Chapter 3

The Rhetoric of a Major Malfunction: The Institutional and Rhetorical Dimensions of the Explosion of the Space Shuttle *Challenger*

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Abstract

An examination of the language involved in the fatal decision to launch the Space Shuttle Challenger in 1986 illustrates the need for a better understanding of the relation between ethical character and linguistic practice. Delineating a conflict that goes back to Plato's encounter with the sophists, this chapter employs the classical concepts of physis *and* nomos*—roughly translated as* fact *and* culture*—to show how managerial character, which identifies with and seeks to protect the corporate interest, can fail to acknowledge the facts, even when the facts are communicated with clarity, brevity, and purpose. Thus, the analysis raises serious questions about the effects of authority upon communication and reason.*

Since the explosion of the Space Shuttle *Challenger* on January 28, 1986, there has been a considerable amount of discussion on how organizations such as NASA and its contractor for the Solid Rocket Booster Motor, Morton Thiokol, with their combined records of meticulousness and technological achievement, could have ignored the obvious physical evidence pointing to the danger of the 0-ring seals and allowed the shuttle to fly. Lower-level engineers had made numerous attempts to alert NASA and Morton-Thiokol managers to the catastrophic consequences of continuing to fly space shuttles with the faulty 0-rings. Moreover, the decision to approve the shuttle mission contradicted the ample evidence that the unusually cold temperature at the launch would increase the probability of 0-ring failure.

A central theme in the discussions of the human causes of the *Challenger* explosion has been that an organizational pseudo-reality took hold at NASA and Morton-Thiokol that made it impossible for engineers to convince their superiors of the danger of the faulty 0-rings. Some analyses have described the psychological and ethical dimensions of the construction of this collective delusion (Boisjoly, Curits, & Mellican, 1989; Schwartz, 1987), while others have focused on the structural and organizational infrastructures that generated and maintained misperceptions about the safety of the space shuttle program (Christiansen, 1987; van Gigch, Le Monigne, Logan, & Vervilos, 1988).

Only recently has the discussion focused on the role that language played in creating and maintaining this organizational delusion (Gouran, Hirokawa, & Martz, 1986; Pace, 1988; Winsor, 1988, 1990; Dombrowski, 1991; & Herndl, Fennell, & Miller, 1991). Yet the institutional nature of much of the discourse on the 0-ring seals points to the pivotal role language had in reinforcing the belief that the shuttle was safe. In all discourse situations, but especially ones that occur in formal institutions such as NASA or corporations such as Morton-Thiokol, a writer not only acts as an individual, but also, to a varying degree, as an agent of the institutions in which he or she operates. As is true of all action, each individual's discourse is constrained and informed by the specific practices attributed to his or her role by the institution in which it exists as well as by that institution's larger goals (Perelman, 1986). Institutional language often helps to constitute and then reinforce the cognitive pattern defined by I. A. Janis as Groupthink, "a mode of thinking that people engage in when they are deeply involved in a cohesive in-group" (1972, p. 9).

Although the oral communication that occurred among NASA and Morton-Thiokol Engineers can only be recaptured by participant's recollections, the Rogers Commission and other investigative bodies have collected literally hundreds of thousands of individual pieces of paper which were generated around the Space Shuttle program. Some of these documents, largely memoranda written by Morton-Thiokol managers and engineers on the safety of the 0-ring seal, will be scrutinized in this essay in an attempt to answer the following three questions[1]:

1) How constrained were the writers of these documents by the organizational strictures in which they existed? How much of the discourse was informed by the specific institutional role of the writer as engineer or manager?
2) How important was language in the construction of the pseudo-reality that allowed NASA and Morton-Thiokol engineers to ignore the 0-ring seal problem and approve the flight?
3) Could an individual, solely through oral or written discourse, pierce through the linguistic and extra-linguistic consensus to bring about an awareness among decision makers of the real gravity of the situation?

Two terms central to philosophical and rhetorical debates of fifth-century BC. Greece, *nomos* and *physis*, may offer useful lenses through which to view the discourse of managers and engineers. The meaning of *physis* is fairly easy to translate. It means "nature," though in contrast to *nomos*, the term "reality" may make the distinction clearer. *Nomos*, on the other hand, is much harder to translate. *Nomos* means "belief," "consensus," and even "law." It is something that is believed in, practiced, held to be right. It presupposes an acting subject—a believer, a mind or minds from which the *nomos* emanates. *Physis* is eternal, true, and real; *nomos* is transitory and particular—indeed, the proponents of *nomos* often based their arguments on the wide divergence of customs and beliefs among the various Greek and barbarian states (Barnes, 1979).

