

Notes

Introduction. The Dawn of the Space Age

1. Project RAND, *Preliminary Design of an Experimental World-Circling Spaceship* (Santa Monica, CA: Douglas Aircraft Co, 2 May 1946), p. 1.

2. In recognizing this dichotomy, one must not overlook the Navy's contribution to Project Vanguard and both Army and Navy missile development work throughout this period.

3. Theodore von Kármán with Lee Edson, *The Wind and Beyond: Theodore von Kármán, Pioneer in Aviation and Pathfinder in Space* (Boston: Little, Brown and Company, 1967), pp. 225-227; Michael H. Gorn, *The Universal Man. Theodore von Kármán's Life in Aeronautics*, Smithsonian History of Aviation Series, ed. Von Hardesty. (Washington, D.C.: Smithsonian Institution Press, 1992), p. 82.

4. Gorn, *The Universal Man*, pp. 73-92; von Kármán, *Wind and Beyond*, pp. 234-248; Robert Frank Futrell, *Ideas, Concepts, Doctrine: Basic Thinking in the United States Air Force, 1907-1960*. Vol. I. Maxwell Air Force Base, AL: Air University Press, 1989, p. 543, (hereafter cited as Futrell, *Ideas, 1907-1960*); Frank J. Malina, "Origins and First Decade of the Jet Propulsion Laboratory," in Eugene M. Emme, ed. *The History of Rocket Technology: Essays on Research, Development, and Utility* (Detroit: Wayne State University Press, 1964), pp. 46-52.

5. Roger E. Bilstein, *Orders of Magnitude. A History of the NACA and NASA, 1915-1990*. The NASA History Series. NASA SP-4406, (Washington, D.C.: National Aeronautics and Space Administration, 1989), pp. 1-14; Loyd S. Swenson Jr., James M. Grimwood, and Charles C. Alexander, *This New Ocean: A History of Project Mercury*. The NASA Historical Series. NASA SP-4201 (Washing-

ton, D.C.: National Aeronautics and Space Administration, 1966), pp. 6-9.

6. Quoted in, U.S. House, Committee on Government Operations, *Government Operations in Space (Analysis of Civil-Military Roles and Relationships)*, House Report No. 445, 89th Congress, 1st Session, June 4, 1965, p. 23.

7. See Bilstein, *Orders of Magnitude*, pp. 15-42; Swenson, *This New Ocean*, pp. 9-13; Futrell, *Ideas, 1907-1960*, pp. 541-543.

8. Space generally came to mean the region above 50 miles in altitude, beyond which aerodynamic vehicles had insufficient oxygen. Orbiting spacecraft needed approximately 100 miles altitude to remain in Earth orbit. See Robert L. Perry, *Origins of the USAF Space Program, 1945-1956*. V, *History of DCAS 1961*. AFSC Historical Publications Series 62-24-10 (Los Angeles, CA: Air Force Systems Division, Space Systems Division, 1961), p 1; Swenson, *This New Ocean*, p. 13; Rip Bulkeley, *The Sputniks Crisis an Early United States Space Policy: A Critique of the Historiography of Space* (Bloomington, ID: Indiana University Press, 1991), pp. 46-48.

9. Discussion of the space pioneers is based on the following: Perry, *Origins of the USAF Space Program*, pp. 2-6; Swenson, *This New Ocean*, pp. 13-18; Walter A. McDougall, *...the Heavens and the Earth: A Political History of the Space Age* (New York: Basic Books, 1985), pp. 20-21, 76-78; Bilstein, *Orders of Magnitude*, pp. 12-14.

10. Oberth had returned to Rumania in 1930 to teach and, because of his difficult personality and Rumanian citizenship, did not join the Peenemuende project until 1941. Although the von Braun group did not acknowledge its debt to Oberth, Oberth's patents covered their innovations, which

were accomplished independently of Goddard's work. For German rocket developments, see Michael J. Neufeld, *The Rocket and the Reich: Peenemuende and the Coming of the Ballistic Missile Era* (New York: The Free Press, 1995).

