	1559.29	575.32
25	1704.01	679.84	1551.25	575.32
26	1712.05	687.88	1537.85	580.68
27	1717.41	693.24	1529.81	583.36
28	1720.09	693.24	1521.77	588.72
29	1725.45	695.92	1524.45	599.44
30	1725.45	698.6	1529.81	612.84
31	1730.81	701.28	1532.49	620.88
32	1733.49	703.96	1545.89	634.28
33	1736.17	703.96	1551.25	647.68
34	1741.53	706.64	1553.93	655.72
35	1741.53	709.32	1559.29	663.76
36	1746.89	712	1567.33	671.8
37	1749.57	712	1572.69	679.84
38	1752.25	714.68	1583.41	695.92
39	1754.93	717.36	1586.09	703.96
40	1760.29	717.36	1594.13	717.36
41	1765.65	720.04	1602.17	728.08
42	1771.01	720.04	1604.85	730.76
43	1773.69	722.72	1607.53	738.8
44	1779.05	725.4	1612.89	746.84
45	1784.41	725.4	1618.25	752.2

RISER AND TAIL DATA - BAG STRIP STAGE

	A	B	C	D
46	1787.09	728.08	1623.61	760.24
47	1789.77	728.08	1623.61	765.6
48	1795.13	730.76	1626.29	770.96
49	1797.81	730.76	1628.97	776.32
50	1800.49	733.44	1634.33	779
51	1805.85	733.44	1639.69	779
52	1808.53	733.44	1642.37	779
53	1811.21	733.44	1653.09	779
54	1813.89	738.8	1661.13	776.32
55	1819.25	738.8	1669.17	773.64
56	1821.93	741.48	1677.21	770.96
57	1827.29	738.8	1674.53	779
58	1829.97	746.84	1682.57	781.68
59	1829.97	749.52	1682.57	789.72
60	1838.01	757.56	1682.57	792.4
61	1843.37	757.56	1679.89	797.76
62	1854.09	760.24	1679.89	803.12
63	1859.45	760.24	1674.53	805.8
64	1867.49	760.24	1671.85	805.8
65	1878.21	760.24	1663.81	805.8
66	1886.25	760.24	1655.77	803.12
67	1894.29	765.6	1653.09	803.12
68	1902.33	768.28	1645.05	803.12
69	1907.69	770.96	1634.33	805.8
70	1915.73	773.64	1631.65	808.48
71	1923.77	773.64	1623.61	805.8
72	1926.45	776.32	1615.57	803.12
73	1934.49	776.32	1607.53	800.44
74	1937.17	776.32	1602.17	797.76
75	1939.85	776.32	1599.49	795.08
76	1947.89	779	1591.45	789.72
77	1961.29	779	1586.09	787.04
78	1966.65	781.68	1586.09	787.04
79	1972.01	781.68	1578.05	784.36
80	1980.05	781.68	1570.01	770.96
81	1988.09	781.68	1561.97	765.6
82	1990.77	781.68	1556.61	757.56
83	1996.13	781.68	1548.57	752.2
84	2004.17	781.68	1548.57	746.84
85	2012.21	784.36	1543.21	744.16
86	2025.61	787.04	1535.17	736.12
87	2028.29	784.36	1529.81	728.08
88	2039.01	784.36	1527.13	722.72
89	2044.37	781.68	1521.77	717.36
90	2049.73	781.68	1519.09	714.68

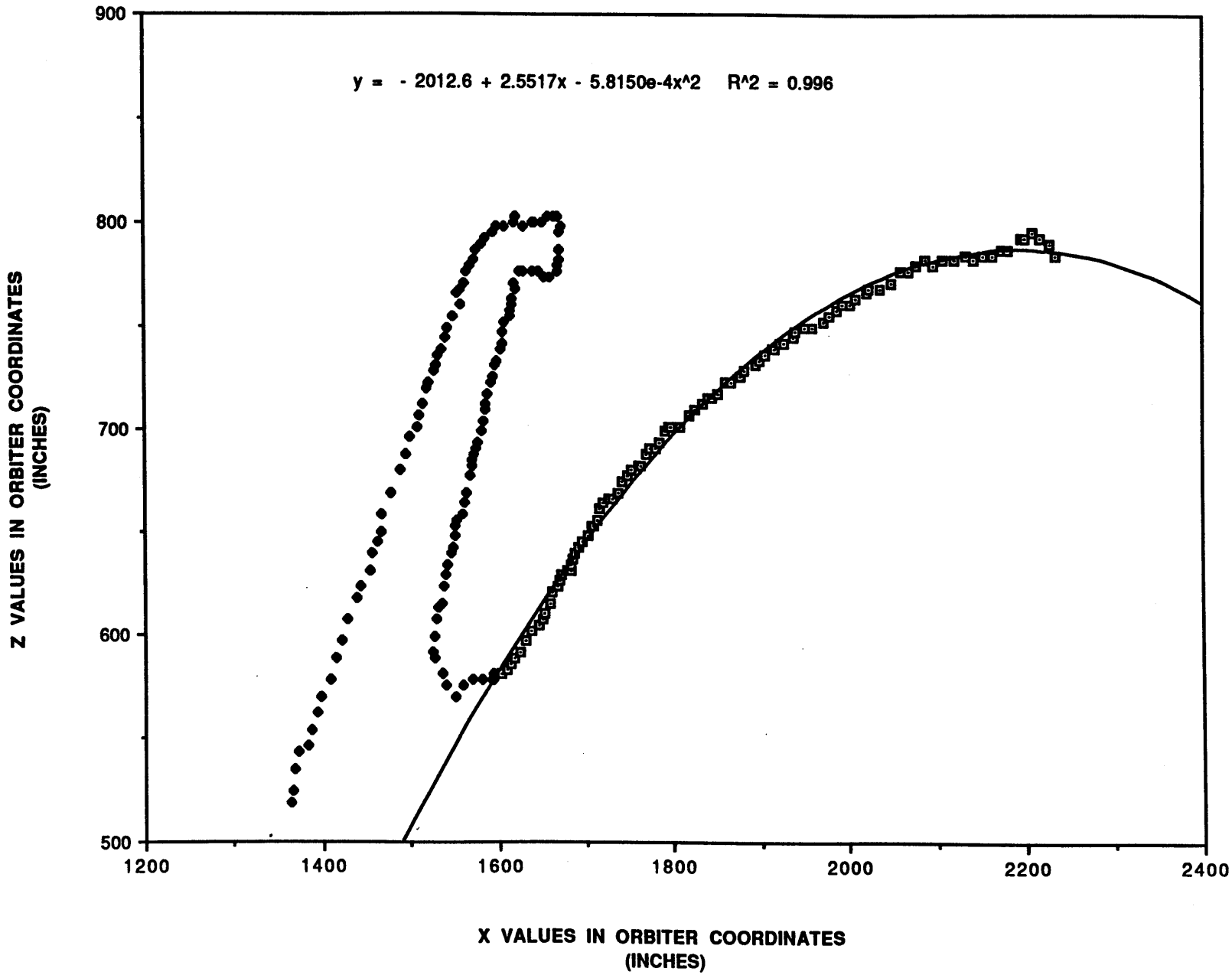
RISER AND TAIL DATA - BAG STRIP STAGE

	A	B	C	D
91	2063.13	776.32	1513.73	709.32
92	2076.53	781.68	1503.01	701.28
93	2081.89	784.36	1497.65	693.24
94	2089.93	784.36	1494.97	687.88
95	2097.97	784.36	1492.29	682.52
96	2108.69	784.36	1484.25	674.48
97	2114.05	781.68	1478.89	671.8
98	2122.09	781.68	1476.21	663.76
99	2127.45	779	1468.17	655.72
100	2138.17	776.32	1462.81	650.36
101	2146.21	773.64	1457.45	645
102	2156.93	770.96	1457.45	642.32
103	2164.97	773.64	1449.41	634.28
104	2178.37	776.32	1446.73	628.92
105	2186.41	776.32	1438.69	623.56
106	2191.77	779	1433.33	615.52
107	2194.45	779	1430.65	607.48
108	2202.49	773.64	1422.61	604.8
109	2207.85	776.32	1417.25	599.44
110	2210.53	770.96	1409.21	591.4
111			1406.53	591.4
112			1401.17	583.36
113			1393.13	575.32
114			1387.77	561.92
115			1377.05	553.88
116			1366.33	543.16
117			1355.61	535.12
118			1358.29	527.08
119			1352.93	519.04

Cell: C5
Note: THIS IS THE COORDINATE OF THE STINGER.

Cell: C6
Note: THIS IS THE COORDINATE OF THE BACK OF THE TAIL JUST ABOVE THE AIRBRAKE.

RISER CURVATURE - POST BAG STRIP STAGE



RISER AND TAIL DATA - POST BAG STRIP STAGE

	A	B	C	D
1		COORDINATES	IN INCHES	
2				
3	RISER		TAIL	
4	X	Z	X	Z
5	1602.17	580.68	1594.13	578
6	1610.21	583.36	1666.49	779
7	1612.89	586.04	1594.13	580.68
8	1618.25	588.72	1591.45	578
9	1623.61	591.4	1580.73	578
10	1631.65	596.76	1570.01	578
11	1637.01	602.12	1559.29	575.32
12	1645.05	604.8	1551.25	569.96
13	1650.41	607.48	1540.53	575.32
14	1650.41	607.48	1535.17	580.68
15	1653.09	610.16	1527.13	588.72
16	1658.45	615.52	1524.45	591.4
17	1661.13	620.88	1527.13	599.44
18	1666.49	623.56	1529.81	607.48
19	1669.17	626.24	1532.49	612.84
20	1671.85	628.92	1535.17	615.52
21	1677.21	631.6	1537.85	623.56
22	1682.57	631.6	1540.53	628.92
23	1682.57	634.28	1543.21	634.28
24	1685.25	636.96	1545.89	639.64
25	1687.93	639.64	1548.57	642.32
26	1690.61	642.32	1551.25	647.68
27	1695.97	645	1551.25	653.04
28	1701.33	647.68	1553.93	655.72
29	1706.69	653.04	1559.29	658.4
30	1709.37	653.04	1561.97	663.76
31	1712.05	655.72	1564.65	669.12
32	1714.73	661.08	1567.33	677.16
33	1720.09	663.76	1570.01	682.52
34	1725.45	666.44	1570.01	685.2
35	1730.81	666.44	1572.69	687.88
36	1736.17	669.12	1575.37	690.56
37	1741.53	674.48	1578.05	693.24
38	1746.89	677.16	1580.73	698.6
39	1752.25	679.84	1583.41	703.96
40	1760.29	682.52	1586.09	709.32
41	1762.97	682.52	1586.09	712
42	1768.33	687.88	1588.77	717.36
43	1773.69	690.56	1591.45	722.72
44	1779.05	690.56	1594.13	725.4
45	1784.41	693.24	1596.81	730.76

RISER AND TAIL DATA - POST BAG STRIP STAGE

	A	B	C	D
46	1789.77	698.6	1599.49	733.44
47	1795.13	701.28	1602.17	738.8
48	1797.81	701.28	1604.85	741.48
49	1808.53	701.28	1604.85	746.84
50	1819.25	706.64	1607.53	752.2
51	1824.61	709.32	1612.89	754.88
52	1832.65	712	1612.89	757.56
53	1840.69	714.68	1615.57	760.24
54	1843.37	714.68	1615.57	762.92
55	1851.41	717.36	1620.93	768.28
56	1859.45	722.72	1618.25	770.96
57	1864.81	722.72	1623.61	776.32
58	1875.53	725.4	1628.97	776.32
59	1880.89	728.08	1639.69	776.32
60	1894.29	730.76	1645.05	776.32
61	1896.97	733.44	1653.09	773.64
62	1905.01	736.12	1658.45	773.64
63	1913.05	738.8	1666.49	776.32
64	1915.73	738.8	1669.17	781.68
65	1921.09	741.48	1669.17	787.04
66	1926.45	741.48	1669.17	795.08
67	1937.17	744.16	1669.17	795.08
68	1939.85	746.84	1671.85	797.76
69	1950.57	749.52	1666.49	803.12
70	1958.61	749.52	1663.81	803.12
71	1972.01	752.2	1655.77	803.12
72	1972.01	752.2	1650.41	800.44
73	1977.37	754.88	1642.37	800.44
74	1985.41	757.56	1639.69	800.44
75	1993.45	760.24	1628.97	797.76
76	2001.49	760.24	1620.93	803.12
77	2006.85	762.92	1620.93	803.12
78	2020.25	765.6	1618.25	800.44
79	2022.93	768.28	1607.53	797.76
80	2036.33	768.28	1599.49	797.76
81	2049.73	770.96	1594.13	795.08
82	2060.45	776.32	1586.09	792.4
83	2068.49	776.32	1580.73	789.72
84	2076.53	779	1575.37	787.04
85	2087.25	781.68	1572.69	781.68
86	2095.29	779	1567.33	779
87	2106.01	781.68	1564.65	776.32
88	2119.41	781.68	1561.97	770.96
89	2132.81	784.36	1556.61	768.28
90	2140.85	781.68	1553.93	765.6

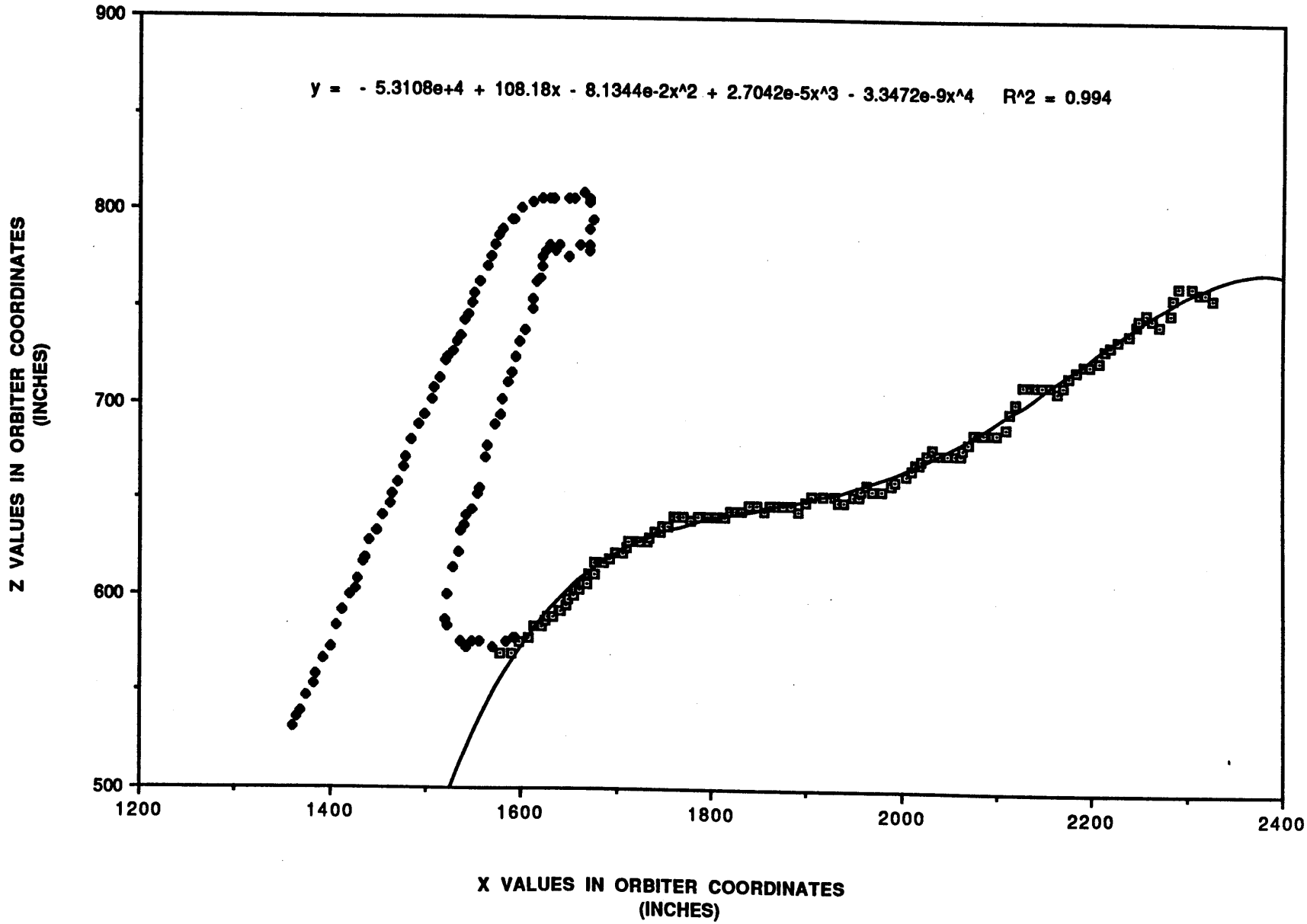
RISER AND TAIL DATA - POST BAG STRIP STAGE

	A	B	C	D
91	2151.57	784.36	1556.61	760.24
92	2162.29	784.36	1548.57	754.88
93	2173.01	787.04	1543.21	749.52
94	2181.05	787.04	1540.53	744.16
95	2194.45	792.4	1535.17	738.8
96	2199.81	792.4	1532.49	736.12
97	2207.85	795.08	1529.81	730.76
98	2215.89	792.4	1527.13	728.08
99	2226.61	789.72	1521.77	722.72
100	2234.65	784.36	1519.09	720.04
101			1513.73	712
102			1511.05	706.64
103			1508.37	701.28
104			1500.33	695.92
105			1494.97	687.88
106			1489.61	679.84
107			1478.89	669.12
108			1468.17	658.4
109			1468.17	650.36
110			1462.81	645
111			1457.45	639.64
112			1454.77	631.6
113			1444.05	623.56
114			1438.69	618.2
115			1427.97	607.48
116			1422.61	596.76
117			1414.57	588.72
118			1409.21	578
119			1398.49	569.96
120			1393.13	561.92
121			1387.77	553.88
122			1382.41	545.84
123			1371.69	543.16
124			1369.01	535.12
125			1366.33	524.4
126			1363.65	519.04

Cell: C5
Note: THIS IS THE COORDINATE OF THE STINGER.

Cell: C6
Note: THIS IS THE COORDINATE OF THE BACK OF THE TAIL JUST ABOVE THE AIRBRAKE.

RISER CURVATURE - INITIAL DEPLOY



RISER AND TAIL DATA - INITIAL DEPLOY STAGE

	A	B	C	D
1		COORDINATES	IN INCHES	
2				
3	RISER		TAIL	
4	X	Z	X	Z
5	1577.60945	569.739726	1594.13	578
6	1588.62315	569.739726	1671.22589	779
7	1596.88342	575.246575	1591.37658	578
8	1607.89712	578	1583.1163	575.246575
9	1613.40397	583.506849	1569.34918	572.493151
10	1621.66425	583.506849	1555.58205	575.246575
11	1624.41767	586.260274	1547.32178	575.246575
12	1627.1711	589.013699	1541.81493	572.493151
13	1632.67795	589.013699	1536.30808	575.246575
14	1638.18479	591.767123	1522.54096	583.506849
15	1640.93822	591.767123	1519.78753	586.260274
16	1646.44507	594.520548	1522.54096	600.027397
17	1649.19849	597.273973	1528.04781	613.794521
18	1654.70534	600.027397	1533.55466	622.054795
19	1657.45877	602.780822	1536.30808	633.068493
20	1660.21219	602.780822	1539.06151	635.821918
21	1662.96562	605.534247	1541.81493	641.328767
22	1665.71904	605.534247	1547.32178	644.082192
23	1668.47247	605.534247	1552.82863	652.342466
24	1671.22589	611.041096	1555.58205	655.09589
25	1673.97932	611.041096	1561.0889	671.616438
26	1676.73274	611.041096	1563.84233	677.123288
27	1676.73274	616.547945	1572.1026	688.136986
28	1682.23959	616.547945	1577.60945	693.643836
29	1684.99301	616.547945	1580.36288	701.90411
30	1687.74644	616.547945	1585.86973	710.164384
31	1693.25329	619.30137	1588.62315	715.671233
32	1698.76014	622.054795	1594.13	723.931507
33	1707.02041	622.054795	1596.88342	732.191781
34	1709.77384	624.808219	1602.39027	737.69863
35	1712.52726	627.561644	1610.65055	748.712329
36	1720.78753	627.561644	1610.65055	754.219178
37	1723.54096	627.561644	1616.1574	762.479452
38	1731.80123	627.561644	1618.91082	765.232877
39	1734.55466	630.315068	1621.66425	770.739726
40	1740.06151	633.068493	1621.66425	776.246575
41	1745.56836	633.068493	1624.41767	779
42	1748.32178	635.821918	1629.92452	781.753425
43	1753.82863	635.821918	1635.43137	779
44	1759.33548	641.328767	1638.18479	781.753425
45	1764.84233	641.328767	1649.19849	776.246575

Page 1

RISER AND TAIL DATA - INITIAL DEPLOY STAGE

	A	B	C	D
46	1770.34918	641.328767	1660.21219	781.753425
47	1778.60945	638.575342	1671.22589	781.753425
48	1786.86973	641.328767	1671.22589	790.013699
49	1795.13	641.328767	1673.97932	795.520548
50	1803.39027	641.328767	1671.22589	803.780822
51	1814.40397	641.328767	1671.22589	806.534247
52	1819.91082	644.082192	1665.71904	809.287671
53	1825.41767	644.082192	1654.70534	806.534247
54	1830.92452	644.082192	1649.19849	806.534247
55	1839.18479	646.835616	1632.67795	806.534247
56	1847.44507	646.835616	1629.92452	806.534247
57	1855.70534	644.082192	1621.66425	806.534247
58	1861.21219	646.835616	1610.65055	803.780822
59	1869.47247	646.835616	1599.63685	801.027397
60	1874.97932	646.835616	1591.37658	795.520548
61	1883.23959	646.835616	1588.62315	795.520548
62	1891.49986	644.082192	1580.36288	790.013699
63	1899.76014	649.589041	1574.85603	787.260274
64	1905.26699	652.342466	1572.1026	781.753425
65	1916.28068	652.342466	1566.59575	776.246575
66	1930.04781	652.342466	1563.84233	770.739726
67	1932.80123	649.589041	1555.58205	762.479452
68	1938.30808	649.589041	1555.58205	762.479452
69	1949.32178	652.342466	1550.07521	756.972603
70	1954.82863	652.342466	1547.32178	751.465753
71	1957.58205	655.09589	1544.56836	745.958904
72	1963.0889	657.849315	1539.06151	743.205479
73	1968.59575	655.09589	1536.30808	734.945205
74	1979.60945	655.09589	1530.80123	732.191781
75	1987.86973	657.849315	1528.04781	726.684932
76	1993.37658	660.60274	1522.54096	723.931507
77	2004.39027	663.356164	1519.78753	721.178082
78	2009.89712	666.109589	1514.28068	712.917808
79	2015.40397	668.863014	1508.77384	707.410959
80	2018.1574	668.863014	1506.02041	701.90411
81	2020.91082	671.616438	1497.76014	693.643836
82	2026.41767	674.369863	1492.25329	688.136986
83	2031.92452	677.123288	1483.99301	679.876712
84	2037.43137	674.369863	1478.48616	671.616438
85	2048.44507	674.369863	1475.73274	666.109589
86	2056.70534	674.369863	1470.22589	657.849315
87	2062.21219	674.369863	1464.71904	652.342466
88	2064.96562	677.123288	1461.96562	646.835616
89	2070.47247	679.876712	1453.70534	641.328767
90	2075.97932	685.383562	1448.19849	633.068493

Page 2

RISER AND TAIL DATA - INITIAL DEPLOY STAGE

	A	B	C	D
91	2081.48616	685.383562	1439.93822	627.561644
92	2086.99301	685.383562	1437.18479	619.30137
93	2095.25329	685.383562	1434.43137	616.547945
94	2100.76014	685.383562	1428.92452	608.287671
95	2109.02041	688.136986	1426.1711	602.780822
96	2114.52726	696.39726	1420.66425	600.027397
97	2120.03411	701.90411	1412.40397	591.767123
98	2128.29438	710.164384	1406.89712	583.506849
99	2136.55466	710.164384	1401.39027	572.493151
100	2139.30808	710.164384	1393.13	566.986301
101	2142.06151	710.164384	1384.86973	558.726027
102	2147.56836	710.164384	1382.1163	553.219178
103	2155.82863	710.164384	1373.85603	547.712329
104	2164.0889	707.410959	1368.34918	539.452055
105	2169.59575	710.164384	1365.59575	536.69863
106	2175.1026	715.671233	1360.0889	531.191781
107	2175.1026	715.671233		
108	2183.36288	718.424658		
109	2191.62315	721.178082		
110	2197.13	721.178082		
111	2208.1437	723.931507		
112	2213.65055	729.438356		
113	2219.1574	732.191781		
114	2227.41767	734.945205		
115	2238.43137	737.69863		
116	2246.69164	743.205479		
117	2249.44507	745.958904		
118	2257.70534	748.712329		
119	2263.21219	745.958904		
120	2271.47247	743.205479		
121	2282.48616	748.712329		
122	2285.23959	756.972603		
123	2290.74644	762.479452		
124	2304.51356	762.479452		
125	2312.77384	759.726027		
126	2318.28068	759.726027		
127	2326.54096	756.972603		

Cell: C5
Note: THIS IS THE COORDINATE OF THE STINGER.

Cell: C6
Note: THIS IS THE COORDINATE OF THE BACK OF THE TAIL JUST ABOVE THE AIRBRAKE.

Summary of Analysis of Visual Events
STS-49
06/16/92

Task Number
10.12

Title : Drag Chute Performance Analysis

Analysts : Shannon Harris
Date : 06/16/92

Camera Number :
Frame Number :
GMT :

Requestor : J. Kennedy
Phone : 483-8942
Mail Code : ES62

Description of Analysis

Landing films and video were viewed for two views of riser line at three different points of drag chute deployment, (bag strip, post bag strip, initial deploy), to formulate a 3-D image of riser line. Only one video (TV4) was found that had a clear image of the riser. This is a side-view. No cameras from a back-view (ie position 5R, 7R) were found and therefore horizontal movement of the riser line cannot be detected. Video TV4 was digitized at bag strip, post bag strip, and initial deploy.

Image Analysis Tools & Techniques

Photo/TV Analysis Group Request Form
STS-49
06/12/92

Task Number --> 11

Request Date : 05/01/92
Completion Date : 05/14/92

Requestor : K. Armstrong
Phone : 483-2571
Mail Code : DF42

Analyst Name	Phone Number	Assignment
C. Dailey	483-5336	Lead/Analysis/R. time sup
C. Sapp	483-5141	Analysis/real time sup.
R. Bhaskar	244-5322	Analysis/real time sup.

Task Title

ASEM Evaluation

Objectives

To evaluate our capabilities in image analysis as part of simulation of space station assembly.

To provide image analysis for ASEM personnel to use to verify and correct their assembly models.

Hypothesis

Reporting

Results will be given to K. Armstrong. Results and lessons learned will be input to SSF project plan.

Analysis Strategy

ASEM Tasks

1. Calculate speed and direction of hardware inadvertantly dropped during EVA (real time analysis)

2. Calculate velocities and accellerations during CPD evaluation

3. Determine relative velocity of crewman with respect to vehicle during +X translation (Crewman will be floating free near forward bulkhead when the Orbiter performs a +X burn)

4. Determine speed of deployment of self-rescue devices (TP, BP, IP, AR)

5. Measure separation between fixture and MPESS legs during installation positioning after each positioning cue. (They will use several positioning cue scenarios such as voice only, PB cameras only, direct observation through window, etc. It should be clear to us when a scenario is completed.)

6. Determine range of motion and speeds induced to MPESS and stack during mass handling operations

7. Determine amplitude of bouncing of MPESS and stack during installation into the PRLAs

8. Determine amplitude of bouncing of RMS during pallet positioning maneuvers

9. Determine EVA times (specifically elapsed time) for tasks and subtasks performed in the EVA timeline

10. Determine maximum EVA translation rates during EVA as well as time of occurrence.

11. Determine if any ice particles come out of EMU sublimator (in the backpack) and the quantity of any observed.

12. Determine if RCS jets leak, and measure quantity of any observed leakage.

13. Determine video quality of all video sources for Quality Control of EVA operations.

14. Compare EMU TV. to CCTV
15. Evaluate Connector verification
16. ~~Is EMU~~ Evaluate if EMU camera is sufficient to document assembly work.

ASEM SCREENING (4/14/92)

General Notes:

Difficult to understand audio transmission of EVA personnel.
Difficult to identify astronaut by suit markings if >~30 ft.
Overall procedures were hurried.
KT's voice hardest to understand - higher freqs.?
Identification of sub-tasks not easy, especially with no video
Approx. 1/2 hour video out of 8 hours recorded
Timelines slower than in WETF according to announcer

TIME	DESCRIPTION OF ACTIVITY
16:28:00	RMS Elbow Camera
	View of egress of Kathy Thornton (KT) and Tom Akers (TA)
16:36:00	LOV / Control Center
	15 second LOV
16:36:00	Payload Bay Camera D
	View of TA by the ASEM structure
16:42:00	RMS Elbow Camera
	Pan out to view KT move by base of RMS arm
16:45:00	LOV / Control Center
	Commentator says next view at 18:05
	LOS at 17:19
	AOS at 17:25 - just audio
	17:31 - new tapes - 2
	Astronaut asks KT to turn Helmet Cam on
	HOUSTON - Turn RCS thruster jets to auto
	HOUSTON - Turn EMU TV off - may be causing DCN problem
18:05:19	Payload Bay Camera D
18:05:32	Payload Bay Camera D - tilted down
	video synch problem - color saturation
18:10:54	LOV / Control Center
18:12:35	Payload Bay Camera D
	KT's suit may be giving problems - ref <4.0 pressure reading as critical to abort EVA
18:14:22	RMS Elbow Camera

Camera	Key assigned
PB Cam A	A
PB Cam B	B
PB Cam C	C
PB Cam D	D
Keel Camera	K
Elbow	E
Wrist	W
Camcorder	M
Control Center / LOV	L
EMU 1 / K.T.	Z
EMU 2 / T. A.	X

18:14:26	Payload Bay Camera D
	18:18 - TA using Crew Propulsive Device (CPD) with nitrogen gas as propellant
18:19:44	RMS Elbow Camera
18:19:52	Payload Bay Camera D
18:19:57	LOV / Control Center
	TA says hardest thing is with the gloves being stiff, it is hard to (control) ... CPDS
	18:24 - RMS arm appears to have MPESS fixture according to graphics
	18:26 - new tapes - 3
	TA says RH nozzle doesn't want to stay on - can't tell if pitching up or down, can't translate in (?)
	TA says hard to discern rates, direction and orientation with respect to Orbiter - also need to use 2 hands
	TA trying long CPD translation - need to continually correct for pitch or yaw
	18:40 - HOUSTON - Dave Leestma to help with EVA
	18:45 - Orbit 2 handover from Orbit 1
	Endeavour - KU antenna direct stow switch to "on" when ready - remark that this KU antenna flew on 41G (Leestma)
	LOS at 18:57
	19:00 - Mission Status Briefing (Stopped VTR recording)
	19:19 - Status briefing over, VTR Started again
	19:41 - new tapes - 4
19:41:48	Payload Bay Camera D
19:46:17	LOV / Control Center
	19:50 - Houston directs EVA to do a 3-leg install only
19:50:37	Payload Bay Camera D
	Very noisy video
19:50:55	LOV / Control Center
19:50:59	Payload Bay Camera D
19:51:03	LOV / Control Center
19:51:36	RMS Elbow Camera
19:51:58	Payload Bay Camera D
	Noted rocking of MPESS & RMS
19:53:59	LOV / Control Center
	20:00 - Houston says waive req. for Portable Foot Restraints (PFR) when installing pallet, delete 2nd pallet installat
	20:14 - In attempting to attach pallet to fixture, mention was made of no perspective to position pallet
	20:15 - Houston instructs to skip the EMU and CCTV cues, and skip directly to EVA voice
	LOS at 20:33 - space popcorn sounds just prior to LOS and just after AOS ...
	AOS at 20:34
	20:36 - Houston says customer satisfied with pallet installation - do interim stow of disconnect
	20:41 - Houston says stow legs and no BP eval.
	20:45 - new tapes - 5

	20:48 - Re-stowing MPESS within payload bay						
	21:05 - Houston says they are seeing some unusual signatures on cameras, asked crew to cycle through them (if temps						
	21:48 - new tapes - 6						
	21:50 - Beginning disassembly of truss fixture						
	22:21 - new tapes - 7						
	22:42 - Houston says that the Astro rope and the wrench caddy should be brought in						
	22:46 - Disassembly of everything except the face plane completed - may not require disassembly of face plane						
	22:52 - new tapes - 8						
	23:23 - new tapes - 9						
	23:24 - Getting ready for ingress						
	23:25 - Moving RMS arm - completed RMS video survey of structures in payload bay (including face plane structure)						
	23:32 - Beginning ingress						
	23:35 - Stowing away the RMS arm						
	23:42 - Outer hatch closed and locked						
	23:52 - Repressurization underway						
	LOS at 23:53						
	23:55 - end tapes						

Photo/TV Analysis Group Request Form
STS-49
06/12/92

Task Number --> 12

Request Date : 05/07/92
Completion Date : 05/08/92

Requestor : Cecil Gibson
Phone :
Mail Code :

Analyst Name	Phone Number	Assignment
Team		Screening
C. Dailey		Lead

Task Title

Flare in SSME plume starting at 84 seconds MET

Objectives

To determine the characteristics of red pluses seen between 84 seconds to 119 seconds

Hypothesis

This visual phenomenon may be related to a rise in the SSME #2 high pressure fuel pump temperature.

Reporting

To the MER with copy to Cecil Gibson

Analysis Strategy

1) Identify all events on KTV5
Look at time frame prior to 84 seconds and after separation.

2) Check other videos for possible evidence of these flares.

3) Review D2 tape for better fidelity.

4) Review previous mission at 28.5 degrees similar lighting preferred and pad B.

Summary of Analysis of Visual Events
STS-49
06/09/92

Task Number
12

Title : Flare in SSME plume starting at 84 seconds MET

Analysts : Hartman, Snyder, Israel, Dailey, Morris
Date : 05/08/92

Camera Number : KTV5
Frame Number :
GMT :

Requestor : Cecil Gibson
Phone :
Mail Code :

Description of Analysis

KTV-5 was re-screened to look for events prior to 84 seconds and after SRB separation (127.281 sec MET).

One event was seen prior to the original earliest event. (The earliest time an event is currently seen in 84.427 sec MET). Nine possible events were noted after SRB separation up to 142.085 sec MET.

In addition to the above mentioned events the entire launch sequence was re-screened and additional events were noted with the original time frame from 84 seconds to 119 seconds. A total of 26 possible events have been recorded.

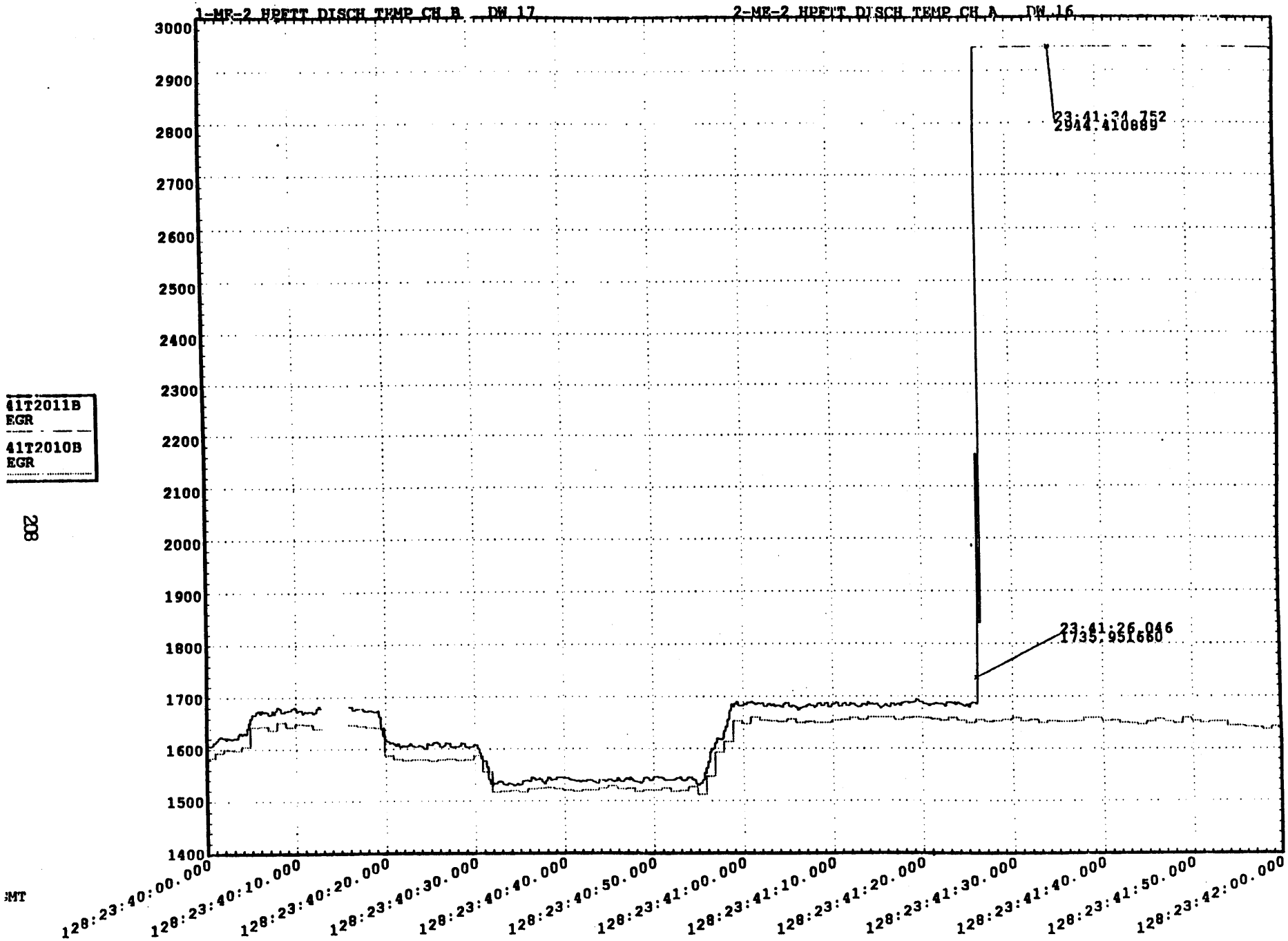
Image Analysis Tools & Techniques

U.S. GOVT

M E
FOR

SAMPLE RATE: 0 (sec/sample)
ENGFID DATA: ENGFID

Subsystem:
Flight:



GMT

Summary of Analysis of Visual Events
STS-49
06/09/92

Task Number
12.01

Title : Flare in SSME plume starting at 84 seconds MET

Analysts : Disler, Gastineau, Bhaskar
Date : 05/07/92

Camera Number : KTV-5
Frame Number :
GMT :

Requestor : Cecil Gibson
Phone :
Mail Code :

Description of Analysis

Previous mission views of KTV-5 from missions STS-33 and STS-38 were screened to see if a similar flare phenomena was visible. Missions STS-33 provided the most similar view due to time of launch (although much darker than STS-49), launch pad (also 39B), and Orbiter inclination (approximately 28 degrees).

The STS-33 KTV view did not show the same flare event. Color distortions were present in the STS-33 view of the SLV at about the same view angles.

Image Analysis Tools & Techniques

Summary of Analysis of Visual Events
STS-49
06/09/92

Task Number
12.02

Title : Flare in SSME plume starting at 84 seconds MET

Analysts : Disler, Gastineau
Date : 05/08/92

Camera Number : KTV-5
Frame Number :
GMT :

Requestor : Cecil Gibson
Phone :
Mail Code :

Description of Analysis

The STS-49 D2 tape of KTV-5 was screened in building 8 (Jim Parido shift supervisor and Jim Wheeler).

Building 8 TV reported that the KTV-5 view had a 4 line vertical jitter that was introduced at the time of recording at launch. On the D2 view a sensor "lag" is very apparent. The sensor lag is one good explanation for the flare event that sas seen on the 3/4" video view.

Image Analysis Tools & Techniques

Photo/TV Analysis Group Request Form
STS-49
06/12/92

Task Number --> 13

Request Date : 05/11/92
Completion Date : 05/13/92

Requestor : C. Ortiz
Phone : 483-8879
Mail Code : ES3

Analyst Name	Phone Number	Assignment
T. Morris	483-2484	Timing
S. Isreal	244-5106	Velocity and Size

Task Title

Rectangular Debris Characterization

Objectives

Hypothesis

Reporting

Analysis Strategy

1) Time the overlap of E-34, E-5 and E-6

   Time first view of rectangular piece through when it passed by the body flap on E-5 and E-6.

   Find exact film rate by counting frames in 1 second

   Find overlap of events between E-34 and E-5 or E-6.

   Time when you see the LH2 umbilical leave the scene in E-5 or E-6 and when it enters scene in E-34.

   Synchronize all three films by determining frame for each film at the same time

2) Calculate descent rate of the rectangular piece

3) Calculate size of rectangular piece

Summary of Analysis of Visual Events
STS-49
06/15/92

Task Number
13

Title : Rectangular Debris Characterization

Analysts : T. Morris
Date : 05/13/92

Camera Number : *
Frame Number :
GMT :

Requestor : C. Ortiz
Phone : 483-8879
Mail Code : ES3

Description of Analysis

*E-5, E-6 and E-34 were time for events.

Three events were noted and timed relating to the rectangular debris at launch. First, on E-5 and E-6, the debris was timed when it was just noted: E-5 - 128:23:40:01.087, E-6 - 128:23:40:01.378. Then the debris was timed on both cameras for when it passed the umbilicals: E-5 - 128:23:40:01.295, E-6 - 128:23:40:01.378. Lastly the debris was timed for when it passed by the body flap: E-5 - 128:23:40:01.765, E-6 - 128:23:40:01.790.

On camera E-34 two events were timed. The white spot on the underside of the vehicle was first seen at 128:23:40:01.905 and the umbilicals were first noted at 128:23:40:03.354.

Image Analysis Tools & Techniques

Summary of Analysis of Visual Events
STS-49
06/09/92

Task Number
13.01

Title : Rectangular Debris Characterization

Analysts : S. Israel
Date : 05/13/92

Camera Number : *
Frame Number :
GMT :

Requestor : C. Ortiz
Phone : 483-8879
Mail Code : ES3

Description of Analysis

1). Digitized spatial information of the leading and trailing edges of rectangular debris using 16mm film motion analyzer and films E-5 and E-6.

2) Digitized an object on the space shuttle in the FOV and determined its coordinates using Cad information.

3) Digitized another known position in the FOV to determine the angular FOV of the minimum resolvable element of the system.

4) Determined the three dimensional position of the object over the interval that the debris was seen on both E-5 and E-6. The error in the claculation of position is delivered with positional data. the errors in position ar large due to the cameras optical paths were nearly parallel.

5) The leading edge of the debris was determined to be traveling at 86.04 inches per second and the trailing edge at 100.05 inchec per second.

6) Camera E-34 showed a light area just after this time interval. The light area appeared to travel with the vehicle. however, the data was inconclusive as to whether light area was the source of the rectangular debris, since the debris was first spotted significantly after liftoff.

Image Analysis Tools & Techniques

Purpose

Show a positional profile of a piece of debris over time. Include velocity analysis of debris.

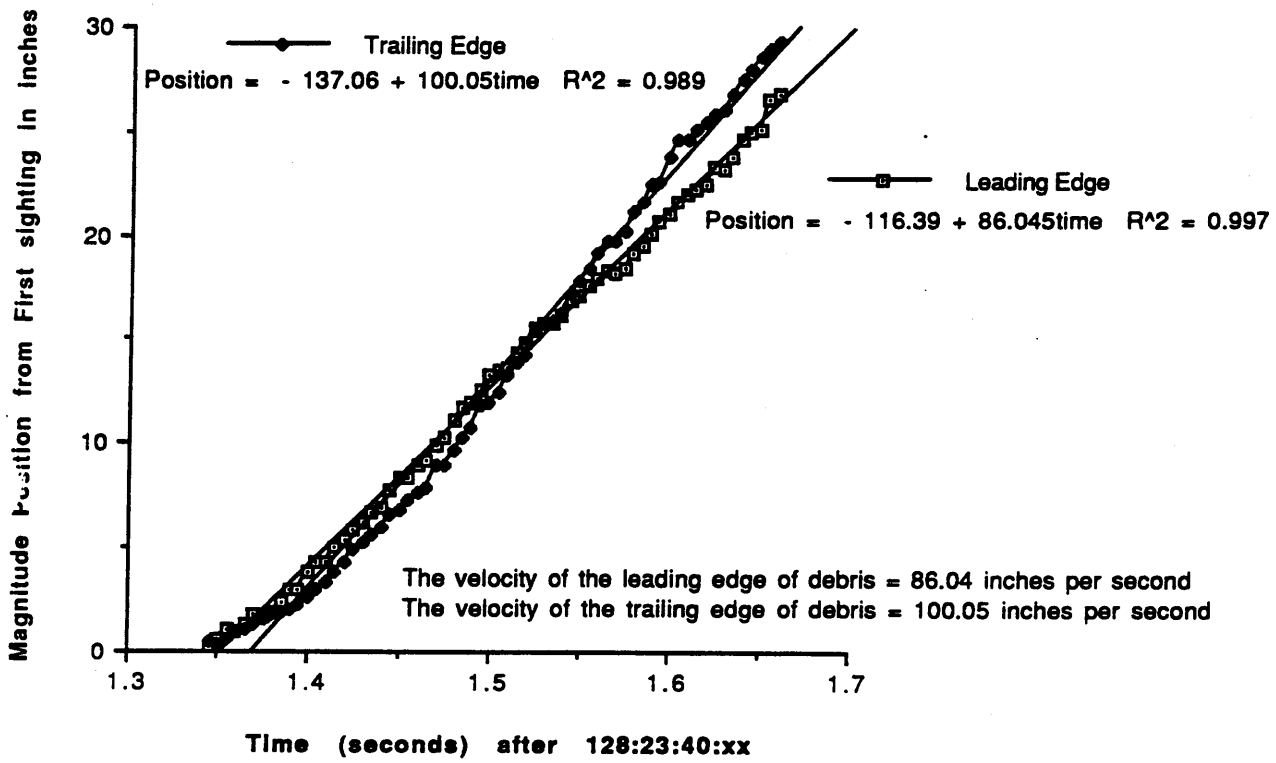
Procedures

1. Digitized spatial information of the leading and trailing edges of rectangular debris using 16 mm film motion analyzer and films E% and E6
2. Digitized an object on the Space Shuttle in the FOV and determined its coordinates using Cad information.
3. Digitized another known position in the FOV to determine the angular FOV of the minimum resolvable element of the system.
4. Determined the three dimensional position of the object over the interval that the debris was seen on both E5 and E6.
5. Camera E34 showed a light area just after this time interval. The light area appeared to travel with the vehicle. Time first sighting to determine if the location of this area is associated with rectangular debris.

Results

1. The leading edge of the debris was determined to be traveling at 86.04 inches per second and the trailing edge at 100.05 inches per second. The error in the calculation of position is delivered with positional data. The errors in position are large due to the cameras optical paths were nearly parallel.
2. The data was inconclusive as to whether is light area observed on camera E34 was the source of the rectangular debris, since the debris was first spotted significantly after liftoff.

Positional Data for Rectangular Debris Observed During the Launch of STS-49 on Cameras E5 and E6



Debris Data Taken from Camera STS-49 E5 and E6. Positional information was taken for the leading and trailing edges

	Leading Edge Data					Trailing Edge Data			
	X position in inches	Y position in inches	Z position in inches	Distance from first ob.	Time after 128:23:40: in seconds	X position in inches	Y position in inches	Z position in inches	Distance from first ob.
Position	1629.47	537.326	224.434		1.3404	1628.95	536.071	225.204	
Error (+/-)	20.7227	11.1797	16.1904		1.34288	21.0339	11.2736	16.8029	
Position	1629.48	537.387	224.232	0.21117	1.34536	1628.75	535.685	224.918	0.51846
Error (+/-)	20.7356	11.2091	16.2469		1.34784	20.948	11.2487	16.6316	
Position	1629.68	537.817	224.103	0.62861	1.35033	1629.01	536.292	224.859	0.41553
Error (+/-)	20.6588	11.1787	16.0915		1.35281	20.9146	11.2422	16.5698	
Position	1629.87	538.126	223.933	1.02708	1.35529	1628.99	536.208	224.635	0.58749
Error (+/-)	20.6622	11.1935	16.1149		1.35777	20.8421	11.2171	16.4229	
Position	1629.74	537.823	223.605	1.00414	1.36025	1629.21	536.603	224.39	1.0072
Error (+/-)	20.6023	11.1836	16.0119		1.36273	20.8522	11.2458	16.4754	
Position	1629.81	538.067	223.466	1.26664	1.36521	1629.11	536.444	224.212	1.0723
Error (+/-)	20.6068	11.2067	16.0471		1.3677	20.8344	11.254	16.4578	
Position	1630.07	538.651	223.33	1.82739	1.37018	1629.14	536.717	224.079	1.31173
Error (+/-)	20.5672	11.2023	15.9819		1.37266	20.6562	11.1729	16.0803	
Position	1629.87	538.208	223.072	1.66995	1.37514	1629.17	536.727	223.856	1.51524
Error (+/-)	20.4771	11.167	15.8047		1.37762	20.6177	11.1674	16.0153	
Position	1629.77	538.176	222.791	1.87504	1.3801	1629.08	536.685	223.587	1.73503
Error (+/-)	20.4743	11.2001	15.8406		1.38258	20.5995	11.1893	16.0148	
Position	1630.05	538.853	222.674	2.40238	1.38507	1629.09	536.727	223.453	1.8752
Error (+/-)	20.4445	11.2033	15.8006		1.38755	20.5332	11.163	15.8832	
Position	1630.31	539.456	222.558	2.96032	1.39003	1629.03	536.784	223.304	2.03158
Error (+/-)	20.3449	11.1614	15.6047		1.39251	20.4113	11.1125	15.6428	
Position	1630.31	539.215	222.343	2.94105	1.39499	1629.12	536.987	223.105	2.29698
Error (+/-)	20.3417	11.1633	15.6023		1.39747	20.3889	11.1201	15.6192	
Position	1630.78	540.141	222.178	3.83919	1.39995	1629.33	537.311	222.89	2.65372
Error (+/-)	20.3009	11.1574	15.5363		1.40244	20.3406	11.1058	15.5324	
Position	1630.95	540.452	221.933	4.26761	1.40492	1629.49	537.756	222.767	3.01215
Error (+/-)	20.2735	11.1635	15.5043		1.4074	20.2903	11.0957	15.4483	
Position	1630.93	540.264	221.719	4.25842	1.40988	1629.67	537.96	222.508	3.37063
Error (+/-)	20.2209	11.1401	15.4017		1.41236	20.2115	11.0624	15.2976	

Position	1631.3	541.051	221.539	5.06071	1.41484	1629.78	538.299	222.248	3.79348
Error (+/-)	20.1902	11.1447	15.3635		1.41732	20.106	11.03	15.1129	
Position	1631.41	541.242	221.212	5.42808	1.41981	1629.96	538.725	222.007	4.27765
Error (+/-)	20.1844	11.1714	15.3867		1.42229	20.1344	11.0744	15.2035	
Position	1631.61	541.626	221.054	5.87349	1.42477	1630.23	539.304	221.786	4.8758
Error (+/-)	20.1264	11.1503	15.2802		1.42725	20.0611	11.0547	15.0793	
Position	1631.76	541.859	220.866	6.20867	1.42973	1630.44	539.703	221.628	5.3101
Error (+/-)	20.0071	11.0886	15.0438		1.43221	19.9228	10.9841	14.8112	
Position	1632.01	542.266	220.693	6.69548	1.43469	1630.57	539.981	221.423	5.67622
Error (+/-)	19.9769	11.083	14.996		1.43717	19.9518	11.0226	14.8936	
Position	1632.11	542.34	220.406	6.95148	1.43966	1630.66	540.121	221.163	5.97259
Error (+/-)	19.9376	11.0766	14.9354		1.44214	19.873	10.9943	14.7558	
Position	1632.47	543.099	220.278	7.72026	1.44462	1630.91	540.73	221.016	6.56545
Error (+/-)	19.896	11.0692	14.8707		1.4471	19.7602	10.9466	14.5537	
Position	1632.81	543.659	220.161	8.33805	1.44958	1630.98	540.911	220.83	6.8347
Error (+/-)	19.8409	11.041	14.7651		1.45206	19.6694	10.909	14.3946	
Position	1632.79	543.528	219.857	8.39468	1.45454	1631.18	541.247	220.551	7.30923
Error (+/-)	19.8143	11.0442	14.7332		1.45703	19.6912	10.9457	14.4628	
Position	1633.05	543.923	219.632	8.90887	1.45951	1631.3	541.478	220.266	7.69249
Error (+/-)	19.7725	11.0337	14.6661		1.46199	19.6484	10.9438	14.4051	
Position	1633.2	544.079	219.445	9.18926	1.46447	1631.41	541.585	220.115	7.89847
Error (+/-)	19.722	11.0093	14.5726		1.46695	19.6009	10.921	14.3193	
Position	1633.56	544.744	219.223	9.94676	1.46943	1631.97	542.697	219.899	9.0123
Error (+/-)	19.6748	11.0001	14.5009		1.47191	19.5158	10.892	14.1798	
Position	1633.67	544.994	219.052	10.268	1.4744	1631.87	542.503	219.632	8.99702
Error (+/-)	19.6564	11.0073	14.4848		1.47688	19.4349	10.863	14.0474	
Position	1634.08	545.72	218.756	11.1322	1.47936	1632.14	543.129	219.378	9.69303
Error (+/-)	19.6196	11.0102	14.4403		1.48184	19.3886	10.8641	13.9907	
Position	1634.4	546.162	218.614	11.6714	1.48432	1632.45	543.523	219.102	10.2499
Error (+/-)	19.5556	10.9723	14.3168		1.4868	19.3063	10.8238	13.847	
Position	1634.5	546.278	218.376	11.9223	1.48928	1632.64	543.92	218.929	10.7063
Error (+/-)	19.4625	10.9278	14.1507		1.49177	19.22	10.7871	13.7039	
Position	1634.75	546.846	218.111	12.5881	1.49425	1633.08	544.944	218.659	11.7754
Error (+/-)	19.4489	10.9516	14.1591		1.49673	19.2106	10.8196	13.726	
Position	1635.08	547.374	217.89	13.2386	1.49921	1633.11	544.927	218.367	11.9357
Error (+/-)	19.4485	10.9664	14.1745		1.50169	19.1225	10.7831	13.5825	

Position	1635.19	547.456	217.636	13.4754	1.50417	1633.31	545.282	218.168	12.387
Error (+/-)	19.3618	10.9238	14.0205		1.50665	19.0715	10.7656	13.504	
Position	1635.24	547.415	217.43	13.5699	1.50914	1633.77	546.041	217.966	13.2314
Error (+/-)	19.3197	10.9054	13.9489		1.51162	19.017	10.7436	13.4172	
Position	1635.6	548.108	217.193	14.3602	1.5141	1633.97	546.544	217.663	13.8495
Error (+/-)	19.2346	10.8742	13.8118		1.51658	18.9904	10.7613	13.4039	
Position	1635.8	548.419	216.969	14.7944	1.51906	1634.15	546.837	217.461	14.2449
Error (+/-)	19.2188	10.8798	13.7984		1.52154	18.9121	10.7257	13.2766	
Position	1636.23	549.121	216.833	15.5761	1.52402	1634.79	547.978	217.3	15.4397
Error (+/-)	19.1158	10.8191	13.6113		1.5265	18.8365	10.6904	13.1541	
Position	1636.27	549.194	216.552	15.7866	1.52899	1634.92	548.099	217.016	15.73
Error (+/-)	19.0672	10.8112	13.5453		1.53147	18.8009	10.6826	13.1057	
Position	1636.24	549.007	216.234	15.7974	1.53395	1634.9	548.113	216.693	15.9022
Error (+/-)	18.9472	10.7491	13.341		1.53643	18.7317	10.6674	13.0121	
Position	1636.39	549.259	216.036	16.149	1.53891	1635.09	548.342	216.386	16.3107
Error (+/-)	18.8658	10.7112	13.2087		1.54139	18.6274	10.6166	12.8454	
Position	1636.75	549.943	215.855	16.9055	1.54387	1635.56	549.193	216.204	17.233
Error (+/-)	18.7855	10.676	13.0817		1.54636	18.4835	10.5367	12.6099	
Position	1636.8	550.003	215.507	17.1509	1.54884	1635.75	549.592	215.894	17.7704
Error (+/-)	18.7399	10.6726	13.0265		1.55132	18.5401	10.6046	12.737	
Position	1636.95	550.234	215.234	17.5286	1.5538	1636.06	549.992	215.557	18.3688
Error (+/-)	18.7722	10.7152	13.1052		1.55628	18.5146	10.606	12.7102	
Position	1637.18	550.581	215.074	17.9662	1.55876	1636.47	550.686	215.417	19.1288
Error (+/-)	18.65	10.6423	12.8955		1.56124	18.4436	10.5684	12.5967	
Position	1637.31	550.875	214.876	18.3408	1.56373	1636.72	551.112	215.15	19.6898
Error (+/-)	18.5621	10.6043	12.761		1.56621	18.3509	10.5271	12.4572	
Position	1637.18	550.497	214.563	18.1762	1.56869	1636.71	551.025	214.862	19.77
Error (+/-)	18.517	10.5892	12.6967		1.57117	18.328	10.5297	12.4351	
Position	1637.26	550.571	214.219	18.4497	1.57365	1636.89	551.289	214.514	20.2227
Error (+/-)	18.4525	10.5698	12.6076		1.57613	18.2494	10.5012	12.3246	
Position	1637.58	551.252	214.134	19.1278	1.57861	1637.44	552.242	214.421	21.2112
Error (+/-)	18.324	10.4969	12.4001		1.5811	18.1835	10.4639	12.2204	
Position	1637.65	551.464	213.879	19.4466	1.58358	1637.59	552.533	214.11	21.6519
Error (+/-)	18.2377	10.4659	12.2793		1.58606	18.1154	10.4444	12.1311	
Position	1637.93	552.01	213.624	20.1036	1.58854	1637.96	553.286	213.901	22.4802
Error (+/-)	18.2008	10.4647	12.2392		1.59102	18.1428	10.4878	12.1998	

Position	1638.16	552.499	213.359	20.6995	1.5935	1637.99	553.177	213.533	22.5955
Error (+/-)	18.1466	10.4552	12.1736		1.59598	17.9835	10.3978	11.9522	
Position	1638.33	552.751	213.236	21.0195	1.59847	1638.67	554.334	213.437	23.8021
Error (+/-)	18.065	10.4069	12.0444		1.60095	17.9878	10.407	11.965	
Position	1638.56	553.232	212.934	21.6286	1.60343	1638.98	554.946	213.096	24.5673
Error (+/-)	18.0139	10.4019	11.9871		1.60591	17.9331	10.4017	11.9044	
Position	1638.71	553.533	212.703	22.0395	1.60839	1639.03	554.776	212.738	24.6379
Error (+/-)	18.0502	10.4477	12.0664		1.61087	17.9895	10.4513	12.0071	
Position	1638.71	553.532	212.324	22.2432	1.61335	1639.26	555.219	212.582	25.1468
Error (+/-)	17.9669	10.4204	11.9558		1.61583	17.9596	10.4467	11.9722	
Position	1638.7	553.613	212.094	22.4232	1.61832	1639.39	555.378	212.277	25.4729
Error (+/-)	17.8578	10.3698	11.7992		1.6208	17.9216	10.4409	11.9281	
Position	1639.15	554.38	211.886	23.2801	1.62328	1639.6	555.62	212.02	25.8748
Error (+/-)	17.7809	10.333	11.689		1.62576	17.8629	10.4118	11.8422	
Position	1639.07	554.066	211.644	23.1505	1.62824	1639.73	555.679	211.756	26.1073
Error (+/-)	17.7174	10.2956	11.5927		1.63072	17.7469	10.3406	11.6619	
Position	1639.33	554.546	211.379	23.7526	1.6332	1640.06	556.238	211.532	26.7796
Error (+/-)	17.6188	10.2495	11.455		1.63569	17.7395	10.3526	11.6652	
Position	1639.72	555.479	211.246	24.6697	1.63817	1640.42	556.821	211.221	27.5279
Error (+/-)	17.5423	10.2247	11.359		1.64065	17.614	10.2867	11.4831	
Position	1639.88	555.736	211.104	24.9994	1.64313	1640.7	557.189	211.049	28.0067
Error (+/-)	17.5104	10.2126	11.3178		1.64561	17.6083	10.2892	11.4797	
Position	1639.89	555.574	210.69	25.11	1.64809	1640.98	557.638	210.817	28.5811
Error (+/-)	17.3746	10.1368	11.1227		1.65057	17.6168	10.3114	11.5076	
Position	1640.52	556.922	210.463	26.4822	1.65306	1641.08	557.85	210.447	28.9716
Error (+/-)	17.3002	10.1211	11.0391		1.65554	17.4708	10.2401	11.3035	
Position	1640.68	557.07	210.26	26.7666	1.65802	1641.29	558.089	210.351	29.2881
Error (+/-)	17.3578	10.1677	11.1332		1.6605	17.4878	10.2511	11.3294	

Summary of Analysis of Visual Events
STS-49
06/09/92

Task Number
13.02

Title : Rectangular Debris Characterization

Analysts : J. Disler
Date : 05/14/92

Camera Number :		**Requestor :**	C. Ortiz
Frame Number :		**Phone :**	483-8879
GMT :		**Mail Code :**	ES3

Description of Analysis

Greg Katnik/KSC reported that no TPS tile shim was found on the post landing walkdown pad inspection.. KSC believes that the debris is from the LO2 feedline bellows. The ice debris team noted ice in the LO2 feedline bellows prior to launch.

