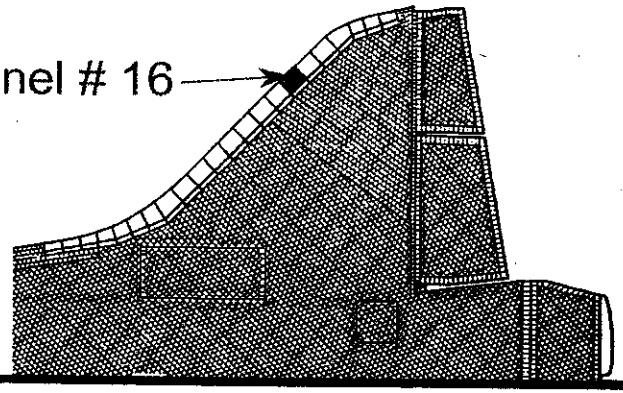
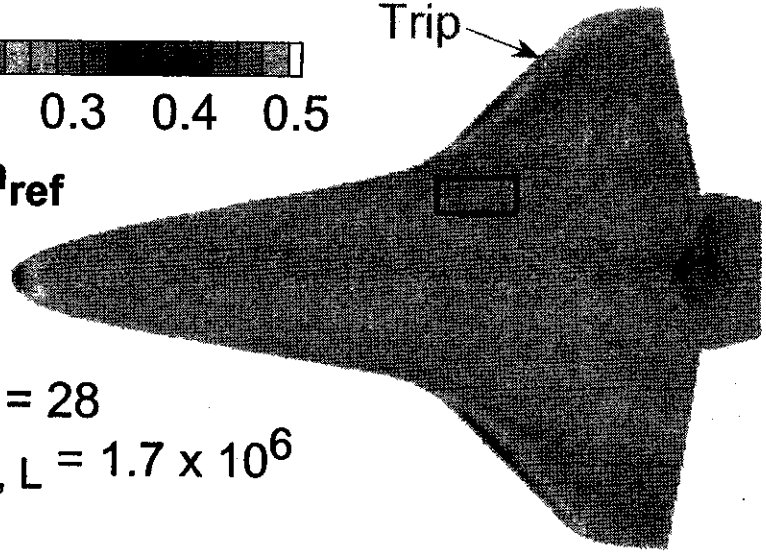
Effect of L.E. Roughness on Orbiter Windward Nondimensional Heating

NASA LaRC 20-Inch Mach 6 Air

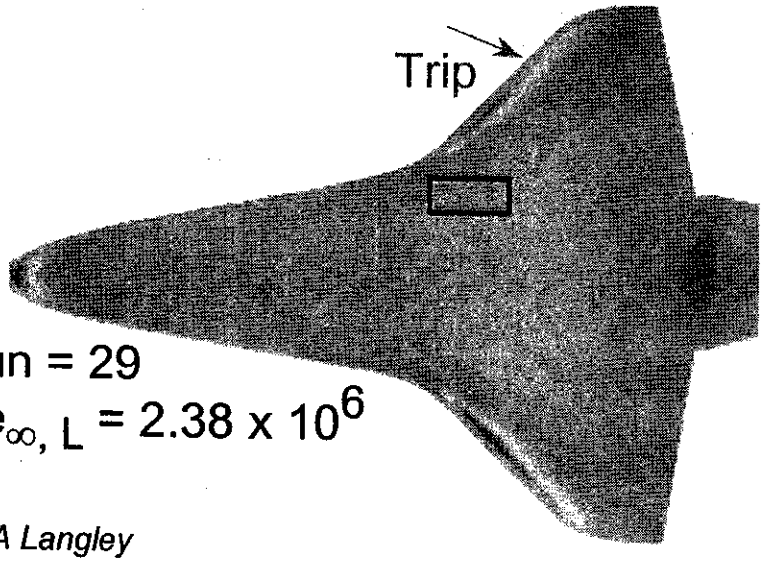
α = 40 deg Panel # 16 0.0075 Scale

	Model	FS
Trip height (in)	0.0035	0.47
Trip size (in)	0.1x0.1	13x13

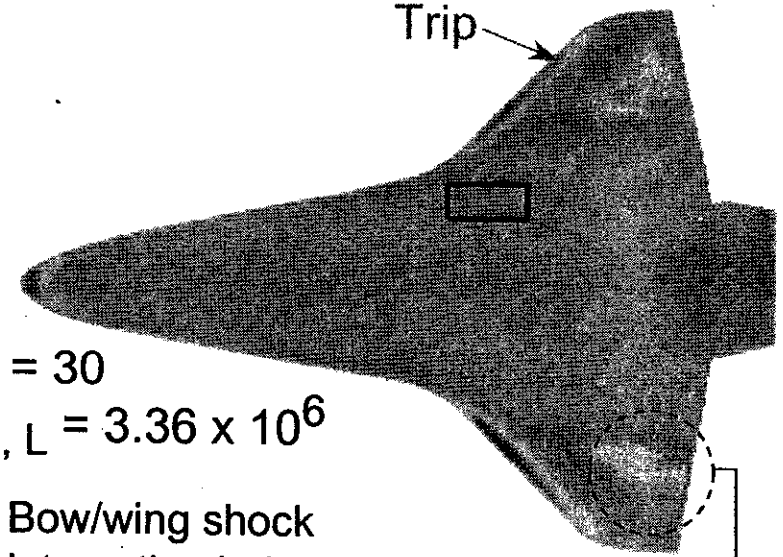




Run = 28
$Re_{\infty, L} = 1.7 \times 10^6$



Run = 29
$Re_{\infty, L} = 2.38 \times 10^6$



Run = 30
$Re_{\infty, L} = 3.36 \times 10^6$

Bow/wing shock
interaction induced transition

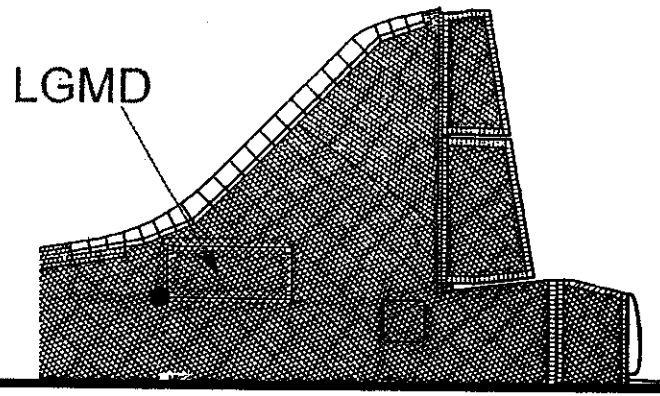
NASA Langley
Aerothermodynamics Branch

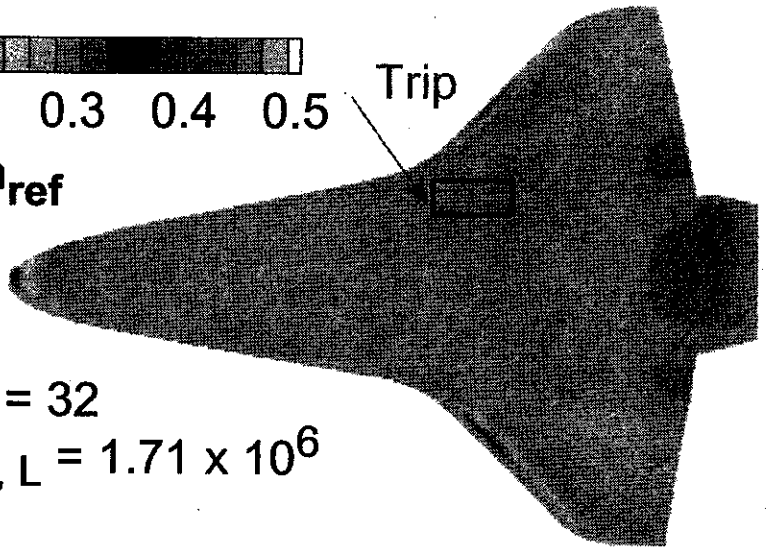
Effect of L.E. Roughness on Orbiter Windward Nondimensional Heating

NASA LaRC 20-Inch Mach 6 Air

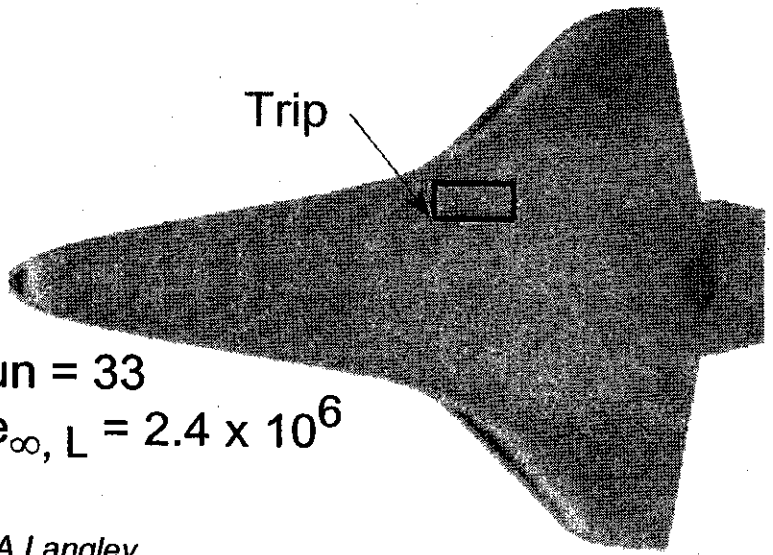
α = 40 deg Inboard LGMD 0.0075 Scale

	Model	FS
Trip height (in)	0.0035	0.47
Trip size (in)	0.005x0.005	7x7

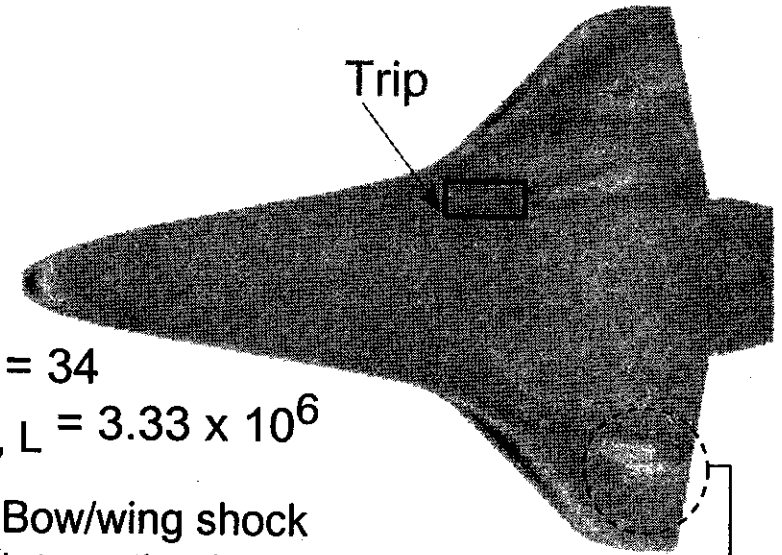




Run = 32
$Re_{\infty, L} = 1.71 \times 10^6$



Run = 33
$Re_{\infty, L} = 2.4 \times 10^6$



Run = 34
$Re_{\infty, L} = 3.33 \times 10^6$

Bow/wing shock
interaction induced transition

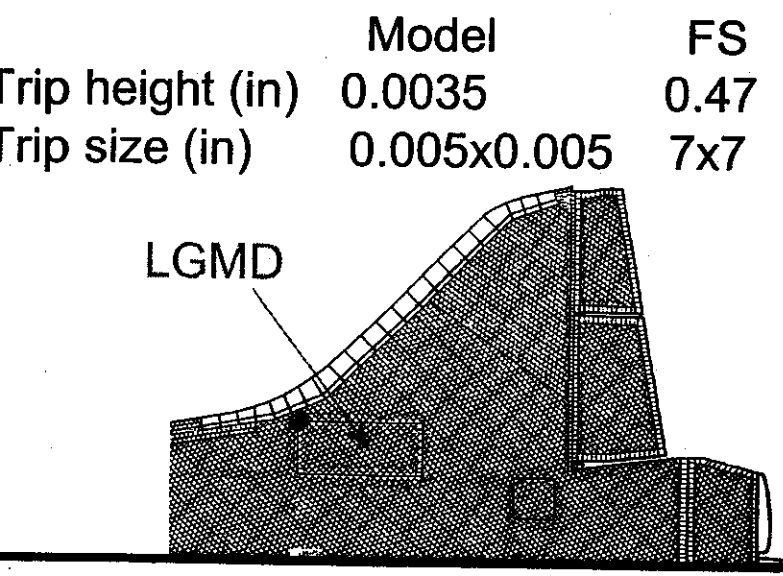
NASA Langley
Aerothermodynamics Branch

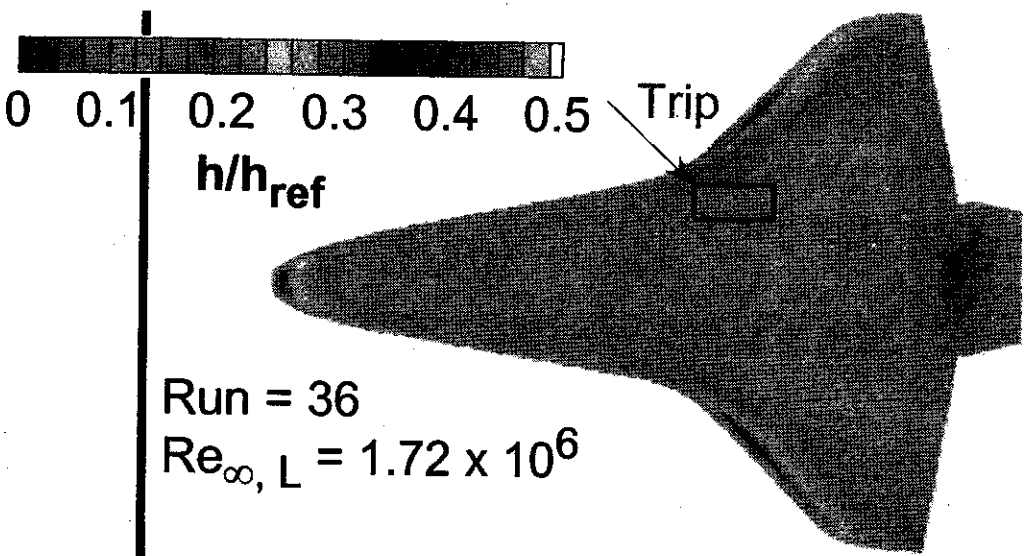
Effect of L.E. Roughness on Orbiter Windward Nondimensional Heating