Plato, through the mouth of Socrates, bitterly attacks the proponents of *nomos* in the *Gorgias*. Because Socrates and Plato are clearly in the camp of *physis*, they believe in absolutes. Because there is a reality out there, one side of an argument actually can be true and therefore "better" than another side. And indeed the major fault that Socrates, along with others, found with rhetoric is that it was often the art of making the worse argument seem the better, of establishing a false *nomos* at the expense of a true *physis*. In the *Gorgias*, Socrates finally categorizes Rhetoric not as an art, but as a species of "pandering," the activity of making something that is actually harmful, that is untrue, seem attractive.

This distinction between *nomos* and *physis*, of two ways of viewing and communicating reality, is directly analogous to the gulf between the reality created by NASA and Morton-Thiokol managers and the physical reality identified by various Morton-Thiokol engineers. The reality of the managers was the reality of social and institutional consensus. As managers, they had to be group players, more devoted to the interests and goals of the company that they represented and which amply rewarded them, than to any individual belief that the engineering of the shuttle was unsound. Their decisions were determined by the hat they wore.

The metaphor of "wearing a hat" refers directly to the language used in approving the mission. On the night before the launch, the engineering staff at Morton Thiokol urged that the launch be postponed because of the extreme and unusual cold weather. The 0-ring seals that connected the booster had failed six times in previous flights. The seals had eroded and hot gases had escaped, creating a condition known as a blow-by. The worst occurrence had been on mission 51-B in April, 1985, where eighty percent of the nozzle joint on the solid rocket motor had actually vaporized. The April launch had been the coldest launch to date, and the temperature at Cape Kennedy on the morning of the *Challenger* launch was projected to be 20 degrees colder. The engineers realized that since both the seals themselves and the putty were polymers, the colder temperature would make the substance less elastic and less likely to seal. If the exploding gases escaped through the seal, then the whole shuttle assembly would blow up.

The engineers convinced the Vice President for Engineering, Robert Lund, that cold temperatures would make the seals unsafe, and, consequently, during the Flight Readiness Review, Morton Thiokol, by telecom, refused to give a recommendation to launch. They presented their criteria for launch in bullet form. The launch criteria of the Thiokol engineers was quite simple:

RECOMMENDATIONS

- 0-ring TEMP MUST BE > 53F. AT LAUNCH
  DEVELOPMENT MOTORS AT 47 to 52F. WITH PUTTY PACKING
  HAD NO BLOW-BY
  SRM 15 (THE BEST SIMULATION) WORKED AT 53F.

- PROJECT AMBIENT CONDITIONS (TEMP & WIND)
  TO DETERMINE LAUNCH TIME

The senior managers at NASA's Marshall's Space Flight center were furious. Only five days before, at Morton-Thiokol's request, they had given formal "closure" to the 0-ring seal problem, eliminating it from their monthly problems report. They declared the problem "closed" by the curious logic that tests leading up to a safe redesign were under way; therefore, the problem was being addressed; therefore, it was no longer an open problem. In other words, the quantifiable probability of 0-rings causing an explosion was transformed by consensus into the belief that since "it is being addressed," it was not a problem.

Marshall, which was also negotiating with Morton-Thiokol on a one-billion dollar contract for Thiokol to continue manufacturing the solid rocket motors for the space shuttle, demanded that the company reconsider its technical recommendation not to launch. Larry Mulloy, Marshall Space Flight Center's Solid Rocket Booster Project Manager, angrily challenged the logic of the Thiokol recommendation, claiming that the data were inconclusive and, furthermore, Thiokol was establishing a new Launch Commit Criterion based on the 53 degree Fahrenheit benchmark. Mulloy was worried that such criteria would possibly postpone the flight until the Spring. "My God, Thiokol," he is quoted as saying, "When do you want me to launch? Next April?" (McConnell, 196)

However, George Hardy, Marshall's deputy director for science and engineering, stated that although he was "appalled" by the recommendation not to launch, it was impossible for NASA to approve a launch against the recommendation of one its primary contractors. Under intense pressure from the very persons with whom he was negotiating his company's largest contract, Joe Kilminster, Thiokol's Vice President, Space Boosters Program, asked for a five-minute off-line caucus so that Thiokol could review its data.

