National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
2101 NASA Parkway
Houston, Texas 77058-3696

October 29, 2008

Reply to Attn of: AP121-FOIA-08-208

Mr. James Oberg
915 Avenue J
Dickinson, TX 77539

Dear Mr. Oberg:

This is in response to your Freedom of Information Act (FOIA) request, received August 28, 2008, for a copy of "all correspondence, email or hardcopy, between Mr. Nicholas Johnson and Dr. Jousef Butt, regarding the NASA-performed analysis of the USA-193 satellite threat."

The requested information is enclosed with the exception of third-party names. It is my initial determination that the third-party names are exempt from disclosure under Exemption (b)(6) of the FOIA [5 U.S.C.§ 552 (b)(6)]. FOIA Exemption (b)(6) refers to "personnel and medical files and similar files the disclosure of which would constitute a clearly unwarranted invasion of personal privacy" 5 U.S.C. § 552(b)(6). See Department of State v. Washington Post Company, 456 U.S. 595,599-603 (1982); New York Times v. NASA, 920 F.2d 1002 (D.C. Cir. 1990).

The names of the third-parties involved clearly satisfy the FOIA Exemption (b)(6) threshold requirement; that is, this information is highly personal in nature and directly concerns matters involving each individual's private life. In assessing the public interest in disclosure of such personal information, the Supreme Court, in *Dep't of Just. v. Reporters Committee for Freedom of the Press*, 489 U.S. 749, 773, sharply limited the concept of "public interest" under FOIA to the "core purpose" for which Congress enacted it: To "shed[]light on an agency's performance of its statutory duties." Disclosure of the aforementioned personal information does not appear to qualify under this narrow standard. However, even if some public interest could be found, after weighing both competing interests, it is clear in this instance that the harm to personal privacy of each individual outweighs any benefit of disclosure. See Department of Air Force v. Rose, 425 U.S. 352, 372.

You are advised that you may appeal to the NASA Administrator this initial determination to withhold the cited information. Your appeal must: (1) be addressed to the Administrator, NASA, Washington, DC 20546; (2) be clearly identified on the

envelope and in the letter as an "Appeal under the Freedom of Information Act;" (3) include a copy of the request for the Agency record, and a copy of the contested initial determination; (4) to the extent possible, state the reasons you believe the initial determination should be reversed; and (5) be sent to the Administrator within 30 calendar days of the receipt of this initial determination

A determination has been made that reproduction costs for this request were minimal. Accordingly, in keeping with NASA's policy to provide the widest practicable dissemination of information concerning its activities, reproduction costs have been waived.

Sincerely,

Stella Luna
JSC FOIA Public Liaison Officer

Enclosures

Subject: USA-193 FOIA Request 08-208

From: Johnson, Nicholas L. (JSC-KX)
Sent: Monday, August 11, 2008 8:39 AM
To: 'ybutt2002@yahoo.com'
Subject: RE: USA-193 -- Fw: FOIA request 08-191

Dr. Butt,

Various US Government agencies independently examined the likely extent of a hydrazine cloud emanating from the USA-193 titanium tank had it impacted on land after an intact, uncontrolled reentry. In February, US Government officials publicly stated that the extent of the cloud hazardous to human health might cover an area equivalent to two football fields. The actual extent, of course, would be dependent upon the terrain, wind, and temperature of the impact site, among other factors.

Due to the magnitude of this potential threat area, NASA developed a new risk assessment model employing a high fidelity, world-wide population distribution database. The NASA white paper authored by Dr. [redacted], which you possess, was prepared specifically to describe the methodology required to determine risks when very large casualty areas are involved. A significant aspect of the USA-193 threat, due to the large extent of the resultant hydrazine cloud, was that not only was the probability of casualty to one person high, but also the probability of incurring harm to more than one person was much higher than previous reentries. Dr. [redacted]'s technique also explicitly addresses that issue.

The issue of safety associated with the launch of a vehicle with a similar size hydrazine tank is very different, at least for U.S. space launches. If a launch vehicle malfunction were to occur early in flight, the remaining components of the launch vehicle and its payload would fall into designated broad ocean areas and pose very little threat of human casualty. If the launch vehicle malfunction were to occur later in flight, the vehicle would breakup on its reentry into the atmosphere from its ballistic trajectory. Since the hydrazine would be in a liquid, pressurized state, it would quickly be released and dissipated prior to impact.

Please note that many types of launch vehicles carry much greater amounts of propellants or other fluids which are capable of posing health hazards to humans. It is for this reason that launch azimuths are strictly constrained and that launch vehicles employ self-destruct mechanisms in the event that the vehicle deviates from its planned trajectory.