The debris seen on cameras E-52, E-53 and E-79 appear to be ice coming from forward portions of the SLV and are probably ice from the feedline bellows.

Steve Isreal's coordinate data appears to indicate that the debris originated away from the Orbiter, possibly the ET side.

The evidence appears to be indicating that the debris source is other than mission critical TPS, or umbilical door protection stripping.

Post landing inspection should confirm whether or not the debris comes from the Orbiter.

Image Analysis Tools & Techniques

Summary of Analysis of Visual Events
STS-49
06/09/92

Task Number
13.03

Title : Rectangular Debris Characterization

Analysts : S. Israel
Date : 05/13/92

Camera Number : E5,6,34
Frame Number :
GMT :

Requestor : C. Ortiz
Phone : 483-8879
Mail Code : ES3

Description of Analysis

Digitized spatial information of the leading and trailing edges of rectangular debris using 16mm film motion analyzer and films E-5 and E-6.

Digitized an object on the space shuttle in the FOV and determine its coordinates using Cad information.

Digitized another known position in the FOV to determine the angular FOV of the minimum resolvable element of the system.

Determine the three dimensional position of the object over the interval tht the debris was seen on both E-5 nd E-6. The error in the calculation of position is delivered with positional data. The errors in position are large due to the cameras optical paths were nearly parallel.

The leading edge of the debris was determined to be traveling at 86.04 inches per second and the trailing edge at 100.05 inches per second. The debris appeared to rotate almost 0.5 revolutions over this time period.

Camera E-34 showed a light area just after this time interval. The light area appeared to travel with the vehicle. However, the data was inconclusive as to whether the light area was the source of the rectangular debris, since the debris was first spotted significantly after liftofff.

Image Analysis Tools & Techniques

Photo/TV Analysis Group Request Form
STS-49
06/12/92

Task Number --> 14

Request Date : 05/11/92
Completion Date : 05/21/92

Requestor : G. Overstreet
Phone : 483-8857
Mail Code : ES2

Analyst Name	Phone Number	Assignment
B. Gastineau	483-5167	
R. Bhaskar	244-5322	
M. Snyder	483-5171	Lead

Task Title

Characterize Base Heat Shield Motion at SSME Start-Up

Objectives

Assess the motion of the base heat shield as viewed on E-19, E-20 and E-76. Determine if motion observed occurred on prior missions. Quantify motion.

Hypothesis

The base heat shield moves due to the aeroforces caused during SSME ignition.

Reporting

Report to G. Overstreet, C. Ortiz, B. Rosenbaum

Analysis Strategy

1) Try to determine the frequency of the base heat shield motion

2) Try to determine displacement

3) Attempt to correlate motion with observed pressure waves and SSME gimbling

4) Look for similar lighting conditions on other missions and review for similar movement.

5) Look at FRF film. Do same analysis if necessary

STS-49 Base Heat Shield Flexing

Flexing (characterized by an up and down motion) was noted in the base heat shield, between the SSMEs, from cameras E76, E77, E19, and E20. The flexing occurred at approximately T -4.6 seconds and ended just after all SSMEs had started up at about T - 2.9 seconds MET.

In order to see if the base heat shield flexing seen on STS-49 was unique to OV-105, previous missions were screened. Base heat shield flexing was detected on STS-51J (first flight of OV-104), STS-33, STS-48, STS-45, and STS-49 FRF. According to KSC base heat shield flexing was also observed on the STS-1 FRF (SSME test firing for first flight of OV-102), STS-6 (FRF1 and FRF2) and STS-6 (first flight of OV-099), STS-14 (slightly evident), and STS-28 FRF. According to Rockwell - Downey base heat shield flexing was also seen on STS-41D, STS-51F, and STS-51J FRF.

Since base heat shield flexing has been seen on previous missions it is not unique to OV-105 and may be a normal occurrence.

Measuring the Base Heat Shield flexing using camera E76

Using Overall distance between a control point and a point on the base heat shield

An analysis was conducted to measure the amount of up an down motion exhibited in the base heat shield flexing using film from camera E76. Three separate analysts determined distances from a point on the base heat shield to a control point on the base of the vertical stabilizer over the same 200 frames for which maximum base heat shield movement was observed. Picture 1 shows the location of the point on the base heat shield and the control point on the vertical stabilizer. (The displacement of the base heat shield was slightly off the axis of the line connecting the point on the base heat shield with the control point on the vertical stabilizer and this means that the estimate of the amount of motion may be slightly low.) The average of the three analysts distances was then used to determine the best estimate of the "true" distance for each frame. The average distance for each frame was then normalized so that the first frame had a distance of 0 and subsequent frames represented displacement from that first frame. These displacements from the first frame were then converted to inches. (The width of the OMS pod (measured to be approximately 44 inches was used for scale)). The displacements from the first frame measure the movement of the base heat shield away or towards the base of the vertical stabilizer. The plot of the normalized distances is shown in Figure 1. The distances between successive extreme points was measured and the maximum peak to peak displacement was found to be 1.06 inches with a 95% confidence range of between .24 to 1.88 inches. Note that the overall distance between the base heat shield and the point on the vertical stabilizer increases about 2 inches over the last second and this is thought to be due to the twang caused by SSME startup.

The frequencies of the oscillations seen in the base heat shield flexing were determined using a fourier analysis and the results are shown in Figure 2. Two high frequency peaks were detected at 25 Hz. and 41 Hz.

Using the Displacement of a point on the Base Heat Shield along the X and Y axes

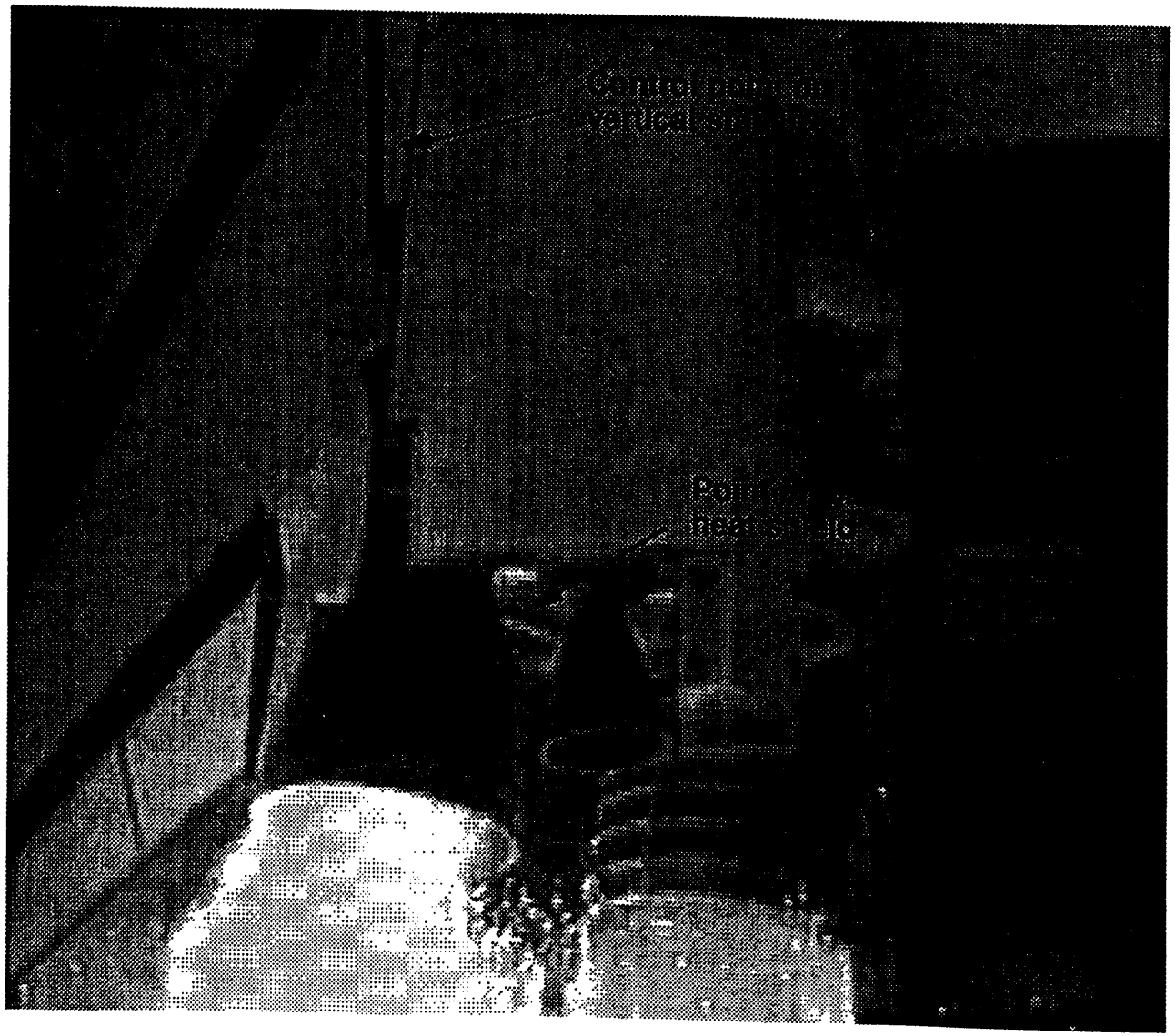
The displacement of a point on the base heat shield was also measured with respect to the X and Y axes of the camera (note that the Y axis of the camera is essentially the same as the orbiters X axis and the X axis of the camera is approximately 30 degrees from the Y axis of the orbiter). Figures 3 and 4 show plots of the position of a point on the base heat shield in the X and Y dimensions. (Both plots show a general increase in position over the entire period due to twang. The base heat shield movement was measured using the peak to peak displacements between adjacent points.) Note that maximum peak to peak displacements are approximately 1.3 inches for each axis with a 95% confidence interval for the Y displacement of between 0.4 and 2.3 inches and for the X displacement the 95% confidence interval is between 0.3 and 2.2 inches.

MSFC conducted an analysis of the base heat shield flexing and they also found that the maximum displacement in the orbiter X and Y axes was approximately one inch. The MSFC preliminary report is included at the end of this report.

A frequency analysis was conducted on the X and Y displacements and the results are shown in Figures 5 and 6. Note that no dominant high frequencies were detected, implying that the base heat shield flexing is occurring randomly. This result contradicts the finding of apparently strong peaks using the control point to base heat shield distance data. Since the distance data incorporates both X and Y displacements it could be showing that peaks in the X and Y combine to create stronger peaks in the distance data.

MSFC also conducted a frequency analysis and found no dominant frequencies. MSFC concluded that the flexing was essentially random.

Picture 1 showing location of point on base heat shield and control point on the vertical stabilizer



Normalized Deflection of the Base Heat shield using Overall Distance Data

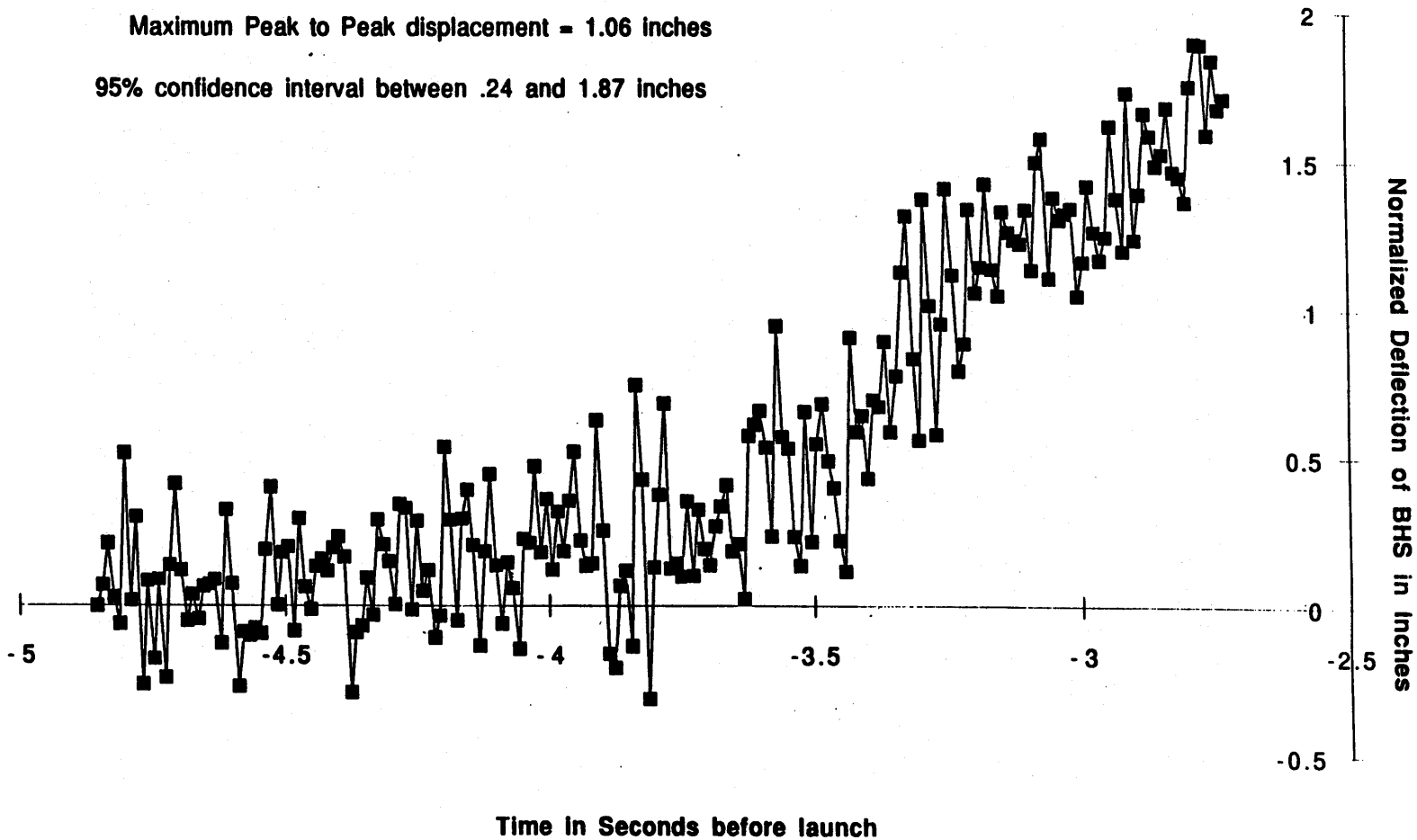
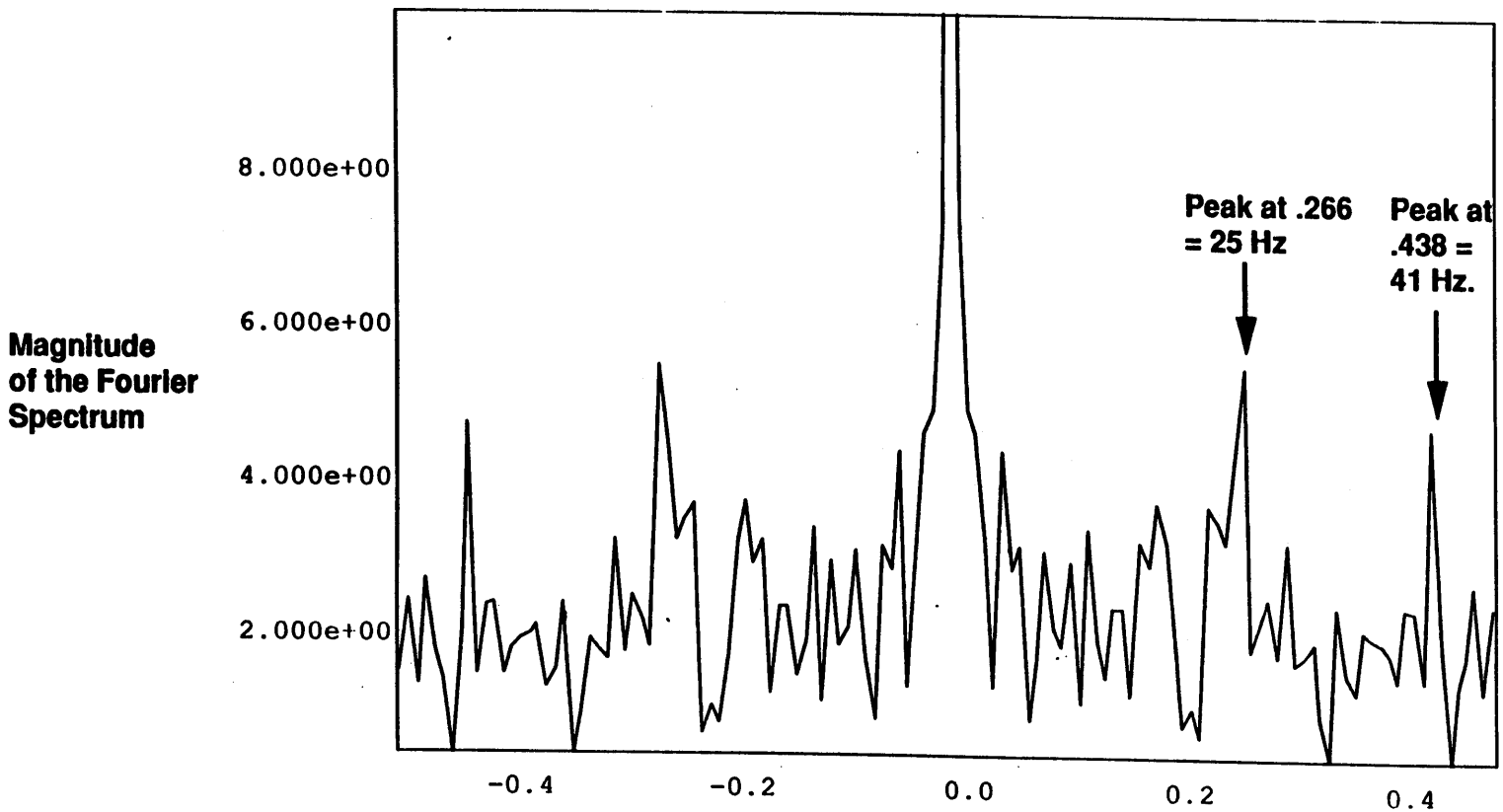


Figure 1

Magnitude of Fourier Spectrum showing frequencies in the flexing of the Base Heat Shield using Overall Distance



Frequencies in cycles per unit (1 unit = 1/94 second)

Note the magnitude at 0 is 22 and is off the graph at this scale.

Figure 2

Normalized Deflection of the Base Heat Shield along the Camera X axis

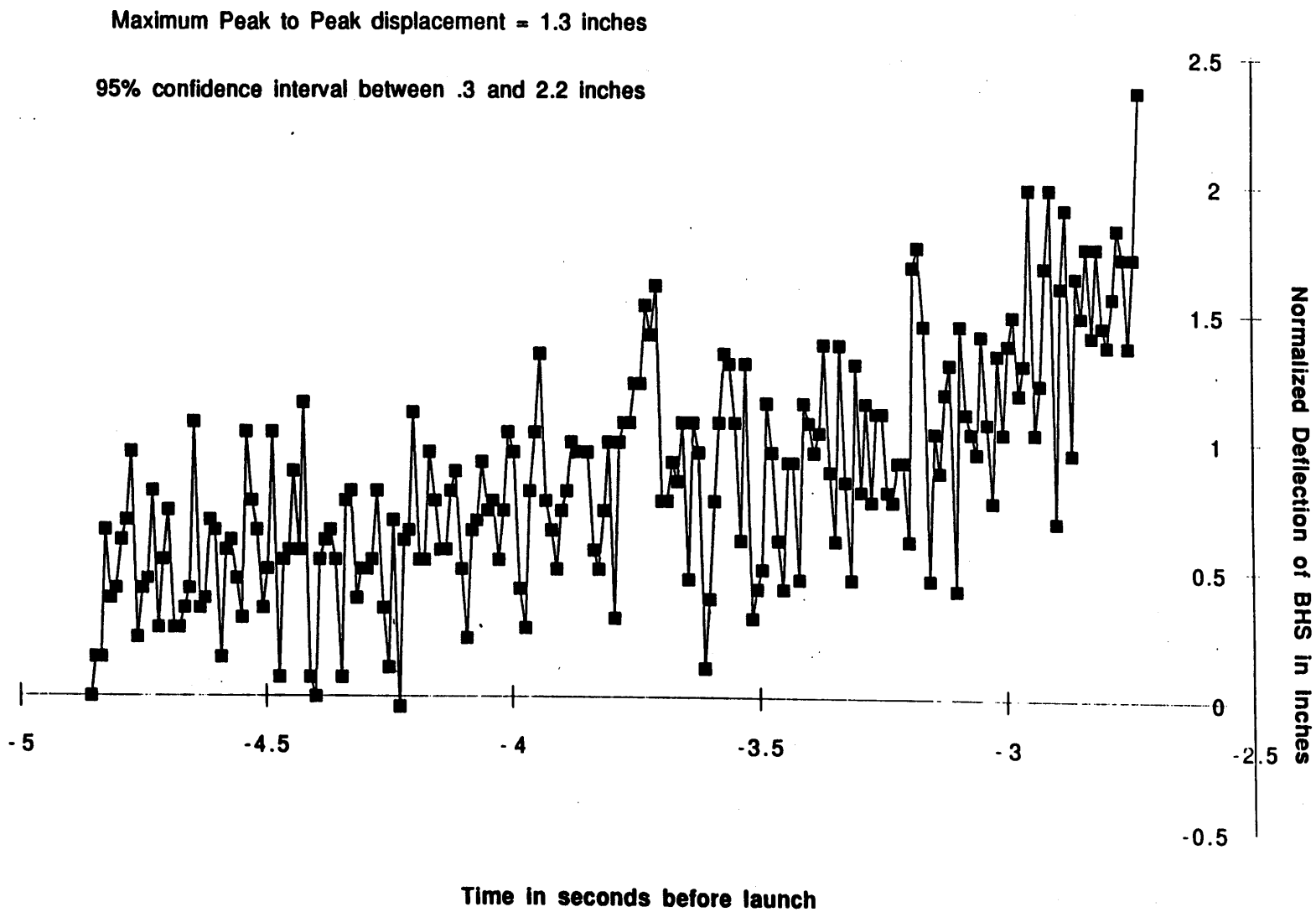


Figure 3

Normalized Deflection of the Base Heat Shield along the Camera Y axis (Orbiter X axis)

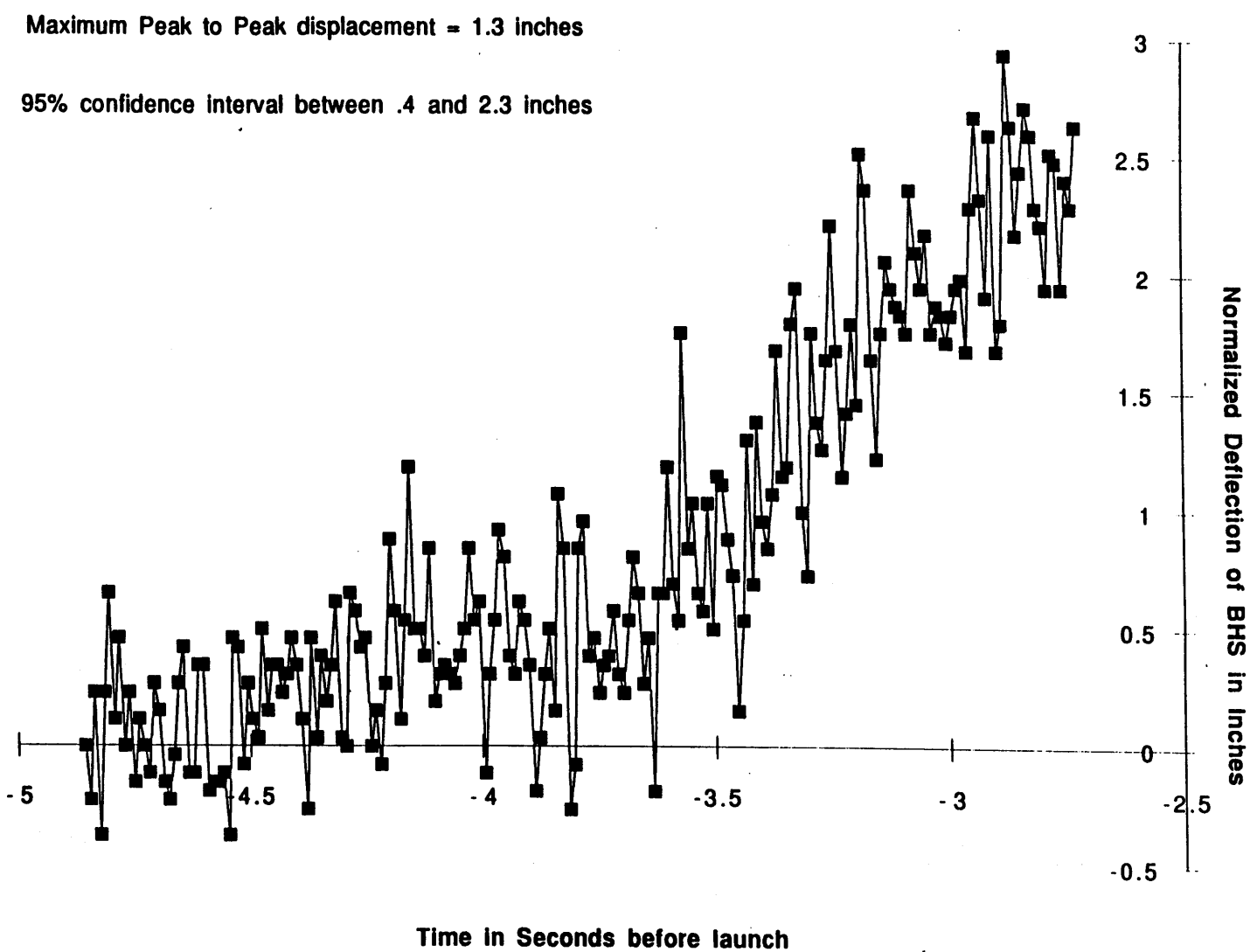
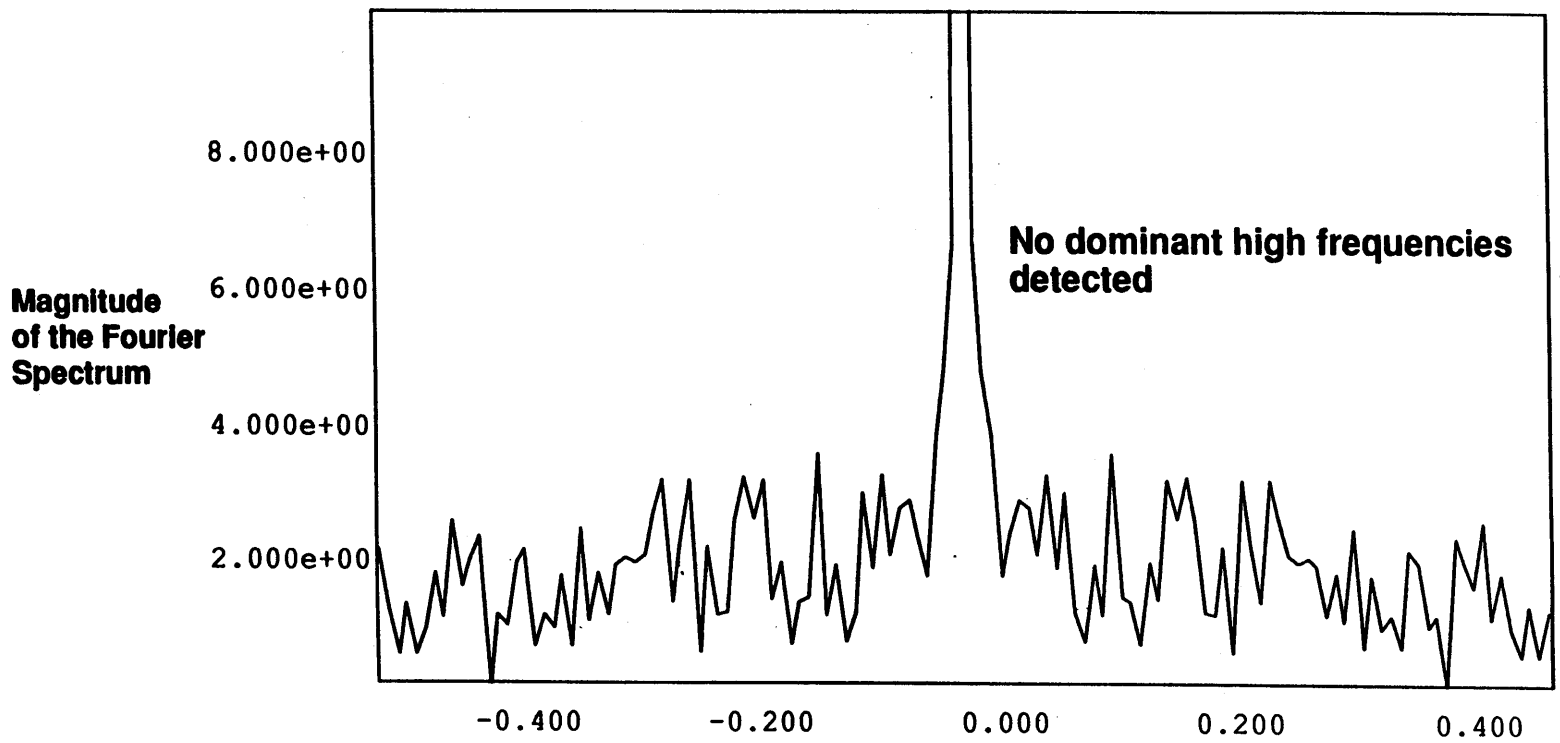


Figure 4

Magnitude of Fourier Spectrum showing frequencies in the flexing of the Base Heat Shield for Camera Y axis (Same as Orbiter X axis)

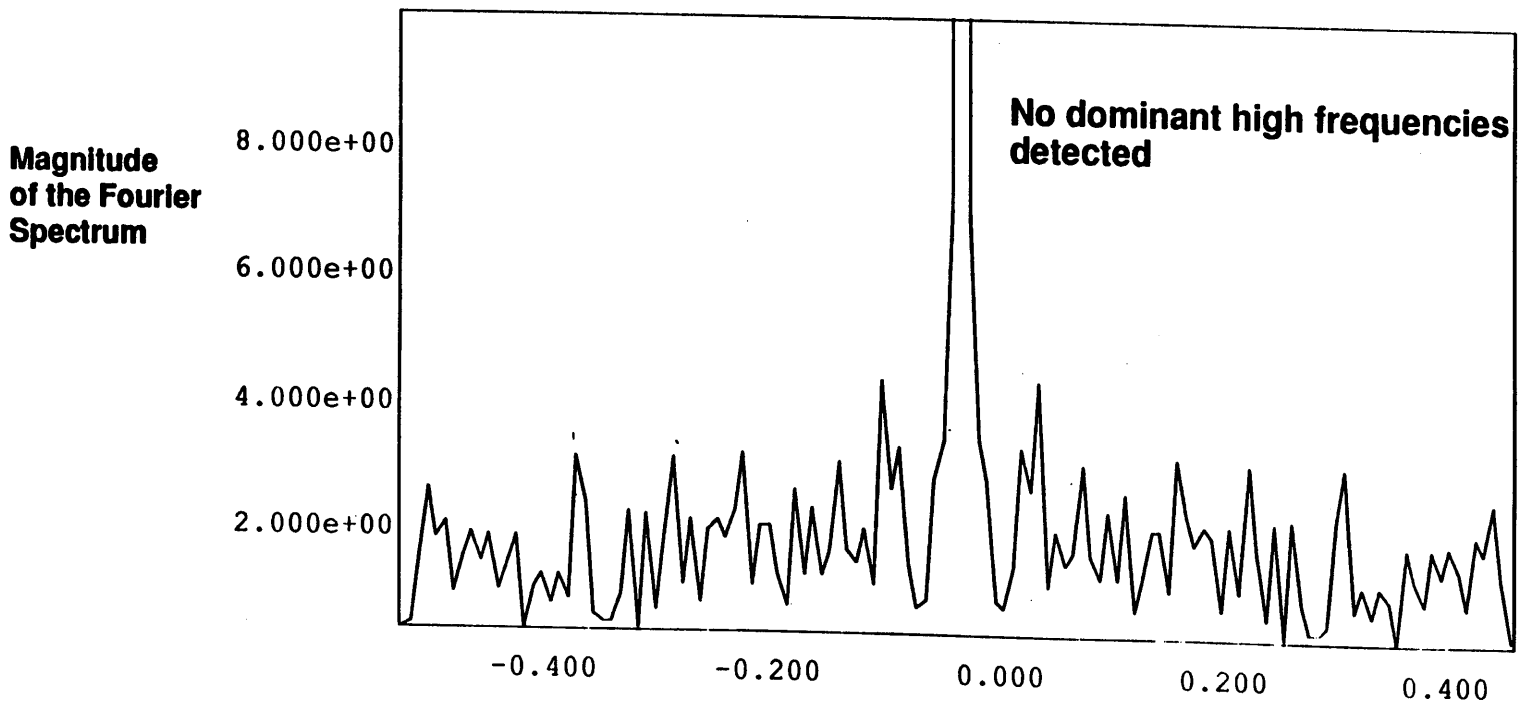


Frequencies in cycles per unit (1 unit = 1/94 second)

Note the magnitude at 0 is over 10,000 and is off the graph at this scale.

Figure 5

Magnitude of Fourier Spectrum showing dominant frequencies in the flexing of the Base Heat Shield for Camera X axis



Frequencies in cycles per unit (1 unit = 1/94 second)

Note the magnitude at 0 is over 3,000 and is off the graph at this scale.

Figure 6

NISFC REPORT (Preliminary)

Rockwell International

Space Systems Division
Rockwell International Corporation
12214 Lakewood Boulevard
P.O. Box 7009
Downey, California 90241-7009

OFFICE USE ONLY		
MESSAGE NUMBER		DATE
MACHINE NUMBER		TIME
☐ DOWNEY COMM CTR.	FAX COM/372-2032 (213) 922-2032	VOICE COM/372-2166 (213) 922-2166
☐ OTHER	FAX COM/_____ ( )	VOICE COM/_____ ( )
ALTERNATE FAX		ALTERNATE FAX

FACSIMILE MESSAGE

LEAD+ 12 PAGE(S)

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FROM: NAME	DIV/ORG	LOCATION	PHONE
BARBARA BILLETER	841/ RI	DNY	x 1563
TO: NAME(S)	**CO/AGENCY,LOC**	**PHONE NO.**	**FACSIMILE NO.**
MIKE SNYDER	LOCKHEED/JSC	x 5171	x 2911

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SIGNATURE

Internal Letter Rockwell International

Date: May 21, 1992 No.

To: C. B. Hopson
SSD - Huntsville
841/ZA06

From: B. L. Viger
SSD - Huntsville
841/ZA03

Subject: STS-49 Base Heat Shield Motion During SSME Mainstage Transition

During film review for STS-49, the Photo Analysis group observed base heat shield motion/oscillation during SSME transition to mainstage (Mach diamond formation prior to L/O). The Photo Analysis group performed a motion analysis study on the base heat shield motion using cameras E-19 and E-76. Figures 1 and 2 show the camera orientation for E-19 and E-76, respectively.

Figures 3 through 8 show the motion of the base heat shield relative to the orbiter axis system. There are three plots each for Xo motion and Yo motion. Plots 3 and 4 represent unfiltered data. Plots 5 and 6 represent three-point-rolling-average-filter data. Plots 7 and 8 represent five-point-rolling-average-filter data.

The following table provides the data accuracy for each camera/target using an RMS averaging routine for multiple data from a fixed point.

CAMERA	HORIZONTAL	VERTICAL
E-19	+.150	+.134
	-.135	-.162
E-76	+.216	+.167
	-.188	-.150

Brian Viger

B. L. Viger

BLV:ajm

CAMERA E-19 VIEW

FIGURE 1

CAMERA E-76 VIEW

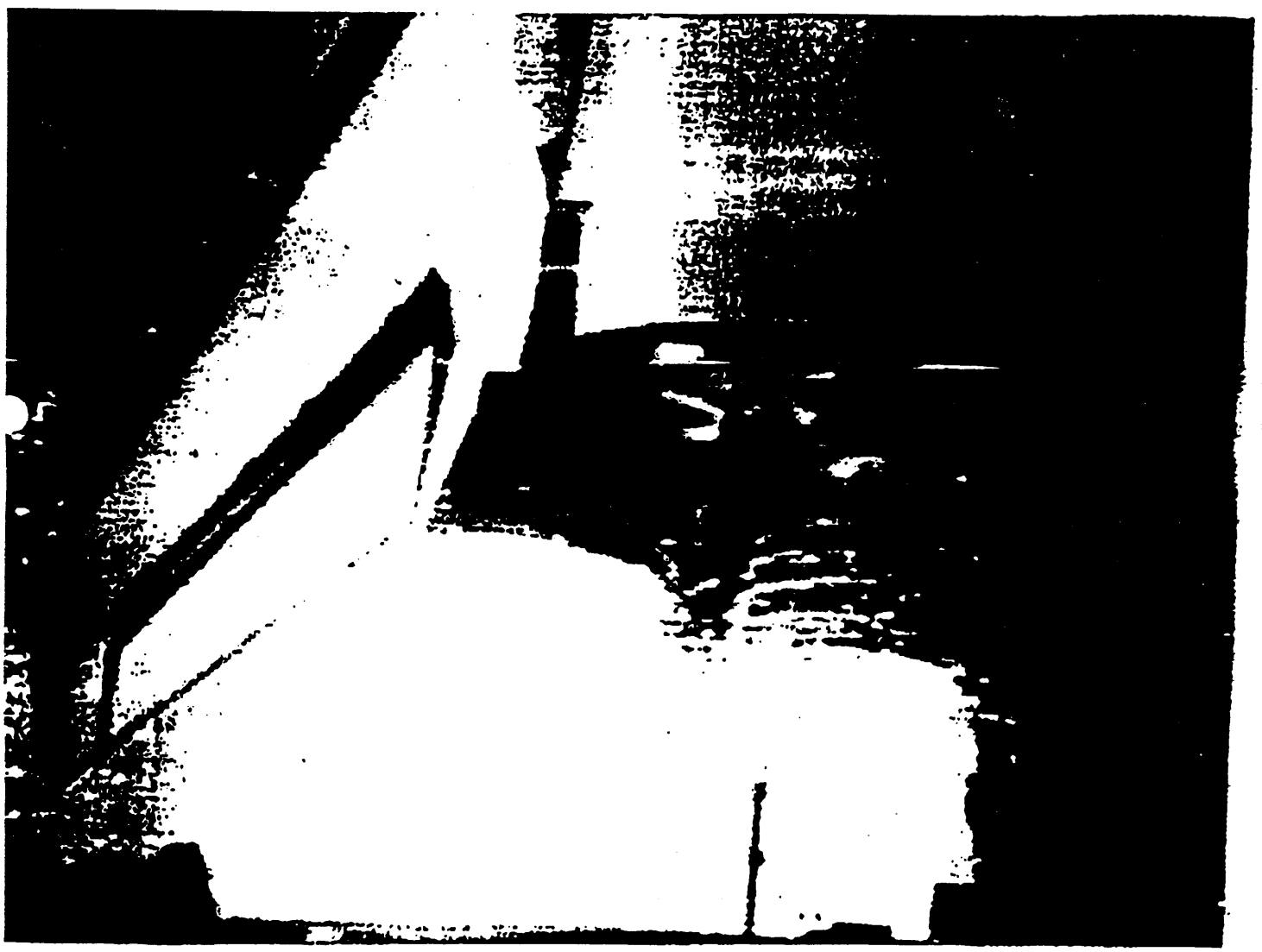


FIGURE 2

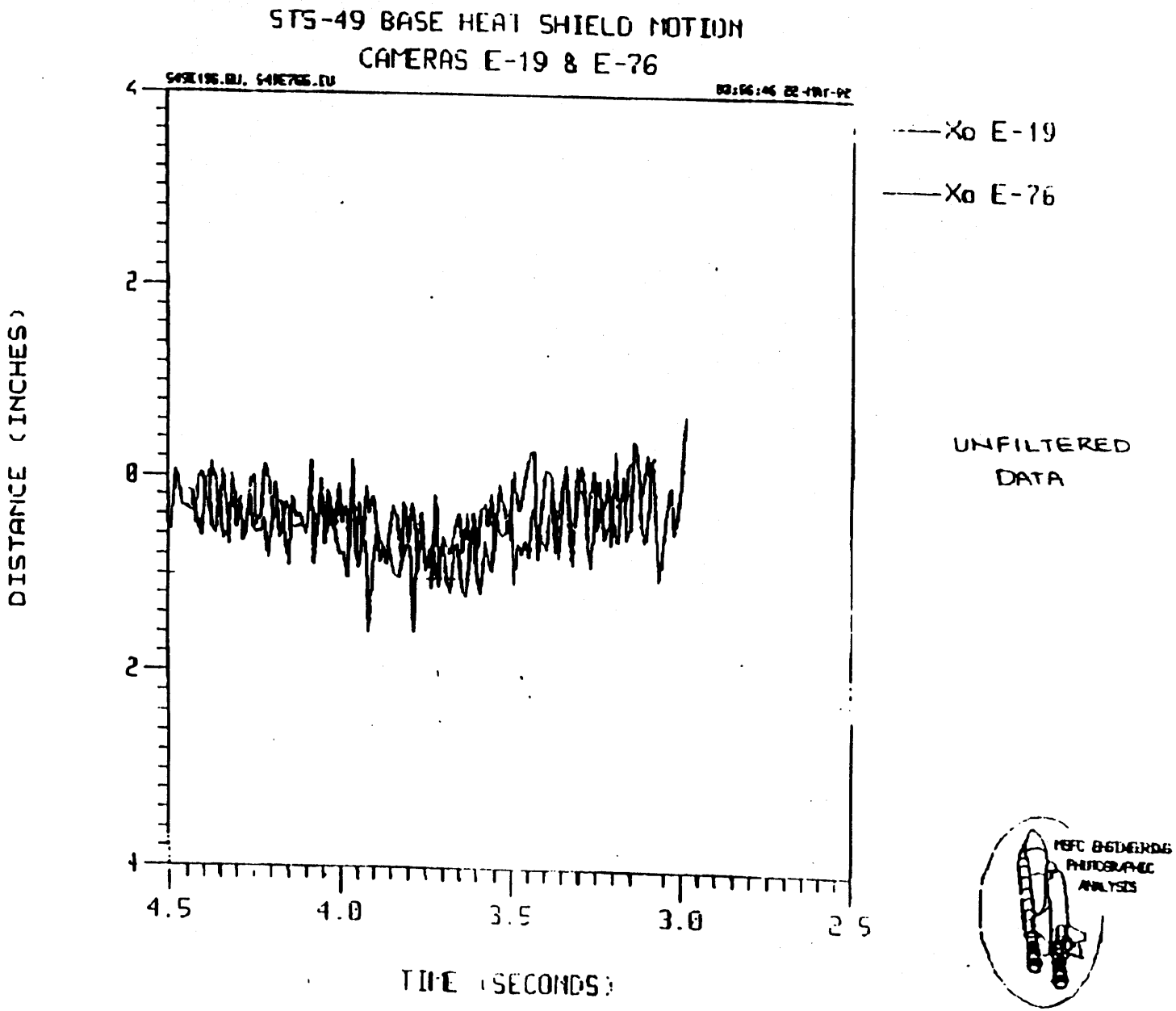

STS-49 BASE HEAT SHIELD MOTION
CAMERAS E-19 & E-76
Xo E-19
Xo E-76
UNFILTERED DATA
DISTANCE (INCHES)
TIME (SECONDS)
4
2
0
2
4
4.5
4.0
3.5
3.0
2.5
MSFC ENGINEERING PHOTOGRAPHIC ANALYSIS

FIGURE 3

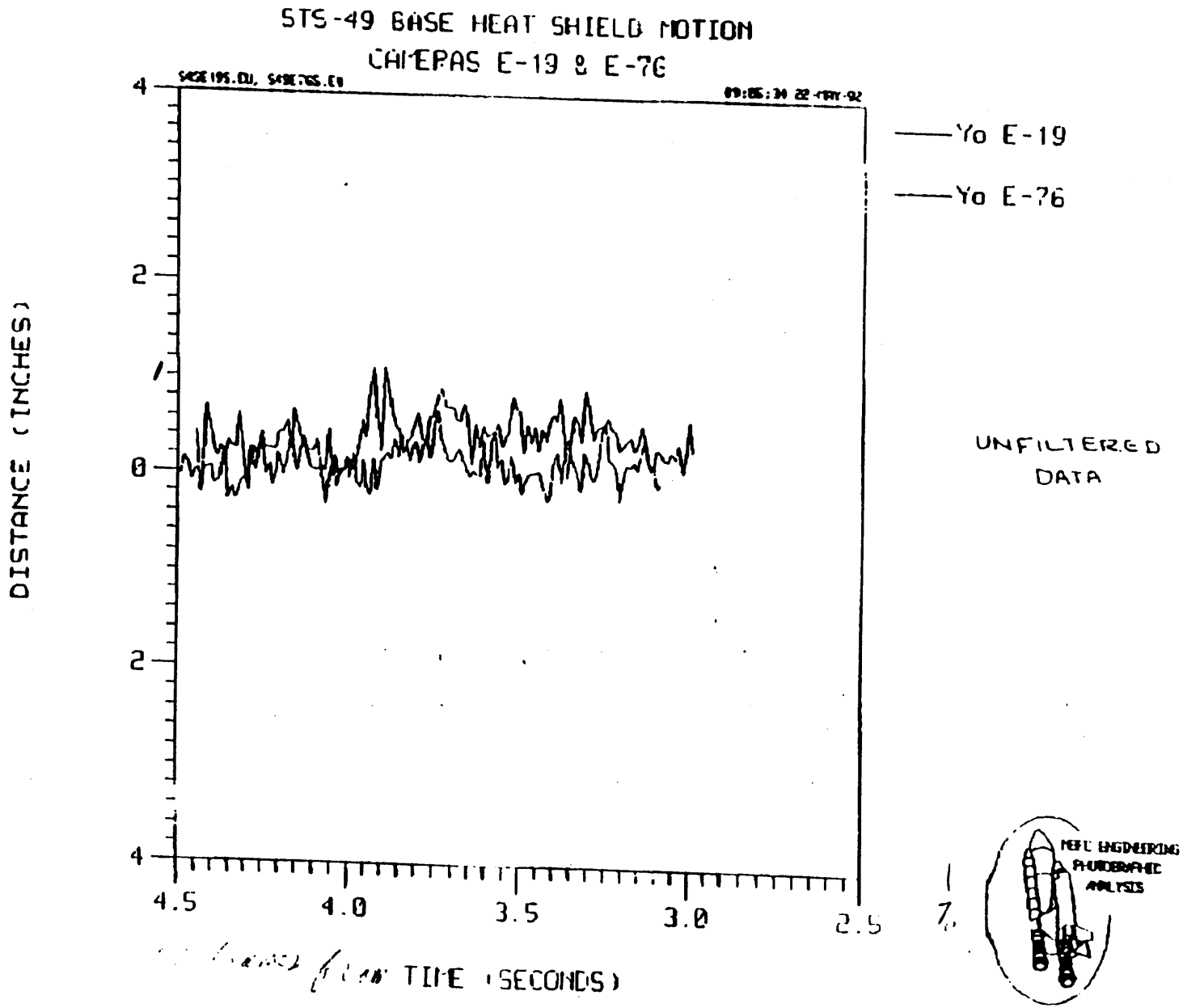

STS-49 BASE HEAT SHIELD MOTION
CAMERAS E-19 & E-76
Yo E-19
Yo E-76
UNFILTERED DATA
DISTANCE (INCHES)
4
2
0
2
4
4.5
4.0
3.5
3.0
2.5
TIME (SECONDS)

FIGURE 4

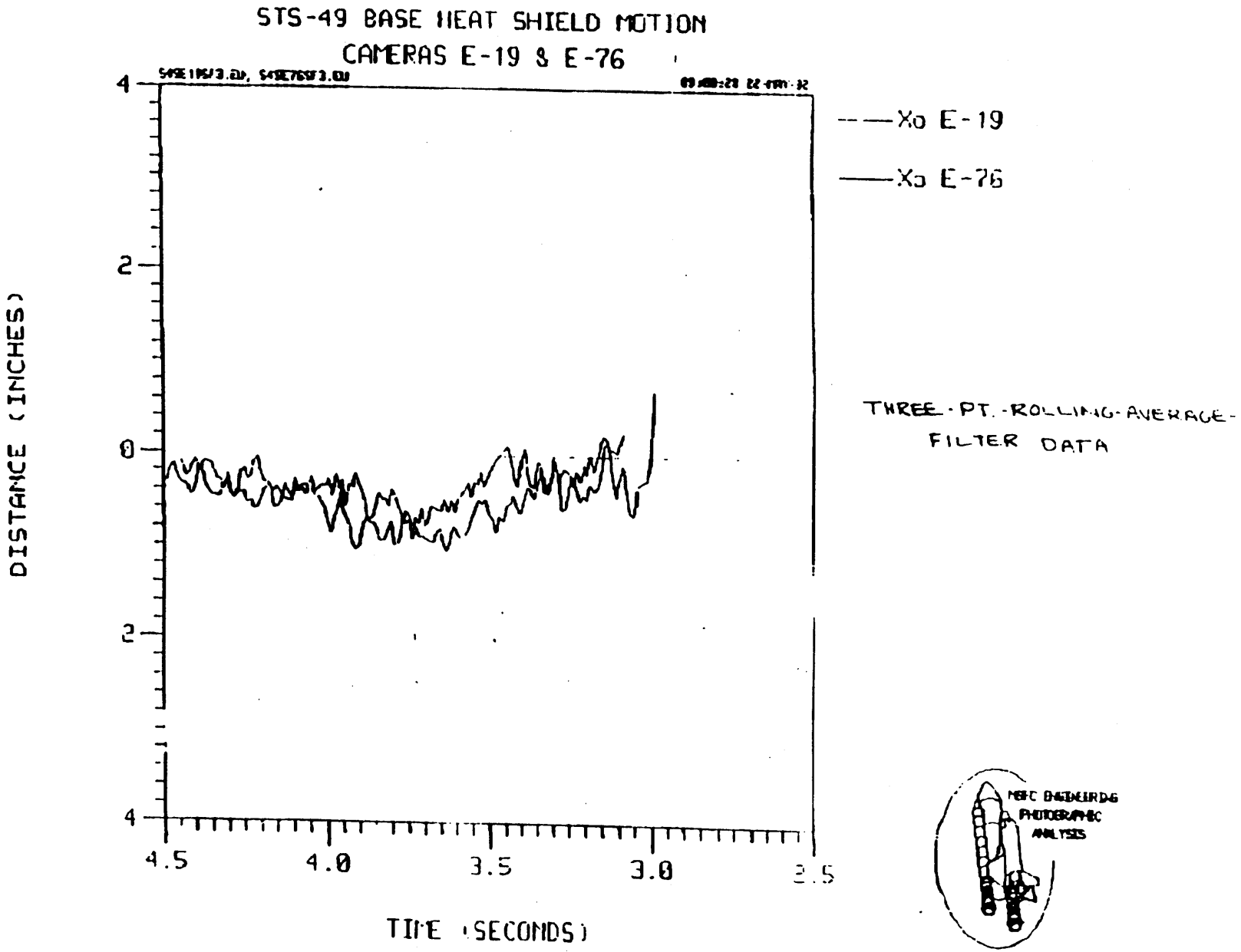

STS-49 BASE HEAT SHIELD MOTION
CAMERAS E-19 & E-76
Xo E-19
Xo E-76
THREE-PT.-ROLLING-AVERAGE-FILTER DATA
DISTANCE (INCHES)
TIME (SECONDS)
4
2
0
2
4
4.5
4.0
3.5
3.0
2.5
MSFC ENGINEERING PHOTOGRAPHIC ANALYSIS

FIGURE 5

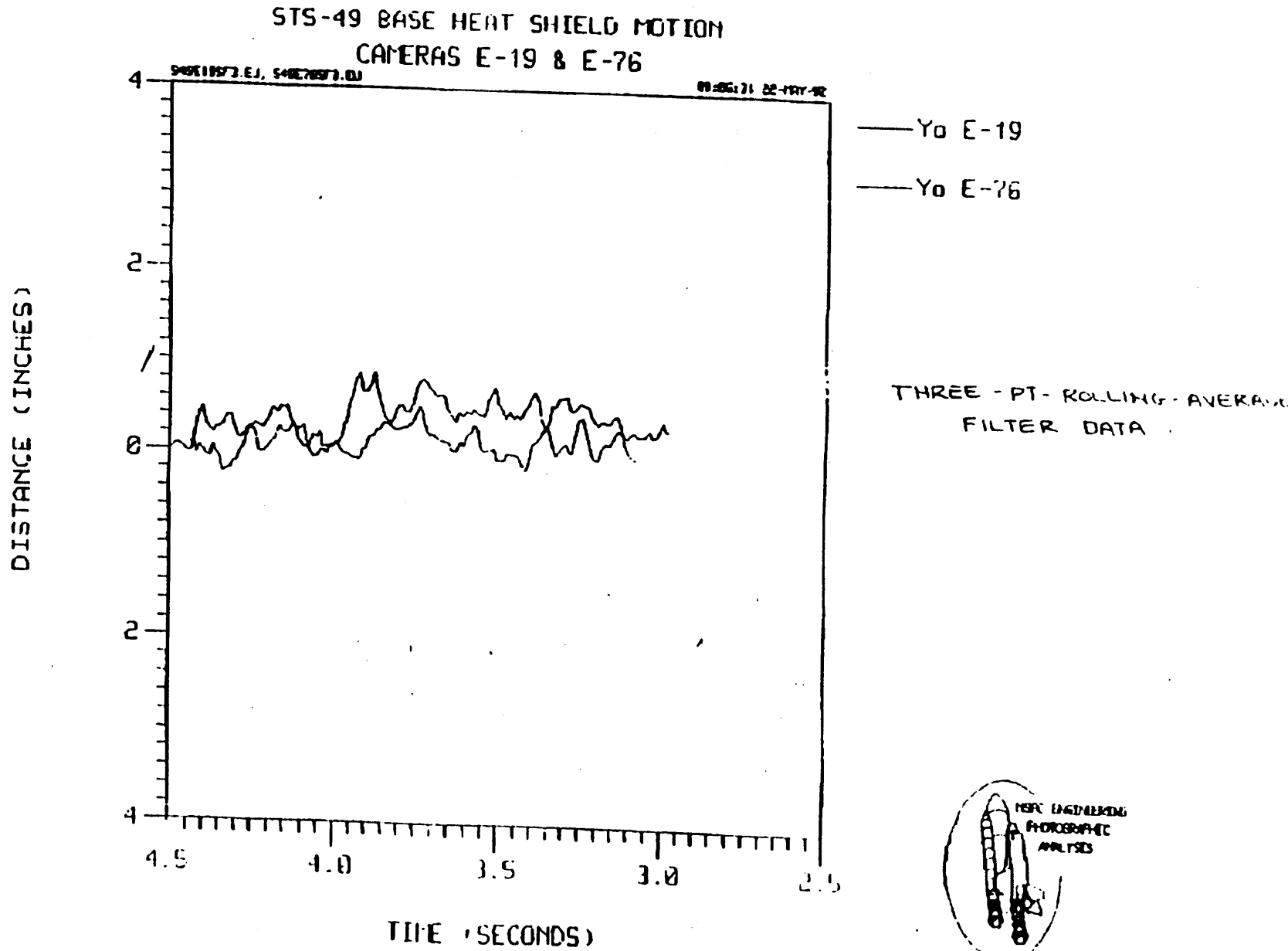

STS-49 BASE HEAT SHIELD MOTION
CAMERAS E-19 & E-76
Yo E-19
Yo E-76
THREE - PT - ROLLING - AVERAGE
FILTER DATA
DISTANCE (INCHES)
TIME (SECONDS)
4
2
0
2
4
4.5
4.0
3.5
3.0
2.5

