NASA

SECTION 23

Michele Lewis

From: DISLER, JONATHAN M. (JON) (JSC-SX) (LM)
Sent: Sunday, January 19, 2003 9:30 PM
To: Armando Oliu (E-mail); BAHR, PATRICIA A. (PAT) (JSC-SJ) (NASA); CONTE, BARBARA A. (JSC-DM) (NASA); Bill Lamkin; SWAN, BOBBIE G. (JSC-CA) (NASA); ELIASON, BRENDA J. (JSC-EA6) (NASA); BALU, BRIAN K. (JSC-NC) (SAIC); ORTIZ-LONGO, CARLOS R., PHD (JSC-EA4) (NASA); CLOUDT, CHRIS R. (JSC-SX) (HEI); HADFIELD, CHRIS (JSC-CB) (CSA); Chris Lessmann; BOYKIN, CHRISTINE M. (JSC-MS2) (NASA); LARSEN, CURTIS E. (JSC-MS2) (NASA); CLEMENTS, DANIEL L. (JSC-NC) (GHG); z BROWN, DAVID M. (JSC-CB) (NASA); MOYER, DAVID S. (JSC-MV5) (NASA); BRETZ, DAVID R. (JSC-SX) (HEI); David Rigby / MPS SSM (E-mail); HAYNES, DENA S. (JSC-EV) (NASA); PREVETT, DONALD E. (DON) (JSC-EP) (NASA); MCCORMACK, DONALD L. (DON) (JSC-MV6) (NASA); Doug White; Douglas Powell (MAF); MAYER, FRED F. (JSC-NC) (SAIC); Gail Hargrove Boeing-Houston Imagery Scrn.; Greg Katnik; GALBREATH, GREGORY F. (GREG) (JSC-ES2) (NASA); BYRNE, GREGORY J., PHD (JSC-SX) (NASA); WALTERS, JAMES B. (BRITT) (JSC-SM) (NASA); 'James Feeley' (E-mail); WALTERS, JAMES B. (BRITT) (JSC-SM) (NASA); JIMENEZ, JAVIER J. (JSC-EB) (LM); Jeff Goodmark (E-mail); RICHART, JENE A. (JSC-MS2) (NASA); LIN, JILL D. (JSC-MV5) (NASA); Jim Harder; 'John McKee' (E-mail); John Ventimiglia; DISLER, JONATHAN M. (JON) (JSC-SX) (LM); Jorge Rivera; KRAMER, JULIE A. (JSC-EA4) (NASA); Karen Alfaro (E-mail); BROWN, KENNETH L. (JSC-MV6) (NASA); CROSBY, KEVIN L. (JSC-SX) (LM); 'L Lohrli' (E-mail); Malcolm Glenn; ERMINGER, MARK D. (JSC-NC) (NASA); ERMINGER, MARK D. (JSC-NC) (NASA); HOLDERMAN, MARK L. (JSC-MS3) (NASA); IVINS, MARSHA S. (JSC-CB) (NASA); MARTINEZ, HUGO E. (JSC-NC) (GHG); z ANDERSON, MICHAEL P. (JSC-CB) (NASA); SNYDER, MICHAEL W. (JSC-SX) (LM); Mike Cagle / Boeing Film Screen; Mike O'farrell; BERTSCH, P. J. (JEFF) (JSC-DM2) (NASA); Pam Madera (E-mail); DYE, PAUL F. (JSC-DA8) (NASA); PAYNE, ROBERT W. (JSC-SA13) (LM); 'Philip Kopfinger' (E-mail); Philip Peterson / Boeing Film Screen (E-mail); Philip Reid / Boeing Film Screen; SAGANTI, PREMKUMAR, PHD (JSC-SF) (LM); ADAMS, RANDALL W. (JSC-MA2) (NASA); SILVESTRI, RAYMOND T. (RAY) (JSC-DM4) (NASA); z HUSBAND, RICK D. (JSC-CB) (NASA); Robbie Robbinson; Robert Page; SCHARF, ROBERT (JSC-SX) (LM); Robert Speece; FRICKE, ROBERT W., JR (JSC-MV) (LM); ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA); WALLACE, RODNEY O. (ROD) (JSC-MS2) (NASA); Rohit Dhawan; CLAYTON, RONALD G. (RONNIE) (JSC-MS2) (NASA); GLANVILLE, ROY W. (JSC-NC) (NASA); Rudy Ramon; SA REP; Sara Brandenburg; Scott Otto; FRICK, STEPHEN N., CDR. (JSC-CB) (NASA); DERRY, STEPHEN M. (STEVE) (JSC-EG3) (NASA); Tom Rieckhoff; Tom Wilson; 'Treith' (E-mail)
Subject: JSC STS-107 Launch Film Screening Report

STS-107
Launch Film Screening Report
January 20, 2003
JSC Image Science and Analysis Group
Human Exploration Science Office / SX

ANOMALY

E204, E208, E212- During ascent at approximately 81 seconds MET, a large light-colored piece of debris was seen to originate from an area near the ET/Orbiter forward attach bipod. The debris appeared to move outboard in a -Y direction, then fell aft along the left Orbiter fuselage, and struck the underside (-Z) of the leading edge of the left wing. The strike appears to ...ve occurred on or relatively close to the wing glove near the Orbiter ...selage. After striking the left wing, the debris broke into a spray of white-colored particles that fell aft along the underside (-Z side) of the

Orbiter left wing. The spray of particles was last seen near the LSRB exhaust plume.

Comparison views of the strike area immediately before and after the event were examined for indications of damage to the wing. The resolution on the films and videos is insufficient to see individual tiles. However, no indications of damage at a larger scale as indicated by changes in brightness of the wing surface area(s) that may indicate damage was noted.

Still views and enhanced movie loops of this event are available for at the following web address:

<http://sn-isag.jsc.nasa.gov/shuttleweb/mission_support/sts-107/launch_video/107launchvideo.shtml>

The times of this event are as follows:

Debris first seen near ET/Orbiter forward attach: 016:15:40:21.699 UTC
Debris contacted left wing:
016:15:40:21.882 UTC

Crew acquired down linked video imaging the External Tank (ET), probably the source of the debris that struck the Orbiter left wing, was reviewed. Unfortunately the view is of the far side of the ET and provided no information as to the source of the debris object.

A down linked view of the Orbiter left wing upper surface from a payload camera did not image the suspected impact area.

OBSERVATIONS:

Selected launch views are available for viewing at:

<http://sn-isag.jsc.nasa.gov/shuttleweb/mission_support/sts-107/launch_film/107launchfilm.shtml>

Other launch film screening event observations similar to those seen on previous missions are:
On the launch video screening report dated 1/16/03 we reported that the right elevon motion may have been greater on STS-107 than has been typically seen. A comparison of the elevon motion was done with views from STS-113 and the previous Columbia flight (STS-109). It was concluded that the motion on STS-107 was normal in that it was similar to the elevon motion seen on STS-113 and STS-109.

E5, E17, E18, E19, E20 - Orange vapor (possibly free burning hydrogen) was seen forward of the SSME rims and near the base heat shield during SSME ignition. The orange vapor on the STS-107 films appeared to be similar to those typically seen on previous mission films and videos.

9, E20, E76 - During SSME start-up, the SSME Mach diamonds formed in the expected sequence (3, 2, 1). The times for the Mach diamond formation given below are from the engineering film E76:

SSME #3 - 15:38:56.736 UTC
SSME #2 - 15:38:56.816 UTC
SSME #1 - 15:38:57.227 UTC

The start times for SSME ignition based on the E76 film were:

SSME #3 - 15:38:55.215 UTC
SSME #2 - 15:38:55.355 UTC
SSME #1 - 15:38:55.455 UTC

E5, E76 - Movement of the SSME #3 Dome Mounted Heat Shield (DMHS) blanket was seen during SSME ignition on camera E5. On camera E76, SSME #2 and SSME #3 DMHS blanket movement was seen during SSME ignition (15:38:56.466 UTC). This event has been seen on previous mission films.

E1, E2, E4, E5, E20, E31 - Typical of previous missions, multiple pieces of ice debris were seen falling from the ET/Orbiter umbilicals and along the body flap during SSME ignition through liftoff. Ice debris was seen falling near the LH2 umbilical four inch recirculation line. None of the debris were seen to contact the launch vehicle.

E5, E18, E20, E31 - A line of frost was visible at the juncture of the base of SSME #2 and the Dome Mounted Heat Shield (DMHS) during liftoff.

E18, E20 - Typical of previous missions, small areas of tile surface material erosion were seen forming on the base heat shield and on the RCS stingers at the following times:

15:38:56.000 UTC - Erosion mark inboard of the left RCS stinger
15:38:56.562 UTC - Erosion mark outboard of SSME #2 near the body flap
15:38:57.329 UTC - Erosion mark on the tip of the left RCS stinger
15:38:58.639 UTC - Erosion mark on the left OMS pod between the OMS nozzle and vertical stabilizer

E2, E19- Faint, light-orange-colored flashes were seen in the SSME exhaust plumes, possibly debris induced, during SSME ignition and through liftoff at the times shown below:

SSME #1 - 15:38:57.728 UTC
SSME #1 - 15:38:58.385 UTC
SSME #1 - 15:38:58.779 UTC
SSME #1 - 15:38:59.019 UTC
SSME #3 - 15:38:57.395 UTC
SSME #3 - 15:38:59.532 UTC

Flashes in the SSME exhaust plume prior to liftoff have been seen on previous mission films.

E17 - Several small, dark-colored pieces of debris (possibly paint chips)

were seen falling from a seam line on the -Z side of the LO2 TSM just before
liftoff (15:38:59.566 UTC).

1, E5, E17, E52 - As typically seen on previous missions, multiple pieces
of SRB throat plug and/or SRB flame duct debris were seen near the right and
left SRBs during liftoff. On camera E1, two pieces of SRB flame duct debris
were seen arcing between the two SRB's and falling aft along the -Z side of
the body flap during liftoff (15:39:00.4 UTC). On camera E17, a large
appearing, light-colored piece of probable SRB throat plug material was seen
aft of the vehicle during liftoff (15:39:01.873 UTC). At liftoff,
light-colored debris was seen falling aft near the +Y side of the RSRB aft
skirt (15:39:02.456 UTC). On camera E52, debris from the base of the SRB's
was seen traveling north of the MLP at liftoff (15:39:02.203 UTC).

E5- A light-colored piece of debris was seen falling aft from near the
ET/RSRB aft attach during liftoff (15:39:01.235 UTC).

E8 - SRB ignition was at 15:39:00.000 UTC based on the observation of the
PIC firing at RSRB holddown post M-2.

E18 - A dark-colored, flexible, strap or tag-like object was seen on the LH2
TSM T-0 umbilcal disconnect prior to liftoff.

..9 - A long, dark-colored, flexible, strap-like object was seen coming from
the top of the LH2 TSM T-0 door before detaching and falling aft in front of
the TSM T-0 door after liftoff (15:39:03.582 UTC)

E8, E13 - The left and right SRB GN2 purge lines appeared wrapped, upright,
and intact until they were obscured by exhaust plumes at 15:39:00.000 UTC
(right purge line) and 15:39:00.003 UTC (left purge line).

