ALI F. ABUTAHA

FAX MESSAGE

TO: Mr. Daniel S. Goldin, Administrator
NASA

FAX: (202) 755-2568

DATE: September 21, 1992

PAGES (including Cover Sheet): 1

REF: "Pulsing-Thrust" Technique

Dear Mr. Goldin:

We informed your office last month of our "pulsing-thrust" technique for rocket engines and motors. The process provides superior performance for space systems, and it should be of particular interest to NASA. My messages have not been answered and my follow-up calls have not been returned. Since the most recent letters that I, and my State Legislators, received from NASA officials had completely dismissed me and my work, I request a clarification from your office whether this policy continues.

Some acquaintances had offered to bring copies of my reports on "pulsing-thrust" directly to your attention. I propose to bring my reports in person and to discuss the subject with the appropriate officials and experts at the agency. Also, I continue to provide answers to specific inquiries from others, about how to demonstrate and optimize the process; and the experts at NASA may want to become acquainted with the additional information. I have developed a sizable record of theory, test, and operational database in support of the process and the benefits that can be derived from it.

In the event that the agency has changed its long-standing policy towards me and my work, then I propose for your consideration to work with the NASA teams, under purchase orders or contracts; (1) to expound on our "pulsing-thrust" technique, (2) to explain the underlying theories of physics, propulsion, thermodynamics, mechanics and electronics that led us to the process; (3) to demonstrate the process at NASA (or its contractors') facilities, and (4) to develop the technique for use by agencies, contractors, and businesses in the United States.

I hope to hear from your office soon.

Very truly yours,

Ali F. AbuTaha

[illegible] Court, Herndon VA 2207[illegible]
TEL-FAX (703) 713-1122

National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas
77058

NASA

OCT 13 1992

Reply to Attn of EP4-92-L63

Mr. Ali F. AbuTaha

Herndon, VA 220

Dear Mr. AbuTaha:

Thank you for your proposal of September 22, 1992. It has been reviewed by technical personnel in our propulsion department. Their analysis indicates that using a pulsing-thrust technique for rocket engines and motors could not be used for improving propulsion systems presently required by the Johnson Space Center.

Your basic premise that dynamic pressure overshoots occur in rocket engines is correct. For a fixed-area orifice-controlling propellant mass flow into a combustion chamber, the chamber pressure, thrust, and mass flow rate will overshoot nominal values then drop to the steady state conditions as the chamber pressure builds up from ambient to choked flow conditions. For example, the Space Shuttle Orbiter primary reaction control engine has an overshoot of approximately 20 percent at startup. The dynamic overshoot "near-doubling" you state on page 2 of your proposal does not occur in Space Shuttle main engine startups. Chamber pressure is intentionally controlled to prevent overshoots greater than 2 percent above rated thrust level during the approximate 5-second Space Shuttle main engine start transient.

The example you quote from the Handbook of Model Rocketry does show a doubling of thrust at engine startup. A typical model-rocket motor has a propellant grain shape designed to provide an increased lift-off thrust with a corresponding increase in mass flow rate. For a rocket engine with an optimized fixed-nozzle geometry, however, thrust and mass flow rate will increase during start transients; but, specific impulse will correspondingly decrease. Therefore, the specific impulse increases predicted for engines using the "pulsing-thrust" technique will, in fact, not occur.

Thank you for your interest in aiding NASA to develop advanced alternatives to conventional propulsion. We share your concern that more efficient space transportation will require advances in technology and are gratified to know that citizens like you are striving to aid in the identification of these technologies.

Sincerely,

Paul Weitz

Paul J. Weitz
Acting Director

ALI F. ABUTAHA

November 23, 1992

Mr. Paul J. Weitz, Acting Director
Johnson Space Center - NASA
Houston, TX 77058

Dear Mr. Weitz:

Thank you for the letter of October 13, 1992 and for considering my pulsing-thrust technique. My News Release, which was evaluated by your technical personnel, was general in nature and it did not contain the detailed analysis or specific steps required to achieve the proposed thrust advantage. I had hoped to provide this information under Purchase Orders with NASA. Alternatively, I will be glad to provide relevant details in a Seminar or a Colloquium sponsored by the Center(s). This can make the information available to the agency, the industry and academia soon. I hope to hear a favorable response to this alternative proposal.