11. Malina, "Origins and First Decade of the Jet Propulsion Laboratory," pp. 46-52; von Kármán, *Wind and Beyond*, pp. 240-242.

12. Malina, "Origins and First Decade of the Jet Propulsion Laboratory," pp. 46-52.

13. von Kármán, *Wind and Beyond*, p. 243; Gorn, *Universal Man*, pp. 82-92; Malina, "Origins and First Decade of the Jet Propulsion Laboratory," pp. 48-60.

14. Gorn, *Universal Man*, pp. 82-92; Malina, "Origins and First Decade of the Jet Propulsion Laboratory," pp. 48-60.

15. Malina, "Origins and First Decade of the Jet Propulsion Laboratory," pp. 48-66. In the words of Frank Malina, JPL became the country's initial "center for space and long-range missile development."

16. H. H. Arnold, *Global Mission* (New York: Harper & Brothers, Publishers, 1949), p. 532.

17. Theodore von Kármán, *Toward New Horizons: Science, the Key to Air Supremacy. Commemorative Edition, 1950-1992* (Headquarters Air Force Systems Command, 1992), pp. vii-ix; Gorn, *Universal Man*, pp. 108-117.

18. von Kármán, *Toward New Horizons: Science, the Key to Air Supremacy*; Gorn, *Universal Man*, pp. 108-117; von Kármán, *Wind and Beyond*, pp. 289-294; Thomas A. Sturm, *The USAF Scientific Advisory Board: Its First Twenty Years, 1944-1964* (Washington, D.C.: USAF Historical Division Liaison Office, 1967), pp. 2-15.

19. Bruce L. R. Smith, *The RAND Corporation* (Cambridge, MA: 1966), pp. 30-65; R. Cargill Hall, "The Origins of U.S. Space Policy: Eisenhower, Open Skies, and

Freedom of Space" *Colloquy* (December 1993): 5; Futrell, *Ideas, 1907-1960*, pp. 209; McDougall, *...the Heavens and the Earth*, p. 89; von Kármán, *Wind and Beyond*, p. 302.

20. Hall, "Origins of U.S. Space Policy," p. 5; Futrell, *Ideas, 1907-1960*, pp. 209; Edmund Beard, *Developing the ICBM: A Study in Bureaucratic Politics* (New York: Columbia University Press, 1976), pp. 24-26, 112.

21. Perry, "Origins of the USAF Space Program," p. 9; Hall, "Origins of U.S. Space Policy," pp. 5-6; Beard, *Developing the ICBM*, pp. 71-73.

22. Perry, "Origins of the USAF Space Program," p. 9; Hall, "Origins of U.S. Space Policy," pp. 5-6; Beard, *Developing the ICBM*, pp. 71-73.

23. von Kármán, *Toward New Horizons: Science, the Key to Air Supremacy*; Gorn, *Universal Man*, pp. 108-117; von Kármán, *Wind and Beyond*, pp. 289-294; Thomas A. Sturm, *The USAF Scientific Advisory Board: Its First Twenty Years, 1944-1964* (Washington, D.C.: USAF Historical Division Liaison Office, 1967), pp. 2-15.

24. von Kármán, *Wind and Beyond*, p. 293.

25. Bulkeley, *The Sputniks Crisis*, p. 40; Jacob Neufeld, *The Development of Ballistic Missiles in the United States Air Force 1945-1960. General Histories* (Washington, D.C.: Office of Air Force History, 1990), p. 24.

26. Gorn, *Universal Man*, p. 117.

27. Futrell, *Ideas, 1907-1960*, pp. 219-220; Hall, "Early U.S. Proposals," p. 68; Beard, *Developing the ICBM*, pp. 69-72. Bush was slow to change his views. In his 1949 book, *Modern Arms and Free Men*, he conceded that long range missiles could be built, but at too high a cost. Only after Sputnik did he revise his earlier views.

