

Investigation of Alleged Research Misconduct
by Lincoln Laboratory Members of the
1998-5 POET Study Team

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Prepared for
The Honorable Kenneth J. Krieg, USD(AT&L)

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Foreword
Norman R. Augustine

The accompanying report summarizes an investigation into alleged research misconduct relating to the Phase One Engineering Team (POET) evaluation of aspects of the IFT-1A ballistic missile defense flight test. The investigation itself was conducted by Dr. Brendan B. Godfrey. My role, in response to a request by the Under Secretary of Defense for Acquisition, Technology and Logistics, was to opine on the thoroughness and impartiality of the investigation and to serve as advisor and consultant to the investigator. In this capacity, and as a Special Government Employee, I was granted full access to all available information, including classified information, pertaining to the subject investigation. I actively participated in interviews of all but one of the 49 individuals questioned in connection with the allegations and reviewed over 100 documents. In addition, Dr. Godfrey and I conducted frequent informal discussions and communications related to our respective responsibilities.

It is important to note what the subject investigation was *not*. It was *not* an assessment of the overall feasibility of ballistic missile defense, nor was it an examination into the overall efficacy of exoatmospheric discrimination. It *was* an investigation into six specific items identified during an inquiry conducted by Professor Edward Crawley as part of the MIT internal review of the allegations which had been levied.

The present investigation was complicated by the substantial passage of time since the events of interest occurred, with eight years having transpired since the subject POET analysis was conducted and four years since the Inquiry Report was completed. In several instances it was difficult to locate relevant documents (although all documents sought eventually were obtained); in others the firms involved in the events ceased to exist as independent entities; and in still others, individuals retired and their security clearances lapsed,¹ people changed jobs, memories – not unexpectedly – faded; and one individual died. In addition, there continues to be ongoing litigation which impinges on the matter. It also should be observed that the Office of Science and Technology Policy (OSTP) document which officially defines “research misconduct” was not promulgated until 2000, two years after the POET Study was completed. The MIT policy addressing research misconduct does predate the events of concern and is similar in most regards to that ultimately provided by OSTP.

The above considerations notwithstanding, the definitions and procedures prescribed in the OSTP document formed the basis for the conduct of this investigation. According to OSTP, research misconduct is characterized as “fabrication, falsification or plagiarism...” It is further prescribed that to constitute research misconduct the subject transgression must have been committed “intentionally, or knowingly, or recklessly...” – with the above to be substantiated by “the preponderance of evidence.” Moreover, “Research misconduct does not include error or differences of opinion.” It is thus possible that an investigator could find fault with the scope and/or substance of a technical analysis and yet not produce a finding of scientific fraud – if it were deemed that a plausible explanation existed for the course pursued by the researcher(s) and there were no evidence of malicious intent. On the other hand, if the preponderance of evidence

¹ In the case of interviews deemed particularly important, arrangements were made to have clearances temporarily reinstated.

indicated improprieties as described in the OSTP regulation, a finding of research misconduct would be required.

In the case of POET Study 1998-5, several individuals, each with significant credentials, including a Defense Criminal Investigative Service employee, a GAO employee, an MIT professor, and two former TRW employees, asserted the existence of research misconduct or other serious shortcomings in the POET analyses. By the same token, the two investigators identified as principally responsible for the portion of the POET report at issue have had long and notable careers, each holds a PhD, and their views are supported by numerous other individuals and organizations that assert no significant shortcomings are contained in the work in contention.

A number of investigations previously have been conducted into various aspects of these and related allegations, including assessments by Lincoln Laboratory, MIT, the GAO, the FBI, the Defense Criminal Investigative Service, Nichols Research Corporation, and the Utah State University Space Dynamics Laboratory. Of those focusing on the specific issue of research misconduct, none found the parties involved to have been guilty of such activities. However, the inquiry conducted by MIT that formed the impetus for the present examination did specify six issues which raised, in the mind of the individual conducting the inquiry, sufficient questions as to warrant further assessment – hence the conduct of the present investigation.

In the pursuit of this investigation, authority was not provided to compel witnesses to participate in interviews or to produce requested documentation. Nonetheless, only one individual² declined to be interviewed and, in fact, all seemed eager to express their views. None were accompanied by legal counsel and, in the opinions of both the investigator and the advisor, all the individuals interviewed appeared to be forthcoming and sincere in their beliefs – notwithstanding that those beliefs were not infrequently in conflict with those held by others.

In my opinion, the investigator, Dr. Godfrey, carried out his responsibilities very competently, with extraordinary diligence and a sincere effort to ferret out the truth. In recognition of the potential impact of this investigation, he devoted a substantial amount of time and effort to the undertaking, particularly in view of the demands of his regular responsibilities as Director of the Air Force Office of Scientific Research. With the exception of the single reluctant witness mentioned above, I am unaware of any instance where the investigation was intentionally impeded by anyone or any organization. Full access to all requested available documentation was in every case cooperatively provided.³ In my judgment, the accompanying report accurately portrays the circumstances which were investigated and the resolution of the issues identified. I therefore endorse the findings and recommendations contained therein.

² Considered to be somewhat peripheral to the primary thrust of the investigation.

³ As but one example, at the first of our meetings at Lincoln Laboratory, without prior notification I requested access to the secret document files relating to the IFT-1A matter contained in the desk of one of the POET authors. A similar unannounced request was made for first-hand access to the IFT-1A section of the classified document storage vault located in the basement of Lincoln Laboratory. In each case, unimpeded access was immediately provided.

A final brief observation is perhaps in order with regard to my own participation in the investigation. As is presumably the case for any individual possessing knowledge of a topic as narrow as ballistic missile defense and for which there is but one customer, that individual likely will have or have had at least some first-hand participation in the field. Such is my case – with my having been involved at one time or another throughout my career with a number of the organizations related to this investigation. These potential conflicts have been disclosed to the Department of Defense and subjected to its standard conflict of interest review, following which it was determined by the Department’s Office of the General Counsel that my involvements are not of such a nature as to interfere with my ability to perform the duties assigned. This is a view which I share. Nonetheless, I note the above in the spirit of full disclosure.

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Executive Summary

This report summarizes the results of an investigation of alleged research misconduct in connection with Phase One Engineering Team (POET) Study 1998-5 [Tsai 1999a]. Research misconduct is defined [OSTP 2000] as “fabrication, falsification, or plagiarism in proposing, performing, or reviewing research, or in reporting research results.” “Research misconduct does not include honest error or differences of opinion.” “A finding of research misconduct requires that: there be a significant departure from accepted practices of the relevant research community; and the misconduct be committed intentionally, or knowingly, or recklessly; and the allegation be proven by a preponderance of evidence.”

The federal policy goes on to say that “a response to an allegation of research misconduct will usually consist of several phases, including: (1) an inquiry – the assessment of whether the allegation has substance and if an investigation is warranted; (2) an investigation – the formal development of the factual record, and the examination of that record leading to the dismissal of the case or to a recommendation for a finding of research misconduct or other appropriate remedies; (3) adjudication – during which recommendations are reviewed and appropriate corrective actions determined.” Federal policy further provides that there should be safeguards for both informants and subjects of investigation.

An inquiry completed four years ago found that an investigation to address several remaining open issues was warranted [Crawley 2002f]. The present investigation thus is focused on the six specific issues identified by the inquiry and is not intended to assess broader matters, such as the feasibility of ballistic missile defense, the efficacy of exoatmospheric discrimination, the performance of any particular missile defense system, or alleged misconduct by the IFT-1A prime and subcontractors. Of course, any apparent illegalities uncovered, whether or not within the scope of the investigation, were to be reported to appropriate authorities.

POET Study 1998-5 relates to Integrated Flight Test (IFT) 1A of the Ground-Based Interceptor missile defense program, which occurred on 24 June 1997. IFT-1A employed a Payload Launch Vehicle carrying a Sensor Payload (SPL), a Target Launch Vehicle carrying a mock reentry vehicle (MRV) and nine decoys, and assorted range assets. Boeing was the prime contractor, and TRW was the subcontractor responsible for Tracking, Fusion, and Discrimination.

Establishing whether IFT-1A was an experiment or system verification is important in setting the context of this investigation, because experiments and system verifications are held to different contractual and community standards. (For example, subjecting flight data to a variety of possible discrimination algorithms might be considered appropriate in the former case but generally would not be in the latter.) According to the contractor 60-Day Report, the principal objective of IFT-1A was “to reduce risk for subsequent Exoatmospheric Kill Vehicle [EKV] flight tests” [Boeing 1997a, p. 8]. The SPL primary objectives were “to demonstrate exoatmospheric sensor operations, provide sensor sensitivity measurement and calibration data, provide signature data collection, and provide discrimination data collection.” The Ballistic Missile Defense Organization (BMDO) director described the contractor discrimination program at that time as “research and development” [Kadish 2001]. Similarly, according to the General Accountability Office (GAO), program officials described IFT-1A as an “early research and

development test” [GAO 2002a, p. 1]. Demonstrating actual discrimination was not among the stated SPL objectives. Nonetheless, the subcontractor analyzed signature data for this purpose and indicated that the Baseline Algorithm (BLA) correctly performed its discrimination function on the IFT-1A flight data [Boeing 1998a, p. 134].

Also in 1997 a former TRW employee filed a False Claims Act lawsuit against TRW, alleging that the company had misrepresented the capabilities of its discrimination algorithm. The Department of Justice and the Defense Criminal Investigative Service (DCIS) began an investigation into the allegations in order to determine whether the US Government should participate in the lawsuit. To provide an independent assessment of the BLA and its discrimination capability, the BMDO chartered POET Study 1998-5 to conduct (1) a “review of discrimination algorithms, software implementation, and associated data developed by TRW for use in the Boeing EKV for consistency and correctness in its scientific, mathematical and engineering principles”; (2) a “review of [the BLA’s] performance against IFT-1A data”; and (3) an assessment of “potential performance [of the BLA] for IFT-3” [Englander, 1998]. The study was completed near the end of 1998, although discussions with DCIS continued into early 1999. The False Claims Act lawsuit eventually was dismissed, in part because the Department of Defense (DOD) declined, under the “military and state secrets privilege”, to provide classified documents pertaining to the litigation [J. Brown 2003].

In 2000 an MIT professor claimed that the IFT-1A data analysis [Postol 2000] and, subsequently, POET Study 1998-5 [Postol 2001] were fraudulent. He also has stated that he had “made no accusations of misconduct against the MIT Lincoln Laboratory authors of the POET report” [Postol 2002b]. Nevertheless, because two of the study authors were employees of MIT Lincoln Laboratory (LL), the MIT Provost initiated an inquiry [R. Brown 2002b] to determine whether a formal investigation of “research misconduct” was warranted. After several months’ consideration, the professor performing the inquiry recommended that an investigation be conducted, because “sufficient inconsistencies, open issues, and needs for detailed rectifications of facts” remained [Crawley 2002f, p 2].

In brief, the six open issues identified in the Inquiry Report were [Crawley 2002f, pp. 3 - 4].

1. “The POET report is silent on the issue of the calibration and functional status of the IR [infrared] sensor”, despite its elevated temperature and uncertain calibration.
2. “Why was only a subset of the [sensor] data examined by the POET team?”
3. “There are discrepancies between the POET report and the DCIS investigation on the subject of the [BLA] ‘reinitialization’ and [feature] ellipse ‘movement’. The POET report seems internally self-contradictory on the question of the effectiveness and robustness of the algorithms.”
4. “The Report concludes that the EKF [Extended Kalman Filter] appears to track the signals reasonably well. This would suggest that a dominant harmonic is present in the signal, which independent analysis ... suggests is not the case.”
5. “Did the authors, and potentially others within Lincoln Laboratory, [selectively] interpret the scope of effort and responsibility implied by the Statement of Work, and [if so] what impact did it have on the resolution of the four issues outlined above?”
6. “The GAO report and the POET report are at variance on several issues, including the functional status of the sensor and the time window analyzed. Yet the GAO report also

claims that ‘the Department of Defense concurred with our findings’ [GAO 2002a, p. 9]. Where in the interactions of the Lincoln Laboratory, the DOD and the GAO were the discrepancies resolved?”

Upon receipt of the Inquiry Report, the MIT Provost attempted to charter an investigation [R. Brown 2004]. However, the BMDO declined, “due to the national security interests at stake” [Kadish 2003], to authorize access to classified documents deemed necessary to conduct a credible investigation. Then, in early 2006 the Office of the Secretary of Defense (OSD) directed the author of this report to conduct the investigation, granting full access to all relevant information. OSD also appointed a retired industry executive who previously had served as a DOD official to be an advisor and consultant, also with full access to all relevant information. The two spent nine months interviewing nearly 50 individuals and reviewing over 160 documents, many of which were classified. The investigation’s principal findings and supporting rationale in summary form are as follows.