Your letter reveals that serious misconceptions about the overshoot effect prevail. A clear understanding of the effect is requisite to see how to achieve the pulsing-thrust advantage. I will give a concise description of the confusion. I will also share this clarification with other Centers to avoid repeating the same points.

In your letter, you dismiss my assertion of the "near-doubling" of the SSME thrust during start-up, and you then state that the,

> "Chamber pressure is intentionally controlled to prevent overshoots greater than 2 percent above rated thrust level during the approximate 5-second Space Shuttle main engine start transient." (end of 2nd Para).

Either the overshoot is less than 2 (two) percent, as you assert, or it is greater than 70%, as I have stated. The difference is so enormous and consequential that it must be resolved. The significant disparity in our positions is the result of confusion, which I will explain. First, consider the following facts:

1- The dynamic overshoot for the SSME start-up was plainly measured by NASA to be 70%, and not the 2% cited in your letter.

2- In one instance, the 70% measured overshoot, for STS-3 liftoff, was verified by NASA and the Shuttle Prime Contractor using THREE (emphasize, THREE) calibration methods; (see Attachment #1).

3- The engineers who measured the 70% overshoot for the SSME buildup discarded the results, stating that: "STRAIN DATA QUESTIONABLE — TOTAL LOAD CHANGE > THRUST FORCE FOR SSME THRUST BUILDUP." The 70% overshoot for the SSME buildup was discarded even though it was confirmed by three calibration methods.

Is the overshoot for SSME build-up 2 (two) percent, or is it 70%? Why did the engineers discard their own measurements? And, can the enormous difference be explained, and how?

, Herndon, VA 22071
Tel-Fax: (703)

The confusion lies in the mix-up of the pressure developed in a rocket engine, such as the SSME, and the resulting thrust. For example, you say in your letter,

> "... the chamber pressure, thrust, and mass flow rate will overshoot nominal values then drop to the steady state conditions ..."

This sentence reveals the extent of the confusion. It is correct to say that the "thrust" overshoots at start-up, but it is absolutely incorrect to say that the "chamber pressure" also overshoots. The pressure does not overshoot during start-up transients. It merely fluctuates! Let me explain.

As your technical personnel know, or can easily verify, start-up transients involve an input (a forcing function) and an output (a response). The "chamber pressure" in a rocket engine is the INPUT, or the forcing function, to the transient analysis. The input (or the forcing function, or the pressure) rises directly from zero to its steady-state value (see sketch on Page 6). During start-up, the pressure will vary slightly, or fluctuate, before it levels off. Using the non-overshooting input as a measure of the overshoot has led the experts to believe in the small overshoot values, such as the 2 percent cited in your letter. This is a very serious mistake.

The dynamic overshoot must be estimated or measured from the response, or OUTPUT parameters. It is the response that overshoots. It is the effect of the thrust on the Shuttle assembly that overshoots, significantly.

The transient equations and calculations are straightforward (see my January 1992 lengthy paper on Transient-Force Components). By using the non-overshooting pressure-input-profile of the SSMEs and the damping ratio and the frequency of the shuttle assembly, the SSME overshoot is easily calculated to be 70%, at the SRBs' base level. During start-up, the SSME rated thrust (1.125 million lb) overshoots to about 1.9 million lb, which is precisely what the NASA engineers measured.

The STS-3 actual liftoff measurements (Att. #1), which correctly measured the response, had shown an "EXCESS UPWARD FORCE" of about 600,000 lb. By simply adding this force to the WEIGHT of the Orbiter (some 200,000 lb) and the SSME rated thrust (1.125 million lb), you will obtain a maximum SSME thrust effect of 1.9 million lb during start-up; (600,000 + 200,000 + 1,125,000). This is the true measure of the SSME dynamic overshoot, which IS 70%.

By mistakenly believing that the "chamber pressure," which does not overshoot, is the measure of the overshoot, your experts have mixed up the input and the output, or the cause and the effect. The correctly measured and correctly calculated, yet discarded, 70% overshoot (1.9 million lb for 3-SSMEs) is not found in Shuttle Specifications, engineering textbooks, technical journals, encyclopedias, etc.