28. von Kármán, *Wind and Beyond*, p. 230.

29. Futrell, *Ideas, 1907-1960*, pp. 480-481; Bulkeley, *The Sputniks Crisis*, pp. 37-44.

Chapter 1. Before Sputnik

1. Hall, "Early U.S. Proposals," pp. 69-74; Perry, "Origins of the USAF Space Program," pp. 8-13; Hall, "Origins of U.S. Space Policy," pp. 5-6; see also the review of postwar rocket and satellite developments in Constance McLaughlin Green and Milton Lomask, *Vanguard: A History* (Washington, D.C.: Smithsonian Institution Press, 1971).

2. The following discussion of the Rand proposal is based on: Project RAND, *Preliminary Design of an Experimental World-Circling Spaceship* (Santa Monica, CA: Douglas Aircraft Co., 2 May 1946); Merton E. Davies and William R. Harris, *RAND's Role in the Evolution of Balloon and Satellite Observation Systems and Related U.S. Space Technology* (The RAND Corporation, September 1988. R-3692-RC), pp. 3-9; Hall, "Early U.S. Proposals," pp. 74-80; Perry, "Origins of the USAF Space Program," pp. 12-17.

3. It should be noted that Arthur C. Clarke, intrepid British member of the British Planetary Society, suggested such a course using geosynchronous satellite positioning the previous year. He comments on this in his, *The Promise of Space* (New York: Harper & Row, Publishers, 1968), pp. 97-101.

4. Project RAND, *Preliminary Design of an Experimental World-Circling Spaceship* (Santa Monica, CA: Douglas Aircraft Co., 2 May 1946), p. 10.

5. *Ibid.*, pp. 1-2.

6. It also should be noted that the Key West Agreement worked out by the Joint Chiefs of Staff at Key West, Florida, in March of 1948 accorded the Air Force operations in air space, but did not address activities in outer space. Logically, the Air Force thus devoted its attention and budget priorities to air-breathing cruise missiles. Futrell, *Ideas, 1907-1960*, p. 198.

7. For postwar V-2 experiments, see especially David H. DeVorkin, *Science with a Vengeance: How the Military Created the US*

Space Sciences after World War II (New York: Springer-Verlag, 1992); Neufeld, *Development of Ballistic Missiles*, p. 36; Malina, "Origins and First Decade of the Jet Propulsion Laboratory," pp. 48-66; U.S. House, Committee on Government Operations, *Government Operations in Space (Analysis of Civil-Military Roles and Relationships)*, House Report No. 445, 89th Congress, 1st Session, June 4, 1965, p. 24-26.

8. Malina, "Origins and First Decade of the Jet Propulsion Laboratory," p. 65; Green and Lomask, *Vanguard*, p. 10.

9. DeVorkin, *Science with a Vengeance*, pp. 168-182; Green and Lomask, *Vanguard*, pp. 10-11. Despite development by the Office of Naval Research, the Vanguard generally is regarded as a largely civilian program in contrast with its competitors for America's scientific satellite entry in the International Geophysical Year program.

10. Neufeld, *Development of Ballistic Missiles*, pp. 24-27, 44-50; Beard, *Developing the ICBM*, pp. 43-82.

11. Beard, *Developing the ICBM*, pp. 17-29; Neufeld, *Development of Ballistic Missiles*, pp. 13-23.

12. Beard, *Developing the ICBM*, pp. 17-29; Neufeld, *Development of Ballistic Missiles*, pp. 13-23; Donald R. Baucom, *The Origins of SDI, 1944-1983* (Lawrence, KS: University Press of Kansas, 1992), pp. 1-15. As Baucom points out, following the 1958 decision, the Army dominated the missile defense arena until the Strategic Defense Initiative Organization began operations in 1984. He argues that the Air Force continued to lag in the missile defense activities, and at present ranks behind both the Army and the Navy in terms of size and scope of missile defense programs. Donald R. Baucom, "Manuscript Review Comments," 8 December 1995.