NASA LaRC 20-Inch Mach 6 Air

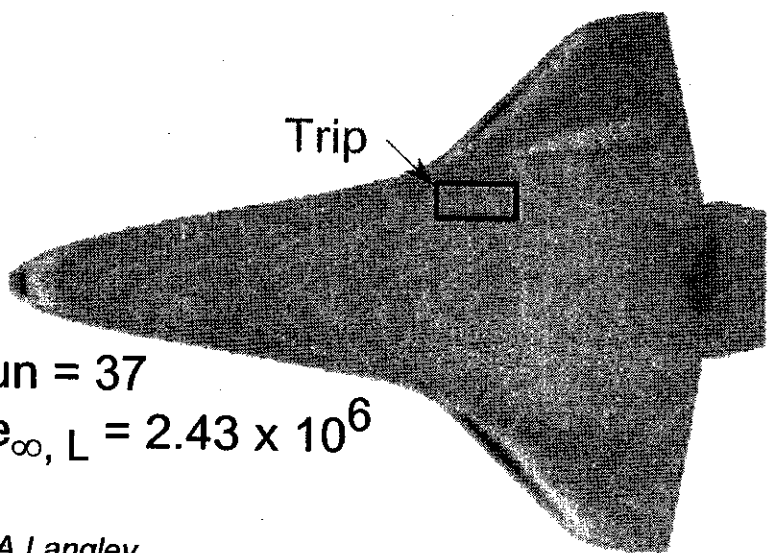
α = 40 deg Outboard LGMD 0.0075 Scale

	Model	FS
Trip height (in)	0.0035	0.47
Trip size (in)	0.005x0.005	7x7

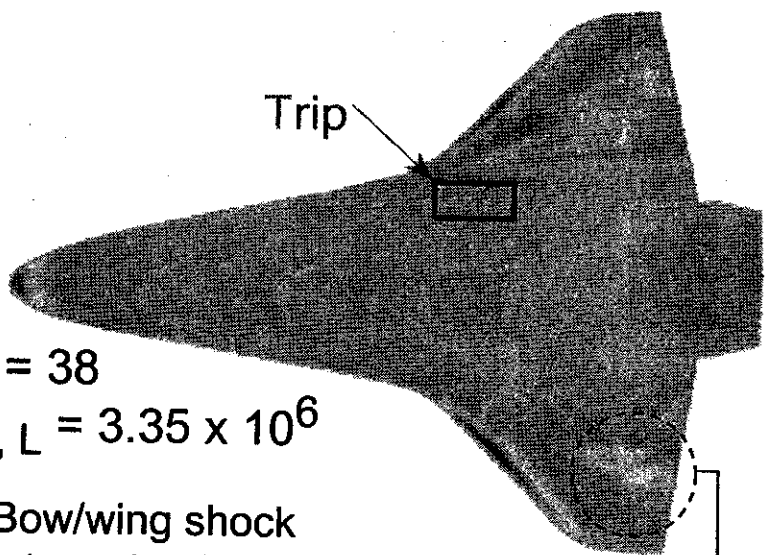




Run = 36
$Re_{\infty, L} = 1.72 \times 10^6$



Run = 37
$Re_{\infty, L} = 2.43 \times 10^6$



Run = 38
$Re_{\infty, L} = 3.35 \times 10^6$

Bow/wing shock
interaction induced transition

ASA Langley
erothermodynamics Branch

Effect of L.E. Roughness on Orbiter Windward Nondimensional Heating

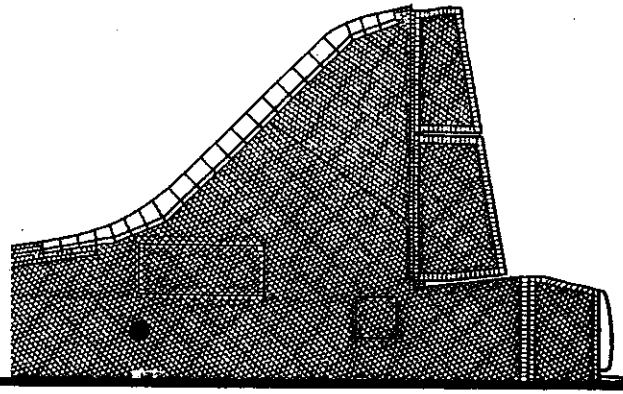
NASA LaRC 20-Inch Mach 6 Air

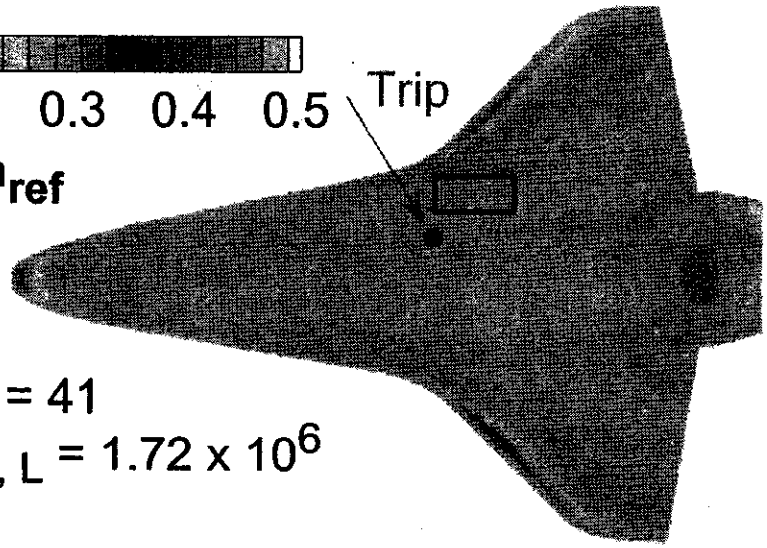
α = 40 deg 0.0075 Scale

	Model	FS
Trip height (in)	0.0035	0.47
Trip size (in)	0.005x0.005	7x7

0 0.1 0.2 0.3 0.4 0.5

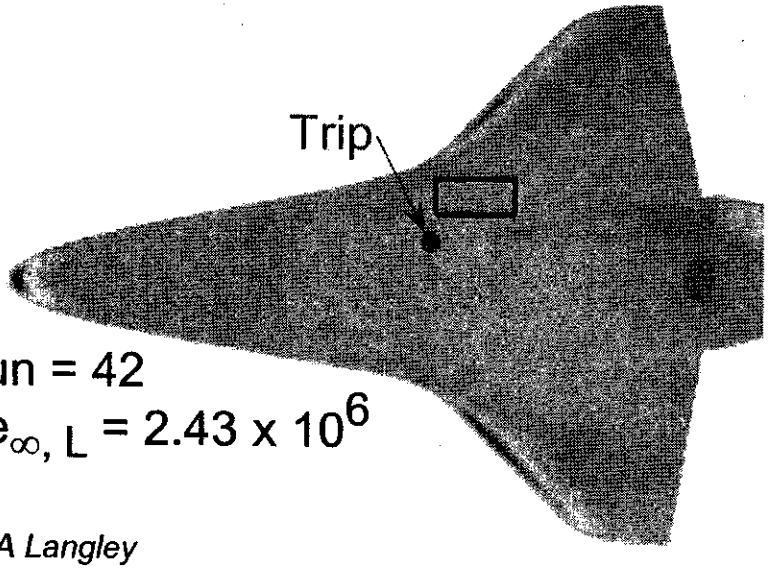
h/h_{ref}





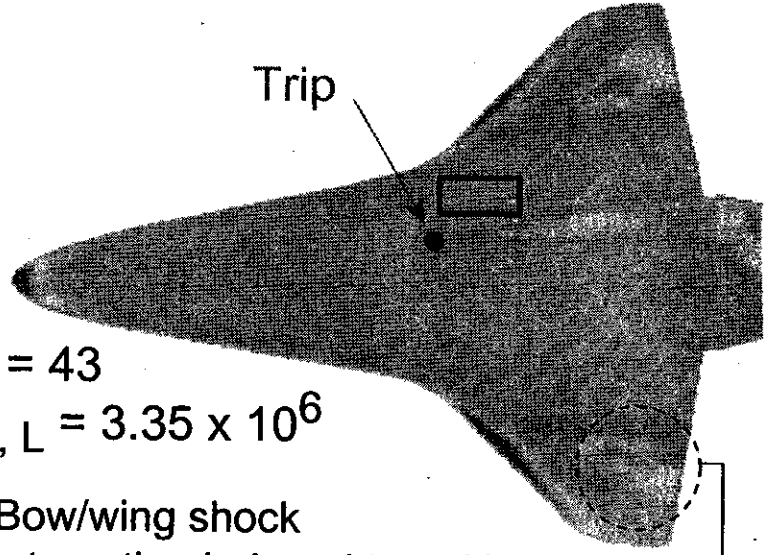
Run = 41

$Re_{\infty, L} = 1.72 \times 10^6$



Run = 42

$Re_{\infty, L} = 2.43 \times 10^6$



Run = 43

$Re_{\infty, L} = 3.35 \times 10^6$

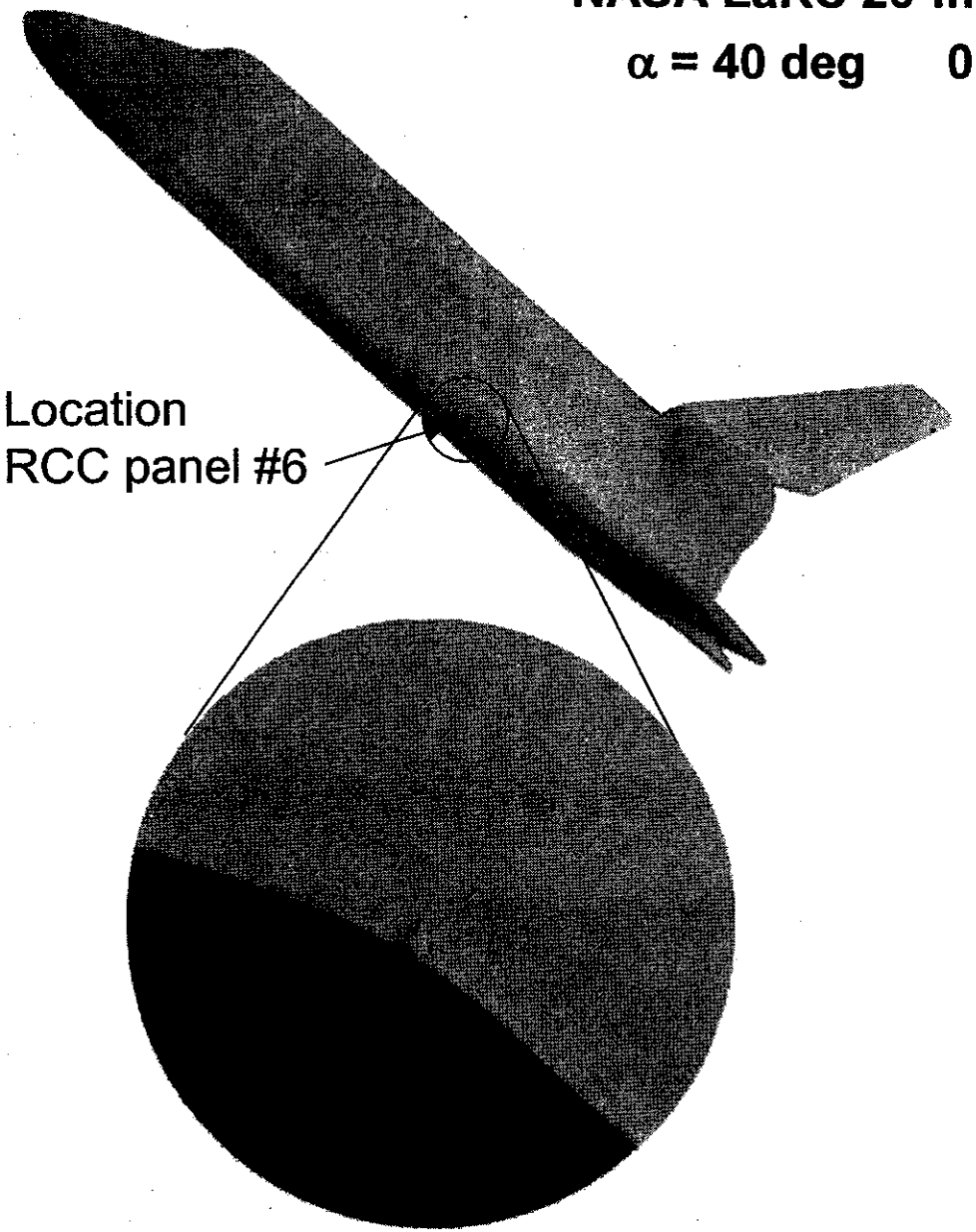
Bow/wing shock
interaction induced transition

NASA Langley
Aerothermodynamics Branch

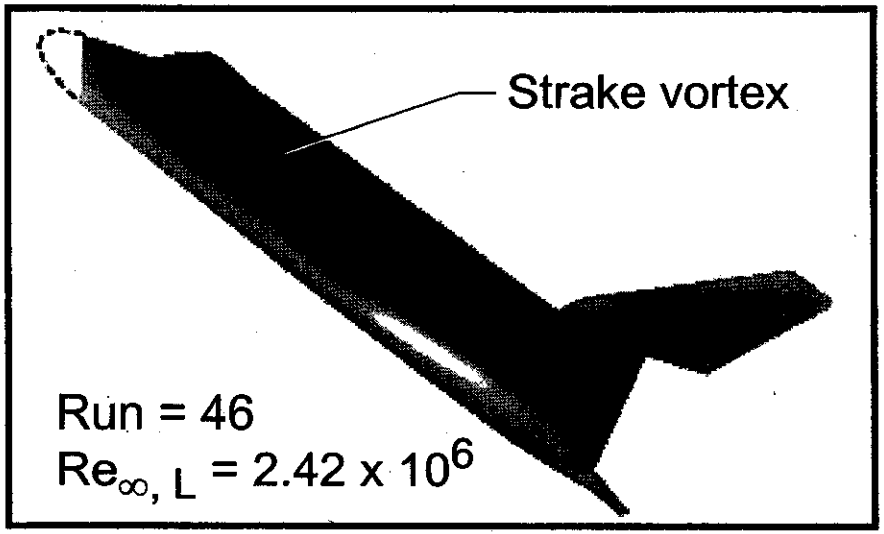
Effect of RCC Panel #6 L.E. Cavity on Orbiter Fuselage Thermal Mapping

NASA LaRC 20-Inch Mach 6 Air

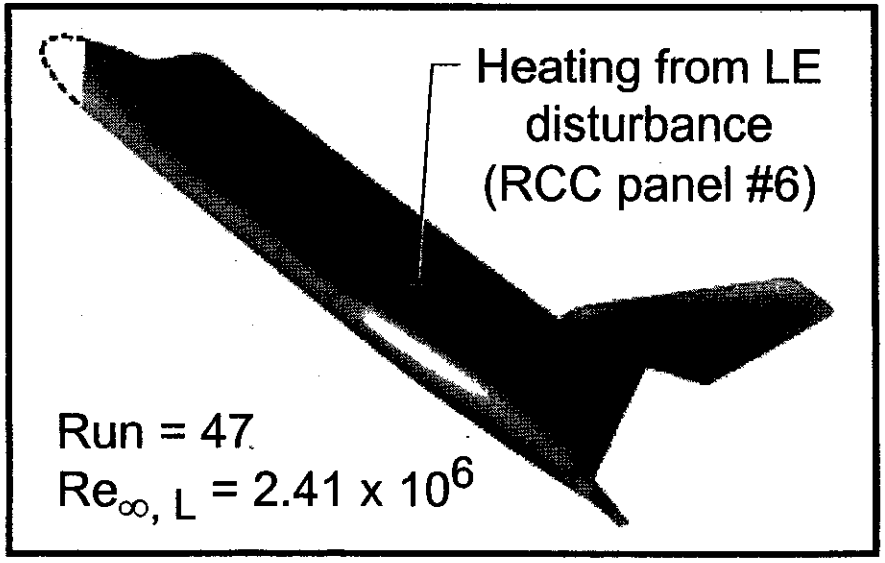
α = 40 deg 0.0075 Scale



Baseline Smooth LE



RCC Panel #6 "Notch"



NASA Langley
Aerothermodynamics Branch

Summary

- OML shape changes along wing LE and in vicinity of MLG produce by-pass boundary layer transition near freestream flight length Reynolds number
- Wing heating augmentation a factor of 2 to 3 above laminar values
  - "Healthy" TPS tiles should provide adequate temperature margins
  - Adequate margins for damage/compromised TPS?
- Surface cavity at RCC panel #6 produced externally driven heating augmentation on Orbiter fuselage

Future Plans

- Aerodynamic increments on ceramic heating-transfer model/metallic aero model
  - Asymmetric transition via cavities/protuberances

- Aerothermal/transition tests in LaRC 20-Inch Mach 13-18 Simulator
  - Location of wing/bow shock interaction more appropriate to flight
  - Low Reynolds number more appropriate to flight

- Correlation of roughness induced transition along wing LE and MLG using Re_k, Re_θ/M_e. Comparison with existing Orbiter correlations (Berry, Bouslog, Reda etc).

- Reproduce "early transition" event associated with STS-28 and STS-73 in wind tunnel to provide insight into extrapolation to flight

- Cavity flows [missing tile(s)]

X-Sender: a.h.phillips@pop.larc.nasa.gov
Date: Tue, 18 Feb 2003 18:02:20 -0500
To: "Pamela F. Richardson" <Pamela.Richardson@hq.nasa.gov>
From: "Alan H. Phillips" <a.h.phillips@larc.nasa.gov>
Subject: Fwd: Main Gear Breach Concerns re: Columbia STS 107 (01/30/03 e-mail) - Please FWD to R.H.DAUGHERTY@larc.nasa.gov
Cc: "Peter J. Rutledge" <prutledg@mail.hq.nasa.gov>,
Jim Lloyd <Jlloyd@hq.nasa.gov>

Pls forward to the responsible parties. Note that it has ALREADY been sent to the HCAT.

Alan

X-Priority: 1 (Highest)
Date: Tue, 18 Feb 2003 17:34:50 -0500
To: hcat@hq.nasa.gov
From: "Mark J. Shuart" <m.j.shuart@larc.nasa.gov>
Subject: Fwd: Main Gear Breach Concerns re: Columbia STS 107 (01/30/03 e-mail) - Please FWD to R.H.DAUGHERTY@larc.nasa.gov
Cc: "SAUNDERS, MARK P" <M.P.SAUNDERS@larc.nasa.gov>,
"PHILLIPS, ALAN H" <A.H.PHILLIPS@larc.nasa.gov>,
"WYATT, CYNTHIA A" <C.A.WYATT@larc.nasa.gov>,
"CLEGHORN, CHERYL W" <C.W.CLEGHORN@larc.nasa.gov>
To Whom It May Concern:

More info on Shuttle doors.

Mark J. Shuart, PhD .
Director for Structures & Materials
NASA Langely Research Center
Hampton, VA 23681
==========

From: '
To: <m.j.shuart@larc.nasa.gov>
Cc: '
Subject: Main Gear Breach Concerns re: Columbia STS 107 (01/30/03 e-mail) - Please FWD to R.H.DAUGHERTY@larc.nasa.gov
Date: Mon, 17 Feb 2003 16:03:32 -0600
X-Priority: 1
X-Spam-Status: No, hits=-96.4 required=3.8
tests=X_PRIORITY_HIGH,DEAR_SOMEBODY,MAILTO_LINK,USER_IN_WHITELIST
version=2.01
Dear Mr. Daugherty,

I write to you directly to thank you for the extremely relevant information you had sent to NASA

mission control just 2 days prior to the tragic loss of the Columbia Crew and vehicle. It seems, that your observations of Jan.30, 2003 were not only timely and accurate, but unfortunately "prophetic", which adds credible evidence to the investigation. Although, I'm not an expert in the field myself, I worked in the aviation industry for several years, while training for a pilot's license. I am also a scholar in a humanities field, which requires extensive travel internationally and in consequence, I've always followed closely NTSB inquiries into airline accidents. After reading your e-mail on Feb.12 (NASA press-release) re: potential damage to the LMG tires, and probable consequential sequence of events, even of a catastrophic level due to earlier substantial breach of wheel well (81sec.of launch - foam fragment damages left wing/ shuttle skin, exposing it to plasma at re-entry) I have spent the last few days intensively analyzing available data on the shuttle tragedy and archival material from the NTSB web-site re: tire-damage related accidents. At this time, the only analogy, that I can offer, though somewhat far-fetched, is the disastrous take-off of the Air France Concorde supersonic jet on July 25, 2000. I have included below a few excerpts from press-releases re: Concorde crash, that I thought you might find interesting, in support of your theory and the scenarios you presented in your analysis. As a researcher I wish to bring this information to your attention (my comments are italicized), since you have displayed such concern and expertise in this subject:

1) excerpt after ABC News (July 30, 2000): "Concorde supersonic jets had at least a dozen blown tire incidents before the crash of an Air France Concorde earlier this week, according to safety reports obtained by ABCNews.com from U.S. aviation agencies and accounts by British Airways. Evidence released Friday by French authorities suggests a tire blowout during takeoff of the Air France Concorde at Paris' Charles de Gaulle airport **initiated a sequence of events** that led to the crash Tuesday (...). *(I'm aware that there's a major difference here: tire blow-out at Concorde's take-off, max. cruising speed inflight - Mach 2, while Columbia was traveling at Mach 23 at an altitude of 231,304 ft upon landfall at California coast, RMC)*

Debris from a blown tire can rupture fuel tanks and fuel lines and be sucked into engines, which are uniquely located above the open landing gear on a Concorde.(...) *(the engine & fuel tanks on the shuttle are located well behind and above the wheel well, although in close proximity to it and to the hydraulic lines, electrical wiring...etc., RMC)*

French authorities said Friday they believe one tire and possibly two burst as the Concorde was accelerating down the runway.(...) But a ruptured tire on a Concorde can be especially serious, experts say, because of the aircraft's unique design, which allows it to cruise at twice the speed of sound.(...)The most serious incident occurred at Washington's Dulles International Airport in **June 1979, when two tires blew out on the left landing gear (!)**. Debris punctured three fuel tanks, **severed hydraulic lines and electrical wires (!)** (*emphasis added, RMC*), and damaged the No. 2 engine. Fuel poured out of the wing, but didn't catch fire.
http://abcnews.go.com/sections/world/DailyNews/concordesafety_000729.html

2) excerpt after BBC News.com (July 28, 2000): "Concorde has experienced **"potentially catastrophic" problems with tyres** prior to Tuesday's fatal crash, according to US safety officials.(...) In Washington, the National Transportation Safety Board (NTSB) has released details of four incidents in which Air France Concordes blew tyres on take-off.(...) In 1981, the NTSB said that in June 1979 an Air France Concorde experienced blow-outs of tyres numbers five and six on the left-hand side while taking off from Washington's Dulles Airport.