FIGURE 6

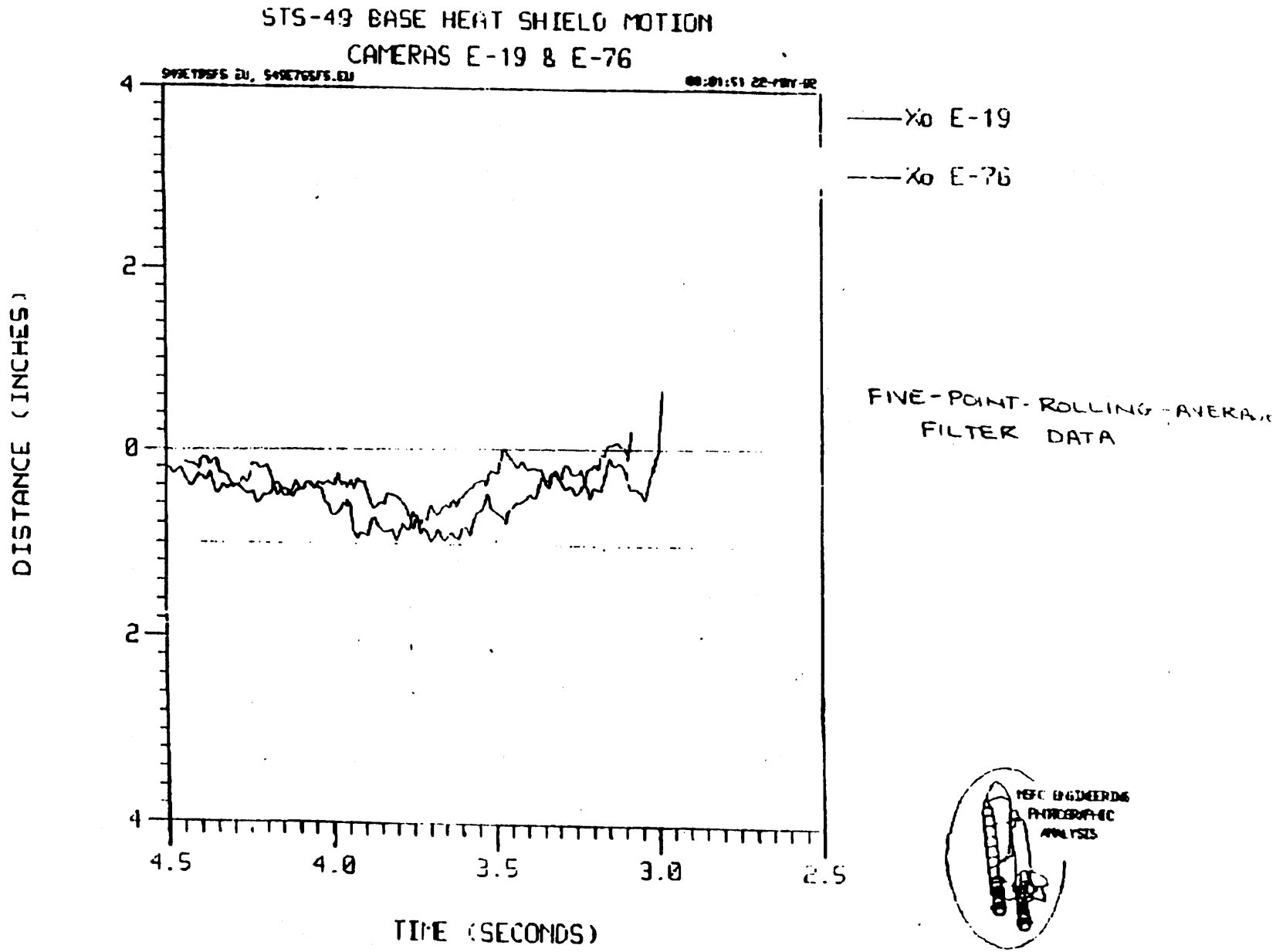

STS-49 BASE HEAT SHIELD MOTION
CAMERAS E-19 & E-76
Xo E-19
Xo E-76
FIVE-POINT-ROLLING-AVERAGE
FILTER DATA
DISTANCE (INCHES)
TIME (SECONDS)
4
2
0
2
4
4.5
4.0
3.5
3.0
2.5

FIGURE 7

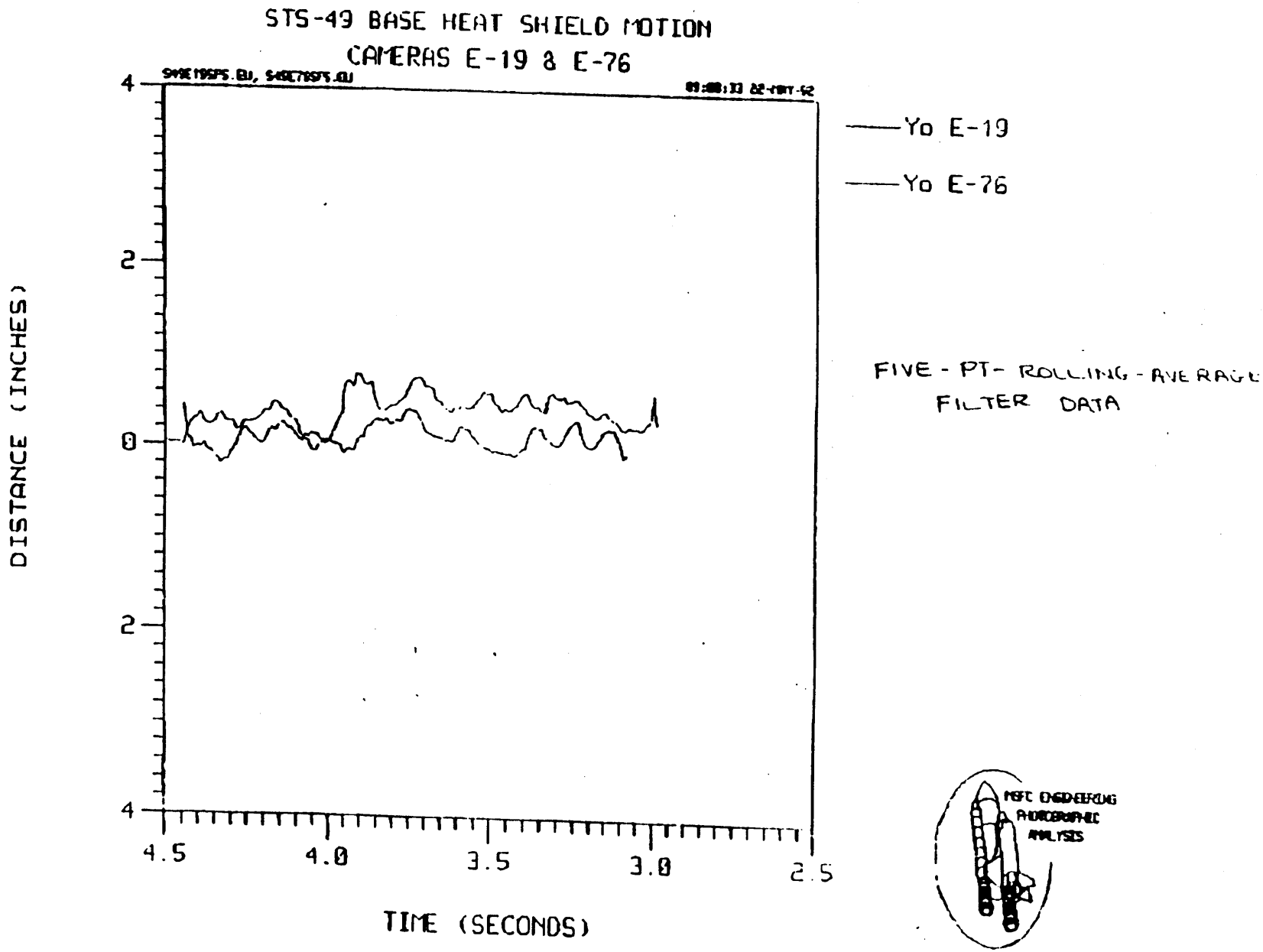

STS-49 BASE HEAT SHIELD MOTION
CAMERAS E-19 & E-76
Yo E-19
Yo E-76
FIVE - PT- ROLLING - AVERAGE
FILTER DATA
DISTANCE (INCHES)
4
2
0
2
4
4.5
4.0
3.5
3.0
2.5
TIME (SECONDS)

FIGURE 8

Internal Letter

Rockwell International

Date: .May 22, 1992

No: .112-CBH-92-134

TO: (Name, Organization, Internal Address)
.J.A. Collins
.SSD - Huntsville
.D/112, 841-ZA17

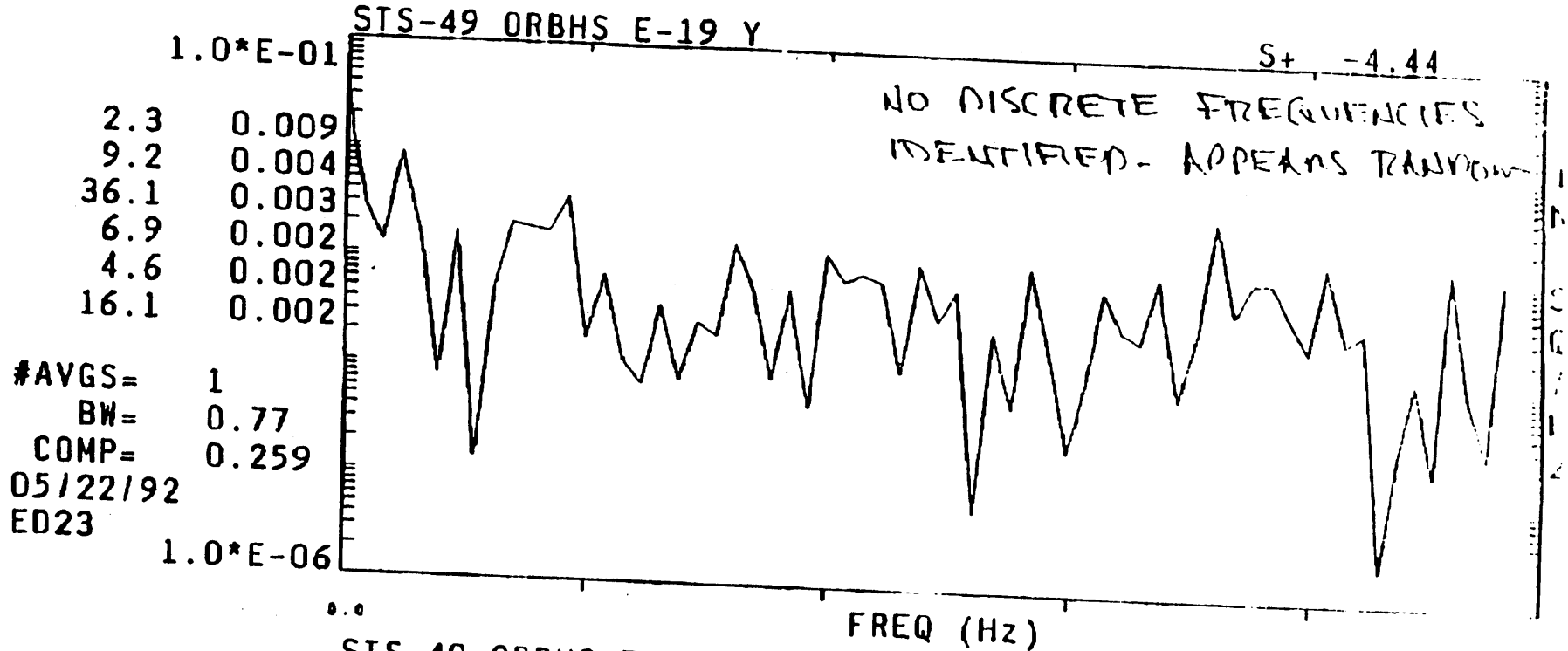
FROM: (Name, Organization, Internal Address, Phone)
.C. B. Hopson
.SSD - Huntsville
.D/112, 841-ZA06
.3361

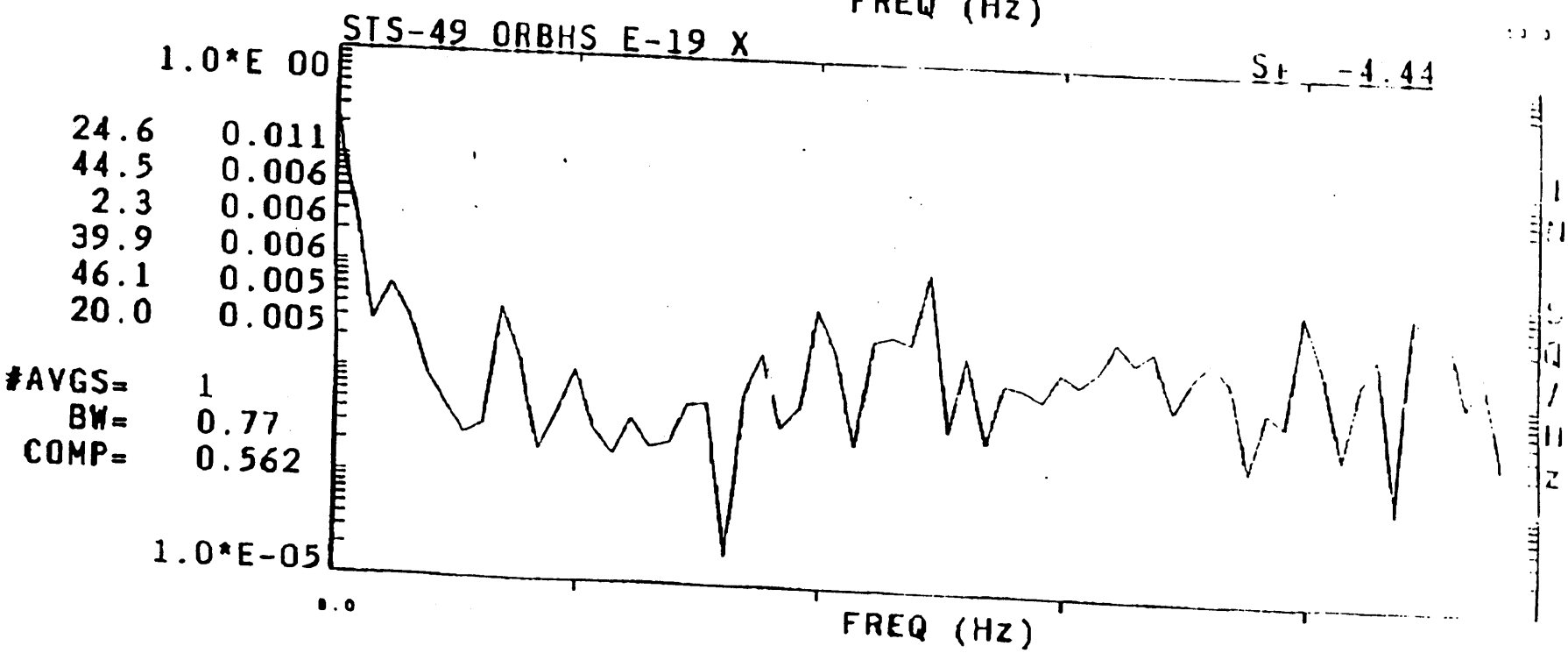
Subject: . STS-49 Orbiter Heat Shield Motion Spectra

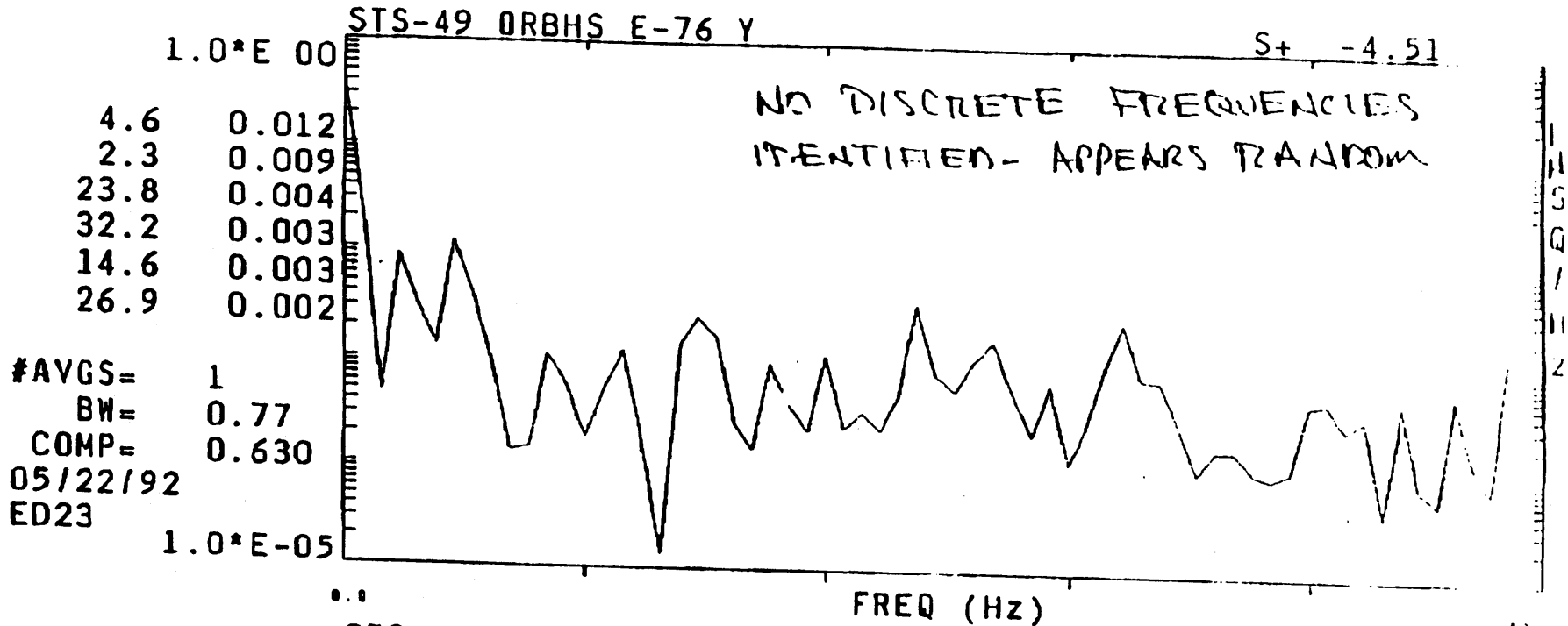
Frequency analyses have been performed on camera E-19 and E-76 displacement data digitized by the Photgraphic Analysis group.No discrete frequencies were identified. The data appear to be random.

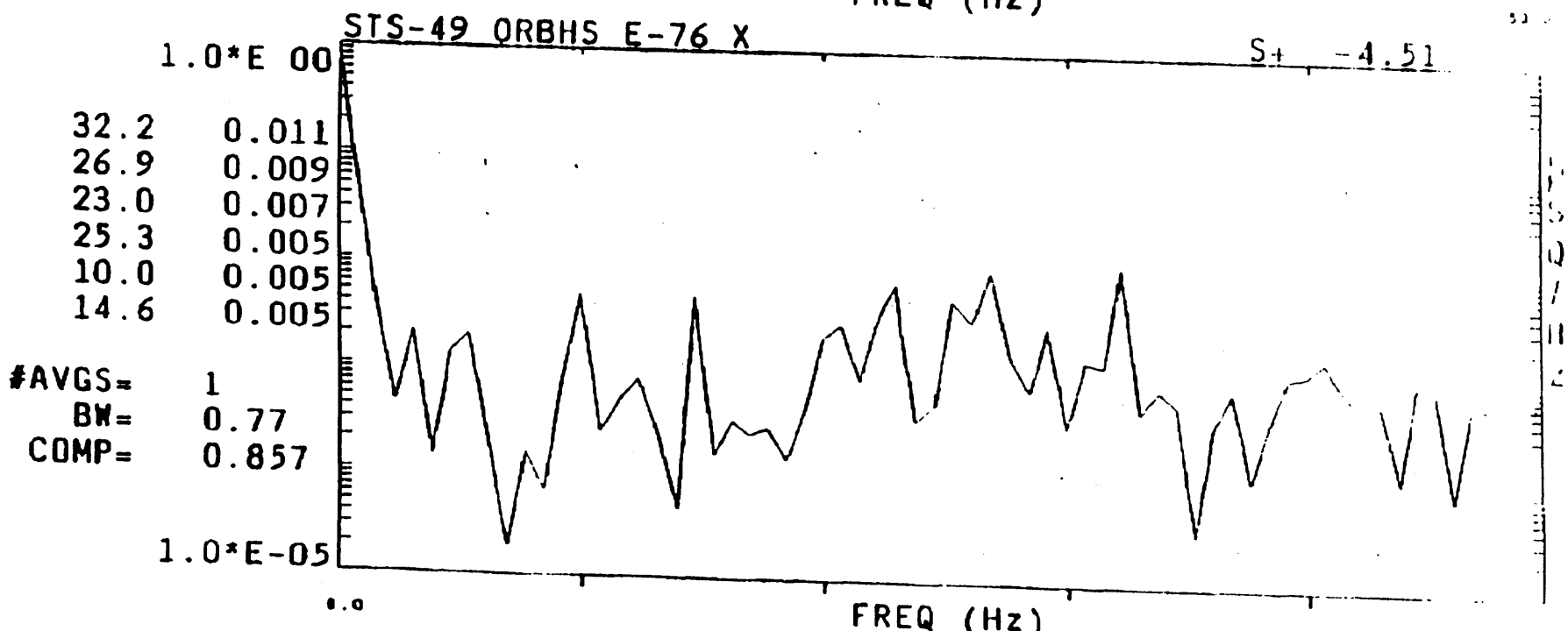
Attachment

Charles B. Hopson
Supervisor
Simulation/Analysis


STS-49 ORBHS E-19 Y
1.0*E-01
1.0*E-06
S+ -4.44
NO DISCRETE FREQUENCIES IDENTIFIED - APPEARS RANDOM
2.3 0.009
9.2 0.004
36.1 0.003
6.9 0.002
4.6 0.002
16.1 0.002
#AVGS= 1
BW= 0.77
COMP= 0.259
05/22/92
ED23
0.0
FREQ (Hz)


STS-49 ORBHS E-19 X
1.0*E 00
1.0*E-05
S+ -4.44
24.6 0.011
44.5 0.006
2.3 0.006
39.9 0.006
46.1 0.005
20.0 0.005
#AVGS= 1
BW= 0.77
COMP= 0.562
0.0
FREQ (Hz)


STS-49 ORBHS E-76 Y
S+ -4.51
NO DISCRETE FREQUENCIES
IDENTIFIED- APPEARS RANDOM
1.0*E 00
4.6 0.012
2.3 0.009
23.8 0.004
32.2 0.003
14.6 0.003
26.9 0.002
#AVGS= 1
BW= 0.77
COMP= 0.630
05/22/92
ED23
1.0*E-05
0.0
FREQ (Hz)


STS-49 ORBHS E-76 X
S+ -4.51
1.0*E 00
32.2 0.011
26.9 0.009
23.0 0.007
25.3 0.005
10.0 0.005
14.6 0.005
#AVGS= 1
BW= 0.77
COMP= 0.857
1.0*E-05
0.0
FREQ (Hz)

From: SN::GASTINEAU "Brian Gastineau 483-5167" 13-MAY-1992 10:47:36.09
To: @PHOTOTV,KSCDL1::KATNIK
CC: GASTINEAU
Subj: A preliminary assesment of STS-49 Base Heat Shield flexing

Galen Overstreet (ES23, #3-8857), a JSC structures engineer, came over to review films from previous missions. He has concluded that the observed flexing is not mission specific. The main proof came from review of STS-33 camera E19 which showed flexing of the Base Heat Shield. Films from missions 44,48,38,33 (the four available night launches), 49,and FRF49 were quickly reviewed but most did not offer good views of the Base Heat Shield due to lighting and/or vapors in the area.

Before this task is closed, we will review missions 51J (the first flight of Atlantis, other first flights were not available). The missions which have been screened (33,38,44,48,49, and FRF49) will be reviewed more carefully. Attempts will be made to quantify the deflection and determine a frequency of the vibrations. It is also hoped to establish a timeline relating the Base Heat Shield motion to SSME bell motion.

Mr Overstreet's hypothesis is that the motion is caused by pressure waves from the main engines during SSME ignition. Mr Overstreet gave a simplified description of the area as a layer of silicon, a layer of felt-like material, another layer of silicon, and then the tiles. He had talked with other engineers and relayed that the time of greatest stress on this area was during ET separation.

From: SN::SNYDER 13-MAY-1992 16:29:57.28
To: @MISSION
CC: SNYDER
Subj: JSC Photo/TV Analysis Report for STS-49 - 4th Day Film

STS-49
JSC Photo/TV Analysis Report
16:15 CDT May 13, 1992

On Wednesday, two of two expected films arrived. To date, a total of forty 16mm films, twenty -one 35mm films and twenty-three videos have been screened. No more films are expected until after landing.

Camera E77 - Flexing of the base heat shield was again noted during SSME ignition. This event was also seen on E76, E19, and E20. Photo analysts and a JSC structures engineer reviewed films from previous missions. The preliminary conclusion is that the observed flexing is not mission specific. The main evidence for this came from a review of STS-33 (camera E-19), which showed flexing of the base heat shied. Rockwell-Downey has reported seeing the base heat shield motion on STS-51J films (the first flight of Atlantis) plus slight motion on STS-51F and STS-44.

Attempts to quantify the deflections and determine a frequency of vibration from the photography are being made. A timeline to relate the base heat shield motion to SSME bell motion will be made. Previous mission films will continue to be examined. A hypothesis is that the motion is caused by pressure waves from the main engines during SSME ignition.

The following items merit mentioning but are not considered anomalous:

Camera E77 - Two small pieces of white debris were seen falling from the edge of the right inboard elevon at liftoff.

Camera E79 - A white piece of debris was seen moving from left to right across the ET LO2 feedline and then falling aft along the LO2 feed line at liftoff. A task is in progress to determine if this debris is related to the debris seen falling aft along the orbiter fuselage under surface tiles at liftoff (Cameras E52 and E54).

Other normal events observed included: RCS paper debris, ice debris from the LH2 and LO2 umbilicals, and ice from the LO2 TSM.

Summary of Analysis of Visual Events
STS-49
06/09/92

Task Number
14

Title : Characterize Base Heat Shield Motion at SSME Start-Up

Analysts : B. Gastineau, B. Picken
Date : 05/22/92

Camera Number :		**Requestor :**	G. Overstreet
Frame Number :		**Phone :**	483-8857
GMT :		**Mail Code :**	ES2

Description of Analysis

Films from previous missions were screened in search of evidence of base heat shield flexing. The findings are on the attached page.

Image Analysis Tools & Techniques

FMA

STS-49 Base Heat Shield Flexing
screening of prior missions

Mission	Camera	comments
STS-51J	E19	motion detected
	E20	no motion detected (camera vibration)
	E76	motion detected
STS-33	E19	motion detected
	E76	motion detected (hazy)
STS-38	E19	inconclusive
	E76	inconclusive
STS48	E19	no motion detected
	E20	no motion detected (camera vibration)
	E76	motion detected (hazy)
STS-44	E19	no motion detected (camera vibration)
	E20	no motion detected
	E76	no motion detected
STS-42	E76	Motion detected (hazy) ?
STS-45	E76	motion detected (hazy)
STS-49 FRF	E19	slight motion detected (camera vibration)
	E20	no motion detected (camera vibration and hazy)
	E76	motion detected

Rudy Ramon called and gave the following report

Mission	Vehicle	Camera	Findings
STS-1	102	19,20	No evidence
STS-6 FRF	99	19,20,23	Motion detected
STS-6 flight	99	19,20,23	Motion detected
41D	103	19,20	Slight motion detected
		23	No evidence
51J FRF	104	E-23	No
51J		19	Motion detected
		20	inconclusive, camera vibration
		23	slight motion detected
STS-48	103	19,20	No evidence
STS-44	104	19,20	Slight motion
51F	099	20,23	slight motion
		19	Too dark
STS-42	103	19	No evidence
STS-45	104	19	No evidence

Dave Pitts

From: SN::PITTS 13-MAY-1992 12:15:26.10
To: @PHOTOTV.DIS,KSCDL1::KATNIK,8612::PHOTO
CC:
Subj: Base Heat sheild flexture - Screening Results from Ri-D

Rudy Ramon called and gave the following report

Mission	Vehicle	Camera	Findings
STS-1	102	19,20	No evidence
STS-6 FRF	99	19,20,23	Motion detected (poor notes??)
STS-6 flight	99	19,20,23	Motion detected (poor notes??)
41D	103	19,20	Slight motion detected
		23	No evidence
51J FRF	104	E-23	No
51J		19	Motion detected
		20	inconclusive, camera vibration
		23	slight motion detected
STS-48	103	19,20	No evidence
STS-44	104	19,20	Slight motion
51F	099	20,23	slight motion
		19	Too dark
STS-42	103	19	No evidence
STS-45	104	19	No evidence

My notes are suspect on STS-6. I'll check with Rudy again.
Dave Pitts

Base Heat Shield Flexure

Mission	Vehicle	Cameras	Remarks
STS-1 FRF	102	E-19, 20	Conclusive movement
STS-1	102	E-19, 20	Inconclusive due to lighting and camera vibration
STS-6 FRF1	099	E-19, 20	Conclusive movement
STS-6 FRF2	099	E-19 E-20	Conclusive movement Inconclusive due to camera vibration
STS-6	099	E-19, 20	Conclusive movement
STS-14 Abort	103	E-19, 20	Inconclusive due to smoke
STS-14	103	E-19, 20	Slightly evident
STS-28 FRF	104	E-19, 20	Conclusive movement
STS-26R FRF	103	E-19, 20	No movement detected due to camera vibration
STS-26R	103	E-19 E-20	Inconclusive due to camera vibration Conclusive movement
STS-49 FRF	105	E-19,20,76,77	Conclusive movement
STS-49	105	E-19,20,76,77	Conclusive movement

STS-49 BASE HEAT SHIELD MOTION SUPPORT TO NASA HEADQUARTERS

Thomas D. Whitmeyer/Vitro Corporation visited Dave Pitts/SN5 on 5/27/92 to view films of the STS-49 base heat shield motion. Mr. Whitmeyer is supporting Col. Fred Gregory who has been recently assigned to NASA headquarters. Mr. Whitmeyer was shown films from STS-49 showing the flexing of the base heat shield as well as a film from STS-33 that also showed this same flexing motion. A film to video conversion has been requested from the JSC Image Sciences Division/JL for the following views:

Motion visible: STS-49, STS-49 FRF, STS-33 - Cameras E-76.

Slight motion visible: STS-44 - Camera E-76.

No motion visible: STS-42 - Camera E-76.

First flight of OV-101: STS-6 - Camera E-76.

OV-101 FRF: STS-6 - Camera E-76.

First flight of OV-104: STS-51J - Camera E-76

These views will be forwarded to Mr. Whitmeyer for use at NASA headquarters.

Mr. Whitmeyer was briefed on the status of the task and given copies of selected background material on the base heat shield from the task book. He was also briefed on the STS-45 ET venting event and given pictures showing the venting from the LH2 umbilical area and the ET intertank area.

Mr. Whitmeyer can be reached at (202) 646-6344.

Summary of Analysis of Visual Events
STS-49
06/12/92

Task Number
14.01

Title : Characterize Base Heat Shield Motion at SSME Start-Up

Analysts : B. Gastineau
Date : 05/19/92

Camera Number : E-77
Frame Number : 334-517
GMT :

Requestor : G. Overstreet
Phone : 483-8857
Mail Code : ES2

Description of Analysis

Data was collected from Camera E-77 for the base heat shield motion study. Frames 334-517 were used. The data is stored at [STS.LAUNCH.HEATSHIELD_14.E77]MOTION.LOG

Three points were collected on each frame:
1. Top rivot at the base of the vertical stabilizer
2. Lower right corner of the left OMS Pod stinger
3. Seventh visible rivot from the left on the SSME #3 base heat shield

Data analysis was being completed in conjunction with data collected from E-76 at the time of this documentation.

Image Analysis Tools & Techniques

70mm Film Motion Analyzer

Summary of Analysis of Visual Events
STS-49
06/12/92

Task Number
14.02

Title : Characterize Base Heat Shield Motion at SSME Start-Up

Analysts : M. Snyder
Date : 05/21/92

Camera Number : E-76
Frame Number : 300-500
GMT :

Requestor : G. Overstreet
Phone : 483-8857
Mail Code : ES2

Description of Analysis

Data was collected from camera E-76 for the base heat shield motion study. Starting at frame 300 and continuing to frame 500 three points were selected: one on the bottom rivot on the base of the vertical stabilizer, one on the second dot from the left on the bottom of the base heat shield, and one on the left edge of the top of the base of the stinger. The last 12 entries were the coordinates of three objects used for scale. Three points were used for scale: the width of the OMS nozzle, the top of the RCS Stinger, and the width of the base of the OMS nozzle. The firsdt six points were from frame 501 and the last six were from 300.

These digitized points were saved in the file flex.log in [STS.Launch.Heatshield_14.E76] on the STS-49 mission disk.

Image Analysis Tools & Techniques

Viewed films on FMA

This spreadsheet contains the results of distances measured between a point on the base of the vertical stabilizer and a point on the base heat shield measured over 200 frames on camera E76. Three separate analysts determined distances for each frame independently. The average of the three analysts distances was then used to determine the best estimate of the "true" distance for each frame. The average distance for each frame was then normalized so that the first frame had a distance of 0 and subsequent frames represented displacement from that first frame. These displacements from the first frame were then converted to inches. The width of the OMS pod (measured to be approximately 44 inches was used for scale). The displacements from the first frame measure the movement of the base heat shield away or towards the base of the vertical stabilizer. The plot of the normalized distances was plotted and the distances between successive extreme points was measured and a maximum peak to peak displacement was found. (Note a fortran program was used to determine the distances between successive extreme points.)

The columns in the spreadsheet are defined as : **Time** = time since frame 300, **mike dist** = Distance between point on base of tail and BHS measured by Mike Snyder, **brian dist** = Distance measured by Brian Gastineau, **brett dist** = Distance measured by Brett Picken, **average dist** = average distance for a frame for three analysts, **average Normal** = normalized distance from frame 300, **average Normal inches** = normalized distance from frame 300 in inches, **start_range for Peak** = beginning value of an extrema, **end_range for Peak** = ending value of an extrema, **Total_peak** = Total amount of displacement between two extrema, **scale** = scale in inches perpixel, error = +/- 2 standard deviations using Al Feivesons error characterization, max_total_peak = maximum peak to peak displacement, **total_2sd** = maximum displacement + error, **total_-2sd** = peak to peak displacement - error.

frame	Time	mike dist	brian dist	brett dist	average dist	average Normal	average Normal inches	start_range for Peak	end_range for Peak	Total_peak
300	0	82.33839	82.2334	82.19686	82.25621	0	0	0	0.2112222	0.2112222
301	0.01042	82.20008	82.3692	82.30987	82.29306	0.036857	0.07024384	0.2112222	-5.95E-02	0.2707646
302	0.02083	82.42938	82.4267	82.24503	82.36703	0.110829	0.21122217	-5.95E-02	0.5173163	0.5768587
303	0.03125	82.04702	82.3122	82.45747	82.27224	0.016036	0.03056175	0.5173163	2.06E-02	0.4967125
304	0.04167	82.39403	82.1626	82.11828	82.22496	-0.03124	-0.0595424	2.06E-02	0.3015104	0.2809066
305	0.05208	82.59852	82.437	82.54739	82.52764	0.271437	0.51731628	0.3015104	-0.2612942	0.5628046
306	0.0625	82.30149	82.0493	82.45025	82.26702	0.010811	0.02060379	-0.2612942	8.48E-02	0.3461008
307	0.07292	82.46195	82.3886	82.39272	82.41441	0.158203	0.30151043	8.48E-02	-0.1763486	0.2611552
308	0.08333	82.19161	82.1509	82.01485	82.1191	-0.1371	-0.2612942	-0.1763486	9.01E-02	0.2664938
309	0.09375	82.41757	82.1777	82.30683	82.3007	0.044498	0.08480664	9.01E-02	-0.2402298	0.330375
310	0.10417	82.197	82.1757	82.11828	82.16368	-0.09253	-0.1763486	-0.2402298	0.4146645	0.6548943
311	0.11458	82.32495	82.3654	82.22016	82.30351	0.047299	0.09014519	0.4146645	-4.79E-02	0.4625798
312	0.125	82.21491	82.0207	82.15488	82.13016	-0.12605	-0.2402298	-4.79E-02	4.08E-02	0.0886696
313	0.13542	82.23967	82.4152	82.33103	82.32863	0.072424	0.13802952	4.08E-02	-4.23E-02	0.0830859
314	0.14583	82.3897	82.4861	82.54555	82.47378	0.217575	0.41466452	-4.23E-02	8.91E-02	0.131447
315	0.15625	82.3031	82.3731	82.28335	82.31984	0.063638	0.12128487	8.91E-02	-0.1237178	0.2128332
316	0.16667	82.22057	82.283	82.1896	82.23106	-0.02514	-0.0479153	-0.1237178	0.3267347	0.4504525
317	0.17708	82.18235	82.396	82.25439	82.27759	0.021384	0.04075428	0.3267347	-0.269173	0.5959077
318	0.1875	82.26612	82.2161	82.21981	82.23399	-0.02221	-0.0423316	-0.269173	-8.53E-02	0.1838407
319	0.19792	82.40727	82.283	82.18344	82.29124	0.035037	0.06677438	-8.53E-02	-9.62E-02	0.0108293
320	0.20833	82.38475	82.329	82.172	82.29526	0.039052	0.07442786	-9.62E-02	-7.18E-02	0.0243712
321	0.21875	82.22788	82.2256	82.45546	82.30297	0.046759	0.08911538	-7.18E-02	-9.07E-02	0.0188766
322	0.22917	82.22199	82.1011	82.25074	82.19129	-0.06491	-0.1237178	-9.07E-02	0.4036459	0.4943129
323	0.23958	82.40458	82.4248	82.45351	82.42764	0.171438	0.32673472	0.4036459	3.46E-03	0.4001864
324	0.25	82.4104	82.2639	82.21446	82.29624	0.040032	0.07629418	3.46E-03	0.1993893	0.1959298
325	0.26042	82.21917	81.9921	82.13367	82.11497	-0.14124	-0.269173	0.1993893	-8.24E-02	0.2818181
326	0.27083	82.17351	82.3291	82.13169	82.21143	-0.04477	-0.0853323	-8.24E-02	0.2952904	0.3777192
327	0.28125	82.16765	82.1683	82.28129	82.20575	-0.05046	-0.0961616	0.2952904	-1.13E-02	0.3065909
328	0.29167	82.21023	82.2064	82.23898	82.21854	-0.03767	-0.0717904	-1.13E-02	0.1581013	0.1694018
329	0.30208	82.10001	82.2294	82.29646	82.20863	-0.04757	-0.090667	0.1581013	0.1194583	0.038643
330	0.3125	82.40966	82.2294	82.43057	82.35655	0.100339	0.19123142	0.1194583	0.2344728	0.1150145
331	0.32292	82.43118	82.3827	82.59017	82.468	0.211794	0.40364594	0.2344728	-0.2898449	0.5243177
332	0.33333	82.20003	82.3482	82.22583	82.25802	0.001815	0.00345951	-0.2898449	9.57E-02	0.3855669
333	0.34375	82.41902	82.3328	82.30219	82.35135	0.095141	0.18132359	9.57E-02	-2.98E-02	0.1255427
334	0.35417	82.31907	82.3711	82.39227	82.36083	0.10462	0.19938934	-2.98E-02	0.2915214	0.3213421
335	0.36458	82.19911	82.147	82.29271	82.21296	-0.04325	-0.0824288	0.2915214	6.58E-03	0.2849384
336	0.375	82.57494	82.3425	82.31602	82.41115	0.154939	0.29529043	6.58E-03	0.3441959	0.3376129
337	0.38542	82.33233	82.283	82.25439	82.28991	0.033707	0.06423959	0.3441959	-1.09E-02	0.355125
338	0.39583	82.4221	82.1796	82.14915	82.25028	-0.00593	-0.0113005	-1.09E-02	0.2889799	0.299909

339	0.40625	82.37545	82.283	82.32171	82.32673	0.070522	0.13440321	0.2889799	5.21E-02	0.2368348	
340	0.41667	82.36473	82.4191	82.23363	82.33916	0.082956	0.15810128	5.21E-02	0.1216303	0.0694852	
341	0.42708	82.31573	82.4114	82.2295	82.31889	0.06268	0.11945827	0.1216303	-0.1036799	0.2253102	
342	0.4375	82.55581	82.3024	82.2198	82.35933	0.103122	0.19653502	-0.1036799	0.5378038	0.6414837	
343	0.44792	82.5103	82.2294	82.39798	82.37923	0.123028	0.23447278	0.5378038	-4.65E-02	0.5843039	
344	0.45833	82.3132	82.4823	82.2352	82.34356	0.087359	0.16649214	-4.65E-02	0.3934225	0.4399226	
345	0.46875	82.11026	82.1662	82.03591	82.10412	-0.15208	-0.2898449	0.3934225	-0.130729	0.5241515	
346	0.47917	82.46779	82.1049	82.05892	82.21053	-0.04568	-0.0870536	-0.130729	0.4457462	0.5764752	
347	0.48958	82.27495	82.2735	82.11653	82.22166	-0.03454	-0.0658342	0.4457462	-5.79E-02	0.5036528	
348	0.5	82.5176	82.3961	82.00564	82.30643	0.050226	0.09572204	-5.79E-02	0.1480073	0.2059139	
349	0.51042	82.31638	82.3732	82.03213	82.24056	-0.01565	-0.0298207	0.1480073	-0.1418505	0.2898578	
350	0.52083	82.38708	82.5244	82.31601	82.40917	0.152962	0.29152142	-0.1418505	0.2269403	0.3687908	
351	0.53125	82.58525	82.3082	82.20066	82.36469	0.108483	0.20675137	0.2269403	0.2122694	0.0146709	
352	0.54167	82.28084	82.4784	82.24866	82.33597	0.079769	0.1520264	0.2122694	0.471702	0.2594326	
353	0.55208	82.26171	82.3118	82.20549	82.25966	0.003454	0.00658297	0.471702	0.1805694	0.2911326	
354	0.5625	82.58095	82.3751	82.35437	82.43681	0.1806	0.34419589	0.1805694	0.3618069	0.1812375	
355	0.57292	82.50191	82.4632	82.32534	82.43013	0.173928	0.33147952	0.3618069	0.1226149	0.239192	
356	0.58333	82.49551	82.2275	82.02842	82.25047	-0.00573	-0.0109291	0.1226149	0.3200421	0.1974272	
357	0.59375	82.54992	82.6068	82.06679	82.40783	0.151628	0.28897986	0.3200421	0.1850641	0.134978	
358	0.60417	82.23242	82.3157	82.30253	82.28357	0.027361	0.05214513	0.1850641	0.5203124	0.3352483	
359	0.61458	82.4207	82.3233	82.21604	82.32003	0.06382	0.12163029	0.5203124	0.1355961	0.3847163	
360	0.625	82.20587	82.2198	82.17974	82.20181	-0.0544	-0.1036799	0.1355961	0.628232	0.4926359	
361	0.63542	82.37216	82.2601	82.08765	82.23997	-0.01624	-0.030951	0.628232	-0.2065428	0.8347748	
362	0.64583	82.60872	82.5902	82.41628	82.53839	0.282187	0.53780383	-0.2065428	0.118372	0.3249148	
363	0.65625	82.54271	82.3692	82.31562	82.40919	0.152982	0.29155903	0.118372	-0.1333549	0.2517269	
364	0.66667	82.31321	82.306	82.07618	82.23181	-0.0244	-0.0465001	-0.1333549	0.7470779	0.8804328	
365	0.67708	82.45954	82.5859	82.18749	82.41099	0.154783	0.29499223	0.7470779	-0.3106495	1.0577274	
366	0.6875	82.81391	82.4632	82.11082	82.46264	0.20643	0.39342249	-0.3106495	0.68459	0.9952395	
367	0.69792	82.49861	82.3769	82.2179	82.36447	0.108262	0.20633123	0.68459	0.1270372	0.5575528	
368	0.70833	82.49862	82.172	81.89226	82.18761	-0.06859	-0.130729	0.1270372	0.1441227	0.0170855	
369	0.71875	82.40623	82.3865	82.26784	82.35353	0.097324	0.18548493	0.1441227	0.1002073	0.0439154	
370	0.72917	82.62427	82.4383	82.4077	82.49009	0.233884	0.44574615	0.1002073	0.3537037	0.2534964	
371	0.73958	82.35731	82.3559	82.27353	82.32893	0.072721	0.13859424	0.3537037	0.1029512	0.2507525	
372	0.75	82.45581	82.3502	81.87144	82.22582	-0.03038	-0.0579066	0.1029512	0.3254286	0.2224774	
373	0.76042	82.41041	82.2773	82.3139	82.33387	0.07766	0.14800726	0.3254286	0.1382644	0.1871642	
374	0.77083	82.38544	82.3022	82.17771	82.28844	0.032238	0.06144039	0.1382644	0.4083929	0.2701285	
375	0.78125	82.33137	82.2183	81.99571	82.18178	-0.07443	-0.1418505	0.4083929	0.1843996	0.2239933	
376	0.79167	82.41788	82.3194	82.38853	82.37528	0.119076	0.22694035	0.1843996	0.2096299	0.0252303	
377	0.80208	82.46946	82.2505	82.38284	82.36758	0.111378	0.21226938	0.2096299	2.50E-02	0.1846639	
378	0.8125	82.6766	82.3942	82.44035	82.50371	0.247503	0.47170198	2.50E-02	0.6608283	0.6358623	
379	0.82292	82.49441	82.331	82.22749	82.35095	0.094745	0.18056935	0.6608283	0.2352625	0.4255658	

380	0.83333	82.48626	82.4918	82.36006	82.44605	0.189841	0.36180693	0.2352625	0.9457188	0.7104563	
381	0.84375	82.13422	82.4077	82.41972	82.32054	0.064336	0.12261485	0.9457188	0.1356315	0.8100873	
382	0.85417	82.4264	82.446	82.39996	82.42413	0.167927	0.32004214	0.1356315	0.6574782	0.5218467	
383	0.86458	82.56461	82.2678	82.22749	82.35331	0.097103	0.18506411	0.6574782	0.2179287	0.4395495	
384	0.875	82.67416	82.2504	82.40569	82.44343	0.187224	0.35681885	0.2179287	0.6824593	0.4645306	
385	0.88542	82.58198	82.4403	82.56533	82.52922	0.273009	0.52031234	0.6824593	0.1177267	0.5647326	
386	0.89583	82.32518	82.2581	82.53262	82.37198	0.11577	0.22063994	0.1177267	0.9065001	0.7887734	
387	0.90625	82.37378	82.1585	82.44974	82.32735	0.071148	0.13559613	0.9065001	0.588909	0.3175911	
388	0.91667	82.54432	82.285	82.16474	82.33134	0.075135	0.14319654	0.588909	0.6435597	0.0546507	
389	0.92708	82.52943	82.6414	82.58672	82.58584	0.329634	0.628232	0.6435597	0.4318002	0.2117595	
390	0.9375	82.39874	82.4191	82.3502	82.38936	0.133149	0.25376087	0.4318002	0.6953135	0.2635133	
391	0.94792	82.11927	82.2006	82.19891	82.17294	-0.08326	-0.15869	0.6953135	0.6732963	0.0220172	
392	0.95833	82.20492	82.2179	82.02068	82.14783	-0.10837	-0.2065428	0.6732963	0.8927101	0.2194138	
393	0.96875	82.34471	82.3757	82.15487	82.29176	0.035555	0.06776206	0.8927101	0.5882636	0.3044465	
394	0.97917	82.44041	82.3846	82.12998	82.31832	0.06211	0.11837201	0.5882636	1.318794	0.7305304	
395	0.98958	82.26815	82.2947	81.99582	82.18623	-0.06997	-0.1333549	1.318794	0.5614937	0.7573003	
396	1	82.78556	82.6647	82.49431	82.6482	0.391993	0.74707786	0.5614937	1.374511	0.8130173	
397	1.01042	82.68244	82.4057	82.35438	82.48083	0.224627	0.42810497	1.374511	0.5787878	0.7957232	
398	1.02083	82.09269	82.1279	82.05903	82.09321	-0.163	-0.3106495	0.5787878	1.411065	0.8322772	
399	1.03125	82.14752	82.3849	82.44245	82.32496	0.068754	0.13103449	1.411065	0.7944778	0.6165872	
400	1.04167	82.71168	82.4212	82.2301	82.45432	0.198113	0.37757307	0.7944778	1.340064	0.5455862	
401	1.05208	82.66435	82.559	82.62287	82.61541	0.359206	0.68458998	1.340064	1.057919	0.282145	
402	1.0625	82.3656	82.3828	82.22016	82.32286	0.066657	0.12703722	1.057919	1.425391	0.367472	
403	1.07292	82.40389	82.3544	82.23724	82.33183	0.075621	0.14412269	1.425391	1.048512	0.376879	
404	1.08333	82.26587	82.289	82.37145	82.30879	0.052579	0.10020732	1.048512	1.333837	0.285325	
405	1.09375	82.32333	82.5135	82.4886	82.4418	0.185589	0.35370375	1.333837	1.224812	0.109025	
406	1.10417	82.29646	82.3025	82.33167	82.31022	0.054019	0.10295119	1.224812	1.337742	0.11293	
407	1.11458	82.40946	82.3963	82.47511	82.42696	0.170753	0.32542863	1.337742	1.135189	0.202553	
408	1.125	82.24665	82.5056	82.31816	82.35682	0.10061	0.19174669	1.135189	1.577594	0.442405	
409	1.13542	82.33552	82.329	82.32171	82.32875	0.072548	0.13826439	1.577594	1.107588	0.470006	
410	1.14583	82.48858	82.3482	82.35652	82.39777	0.141561	0.26979239	1.107588	1.379229	0.271641	
411	1.15625	82.59934	82.4595	82.24143	82.43343	0.17722	0.33775278	1.379229	1.304217	0.075012	
412	1.16667	82.53438	82.5191	82.35797	82.47049	0.214285	0.40839293	1.304217	1.342605	0.038388	
413	1.17708	82.30816	82.3885	82.36219	82.35296	0.096755	0.1843996	1.342605	1.046845	0.29576	
414	1.1875	82.49702	82.3509	82.25071	82.3662	0.109993	0.20962992	1.046845	1.416739	0.369894	
415	1.19792	82.07849	82.4077	82.32171	82.26931	0.0131	0.02496598	1.416739	1.168166	0.248573	
416	1.20833	82.51696	82.5419	82.61653	82.55846	0.302253	0.57604703	1.168166	1.618772	0.450606	
417	1.21875	82.64546	82.515	82.57456	82.57833	0.322125	0.61392092	1.618772	1.199435	0.419337	
418	1.22917	82.87212	82.4808	82.45592	82.60294	0.346738	0.66082831	1.199435	1.729246	0.529811	
419	1.23958	82.56514	82.5732	82.4751	82.53781	0.281599	0.5366845	1.729246	1.236889	0.492357	
420	1.25	82.44216	82.3502	82.34658	82.37965	0.123443	0.23526251	1.236889	1.661591	0.424702	

421	1.26042	83.01498	82.6421	82.60025	82.75243	0.49622	0.94571878	1.661591	1.485474	0.176117	
422	1.27083	82.5608	82.5095	82.59803	82.5561	0.299895	0.57155373	1.485474	1.680522	0.195048	
423	1.28125	82.69109	82.3769	82.53986	82.53595	0.279742	0.53314389	1.680522	1.365512	0.31501	
424	1.29167	82.56929	82.3409	82.22794	82.37936	0.123158	0.2347201	1.365512	1.894091	0.528579	
425	1.30208	82.42671	82.2372	82.31816	82.32737	0.071166	0.13563146	1.894091	1.590388	0.303703	
426	1.3125	82.80732	82.449	82.54725	82.60119	0.34498	0.65747823	1.590388	1.837872	0.247484	
427	1.32292	82.52201	82.2658	82.32383	82.37055	0.114348	0.21792872	1.837872	1.677735	0.160137	
428	1.33333	82.8355	82.4156	82.37883	82.5433	0.287096	0.54716057	1.677735	1.711645	0.03391	
429	1.34375	82.71789	82.5653	82.55967	82.61429	0.358088	0.68245928			max_total_peak	
430	1.35417	82.63184	82.5427	82.36325	82.51259	0.256386	0.48863177		error	1.0577274	
431	1.36458	82.60754	82.3922	82.39631	82.46537	0.209159	0.39862465		0.81784781	total_2sd	
432	1.375	82.34993	82.4005	82.36437	82.37162	0.11541	0.21995334			1.8755752	
433	1.38542	82.46533	82.3125	82.17612	82.31798	0.061771	0.11772667			total_-2sd	
434	1.39583	82.84822	82.7121	82.63528	82.73185	0.475642	0.9065001			0.2398796	
435	1.40625	82.61177	82.6222	82.46161	82.56521	0.309002	0.58890904				
436	1.41667	82.85196	82.4446	82.48513	82.59388	0.337677	0.6435597				
437	1.42708	82.6528	82.4673	82.32822	82.48277	0.226566	0.43180017				
438	1.4375	82.61269	82.7256	82.5248	82.62104	0.364832	0.69531345				
439	1.44792	82.716	82.5867	82.52576	82.60949	0.35328	0.67329628				
440	1.45833	82.97092	82.6669	82.53601	82.72461	0.468407	0.89271017				
441	1.46875	82.77743	82.405	82.51221	82.56487	0.308663	0.58826359				
442	1.47917	82.83714	82.5994	82.554	82.66352	0.407317	0.77628243				
443	1.48958	83.02841	82.9298	82.58801	82.84874	0.592539	1.12928635				
444	1.5	83.18533	82.9064	82.7528	82.94818	0.691974	1.31879423				
445	1.51042	82.76478	82.7806	82.53929	82.6949	0.438698	0.83608953				
446	1.52083	82.50332	82.6549	82.4943	82.55082	0.294617	0.56149368				
447	1.53125	83.09531	83.0408	82.7961	82.97741	0.721208	1.37451088				
448	1.54167	82.85199	82.8136	82.70321	82.78962	0.533409	1.01659436				
449	1.55208	82.85222	82.4134	82.41405	82.5599	0.303691	0.57878782				
450	1.5625	82.99183	82.6985	82.58003	82.75678	0.500575	0.95401789				
451	1.57292	83.27923	82.9008	82.80972	82.99659	0.740388	1.41106454				
452	1.58333	83.05703	82.6929	82.78087	82.84359	0.587383	1.11946103				
453	1.59375	82.79479	82.7144	82.50998	82.67307	0.416864	0.79447775				
454	1.60417	82.90567	82.5473	82.71068	82.7212	0.464995	0.88620899				
455	1.61458	83.0972	82.8712	82.9096	82.95934	0.703134	1.34006357				
456	1.625	82.97112	82.6499	82.81284	82.8113	0.555092	1.05791939				
457	1.63542	83.34743	82.7481	82.47455	82.85669	0.600486	1.14443317				
458	1.64583	83.25937	82.9321	82.82089	83.00411	0.747906	1.42539144				
459	1.65625	82.94034	82.9265	82.69285	82.85322	0.597013	1.13781467				
460	1.66667	82.87959	82.7267	82.81284	82.80636	0.550156	1.04851214				
461	1.67708	83.06079	82.9208	82.88659	82.95607	0.699867	1.3338372				

462	1.6875	83.23703	82.8147	82.70565	82.91912	0.662915	1.26341206				
463	1.69792	83.13365	82.8034	82.78002	82.90569	0.649479	1.23780551				
464	1.70833	83.07818	82.904	82.71442	82.89887	0.642661	1.22481207				
465	1.71875	83.19154	82.9084	82.77443	82.95812	0.701916	1.33774247				
466	1.72917	82.99786	82.7064	82.85125	82.85184	0.595636	1.1351889				
467	1.73958	83.3559	82.9888	82.78322	83.04265	0.786441	1.49883337				
468	1.75	83.23322	82.9976	83.02107	83.08397	0.827766	1.5775936				
469	1.76042	83.16805	82.7369	82.60718	82.83736	0.581153	1.107588				
470	1.77083	83.21445	82.9761	82.74911	82.97989	0.723684	1.37922905				
471	1.78125	83.05504	82.8633	82.90329	82.94053	0.684325	1.30421679				
472	1.79167	83.15854	82.8723	82.82341	82.9514	0.695194	1.32493167				
473	1.80208	83.05331	82.948	82.88071	82.96067	0.704467	1.34260496				
474	1.8125	83.04163	82.8401	82.53474	82.80549	0.549281	1.04684457				
475	1.82292	83.04759	82.8328	82.71621	82.86554	0.609332	1.16129209				
476	1.83333	83.08801	82.9225	82.98822	82.99957	0.743366	1.4167391				
477	1.84375	83.15283	82.8024	82.80095	82.91873	0.662523	1.26266557				
478	1.85417	82.98233	82.7688	82.85626	82.86915	0.612939	1.16816629				
479	1.86458	83.18721	82.824	82.71878	82.91	0.65379	1.2460219				
480	1.875	83.52067	82.8928	82.90327	83.10558	0.849372	1.61877169				
481	1.88542	83.31962	82.8544	82.76019	82.97807	0.72186	1.37575286				
482	1.89583	83.04047	82.8674	82.7488	82.88555	0.629346	1.19943485				
483	1.90625	83.3408	83.1009	83.04889	83.16354	0.907339	1.72924611				
484	1.91667	83.0744	82.5762	83.06505	82.9052	0.648998	1.2368895				
485	1.92708	82.99429	82.9368	83.02662	82.98591	0.7297	1.39069534				
486	1.9375	83.52479	83.1128	82.74654	83.12805	0.87184	1.66159106				
487	1.94792	83.51294	82.9648	82.78753	83.08844	0.832231	1.58610201				
488	1.95833	83.1804	83.0595	82.86701	83.03564	0.779431	1.48547437				
489	1.96875	83.33733	83.0843	82.74653	83.05605	0.799842	1.52437351				
490	1.97917	83.43209	83.0353	82.94658	83.13798	0.881773	1.68052218				
491	1.98958	83.42539	82.8488	82.80417	83.02612	0.769918	1.46734398				
492	2	83.22101	83.0019	82.82571	83.01619	0.759988	1.44841822				
493	2.01042	83.22795	82.8507	82.83942	82.97269	0.716486	1.36551166				
494	2.02083	83.1051	83.0217	83.39992	83.17556	0.91935	1.75213794				
495	2.03125	83.36436	83.0601	83.32571	83.25004	0.993833	1.89409149				
496	2.04167	83.30569	83.2354	83.20484	83.24866	0.992451	1.89145655				
497	2.05208	83.05398	83.1009	83.11713	83.09069	0.83448	1.59038816				
498	2.0625	83.33519	83.2608	83.06561	83.22054	0.964335	1.83787183				
499	2.07292	83.22665	83.0576	83.1253	83.13652	0.88031	1.67773456				
500	2.08333	83.30418	83.08	83.07873	83.15431	0.898103	1.71164456				
scale											
1.9058											