13. Neufeld, *Development of Ballistic Missiles*, pp. 50-56.

14. Beard, *Developing the ICBM*, pp. 111-112.
15. *Ibid.*, pp. 52-55.
16. Beard, *Developing the ICBM*, p. 61.
17. Bulkeley, *The Sputniks Crisis*, p. 71.
18. Beard, *Developing the ICBM*, pp. 107-113; Futrell, *Ideas, 1907-1960*, pp. 275-278.
19. Doolittle's role is recounted by Ivan Getting in, Gen Bernard A. Schriever, *et al*, *Reflections on Research and Development in the United States Air Force*, Jacob Neufeld, ed. (Washington, D.C.: Center for Air Force History, 1993), p. 40.
20. Bulkeley, *The Sputniks Crisis*, pp. 74-77.
21. Futrell, *Ideas, 1907-1960*, pp. 488-489; Beard, *Developing the ICBM*, pp. 129-130.
22. Beard, *Developing the ICBM*, pp. 130-145. Ongoing doubts about the project's technical feasibility rather than roles and missions concerns apparently prompted the Air Staff to refer ARDC's request to the Guided Missiles Committee. Since spring 1950, the Air Force had been authorized exclusive development of long-range strategic missiles, although the Army and Navy continued to contest both development and operational responsibility for missiles. Neufeld, *Development of Ballistic Missiles*, p. 56.
23. Beard, *Developing the ICBM*, pp. 129-151.
24. The following analysis is based on: Davies, *RAND's Role...Satellite Observation Systems*, pp. 9-19; Hall, "Early U.S. Proposals," pp. 80-84.
25. Perry, "Origins of the USAF Space Program," p. 23.
26. Bulkeley, *The Sputniks Crisis*, pp. 78-82; Hall, "Early U.S. Proposals," pp. 85-88.
27. Davies, *RAND's Role...Satellite Observation Systems*, pp. 18-19; Hall, "Early U.S. Proposals," pp. 88-91.
28. Perry, "Origins of the USAF Space Program," pp. 29-37; Davies, *RAND's Role...Satellite Observation Systems*, pp. 23-35.
29. Davies, *RAND's Role...Satellite Observation Systems*, pp. 35-39; Hall, "Origins of U.S. Space Policy," pp. 6, 19-20.
30. Robert A. Divine, *The Sputnik Challenge* (New York: Oxford University Press, 1993), p. 18; Futrell, *Ideas, 1907-1960*, pp. 424-428; Fred I. Greenstein, *The Hidden-Hand Presidency: Eisenhower as Leader* (New York: Basic Books, 1982), p. 70.
31. James R. Killian, Jr., *Sputnik, Scientists, and Eisenhower: A Memoir of the First Special Assistant to the President for Science and Technology* (Cambridge: The MIT Press, 1977), p. 68; Hall, "Origins of U.S. Space Policy," pp. 19-20.
32. Davies, *RAND's Role...Satellite Observation Systems*, pp. 48-56.
33. Killian, *Sputnik, Scientists, and Eisenhower*, p. 68; Hall, "Origins of U.S. Space Policy," pp. 19-20.
34. Divine, *Sputnik Challenge*, pp. 22-23; Beard, *Developing the ICBM*, 145-151.
35. For the most comprehensive study of the missile program and Gardner's role, see Beard, *Developing the ICBM*, pp. 143-194, and Neufeld, *Development of Ballistic Missiles*, pp. 95-151; John T. Greenwood, "The Air Force Ballistic Missile and Space Program (1954-1974)," *Aerospace Historian* 21 Winter (1974): 190-197. The von Neumann Committee is often referred to as the Teapot Committee. According to Dr. Simon Ramo, however, this designation applies only to a second committee, which Gardner formed at the same time, to examine non-strategic missile programs. The latter received the name Teapot Committee when Gardner objected to Ramo's first suggestion, Tea Garden, because he believed the association with his own name was too close. By contrast, the von Neumann Committee should receive no other designation than Strategic Missile Evaluation Committee (SMEC). Dr. Simon Ramo, telephone conversation with Mr. George W. Bradley, Director of History, Air Force Space Command, 7 March 1997.
36. Bruno W. Augenstein, *Evolution of the U.S. Military Space Program, 1945-1960: Some*