Tyre debris and wheel shrapnel, it said, resulted in damage to number two engine, the puncture of three fuel tanks and the severance of several hydraulic and electrical wires. A large hole was also torn in the skin of the top wing." (!) (*emphasis added, RMC*)http://news.bbc.co.uk/1/hi/world/europe/856173.stm
3) excerpt from safe-skies.com (Sept. 1, 2002): "The July 25 accident shows that the **destruction of a tire**, an event that we cannot say will not recur, **had catastrophic consequences in a short period of time, preventing the crew from rectifying the situation**. UN-grounding the Concorde will be difficult!" http://www.safe-skies.com/concorde_crash.htm *(There was nothing that the Columbia crew could have done had they been aware of this last-minute potentially fatal danger, but how can we continue to resign shuttle crews to such helplessness?)*
In terms of Columbia's tires: we know, thusfar, that one of its radial tires has been recovered near Hemphill, Texas as confirmed by NASA. Has it been determined which of the shuttle's tires was found and if the incurred damage was the result of a rupture inflight, or as a result of impact when it fell to the ground?

Mr. Daugherty, I appreciate your patience in reviewing this communication from a concerned, but keen observer. I am still dealing with the extreme grief I feel over this terrible loss and I wish I could do more to help in the investigative process. I've also been tuning in daily to NASA briefings and those of CAIB. Please feel free to call on me or to forward this information to the appropriate individuals at NASA. Sometimes, the observations of an outsider can bring some relevance or validity to issues at hand. It is my constant prayer that the future will bring more thorough preventive measures for shuttle crew safety and concrete escape contingency plans for the crew in event of any type of safety breach. The latter should, in my opinion, be of utmost importance to address and resolve (whatever the monetary cost involved), before the next manned-shuttle mission takes flight. It is unacceptable, in my opinion, to send people into space, who are willing to risk their lives, without the possibility of giving them realistic options for survival (e.g. reaching a safe bailout altitude; ejections seats...etc.) when faced with such danger as was the experience of the unforgettable Columbia Seven.
God bless you and your colleagues. Godspeed with the investigation!

Thank you again for your work and please stay in touch, if possible.

Respectfully yours,

Buckman Laboratories International, Inc.
1256 N. McLean Blvd.
Memphis, TN 38108-1241

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Mark J. Shuart, PhD
Director for Structures & Materials

NASA Langely Research Center
Hampton, VA 23681

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****
Alan H. Phillips
Director, Office of Safety and Mission Assurance
NASA Langley Research Center
5A Hunsaker Loop
Building 1162, Room 112C
Mail Stop 421
Hampton, VA 23681

(757)864-3361 Voice
(757)864-6327 Fax
****

X-Sender: a.h.phillips@pop.larc.nasa.gov
Date: Fri, 14 Feb 2003 12:59:51 -0500
To: "Pamela F. Richardson" <Pamela.Richardson@hq.nasa.gov>
From: "Alan H. Phillips" <a.h.phillips@larc.nasa.gov>
Subject: Fwd: Waste Water Ice Shuttle Damage
Cc: "Peter J. Rutledge" <prutledg@mail.hq.nasa.gov>,
Jim Lloyd <Jlloyd@hq.nasa.gov>

Pls forward to the responsible parties. Note that it has ALREADY been sent to the HCAT.

Thanks.

Alan

Date: Fri, 14 Feb 2003 07:44:43 -0500
To: hcat@hq.nasa.gov
From: "Mark J. Shuart" <m.j.shuart@larc.nasa.gov>
Subject: Fwd: Waste Water Ice Shuttle Damage
Cc: M.P.SAUNDERS@larc.nasa.gov, A.H.PHILLIPS@larc.nasa.gov,
C.A.WYATT@larc.nasa.gov, C.W.CLEGHORN@larc.nasa.gov

To Whom It May Concern:

Here's more.

Mark J. Shuart, PhD
Director for Structures & Materials
NASA Langley Research Center
Hampton, VA 23681
phone: (757) 864-3492
fax: (757) 864-7792

==========

From:
To: m.j.shuart@larc.nasa.gov
Subject: Waste Water Ice Shuttle Damage
Date: Thu, 13 Feb 2003 21:27:43 -1000
X-OriginalArrivalTime: 14 Feb 2003 07:27:43.0750 (UTC) FILETIME=[90633260:01C2D3FA]

Dear Sir:

Is it possible that ice gathering around the waste water
vent broke free and damaged the shuttle wing when the
retro rocket was fired?

I believe that there is a heater on that vent to prevent ice from accumulating, but it could have malfunctioned or not been turned on.

I know it is just another theory, but I don't know who to contact to see if that is a valid point.

I am a retired Air Force pilot and I have had pitot tube heaters that failed if the water came too fast for the heater to melt the ice.

Sincerely,

Major USAF Ret.

--
Mark J. Shuart, PhD
Director for Structures & Materials
NASA Langely Research Center
Hampton, VA 23681

--
****
Alan H. Phillips
Director, Office of Safety and Mission Assurance
NASA Langley Research Center
5A Hunsaker Loop
Building 1162, Room 112C
Mail Stop 421
Hampton, VA 23681

(757)864-3361 Voice
(757)864-6327 Fax
****

X-Sender: a.h.phillips@pop.larc.nasa.gov
Date: Fri, 14 Feb 2003 12:57:24 -0500
To: "Pamela F. Richardson" <Pamela.Richardson@hq.nasa.gov>
From: "Alan H. Phillips" <a.h.phillips@larc.nasa.gov>
Subject: Fwd: Columbia
Cc: "Peter J. Rutledge" <prutledg@mail.hq.nasa.gov>,
Jim Lloyd <Jlloyd@hq.nasa.gov>

Pls forward to the responsible parties. Note that it has ALREADY been sent to the HCAT.

Thanks.

Alan Date: Thu, 13 Feb 2003 17:45:43 -0500
To: hcat@hq.nasa.gov
From: "Mark J. Shuart" <m.j.shuart@larc.nasa.gov>
Subject: Columbia
Cc: M.P.SAUNDERS@larc.nasa.gov, A.H.PHILLIPS@larc.nasa.gov,
C.A.WYATT@larc.nasa.gov, C.W.CLEGHORN@larc.nasa.gov
To Whom It May Concern:

Here's more.

Mark J. Shuart, PhD
Director for Structures & Materials
NASA Langley Research Center
Hampton, VA 23681
phone: (757) 864-3492
fax: (757) 864-7792

==========

From
To: <m.j.shuart@larc.nasa.gov>
Date: Thu, 13 Feb 2003 13:20:08 -0700
X-Priority: 3
Hi!

I just read your email on the NASA webpage. I am emailing you since you are within NASA and would know who to contact with regard to som information I found on a news web site a week and a half ago, and you would know how to contact people like Adm. Harold W. Gehman Jr on the shuttle investigation board.

February 2 the Swedish newspaper Dagens Nyheter (www.dn.se) published an article in regard of NASA and security problems. Attached to the web article there were three photos, whereof one from the video conference between prime minister Sharon and the Israeli astronaut. The photo published online at http://www.dn.se/DNet/jsp/polopoly.jsp?d=148&a=104187 show structural damage and two cracks in the left wing of the shuttle. I have tried to bring this to the attention of several big news networks and NASA to find out why this photo has not been reported in the US.

It is my hope that you will know who to contact to verify the photo, and possibly contact the investigation board with the information since I have been unable to contact them.

Sincerely

** Los Alamos National Laboratory
** Los Alamos, NM 87545

To Whom It May Concern:

Here's more.

Mark J. Shuart, PhD
Director for Structures & Materials
NASA Langley Research Center
Hampton, VA 23681
phone: (757) 864-3492
fax: (757) 864-7792
--
Mark J. Shuart, PhD
Director for Structures & Materials
NASA Langely Research Center
Hampton, VA 23681

--
****
Alan H. Phillips
Director, Office of Safety and Mission Assurance
NASA Langley Research Center
5A Hunsaker Loop
Building 1162, Room 112C
Mail Stop 421
Hampton, VA 23681

(757)864-3361 Voice
(757)864-6327 Fax
****

X-Sender: a.h.phillips@pop.larc.nasa.gov
Date: Tue, 18 Feb 2003 17:59:55 -0500
To: "Pamela F. Richardson" <Pamela.Richardson@hq.nasa.gov>
From: "Alan H. Phillips" <a.h.phillips@larc.nasa.gov>
Subject: Fwd: Shuttle MLG gear doors ??
Cc: "Peter J. Rutledge" <prutledg@mail.hq.nasa.gov>,
Jim Lloyd <Jlloyd@hq.nasa.gov>

Pls forward to the responsible parties. Note that it has ALREADY been sent to the HCAT.

Alan

Date: Tue, 18 Feb 2003 17:31:26 -0500
To: hcat@hq.nasa.gov
From: "Mark J. Shuart" <m.j.shuart@larc.nasa.gov>
Subject: Fwd: Shuttle MLG gear doors ??
Cc: "SAUNDERS, MARK P" <M.P.SAUNDERS@larc.nasa.gov>,
"PHILLIPS, ALAN H" <A.H.PHILLIPS@larc.nasa.gov>,
"WYATT, CYNTHIA A" <C.A.WYATT@larc.nasa.gov>,
"CLEGHORN, CHERYL W" <C.W.CLEGHORN@larc.nasa.gov>
To Whom It May Concern:

More infomation on Shuttle doors.

Mark J. Shuart, PhD
Director for Structures & Materials
NASA Langely Research Center
Hampton, VA 23681

==========

Date: Fri, 14 Feb 2003 21:53:42 +0100
From:
Subject: Shuttle MLG gear doors ??
To: m.j.shuart@larc.nasa.gov, david.f.lechner1@jsc.nasa.gov,
r.h.daugherty@larc.nasa.gov, H.M.ADELMAN@larc.nasa.gov,
carlisle.c.campbell@nasa.gov
Cc: "

Importance: Normal
X-Priority: 3 (Normal)
Dear Sir

I read with utmost interest your e-mail from the NASA website (i.e. e-mail of 31 January 2003). I have some questions you may easily answer, as they puzzle me. I am an engineering manager at the Dutch Space Structures and Mechanical division called Dutch Space in Leiden . The Netherlands : We are as a company involved in mechanisms for solar

arrays, for the European Robotic Arm on the ISS, but also in launch vehicles such as the ARIANE 5 and also such as re-entry vehicles rudders like the hot rudder of the X-38 vehicle of which we delivered the rudders via ESA to NASA'.

I know you are very busy with the FAR, so if you have no time I understand completely. Just trying to think in parallelŠŠ.(maybe along the complete wrong track, but that's typical for FMECA and FAR analyses, I would say)

First of all, I understand that the doors are closed by a special procedure, using a kind of broom stick to close the doors. Is this correctŠŠ.?? Apparently, the doors then fall into an over-centre lock.??

1. How is this controlled and how is it guaranteed that the doors are 100% closed but that there is no such a play in the mechanism or in the door levers, such that a partially opening could occur ??.

2. A small opening of the doors could occur unnoticed if the switches are ill set, still the doors could be blocked by the over center locking mechanism. A partly opening may not be critical (TBC/ Acoustics and sinus and random vibrations) during the ascent, but will be very critical during re entryŠŠ..A gap in reentry technology is devastating.

3. As the temperature sensors in the wheel bay go off-line, or even out of order, one could think that the cable bundle for the telemetry is subjected to degradation / abrasion. Is it possible by evaluating **the sequence** in telemetry drop-out to determine which part of the cable gets the intense heat (twisted cable may give an indication of the spot??)

4. Is there a duct running from the leading edge to the wheel bay?? As the leading edge is damaged (is this confirmed yet ??) some gaseous plasma could reach the inner wheel bay?? How?

5. Are there any other places other than the wheel bay (but close by) of which the temperature has been monitored and show erroneous telemetry readings?

Other question related to the tiles:

6. Have impact damage analyses also been executed on so called degraded tiles i.e. tiles which have been used more times or bond line for thermal expansion compensation of which the bond line has been hardened due to thermal cycling effects??

Sincerely yours

Dutch Space
2303 DB Leiden
The Netherlands

--
Mark J. Shuart, PhD
Director for Structures & Materials
NASA Langely Research Center
Hampton, VA 23681

--
****
Alan H. Phillips
Director, Office of Safety and Mission Assurance
NASA Langley Research Center
5A Hunsaker Loop
Building 1162, Room 112C
Mail Stop 421
Hampton, VA 23681

(757)864-3361 Voice
(757)864-6327 Fax
****

X-Sender: a.h.phillips@pop.larc.nasa.gov
Date: Fri, 14 Feb 2003 12:46:45 -0500
To: "Pamela F. Richardson" <Pamela.Richardson@hq.nasa.gov>
From: "Alan H. Phillips" <a.h.phillips@larc.nasa.gov>
Subject: Fwd: Shuttle landing gear
Cc: "Peter J. Rutledge" <prutledg@mail.hq.nasa.gov>,
Jim Lloyd <Jlloyd@hq.nasa.gov>

Pls forward to the responsible parties. Note that it has ALREADY been sent to the HCAT.

Thanks.

Alan

Date: Thu, 13 Feb 2003 08:19:29 -0500
To: hcat@hq.nasa.gov
From: "Mark J. Shuart" <m.j.shuart@larc.nasa.gov>
Subject: Fwd: Shuttle landing gear
Cc: "SAUNDERS, MARK P" <M.P.SAUNDERS@larc.nasa.gov>,
"PHILLIPS, ALAN H" <A.H.PHILLIPS@larc.nasa.gov>,
"WYATT, CYNTHIA A" <C.A.WYATT@larc.nasa.gov>,
C.W.CLEGHORN@larc.nasa.gov
To Whom It May Concern:

Here's more.

Mark J. Shuart, PhD
Director for Structures & Materials
NASA Langley Research Center
Hampton, VA 23681
phone: (757) 864-3492
fax: (757) 864-7792
==========

From:
Date: Thu, 13 Feb 2003 04:00:56 EST
Subject: Shuttle landing gear
To: r.h.daugherty@larc.nasa.gov, m.j.shuart@larc.nasa.gov,
david.f.lechner1@jsc.nasa.gov
As a concerned supporter of the space program, I hope that you will take a moment to look at the attached image. It seems to explain to so-called "jagged" edge of the left wing seen in the blurry AF telescope picture. The image seems to be consistent with current theories regarding the left landing gear.

Sincerely yours,

Glendale, Ca

 compShuttle.jpg

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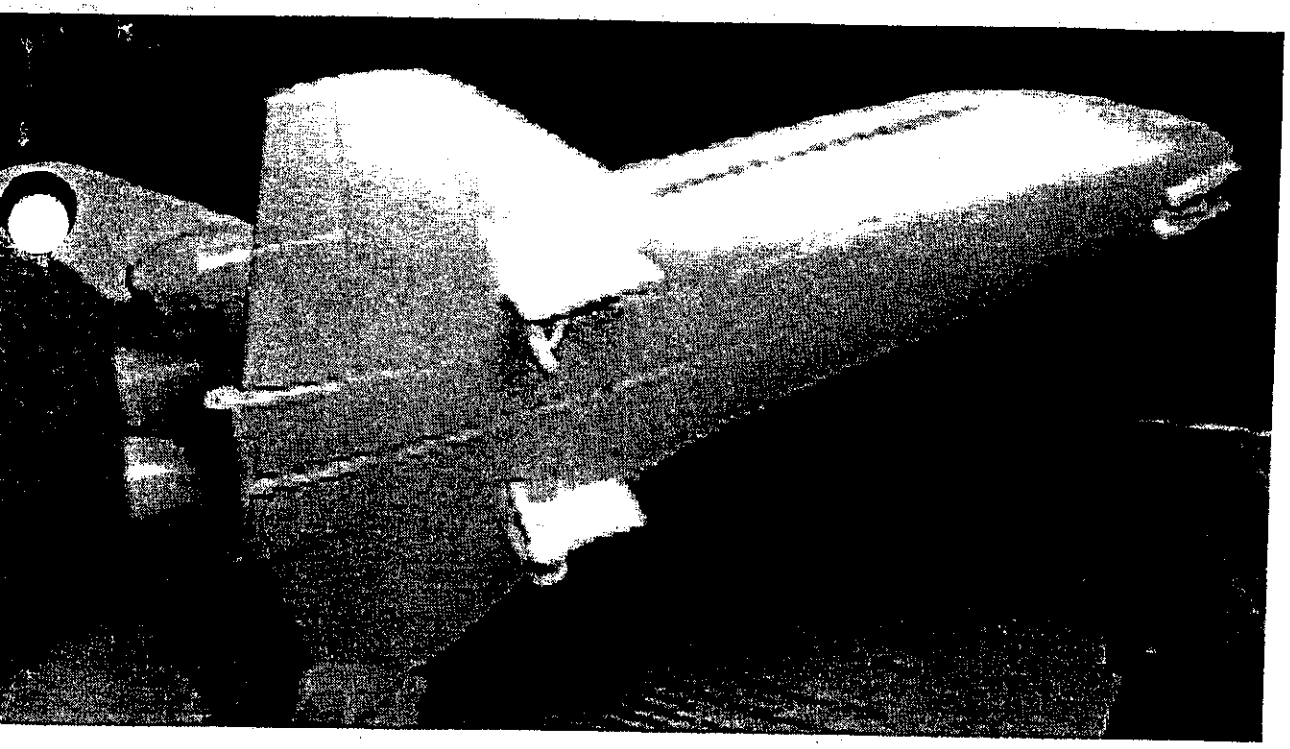
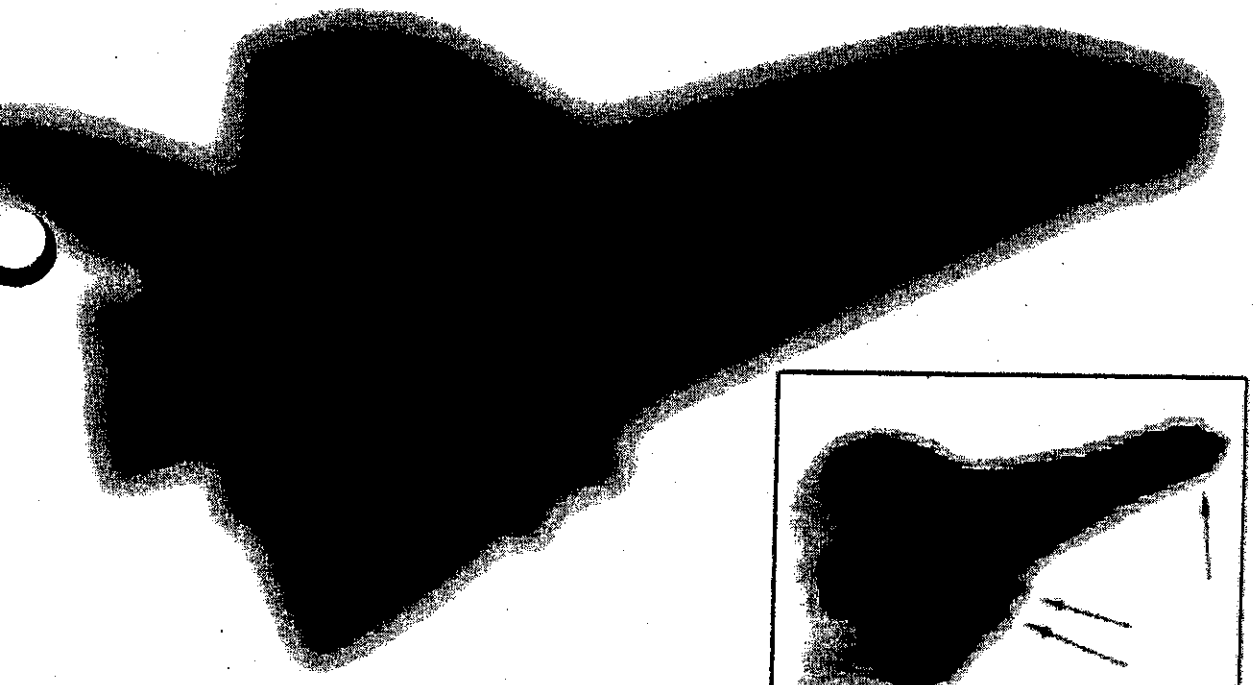
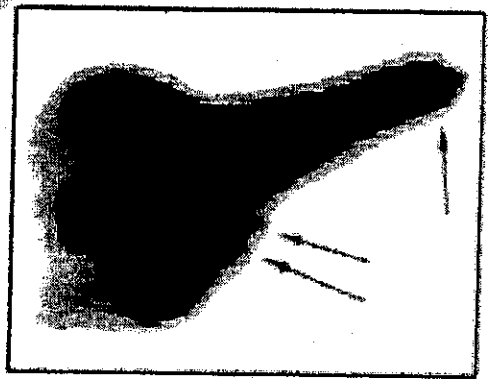
****
Alan H. Phillips
Director, Office of Safety and Mission Assurance
NASA Langley Research Center
5A Hunsaker Loop
Building 1162, Room 112C
Mail Stop 421
Hampton, VA 23681

(757)864-3361 Voice
(757)864-6327 Fax
****







X-Sender: a.h.phillips@pop.larc.nasa.gov
Date: Fri, 14 Feb 2003 12:44:52 -0500
To: "Pamela F. Richardson" <Pamela.Richardson@hq.nasa.gov>
From: "Alan H. Phillips" <a.h.phillips@larc.nasa.gov>
Subject: Fwd: Main Landing Gear
Cc: "Peter J. Rutledge" <prutledg@mail.hq.nasa.gov>,
Jim Lloyd <Jlloyd@hq.nasa.gov>

Pls forward to the responsible parties. Note that it has ALREADY been sent to the HCAT.