Measuring Base Heat ,eflection In X and Y

frame	Time	Time before launch	mike Xnorm	mike Ynorm	Xnorm Normal	Ynorm Normal	Xnorm inches	Ynorm inches	start_range for Peak X	end_range for Peak X	Total Peak	start_range for Peak Y	end_range for Peak Y	Total_peak
300	0	-4.855766	24.40001	-78.64	0	0	0	0	0	0.1525057	0.1525057	0	-0.2286823	0.2286823
301	0.01064	-4.8451277	24.31999	-78.52	0.08002	-0.11999	0.15250566	-0.2286823	0.1525057	0.1524675	3.82E-05	-0.2286823	0.2287204	0.4574027
302	0.02128	-4.8344894	24.32001	-78.76	0.08	0.12001	0.15246754	0.22872037	0.1524675	0.6480061	0.4955386	0.2287204	-0.381207	0.6099274
303	0.03191	-4.8238511	24.06	-78.44	0.34001	-0.20002	0.64800612	-0.381207	0.6480061	0.381207	0.2667991	-0.381207	0.6480061	1.0292131
304	0.04255	-4.8132128	24.19999	-78.76	0.20002	0.11999	0.38120698	0.22868226	0.381207	0.9529222	0.5717152	0.6480061	0.1143316	0.5336745
305	0.05319	-4.8025745	24.18001	-78.98	0.22	0.34001	0.41928575	0.64800612	0.9529222	0.2287204	0.7242018	0.1143316	0.4573836	0.343052
306	0.06383	-4.7919362	24.08	-78.7	0.32001	0.05999	0.60988924	0.1143316	0.2287204	0.8004737	0.5717533	0.4573836	0	0.4573836
307	0.07447	-4.7812979	24.03999	-78.88	0.36002	0.23999	0.68614207	0.45738357	0.8004737	0.2668563	0.5336174	0	0.2287013	0.2287013
308	0.08511	-4.7706596	23.90001	-78.64	0.5	0	0.95292215	0	0.2668563	0.7242208	0.4573645	0.2287013	-0.1524485	0.3811498
309	0.09574	-4.7600213	24.28	-78.76	0.12001	0.12	0.22872037	0.22870132	0.7242208	0.2668373	0.4573835	-0.1524485	0.1143697	0.2668182
310	0.10638	-4.749383	24.18	-78.56	0.22001	-0.07999	0.41930481	-0.1524485	0.2668373	1.067311	0.8004737	0.1143697	-0.1143507	0.2287204
311	0.11702	-4.7387447	24.16	-78.7	0.24001	0.06001	0.45742169	0.11436972	1.067311	0.343071	0.72424	-0.1143507	0.2668182	0.3811689
312	0.12766	-4.7281064	23.98	-78.64	0.42001	1E-05	0.80047367	1.9058E-05	0.343071	0.6861039	0.3430329	0.2668182	-0.2287013	0.4955195
313	0.1383	-4.7174681	24.25999	-78.58	0.14002	-0.06	0.26685632	-0.1143507	0.6861039	0.1525057	0.5335982	-0.2287013	0.4193048	0.6480061
314	0.14894	-4.7068298	24.11999	-78.78	0.28002	0.14	0.53367452	0.2668182	0.1525057	0.6099274	0.4574217	0.4193048	-0.1143507	0.5336555
315	0.15957	-4.6961915	24.02001	-78.72	0.38	0.08001	0.72422084	0.1524866	0.6099274	0.3049541	0.3049733	-0.1143507	0.343052	0.4574027
316	0.17021	-4.6855532	24.25999	-78.56	0.14002	-0.07999	0.26685632	-0.1524485	0.3049541	1.029175	0.7242209	0.343052	-0.1906035	0.5336555
317	0.18085	-4.6749149	24.26	-78.52	0.14001	-0.12	0.26683726	-0.2287013	1.029175	0.343071	0.686104	-0.1906035	-0.1143507	0.0762528
318	0.19149	-4.6642766	24.22	-78.62	0.18001	-0.01999	0.34307103	-0.0380978	0.343071	1.029175	0.686104	-0.1143507	-0.3811689	0.2668182
319	0.20213	-4.6536383	24.17999	-78.78	0.22002	0.13999	0.41932386	0.26679914	1.029175	7.63E-02	0.95288405	-0.3811689	0.4573836	0.8385525
320	0.21277	-4.643	23.83999	-78.86	0.56002	0.22001	1.06731093	0.41930481	7.63E-02	0.8767074	0.80041645	0.4573836	-7.62E-02	0.533598301
321	0.2234	-4.6323617	24.22	-78.58	0.18001	-0.06	0.34307103	-0.1143507	0.8767074	0.5717914	0.304916	-7.62E-02	0.2667992	0.343013901
322	0.23404	-4.6217234	24.2	-78.58	0.20001	-0.06	0.38118792	-0.1133507	0.5717914	1.143526	0.5717346	0.2667992	3.81E-02	0.228701371
323	0.24468	-4.6110851	24.04001	-78.82	0.36	0.18	0.68610395	0.34305197	1.143526	3.81E-05	1.143487883	3.81E-02	0.4955386	0.457440771
324	0.25532	-4.6004468	24.05999	-78.82	0.34002	0.17999	0.64802518	0.34303292	3.81E-05	0.6480061	0.647967983	0.4955386	0.1524675	0.3430711
325	0.26596	-4.5898085	24.31999	-78.54	0.08002	-0.10001	0.15250566	-0.1906035	0.6480061	7.63E-02	0.571753267	0.1524675	0.343052	0.1905845
326	0.2766	-4.5791702	24.10001	-78.56	0.3	-0.07999	0.57175329	-0.1524485	7.63E-02	0.8004927	0.724239867	0.343052	0.2287204	0.1143316
327	0.28723	-4.5685319	24.07998	-78.56	0.32003	-0.07998	0.60992735	-0.1524294	0.8004927	0.381207	0.4192857	0.2287204	0.4573836	0.2286632
328	0.29787	-4.5578936	24.16001	-78.58	0.24	-0.06	0.45740263	-0.1143507	0.381207	0.8004927	0.4192857	0.4573836	-0.2668373	0.7242209
329	0.30851	-4.5472553	24.24	-78.44	0.16001	-0.2	0.30495415	-0.3811689	0.8004927	0.1143697	0.686123	-0.2668373	0.4573836	0.7242209
330	0.31915	-4.536817	23.86	-78.88	0.54001	0.23999	1.02917498	0.45738357	0.1143697	0.6861039	0.5717342	0.4573836	3.81E-02	0.419285771
331	0.32979	-4.5259787	24	-78.86	0.40001	0.22	0.76235678	0.41928575	0.6861039	-3.81E-02	0.724201699	3.81E-02	0.3811498	0.343051971
332	0.34043	-4.5153404	24.06	-78.6	0.34001	-0.03999	0.64800612	-0.0762147	-3.81E-02	1.105428	1.143525799	0.3811498	0.1905654	0.1905844
333	0.35106	-4.5047021	24.22	-78.78	0.18001	0.13999	0.34307103	0.26679914	1.105428	0.5336364	0.5717916	0.1905654	0.6098893	0.4193239
334	0.3617	-4.4940638	24.14	-78.7	0.26001	0.06	0.49553858	0.11435066	0.5336364	0.9529603	0.4193239	0.6098893	0	0.6098893
335	0.37234	-4.4834255	23.86	-78.66	0.54001	0.01999	1.02917498	0.03809783	0.9529603	0.5717723	0.381188	0	0.647968	0.647968
336	0.38298	-4.4727872	24.35998	-78.9	0.04003	0.26001	0.07629095	0.49553858	0.5717723	0.8766884	0.3049161	0.647968	0.4192857	0.2286823
337	0.39362	-4.4621489	24.11999	-78.72	0.28002	0.08	0.53367452	0.15246754	0.8766884	0.2287204	0.647968	0.4192857	0.4574026	0.0381169
338	0.40426	-4.4515106	24.10001	-78.82	0.3	0.18	0.57175329	0.34305197	0.2287204	0.9148243	0.6861039	0.4574026	0	0.4574026
339	0.41489	-4.4408723	23.94	-78.82	0.46001	0.17999	0.87670744	0.34303292	0.9148243	0.7242208	0.1906035	0	0.1524294	0.1524294
340	0.42553	-4.430234	24.09999	-78.76	0.30002	0.12001	0.57179141	0.22872037	0.7242208	0.7623568	0.038136	0.1524294	-7.63E-02	0.228682203
341	0.43617	-4.4195957	23.8	-78.8	0.60001	0.16	1.14352564	0.30493509	0.7623568	0.5336555	0.2287013	-7.63E-02	0.8766693	0.952922103
342	0.44681	-4.4089574	24.36	-78.88	0.04001	0.23999	0.07625283	0.45738357	0.5336555	1.029175	0.4955195	0.8766693	0.1143507	0.7623186
343	0.45745	-4.3983191	24.39999	-78.82	2E-05	0.17999	3.8117E-05	0.34303292	1.029175	0.2668563	0.7623187	0.1143507	1.181585	1.0672343
344	0.46809	-4.3876809	24.11999	-78.7	0.28002	0.05999	0.53367452	0.1143316	0.2668563	1.33411	1.0672537	1.181585	0.4955195	0.6860655
345	0.47872	-4.3770426	24.08	-78.5	0.32001	-0.14001	0.60988924	-0.2668373	1.33411	0.4955386	0.8385714	0.4955195	0.4955386	1.91E-05
346	0.48936	-4.3664043	24.06	-78.88	0.34001	0.23999	0.64800612	0.45738357	0.4955386	0.991039	0.4955004	0.4955386	0.3811879	0.1143507
347	0.5	-4.355766	24.11999	-78.66	0.28002	0.01999	0.53367452	0.03809783	0.991039	0.9529412	0.0380978	0.3811879	0.8385715	0.4573836
348	0.51064	-4.3451277	24.36	-78.84	0.04001	0.19999	0.07625283	0.3811498	0.9529412	0.9539412	0.001	0.8385715	0.1905844	0.6479871
349	0.52128	-4.3344894	24	-78.74	0.40001	0.09999	0.76235678	0.19056537	0.9539412	0.4955386	0.4584026	0.1905844	0.343052	0.1524676
350	0.53191	-4.3238511	23.97999	-78.82	0.42002	0.17999	0.80049272	0.34303292	0.4955386	0.991039	0.4955004	0.343052	0.2668182	0.0762338
351	0.54255	-4.3132128	24.19999	-78.96	0.20002	0.32001	0.38120698	0.60988924	0.991039	0.3049541	0.6860849	0.2668182	0.8385715	0.5717533
352	0.55319	-4.3025745	24.14	-78.66	0.26001	0.02001	0.49553858	0.03813594	0.3049541	1.219778	0.9148239	0.8385715	0.5336364	0.3049351

353	0.56383	-4.2919362	24.14	-78.64	0.26001	0	0.49553858	0	1.219778	1.21974	3.8E-05	0.5336364	0.6098893	0.0762529
354	0.57447	-4.2812979	24.12001	-78.98	0.28	0.33999	0.5336364	0.647968	1.21974	1.524675	0.304935	0.6098893	-0.1143125	0.7242018
355	0.58511	-4.2706596	23.97999	-78.94	0.42002	0.30001	0.80049272	0.57177235	1.524675	1.410363	0.114312	-0.1143125	0.9148243	1.0291368
356	0.59574	-4.2600213	24.22001	-78.86	0.18	0.22	0.34305197	0.41928575	1.410363	1.600947	0.190584	0.9148243	0.3049351	0.6098892
357	0.60638	-4.249383	24.34	-78.88	0.06001	0.24	0.11436972	0.45740263	1.600947	0.7623568	0.8385902	0.3049351	0.6098702	0.3049351
358	0.61702	-4.2387447	24.04001	-78.64	0.36	0	0.68610395	0	0.7623568	0.9148243	0.1524675	0.6098702	-0.1905654	0.8004356
359	0.62766	-4.2281064	24.42	-78.72	-0.01999	0.07998	-0.0380978	0.15242943	0.9148243	0.8385906	0.0762337	-0.1905654	0.4955386	0.686104
360	0.6383	-4.2174681	24.08	-78.6	0.32001	-0.04001	0.60988924	-0.0762528	0.8385906	1.067311	0.2287204	0.4955386	0.1524675	0.3430711
361	0.64894	-4.2068298	24.06002	-78.78	0.33999	0.14	0.647968	0.2668182	1.067311	0.4574026	0.6099084	0.1524675	1.067254	0.9147865
362	0.65957	-4.1961915	23.81999	-79.1	0.58002	0.45999	1.10542781	0.87666932	0.4574026	1.067311	0.6099084	1.067254	-0.2668182	1.3340722
363	0.67021	-4.1855532	24.12001	-78.94	0.28	0.3	0.5336364	0.57175329	1.067311	0.1143888	0.9529222	-0.2668182	0.9529222	1.2197404
364	0.68085	-4.1749149	24.11999	-78.7	0.28002	0.06	0.53367452	0.11435066	0.1143888	1.334129	1.2197402	0.9529222	0.3811879	0.5717343
365	0.69149	-4.1642766	23.89999	-78.92	0.50002	0.28	0.95296027	0.5336364	1.334129	0.6099274	0.7242016	0.3811879	0.4574217	0.0762338
366	0.70213	-4.1536383	24	-79.26	0.40001	0.61998	0.76235678	1.18158535	0.6099274	1.295993	0.6860656	0.4574217	0.2286823	0.2287394
367	0.71277	-4.143	24.1	-78.9	0.30001	0.26	0.57177235	0.49551952	1.295993	0.3049351	0.9910579	0.2286823	0.5717533	0.343071
368	0.7234	-4.1323617	24.1	-78.9	0.30001	0.26001	0.57277235	0.49553858	0.3049351	1.143526	0.8385909	0.5717533	0.2287013	0.343052
369	0.73404	-4.1217234	23.97999	-78.84	0.42002	0.20001	0.80049272	0.38118792	1.143526	0.4193048	0.7242212	0.2287013	0.8004737	0.5717724
370	0.74468	-4.1110851	23.94001	-79.08	0.46	0.44	0.87668838	0.83857149	0.4193048	0.9148434	0.4955386	0.8004737	0.2668182	0.5336555
371	0.75532	-4.1004468	24.14	-78.74	0.26001	0.1	0.49553858	0.19058443	0.9148434	0.4574026	0.4574408	0.2668182	0.4573836	0.1905654
372	0.76596	-4.0898085	24.28	-78.8	0.12001	0.16001	0.22872037	0.30495415	0.4574026	1.143564	0.6861614	0.4573836	-0.1905654	0.647949
373	0.7766	-4.0791702	24.05999	-78.82	0.34002	0.18	0.64802518	0.34305197	1.143564	0.9529412	0.1906228	-0.1905654	0.647968	0.8385334
374	0.78723	-4.0685319	24.03999	-78.8	0.36002	0.16	0.68614207	0.30493509	0.9529412	1.372246	0.4193048	0.647968	0.6479489	1.91E-05
375	0.79787	-4.0578936	23.92	-78.78	0.48001	0.14	0.91482432	0.2668182	1.372246	0.6098893	0.7623567	0.6479489	1.181623	0.5336741
376	0.80851	-4.0472553	24.02001	-78.84	0.38	0.2	0.72422084	0.38116886	0.6098893	1.372208	0.7623187	1.181623	0.5336174	0.6480056
377	0.81915	-4.036617	24	-78.9	0.40001	0.26001	0.76235678	0.49553858	1.372208	0.4574217	0.9147863	0.5336174	1.753415	1.2197976
378	0.82979	-4.0259787	24.12	-79.08	0.28001	0.44	0.53365546	0.83857149	0.4574217	1.295993	0.8385713	1.753415	0.8385715	0.9148435
379	0.84043	-4.0153404	24.02001	-78.92	0.38	0.28	0.72422084	0.5336364	1.295993	0.8004927	0.4955003	0.8385715	1.029137	0.1905655
380	0.85106	-4.0047021	23.86	-78.96	0.54001	0.32001	1.02917498	0.60988924	0.8004927	1.143545	0.3430523	1.029137	0.5717533	0.4573837
381	0.8617	-3.9940638	23.90001	-78.58	0.5	-0.05998	0.95292215	-0.1143125	1.143545	0.7623568	0.3811882	0.5717533	1.029175	0.4574217
382	0.87234	-3.9834255	24.18001	-78.8	0.22	0.15999	0.41928575	0.30491603	0.7623568	1.105428	0.3430712	1.029175	0.4955004	0.5336746
383	0.88298	-3.9727872	24.25999	-78.92	0.14002	0.28001	0.26685632	0.53365546	1.105428	0.7623568	0.3430712	0.4955004	1.143545	0.6480446
384	0.89362	-3.9621489	23.97999	-79.12	0.42002	0.48001	0.80049272	0.91482432	0.7623568	0.9158243	0.1534675	1.143545	0.1524675	0.9910775
385	0.90426	-3.9515106	23.86	-79.06	0.54001	0.42	1.02917498	0.80045461	0.9158243	0.6099274	0.3058969	0.1524675	1.295955	1.1434875
386	0.91489	-3.9408723	23.7	-78.84	0.70001	0.2	1.33411007	0.38116886	0.6099274	1.753396	1.1434686	1.295955	0.6860849	0.6098701
387	0.92553	-3.930234	24	-78.8	0.40001	0.16	0.76235678	0.30493509	1.753396	0.4574217	1.2959743	0.6860849	1.372189	0.6861041
388	0.93617	-3.9195957	24.05999	-78.96	0.34002	0.32	0.64802518	0.60987018	0.4574217	1.029156	0.5717343	1.372189	0.8385715	0.5336175
389	0.94681	-3.9089574	24.14	-78.92	0.26001	0.28	0.49553858	0.5336364	1.029156	0.8766884	0.1524676	0.8385715	1.677162	0.8385905
390	0.95745	-3.8983191	24.02	-78.82	0.38001	0.18	0.72423989	0.34305197	0.8766884	1.295993	0.4193046	1.677162	1.143526	0.533636
391	0.96809	-3.8876809	23.98001	-78.54	0.42	-0.09999	0.80045461	-0.1905654	1.295993	0.4192857	0.8767073	1.143526	1.94398	0.800454
392	0.97872	-3.8770426	23.88001	-78.66	0.52	0.01999	0.99103904	0.03809783	0.4192857	1.448461	1.0291753	1.94398	0.7242018	1.2197782
393	0.98936	-3.8664043	23.9	-78.8	0.50001	0.18001	0.95294121	0.30495415	1.448461	0.9529412	0.4955198	0.7242018	1.753339	1.0291372
394	1	-3.855766	23.9	-78.9	0.50001	0.26001	0.95394121	0.49553858	0.9529412	1.410325	0.4573838	1.753339	1.257857	0.495482
395	1.01064	-3.8451277	23.89999	-78.72	0.50002	0.08	0.95296027	0.15246754	1.410325	0.7623568	0.6479682	1.257857	2.21076	0.952903
396	1.02128	-3.8344894	24.10001	-79.2	0.3	0.55999	0.57175329	1.06725375	0.7623568	1.33411	0.5717532	2.21076	1.143507	1.067253
397	1.03191	-3.8238511	24.14	-79.08	0.26001	0.44	0.49553858	0.83857149	1.33411	1.029156	0.304954	1.143507	1.791513	0.648006
398	1.04255	-3.8132128	24.01999	-78.5	0.38002	-0.14	0.72425895	-0.2668182	1.029156	1.486597	0.457441	1.791513	1.448461	0.343052
399	1.05319	-3.8025745	23.88001	-78.6	0.52	-0.04	0.99103904	-0.0762338	1.486597	1.181643	0.304954	1.448461	2.515733	1.067272
400	1.06383	-3.7919362	24.24	-79.08	0.16001	0.43999	0.30495415	0.83855244	1.181643	1.982097	0.800454	2.515733	1.219778	1.295955
401	1.07447	-3.7812979	23.88001	-79.14	0.52	0.5	0.99103904	0.95292215	1.982097	1.029213	0.952884	1.219778	2.058312	0.838534
402	1.08511	-3.7706596	23.84	-78.84	0.56001	0.20001	1.06729187	0.38118792	1.029213	1.982097	0.952884	2.058312	1.753396	0.304916
403	1.09574	-3.7600213	23.83999	-78.88	0.56002	0.24001	1.06731093	0.45742169	1.982097	0.686123	1.295974	1.753396	2.363247	0.609851
404	1.10638	-3.749383	23.75999	-78.76	0.64002	0.11999	1.21977847	0.22868226	0.686123	1.905844	1.219721	2.363247	1.943942	0.419305
405	1.11702	-3.7387447	23.76001	-78.82	0.64	0.18	1.21974035	0.34305197	1.905844	0.9529603	0.9528837	1.943942	2.172662	0.22872
406	1.12766	-3.7281064	23.60001	-78.84	0.8	0.20001	1.52467544	0.38118792	0.9529603	1.639064	0.6861037	2.172662	1.753377	0.419285
407	1.1383	-3.7174681	23.65999	-78.94	0.74002	0.3	1.4103629	0.57175329	1.639064	1.486559	0.152505	1.753377	1.867708	0.114331

408	1.14894	-3.7068298	23.55999	-78.8	0.84002	0.15999	1.60094733	0.30491603	1.486559	1.753396	0.266837	1.867708	1.71526	0.152448	
409	1.15957	-3.6961915	24	-78.76	0.40001	0.12	0.76235678	0.22870132	1.753396	1.410325	0.343071	1.71526	1.982097	0.266837	
410	1.17021	-3.6855532	24	-78.92	0.40001	0.28	0.76335678	0.5336364	1.410325	1.753415	0.34309	1.982097	1.677124	0.304973	
411	1.18085	-3.6749149	23.92	-79.06	0.48001	0.42001	0.91482432	0.80047367	1.753415	1.372227	0.381188	1.677124	2.668201	0.991077	
412	1.19149	-3.6642766	23.96	-78.98	0.44001	0.34001	0.83859055	0.64800612	1.372227	1.82963	0.457403	2.668201	1.905844	0.762357	
413	1.20213	-3.6536383	23.83999	-78.78	0.56002	0.14	1.06731093	0.2668182	1.82963	1.372208	0.457422	1.905844	2.591948	0.686104	
414	1.21277	-3.643	24.16001	-78.88	0.24	0.23999	0.45740263	0.45738357	1.372208	2.363304	0.991096	2.591948	1.677181	0.914767	
415	1.2234	-3.6323617	23.83999	-78.54	0.56002	-0.09999	1.06731093	-0.1905654				1.677181	2.934981	1.2578	
416	1.23404	-3.6217234	23.90001	-78.98	0.5	0.33999	0.95292215	0.647968				2.934981	2.172662	0.762319	
417	1.24468	-3.6110851	24.33999	-78.98	0.06002	0.33998	0.11438878	0.64794895				2.172662	2.706299	0.533637	
418	1.25532	-3.6004468	24.20002	-79.26	0.19999	0.62	0.3811498	1.18162347				2.706299	1.943961	0.762338	
419	1.26596	-3.5898085	24	-79	0.40001	0.36001	0.76235678	0.68612301				1.943961	2.515695	0.571734	
420	1.2766	-3.5791702	23.84	-78.92	0.56001	0.27999	1.06729187	0.53361735				2.515695	1.943942	0.571753	
421	1.28723	-3.5685319	23.69999	-79.56	0.70002	0.92002	1.33412913	1.75341488				1.943942	2.401383	0.457441	
422	1.29787	-3.5578936	23.72001	-79.08	0.88	0.44	1.29597413	0.83857149				2.401383	2.287013	0.11437	
423	1.30851	-3.5472553	23.83999	-79.18	0.56002	0.53999	1.06731093	1.02913687				2.287013	2.630084	0.343071	
424	1.31915	-3.536617	24.07998	-78.98	0.32003	0.34001	0.60992735	0.64800612							
425	1.32979	-3.5259787	23.72	-78.94	0.68001	0.3	1.29599318	0.57175329							
426	1.34043	-3.5153404	24.24001	-79.18	0.16	0.54001	0.30493509	1.02917498							
427	1.35106	-3.5047021	24.18001	-78.9	0.22	0.25999	0.41928575	0.49550046							
428	1.3617	-3.4940638	24.14	-79.24	0.26001	0.60002	0.49553858	1.1435447							
429	1.37234	-3.4834255	23.8	-79.22	0.60001	0.58001	1.14352564	1.10540875			max_total_peak_X			max_total_peak_Y	
430	1.38298	-3.4727872	23.89999	-79.1	0.50002	0.46001	0.95296027	0.87670744			1.2959743		error	1.3340722	
431	1.39362	-3.4621489	24.07998	-79.02	0.32003	0.38	0.60992735	0.72422084			total_2sd		0.95702992	total_2sd	
432	1.40426	-3.4515106	24.18	-78.72	0.22001	0.08	0.41930481	0.15246754			2.253004222			2.291102122	
433	1.41489	-3.4408723	23.91999	-78.92	0.48002	0.27999	0.91484338	0.53361735			total_-2sd			total_-2sd	
434	1.42553	-3.430234	23.92	-79.32	0.48001	0.67999	0.91482432	1.29595507			0.338944378			0.377042278	
435	1.43617	-3.4195957	24.16001	-79	0.24	0.35999	0.45740263	0.68608489							
436	1.44681	-3.4089574	23.79998	-79.36	0.60003	0.71999	1.14356376	1.37218884							
437	1.45745	-3.3983191	23.83999	-79.14	0.56002	0.5	1.06731093	0.95292215							
438	1.46809	-3.3876809	23.9	-79.08	0.50001	0.44	0.95294121	0.83857149							
439	1.47872	-3.3770426	23.86	-79.2	0.54001	0.55998	1.02917498	1.06723469							
440	1.48936	-3.3664043	23.67999	-79.52	0.72002	0.88001	1.37224602	1.67716205							
441	1.5	-3.355766	23.94	-79.24	0.46001	0.60001	0.87670744	1.14352564							
442	1.51064	-3.3451277	24.08	-79.26	0.32001	0.61999	0.60988924	1.18160441							
443	1.52128	-3.3344894	23.68001	-79.58	0.72	0.93999	1.3722079	1.79147459							
444	1.53191	-3.3238511	23.95999	-79.66	0.44002	1.02001	0.83860961	1.94398025							
445	1.54255	-3.3132128	24.16	-79.16	0.24001	0.51999	0.45742169	0.99101998							
446	1.55319	-3.3025745	23.72	-79.02	0.68001	0.37999	1.29599318	0.72420178							
447	1.56383	-3.2919362	23.97999	-79.56	0.42002	0.91998	0.80049272	1.75333864							
448	1.57447	-3.2812979	23.79999	-79.36	0.60002	0.72002	1.1435447	1.37224602							
449	1.58511	-3.2706596	24	-79.3	0.40001	0.66	0.76235678	1.25785724							
450	1.59574	-3.2600213	23.82	-79.5	0.58001	0.86001	1.10540875	1.63904516							
451	1.60638	-3.249383	23.81999	-79.8	0.58002	1.15999	1.10542781	2.21076033							
452	1.61702	-3.2387447	23.98	-79.52	0.42001	0.88	0.80047367	1.67714299							
453	1.62766	-3.2281064	24	-79.24	0.40001	0.6	0.76235678	1.14350658							
454	1.6383	-3.2174681	23.92	-79.38	0.48001	0.74	0.91482432	1.41032478							
455	1.64894	-3.2068298	23.92	-79.58	0.48001	0.94001	0.91582432	1.7915127							
456	1.65957	-3.1961915	24.07998	-79.4	0.32003	0.76001	0.60992735	1.44846073							
457	1.67021	-3.1855532	23.52	-79.96	0.88001	1.32001	1.67716205	2.51573354							
458	1.68085	-3.1749149	23.48	-79.88	0.92001	1.23999	1.75339582	2.36322788							
459	1.69149	-3.1642766	23.63999	-79.5	0.76002	0.86001	1.44847979	1.63904516							
460	1.70213	-3.1536383	24.16	-79.28	0.24001	0.64002	0.45742169	1.21977847							
461	1.71277	-3.143	23.86001	-79.56	0.54	0.92001	1.02915592	1.75339582							
462	1.7234	-3.1323617	23.94001	-79.72	0.46	1.08	0.87668838	2.05831185							

463	1.73404	-3.1217234	23.78	-79.66	0.62001	1.02	1.18164253	1.94396119
464	1.74468	-3.1110851	23.72	-79.62	0.68001	0.98001	1.29599318	1.86774648
465	1.75532	-3.1004468	24.18001	-79.8	0.22	0.96	0.41928575	1.82961053
466	1.76596	-3.0898085	23.64	-79.56	0.76001	0.92001	1.44846073	1.75339582
467	1.7766	-3.0791702	23.82	-79.88	0.58001	1.24	1.10540875	2.36324694
468	1.78723	-3.0685319	23.86	-79.74	0.54001	1.10001	1.02917498	2.09644779
469	1.79787	-3.0578936	23.9	-79.66	0.50001	1.01999	0.95294121	1.94394213
470	1.80851	-3.0472553	23.66001	-79.78	0.74	1.14	1.41032478	2.17266251
471	1.81915	-3.036617	23.84	-79.56	0.56001	0.92	1.06729187	1.75337676
472	1.82979	-3.0259787	24	-79.62	0.40001	0.97999	0.76235678	1.86770836
473	1.84043	-3.0153404	23.7	-79.6	0.70001	0.96001	1.33411007	1.82962959
474	1.85106	-3.0047021	23.86001	-79.54	0.54	0.9	1.02915592	1.71525987
475	1.8617	-2.9940638	23.68	-79.6	0.72001	0.96	1.37222696	1.82961053
476	1.87234	-2.9834255	23.61999	-79.66	0.78002	1.01999	1.48659667	1.94394213
477	1.88298	-2.9727872	23.78	-79.68	0.62001	1.04001	1.18164253	1.98209713
478	1.89362	-2.9621489	23.72	-79.52	0.68001	0.87999	1.29599318	1.67712393
479	1.90426	-2.9515106	23.36	-79.84	1.04001	1.19998	1.98209713	2.28697505
480	1.91489	-2.9408723	23.85998	-80.04	0.54003	1.40001	1.0292131	2.66820108
481	1.92553	-2.930234	23.75999	-79.86	0.64002	1.22001	1.21977847	2.32514911
482	1.93617	-2.9195957	23.51999	-79.84	0.88002	1	1.6771811	1.9058443
483	1.94681	-2.9089574	23.36	-80	1.04001	1.36	1.98209713	2.59194825
484	1.95745	-2.8983191	24.04	-79.52	0.36001	0.88002	0.68612301	1.6771811
485	1.96809	-2.8876809	23.55999	-79.58	0.84002	0.94002	1.60094733	1.79153176
486	1.97872	-2.8770426	23.40001	-80.18	1	1.53999	1.9058443	2.93498117
487	1.98936	-2.8664043	23.89999	-80.02	0.50002	1.38001	0.95296027	2.6300842
488	2	-2.855766	23.53999	-79.78	0.86002	1.14	1.63906422	2.17266251
489	2.01064	-2.8451277	23.62001	-79.92	0.78	1.28	1.48655856	2.43948071
490	2.02128	-2.8344894	23.48	-80.06	0.92001	1.42	1.75339582	2.70629891
491	2.03191	-2.8238511	23.66001	-80	0.74	1.36	1.41032478	2.59194825
492	2.04255	-2.8132128	23.47999	-79.84	0.92002	1.20001	1.75341488	2.28703222
493	2.05319	-2.8025745	23.64002	-79.8	0.75999	1.16001	1.44842261	2.21079845
494	2.06383	-2.7919362	23.68	-79.66	0.72001	1.02	1.37222696	1.94396119
495	2.07447	-2.7812979	23.58001	-79.96	0.82	1.31999	1.56279233	2.51569542
496	2.08511	-2.7706596	23.44	-79.94	0.96001	1.30001	1.82962959	2.47761665
497	2.09574	-2.7600213	23.5	-79.66	0.90001	1.01999	1.71527893	1.94394213
498	2.10638	-2.749383	23.68001	-79.9	0.72	1.26001	1.3722079	2.40138288
499	2.11702	-2.7387447	23.5	-79.84	0.90001	1.2	1.71527893	2.28701316
500	2.12766	-2.7281064	23.15998	-80.02	1.24003	1.38001	2.36330411	2.6300842
scale								
1.9058								

This spreadsheet contains the results of changes in the X and Y positions of a point on the base heat shield measured over 200 frames on camera E76. The X and Y positions were corrected for camera vibration by subtrating the X and Y coordintates of a control point located on the base of the vertical stabilizer from the X and Y coordinates of the point on the base heat shield. The corrected X and Y positions for each frame were then normalized so that the first frame had an X and Y coordinate of 0 and subsequent frames represented displacement from that first frame. These displacements from the first frame were then converted to inches. The width of the OMS pod (measured to be approximately 44 inches was used for scale). The displacements from the first frame measure the movement of the base heat shield in the Y dimension (X in orbiter coordinates) and the X dimension (30 degrees from the orbiter Y axis). The distances between successive extreme normalized X and Y position points were measured and a maximum peak to peak displacement was found. (Note a fortran program was used to determine the distances between successive extreme points.)

The columns in the spreadsheet are defined as : **Time** = time since frame 300, **Time before launch** = time in seconds before liftoff, **mike Xnorm** = corrected X coordinate of point on BHS, **mike Ynorm** = corrected Y coordinate of point on BHS, **Xnorm normal** = Normalized X coordinate, **Ynorm Normal** = Normalized Y coordinate, **Xnorm inches** = normalized X coordinate from frame 300 in inches, **Ynorm inches** = normilized Y coordinate in inches, **start_range for Peak X** = beginning value of an extrema in X, **end_range for Peak X** = ending value of an extrema in X, **Total peak** = Total amount of displacement between two extrema in X, **start_range for Peak Y** = beginning value of an extrema in Y, **end_range for Peak Y** = ending value of an extrema in Y, **Total_peak** = Total amount of displacement between two extrema in Y, **scale** = scale in inches per pixel, **error** = +/- 2 standard deviations using Al Felvesons error characterization, **max_total_peak_X** = maximum peak to peak X displacement, **total_2sd** = maximum displacement + error, **total_-2sd** = peak to peak displacement - error, **max_total_peak_Y** = maximum peak to peak Y displacement.

Flexible Heat Shield Seal

General Information:

The seal assembly bridging the gap between the engine-mounted heat shield and the fixed base heat shield acts as both a pressure barrier and a thermal protection layer for the engines and aft fuselage components. The seal assembly controls leakage of purge gas during ground operations and then minimizes the ingestion of engine exhaust gases into the aft fuselage during ascent. This is accomplished by a flexible, sliding seal which ensures pressure integrity even while the SSME's are gimbaled.

The base heat shield seal rings are constructed from two semi-circular segments and is mounted on 48 cres spacers with graphite shoes that slide on the engine-mounted heat shield surface. The spacers maintain a proper distance between the seal ring and the heat shield which allows the teflon- coated silicon rubber seal to maintain correct bearing pressure for optimum sealing with minimum wear. Housed above each spacer, a compression spring in a spring can assembly maintains the required contact between the rubber seal and the engine heat shield surface.

Each seal ring is stabilized in it's positions by means of four link fittings. These links allow for telescoping between the ring of the engine-mounted heat shield and the dome support. Lateral positioning and circular movement is prevented by these links. The strut adjustment fitting allows for some play to aid installation, but jam nuts are used for positive locking.

The thermal blankets and sliding radiation seal insulates the area from

excessive heat. The sliding seal protects the shoe from the severe thermal environment during engine firing when loads and movements of the seal are greatest.

The flexible seal spans the gap between the dome aft ring cover and the seal ring and provides a pressure regulating barrier for the aft fuselage compartment. The seal is made from a glass fabric sheet coated with silicone rubber and sewn to a monel knitted mesh for electrostatic protection. Installed with initial slack, the flexible seal will accommodate relative deflections between the engine-mounted heat shield and the heat shield domes.

The strength of the flexible seal is made sufficient to carry both a 3.71 psi ultimate burst pressure or a 1.86 psi ultimate collapse pressure in either the spanwise direction by way of pivot tubes and retainer clips or in the hoop direction throught the flexible splice.

FORM 994-B-1 REV 10-80

PREP:

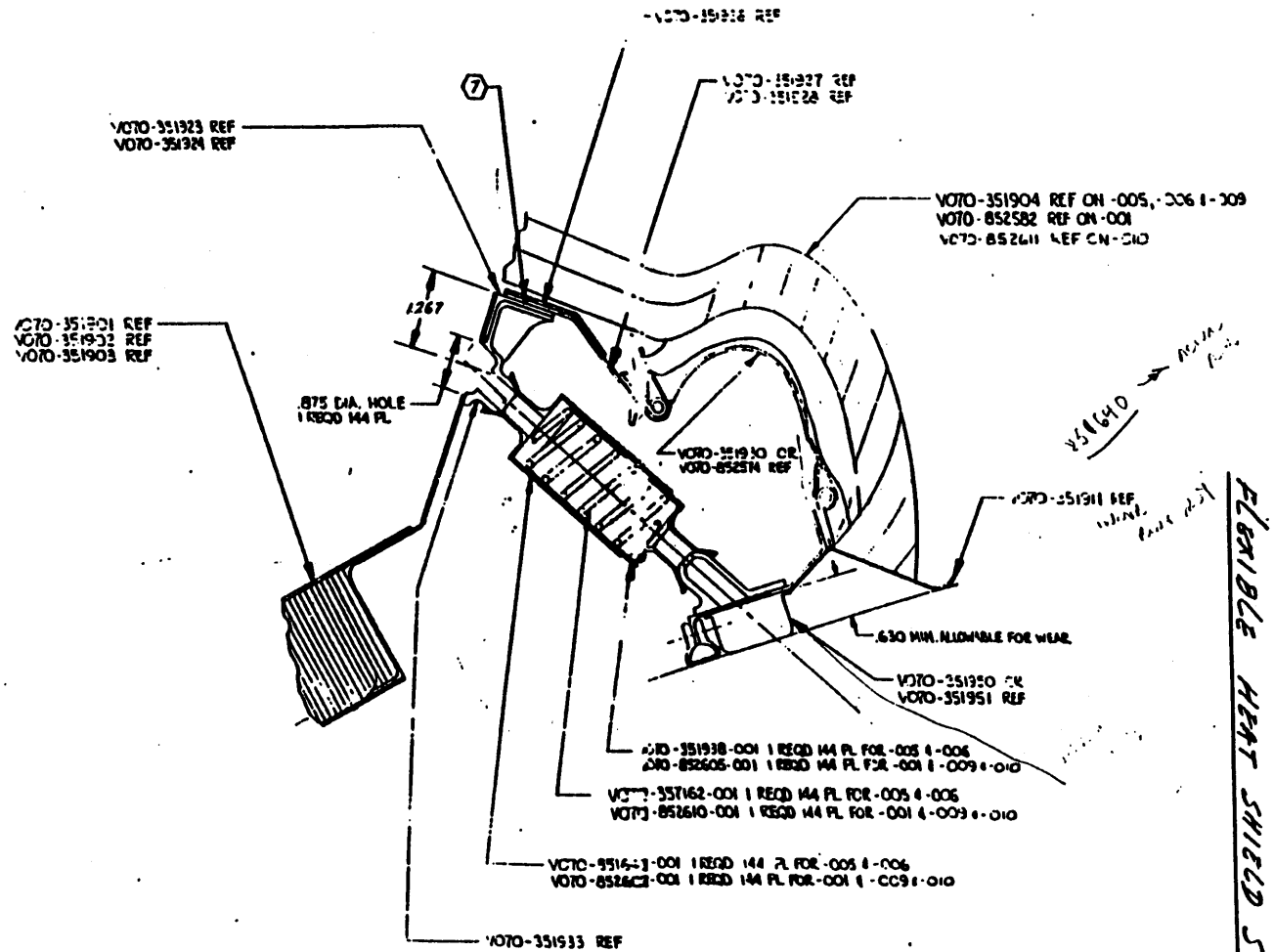
CHECKED BY:

DATE:

REF:

Rockwell International

AFT FUSELAGE - SHELL AND BASE HEAT SHIELD

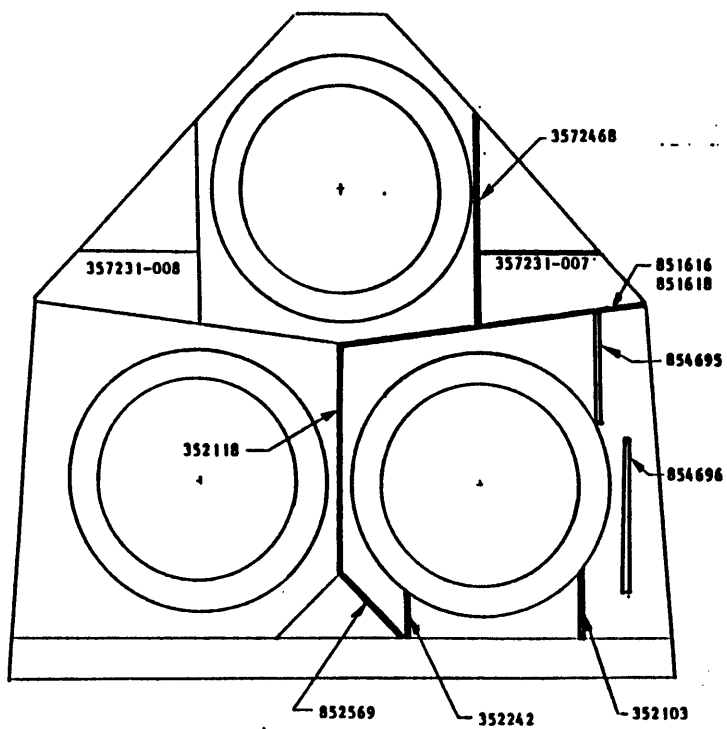


FLEXIBLE HEAT SHIELD SEAL

PAGE NO.	B.7-31.3 OF
REPORT NO.	STS 85-0254
MODEL NO.	OV-103
DWG. NO.	VOTO-852700

PREPARED BY: Yin	Rockwell International	PAGE NO. 8.7.2.0.2 OF
CHECKED BY:		REPORT NO. STS 85-0254
DATE: SEP. 18. 86	AFT FUSELAGE - SHELL AND BASE HEAT SHIELD	MODEL NO. OV103
REF.		DWG. NO.

Heat Shield Beams/Frames



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PREPARED BY: C. CHIN	Rockwell International	PAGE NO. 8.7.2.0.3
CHECKED BY:		REPORT NO. STS 85 0254
DATE: 2-17-88	AFT FUSELAGE - SHELL AND BASE HEAT SHIELD	MODEL NO. OV-103
REF.		DWG. NO.

SUPPORT STRUCTURE - BASE HEAT SHIELD

MINIMUM MARGINS OF SAFETY

DWG. NO. V070-	TITLE	LOAD I.D.	PAGE NO.	FAILURE MODE	M.S.
352103	Y.90 VERTICAL BEAM	TABL 1158 ATBR 117	8.7.2.1.12	FASTENER BEARING	.13
352118	Y.0.0 VERTICAL BEAM	TABL 1059	8.7.2.2.18	LATERAL STABILITY	.89
352242	Y.70 SUPPORT BEAM	COMP. PRESS	8.7.2.7.8	CAP CRIPPLING	.06
357231	Z.433.44 HORIZONTAL BEAM	IVBR 345	8.7.2.4.10	WEB BUCKLING	.37
357246	Y.54 VERTICAL BEAM	FWBL 303	8.7.2.5.11	WEB BUCKLING	.47
852569	LOWER ACCESS DOOR BEAM	TABR 1066 TTBR 115	8.7.2.6.18	FASTENER BEARING	.07
352116	HORIZONTAL BEAM CAP	TABR 1158 ATBL 117	8.7.2.7.13	TENSION	.23
851618	HORIZONTAL BEAM WEB	IVBR 303	8.7.2.7.18	BUCKLING	.44
851625	FITTING SUPPORT	IVBR 320	8.7.2.7.48	FASTENER BEARING	.16
854695	Y.105 VERTICAL INTERCOSTAL	TABR 1158	8.7.2.8.7	WEB BUCKLING	.37
854696	Y.112 VERTICAL BEAM	TABR 1158 TTBL 109	8.7.2.9.7	WEB BUCKLING	.01
859668	SUPPORT STRUT	TTBL 109 PRESS. LOAD	8.7.2.10.4	COMP. + BENDING	.58
357242	CLOSE OUT ANGLE	TABR 2026 ATBL 117	8.7.2.11.35	CRIPPLING	.11

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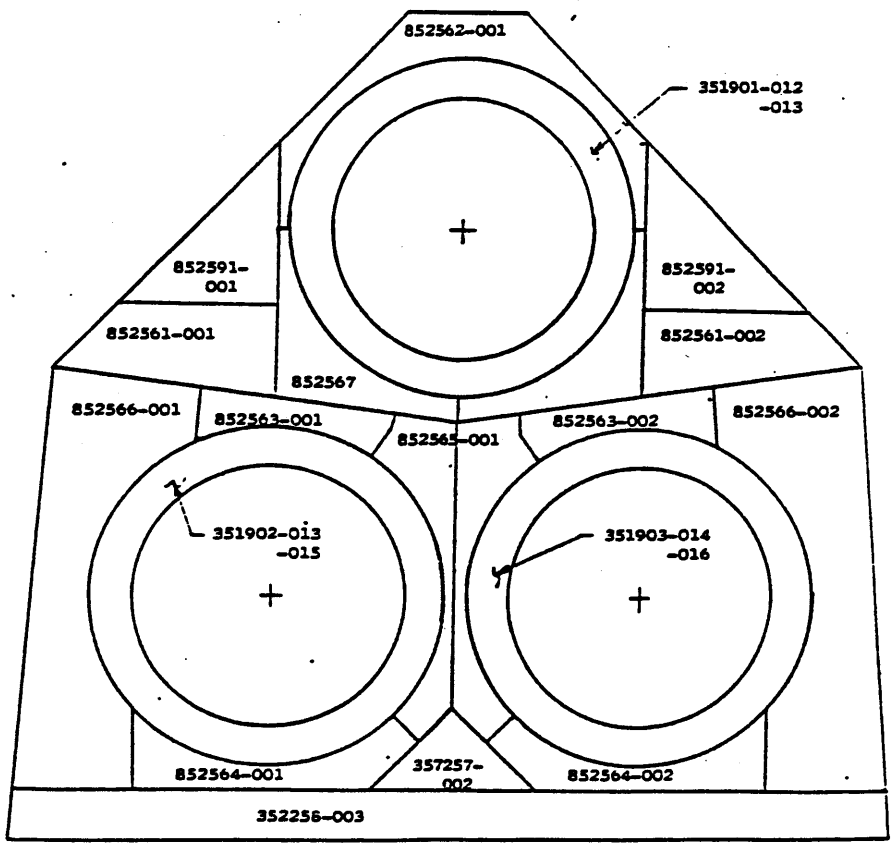
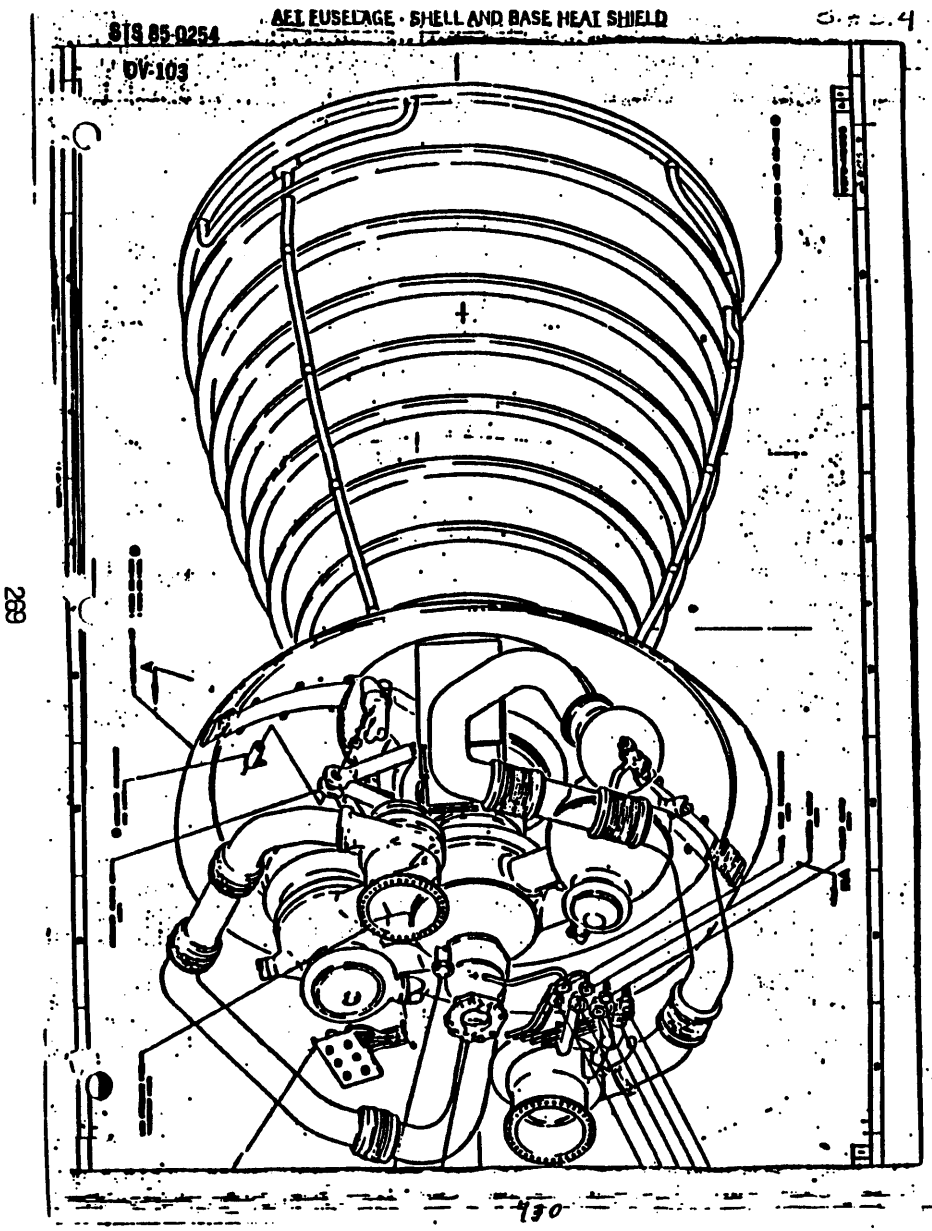
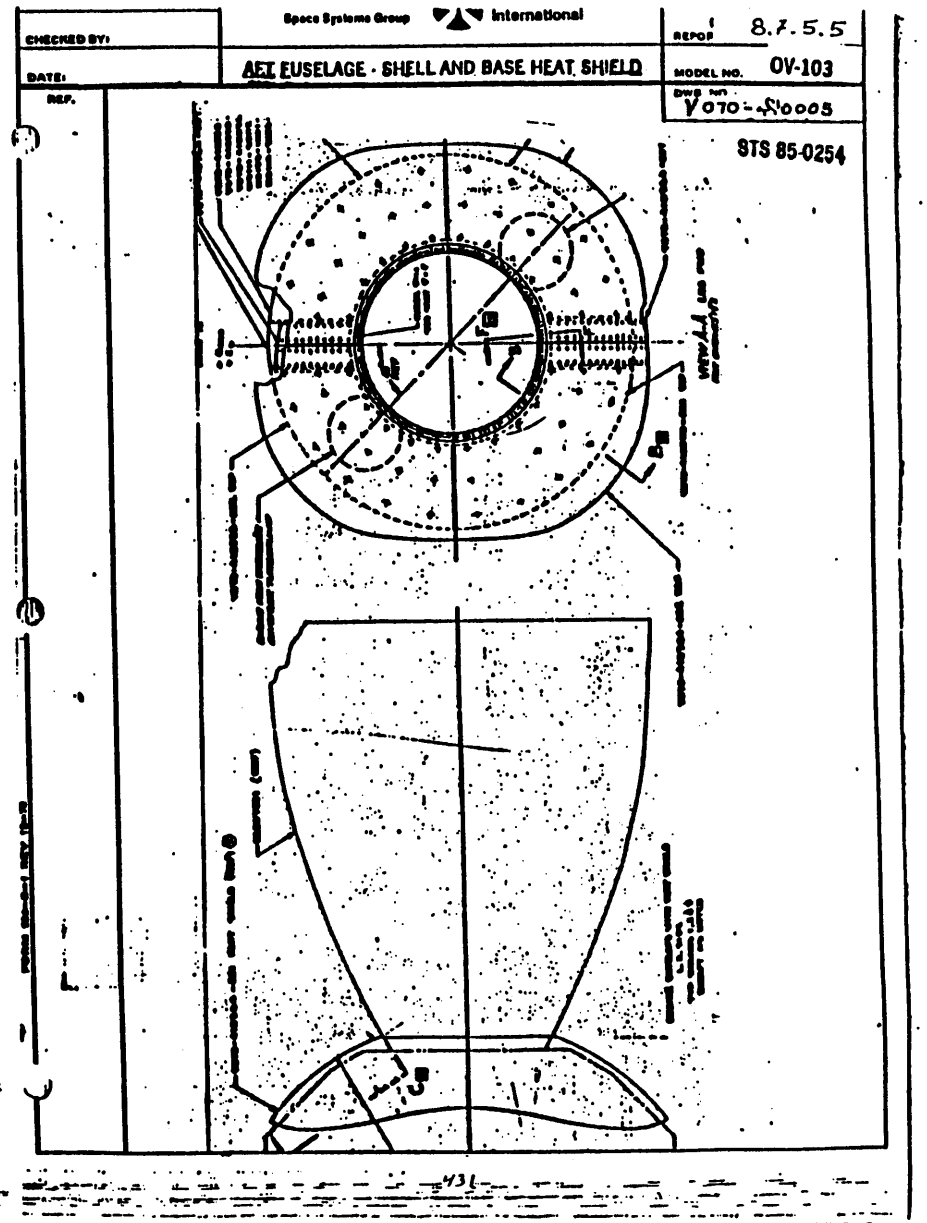
PREPARED BY: Yin	Rockwell International	PAGE NO. 8.7.0.1
CHECKED BY:		REPORT NO. STS 85-0
DATE: Nov. 21. 87	AFT FUSELAGE - SHELL AND BASE HEAT SHIELD	MODEL NO. C
REF.		DWG. NO.

OV-103 Heat Shield - Aft Fuselage

Part Number data V070-xxxxxx




STS 85-0254
AFT FUSELAGE - SHELL AND BASE HEAT SHIELD
OV-103
8.7.5.4
430


Space Systems Group
International
CHECKED BY:
DATE:
REF.
AFT FUSELAGE - SHELL AND BASE HEAT SHIELD
REPORT 8.7.5.5
MODEL NO. OV-103
DWG NO. V070-510005
STS 85-0254
431

ENGINE MOUNTED HEAT SHIELD

General

The heat shield matched set (VO70-410364) consists of two honeycomb sandwich composite partial segments (ME364-0009-0013 and -0014), two shear plates (ME364-0009-0015 and -0016), and two doubler plates (ME364-0009-0017 and -0018) which, when bolted together, form a spherical disc assembly. The assembled heat shield geometry is that of a truncated spherical shell of radius 61.789 inches. The heat shield matched set is bolted to the engine attachment flange by a retainer ring at the inner edge while the outer edge is free of attachment (refer to pages 8.7.5.4 and 8.7.5.5). The function of the engine mounted heat shield in conjunction with the aft body fixed heat shield is to provide thermal protection to the engines and vehicle components located inside the aft fuselage.

Material

Sandwich Panels. The inner and outer face sheets of the honeycomb sandwich composite panels are fabricated from Inconel 625 per AMS5599, 0.025 inches thick (ME364-0009-0013 and -0014).

Core. The core ribbon of the honeycomb composite is fabricated from Inconel 625 per AMS5599 per Astech Spec. TRR2214, 0.0040 inches thick, 0.05 inches deep. The formed core is 1/4 inch B cell.

Doubler Plate. The doubler plate is fabricated from Inconel 718 bar per AMS5663 (ME364-0009-0017 and -0018).

Shear Plate. The shear plate is fabricated from Rene 41 per AMS5545, 0.040 inches thick (ME364-0009-0015 and -0016).

NASTRAN Finite Element Model

The NASTRAN finite element model of the engine mounted heat shield is presented on pages 8.7.5.12 through 8.7.5.32. A diagram of the finite element sign convention is shown on page 8.7.5.56.

The primary design loads on the engine mounted heat shield are thermal loads. The temperature data used in the analysis for the 103 vehicle is presented on pages 8.7.5.33 through 8.7.5.40 which define the temperature distribution versus location for a given time. The times range from 20 seconds to 490 seconds after liftoff with an average time interval of 50 seconds.

The presented flight thermal data shows a maximum temperature of 1590 degees Fahrenheit at the seal contact circle 23 inches from the engine heat shield mount at 400 seconds after liftoff. The maximum temperature

gradient between the inner and outer surfaces is 465 degrees Fahrenheit/0.55 inches which occurs at 150 seconds at a distance of 4 inches from the engine mount. The maximum temperature gradient in the in-plane direction is 800 degrees Fahrenheit/inch which occurs at 300 seconds between the 24 and 25 inch locations. The critical thermal loads occur at 150, 300, and 400 seconds after liftoff.

Engine Heat Shield/Seal Certification Test

The purpose of the Engine Heat Shield/Seal Certification Test (STS 82-0375) was to establish the 'life' of the engine heat shield. The testing to date has shown that the heat shield in an undamaged condition can sustain the 'worst case' flight environment including pressure, temperature, structural deflections, and engine gimballing. It has also shown that the heat shield can sustain structural damage from both gimballing the VO70-351950 spacers over the heat shield, which can cause grooves or indentations in the honeycomb face sheet, and from thermal cycling, which can cause 'ripples' in the honeycomb face sheet and subsequent failures in the core. The testing has also shown that the heat shield can still maintain structural integrity with both types of damage in existence.

From numerous inspections, it has been further established that these external indentations and ripples can be located and monitored with normal visual inspection techniques. The internal core damage only occurs after the ripples appear and can be detected by normal x-ray techniques.

The test program as defined does not lend itself to establish exactly the time at which the heat shield is no longer capable of performing its intended function a minimum of one additional flight with external physical damage present. Therefore a developmental test program was defined and performed to verify acceptability of criteria selected to define the limit of heat shield face sheet deformation beyond which the heat shield must be replaced.

VO70-410364 Engineering Order B01

According to VO70-410364 Engineering Order B01 dated February 11, 1982 the engine mounted heat shield shall be considered an inspection item for damage incurred during flight such that after each flight the convex surface of each heat shield shall be inspected for signs of damage and/or surface deformations. Heat shield sets with thermally induced surface deformations that exceed 0.030 inch, when measured from peak to lowest adjoining depressions, shall be removed and replaced. Heat shield sets with mechanical damage (gouges, etc.) that exceed 0.020 inch when measured from peaks to the lowest adjoining depressions, shall be submitted to material review.

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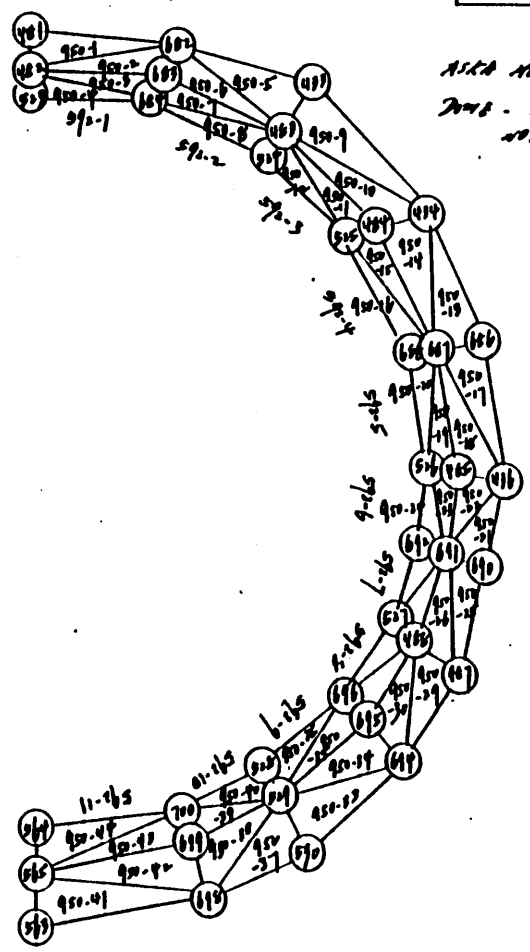
Base Heat Shield Dome

The base heat shield domes serve as an extension of the base heat shield and as a support for the flexible seal and blanket assemblies and for the engine mounted heat shield sliding seal assembly.