When Morton-Thiokol went off-line at the Solid-Rocket Project Headquarters in Brigham City, Utah, a meeting was held with four Thiokol Vice Presidents and the project engineers, presided over by Jerald Mason, a Senior Vice President. At the start of the meeting Mason announced that a management decision was needed and, indeed, the engineers were prevented from speaking during the whole next thirty minutes of the discussion. It was at this point that Mason turned to Robert Lund, the Vice President of Engineering, and said, "Take off your engineering hat, Bob, and put on your management hat." The managers then agreed to reverse the decision and recommend the launch.

"Wearing a management hat" is to act as a manager, to accept the institutional goals that inform the position and that dictate that the manager be concerned primarily with the realm of *nomos*, social consensus, rather than the world of *physis*, the primary concern of those who wear "an engineering hat." In this case wearing a "management hat," that is, occupying the role of a Vice President at Morton-Thiokol, made both the original decision of the previous summer to request closure and the immediate decision to overrule the engineers and approve the launch inevitable. Morton-Thiokol, as all corporations, has the primary institutional goal of maximizing its income, which, in this specific case, means protecting a highly lucrative government contract. Part of a Vice President's role is to keep the customer happy and to make sure that the contract is renewed. Although probably never explicitly stated by any of those involved, it is interesting to analyze the alternatives and possible consequences of various management decisions. For example, if the managers back the decision not to launch, Morton-Thiokol may lose the contract and at least some of these men will probably lose their jobs. If they decide to launch and the shuttle blows up, as is what indeed did happen, the men still risk losing their jobs. (And indeed, of the four Vice Presidents at the meeting, all but Robert Lund subsequently took early retirement.) However, if they decide to launch and the mission is successful, then Thiokol will probably keep the contract and the managers will keep their jobs. Thus their own self-interest within the institution provides a powerful incentive to create a consensus, a *nomos*, that makes the problems of the 0-ring seals and the consequent possibility of a shuttle disaster go away. The creation of this consensus, this *nomos*, did not begin the night before the shuttle launch. It was created earlier and through both managerial and technical language. This assertion can best be demonstrated by an examination of two of the memoranda that passed between Thiokol executives and engineers in August, when the engineers became fully aware of the dangers, and in the two launch recommendations that Thiokol presented to NASA the night before the explosion. Exhibit A is a memorandum by Joe Kilminster, Vice President of Space Booster Programs, to Robert Lund, the Vice President for Engineering, but really intended for the senior engineering staff.

Kilminster's memorandum moves the frame of discourse away from physical reality to the organizational hierarchy of management. As a speech act, Kilminster's memorandum can be viewed as an explicit act of congratulation and expression of gratitude, as the words "appreciation" and "grateful" indicate. But it is a specific species of congratulation, that of a superior approving the actions of a subordinate. Congratulating can be schematized as Speaker congratulating Hearer for performing Act A, thus presupposing that the act has been accomplished. But what is the act defined in the memorandum? It is the "addressing of an anomaly," the providing of a rationale, not the solving of a problem. This language appears to be common to the discourse of managers throughout NASA and Morton Thiokol. Judson Lovingood, Deputy Manager of the Shuttle Projects Office, for example, stated before the Rogers Commission, "We do have occasional anomalies which are sometimes disposed of as being within our experience" (Presidential Commission, vol. 4, p. 86).

As stated before, the text has two audiences, R. K. Lund, the Vice President, and the engineers who are copied. It is this second audience that is the primary target of the implicatures and presuppositions. Indeed, the word choice, tone, and speech acts of the memorandum all give the clear indication that the engineers are being thanked for demonstrating that there was no problem at all. This view of reality, necessary for the successful functioning of Morton-Thiokol and of Joe Kilminster, is thus communicated to Kilminster's subordinates. Although the tone of the letter is laudatory and friendly, behind that tone are implicit instructions to the engineers that they should cease to consider the 0-rings as a major area of concern.

Roger Boisjoly in his memorandum, Exhibit B, wears a very different hat, as his words, "engineering standpoint" indicate. The role of an engineer can be described as making physical objects work. This includes determining if an object works, and if it doesn't, figuring out a way to fix it. Although Boisjoly exists in a world with its own *nomos*, its own communally created meaning, it is a world that is more closely connected to an extralinguistic reality, a *physis*, indeed physics.