Alan

Date: Wed, 12 Feb 2003 17:47:40 -0500
To: hcat@hq.nasa.gov
From: "Mark J. Shuart" <m.j.shuart@larc.nasa.gov>
Subject: Fwd: Main Landing Gear
Cc: "SAUNDERS, MARK P" <M.P.SAUNDERS@larc.nasa.gov>,
"PHILLIPS, ALAN H" <A.H.PHILLIPS@larc.nasa.gov>,
"WYATT, CYNTHIA A" <C.A.WYATT@larc.nasa.gov>
To Whom It May Concern:

I am advised to send information such as the message I received below directly to you.

Mark J. Shuart, PhD
Director for Structures & Materials
NASA Langley Research Center
Hampton, VA 23681
phone: (757) 864-3492
fax: (757) 864-7792
==========

Date: Wed, 12 Feb 2003 16:06:11 -0600
From:
Subject: Main Landing Gear
To: m.j.shuart@larc.nasa.gov
X-Priority: 3

----- Original Message -----
From:
To: david.f.lechner1@jsc.nasa.gov
Sent: Wednesday, February 12, 2003 4:04 PM
Subject: Main Landing Gear

This is an educated observation of the high-definition military photo of the shuttle Columbia as it flew over an Air Force base in New Mexico on Feb 1:

In your investigations, please consider that the main landing gear under the left wing was somehow in the down position. At the angle at which the photo was taken, the tires of the landing gear would appear before the leading edge of the left wing. It is more likely that the two "bumps" on the front edge of the left wing were the two tires rather than damage. Damage would most likely appear as missing wing. The dark smoke behind the wing is probably smoke from the burning tires. The high temperatures near the left landing gear makes sense since the landing gear doors were open. It also makes since that signals were lost at other area of the wing, because the fire in the wheel well burned through the nearby control wires. This also explains the excessive drag on the left side. It was only a matter of time before the extra drag put the shuttle out of control.


columbia.jpg

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****

Alan H. Phillips
Director, Office of Safety and Mission Assurance
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5A Hunsaker Loop
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Mail Stop 421
Hampton, VA 23681

(757)864-3361 Voice
(757)864-6327 Fax

****


Tires of landing gear

Wayne R. Frazier, 11:12 AM 2/14/2003 -0500, Comparison of Rogers Cmmission to Columbia Acci

X-Sender: wfrazier@mail.hq.nasa.gov
X-Mailer: QUALCOMM Windows Eudora Version 4.3.2
Date: Fri, 14 Feb 2003 11:12:33 -0500
To: yolanda.y.marshall1@jsc.nasa.gov, Oscar.Toledo-1@ksc.nasa.gov,
Amanda.Goodson@msfc.nasa.gov, Michael.Smiles@ssc.nasa.gov,
mark.d.erminger@nasa.gov, GarriH@kscems.ksc.nasa.gov,
Alex.Adams@msfc.nasa.gov, roy.w.glanville@nasa.gov
From: "Wayne R. Frazier" <wfrazier@hq.nasa.gov>
Subject: Comparison of Rogers Cmmission to Columbia Accident
Investigation Board
Cc: jlloyd@hq.nasa.gov, jlemke <jlemke@hq.nasa.gov>, prutledg@hq.nasa.gov,
prichard@hq.nasa.gov

More updates to our history trail. Please send me any updates especially as things evolve for the CAIB.


Comparison of Rogers Cmmission to Columbia Accident Investigation Board.doc

~~~~~~

Wayne R. Frazier
NASA Headquarters - Code QS
Office of Safety and Mission Assurance
Washington,DC 20546-0001
Ph: 202 358-0588 Fax: 202 358-3104

~~~~~~

"Mission success starts with safety"

Comparison of Roger's Cmmission to Columbia Accident Investigation Board

Here is what we have assembled so far using mostly data in Appendices in Vol II to the Roger's commission report and input from the SMA community. Thanks to all. This answered the mail and legal and Code Q contrasted this with how the CAIB is organized to show that the CAIB is set up similarly to how Roger's' finally evolved. We will further refine it as we get more actions from the hearings. Info only, no need to respond.

Comparison of timelines
(my paraphrase of the Roger's Commission timeline) (all 1986 dates.)

Challenger (51-L)	Columbia (STS-107)
Jan 28, 86- Challenger mishap	Feb 1,03 Columbia mishap
Feb 3-President Reagan announces Oversight Commission	Feb 1 NASA appoints board
Feb 6 Commission Chair sworn in and hearings begin	Feb 2 Board arrives at Shreveport LA and convenes at Barksdale AFB
Feb 10 Exec Dir appointed, experienced investigators appointed Feb 10 Commission in closed session learns of concerns about troubled joint and "flawed"decision process	
Feb 14 Commission executive session	
Feb 15 role changed from oversight to active investigation as a result, 4 teams formed	Feb 3-6 Board observes debris collection
Feb 18-Roger's briefs Congress on new direction	Feb 5 Consultant Roger Tetrault added to board
Feb 25-27 Public hearings	Feb 6 Board arrives at JSC for initial deliberations
Late Feb, early Mar- 4 subteams begin investigation efforts	Feb 7 Board begins initial deliberations
	Feb 12 Charter changed as a result of Congressional Hearings
	Date XX Task Force named

In the first few days of the Roger's Commission closed sessions, (Feb 10,13 and 14th) the commission began to learn of the troubled history of the Solid Rocket Motor (SRM) joint and seal, and disturbing developments about the launch decision. , and that many of the NASA folks briefing the commission and providing analysis were involved in that decision. The Commission went into Executive Session on Feb 14 to discuss On Feb 15th Chairman Roger's issued a statement reflecting a change in direction of the commission activities from one of over sight to one of direct investigation and analysis. The commission divided itself into 4 panels:

Development and Production team chaired by Joe Sutter.

Pre-launch activities team led by David Acheson

Mission Planning and Operations team chaired by Dr. Sally Ride.

Accident Analysis team chaired by MG Don Kutyna. (On Feb 18th Chairman Rodgers described this new approach to Congress.

The new panels began their work on Feb 18th or 19th, going to MSFC, KSC and Thiokol to redirect efforts.

NASA was directed to reorganize its interface with the Roger's commission to match up to these new Commission teams. On Feb 5, William Graham, Acting Administrator of NASA wrote a memo to the Associate Administrator for Space Flight establishing the Data and Design Analysis Task Force (DDATF) chaired by Rear Adm Richard Truly. The DDATF was chartered to " Determine, review, and analyze the facts and circumstances surrounding the launch of STS mission 51-L" and to replace the NASA interim Mishap Investigation Board which seems to have been appointed soon after the mishap by Mr. Graham. (need data on this)

On Mar 11, the Acting Administrator wrote a second memo to the Adm Truly, finalizing the DDATF membership (and presumably to directly interface with the Roger's Commission's new teams). The NASA teams were as follows:

NASA Dev and Production team

T.J. Lee MSFC Chair
C.E. McCullough JSC
Robert Stewart JSC
Ms. S.G. Henderson MSFC
D. L. Riley JSC
+ senior members from level III project offices

NASA Prelaunch team

Tom Utsman KSC Chair
Col R. Bourne USAF
J. Harrington KSC
W. Rock KSC
M. Jones KSC
S. Hawley JSC

NASA Mission Planning and Operations

Tommy Holloway JSC Chair
Harold Draughon JSC

others???

NASA Accident Analysis

J. R. Thompson MSFC Chair
John W. Thomas MSFC
+ level III project team leads

SSME/G.D. Hopson
SRM/R.J. Schwinghamer
SRB/G.F. McDonough
Systems Working Group/H.N. Scofield
IUS/TDRS Systems Working Group/R.W. Hughes
Recovery Support/C.R. McIntosh

Photo Analyses Support/G.F. McDonough
Orbiter & GFE/G.A. Coultas (JSC)
Orbiter/Payload Interface/L.E. Bell (JSC)
TDRS/SPARTAN/R.C. Bauman (GSFC)
+Morton Thiokol

Search, Recovery, and Reconstruction

On Mar 20 Adm Truly established a fifth team by memo to Col Ed O'Connor tasking him to lead a Search, Recovery, and Reconstruction team.

Photo and TV Support

On Mar 20 Adm Truly also established a Photo and TV support Team led by Dan Germany of JSC.

These teams provided data and analysis to the full Roger's commission who validated the data and analyses with their own dedicated investigative and testing staff. Each NASA team provided a final written report which is in vol II and Vopl III of the final Roger's Commission reports.

Some observations and notes:

NASA was unprepared for a major Shuttle contingency both from an emergency response standpoint and from a public affairs standpoint. NASA had no top level contingency plan for a major mission failure. NASA had no plan for releasing information in real time to the press. The expectation was that when any internal investigations had finished and been approved by their appointing authority, the results would be made available to the public and press as per normal NASA procedure. Partly due to NASA's slowness, the Roger's Commission was chartered. It was originally established to be an

oversight board, and transitioned to actual investigation after members learned of involvement of key NASA and contractor officials in the launch decision.

The CAIB was chartered from the start as an accident investigation board and expected to perform their own analysis and investigation to determine the facts and probable cause. This approach has been briefed to ASAP, NTSB, Navy, Air Force and other organizations interested in NASA's response to a major shuttle disaster. The CAIB subsequently established a task force (per the contingency plan) headed by Frank Buzzard [redacted]. The task force is the direct interface between the CAIB and the NASA and contractor engineering and management communities. The CAIB has also established several other working groups e.g. Independent Analysis and Support Team and DOD Columbia Investigations Support Team

X-Authentication-Warning: spinoza.public.hq.nasa.gov: majordom set sender to owner-code-q using -f
X-Sender: mkowales@mail.hq.nasa.gov
X-Mailer: QUALCOMM Windows Eudora Version 4.3.2
Date: Wed, 12 Feb 2003 10:40:27 -0500
To: code-q@lists.hq.nasa.gov, bwatkins@mail.hq.nasa.gov,
whill@mail.hq.nasa.gov, dwhitehe@mail.hq.nasa.gov
From: Mark Kowaleski <mkowales@hq.nasa.gov>
Subject: Fwd: 02/11/03 MRT -- OVEWG TIMELINE
Sender: owner-code-q@lists.hq.nasa.gov

FYI...

From: "ERMINGER, MARK D. (JSC-NC) (NASA)" <mark.d.erminger@nasa.gov>
To: "H - Kowaleski Mark (E-mail)" <mkowales@mail.hq.nasa.gov>,
"H - Bihner Bill (E-mail)" <wbihner@mail.hq.nasa.gov>
Subject: 02/11/03 MRT -- OVEWG TIMELINE
Date: Tue, 11 Feb 2003 12:08:44 -0600
Importance: high
X-Message-Flag: Follow up
X-Mailer: Internet Mail Service (5.5.2653.19)

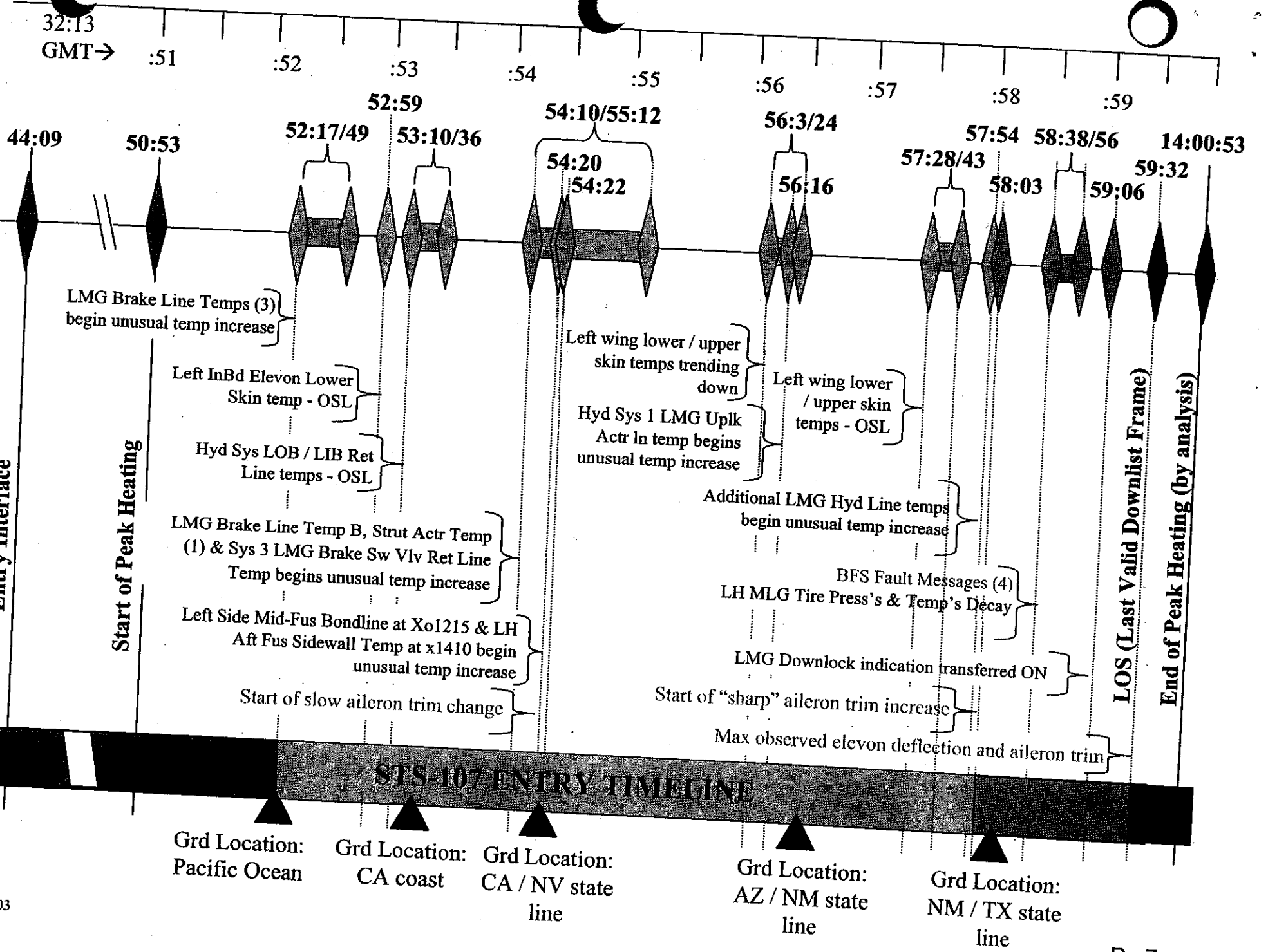
This timeline was baselined by Vehicle Engineering and presented to the MRT today.

02112003MRT_Graphic Timeline.pdf

DATA REVIEW AND TIMELINE TEAM

February 10, 2003

Don McCormack/MV


32:13
GMT→
:51
:52
:53
:54
:55
:56
:57
:58
:59
44:09
50:53
52:17/49
52:59
53:10/36
54:10/55:12
54:20
54:22
56:3/24
56:16
57:28/43
57:54
58:03
58:38/56
59:06
59:32
14:00:53
LMG Brake Line Temps (3) begin unusual temp increase
Left InBd Elevon Lower Skin temp - OSL
Hyd Sys LOB / LIB Ret Line temps - OSL
LMG Brake Line Temp B, Strut Actr Temp (1) & Sys 3 LMG Brake Sw Vlv Ret Line Temp begins unusual temp increase
Left Side Mid-Fus Bondline at Xo1215 & LH Aft Fus Sidewall Temp at x1410 begin unusual temp increase
Start of slow aileron trim change
Left wing lower / upper skin temps trending down
Hyd Sys 1 LMG Uplk Actr ln temp begins unusual temp increase
Left wing lower / upper skin temps - OSL
Additional LMG Hyd Line temps begin unusual temp increase
BFS Fault Messages (4)
LH MLG Tire Press's & Temp's Decay
LMG Downlock indication transferred ON
Start of "sharp" aileron trim increase
Max observed elevon deflection and aileron trim
Start of Peak Heating
LOS (Last Valid Downlist Frame)
End of Peak Heating (by analysis)
STS-107 ENTRY TIMELINE
Grd Location: Pacific Ocean
Grd Location: CA coast
Grd Location: CA / NV state line
Grd Location: AZ / NM state line
Grd Location: NM / TX state line

James Lloyd, 03:35 PM 2/11/2003 -0500, Fwd: columbia sensor wire locations Rev 1.ppt

X-Sender: jlloyd@mail.hq.nasa.gov
X-Mailer: QUALCOMM Windows Eudora Version 4.3.2
Date: Tue, 11 Feb 2003 15:35:38 -0500
To: boconnor@mail.hq.nasa.gov
From: James Lloyd <jlloyd@hq.nasa.gov>
Subject: Fwd: columbia sensor wire locations Rev 1.ppt
Cc: prichard@hq.nasa.gov, rpatrican@hq.nasa.gov, prutledg@hq.nasa.gov, jlemke <jlemke@hq.nasa.gov>, Mark Kowaleski <mkowales@hq.nasa.gov>

Bryan,
Pam sent you a single annotated slide earlier supporting her theory that something may have started in the wheel well area (I would say started in or around). A series of charts that Rich received today give one a clear idea of the time sequencing of off nominal and drop outs of sensors (both P and T). Run it fast like an animation and you will see the progression of events.