E7, E10, E11, E14 - The left and right SRB north holddown post blast shields
closed prior to when the SRB nozzle exit plane rose past the level of the
SRB holddown post shoes, as they are designed to do. However, the holddown
post M4 blast shield may have closed quicker than typical.

E33, E34, E36, E39, E52- The GH2 vent arm retraction appeared normal. Ice
and vapors were seen falling aft along the ET during the vent arm
retraction. The GH2 vent arm contact with the deceleration cable on the E39
camera close-up view from inside the FSS of the vent arm capture was
visible. As designed, the arm appeared to make contact very close to the
center position of the deceleration cable. The vent arm appeared to latch
normally with no rebound. A measurement of the position of the vent arm
with respect to the center of the deceleration cable at the time of initial
contact will be made and reported separately.

E207, E212 - An assessment of the body flap motion during ascent compared to that seen on previous missions could not be made because of the soft focus on the STS-107 long range tracking camera views.

E52, E212, E213, E222, E223- Multiple pieces of debris, too numerous to count (mostly umbilical ice and RCS paper debris), were seen falling aft of the launch vehicle during ascent. Umbilical ice and RCS paper debris during ascent has been seen on previous mission films and videos. Examples are:

15:39:17.021 UTC: Forward RCS paper debris noted falling aft along the right wing (E52)
15:39:20.093 UTC: RCS paper debris noted. (E223)
15:39:20.169 UTC: Spray of RCS paper debris noted aft of the SSMEs. (E222)
15:39:23.9 UTC: Debris from ET/Orbiter umbilicals noted falling aft along body flap. (E213)
Frame 960: RCS paper debris noted falling aft of SSME exhaust plume. (E212)

E5, E20, E31, E52, E212, E222 - Pieces of orange-colored umbilical purge barrier material were seen falling aft along the -Z side of the body flap during SSME ignition (15:38:57.703 UTC). On camera E20, three pieces of light-orange colored umbilical purge barrier material were noted falling aft near SSME #2 prior to liftoff (15:38:58.394 UTC). Umbilical purge barrier material was seen falling along the body flap during tower clear on camera E52. On camera E222, a piece of umbilical purge barrier material was seen near the Orbiter right wing during liftoff (15:39:03.014 UTC). During early ascent, multiple pieces of umbilical purge barrier material were seen falling aft of the left wing on the camera E52 view. On camera E212, a piece of umbilical purge barrier material was seen falling along the body flap. On camera E222, a piece of umbilical purge barrier material was seen falling aft of the body flap at approximately 32 seconds MET (15:39:31.840 UTC). Purge barrier material falling from the ET umbilicals has been typically seen on previous mission tracking camera views.

Cameras E52, E213, E220, E222, E223 - Light-colored flares (possibly debris induced) were seen in the SSME exhaust plumes during ascent on the intermediate and long range tracking camera films. Examples of the flares observed are:

15:39:14.576 UTC: Flare noted in SSME exhaust plume (E52)
15:39:33.178 UTC: Flare seen in SSME exhaust plume (E213)
15:39:33.424 UTC: Flare seen in SSME exhaust plume (E213)
15:39:33.471 UTC: Flare seen in SSME exhaust plume (E222)
15:39:33.475 UTC: Flare seen in SSME exhaust plume (E213)
15:39:35.469 UTC: Flare seen in SSME exhaust plume (E213)
15:39:35.633 UTC: Flare seen in SSME exhaust plume (E213)
15:39:37.175 UTC: Flare seen in SSME exhaust plume (E222)
15:39:37.177 UTC: Flare seen in SSME exhaust plume (E213)

15:39:40.367 UTC: Flare seen in SSME exhaust plume (E213)
15:39:33.168 UTC: Flare seen in SSME exhaust plume (E213)
15:39:41.992 UTC: Flare seen in SSME exhaust plume (E213)
15:39:51.001 UTC: Flare seen in SSME exhaust plume (E220)
5:39:57.060 UTC: Flare seen in SSME exhaust plume (E223)

Flares in the SSME exhaust plumes have been seen on previous missions films
and videos.

E204, E207, E220, E222, E223 - As on previous missions, debris was seen exiting the SRB exhaust plumes. The debris exiting the SRB exhaust plumes
during the majority of ascent is probably instafoam from the aft end of the
SRBs. The more dense appearing debris near the time of tail-off, just prior
to SRB separation, is probably SRB slag debris. Examples of this debris are:

15:39:27.186 UTC: Debris seen falling along SRB exhaust plume (E223)
15:39:48.926 UTC: Debris seen falling along SRB exhaust plume (E220)
15:39:49.350 UTC: Debris seen falling along SRB exhaust plume (E223)

SRB separation was timed at 15:41:06.536 UTC on camera E207.

Other normal events observed included: RCS paper debris, ice and vapor from
the LO2 and LH2 TSM T-0 umbilicals prior to and after disconnect, ET twang,
multiple pieces of debris in the exhaust cloud after liftoff including rope-like debris (probable water baffle material), acoustic waves in the exhaust cloud after liftoff, charring of the ET aft dome, ET aft dome outgassing, vapor off the SRB stiffener rings, expansion waves, linear optical effects, recirculation, SRB plume brightening, and SRB slag debris
after SRB separation.

Normal Pad events observed included: Hydrogen igniter operation, MLP deluge
water activation, FSS deluge water operation, LH2 and LO2 TSM door closure,
and sound suppression system water operation.

NOTES:

Twelve 16 mm films, thirteen 35 mm films, and 24 launch videos were screened. The focus on several of the long range tracking camera film views
was very soft which hindered imagery analysis and the analysis of the debris
strike to the Orbiter wing.

This concludes the routine JSC STS-107 launch film and video screening. Image enhancements of the debris strike event, web site updates, or other
special support requests, will be performed prior to landing.

Jon Disler / SX3-LM
Chris Cloudt / SX3-HEI
Joe Caruana / SX3-LM

Michele Lewis

From: ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA)
Sent: Monday, January 20, 2003 12:24 AM
To: SHACK, PAUL E. (JSC-EA42) (NASA); 'Woodworth,Warren'
Cc: KOWAL, T. J. (JOHN) (JSC-ES3) (NASA); MADDEN, CHRISTOPHER B. (CHRIS) (JSC-ES3) (NASA); RICKMAN, STEVEN L. (JSC-ES3) (NASA); ROGERS, JOSEPH E. (JOE) (JSC-ES2) (NASA)
Subject: RE: Impact Damage Reports

Paul,
This is all I know and maybe you already have been getting the photo summaries from Jon Disler. Disler's imaging analysis group seems to be the focus of all initial information and will issue another report Monday. It looks as if Carlos Ortiz/Boeing sys. integ. (not ours of JSC) is standing by to be turned on, if necessary, to do some kind of transport analysis. Mike Dunham is aware and can do impact analysis if and when we know more.

I assume the MER is plugged into Jon Disler's periodic reports? Is there a chit in work for the crew to try see the top side of the left wing somehow? We know the RMS and RMS Cameras are not available, but what about the left side hatch little window (in the mid-deck)?

I talked briefly to ES3/Thermal Branch engineers on Friday about potential damage to the wing and where the worst heating would occur on entry. The answer is the bottom side, of course, and the closer to the root or glove is worse than outboard. For info for mission ops decision options, I asked about higher cross-range entry trajectories, as would occur on a hypothetical second or third de-orbit entry compared to the first de-orbit opportunity. The predicted heating would be somewhat higher (but not a lot higher they say) for the second de-orbit try with additional cross-range. I don't know about heating from a third de-orbit attempt to the same landing site.

Rodney Rocha
Division Chief Engineer (DCE), ES-Structural Engineering Division
- **Chair, Space Shuttle Loads & Dynamics Panel**
- **Mail Code ES2 x38889**

-----Original Message-----
From: SHACK, PAUL E. (JSC-EA42) (NASA)
Sent: Sunday, January 19, 2003 5:23 PM
To: ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA); 'Woodworth,Warren'
Subject: Impact Damage Reports

If you guys have anything info on the debris impact assessment, would you please forward. Thanks

RE: STS-107 JSC STS-107
ıg Range Trackıınch Film Scree

Michele Lewis

From: MCCORMACK, DONALD L. (DON) (JSC-MV6) (NASA)
Sent: Monday, January 20, 2003 6:42 AM
To: SHACK, PAUL E. (JSC-EA42) (NASA); SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA)
Subject: FW: JSC STS-107 Launch Film Screening Report

fyi

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A down linked view of the Orbiter left wing upper surface from a payload bay camera did not image the suspected impact area.

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SSME #3 - 15:38:59.532 UTC

Flashes in the SSME exhaust plume prior to liftoff have been seen on previous mission films.

E17 - Several small, dark-colored pieces of debris (possibly paint chips) were seen falling from a seam line on the -Z side of the LO2 TSM just before liftoff (15:38:59.566 UTC).

E1, E5, E17, E52 - As typically seen on previous missions, multiple pieces of SRB throat plug and/or SRB flame duct debris were seen near the right and left SRBs during liftoff. On camera E1, two pieces of SRB flame duct debris were seen arcing between the two SRB's and falling aft along the -Z side of the body flap during liftoff (15:39:00.4 UTC). On camera E17, a large appearing, light-colored piece of probable SRB throat plug material was seen aft of the vehicle during liftoff (15:39:01.873 UTC). At liftoff, light-colored debris was seen falling aft near the +Y side of the RSRB aft skirt (15:39:02.456 UTC). On camera E52, debris from the base of the SRB's was seen traveling north of the MLP at liftoff (15:39:02.203 UTC).

E5- A light-colored piece of debris was seen falling aft from near the ET/RSRB aft attach during liftoff (15:39:01.235 UTC).

E8 - SRB ignition was at 15:39:00.000 UTC based on the observation of the PIC firing at RSRB holddown post M-2.

E18 - A dark-colored, flexible, strap or tag-like object was seen on the LH2 TSM T-0 umbilcal disconnect prior to liftoff.

E19 - A long, dark-colored, flexible, strap-like object was seen coming from the top of the LH2 TSM T-0 door before detaching and falling aft in front of the TSM T-0 door after liftoff (15:39:03.582 UTC)

E8, E13 - The left and right SRB GN2 purge lines appeared wrapped, upright, and intact until they were obscured by exhaust plumes at 15:39:00.000 UTC (right purge line) and 15:39:00.003 UTC (left purge line).

E7, E10, E11, E14 - The left and right SRB north holddown post blast shields closed prior to when the SRB nozzle exit plane rose past the level of the SRB holddown post shoes, as they are designed to do. However, the holddown post M4 blast shield may have closed quicker than typical.

E33, E34, E36, E39, E52- The GH2 vent arm retraction appeared normal. Ice and vapors were seen falling aft along the ET during the vent arm retraction. The GH2 vent arm contact with the deceleration cable on the E39 camera close-up view from inside the FSS of the vent arm capture was visible. As designed, the arm appeared to make contact very close to the center position of the deceleration cable. The vent arm appeared to latch normally with no rebound. A measurement of the position of the vent arm with respect to the center of the deceleration cable at the time of initial contact will be made and reported separately.