As a speech act, Boisjoly's memorandum is performing an act of informing, but a specific type of informing: "reminding," "reasserting," or "seaming" may be approximate terms, but probably the most accurate terminology is the phrase he uses in the memorandum, "insuring that the speaker is fully aware." What this memorandum really is is a "cover memo"—something written both to document the author's position in order to provide later written evidence, if needed, and often used to compel someone else in an organization, usually someone in power, to change a course of action.

In his discourse, Boisjoly attempts to redefine the 0-ring seals away from Kilminster's "anomaly," which has been "addressed" back into the engineering frame of physical laws, probabilities, and consequences. Language, such as "seriousness," "problem," and "catastrophe of the highest order—loss of human life," seeks to demonstrate a problem, delineate its possible catastrophic consequences, and propose a solution. All to no avail.

Boisjoly, trying to use language appropriate to his conception of management rhetoric, employs a much more formal tone than Joe Kilminster in his memorandum, even with Boisjoly's use of the sports metaphor "jump ball." The sentence, "An unofficial team . . . with leader, was formed on 19 July 1985 and was tasked with solving the problem for both the short and long term" provides a good example of Boisjoly's style. Those in relatively lower positions of power and privilege often tend to be more conservative and formal in their lexical and syntactic choices, trying to mimic their perception of the discourse of those with greater power and privilege. Likewise, those who actually hold power, like Kilminster, can be less formal in their language. Thus, stylistically as well as rhetorically, the language of both managers and engineers is largely determined by their respective roles within an organizational hierarchy.

The night before the launch, at the end of the off-line meeting of Morton-Thiokol managers and engineers (where the engineers were not allowed to speak), Joe Kilminster called NASA and stated that upon reassessment, his people found the data "inconclusive" (McConnell, 200). NASA requested a formal FAX outlining Morton-Thiokol's rationale, and one was sent. Because the Kilminster FAX is responding to engineering objections, it has the form of a well thought scientific proof. A copy of that FAX is Exhibit C. It consists of a series of nested bullets—giving the impression of a logical and structured argument in which we can assume that the last major bullet, "MTI RECOMMENDS STS-51L LAUNCH PROCEED ON 28 JANUARY 1986," derives logically and orderly from the preceding bullets. However, examination of the preceding assertions leads to the conclusion that, with one exception, they either represent unknowable facts or actually argue against recommending that the launch proceed. Indeed, even the subsidiary supporting bullet really provides a good argument against launching. "SRM-25 will not be significantly different than SRM-15," it states. The seal in flight SRM-15 had, however, eroded 80 percent. The reasoning is analogous to arguing that a car is safe because the last time it was driven, a wheel came only four-fifths off the hub.

A line-by-line analysis of the FAX demonstrates how the forms of technical communication also contribute to the construction of the organizational pseudo-reality that allowed the shuttle to fly. The first bullet is clear enough—the ambient temperature will be 20 degrees colder than the SRM-15 0-rings. The second bullet is true, but again argues against launch rather than for it. The temperature data did not conclusively predict 0-ring blow-by. Blow-by had occurred in some flights with relatively high temperatures. But the worst blow-bys had occurred during the low-temperature flights, indicating that there was some sort of correlation between low temperature and 0-ring seal erosion. According to NASA's basic logic, inconclusive data is grounds not to launch—the burden of proof is always to prove it is safe to launch. But the logic underlying these bullets turns all that around.

The engineering assessment itself gives convincing arguments not to launch in the first and second sub-bullets: "COLDER 0-RINGS WILL HAVE INCREASED DUROMETER ('HARDER')," and "'HARDER' O-RINGS WILL TAKE LONGER TO 'SEAT'." The third sub-bullet, however, makes unknowable predictions from one piece of information provided by Boisjoly that is included as the sub-bullet, "O-ring PRESSURE LEAK CHECK PLACES SECONDARY SEAL IN OUTBOARD POSITION WHICH MINIMIZES SEALING TIME." Although the statement is true, it by no means establishes the two claims derived from it, "PRESSURE WILL GET TO THE SECONDARY SEAL BEFORE THE METAL PARTS ROTATE," nor the more general claim that "IF THE PRIMARY SEAL DOES NOT SEAT, THE SECONDARY SEAL WILL SEAT." Indeed, as the testimony during the Rogers Commission demonstrated, both claims essentially came out of thin air. In none of the testing of the 0-ring seals was there any conclusive evidence that the failure of the primary seal will necessitate the seating of the secondary seal that is the last barrier to the catastrophic leakage of exploding gasses. Thus the careful arrangement and indentation of the claims disguise the true, organizational motive, for the discourse, and allowed, in the words of Plato's *Gorgias*, "the worse argument to appear the better."