Regards,

Nicholas Johnson

From: yousaf butt [mailto:ybutt2002@yahoo.com]
Sent: Saturday, August 09, 2008 9:04 AM
To: Johnson, Nicholas L. (JSC-KX)
Subject: RE: USA-193 -- Fw: FOIA request 08-191

Dr. Johnson,

Thank you for pointing me to the Military Channel's "Satellite Shootdown" program. In it Gen Obering quotes a roughly ~1/30 chance of human casualty from the tank/hydrazine had the satellite been allowed to re-enter. The only way I can independently arrive at a remotely similar number is to assume a non-clustered distribution of people on the globe, and an very large lethality radius (tens of meters). Myself -- and several expert colleagues -- cannot support either of these assumptions, nor the final number quoted by Gen. Obering.

In any case -- just for the sake of argument -- if Gen. Obering's number were to be correct, this would raise another serious issue: since space launches are no better than ~99% effective in properly inserting their payloads to orbit, this would mean that satellites with any similar Ti hydrazine tanks ought not to be launched as the cumulative probability for a potential casualty from an unsuccessful launch or orbital insertion is ~(1/30)*(1/100) = 1/3000, which is substantially higher than NASA and USG's 1/10,000 adopted safe value.

Do you agree that there may be merit in imposing a moratorium on launching satellites with similar Ti hydrazine tanks as on USA-193, pending a better design (e.g. design-for-demise), or a more refined calculation of the risk numbers than those quoted by Gen. Obering?

Best regards,
Yousaf

--- On **Wed, 8/6/08, Johnson, Nicholas L. (JSC-KX) <*nicholas.l.johnson@nasa.gov*>** wrote:
From: Johnson, Nicholas L. (JSC-KX) <nicholas.l.johnson@nasa.gov>
Subject: RE: USA-193 -- Fw: FOIA request 08-191
To: ybutt2002@yahoo.com
Date: Wednesday, August 6, 2008, 2:27 PM

Dr. Butt,

At the direction of the USG, NASA is not permitted to discuss the final assessed human casualty risk from the potential hydrazine cloud. Dr. Matney's paper was written only to present the methodology for calculating risk posed by a large debris casualty area (as defined by NASA), i.e., in this case an extended hydrazine cloud. Former techniques, including those used by NASA, for relatively small, discrete satellite components were insufficient. I do note that Lt. Gen. Obering did mention a range of risk values in the recent "Satellite Shootdown" program on the Military Channel.

The human casualty risk from components of USA-193 (excluding hydrazine) was much less than the risk posed by the hydrazine.

The CGRO spacecraft was designed from the start for a controlled reentry at end of mission because of concern about risks to people and property on Earth from the unique elements of the vehicle. This was before the 1 in 10,000 criterion was set by NASA and later adopted by the US Government. Had CGRO been allowed to reenter in an uncontrolled fashion it would indeed have presented a human casualty risk substantially greater than 1 in 10,000.

I reiterate that more than one USG organization assessed that the titanium tank would have survived reentry. This work was originally done in 2007 and was the reason that Operation Burnt Frost was even considered. During Operation Burnt Frost these results were thoroughly revalidated.

Nicholas Johnson

From: yousaf butt [mailto:ybutt2002@yahoo.com]
Sent: Wednesday, August 06, 2008 11:43 AM
To: Johnson, Nicholas L. (JSC-KX)
Subject: RE: USA-193 -- Fw: FOIA request 08-191

Dr. Johnson,
thank you for the information.

Although you mention that no documents were kept
of the final consensus numbers, could you simply inform me
of those values? eg. the probability of one or more
persons being hurt or killed by the tank/contents?

Dr. [redacted]'s paper appears to be incomplete in this
respect, and our own calculations show that for a
5m lethality radius the risk of death of one or more
people would be below 1/10000, taking into account
clustering of the population.

e.g. Was a similar exercise done, as was with CGRO?
In that case, the numbers released mentioned
1/1000 risk, and that was a far larger satellite. Personally,
I felt even those numbers were a bit high also.

I understand that at times the risk is hard to quantify
but were consensus bounding values obtained? Could
you kindly share these with me? If not, would you
be able to tell me the contact information of the
relevant person at DoD that I may contact to ask about
this?

I hope you will understand that all we have publicly available to us is the White Paper which uses a fairly low-fidelity model biased towards tank survival, and still results in ablation of 4 out of 5 Ti nodes, leaving just 0.7mm tank thickness. We are planning to re-do the identical simulation with 20 nodes, but feel already certain that 19 out of 20 will also ablate away. In fact, given the temperature and dwell time, I would venture that for n nodes used in the simulation n-1 would ablate, but we will check all this shortly. And this for a highly optimistic (of tank survival) model.

The SCARAB codes for the non-tumbling case of the 75% full Ti tank re-entering do result in burn-through.