E207, E212 - An assessment of the body flap motion during ascent compared to that seen on previous missions could not be made because of the soft focus on the STS-107 long range tracking camera views.

E52, E212, E213, E222, E223- Multiple pieces of debris, too numerous to count (mostly umbilical ice and RCS paper debris), were seen falling aft of the launch vehicle during ascent. Umbilical ice and RCS paper debris during ascent has been seen on previous mission films and videos. Examples are:

15:39:17.021 UTC: Forward RCS paper debris noted falling aft along the right wing (E52)
15:39:20.093 UTC: RCS paper debris noted. (E223)
15:39:20.169 UTC: Spray of RCS paper debris noted aft of the SSMEs. (E222)
15:39:23.9 UTC: Debris from ET/Orbiter umbilicals noted falling aft along body flap. (E213)
Frame 960: RCS paper debris noted falling aft of SSME exhaust plume. (E212)

E5, E20, E31, E52, E212, E222 - Pieces of orange-colored umbilical purge barrier material were seen falling aft along the -Z side of the body flap during SSME ignition (15:38:57.703 UTC). On camera E20, three pieces of light-orange colored umbilical purge barrier material were noted falling aft near SSME #2 prior to liftoff (15:38:58.394 UTC). Umbilical purge barrier material was seen falling along the body flap during tower clear on camera E52. On camera E222, a piece of umbilical purge barrier material was seen near the Orbiter right wing during liftoff (15:39:03.014 UTC). During early ascent, multiple pieces of umbilical purge barrier material were seen falling aft of the left wing on the camera E52 view. On camera E212, a piece of umbilical purge barrier material was seen falling along the body flap. On camera E222, a piece of umbilical purge barrier material was seen falling aft of the body flap at approximately 32 seconds MET (15:39:31.840 UTC). Purge barrier material falling from the ET umbilicals has been typically seen on previous mission tracking camera views.

Cameras E52, E213, E220, E222, E223 - Light-colored flares (possibly debris induced) were seen in the SSME exhaust plumes during ascent on the intermediate and long range tracking camera films. Examples of the flares observed are:

15:39:14.576 UTC: Flare noted in SSME exhaust plume (E52)
15:39:33.178 UTC: Flare seen in SSME exhaust plume (E213)
15:39:33.424 UTC: Flare seen in SSME exhaust plume (E213)
15:39:33.471 UTC: Flare seen in SSME exhaust plume (E222)
15:39:33.475 UTC: Flare seen in SSME exhaust plume (E213)
15:39:35.469 UTC: Flare seen in SSME exhaust plume (E213)
15:39:35.633 UTC: Flare seen in SSME exhaust plume (E213)
15:39:37.175 UTC: Flare seen in SSME exhaust plume (E222)
15:39:37.177 UTC: Flare seen in SSME exhaust plume (E213)
15:39:40.367 UTC: Flare seen in SSME exhaust plume (E213)
15:39:33.168 UTC: Flare seen in SSME exhaust plume (E213)
15:39:41.992 UTC: Flare seen in SSME exhaust plume (E213)
15:39:51.001 UTC: Flare seen in SSME exhaust plume (E220)
15:39:57.060 UTC: Flare seen in SSME exhaust plume (E223)

Flares in the SSME exhaust plumes have been seen on previous missions films and videos.

E204, E207, E220, E222, E223 - As on previous missions, debris was seen exiting the SRB exhaust plumes. The debris exiting the SRB exhaust plumes during the majority of ascent is probably instafoam from the aft end

of the SRBs. The more dense appearing debris near the time of tail-off, just prior to SRB separation, is probably SRB slag debris. Examples of this debris are:

5:39:27.186 UTC: Debris seen falling along SRB exhaust plume (E223)
15:39:48.926 UTC: Debris seen falling along SRB exhaust plume (E220)
15:39:49.350 UTC: Debris seen falling along SRB exhaust plume (E223)

SRB separation was timed at 15:41:06.536 UTC on camera E207.

Other normal events observed included: RCS paper debris, ice and vapor from the LO2 and LH2 TSM T-0 umbilicals prior to and after disconnect, ET twang, multiple pieces of debris in the exhaust cloud after liftoff including rope-like debris (probable water baffle material), acoustic waves in the exhaust cloud after liftoff, charring of the ET aft dome, ET aft dome outgassing, vapor off the SRB stiffener rings, expansion waves, linear optical effects, recirculation, SRB plume brightening, and SRB slag debris after SRB separation.

Normal Pad events observed included: Hydrogen igniter operation, MLP deluge water activation, FSS deluge water operation, LH2 and LO2 TSM door closure, and sound suppression system water operation.

NOTES:

Twelve 16 mm films, thirteen 35 mm films, and 24 launch videos were screened. The focus on several of the long range tracking camera film views was very soft which hindered imagery analysis and the analysis of the debris strike to the Orbiter wing.

This concludes the routine JSC STS-107 launch film and video screening. Image enhancements of the debris strike event, web site updates, or other special support requests, will be performed prior to landing.

Jon Disler / SX3-LM
Chris Cloudt / SX3-HEI
Joe Caruana / SX3-LM

Michele Lewis

From: SHACK, PAUL E. (JSC-EA42) (NASA)
Sent: Thursday, January 30, 2003 5:27 PM
To: BENZ, FRANK J. (JSC-EA) (NASA); HAMILTON, DAVID A. (DAVE) (JSC-EA) (NASA); HANSEN, LAURI N. (JSC-EA1) (NASA)
Cc: SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA)
Subject: FW: STS-107 Wing Debris Impact on Ascent: Final analysis case completed

Importance: High

Just a heads up on possible high level management activity -

The Langley Center Director heard about the debris impact and the actions being worked through LaRC's membership on the Wheel & Tire PRT. He is writing to Bill Readdy to offer Langley's help since they are landing gear experts, in spite of there being no technical concern based on the analyses that have been completed.

SUMMARY: Though this case predicted some higher temperatures at the outer layer of the honeycomb aluminum face sheet and subsequent debonding of the sheet, there is no predicted burn-through of the door, no breeching of the thermal and gas seals, nor is there door structural deformation or thermal warpage to open the seal to hot plasma intrusion. Though degradation of the TPS and door structure is likely (if the impact occurred here), there is no safety of flight (entry, descent, landing) issue.

What goes up must come down, so I did give Ralph a heads up that he may hear from HQ.

-----Original Message-----
From: ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA)
Sent: Sunday, January 26, 2003 7:45 PM
To: SHACK, PAUL E. (JSC-EA42) (NASA); MCCORMACK, DONALD L. (DON) (JSC-MV6) (NASA); OUELLETTE, FRED A. (JSC-MV6) (NASA); ROGERS, JOSEPH E. (JOE) (JSC-ES2) (NASA); GALBREATH, GREGORY F. (GREG) (JSC-ES2) (NASA); JACOBS, JEREMY B. (JSC-ES4) (NASA); SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA); KRAMER, JULIE A. (JSC-EA4) (NASA); CURRY, DONALD M. (JSC-ES3) (NASA); KOWAL, T. J. (JOHN) (JSC-ES3) (NASA); RICKMAN, STEVEN L. (JSC-ES3) (NASA); SCHOMBURG, CALVIN (JSC-EA) (NASA); CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA)
Subject: STS-107 Wing Debris Impact on Ascent: Final analysis case completed

As you recall from Friday's briefing to the MER, there remained open work to assess analytically predicted impact damage to the wing underside in the region of the main landing gear door. This area was considered a low probability hit area by the image analysis teams, but they admitted a debris strike here could not be ruled out.

As with the other analyses performed and reported on Friday, this assessment by the Boeing multi-technical discipline engineering teams also employed the system integration's dispersed trajectories followed by serial results from the *Crater* damage prediction tool, thermal analysis, and stress analysis. It was reviewed and accepted by the ES-DCE (R. Rocha) by Sunday morning, Jan. 26. The case is defined by a large area gouge about 7 inch wide and about 30 inch long with sloped sides like a crater, and reaching down to the densified layer of the TPS.

SUMMARY: Though this case predicted some higher temperatures at the outer layer of the honeycomb aluminum face sheet and subsequent debonding of the sheet, there is no predicted burn-through of the door, no breeching of the thermal and gas seals, nor is there door structural deformation or thermal warpage to open the seal to hot plasma intrusion. Though degradation of the TPS and door structure is likely (if the impact occurred here), there is no safety of flight (entry, descent, landing) issue.

Note to Don M. and Fred O.: On Friday I believe the MER was thoroughly briefed and it was clear that open work remained (viz., the case summarized above), the message of open work was not clearly given, in my opinion, to Linda Ham at the MMT. I believe we left her the impression that engineering assessments and cases were all finished and we could state with finality no safety of flight issues or questions remaining. This very serious case could not be ruled out and it was a very good thing we carried it through to a finish.

dney Rocha (ES2) x38889
- **Division Shuttle Chief Engineer (DCE), ES-Structural Engineering Division**
- **Chair, Space Shuttle Loads & Dynamics Panel**

Tracking:

Recipient	Read
BENZ, FRANK J. (JSC-EA) (NASA)	
HAMILTON, DAVID A. (DAVE) (JSC-EA) (NASA)	Read: 2/3/2003 2:20 PM
HANSEN, LAURI N. (JSC-EA1) (NASA)	
SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA)	Read: 1/30/2003 5:27 PM

Michele Lewis

From: SCHOMBURG, CALVIN (JSC-EA) (NASA)
Sent: Tuesday, January 21, 2003 10:26 AM
To: SHACK, PAUL E. (JSC-EA42) (NASA); SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA); HAMILTON, DAVID A. (DAVE) (JSC-EA) (NASA)
Subject: FW: STS-107 Post-Launch Film Review - Day 1


107film1.pdf


E212.mpg

FYI-TPS took a hit-should not be a problem-status by end of week.