This is not to say that the Vice Presidents who wrote the FAX really believed or disbelieved in the truth of what they were saying. It was simply "a management decision" and had to be treated as such. Even so, one last feature of the FAX indicates the ambivalence with which the FAX was made. Under Kilminster's signature is a small disclaimer, "information on this page was prepared to support an oral presentation and cannot be considered without the oral discussion." Yet from all accounts, when Morton-Thiokol came back on-line, all Kilminster stated was essentially what is inscribed in the FAX. Indeed, after Kilminster's extremely brief presentation, George Hardy, the Deputy Director of Science and Engineering at NASA's Marshall Space Flight Center in Huntsville, asked that Thiokol put their specific launch recommendations in writing, sign it, and fax it to Kennedy and Marshall. Thus the FAX we have purports to be only intelligible if considered with an oral presentation, that, in fact, by all accounts, contained no additional information. Not only are some of the bullets based on assertions that simply do not exist, but the FAX as a whole bases part of its authority on a supplementary presentation that never occurred.

One important way that managerial rhetoric at both NASA and Morton-Thiokol created the pseudo-reality that allowed the *Challenger* to fly was to deny, in almost all discourse, the real probability of failure of any part of the shuttle. Indeed, this inability to accept without modification the failure rates calculated by line engineers was what prompted Nobel laureate Richard Feynman to write his own appendix to the Rogers Commission Report, "Appendix F—Personal Observations on Reliability of Shuttle." In the conclusion to this report, Feynman states:

> Official management . . . claims to believe that the probability of failure is a thousand times less [than the order of one percent]. One reason for this may be an attempt to assure the government of NASA perfection and success in order to ensure the supply of funds. The other may be that they sincerely believe it to be true, demonstrating an almost incredible lack of communication between themselves and their working engineers. . . . Let us make recommendations to ensure that NASA officials deal in a world of reality in understanding technological weaknesses and imperfections well enough to be actively trying to eliminate them. (Presidential Commission, vol. 2, F4-F5)

Both NASA and Morton-Thiokol, however, never really evaluated the probability of failure of the 0-rings in relation to the consequences. Indeed, a report of a panel of the National Research Council, the operating arm of the National Academy of Sciences and Engineering, concluded that using standard engineering risk analysis, the likelihood of a catastrophic failure as a result of the 0-rings was between 1 and 11 percent. But the standard techniques to determine both the relative effect of a component failure and the probability of its occurrence were subverted by the reality created by NASA constructed categories, linguistic categories that made the criticality of almost every component equal. If a component was critical, it had the status of Criticality 1. If there was a backup system, such as the secondary 0-ring seal, it had the status of Criticality 1R. To use the analogy of an automobile, since there are two systems of headlights on most cars—high and low beams, and two braking systems, the regular one and the emergency brake, both system would have the status of Criticality 1R. Having one headlight fail, however, is much less dangerous than having a front brake fail. The NASA system, however, made no such categorical or linguistic distinctions.

Indeed, managers, even managers who were proud of being engineers, refused to admit that there was always a probability of failure. These men created a linguistic universe where not only do all cars have the 60,000 mile comprehensive guarantee, but one never has to use it, since machinery never breaks down. As Feynman stated in an interview:

> What they [the managers] did is figure out a way with their system of criteria and all the other rules that were supposed to operate that they could continue to operate in spite of the rules. . . . Their effort consisted of rearranging their definitions of criteria so they could keep going . . . so it didn't look so bad. (Feynman, Interview)

Feynman has given several versions on how he told Jason Lovingood that he wanted to talk alone to the line engineers under him about the possible failure rate of the main engines (Feynman, "An Outsider's View of the *Challenger* Inquiry" 34; "What Do You Care What Other People Think," 180-184).