The oversight seems trivial, but it is not obvious. I will elaborate further:

1- When a person stands motionless on a spring-activated bathroom scale, the dial indicates his or her weight; or the steady-state condition.

2- If the person suddenly steps on the scale from zero height, the dial overshoots, registering greater force (than the person's weight) on the scale. We can calculate the dynamic overshoot, or transient response - which is double (100%) the weight of the person for a perfectly elastic spring.

3- In both cases, the weight (in pounds or newtons) is transmitted to the scale through the area of the feet (square inches or square meters). In both cases, a constant pressure (pounds per square inches or newtons per square meters) is applied to the surface of the scale. The pressure (which reflects the constant weight of the person) rises directly from zero to the constant steady-state value. The <u>pressure</u> on the scale is the INPUT forcing function.

   THE PRESSURE ON THE SCALE DOES NOT OVERSHOOT. The weight of the person does not overshoot. The "quantity of matter" in his body does not increase. But, the effect on the scale overshoots; and the scale must be designed to the correct overshoot value, and not to the maximum fluctuating pressure, or weight, value.

A person may gain or lose a few pounds (say, 2 percent fluctuation in weight) over time, but this should not affect the dynamic overshoot significantly. If the weight of the person is 100 lb and it increases to 102 lb, then the (say, 100%) overshoots are 200 lb and 204 lb, respectively. For design purposes, the overshoot is not the difference between 100 pounds and 102 pounds (or, 2 percent), but it is the difference between 100 and 200 lb, or 102 and 204 lb (or, 100%), which is very consequential. The "2 percent" overshoot in your letter is similar to using the 102 lb weight value to be the overshoot value, which is simply wrong.

By analogy, the SSME chamber pressure of about 3,000 psi (pounds per square inch) may fluctuate to 3,060 psi during start-up; or a 2 percent variation. This is a fluctuation in the INPUT, and it is NOT a measure of the dynamic overshoot.

The SSME thrust for the two "pressures" above are 375,000 lb and 382,500 lb per engine, or 1.125 million lb and 1.15 million lb for 3-SSMEs, respectively. If, as you say, the SSME thrust overshoots only from 1.125 million lb to 1.15 million lb (the 2 percent overshoot in your letter) during start-up; then, what do you make of the correct "thrust" measurements that show the SSME thrust to overshoot from 1.125 million pounds to 1.9 million pounds (the 70% overshoot)?

The 1.9 million lb thrust overshoot corresponds to a pressure of about 5,100 psi. To expect the chamber pressure to rise to about 5,000 psi during start-up is like expecting a slim person to become fat instantly because he or she stepped suddenly on a weight-scale. The confusion should finally be crystal-clear.

Confusing the minor fluctuation of pressure for the overshoot has not been limited to the SSMEs. In the case of the solid-propellant model rockets, you agree that the start-up thrust is doubled (i.e., to the limiting 100% overshoot). It is precisely because the "response" (and not the pressure) was measured in the two million tests of model rockets that the nearly 100% overshoot was noted and recorded. Yet you, as the other experts, refer to the "propellant grain shape" as the primary cause of "increased lift-off thrust." Again, the INPUT is confused for the OUTPUT.

The "propellant grain shape" determines the internal pressure during burn (like the weight of a person determines the pressure on the above scale), and it is not a measure of the overshoot. I emphasize that the doubled-thrust (the 100% overshoot agreed to in your letter) from the Handbook of Model Rocketry was for end-burning models! This should help to make it clear that the "propellant grain shape" is not relevant to the 100% overshoot.

Solid rocket propellants surge to full power faster than liquid engines, and this is why they overshoot by nearly 100%. In the case of the Shuttle's Booster Separation Motors (BSM), the overshoot was initially specified to be 6.5%; it was then increased to 30%; and recently, the BSM overshoot was increased to 100%. Obviously, the BSM overshoot did not increase between 1972 and 1991; and the nearly 100% overshoot was always there.

"How fast" determines the overshoot magnitude. The shuttle's Solid Rocket Boosters (SRB) come up to full power nearly as fast as the BSM, or even the model rockets. The SRB overshoot must then be nearly 100% (calculations give 96.9% for a damping ratio of 0.01). Yet, the initial and recent (1991) Specs for the SRBs give minor, or no, start-up transient-overshoot-factors for a variety of forces that affect the Shuttle design. Why? The answer is now obvious. Accurate measurements of the pressure in the SRM show only minor fluctuations (such as the 2 percent for the SSMEs). Again, the confusion by the experts is obvious.