-----Original Message-----
From: Oliu-1, Armando [mailto:Armando.Oliu-1@nasa.gov]
Sent: Friday, January 17, 2003 6:08 PM
To: Abner, Charlie; ADAMS, RANDALL W. (JSC-MA2) (NASA); 'Ayotte, William'; Blue, John B; BROWN, KENNETH L. (JSC-MV6) (NASA); 'Buckingham, Bruce'; Bulloch-1, Steve; Bursian, Henry; BYRNE, GREGORY J., PHD (JSC-SX) (NASA); Chitko, Pete J.; 'cookjh@thiokol.com'; DERRY, STEPHEN M. (STEVE) (JSC-EG3) (NASA); DISLER, JONATHAN M. (JON) (JSC-SX) (LM); DISLER, JONATHAN M. (JON) (JSC-SX) (LM); 'Eastwood Martin'; Estrada-1, Carlos; FRICKE, ROBERT W., JR (JSC-MV) (LM); GAETJENS, WILLIAM M. (JSC-CB) (USA); Glenn-1, Malcolm; GOMEZ, REYNALDO J. (RAY) (JSC-EG3) (NASA); 'GRP DOC Mission Support Room'; Guidi-1, John; Hawkins, Tyrell; Herman, Robert S; Herst, Terri; Holloway, Darrell L; 'Holmes Steve'; Huff, Joy N.; 'Jay.Sambamurthi@msfc.nasa.gov'; Jones-1, Frank; Kelley-1, David; 'Khodadoust, Abdollah'; Kienitz, Fred; 'Kinder Gerald'; 'Koenig Lisa'; 'Kopfinger, Philip A'; Lafleur, Tom C; Leggett, Kenneth D; Leinbach-1, Mike; HAM, LINDA J. (JSC-MA2) (NASA); 'Mango, Ed'; McClymonds, Jack'; MCCORMACK, DONALD L. (DON) (JSC-MV6) (NASA); Mosteller-1, Ted; Mulligan-1, Melanie; Nguyen-1, Bao; 'O'Farrell Mike'; ORTIZ-LONGO, CARLOS R., PHD (JSC-EA4) (NASA); 'Otte Neil'; 'Otto, Scott'; 'Page, Robert'; Payne-1, Michael; 'Ramirez, Juan'; Revay, Kenneth P; 'Rieckhoff, Tom - PC'; 'Rieckhoff, Tom - UNIX'; ROE, RALPH R. (JSC-MV) (NASA); SCHOMBURG, CALVIN (JSC-EA) (NASA); 'Schricker, B.'; 'snichols@hq.nasa.gov'; Sofge, Al (NASA HQ); 'Speece, Robert'; Stevenson-1, Charlie; 'Stone, Jeff'; Tenbusch-1, Ken; Wells-1, Joel; Wilson, Thomas F.; Rivera, Jorge; Greenwell-1, Shawn; Oliu-1, Armando; Crisafulli, Anthony; Brewer, Raymond J; Marren, Tom; Thompson-1, Becky J.; Key, John; Lorick, Vicky K; Champagne, Lorraine C; Kent, William T. "Tim"; Spaulding-1, Jeff; Altemus-1, Steve; Mullins, Michael B; Powell, Doug; Cross, Donald G; Hammel-1, Donald; Stoner-1, Michael D; Greby, Mark J
Subject: STS-107 Post-Launch Film Review - Day 1

Attached is the Day 1 report and an MPG of Anomaly #1.

<<107film1.pdf>> <<E212.mpg>>

Michele Lewis

From: ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA)
Sent: Monday, January 20, 2003 9:47 PM
To: SHACK, PAUL E. (JSC-EA42) (NASA); SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA)
Cc: KRAMER, JULIE A. (JSC-EA4) (NASA); MILLER, GLENN J. (JSC-EA) (NASA); RICKMAN, STEVEN L. (JSC-ES3) (NASA); MADDEN, CHRISTOPHER B. (CHRIS) (JSC-ES3) (NASA)
Subject: FW: STS-107 Debris Analysis Team Plans

FYI on forthcoming activity. From USA/Pam Madera and her talking to Boeing contacts:

- It appears that the image folks can only state the impactor is 20 inch max dimension plus/minus 10 inch. It has a max thickness of about 4 inch or so due to the known thicknesses of the ET insulation in the forward bipod area.
- Boeing Load/Stress group is researching if such insulation impacts are in the data base of previous impact tests on Orbiter TPS.

Rodney Rocha

- **Division Chief Engineer (DCE), ES-Structural Engineering Division**
- **Chair, Space Shuttle Loads & Dynamics Panel**
- **Mail Code ES2 x38889**

: Madera, Pamela L [mailto:pam.l.madera@usahq.unitedspacealliance.com]
Sent: Monday, January 20, 2003 5:47 PM
To: CURRY, DONALD M. (JSC-ES3) (NASA); ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA); LEVY, VINCENT M. (JSC-EG) (NASA); KOWAL, T. J. (JOHN) (JSC-ES3) (NASA); DERRY, STEPHEN M. (STEVE) (JSC-EG3) (NASA)
Cc: 'Scott Christensen V (E-mail)'; 'Norman Ignacio (Nacho) (E-mail)'; CHAO, DENNIS; Stoner-1, Michael D; 'Carlos Ortiz (E-mail)'; 'Michael J Dunham (E-mail)'; Sebesta, Stephen P; CORONADO, DIANA; "Craig Madden' (E-mail)'; Bell, Dan R.; Gordon, Michael P.; Paul A Parker (E-mail)
Subject: STS-107 Debris Analysis Team Plans

The Boeing/USA team would like to meet with you Tuesday at 2:00 on meet-me-line number
to discuss analysis plans for assessing the STS-107 Debris Impact.

Pam Madera
Vehicle and Systems Analysis Subsystem Area Manager
Phone: 281-282-4453

Michele Lewis

From: ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA)
Sent: Thursday, January 23, 2003 8:59 AM
To: SHACK, PAUL E. (JSC-EA42) (NASA); SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA); KRAMER, JULIE A. (JSC-EA4) (NASA); CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA); MILLER, GLENN J. (JSC-EA) (NASA)
Subject: FW: STS-107 Debris Analysis Team Meeting

FYI.

Rodney Rocha
Structural Engineering Division (ES-SED)

- **ES Div. Chief Engineer (Space Shuttle DCE)**
- **Chair, Space Shuttle Loads & Dynamics Panel**

Mail Code ES2 Phone 281-483-8889

-----Original Message-----
From: Madera, Pamela L [mailto:pam.l.madera@usahq.unitedspacealliance.com]
Sent: Wednesday, January 22, 2003 11:22 AM
To: CURRY, DONALD M. (JSC-ES3) (NASA); ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA); LEVY, VINCENT M. (JSC-EG) (NASA); KOWAL, T. J. (JOHN) (JSC-ES3) (NASA); DERRY, STEPHEN M. (STEVE) (JSC-EG3) (NASA); Nagle, Scott M; Carlos Ortiz (E-mail); GOMEZ, REYNALDO J. (RAY) (JSC-EG3) (NASA); DISLER, JONATHAN M. (JON) (JSC-SX) (LM); Jacobs, William A
Cc: 'Scott Christensen V (E-mail)'; 'Norman Ignacio (Nacho) (E-mail)'; CHAO, DENNIS; Stoner-1, Michael D; 'Carlos Ortiz (E-mail)'; 'Michael J Dunham (E-mail)'; Sebesta, Stephen P; CORONADO, DIANA; "Craig Madden' (E-mail)'; Bell, Dan R.; Gordon, Michael P.; 'Paul A Parker (E-mail)'; ISHMAEL, MOHAMED I. (GEORGE) (JSC-NC) (SAIC); ALEXANDER, ED
Subject: STS-107 Debris Analysis Team Meeting

Rodney Rocha has conference room 221 in JSC Building 13 available for today's 1:00 PM telecon. Located on second floor. The dial in number is the same as below. I propose the following agenda:

Review of transport analysis (Carlos Ortiz - charts attached)
Discussion of appropriate Particle Size (Ortiz, Disler, all)
Review of Flight Design Plans for Assessing Options (Bill Jacobs)
Status of Impact Damage Assessment (P. Parker)
Status of Thermal Analysis (Norm Ignacio/Dennis Chao)
Approach for stress assessment (Dunham)
Discussion on Need/Rationale for Mandatory Viewing of damage site (All)

<<STS-107 Preliminary Debris Assessment - rev2.ppt>>

Pam Madera
Vehicle and Systems Analysis Subsystem Area Manager
Phone: 281-282-4453

----Original Message----

From: Madera, Pamela L

Sent: Monday, January 20, 2003 5:47 PM

To: CURRY, DONALD M; ROCHA, ALAN RODNEY; LEVY, VINCENT M; KOWAL, T JOHN; DERRY, STEPHEN M

Cc: 'Scott Christensen V (E-mail)'; 'Norman Ignacio (Nacho) (E-mail)'; CHAO, DENNIS; Stoner-1, Michael D; 'Carlos Ortiz (E-mail)'; 'Michael J Dunham (E-mail)'; Sebesta, Stephen P; CORONADO, DIANA; "Craig Madden' (E-mail)'; Bell, Dan R.; Gordon, Michael P.; Paul A Parker (E-mail)

Subject: STS-107 Debris Analysis Team Plans

The Boeing/USA team would like to meet with you Tuesday at 2:00 on meet-me-line number ' to discuss analysis plans for assessing the STS-107 Debris Impact.

Pam Madera
Vehicle and Systems Analysis Subsystem Area Manager
Phone: 281-282-4453

Michele Lewis

From: Madera, Pamela L [pam.l.madera@usahq.unitedspacealliance.com]
Sent: Monday, January 27, 2003 10:12 AM
To: SHACK, PAUL E. (JSC-EA42) (NASA)
Subject: FW: STS-107 Debris Analysis Team Meeting

Pam Madera
Vehicle and Systems Analysis Subsystem Area Manager
Phone: 281-282-4453

-----Original Message-----
From: Madera, Pamela L
Sent: Friday, January 24, 2003 1:54 PM
To: ISHMAEL, MOHAMED I
Subject: RE: STS-107 Debris Analysis Team Meeting

Pam Madera
Vehicle and Systems Analysis Subsystem Area Manager
Phone: 281-282-4453

-----Original Message-----
From: ISHMAEL, MOHAMED I. (GEORGE) (JSC-NC) (SAIC) [mailto:mohamed.i.ishmael1@jsc.nasa.gov]
Sent: Friday, January 24, 2003 1:38 PM
To: 'Madera, Pamela L'
Subject: RE: STS-107 Debris Analysis Team Meeting

Hello Pam,
Could I get a copy of this mornings' MER charts?
Thanks.
SSE:TPS/LESS/RCC, etc.
281.483.4130

-----Original Message-----
From: Madera, Pamela L [mailto:pam.l.madera@usahq.unitedspacealliance.com]
Sent: Wednesday, January 22, 2003 11:22 AM
To: CURRY, DONALD M. (JSC-ES3) (NASA); ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA); LEVY, VINCENT M. (JSC-EG) (NASA); KOWAL, T. J. (JOHN) (JSC-ES3) (NASA); DERRY, STEPHEN M. (STEVE) (JSC-EG3) (NASA); Nagle, Scott M; Carlos Ortiz (E-mail); GOMEZ,

REYNALDO J. (RAY) (JSC-EG3) (NASA); DISLER, JONATHAN M. (JON) (JSC-SX) (LM); Jacobs, William A
Cc: 'Scott Christensen V (E-mail)'; 'Norman Ignacio (Nacho) (E-mail)'; CHAO, DENNIS; Stoner-1, Michael D; 'Carlos Ortiz (E-mail)'; 'Michael J Dunham (E-mail)'; Sebesta, Stephen P; CORONADO, DIANA; "Craig Madden' (E-mail)'; Bell, Dan R.; Gordon, Michael P.; 'Paul A Parker (E-mail)'; ISHMAEL, MOHAMED I. (GEORGE) (JSC-NC) (SAIC); ALEXANDER, ED
Subject: STS-107 Debris Analysis Team Meeting

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Status of Impact Damage Assessment (P. Parker)
Status of Thermal Analysis (Norm Ignacio/Dennis Chao)
Approach for stress assessment (Dunham)
Discussion on Need/Rationale for Mandatory Viewing of damage site (All)

<<STS-107 Preliminary Debris Assessment - rev2.ppt>>

Pam Madera
Vehicle and Systems Analysis Subsystem Area Manager
Phone: 281-282-4453

-----Original Message-----
From: Madera, Pamela L
Sent: Monday, January 20, 2003 5:47 PM
To: CURRY, DONALD M; ROCHA, ALAN RODNEY; LEVY, VINCENT M; KOWAL, T JOHN; DERRY, STEPHEN M
Cc: 'Scott Christensen V (E-mail)'; 'Norman Ignacio (Nacho) (E-mail)'; CHAO, DENNIS; Stoner-1, Michael D; 'Carlos Ortiz (E-mail)'; 'Michael J Dunham (E-mail)'; Sebesta, Stephen P; CORONADO, DIANA; "Craig Madden' (E-mail)'; Bell, Dan R.; Gordon, Michael P.; Paul A Parker (E-mail)

Subject: STS-107 Debris Analysis Team Plans

The Boeing/USA team would like to meet with you Tuesday at 2:00 on meet-me-line number to discuss analysis plans for assessing the STS-107 Debris Impact.