X-Sender: rpatrica@mail.hq.nasa.gov
X-Mailer: QUALCOMM Windows Eudora Version 4.3.2
Date: Tue, 11 Feb 2003 13:53:49 -0500
To: jlloyd@hq.nasa.gov, prutledg@hq.nasa.gov, mkowales@hq.nasa.gov
From: Richard Patrican <rpatrica@hq.nasa.gov>
Subject: columbia sensor wire locations Rev 1.ppt

Summary of sensors on Left wing and chronology of failure - FYI. From the HCAT.

Rich Patrican
Manager, International Space Station
Office of Safety and Mission Assurance
Headquarters Office 5X35
Phone: 202-358-0569
Fax: 202-358-2772


columbia sensor wire locations Rev 111.ppt

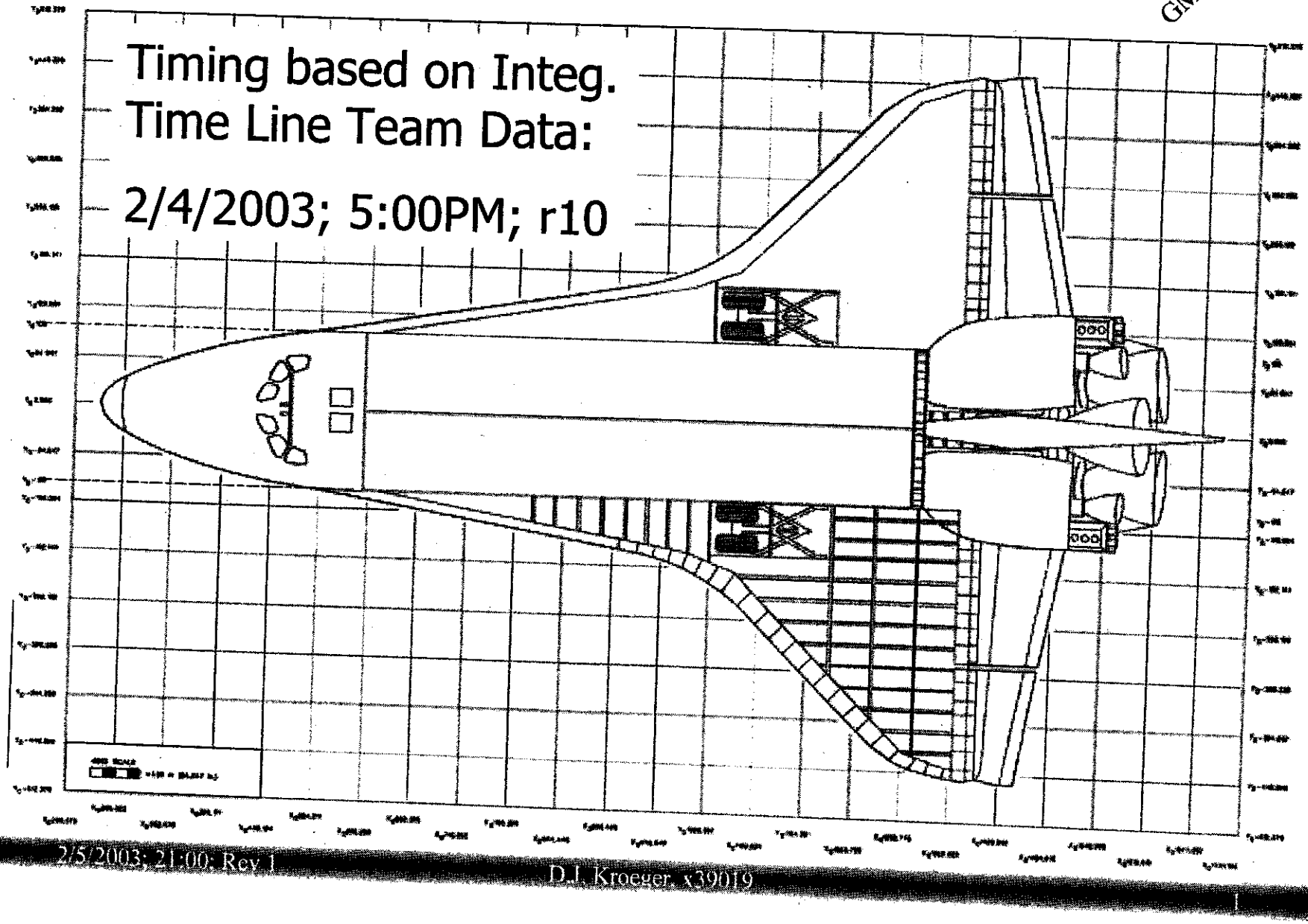
Jim

GMT 13:52:00

LOS 13:59:32

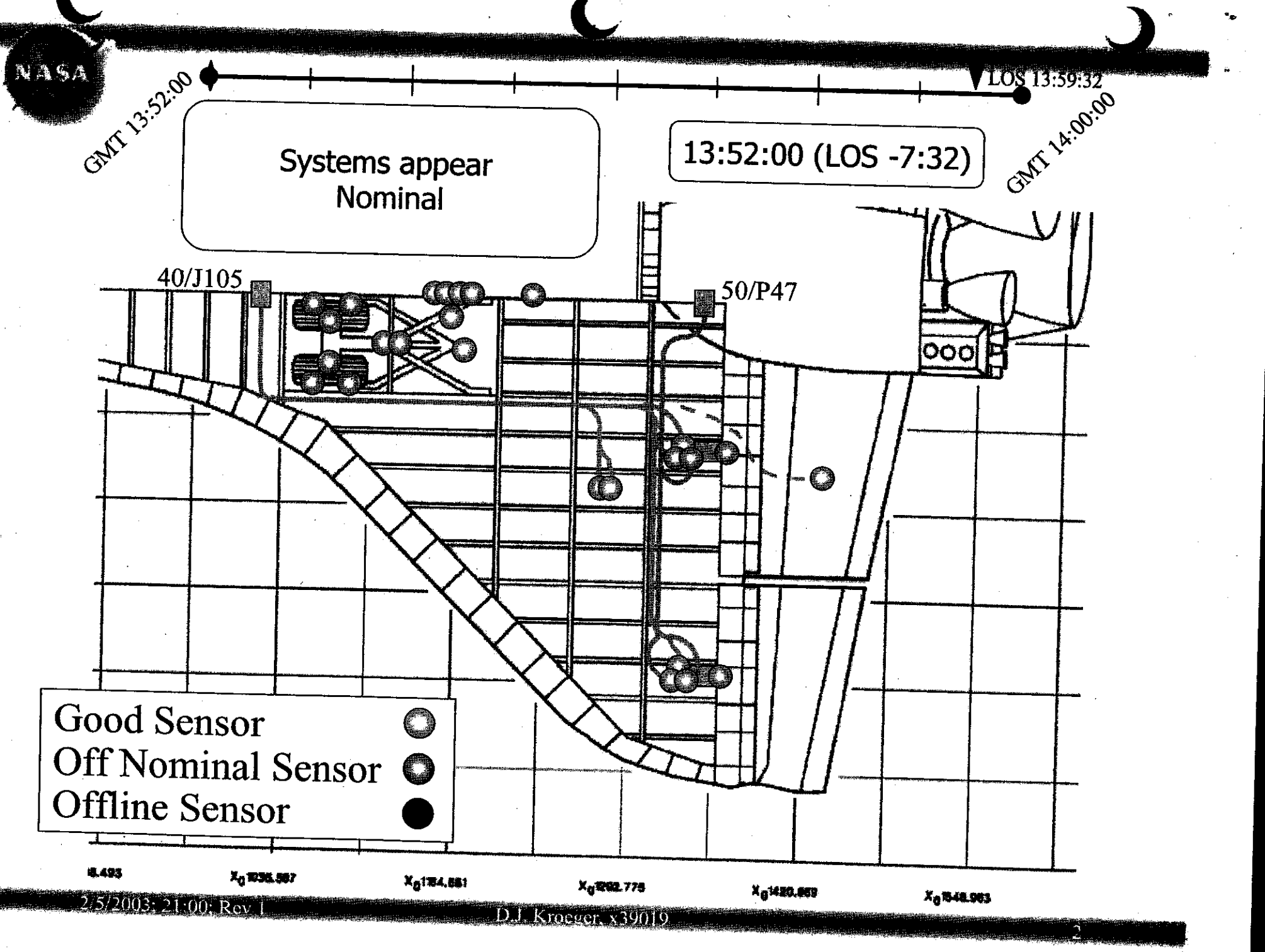
GMT 14:00:00

Shuttle X-Y Axis Plane



2/5/2003; 21:00; Rev 1

D.L. Kroeger, x39019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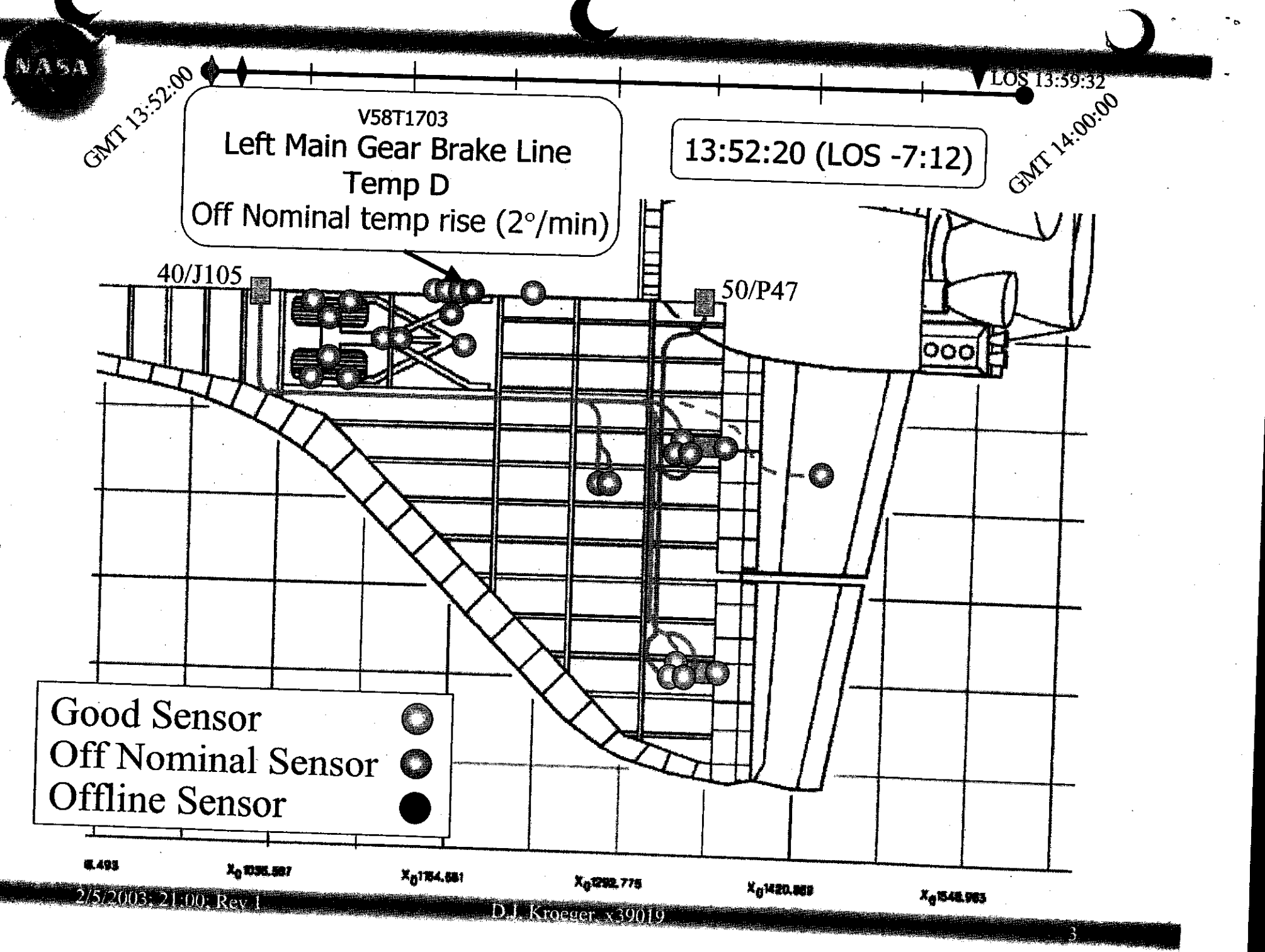