The initial Space Shuttle Specifications included greatly underestimated overshoot factors of 1% to 10%. You can find these in the JSC 07700 Specs and many other documents. Specific examples are given in my papers on the subject.

Several congressional committees, Distinguished Legislators and others have inquired about my assertions for several years now. They were repeatedly assured by experts from NASA, the Congress, industry, universities, and elsewhere that the dynamic overshoot is less than 2 percent, and not greater than 70%. These assurances have been primarily based on the NON-OVERSHOOTING pressure read-outs in rocket engines and motors. The simple and straightforward explanations given in this letter show the implausibility of these assurances.

The primary purpose of this letter is to delineate the confusion in the counter-assertions that have been repeatedly made by your experts and by myself for several years now. I reiterate: the input forcing function; e.g., the pressure; fluctuates slightly, but does not overshoot. The response, however, overshoots, by 70% to 100% in the case of the Shuttle. The problem is widespread in engineering, and it is of serious proportions primarily because of the conviction with which the experts have dismissed it so far. NASA should immediately start a comprehensive examination of the effect to help, not only the space program, but also the economy.

Let me summarize (see sketch, Page 6):

1- The "pressure" in rocket engines and motors fluctuates slightly during start-up, such as the 2 percent mentioned in your letter; but the pressure does not overshoot, nor should it be expected to overshoot. This is also true for other engines, motors, turbines, generators, etc.

2- The "response" to the rising pressure is the true measure of the overshoot, which IS 70% to 100% in the case of the Shuttle. The overshoot is about 70% for the SSMEs, as correctly measured by NASA before, and as calculated from correct transient analysis.

I have done a very extensive research of the overshoot effect. The subject is well treated in textbooks on feedback control systems, but it is hardly described, discussed, or analyzed in engineering textbooks on propulsion, spacecraft and aircraft design, and related engineering subjects. This is a very serious shortcoming in our educational, industrial, economic and aerospace infrastructures. Perhaps, we can finally resolve this overshoot business, once and for all.

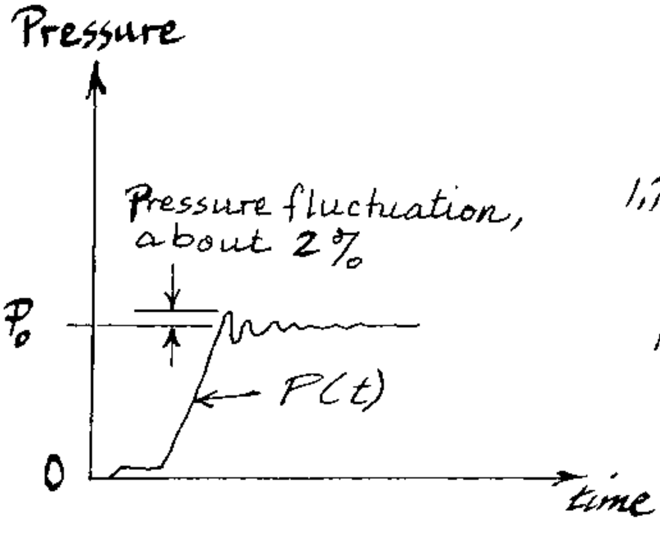
Notwithstanding that the technical personnel in your propulsion department had dismissed my proposed pulsing-thrust advantage, I am available to give the specific details of the technique in a NASA sponsored Seminar, or Colloquium. I will inform you if other Seminars are scheduled, as your technical personnel may want to attend. Please note the change of our address.