Pam Madera
Vehicle and Systems Analysis Subsystem Area Manager
Phone: 281-282-4453

Michele Lewis

From: CURRY, DONALD M. (JSC-ES3) (NASA)
Sent: Tuesday, January 21, 2003 12:23 PM
To: RICKMAN, STEVEN L. (JSC-ES3) (NASA); KOWAL, T. J. (JOHN) (JSC-ES3) (NASA)
Subject: RCC Damage Threshold

Attached are charts showing RCC damage threshold due to impact.

RCC damage threshold2.pdf

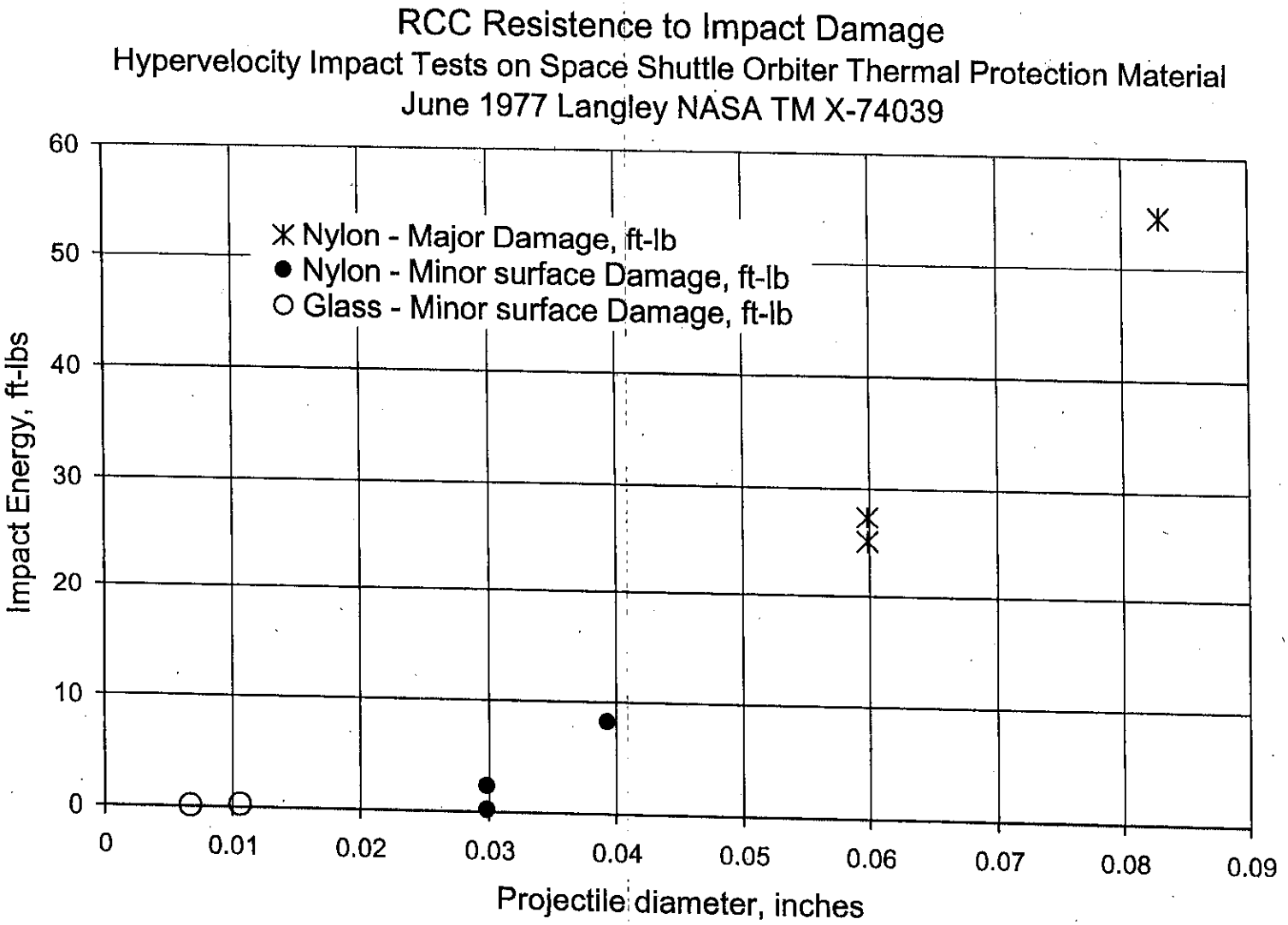
Don C

Hypervelocity Impact Tests on Space Shuttle Orbiter Using Nylon and Glass Projectiles Thermal Protection Material