The domes are basically a bonded aluminum honeycomb sandwich structure closed out by integrally machined rings. Bolts thru the base ring attach the dome assemblies to the base heat shield. The aft ring supports the seal installations.

	V070-351901-012 -013	V070-351902-013 -014	V070-351903-015 -016
Core	MIL -C-7438 Flex core 3.1 F40-20 (5056) ST		
Face sheet	.016 2024-T81 Al. sheet QQ-A-250/4		
Edge member	V070-351917 V070-351918	V070-351919 V070-351920	V070-351919 V070-351920
Ring	V070-351914 V070-357195	V070-351915 V070-357197	V070-351916 V070-357196
Spacer			V070-851756

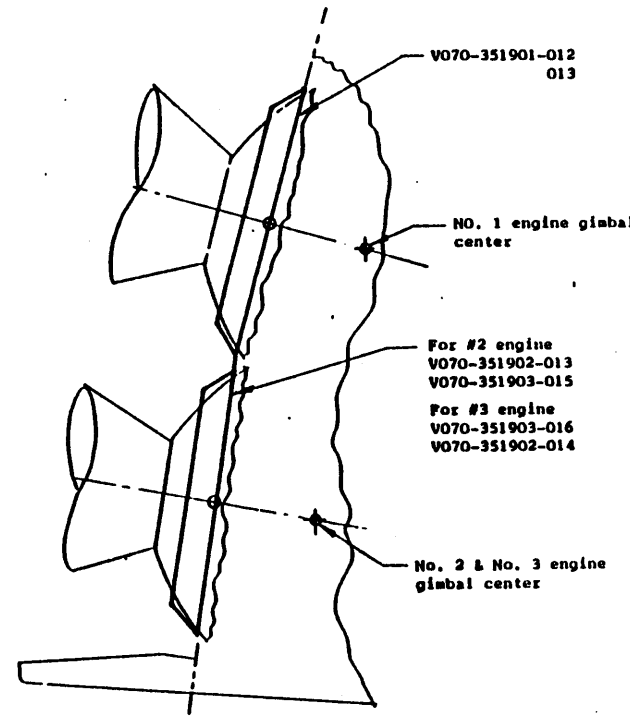


PREPARED BY: P. Moya	Rockwell International	PAGE NO. 8.7.4.1.0
CHECKED BY:		REPORT NO. STS85-0254
DATE: Jan 22, 1988	Aft Fuselage - Shell and Base Heat Shield	MODEL NO. OV-103

SECTION 8.7.4.1

BASE HEAT SHIELD DOMES

PREPARED BY: Yin	Rockwell International	PAGE NO. 8.7.4.1.1 OF
CHECKED BY:		REPORT NO. STS 85-0254
DATE: JAN. 15, 88	AFT FUSELAGE - SHELL AND BASE HEAT SHIELD	MODEL NO. 103
REF.		DWG NO. V070-852700



U.S. GOV'T

Photo/TV Analysis Group Request Form
STS-49
06/12/92

Task Number --> 15

Request Date : 05/13/92
Completion Date : 05/14/92

Requestor : R. Dittemore
Phone : 483-5417
Mail Code : DA8

Analyst Name	Phone Number	Assignment
J. Hartman	483-5337	Lead
M. Snyder	483-5171	

Task Title

INTEL Satellite Enhancements

Objectives

Acquire and provide enlargements, and/or edge enhancements of the rear of the INTEL satellite to determine if any sharp edges or projections exist and could be dangerous to satellite capture.

Hypothesis

Reporting

Analysis Strategy

1) Collect .T6A (ESC images) captured by ERSAF.

2) Copy these files to VDAS and any other appropriate systems.

3) Produce unenhanced and enhanced prints to demonstrate capabilities

Summary of Analysis of Visual Events
STS-49
06/15/92

Task Number
15

Title : INTEL Satellite Enhancements

Analysts : J. Hartman/Team
Date : 05/13/92

Camera Number : ESC
Frame Number :
GMT :

Requestor : R. Dittemore
Phone : 483-5417
Mail Code : DA8

Description of Analysis

Three ESC images ESC02007, ESC02011, ESC02020, ESC02022, ESC02023, were downloaded from the VDAS STS-49 mission disk to the mac. Photoshop was used to enhance these images. (the following enhancements were tried: Intensity mapping, histogram equalization, high pass flittering and an (original - Laplacian) kernal filter. The main features in the image to enhance were edges because sharp edges could possibly tear the astronauts suit. These enlarged (3X) images were printed on the 4cast printer from ESC02007 (with a contrast stretch and sharper edge enhancement). ESC02022 (histogram equilization) and ESC02023 (intenisty mapping +90 degrees clockwise rotation). All images that were printed were saved on the STS-49 mission disk [sts.orbit].

Image Analysis Tools & Techniques

Summary of Analysis of Visual Events
STS-49
06/09/92

Task Number
15.01

Title : INTEL Satellite Enhancements

Analysts : J. Hartman, M. Snyder
Date : 05/12/92

Camera Number : ESC
Frame Number :
GMT :

Requestor : R. Dittemore
Phone : 483-5417
Mail Code : DA8

Description of Analysis

The following images of the INSAT were determined to be of possible value and send by ERSAF to VDAS:

ESCO2007.TGA & ESCO2015.TGA
ESCO2008.TGA & ESCO2020.TGA
ESCO2009.TGA & ESCO2022.TGA
ESCO2010.TGA & ESCO2023.TGA

The images were placed on STS-49 [STS.ORBIT]

This images were printed on the 4-cast system and initally ESCO2007.TGA, ESCO2011.TGA and ESCO2015.TGA were selected as possible/useful images to enhance and enlarge.

These images were enlarged and enhanced by Mike Snyder with photoshop and several edge enhancements were produced.

After review with D. Pitts, ESCO2022.TGA and ESCO2023.TGA were selected for edge enhancements.

Image Analysis Tools & Techniques

Summary of Analysis of Visual Events
STS-49
06/09/92

Task Number
15.02

Title : INTEL Satellite Enhancements

Analysts : J. Hartman, M. Snyder
Date : 05/14/92

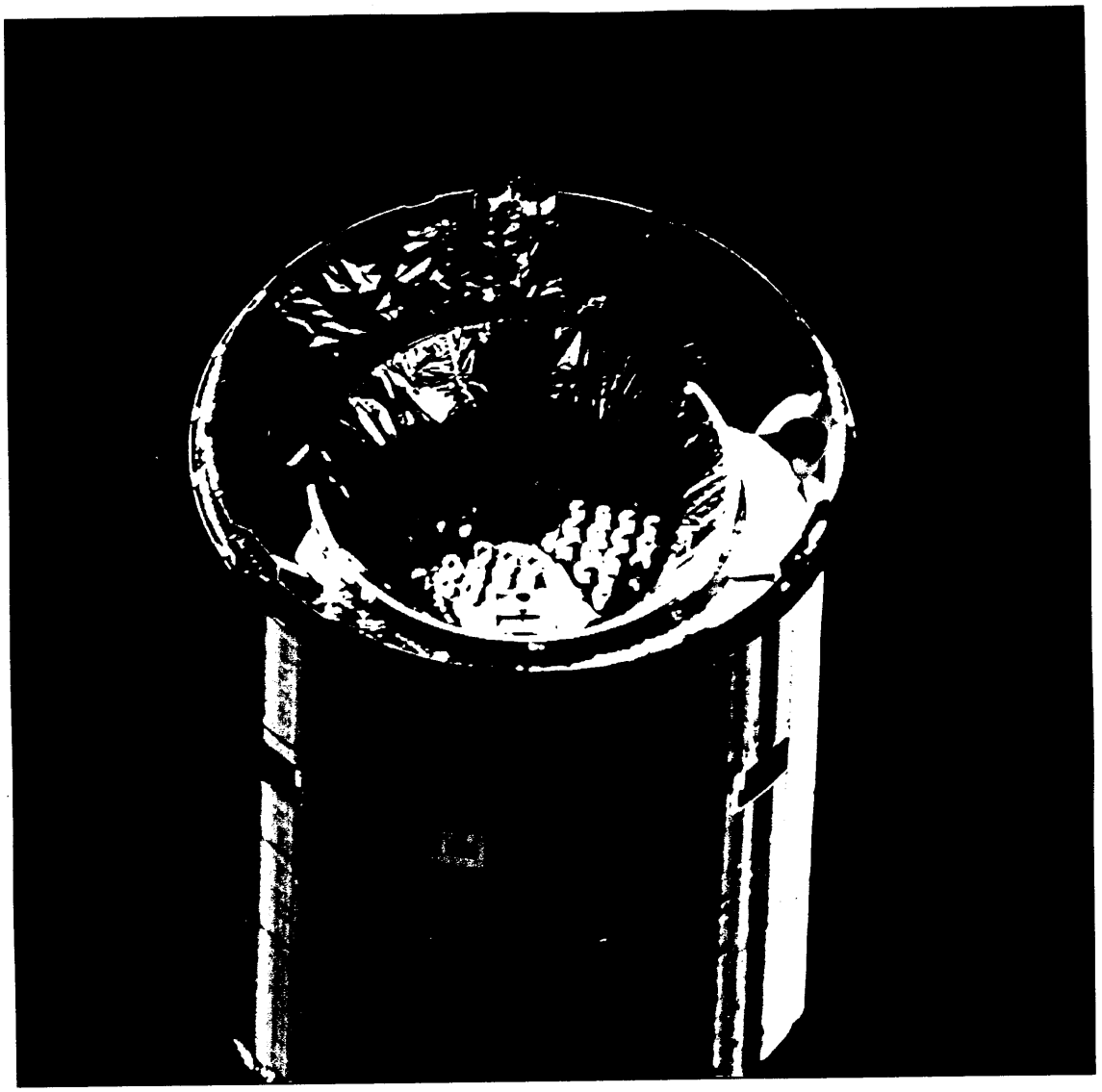
Camera Number :	ESC	**Requestor :**	R. Dittemore
Frame Number :		**Phone :**	483-5417
GMT :		**Mail Code :**	DA8

Description of Analysis

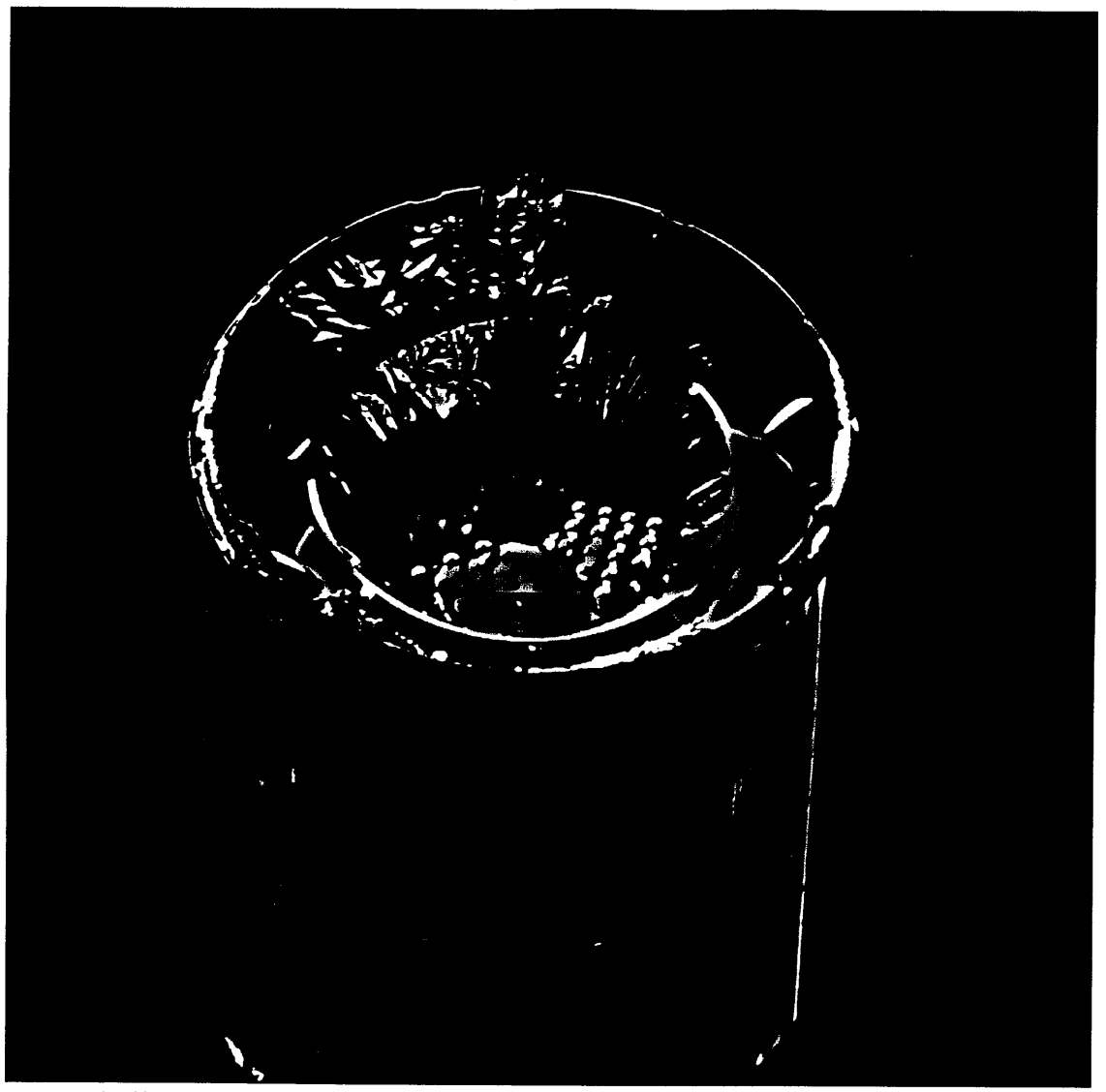
Nine targa format images were obtained from ERSAF which provided views of the base, outer and inner rims of INTELSAT. These images were downloaded to VDAS and placed on the STS-49 mission data base. Several images were then selected which provided the greatest coverage of the circumference of the base and these images were downloaded to a macintosh system where they were enchance using photoshop. Intensity mapping, histogram equalization, high pass filtering and an (original minus Laplacian) kernal filter methods were tried to enhance the edges to determine if any sharp edges existed that oculd possibly tear the astronaut suit.

Three images were finally selected which best displayed the inner and outer rims. these were ESC)2007 with a contrast stretch and sharper edge enhancement. ESCO2022 with a histogram equalization and ESCO2023 with an intensity mapping +90 degrees clockwise rotation were created and printed as 2X enlargements on the $cast printer system for distribution to the requester.

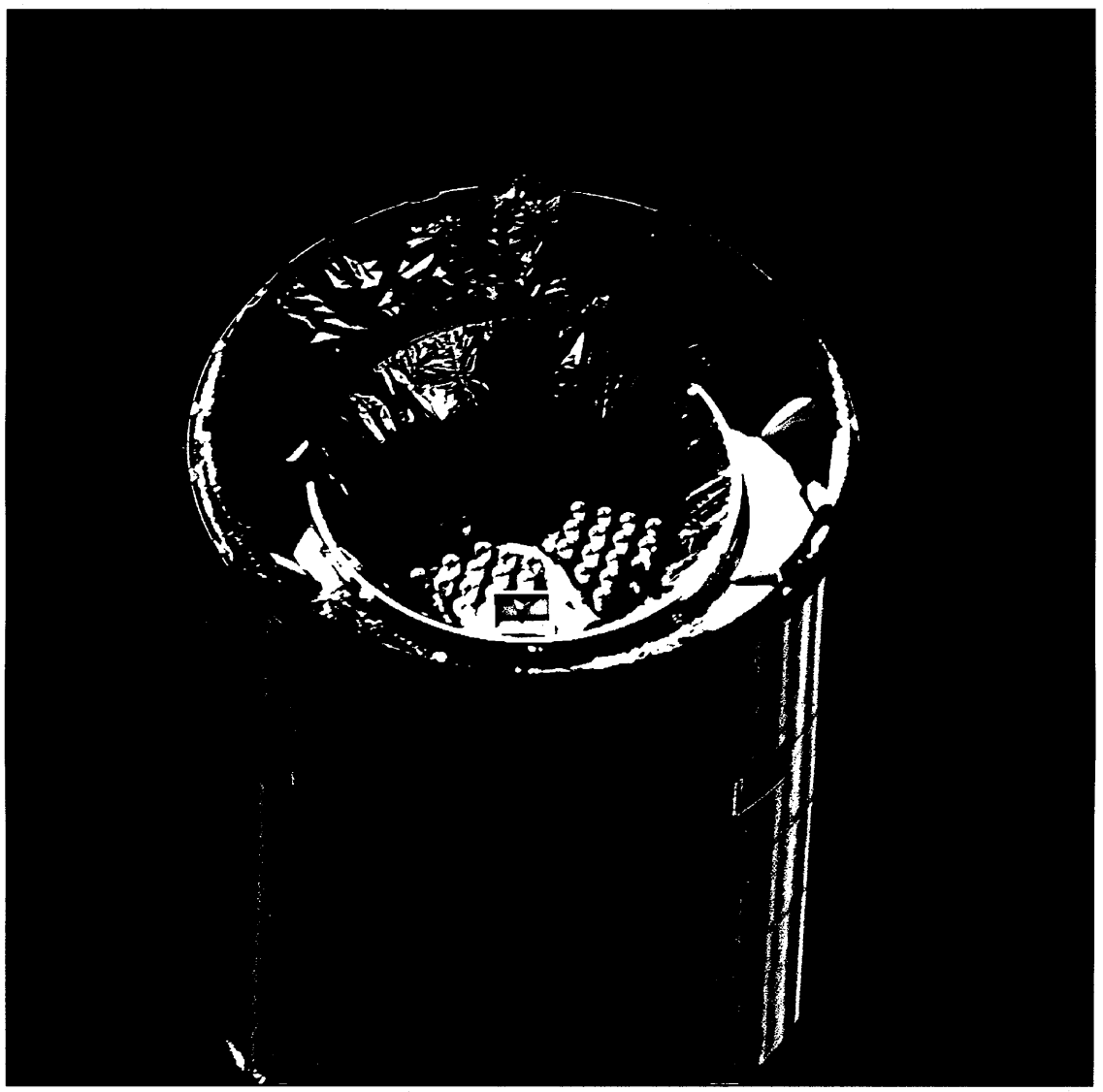
Image Analysis Tools & Techniques



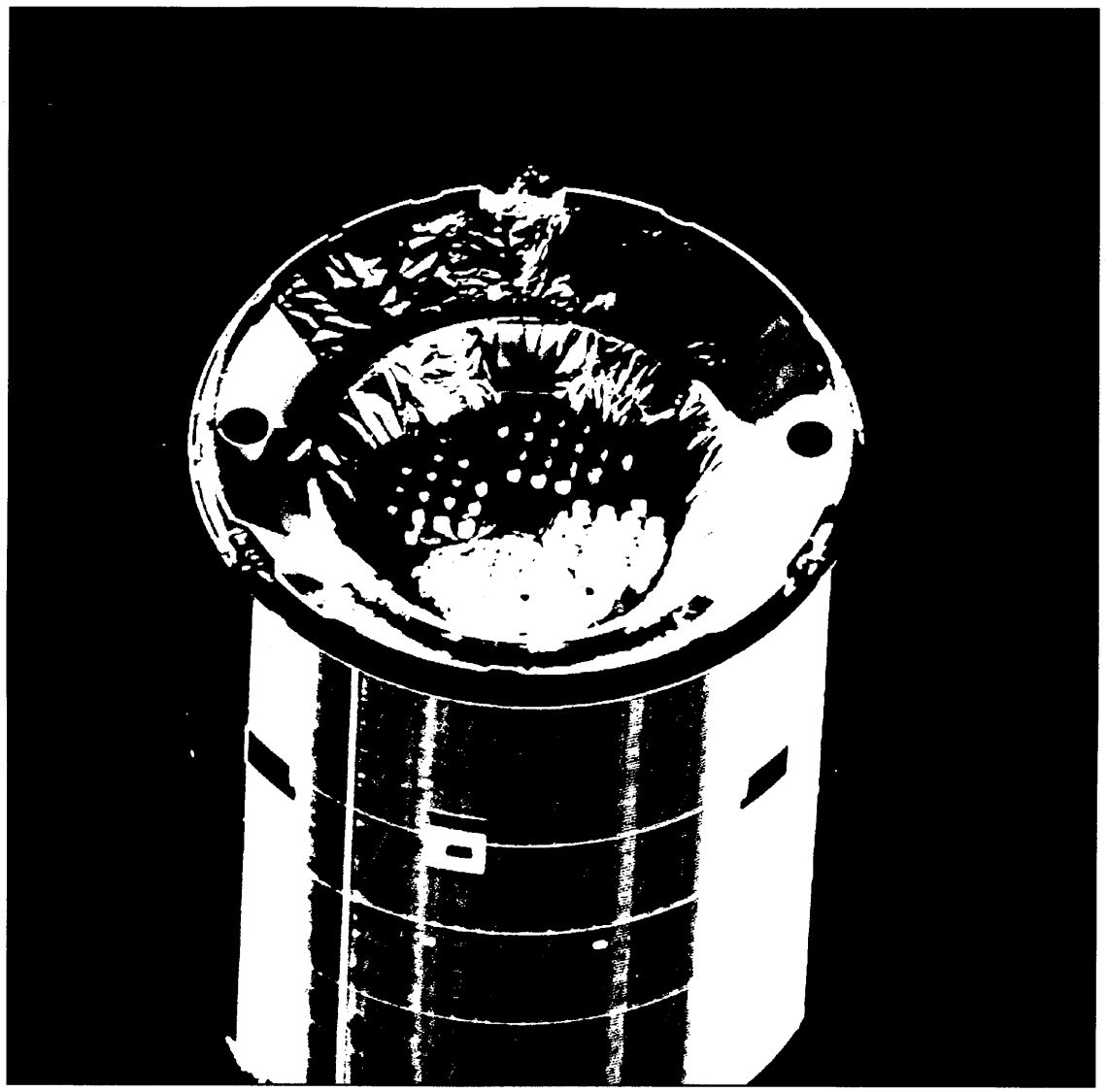
Contrast Stretch



High Pass Filter



Original - Laplacian Filter



Contrast Stretch

Photo/TV Analysis Group Request Form
STS-49
06/12/92

Task Number --> 16

Request Date : 05/14/92
Completion Date : 05/14/92

Requestor : C. Ortiz
Phone : 483-8879
Mail Code : ES3

Analyst Name	Phone Number	Assignment
J. Disler	483-5182	Review films, report
B. Gastineau	483-5167	Review films, report

Task Title

Determine Source of Debris on Underside of Orbiter at Mid Fuselage

Objectives

Flashing piece of debris (light on one side, dark on the other) first seen at Orbiter mid fuselage on the underside of the Orbiter fell aft at tower clear. Seen on Camera E-52. Time was 23:40:04.622 (frame 1371). Review film E-54 to determine source of debris.

Hypothesis

Reporting

Call Carlos Ortiz and report findings

Analysis Strategy

Review camera E-54. Greg Katnik/KSC believes it can be seen on E-54 at 23:40:04.225 (frame 1329) crossing in front of some tiles. He believes that it is a thin object and the dark appearance is an edge of the view.

Verify if the debris source could be from the ET feedline belows. Note other possible debris sources.

Summary of Analysis of Visual Events
STS-49
06/09/92

Task Number
16

Title : Determine Source of Debris on Underside of Orbiter at Mid Fuselage

Analysts : J. Disler, B. Gastineau
Date : 05/14/92

Camera Number :	E52,E54	**Requestor :**	C. Ortiz
Frame Number :		**Phone :**	483-8879
GMT :		**Mail Code :**	ES3

Description of Analysis

Camera E-54 film was reviewed and a very small piece (on this view) of debris was seen in front of the Orbiter tiles. The times the debris were in view are:

23:40:04.205 (Frame 1327) through 23:40:04.437 (Frame 1350)
The debris appears to be the same one seen on E-52 at 23:40:04.622 UTC.
The debris is forward of the wing. The distance from tip from tip from the Orbiter nose where the debris was first seen is 36.3 feet. This means that the debris source would have to be at this position or further forward on the Orbiter longitudinal axis.

The LO2 feedline on the ET or the ET/Orbiter forward attach are both possible debris sources.
The actual source of the debris can not be determined visually from either the E-52 or E-54 films.

On camera E-79, a white piece of debris was seen falling along the ET LO2 feedline during liftoff. This debris was first seen below the ET intertank on the left edge of the view. The debris traveled across the LO2 feedline and fell aft along the right side of the LO2 feedline before it was lost from view.

Since debris is now known to have been falling near the LO2 feedline (based on the E-79 view), it is probably safe to assume that the small piece of debris seen in front of the Orbiter tiles on cameras E-52 and E-54 was ice from the LO2 feedline (or other source).

Therefore, the debris is unlikely to be a piece of tile which could have been a mission critical event.

Image Analysis Tools & Techniques

From: SN::PITTS 12-MAY-1992 10:35:40.25
To: @PHOTOTV.DIS
CC:
Subj: b & w tile seen in E-52

Greg Katnik called and believes the debris is a piece of ice from the feedline bellows. He thinks it can be seen in E-54 a 40:04.225 crossing in front of some tiles. He believes that it is thin and the dark appearance is edge on.
Dave

U.S. Gov't

Photo/TV Analysis Group Request Form
STS-49
06/10/92

Task Number --> 17

Request Date : 06/05/92
Completion Date :

Requestor : Harold Nitske
Phone : 483-1434
Mail Code : EE6

Analyst Name	Phone Number	Assignment
Mike Snyder	35171	Lead-Analysis

Task Title

Debris during ASEM

Objectives

Determine source of debris and identify debris seen be Kathy Thorton during EVA.

Hypothesis

May have come from KU-band Antenna.

Reporting

Analysis Strategy

Use multiple videos and perform 3-D trajectory analysis. Contact Lisa Leonard (KU-band sub-system manager).

Rawinsonde Data

TFILE did OPEN on window 0
UL LIST 74794 21
STATION: 74794 DAY/TIME: 92128 210000 LAT/LONG: 284666 805500

KSC
RAWINSONDE
@ 21:00 GMT

LEVEL	TEMP	DEW PT	DIR	SPEED	HEIGHT
1012.0	17.0	14.1	10.0	7.7	3.0
1000.0	16.0	13.3	345.0	8.7	104.8
977.0	14.2	13.3	330.1	7.7	302.5
976.8	14.2	13.3	330.0	7.7	304.0
960.0	13.0	12.8	308.3	6.4	450.9
942.1	12.6	11.9	285.0	5.1	609.0
915.0	12.0	10.6	252.7	7.2	855.0
908.6	11.6	10.3	245.0	7.7	914.0
876.0	9.6	8.7	230.0	10.2	1219.0
873.0	9.4	8.6	229.4	10.4	1247.8
850.0	7.4	7.0	225.0	12.3	1469.1
842.0	6.6	6.3	223.9	12.6	1547.1
828.0	3.4	3.4	222.0	13.2	1684.2
813.3	.8	.7	220.0	13.8	1829.0
806.0	-.5	-.7	221.2	14.3	1901.6
782.9	-.8	-1.0	225.0	15.9	2134.0
753.6	-1.1	-1.5	225.0	15.9	2439.0
735.0	-1.3	-1.8	221.7	16.2	2639.2
725.5	-1.3	-1.8	220.0	16.4	2743.0
719.0	-1.3	-1.8	220.0	16.7	2815.1
700.0	-1.7	-2.2	220.0	17.4	3028.8
673.0	-3.3	-3.6	220.0	18.2	3341.6
659.0	-3.7	-4.2	220.0	18.6	3508.1
646.6	-4.7	-5.1	220.0	19.0	3658.0
628.0	-6.3	-6.5	220.0	21.5	3887.6
599.0	-8.9	-9.5	220.0	25.6	4256.3
598.1	-8.9	-10.0	220.0	25.7	4268.0
588.0	-9.1	-16.1	218.9	27.5	4399.9
573.0	-10.5	-15.5	217.3	30.2	4599.6
557.0	-11.7	-16.4	215.5	33.1	4817.3
552.6	-12.2	-23.4	215.0	33.9	4878.0
540.0	-13.7	-43.7	218.5	35.6	5054.0
523.0	-13.7	-43.7	223.3	37.9	5297.1
500.0	-16.3	-46.3	230.0	41.1	5637.4
491.0	-15.9	-45.9	230.0	42.0	5774.2
489.8	-16.0	-46.0	230.0	42.1	5792.0
483.0	-16.7	-46.7	230.0	42.8	5897.8
470.3	-17.6	-47.6	230.0	44.2	6097.0
442.0	-19.7	-49.7	231.9	46.4	6560.5
400.0	-26.3	-56.3	235.0	49.8	7292.4
381.8	-28.7	-58.7	235.0	50.9	7621.0
350.3	-33.0	-63.0	240.0	51.9	8231.0
322.0	-37.3	-67.3	233.5	51.2	8826.4
307.4	-38.7	-68.7	230.0	50.9	9146.0
300.0	-39.5	-69.5	230.0	50.9	9313.1
270.0	-45.6		225.0	52.9	10023.0
268.5	-45.9		225.0	52.9	10060.0
264.0	-46.9		226.9	52.7	10174.4
256.5	-46.9		230.0	52.4	10365.0
250.0	-46.9		230.0	51.4	10535.7
244.9	-47.5		230.0	50.9	10670.0
211.0	-52.1		230.0	46.0	11647.1
200.0	-53.3		230.0	44.2	11992.9
195.0	-54.3		230.0	43.2	12155.7
185.0	-51.7		231.0	40.2	12495.3
168.0	-54.7		232.8	34.7	13116.5
150.0	-54.1		235.0	28.2	13842.9
139.1	-53.8		235.0	24.6	14329.0
133.0	-53.7		230.3	23.2	14615.6

CLOUD

CLOUD

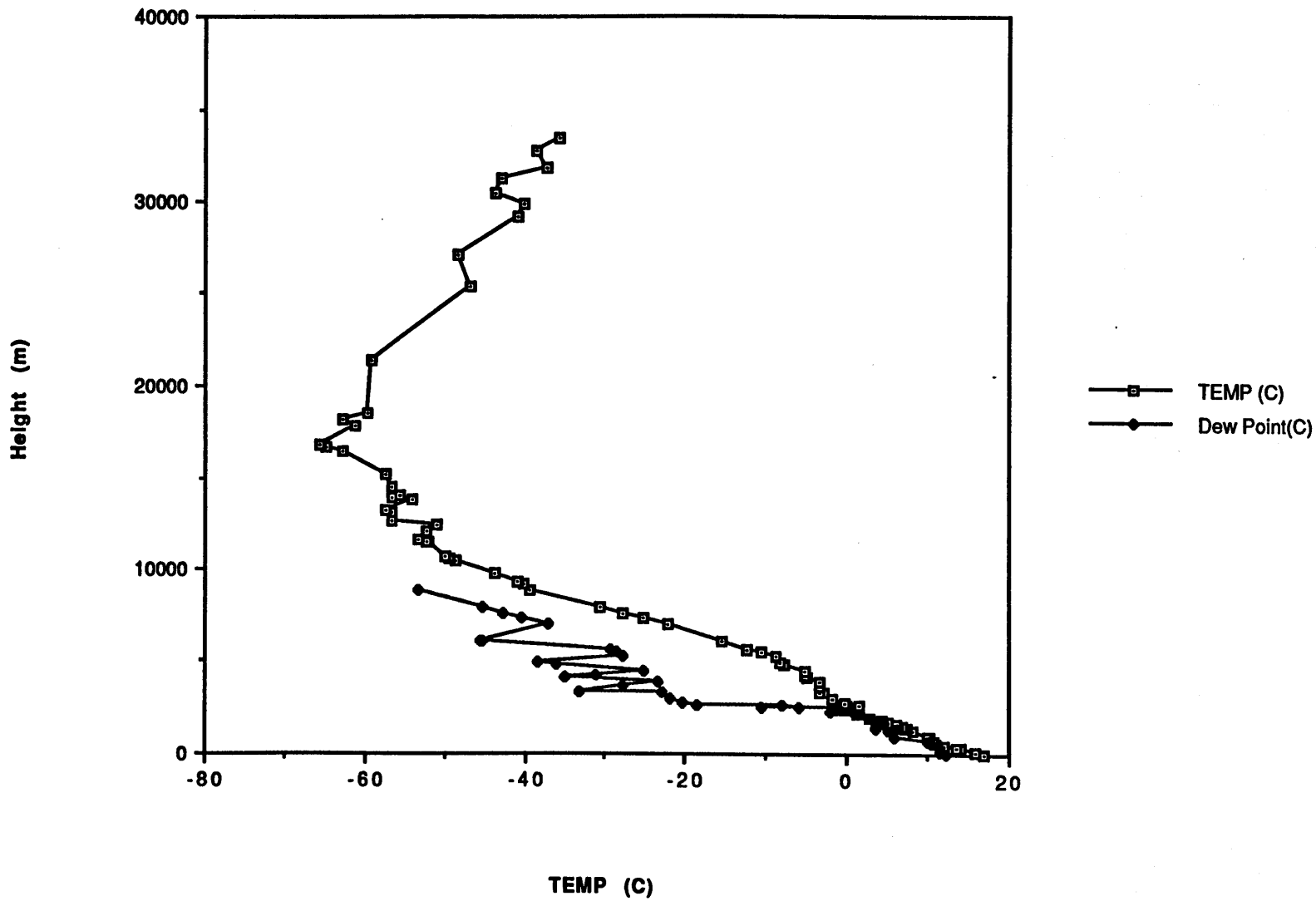
NOT REPRESENTATIVE
@ LIFTOFF

```
    132.6   -53.9            230.0    23.1  14634.0
    126.4   -57.1            235.0    23.6  14939.0
    126.0   -57.3            235.0    23.6  14960.4
    120.4   -58.2            235.0    24.1  15243.0
    114.7   -59.3            235.0    24.1  15548.0
    106.0   -60.9            229.2    20.6  16044.5
    100.0   -60.5            225.0    18.0  16407.2
     95.1   -59.7                          16720.8
     87.0   -62.5                          17273.9
     78.8   -62.1                          17885.6
     74.4   -57.1                          18245.1
     55.0   -56.7                          20159.4
     42.7   -52.5                          21780.5
 PARCEL: DEW PT.= 285.7 POT. TEMP= 290.1 EQUIV.POT.TEMP= 316.8 MIX= 10.1
 PRECIP.WATER=27.19 CONV.TEMP= 17.3 FCST MAX=    .0 LIFTED INDEX=  1.8
 TOTALS= 47.0 EQUIL.PRES.= 473.6 K-INDEX= 30.2 SWEAT INDEX=247.6
UL      --  DONE
TFILE CLOSE
```

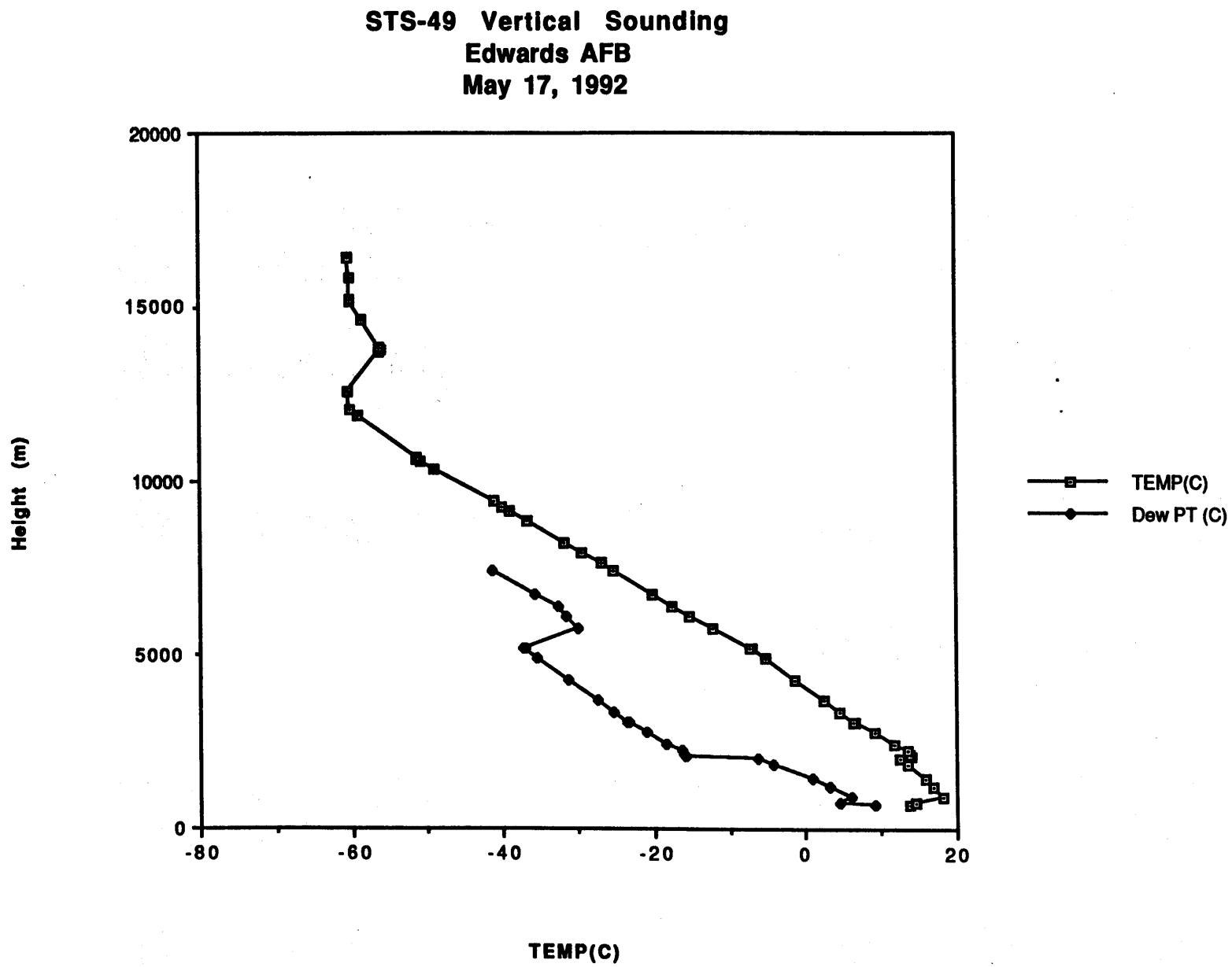
	Pressure (mb)	TEMP (C)	Dew Point (C)	Wind DIR	Wind SPD (kts	Height (mb)
	1012.000	17.00	14.10	10.000	7.70	3.00000
2	1000.000	16.00	13.30	345.000	8.70	104.80000
3	977.000	14.20	13.30	330.100	7.70	302.50000
4	976.800	14.20	13.30	330.000	7.70	304.00000
5	960.000	13.00	12.80	308.300	6.40	450.90000
6	942.100	12.60	11.90	285.000	5.10	609.00000
7	915.000	12.00	10.60	252.700	7.20	855.00000
8	908.600	11.60	10.30	245.000	7.70	914.00000
9	876.000	9.60	8.70	230.000	10.20	1219.00000
10	873.000	9.40	8.60	229.400	10.40	1247.80000
11	850.000	7.40	7.00	225.000	12.30	1469.10000
12	842.000	6.60	6.30	223.900	12.60	1547.10000
13	828.000	3.40	3.40	222.000	13.20	1684.20000
14	806.000	-0.50	-0.70	221.200	14.30	1901.60000
15	782.900	-0.80	-1.00	225.000	15.90	2134.00000
16	753.600	-1.10	-1.50	225.000	15.90	2439.00000
17	735.000	-1.30	-1.80	221.700	16.20	2639.20000
18	725.500	-1.30	-1.80	220.000	16.40	2743.00000
19	719.000	-1.30	-1.80	220.000	16.70	2815.10000
20	700.000	-1.70	-2.20	220.000	17.40	3028.80000
21	673.000	-3.30	-3.60	220.000	18.20	3341.60000
22	659.000	-3.70	-4.20	220.000	18.60	3508.10000
23	646.600	-4.70	-5.10	220.000	19.00	3658.00000
24	628.000	-6.30	-6.50	220.000	21.50	3887.60000
25	599.000	-8.90	-9.50	220.000	25.60	4256.30000
26	598.100	-8.90	-10.00	220.000	25.70	4268.00000
[illegible]	588.000	-9.10	-16.10	218.900	27.50	4399.90000
28	573.000	-10.50	-15.50	217.300	30.20	4599.60000
29	557.000	-11.70	-16.40	215.500	33.10	4817.30000
30	552.600	-12.20	-23.40	215.000	33.90	4878.00000
31	540.000	-13.70	-43.70	218.500	35.60	5054.00000
32	523.000	-13.70	-43.70	223.300	37.90	5297.10000
33	500.000	-16.30	-46.30	230.000	41.10	5637.40000
34	491.000	-15.90	-45.90	230.000	42.00	5774.20000
35	489.800	-16.00	-46.00	230.000	42.10	5792.00000
36	483.000	-16.70	-46.70	230.000	42.80	5897.80000
37	470.300	-17.60	-47.60	230.000	44.20	6097.00000
38	442.000	-19.70	-49.70	231.900	46.40	6560.50000
39	400.000	-26.30	-56.30	235.000	49.80	7292.40000
40	381.800	-28.70	-58.70	235.000	50.90	7621.00000
41	350.300	-33.00	-63.00	240.000	51.90	8231.00000
42	322.000	-37.30	-67.30	233.500	51.20	8826.40000
43	307.400	-38.70	-68.70	230.000	50.90	9146.00000
44	300.000	-39.50	-69.50	230.000	50.90	9313.10000
45	270.000	-45.60		225.000	52.90	10023.00000
46	268.500	-45.90		225.000	52.90	10060.00000
47	264.000	-46.90		226.900	52.70	10174.40000
48	256.500	-46.90		230.000	52.40	10365.00000
49	250.000	-46.90		230.000	51.40	10535.70000
50	244.900	-47.50		230.000	50.90	10670.00000
51	211.000	-52.10		230.000	46.00	11647.10000
52	200.000	-53.30		230.000	44.20	11992.90000
[illegible]	195.000	-54.30		230.000	43.20	12155.70000
54	185.000	-51.70		231.000	40.20	12495.30000
55	168.000	-54.70		232.800	34.70	13116.50000
56	150.000	-54.10		235.000	28.20	13842.90000

	Pressure (mb)	TEMP (C)	Dew Point (C)	Wind DIR	Wind SPD (kts	Height (mb)
57	139.100	-53.80		235.000	24.60	14329.00000
58	133.000	-53.70		230.300	23.20	14615.60000
59	132.600	-53.90		230.000	23.10	14634.00000
60	126.400	-57.10		235.000	23.60	14939.00000
61	126.000	-57.30		235.000	23.60	14960.40000
62	120.400	-58.20		235.000	24.10	15243.00000
63	114.700	-59.30		235.000	24.10	15548.00000
64	106.000	-60.90		229.200	20.60	16044.50000
65	100.000	-60.50		225.000	18.00	16407.20000
66	95.100	-59.70				16720.80000
67	87.000	-62.50				17273.90000
68	78.800	-62.10				17885.60000
69	74.400	-57.10				18245.10000
70	55.000	-56.70				20159.40000
71	42.700	-52.50				21780.50000

STS-49 Launch Vertical Profile
KSC 8/00:00GMT



	Level (mb)	TEMP(C)	Dew PT (C)	Wind DIR	Wind SPD (kts)	Height (m)
1	928.000	13.800	9.300	250.000	1.000	702.000
2	925.000	14.600	4.600	300.000	1.000	729.400
3	905.200	18.200	6.200	295.000	1.500	914.000
4	905.000	18.200	6.200	295.700	1.500	915.500
5	873.400	17.000	3.300	80.000	1.000	1219.000
6	850.000	16.000	1.000	110.000	2.000	1450.600
7	812.700	13.600	-4.300	125.000	5.100	1829.000
8	798.000	12.600	-6.400	147.800	5.600	1983.600
9	791.000	14.200	-15.800	158.700	5.800	2057.600
10	783.900	13.900	-16.100	170.000	6.100	2134.000
11	776.000	13.600	-16.400	168.600	6.500	2218.800
12	755.700	11.700	-18.300	165.000	7.700	2439.000
13	728.500	9.100	-20.900	165.000	7.700	2743.000
14	704.000	6.600	-23.400	174.300	6.200	3027.500
15	702.200	6.500	-23.500	175.000	6.100	3048.000
16	700.000	6.400	-23.600	175.000	6.100	3074.200
17	676.000	4.600	-25.400	160.000	5.100	3353.000
18	650.700	2.600	-27.400	140.000	5.100	3658.000
19	602.900	-1.300	-31.300	185.000	2.500	4268.000
20	558.600	-5.300	-35.300	225.000	5.600	4878.000
21	539.000	-7.100	-37.100	215.600	5.100	5164.100
22	537.700	-7.300	-36.900	215.000	5.100	5182.000
23	500.000	-12.100	-30.100	210.000	5.600	5744.200
24	477.200	-15.300	-31.600	195.000	6.100	6097.000
25	461.000	-17.700	-32.700	192.900	6.100	6358.900
26	439.700	-20.200	-35.600	190.000	6.100	6707.000
27	400.000	-25.300	-41.300	200.000	5.600	7405.700
28	388.000	-27.000		205.000	6.600	7621.000
29	371.500	-29.400		210.000	7.200	7926.000
30	355.800	-31.900		240.000	8.700	8231.000
31	326.300	-36.700		255.000	9.700	8841.000
32	312.500	-39.100		245.000	9.700	9146.000
33	307.000	-40.100		240.600	9.900	9270.200
34	300.000	-41.100		235.000	10.200	9427.400
35	260.600	-49.200		215.000	10.200	10365.000
36	253.000	-50.900		215.000	10.200	10561.500
37	250.000	-51.300		215.000	10.200	10639.100
38	248.800	-51.500		215.000	10.200	10670.000
39	205.400	-59.000		245.000	11.300	11890.000
40	200.000	-60.100		245.000	11.300	12060.900
41	183.000	-60.500		246.700	12.300	12614.900
42	153.600	-56.300		250.000	14.400	13719.000
43	152.000	-56.100		250.000	14.100	13783.300
44	150.000	-56.300		250.000	13.800	13867.500
45	132.800	-58.500		235.000	11.800	14634.000
46	122.000	-60.100		239.400	12.200	15168.800
47	120.600	-60.100		240.000	12.300	15243.000
48	109.300	-60.200		250.000	11.300	15853.000
49	100.000	-60.300		245.000	8.200	16409.600


STS-49 Vertical Sounding
Edwards AFB
May 17, 1992
Height (m)
20000
15000
10000
5000
0
-80
-60
-40
-20
0
20
TEMP(C)
TEMP(C)
Dew PT (C)

STS-49 Day of Launch First Stage Trajectory Data

NOMINAL DISPLAY DATA FOR STS-49 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	68.07	179.85	.0	-2.	1.	0.	.001	90.00	1341.	.000	90.00	.0
.96	.01	-1.01	18.65	92.22	.2	0.	3.	11.	82.863	10.46	1341.	.477	89.94	.0
1.92	.02	3.66	7.70	61.69	.9	3.	7.	28.	82.774	4.12	1341.	1.191	89.85	.0
2.88	.04	4.88	4.72	41.15	2.4	12.	11.	45.	82.694	2.37	1341.	1.918	89.75	.0
3.84	.06	5.33	3.30	29.68	4.6	24.	15.	63.	82.849	1.54	1342.	2.669	89.67	.0
4.80	.07	5.49	2.44	22.25	7.7	42.	19.	82.	83.005	.98	1343.	3.460	89.58	.0
5.76	.09	5.53	1.85	17.02	11.8	65.	22.	101.	83.135	.58	1344.	4.287	89.48	.0
6.72	.11	5.52	1.43	13.26	16.9	93.	24.	121.	83.267	.34	1346.	5.143	89.39	.0
7.68	.13	5.48	1.09	10.23	23.1	127.	25.	142.	83.379	.04	1348.	6.020	89.30	.0
8.64	.14	5.96	.53	8.54	30.4	181.	16.	164.	83.392	-1.01	1350.	6.914	89.20	.0
9.60	.16	7.15	-.11	14.59	38.8	277.	-4.	185.	83.683	-.49	1353.	7.822	89.13	.0
10.56	.18	8.92	-.33	31.98	48.2	430.	-16.	207.	84.461	4.29	1358.	8.732	89.15	.0
11.52	.20	10.48	.19	66.56	58.6	614.	11.	229.	85.469	20.49	1366.	9.619	89.28	.0
12.48	.22	11.19	.85	113.50	69.9	783.	60.	251.	85.520	49.91	1378.	10.457	89.47	.0
13.44	.24	11.29	1.12	149.55	82.3	929.	92.	273.	83.965	72.54	1395.	11.234	89.64	.0
14.40	.26	10.89	1.09	170.86	95.8	1043.	104.	296.	81.459	81.83	1415.	11.940	89.74	.0
15.36	.28	9.62	.69	-178.78	110.5	1063.	77.	319.	78.758	84.36	1437.	12.591	89.75	.0
16.32	.31	7.63	.20	-176.23	126.7	966.	25.	344.	76.305	84.72	1460.	13.222	89.70	.0
17.28	.33	5.22	.04	-178.55	144.5	754.	5.	369.	74.237	84.84	1484.	13.855	89.64	.1
18.24	.35	2.71	.28	178.33	163.9	443.	45.	395.	72.617	85.23	1506.	14.506	89.61	.1
19.20	.38	.90	.62	176.47	183.9	165.	115.	422.	71.384	85.75	1528.	15.155	89.61	.1
20.16	.40	-.27	.77	176.05	204.3	-55.	158.	447.	70.338	86.24	1549.	15.779	89.62	.1
21.12	.42	-1.06	.76	176.47	225.8	-239.	171.	474.	69.416	86.64	1571.	16.397	89.63	.1
22.08	.45	-1.69	.67	176.96	248.1	-419.	166.	500.	68.597	86.92	1593.	17.004	89.63	.2
23.04	.47	-2.25	.63	177.32	270.6	-608.	170.	527.	67.867	87.15	1614.	17.587	89.63	.2
24.00	.49	-2.73	.58	177.49	292.9	-800.	170.	552.	67.219	87.32	1636.	18.140	89.63	.2
24.96	.52	-3.13	.59	177.58	315.0	-987.	185.	578.	66.640	87.46	1657.	18.668	89.63	.3
25.92	.54	-3.47	.56	177.60	337.0	-1170.	188.	603.	66.117	87.57	1678.	19.173	89.63	.3
26.88	.56	-3.77	.55	177.63	358.6	-1353.	197.	627.	65.644	87.67	1698.	19.659	89.62	.3
27.84	.58	-4.02	.52	177.64	379.7	-1525.	196.	651.	65.215	87.74	1719.	20.128	89.62	.4
28.80	.61	-4.22	.52	177.67	400.3	-1691.	207.	676.	64.825	87.80	1739.	20.582	89.61	.4
29.76	.63	-4.38	.50	177.66	419.8	-1840.	210.	699.	64.450	87.85	1759.	21.005	89.61	.5
30.72	.65	-4.44	.49	177.66	437.5	-1943.	216.	721.	64.065	87.90	1779.	21.381	89.60	.5
31.68	.67	-4.44	.45	177.67	453.8	-2013.	205.	742.	63.655	87.93	1798.	21.714	89.59	.6
32.64	.69	-4.50	.41	177.74	469.6	-2112.	194.	763.	63.253	87.95	1817.	22.031	89.58	.6
33.60	.71	-4.58	.37	177.81	484.8	-2218.	180.	784.	62.870	87.96	1836.	22.337	89.57	.7
34.56	.73	-4.52	.34	177.91	499.5	-2260.	172.	805.	62.507	87.97	1855.	22.633	89.56	.7
35.52	.75	-4.33	.31	178.00	513.7	-2223.	159.	826.	62.135	87.97	1875.	22.911	89.55	.8
36.48	.77	-4.09	.28	178.15	527.1	-2154.	149.	846.	61.747	87.96	1895.	23.171	89.53	.9
37.44	.79	-3.89	.24	178.33	540.0	-2100.	132.	867.	61.337	87.95	1915.	23.410	89.52	.9
38.40	.81	-3.83	.24	178.49	552.2	-2115.	131.	888.	60.921	87.94	1935.	23.634	89.50	1.0
39.36	.83	-3.86	.23	178.65	563.7	-2174.	128.	908.	60.513	87.93	1955.	23.847	89.48	1.1

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NOMINAL DISPLAY DATA FOR STS-49 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	2.33	2.16	.21	-179.58	478.3	1034.	102.	2219.	48.920	87.89	3263.	30.833	88.90	6.8
81.60	2.38	2.51	.25	-179.59	458.8	1150.	113.	2268.	48.401	87.91	3316.	30.757	88.90	7.0
82.56	2.42	2.72	.29	-179.63	439.5	1194.	129.	2317.	47.875	87.94	3370.	30.665	88.89	7.3
83.52	2.46	2.75	.32	-179.68	420.7	1156.	137.	2367.	47.350	87.96	3423.	30.563	88.89	7.5
84.48	2.51	2.68	.34	-179.73	402.3	1077.	137.	2417.	46.833	87.99	3478.	30.456	88.89	7.8
85.44	2.56	2.53	.34	-179.77	384.6	973.	131.	2467.	46.328	88.01	3532.	30.347	88.89	8.0
86.40	2.60	2.39	.35	-179.79	367.2	879.	129.	2518.	45.837	88.04	3587.	30.237	88.89	8.3
87.36	2.65	2.30	.36	-179.83	350.1	804.	126.	2568.	45.359	88.06	3641.	30.124	88.89	8.6
88.32	2.69	2.25	.37	-179.86	333.1	750.	124.	2619.	44.890	88.08	3696.	30.008	88.89	8.9
89.28	2.74	2.24	.38	-179.88	316.6	709.	122.	2670.	44.430	88.11	3750.	29.889	88.89	9.2
90.24	2.78	2.28	.39	-179.91	300.6	687.	117.	2721.	43.976	88.13	3805.	29.766	88.89	9.5
91.20	2.83	2.37	.38	-179.92	285.2	677.	109.	2772.	43.525	88.16	3860.	29.640	88.90	9.8
92.16	2.87	2.49	.37	-179.91	270.4	672.	99.	2824.	43.077	88.18	3916.	29.509	88.90	10.1
93.12	2.92	2.61	.36	-179.89	256.0	669.	93.	2877.	42.632	88.20	3973.	29.372	88.90	10.4
94.08	2.96	2.67	.37	-179.88	242.2	648.	89.	2930.	42.189	88.22	4030.	29.230	88.90	10.8
95.04	3.00	2.67	.31	-179.80	228.9	611.	71.	2983.	41.753	88.24	4087.	29.086	88.90	11.1
96.00	3.05	2.65	.27	-179.73	216.2	573.	58.	3036.	41.326	88.26	4143.	28.940	88.91	11.5
96.96	3.09	2.65	.28	-179.69	204.0	541.	58.	3089.	40.905	88.28	4200.	28.793	88.91	11.8
97.92	3.14	2.67	.30	-179.67	192.4	513.	57.	3143.	40.491	88.30	4257.	28.643	88.91	12.2
98.88	3.18	2.70	.31	-179.66	181.2	489.	56.	3196.	40.082	88.32	4314.	28.492	88.92	12.6
99.84	3.22	2.73	.31	-179.68	170.2	465.	53.	3250.	39.679	88.34	4372.	28.339	88.92	13.0
100.80	3.26	2.76	.32	-179.69	159.8	442.	51.	3304.	39.281	88.36	4429.	28.183	88.93	13.4
101.76	3.30	2.79	.34	-179.71	149.9	418.	51.	3358.	38.888	88.38	4486.	28.026	88.93	13.8
102.72	3.34	2.80	.35	-179.72	140.7	395.	49.	3411.	38.501	88.40	4543.	27.866	88.94	14.2
103.68	3.38	2.82	.35	-179.72	132.1	372.	46.	3464.	38.119	88.42	4600.	27.706	88.94	14.6
104.64	3.42	2.82	.37	-179.72	123.9	350.	45.	3517.	37.743	88.44	4656.	27.543	88.95	15.0
105.60	3.46	2.82	.37	-179.71	116.2	328.	44.	3570.	37.372	88.46	4712.	27.379	88.95	15.5
106.56	3.50	2.82	.38	-179.69	108.9	307.	41.	3623.	37.007	88.47	4768.	27.214	88.96	15.9
107.52	3.54	2.83	.37	-179.65	102.0	288.	38.	3675.	36.646	88.49	4824.	27.049	88.96	16.4
108.48	3.58	2.83	.37	-179.62	95.5	271.	35.	3728.	36.289	88.51	4880.	26.883	88.97	16.9
109.44	3.62	2.84	.38	-179.64	89.3	254.	34.	3781.	35.937	88.52	4936.	26.715	88.97	17.3
110.40	3.66	2.83	.38	-179.68	83.5	237.	32.	3831.	35.591	88.54	4990.	26.546	88.98	17.8
111.36	3.69	2.79	.39	-179.69	77.9	218.	30.	3880.	35.253	88.55	5041.	26.374	88.99	18.3
112.32	3.72	2.79	.38	-179.70	72.6	203.	27.	3923.	34.926	88.57	5088.	26.200	88.99	18.8
113.28	3.75	2.89	.41	-179.69	67.3	195.	28.	3961.	34.607	88.59	5128.	26.020	89.00	19.3
114.24	3.76	3.02	.47	-179.69	62.3	188.	29.	3992.	34.298	88.60	5162.	25.833	89.01	19.8
115.20	3.78	3.17	.50	-179.65	57.6	183.	29.	4018.	33.995	88.62	5191.	25.642	89.02	20.4
116.16	3.79	3.31	.54	-179.60	53.2	176.	29.	4040.	33.696	88.63	5216.	25.448	89.03	20.9
117.12	3.80	3.47	.57	-179.56	49.1	170.	28.	4059.	33.401	88.65	5238.	25.251	89.03	21.4
118.08	3.80	3.65	.56	-179.49	45.2	165.	25.	4076.	33.108	88.67	5258.	25.052	89.04	22.0
119.04	3.80	3.68	.54	-179.42	41.7	153.	23.	4090.	32.817	88.68	5275.	24.850	89.05	22.5
120.00	3.80	3.54	.52	-179.36	38.4	136.	20.	4103.	32.529	88.70	5291.	24.647	89.06	23.0