1. The infrared sensor did not reach its nominal operating temperature due to an equipment malfunction, and the actual temperature varied significantly during the measurements. Electrical noise in a power supply also was a problem [Huppi 2001]. The POET study made no mention of these facts. Omitting discussion of such critical information in a scientific journal article might constitute research misconduct. However, this was not a scientific journal article, and the two LL members of the POET team responded that the classified POET study was meant only for about 10 people, that the sensor problems were known to those involved in IFT-1A, and that the sensor produced adequate data anyway [Meins 2002, pp. 2, 4 - 6], all of which were true. Indeed, the contractor had reported the sensor cooling problems [Boeing 1998a] prior to the publication of the POET report. It also might be argued that assessing the experimental performance of the IFT-1A sensor was beyond the scope of the POET study. Nonetheless, this investigation concludes that sensor performance was so important that it should have been discussed in the POET report. This omission does not, however, rise to the level of research misconduct, due to the extenuating circumstances just described.
2. The POET study analyzed 17 seconds of a much longer period of collected data. There seems to be general agreement that the data obtained prior to this 17-second window was of too low a quality to be of much use due to the low signal-to-noise ratio. On the other hand, some critics of the TRW IFT-1A data analysis believe that as much as 11 seconds of usable data beyond the 17-second window should have been analyzed as well and would have caused the BLA ultimately to identify a decoy as the MRV. The two LL authors responded that analyzing the additional data was unnecessary, because the targeting algorithm would have selected the MRV for targeting prior to the beginning of the 11 seconds in question [Meins 2002, p. 6 - 7]. An analysis conducted in support of the present investigation identified about 7 additional seconds of useful data before images began streaking and multiple objects began permanently leaving the field of view [Kraemer 2006]. The present investigation concludes that the POET study could have analyzed the additional 7 seconds of data together with the 17 seconds in order to gain further insight into the effectiveness of the discrimination algorithm. However, the amount of time to be analyzed was to some degree a matter of professional judgment, and analyzing just the 17 seconds does not constitute research misconduct. During the additional 7 seconds, the BLA continued to properly identify the MRV, although the

probability assigned to one particular decoy increased significantly during the final seconds [Boeing, 1998a]. A retired scientist involved in the TRW discrimination analysis suggested in an interview that the increasing probability assigned to the decoy during the final seconds was an anomaly due to rapid motion of objects across the field of view.

3. The third open issue has three components. Contractor plots of the “Object Ranking Metric”, which was the BLA-based probability that an object was the MRV, displayed an abrupt change part way through the 17-second data window [Boeing 1997b and 1998a, Sec. 4.4.2.5.4.3]. The DCIS investigator alleged that the abrupt change was due to reinitializing the calculation, and the POET study, which repeated the contractor computation, concluded that the abrupt change was due to the inclusion of an additional data feature when it became available [Tsai 1999a, p. 25 - 29]. Examination of the contractor and POET reports, including data used in determining the Object Ranking Metric, indicates that the POET report is correct. Consequently, the investigation concludes that no research misconduct occurred in this regard. Next, the DCIS investigator questioned why feature ellipses changed from the 45-Day analysis (as described in [Boeing 1998b, pp. 154 – 185]) to the 60-Day Report [Boeing 1997b, Sec. 4.4.2.5.4.3] to the revised 60-Day Report [Boeing 1998a, Sec. 4.4.2.5.4.3], while the POET report accepted the contractor explanations for these two changes. The first change, involving both the locations and orientations of several ellipses, was attributed by the contractor to an error in the Gap-Filling Algorithm (GFA) as employed by Monte Carlo simulations of the target signatures and sensor performance in the 45-day analysis. Discussions with the POET authors and with contractor personnel as part of the investigation suggested that this was, for the most part, a plausible explanation. (Why the GFA would cause some ellipses to tilt in the particular direction predicted in the 45-day analysis is not obvious to the investigator.) However, only by reproducing the simulations could the contractor explanation have been validated. Doing so was beyond the scope of the POET study, and this investigation concludes that not conducting such an analysis does not constitute research misconduct. The second change was a decrease by a factor of about 2.5 in the sizes of all the ellipses, which the contractor explained as a scaling error in the original 60-Day Report. This explanation is demonstrably true, because the Monte Carlo results on which the ellipses were based were identical in both versions of the 60-Day Report and consistent with the sizes of the ellipses in the revised report. Finally, the POET report can only be considered generous in stating that “overall, the BLA are well designed and work properly, with only some refinements or redesign required to increase the robustness of the overall discrimination function”, especially in light of concerns expressed elsewhere in the report itself. Nonetheless, the several BLA deficiencies are articulated clearly in the immediately subsequent paragraphs of the POET report [Tsai 1999a, p. iii]. In view of these disclosures, the investigation concludes that the choice of wording in a single sentence, taken by itself, does not rise to the level of research misconduct.
4. On multiple occasions, the MIT professor alleging research misconduct has stated that the POET EKF analysis must be wrong in claiming to identify an oscillation in the flight data, because no dominant frequency was visible in its power spectrum. As part of this investigation, a review of the sensor data used in the POET study to examine the EKF indicated that a dominant frequency was, in fact, present, although it was not obvious in the power spectrum figures apparently available to the professor. Additionally, as part of

the present investigation, an individual highly experienced in the use of Kalman Filters first reviewed the description of the EKF analysis in the POET report and found it to be credible, with the limitations of the EKF properly documented in that report, and then verified the software used by the POET team and reproduced some of the EKF computations themselves. (In particular, Figure 15 of the POET Report was reproduced.) It should be noted that the EKF had been deleted from the BLA prior to IFT-1A and thus had no operational impact. The investigation concludes that this issue involves no research misconduct.

5. The BMDO director stated at the time of the POET study that “the scope of the POET review has been narrowly defined to provide confidence to the NMD [National Missile Defense] Program Manager that the Boeing EKV, utilizing TRW-supplied algorithms, will indeed technically perform as required” [Lyles, 1998]. Interviews with MDA officials conducted during the investigation indicate that BMDO management was satisfied that the POET study met the requirements of the Statement of Work, including the additional task of analyzing the EKF. This investigation agrees. Additionally, although the Statement of Work (SOW) itself may, in retrospect, have been too narrow, its content was a management decision. For these reasons the investigation concludes that no research misconduct exists for this issue either.
6. The GAO reports and the POET report are not at variance on the functional status of the sensor and the time window analyzed. Rather, the GAO reports, written three years after the POET report, discussed these two matters, and the POET report did not. Interviews conducted as part of the investigation indicated that the GAO report authors did not fault the POET study (with the exception of one author, who also faulted the GAO study). The OSD official who formally concurred with the GAO reports stated in an interview that he did so, because the reports were not critical of BMDO’s conduct and contained no recommendations for substantive action. Concurrence by OSD with the GAO reports was, in any case, an OSD management decision. The investigation concludes that this issue does not involve research misconduct.

The investigator also was alert for possible instances of research misconduct in connection with POET Study 1998-5 yet not directly related to the issues identified in the Inquiry Report but did not encounter any.

Ballistic missile defense is an exceedingly complex undertaking. Competent people could, and did, disagree on many technical issues, such as whether reentry vehicles and decoys could be distinguished reliably. The manner in which the POET team presented its results should have more prominently emphasized caveats and limitations. However, when the available facts are considered, the team’s actions do not rise to the level of research misconduct. There are plausible explanations for their actions, and no evidence was found of intentional efforts to deceive. The investigation concludes, therefore, that neither the POET team nor the management of Lincoln Laboratory is guilty of research misconduct with respect to POET Study 1998-5.

The investigation made several findings of a procedural nature. The most important are these:

1. BMDO and contractor statements that IFT-1A demonstrated the discrimination capabilities of the BLA seem overly broad and were not fully substantiated by the IFT-1A data. Moreover, as noted above, IFT-1A was an experiment, not a system verification.

2. The DCIS investigator relied primarily on a scientist with a strong interest in the outcome of his investigation for technical advice.
3. MIT initiated its inquiry without clear, written allegations [Canizares 2006, p. 17]. As noted above, the MIT professor who first claimed “scientific fraud” has stated that his charges were not aimed specifically at the POET study authors. Also, MIT did not protect adequately the confidentiality of the inquiry process. Copies of a draft version of the report were not controlled, and some information found its way into newspapers; e. g., [Broad 2003]. MIT did not follow its policy that “after considering the responses of the alleged offender, the fact finder should” include “an accurate summary of the information offered by the alleged offender” in the inquiry final report [MIT 1997b].
4. Access to relevant classified information indeed was necessary to conduct this investigation.
5. Excessive delay occurred in addressing the allegations of research misconduct, especially between the end of the inquiry and the beginning of the investigation. In particular, the DOD did not follow the federal requirement to initiate an investigation responding to the Inquiry Report in a reasonable period of time, despite MIT’s repeated requests. Over the past five years, many participants changed positions or retired, and one key participant died. Participants’ recollections of events, of course, also faded.
6. Complex inquiries and investigations of research misconduct should be performed by more than one person.

In conclusion, the investigation recommends:

1. Charges of research misconduct in connection with POET Study 1998-5 be dismissed.
2. Reasonable efforts be made to publicly exonerate the two Lincoln Laboratory authors, in accordance with their wishes.
3. Confidentiality requirements be strengthened in the OSTP, DOD, and MIT research misconduct policies, and then enforced.
4. A requirement for a complete set of written allegations, along with the basis for making them, be added to the OSTP, DOD, and MIT research misconduct policies.
5. DCIS investigators be provided with knowledgeable, disinterested technical assistance when conducting technically complex investigations.
6. A lessons-learned report be prepared by OSD several months from the date of the present report. (It is possible that not all lessons will have been learned until some months after this report has been released.)

Finally, the investigator affirms that, to the best of his ability, he conducted this investigation in a thorough and unbiased manner and that no one attempted to improperly influence the outcome.

1. Background

The 2002 General Accountability Office (GAO) reports [GAO 2002a and 2002b, pp. 1-4] provided a thorough summary of relevant events until that time, and the current report quotes extensively from them:

History through 2000. “For a number of years, the Department of Defense has been researching and developing defenses against ballistic missile attacks on the United States, its deployed forces, friends, and allies. In 1990, the Department awarded research and development contracts to three contractors to develop and test exoatmospheric kill vehicles. The Department planned to use the best of the three vehicles in a follow-on missile defense program. One of the contractors, Rockwell International, subcontracted a portion of its kill vehicle design work to TRW. TRW was tasked with developing software that could operate on a computer onboard the kill vehicle. The software was to analyze data collected in flight by the kill vehicle’s sensor (which collects real-time information about threat objects), enabling the kill vehicle to distinguish an enemy reentry vehicle from accompanying decoys.

“The three contractors proceeded with development of the kill vehicle designs and built and tested key subsystems (such as the sensor) until 1994. In 1994, the Department of Defense eliminated Martin Marietta from the competition. Both Rockwell — portions of which in December 1996 became Boeing North American — and Hughes — now Raytheon — continued designing and testing their kill vehicles. In 1997 and 1998, the National Missile Defense Joint Program Office conducted tests, in space, of the sensors being developed by the contractors for their competing kill vehicles. Boeing’s sensor was tested in June 1997 (Integrated Flight Test 1A) and Raytheon’s sensor was tested in January 1998 (Integrated Flight Test 2). Program officials said these tests were not meant to demonstrate that the sensor met performance requirements, nor were they intended to be the basis for any contract award decisions. Rather, they were early research and development tests that the program office considered experiments to primarily reduce risk in future flight tests. Specifically, the tests were designed to determine if the sensor could operate in space; to examine the extent to which the sensor could detect small differences in infrared emissions; to determine if the sensor was accurately calibrated; and to collect target signature data for post-mission discrimination analysis.

“After the two sensor tests, the program office planned another 19 flight tests from 1999 through 2005 in which the kill vehicle would attempt to intercept a mock warhead. Initially, Boeing’s kill vehicle was scheduled for testing in Integrated Flight Test 3 and Raytheon’s in Integrated Flight Test 4. However, Boeing became the Lead System Integrator for the National Missile Defense Program in April 1998 and, before the third flight test was conducted, selected Raytheon as the primary kill vehicle developer.

“Meanwhile, in September 1995, TRW had hired a senior staff engineer, Dr. Nira Schwartz, to work on various projects, including the company’s effort to develop the exoatmospheric kill vehicle’s discrimination software. The engineer helped evaluate some facets of a technology known as the Extended Kalman Filter Feature Extractor, which TRW planned to add as an enhancement to its discrimination software. The engineer reported to TRW in February 1996 that tests revealed that the Filter could not extract the key characteristics, or features, from

various target objects that an enemy missile might deploy and demanded that the company inform Rockwell and the Department of Defense. TRW fired the engineer in March 1996. In April 1996, the engineer filed a lawsuit under the False Claims Act alleging that TRW falsely reported or hid information to make the National Missile Defense Joint Program Office believe that the Extended Kalman Filter Feature Extractor met the Department's technical requirements. The engineer has amended the lawsuit several times, including adding allegations that TRW misled the Department of Defense about the ability of its discrimination software to distinguish a warhead from decoys and that TRW's test reports on Integrated Flight Test 1A falsely represented the discrimination software's performance.

"The False Claims Act allows a person to bring a lawsuit on behalf of the U.S. government if he or she has knowledge that a person or company has made a false or fraudulent claim against the government. If the suit is successful, the person bringing the lawsuit may share in any money recovered. The Department of Justice reviews all lawsuits filed under the act before deciding whether to join them. If it does, it becomes primarily responsible for prosecuting the case.

"To determine whether it should join the engineer's lawsuit against TRW, Justice asked the Defense Criminal Investigative Service, a unit within the Department of Defense Inspector General's office, to examine the allegations. The engineer cooperated with the Investigative Service for more than 2 years. During the course of the Department of Defense's investigation into the allegations of contractor fraud, two groups examined the former employee's specific allegations regarding the performance of TRW's basic discrimination software and performed limited evaluations of the Extended Kalman Filter Feature Extractor. The first was Nichols Research Corporation, a contractor providing technical assistance to the Ground Based Interceptor Project Management Office for its oversight of the exoatmospheric kill vehicle contracts. (This office within the National Missile Defense Joint Program Office is responsible for the exoatmospheric kill vehicle contracts.) Because an investigator for the Defense Criminal Investigative Service was concerned about the ability of Nichols to provide a truly objective assessment, the National Missile Defense Joint Program Office asked an existing advisory group, known as the Phase One Engineering Team, to undertake another review of the specific allegations of fraud with respect to the software. This group is comprised of scientists from Federally Funded Research and Development Centers who were selected for the review team because of their knowledge of the National Missile Defense system. In addition, both Nichols and the Phase One Engineering Team assessed the feasibility of using the Extended Kalman Filter Feature Extractor to extract additional features from target objects that an enemy missile might deploy.

"The Department of Justice and the Defense Criminal Investigative Service investigated the engineer's allegations until March 1999. At that time, the Department of Justice decided not to intervene in the lawsuit. The engineer has continued to pursue her lawsuit without Justice's intervention. [Additional information on the Defense Criminal Investigative Service (DCIS) investigation is contained in Chapter 2, "Previous Relevant Investigations".]

"When a Massachusetts Institute of Technology professor, Dr. Theodore Postol, learned of the engineer's claims, he conducted his own analysis of Integrated Flight Test 1A. In May 2000, the

professor wrote to the White House [Chief of Staff] alleging that Boeing North American and TRW misrepresented the results of the test.

“The professor claimed that his analysis of Integrated Flight Test 1A showed that the system can be defeated by the simplest of decoys and that the National Missile Defense Joint Program Office and its contractors attempted to hide this fact by tampering with the flight test data and altering their analysis of the sensor’s discrimination capabilities. The professor also alleged that objects deployed as part of Integrated Flight Test 1A displayed no distinguishable differences that Boeing’s infrared sensor could use to identify the mock warhead from decoys and that the program office hid the sensor’s weaknesses by reducing the number of decoys planned for future tests. Further, the professor claimed that the Phase One Engineering Team’s analysis was faulty.”

Allegations by Prof. Postol to the White House Chief of Staff. Allegations in the letter directed at the Phase One Engineering Team (POET) study and apparently at the Ballistic Missile Defense Organization (BMDO) included [Postol 2000, Attachment B]:

- “The BMDO-POET Team used an erroneous example of simulated data to show that they could detect an oscillating component in a signal.” “However, the BMDO-POET Team did not show that they could find oscillating components in the signals from the IFT-1A experiment. This is because there is no oscillating component in the IFT-1A data.”
- “The BMDO-POET Team ... arbitrarily stopped the analysis of the data, and ... began a second fit to the data. Not surprisingly, the warhead was quickly selected as the target during this time interval.” “This result was simply fortuitous, as they obviously chose the time period where the warhead was bright relative to other targets...”
- “Data from the tenth object, a partially inflated medium balloon, is not shown in the figure, as this data was inexplicably removed from the IFT-1A telemetry, apparently because its signal appeared more like that expected for the warhead than the warhead itself.”

(IFT means Integrated Flight Test.) Included with the letter as its Attachment D was a redacted version of a draft [Tsai 1998b] of the POET study. Apparently, the DCIS investigator had masked portions of the draft to remove presumed classified information, copied it, and provided it to Dr Schwartz to aid his investigation. A copy then found its way to Prof. Postol.

A number of classified rebuttals were written in response to Prof. Postol’s letter, including [Handler 2000] and [Keane 2002]. In general, they disputed all of the allegations. Based on these rebuttals, the White House Chief of Staff personally acknowledged Prof. Postol’s letter [Podesta 2000] but apparently took no further action.

GAO and FBI Responses to Congress. Prof. Postol subsequently shared his concerns with Members of Congress, who in turn requested both the Federal Bureau of Investigation (FBI) and the GAO to investigate. As explained in Chapter 2, “Previous Relevant Investigations”, the issues forwarded to the two investigative organizations included allegations not only of fraudulent misrepresentation of IFT-1A data and analysis but also of improper efforts by the Department of Defense (DOD) to classify portions of his earlier letter and attachments to the White House Chief of Staff.

Both the FBI and GAO found that DOD had acted properly in attempting to classify parts of Prof. Postol's letter and attachments [FBI 2001], [Hast 2001]. In addition, the FBI found no evidence of criminal misconduct, instead stating "that Postol's claim that data had been altered was unfounded. As to Postol's claim that the system is incapable of distinguishing between warheads and decoys, there is a dispute among scientists about the ability of the system to discriminate based on scientific grounds. This is a scientific dispute and Postol's attempt to raise it to the level of criminal conduct has no basis in fact" [FBI 2001].

After an extensive review, the GAO in two reports released concurrently [GAO 2002a and 2002b] responded in detail to seven specific questions posed by Members of Congress. In sections of the two reports, the GAO summarized, but did not express an opinion on the adequacy of, the POET report. It did, however, observe that the POET team did not verify the accuracy of the data reduction performed by the contractor or develop its own reference data and, consequently, could not verify all aspects of the contractor claims of having successfully discriminated the mock reentry vehicle (MRV) in IFT-1A. Overall, the two reports identified no criminal misconduct. It should be noted, however, that one of the GAO investigators recently alleged that the GAO investigation did uncover evidence of misconduct but suppressed it [Ghoshroy 2005]. GAO management has denied these charges [Walker 2006]. More detail is provided in Chapter 2, "Previous Relevant Investigations".

MIT Inquiry into Alleged POET Team Research Misconduct. Also in 2001, Prof. Postol requested in conversations and an exchange of emails with Massachusetts Institute of Technology (MIT) President Charles Vest that "scientific fraud" associated with the POET Report be investigated [Postol 2002a and attachments]. MIT Provost Robert Brown selected Prof. Edward Crawley in early 2002 to conduct an inquiry [R. Brown 2002b]. (By federal and MIT policies, an inquiry first is conducted into allegations of research misconduct in order to determine whether an investigation is warranted [OSTP 2000], [MIT 1997b]. Procedures for addressing charges of research misconduct are described in Chapter 3, "Investigation Process".)

Prof. Postol's concerns at that time were spelled out in his first letter to Prof. Crawley [Postol 2002e]. He began by stating that he had "made no accusations of misconduct against the MIT Lincoln Laboratory authors of the POET Report... The matter at issue is the accuracy of the scientific findings..." These scientific issues included the quality of the IFT-1A data (in light of a higher than desired IFT-1A sensor temperature), performance of the Extended Kalman Filter (EKF), and purported errors in the "confusion matrix" (a measure of the overlap among the computed feature ellipses of the MRV and decoys). Prof. Postol concluded by emphasizing his view of the seriousness of the situation, stating that "Lincoln Laboratory [LL] managers, and the MIT Administrators who manage Lincoln, need to explain how they could know that this report contained fraudulent scientific conclusions and yet no effort was made to inform the Defense Criminal Investigative Service or the Department of Justice. If Lincoln Laboratory knowingly provided false information under these conditions, the Laboratory was in effect impeding an investigation of fraud." He went on to say that "there can be no investigation of misconduct where the management of Lincoln Laboratory can be excluded, including the Director..."

Prof. Crawley conducted his inquiry during the Spring and early Summer of 2002, interviewing Prof. Postol; Dr. Ming-Jer Tsai and Dr. Charles Meins, the two POET Report authors from LL;

Dr. David Briggs, LL Director; and others. He also reviewed a substantial amount of printed material provided by Provost Brown, Prof. Postol, and the POET authors. During this time, Prof. Postol made additional allegations, most of which eventually were included in the Inquiry Report. In the first draft, Prof. Crawley concluded that an investigation was not warranted [Crawley 2002c]. He then shared the draft with the two POET Report authors and with Prof. Postol, as required by MIT policy, and with a few other individuals. Drs. Tsai and Meins reportedly expressed few concerns regarding the draft report.

Prof. Postol, on the other hand, expressed serious concerns in three additional letters to Prof. Crawley and in two additional interviews. For instance, he stated that “there are very serious inconsistencies between the facts reported in the MIT First Draft Report and those reported by two separate federal investigations. MIT’s knowledge of these inconsistencies and failure to resolve them has the potential to implicate the MIT Administration, and you [Prof. Crawley], as partners to an effort to cover up possible fraud and obstruction of justice” [Postol 2002h]. Near the end of the final interview, Prof. Postol suggested that “if you were to take the position that [‘]there’s enough uncertainty from what I can gather given the resources that I have available to me and the time that I have available to me that this will require an external investigation to determine whether or not something improper had occurred[’], that’s fine with me” [Crawley 2002e]. Subsequently, Prof. Crawley revised his draft report to recommend a formal investigation, stating that “I find there are still sufficient inconsistencies, open issues, and needs for detailed rectification of facts that the allegations cannot be closed by this inquiry” [Crawley 2002f]. Appendix C reproduces the first four pages of the Inquiry Report (except for a short paragraph outlining the structure of the report), which summarize the overall findings of the inquiry. The remainder of the Inquiry Report contains some sensitive information and may not be reproduced here. The two POET Report authors and Prof. Postol were given the opportunity to review the Inquiry Report, and Drs. Meins and Tsai prepared an extensive rebuttal [Meins 2002]. Prof. Crawley stated during the current investigation that he had not seen the rebuttal.

Provost Brown advised the Missile Defense Agency (MDA), the successor organization to the BMDO, in February 2003 that MIT intended “to initiate an investigation into the issues identified in the Inquiry Report” [R. Brown 2003a]. However, doing so required that MDA grant access to relevant classified documents, which MDA declined to do, stating that Prof. Postol’s allegations appeared “to be an attempt to misuse the academic research process by repackaging and resurrecting challenges that have been found to be without basis” [Kadish 2004].

Prof. Postol also charged in early 2002 that the MIT administration had failed to investigate his POET study allegations in a timely manner and also had attempted to intimidate him and improperly influence his research [Postol 2002a]. Findings of the subsequent investigation into these matters by Dr. Frank Press [Press 2002] are described in Chapter 2, “Previous Relevant Investigations”.

False Claims Act Lawsuit Dismissed. Dr. Schwartz’ False Claims Act lawsuit was dismissed in 2003, in part because the Department of Defense (DOD) declined, under the “military and state secrets privilege”, to provide classified documents pertaining to the litigation [J. Brown 2003].

2. Previous Relevant Investigations

Several formal investigations related in one way or another to the present investigation have been conducted. In considering the relevance of those investigations, it is important to be precise in stating what they concluded, and the present investigation attempts to do so here.

DCIS Investigation of Allegations by Dr. Nira Schwartz. The first, and longest running, investigation was performed by DCIS from June 1996 to August 1999 on behalf of the Department of Justice (DOJ), which sought to determine whether it should join the False Claims Act lawsuit filed by Dr. Nira Schwartz against TRW. The DCIS and DOJ principal investigators were lawyers and relied heavily on Dr. Schwartz, the “relator”, for technical advice. Another TRW scientist and an Army scientist also provided advice. Issues included whether the contractor falsely claimed that it could discriminate between the IFT-1A MRV and decoys, whether it modified algorithm predictions to match the experimental data, whether it used data selectively to match predictions, and whether it falsely claimed that its EKF could extract information useful to discrimination from the data. At the request of that investigation team, BMDO commissioned Nichols Research Corporation (NRC), already under contract to provide technical advice to BMDO, to conduct an assessment of the TRW Base Line Algorithm (BLA) and the EKF. To assess the BLA, NRC compiled and ran the TRW test bed software for 50 representative scenarios and found that “performance results for the vast majority of independent cases exceeded the discrimination requirements” of the Technical Requirements Document (TRD) [MD-PEO 1993] near-term threat. They attributed the poor results of three scenarios to problems with the Gap-Filling Algorithm (GFA), as well as to software errors [Barton 1997]. To assess the EKF, NRC coded the TRW algorithm and ran it for various synthetic but realistic data sets, finding that the “algorithm provides good [feature] extraction capability over a wide range of signature variations consistent with scenario and engagement dynamics for the near-term threat.” NRC did, however, note that “unless the threat and its deployment kinematics are well-defined ..., the performance of the EKFFE [EKF Feature Extractor] (or any estimative/predictive filter) will most likely be suboptimal” [Barton 1998]. However, because the DCIS investigation team felt that NRC was not sufficiently independent, it requested another study. POET Study 1998-5 was the outcome.

Like NRC, POET concluded that the BLA and EKF worked but were fragile. Throughout the DCIS investigation, the investigation team exchanged numerous letters with BMDO and others. Many of the questions posed were addressed by the POET team in Appendix B of its report, although not always to the satisfaction of the DCIS investigator or Dr. Schwartz. Areas of specific disagreement included choice of IFT-1A data to be analyzed, explanations for changes in feature ellipses as published by the contractor, and alternative approaches for computing the probability that a detected object was the MRV. In addition, the DCIS investigator requested that the scope of the POET study Statement of Work (SOW) be expanded to include assessing “the concept and performance of the Threat Typing Sensitivity Study Report” and verifying that the contractor’s BLA and IFT-1A data analysis “comply without exception to the TRD” [Reed 1998e]. This was not done, because compliance with the TRD, including the role of threat typing, was considered a systems-level issue, well beyond the scope of the assessing the BLA [Handler, 1998]. (Threat typing refers to knowledge of the threat reentry vehicles(s) and decoys obtained prior to launch, typically by intelligence assessments.) Based on the NRC and POET

studies, and at the recommendation of the Army Legal Services Agency [Hoffman 1999], DOJ decided in March 1999 not to join Dr. Schwartz' lawsuit. The investigation itself was closed five months later without criminal charges [Reed 1999h]. Nonetheless, the principal DCIS investigator believed that the contractor had misrepresented the capabilities of its BLA [Reed 1999g].

The DCIS investigation did result in a Management Control Deficiency Report (MCDR), recommending "that a second independent POET be assembled, by an upper level management authority, to verify and ensure compliance with contract requirements by: 1.) Evaluating the eleven (11)-detailed reports, generated by Dr. Nira Schwartz and two other engineers, that specifically identified problem areas in TRW discrimination algorithms and 2.) Validating the initial POET report, which contains apparent inconsistent and contradictory conclusions, so as to adequately address the issues raised in the aforementioned eleven- (11) reports" [Reed 2000]. The MCDR was advisory in nature, and the BMDO director declined to act on its recommendations, responding that the matter had been studied enough. He also stated, "given the nature of research and development programs, it would have been unreasonable to expect that the preliminary version of TRW's software developed in advance of the availability of real-world flight data would be the final solution to the challenges of discrimination. Both the GBI Office and the POET review team verified that TRW's discrimination approach, while it could be improved, was sound. Both recognized it as a work in progress, as expected given the state of [Exoatmospheric Kill Vehicle] EKV development effort in the 1995-1998 time frame" [Kadish 2001].

FBI Investigation of Allegations by Prof. Postol. On 15 June 2000, fifty-three Members of Congress requested that the FBI investigate charges by Prof. Theodore Postol that BMDO flight experiments were unable to discriminate between MRVs and decoys and that the experimental data was altered to hide this fact. The Members of Congress also requested that the FBI investigate whether DOD violated Executive Order 12958 by retroactively classifying Prof. Postol's letter containing those charges [Kucinich 2000b]. (Prof. Postol's letter was addressed to Mr. John Podesta, then White House Chief of Staff [Postol 2000].) Rep. Kucinich in a separate letter requested that the DOD Inspector General (IG) also investigate the second of these issues [Kucinich 2000a]. The FBI and the DCIS, a component of the DOD/IG office, jointly conducted the requested investigations with the FBI as lead. The FBI concluded in early 2001 "that Postol's claim that data had been altered was unfounded. As to Postol's claim that the system is incapable of distinguishing between warheads and decoys, there is a dispute among scientists about the ability of the system to discriminate based on scientific grounds. This is a scientific dispute and Postol's attempt to raise it to the level of criminal conduct has no basis in fact." With respect to the alleged violation of Executive Order 12958 by DOD, the FBI found that Prof. Postol's letter did, in fact, contain classified material, although he "used this information believing it to be unclassified" [FBI 2001]. In its formal response to the Members of Congress, the FBI stated that its investigation "did not identify any criminal fraud or cover-up by Pentagon officials or contractors involved with the National Missile Defense System" [Kubic 2001].

GAO Investigation of Allegation that DOD Misused the Classification Process. Rep. Markey requested that the GAO also investigate whether (as paraphrased by GAO) the DOD "misused the classification process to stifle public discussion of possible problems with the

National Missile Defense System.” The GAO replied that “DOD’s actions were performed in accordance with Executive Order 12958. Similarly, BMDO’s subsequent request that the Defense Security Service [DSS] contact Dr. Postol to discuss concerns that his letter contained classified information was made in accordance with DOD’s regulations” [Hast 2001].

GAO Investigations of Allegations Relating to IFT-1A. On 28 February 2002, GAO released two similar reports on IFT-1A in response to requests by Rep. Markey [GAO 2002a] and by Sen. Grassley and Rep. Berman [GAO 2002b]. The reports first provided a thorough historical summary and then, taken together, answered seven specific questions. First, GAO found that the contractors “disclosed the key results and limitations of Integrated Flight Test 1A in written reports” [GAO 2002a, p. 5]. However, GAO expressed concern that the contractor reports sometimes characterized the test in subjective terms, such as “success” and “excellent”, which “increased the likelihood that test results would be interpreted in different ways and might even be misinterpreted” [GAO 2002a, p. 6]. Second, GAO did not express an opinion on whether discrimination using the BLA was possible but instead reported that “the Phase One Engineering Team and Nichols Research Corporation have noted that TRW’s software used prior knowledge of warhead and decoy differences, to the maximum extent available, to discriminate one object from the other and cautioned such knowledge may not always be available in the real world” [GAO 2002a, p. 7]. Third, GAO summarized, but did not express an opinion on, the adequacy of the POET report. It did, however, point out that, “because the Phase One Engineering Team did not process the raw data from Integrated Flight Test 1A or develop its own reference data, the team cannot be said to have definitely proved or disproved TRW’s claim that its software successfully discriminated the mock warhead from decoys using data collected from Integrated Flight Test 1A” [GAO 2002a, p. 9]. It made a similar observation about the NRC evaluation of the BLA [GAO 2002b, p. 7]. Fourth, GAO explained that BMDO relied on, for instance, “the sponsoring agreement between the Air Force and Lincoln Laboratory” to “avoid any action that would put its personnel in perceived or actual conflicts of interest regarding either unfair competition or objectivity.” However, GAO noted that the POET team members might be viewed as “insiders” [GAO 2002b, p. 38-39]. GAO also commented on how BMDO and the Army exercised contractor oversight, why they reduced the number of decoys in later flight tests, and how DOJ decided not to join Dr. Schwartz’ lawsuit. In all, the two GAO reports provided a comprehensive factual account of IFT-1A, the POET study, and related activities but drew few conclusions. In particular, the GAO reported no misconduct.

In late 2005, one of the authors of the two GAO reports accused GAO of suppressing “evidence that the contractor made false statements about success and skewed test results by manipulating data”. Key concerns relating to the contractor included discrepancies between the contractor 45- and 60-Day Reports, claims for the target acquisition range, and claims for discrimination. The GAO author also stated that “the contractor discrimination software ... was actually based on concepts developed through many years of government-funded research by MIT Lincoln Laboratory”, thereby creating a conflict of interest for members of the POET team [Ghoshroy 2005]. GAO has strongly denied the accusations against it and offered alternative explanations for the concerns [Walker 2006].

Press Investigation of Alleged Misconduct by MIT Administration. At the request of MIT, Dr. Frank Press, former Science Advisor to the U. S. President, in 2002 investigated two

complaints by Prof. Postol, “that [MIT] President Vest and ‘his inner circle of administrators’ failed to investigate in a timely manner Professor Postol’s allegations of scientific fraud related to POET Study 1998-5” and “that President Vest attempted to intimidate or otherwise improperly influence Professor Postol’s research”. (The latter complaint involved, in part, an alleged attempt by DSS agents to “entrap and intimidate Professor Postol.” The FBI and 2001 GAO investigations, discussed previously, concluded that DSS actions did not violate Executive Order 12958 but did not address any alleged entrapment or intimidation.) In the conclusion of his letter report, Dr. Press stated “that the initiation of an inquiry into Professor Postol’s allegation of scientific fraud, though prolonged, did not violate the standard set by MIT’s Policies and Procedures. However, we also believe that Professor Postol could have been better informed about the progress of the fraud inquiry, although this is not required by MIT’s Policies. We found no evidence of attempted intimidation by either President Vest [or] Provost Brown” [Press 2002].

3. Investigation Process

As described in Chapter 1, “Background”, the MIT Administration attempted to conduct a classified investigation of the open issues listed in Prof. Crawley’s Inquiry Report, but the MDA declined to grant access to the necessary classified documents. There the matter stood until late 2005, when MIT President Susan Hockfield and Deputy Undersecretary of Defense Kenneth Krieg agreed that DOD would conduct the investigation.

Investigation Charter. On 3 January 2006, Mr Krieg verbally requested Dr. Brendan Godfrey to conduct the investigation, which he agreed to do. The text of the formal appointment letter [Krieg 2006a], dated 8 February 2006, appears in Appendix A. The investigator has been a practicing physicist and research manager for some 37 years, presently as the Director of the Air Force Office of Scientific Research. His work on ballistic missile defense focused on laser and particle beam concepts and concluded 12 years ago. Appendix I contains a brief biography of Dr. Godfrey.

At about the same time, Mr. Norman Augustine, was asked to participate in the investigation as an advisor and consultant. Upon his agreement, he was appointed an unpaid Special Government Employee. His responsibilities were defined in an email from Mr. Douglas Larsen, legal advisor to the investigation. The thrust of that email is contained in Appendix B. Now retired, Mr. Augustine has held senior positions in both industry and government. He has been involved in ballistic missile defense in a variety of capacities in the past. He also has served on the MIT Board of Trustees. Appendix I likewise contains a brief biography of Mr. Augustine.

Federal Policy. As stipulated in the appointment letter, the investigation was to cover “the six issues identified in the MIT inquiry officer’s report using the standards in the *Federal Policy on Research Misconduct* as implemented in DOD Instruction 3210.7, *Research Integrity and Misconduct*.” Thus, the investigation was not to encompass such broader issues as the feasibility of ballistic missile defense, the efficacy of exoatmospheric discrimination, the performance of any particular missile defense system, or alleged misconduct by the IFT-1A prime and subcontractors. Of course, any apparent illegalities uncovered, whether or not within the scope of the investigation, were to be reported to appropriate authorities.

The *Federal Policy on Research Misconduct* [OSTP 2000] defines research misconduct as “fabrication, falsification, or plagiarism in proposing, performing, or reviewing research, or in reporting research results.” “Research misconduct does not include honest error or differences of opinion.” “A finding of research misconduct requires that: there be a significant departure from accepted practices of the relevant research community; and the misconduct be committed intentionally, or knowingly, or recklessly; and the allegation be proven by a preponderance of evidence.”

The federal policy goes on to say that “a response to an allegation of research misconduct will usually consist of several phases, including: (1) an inquiry – the assessment of whether the allegation has substance and if an investigation is warranted; (2) an investigation – the formal development of the factual record, and the examination of that record leading to the dismissal of the case or to a recommendation for a finding of research misconduct or other appropriate

remedies; (3) adjudication – during which recommendations are reviewed and appropriate corrective actions determined.” Federal policy further provides that there should be safeguards for both informants and subjects of investigation. The investigators are to conduct the investigation in a fair and unbiased manner, make a good faith effort to protect the confidentiality of any sensitive information provided to them, and complete the investigation in a timely manner.

Mr Krieg has designated himself the adjudicator for item (3) of the process just described [Krieg 2006a].

The *Federal Policy on Research Misconduct* is similar to the *MIT Policy on Academic Misconduct and Dishonesty* [MIT 1997b], under which the inquiry was conducted.

DOD Instruction 3210.7 [DOD 2004] supplements the OSTP policy by specifying that those accused of research misconduct are entitled to “a description of substantial allegations made against them; ... reasonable access to the data and other supporting evidence related to the allegation; and ... the opportunity to respond to the allegation, the evidence, and the findings.”

The investigator met with Dr. Kenneth Roth and Mr. Roger Sudbury, representing LL management, and Dr. Tsai and Dr. Meins on 15 December 2006. The four read pages 1 – 35 of the report and had the opportunity, if they wished, to read the appendices as well. They then verbally accepted the report as written, suggesting only a few minor corrections that did not change the substance of the report. With respect to Recommendation 2, appearing on page 34, the two POET authors requested that LL employees be informed of the outcome of the investigation and subsequent adjudication. The management representatives agreed that this would be appropriate. The written response by the LL POET authors to the present investigation report, received on 20 December 2006, is contained in Appendix D. Their two recommended changes have been incorporated. LL management did not submit a written response.

DOD Instruction 3210.7 also provides that the accused have the right to appeal the adjudication decision to an authority not “directly involved in the inquiry, investigation, or adjudication ...”

Documents reviewed. The findings of the investigation are based largely on the review of over 160 documents, listed in Appendix F. The documents were obtained as follows:

- At the beginning of the investigation, MDA provided six large binders of documents, the majority of which were classified.
- The investigation advisor skimmed the POET classified holdings at LL and identified several dozen mostly classified documents, copies of which were provided promptly.
- Upon request, the DCIS provided copies of its correspondence associated with its two investigations described in Chapter 2, “Previous Relevant Investigations”.
- Upon request, the GAO provided several background documents.
- Prof. Postol provided several documents and letters.
- Several individuals provided information by email.
- By cross-referencing the available documents, the investigator identified a few more documents that appeared to be useful, and they were provided promptly by MDA or LL.

Thus, it seems likely that the investigation had access to all relevant, important documents, although this of course cannot be guaranteed.

Among the most useful of the documents reviewed were POET Study 1998-5 and its redacted earlier draft, the separate LL analysis of IFT-1A data quality, the interim and final draft Inquiry Reports, the Response to the Inquiry Report by Drs. Meins and Tsai, the three GAO reports, the DCIS investigation close-out report and MCDR, the FBI investigation summary reports, the Boeing-TRW 60-Day Report Addendum, the July 1998 contractor briefing to the POET Team, the BLA and EKF assessments by NRC, and certain letters by Prof. Postol.

Interviews. This review of written documentation was complemented by interviews, typically in person but sometimes by telephone, with 49 individuals who had been involved in IFT-1A, the POET study, or the related investigations. (Dr. Schwartz was not interviewed due to her involvement in continuing legal matters.) Although many of the interviewees had strong feelings on these matters, each seemed forthright and anxious to share their insights. Appendix E lists the individuals interviewed.

The investigator and the advisor met four times with Mr. Krieg and members of his staff:

- Discussion of investigation background, scope, and timeline (17 March 2006)
- Presentation of investigation progress (31 July 2006)
- Informal discussion of investigation progress (5 October 2006)
- Presentation of investigation findings and recommendations (4 December 2006)

In addition, the advisor met earlier on one occasion with Mr. Krieg to discuss the advisor's potential participation in the investigation.

Electronic data analyzed. The IFT-1A sensor data analyzed by the POET team and subsequently by an LL staff member for sensor performance [Schulz, 2004] had been preserved electronically on several computer disks, listed in Appendix G. The data files include simulated signatures from the 45-Day and 60-Day analyses, corresponding simulated features, simulated feature ellipses, flight data amplitudes, flight data signal-to-noise ratios, corresponding flight data tracks and features, and the raw focal plane array (FPA) data. Track files from the original 60-Day Report [Boeing 1997b] did not include one small, faint decoy. The POET team reportedly did not have the raw FPA data.

At the request of the investigator, three colleagues at the Air Force Research Laboratory (AFRL) reviewed this collection of data, and particularly the raw focal plane array data, to assess the data quality as a function of time and to observe when objects left the view of the focal plane [Kraemer 2006]. Another AFRL colleague obtained the software employed by the POET team to analyze the EKF, then examined the software, ran it on simulated and actual flight data, and reviewed the POET study EKF results.

4. Discussion

In recommending that an investigation be conducted, the Inquiry Report made two fundamental points: “there are still sufficient inconsistencies, open issues, and needs for detailed rectification of facts that the allegations cannot be closed by this inquiry”, and “there was enough involvement by MIT Lincoln Laboratory employees and management in the preparation and subsequent discussion of the POET Report that it would be appropriate to continue to consider it the subject of an investigation commissioned by MIT” [Crawley 2002f, p. 2].

Role of Lincoln Laboratory. Investigation interviews with several individuals included discussions of the second point. From those interviews it appears that LL management neither specified the overall content of the POET report nor approved its release. On the other hand, LL management did select the LL members of the POET team, and reviewed and may have suggested changes to the report. Moreover, Dr. Tsai, an LL senior scientist, was the technical leader of the study and principal author of the report. Consequently, this investigation agrees with the inquiry that there was sufficient connection between LL and the POET study to justify MIT conducting an inquiry and investigation. Of course, even without this connection the DOD has authority to conduct the investigation, because the POET study was funded by a DOD agency. All LL interviewees, including the two authors, stated firmly to the investigator and advisor that no pressure was put on the authors to reach particular conclusions in their report.

Inquiry Issues. The six issues identified by the Inquiry Report [Crawley 2002b, pp. 3 - 4] can be summarized as:

1. “The POET report is silent on the issue of the calibration and functional status of the IR [infrared] sensor”, despite its elevated temperature and uncertain calibration.
2. “Why was only a subset of the [sensor] data examined by the POET team?”
3. “There are discrepancies between the POET report and the DCIS investigation on the subject of the [BLA] ‘reinitialization’ and [feature] ellipse ‘movement’. The POET report seems internally self-contradictory on the question of the effectiveness and robustness of the algorithms.”
4. “The Report concludes that the EKF appears to track the signals reasonably well. This would suggest that a dominant harmonic is present in the signal, which independent analysis ... suggests is not the case.”
5. “Did the authors, and potentially others within Lincoln Laboratory, [selectively] interpret the scope of effort and responsibility implied by the Statement of Work, and [if so] what impact did it have on the resolution of the four issues outlined above?”
6. “The GAO report and the POET report are at variance on several issues, including the functional status of the sensor and the time window analyzed. Yet the GAO report also claims that ‘the Department of Defense concurred with our findings’ [GAO 2002a, p. 9]. Where in the interactions of the Lincoln Laboratory, the DOD and the GAO were the discrepancies resolved?”

The literal wording of these six issues is contained in the Inquiry Report “Recommendations and Rationale”, reproduced as Appendix C of this investigation report.

Status of IFT-1A. Establishing whether IFT-1A was an experiment or a system verification is important in setting the context for examining these issues, because experiments and system

verifications are held to different contractual and community standards. (For example, subjecting flight data to a variety of possible discrimination algorithms might be considered appropriate in the former case but generally would not be in the latter.) According to the contractor 60-Day Report, the principal objective of IFT-1A was “to reduce risk for subsequent Exoatmospheric Kill Vehicle flight tests” [Boeing 1997a, p. 8]. The sensor payload (SPL) primary objectives were “to demonstrate exoatmospheric sensor operations, provide sensor sensitivity measurement and calibration data, provide signature data collection, and provide discrimination data collection.” The BMDO director described the contractor discrimination program at that time as “research and development” [Kadish 2001]. Similarly, according to the GAO, program officials described IFT-1A as an “early research and development test” [GAO 2002a, p. 1].

Although demonstrating actual discrimination was not among the stated SPL objectives, the subcontractor analyzed sensor output for this purpose and indicated that the performance of the Baseline Algorithm (BLA) correctly performed its discrimination function on the IFT-1A flight data [Boeing 1998a, p. 134]. BMDO directors also described IFT-1A (and the subsequent IFT-2, which had similar objectives but a competing sensor package and discrimination algorithm) as having demonstrated the ability to discriminate between warheads and decoys [Lyles 1998]. Likewise, “IFT-1A and 2 demonstrated a robustness in discrimination capability that went beyond the baseline threat...” [Kadish 2000].

The investigation concludes, on balance, that data acquisition and subsequent analysis conducted as part of IFT-1A are to be viewed as an experiment, and the POET report should be considered in that light. This is true notwithstanding the broad statements made by BMDO officials and by the contractor about what IFT-1A demonstrated.

The six Inquiry Report issues are now considered in turn. Two closely related allegations by Prof. Postol, improper manipulation of simulation predictions and flight data, and deletion of the data for one of the decoys, also are addressed.

Sensor Performance and Calibration. The IFT-1A infrared sensor FPA was intended to operate at a constant nominal temperature for an extended period. In fact, the sensor only reached 1.2 -1.5° K above the nominal temperature, and then only for the last 25 – 30 seconds of target data collection, due to a partial blockage of coolant gas. Ground-based calibration data indicated a variation in sensor sensitivity of almost 10% over that temperature range in one of the measurement bands [Huppi 2001]. An on-board calibration also was undertaken by observing a star, but a low signal-to noise ratio reduced its effectiveness. There was some ambiguity about whether star calibration results were used to adjust sensor data before analysis [Boeing 1998a, Sec 4.4.2.3 vs. 4.4.2.4.9]. The GAO reported that star calibration results were inconsistent [GAO 2002a], and one of the POET authors stated in an investigation interview that the IFT-1A flight data received by the POET team had been calibrated by the contractor using ground-based calibration information. The low pointing agility of the payload launch vehicle on which the FPA was mounted for the IFT-1A flight also enhanced sensor noise [Schultz 2004], as did rapid variation in the sensor temperature early in the data collection period. Electrical noise from a power supply was present as well [Huppi 2001].

The POET study made no mention of these facts but instead accepted data provided by the contractor as a given. Omitting a discussion of such critical information in a scientific journal article might have constituted research misconduct. However, this was not a scientific journal article, and the two LL members of the POET team responded that the classified POET report was meant only for about 10 people, that the sensor problems were known to those involved in IFT-1A, and that the sensor produced adequate data anyway for at least 17 seconds [Meins 2002, pp. 2, 4 - 6], all of which were true. Based on DCIS correspondence [Reed 2000], members of the DCIS investigation team were among those familiar with the contents of the 60-Day Report. It also might be argued that assessing the experimental performance of the IFT-1A sensor was beyond the scope of the POET study. Nonetheless, this investigation concludes that sensor performance was so important that it should have been discussed in the report. This omission does not, however, rise to the level of research misconduct, due to the extenuating circumstances just described.

For completeness, it should be noted that the 60-Day Report was inconsistent in discussing sensor performance. Although, as just mentioned, the report addendum discussed sensor issues in some detail [Boeing 1998a], the main report, published earlier, stated in its summary section, "Sensor operation and data acquisition were nominal, as monitored during flight and by detailed reviews and analysis of the recorded telemetry data." It went on to say, "The sensor cooled to operating range with a hold time significantly greater than the required" period [Boeing 1997b, p.12].

Choice of Data Analyzed. The POET study analyzed 17 seconds of a much longer period of available data. There seems to be general agreement that the data obtained prior to this 17-second window was of too low a quality to be of much use, due to the low signal-to-noise ratio, which was a consequence of the sensor cooling problem described above. A subsequent LL review of IFT-1A sensor performance supported this view [Schultz 2004]. On the other hand, some critics of the TRW IFT-1A data analysis believe that as much as 11 seconds of usable data beyond the 17-second window should also have been analyzed and would have caused the BLA ultimately to identify a decoy as the MRV. The two LL POET authors responded that analyzing the additional data was unnecessary, because the targeting algorithm was programmed to select the MRV prior to the beginning of the 11 seconds in question [Meins 2002, p. 6 - 7]. They subsequently added in response to the investigation report draft, "the POET report concentrated on the analysis reported by TRW. [The POET team] therefore used the same span of data that TRW did" [Tsai 2006]. An analysis conducted in support of the present investigation identified only 7 additional seconds of useful data before images began streaking and multiple objects began permanently leaving the field of view [Kramer 2006]. The investigation concludes that the POET study could have analyzed the additional 7 seconds of data together with the 17 seconds in order to gain further insight into the effectiveness of the discrimination algorithm. However, the amount of time to be analyzed is to some degree a matter of professional judgment, and analyzing just the 17 seconds does not constitute research misconduct. During the additional 7 seconds, the BLA continued properly to identify the MRV, although the probability assigned to one decoy increased significantly during the final seconds [Boeing, 1998a]. A retired TRW scientist involved in the 60-Day discrimination analysis suggested in an interview that the increasing probability assigned to the decoy during the final few seconds was due to rapid relative motion of objects across the field of view.

Again for completeness, it should be noted that Prof. Postol has asserted that “highly anomalous behavior of the sensor ... rendered the IFT-1A data useless when applied to the Baseline Algorithm” [Postol 2006], presumably due to allegedly inadequate calibration data [Postol 2002e]. This assertion apparently is meant to apply even to the time when the sensor temperature had stabilized. However, as discussed above, ground-based calibration data permitted sensor output to be calibrated to within about 10%, sufficient for meaningful comparison of IFT-1A data with BLA predictions.

BLA ‘Reinitialization’. The third open issue has three components, the first of which is alleged reinitialization of the BLA software by the contractor in order obtain better discrimination results. Contractor plots of the “Object Ranking Metric”, which was the BLA-based probability that an object was the MRV, displayed an abrupt change part way through the 17-second data window [Boeing 1997b and 1998a, Sec. 4.4.2.5.4.3]. The DCIS investigator alleged that the abrupt change was due to reinitializing the calculation [Reed 2000], and the POET study, which repeated the contractor computation, concluded that the abrupt change was due to the inclusion of an additional data feature when it became available [Tsai 1999a, p. 25 - 29]. Examination of the contractor and POET reports, including data used in determining the Object Ranking Metric, indicates that the POET report is correct. For instance, several figures overlaying actual and predicted signature features in section Sec. 4.4.2.5.4.3 of the 60-Day report show first one-dimensional (i.e., one feature only) and then two-dimensional distributions of flight data features. Examining these figures also shows that a single feature is insufficient to achieve good discrimination, which explains the inconclusive discrimination results in plots of the “Object Ranking Metric” for the first several seconds. During the investigation interviews, the POET authors provided cogent explanations of the computational transition from one to two features. Consequently, the investigation concludes that no research misconduct occurred in this regard.

Ellipse ‘Movement’. To assess this second component of the third issue from the Inquiry Report, it is necessary to understand what feature ellipses are and how they are calculated. The MRV and decoys appeared as time- and frequency-dependent point sources to the IFT-1A FPA. They were discriminated by comparison with expected signatures, the latter computed using prior knowledge of the characteristics of the objects and an understanding of the underlying physics. Because many of these characteristics were uncertain or known only statistically, the computations were performed 1000 times in a Monte Carlo fashion. Then, a number of numerical characteristics of the solutions, called “features”, were derived from the numerical predictions, and their multivariate mean and covariance calculated. If two features were considered, then the two-dimensional mean and covariance could be represented graphically as an ellipse within which most (e.g., one-sigma) of the simulated feature points lay. If the corresponding features from the flight data lay close to the predicted means of the respective ellipses and the ellipses did not overlap excessively, the objects could be discriminated accurately. (Note that these ellipses were plotted in various reports for illustrative purposes only. The actual Object Ranking Metric was calculated directly from the means and covariance matrices.)

The DCIS investigator noted that the ellipses from the 45-day analysis as described in the revised 60-Day Report [Boeing 1998b, pp. 154 – 185], from the 60-day analysis as described in the

original 60-Day Report, [Boeing 1997b, Sec. 4.4.2.5.4.3], and from the 60-day analysis as described in the revised 60-Day Report [Boeing 1998a, Sec. 4.4.2.5.4.3] were significantly different in many instances, and alleged that they were changed by the contractor after the flight in order to create the appearance of successful discrimination [Reed 2000]. In contrast, the POET report accepted the contractor explanations for these changes. The change between the ellipses in the 60-Day Report and the revised 60-Day Report is easy to explain. The various ellipses differed only in size (by a factor of about 2.5) between the two versions of the 60-Day Report, and the contractor explanation that the ellipses in the original 60-Day Report were incorrectly scaled is demonstrably true [Boeing 1998b]. The Monte Carlo results upon which the ellipses were based were identical in both versions of the report and consistent with the sizes of the ellipses in the revised report. Moreover, a retired contractor scientist confirmed this interpretation to the investigator, stating that he himself made the coding error.

The second change was between the 45-day analysis and the 60-day analysis, both described in the revised 60-Day Report. (The so-called 45-Day Report actually was a set of briefing slides, which contained no ellipses [Crowder 1997a].) The locations, sizes, and orientations of several ellipses changed, in some cases significantly. The contractor attributed this to an error in the GFA. The GFA was a portion of the BLA software that estimated brief segments of object tracks that were missing from the flight data, typically due to low signal-to-noise ratios early in the one-minute observation period, when the targets were far from the sensor, hence faint, and the FPA temperature was much too high. Consistent with the Monte Carlo simulation process described previously, the poorly designed GFA also was employed in the feature predictions, leading to errors in the ellipses, according to the contractor. In the 45-day analysis, the simulations spanned 47 seconds of the observation period, and the GFA greatly impacted the simulation results. In the 60-day analysis, the simulations spanned only 23 seconds [Boeing 1998b, p 156]. Consequently, the GFA had minimal impact on the 60-day analysis ellipses and flight data. Contractor researchers stated in a briefing to the POET team [Boeing 1998b] that they also ran simulations of the shorter time period with the GFA disabled and obtained ellipses essentially identical to those for the same shorter time period with the GFA not disabled. Interviews with the POET authors and with contractor personnel as part of the investigation suggest that this explanation is, for the most part, plausible. (Why the GFA would cause some ellipses to tilt in the particular direction predicted in the 45-day analysis is not obvious to the investigator.) However, only by reproducing the simulations could the contractor explanation have been validated. Doing so was beyond the scope of the POET study and far beyond the scope of the present investigation. The investigator believes that it was not unreasonable for the POET team to have accepted the contractor's explanation instead of reproducing the contractor's results. The preponderance of the limited evidence on this matter does not indicate research misconduct.

The larger question of whether the contractor was justified in selecting only the time period of the simulations that gave favorable results will be addressed later in this Chapter.

POET Report Internal Inconsistencies. In its Executive Summary the POET report stated that “overall, the BLA are well designed and work properly, with only some refinements or redesign required to increase the robustness of the overall discrimination function” [Tsai 1999a, p. iii]. In the Inquiry Report and in an interview as part of this investigation, Prof. Crawley expressed

concern that this statement did not adequately capture the shortcomings of the BLA and its use to analyze the IFT-1A data that were identified in the body of the POET report. This investigation agrees that the quoted sentence was overly generous. Nonetheless, several BLA deficiencies were articulated clearly in the immediately subsequent paragraphs of the POET report Executive Summary. Identified deficiencies included the GFA, lack of independence among some target features, use of a so-called “confidence” factor in the final targeting decision, the need for fairly detailed prior knowledge of the objects to be discriminated, and a classified issue. In view of these disclosures, the investigation concludes that the choice of wording in a single sentence, viewed in isolation, does not rise to the level of research misconduct.

Extended Kalman Filter. Prof. Postol has stated repeatedly that the POET team “did not show that they could find oscillating components in the signals from the IFT-1A experiment [using the EKF]. This is because there is no oscillating component in the IFT-1A data.” The basis for his statement presumably is the absence of a clear spike in the power spectral density of the MRV data, as plotted in the redacted form of the POET report [Postol 2000]. However, the figures in question had no scales because of the redaction. Hence, there was no way for Prof Postol to know that the spike from the oscillatory signal was buried in the broad zero-frequency spike. (The POET report included these figures as part of its discussion of a low-pass filter to reduce high-frequency noise, and the figures were scaled to show just that – the noise.) In fact, a cursory examination of the MRV data plotted in the POET report reveals a low-frequency oscillation, although with much noise superimposed.

To further clarify the situation, an individual highly experienced in the use of Kalman Filters reviewed the description of the EKF analysis in the POET report as part of the current investigation. He found it to be credible, with the limitations of the EKF properly documented in the POET report. For instance, the POET report correctly emphasized that convergence of the EKF for IFT-1A data was quite sensitive to the choice of initialization parameters and, therefore, probably was not suitable for BLA purposes. He then verified the correctness of the software used by the POET team and reproduced some of the POET EKF computations themselves. (In particular, Figure 15 of the POET report was reproduced.) The investigator also examined the software and found it to embody a standard EKF formulation. The investigation concludes that this issue involves no research misconduct. For completeness, it should be noted that the EKF had been deleted from the BLA prior to IFT-1A.

Interpretation of the Statement of Work. The BMDO director stated at the time of the POET study that “the scope of the POET review has been narrowly defined to provide confidence to the {National Missile Defense} NMD Program Manager that the Boeing EKV, utilizing TRW-supplied algorithms, will indeed technically perform as required” [Lyles, 1998]. The SOW, reproduced in Appendix A of the POET report [Tsai 1999a], contained three tasks,

- “Review of discrimination algorithms, software implementation, and associated [simulation] data developed by TRW for use in the BOEING EKV for consistency and correctness in its scientific, mathematical, and engineering principles”
- “Review of performance [of the BLA] against IFT-1A data”
- “[If] possible within the 2-month study ... estimate the performance the algorithms, implementation and associated data would provide given the expected data from IFT 3.”

(IFT 3 was to have been the second flight of the Boeing EKV.) In addition, the EKF initially proposed but not employed by TRW was analyzed. This additional task was performed by verbal agreement between BMDO and the POET team, reportedly because allegations about the EKF were central to Dr. Schwartz' lawsuit. The POET report also provided responses in its Appendix B to numerous questions posed by the DCIS investigation team. All tasks were accomplished, although over six months rather than two.

Interviews with MDA officials conducted during the investigation indicate that BMDO management was satisfied that the POET study met the requirements of the SOW, including the additional task of analyzing the EKF. This investigation agrees. Additionally, although the SOW itself may have been narrow, its content was a BMDO management decision. For these reasons the investigation concludes that no research misconduct exists with respect to this issue.

Reconciliation of GAO and POET Reports. Contrary to the assertion in issue 6 of the Inquiry Report, the GAO reports [GAO 2002a, 2002b] and the POET report are not at variance on the functional status of the sensor and the time window analyzed. Rather, the GAO reports, written three years after the POET report, discussed these two matters, and the POET report did not. In interviews conducted as part of the present investigation, the GAO report authors did not fault the POET study (with the exception of Mr. Ghoshroy, who also faulted the GAO study). The Office of the Secretary of Defense (OSD) official who concurred formally on the GAO reports stated in an interview conducted as part of the present investigation that he did so, because the reports were not critical of BMDO's conduct and contained no recommendations for substantive action. Concurrence by OSD with the GAO reports was, in any case, an OSD management decision. The investigation concludes that this issue does not involve research misconduct.

Alleged Improper Manipulation of Simulation Predictions and IFT-1A Flight Data. Underlying the allegation that the contractor improperly changed the feature ellipses, discussed previously, is a larger allegation raised by the DCIS investigation team [Reed 2000] and subsequently by Prof. Postol [Postol 2000]:

- The contractor fraudulently used knowledge obtained from the IFT-1A flight to modify the simulation predications to improve discrimination results.
- The contractor selected only the most favorable portion of the flight data for comparison with the predictions, again to improve discrimination results.

Certainly, the contractor did incorporate into its predictions the actual cloud cover at the time of the flight, and a sensor noise model based on the actual time history of the FPA temperature. In addition, the contractor used only the low noise segments of the simulated data and the flight data for comparison [Boeing 1998a]. Whether these actions were improper depends principally on the purpose of IFT-1A. As explained at the beginning of this chapter, IFT-1A was an experiment, not a system verification. So, using information from the experiment to improve the computational model and thereby enhance its ability to discriminate was reasonable, provided that the actions were disclosed and that the model remained internally consistent. In addition, utilizing only the data that was not corrupted by noise was reasonable, provided that enough data was left to make meaningful comparisons and that the criteria for discarding the other data were disclosed. The investigation observed that these requirements were met, although the revised 60-Day Report could have been clearer in this regard [Boeing 1998a, Sec. 4.4.2.5.4.2].

Alleged Suppression of Misdeployed Decoy. As quoted in Chapter 1, “Background”, Prof. Postol claimed in a letter to the White House Chief of Staff [Postol 2000] that “Data from the tenth object, a partially inflated medium balloon, is not shown in the figure, as this data was inexplicably removed from the IFT-1A telemetry, apparently because its signal appeared more like that expected for the warhead than the warhead itself.” Actually, all medium balloons, partially inflated or otherwise, were represented in the reduced IFT-1A data analyzed by the POET team and depicted in several figures of their report. Instead, a small decoy was missing from this data, because it was too faint to follow easily in the FPA output when analyzed for the original 60-Day Report [Boeing 1997b]. Even this decoy was present in the reduced IFT-1A data prepared for the revised 60-Day Report [Boeing 1998a, Sec. 4.4.2.4.8.3]. Confusing this faint decoy with the MRV was highly unlikely, because their feature sets were well separated.

The investigation also developed several observations of a non-technical nature.

Claims that IFT-1A Verified Discrimination Capability. As noted above, both BMDO officials and the contractor made broad claims about the ability of the contractor EKV and BLA software to discriminate the MRV. To be sure, IFT-1A represented a useful step toward assessing discrimination capability. However, in light of the BLA shortcomings and IFT-1A experimental difficulties identified in the POET and GAO reports, those claims seem overly broad, if based on IFT-1A results. (Whether such claims were warranted based on the results of IFT-2 is beyond the scope of this investigation.) As noted by the GAO, the contractor made laudatory comments about IFT-1A, such as characterizing the test as a “success” and the sensor’s performance as “excellent”, that “increased the likelihood that test results would be interpreted in different ways and might even be misunderstood” [GAO 2002a, p. 6].

Technical Assistance for DCIS Investigation. The DCIS investigator was a lawyer with considerable investigative experience but little scientific background. He relied primarily on Dr. Schwartz, the “relator”, who had a strong financial and personal interest in the outcome of the DCIS investigation, for technical advice.

Written List of Allegations and the Basis for Them. MIT initiated its inquiry without clear, written allegations [Canizares 2006, p. 17], although it reportedly did request them from Prof. Postol [R. Brown 2002b]. Instead, allegations were accumulated during the early part of the inquiry from letters and interviews with Prof. Postol. As noted previously, Prof. Postol stated that his charges were not aimed specifically at the POET study authors.

Confidentiality of the Inquiry. The importance of confidentiality was stressed in several inquiry interviews; e.g., [Crawley 2002d]. Nonetheless, according to investigation interviews with MIT employees, copies of a draft version of the Inquiry Report were not controlled adequately. Some information found its way into newspapers; e. g., [Broad 2003]. Apparently, this violation of federal and MIT policy was not investigated.

Comments by Meins and Tsai not Reflected in Inquiry Report. According to MIT policy [MIT 1997b], “After considering the responses of the alleged offender, the fact finder should prepare a final report, including an accurate summary of the information offered by the alleged offender...” Although the two LL authors prepared an extensive rebuttal to the Inquiry Report

[Meins 2002] and submitted it to MIT management, Prof. Crawley reported in an investigation interview that he was not aware of the rebuttal and, therefore, did not summarize it in his final report. Incidentally, that final report is labeled “draft” [Crawley 2002f].

Need for Classified Access in order to Perform Investigation. The investigation recommended by the Inquiry Report was delayed for three years, because MDA did not authorize access to relevant classified documents. Prof. Postol has made statements suggesting that the investigation could have been performed using only publicly available information [Postol 2006b]. This investigation does not agree. Several of the key documents already identified in Chapter 3, “Investigation Process”, are classified. Access to classified information surrounding the majority of the technical issues discussed above was necessary to resolve them. A number of investigation interviews were conducted at a classified level. Most importantly, conducting an investigation into alleged research misconduct associated with the POET report without actually reading that classified report would have been inherently unreasonable and unjust.

Delays in Initiating the Investigation. On the other hand, Prof. Postol is correct that the investigation should have been conducted sooner. DOD did not follow the federal requirement to initiate an investigation responding to the Inquiry Report in a reasonable period of time. Delays made the investigation more difficult, left charges against the POET authors unresolved and tended to discredit DOD. The inquiry also might have been initiated sooner, although an external advisor concluded that the inquiry delay was not unreasonable [Press 2002]. Over the past several years, many participants changed positions or retired, and one key participant died. Participants’ recollections of events, of course, also faded.

Value of an Advisor. The investigator found it extremely valuable to have a knowledgeable advisor with whom to discuss issues. This was especially the case, because the present investigation of alleged research misconduct apparently was the first conducted by DOD under the OSTP 2000 guidelines.

Prof. Crawley remarked during the interview for the current investigation that an “Inquiry Handbook” would have been useful to him. The investigator also might have benefited from an “Investigation Handbook”.

Allegation of Financial and Other Irregularities. During the course of this investigation, Prof. Postol raised issues of financial irregularities at MIT and was referred by the investigator to the office of the DOD General Counsel. He also has suggested in various materials that MIT and LL management may be guilty of misleading Congress and federal investigators. Evidence of such actions should be submitted by him to the DOD/IG, FBI or other appropriate authority.

5. Findings

The findings resulting from the assessments in Chapter 4, “Discussion”, are summarized here.

- There was sufficient connection between LL and the POET study to justify MIT conducting an inquiry.
- IFT-1A primarily was an experiment, not a system verification.
- Allegations of possible research misconduct against the POET team and LL management, as articulated in the Inquiry Report, were not substantiated by a preponderance of evidence.
- Related allegations of improper manipulation of simulation predictions and IFT-1A flight data, and of suppressing data on a misdeployed balloon were not substantiated by a preponderance of evidence.
- BMDO and contractor statements that IFT-1A demonstrated the discrimination capabilities of the BLA seem overly broad in light of the limitations of IFT-1A, including the BLA.
- The DCIS investigator relied for technical advice primarily on a scientist with a strong interest in the outcome of his investigation.
- MIT initiated its inquiry without clearly written allegations, did not protect the confidentiality of the inquiry process adequately, and did not follow its policy that the fact finder consider the responses of the alleged offenders and include in the inquiry final report an accurate summary of the information offered.
- Access to relevant classified information was essential to the conduct of this investigation.
- Excessive delay occurred in addressing the allegations of research misconduct, especially between the end of the inquiry and the beginning of this investigation.
- Complex inquiries and investigations of research misconduct should be performed by more than one person.

6. Recommendations

In conclusion, the investigation recommends:

1. Charges of research misconduct in connection with POET Study 1998-5 be dismissed.
2. Reasonable efforts be made to publicly exonerate the two POET authors at LL, in accordance with their wishes.
3. Confidentiality requirements be strengthened in the OSTP, DOD, and MIT research misconduct policies, and then enforced.
4. A requirement for a complete set of written allegations, along with the basis for making them, be added to the OSTP, DOD, and MIT research misconduct policies.
5. DCIS investigators be provided with knowledgeable, disinterested technical assistance when conducting technically complex investigations.
6. A lessons-learned report be prepared by OSD several months from the date of the present report. (It is likely that not all lessons will have been learned until some months after this report has been released.)

7. Acknowledgements

This investigation could not have been completed without the dedication and hard work of Mr. Norman Augustine, who joined the investigator in conducting nearly every interview, reviewed dozens of documents, repeatedly reviewed drafts of this report, and shared his excellent judgment on many difficult issues.

The investigator wishes also to express his appreciation to each of the 49 individuals who voluntarily shared with Mr. Augustine and him their recollections and assessments of the issues addressed in this report. Their insights went well beyond the information available in written reports. Although many of the interviewees had strong feelings on these matters, each of them seemed forthright, and in our view not one attempted to improperly influence the investigation.

The investigator thanks Mr. Roger Sudbury of Lincoln Laboratory, Mr. Thomas Duffy of the Missile Defense Agency, and Mr. Keith Dixon of the Defense Criminal Investigative Service for tirelessly tracking down and providing copies of over 160 documents, many of which were classified.

Finally, the investigator thanks his colleagues Drs. Kathleen Kraemer, Stephen Price, and Robert Morris for independently assessing the quality of the IFT-1A sensor data and Dr. Eric Blasch for evaluating the POET EKF analysis.

Appendix A

Charge to the Investigator

MEMORANDUM FOR DR. BRENDAN B. GODFREY, DIRECTOR, AIR FORCE
OFFICE OF SCIENTIFICRESEARCH

THROUGH: SECRETARY OF THE AIR FORCE

SUBJECT: Designation as Investigator into Allegations of Research Misconduct at
Lincoln Laboratory

In 2001, a faculty member lodged research misconduct allegations with the Massachusetts Institute of Technology (MIT) against two Lincoln Laboratory scientists who contributed to a Phase One Engineering Team (POET) review of some portions of a 1997 missile defense-related flight test. Under Federal policy, responses to allegations of research misconduct include three phases: inquiry, investigation, and adjudication. Consistent with that policy, MIT conducted an inquiry that concluded there were six open issues that warranted investigation. In February 2003, the MIT Provost advised the Missile Defense Agency that MIT intended to proceed to an investigation of the unresolved issues and requested that outside investigators for MIT be allowed access to classified information. The Department, for national security reasons, declined to authorize the requested access to classified information. Thus, the inquiry phase has been completed, but the investigation and adjudication phases have not.

I have determined that the allegations relate to a major acquisition program of the Department, and that it is in the public interest for the Department to complete the investigation of these allegations. Accordingly, with the approval of the Secretary of the Air Force, I designate you as the investigator. I will perform the function of adjudicator.

You will investigate the six issues identified in the MIT inquiry officer's report using the standards in the *Federal Policy on Research Misconduct* as implemented in DOD Instruction 3210.7, *Research Integrity and Misconduct*. You may consider prior investigations of related allegations that were conducted by other Government entities, e.g., the Government Accountability Office, the Federal Bureau of Investigation, and the Defense Criminal Investigative Service. At the conclusion of your investigation, you are to prepare a report of your findings and recommendations and submit it directly to me. Mr. Douglas Larsen, Deputy General Counsel (Acquisition & Logistics), Office of the General Counsel of the Department of Defense, is available to provide legal advice in regard to this matter. You may contact him at 703-614-4398 or larsend@dodgc.osd.mil.

/s/ Kenneth Krieg, 8 Feb 06

Appendix B

Advisor's Statement of Responsibility

The actual investigation of alleged research misconduct is to be conducted by Dr. Brendan Godfrey. The role of the advisor and consultant to the investigator is to assist in ensuring that the investigation has been thorough and impartial. This will include advising whether or not the investigator has been provided full access to all relevant information, whether or not the review has been conducted in a balanced fashion, and whether or not the investigator has been impeded in any way in carrying out his efforts. The advisor's comments on the investigation will be available to the USD(AT&L) and unclassified comments will be available to MIT. It is specifically not the advisor's role to opine on the merits of the allegation of academic misconduct, or to certify the technical accuracy of any analyses performed in conjunction with the review process.

[Larsen 2006]

Appendix C
Inquiry Report Summary Section

Report to the Provost
On the Inquiry into the
Allegations of Research Misconduct
In Connection with POET Study 1998-5

Submitted by Prof. Ed Crawley
October 29, 2002

Background

This *Inquiry* report was commissioned by Provost Brown, by his letter of March 1, 2002 to Professor Ed Crawley. The allegations of academic misconduct were with regard to the work of Dr. Ming-Jer Tsai and Dr. Charles K. Meins, senior staff members at Lincoln Laboratory, in their work on the POET Study 1998-5, “Independent Review of TRW Discrimination Techniques, Final Report”, issued Jan 25, 1999 (the Report). Academic misconduct is defined in Section 10.1 of MIT Policies and Procedures.

Principle Recommendation of the Inquiry

An investigation into the preparation and subsequent presentation of the POET Report is recommended.

Recommendations and Rationale

Background

The inquiry that I have concluded is at the extreme end of the complexity scale for those imagined by MIT’s processes. The issues that compound the inquiry include:

- The respondents are not members of the campus community, but are members of the technical staff at the Lincoln Laboratory, a place with a different organizational culture and special charter. The nature of the management structure of the Lincoln Laboratory involves their management in supervision and review of work products in ways not common on campus.
- The actual POET Report 1998-5 that is the direct subject of this inquiry is classified. The complainant has only had access to the redacted unclassified version, and various third party commentaries on the report. Because of the classification issue, the respondents are somewhat limited in their ability to respond. As part of the inquiry, I have had access to the classified report.
- The issue at the heart of the POET Report has been the subject of at least three other investigations, conducted by or on behalf of the federal government. Not only does this

create a substantial amount of information in review, but it introduces the possibility of reaching conclusions that may be at variance with those reached by the other reports on the topic, and the burden of reconciling those variances.

Recommendation, Findings and Rationale

At this time, I find that an investigation is warranted, and recommend that one be carried out. This recommendation is based on two aspects of rationale: the inability to close the issue at the level of an inquiry; and the standing of the effort to write and present the POET Report as, in part, a product of MIT employees.

To date, I have conducted an inquiry at least as comprehensive as envisioned by Policies and Procedures. I have conducted several rounds of meetings with the complainant and respondents, and have read volumes of materials supplied by both (including the classified version of the POET Report, and other federal government agency reports written on the issue). I have written an interim draft of my report, and have received input on the interim draft from all parties. A more detailed description of the inquiry process is given at the end of this document.

At the conclusion of the process, I find there are still sufficient inconsistencies, open issues, and needs for detailed rectification of facts that the allegations cannot be closed by this inquiry. Under the criteria stated in MIT Policies and Procedures, I am therefore recommending that an investigation be carried out.

Furthermore, I find that there was enough involvement of MIT Lincoln Laboratory employees and management in the preparation and subsequent discussions of the POET Report that it would be appropriate to continue to consider it the subject of an investigation commissioned by MIT.

Additionally, I find that issues under discussion are of critical importance for reasons of both process and product. The process issues associated with the preparation of the POET Report go to the fundamental basis of the relationship between the government and the Lincoln Laboratory as an FFRDC managed by MIT in the public interest. The product, the POET Report, had material impact on a legal action, and potentially on the national debate on ballistic missile defense.

What is most at issue is not the detailed technical merit of the work the Lincoln Laboratory staff did. Rather it is the scope and completeness of the work – what they did and didn't do, how the results were portrayed and reported, and the interpretation of their technical results in contrast with those of other investigations.