Sincerely yours,

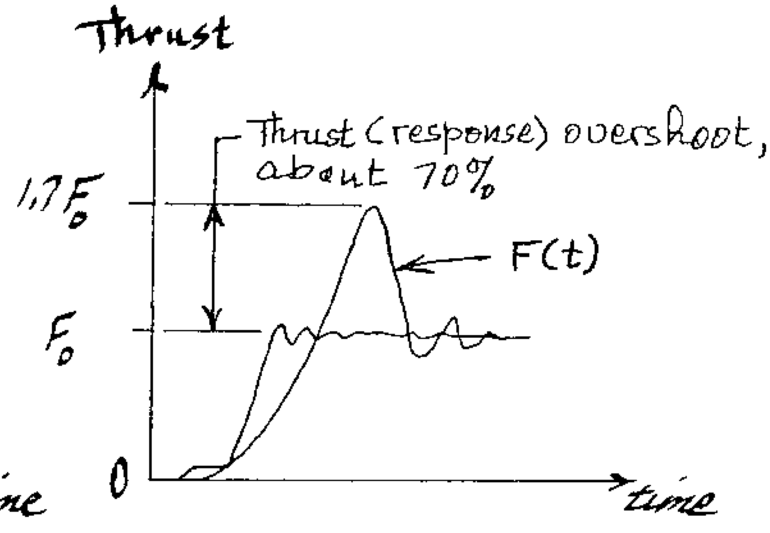
Ali F. AbuTaha

Attachment

cc: NASA Headquarters
NASA Centers



Typical Transient Input



Transient Input and Response

Pressure, P(t), in SSME rises directly from 0 to P_o

Pressure fluctuates slightly, but <u>DOES NOT</u> overshoot, at start-up

The 2% pressure fluctuation IS NOT THE OVERSHOOT

P_o is the INPUT forcing function in transient analysis

P_o does not overshoot to $1.7P_o$

F(t) is the response to P(t)

F_o corresponds to P_o

F_o is the rated thrust level: 1.1 million lb

F(t) overshoots to 1.9 million lb, or to $1.7F_o$

F(t) overshoots by 70% at start-up

A clear distinction must be made between the <u>INPUT</u>, which does not overshoot or which fluctuates slightly, and the <u>RESPONSE</u>, which overshoots significantly.

Attachment #1

70% overshoot verified using THREE Calibration methods

ORGANIZATION: SYSTEMS DYNAMICS LABORATORY	MARSHALL SPACE FLIGHT CENTER SRB LOADS STS-3	NAME: BULLOCK/HAYS DATE: APRIL 1982

STS-3 M.L.P SUPPORT POST LOADS COMPARISON

RI (FULL STACK) VS. INDIVIDUAL SRM SEGMENT CALIBRATION FACTORS (C.F.)

POST	(1) ROCKWELL C.F. (KIPS)	(2) FWD CTR. SEG. C.F. (KIPS)	(3) FWD SEG. C.F. (KIPS)	% DIFF. (2) VS (1)	% DIFF. (3) VS (1)
1	-454	-703	-620	+7	-5
2	-515	-559	-5[illegible]7	+8	+14
3	1307	1326	1291	+3	-1
4	1403	1407	14[illegible]	0	0
5	-494	-512	-48[illegible]	+4	-3
6	-675	-667	-6[illegible]	-1	+2
7	1213	1201	1228	-1	+1
8	1233	1227	1234	0	0
	↑ 526 KIPS	↑ 624 KIPS	↑ 580 KIPS		

\+ COMPRESSION
\- TENSION
↑ EXCESS UPWARD FORCE (WT. + THR.)

NOTE: NEGATIVE LOADS ARE POST LOADS NOT BOLT LOADS

FILE NO. 8

PC 086081

0209 SSC013

NOTICE: If the film image is less clear than this notice, it is due to the quality of the document being filmed

STS-3 measurements show 70% overshoot

EXCESS UPWARD FORCE ≃ 600,000 lb
Orbiter Weight (WT.) ≃ 200,000 lb
SSME Rated Thrust ≃ 1,100,000 lb

TOTAL SSME start-up Thrust = 1,900,000 lb.
OR, 70% overshoot (NOT 2%)

ALI F. ABUTAHA

November 23, 1992

Mr. Aaron Cohen, Acting Deputy Administrator
National Aeronautics And Space Administration
NASA Headquarters
Washington, D.C. 20546

Dear Mr. Cohen:

It has taken me considerable time and effort to figure out exactly the basis for the vast difference of opinion with the other experts, at NASA and elsewhere, regarding the dynamic overshoot effect. Transient analysis is not new to engineering, and I could not see how to describe my engineering argument with the other engineers. The enclosed letter to Mr. Paul J. Weitz at JSC explains the serious mix-up by the other experts, as best as I can describe it.