Lovingood responded that he didn't need to talk to the line engineers, since he, the manager, was an engineer himself. Feynman still insisted that he wanted to talk to the engineers, and they finally arrived at a compromise. Lovingood and the three engineers under him sat in a room and each wrote on a piece of paper an estimate of the failure rate for the motors. Each of the engineers gave an estimate somewhere between 1 in 100 and 1 in 300. Lovingood first stated that the failure rate was not quantifiable and that reliability was judged from "past experience, quality control manufacturing, and engineering judgment" (Feynman, "What Do You Care," 182). After Feynman reminded the manager that all rates are quantifiable, the manager said zero. When Feynman pressed him, Lovingood said the confidence rate was 100 percent minus Episolon. "What is Episolon?" asked Feynman. Lovingood responded that it was 10^5 or 1 in 100,000.

Feynman asked Lovingood to explain the difference between the engineering and managerial assessment of risk. Lovingood responded by sending a report that contained sentences such as, "The probability of mission success is necessarily very close to 1.0," and "Historically, this high degree of mission success has given rise to a difference in philosophy between manned and unmanned space flight programs; i. e. numerical probability vs. engineering judgment" (183n). While "numerical probability" is clearly within the discourse frame of engineers, "engineering assessment," although containing the word "engineering," is clearly management rhetoric. As Feynman writes, "As far as I can tell, 'engineering judgment' means they're going to just make up numbers" (183n).

To return to the questions posed at the beginning of this article, it is clear that, at least in the case of the *Challenger*, the language of engineers and managers differed considerably. The engineering reports and memoranda are carefully logical, with numbers and predictions based on hard data. Furthermore, contrary to common preconceptions almost all of the prose of the Thiokol engineers examined, both in memoranda and in reports, is lucid and direct. To readers after the explosion, Boisjoly's memoranda are painful in the accuracy of his prediction of the consequence of NASA's and Thiokol's policy of continuing to fly despite the 0-ring seal problem.

The communication of the managers, on the other hand, often displays a facility by which they were able to translate the physical observations and numerical probabilities of the engineers into "judgments" and "decisions" that reflected not physical reality, but the organizational imperatives under which they operated. Problems and failures of systems were redefined as "malfunctions" or even more commonly and deceptively as "anomalies." Sometimes, when they would make what appeared to be factual statements, the statements had no basis in experience.

Managerial language was certainly not the ultimate cause of the *Challenger* disaster. The forces that led to the creation of the mindset were primarily organizational and extralinguistic. Language, however, was an essential vehicle by which this organizational reality could be accepted and communicated among managers. It enabled them to redefine the reality presented to them by their subordinates. Although managerial rhetoric in itself did not originate the managerial mindset, it was an essential element both in creating and maintaining a shaky sense that the solid-rocket motor was safe.

Finally, there is the speculation as to whether it was at all possible that language could itself pierce this linguistically maintained reality. Could engineers have used language to move the frame away from that constructed by managers and back to the one connected to the physical reality exhibited by the previous 0-ring seal failures? As Van Gigch notes, in terms of managerial malfunction, the *Challenger* disaster can be schematized as a situation where a subsystem had the logic to analyze the situation but lacked the authority to solve the problem. If the four Thiokol managers had just maintained the original engineering position not to launch during the teleconference, the disaster would not have occurred the next day. But the eloquent but, unfortunately, ultimately ineffectual weekly memoranda that Roger Boisjoly wrote during the six months before the explosion suggest the improbability that words alone could have altered the world-view of those wearing management hats. There were individuals in the crowd shouting that the emperor had no clothes, and they were shouting clearly, but those around the emperor did not listen.

Notes

1. Although only four documents will be discussed in the paper, this study examined all of the Morton-Thiokol reports and memoranda on the O-Ring Seals collected by the Presidential (Rogers) Commission. These documents included two formal reports in August and September 1985 and numerous internal memoranda.

2. This is not to say that such rhetoric and mindsets were universal among management at NASA and Morton-Thiokol. One Thiokol senior manager at the Kennedy Space Center, Al McDonald, had long arguments with senior NASA officials the night before the launch, trying to persuade them to delay the mission even though they had a formal recommendation to launch from Morton-Thiokol.

Exhibit A

MORTON THIOKOL INC

Wasatch Division

RECEIVED
9 JUL 1985
R. K. LUND

Interoffice Memo

5 July 1985
E000-FY86-003

TO: R. K. Lund
Vice President, Engineering

CC: B. C. Brinton, A. R. Thompson, M. Salita, R. M. Boisjoly, Greg Gorman, Jerry Burn

FROM: Vice President, Space Booster Programs

SUBJECT: SRM-16A Nozzle Seal Anomaly

I wish to express my personal appreciation for the outstanding work accomplished by Engineering personnel to address the SRM-16A nozzle primary seal anomaly and provide the technical rationale for SRM-19 flight readiness.