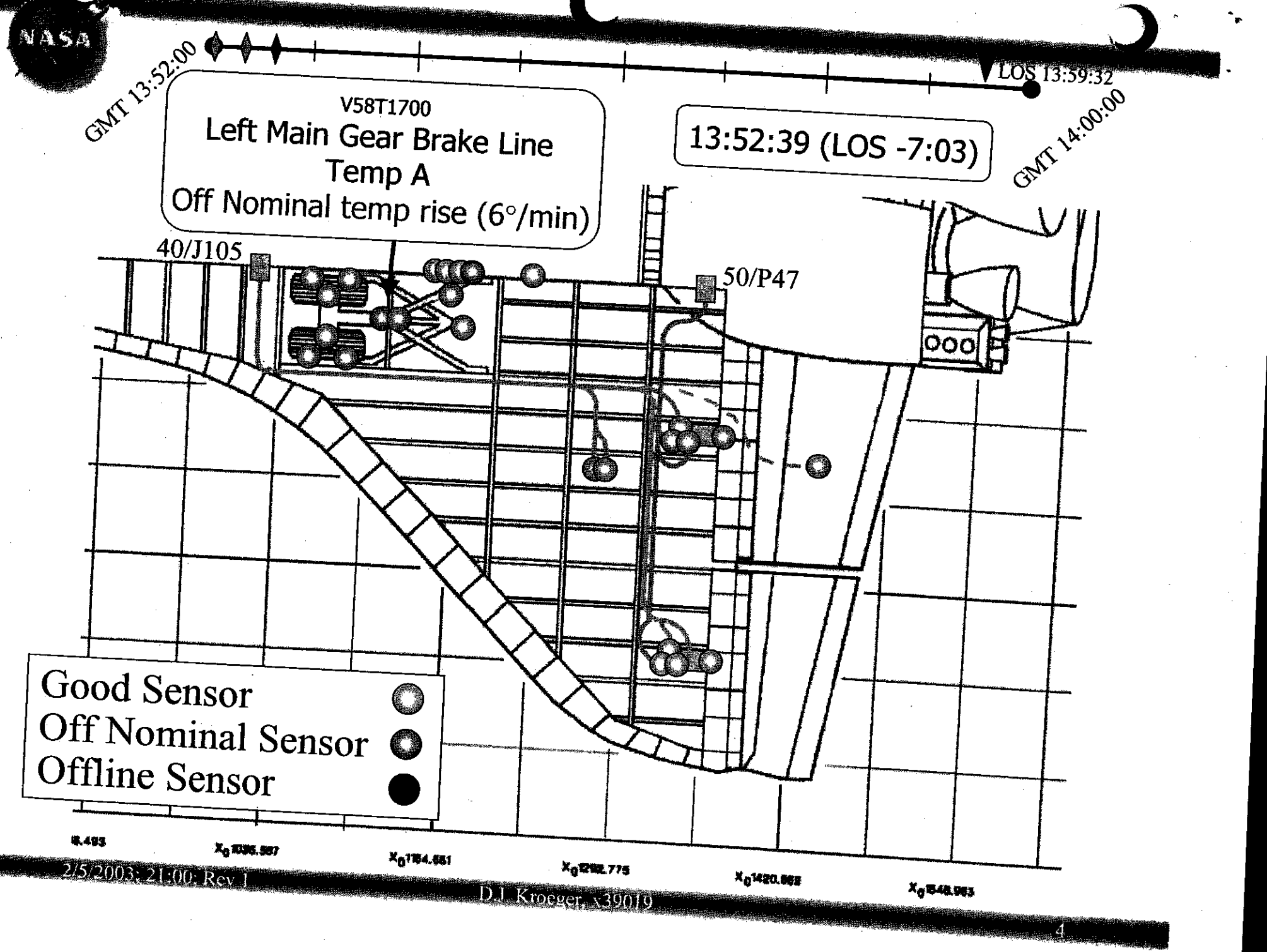
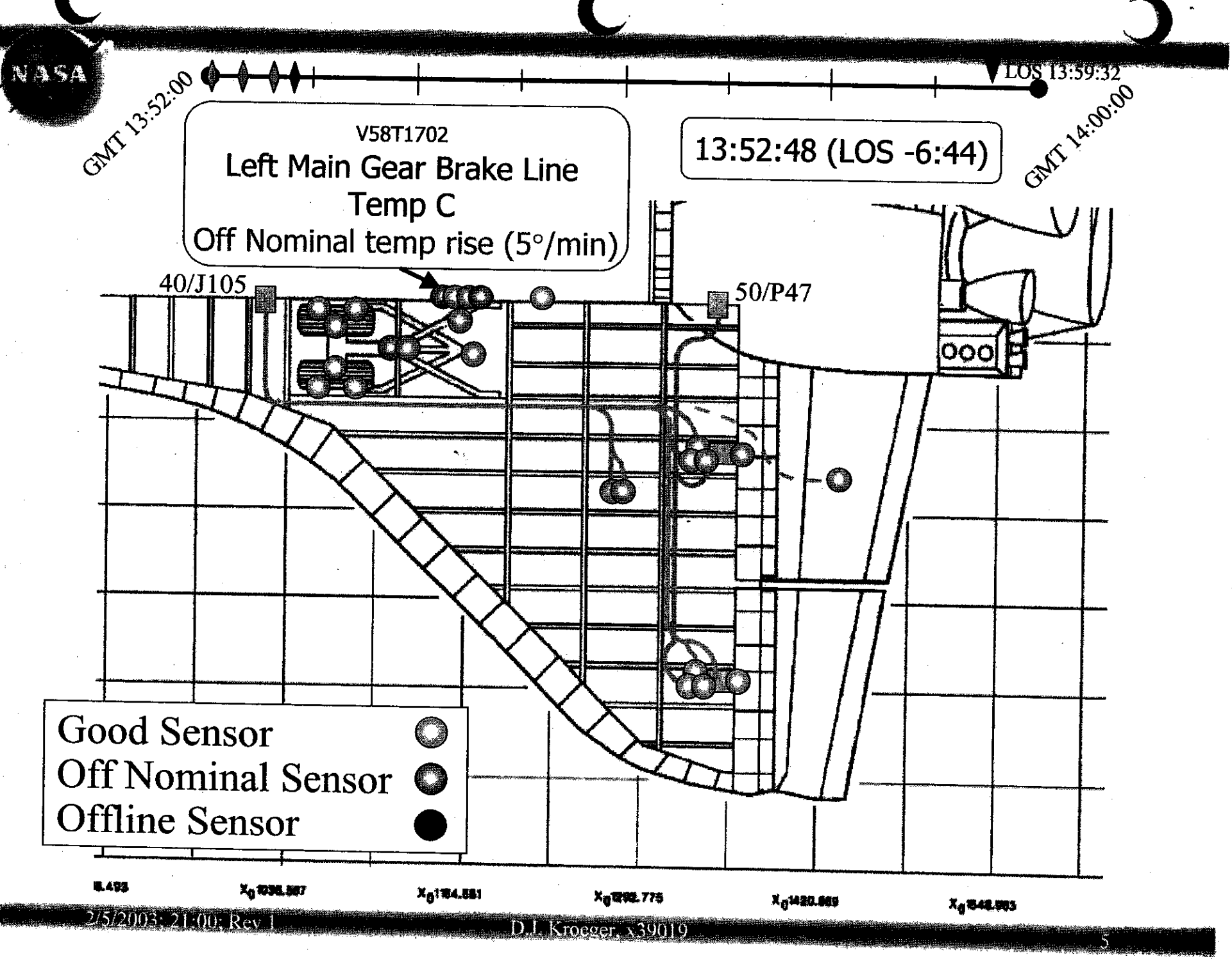
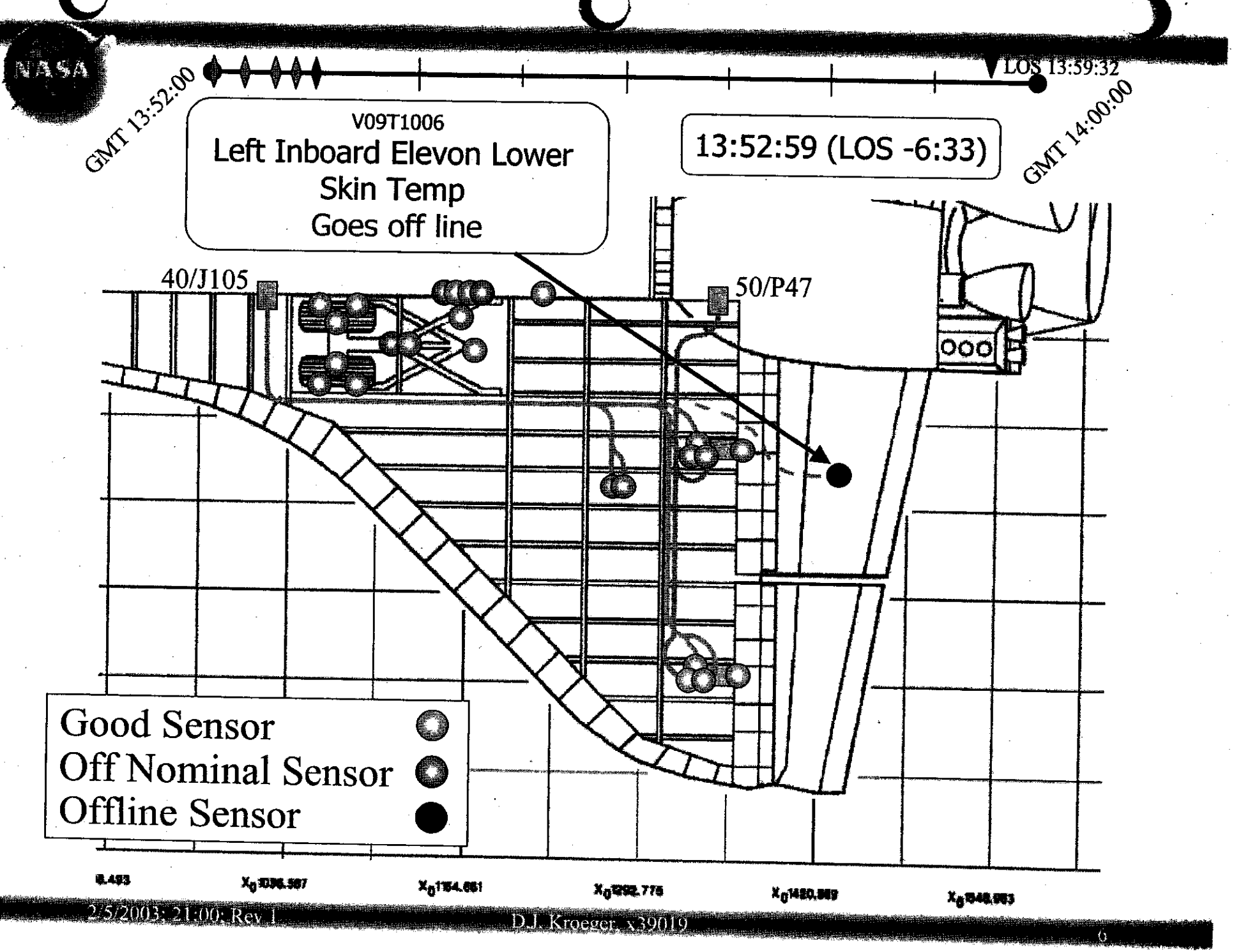
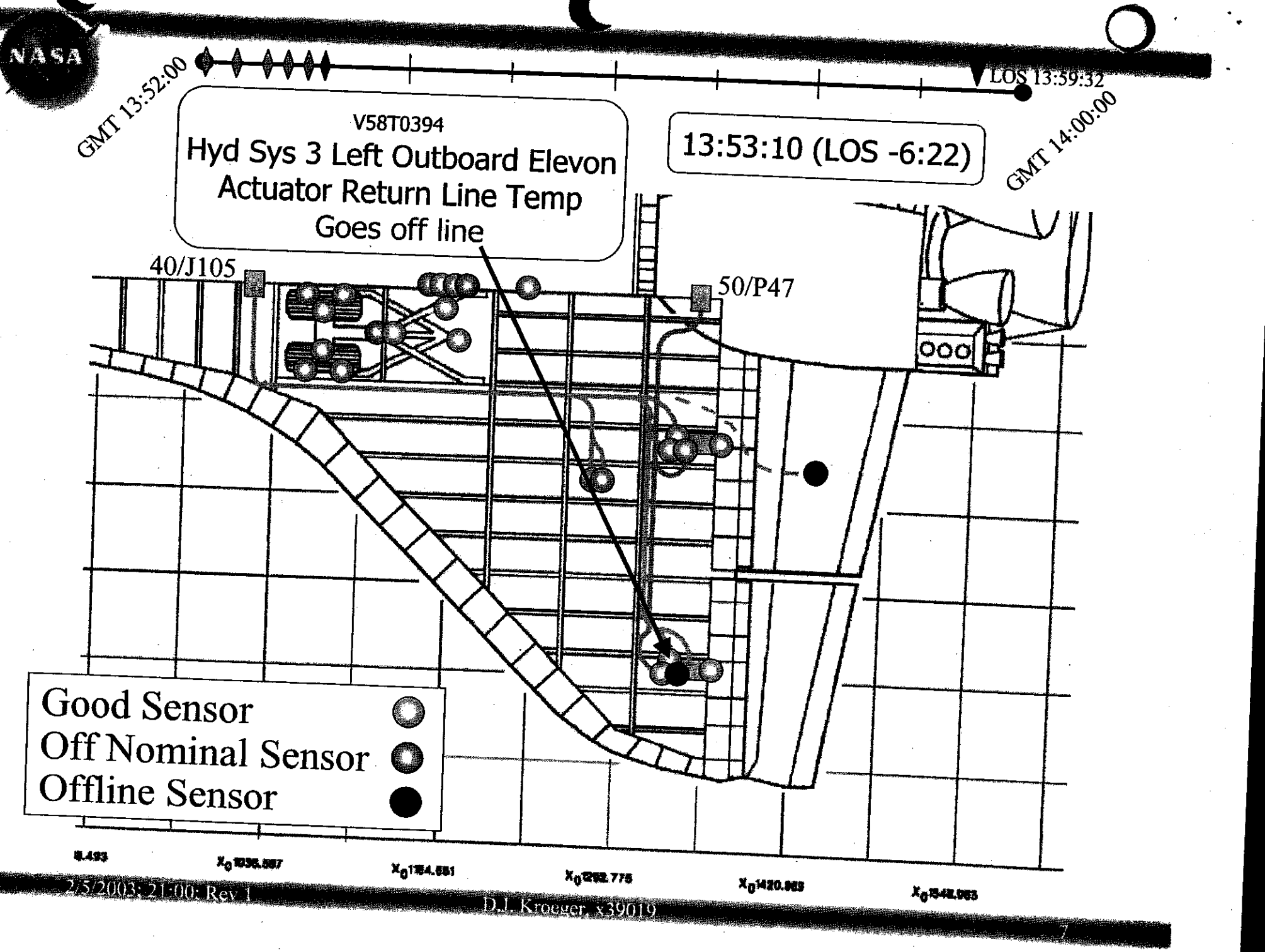
LOS 13:59:32
GMT 14:00:00
Systems appear Nominal
13:52:00 (LOS -7:32)
40/J105
50/P47
Good Sensor
Off Nominal Sensor
Offline Sensor


GMT 13:52:00
LOS 13:59:32
GMT 14:00:00
V58T1703
Left Main Gear Brake Line
Temp D
Off Nominal temp rise (2°/min)
13:52:20 (LOS -7:12)
40/J105
50/P47
Good Sensor
Off Nominal Sensor
Offline Sensor


GMT 13:52:00
LOS 13:59:32
GMT 14:00:00
V58T1700
Left Main Gear Brake Line
Temp A
Off Nominal temp rise (6°/min)
13:52:39 (LOS -7:03)
40/J105
50/P47
Good Sensor
Off Nominal Sensor
Offline Sensor


GMT 13:52:00
LOS 13:59:32
GMT 14:00:00
V58T1702
Left Main Gear Brake Line
Temp C
Off Nominal temp rise (5°/min)
13:52:48 (LOS -6:44)
40/J105
50/P47
Good Sensor
Off Nominal Sensor
Offline Sensor