June 1977

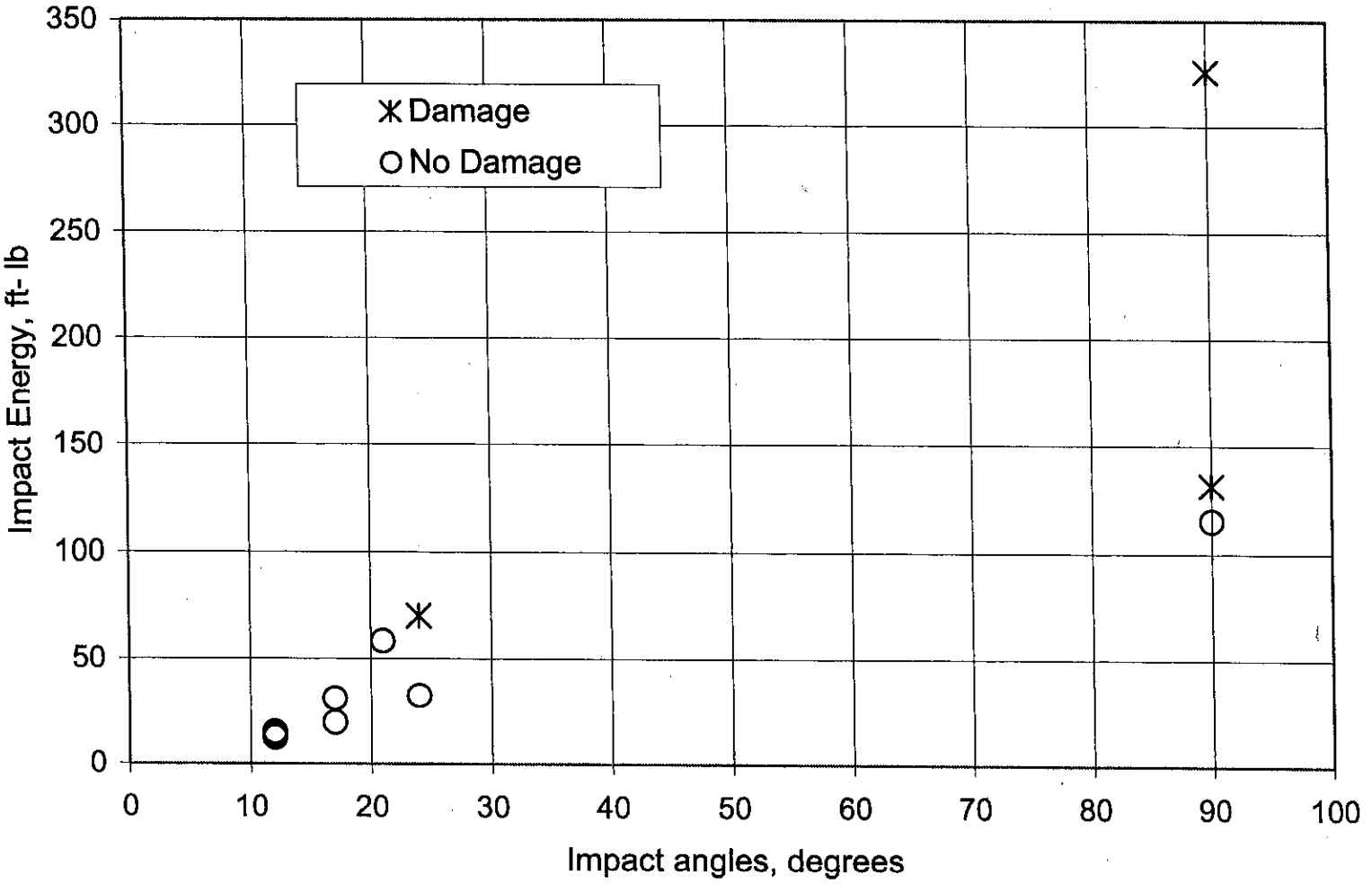
NASA/Langley

NASA TM X-74039

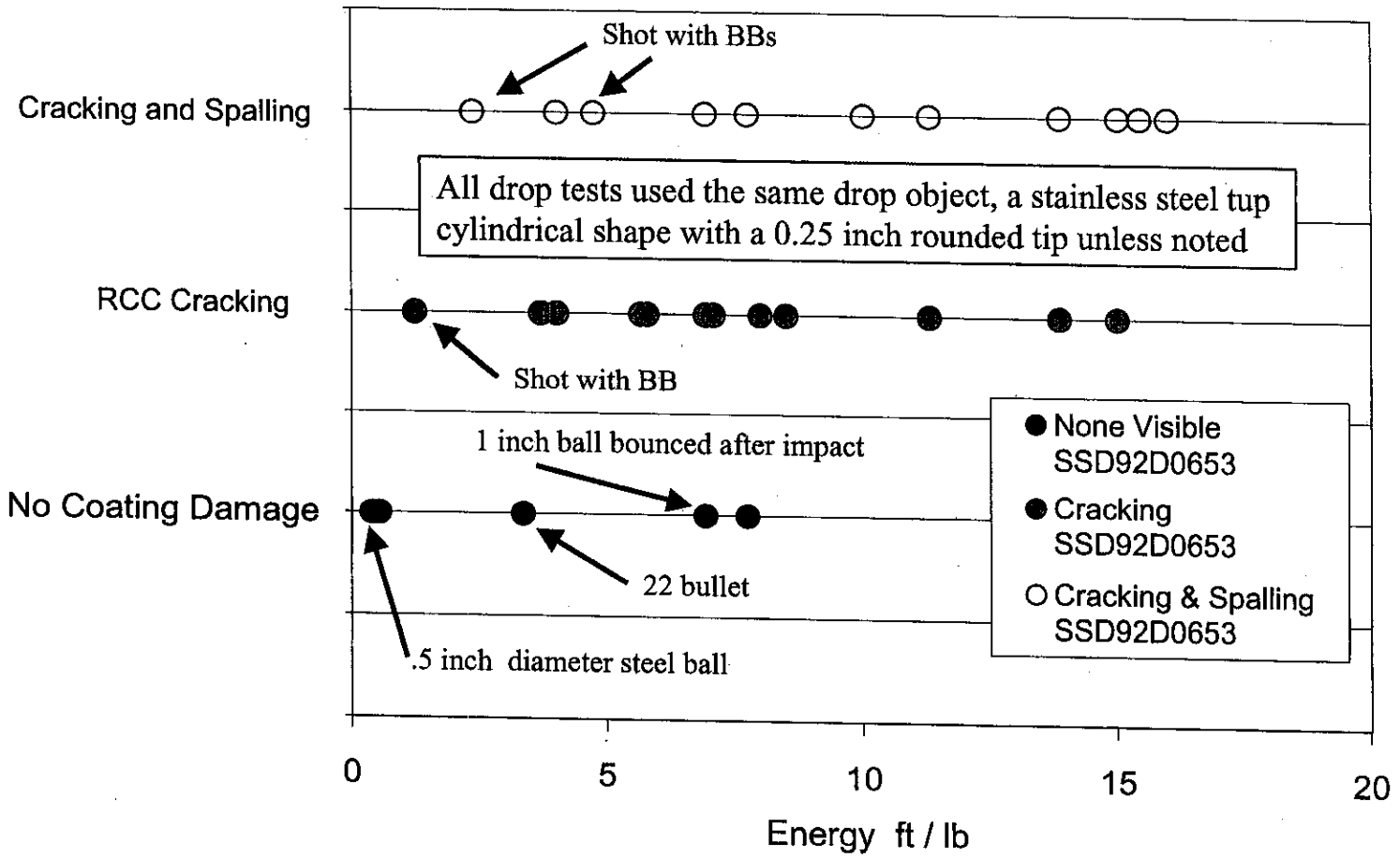

RCC Resistence to Impact Damage
Hypervelocity Impact Tests on Space Shuttle Orbiter Thermal Protection Material
June 1977 Langley NASA TM X-74039
Nylon - Major Damage, ft-lb
Nylon - Minor surface Damage, ft-lb
Glass - Minor surface Damage, ft-lb
Impact Energy, ft-lbs
60
50
40
30
20
10
0
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
Projectile diameter, inches

Test Results for Ice Impact On Orbiter RCC Surfaces
November 1984
Ice, cylinder shape

RCC Resistence to Impact Damage
Ice cylinder shape Low Velocity Air Gun – Southwest Research Institute



Damage as a Function of Energy - High Velocity Tests



SUMMARY OF IMPACT TEST DATA

RCC DAMAGE THRESHOLD

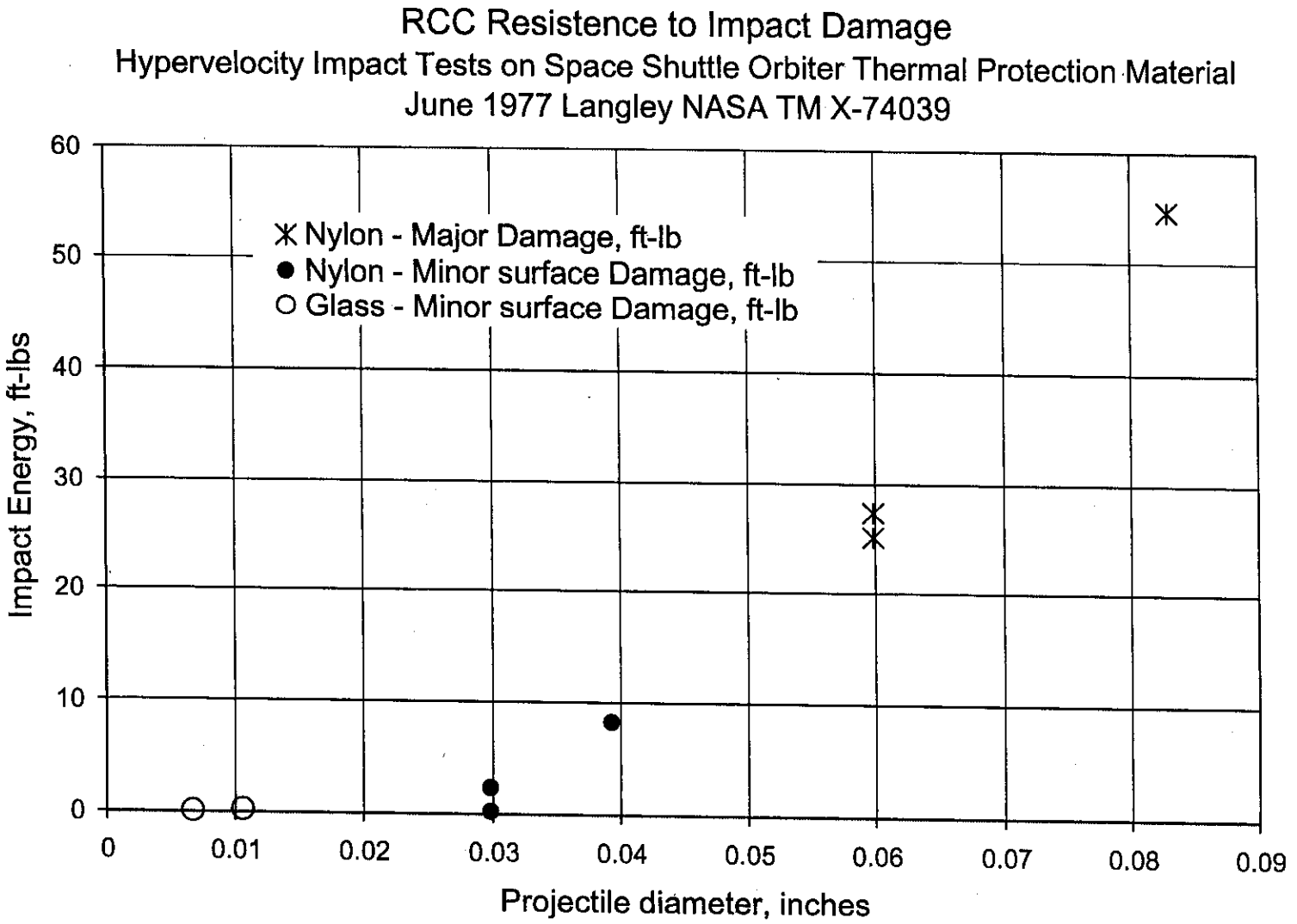
- 7.5 FT-LB - STEEL BALL DROP TEST
- NYLON PROJECTILE - NASA-LANGLEY HYPERVELOCITY TESTS (1977)
  - 0.15 FT-LB - EXTERIOR SURFACES PENETRATION
  - 2.2 FT-LB - COATING PENETRATION TO CARBON MATRIX
  - 8.1 FT-LB - IMPACT CRATER IN FRONT SURFACE, SPALLATION CRATER BACK SURFACE
  - 25 FT-LB - COMPLETE PENETRATION OF SPECIMEN

Reference:
Engineering Directorate, Johnson Space Center, Houston, Texas
CARBON-CARBON IMPACT REVIEW BRIEFING, February 1985
D. M. Curry, Thermal Branch

Hypervelocity Impact Tests on Space Shuttle Orbiter Using Nylon and Glass Projectiles Thermal Protection Material

June 1977

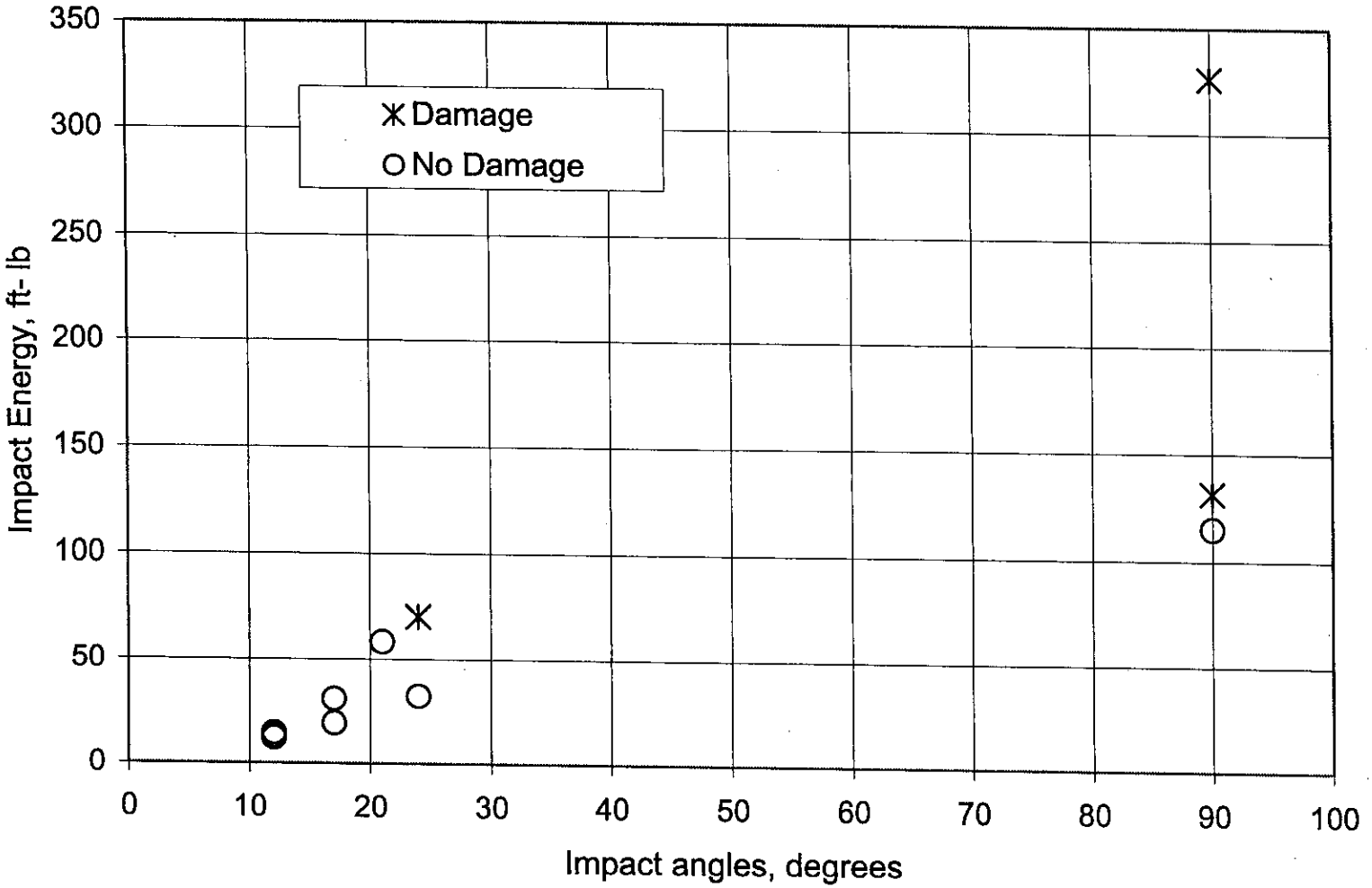
NASA/Langley
NASA TM X-74039


RCC Resistence to Impact Damage
Hypervelocity Impact Tests on Space Shuttle Orbiter Thermal Protection Material
June 1977 Langley NASA TM X-74039
Nylon - Major Damage, ft-lb
Nylon - Minor surface Damage, ft-lb
Glass - Minor surface Damage, ft-lb
Impact Energy, ft-lbs
60
50
40
30
20
10
0
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
Projectile diameter, inches