Any technical information that you could supply to convince us otherwise would be very welcome. And especially any final risk numbers: probability of tank survival? probability of death/injury? would be welcome.

Again, thanks very much for your time & hope the tropical storm was not much of an issue.

Best regards,
Yousaf

--- On **Mon, 8/4/08, Johnson, Nicholas L. (JSC-KX) <*nicholas.l.johnson@nasa.gov*>** wrote:
From: Johnson, Nicholas L. (JSC-KX) <nicholas.l.johnson@nasa.gov>
Subject: RE: USA-193 -- Fw: FOIA request 08-191
To: ybutt2002@yahoo.com
Date: Monday, August 4, 2008, 1:46 PM

Dr. Butt,

If one assumes that the tank is stable, yes, the consequence would be different than with the random tumbling case. We did look at that scenario. However, it is not clear that the tank would indeed become stable, certainly not with any reasonable confidence.

Re other reports, NASA prepared no other unclassified papers on this subject during the January-February period of Operation Burnt Frost. The two papers you received were done solely as an efficient means of communicating with other USG organizations who were working on these two topics. All major issues, e.g., tank survivability and calculation of human casualty risk, were addressed by multiple organizations to form a consensus on technical matters.

In fact, we prepared no other similar summaries at all, at any classification level. Be advised that

this was a highly intense period of activity (only one official day off from early January until after the intercept in late February) during which no time was permitted for unnecessary documentation. Finally, any classified data would have to be requested from the Department of Defense, since NASA does not hold any classification or de-classification authority.

Please note that JSC officially closed today at noon local time due to the approaching Tropical Storm/Hurricane and will remain closed until Wednesday at the earliest. I am about to disconnect my IT equipment and bag it as a precaution. If you have any further questions, I will address them as soon as possible later this week.

Nicholas Johnson

From: yousaf butt [mailto:ybutt2002@yahoo.com]
Sent: Monday, August 04, 2008 11:52 AM
To: Johnson, Nicholas L. (JSC-KX)
Subject: RE: USA-193 -- Fw: FOIA request 08-191

Dear Nicholas,

yes, agreed that the evacuation of the hydrazine melt from the inlet reduces heat flow into the rest of the hydrazine, but we find it results in burn-through of the Ti at that location, precisely because the hydrazine heat-sink there is missing.

And if the tumbling assumption is relaxed (as it ought to be for the asymmetrical hydrazine placement in the tank) then the heat load is a factor of several higher than in the White Paper in the Ti tank region close to the stagnation point. Note even in the White Paper 4 out of 5 finite element nodes are ablated away leading to just ~0.7mm of Ti.

Do you agree that it is most likely that the tank would have ablated (even partially), whether or not the frozen hydrazine made it to the ground (which is another problem altogether)?

I understand if the relevant studies are classified, but would you be at liberty to tell me simply the titles of the studies, as this would allow me to try to obtain the studies via FOIA rather than burden you further? I hope at some future time that you will be able to publish this work as many folks are eager to see it.

Thank you for your time.

Best regards,
Yousaf

--- On **Mon, 8/4/08, Johnson, Nicholas L. (JSC-KX) <*nicholas.l.johnson@nasa.gov*>** wrote:
From: Johnson, Nicholas L. (JSC-KX) <nicholas.l.johnson@nasa.gov>
Subject: RE: USA-193 -- Fw: FOIA request 08-191
To: ybutt2002@yahoo.com
Date: Monday, August 4, 2008, 10:29 AM

Dr. Butt,

As you are aware, activities associated with the reentry assessment of USA-193 were conducted in a highly classified environment. While I am not a liberty to answer some of your inquiries below, I can assure you that issues such as the evacuation of melted hydrazine from the tank during reentry were considered in the parametric analyses performed. The release of melted hydrazine via the propellant inlet valve can actually reduce the rate of heat transfer into the remaining frozen hydrazine.

If one believes that all of the hydrazine was initially frozen, then the outcome at Earth impact was relatively insensitive to the assumed temperature of the tank and hydrazine prior to reentry. Various initial temperatures were evaluated.

Regards,

Nicholas Johnson

From: yousaf butt [mailto:ybutt2002@yahoo.com]
Sent: Monday, August 04, 2008 9:15 AM
To: Johnson, Nicholas L. (JSC-KX)
Subject: RE: USA-193 -- Fw: FOIA request 08-191

Dear Nicholas,
thank you very much for your prompt and detailed reply.

Would it be possible for you to share the contents or write-ups of the more sophisticated NASA studies of the Ti tank that you mention?

While I fully trust your expertise and opinion on this, it is not what we see in our simulations -- and it is certainly possible that we are wrong.