GMT 13:52:00
LOS 13:59:32
GMT 14:00:00
V09T1006
Left Inboard Elevon Lower
Skin Temp
Goes off line
13:52:59 (LOS -6:33)
40/J105
50/P47
Good Sensor
Off Nominal Sensor
Offline Sensor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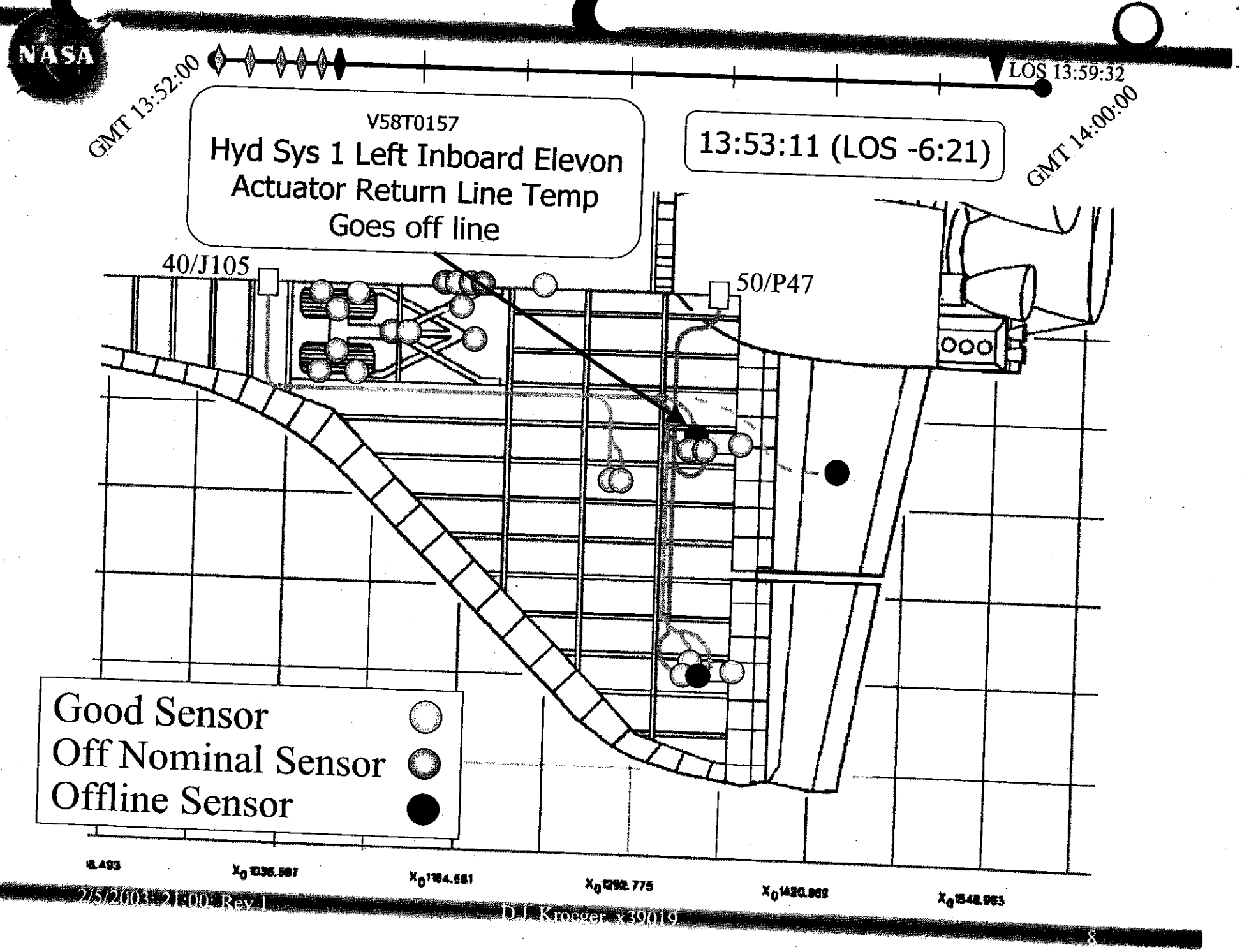
LOS 13:59:32
GMT 14:00:00
V58T0394
Hyd Sys 3 Left Outboard Elevon Actuator Return Line Temp Goes off line
13:53:10 (LOS -6:22)
40/J105
50/P47
Good Sensor
Off Nominal Sensor
Offline Sensor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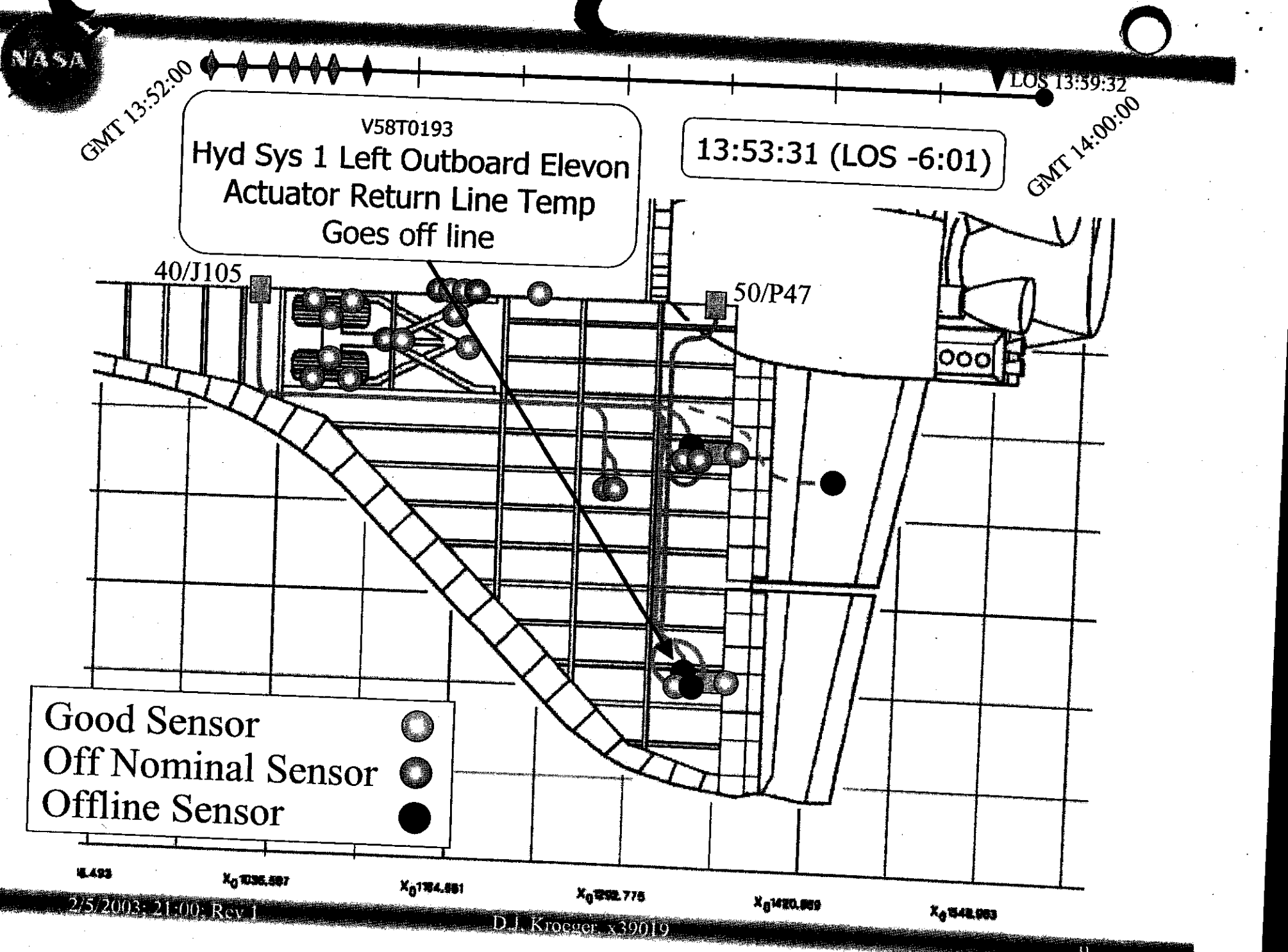
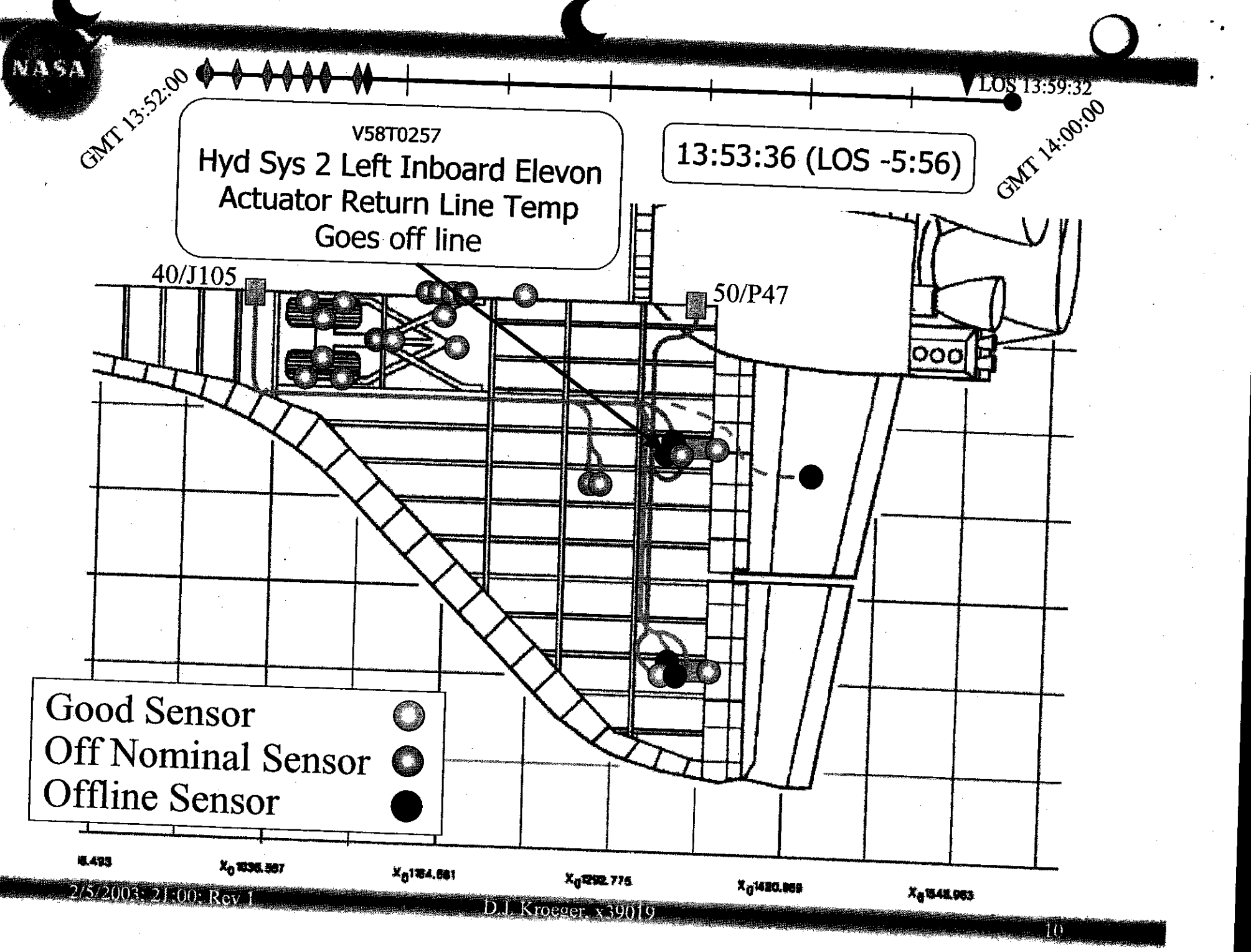
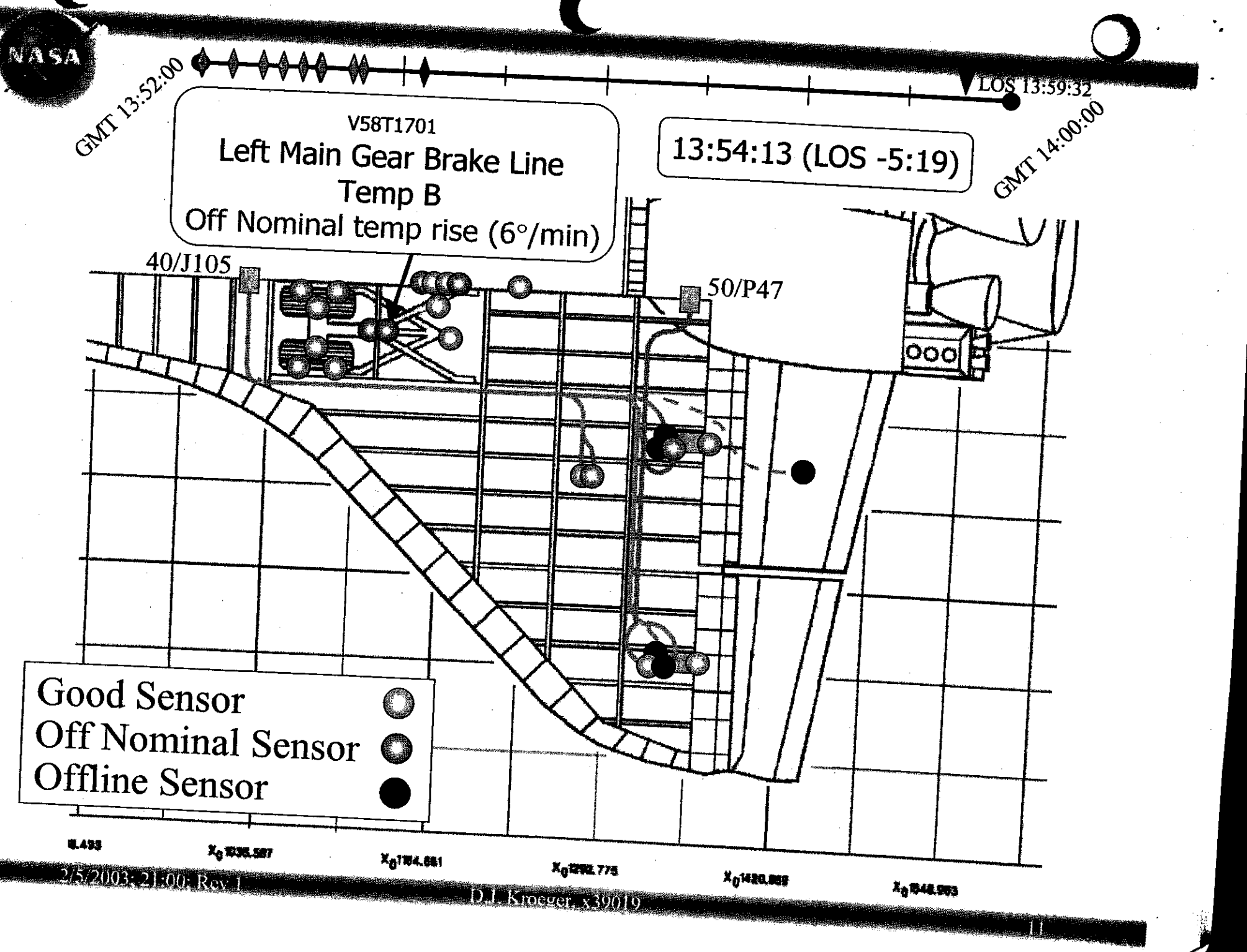
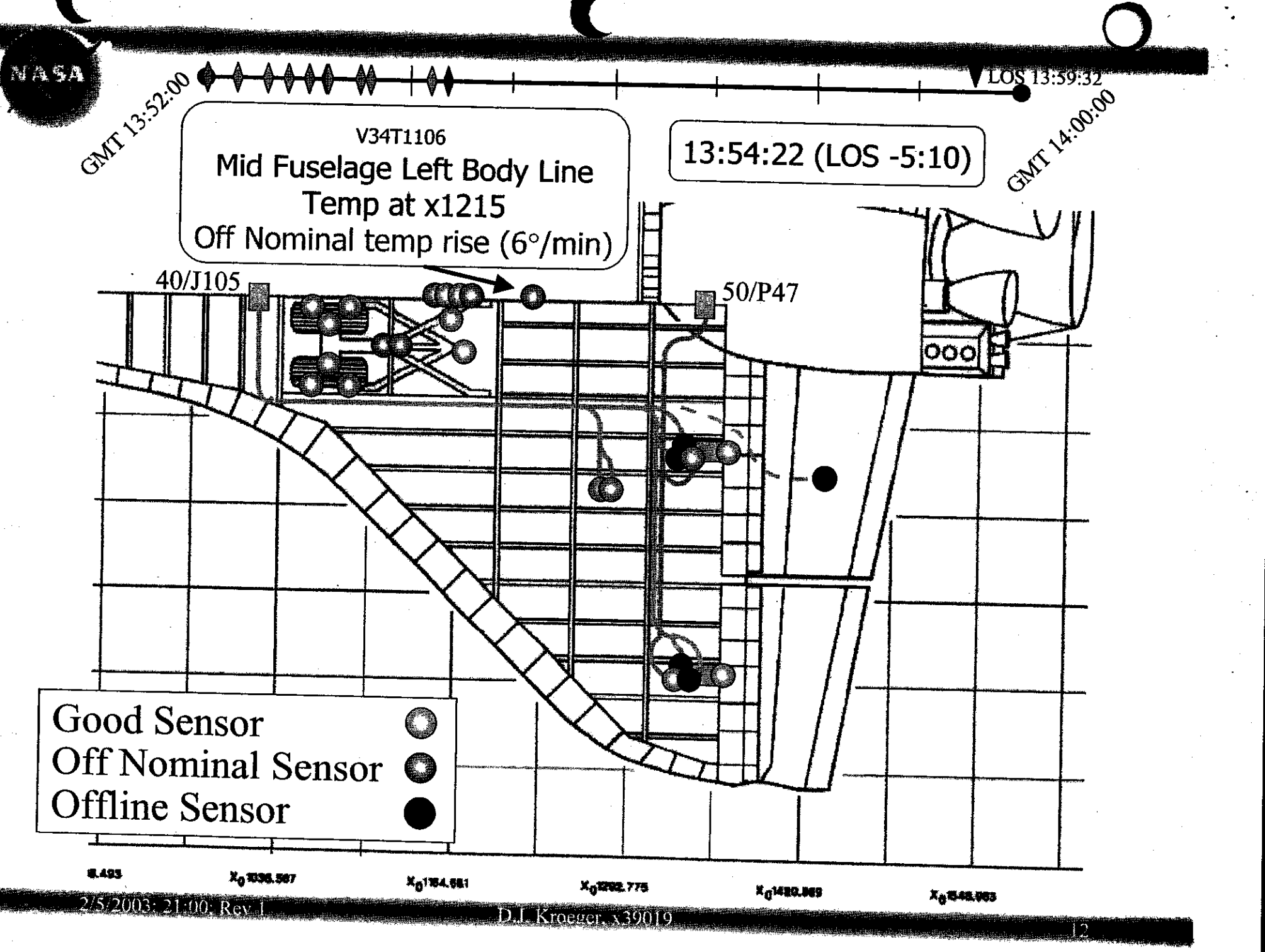
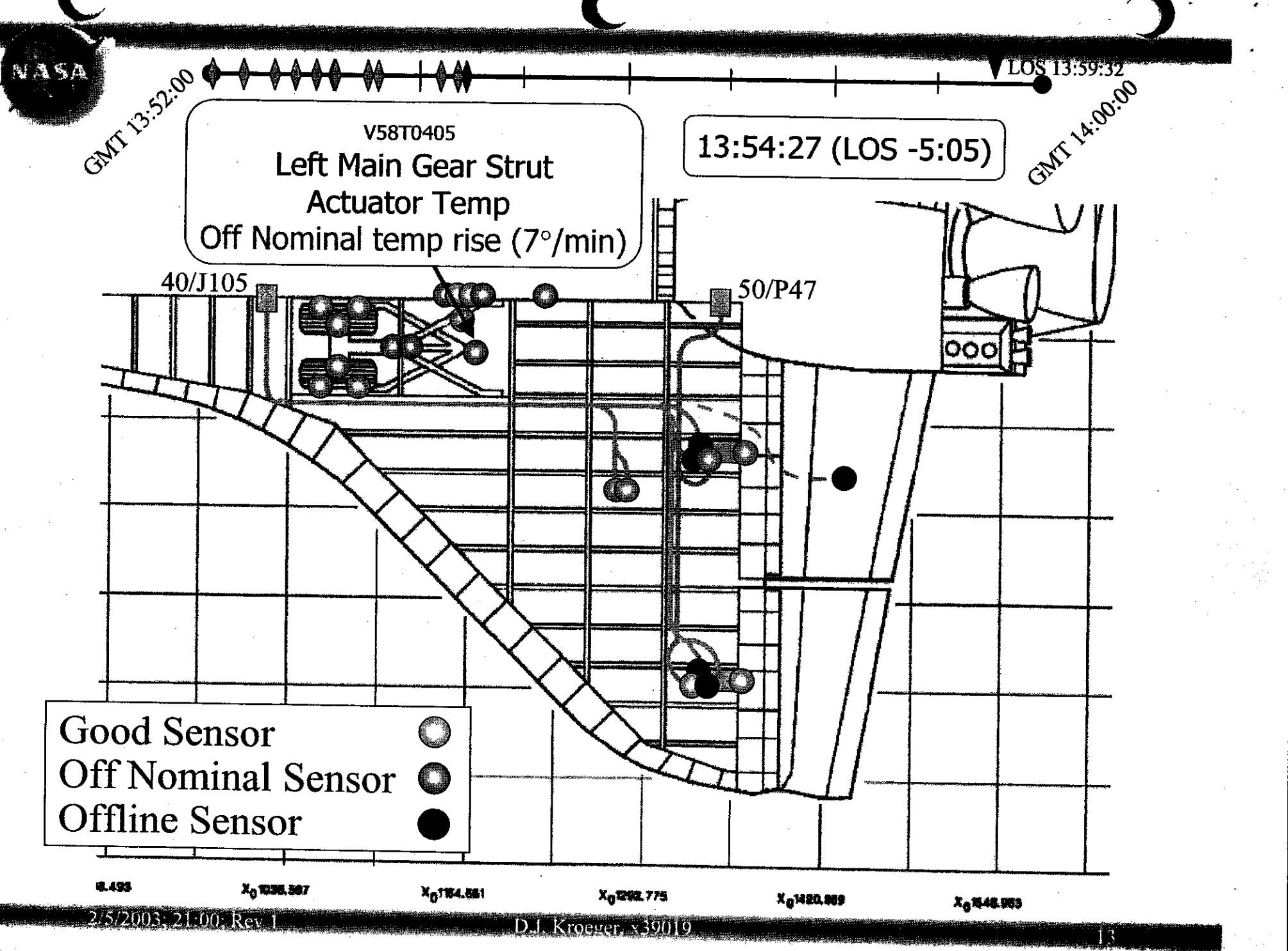
LOS 13:59:32
GMT 14:00:00
V58T0157
Hyd Sys 1 Left Inboard Elevon
Actuator Return Line Temp
Goes off line
13:53:11 (LOS -6:21)
40/J105
50/P47
Good Sensor
Off Nominal Sensor
Offline Sensor
X0 1036.587
X0 1164.581
X0 1292.775
X0 1420.969
X0 1548.963

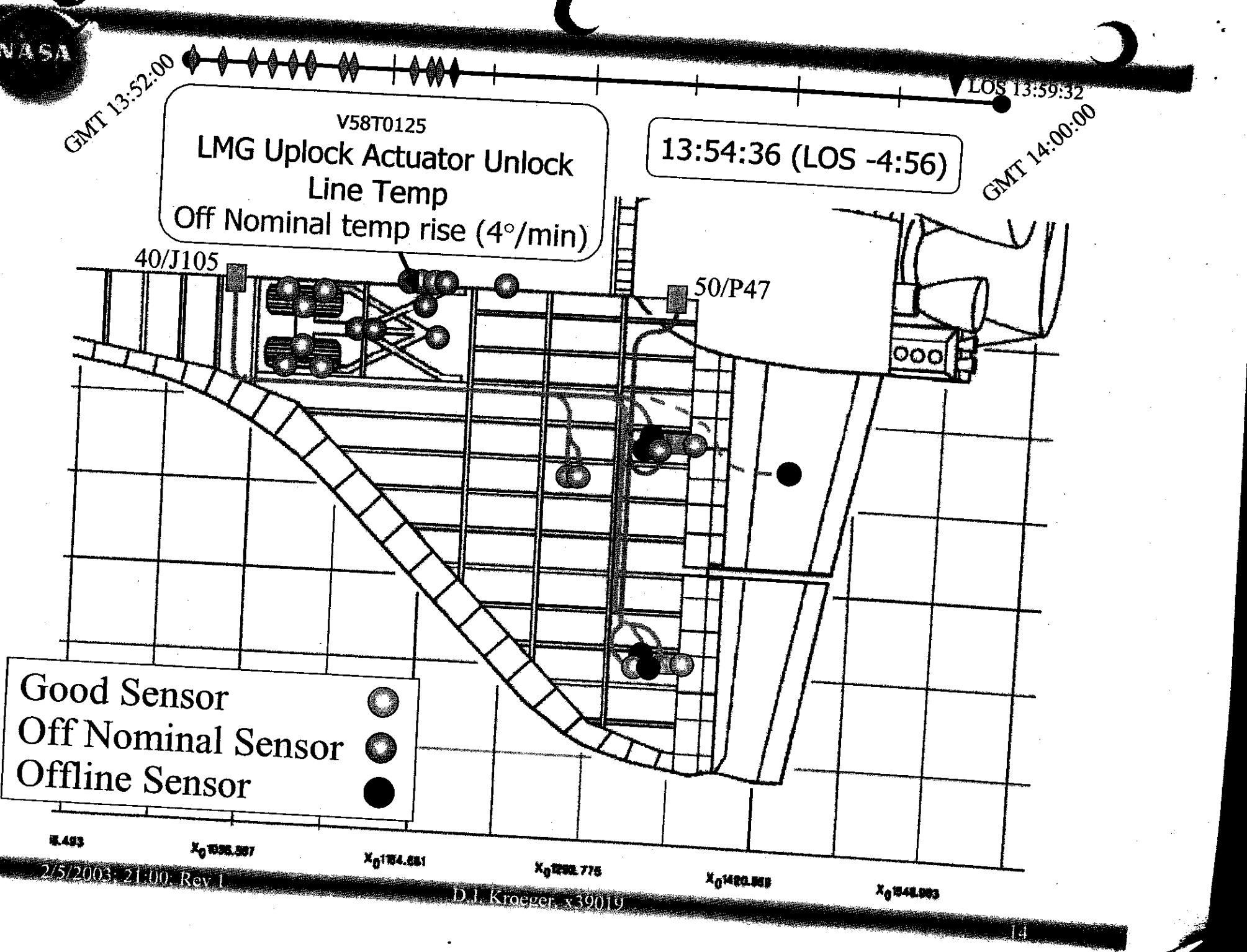

GMT 13:52:00
LOS 13:59:32
GMT 14:00:00
V58T0193
Hyd Sys 1 Left Outboard Elevon
Actuator Return Line Temp
Goes off line
13:53:31 (LOS -6:01)
40/J105
50/P47
Good Sensor
Off Nominal Sensor
Offline Sensor