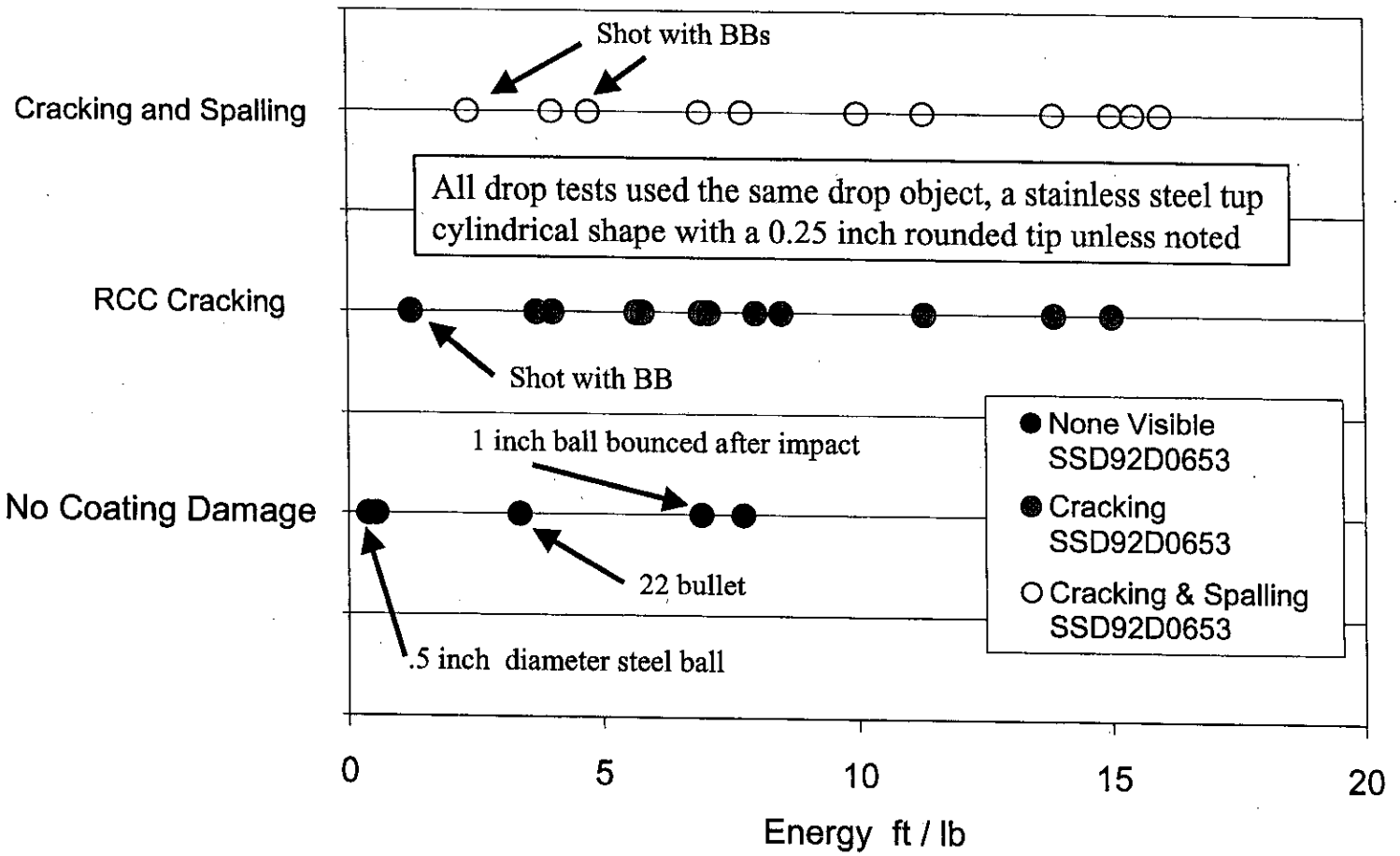
Test Results for Ice Impact On Orbiter RCC Surfaces
November 1984
Ice, cylinder shape

RCC Resistence to Impact Damage

Ice cylinder shape Low Velocity Air Gun – Southwest Research Institute



Damage as a Function of Energy - High Velocity Tests



SUMMARY OF IMPACT TEST DATA

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Reference:
Engineering Directorate, Johnson Space Center, Houston, Texas
CARBON-CARBON IMPACT REVIEW BRIEFING, February 1985
D. M. Curry, Thermal Branch

Michele Lewis

From: ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA)
Sent: Monday, January 20, 2003 12:24 AM
To: SHACK, PAUL E. (JSC-EA42) (NASA); 'Woodworth,Warren'
Cc: KOWAL, T. J. (JOHN) (JSC-ES3) (NASA); MADDEN, CHRISTOPHER B. (CHRIS) (JSC-ES3) (NASA); RICKMAN, STEVEN L. (JSC-ES3) (NASA); ROGERS, JOSEPH E. (JOE) (JSC-ES2) (NASA)
Subject: RE: Impact Damage Reports

Paul,
This is all I know and maybe you already have been getting the photo summaries from Jon Disler. Disler's imaging analysis group seems to be the focus of all initial information and will issue another report Monday. It looks as if Carlos Ortiz/Boeing sys. integ. (not ours of JSC) is standing by to be turned on, if necessary, to do some kind of transport analysis. Mike Dunham is aware and can do impact analysis if and when we know more.

I assume the MER is plugged into Jon Disler's periodic reports? Is there a chit in work for the crew to try see the top side of the left wing somehow? We know the RMS and RMS Cameras are not available, but what about the left side hatch little window (in the mid-deck)?

I talked briefly to ES3/Thermal Branch engineers on Friday about potential damage to the wing and where the worst heating would occur on entry. The answer is the bottom side, of course, and the closer to the root or glove is worse than outboard. For info for mission ops decision options, I asked about higher cross-range entry trajectories, as would occur on a hypothetical second or third de-orbit entry compared to the first de-orbit opportunity. The predicted heating would be somewhat higher (but not a lot higher they say) for the second de-orbit try with additional cross-range. I don't know about heating from a third de-orbit attempt to the same landing site.

Rodney Rocha
- **Division Chief Engineer (DCE), ES-Structural Engineering Division**
- **Chair, Space Shuttle Loads & Dynamics Panel**
- **Mail Code ES2 x38889**

-----Original Message-----
From: SHACK, PAUL E. (JSC-EA42) (NASA)
Sent: Sunday, January 19, 2003 5:23 PM
To: ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA); 'Woodworth,Warren'
Subject: Impact Damage Reports

If you guys have anything info on the debris impact assessment, would you please forward. Thanks


RE: STS-107 JSC STS-107
ıg Range Trackıınch Film Screeı

Michele Lewis

From: KOWAL, T. J. (JOHN) (JSC-ES3) (NASA)
Sent: Monday, January 27, 2003 1:04 PM
To: ORTIZ-LONGO, CARLOS R., PHD (JSC-EA4) (NASA); SHACK, PAUL E. (JSC-EA42) (NASA); SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA)
Subject: RE: STS-107 Post-Launch Film Review - Day 1

All I've heard is Mach 2.5.

John Kowal
ES3/Thermal Branch
NASA-Johnson Space Center
(281) 483-8871

-----Original Message-----
From: ORTIZ-LONGO, CARLOS R., PHD (JSC-EA4) (NASA)
Sent: Monday, January 27, 2003 11:48 AM
To: SHACK, PAUL E. (JSC-EA42) (NASA); KOWAL, T. J. (JOHN) (JSC-ES3) (NASA); SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA)
Subject: RE: STS-107 Post-Launch Film Review - Day 1

This is, certainly, the largest one I have seen hit the Orbiter. The size and density of the debris cloud tells me that the hit is probably large in surface area but shallow. In the other two more significant hits I remember, the debris clouds were both narrow and "dense" (more resembling a con-trail). When the Orbiters came back, the hits were narrow, long, and deep. At what time or altitude did this occurred?

C

-----Original Message-----
From: SHACK, PAUL E. (JSC-EA42) (NASA)
Sent: Monday, January 27, 2003 8:56 AM
To: ORTIZ-LONGO, CARLOS R., PHD (JSC-EA4) (NASA)
Subject: FW: STS-107 Post-Launch Film Review - Day 1

top view

-----Original Message-----
From: SCHOMBURG, CALVIN (JSC-EA) (NASA)
Sent: Tuesday, January 21, 2003 9:26 AM
To: SHACK, PAUL E. (JSC-EA42) (NASA); SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA); HAMILTON, DAVID A. (DAVE) (JSC-EA) (NASA)
Subject: FW: STS-107 Post-Launch Film Review - Day 1

FYI-TPS took a hit-should not be a problem-status by end of week.

-----Original Message-----
From: Oliu-1, Armando [mailto:Armando.Oliu-1@nasa.gov]
Sent: Friday, January 17, 2003 6:08 PM
To: Abner, Charlie; ADAMS, RANDALL W. (JSC-MA2) (NASA); 'Ayotte, William'; Blue, John B; BROWN, KENNETH L. (JSC-MV6) (NASA); 'Buckingham, Bruce'; Bulloch-1, Steve; Bursian, Henry; BYRNE, GREGORY J., PHD (JSC-SX) (NASA); Chitko, Pete J.; 'cookjh@thiokol.com'; DERRY, STEPHEN M. (STEVE) (JSC-EG3) (NASA); DISLER, JONATHAN M. (JON) (JSC-SX) (LM); DISLER, JONATHAN M. (JON) (JSC-SX) (LM); 'Eastwood Martin'; Estrada-1, Carlos; FRICKE, ROBERT W., JR (JSC-MV) (LM); GAETJENS, WILLIAM M.