One aspect that appears to be missing in written and anecdotal USG studies I have heard about is that little account is taken of the fact that the tank was only ~75% full which would tend to counter the spherical symmetry assumption; and no studies (that I am aware of) took account of the fact that leakage of hydrazine melt (under few g's) would occur at the fuel inlet, leading to the formation of a hotspot. I am also curious why the authors of the White Paper say that an initial temperature of 214K was "dictated" to them whereas they believed (correctly) that it ought to have been substantially higher. Who would dictate temperatures in

an independent technical analysis, and why?

I am trying to understand this situation better and would appreciate any help. I am simply being somewhat scientifically skeptical and hope that it is not coming across as being belligerent. I am happy to hear that USG officials were really only motivated by the safety aspect of the re-entry.

Again, if it is possible to see some of the more sophisticated NASA studies of the Ti tank that you mentioned this would be very useful.

Thanks again for the information you have already provided.

Best regards,
Yousaf

--- On **Mon, 8/4/08, Johnson, Nicholas L. (JSC-KX) <*nicholas.l.johnson@nasa.gov*>** wrote:
From: Johnson, Nicholas L. (JSC-KX) <nicholas.l.johnson@nasa.gov>
Subject: RE: USA-193 -- Fw: FOIA request 08-191
To: ybutt2002@yahoo.com
Date: Monday, August 4, 2008, 8:20 AM

Dr. Butt,

The document you received was a white paper summarizing one analytical approach to the hydrazine/tank problem. More sophisticated analyses by NASA have also been performed, including consideration of the hydrazine in layers. Moreover, prior to the decision to engage USA-193 other independent analyses by other USG organizations were also performed. While all differ in some details, the result was always the same: the titanium tank would survive intact with slush hydrazine inside.

Recognize that there is no one single answer to this problem since a variety of conditions could have existed at the time of the breakup of the spacecraft at about 78 km, at which time the titanium tank would have been separated. By analyzing various initial conditions and by using independent methodologies, the likely outcome was bounded. Also recall that NASA has considerable experience with analyzing the reentry survivability of empty titanium tanks, and several such tanks have been recovered on the ground to provide validation of these reentry assessments. The primary issues in the USA-193 case were how the additional mass of the hydrazine would affect the tank itself (additional mass would have affected the ballistic coefficient and the subsequent heating profile) and how much energy might be transferred through the tank wall to the frozen hydrazine.

We have conducted numerous direct comparisons between NASA reentry assessment codes and SCARAB with the assistance of ESA, DLR, and HTG. Overall, the results of our codes match very well with those of SCARAB.

Finally, as someone who was intimately involved in the efforts of the USG interagency group

evaluating the threat posed by USA-193, I can tell you that at NO time was any issue other than the hydrazine risk to people on Earth considered in the decision to engage USA-193. This was my personal observation during countless meetings and communications, including a meeting with the President's Science Advisor and an NSC meeting I attended at the White House. Speculations about other motives are just that: speculations by people who were not there. No amount of technical analyses will help you "better understand the rationale behind the apparent necessity of the interception of USA-193".

Regards,

Nicholas L. Johnson
Chief Scientist for Orbital Debris
NASA Johnson Space Center

From: yousaf butt [mailto:ybutt2002@yahoo.com]
Sent: Sunday, August 03, 2008 1:11 PM
To: Johnson, Nicholas L. (JSC-KX)
Cc: ybutt@head.cfa.harvard.edu
Subject: USA-193 -- Fw: FOIA request 08-191

Dear Dr. Johnson,

My congratulations on your recent award re. the studies done on USA-193.

I have received the attached two documents via Freedom of Information Act (FOIA) request made to JSFC/NASA. I am writing to ask if you'd have any further details regarding the scientific studies that may have been done prior to USA-193's interception earlier this year.

I cannot say I fully support the simplifying assumptions made in hydrazine tank white paper. e.g. the assumption of a shell of hydrazine with a void in the center attached to the Ti tank is highly unrealistic, and serves only to act as a heat-sink, whereas in reality hotspots formed on the Ti tank would have led to burn-through. Furtherm, the assumption that the hydrazine acts as a single, enormous finite-element -- absorbing all the heat until it all melts -- is considered unrealistic even by the authors of the study.

In any case, the authors find that 4 out of 5 Ti finite elements are ablated away even with these unrealistic assumptions. If 20 finite elements were considered instead, 19 of those would have been ablated leaving only a thin Ti foil.

I would like to ask you if there were higher-fidelity studies made of the hydrazine tank re-entry or if this is the only study you are aware of.

My independent technical analysis via the SCARAB code does not support the conclusion that the 75% full hydrazine tank would have survived re-entry, and I am attempting to better understand the rationale behind the apparent necessity of

the interception of USA-193.

Any further details you could supply that would help me moderate my conclusions prior to their publication would be very helpful to this debate.

Again, my congratulations on your award & I look forward to hearing from you.

Best regards,
Yousaf