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NOMINAL DISPLAY DATA FOR STS-49 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)
157.76	4.64	1.66	1.95	179.34	2.9	5.	6.	4703.	22.118	89.73	5979.	17.226	89.79	47.0
158.72	4.69	1.50	1.89	179.36	2.8	4.	5.	4722.	21.873	89.75	6001.	17.050	89.81	47.6
159.68	4.73	1.33	1.84	179.37	2.6	3.	5.	4742.	21.630	89.78	6022.	16.874	89.83	48.3
160.64	4.78	1.17	1.80	179.35	2.5	3.	4.	4762.	21.389	89.80	6043.	16.700	89.85	49.0
161.60	4.83	1.04	1.76	179.35	2.3	2.	4.	4782.	21.150	89.82	6065.	16.528	89.86	49.7
162.56	4.87	.90	1.72	179.37	2.2	2.	4.	4802.	20.912	89.85	6087.	16.356	89.88	50.4
163.52	4.92	.75	1.69	179.39	2.1	2.	4.	4822.	20.677	89.87	6109.	16.185	89.90	51.1
164.48	4.95	.58	1.65	179.42	1.9	1.	3.	4843.	20.443	89.89	6131.	16.015	89.92	51.8
165.44	4.99	.41	1.62	179.45	1.8	1.	3.	4863.	20.210	89.91	6153.	15.846	89.93	52.5
166.40	5.02	.26	1.60	179.45	1.7	0.	3.	4884.	19.980	89.93	6175.	15.679	89.95	53.3
167.36	5.06	.11	1.56	179.47	1.6	0.	2.	4905.	19.751	89.96	6197.	15.513	89.97	54.0
168.32	5.10	-.04	1.51	179.51	1.5	0.	2.	4926.	19.524	89.98	6220.	15.348	89.98	54.7
169.28	5.14	-.20	1.47	179.52	1.4	0.	2.	4947.	19.299	90.00	6243.	15.184	90.00	55.4
170.24	5.17	-.35	1.42	179.53	1.3	0.	2.	4969.	19.076	90.02	6266.	15.021	90.01	56.2
171.20	5.21	-.50	1.38	179.55	1.2	-1.	2.	4990.	18.854	90.04	6289.	14.859	90.03	56.9
172.16	5.25	-.65	1.35	179.54	1.1	-1.	1.	5012.	18.634	90.06	6312.	14.698	90.05	57.6
173.12	5.29	-.79	1.33	179.53	1.0	-1.	1.	5034.	18.416	90.08	6335.	14.539	90.06	58.4
174.08	5.32	-.93	1.30	179.56	1.0	-1.	1.	5056.	18.200	90.10	6358.	14.381	90.08	59.1
175.04	5.36	-1.07	1.26	179.58	.9	-1.	1.	5078.	17.986	90.12	6382.	14.224	90.09	59.9
176.00	5.39	-1.20	1.21	179.62	.8	-1.	1.	5101.	17.773	90.14	6406.	14.068	90.11	60.6
176.96	5.43	-1.33	1.15	179.64	.8	-1.	1.	5123.	17.562	90.15	6430.	13.913	90.12	61.4
177.92	5.46	-1.46	1.10	179.62	.7	-1.	1.	5146.	17.353	90.17	6454.	13.759	90.13	62.2
178.88	5.50	-1.59	1.05	179.62	.7	-1.	1.	5169.	17.146	90.19	6478.	13.606	90.15	62.9
179.84	5.54	-1.71	1.00	179.66	.6	-1.	1.	5192.	16.940	90.21	6502.	13.455	90.16	63.7
180.80	5.57	-1.83	.97	179.67	.6	-1.	1.	5215.	16.736	90.22	6526.	13.304	90.18	64.5
181.76	5.61	-1.96	.93	179.70	.6	-1.	1.	5239.	16.534	90.24	6551.	13.155	90.19	65.3
182.72	5.65	-2.08	.89	179.72	.5	-1.	0.	5262.	16.334	90.26	6576.	13.007	90.20	66.0
183.68	5.68	-2.19	.84	179.72	.5	-1.	0.	5286.	16.135	90.28	6600.	12.860	90.22	66.8
184.64	5.72	-2.31	.77	179.73	.5	-1.	0.	5310.	15.938	90.29	6625.	12.714	90.23	67.6
185.60	5.76	-2.42	.72	179.77	.4	-1.	0.	5334.	15.743	90.31	6650.	12.569	90.24	68.4
186.56	5.80	-2.53	.68	179.77	.4	-1.	0.	5358.	15.550	90.32	6676.	12.425	90.26	69.2
187.52	5.84	-2.64	.65	179.78	.4	-1.	0.	5382.	15.358	90.34	6701.	12.283	90.27	70.0
188.48	5.87	-2.75	.61	179.81	.4	-1.	0.	5407.	15.168	90.35	6726.	12.141	90.28	70.8
189.44	5.91	-2.86	.58	179.83	.3	-1.	0.	5432.	14.979	90.37	6752.	12.001	90.29	71.7
190.40	5.95	-2.97	.54	179.84	.3	-1.	0.	5456.	14.792	90.39	6778.	11.861	90.31	72.5
191.36	5.99	-3.07	.48	179.85	.3	-1.	0.	5481.	14.607	90.40	6804.	11.723	90.32	73.3
192.32	6.03	-3.17	.43	179.85	.3	-1.	0.	5506.	14.424	90.41	6830.	11.585	90.33	74.1
193.28	6.07	-3.27	.37	179.84	.3	-1.	0.	5532.	14.242	90.43	6856.	11.449	90.34	75.0
194.24	6.11	-3.37	.31	179.86	.3	-1.	0.	5557.	14.062	90.44	6882.	11.314	90.35	75.8
195.20	6.15	-3.47	.26	179.89	.2	-1.	0.	5583.	13.883	90.46	6909.	11.180	90.36	76.7
196.16	6.19	-3.58	.21	179.91	.2	-1.	0.	5608.	13.706	90.47	6935.	11.047	90.38	77.5
197.12	6.23	-3.67	.17	179.94	.2	-1.	0.	5634.	13.531	90.48	6962.	10.915	90.39	78.3

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NOMINAL DISPLAY DATA FOR STS-49 CYCLE FLT
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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)
238.40	7.26	-6.40	-1.59	-179.83	.0	0.	0.	6887.	7.365	90.88	8238.	6.152	90.73	119.4
239.36	7.28	-6.43	-1.63	-179.81	.0	0.	0.	6919.	7.251	90.89	8271.	6.061	90.74	120.5
240.32	7.29	-6.46	-1.67	-179.82	.0	0.	0.	6952.	7.137	90.89	8304.	5.970	90.75	121.6
241.28	7.31	-6.49	-1.70	-179.83	.0	0.	0.	6984.	7.025	90.90	8337.	5.881	90.75	122.7
242.24	7.33	-6.52	-1.72	-179.82	.0	0.	0.	7017.	6.914	90.90	8370.	5.792	90.76	123.7
243.20	7.34	-6.56	-1.74	-179.82	.0	0.	0.	7050.	6.804	90.91	8403.	5.704	90.76	124.8
244.16	7.36	-6.59	-1.77	-179.82	.0	0.	0.	7083.	6.694	90.91	8437.	5.617	90.77	125.9
245.12	7.37	-6.62	-1.81	-179.82	.0	0.	0.	7116.	6.587	90.92	8470.	5.530	90.77	127.0
246.08	7.38	-6.64	-1.86	-179.81	.0	0.	0.	7150.	6.480	90.92	8504.	5.444	90.78	128.1
247.04	7.40	-6.67	-1.90	-179.81	.0	0.	0.	7183.	6.374	90.93	8538.	5.360	90.78	129.2
248.00	7.41	-6.69	-1.95	-179.81	.0	0.	0.	7217.	6.270	90.93	8571.	5.276	90.79	130.3
248.96	7.42	-6.72	-1.99	-179.84	.0	0.	0.	7251.	6.166	90.94	8606.	5.192	90.79	131.5
249.92	7.44	-6.74	-2.03	-179.85	.0	0.	0.	7285.	6.064	90.94	8640.	5.110	90.79	132.6
250.88	7.45	-6.77	-2.05	-179.83	.0	0.	0.	7319.	5.962	90.95	8674.	5.028	90.80	133.7
251.84	7.47	-6.78	-2.07	-179.81	.0	0.	0.	7353.	5.862	90.95	8709.	4.947	90.80	134.8
252.80	7.49	-6.80	-2.10	-179.80	.0	0.	0.	7387.	5.763	90.96	8743.	4.867	90.81	136.0
253.76	7.50	-6.82	-2.13	-179.81	.0	0.	0.	7422.	5.665	90.96	8778.	4.787	90.81	137.1
254.72	7.52	-6.84	-2.17	-179.84	.0	0.	0.	7457.	5.567	90.96	8813.	4.708	90.81	138.3
255.68	7.54	-6.86	-2.21	-179.87	.0	0.	0.	7491.	5.471	90.97	8848.	4.630	90.82	139.4
256.64	7.56	-6.88	-2.25	-179.86	.0	0.	0.	7526.	5.376	90.97	8883.	4.553	90.82	140.6
257.60	7.58	-6.89	-2.30	-179.84	.0	0.	0.	7562.	5.282	90.97	8919.	4.476	90.83	141.8
258.56	7.60	-6.90	-2.33	-179.82	.0	0.	0.	7597.	5.189	90.98	8954.	4.400	90.83	142.9
259.52	7.61	-6.92	-2.34	-179.80	.0	0.	0.	7632.	5.097	90.98	8990.	4.325	90.83	144.1
260.48	7.63	-6.93	-2.37	-179.80	.0	0.	0.	7668.	5.006	90.99	9026.	4.251	90.84	145.3
261.44	7.65	-6.94	-2.39	-179.82	.0	0.	0.	7704.	4.915	90.99	9062.	4.177	90.84	146.5
262.40	7.67	-6.96	-2.43	-179.85	.0	0.	0.	7740.	4.826	90.99	9098.	4.104	90.84	147.7
263.36	7.69	-6.97	-2.47	-179.88	.0	0.	0.	7776.	4.738	90.99	9134.	4.032	90.85	148.9
264.32	7.72	-6.97	-2.52	-179.88	.0	0.	0.	7812.	4.651	91.00	9170.	3.960	90.85	150.1
265.28	7.74	-6.98	-2.55	-179.86	.0	0.	0.	7848.	4.564	91.00	9207.	3.890	90.85	151.3
266.24	7.76	-6.98	-2.57	-179.84	.0	0.	0.	7885.	4.479	91.00	9244.	3.819	90.86	152.5
267.20	7.78	-6.99	-2.58	-179.81	.0	0.	0.	7921.	4.394	91.01	9280.	3.750	90.86	153.8
268.16	7.80	-7.00	-2.61	-179.82	.0	0.	0.	7958.	4.311	91.01	9317.	3.681	90.86	155.0
269.12	7.82	-7.00	-2.64	-179.84	.0	0.	0.	7995.	4.228	91.01	9355.	3.613	90.86	156.2
270.08	7.84	-7.00	-2.69	-179.85	.0	0.	0.	8032.	4.147	91.01	9392.	3.545	90.87	157.5
271.04	7.86	-7.00	-2.73	-179.86	.0	0.	0.	8070.	4.066	91.02	9429.	3.479	90.87	158.7
272.00	7.89	-7.00	-2.77	-179.84	.0	0.	0.	8107.	3.986	91.02	9467.	3.413	90.87	160.0
272.96	7.91	-7.00	-2.81	-179.83	.0	0.	0.	8145.	3.907	91.02	9505.	3.347	90.87	161.2
273.92	7.93	-7.00	-2.83	-179.83	.0	0.	0.	8182.	3.828	91.02	9543.	3.282	90.88	162.5
274.88	7.96	-6.99	-2.85	-179.81	.0	0.	0.	8220.	3.751	91.03	9581.	3.218	90.88	163.8
275.84	7.98	-6.99	-2.86	-179.81	.0	0.	0.	8258.	3.675	91.03	9619.	3.154	90.88	165.0
276.80	8.01	-6.99	-2.89	-179.85	.0	0.	0.	8297.	3.599	91.03	9657.	3.091	90.88	166.3
277.76	8.03	-6.99	-2.93	-179.88	.0	0.	0.	8335.	3.524	91.03	9696.	3.029	90.89	167.6

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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)
319.04	9.22	-6.16	-4.08	-179.96	.0	0.	0.	10141.	1.035	91.06	11505.	.912	90.93	229.1
320.00	9.25	-6.13	-4.10	-179.95	.0	0.	0.	10187.	.992	91.06	11551.	.875	90.93	230.7
320.96	9.28	-6.10	-4.13	-179.94	.0	0.	0.	10233.	.950	91.05	11597.	.838	90.93	232.2
321.92	9.32	-6.06	-4.15	-179.93	.0	0.	0.	10279.	.908	91.05	11643.	.802	90.93	233.8
322.88	9.35	-6.03	-4.16	-179.94	.0	0.	0.	10326.	.867	91.05	11690.	.766	90.93	235.4
323.84	9.38	-6.00	-4.17	-179.98	.0	0.	0.	10373.	.826	91.05	11737.	.730	90.93	237.0
324.80	9.42	-5.96	-4.20	179.99	.0	0.	0.	10419.	.786	91.05	11783.	.695	90.93	238.7
325.76	9.45	-5.93	-4.24	179.99	.0	0.	0.	10466.	.747	91.05	11830.	.661	90.93	240.3
326.72	9.49	-5.89	-4.27	-179.99	.0	0.	0.	10514.	.708	91.05	11878.	.627	90.93	241.9
327.68	9.53	-5.86	-4.29	-179.97	.0	0.	0.	10561.	.670	91.05	11925.	.593	90.93	243.5
328.64	9.56	-5.81	-4.30	-179.95	.0	0.	0.	10609.	.633	91.05	11973.	.560	90.93	245.2
329.60	9.60	-5.78	-4.31	-179.94	.0	0.	0.	10656.	.595	91.05	12021.	.528	90.93	246.8
330.56	9.64	-5.74	-4.33	-179.97	.0	0.	0.	10704.	.559	91.05	12069.	.496	90.93	248.5
331.52	9.68	-5.71	-4.36	179.99	.0	0.	0.	10753.	.523	91.05	12117.	.464	90.93	250.2
332.48	9.72	-5.67	-4.39	179.96	.0	0.	0.	10801.	.488	91.05	12165.	.433	90.93	251.8
333.44	9.75	-5.64	-4.42	179.96	.0	0.	0.	10850.	.453	91.05	12214.	.402	90.93	253.5
334.40	9.79	-5.59	-4.45	179.98	.0	0.	0.	10898.	.419	91.05	12263.	.372	90.93	255.2
335.36	9.83	-5.56	-4.47	-180.00	.0	0.	0.	10948.	.385	91.04	12312.	.343	90.93	256.9
336.32	9.87	-5.51	-4.48	-179.98	.0	0.	0.	10997.	.352	91.04	12361.	.313	90.93	258.6
337.28	9.92	-5.48	-4.49	-179.98	.0	0.	0.	11046.	.320	91.04	12410.	.284	90.93	260.3
338.24	9.96	-5.43	-4.49	-179.98	.0	0.	0.	11096.	.288	91.04	12460.	.256	90.93	262.0
339.20	10.00	-5.40	-4.50	179.99	.0	0.	0.	11146.	.256	91.04	12510.	.228	90.93	263.8
340.16	10.04	-5.36	-4.53	179.96	.0	0.	0.	11196.	.225	91.04	12560.	.201	90.93	265.5
341.12	10.08	-5.32	-4.56	179.94	.0	0.	0.	11246.	.195	91.04	12610.	.174	90.93	267.2
342.08	10.13	-5.27	-4.60	179.96	.0	0.	0.	11296.	.165	91.04	12661.	.147	90.93	269.0
343.04	10.17	-5.21	-4.62	179.97	.0	0.	0.	11347.	.136	91.04	12711.	.121	90.93	270.7
344.00	10.22	-5.15	-4.63	179.99	.0	0.	0.	11398.	.107	91.04	12762.	.096	90.93	272.5
344.96	10.26	-5.10	-4.64	180.00	.0	0.	0.	11449.	.078	91.04	12814.	.070	90.93	274.3
345.92	10.31	-5.06	-4.66	179.98	.0	0.	0.	11501.	.051	91.03	12865.	.045	90.92	276.1
346.88	10.35	-5.03	-4.69	179.95	.0	0.	0.	11552.	.023	91.03	12916.	.021	90.92	277.9
347.84	10.40	-4.99	-4.72	179.93	.0	0.	0.	11604.	-.004	91.03	12968.	-.003	90.92	279.7
348.80	10.45	-4.95	-4.75	179.93	.0	0.	0.	11656.	-.030	91.03	13020.	-.027	90.92	281.5
349.76	10.49	-4.90	-4.78	179.95	.0	0.	0.	11708.	-.056	91.03	13073.	-.050	90.92	283.3
350.72	10.54	-4.86	-4.81	179.97	.0	0.	0.	11761.	-.081	91.03	13125.	-.073	90.92	285.1
351.68	10.59	-4.82	-4.81	179.97	.0	0.	0.	11813.	-.106	91.03	13178.	-.095	90.92	286.9
352.64	10.64	-4.77	-4.81	179.98	.0	0.	0.	11866.	-.130	91.03	13231.	-.117	90.92	288.8
353.60	10.69	-4.73	-4.82	179.97	.0	0.	0.	11919.	-.154	91.03	13284.	-.138	90.92	290.6
354.56	10.74	-4.69	-4.83	179.94	.0	0.	0.	11973.	-.177	91.02	13337.	-.159	90.92	292.5
355.52	10.79	-4.65	-4.83	179.92	.0	0.	0.	12026.	-.200	91.02	13391.	-.179	90.92	294.3
356.48	10.84	-4.60	-4.85	179.91	.0	0.	0.	12080.	-.222	91.02	13445.	-.199	90.92	296.2
357.44	10.89	-4.55	-4.89	179.93	.0	0.	0.	12134.	-.244	91.02	13499.	-.219	90.92	298.1
358.40	10.94	-4.51	-4.92	179.95	.0	0.	0.	12188.	-.265	91.02	13553.	-.238	90.92	300.0

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399.68	13.71	-2.34	-5.58	179.88	.0	0.	0.	14773.	-.748	90.97	16137.	-.684	90.89	389.7
400.64	13.78	-2.27	-5.61	179.90	.0	0.	0.	14839.	-.749	90.97	16204.	-.686	90.89	392.0
401.60	13.86	-2.22	-5.62	179.92	.0	0.	0.	14906.	-.751	90.97	16271.	-.688	90.89	394.3
402.56	13.94	-2.15	-5.63	179.94	.0	0.	0.	14973.	-.752	90.97	16338.	-.689	90.89	396.6
403.52	14.02	-2.09	-5.63	179.93	.0	0.	0.	15041.	-.752	90.97	16405.	-.690	90.89	398.9
404.48	14.09	-2.04	-5.64	179.89	.0	0.	0.	15109.	-.752	90.97	16473.	-.690	90.89	401.3
405.44	14.17	-1.97	-5.66	179.87	.0	0.	0.	15177.	-.752	90.97	16542.	-.690	90.89	403.6
406.40	14.25	-1.91	-5.69	179.88	.0	0.	0.	15246.	-.751	90.97	16610.	-.690	90.89	406.0
407.36	14.33	-1.84	-5.71	179.90	.0	0.	0.	15315.	-.751	90.97	16679.	-.689	90.89	408.3
408.32	14.41	-1.78	-5.71	179.92	.0	0.	0.	15384.	-.749	90.97	16749.	-.688	90.89	410.7
409.28	14.49	-1.72	-5.71	179.93	.0	0.	0.	15454.	-.748	90.97	16819.	-.687	90.89	413.1
410.24	14.57	-1.66	-5.71	179.91	.0	0.	0.	15524.	-.745	90.96	16889.	-.685	90.89	415.5
411.20	14.65	-1.59	-5.71	179.89	.0	0.	0.	15595.	-.743	90.96	16959.	-.683	90.89	417.9
412.16	14.73	-1.52	-5.72	179.86	.0	0.	0.	15666.	-.740	90.96	17030.	-.681	90.89	420.4
413.12	14.81	-1.47	-5.76	179.85	.0	0.	0.	15737.	-.737	90.96	17101.	-.678	90.89	422.8
414.08	14.89	-1.40	-5.79	179.87	.0	0.	0.	15808.	-.734	90.96	17173.	-.675	90.89	425.2
415.04	14.97	-1.34	-5.81	179.90	.0	0.	0.	15880.	-.730	90.96	17245.	-.672	90.89	427.7
416.00	15.05	-1.27	-5.84	179.92	.0	0.	0.	15953.	-.726	90.96	17317.	-.669	90.88	430.2
416.96	15.13	-1.21	-5.85	179.92	.0	0.	0.	16025.	-.721	90.96	17390.	-.665	90.88	432.7
417.92	15.21	-1.15	-5.84	179.92	.0	0.	0.	16099.	-.716	90.96	17463.	-.660	90.88	435.2
418.88	15.29	-1.08	-5.84	179.89	.0	0.	0.	16172.	-.711	90.96	17537.	-.656	90.88	437.7
419.84	15.37	-1.03	-5.84	179.86	.0	0.	0.	16246.	-.706	90.96	17610.	-.651	90.88	440.2
420.80	15.45	-.97	-5.84	179.86	.0	0.	0.	16320.	-.700	90.96	17685.	-.646	90.88	442.7
421.76	15.53	-.91	-5.84	179.88	.0	0.	0.	16395.	-.693	90.96	17760.	-.640	90.88	445.2
422.72	15.62	-.85	-5.85	179.91	.0	0.	0.	16470.	-.687	90.96	17835.	-.634	90.88	447.8
423.68	15.70	-.79	-5.87	179.92	.0	0.	0.	16546.	-.680	90.96	17910.	-.628	90.88	450.4
424.64	15.78	-.73	-5.90	179.91	.0	0.	0.	16622.	-.672	90.96	17986.	-.621	90.88	452.9
425.60	15.86	-.68	-5.92	179.91	.0	0.	0.	16698.	-.664	90.96	18063.	-.614	90.88	455.5
426.56	15.94	-.63	-5.92	179.90	.0	0.	0.	16775.	-.656	90.96	18140.	-.607	90.88	458.1
427.52	16.02	-.58	-5.91	179.89	.0	0.	0.	16853.	-.647	90.95	18217.	-.599	90.88	460.7
428.48	16.11	-.53	-5.92	179.89	.0	0.	0.	16930.	-.638	90.95	18295.	-.591	90.88	463.4
429.44	16.19	-.47	-5.91	179.90	.0	0.	0.	17009.	-.629	90.95	18373.	-.582	90.88	466.0
430.40	16.27	-.42	-5.92	179.91	.0	0.	0.	17087.	-.619	90.95	18451.	-.574	90.88	468.6
431.36	16.35	-.37	-5.93	179.92	.0	0.	0.	17166.	-.609	90.95	18531.	-.564	90.88	471.3
432.32	16.44	-.33	-5.95	179.93	.0	0.	0.	17246.	-.599	90.95	18610.	-.555	90.88	474.0
433.28	16.52	-.30	-5.97	179.93	.0	0.	0.	17326.	-.588	90.95	18690.	-.545	90.88	476.6
434.24	16.61	-.28	-6.00	179.90	.0	0.	0.	17406.	-.576	90.95	18770.	-.534	90.88	479.3
435.20	16.69	-.25	-6.02	179.88	.0	0.	0.	17487.	-.564	90.95	18851.	-.523	90.89	482.1
436.16	16.77	-.21	-6.04	179.87	.0	0.	0.	17568.	-.551	90.95	18933.	-.512	90.89	484.8
437.12	16.86	-.15	-6.04	179.90	.0	0.	0.	17650.	-.539	90.95	19015.	-.500	90.89	487.5
438.08	16.95	-.09	-6.03	179.92	.0	0.	0.	17733.	-.525	90.95	19097.	-.488	90.89	490.3
439.04	17.03	-.03	-6.03	179.95	.0	0.	0.	17815.	-.512	90.95	19180.	-.475	90.89	493.0

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480.32	20.77	1.73	-6.20	179.90	.1	0.	0.	21634.	.281	91.08	22998.	.264	91.01	624.6
481.28	20.86	1.79	-6.23	179.92	.1	0.	0.	21724.	.302	91.08	23089.	.284	91.02	627.9
482.24	20.94	1.87	-6.27	179.94	.1	0.	0.	21815.	.322	91.09	23179.	.303	91.03	631.3
483.20	21.02	1.96	-6.30	179.97	.1	0.	0.	21904.	.342	91.10	23268.	.322	91.03	634.7
484.16	21.09	2.05	-6.33	179.98	.1	0.	0.	21993.	.362	91.11	23358.	.341	91.04	638.1
485.12	21.17	2.13	-6.35	179.96	.1	0.	0.	22083.	.381	91.11	23448.	.359	91.05	641.5
486.08	21.25	2.19	-6.38	179.92	.1	0.	0.	22173.	.401	91.12	23537.	.378	91.06	645.0
487.04	21.33	2.25	-6.39	179.90	.1	0.	0.	22263.	.420	91.13	23628.	.396	91.06	648.4
488.00	21.41	2.32	-6.38	179.92	.1	0.	0.	22354.	.440	91.14	23719.	.415	91.07	651.9
488.96	21.49	2.37	-6.37	179.94	.1	0.	0.	22443.	.459	91.15	23808.	.433	91.08	655.3
489.92	21.56	2.41	-6.37	179.97	.1	0.	0.	22533.	.478	91.15	23898.	.451	91.09	658.8
490.88	21.64	2.47	-6.36	179.99	.1	0.	0.	22623.	.498	91.16	23988.	.469	91.10	662.3
491.84	21.71	2.50	-6.35	179.99	.1	0.	0.	22713.	.517	91.17	24078.	.487	91.11	665.9
492.80	21.79	2.55	-6.34	179.96	.1	0.	0.	22803.	.536	91.18	24168.	.506	91.12	669.4
493.76	21.86	2.60	-6.34	179.93	.1	0.	0.	22894.	.556	91.19	24259.	.524	91.12	672.9
494.72	21.94	2.63	-6.33	179.91	.1	0.	0.	22984.	.574	91.20	24349.	.542	91.13	676.5
495.68	22.01	2.63	-6.33	179.92	.1	0.	0.	23074.	.594	91.21	24439.	.560	91.14	680.1
496.64	22.08	2.59	-6.32	179.95	.1	0.	0.	23163.	.613	91.22	24528.	.579	91.15	683.7
497.60	22.15	2.52	-6.31	179.97	.1	0.	0.	23253.	.632	91.23	24618.	.597	91.16	687.3
498.56	22.23	2.44	-6.31	179.99	.1	0.	0.	23344.	.653	91.24	24709.	.617	91.17	690.9
499.52	22.30	2.35	-6.30	-179.99	.1	0.	0.	23435.	.674	91.25	24800.	.637	91.18	694.5
500.48	22.37	2.28	-6.31	-180.00	.1	0.	0.	23525.	.695	91.27	24890.	.657	91.20	698.1
501.44	22.43	2.24	-6.35	179.98	.1	0.	0.	23616.	.716	91.28	24981.	.677	91.21	701.8
502.40	22.50	2.24	-6.41	179.95	.1	0.	0.	23707.	.738	91.29	25072.	.698	91.22	705.5
503.20	22.55	2.23	-6.47	179.95	.1	0.	0.	23783.	.756	91.30	25148.	.715	91.23	708.5
503.68	22.59	2.22	-6.50	179.96	.1	0.	0.	23827.	.766	91.30	25192.	.725	91.23	710.4
504.64	22.65	2.18	-6.56	179.99	.1	0.	0.	23917.	.788	91.31	25282.	.745	91.24	714.1
505.60	22.70	2.12	-6.60	-179.99	.1	0.	0.	24005.	.809	91.33	25370.	.766	91.25	717.8
506.56	22.75	2.06	-6.63	-179.99	.1	0.	0.	24088.	.829	91.34	25453.	.785	91.27	721.5
507.52	22.80	2.02	-6.63	179.97	.1	0.	0.	24171.	.850	91.35	25536.	.805	91.28	725.3
508.48	22.85	2.04	-6.62	179.95	.1	0.	0.	24255.	.871	91.37	25620.	.824	91.29	729.0
509.44	22.89	2.09	-6.57	179.91	.1	0.	0.	24339.	.892	91.38	25705.	.844	91.31	732.8
510.40	22.93	2.16	-6.52	179.91	.1	0.	0.	24424.	.913	91.39	25789.	.864	91.32	736.6
511.36	22.96	2.21	-6.47	179.93	.1	0.	0.	24498.	.931	91.41	25864.	.881	91.34	740.4
512.32	22.94	2.12	-6.45	179.87	.1	0.	0.	24523.	.937	91.44	25888.	.888	91.37	744.2
513.28	22.90	1.96	-6.46	179.77	.1	0.	0.	24530.	.940	91.48	25896.	.890	91.40	748.0
514.24	22.85	1.78	-6.48	179.66	.1	0.	0.	24534.	.942	91.52	25900.	.892	91.44	751.8
515.20	22.80	1.59	-6.50	179.53	.1	0.	0.	24538.	.944	91.55	25903.	.894	91.47	755.6
516.16	22.76	1.39	-6.53	179.41	.1	0.	0.	24540.	.945	91.59	25906.	.895	91.51	759.4
517.12	22.71	1.18	-6.57	179.29	.1	0.	0.	24542.	.947	91.63	25907.	.897	91.54	763.2
518.08	22.65	.97	-6.61	179.17	.1	0.	0.	24542.	.948	91.67	25908.	.898	91.58	767.0
MECO (THRUST=0)														
518.85	22.61	.80	-6.65	179.07	.0	0.	0.	24542.	.949	91.70	25908.	.899	91.61	770.1

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NOMINAL DISPLAY DATA FOR STS-49 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	28.627	-80.621	-27.	0.	0.	1341.	.0	89.8	-83.7	100.	.25	4523561.	1597444.
.96	28.627	-80.621	-24.	11.	11.	1341.	.0	89.7	-84.9	100.	1.54	4503237.	1594451.
1.92	28.627	-80.621	-5.	28.	28.	1341.	.0	89.5	-86.1	100.	1.55	4477391.	1591458.
2.88	28.627	-80.621	30.	45.	45.	1341.	.0	89.5	-87.0	100.	1.56	4451556.	1588465.
3.84	28.627	-80.621	81.	63.	63.	1342.	.0	89.6	-88.9	100.	1.58	4425620.	1585472.
4.80	28.627	-80.621	150.	81.	82.	1343.	.0	89.6	-90.0	104.	1.62	4399432.	1582383.
5.76	28.627	-80.621	237.	101.	101.	1344.	.0	89.6	-89.6	104.	1.65	4373002.	1579269.
6.72	28.627	-80.621	344.	121.	121.	1346.	.0	89.6	-88.9	104.	1.67	4346372.	1576155.
7.68	28.627	-80.621	469.	141.	142.	1348.	.0	89.6	-87.9	104.	1.69	4319619.	1573041.
8.64	28.627	-80.621	615.	163.	164.	1350.	.0	89.6	14.9	104.	1.70	4292790.	1569926.
9.60	28.627	-80.621	782.	184.	185.	1353.	136.6	87.8	44.0	104.	1.72	4265896.	1566812.
10.56	28.628	-80.621	969.	206.	207.	1358.	147.6	84.5	42.1	104.	1.73	4238970.	1563698.
11.52	28.628	-80.621	1178.	228.	229.	1366.	157.8	80.5	35.2	104.	1.74	4212036.	1560584.
12.48	28.628	-80.621	1407.	250.	251.	1378.	166.5	76.8	27.0	104.	1.76	4185106.	1557470.
13.44	28.628	-80.621	1658.	272.	273.	1395.	173.3	73.5	18.3	104.	1.77	4158179.	1554355.
14.40	28.628	-80.621	1929.	293.	296.	1415.	179.2	70.8	10.4	104.	1.78	4131248.	1551241.
15.36	28.628	-80.620	2220.	313.	319.	1437.	182.6	69.3	4.8	104.	1.80	4104303.	1548127.
16.32	28.628	-80.620	2530.	334.	344.	1460.	183.0	69.0	2.5	104.	1.81	4077339.	1545013.
17.28	28.628	-80.620	2861.	355.	369.	1484.	181.2	69.4	2.8	104.	1.83	4050354.	1541899.
18.24	28.628	-80.620	3213.	377.	395.	1506.	179.3	70.3	4.4	102.	1.84	4023355.	1538788.
19.20	28.628	-80.619	3586.	400.	422.	1528.	178.5	71.0	5.6	93.	1.82	3996535.	1535868.
20.16	28.628	-80.619	3980.	421.	447.	1549.	178.3	71.2	6.0	89.	1.82	3969943.	1533184.
21.12	28.628	-80.618	4395.	443.	474.	1571.	178.5	71.2	5.9	89.	1.84	3943376.	1530523.
22.08	28.628	-80.618	4831.	466.	500.	1593.	178.6	71.1	5.6	89.	1.84	3916886.	1527862.
23.04	28.628	-80.617	5289.	488.	527.	1614.	178.8	71.0	5.4	89.	1.82	3890722.	1525201.
24.00	28.628	-80.617	5768.	509.	552.	1636.	178.8	70.9	5.2	89.	1.81	3864984.	1522539.
24.96	28.628	-80.616	6267.	530.	578.	1657.	178.8	70.8	5.2	89.	1.80	3839628.	1519878.
25.92	28.628	-80.615	6786.	551.	603.	1678.	178.7	70.6	5.0	89.	1.79	3814610.	1517217.
26.88	28.628	-80.615	7325.	571.	627.	1698.	178.7	70.5	4.9	89.	1.78	3789899.	1514556.
27.84	28.628	-80.614	7883.	592.	651.	1719.	178.6	70.4	4.8	89.	1.77	3765471.	1511895.
28.80	28.628	-80.613	8460.	611.	676.	1739.	178.6	70.3	4.7	89.	1.77	3741306.	1509234.
29.76	28.628	-80.612	9056.	631.	699.	1759.	178.5	70.1	4.6	79.	1.73	3717529.	1506716.
30.72	28.628	-80.611	9671.	648.	721.	1779.	178.5	69.9	4.5	70.	1.69	3694270.	1504487.
31.68	28.628	-80.610	10301.	665.	742.	1798.	178.4	69.5	4.3	67.	1.67	3671456.	1502474.
32.64	28.628	-80.609	10948.	682.	763.	1817.	178.3	69.3	4.2	67.	1.67	3648882.	1500472.
33.60	28.628	-80.608	11610.	698.	784.	1836.	178.3	69.0	4.1	67.	1.67	3626524.	1498470.
34.56	28.628	-80.607	12288.	714.	805.	1855.	178.3	68.7	4.0	67.	1.66	3604381.	1496469.
35.52	28.628	-80.606	12981.	730.	826.	1875.	178.4	68.2	3.9	67.	1.66	3582444.	1494467.
36.48	28.628	-80.605	13689.	745.	846.	1895.	178.5	67.6	3.8	67.	1.66	3560710.	1492465.
37.44	28.628	-80.603	14412.	761.	867.	1915.	178.6	67.0	3.7	67.	1.65	3539171.	1490464.
38.40	28.628	-80.602	15150.	776.	888.	1935.	178.8	66.6	3.7	67.	1.65	3517826.	1488462.
39.36	28.628	-80.601	15901.	790.	908.	1955.	179.0	66.3	3.7	67.	1.65	3496675.	1486460.

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NOMINAL DISPLAY DATA FOR STS-49 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	28.632	-80.492	64001.	1673.	2219.	3263.	180.6	47.0	4.1	104.	2.46	2600718.	1372500.
81.60	28.632	-80.488	65618.	1696.	2268.	3316.	180.7	46.0	4.2	104.	2.47	2579460.	1369385.
82.56	28.632	-80.483	67257.	1719.	2317.	3370.	180.7	45.2	4.3	104.	2.47	2558376.	1366271.
83.52	28.632	-80.479	68918.	1741.	2367.	3423.	180.6	44.6	4.3	104.	2.47	2537516.	1363157.
84.48	28.632	-80.474	70600.	1763.	2417.	3478.	180.6	44.1	4.4	104.	2.47	2516865.	1360043.
85.44	28.632	-80.469	72302.	1785.	2467.	3532.	180.6	43.7	4.4	104.	2.47	2496399.	1356929.
86.40	28.632	-80.464	74026.	1806.	2518.	3587.	180.5	43.3	4.5	104.	2.46	2476160.	1353815.
87.36	28.633	-80.458	75770.	1828.	2568.	3641.	180.5	42.9	4.5	104.	2.45	2456197.	1350700.
88.32	28.633	-80.453	77535.	1848.	2619.	3696.	180.5	42.5	4.6	104.	2.43	2436539.	1347586.
89.28	28.633	-80.447	79319.	1869.	2670.	3750.	180.5	42.1	4.6	104.	2.43	2417135.	1344472.
90.24	28.633	-80.442	81123.	1889.	2721.	3805.	180.5	41.6	4.6	104.	2.44	2397867.	1341358.
91.20	28.633	-80.436	82947.	1909.	2772.	3860.	180.4	41.0	4.6	104.	2.45	2378680.	1338244.
92.16	28.633	-80.430	84789.	1929.	2824.	3916.	180.4	40.5	4.6	104.	2.46	2359582.	1335129.
93.12	28.633	-80.423	86651.	1949.	2877.	3973.	180.4	39.9	4.6	104.	2.46	2340605.	1332015.
94.08	28.634	-80.417	88531.	1968.	2930.	4030.	180.4	39.5	4.6	104.	2.46	2321787.	1328901.
95.04	28.634	-80.410	90429.	1987.	2983.	4087.	180.5	39.0	4.7	104.	2.45	2303187.	1325787.
96.00	28.634	-80.404	92345.	2005.	3036.	4143.	180.5	38.7	4.7	104.	2.44	2284823.	1322673.
96.96	28.634	-80.397	94279.	2023.	3089.	4200.	180.5	38.3	4.7	104.	2.44	2266664.	1319559.
97.92	28.634	-80.390	96230.	2041.	3143.	4257.	180.6	37.9	4.8	104.	2.44	2248673.	1316444.
98.88	28.634	-80.383	98198.	2058.	3196.	4314.	180.6	37.5	4.8	104.	2.43	2230846.	1313330.
99.84	28.635	-80.375	100182.	2075.	3250.	4372.	180.6	37.0	4.8	104.	2.43	2213199.	1310216.
100.80	28.635	-80.368	102182.	2092.	3304.	4429.	180.6	36.6	4.8	104.	2.42	2195750.	1307102.
101.76	28.635	-80.360	104198.	2108.	3358.	4486.	180.5	36.2	4.8	104.	2.41	2178515.	1303988.
102.72	28.635	-80.352	106229.	2124.	3411.	4543.	180.5	35.8	4.8	104.	2.40	2161511.	1300873.
103.68	28.635	-80.344	108275.	2139.	3464.	4600.	180.5	35.4	4.8	104.	2.38	2144808.	1297759.
104.64	28.636	-80.336	110336.	2153.	3517.	4656.	180.5	35.1	4.8	104.	2.36	2128454.	1294645.
105.60	28.636	-80.328	112410.	2167.	3570.	4712.	180.6	34.7	4.8	104.	2.35	2112430.	1291531.
106.56	28.636	-80.319	114497.	2181.	3623.	4768.	180.6	34.3	4.8	104.	2.34	2096682.	1288417.
107.52	28.636	-80.310	116597.	2194.	3675.	4824.	180.6	34.0	4.8	104.	2.34	2081146.	1285303.
108.48	28.636	-80.302	118709.	2207.	3728.	4880.	180.6	33.6	4.8	104.	2.33	2065744.	1282188.
109.44	28.636	-80.293	120834.	2219.	3781.	4936.	180.6	33.2	4.8	104.	2.29	2050608.	1279074.
110.40	28.637	-80.283	122969.	2230.	3831.	4990.	180.6	32.9	4.8	104.	2.22	2035984.	1275960.
111.36	28.637	-80.274	125115.	2239.	3880.	5041.	180.6	32.6	4.8	104.	2.10	2022117.	1272846.
112.32	28.637	-80.265	127268.	2246.	3923.	5088.	180.6	32.3	4.9	104.	1.92	2009401.	1269732.
113.28	28.637	-80.255	129427.	2250.	3961.	5128.	180.6	31.9	4.9	104.	1.70	1998241.	1266617.
114.24	28.637	-80.245	131587.	2250.	3992.	5162.	180.6	31.4	5.0	104.	1.49	1988658.	1263503.
115.20	28.638	-80.235	133745.	2246.	4018.	5191.	180.7	31.0	5.1	104.	1.35	1980287.	1260389.
116.16	28.638	-80.225	135899.	2241.	4040.	5216.	180.7	30.5	5.1	104.	1.24	1972841.	1257275.
117.12	28.638	-80.215	138048.	2235.	4059.	5238.	180.8	30.1	5.2	104.	1.15	1966206.	1254161.
118.08	28.638	-80.205	140189.	2226.	4076.	5258.	180.8	29.6	5.2	104.	1.07	1960269.	1251046.
119.04	28.638	-80.195	142322.	2217.	4090.	5275.	180.9	29.3	5.2	104.	1.00	1954955.	1247932.
120.00	28.639	-80.185	144446.	2207.	4103.	5291.	180.9	29.1	5.2	104.	.94	1950204.	1244818.

ROCKWELL COPIER
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NOMINAL DISPLAY DATA FOR STS-49 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)
157.76	28.644	-79.732	219671.	1771.	4703.	5979.	180.1	20.7	7.5	104.	1.02	1445689.	1122327.
158.72	28.644	-79.719	221365.	1759.	4722.	6001.	180.1	20.6	7.5	104.	1.02	1442574.	1119213.
159.68	28.644	-79.706	223049.	1748.	4742.	6022.	180.1	20.5	7.4	104.	1.02	1439459.	1116099.
160.64	28.644	-79.692	224722.	1737.	4762.	6043.	180.1	20.4	7.4	104.	1.02	1436345.	1112984.
161.60	28.644	-79.679	226383.	1725.	4782.	6065.	180.0	20.3	7.4	104.	1.02	1433230.	1109870.
162.56	28.644	-79.666	228034.	1714.	4802.	6087.	180.0	20.2	7.3	104.	1.03	1430115.	1106756.
163.52	28.644	-79.653	229674.	1703.	4822.	6109.	180.0	20.1	7.3	104.	1.03	1427000.	1103642.
164.48	28.644	-79.639	231303.	1691.	4843.	6131.	180.0	20.0	7.3	104.	1.03	1423885.	1100528.
165.44	28.644	-79.626	232922.	1680.	4863.	6153.	180.0	19.9	7.2	104.	1.03	1420770.	1097413.
166.40	28.644	-79.612	234529.	1669.	4884.	6175.	180.0	19.8	7.2	104.	1.04	1417655.	1094299.
167.36	28.644	-79.599	236126.	1658.	4905.	6197.	180.0	19.7	7.2	104.	1.04	1414540.	1091185.
168.32	28.644	-79.585	237712.	1646.	4926.	6220.	180.0	19.6	7.1	104.	1.04	1411425.	1088071.
169.28	28.644	-79.571	239287.	1635.	4947.	6243.	180.0	19.6	7.1	104.	1.04	1408310.	1084957.
170.24	28.644	-79.557	240851.	1624.	4969.	6266.	180.0	19.5	7.0	104.	1.04	1405195.	1081842.
171.20	28.644	-79.543	242405.	1613.	4990.	6289.	180.0	19.4	7.0	104.	1.05	1402080.	1078728.
172.16	28.644	-79.529	243947.	1601.	5012.	6312.	180.0	19.3	6.9	104.	1.05	1398966.	1075614.
173.12	28.644	-79.515	245479.	1590.	5034.	6335.	180.0	19.2	6.9	104.	1.05	1395851.	1072500.
174.08	28.644	-79.501	247001.	1579.	5056.	6358.	180.0	19.1	6.9	104.	1.05	1392736.	1069386.
175.04	28.644	-79.487	248511.	1568.	5078.	6382.	180.0	19.1	6.9	104.	1.06	1389621.	1066272.
176.00	28.644	-79.473	250012.	1557.	5101.	6406.	180.0	19.0	6.8	104.	1.06	1386506.	1063157.
176.96	28.644	-79.458	251501.	1546.	5123.	6430.	180.0	18.9	6.8	104.	1.06	1383391.	1060043.
177.92	28.644	-79.444	252980.	1535.	5146.	6454.	180.0	18.8	6.7	104.	1.06	1380276.	1056929.
178.88	28.643	-79.429	254448.	1524.	5169.	6478.	179.9	18.7	6.7	104.	1.07	1377161.	1053815.
179.84	28.643	-79.415	255905.	1513.	5192.	6502.	180.0	18.6	6.6	104.	1.07	1374046.	1050701.
180.80	28.643	-79.400	257352.	1502.	5215.	6526.	180.0	18.6	6.6	104.	1.07	1370931.	1047586.
181.76	28.643	-79.385	258789.	1491.	5239.	6551.	180.0	18.5	6.6	104.	1.07	1367816.	1044472.
182.72	28.643	-79.370	260215.	1480.	5262.	6576.	180.0	18.4	6.5	104.	1.08	1364702.	1041358.
183.68	28.643	-79.355	261630.	1469.	5286.	6600.	180.0	18.3	6.5	104.	1.08	1361587.	1038244.
184.64	28.643	-79.340	263035.	1458.	5310.	6625.	180.0	18.2	6.4	104.	1.08	1358472.	1035130.
185.60	28.643	-79.325	264430.	1447.	5334.	6650.	180.0	18.2	6.4	104.	1.08	1355357.	1032016.
186.56	28.643	-79.310	265814.	1436.	5358.	6676.	180.0	18.1	6.3	104.	1.09	1352242.	1028901.
187.52	28.643	-79.294	267187.	1425.	5382.	6701.	180.0	18.0	6.3	104.	1.09	1349127.	1025787.
188.48	28.643	-79.279	268551.	1415.	5407.	6726.	180.0	17.9	6.3	104.	1.09	1346012.	1022673.
189.44	28.643	-79.264	269903.	1404.	5432.	6752.	180.0	17.8	6.3	104.	1.09	1342897.	1019559.
190.40	28.643	-79.248	271246.	1393.	5456.	6778.	180.0	17.8	6.2	104.	1.10	1339782.	1016445.
191.36	28.642	-79.232	272578.	1382.	5481.	6804.	180.0	17.7	6.2	104.	1.10	1336667.	1013330.
192.32	28.642	-79.217	273900.	1371.	5506.	6830.	180.0	17.6	6.1	104.	1.10	1333552.	1010216.
193.28	28.642	-79.201	275211.	1361.	5532.	6856.	179.9	17.5	6.1	104.	1.10	1330437.	1007102.
194.24	28.642	-79.185	276512.	1350.	5557.	6882.	179.9	17.4	6.0	104.	1.11	1327323.	1003988.
195.20	28.642	-79.169	277803.	1339.	5583.	6909.	180.0	17.4	6.0	104.	1.11	1324208.	1000874.
196.16	28.642	-79.153	279084.	1329.	5608.	6935.	180.0	17.3	5.9	104.	1.11	1321093.	997759.
197.12	28.642	-79.137	280354.	1318.	5634.	6962.	180.0	17.2	5.9	104.	1.11	1317978.	994645.

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NOMINAL DISPLAY DATA FOR STS-49 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)
238.40	28.633	-78.359	325625.	883.	6887.	8238.	180.0	13.8	4.1	104.	1.24	1184037.	860735.
239.36	28.633	-78.338	326468.	873.	6919.	8271.	180.0	13.7	4.0	104.	1.24	1180922.	857621.
240.32	28.632	-78.318	327302.	863.	6952.	8304.	180.0	13.6	4.0	104.	1.25	1177807.	854507.
241.28	28.632	-78.298	328126.	854.	6984.	8337.	180.0	13.5	3.9	104.	1.25	1174692.	851393.
242.24	28.632	-78.277	328941.	844.	7017.	8370.	180.0	13.4	3.9	104.	1.25	1171577.	848279.
243.20	28.631	-78.257	329747.	835.	7050.	8403.	180.0	13.4	3.9	104.	1.26	1168462.	845164.
244.16	28.631	-78.236	330544.	825.	7083.	8437.	180.0	13.3	3.8	104.	1.26	1165347.	842050.
245.12	28.631	-78.215	331332.	816.	7116.	8470.	180.0	13.2	3.8	104.	1.26	1162232.	838936.
246.08	28.630	-78.194	332110.	807.	7150.	8504.	180.0	13.1	3.7	104.	1.27	1159117.	835822.
247.04	28.630	-78.173	332880.	797.	7183.	8538.	180.0	13.0	3.7	104.	1.27	1156002.	832708.
248.00	28.630	-78.152	333641.	788.	7217.	8571.	180.0	13.0	3.6	104.	1.27	1152887.	829594.
248.96	28.630	-78.131	334393.	778.	7251.	8606.	179.9	12.9	3.6	104.	1.28	1149773.	826479.
249.92	28.629	-78.110	335136.	769.	7285.	8640.	179.9	12.8	3.5	104.	1.28	1146658.	823365.
250.88	28.629	-78.088	335870.	760.	7319.	8674.	180.0	12.7	3.5	104.	1.28	1143543.	820251.
251.84	28.629	-78.067	336595.	751.	7353.	8709.	180.0	12.6	3.5	104.	1.29	1140428.	817137.
252.80	28.628	-78.045	337311.	741.	7387.	8743.	180.0	12.6	3.4	104.	1.29	1137313.	814023.
253.76	28.628	-78.024	338018.	732.	7422.	8778.	180.0	12.5	3.4	104.	1.29	1134198.	810908.
254.72	28.628	-78.002	338717.	723.	7457.	8813.	179.9	12.4	3.3	104.	1.30	1131083.	807794.
255.68	28.627	-77.980	339406.	714.	7491.	8848.	179.9	12.3	3.3	104.	1.30	1127968.	804680.
256.64	28.627	-77.958	340087.	705.	7526.	8883.	179.9	12.3	3.2	104.	1.31	1124853.	801566.
257.60	28.627	-77.936	340760.	696.	7562.	8919.	179.9	12.2	3.2	104.	1.31	1121738.	798452.
258.56	28.626	-77.914	341423.	687.	7597.	8954.	180.0	12.1	3.2	104.	1.31	1118623.	795338.
259.52	28.626	-77.891	342078.	678.	7632.	8990.	180.0	12.0	3.1	104.	1.32	1115508.	792223.
260.48	28.626	-77.869	342724.	669.	7668.	9026.	180.0	11.9	3.1	104.	1.32	1112394.	789109.
261.44	28.625	-77.846	343362.	660.	7704.	9062.	180.0	11.9	3.1	104.	1.32	1109279.	785995.
262.40	28.625	-77.824	343991.	651.	7740.	9098.	179.9	11.8	3.0	104.	1.33	1106164.	782881.
263.36	28.625	-77.801	344611.	642.	7776.	9134.	179.9	11.7	3.0	104.	1.33	1103049.	779767.
264.32	28.624	-77.778	345223.	633.	7812.	9170.	179.9	11.6	2.9	104.	1.33	1099934.	776652.
265.28	28.624	-77.755	345827.	624.	7848.	9207.	179.9	11.5	2.9	104.	1.34	1096819.	773538.
266.24	28.623	-77.732	346422.	615.	7885.	9244.	180.0	11.5	2.8	104.	1.34	1093704.	770424.
267.20	28.623	-77.709	347008.	607.	7921.	9280.	180.0	11.4	2.8	104.	1.35	1090589.	767310.
268.16	28.623	-77.686	347586.	598.	7958.	9317.	180.0	11.3	2.8	104.	1.35	1087474.	764196.
269.12	28.622	-77.662	348156.	589.	7995.	9355.	180.0	11.2	2.7	104.	1.35	1084359.	761081.
270.08	28.622	-77.639	348717.	580.	8032.	9392.	180.0	11.1	2.7	104.	1.36	1081244.	757967.
271.04	28.622	-77.615	349270.	572.	8070.	9429.	179.9	11.1	2.6	104.	1.36	1078130.	754853.
272.00	28.621	-77.591	349815.	563.	8107.	9467.	180.0	11.0	2.6	104.	1.37	1075015.	751739.
272.96	28.621	-77.567	350352.	554.	8145.	9505.	180.0	10.9	2.5	104.	1.37	1071900.	748625.
273.92	28.620	-77.543	350880.	546.	8182.	9543.	180.0	10.8	2.5	104.	1.37	1068785.	745511.
274.88	28.620	-77.519	351400.	537.	8220.	9581.	180.0	10.7	2.5	104.	1.38	1065670.	742396.
275.84	28.620	-77.495	351912.	529.	8258.	9619.	180.0	10.7	2.5	104.	1.38	1062555.	739282.
276.80	28.619	-77.471	352415.	520.	8297.	9657.	180.0	10.6	2.4	104.	1.39	1059440.	736168.
277.76	28.619	-77.446	352911.	512.	8335.	9696.	179.9	10.5	2.4	104.	1.39	1056325.	733054.

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NOMINAL DISPLAY DATA FOR STS-49 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)
319.04	28.600	-76.283	367012.	183.	10141.	11505.	180.0	7.2	.6	104.	1.59	922384.	599144.
320.00	28.600	-76.253	367184.	176.	10187.	11551.	180.0	7.1	.6	104.	1.60	919269.	596030.
320.96	28.599	-76.223	367349.	169.	10233.	11597.	180.0	7.0	.5	104.	1.60	916154.	592916.
321.92	28.599	-76.193	367509.	162.	10279.	11643.	180.0	7.0	.5	104.	1.61	913039.	589801.
322.88	28.598	-76.162	367661.	156.	10326.	11690.	180.0	6.9	.5	104.	1.61	909924.	586687.
323.84	28.598	-76.132	367807.	149.	10373.	11737.	180.0	6.8	.4	104.	1.62	906809.	583573.
324.80	28.597	-76.101	367947.	142.	10419.	11783.	179.9	6.7	.4	104.	1.62	903694.	580459.
325.76	28.597	-76.071	368081.	136.	10466.	11830.	179.9	6.7	.3	104.	1.63	900579.	577345.
326.72	28.596	-76.040	368208.	129.	10514.	11878.	180.0	6.6	.3	104.	1.64	897465.	574230.
327.68	28.596	-76.009	368330.	123.	10561.	11925.	180.0	6.5	.3	104.	1.64	894350.	571116.
328.64	28.595	-75.978	368445.	117.	10609.	11973.	180.0	6.4	.2	104.	1.65	891235.	568002.
329.60	28.595	-75.946	368553.	110.	10656.	12021.	180.0	6.4	.2	104.	1.65	888120.	564888.
330.56	28.594	-75.915	368656.	104.	10704.	12069.	180.0	6.3	.2	104.	1.66	885005.	561774.
331.52	28.594	-75.884	368753.	98.	10753.	12117.	180.0	6.2	.1	104.	1.67	881890.	558660.
332.48	28.593	-75.852	368844.	91.	10801.	12165.	179.9	6.1	.1	104.	1.67	878775.	555545.
333.44	28.592	-75.820	368928.	85.	10850.	12214.	179.9	6.1	.0	104.	1.68	875660.	552431.
334.40	28.592	-75.788	369007.	79.	10898.	12263.	180.0	6.0	.0	104.	1.68	872545.	549317.
335.36	28.591	-75.756	369080.	73.	10948.	12312.	180.0	5.9	-.1	104.	1.69	869430.	546203.
336.32	28.591	-75.724	369148.	67.	10997.	12361.	180.0	5.9	-.1	104.	1.69	866315.	543089.
337.28	28.590	-75.691	369209.	61.	11046.	12410.	180.0	5.8	-.1	104.	1.70	863201.	539974.
338.24	28.590	-75.659	369265.	55.	11096.	12460.	180.0	5.7	-.1	104.	1.71	860086.	536860.
339.20	28.589	-75.626	369315.	49.	11146.	12510.	180.0	5.6	-.2	104.	1.71	856971.	533746.
340.16	28.589	-75.593	369359.	43.	11196.	12560.	179.9	5.6	-.2	104.	1.72	853856.	530632.
341.12	28.588	-75.560	369398.	38.	11246.	12610.	179.9	5.5	-.3	104.	1.73	850741.	527518.
342.08	28.588	-75.527	369432.	32.	11296.	12661.	179.9	5.4	-.3	104.	1.73	847626.	524403.
343.04	28.587	-75.494	369460.	26.	11347.	12711.	180.0	5.3	-.4	104.	1.74	844511.	521289.
344.00	28.587	-75.460	369482.	21.	11398.	12762.	180.0	5.2	-.4	104.	1.75	841396.	518175.
344.96	28.586	-75.427	369500.	15.	11449.	12814.	180.0	5.2	-.4	104.	1.75	838281.	515061.
345.92	28.586	-75.393	369512.	10.	11501.	12865.	180.0	5.1	-.5	104.	1.76	835166.	511947.
346.88	28.585	-75.359	369518.	4.	11552.	12916.	179.9	5.0	-.5	104.	1.76	832051.	508833.
347.84	28.585	-75.325	369519.	-1.	11604.	12968.	179.9	5.0	-.6	104.	1.77	828936.	505718.
348.80	28.584	-75.291	369516.	-7.	11656.	13020.	179.9	4.9	-.6	104.	1.78	825822.	502604.
349.76	28.583	-75.257	369507.	-12.	11708.	13073.	180.0	4.8	-.7	104.	1.78	822707.	499490.
350.72	28.583	-75.222	369493.	-17.	11761.	13125.	180.0	4.8	-.7	104.	1.79	819592.	496376.
351.68	28.582	-75.188	369474.	-22.	11813.	13178.	180.0	4.7	-.7	104.	1.80	816477.	493262.
352.64	28.582	-75.153	369450.	-28.	11866.	13231.	180.0	4.6	-.7	104.	1.81	813362.	490147.
353.60	28.581	-75.118	369421.	-33.	11919.	13284.	180.0	4.6	-.8	104.	1.81	810247.	487033.
354.56	28.581	-75.083	369387.	-38.	11973.	13337.	180.0	4.5	-.8	104.	1.82	807132.	483919.
355.52	28.580	-75.048	369349.	-43.	12026.	13391.	179.9	4.4	-.8	104.	1.83	804017.	480805.
356.48	28.580	-75.012	369306.	-47.	12080.	13445.	179.9	4.4	-.9	104.	1.83	800902.	477691.
357.44	28.579	-74.977	369258.	-52.	12134.	13499.	180.0	4.3	-.9	104.	1.84	797787.	474577.
358.40	28.578	-74.941	369205.	-57.	12188.	13553.	180.0	4.2	-1.0	104.	1.85	794672.	471462.