You and your people certainly provided the horsepower in a very short response time to conduct the analytical and test effort required to establish the basis for a MTI recommendation relative to the next flight.

It is always dangerous to identify people because I know there are others involved, but I think Boyd, Mark, Arnie, Roger, Greg and Jerry went beyond the call and I am once again greatful for their timely and outstanding support.

Joe

Joe C. Kilminster

Joe is right
The work was superb
Thanks!

Bob

Exhibit B

MORTON THIOKOL INC
Wasatch Division

Interoffice Memo

31 July 1985
2870:FY86:073

TO: R. K. Lund
Vice President, Engineering

CC: B. C. Brinton, A. J. McDonald, L. H. Sayer, J. R. Kapp

FROM: R. M. Boisjoly
Applied Mechanics - Ext. 3525

SUBJECT: SRM O-Ring Erosion/Potential Failure Criticality

This letter is written to insure that management is fully aware of the seriousness of the current O-Ring erosion problem in the SRM joints from an engineering standpoint.

The mistakenly accepted position on the joint problem was to fly without fear of failure and to run a series of design evaluations which would ultimately lead to a solution or at least a significant reduction of the erosion problem. This position is now drastically changed as a result of the SRM 16A nozzle joint erosion which eroded a secondary O-Ring with the primary O-Ring never sealing.

If the same scenario should occur in a field joint (and it could), then it is a jump ball as to the success or failure of the joint because the secondary O-Ring cannot respond to the clevis opening rate and may not be capable of pressurization. The result would be a catastrophe of the highest order - loss of human life.

An unofficial team (a memo defining the team and its purpose was never published) with leader was formed on 19 July 1985 and was tasked with solving the problem for both the short and long term. This unofficial team is essentially nonexistent at this time. In my opinion, the team must be officially given the responsibility and the authority to execute the work that needs to be done on a non-interference basis (full time assignment until completed).

- 2 - 31 July 1985

It is my honest and very real fear that if we do not take immediate action to dedicate a team to solve the problem, with the field joint having the number one priority, then we stand in jeopardy of losing a flight along with all the launch pad facilities.

Roger M Boisjoly

R. M. Boisjoly

Concurred by:

Jack R Kapp

J. R. Kapp, Manger
Applied Mechanics

Exhibit C

MTI ASSESSMENT OF TEMPERATURE CONCERN ON SRM-25 (51L) LAUNCH

- 0 CALCULATIONS SHOW THAT SRM-25 O-RINGS WILL BE 20° COLDER THAN SRM-15 O-RINGS.
- 0 TEMPERATURE DATA NOT CONCLUSIVE ON PREDICTING PRIMARY O-RING BLOW-BY
- 0 ENGINEERING ASSESSMENT IS THAT:
  - 0 COLDER O-RINGS WILL HAVE INCREASED EFFECTIVE DUROMETER ("HARDER")
  - 0 "HARDER" O-RINGS WILL TAKE LONGER TO "SEAT"
    - 0 MORE GAS MAY PASS PRIMARY O-RING BEFORE THE PRIMARY SEAL SEATS (RELATIVE TO SRM-15)
      - 0 DEMONSTRATED SEALING THRESHOLD IS 3 TIMES GREATER THAN 0.038" EROSION EXPERIENCED ON SRM-15
  - 0 IF THE PRIMARY SEAL DOES NOT SEAT, THE SECONDARY SEAL WILL SEAT
    - 0 PRESSURE WILL GET TO SECONDARY SEAL BEFORE THE METAL PARTS ROTATE
      - 0 O-RING PRESSURE LEAK CHECK PLACES SECONDARY SEAL IN OUTBOARD POSITION WHICH MINIMIZES SEALING TIME
- 0 MTI RECOMMENDS STS-51L LAUNCH PROCEED ON 28 JANUARY 1986
  - 0 SRM-25 WILL NOT BE SIGNIFICANTLY DIFFERENT FROM SRM-15

JOE C. KILMINSTER, VICE PRESIDENT
SPACE BOOSTER PROGRAMS

MORTON THIOKOL INC
Wasatch Division

INFORMATION ON THIS PAGE WAS PREPARED TO SUPPORT AN ORAL PRESENTATION AND CANNOT BE CONSIDERED COMPLETE WITHOUT THE ORAL DISCUSSION

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