I have tried hard to conduct myself in a professional manner, suppressing natural human reactions so as not to irritate others. I know that my mere persistence has been irritating, but if I succeeded in identifying an oversight that is fundamental to safety and reliability, then, perhaps, my persistence, and not the irritation, will be remembered.

Reference to the pulsing-thrust technique, which I brought to your attention before, some experts have already dismissed the process before even seeing the detailed analysis and specific steps required to achieve the proposed thrust advantage. My patent application on the process requires considerable amendments, and I am unable to make the necessary changes soon. I, therefore, offer to describe the process in detail in short Seminars or Colloquia to be sponsored by NASA and others. I hope to hear a favorable response from NASA.

Very truly yours,

Ali F. AbuTaha

Enclosure

Pls. note change of address

[illegible] t, Herndon, VA 22071
Tel-Fax: (703) 904-0456

ALI F. ABUTAHA

November 23, 1992

Mr. T. J. Lee, Director
MSFC - NASA
Marshall Space Flight Center, Alabama 35812

Dear Mr. Lee:

Thank you for your kind letter of September 24, 1992. Due to personal circumstances, I have not been able to prepare a detailed unsolicited proposal on the pulsing-thrust technique. My patent application requires considerable amendments, which when completed will show the applicability of the method to a variety of systems, in addition to rocket engines and motors. I therefore believe that the best way to proceed would be to make full public disclosure of the analysis and specific steps required to achieve the proposed thrust advantage. I am prepared to explain these details in open Seminars (1-2 hours) at the MSFC, other Centers, and elsewhere, and I hope the Marshall Space Flight Center would consider this alternative approach.

It has taken me considerable time to figure out the basis for the difference of opinion with the other experts regarding the dynamic overshoot subject. This is explained in the enclosed letter, and I welcome the opinion of the technical experts at the Marshall Space Flight Center.

I hope to hear from you again.

Very truly yours,

Ali F. AbuTaha

Enclosure

Herndon, VA 22071
Tel-Fax: (703) ___ ____

ALI F. ABUTAHA

November 9, 1992

Mr. Pierre J. Madon, Vice President E&R
INTELSAT
3400 International Drive, N.W.
Washington, D.C. 20008-3098

Dear Mr. Madon:

Thank you for your letters of 4 September and 13 October 1992 and for meeting with me on 25 September 1992. The pulsing-thrust technique required extensive analysis in physics, propulsion, dynamics, thermodynamics, etc. The first equation in your mathematical analysis clearly shows the dynamic overshoot doubled-response. The advantage is there, and the question is how to harness it.

As to my shuttle-related study, the Institution of Mechanical Engineers in the UK had reviewed my 1992 paper and described it as "an excellent piece of work with far-reaching consequences." There have been other favorable reviews by other competent experts. I had sent the paper to several INTELSAT experts, but I have not heard from any of them. I only disclosed full details of that work in 1992, and the assessment that you made several years ago of my work lacked the specific technical details. As a citizen of the United States, I take exception to your criticism of my conduct in that case. Strictly, out of consideration to NASA and to the (U.S.) national security, I had shared the specifics of my results ONLY with NASA in 1986 in closed-door meetings. I might add that the near-doubling-dynamic-overshoot effect was also overlooked in the design of other systems, including the INTELSAT systems. The dynamic overshoot effect is generally not even discussed in engineering textbooks on spacecraft design and propulsion.

I had sent to you before the enclosed sample comments from senior engineers to my program, Anatomy of Failure Mechanisms in Modern Systems. No one from INTELSAT attended the programs. I wish that the opinions expressed about me and my work will be based on knowledge of my work, and not lack of it. Both the pulsing-thrust technique and the Anatomy of Failure Mechanisms are relevant to INTELSAT systems, and I will be glad to share both with INTELSAT; under contract. INTELSAT may also want to sponsor an appropriate forum to disclose the pulsing-thrust details. Please note the change of our address as shown below.

Sincerely yours,

Ali F. AbuTaha

cc: **Mr. Irving Goldstein, Director General & CEO, INTELSAT**

t, Herndon, VA 22071
TEL-FAX (70[illegible]