(JSC-CB) (USA); Glenn-1, Malcolm; GOMEZ, REYNALDO J. (RAY) (JSC-EG3) (NASA); 'GRP DOC Mission Support Room'; Guidi-1, John; Hawkins, Tyrell; Herman, Robert S; Herst, Terri; Holloway, Darrell L; 'Holmes Steve'; Tuff, Joy N.; 'Jay.Sambamurthi@msfc.nasa.gov'; Jones-1, Frank; Kelley-1, David; 'Khodadoust, Abdollah'; Kienitz, Fred; 'Kinder Gerald'; 'Koenig Lisa'; 'Kopfinger, Philip A'; Lafleur, Tom C; Leggett, Kenneth D; Leinbach-1, Mike; HAM, LINDA J. (JSC-MA2) (NASA); 'Mango, Ed'; 'McClymonds, Jack'; MCCORMACK, DONALD L. (DON) (JSC-MV6) (NASA); Mosteller-1, Ted; Mulligan-1, Melanie; Nguyen-1, Bao; 'O'Farrell Mike'; ORTIZ-LONGO, CARLOS R., PHD (JSC-EA4) (NASA); 'Otte Neil'; 'Otto, Scott'; 'Page, Robert'; Payne-1, Michael; 'Ramirez, Juan'; Revay, Kenneth P; 'Rieckhoff, Tom - PC'; 'Rieckhoff, Tom - UNIX'; ROE, RALPH R. (JSC-MV) (NASA); SCHOMBURG, CALVIN (JSC-EA) (NASA); 'Schricker, B.'; 'snichols@hq.nasa.gov'; Sofge, Al (NASA HQ); 'Speece, Robert'; Stevenson-1, Charlie; 'Stone, Jeff'; Tenbusch-1, Ken; Wells-1, Joel; Wilson, Thomas F.; Rivera, Jorge; Greenwell-1, Shawn; Oliu-1, Armando; Crisafulli, Anthony; Brewer, Raymond J; Marren, Tom; Thompson-1, Becky J.; Key, John; Lorick, Vicky K; Champagne, Lorraine C; Kent, William T. "Tim"; Spaulding-1, Jeff; Altemus-1, Steve; Mullins, Michael B; Powell, Doug; Cross, Donald G; Hammel-1, Donald; Stoner-1, Michael D; Greby, Mark J
Subject: STS-107 Post-Launch Film Review - Day 1

Attached is the Day 1 report and an MPG of Anomaly #1.

<<107film1.pdf>> <<E212.mpg>>

Michele Lewis

From: KOWAL, T. J. (JOHN) (JSC-ES3) (NASA)
Sent: Monday, January 27, 2003 11:35 AM
To: ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA)
Cc: ROGERS, JOSEPH E. (JOE) (JSC-ES2) (NASA); GALBREATH, GREGORY F. (GREG) (JSC-ES2) (NASA); JACOBS, JEREMY B. (JSC-ES4) (NASA); CURRY, DONALD M. (JSC-ES3) (NASA); RICKMAN, STEVEN L. (JSC-ES3) (NASA); SCHOMBURG, CALVIN (JSC-EA) (NASA); CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA); MADDEN, CHRISTOPHER B. (CHRIS) (JSC-ES3) (NASA)
Subject: RE: STS-107 Wing Debris Impact on Ascent: Final analysis case completed

I talked to Ignacio about the analysis he ran. In the case he ran, the large gouge is in the acreage of the door. If the gouge were to occur in a location where it passes over the thermal barrier on the perimeter of the door, the statement that there is "no breeching of the thermal and gas seals" would not be valid. I think this point should be clarified; otherwise, the note sent out this morning gives a false sense of security.

John Kowal
ES3/Thermal Branch
NASA-Johnson Space Center
(281) 483-8871

-----Original Message-----
From: ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA)
Sent: Sunday, January 26, 2003 7:45 PM
To: SHACK, PAUL E. (JSC-EA42) (NASA); MCCORMACK, DONALD L. (DON) (JSC-MV6) (NASA); OUELLETTE, FRED A. (JSC-MV6) (NASA)
Cc: ROGERS, JOSEPH E. (JOE) (JSC-ES2) (NASA); GALBREATH, GREGORY F. (GREG) (JSC-ES2) (NASA); JACOBS, JEREMY B. (JSC-ES4) (NASA); SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA); KRAMER, JULIE A. (JSC-EA4) (NASA); CURRY, DONALD M. (JSC-ES3) (NASA); KOWAL, T. J. (JOHN) (JSC-ES3) (NASA); RICKMAN, STEVEN L. (JSC-ES3) (NASA); SCHOMBURG, CALVIN (JSC-EA) (NASA); CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA)
Subject: STS-107 Wing Debris Impact on Ascent: Final analysis case completed

As you recall from Friday's briefing to the MER, there remained open work to assess analytically predicted impact damage to the wing underside in the region of the main landing gear door. This area was considered a low probability hit area by the image analysis teams, but they admitted a debris strike here could not be ruled out.

As with the other analyses performed and reported on Friday, this assessment by the Boeing multi-technical discipline engineering teams also employed the system integration's dispersed trajectories followed by serial results from the *Crater* damage prediction tool, thermal analysis, and stress analysis. It was reviewed and accepted by the ES-DCE (R. Rocha) by Sunday morning, Jan. 26. The case is defined by a large area gouge about 7 inch wide and about 30 inch long with sloped sides like a crater, and reaching down to the densified layer of the TPS.

SUMMARY: Though this case predicted some higher temperatures at the outer layer of the honeycomb aluminum face sheet and subsequent debonding of the sheet, there is no predicted burn-through of the door, no breeching of the thermal and gas seals, nor is there door structural deformation or thermal warpage to open the seal to hot plasma intrusion. Though degradation of the TPS and door structure is likely (if the impact occurred here), there is no safety of flight (entry, descent, landing) issue.

Note to Don M. and Fred O.: On Friday I believe the MER was thoroughly briefed and it was clear that open work remained (viz., the case summarized above), the message of open work was not clearly given, in my opinion, to Linda Ham at the MMT. I believe we left her the impression that engineering assessments and cases were all finished and we could state with finality no safety of flight issues or questions remaining. This very serious case could not be ruled out and it was a very good thing we carried it through to a finish.

Rodney Rocha (ES2) x38889
- **Division Shuttle Chief Engineer (DCE), ES-Structural Engineering Division**
- **Chair, Space Shuttle Loads & Dynamics Panel**

Michele Lewis

From: KOWAL, T. J. (JOHN) (JSC-ES3) (NASA)
Sent: Monday, January 27, 2003 9:38 AM
To: ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA)
Subject: RE: STS-107 Wing Debris Impact on Ascent: Final analysis case completed

Rodney, I would like to see the details of this analysis.

John Kowal
ES3/Thermal Branch
NASA-Johnson Space Center
(281) 483-8871

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From: ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA)
Sent: Sunday, January 26, 2003 7:45 PM
To: SHACK, PAUL E. (JSC-EA42) (NASA); MCCORMACK, DONALD L. (DON) (JSC-MV6) (NASA); OUELLETTE, FRED A. (JSC-MV6) (NASA)
Cc: ROGERS, JOSEPH E. (JOE) (JSC-ES2) (NASA); GALBREATH, GREGORY F. (GREG) (JSC-ES2) (NASA); JACOBS, JEREMY B. (JSC-ES4) (NASA); SERIALE-GRUSH, JOYCE M. (JSC-EA) (NASA); KRAMER, JULIE A. (JSC-EA4) (NASA); CURRY, DONALD M. (JSC-ES3) (NASA); KOWAL, T. J. (JOHN) (JSC-ES3) (NASA); RICKMAN, STEVEN L. (JSC-ES3) (NASA); SCHOMBURG, CALVIN (JSC-EA) (NASA); CAMPBELL, CARLISLE C., JR (JSC-ES2) (NASA)
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Rodney Rocha (ES2) x38889
- **Division Shuttle Chief Engineer (DCE), ES-Structural Engineering Division**
- **Chair, Space Shuttle Loads & Dynamics Panel**

Michele Lewis

From: Madera, Pamela L [pam.l.madera@usahq.unitedspacealliance.com]

Sent: Wednesday, January 22, 2003 12:22 PM

To: CURRY, DONALD M. (JSC-ES3) (NASA); ROCHA, ALAN R. (RODNEY) (JSC-ES2) (NASA); LEVY, VINCENT M. (JSC-EG) (NASA); KOWAL, T. J. (JOHN) (JSC-ES3) (NASA); DERRY, STEPHEN M. (STEVE) (JSC-EG3) (NASA); Nagle, Scott M; Carlos Ortiz (E-mail); GOMEZ, REYNALDO J. (RAY) (JSC-EG3) (NASA); DISLER, JONATHAN M. (JON) (JSC-SX) (LM); Jacobs, William A

Cc: 'Scott Christensen V (E-mail)'; 'Norman Ignacio (Nacho) (E-mail)'; CHAO, DENNIS; Stoner-1, Michael D; 'Carlos Ortiz (E-mail)'; 'Michael J Dunham (E-mail)'; Sebesta, Stephen P; CORONADO, DIANA; "Craig Madden' (E-mail)'; Bell, Dan R.; Gordon, Michael P.; 'Paul A Parker (E-mail)'; ISHMAEL, MOHAMED I. (GEORGE) (JSC-NC) (SAIC); ALEXANDER, ED

Subject: STS-107 Debris Analysis Team Meeting

Rodney Rocha has conference room 221 in JSC Building 13 available for today's 1:00 PM telecon. Located on second floor. The dial in number is the same as below. I propose the following agenda:

Review of transport analysis (Carlos Ortiz - charts attached)
Discussion of appropriate Particle Size (Ortiz, Disler, all)
Review of Flight Design Plans for Assessing Options (Bill Jacobs)
Status of Impact Damage Assessment (P. Parker)
Status of Thermal Analysis (Norm Ignacio/Dennis Chao)
Approach for stress assessment (Dunham)
Discussion on Need/Rationale for Mandatory Viewing of damage site (All)

<<STS-107 Preliminary Debris Assessment - rev2.ppt>>

Pam Madera
Vehicle and Systems Analysis Subsystem Area Manager
Phone: 281-282-4453

-----Original Message-----

From: Madera, Pamela L

Sent: Monday, January 20, 2003 5:47 PM

To: CURRY, DONALD M; ROCHA, ALAN RODNEY; LEVY, VINCENT M; KOWAL, T JOHN; DERRY, STEPHEN M

Cc: 'Scott Christensen V (E-mail)'; 'Norman Ignacio (Nacho) (E-mail)'; CHAO, DENNIS; Stoner-1, Michael D; 'Carlos Ortiz (E-mail)'; 'Michael J Dunham (E-mail)'; Sebesta, Stephen P; CORONADO, DIANA; "Craig Madden' (E-mail)'; Bell, Dan R.; Gordon, Michael P.; Paul A Parker (E-mail)

Subject: STS-107 Debris Analysis Team Plans

The Boeing/USA team would like to meet with you Tuesday at 2:00 on meet-me-line number to discuss analysis plans for assessing the STS-107 Debris Impact.

Pam Madera
Vehicle and Systems Analysis Subsystem Area Manager
Phone: 281-282-4453

Pager: