



INSTITUTE FOR DEFENSE ANALYSES

**The Report of the Independent Review
Committee on SpaceX Falcon 9 v1.1
Certification**

Larry D. Welch, General, USAF (Ret.)

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INSTITUTE FOR DEFENSE ANALYSES
4850 Mark Center Drive
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INSTITUTE FOR DEFENSE ANALYSES

Report of the Independent Review Committee

Lt/Gen Ellen M. Pawlikowski

The following is the report of the Independent Review Committee. It addresses the specific questions in Project FA-2-2505. It provides a general discussion of the relevant issues and provides specific recommendations to address the issues. It is based on extensive discussions with the Space and Missile Systems New Entrant Certification Team and with relevant individuals at Space X. I believe it provides for a realistic path to add the potential benefits of competition to the goal of sustaining affordable assured access to space for the long term in the face of a set of future uncertainties.

A handwritten signature in black ink that reads "Larry D. Welch". The signature is written in a cursive, flowing style.

Larry D. Welch, General, USAF (Ret.)

IDA Project Leader

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A. Tasking, Participation, and Meetings

The IDA Independent Strategic Assessment Group (ISAG) is tasked to form an Independent Review Committee (IRC). The IRC is to provide recommendations on the following:

- Changes to the Cooperative Research and Development Agreement (CRADA) to include redefining the definitions of limitations and liens.
- Adjustments to Partnered Plans and reassessment of risk levels for open issues.
- Incorporation of certification for vertical integration into the CRADA.
- Providing for the opportunity to incorporate innovative evolution of the Falcon 9.

The IRC was composed of:

- General (Ret) Larry Welch, Chairman, IDA ISAG.
- Lt/General Ellen Pawlikowski, SAF/AQ.
- Ms. Gwynne Shotwell, President and COO, SpaceX.

A New Entrant Certification Team (NECT) composed of SMC, Aerospace, and ManTech was formed to advise the Certifying Official.

IRC Meetings were scheduled on these dates:

- 2–4 February 2015 at SMC and SpaceX to discuss issues and differences.
- 17 February 2015 at SMC to receive the report of the NECT.
- 2 March 2015 at SMC to report to the Certifying Official.

B. Objectives of Competition

The needed and expected benefit of a competitive environment is higher confidence in assured access to space over the long term, dealing with uncertain future developments. It is enabled with reliable launch to orbit, resiliency in the face of adverse situations, schedule responsiveness, continuing evolution through innovation and technological advance, and availability of launch capability. It can be adversely affected by any, or any combination, of the risks associated with these enablers as well as cost. The risk assessment needs to address the full set of risks to assured access to space.

Over the past 15 years since the failures associated with Titan IV launches, the Air Force has built up a highly structured approach to flight worthiness that includes certification. The approach includes hundreds of specific elements with prescriptions for standards, processes, and procedures for satisfying the elements. This approach has served

the Air Force and the National Reconnaissance Office (NRO) well in producing a near-perfect record of delivery to orbit using the current Evolved Expendable Launch Vehicle (EELV) family and launch system. This approach is different from that of commercial providers and therefore different from that of likely New Entrants, such as SpaceX. It is certainly foreign to the SpaceX planned approach to qualify Falcon 9 v1.1 for launch services for national security payloads.

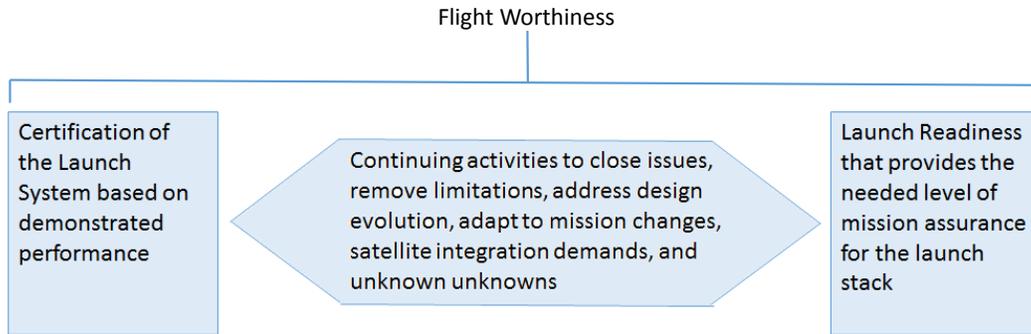
C. Changes to the CRADA and Partnership

The July 2013 CRADA between the Space and Missiles Center and SpaceX was intended to define a mutually agreed path to provide a competitive environment by certifying the SpaceX Falcon 9 v1.1 to compete to deliver National Security Space (NSS) payloads to orbit. The intent of the CRADA was to define a partnership leading to Initial Certification of SpaceX to compete for delivery of an NRO payload. The goal was certification in December 2014. The SMC assessment and evaluation determined that SpaceX with the Falcon 9 v1.1 was not yet qualified.

There is a large gap between the perceptions of the partners in the CRADA. There is also a lack of common understanding of some basic objectives and definitions embodied in the CRADA. The IRC identified a number of specific disconnects among definitions, objectives, and perceptions.

1. The Scope of Certification

There is a lack of clarity regarding what the Certifying Official is actually addressing. At the time of certification, it needs to be clear that the Certifying Official is not certifying readiness to launch. That will come with satisfactorily meeting mission assurance requirements for the actual launch. Instead, the certification should be a declaration of confidence in the New Entrant's ability to satisfactorily meet all the requirements to successfully deliver to orbit on schedule with the defined level of risk. This certification should require demonstrated performance. It should not require that the New Entrant complete all the work that will be required to certify a launch with a national security payload. The following figure illustrates the scope of activity involved in meeting the requirements for a specific launch with a specific payload.



Flight Worthiness is the full set of activities the Certifying Official must consider in assessing risk. The activities include Initial Certification of the launch system with identified and evaluated open issues and limitations. Flight Worthiness includes not only the Initial Certification of the system but also the ensuing activities and milestones to close issues and limitations and the detailed mission-assurance activities associated with launch or flight readiness. The Certifying Official must have confidence in the New Entrant’s capability to address the full set of activities. The activities will include the need to revalidate the Initial Certification as design changes emerge from closure activities, new demands, or opportunities to introduce innovative solutions or improvements. The time from Initial Certification to launch is likely to be more than 2 years. Changes and adjustments for a New Entrant will inevitably occur during that period.

There is a need to distinguish between evaluation of New Entrant capabilities from the purpose of a specific process and hardware evaluation. A clear understanding of demonstrated capabilities is essential to have confidence in projecting the risk from the time of certification to delivery on orbit for the Certifying Official to perform the expected function. New Entrant capabilities include engineering, design, manufacturing, quality control, analysis, testing and verification, and integration. The purpose of a specific process and hardware evaluation can be regarded as a demonstration of capabilities or as a validation of the reliability of the delivered launch system. In the launch readiness phase of the flight worthiness structure and process, the latter—validation of reliability - is a valid use. At certification time, which can be months to years earlier than first launch for a New Entrant, the former—demonstration of capabilities—is more useful.

2. Adjusting to Buying Services

There is a stark disconnect in perceptions of the purpose of the certification process. All seem to agree that an actual launch with a national security space payload will require mission assurance activity that reduces the launch risk to a defined level. The fundamental issue in question is the required activity for the Initial Certification. The SpaceX view is that the Air Force should have confidence in SpaceX capabilities based on its track record of performance. SpaceX contends that 15 successful launches in 15 attempts, 10 with

Falcon 9 v1.1, 6 with a payload fairing, demonstrates that the remaining risks are well in hand and acceptable. In contrast, the Air Force team has approached certification as a detailed design review. This Air Force approach drove SpaceX to change design, alter processes, and change its organizational structure. The result is over 400 discrete issues that need to be resolved.

Neither view was the intent of the original certification plan. The intent was a partnership that leveraged the commercial practices and experience of SpaceX and decades of Air Force experience to meet the needs of the Air Force for confidence in the capability and reliability of the SpaceX launch system. In particular, it was never envisioned that the Air Force would drive changes in design, processes, and organization to achieve certification. Neither was it expected the Falcon 9 launch experience would suffice to provide the needed confidence in Falcon 9 v1.1 for national security payloads. Instead, it was expected there would be a manageable set of issues requiring resolution, some requiring resolution at the top level. Further, the intent of the CRADA was an agreement on a collaborative/cooperative effort. Instead, it appears to have evolved into a propensity by the government certification team to dictate conditions to SpaceX in detail without a productive structure or process to resolve issues as they occur at the level appropriate to the magnitude of the issue. The result to date has been SpaceX gradually and reluctantly acceding to the Air Force team demands. This can be the worst of all worlds, pressing the Falcon 9 commercially oriented approach into a comfortable government mold that eliminates or significantly reduces the expected benefits to the government of the commercial approach. Both teams need to adjust.

The SMC team needs to embrace SpaceX innovation and practices as intrinsic to the nature and potential value of a New Entrant with new technologies and practices providing a valuable addition to assured access to space, leveraging the potential benefits from a competitive environment. SpaceX needs to embrace the Air Force team's need for information and data to understand how SpaceX practices and solutions provide for the needed confidence in the level of risk that must be borne by the Air Force. SpaceX also needs to take advantage of the rich experience of the Air Force team in dealing with a wide variety of payload and orbit demands on launch systems. Both teams need to understand that there can be no good outcome from unresolved disputes that must constantly be elevated to the top. Instead, both teams need to commit to leveraging SpaceX approaches and practices and the Air Force team's experience so that both contribute to the best outcome. The IRC heard evidence from SpaceX and the Air Force of notable progress toward this end in recent weeks.

3. The Balance between the What and How

The daily focus of members of the NECT for the past decade or so has been intensely on confidence in individual successful deliveries to orbit. That requires assessment of

specific processes and hardware associated with the specific launch vehicle. The traditional approach is prescriptive. There seems to be mutual agreement on the approach to meeting this need for a specific launch. But the outcome of applying this approach to certification results in a large number of open issues with various levels of fidelity in defining the achievable schedule and consequence of the issue. This makes it difficult to identify issues that continue to pose a significant risk to readiness for a successful delivery to orbit on the agreed schedule. It is neither possible nor should it be necessary to close all the issues by the certification date as currently required by language in the CRADA. It is possible and necessary to have confidence that the New Entrant can and will close the issues on an acceptable schedule to assure readiness to launch on the scheduled date. Applying the heavily prescriptive approach throughout the certification process can be contrary to the potential benefits of innovation and emerging best practices. Significantly better communications between SpaceX and SMC are needed to achieve mutual understanding of possibilities for successfully accomplishing the what. The advantage of the heavily prescriptive approach is that it is based on a rich set of successful past experience with currently certified national security space-capable launch vehicles. The disadvantage is that it is based on experience with past designs and processes. There needs to be a balance between prescribing the how and allowing other approaches to achieving the intent of the what.

4. Evaluating the Issues—Quantity vs. Consequence

The process followed by SMC and Aerospace to determine certification qualification has been focused on a large number of detailed processes for design, analysis of performance across the spectrum of expected environments, production, quality control, testing, and other processes. The issue is whether this activity is to actually qualify flight hardware or to demonstrate that the SpaceX processes and hardware approaches provide confidence that SpaceX can deliver qualified hardware, support, and processes as required to meet the launch schedule. A mechanism to resolve the differences in perspective between the NECT and the New Entrant is essential to realize the potential benefits from New Entrants. There will be issues that must be resolved at the level of the Certifying Official, but that demand needs to be limited to major issues. To create a manageable situation that contributes to continuing assured access to space, there needs to be enough daily interface between SMC and the New Entrant to minimize the surprises and to provide opportunity for full understanding of differences in view on risk.

5. Recommendations

The Certifying Official should:

- Clearly establish that the expectation is that the Air Force, NRO, and NASA will benefit from buying services from SpaceX as a commercial provider and that

attempting to drive SpaceX to a different model is counterproductive to the reason for the national policy on encouraging the use of qualified commercial providers for national security payloads.

- Direct the SMC Launch Readiness Director and the Chief Engineer to engage SpaceX at the right level to arbitrate most technical issues at appropriate levels below the Certifying Official.
- Review all burn-down plans that involve design, process, and organizational changes to determine whether it is appropriate for the government to drive intrusive changes as a condition of certification.
- Reach agreement with the management of SpaceX to establish a continuing SMC presence in the SpaceX facility to ensure better communication, fewer surprises, and better mutual understanding of issues. This is not more oversight and monitoring. It is to promote effective partnership.
- Reach agreement with the management of SpaceX on the approach to continuing focus on understanding specific performance needs and on reaching mutual agreement on acceptable approaches to meeting these needs.
- Require demonstration of New Entrant engineering, design, manufacturing, quality control, and analysis sufficiently rigorous to give confidence that the risks extending to delivery on orbit on schedule are understood and acceptable.
- Require that open issues be binned to identify those that pose more than low risk in mission assurance on scheduled launch date
- Consider labeling the certification step that qualifies the New Entrant to compete for a launch award as “Initial Certification” to more clearly communicate that activities that are part of certification are dynamic.

The CRADA should be amended to:

- Clearly state that the Certifying Official is certifying confidence that the New Entrant has the demonstrated capability to design, produce, qualify, and deliver the launch vehicle and ground system and to provide the future mission-assurance support required to deliver to a specific orbit on a specific schedule with a specific level of risk. The SMC NECT COA 1 is compatible with the intent of this recommendation.
- Require an agreed schedule to close open issues in an acceptable time frame compatible with the launch schedule.
- Allow the Certifying Official to accept issues and limitations closed after the certification date with agreed closure milestones and contractual processes for dealing with failure to meet the milestones.

D. The Vertical Integration Issue

1. Challenge

Vertical Integration is one of four limitations allowed in the CRADA with an undefined path to resolution. The assumption was that Vertical Integration would be handled outside the certification process. The four limitations are:

- Secure Flight Termination System
- Global Positioning System Metric Tracking
- Vertical Integration
- Information Assurance Certification

The four limitations must be addressed before launch and should be addressed in the certification process. Vertical Integration needs to be closed well before integration begins—probably 6 to 12 months before launch. Closing these limitations is part of the closure required as part of the end-to-end Flight Worthiness requirement that the Certifying Official must consider in the overall risk assessment.

2. Recommendation

The CRADA should be amended to characterize the four limitations listed as open issues to be closed before required launch or stack-integration activities.

E. Opportunity for Innovation

1. Challenge

The changes to the certification mindset and process suggested above are inherently innovation friendly. System changes, whether characterized as innovation or response to issue closure or unknown unknowns, are a fact of life over the life of any system. Accommodating this fact of life begins with the concept that the front end of the certification activity is not certifying a fixed design or set of hardware. It is using existing design information, processes, and hardware to ensure that confidence in the New Entrant's delivering the needed capabilities to deliver on orbit is warranted based on demonstrated capability. To enable innovation and design response to issues, it will be essential for the government to have access to the full set of design information, component and system performance, analysis, test data, and other information to assure the Certifying Official that changes in design—component or system—do not adversely affect the basis for certification.

2. Recommendation

The Certifying Official should ensure that the New Entrant understands and agrees to the level of information sharing required to enable innovation or design response to issues without compromising confidence in the risk assessment of capability to deliver on orbit.

Appendix A
Project Description Amendment: Secretary of the
Air Force (SecAF) and Commander Air Force
Space Command (AFSPC) Independent Strategic
Assessment Group (ISAG)

PROJECT DESCRIPTION AMENDMENT

FA-2-2505
AMENDMENT NO. 18

TITLE: Secretary of the Air Force (SecAF) and Commander Air Force Space Command (AFSPC) Independent Strategic Assessment Group (ISAG)

This project description amendment is for work to be performed by the Institute for Defense Analyses (IDA) under contract number HQ0034-14-D-0001 (see Paragraph 9f) for the SecAF, the Department of Defense (DoD) Executive Agent for Space, with Responsibilities and Authorities pursuant to DoDD 5101.02E. This is follow-on work previously performed by IDA under project description FA-2-2505 and funded in Task 01.

1.

2. BACKGROUND:

a. The SecAF, as the DoD Executive Agent for Space, is responsible for providing the space capabilities required to support national security objectives. The envisioned organization of the future requires an objective assessment of its current capabilities, identification of operational gaps, and how the organization needs to be modified to address new responsibilities and any gaps associated with the current organizational needs. For this amendment, the SecAF has asked IDA to assemble an independent group to conduct an independent and objective assessment to provide recommendations to the New Entrant Certification Official to streamline and expedite the certification of the SpaceX Falcon 9 v1.1. IDA was chosen because of its objectivity and mission-knowledge expertise.

b. Today's space launch program in the AF places an emphasis on maintaining assured access to space, driving down the costs of launch services, increasing opportunities for competition, and sustaining schedule dependability. Over the past year, the Air Force has been working to certify SpaceX for the Evolved Expendable Launch Vehicle (EELV) while protecting mission assurance. Launch Mission Assurance processes and standards were developed in response to major failures in the late 1990s. These processes and standards are what now comprise the launch certification process. Given the importance of increased competition as part of its future space launch strategy, it is incumbent on the government to incorporate lessons learned from the recent AF certification work. The goal is to assure that the process of certification is efficient and effective, with well-defined, reasonable expectations to achieve mission assurance, and ensure that no unnecessary requirements are placed on new entrants and the government. Such lessons learned can follow the successful independent construct and have continuity to the original 1999 Launch Broad Area Review (BAR) study examining the state of mission launch assurance, and its successor 2010 Study ("BAR X") assessing progress.

3. OBJECTIVE:

The overall objective of this project is to provide independent and objective assessments of topics and recommendations to address shortfalls and future opportunities. The recommendations will include changes to policy, processes, training, and operations as required.

4. STATEMENT OF WORK:

IDA will:

a. Establish an Independent Review Committee (IRC). The IRC will assist the ISAG in providing an independent assessment of recommendations to streamline and expedite the certification process of the Falcon 9. The IRC will consist of an ISAG Chairman, and a member of SAF/AQ and SpaceX. ISAG complies with DoD policy on the use of "Senior Mentors" in that, IDA does not do any mentoring. Additionally, this project focuses on Strategic Assessments and does not participate in any of the activities listed in the DoD policy.

b. Ensure the current Falcon 9 certification team, to include government and contractor members, examines the existing Cooperative Research and Development Agreement (CRADA) and status of the certification process and provide recommendations to modify the CRADA and/or the certification plans. The goal is to achieve Falcon 9 certification NLT 30 June 2015. The team should consider lessons learned in the certification process since the CRADA was signed in June 2013. In addition, the team should take into account the Space X Falcon 9 flight performance in the last 18 months.

5. SCHEDULE AND DELIVERABLES:

a. The team will present to the IRC an initial preliminary review on 2 Feb 15 or within one week of this amendment on Falcon 9 CRADA findings/recommendations task. The initial review will cover but is not limited to:

- 1) Changes to the CRADA to include refining the definitions of limitations and liens.
- 2) Adjustments to Partnered Plans and reassessment of risk levels for open issues.
- 3) Incorporation of certification for vertical integration into the CRADA.
- 4) Providing the opportunity to incorporate innovation evolution of the Falcon 9.

b. The team will present a final review to the IRC within three weeks from the date of this amendment.

c. Within 7 days from the final review, the ISAG (IRC) will provide the certifying official the final presentation and report.

All work on this project description amendment will be completed by 30 April 2015.

6. CORE STATEMENT:

This research is consistent with IDA's mission in that it will support specific analytical requirements of the SecAF and will assist the SecAF with planning efforts. Accomplishment of this project requires an organization free of business conflicts of interests; with broad access to information; with a comprehensive knowledge of SecAF needs and problems; and with independence from parochial interests. The research draws upon IDA's core competencies in Technology Assessments, specifically in the area of space, cyber, air, missile and weapons technologies. Performance of this project will benefit from and contribute to the long-term continuity of IDA's research program.

7. FUNDING:

This project description amendment authorizes \$10,000 in FY15 for the performance of the Statement of Work herein. The SecAF's office has reviewed the costs and (noting paragraph 10c below) has found them reasonable for the work to be performed.

8. TECHNICAL COGNIZANCE:

The SAF/SP POC, Colonel Gregory Wood (703-693-2359) [gregory.e.wood3.mil@mail.mil] is the technical cognizant official for this project description amendment. The IDA POC is Mr. L. Kirk Lewis (703-578-2824) [klewis@ida.org].

9. SPECIFIC ADMINISTRATIVE INSTRUCTIONS:

a. If at any time during the course of performing this project, SecAF or IDA identifies the need for substantial changes, a SecAF-approved amendment to this project description will be submitted to the IDA Contracting Officer's Representative, with a copy to the SecAF or her project officer, as appropriate.

b. This project will be conducted under Industrial Security Procedures specified in DoD 5220.22-M, "National Industrial Security Program Operating Manual," or as directed by the IDA Contracting Officer's Representative.

c. This is a project description award under the IDA Systems and Analyses Center (IDA/SAC) FFRDC contract awarded by DoD. Prior to contract award, a comprehensive review was conducted by DoD, and approved by USD(AT&L). The comprehensive review determined that IDA/SAC continues to provide SecAF with fully informed, objective, conflict-free, state of the art work, and that IDA/SAC continues to be a cost-effective and efficient operation. The comprehensive review noted that IDA/SAC is the lowest-cost DoD FFRDC per staff-year of technical effort. The IDA/SAC FFRDC contract is subject to the Cost Accounting Standards (CAS) for government contracting and the Federal Acquisition Regulation (FAR), with resident DCAA auditors. IDA has a currently approved CAS disclosure statement and has certified that costs estimated for this effort are consistent with established practices and procedures.

d. SAF/SP will have 30 calendar days in which to respond to IDA on any draft final deliverable, providing review comment, approval of security classification, and distribution

instructions.

e. A general "need-to-know" is hereby established in connection with IDA performance of this project description. Access to classified documents and publications and security clearances necessary to complete the project will be obtained through the IDA Contracting Officer's Representative, unless otherwise instructed.

f. Contract number HQ0034-14-D-0001 contains all current terms and conditions and has a September 30, 2018 end-date for new funding. Funds can be spent past this date (as long as it is consistent with the Period of Performance identified in the contract amendment funding this project) as outlined in the scheduled and deliverables paragraph.

Ellen M Pawlikowski DATE: 1/26/15
ELLEN M. PAWLIKOWSKI, Lieutenant General, USAF
Military Deputy, Office of the Assistant Secretary of the Air Force (Acquisition)

David S. C. Chu DATE: 27 Jan '15
David S. C. Chu
President, Institute for Defense Analyses

Bradrick Oeth DATE: 1/23/2015
Bradrick Oeth
Contracting Officer's Representative
Office of the Deputy Director, OSD Studies and FFRDC Management

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