Specifically, at the conclusion of the inquiry, the principal open issues are:

1. The functional status of the IR sensors onboard the emulated EKV during IFT-1A. The POET Report is silent on the issue of the calibration and functional status of the IR sensors. By this silence, the authors imply that the sensors were functioning sufficiently well that their functional status did not impact the question “What performance do the algorithms, software implementation, and associated data provided using the data provided by IFT1A” (extracted

from the POET Statement of Work, paragraph A.1.2 Objectives, p. 37). In contrast, the GAO report raises serious issues about the functionality of the sensor.

2. The time span of data analyzed as part of the POET Study. The POET Report analyzes about 17 seconds of the total of about 60 seconds of data taken. According to the GAO Report, all the data was available to TRW. Therefore in analyzing the performance of the TRW algorithm, why was only a subset of the data examined by the POET team?
3. The target identification algorithm, particularly with regard to “re-initialization” of the algorithm which calculates the *a posteriori* probability of a target being classified as a true reentry vehicle (P_{AT}), the “movement” of the feature ellipses between two of TRW’s reports, and the robustness of the algorithm. There are discrepancies between the POET Report and a DCIS investigation on the subject of the “re-initialization” and ellipse “movement”. The POET Report seems internally self-contradictory on the question of the effectiveness and robustness of the algorithms.
4. The applicability of the extended Kalman filter (EKF). The Report concludes that the EKF appears to track the signals reasonably well. This would suggest that a dominant harmonic is present in the signal, which independent analysis by Prof. Postol suggests is not the case.

Two additional issues are related to the process used in the POET study, and its subsequent reporting. Of course, these issues are not explicitly addressed in the POET Report, but rather emerge from an examination of the overall record.

5. The process of setting and interpreting the scope of the POET study. The POET study was commissioned by MDA (then BMDO) in response to a DCIS request. There was a written Statement of Work, which is included in the Report. However, in some cases, the authors appear to have interpreted this SOW quite narrowly, and in other aspects expanded upon it. How did the authors, and potentially others within the Lincoln Laboratory, interpret the scope of effort and responsibility implied by the Statement of Work, and what impact did it have on the resolution of the four issues outlined above?
6. The process of responding to the GAO report. The GAO report and the POET report are at variance on several issues, including the functional status of the sensor and time window analyzed. Yet the GAO report also claims that “the Department of Defense concurred with our findings” (GAO -02-124, p. 9). Where in the interactions of the Lincoln Laboratory, the DOD and the GAO were the discrepancies resolved?

A suggested set of initial steps in the investigation is listed below. These are intended as neither prescriptive nor inclusive, but merely a guide as how to begin an investigation of this matter.

1. Read the unclassified version of the POET Report, GAO reports and other general background materials.
2. Meet with the complainant and respondents, in a first round to gain an understanding of the issues. Read the classified POET Report. Then meet with all parties again in a second round to identify with some precision the discrepancies and open issues.
3. Read the history of DCIS correspondence with MDA, the history of Lincoln Laboratory correspondence with MDA and the GAO, and other applicable primary source documents as available.
4. Meet with appropriate DCIS, MDA and GAO officials as available.

Appendix D
Response by Lincoln Laboratory POET Authors

We feel that Dr. Godfrey and Mr. Augustine have conducted a thorough and credible study. We were given a fair hearing, our case was clearly understood, and we were given the opportunity to address and rebut the various charges. Dr. Godfrey involved a team of scientists to analyze the data used in the POET report and we appreciate their efforts in replicating the results contained in POET Study 1998-5.

With the exception of two minor technical points, we accept all the findings and conclusions as described in the investigation report. The first point is on page 26 ("Choice of Data Analyzed") where the question of the appropriate span of data is discussed. The POET report concentrated on the analysis reported by TRW. We therefore used the same span of data that TRW did. The second point is on page 27 ("Ellipse Movement") where the data gaps are discussed. The investigation report noted the change of sensor noise over time which, while true, was a secondary concern. The primary issue was the decreasing range between the sensor and the targets over time. Target detections first occur when the target intensity is comparable to the detection threshold: some of the measurements are above the threshold and the rest below. This leads to gaps in the data. Since the threshold decreases as range decreases, starting the analysis at a shorter range (later time) yields fewer gaps to fill.

We particularly appreciate the recommendation that MIT issue a public statement exonerating us of the allegations. On this point, a simple statement saying that we were cleared of the charges of academic misconduct is preferred.

Dr. Ming-Jer Tsai
Dr. Charles K Meins Jr
MIT Lincoln Laboratory

[Tsai 2006]

Appendix E
Individuals Interviewed

Alan, Douglas, Director, Missile Defense Technologies, Computer Science Corporation (4 August 2006)

Barcikowski, Henry, Missile Defense Agency (25 September 2006)

Barkakati, Naba, GAO (9 June 2006)

Barton, Phillip, Principal Lead Scientist, Computer Science Corporation (4 August 2006)

Bernstein, Harvey, Vice President, Office of General Counsel, Computer Science Corporation (4 August 2006)

Beitzel, Wallace, TRW, retired (18 October 2006)

Blasch, Eric, AFRL/SN (4 October 2006, 30 October 2006)

Branstetter, Ross, MDA Principal Deputy General Council (18 April 2006)

Briggs, David, Director, Lincoln Laboratory (12 April 2006)

Brown, Robert, President, Boston University (16 May 06)

Canizares, Claude, Associate Provost, MIT (12 April 2006)

Cifrino, Michael, MDA General Council (18 April 2006, 25 September 2006)

Crawley, Edward, Professor, MIT (26 April 2006)

Crowder, Hank, TRW, retired (4 December 2006)

Danchick, Raymond, TRW retired engineer (8 August 2006)

Dinneen, Gerald, Lincoln Laboratory consultant (14 June 2006)

Dixon, Keith, DCIS (8 May 2006)

Duffy, Thomas, MDA Deputy General Council (18 April 2006)

Egan, Dennis, trial attorney (retired), Commercial Litigation Branch, Civil Division, Department of Justice (31 July 2006)

Englander, Keith, MDA/DE (18 April 2006)

Evans, Eric, Director, Lincoln Lab (11 October 2006)

Garwin, Richard, IBM (20 April 2006)

Ghoshroy, Subrata, GAO on leave to MIT (14 June 2006)

Handler, Frank, LLNL (8 May 2006)

Kanamine, Anne, DOD/IG (20 April 2006)

Keane, Dennis, Assistant Division Head (Div 3), Lincoln Laboratory (13 April 2006)

Kraemer, Kathleen, AFRL/VSB (14 June 2006, 11 October 2006)

Kleinburd, Alan, assistant director, Commercial Litigation Branch, Civil Division, Department of Justice (31 July 2006)

Krieg, Kenneth, USD(AT&L) (17 Mar 2006, 31 July 2006, 5 October 2006, 4 December 2006)

Larsen, Douglas, Office of OSD General Council (10 Mar 2006 and other times)

Meins, Charles, Senior Staff, Lincoln Laboratory (13 April 2006, 11 October 2006, 17 November 2006)

Morris, Robert, AFRL/VSB (16 May 2006, 11 October 2006)

Ng, Larry, Lockheed-Martin Corp (16 May 2006)

Nielsen, Carl, Special Assistant to the Director, Lincoln Laboratory (13 April 2006)

Obering, Lt Gen Henry, MDA Director (18 April 2006)

Placido, Charlene, Assistant Dean of Research, MIT (12 April 2006)

Postol, Theodore, Professor, MIT (13 April 2006)

Price, Steve, AFRL/VSB (11 October 2006)

Reed, Samuel, retired DCIS investigator (30 August 2006)
Reif, Rafael, Provost, MIT (13 April 2006)
Rhodes, Keith, GAO Chief Technologist (7, 9 June 2006)
Schneider, George R., former OSD Director of Strategic and Tactical Systems (23 June 2006)
Schultz, Kenneth, Senior Staff, Lincoln Laboratory (13 April 2006, 14 June 2006, 11 October 2006)
Sudbury, Roger, Director's Staff for Special Assignments, Lincoln Laboratory (12-13 April 2006)
Swope, Jeffery, MIT Counsel; Edwards, Angell, Palmer & Dodge (13 April 2006)
Tabaczynski, John, Lincoln Laboratory (14 June 2006)
Tran, Naba, GAO (9 June 2006)
Tsai, Ming-Jer, Senior Staff, Lincoln Laboratory (13 April 2006, 11 October 2006)
Vest, Charles, President Emeritus, MIT (16 May 2006)

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Appendix H Table of Acronyms

AFRL	Air Force Research Laboratory
BLA.....	Baseline Algorithm
BMDO.....	Ballistic Missile Defense Organization
DCIS	Defense Criminal Investigative Service
DOD.....	Department of Defense
DOJ	Department of Justice
DSS	Defense Security Service
EKF	Extended Kalman Filter
EKV	Exoatmospheric Kill Vehicle
FBI	Federal Bureau of Investigation
FFRDC.....	Federally Funded Research and Development Center
FPA	Focal Plane Array
GAO.....	General Accountability Office
GFA.....	Gap-Filling Algorithm
IFT.....	Integrated Flight Test
IG	Inspector General
IR.....	infrared
LL.....	Lincoln Laboratory
MCDR.....	Management Control Deficiency Report
MDA	Missile Defense Agency
MIT	Massachusetts Institute of Technology
MRV	Mock Reentry Vehicle
NMD	National Missile Defense
NRC	Nichols Research Corporation
OSD.....	Office of the Secretary of Defense
OSTP.....	Office of Science and Technology Policy
POET.....	Phase One Engineering Team
SOW.....	Statement of Work
SPL.....	Sensor Payload
TRD.....	Technical Requirements Document
USD(AT&L).....	Undersecretary of Defense for Acquisition, Technology and Logistics

Appendix I

Biographical Information

Norman R. Augustine graduated from Princeton University in 1957 and was awarded a BSE in Aeronautical Engineering, magna cum laude, and has been elected to Tau Beta Pi, Phi Beta Kappa and Sigma Xi. He subsequently was granted an MSE in Aeronautical Engineering, also from Princeton. In his practice of engineering he held the position of Vice President for Technical Operations of the Martin Marietta Corporation, was a licensed professional engineer in the State of Texas, served as president of the American Institute of Aeronautics and Astronautics, chairman of the National Academy of Engineering, chairman of the Defense Science Board, and as a member of the President's Council of Advisors on Science and Technology in both Democratic and Republican administrations. In business he served as chairman and CEO of the Martin Marietta Corporation and of the Lockheed Martin Corporation, the latter at the time of his service employing some 62,000 engineers and scientists. In government, Mr. Augustine has been Assistant Director of Defense Research and Engineering in the office of the Secretary of Defense, Assistant Secretary of the Army for Research and Development, and Under Secretary of the Army. In academia, he has served as a trustee of Johns Hopkins, MIT and Princeton, and has been a Lecturer with the Rank of Professor at Princeton University. Mr. Augustine is a fellow of the Royal Aeronautical Society, the American Astronautical Society, the Institute of Electrical and Electronic Engineers, the American Academy of Arts and Sciences, the American Association for the Advancement of Science, and the American Institute of Aeronautics and Astronautics. He has been awarded the Department of Defense Distinguished Service Medal five times and the Joint Chiefs of Staff Distinguished Public Service Award. He has received twenty honorary degrees and has been awarded the National Medal of Technology by the President of the United States.

Brendan B. Godfrey received a BS in Physics from the University of Minnesota in 1967, graduating with High Distinction, and a PhD in Physics from Princeton University in 1970. A member of the federal Senior Executive Service, he currently is Director of the Air Force Office of Scientific Research, responsible for the \$400M basic research program of the U.S. Air Force. Dr. Godfrey began his professional career in 1970 as an Air Force officer at the Air Force Weapons Laboratory, Kirtland AFB, New Mexico, where he performed research on numerical simulation of plasmas. In 1972 he joined the Los Alamos National Laboratory, N.M., where he later was responsible for establishing the intense particle beam research program. He moved to the private sector in 1979 to manage and conduct intense microwave and particle beam research at Mission Research Corp., becoming Vice President and Regional Manager in 1987. In 1989 Dr. Godfrey returned to the Air Force as a civilian to be Chief Scientist of the Air Force Weapons Laboratory. His later assignments include Director of Advanced Weapons and Survivability of the Phillips Laboratory at Kirtland AFB, Director of the Armstrong Laboratory at Brooks AFB, Texas, and Director of Plans and Programs for the Air Force Research Laboratory at Wright-Patterson AFB, Ohio. Prior to his current assignment, he was Deputy Director of the 311th Human Systems Wing, Brooks City-Base, Texas. Dr. Godfrey is known for his contributions to computational plasma physics theory and applications. The Minneapolis native is the author of more than 200 publications and reports. Dr. Godfrey is a fellow of the American Physical Society and of the Institute of Electrical and Electronics Engineers. He twice received Meritorious Presidential Rank Awards, and numerous recognitions from the Air Force.