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NOMINAL DISPLAY DATA FOR STS-49 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)
399.68	28.552	-73.243	363538.	-193.	14773.	16137.	180.0	1.6	-2.6	104.	2.22	660731.	337552.
400.64	28.552	-73.199	363352.	-195.	14839.	16204.	180.0	1.5	-2.6	104.	2.23	657616.	334438.
401.60	28.551	-73.156	363164.	-196.	14906.	16271.	180.0	1.5	-2.7	104.	2.24	654501.	331324.
402.56	28.551	-73.112	362976.	-197.	14973.	16338.	180.0	1.4	-2.7	104.	2.25	651386.	328210.
403.52	28.550	-73.068	362786.	-198.	15041.	16405.	180.0	1.3	-2.7	104.	2.27	648272.	325096.
404.48	28.549	-73.023	362595.	-199.	15109.	16473.	180.0	1.3	-2.7	104.	2.28	645157.	321982.
405.44	28.549	-72.979	362404.	-200.	15177.	16542.	179.9	1.2	-2.8	104.	2.29	642042.	318867.
406.40	28.548	-72.934	362211.	-201.	15246.	16610.	180.0	1.1	-2.8	104.	2.30	638927.	315753.
407.36	28.547	-72.889	362018.	-201.	15315.	16679.	180.0	1.1	-2.9	104.	2.31	635812.	312639.
408.32	28.547	-72.844	361825.	-202.	15384.	16749.	180.0	1.0	-2.9	104.	2.32	632697.	309525.
409.28	28.546	-72.799	361631.	-202.	15454.	16819.	180.0	1.0	-2.9	104.	2.33	629582.	306411.
410.24	28.545	-72.753	361436.	-203.	15524.	16889.	180.0	.9	-3.0	104.	2.34	626467.	303296.
411.20	28.545	-72.708	361242.	-203.	15595.	16959.	180.0	.8	-3.0	104.	2.36	623352.	300182.
412.16	28.544	-72.662	361047.	-203.	15666.	17030.	179.9	.8	-3.0	104.	2.37	620237.	297068.
413.12	28.543	-72.616	360852.	-203.	15737.	17101.	179.9	.7	-3.1	104.	2.38	617122.	293954.
414.08	28.542	-72.569	360657.	-203.	15808.	17173.	179.9	.7	-3.1	104.	2.39	614007.	290840.
415.04	28.542	-72.523	360462.	-203.	15880.	17245.	180.0	.6	-3.2	104.	2.40	610893.	287725.
416.00	28.541	-72.476	360267.	-203.	15953.	17317.	180.0	.5	-3.2	104.	2.42	607778.	284611.
416.96	28.540	-72.429	360072.	-202.	16025.	17390.	180.0	.5	-3.3	104.	2.43	604663.	281497.
417.92	28.540	-72.382	359878.	-202.	16099.	17463.	180.0	.4	-3.3	104.	2.44	601548.	278383.
418.88	28.539	-72.334	359684.	-201.	16172.	17537.	180.0	.4	-3.3	104.	2.45	598433.	275269.
419.84	28.538	-72.287	359491.	-201.	16246.	17610.	179.9	.3	-3.3	104.	2.47	595318.	272155.
420.80	28.538	-72.239	359299.	-200.	16320.	17685.	179.9	.2	-3.4	104.	2.48	592203.	269040.
421.76	28.537	-72.191	359107.	-199.	16395.	17760.	180.0	.2	-3.4	104.	2.49	589088.	265926.
422.72	28.536	-72.142	358917.	-198.	16470.	17835.	180.0	.1	-3.4	104.	2.51	585973.	262812.
423.68	28.535	-72.094	358727.	-197.	16546.	17910.	180.0	.1	-3.5	104.	2.52	582858.	259698.
424.64	28.535	-72.045	358538.	-196.	16622.	17986.	180.0	.0	-3.5	104.	2.53	579743.	256584.
425.60	28.534	-71.996	358351.	-194.	16698.	18063.	180.0	360.0	-3.6	104.	2.55	576629.	253469.
426.56	28.533	-71.947	358165.	-193.	16775.	18140.	180.0	360.0	-3.6	104.	2.56	573514.	250355.
427.52	28.533	-71.898	357981.	-191.	16853.	18217.	180.0	359.9	-3.6	104.	2.57	570399.	247241.
428.48	28.532	-71.848	357798.	-189.	16930.	18295.	180.0	359.9	-3.6	104.	2.59	567284.	244127.
429.44	28.531	-71.798	357617.	-188.	17009.	18373.	180.0	359.8	-3.7	104.	2.60	564169.	241013.
430.40	28.530	-71.748	357438.	-186.	17087.	18451.	180.0	359.8	-3.7	104.	2.62	561054.	237899.
431.36	28.530	-71.698	357261.	-183.	17166.	18531.	180.0	359.8	-3.7	104.	2.63	557939.	234784.
432.32	28.529	-71.647	357086.	-181.	17246.	18610.	180.0	359.7	-3.8	104.	2.65	554824.	231670.
433.28	28.528	-71.596	356914.	-178.	17326.	18690.	180.0	359.7	-3.8	104.	2.66	551709.	228556.
434.24	28.527	-71.545	356744.	-176.	17406.	18770.	180.0	359.7	-3.9	104.	2.68	548594.	225442.
435.20	28.527	-71.494	356576.	-173.	17487.	18851.	179.9	359.7	-3.9	104.	2.69	545479.	222328.
436.16	28.526	-71.443	356412.	-170.	17568.	18933.	179.9	359.6	-4.0	104.	2.71	542365.	219213.
437.12	28.525	-71.391	356250.	-167.	17650.	19015.	180.0	359.6	-4.0	104.	2.72	539250.	216099.
438.08	28.524	-71.339	356092.	-163.	17733.	19097.	180.0	359.6	-4.0	104.	2.74	536135.	212985.
439.04	28.524	-71.287	355936.	-160.	17815.	19180.	180.0	359.5	-4.0	104.	2.75	533020.	209871.

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NOMINAL DISPLAY DATA FOR STS-49 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)
480.32	28.486	-68.796	354154.	105.	21634.	22998.	179.9	358.5	-5.3	86.	2.97	407652.	84534.
481.28	28.485	-68.733	354259.	113.	21724.	23089.	179.9	358.5	-5.4	86.	2.99	405080.	81963.
482.24	28.484	-68.669	354371.	122.	21815.	23179.	179.9	358.4	-5.5	84.	2.94	402512.	79396.
483.20	28.482	-68.604	354492.	130.	21904.	23268.	179.9	358.4	-5.5	84.	2.95	400000.	76885.
484.16	28.481	-68.540	354620.	138.	21993.	23358.	179.9	358.3	-5.6	83.	2.94	397492.	74377.
485.12	28.480	-68.475	354756.	146.	22083.	23448.	179.9	358.2	-5.6	83.	2.96	395010.	71896.
486.08	28.479	-68.410	354900.	154.	22173.	23537.	179.9	358.2	-5.7	83.	2.97	392529.	69415.
487.04	28.478	-68.345	355052.	162.	22263.	23628.	179.9	358.1	-5.7	83.	2.99	390047.	66935.
488.00	28.477	-68.279	355211.	170.	22354.	23719.	179.9	358.1	-5.7	81.	2.94	387569.	64457.
488.96	28.476	-68.214	355379.	179.	22443.	23808.	179.9	358.1	-5.7	81.	2.96	385148.	62037.
489.92	28.475	-68.148	355555.	187.	22533.	23898.	179.9	358.0	-5.8	80.	2.94	382729.	59619.
490.88	28.473	-68.081	355738.	195.	22623.	23988.	179.9	358.0	-5.8	80.	2.96	380337.	57228.
491.84	28.472	-68.015	355929.	204.	22713.	24078.	179.9	358.0	-5.8	80.	2.98	377946.	54837.
492.80	28.471	-67.948	356129.	212.	22803.	24168.	179.9	358.0	-5.8	80.	3.00	375554.	52446.
493.76	28.470	-67.881	356337.	221.	22894.	24259.	179.9	357.9	-5.8	78.	2.94	373166.	50059.
494.72	28.468	-67.813	356552.	229.	22984.	24349.	179.9	357.9	-5.8	78.	2.96	370835.	47728.
495.68	28.467	-67.746	356776.	238.	23074.	24439.	179.9	357.9	-5.9	77.	2.94	368506.	45400.
496.64	28.466	-67.678	357009.	246.	23163.	24528.	179.9	358.0	-5.9	77.	2.96	366204.	43099.
497.60	28.465	-67.610	357249.	255.	23253.	24618.	179.9	358.1	-5.9	77.	2.97	363903.	40798.
498.56	28.463	-67.541	357499.	264.	23344.	24709.	179.9	358.2	-5.9	77.	2.99	361601.	38497.
499.52	28.462	-67.473	357757.	274.	23435.	24800.	179.9	358.3	-5.9	76.	2.97	359302.	36199.
500.48	28.461	-67.404	358025.	284.	23525.	24890.	179.9	358.4	-6.0	76.	2.99	357031.	33928.
501.44	28.459	-67.334	358303.	294.	23616.	24981.	179.9	358.5	-6.0	75.	2.97	354762.	31660.
502.40	28.458	-67.265	358589.	304.	23707.	25072.	179.9	358.5	-6.1	75.	2.99	352520.	29419.
503.20	28.457	-67.207	358836.	312.	23783.	25148.	179.9	358.5	-6.2	75.	3.01	350652.	27552.
503.68	28.456	-67.172	358987.	317.	23827.	25192.	179.9	358.5	-6.2	73.	2.93	349555.	26455.
504.64	28.455	-67.102	359296.	327.	23917.	25282.	179.9	358.6	-6.3	73.	2.95	347373.	24274.
505.60	28.453	-67.031	359615.	337.	24005.	25370.	179.9	358.7	-6.4	68.	2.77	345226.	22128.
506.56	28.452	-66.961	359944.	347.	24088.	25453.	179.9	358.8	-6.4	67.	2.74	343222.	20125.
507.52	28.450	-66.890	360282.	357.	24171.	25536.	179.9	358.8	-6.5	67.	2.76	341220.	18123.
508.48	28.449	-66.819	360629.	367.	24255.	25620.	179.8	358.8	-6.5	67.	2.77	339217.	16121.
509.44	28.447	-66.748	360986.	377.	24339.	25705.	179.8	358.8	-6.4	67.	2.79	337215.	14120.
510.40	28.446	-66.676	361353.	387.	24424.	25789.	179.8	358.7	-6.4	67.	2.81	335213.	12118.
511.36	28.444	-66.604	361730.	396.	24498.	25864.	179.8	358.7	-6.4	67.	1.46	333462.	10368.
512.32	28.443	-66.532	362112.	399.	24523.	25888.	179.8	358.8	-6.4	67.	.49	332865.	9771.
513.28	28.441	-66.460	362496.	401.	24530.	25896.	179.7	358.9	-6.4	67.	.17	332675.	9583.
514.24	28.439	-66.388	362881.	401.	24534.	25900.	179.6	359.1	-6.4	67.	.14	332566.	9474.
515.20	28.438	-66.316	363267.	402.	24538.	25903.	179.5	359.2	-6.4	67.	.11	332478.	9387.
516.16	28.436	-66.244	363653.	403.	24540.	25906.	179.5	359.2	-6.4	67.	.08	332409.	9319.
517.12	28.434	-66.172	364040.	404.	24542.	25907.	179.5	359.2	-6.4	67.	.05	332362.	9272.
518.08	28.432	-66.100	364428.	404.	24542.	25908.	179.5	359.2	-6.4	67.	.02	332335.	9246.
MECO	(THRUST=0)												
518.85	28.431	-66.043	364738.	404.	24542.	25908.	179.5	359.2	-6.4	67.	.00	332327.	9239.

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2	ADINIT	=	+9.42E+01	IV97U4306C
4	ALIM1	=	+9.2000000E+01	IV97U4308C
6	ALIM2	=	+9.47E+01	IV97U4309C
8	ALL	=	+9.5500000E+01	IV97U4307C
9	ALS1G	=	+5.0000000E+00	IV97U1402C
10	AZMTHL	=	90.55	
12	CINT	=	+1.0E-02	IV97U4418C
14	CPROP	=	+1.5E-01	IV97U4419C
15	DTFCD	=	+3.20E-01	
17	DTMAXX	=	+1.00E+20	IV97U4369C
19	DTMINK	=	+6.871E+00	IV97U4350C
21	DTMINN	=	+2.0E+00	IV97U4370C
23	DTRD	=	+4.0000000E+01	IV97U4371C
26	DTTAIL(1)	=	+8.76E-01	IV96U8335C
27	DTTAIL(2)	=	+8.71E-01	IV96U8334C
28	EFMFED(1)	=	-9.14649336771D-01	IV97U5738C
29	EFMFED(4)	=	-4.04230495028D-01	IV97U5739C
30	EFMFED(7)	=	+3.78122120905D-03	IV97U5740C
31	EFMFED(2)	=	+4.04226977574D-01	IV97U5741C
32	EFMFED(5)	=	-9.14657152541D-01	IV97U5742C
33	EFMFED(8)	=	-1.68638882728D-03	IV97U5743C
34	EFMFED(3)	=	+4.14021081465D-03	IV97U5744C
35	EFMFED(6)	=	-1.39828015377D-05	IV97U5745C
36	EFMFED(9)	=	+9.99991429193D-01	IV97U5746C
37	EFPSW	=	.FALSE.	IV99U7441C
39	EPSTP	=	+4.0E-02	IV97U4381C
41	EPSX	=	+2.0E-02	IV97U4380C
43	ETB	=	+5.0000000E+00	IV97U4382C
45	FTFACT	=	+9.98E+01	IV97U4389C
47	FTFMIN	=	+6.5E-01	IV97U4838C
49	FTOMS	=	+6.0000000E+03	IV97U4390C
51	FTRCS	=	+8.772E+02	IV97U4391C
53	FTSSME	=	+4.7000000E+05	IV97U4392C
54	GAMD	=	+1.6196655E-02	IV97U4394C
55	GAMDN	=	+1.6196655E-02	IV97U4396C
58	GMTLRF	=	+9.279840D+06	IV99U7442C
59	IPRLNM	=	1	IV99U7557C
60	KCMD	=	+100	
61	KMAX	=	+104	IV97U4424C
62	KMAX2	=	+109	IV99U7107C
63	KMINAL	=	+80	IV99U7558C
64	KMIN	=	+67	IV97U4425C
65	LTHRT	=	+2	IV99U7559C
66	LTHRTL	=	+3	IV99U7560C
68	NMAX	=	+1	IV97U4445C
71	NSEG	=	+10	IV97U4447C1
72	NSEG	=	+20	IV97U4447C3
88	PHIG(2)	=	+1.0E+00	IV97U4452C
89	PHIG(3)	=	+1.0E+00	IV97U4453C
90	PHIG(4)	=	+1.0E+00	IV97U4454C
91	PHIG(5)	=	+1.0E+00	IV97U4455C
92	PHIG(6)	=	+1.0E+00	IV97U4456C
93	PHIG(7)	=	+1.0E+00	IV97U4457C
94	PHIG(8)	=	+1.0E+00	IV97U4458C
95	PHIG(9)	=	+1.0E+00	IV97U4459C
96	PHIG(10)	=	+1.0E+00	IV97U4460C
97	PHIG(11)	=	+1.0E+00	IV97U4461C

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158	PSI(4)	=	+4.1739E-01	IV97U4528C
159	PSI(5)	=	+4.1795E-01	IV97U4532C
160	PSI(6)	=	+4.166E-01	IV97U4536C
161	PSI(7)	=	+4.1455E-01	IV97U4540C
162	PSI(8)	=	+4.131E-01	IV97U4544C
163	PSI(9)	=	+4.1288E-01	IV97U4548C
164	PSI(10)	=	+4.1227E-01	IV97U4552C
165	PSI(11)	=	+4.1127E-01	IV97U4556C
166	PSI(12)	=	+4.0993E-01	IV97U4560C
167	PSI(13)	=	+4.0962E-01	IV97U4564C
168	PSI(14)	=	+4.0938E-01	IV97U4568C
169	PSI(15)	=	+4.0919E-01	IV97U4572C
170	PSI(16)	=	+4.0865E-01	IV97U4576C
171	PSI(17)	=	+4.0697E-01	IV97U4580C
172	PSI(18)	=	+4.0643E-01	IV97U4584C
173	PSI(19)	=	+4.0452E-01	IV97U4588C
174	PSI(20)	=	+4.0411E-01	IV97U4592C
175	PSI(21)	=	+4.0477E-01	IV97U4596C
176	PSI(22)	=	+4.0596E-01	IV97U4600C
177	PSI(23)	=	+4.0754E-01	IV97U4604C
178	PSI(24)	=	+4.0785E-01	IV97U4608C
179	PSI(25)	=	+4.0793E-01	IV97U4612C
180	PSI(26)	=	+4.0779E-01	IV97U4616C
181	PSI(27)	=	+4.0824E-01	IV97U4620C
182	PSI(28)	=	+4.085E-01	IV97U4624C
183	PSI(29)	=	+4.0816E-01	IV97U4628C
184	PSI(30)	=	+4.0816E-01	IV97U4632C
185	PTCHF	=	+7.0E-03	IV99U7561C
186	PTCHFL	=	+3.0E-03	IV99U7562C
187	PTCHP	=	+5.0E-01	IV99U7563C
188	QPOLY(1)	=	+6.0E+01	IV97U4640C
189	QPOLY(2)	=	+3.9E+02	IV97U4641C
190	QPOLY(3)	=	+6.75E+02	IV97U4642C
191	QPOLY(4)	=	+1.223E+03	IV97U4643C
192	RDMAG	=	+2.1272079E+07	IV97U4647C
193	RDNOM	=	+2.1272079E+07	IV97U4645C
195	RHOMAG	=	+1.0000000E+00	IV97U4650C
197	SLOPEN	=	-1.670E-06	IV99U7443C
198	TADA	=	+1.000E+03	IV97U4661C
200	TABORT	=	+1.0E+01	IV98U7961C
201	TFAIL	=	+0.0E+00	IV96U9384C
202	THETT(1,1)	=	+4.1421E-01	IV97U4667C
203	THETT(2,1)	=	+3.1537E-01	IV97U4671C
204	THETT(3,1)	=	+3.1537E-01	IV97U4675C
205	THETT(4,1)	=	+3.1956E-01	IV97U4679C
206	THETT(5,1)	=	+3.2055E-01	IV97U4683C
207	THETT(6,1)	=	+3.2046E-01	IV97U4687C
208	THETT(7,1)	=	+3.1932E-01	IV97U4691C
209	THETT(8,1)	=	+3.1742E-01	IV97U4695C
210	THETT(9,1)	=	+3.1528E-01	IV97U4699C
211	THETT(10,1	=	+3.0813E-01	IV97U4703C
212	THETT(11,1	=	+2.9543E-01	IV97U4707C
213	THETT(12,1	=	+2.8524E-01	IV97U4711C
214	THETT(13,1	=	+2.7665E-01	IV97U4715C
215	THETT(14,1	=	+2.6983E-01	IV97U4719C
216	THETT(15,1	=	+2.674E-01	IV97U4723C
217	THETT(16,1	=	+2.6456E-01	IV97U4727C

ROCKWELL COPIER
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275   THETT(14,3    =  +2.685E-01                    !V99U6444C
276   THETT(15,3    =  +2.658E-01                    !V99U6445C
277   THETT(16,3    =  +2.632E-01                    !V99U6446C
278   THETT(17,3    =  +2.623E-01                    !V99U6447C
279   THETT(18,3    =  +2.611E-01                    !V99U6448C
280   THETT(19,3    =  +2.546E-01                    !V99U6449C
281   THETT(20,3    =  +2.451E-01                    !V99U6450C
282   THETT(21,3    =  +2.398E-01                    !V99U6451C
283   THETT(22,3    =  +2.305E-01                    !V99U6452C
284   THETT(23,3    =  +2.167E-01                    !V99U6453C
285   THETT(24,3    =  +2.102E-01                    !V99U6454C
286   THETT(25,3    =  +1.962E-01                    !V99U6455C
287   THETT(26,3    =  +1.867E-01                    !V99U6456C
288   THETT(27,3    =  +1.77E-01                     !V99U6457C
289   THETT(28,3    =  +1.668E-01                    !V99U6458C
290   THETT(29,3    =  +1.529E-01                    !V99U6459C
291   THETT(30,3    =  +1.126E-01                    !V99U6460C
292   THROTT(1)     =  +1.04E+02                     !V97U4808C
293   THROTT(2)     =  +8.9E+01                      !V97U4809C
294   THROTT(3)     =  +6.7E+01                      !V97U4810C
295   THROTT(4)     =  +1.04E+02                     !V97U4811C
296   THRTF         =  +5.34375E+03                  !V99U7564C
297   THRTFL        =  +4.0E+03                      !V99U7565C
299   TLAG          =  +5.0000000E-01                !V97U4834C
300   TNZRFO(1)     =  -6.02E-02                     !V97U2138C
301   TNZRFO(2)     =  -6.14E-02                     !V97U2139C
302   TNZRFO(3)     =  -7.87E-02                     !V97U2140C
303   TNZRFO(4)     =  -1.299E-01                    !V97U2141C
304   TNZRFO(5)     =  -1.046E-01                    !V97U2142C
305   TNZRFO(6)     =  -1.243E-01                    !V97U2143C
306   TNZRFO(7)     =  -1.503E-01                    !V97U2144C
307   TNZRFO(8)     =  -1.88E-01                     !V97U2145C
308   TNZRFO(9)     =  -1.988E-01                    !V97U2146C
309   TNZRFO(10)    =  -1.927E-01                    !V97U2147C
310   TNZRFO(11)    =  -2.579E-01                    !V97U2148C
311   TNZRFO(12)    =  -2.652E-01                    !V97U2149C
312   TNZRFO(13)    =  -2.654E-01                    !V97U2150C
313   TNZRFO(14)    =  -2.168E-01                    !V97U2151C
314   TNZRFO(15)    =  -1.269E-01                    !V97U2152C
315   TNZRFO(16)    =  -1.151E-01                    !V97U2153C
316   TNZRFO(17)    =  -8.21E-02                     !V97U2154C
317   TNZRFO(18)    =  -8.92E-02                     !V97U2155C
318   TNZRFO(19)    =  -1.077E-01                    !V97U2156C
319   TNZRFO(20)    =  -1.27E-01                     !V97U2157C
320   TREFAD        =  +1.728E+01                    !V99U7566C
321   TRIMDT        =  +1.2000000E+01                !V98U9809C
322   TSRPTO(1)     =  -2.69E-01                     !V97U1714C
323   TSRPTO(2)     =  -1.83E-01                     !V97U1715C
324   TSRPTO(3)     =  -4.15E-01                     !V97U1716C
325   TSRPTO(4)     =  -8.81E-01                     !V97U1717C
326   TSRPTO(5)     =  -6.37E-01                     !V97U1718C
327   TSRPTO(6)     =  -1.02E+00                     !V97U1719C
328   TSRPTO(7)     =  -1.112E+00                    !V97U1720C
329   TSRPTO(8)     =  -7.34E-01                     !V97U1721C
330   TSRPTO(9)     =  -8.13E-01                     !V97U1722C
331   TSRPTO(10)    =  -8.97E-01                     !V97U1723C
332   TSRPTO(11)    =  -1.462E+00                    !V97U1724C
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ROCKWELL COPIER
ROCKWELL COPIER
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242:
198:

199:
200:
201:
202:LTQS RUNID: F8MKC1 START: 12/11/91 19:31 TIME: 19:31
203:TRAJ PROC RUN 15 - SVDS ASCT 17 ADI OUTPUT
204:
205:
206:
207: DOL ASCENT ADI-NOMINAL
208:

TIME	THETA	HDOT	H
0:30	70	635	9K
0:50	64	944	25K
1:10	58	1377	48K
1:30	42	1884	81K
1:50	33	2226	122K

STAGING

VI	THETA	HDOT	H
6	21	1760	36NM
7	17	1303	46
8	14	955	53
9	12	675	56
10	10	448	59
12	6	113	61
14	4	-92	61
16	2	-190	60
18	0	-195	59
20	-1	-118	58
22	-1	21	58
24	-2	197	59
25906	-1	406	60

ROCKWELL COPIER
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Launch Tracking Cameras Azimuth and Elevation Data

CB ET 208A

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
000	00:00:00.0	000	000000	+000.000	-000.000	00	*
128	23:40:02.0	011	002049	+000.000	-000.000	04	
128	23:40:03.0	011	002049	+000.000	-000.000	04	
128	23:40:04.0	011	002049	+000.000	-000.000	04	
128	23:40:05.0	011	002049	+000.000	+000.000	04	
128	23:40:06.0	011	002049	+000.000	+000.000	04	
128	23:40:07.0	011	002049	+000.000	+000.000	04	
128	23:40:08.0	011	002049	+000.000	+000.000	04	
128	23:40:09.0	011	002049	+000.000	+000.000	04	
128	23:40:10.0	011	002049	+000.000	+000.000	04	
128	23:40:11.0	011	002049	+000.000	+000.000	04	
128	23:40:12.0	011	002049	+000.000	+000.000	04	
128	23:40:13.0	011	002049	+000.000	+000.000	04	
128	23:40:14.0	011	002049	+000.000	+000.000	04	
128	23:40:15.0	011	002049	+000.000	+000.000	04	
128	23:40:16.0	011	002049	+000.000	+000.000	04	
128	23:40:17.0	011	002049	+000.000	+000.000	04	
128	23:40:18.0	011	002049	+000.000	+000.000	04	
128	23:40:19.0	011	002049	+000.000	+000.000	04	
128	23:40:20.0	011	002049	+000.000	+000.000	04	
128	23:40:21.0	011	002049	+000.000	+000.000	04	
128	23:40:22.0	011	002049	+000.000	+000.000	04	
128	23:40:23.0	011	002049	+000.000	+000.000	04	
128	23:40:24.0	011	002049	+000.000	+000.000	04	
128	23:40:25.0	011	002049	+000.000	+000.000	04	
128	23:40:26.0	011	002049	+000.000	+000.000	04	
128	23:40:27.0	011	002049	+000.000	+000.000	04	
128	23:40:28.0	011	002049	+000.000	+000.000	04	
128	23:40:29.0	011	002049	+000.000	+000.000	04	
128	23:40:30.0	011	002049	+000.000	+000.000	04	
128	23:40:31.0	011	002049	+000.000	+000.000	04	
128	23:40:32.0	011	002049	+000.000	+000.000	04	
128	23:40:33.0	011	002049	+000.000	+000.000	04	
128	23:40:34.0	011	002049	+000.000	+000.000	04	
128	23:40:35.0	011	002049	+000.000	+000.000	04	
128	23:40:36.0	011	002049	+000.000	+000.000	04	
128	23:40:37.0	011	002049	+000.000	+000.000	04	
128	23:40:38.0	011	002049	+000.000	+000.000	04	
128	23:40:39.0	011	002049	+000.000	+000.000	04	
128	23:40:40.0	011	002049	+000.000	+000.000	04	
128	23:40:41.0	011	002049	+000.000	+000.000	04	
128	23:40:42.0	011	002049	+000.000	+000.000	04	
128	23:40:43.0	011	002049	+000.000	+000.000	04	
128	23:40:44.0	011	002049	+000.000	+000.000	04	
128	23:40:45.0	011	002049	+000.000	+000.000	04	T
128	23:40:46.0	011	002049	+000.000	+000.000	04	T
128	23:40:47.0	011	002049	+000.000	+000.000	04	T
128	23:40:48.0	011	002049	+000.000	+000.000	04	T
128	23:40:49.0	011	002049	+000.000	+000.000	04	T
128	23:40:50.0	011	002049	+000.000	+000.000	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
128	23:40:51.0	011	002049	+000.000	+000.000	04	T
128	23:40:52.0	011	002049	+000.000	+000.000	04	T
128	23:40:53.0	011	002049	+000.000	+000.000	04	T
128	23:40:54.0	011	002049	+000.000	+000.000	04	
128	23:40:55.0	011	002049	+000.000	+000.000	04	
128	23:40:56.0	011	002049	+000.000	+000.000	04	
128	23:40:57.0	011	002049	+000.000	+000.000	04	
128	23:40:58.0	011	002049	+000.000	+000.000	04	
128	23:40:59.0	011	002049	+000.000	+000.000	04	
128	23:41:00.0	011	002049	+000.000	+000.000	04	
128	23:41:01.0	011	002049	+000.000	+000.000	04	
128	23:41:02.0	011	002049	+000.000	+000.000	04	
128	23:41:03.0	011	002049	+000.000	+000.000	04	
128	23:41:04.0	011	002049	+000.000	+000.000	04	
128	23:41:05.0	011	002049	+000.000	+000.000	04	
128	23:41:06.0	011	002049	+000.000	+000.000	04	
128	23:41:07.0	011	002049	+000.000	+000.000	04	
128	23:41:08.0	011	002049	+000.000	+000.000	04	
128	23:41:09.0	011	002049	+000.000	+000.000	04	
128	23:41:10.0	011	002049	+000.000	+000.000	04	
128	23:41:11.0	011	002049	+000.000	+000.000	04	
128	23:41:12.0	011	002049	+000.000	+000.000	04	
128	23:41:13.0	011	002049	+000.000	+000.000	04	
128	23:41:14.0	011	002049	+000.000	+000.000	04	
128	23:41:15.0	011	002049	+000.000	+000.000	04	
128	23:41:16.0	011	002049	+000.000	+000.000	04	
128	23:41:17.0	011	002049	+000.000	+000.000	04	
128	23:41:18.0	011	002049	+000.000	+000.000	04	
128	23:41:19.0	011	002049	+000.000	+000.000	04	T
128	23:41:20.0	011	002049	+000.000	+000.000	04	T
128	23:41:21.0	011	002049	+000.000	+000.000	04	T
128	23:41:22.0	011	002049	+000.000	+000.000	04	T
128	23:41:23.0	011	002049	+000.000	+000.000	04	T
128	23:41:24.0	011	002049	+000.000	+000.000	04	T
128	23:41:25.0	011	002049	+000.000	+000.000	04	T
128	23:41:26.0	011	002049	+000.000	+000.000	04	T
128	23:41:27.0	011	002049	+000.000	+000.000	04	T
128	23:41:28.0	011	002049	+000.000	+000.000	04	T
128	23:41:29.0	011	002049	+000.000	+000.000	04	T
128	23:41:30.0	011	002049	+000.000	+000.000	04	T
128	23:41:31.0	011	002049	+000.000	+000.000	04	T
128	23:41:32.0	011	002049	+000.000	+000.000	04	
128	23:41:33.0	011	002049	+000.000	+000.000	04	
128	23:41:34.0	011	002049	+000.000	+000.000	04	
128	23:41:35.0	011	002049	+000.000	+000.000	04	
128	23:41:36.0	011	002049	+000.000	+000.000	04	
128	23:41:37.0	011	002049	+000.000	+000.000	04	
128	23:41:38.0	011	002049	+000.000	+000.000	04	
128	23:41:39.0	011	002049	+000.000	+000.000	04	
128	23:41:40.0	011	002049	+000.000	+000.000	04	

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
128	23:41:41.0	011	002049	+000.000	+000.000	04	
128	23:41:42.0	011	002049	+000.000	+000.000	04	
128	23:41:43.0	011	002049	+000.000	+000.000	04	
128	23:41:44.0	011	002049	+000.000	+000.000	04	
128	23:41:45.0	011	002049	+000.000	+000.000	04	
128	23:41:46.0	011	002049	+000.000	+000.000	04	
128	23:41:47.0	011	002049	+000.000	+000.000	04	
128	23:41:48.0	011	002049	+000.000	+000.000	04	
128	23:41:49.0	011	002049	+000.000	+000.000	04	
128	23:41:50.0	011	002049	+000.000	+000.000	04	
128	23:41:51.0	011	002049	+000.000	+000.000	04	
128	23:41:52.0	011	002049	+000.000	+000.000	04	
128	23:41:53.0	011	002049	+000.000	+000.000	04	
128	23:41:54.0	011	002049	+000.000	+000.000	04	
128	23:41:55.0	011	002049	+000.000	+000.000	04	
128	23:41:56.0	011	002049	+000.000	+000.000	04	
128	23:41:57.0	011	002049	+000.000	+000.000	04	
128	23:41:58.0	011	002049	+000.000	+000.000	04	
128	23:41:59.0	011	002049	+000.000	+000.000	04	
128	23:42:00.0	011	002049	+000.000	+000.000	04	
128	23:42:01.0	011	002049	+000.000	+000.000	04	
128	23:42:02.0	011	002049	+000.000	+000.000	04	
128	23:42:03.0	011	002049	+000.000	+000.000	04	
128	23:42:04.0	011	002049	+000.000	+000.000	04	
128	23:42:05.0	011	002049	+000.000	+000.000	04	T
128	23:42:06.0	011	002049	+000.000	+000.000	04	T
128	23:42:07.0	011	002049	+000.000	+000.000	04	T
128	23:42:08.0	011	002049	+000.000	+000.000	04	T
128	23:42:09.0	011	002049	+000.000	+000.000	04	T
128	23:42:10.0	011	002049	+000.000	+000.000	04	T
128	23:42:11.0	011	002049	+000.000	+000.000	04	T
128	23:42:12.0	011	002049	+000.000	+000.000	04	T
128	23:42:13.0	011	002049	+000.000	+000.000	04	T
128	23:42:14.0	011	002049	+000.000	+000.000	04	T
128	23:42:15.0	011	002049	+000.000	+000.000	04	T
128	23:42:16.0	011	002049	+000.000	+000.000	04	T
128	23:42:17.0	011	002049	+000.000	+000.000	04	T
128	23:42:18.0	011	002049	+000.000	+000.000	04	T
128	23:42:19.0	011	002049	+000.000	+000.000	04	T
128	23:42:20.0	011	002049	+000.000	+000.000	04	T
128	23:42:21.0	011	002049	+000.000	+000.000	04	T
128	23:42:22.0	011	002049	+000.000	+000.000	04	T
128	23:42:23.0	011	002049	+000.000	+000.000	04	T
128	23:42:24.0	011	002049	+000.000	+000.000	04	T
128	23:42:25.0	011	002049	+000.000	+000.000	04	T
128	23:42:26.0	011	002049	+000.000	+000.000	04	T
128	23:42:27.0	011	002049	+000.000	+000.000	04	T
128	23:42:28.0	011	002049	+000.000	+000.000	04	T
128	23:42:29.0	011	002049	+000.000	+000.000	04	T
128	23:42:30.0	011	002049	+000.000	+000.000	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	EMT	TRACK
128	23:42:31.0	011	002049	+000.000	+000.000	04	T
128	23:42:32.0	011	002049	+000.000	+000.000	04	T
128	23:42:33.0	011	002049	+000.000	+000.000	04	T
128	23:42:34.0	011	002049	+000.000	+000.000	04	T
128	23:42:35.0	011	002049	+000.000	+000.000	04	T
128	23:42:36.0	011	002049	+000.000	+000.000	04	T
128	23:42:37.0	011	002049	+000.000	+000.000	04	T
128	23:42:38.0	011	002049	+000.000	+000.000	04	T
128	23:42:39.0	011	002049	+000.000	+000.000	04	T
128	23:42:40.0	011	002049	+000.000	+000.000	04	T
128	23:42:41.0	011	002049	+000.000	+000.000	04	T
128	23:42:42.0	011	002049	+000.000	+000.000	04	T
128	23:42:43.0	011	002049	+000.000	+000.000	04	T
128	23:42:44.0	011	002049	+000.000	+000.000	04	T
128	23:42:45.0	011	002049	+000.000	+000.000	04	T
128	23:42:46.0	011	002049	+000.000	+000.000	04	T
128	23:42:47.0	011	002049	+000.000	+000.000	04	T
128	23:42:48.0	011	002049	+000.000	+000.000	04	T
128	23:42:49.0	011	002049	+000.000	+000.000	04	T
128	23:42:50.0	011	002049	+000.000	+000.000	04	T
128	23:42:51.0	011	002049	+000.000	+000.000	04	T
128	23:42:52.0	011	002049	+000.000	+000.000	04	T
128	23:42:53.0	011	002049	+000.000	+000.000	04	T
128	23:42:54.0	011	002049	+000.000	+000.000	04	T
128	23:42:55.0	011	002049	+000.000	+000.000	04	T
128	23:42:56.0	011	002049	+000.000	+000.000	04	
128	23:42:57.0	011	002049	+000.000	+000.000	04	
128	23:42:58.0	011	002049	+000.000	+000.000	04	
128	23:42:59.0	011	002049	+000.000	+000.000	04	
128	23:43:00.0	011	002049	+000.000	+000.000	04	
128	23:43:01.0	011	002049	+000.000	+000.000	04	
128	23:43:02.0	011	002049	+000.000	+000.000	04	
128	23:43:03.0	011	002049	+000.000	+000.000	04	
128	23:43:04.0	011	002049	+000.000	+000.000	04	
128	23:43:05.0	011	002049	+000.000	+000.000	04	
128	23:43:06.0	011	002049	+000.000	+000.000	04	
128	23:43:07.0	011	002049	+000.000	+000.000	04	
128	23:43:08.0	011	002049	+000.000	+000.000	04	
128	23:43:09.0	011	002049	+000.000	+000.000	04	
128	23:43:10.0	011	002049	+000.000	+000.000	04	
128	23:43:11.0	011	002049	+000.000	+000.000	04	
128	23:43:12.0	011	002049	+000.000	+000.000	04	
128	23:43:13.0	011	002049	+000.000	+000.000	04	
128	23:43:14.0	011	002049	+000.000	+000.000	04	
128	23:43:15.0	011	002049	+000.000	+000.000	04	
128	23:43:16.0	011	002049	+000.000	+000.000	04	
128	23:43:17.0	011	002049	+000.000	+000.000	04	
128	23:43:18.0	011	002049	+000.000	+000.000	04	
128	23:43:19.0	011	002049	+000.000	+000.000	04	
128	23:43:20.0	011	002049	+000.000	+000.000	04	

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
128	23:43:21.0	011	002049	+000.000	+000.000	04	
128	23:43:22.0	011	002049	+000.000	+000.000	04	
128	23:43:23.0	011	002049	+000.000	+000.000	04	
128	23:43:24.0	011	002049	+000.000	+000.000	04	
128	23:43:25.0	011	002049	+000.000	+000.000	04	
128	23:43:26.0	011	002049	+000.000	+000.000	04	
128	23:43:27.0	011	002049	+000.000	+000.000	04	T
128	23:43:28.0	011	002049	+000.000	+000.000	04	T
128	23:43:29.0	011	002049	+000.000	+000.000	04	T
128	23:43:30.0	011	002049	+000.000	+000.000	04	T
128	23:43:31.0	011	002049	+000.000	+000.000	04	T
128	23:43:32.0	011	002049	+000.000	+000.000	04	T
128	23:43:33.0	011	002049	+000.000	+000.000	04	T
128	23:43:34.0	011	002049	+000.000	+000.000	04	T
128	23:43:35.0	011	002049	+000.000	+000.000	04	T
128	23:43:36.0	011	002049	+000.000	+000.000	04	T
128	23:43:37.0	011	002049	+000.000	+000.000	04	T
128	23:43:38.0	011	002049	+000.000	+000.000	04	T
128	23:43:39.0	011	002049	+000.000	+000.000	04	T
128	23:43:40.0	011	002049	+000.000	+000.000	04	T
128	23:43:41.0	011	002049	+000.000	+000.000	04	T
128	23:43:42.0	011	002049	+000.000	+000.000	04	T
128	23:43:43.0	011	002049	+000.000	+000.000	04	T
128	23:43:44.0	011	002049	+000.000	+000.000	04	T
128	23:43:45.0	011	002049	+000.000	+000.000	04	T
128	23:43:46.0	011	002049	+000.000	+000.000	04	T
128	23:43:47.0	011	002049	+000.000	+000.000	04	T
128	23:43:48.0	011	002049	+000.000	+000.000	04	T
128	23:43:49.0	011	002049	+000.000	+000.000	04	T
128	23:43:50.0	011	002049	+000.000	+000.000	04	T
128	23:43:51.0	011	002049	+000.000	+000.000	04	
128	23:43:52.0	011	002049	+000.000	+000.000	04	
128	23:43:53.0	011	002049	+000.000	+000.000	04	
128	23:43:54.0	011	002049	+000.000	+000.000	04	
128	23:43:55.0	011	002049	+000.000	+000.000	04	
128	23:43:56.0	011	002049	+000.000	+000.000	04	
128	23:43:57.0	011	002049	+000.000	+000.000	04	
128	23:43:58.0	011	002049	+000.000	+000.000	04	
128	23:43:59.0	011	002049	+000.000	+000.000	04	
128	23:44:00.0	011	002049	+000.000	+000.000	04	
128	23:44:01.0	011	002049	+000.000	+000.000	04	
128	23:44:02.0	011	002049	+000.000	+000.000	04	
128	23:44:03.0	011	002049	+000.000	+000.000	04	
128	23:44:04.0	011	002049	+000.000	+000.000	04	
128	23:44:05.0	011	002049	+000.000	+000.000	04	
128	23:44:06.0	011	002049	+000.000	+000.000	04	
128	23:44:07.0	011	002049	+000.000	+000.000	04	
128	23:44:08.0	011	002049	+000.000	+000.000	04	
128	23:44:09.0	011	002049	+000.000	+000.000	04	
128	23:44:10.0	011	002049	+000.000	+000.000	04	

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
128	23:44:11.0	011	002049	+000.000	+000.000	04	
128	23:44:12.0	011	002049	+000.000	+000.000	04	
128	23:44:13.0	011	002049	+000.000	+000.000	04	
128	23:44:14.0	011	002049	+000.000	+000.000	04	
128	23:44:15.0	011	002049	+000.000	+000.000	04	
128	23:44:16.0	011	002049	+000.000	+000.000	04	
128	23:44:17.0	011	002049	+000.000	+000.000	04	
128	23:44:18.0	011	002049	+000.000	+000.000	04	
128	23:44:19.0	011	002049	+000.000	+000.000	04	
128	23:44:20.0	011	002049	+000.000	+000.000	04	
128	23:44:21.0	011	002049	+000.000	+000.000	04	
128	23:44:22.0	011	002049	+000.000	+000.000	04	
128	23:44:23.0	011	002049	+000.000	+000.000	04	
128	23:44:24.0	011	002049	+000.000	+000.000	04	
128	23:44:25.0	011	002049	+000.000	+000.000	04	
128	23:44:26.0	011	002049	+000.000	+000.000	04	
128	23:44:27.0	011	002049	+000.000	+000.000	04	
128	23:44:28.0	011	002049	+000.000	+000.000	04	
128	23:44:29.0	011	002049	+000.000	+000.000	04	
128	23:44:30.0	011	002049	+000.000	+000.000	04	
128	23:44:31.0	011	002049	+000.000	+000.000	04	
128	23:44:32.0	011	002049	+000.000	+000.000	04	
128	23:44:33.0	011	002049	+000.000	+000.000	04	
128	23:44:34.0	011	002049	+000.000	+000.000	04	
128	23:44:35.0	011	002049	+000.000	+000.000	04	
128	23:44:36.0	011	002049	+000.000	+000.000	04	
128	23:44:37.0	011	002049	+000.000	+000.000	04	
128	23:44:38.0	011	002049	+000.000	+000.000	04	
128	23:44:39.0	011	002049	+000.000	+000.000	04	
128	23:44:40.0	011	002049	+000.000	+000.000	04	
128	23:44:41.0	011	002049	+000.000	+000.000	04	
128	23:44:42.0	011	002049	+000.000	+000.000	04	
128	23:44:43.0	011	002049	+000.000	+000.000	04	
128	23:44:44.0	011	002049	+000.000	+000.000	04	
128	23:44:45.0	011	002049	+000.000	+000.000	04	
128	23:44:46.0	011	002049	+000.000	+000.000	04	
128	23:44:47.0	011	002049	+000.000	+000.000	04	
128	23:44:48.0	011	002049	+000.000	+000.000	04	
128	23:44:49.0	011	002049	+000.000	+000.000	04	
128	23:44:50.0	011	002049	+000.000	+000.000	04	
128	23:44:51.0	011	002049	+000.000	+000.000	04	
128	23:44:52.0	011	002049	+000.000	+000.000	04	
128	23:44:53.0	011	002049	+000.000	+000.000	04	
128	23:44:54.0	011	002049	+000.000	+000.000	04	
128	23:44:55.0	011	002049	+000.000	+000.000	04	
128	23:44:56.0	011	002049	+000.000	+000.000	04	
128	23:44:57.0	011	002049	+000.000	+000.000	04	
128	23:44:58.0	011	002049	+000.000	+000.000	04	
128	23:44:59.0	011	002049	+000.000	+000.000	04	
128	23:45:00.0	011	002049	+000.000	+000.000	04	

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
128	23:45:01.0	011	002049	+000.000	+000.000	04	
128	23:45:02.0	011	002049	+000.000	+000.000	04	
128	23:45:03.0	011	002049	+000.000	+000.000	04	
128	23:45:04.0	011	002049	+000.000	+000.000	04	
128	23:45:05.0	011	002049	+000.000	+000.000	04	
128	23:45:06.0	011	002049	+000.000	+000.000	04	T
128	23:45:07.0	011	002049	+000.000	+000.000	04	T
128	23:45:08.0	011	002049	+000.000	+000.000	04	T
128	23:45:09.0	011	002049	+000.000	+000.000	04	T
128	23:45:10.0	011	002049	+000.000	+000.000	04	T
128	23:45:11.0	011	002049	+000.000	+000.000	04	T
128	23:45:12.0	011	002049	+000.000	+000.000	04	T
128	23:45:13.0	011	002049	+000.000	+000.000	04	T
128	23:45:14.0	011	002049	+000.000	+000.000	04	T
128	23:45:15.0	011	002049	+000.000	+000.000	04	T
128	23:45:16.0	011	002049	+000.000	+000.000	04	T
128	23:45:17.0	011	002049	+000.000	+000.000	04	T
128	23:45:18.0	011	002049	+000.000	+000.000	04	T
128	23:45:19.0	011	002049	+000.000	+000.000	04	T
128	23:45:20.0	011	002049	+000.000	+000.000	04	T
128	23:45:21.0	011	002049	+000.000	+000.000	04	
128	23:45:22.0	011	002049	+000.000	+000.000	04	
128	23:45:23.0	011	002049	+000.000	+000.000	04	
128	23:45:24.0	011	002049	+000.000	+000.000	04	
128	23:45:25.0	011	002049	+000.000	+000.000	04	
128	23:45:26.0	011	002049	+000.000	+000.000	04	
128	23:45:27.0	011	002049	+000.000	+000.000	04	
128	23:45:28.0	011	002049	+000.000	+000.000	04	
128	23:45:29.0	011	002049	+000.000	+000.000	04	
128	23:45:30.0	011	002049	+000.000	+000.000	04	
128	23:45:31.0	011	002049	+000.000	+000.000	04	
128	23:45:32.0	011	002049	+000.000	+000.000	04	
128	23:45:33.0	011	002049	+000.000	+000.000	04	
128	23:45:34.0	011	002049	+000.000	+000.000	04	
128	23:45:35.0	011	002049	+000.000	+000.000	04	
128	23:45:36.0	011	002049	+000.000	+000.000	04	
128	23:45:37.0	011	002049	+000.000	+000.000	04	
128	23:45:38.0	011	002049	+000.000	+000.000	04	
128	23:45:39.0	011	002049	+000.000	+000.000	04	
128	23:45:40.0	011	002049	+000.000	+000.000	04	
128	23:45:41.0	011	002049	+000.000	+000.000	04	
128	23:45:42.0	011	002049	+000.000	+000.000	04	
128	23:45:43.0	011	002049	+000.000	+000.000	04	
128	23:45:44.0	011	002049	+000.000	+000.000	04	
128	23:45:45.0	011	002049	+000.000	+000.000	04	
128	23:45:46.0	011	002049	+000.000	+000.000	04	
128	23:45:47.0	011	002049	+000.000	+000.000	04	
128	23:45:48.0	011	002049	+000.000	+000.000	04	
128	23:45:49.0	011	002049	+000.000	+000.000	04	
128	23:45:50.0	011	002049	+000.000	+000.000	04	

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	EMT	TRACK
128	23:45:51.0	011	002049	+000.000	+000.000	04	
128	23:45:52.0	011	002049	+000.000	+000.000	04	
128	23:45:53.0	011	002049	+000.000	+000.000	04	
128	23:45:54.0	011	002049	+000.000	+000.000	04	
128	23:45:55.0	011	002049	+000.000	+000.000	04	
128	23:45:56.0	011	002049	+000.000	+000.000	04	
128	23:45:57.0	011	002049	+000.000	+000.000	04	
128	23:45:58.0	011	002049	+000.000	+000.000	04	
128	23:45:59.0	011	002049	+000.000	+000.000	04	
128	23:46:00.0	011	002049	+000.000	+000.000	04	

MIG ET207A

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
128	23:39:58.0	272	002049	+151.304	+000.110	04	T *
128	23:39:59.0	272	002049	+151.304	+000.110	04	T
128	23:40:00.0	272	002049	+151.304	+000.110	04	T
128	23:40:01.0	272	002049	+151.304	+000.110	04	T
128	23:40:02.0	272	002049	+151.304	+000.110	04	T
128	23:40:03.0	272	002049	+151.304	+000.275	04	T
128	23:40:04.0	272	002049	+151.304	+000.374	04	T
128	23:40:05.0	272	002049	+151.271	+000.516	04	T
128	23:40:06.0	272	002049	+151.271	+000.681	04	T
128	23:40:07.0	272	002049	+151.271	+000.890	04	T
128	23:40:08.0	272	002049	+151.238	+001.123	04	T
128	23:40:09.0	272	002049	+151.227	+001.409	04	T
128	23:40:10.0	272	002049	+151.216	+001.728	04	T
128	23:40:11.0	272	002049	+151.205	+002.090	04	T
128	23:40:12.0	272	002049	+151.205	+002.497	04	T
128	23:40:13.0	272	002049	+151.172	+002.947	04	T
128	23:40:14.0	272	002049	+151.128	+003.430	04	T
128	23:40:15.0	272	002049	+151.073	+003.947	04	T
128	23:40:16.0	272	002049	+150.985	+004.507	04	T
128	23:40:17.0	272	002049	+150.831	+005.111	04	T
128	23:40:18.0	272	002049	+150.809	+005.166	04	T
128	23:40:19.0	272	002049	+150.809	+005.166	04	T
128	23:40:20.0	272	002049	+150.669	+007.594	04	T
128	23:40:21.0	272	002049	+150.351	+007.342	04	T
128	23:40:22.0	272	002049	+149.362	+008.869	04	
128	23:40:23.0	272	002049	+149.098	+009.594	04	
128	23:40:24.0	272	002049	+148.747	+010.407	04	
128	23:40:25.0	272	002049	+148.307	+011.231	04	
128	23:40:26.0	272	002049	+147.857	+012.088	04	
128	23:40:27.0	272	002049	+147.384	+012.967	04	
128	23:40:28.0	272	002049	+146.901	+013.824	04	
128	23:40:29.0	272	002049	+146.330	+014.812	04	
128	23:40:30.0	272	002049	+145.802	+015.713	04	
128	23:40:31.0	272	002049	+145.231	+016.636	04	
128	23:40:32.0	272	002049	+144.649	+017.581	04	
128	23:40:33.0	272	002049	+144.055	+018.515	04	
128	23:40:34.0	272	002049	+143.407	+019.492	04	
128	23:40:35.0	272	002049	+142.748	+020.418	04	
128	23:40:36.0	272	002049	+142.111	+021.330	04	
128	23:40:37.0	272	002049	+141.454	+022.253	04	
128	23:40:38.0	272	002049	+140.762	+023.187	04	
128	23:40:39.0	272	002049	+140.037	+024.099	04	
128	23:40:40.0	272	002049	+139.323	+024.988	04	
128	23:40:41.0	272	002049	+138.576	+025.867	04	
128	23:40:42.0	272	002049	+137.884	+026.505	04	
128	23:40:43.0	272	002049	+137.060	+027.361	04	
128	23:40:44.0	272	002049	+136.379	+028.185	04	T
128	23:40:45.0	272	002049	+135.654	+028.987	04	T
128	23:40:46.0	272	002049	+134.907	+029.734	04	T
128	23:40:47.0	272	002049	+134.182	+030.515	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
128	23:40:48.0	272	002049	+133.415	+031.242	04	T
128	23:40:49.0	272	002049	+132.668	+031.967	04	T
128	23:40:50.0	272	002049	+131.910	+032.649	04	T
128	23:40:51.0	272	002049	+131.152	+033.341	04	T
128	23:40:52.0	272	002049	+130.394	+033.000	04	T
128	23:40:53.0	272	002049	+129.647	+034.615	04	T
128	23:40:54.0	272	002049	+128.922	+035.219	04	T
128	23:40:55.0	272	002049	+128.186	+035.802	04	T
128	23:40:56.0	272	002049	+127.439	+036.373	04	T
128	23:40:57.0	272	002049	+126.725	+036.900	04	T
128	23:40:58.0	272	002049	+125.988	+037.428	04	T
128	23:40:59.0	272	002049	+125.277	+037.922	04	T
128	23:41:00.0	272	002049	+124.563	+038.416	04	T
128	23:41:01.0	272	002049	+123.860	+038.889	04	T
128	23:41:02.0	272	002049	+123.157	+039.350	04	T
128	23:41:03.0	272	002049	+122.476	+039.781	04	T
128	23:41:04.0	272	002049	+121.783	+040.199	04	T
128	23:41:05.0	272	002049	+121.113	+040.605	04	T
128	23:41:06.0	272	002049	+120.454	+041.001	04	T
128	23:41:07.0	272	002049	+119.806	+041.364	04	T
128	23:41:08.0	272	002049	+119.147	+041.737	04	T
128	23:41:09.0	272	002049	+118.499	+042.089	04	T
128	23:41:10.0	272	002049	+117.861	+042.418	04	T
128	23:41:11.0	272	002049	+117.235	+042.737	04	T
128	23:41:12.0	272	002049	+116.598	+043.044	04	T
128	23:41:13.0	272	002049	+115.985	+043.319	04	T
128	23:41:14.0	272	002049	+115.381	+043.605	04	T
128	23:41:15.0	272	002049	+114.777	+043.857	04	T
128	23:41:16.0	272	002049	+114.184	+044.099	04	T
128	23:41:17.0	272	002049	+113.601	+044.319	04	T
128	23:41:18.0	272	002049	+113.008	+044.528	04	T
128	23:41:19.0	272	002049	+112.426	+044.714	04	T
128	23:41:20.0	272	002049	+111.855	+044.890	04	T
128	23:41:21.0	272	002049	+111.294	+045.044	04	T
128	23:41:22.0	272	002049	+110.745	+045.165	04	T
128	23:41:23.0	272	002049	+110.185	+045.297	04	T
128	23:41:24.0	272	002049	+109.646	+045.396	04	T
128	23:41:25.0	272	002049	+109.119	+045.472	04	T
128	23:41:26.0	272	002049	+108.592	+045.549	04	T
128	23:41:27.0	272	002049	+108.064	+045.582	04	T
128	23:41:28.0	272	002049	+107.570	+045.604	04	T
128	23:41:29.0	272	002049	+107.065	+045.648	04	T
128	23:41:30.0	272	002049	+106.581	+045.648	04	T
128	23:41:31.0	272	002049	+106.098	+045.648	04	T
128	23:41:32.0	272	002049	+105.647	+045.648	04	T
128	23:41:33.0	272	002049	+105.186	+045.604	04	T
128	23:41:34.0	272	002049	+104.746	+045.527	04	T
128	23:41:35.0	272	002049	+104.318	+045.461	04	T
128	23:41:36.0	272	002049	+103.889	+045.385	04	T
128	23:41:37.0	272	002049	+103.483	+045.297	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
128	23:41:38.0	272	002049	+103.087	+045.209	04	T
128	23:41:39.0	272	002049	+102.692	+045.121	04	T
128	23:41:40.0	272	002049	+102.307	+044.000	04	T
128	23:41:41.0	272	002049	+101.945	+044.901	04	T
128	23:41:42.0	272	002049	+101.571	+044.778	04	T
128	23:41:43.0	272	002049	+101.231	+044.646	04	T
128	23:41:44.0	272	002049	+100.901	+044.514	04	T
128	23:41:45.0	272	002049	+100.561	+044.371	04	T
128	23:41:46.0	272	002049	+100.242	+044.228	04	T
128	23:41:47.0	272	002049	+099.945	+044.074	04	T
128	23:41:48.0	272	002049	+099.627	+043.921	04	T
128	23:41:49.0	272	002049	+099.341	+043.756	04	T
128	23:41:50.0	272	002049	+099.066	+043.580	04	T
128	23:41:51.0	272	002049	+098.792	+043.415	04	T
128	23:41:52.0	272	002049	+098.528	+043.250	04	T
128	23:41:53.0	272	002049	+098.262	+043.064	04	T
128	23:41:54.0	272	002049	+098.031	+042.899	04	T
128	23:41:55.0	272	002049	+097.778	+042.709	04	T
128	23:41:56.0	272	002049	+097.559	+042.523	04	T
128	23:41:57.0	272	002049	+097.339	+042.347	04	T
128	23:41:58.0	272	002049	+097.119	+042.171	04	T
128	23:41:59.0	272	002049	+096.910	+041.984	04	T
128	23:42:00.0	272	002049	+096.724	+041.797	04	T
128	23:42:01.0	272	002049	+096.515	+041.600	04	T
128	23:42:02.0	272	002049	+096.339	+041.424	04	T
128	23:42:03.0	272	002049	+096.163	+041.248	04	T
128	23:42:04.0	272	002049	+095.999	+041.072	04	T
128	23:42:05.0	272	002049	+095.834	+040.897	04	T
128	23:42:06.0	272	002049	+095.669	+040.710	04	T
128	23:42:07.0	272	002049	+095.537	+040.534	04	T
128	23:42:08.0	272	002049	+095.372	+040.369	04	T
128	23:42:09.0	272	002049	+095.229	+040.169	04	T
128	23:42:10.0	272	002049	+095.098	+040.015	04	T
128	23:42:11.0	272	002049	+094.966	+039.839	04	T
128	23:42:12.0	272	002049	+094.834	+039.663	04	
128	23:42:13.0	272	002049	+094.702	+039.499	04	
128	23:42:14.0	272	002049	+094.581	+039.323	04	
128	23:42:15.0	272	002049	+094.460	+039.147	04	
128	23:42:16.0	272	002049	+094.351	+038.993	04	
128	23:42:17.0	272	002049	+094.252	+038.828	04	
128	23:42:18.0	272	002049	+094.142	+038.653	04	
128	23:42:19.0	272	002049	+094.043	+038.477	04	
128	23:42:20.0	272	002049	+093.955	+038.301	04	
128	23:42:21.0	272	002049	+093.856	+038.136	04	
128	23:42:22.0	272	002049	+093.757	+037.961	04	
128	23:42:23.0	272	002049	+093.669	+037.782	04	
128	23:42:24.0	272	002049	+093.590	+037.617	04	
128	23:42:25.0	272	002049	+093.513	+037.452	04	
128	23:42:26.0	272	002049	+093.425	+037.277	04	
128	23:42:27.0	272	002049	+093.337	+037.112	04	

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
128	23:42:28.0	272	002049	+093.260	+036.936	04	
128	23:42:29.0	272	002049	+093.194	+036.760	04	
128	23:42:30.0	272	002049	+093.106	+036.584	04	
128	23:42:31.0	272	002049	+093.040	+036.420	04	
128	23:42:32.0	272	002049	+092.975	+036.244	04	
128	23:42:33.0	272	002049	+092.909	+036.068	04	
128	23:42:34.0	272	002049	+092.843	+035.892	04	
128	23:42:35.0	272	002049	+092.777	+035.717	04	
128	23:42:36.0	272	002049	+092.722	+035.552	04	
128	23:42:37.0	272	002049	+092.667	+035.373	04	
128	23:42:38.0	272	002049	+092.601	+035.186	04	
128	23:42:39.0	272	002049	+092.546	+035.011	04	
128	23:42:40.0	272	002049	+092.502	+034.835	04	
128	23:42:41.0	272	002049	+092.436	+034.659	04	
128	23:42:42.0	272	002049	+092.381	+034.483	04	
128	23:42:43.0	272	002049	+092.337	+034.297	04	
128	23:42:44.0	272	002049	+092.282	+034.121	04	
128	23:42:45.0	272	002049	+092.238	+033.945	04	
128	23:42:46.0	272	002049	+092.195	+033.758	04	
128	23:42:47.0	272	002049	+092.151	+033.593	04	
128	23:42:48.0	272	002049	+092.107	+033.407	04	
128	23:42:49.0	272	002049	+092.063	+033.220	04	
128	23:42:50.0	272	002049	+092.019	+033.044	04	
128	23:42:51.0	272	002049	+091.975	+032.855	04	
128	23:42:52.0	272	002049	+091.931	+032.668	04	
128	23:42:53.0	272	002049	+091.887	+032.492	04	
128	23:42:54.0	272	002049	+091.843	+032.294	04	
128	23:42:55.0	272	002049	+091.799	+032.119	04	
128	23:42:56.0	272	002049	+091.766	+031.921	04	
128	23:42:57.0	272	002049	+091.733	+031.745	04	
128	23:42:58.0	272	002049	+091.700	+031.569	04	
128	23:42:59.0	272	002049	+091.656	+031.371	04	
128	23:43:00.0	272	002049	+091.623	+031.185	04	
128	23:43:01.0	272	002049	+091.590	+030.998	04	
128	23:43:02.0	272	002049	+091.544	+030.811	04	
128	23:43:03.0	272	002049	+091.522	+030.622	04	
128	23:43:04.0	272	002049	+091.489	+030.424	04	
128	23:43:05.0	272	002049	+091.467	+030.237	04	
128	23:43:06.0	272	002049	+091.434	+030.039	04	
128	23:43:07.0	272	002049	+091.401	+029.853	04	
128	23:43:08.0	272	002049	+091.368	+029.666	04	
128	23:43:09.0	272	002049	+091.335	+029.457	04	
128	23:43:10.0	272	002049	+091.313	+029.281	04	
128	23:43:11.0	272	002049	+091.280	+029.073	04	
128	23:43:12.0	272	002049	+091.247	+028.875	04	
128	23:43:13.0	272	002049	+091.225	+028.674	04	
128	23:43:14.0	272	002049	+091.181	+028.488	04	
128	23:43:15.0	272	002049	+091.181	+028.279	04	
128	23:43:16.0	272	002049	+091.137	+028.092	04	
128	23:43:17.0	272	002049	+091.115	+027.883	04	