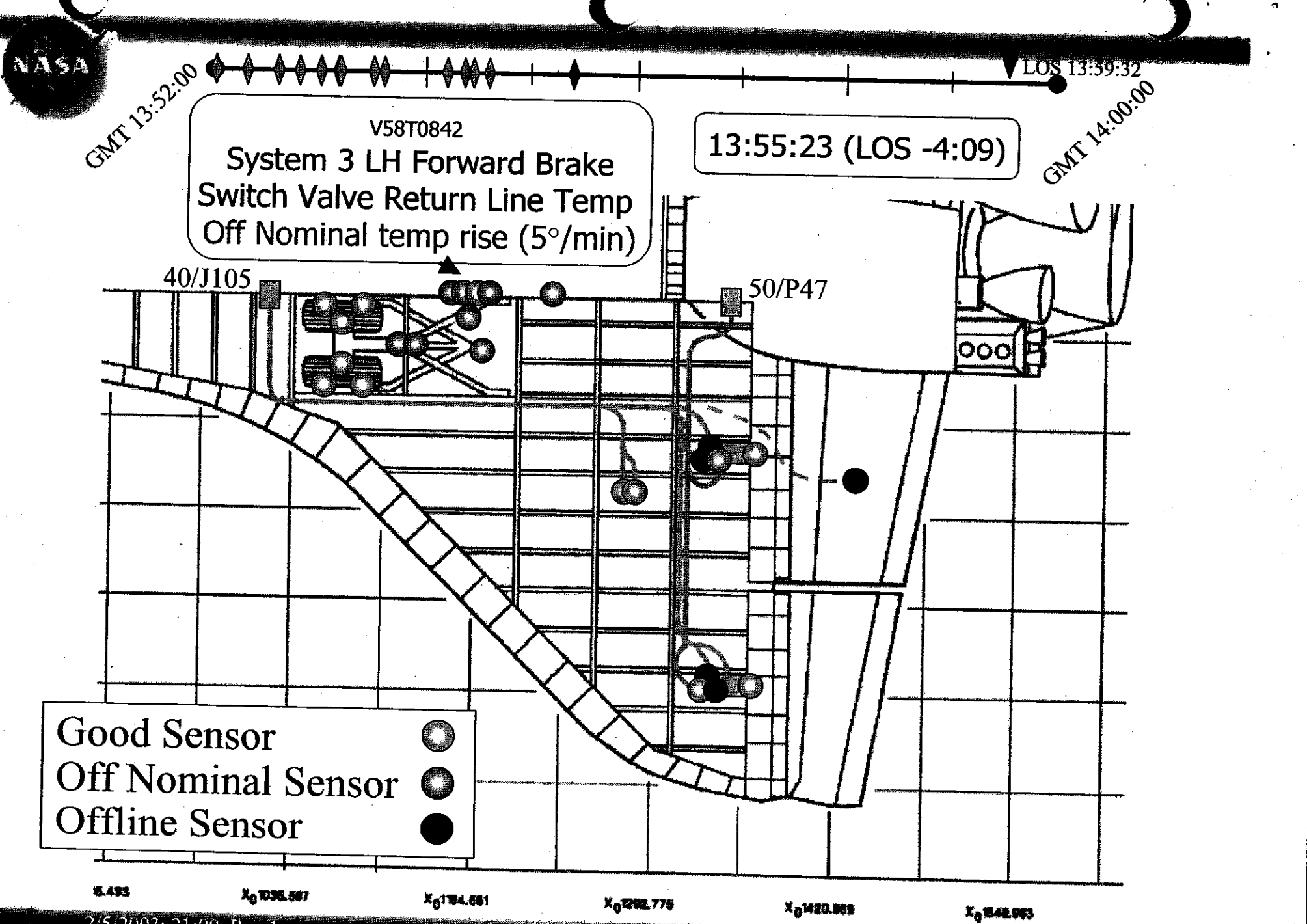

GMT 13:52:00
LOS 13:59:32
GMT 14:00:00
V58T0257
Hyd Sys 2 Left Inboard Elevon Actuator Return Line Temp Goes off line
13:53:36 (LOS -5:56)
40/J105
50/P47
Good Sensor
Off Nominal Sensor
Offline Sensor

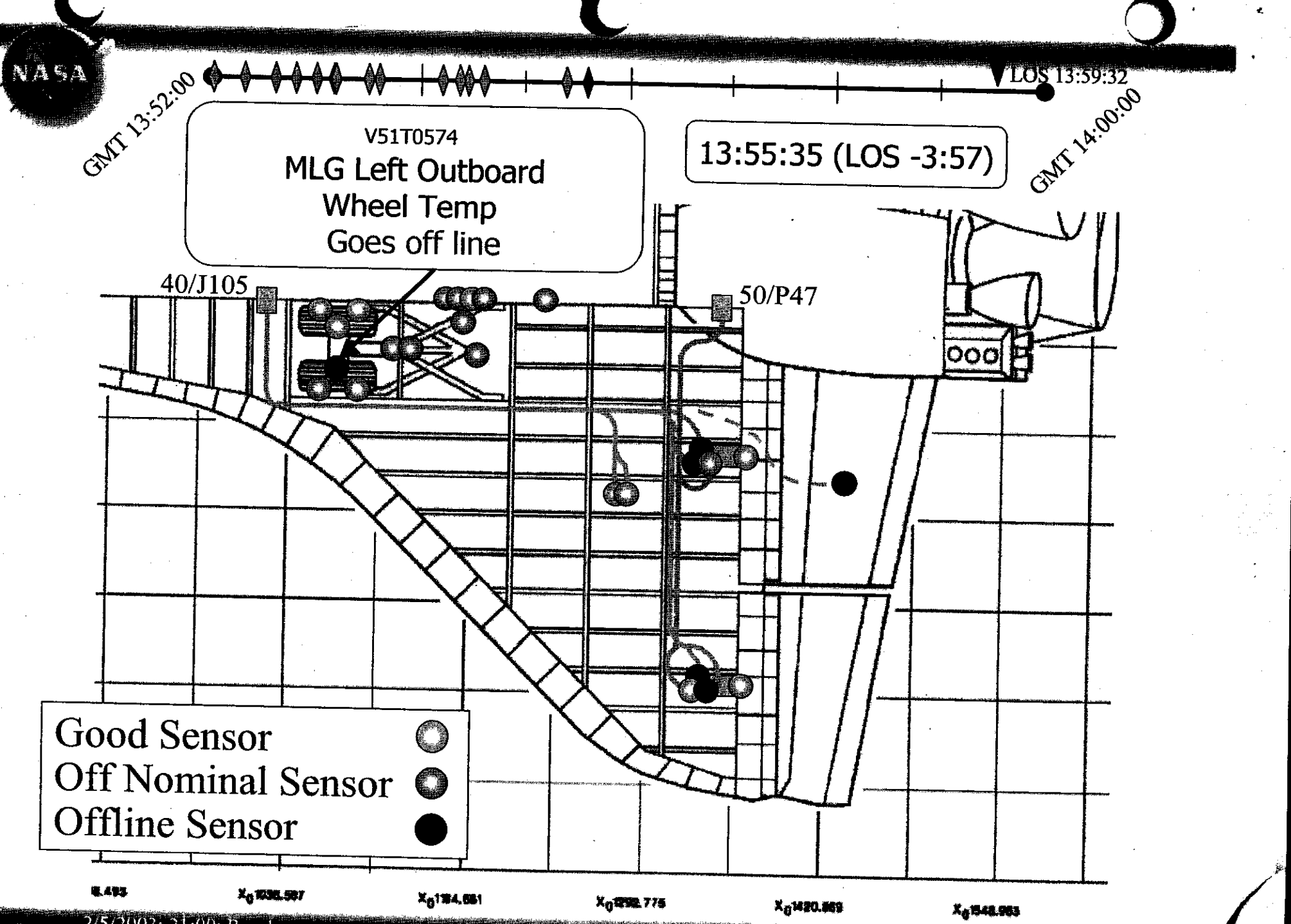

GMT 13:52:00
LOS 13:59:32
GMT 14:00:00
V58T1701
Left Main Gear Brake Line
Temp B
Off Nominal temp rise (6°/min)
13:54:13 (LOS -5:19)
40/J105
50/P47
Good Sensor
Off Nominal Sensor
Offline Sensor

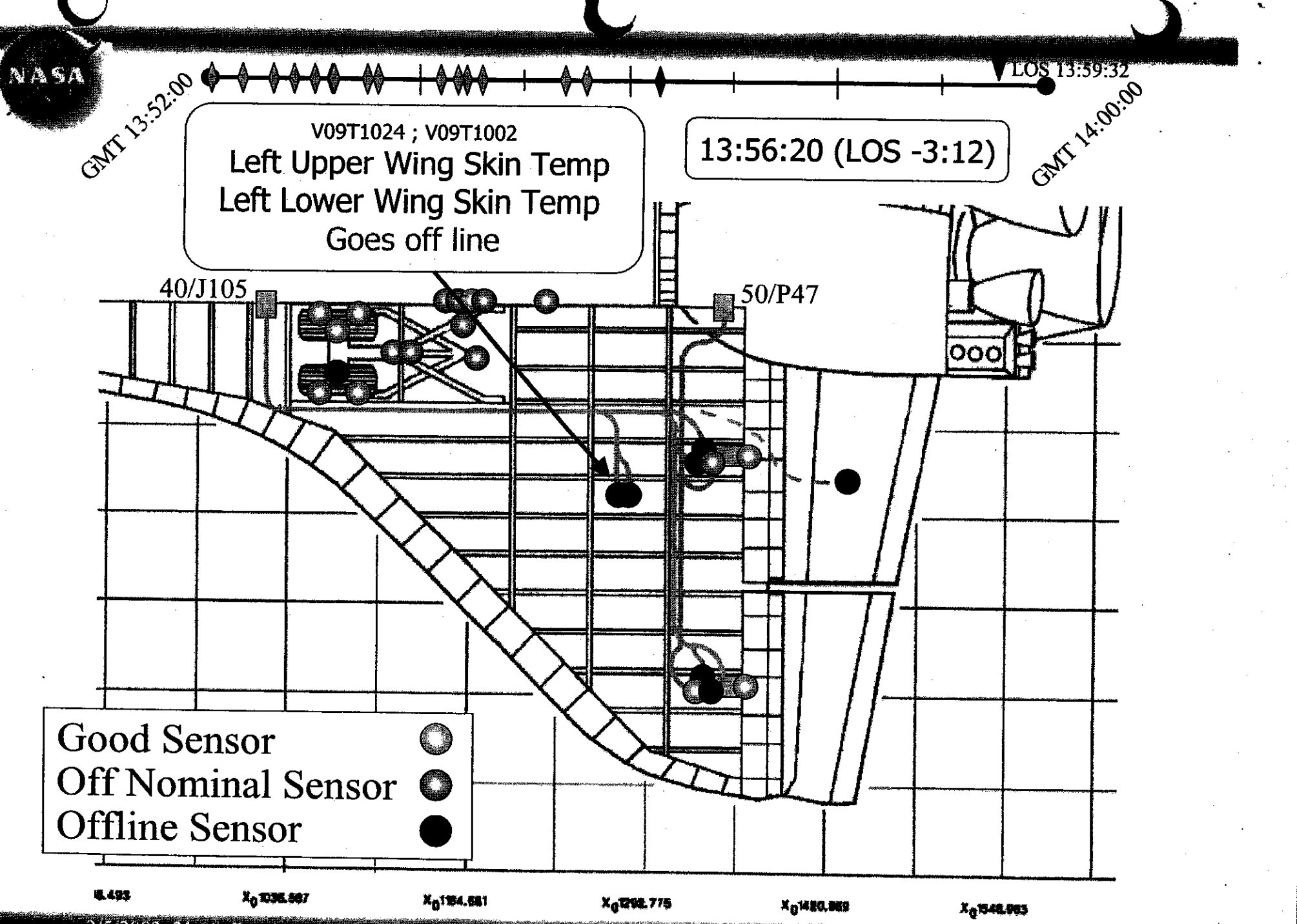

GMT 13:52:00
LOS 13:59:32
GMT 14:00:00
V34T1106
Mid Fuselage Left Body Line
Temp at x1215
Off Nominal temp rise (6°/min)
13:54:22 (LOS -5:10)
40/J105
50/P47
Good Sensor
Off Nominal Sensor
Offline Sensor

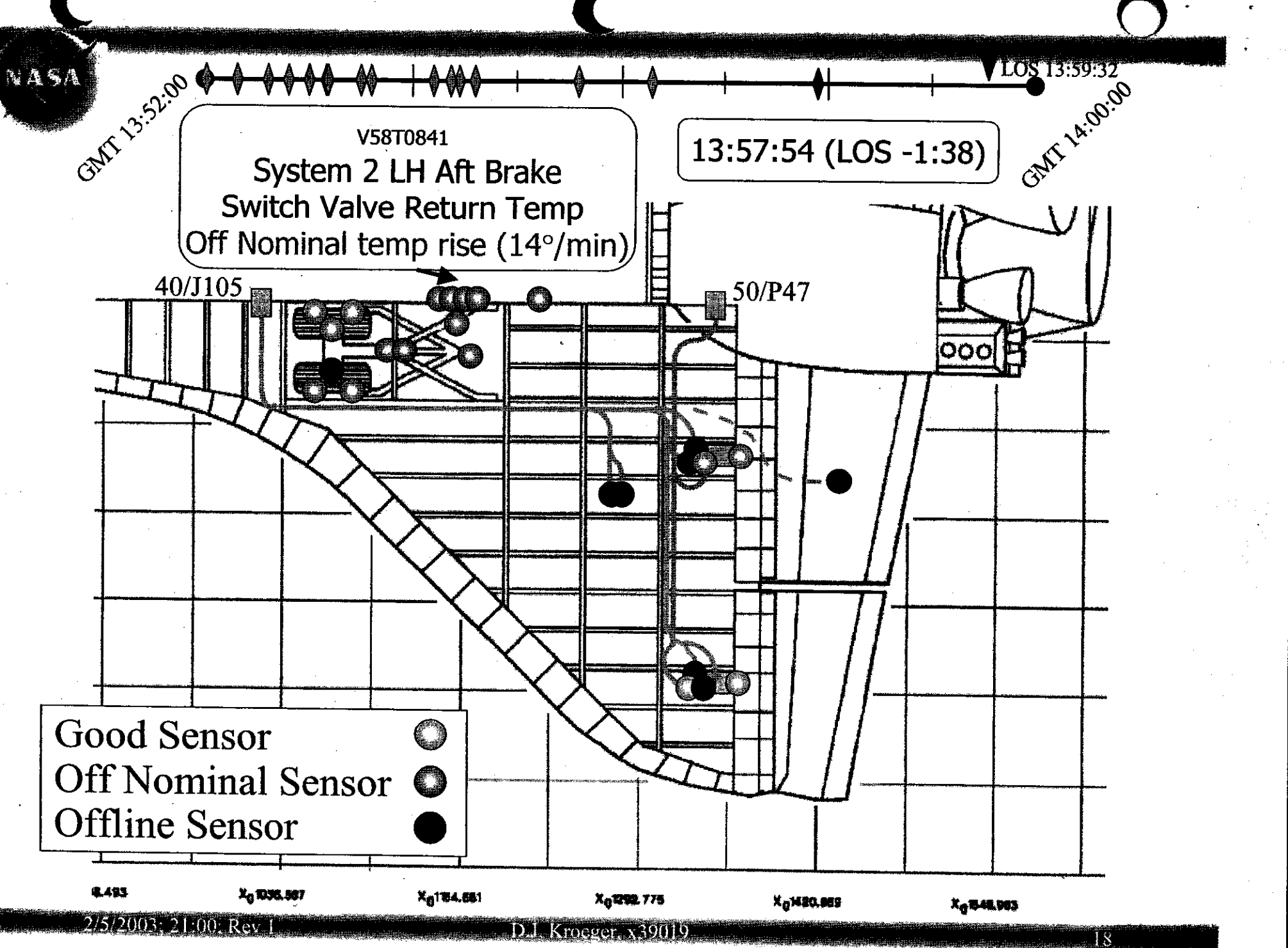

GMT 13:52:00
LOS 13:59:32
GMT 14:00:00
V58T0405
Left Main Gear Strut
Actuator Temp
Off Nominal temp rise (7°/min)
13:54:27 (LOS -5:05)
40/J105
50/P47
Good Sensor
Off Nominal Sensor
Offline Sensor


GMT 13:52:00
LOS 13:59:32
GMT 14:00:00
V58T0125
LMG Uplock Actuator Unlock Line Temp
Off Nominal temp rise (4°/min)
13:54:36 (LOS -4:56)
40/J105
50/P47
Good Sensor
Off Nominal Sensor
Offline Sensor


GMT 13:52:00
LOS 13:59:32
GMT 14:00:00
V58T0842
System 3 LH Forward Brake Switch Valve Return Line Temp
Off Nominal temp rise (5°/min)
13:55:23 (LOS -4:09)
40/J105
50/P47
Good Sensor
Off Nominal Sensor
Offline Sensor


GMT 13:52:00
LOS 13:59:32
GMT 14:00:00
V51T0574
MLG Left Outboard
Wheel Temp
Goes off line
13:55:35 (LOS -3:57)
40/J105
50/P47
Good Sensor
Off Nominal Sensor
Offline Sensor


GMT 13:52:00
LOS 13:59:32
GMT 14:00:00
V09T1024 ; V09T1002
Left Upper Wing Skin Temp
Left Lower Wing Skin Temp
Goes off line
13:56:20 (LOS -3:12)
40/J105
50/P47
Good Sensor
Off Nominal Sensor
Offline Sensor


GMT 13:52:00
LOS 13:59:32
GMT 14:00:00
V58T0841
System 2 LH Aft Brake
Switch Valve Return Temp
Off Nominal temp rise (14°/min)
13:57:54 (LOS -1:38)
40/J105
50/P47
Good Sensor
Off Nominal Sensor
Offline Sensor