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
128	23:43:18.0	272	002049	+091.104	+027.697	04	
128	23:43:19.0	272	002049	+091.049	+027.488	04	
128	23:43:20.0	272	002049	+091.049	+027.301	04	
128	23:43:21.0	272	002049	+091.005	+027.092	04	
128	23:43:22.0	272	002049	+090.983	+026.906	04	
128	23:43:23.0	272	002049	+090.983	+026.683	04	
128	23:43:24.0	272	002049	+090.939	+026.474	04	
128	23:43:25.0	272	002049	+090.917	+026.288	04	
128	23:43:26.0	272	002049	+090.917	+026.079	04	
128	23:43:27.0	272	002049	+090.884	+025.859	04	
128	23:43:28.0	272	002049	+090.862	+025.672	04	
128	23:43:29.0	272	002049	+090.829	+025.464	04	
128	23:43:30.0	272	002049	+090.829	+025.266	04	
128	23:43:31.0	272	002049	+090.797	+025.046	04	
128	23:43:32.0	272	002049	+090.786	+024.835	04	
128	23:43:33.0	272	002049	+090.753	+024.626	04	
128	23:43:34.0	272	002049	+090.753	+024.428	04	
128	23:43:35.0	272	002049	+090.720	+024.219	04	
128	23:43:36.0	272	002049	+090.698	+023.000	04	
128	23:43:37.0	272	002049	+090.698	+023.780	04	
128	23:43:38.0	272	002049	+090.698	+023.571	04	
128	23:43:39.0	272	002049	+090.654	+023.351	04	
128	23:43:40.0	272	002049	+090.643	+023.140	04	
128	23:43:41.0	272	002049	+090.610	+022.909	04	
128	23:43:42.0	272	002049	+090.577	+022.722	04	
128	23:43:43.0	272	002049	+090.566	+022.503	04	
128	23:43:44.0	272	002049	+090.566	+022.283	04	
128	23:43:45.0	272	002049	+090.522	+022.063	04	
128	23:43:46.0	272	002049	+090.511	+021.844	04	
128	23:43:47.0	272	002049	+090.511	+021.632	04	
128	23:43:48.0	272	002049	+090.508	+021.412	04	
128	23:43:49.0	272	002049	+090.497	+021.204	04	
128	23:43:50.0	272	002049	+090.475	+020.973	04	
128	23:43:51.0	272	002049	+090.442	+020.775	04	
128	23:43:52.0	272	002049	+090.442	+020.544	04	
128	23:43:53.0	272	002049	+090.431	+020.333	04	
128	23:43:54.0	272	002049	+090.398	+020.102	04	
128	23:43:55.0	272	002049	+090.398	+019.872	04	
128	23:43:56.0	272	002049	+090.398	+019.652	04	
128	23:43:57.0	272	002049	+090.365	+019.432	04	
128	23:43:58.0	272	002049	+090.354	+019.212	04	
128	23:43:59.0	272	002049	+090.343	+018.979	04	
128	23:44:00.0	272	002049	+090.343	+018.759	04	
128	23:44:01.0	272	002049	+090.332	+018.539	04	
128	23:44:02.0	272	002049	+090.310	+018.320	04	
128	23:44:03.0	272	002049	+090.299	+018.067	04	
128	23:44:04.0	272	002049	+090.299	+017.845	04	
128	23:44:05.0	272	002049	+090.266	+017.614	04	
128	23:44:06.0	272	002049	+090.255	+017.394	04	
128	23:44:07.0	272	002049	+090.255	+017.161	04	

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
128	23:44:08.0	272	002049	+090.233	+016.930	04	
128	23:44:09.0	272	002049	+090.222	+016.688	04	
128	23:44:10.0	272	002049	+090.222	+016.469	04	
128	23:44:11.0	272	002049	+090.211	+016.238	04	
128	23:44:12.0	272	002049	+090.179	+015.993	04	
128	23:44:13.0	272	002049	+090.179	+015.774	04	
128	23:44:14.0	272	002049	+090.168	+015.543	04	
128	23:44:15.0	272	002049	+090.157	+015.323	04	
128	23:44:16.0	272	002049	+090.146	+015.079	04	
128	23:44:17.0	272	002049	+090.146	+014.837	04	
128	23:44:18.0	272	002049	+090.135	+014.593	04	
128	23:44:19.0	272	002049	+090.113	+014.362	04	
128	23:44:20.0	272	002049	+090.113	+014.131	04	
128	23:44:21.0	272	002049	+090.113	+013.911	04	
128	23:44:22.0	272	002049	+090.091	+013.645	04	
128	23:44:23.0	272	002049	+090.080	+013.414	04	
128	23:44:24.0	272	002049	+090.080	+013.159	04	
128	23:44:25.0	272	002049	+090.080	+012.939	04	
128	23:44:26.0	272	002049	+090.080	+012.708	04	
128	23:44:27.0	272	002049	+090.069	+012.467	04	
128	23:44:28.0	272	002049	+090.036	+012.233	04	
128	23:44:29.0	272	002049	+090.036	+011.992	04	
128	23:44:30.0	272	002049	+090.036	+011.747	04	
128	23:44:31.0	272	002049	+090.036	+011.527	04	
128	23:44:32.0	272	002049	+090.025	+011.272	04	
128	23:44:33.0	272	002049	+090.003	+011.041	04	
128	23:44:34.0	272	002049	+090.003	+010.775	04	
128	23:44:35.0	272	002049	+090.003	+010.544	04	
128	23:44:36.0	272	002049	+090.003	+010.300	04	
128	23:44:37.0	272	002049	+089.992	+010.066	04	
128	23:44:38.0	272	002049	+089.992	+009.836	04	
128	23:44:39.0	272	002049	+089.981	+009.594	04	
128	23:44:40.0	272	002049	+089.959	+009.360	04	
128	23:44:41.0	272	002049	+089.959	+009.130	04	
128	23:44:42.0	272	002049	+089.959	+008.915	04	
128	23:44:43.0	272	002049	+089.959	+008.685	04	
128	23:44:44.0	272	002049	+089.959	+008.443	04	
128	23:44:45.0	272	002049	+089.959	+008.166	04	
128	23:44:46.0	272	002049	+089.959	+007.899	04	
128	23:44:47.0	272	002049	+089.948	+007.633	04	
128	23:44:48.0	272	002049	+089.948	+007.531	04	
128	23:44:49.0	272	002049	+091.541	+011.508	04	
128	23:44:50.0	272	002049	+090.937	+014.293	04	
128	23:44:51.0	272	002049	+090.739	+015.669	04	
128	23:44:52.0	272	002049	+090.772	+015.287	04	
128	23:44:53.0	272	002049	+090.827	+015.452	04	
128	23:44:54.0	272	002049	+090.772	+015.200	04	
128	23:44:55.0	272	002049	+090.816	+015.145	04	
128	23:44:56.0	272	002049	+090.772	+014.991	04	
128	23:44:57.0	272	002049	+090.772	+014.922	04	

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
128	23:44:58.0	272	002049	+090.772	+014.812	04	
128	23:44:59.0	272	002049	+090.783	+014.713	04	
128	23:45:00.0	272	002049	+090.783	+014.604	04	
128	23:45:01.0	272	002049	+090.783	+014.483	04	
128	23:45:02.0	272	002049	+090.783	+014.384	04	
128	23:45:03.0	272	002049	+090.772	+014.263	04	
128	23:45:04.0	272	002049	+090.772	+014.139	04	
128	23:45:05.0	272	002049	+090.772	+014.041	04	
128	23:45:06.0	272	002049	+090.772	+013.920	04	
128	23:45:07.0	272	002049	+090.772	+013.810	04	
128	23:45:08.0	272	002049	+090.772	+013.700	04	
128	23:45:09.0	272	002049	+090.772	+013.598	04	
128	23:45:10.0	272	002049	+090.772	+013.477	04	
128	23:45:11.0	272	002049	+090.772	+013.379	04	
128	23:45:12.0	272	002049	+090.772	+013.258	04	
128	23:45:13.0	272	002049	+090.772	+013.159	04	
128	23:45:14.0	272	002049	+090.772	+013.060	04	
128	23:45:15.0	272	002049	+090.772	+012.950	04	
128	23:45:16.0	272	002049	+090.772	+012.827	04	
128	23:45:17.0	272	002049	+090.761	+012.717	04	
128	23:45:18.0	272	002049	+090.750	+012.629	04	
128	23:45:19.0	272	002049	+090.750	+012.530	04	
128	23:45:20.0	272	002049	+090.761	+012.417	04	
128	23:45:21.0	272	002049	+090.761	+012.318	04	
128	23:45:22.0	272	002049	+090.761	+012.198	04	
128	23:45:23.0	272	002049	+090.761	+012.099	04	
128	23:45:24.0	272	002049	+090.772	+012.011	04	
128	23:45:25.0	272	002049	+090.772	+011.909	04	
128	23:45:26.0	272	002049	+090.772	+011.788	04	
128	23:45:27.0	272	002049	+090.772	+011.700	04	
128	23:45:28.0	272	002049	+090.761	+011.613	04	
128	23:45:29.0	272	002049	+090.761	+011.503	04	
128	23:45:30.0	272	002049	+090.750	+011.404	04	
128	23:45:31.0	272	002049	+090.750	+011.302	04	
128	23:45:32.0	272	002049	+090.750	+011.203	04	
128	23:45:33.0	272	002049	+090.750	+011.093	04	
128	23:45:34.0	272	002049	+090.750	+011.003	04	
128	23:45:35.0	272	002049	+090.750	+010.904	04	
128	23:45:36.0	272	002049	+090.750	+010.794	04	
128	23:45:37.0	272	002049	+090.750	+010.695	04	
128	23:45:38.0	272	002049	+090.750	+010.605	04	
128	23:45:39.0	272	002049	+090.750	+010.506	04	
128	23:45:40.0	272	002049	+090.750	+010.407	04	
128	23:45:41.0	272	002049	+090.750	+010.319	04	
128	23:45:42.0	272	002049	+090.750	+010.220	04	
128	23:45:43.0	272	002049	+090.750	+010.118	04	
128	23:45:44.0	272	002049	+090.739	+010.031	04	
128	23:45:45.0	272	002049	+090.739	+009.932	04	
128	23:45:46.0	272	002049	+090.739	+009.819	04	
128	23:45:47.0	272	002049	+090.739	+009.742	04	

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
128	23:45:48.0	272	002049	+090.739	+009.654	04	
128	23:45:49.0	272	002049	+090.739	+009.555	04	
128	23:45:50.0	272	002049	+090.739	+009.465	04	
128	23:45:51.0	272	002049	+090.739	+009.355	04	
128	23:45:52.0	272	002049	+090.739	+009.278	04	
128	23:45:53.0	272	002049	+090.739	+009.179	04	
128	23:45:54.0	272	002049	+090.739	+009.088	04	
128	23:45:55.0	272	002049	+090.739	+009.023	04	
128	23:45:56.0	272	002049	+090.739	+008.957	04	
128	23:45:57.0	272	002049	+090.739	+008.869	04	
128	23:45:58.0	272	002049	+090.739	+008.671	04	
128	23:45:59.0	272	002049	+090.739	+008.635	04	
128	23:46:00.0	272	002049	+090.750	+008.534	04	
128	23:46:01.0	272	002049	+090.739	+008.468	04	
128	23:46:02.0	272	002049	+090.750	+008.358	04	
128	23:46:03.0	272	002049	+090.750	+008.248	04	
128	23:46:04.0	272	002049	+090.739	+008.168	04	
128	23:46:05.0	272	002049	+090.783	+008.080	04	
128	23:46:06.0	272	002049	+090.750	+007.990	04	
128	23:46:07.0	272	002049	+090.772	+007.902	04	
128	23:46:08.0	272	002049	+090.761	+007.825	04	
128	23:46:09.0	272	002049	+090.750	+007.756	04	
128	23:46:10.0	272	002049	+090.739	+007.657	04	
128	23:46:11.0	272	002049	+090.750	+007.548	04	
128	23:46:12.0	272	002049	+090.728	+007.457	04	
128	23:46:13.0	272	002049	+090.750	+007.402	04	
128	23:46:14.0	272	002049	+090.739	+007.314	04	
128	23:46:15.0	272	002049	+090.717	+007.224	04	
128	23:46:16.0	272	002049	+090.750	+007.147	04	
128	23:46:17.0	272	002049	+090.728	+007.056	04	
128	23:46:18.0	272	002049	+090.739	+006.979	04	
128	23:46:19.0	272	002049	+090.717	+006.888	04	
128	23:46:20.0	272	002049	+090.761	+006.801	04	
128	23:46:21.0	272	002049	+090.717	+006.735	04	
128	23:46:22.0	272	002049	+090.750	+006.644	04	
128	23:46:23.0	272	002049	+090.706	+006.589	04	
128	23:46:24.0	272	002049	+090.739	+006.512	04	
128	23:46:25.0	272	002049	+090.706	+006.422	04	
128	23:46:26.0	272	002049	+090.728	+006.345	04	
128	23:46:27.0	272	002049	+090.714	+006.265	04	
128	23:46:28.0	272	002049	+090.714	+006.130	04	
128	23:46:29.0	272	002049	+090.714	+006.064	04	
128	23:46:30.0	272	002049	+090.714	+005.985	04	
128	23:46:31.0	272	002049	+090.714	+005.897	04	
128	23:46:32.0	272	002049	+090.703	+005.842	04	
128	23:46:33.0	272	002049	+090.714	+005.762	04	
128	23:46:34.0	272	002049	+090.714	+005.707	04	
128	23:46:35.0	272	002049	+090.714	+005.639	04	
128	23:46:36.0	272	002049	+090.692	+005.504	04	
128	23:46:37.0	272	002049	+090.692	+005.438	04	

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**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
128	23:39:58.0	010	002049	+357.308	-000.151	04	*
128	23:39:59.0	010	002049	+357.308	-000.151	04	
128	23:40:00.0	010	002049	+357.317	-000.151	04	
128	23:40:01.0	010	002049	+357.322	-000.151	04	
128	23:40:02.0	010	002049	+357.317	-000.151	04	
128	23:40:03.0	010	002049	+357.322	-000.148	04	
128	23:40:04.0	010	002049	+357.330	-000.129	04	
128	23:40:05.0	010	002049	+357.333	-000.102	04	
128	23:40:06.0	010	002049	+357.341	-000.063	04	
128	23:40:07.0	010	002049	+357.325	+000.003	04	
128	23:40:08.0	010	002049	+357.319	+000.066	04	
128	23:40:09.0	010	002049	+357.322	+000.135	04	T
128	23:40:10.0	010	002049	+357.322	+000.187	04	T
128	23:40:11.0	010	002049	+357.319	+000.269	04	T
128	23:40:12.0	010	002049	+357.308	+000.346	04	T
128	23:40:13.0	010	002049	+357.306	+000.439	04	T
128	23:40:14.0	010	002049	+357.325	+000.547	04	T
128	23:40:15.0	010	002049	+357.341	+000.665	04	T
128	23:40:16.0	010	002049	+357.369	+000.786	04	T
128	23:40:17.0	010	002049	+357.410	+000.906	04	
128	23:40:18.0	010	002049	+357.435	+001.052	04	
128	23:40:19.0	010	002049	+357.410	+001.121	04	
128	23:40:20.0	010	002049	+357.435	+001.288	04	
128	23:40:21.0	010	002049	+357.495	+001.456	04	
128	23:40:22.0	010	002049	+357.715	+001.739	04	
128	23:40:23.0	010	002049	+357.764	+001.912	04	
128	23:40:24.0	010	002049	+357.849	+002.008	04	
128	23:40:25.0	010	002049	+357.915	+002.206	04	
128	23:40:26.0	010	002049	+358.050	+002.431	04	
128	23:40:27.0	010	002049	+358.141	+002.694	04	
128	23:40:28.0	010	002049	+358.270	+002.887	04	
128	23:40:29.0	010	002049	+358.393	+003.128	04	
128	23:40:30.0	010	002049	+358.522	+003.354	04	
128	23:40:31.0	010	002049	+358.657	+003.584	04	
128	23:40:32.0	010	002049	+358.797	+003.831	04	
128	23:40:33.0	010	002049	+358.940	+003.994	04	
128	23:40:34.0	010	002049	+359.094	+004.356	04	
128	23:40:35.0	010	002049	+359.258	+004.603	04	
128	23:40:36.0	010	002049	+359.420	+004.864	04	
128	23:40:37.0	010	002049	+359.588	+005.128	04	
128	23:40:38.0	010	002049	+359.764	+005.416	04	
128	23:40:39.0	010	002049	+359.959	+005.707	04	
128	23:40:40.0	010	002049	+000.148	+005.990	04	
128	23:40:41.0	010	002049	+000.346	+006.202	04	
128	23:40:42.0	010	002049	+000.541	+006.548	04	
128	23:40:43.0	010	002049	+000.755	+006.847	04	
128	23:40:44.0	010	002049	+000.975	+007.155	04	
128	23:40:45.0	010	002049	+001.203	+007.462	04	
128	23:40:46.0	010	002049	+001.434	+007.806	04	
128	23:40:47.0	010	002049	+001.659	+008.141	04	

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
128	23:40:48.0	010	002049	+001.890	+008.454	04	
128	23:40:49.0	010	002049	+002.126	+008.773	04	
128	23:40:50.0	010	002049	+002.379	+009.108	04	
128	23:40:51.0	010	002049	+002.639	+009.467	04	
128	23:40:52.0	010	002049	+002.903	+009.808	04	
128	23:40:53.0	010	002049	+003.167	+010.151	04	
128	23:40:54.0	010	002049	+003.433	+010.489	04	
128	23:40:55.0	010	002049	+003.705	+010.846	04	
128	23:40:56.0	010	002049	+003.991	+011.212	04	
128	23:40:57.0	010	002049	+004.279	+011.580	04	
128	23:40:58.0	010	002049	+004.573	+011.928	04	
128	23:40:59.0	010	002049	+004.872	+012.294	04	
128	23:41:00.0	010	002049	+005.177	+012.667	04	
128	23:41:01.0	010	002049	+005.488	+013.063	04	
128	23:41:02.0	010	002049	+005.804	+013.458	04	
128	23:41:03.0	010	002049	+006.122	+013.870	04	
128	23:41:04.0	010	002049	+006.449	+014.260	04	
128	23:41:05.0	010	002049	+006.792	+014.669	04	
128	23:41:06.0	010	002049	+007.152	+015.073	04	
128	23:41:07.0	010	002049	+007.517	+015.499	04	
128	23:41:08.0	010	002049	+007.880	+015.933	04	
128	23:41:09.0	010	002049	+008.242	+016.375	04	
128	23:41:10.0	010	002049	+008.622	+016.806	04	
128	23:41:11.0	010	002049	+009.028	+017.265	04	
128	23:41:12.0	010	002049	+009.396	+017.677	04	
128	23:41:13.0	010	002049	+009.814	+018.125	04	
128	23:41:14.0	010	002049	+010.242	+018.603	04	
128	23:41:15.0	010	002049	+010.679	+019.042	04	
128	23:41:16.0	010	002049	+011.113	+019.501	04	
128	23:41:17.0	010	002049	+011.566	+019.957	04	
128	23:41:18.0	010	002049	+012.033	+020.426	04	
128	23:41:19.0	010	002049	+012.513	+020.901	04	
128	23:41:20.0	010	002049	+013.005	+021.368	04	
128	23:41:21.0	010	002049	+013.530	+021.846	04	
128	23:41:22.0	010	002049	+014.052	+022.305	04	
128	23:41:23.0	010	002049	+014.573	+022.755	04	
128	23:41:24.0	010	002049	+015.112	+023.231	04	
128	23:41:25.0	010	002049	+015.675	+023.700	04	
128	23:41:26.0	010	002049	+016.254	+024.151	04	
128	23:41:27.0	010	002049	+016.853	+024.607	04	
128	23:41:28.0	010	002049	+017.477	+025.030	04	
128	23:41:29.0	010	002049	+018.092	+025.472	04	
128	23:41:30.0	010	002049	+018.704	+025.906	04	
128	23:41:31.0	010	002049	+019.366	+026.348	04	
128	23:41:32.0	010	002049	+020.025	+026.785	04	
128	23:41:33.0	010	002049	+020.668	+027.166	04	
128	23:41:34.0	010	002049	+021.355	+027.584	04	
128	23:41:35.0	010	002049	+022.050	+027.985	04	
128	23:41:36.0	010	002049	+022.744	+028.372	04	
128	23:41:37.0	010	002049	+023.442	+028.732	04	

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
128	23:41:38.0	010	002049	+024.159	+029.092	04	
128	23:41:39.0	010	002049	+024.884	+029.449	04	
128	23:41:40.0	010	002049	+025.631	+029.803	04	
128	23:41:41.0	010	002049	+026.375	+030.152	04	
128	23:41:42.0	010	002049	+027.120	+030.490	04	
128	23:41:43.0	010	002049	+027.870	+030.803	04	
128	23:41:44.0	010	002049	+028.622	+031.097	04	
128	23:41:45.0	010	002049	+029.383	+031.374	04	
128	23:41:46.0	010	002049	+030.146	+031.654	04	
128	23:41:47.0	010	002049	+030.913	+031.924	04	
128	23:41:48.0	010	002049	+031.690	+032.190	04	
128	23:41:49.0	010	002049	+032.470	+032.429	04	
128	23:41:50.0	010	002049	+033.247	+032.665	04	
128	23:41:51.0	010	002049	+034.016	+032.888	04	
128	23:41:52.0	010	002049	+034.791	+033.085	04	
128	23:41:53.0	010	002049	+035.565	+033.264	04	
128	23:41:54.0	010	002049	+036.335	+033.456	04	
128	23:41:55.0	010	002049	+037.101	+033.637	04	
128	23:41:56.0	010	002049	+037.845	+033.802	04	
128	23:41:57.0	010	002049	+038.559	+033.918	04	
128	23:41:58.0	010	002049	+039.257	+034.049	04	
128	23:41:59.0	010	002049	+039.996	+034.184	04	T
128	23:42:00.0	010	002049	+040.718	+034.294	04	T
128	23:42:01.0	010	002049	+041.427	+034.393	04	T
128	23:42:02.0	010	002049	+042.119	+034.483	04	T
128	23:42:03.0	010	002049	+042.797	+034.560	04	T
128	23:42:04.0	010	002049	+043.470	+034.634	04	T
128	23:42:05.0	010	002049	+044.127	+034.700	04	T
128	23:42:06.0	010	002049	+044.778	+034.747	04	T
128	23:42:07.0	010	002049	+045.415	+034.796	04	T
128	23:42:08.0	010	002049	+046.038	+034.829	04	T
128	23:42:09.0	010	002049	+046.642	+034.865	04	T
128	23:42:10.0	010	002049	+047.233	+034.887	04	T
128	23:42:11.0	010	002049	+047.821	+034.904	04	T
128	23:42:12.0	010	002049	+048.414	+034.915	04	T
128	23:42:13.0	010	002049	+049.005	+034.915	04	T
128	23:42:14.0	010	002049	+049.601	+034.917	04	
128	23:42:15.0	010	002049	+050.098	+034.909	04	
128	23:42:16.0	010	002049	+050.699	+034.882	04	
128	23:42:17.0	010	002049	+051.235	+034.860	04	
128	23:42:18.0	010	002049	+051.746	+034.838	04	
128	23:42:19.0	010	002049	+052.248	+034.810	04	
128	23:42:20.0	010	002049	+052.712	+034.769	04	
128	23:42:21.0	010	002049	+053.193	+034.736	04	T
128	23:42:22.0	010	002049	+053.685	+034.684	04	T
128	23:42:23.0	010	002049	+054.163	+034.637	04	T
128	23:42:24.0	010	002049	+054.630	+034.579	04	T
128	23:42:25.0	010	002049	+055.088	+034.525	04	T
128	23:42:26.0	010	002049	+055.541	+034.464	04	T
128	23:42:27.0	010	002049	+055.981	+034.395	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
128	23:42:28.0	010	002049	+056.418	+034.324	04	T
128	23:42:29.0	010	002049	+056.849	+034.244	04	T
128	23:42:30.0	010	002049	+057.269	+034.176	04	T
128	23:42:31.0	010	002049	+057.689	+034.093	04	T
128	23:42:32.0	010	002049	+058.098	+034.008	04	T
128	23:42:33.0	010	002049	+058.497	+033.920	04	T
128	23:42:34.0	010	002049	+058.898	+033.846	04	T
128	23:42:35.0	010	002049	+059.282	+033.734	04	T
128	23:42:36.0	010	002049	+059.669	+033.640	04	T
128	23:42:37.0	010	002049	+060.046	+033.539	04	T
128	23:42:38.0	010	002049	+060.408	+033.442	04	T
128	23:42:39.0	010	002049	+060.782	+033.335	04	T
128	23:42:40.0	010	002049	+061.142	+033.247	04	T
128	23:42:41.0	010	002049	+061.479	+033.140	04	T
128	23:42:42.0	010	002049	+061.826	+033.028	04	T
128	23:42:43.0	010	002049	+062.169	+032.918	04	T
128	23:42:44.0	010	002049	+062.507	+032.805	04	T
128	23:42:45.0	010	002049	+062.842	+032.684	04	
128	23:42:46.0	010	002049	+063.202	+032.566	04	
128	23:42:47.0	010	002049	+063.520	+032.445	04	
128	23:42:48.0	010	002049	+063.833	+032.330	04	
128	23:42:49.0	010	002049	+064.141	+032.206	04	
128	23:42:50.0	010	002049	+064.443	+032.086	04	
128	23:42:51.0	010	002049	+064.742	+031.959	04	
128	23:42:52.0	010	002049	+065.036	+031.830	04	
128	23:42:53.0	010	002049	+065.325	+031.709	04	
128	23:42:54.0	010	002049	+065.613	+031.583	04	
128	23:42:55.0	010	002049	+065.891	+031.454	04	
128	23:42:56.0	010	002049	+066.168	+031.322	04	
128	23:42:57.0	010	002049	+066.437	+031.193	04	
128	23:42:58.0	010	002049	+066.706	+031.064	04	
128	23:42:59.0	010	002049	+066.967	+030.929	04	
128	23:43:00.0	010	002049	+067.225	+030.797	04	
128	23:43:01.0	010	002049	+067.484	+030.660	04	
128	23:43:02.0	010	002049	+067.742	+030.520	04	
128	23:43:03.0	010	002049	+067.992	+030.385	04	
128	23:43:04.0	010	002049	+068.233	+030.251	04	
128	23:43:05.0	010	002049	+068.472	+030.116	04	
128	23:43:06.0	010	002049	+068.695	+029.949	04	
128	23:43:07.0	010	002049	+068.931	+029.817	04	
128	23:43:08.0	010	002049	+069.156	+029.682	04	
128	23:43:09.0	010	002049	+069.379	+029.567	04	
128	23:43:10.0	010	002049	+069.582	+029.421	04	T
128	23:43:11.0	010	002049	+069.810	+029.298	04	T
128	23:43:12.0	010	002049	+070.030	+029.158	04	T
128	23:43:13.0	010	002049	+070.233	+029.015	04	T
128	23:43:14.0	010	002049	+070.450	+028.872	04	T
128	23:43:15.0	010	002049	+070.661	+028.729	04	T
128	23:43:16.0	010	002049	+070.873	+028.595	04	T
128	23:43:17.0	010	002049	+071.060	+028.449	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
128	23:43:18.0	010	002049	+071.263	+028.304	04	T
128	23:43:19.0	010	002049	+071.455	+028.161	04	T
128	23:43:20.0	010	002049	+071.647	+028.015	04	T
128	23:43:21.0	010	002049	+071.856	+027.872	04	T
128	23:43:22.0	010	002049	+072.037	+027.727	04	T
128	23:43:23.0	010	002049	+072.219	+027.598	04	T
128	23:43:24.0	010	002049	+072.392	+027.449	04	T
128	23:43:25.0	010	002049	+072.576	+027.304	04	T
128	23:43:26.0	010	002049	+072.765	+027.150	04	T
128	23:43:27.0	010	002049	+072.935	+027.021	04	T
128	23:43:28.0	010	002049	+073.109	+026.881	04	T
128	23:43:29.0	010	002049	+073.279	+026.730	04	T
128	23:43:30.0	010	002049	+073.444	+026.587	04	T
128	23:43:31.0	010	002049	+073.622	+026.441	04	T
128	23:43:32.0	010	002049	+073.779	+026.285	04	T
128	23:43:33.0	010	002049	+073.941	+026.164	04	T
128	23:43:34.0	010	002049	+074.106	+026.016	04	T
128	23:43:35.0	010	002049	+074.251	+025.865	04	T
128	23:43:36.0	010	002049	+074.416	+025.711	04	T
128	23:43:37.0	010	002049	+074.572	+025.576	04	T
128	23:43:38.0	010	002049	+074.704	+025.447	04	T
128	23:43:39.0	010	002049	+074.855	+025.299	04	T
128	23:43:40.0	010	002049	+075.020	+025.159	04	T
128	23:43:41.0	010	002049	+075.163	+025.008	04	T
128	23:43:42.0	010	002049	+075.309	+024.865	04	T
128	23:43:43.0	010	002049	+075.451	+024.716	04	T
128	23:43:44.0	010	002049	+075.589	+024.601	04	T
128	23:43:45.0	010	002049	+075.721	+024.453	04	T
128	23:43:46.0	010	002049	+075.869	+024.305	04	T
128	23:43:47.0	010	002049	+075.992	+024.159	04	T
128	23:43:48.0	010	002049	+076.108	+024.024	04	
128	23:43:49.0	010	002049	+076.289	+023.879	04	
128	23:43:50.0	010	002049	+076.402	+023.708	04	
128	23:43:51.0	010	002049	+076.531	+023.428	04	
128	23:43:52.0	010	002049	+076.660	+023.115	04	
128	23:43:53.0	010	002049	+076.781	+023.340	04	
128	23:43:54.0	010	002049	+076.915	+023.173	04	
128	23:43:55.0	010	002049	+077.039	+023.038	04	
128	23:43:56.0	010	002049	+077.160	+022.887	04	
128	23:43:57.0	010	002049	+077.275	+022.750	04	
128	23:43:58.0	010	002049	+077.379	+022.621	04	
128	23:43:59.0	010	002049	+077.500	+022.478	04	T
128	23:44:00.0	010	002049	+077.613	+022.354	04	T
128	23:44:01.0	010	002049	+077.731	+022.206	04	T
128	23:44:02.0	010	002049	+077.838	+022.066	04	T
128	23:44:03.0	010	002049	+077.943	+021.929	04	T
128	23:44:04.0	010	002049	+078.063	+021.789	04	T
128	23:44:05.0	010	002049	+078.190	+021.640	04	T
128	23:44:06.0	010	002049	+078.291	+021.539	04	T
128	23:44:07.0	010	002049	+078.376	+021.385	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
128	23:44:08.0	010	002049	+078.484	+021.250	04	T
128	23:44:09.0	010	002049	+078.602	+021.110	04	T
128	23:44:10.0	010	002049	+078.701	+020.981	04	T
128	23:44:11.0	010	002049	+078.788	+020.855	04	T
128	23:44:12.0	010	002049	+078.898	+020.717	04	T
128	23:44:13.0	010	002049	+079.008	+020.583	04	T
128	23:44:14.0	010	002049	+079.099	+020.443	04	T
128	23:44:15.0	010	002049	+079.189	+020.314	04	T
128	23:44:16.0	010	002049	+079.288	+020.182	04	T
128	23:44:17.0	010	002049	+079.384	+020.053	04	T
128	23:44:18.0	010	002049	+079.486	+019.921	04	T
128	23:44:19.0	010	002049	+079.571	+019.778	04	T
128	23:44:20.0	010	002049	+079.667	+019.633	04	
128	23:44:21.0	010	002049	+079.761	+019.503	04	
128	23:44:22.0	010	002049	+079.854	+019.374	04	
128	23:44:23.0	010	002049	+079.945	+019.243	04	
128	23:44:24.0	010	002049	+080.033	+019.116	04	
128	23:44:25.0	010	002049	+080.115	+018.984	04	
128	23:44:26.0	010	002049	+080.200	+018.853	04	
128	23:44:27.0	010	002049	+080.283	+018.732	04	
128	23:44:28.0	010	002049	+080.365	+018.608	04	
128	23:44:29.0	010	002049	+080.458	+018.479	04	
128	23:44:30.0	010	002049	+080.541	+018.347	04	
128	23:44:31.0	010	002049	+080.618	+018.215	04	
128	23:44:32.0	010	002049	+080.697	+018.092	04	
128	23:44:33.0	010	002049	+080.793	+017.982	04	
128	23:44:34.0	010	002049	+080.870	+017.858	04	
128	23:44:35.0	010	002049	+080.947	+017.732	04	
128	23:44:36.0	010	002049	+081.016	+017.611	04	
128	23:44:37.0	010	002049	+081.090	+017.463	04	
128	23:44:38.0	010	002049	+081.164	+017.342	04	
128	23:44:39.0	010	002049	+081.236	+017.216	04	
128	23:44:40.0	010	002049	+081.310	+017.095	04	
128	23:44:41.0	010	002049	+081.381	+016.979	04	
128	23:44:42.0	010	002049	+081.458	+016.859	04	
128	23:44:43.0	010	002049	+081.521	+016.746	04	
128	23:44:44.0	010	002049	+081.598	+016.628	04	T
128	23:44:45.0	010	002049	+081.659	+016.518	04	T
128	23:44:46.0	010	002049	+081.733	+016.397	04	T
128	23:44:47.0	010	002049	+081.810	+016.284	04	T
128	23:44:48.0	010	002049	+081.865	+016.172	04	T
128	23:44:49.0	010	002049	+081.942	+016.046	04	T
128	23:44:50.0	010	002049	+082.005	+015.925	04	T
128	23:44:51.0	010	002049	+082.071	+015.793	04	T
128	23:44:52.0	010	002049	+082.142	+015.688	04	T
128	23:44:53.0	010	002049	+082.200	+015.568	04	T
128	23:44:54.0	010	002049	+082.266	+015.452	04	T
128	23:44:55.0	010	002049	+082.323	+015.348	04	T
128	23:44:56.0	010	002049	+082.386	+015.222	04	T
128	23:44:57.0	010	002049	+082.444	+015.114	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
128	23:44:58.0	010	002049	+082.521	+014.991	04	T
128	23:44:59.0	010	002049	+082.576	+014.884	04	T
128	23:45:00.0	010	002049	+082.647	+014.777	04	T
128	23:45:01.0	010	002049	+082.689	+014.650	04	T
128	23:45:02.0	010	002049	+082.760	+014.540	04	T
128	23:45:03.0	010	002049	+082.820	+014.422	04	T
128	23:45:04.0	010	002049	+082.873	+014.307	04	T
128	23:45:05.0	010	002049	+082.933	+014.194	04	T
128	23:45:06.0	010	002049	+082.982	+014.082	04	T
128	23:45:07.0	010	002049	+083.043	+013.972	04	T
128	23:45:08.0	010	002049	+083.109	+013.884	04	T
128	23:45:09.0	010	002049	+083.153	+013.747	04	T
128	23:45:10.0	010	002049	+083.213	+013.637	04	T
128	23:45:11.0	010	002049	+083.265	+013.530	04	T
128	23:45:12.0	010	002049	+083.315	+013.420	04	T
128	23:45:13.0	010	002049	+083.370	+013.318	04	T
128	23:45:14.0	010	002049	+083.422	+013.217	04	T
128	23:45:15.0	010	002049	+083.474	+013.098	04	T
128	23:45:16.0	010	002049	+083.532	+012.997	04	T
128	23:45:17.0	010	002049	+083.581	+012.890	04	T
128	23:45:18.0	010	002049	+083.639	+012.774	04	T
128	23:45:19.0	010	002049	+083.691	+012.673	04	T
128	23:45:20.0	010	002049	+083.727	+012.566	04	T
128	23:45:21.0	010	002049	+083.782	+012.464	04	T
128	23:45:22.0	010	002049	+083.823	+012.371	04	T
128	23:45:23.0	010	002049	+083.883	+012.263	04	T
128	23:45:24.0	010	002049	+083.936	+012.159	04	T
128	23:45:25.0	010	002049	+083.979	+012.038	04	T
128	23:45:26.0	010	002049	+084.026	+011.942	04	T
128	23:45:27.0	010	002049	+084.065	+011.838	04	T
128	23:45:28.0	010	002049	+084.117	+011.739	04	T
128	23:45:29.0	010	002049	+084.155	+011.646	04	T
128	23:45:30.0	010	002049	+084.207	+011.547	04	T
128	23:45:31.0	010	002049	+084.251	+011.429	04	T
128	23:45:32.0	010	002049	+084.290	+011.338	04	T
128	23:45:33.0	010	002049	+084.334	+011.234	04	T
128	23:45:34.0	010	002049	+084.380	+011.137	04	T
128	23:45:35.0	010	002049	+084.424	+011.030	04	T
128	23:45:36.0	010	002049	+084.468	+010.934	04	T
128	23:45:37.0	010	002049	+084.512	+010.841	04	T
128	23:45:38.0	010	002049	+084.551	+010.745	04	T
128	23:45:39.0	010	002049	+084.592	+010.643	04	T
128	23:45:40.0	010	002049	+084.644	+010.552	04	T
128	23:45:41.0	010	002049	+084.674	+010.448	04	T
128	23:45:42.0	010	002049	+084.716	+010.357	04	T
128	23:45:43.0	010	002049	+084.754	+010.258	04	T
128	23:45:44.0	010	002049	+084.790	+010.176	04	T
128	23:45:45.0	010	002049	+084.836	+010.069	04	T
128	23:45:46.0	010	002049	+084.878	+009.978	04	T
128	23:45:47.0	010	002049	+084.911	+009.871	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
128	23:45:48.0	010	002049	+084.955	+009.789	04	T
128	23:45:49.0	010	002049	+084.993	+009.693	04	T
128	23:45:50.0	010	002049	+085.031	+009.597	04	T
128	23:45:51.0	010	002049	+085.067	+009.503	04	T
128	23:45:52.0	010	002049	+085.100	+009.410	04	T
128	23:45:53.0	010	002049	+085.136	+009.319	04	T
128	23:45:54.0	010	002049	+085.166	+009.229	04	T
128	23:45:55.0	010	002049	+085.210	+009.108	04	
128	23:45:56.0	010	002049	+085.248	+008.998	04	
128	23:45:57.0	010	002049	+085.284	+008.913	04	
128	23:45:58.0	010	002049	+085.320	+008.828	04	
128	23:45:59.0	010	002049	+085.364	+008.740	04	
128	23:46:00.0	010	002049	+085.394	+008.674	04	
128	23:46:01.0	010	002049	+085.430	+008.578	04	
128	23:46:02.0	010	002049	+085.463	+008.487	04	
128	23:46:03.0	010	002049	+085.498	+008.372	04	
128	23:46:04.0	010	002049	+085.542	+008.300	04	
128	23:46:05.0	010	002049	+085.575	+008.215	04	
128	23:46:06.0	010	002049	+085.614	+008.119	04	
128	23:46:07.0	010	002049	+085.652	+008.028	04	

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**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	EMT	TRACK
128	23:39:57.0	355	002049	+000.000	+000.000	04	
128	23:39:58.0	355	002049	+000.000	+000.000	04	
128	23:39:59.0	355	002049	+000.000	+000.000	04	
128	23:40:00.0	355	002049	+000.000	+000.000	04	
128	23:40:01.0	355	002049	+000.000	+000.000	04	
128	23:40:02.0	355	002049	+000.000	+000.000	04	
128	23:40:03.0	355	002049	+000.000	+000.000	04	
128	23:40:04.0	355	002049	+000.000	+000.000	04	
128	23:40:05.0	355	002049	+000.000	+000.000	04	
128	23:40:06.0	355	002049	+000.000	+000.000	04	
128	23:40:07.0	355	002049	+000.000	+000.000	04	
128	23:40:08.0	355	002049	+000.000	+000.000	04	
128	23:40:09.0	355	002049	+000.000	+000.000	04	
128	23:40:10.0	355	002049	+000.000	+000.000	04	
128	23:40:11.0	355	002049	+000.000	+000.000	04	T
128	23:40:12.0	355	002049	+000.000	+000.000	04	T
128	23:40:13.0	355	002049	+000.000	+000.000	04	T
128	23:40:14.0	355	002049	+000.000	+000.000	04	T
128	23:40:15.0	355	002049	+000.000	+000.000	04	T
128	23:40:16.0	355	002049	+000.000	+000.000	04	T
128	23:40:17.0	355	002049	+000.000	+000.000	04	T
128	23:40:18.0	355	002049	+000.000	+000.000	04	T
128	23:40:19.0	355	002049	+000.000	+000.000	04	
128	23:40:20.0	355	002049	+000.000	+000.000	04	
128	23:40:21.0	355	002049	+000.000	+000.000	04	
128	23:40:22.0	355	002049	+000.000	+000.000	04	
128	23:40:23.0	355	002049	+000.000	+000.000	04	
128	23:40:24.0	355	002049	+000.000	+000.000	04	
128	23:40:25.0	355	002049	+000.000	+000.000	04	T
128	23:40:26.0	355	002049	+000.000	+000.000	04	T
128	23:40:27.0	355	002049	+000.000	+000.000	04	T
128	23:40:28.0	355	002049	+000.000	+000.000	04	T
128	23:40:29.0	355	002049	+000.000	+000.000	04	T
128	23:40:30.0	355	002049	+000.000	+000.000	04	T
128	23:40:31.0	355	002049	+000.000	+000.000	04	T
128	23:40:32.0	355	002049	+000.000	+000.000	04	T
128	23:40:33.0	355	002049	+000.000	+000.000	04	T
128	23:40:34.0	355	002049	+000.000	+000.000	04	T
128	23:40:35.0	355	002049	+000.000	+000.000	04	T
128	23:40:36.0	355	002049	+000.000	+000.000	04	T
128	23:40:37.0	355	002049	+000.000	+000.000	04	T
128	23:40:38.0	355	002049	+000.000	+000.000	04	T
128	23:40:39.0	355	002049	+000.000	+000.000	04	T
128	23:40:40.0	355	002049	+000.000	+000.000	04	T
128	23:40:41.0	355	002049	+000.000	+000.000	04	T
128	23:40:42.0	355	002049	+000.000	+000.000	04	T
128	23:40:43.0	355	002049	+000.000	+000.000	04	T
128	23:40:44.0	355	002049	+000.000	+000.000	04	T
128	23:40:45.0	355	002049	+000.000	+000.000	04	T
128	23:40:46.0	355	002049	+000.000	+000.000	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
128	23:40:47.0	355	002049	+000.000	+000.000	04	T
128	23:40:48.0	355	002049	+000.000	+000.000	04	T
128	23:40:49.0	355	002049	+000.000	+000.000	04	T
128	23:40:50.0	355	002049	+000.000	+000.000	04	T
128	23:40:51.0	355	002049	+000.000	+000.000	04	T
128	23:40:52.0	355	002049	+000.000	+000.000	04	T
128	23:40:53.0	355	002049	+000.000	+000.000	04	T
128	23:40:54.0	355	002049	+000.000	+000.000	04	T
128	23:40:55.0	355	002049	+000.000	+000.000	04	T
128	23:40:56.0	355	002049	+000.000	+000.000	04	T
128	23:40:57.0	355	002049	+000.000	+000.000	04	T
128	23:40:58.0	355	002049	+000.000	+000.000	04	T
128	23:40:59.0	355	002049	+000.000	+000.000	04	T
128	23:41:00.0	355	002049	+000.000	+000.000	04	T
128	23:41:01.0	355	002049	+000.000	+000.000	04	T
128	23:41:02.0	355	002049	+000.000	+000.000	04	T
128	23:41:03.0	355	002049	+000.000	+000.000	04	T
128	23:41:04.0	355	002049	+000.000	+000.000	04	T
128	23:41:05.0	355	002049	+000.000	+000.000	04	T
128	23:41:06.0	355	002049	+000.000	+000.000	04	T
128	23:41:07.0	355	002049	+000.000	+000.000	04	T
128	23:41:08.0	355	002049	+000.000	+000.000	04	T
128	23:41:09.0	355	002049	+000.000	+000.000	04	T
128	23:41:10.0	355	002049	+000.000	+000.000	04	T
128	23:41:11.0	355	002049	+000.000	+000.000	04	T
128	23:41:12.0	355	002049	+000.000	+000.000	04	T
128	23:41:13.0	355	002049	+000.000	+000.000	04	T
128	23:41:14.0	355	002049	+000.000	+000.000	04	T
128	23:41:15.0	355	002049	+000.000	+000.000	04	T
128	23:41:16.0	355	002049	+000.000	+000.000	04	T
128	23:41:17.0	355	002049	+000.000	+000.000	04	T
128	23:41:18.0	355	002049	+000.000	+000.000	04	T
128	23:41:19.0	355	002049	+000.000	+000.000	04	T
128	23:41:20.0	355	002049	+000.000	+000.000	04	T
128	23:41:21.0	355	002049	+000.000	+000.000	04	T
128	23:41:22.0	355	002049	+000.000	+000.000	04	T
128	23:41:23.0	355	002049	+000.000	+000.000	04	T
128	23:41:24.0	355	002049	+000.000	+000.000	04	T
128	23:41:25.0	355	002049	+000.000	+000.000	04	T
128	23:41:26.0	355	002049	+000.000	+000.000	04	T
128	23:41:27.0	355	002049	+000.000	+000.000	04	T
128	23:41:28.0	355	002049	+000.000	+000.000	04	T
128	23:41:29.0	355	002049	+000.000	+000.000	04	T
128	23:41:30.0	355	002049	+000.000	+000.000	04	T
128	23:41:31.0	355	002049	+000.000	+000.000	04	T
128	23:41:32.0	355	002049	+000.000	+000.000	04	T
128	23:41:33.0	355	002049	+000.000	+000.000	04	T
128	23:41:34.0	355	002049	+000.000	+000.000	04	T
128	23:41:35.0	355	002049	+000.000	+000.000	04	T
128	23:41:36.0	355	002049	+000.000	+000.000	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
128	23:41:37.0	355	002049	+000.000	+000.000	04	T
128	23:41:38.0	355	002049	+000.000	+000.000	04	T
128	23:41:39.0	355	002049	+000.000	+000.000	04	T
128	23:41:40.0	355	002049	+000.000	+000.000	04	T
128	23:41:41.0	355	002049	+000.000	+000.000	04	T
128	23:41:42.0	355	002049	+000.000	+000.000	04	T
128	23:41:43.0	355	002049	+000.000	+000.000	04	T
128	23:41:44.0	355	002049	+000.000	+000.000	04	T
128	23:41:45.0	355	002049	+000.000	+000.000	04	T
128	23:41:46.0	355	002049	+000.000	+000.000	04	T
128	23:41:47.0	355	002049	+000.000	+000.000	04	T
128	23:41:48.0	355	002049	+000.000	+000.000	04	T
128	23:41:49.0	355	002049	+000.000	+000.000	04	T
128	23:41:50.0	355	002049	+000.000	+000.000	04	T
128	23:41:51.0	355	002049	+000.000	+000.000	04	T
128	23:41:52.0	355	002049	+000.000	+000.000	04	T
128	23:41:53.0	355	002049	+000.000	+000.000	04	T
128	23:41:54.0	355	002049	+000.000	+000.000	04	T
128	23:41:55.0	355	002049	+000.000	+000.000	04	T
128	23:41:56.0	355	002049	+000.000	+000.000	04	T
128	23:41:57.0	355	002049	+000.000	+000.000	04	T
128	23:41:58.0	355	002049	+000.000	+000.000	04	T
128	23:41:59.0	355	002049	+000.000	+000.000	04	T
128	23:42:00.0	355	002049	+000.000	+000.000	04	T
128	23:42:01.0	355	002049	+000.000	+000.000	04	T
128	23:42:02.0	355	002049	+000.000	+000.000	04	T
128	23:42:03.0	355	002049	+000.000	+000.000	04	T
128	23:42:04.0	355	002049	+000.000	+000.000	04	T
128	23:42:05.0	355	002049	+000.000	+000.000	04	T
128	23:42:06.0	355	002049	+000.000	+000.000	04	T
128	23:42:07.0	355	002049	+000.000	+000.000	04	T
128	23:42:08.0	355	002049	+000.000	+000.000	04	T
128	23:42:09.0	355	002049	+000.000	+000.000	04	T
128	23:42:10.0	355	002049	+000.000	+000.000	04	T
128	23:42:11.0	355	002049	+000.000	+000.000	04	T
128	23:42:12.0	355	002049	+000.000	+000.000	04	T
128	23:42:13.0	355	002049	+000.000	+000.000	04	T
128	23:42:14.0	355	002049	+000.000	+000.000	04	T
128	23:42:15.0	355	002049	+000.000	+000.000	04	T
128	23:42:16.0	355	002049	+000.000	+000.000	04	T
128	23:42:17.0	355	002049	+000.000	+000.000	04	T
128	23:42:18.0	355	002049	+000.000	+000.000	04	T
128	23:42:19.0	355	002049	+000.000	+000.000	04	T
128	23:42:20.0	355	002049	+000.000	+000.000	04	T
128	23:42:21.0	355	002049	+000.000	+000.000	04	T
128	23:42:22.0	355	002049	+000.000	+000.000	04	T
128	23:42:23.0	355	002049	+000.000	+000.000	04	T
128	23:42:24.0	355	002049	+000.000	+000.000	04	T
128	23:42:25.0	355	002049	+000.000	+000.000	04	T
128	23:42:26.0	355	002049	+000.000	+000.000	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	PMT	TRACK
128	23:42:27.0	355	002049	+000.000	+000.000	04	T
128	23:42:28.0	355	002049	+000.000	+000.000	04	T
128	23:42:29.0	355	002049	+000.000	+000.000	04	T
128	23:42:30.0	355	002049	+000.000	+000.000	04	T
128	23:42:31.0	355	002049	+000.000	+000.000	04	T
128	23:42:32.0	355	002049	+000.000	+000.000	04	T
128	23:42:33.0	355	002049	+000.000	+000.000	04	T
128	23:42:34.0	355	002049	+000.000	+000.000	04	T
128	23:42:35.0	355	002049	+000.000	+000.000	04	T
128	23:42:36.0	355	002049	+000.000	+000.000	04	T
128	23:42:37.0	355	002049	+000.000	+000.000	04	T
128	23:42:38.0	355	002049	+000.000	+000.000	04	T
128	23:42:39.0	355	002049	+000.000	+000.000	04	T
128	23:42:40.0	355	002049	+000.000	+000.000	04	T
128	23:42:41.0	355	002049	+000.000	+000.000	04	T
128	23:42:42.0	355	002049	+000.000	+000.000	04	T
128	23:42:43.0	355	002049	+000.000	+000.000	04	T
128	23:42:44.0	355	002049	+000.000	+000.000	04	T
128	23:42:45.0	355	002049	+000.000	+000.000	04	T
128	23:42:46.0	355	002049	+000.000	+000.000	04	T
128	23:42:47.0	355	002049	+000.000	+000.000	04	T
128	23:42:48.0	355	002049	+000.000	+000.000	04	T
128	23:42:49.0	355	002049	+000.000	+000.000	04	T
128	23:42:50.0	355	002049	+000.000	+000.000	04	T
128	23:42:51.0	355	002049	+000.000	+000.000	04	T
128	23:42:52.0	355	002049	+000.000	+000.000	04	T
128	23:42:53.0	355	002049	+000.000	+000.000	04	T
128	23:42:54.0	355	002049	+000.000	+000.000	04	T
128	23:42:55.0	355	002049	+000.000	+000.000	04	T
128	23:42:56.0	355	002049	+000.000	+000.000	04	T
128	23:42:57.0	355	002049	+000.000	+000.000	04	T
128	23:42:58.0	355	002049	+000.000	+000.000	04	T
128	23:42:59.0	355	002049	+000.000	+000.000	04	T
128	23:43:00.0	355	002049	+000.000	+000.000	04	T
128	23:43:01.0	355	002049	+000.000	+000.000	04	T
128	23:43:02.0	355	002049	+000.000	+000.000	04	T
128	23:43:03.0	355	002049	+000.000	+000.000	04	
128	23:43:04.0	355	002049	+000.000	+000.000	04	
128	23:43:05.0	355	002049	+000.000	+000.000	04	
128	23:43:06.0	355	002049	+000.000	+000.000	04	
128	23:43:07.0	355	002049	+000.000	+000.000	04	
128	23:43:08.0	355	002049	+000.000	+000.000	04	
128	23:43:09.0	355	002049	+000.000	+000.000	04	
128	23:43:10.0	355	002049	+000.000	+000.000	04	
128	23:43:11.0	355	002049	+000.000	+000.000	04	
128	23:43:12.0	355	002049	+000.000	+000.000	04	
128	23:43:13.0	355	002049	+000.000	+000.000	04	
128	23:43:14.0	355	002049	+000.000	+000.000	04	
128	23:43:15.0	355	002049	+000.000	+000.000	04	
128	23:43:16.0	355	002049	+000.000	+000.000	04	T

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	FMT	TRACK
128	23:43:17.0	355	002049	+000.000	+000.000	04	T
128	23:43:18.0	355	002049	+000.000	+000.000	04	T
128	23:43:19.0	355	002049	+000.000	+000.000	04	T
128	23:43:20.0	355	002049	+000.000	+000.000	04	T
128	23:43:21.0	355	002049	+000.000	+000.000	04	T
128	23:43:22.0	355	002049	+000.000	+000.000	04	T
128	23:43:23.0	355	002049	+000.000	+000.000	04	T
128	23:43:24.0	355	002049	+000.000	+000.000	04	T
128	23:43:25.0	355	002049	+000.000	+000.000	04	
128	23:43:26.0	355	002049	+000.000	+000.000	04	
128	23:43:27.0	355	002049	+000.000	+000.000	04	
128	23:43:28.0	355	002049	+000.000	+000.000	04	
128	23:43:29.0	355	002049	+000.000	+000.000	04	
128	23:43:30.0	355	002049	+000.000	+000.000	04	
128	23:43:31.0	355	002049	+000.000	+000.000	04	
128	23:43:32.0	355	002049	+000.000	+000.000	04	
128	23:43:33.0	355	002049	+000.000	+000.000	04	
128	23:43:34.0	355	002049	+000.000	+000.000	04	
128	23:43:35.0	355	002049	+000.000	+000.000	04	
128	23:43:36.0	355	002049	+000.000	+000.000	04	
128	23:43:37.0	355	002049	+000.000	+000.000	04	
128	23:43:38.0	355	002049	+000.000	+000.000	04	T
128	23:43:39.0	355	002049	+000.000	+000.000	04	T
128	23:43:40.0	355	002049	+000.000	+000.000	04	T
128	23:43:41.0	355	002049	+000.000	+000.000	04	T
128	23:43:42.0	355	002049	+000.000	+000.000	04	T
128	23:43:43.0	355	002049	+000.000	+000.000	04	T
128	23:43:44.0	355	002049	+000.000	+000.000	04	T
128	23:43:45.0	355	002049	+000.000	+000.000	04	T
128	23:43:46.0	355	002049	+000.000	+000.000	04	T
128	23:43:47.0	355	002049	+000.000	+000.000	04	T
128	23:43:48.0	355	002049	+000.000	+000.000	04	T
128	23:43:49.0	355	002049	+000.000	+000.000	04	T
128	23:43:50.0	355	002049	+000.000	+000.000	04	T
128	23:43:51.0	355	002049	+000.000	+000.000	04	T
128	23:43:52.0	355	002049	+000.000	+000.000	04	T
128	23:43:53.0	355	002049	+000.000	+000.000	04	T
128	23:43:54.0	355	002049	+000.000	+000.000	04	T
128	23:43:55.0	355	002049	+000.000	+000.000	04	T
128	23:43:56.0	355	002049	+000.000	+000.000	04	T
128	23:43:57.0	355	002049	+000.000	+000.000	04	T
128	23:43:58.0	355	002049	+000.000	+000.000	04	T
128	23:43:59.0	355	002049	+000.000	+000.000	04	T
128	23:44:00.0	355	002049	+000.000	+000.000	04	T
128	23:44:01.0	355	002049	+000.000	+000.000	04	T
128	23:44:02.0	355	002049	+000.000	+000.000	04	T
128	23:44:03.0	355	002049	+000.000	+000.000	04	
128	23:44:04.0	355	002049	+000.000	+000.000	04	
128	23:44:05.0	355	002049	+000.000	+000.000	04	
128	23:44:06.0	355	002049	+000.000	+000.000	04	

**** PTPO - HIGH DENSITY DATA DUMP UTILITY FOR OPTICS SITES ****

DAY	TIME	SITE	OBJ/TEST	AZIMUTH	ELEVATION	SMT	TRACK
128	23:44:07.0	355	002049	+000.000	+000.000	04	
128	23:44:08.0	355	002049	+000.000	+000.000	04	
128	23:44:09.0	355	002049	+000.000	+000.000	04	
128	23:44:10.0	355	002049	+000.000	+000.000	04	
128	23:44:11.0	355	002049	+000.000	+000.000	04	
128	23:44:12.0	355	002049	+000.000	+000.000	04	
128	23:44:13.0	355	002049	+000.000	+000.000	04	
128	23:44:14.0	355	002049	+000.000	+000.000	04	
128	23:44:15.0	355	002049	+000.000	+000.000	04	
128	23:44:16.0	355	002049	+000.000	+000.000	04	
128	23:44:17.0	355	002049	+000.000	+000.000	04	
128	23:44:18.0	355	002049	+000.000	+000.000	04	
128	23:44:19.0	355	002049	+000.000	+000.000	04	
128	23:44:20.0	355	002049	+000.000	+000.000	04	
128	23:44:21.0	355	002049	+000.000	+000.000	04	
128	23:44:22.0	355	002049	+000.000	+000.000	04	
128	23:44:23.0	355	002049	+000.000	+000.000	04	
128	23:44:24.0	355	002049	+000.000	+000.000	04	
128	23:44:25.0	355	002049	+000.000	+000.000	04	
128	23:44:26.0	355	002049	+000.000	+000.000	04	

Acronym List

Acronym List

AFB	AIR FORCE BASE
ASEM	ASSEMBLY OF STRUCTURES BY EVA METHODS
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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