Key Events in Study, Planning, and Program Management (Rand Corporation, September 1982), pp. 6-7; Davies, *RAND's Role...Satellite Observation Systems*, pp. 48-56.

37. Divine, *Sputnik Challenge*, p. 22.

38. Beard, *Developing the ICBM*, pp. 160-161.

39. Beard, *Developing the ICBM*, p. 184; Neufeld, *Development of Ballistic Missiles*, pp. 122-123.

40. Schriever, et al, *Reflections on Research and Development*, pp. 53-58; Greenwood, "The Air Force Ballistic Missile and Space Program," pp. 190-197.

41. Beard, *Developing the ICBM*, pp. 185-194; Divine, *Sputnik Challenge*, pp. 22-23.

42. Schriever, et al, *Reflections on Research and Development*, pp. 53-58; Greenwood, "The Air Force Ballistic Missile and Space Program," pp. 190-197; Beard, *Developing the ICBM*, pp. 185-194; Divine, *Sputnik Challenge*, pp. 22-23.

43. Perry, "Origins of the USAF Space Program," pp. 40-45; McDougall, ...*the Heavens and the Earth*, pp. 107-111.

44. Perry, "Origins of the USAF Space Program," pp. 40-45; McDougall, ...*the Heavens and the Earth*, pp. 107-111.

45. Davies, *RAND's Role ...Satellite Observation Systems*, pp. 53-55; Hall, "Origins of U.S. Space Policy," pp. 18-21.

46. Perry, "Origins of the USAF Space Program," pp. 40-45; Augenstein, *Evolution of the U.S. Military Space Program*, pp. 6-8.

47. Perry, "Origins of the USAF Space Program," pp. 42-43.

48. *Ibid.*

49. *Ibid.*

50. *Ibid.*, pp. 43-45; Davies, *RAND's Role ...Satellite Observation Systems*, p. 63.

51. Hall, "Origins of U.S. Space Policy," pp. 19-21; Killian, *Sputnik, Scientists, and Eisenhower*, pp. 67-86; Bulkeley, *Sputniks Crisis*, pp. 147-148.

52. Hall, "Origins of U.S. Space Policy," pp. 19-21; Killian, *Sputnik, Scientists, and*

Eisenhower, pp. 67-86; Bulkeley, *Sputniks Crisis*, pp. 147-148. It should be noted that the Killian Panel's deliberations on the U-2 were too secret even to appear in their formal report.

53. Hall, "Origins of U.S. Space Policy," pp. 19-21; Killian, *Sputnik, Scientists, and Eisenhower*, pp. 67-86; Bulkeley, *Sputniks Crisis*, pp. 147-148; Divine, *Sputnik Challenge*, pp. 23-25.

54. For a comprehensive treatment of the IGY issue, see Bulkeley, *Sputniks Crisis*, pp. 89-122; Hall, "Origins of U.S. Space Policy," pp. 20-21, notes 38 and 39.

55. Perry, "Origins of the USAF Space Program," pp. 45-47; McDougall, ...*the Heavens and the Earth*, pp. 118-119; Green and Lomask, *Vanguard*, pp. 16-18.

56. Hall, "Origins of U.S. Space Policy," pp. 20-21; Bulkeley, *Sputniks Crisis*, pp. 157-158, 213; R. Cargill Hall, "The Eisenhower Administration and the Cold War: Framing American Astronautics to Serve National Security" *Prologue* (Spring 1995) 27 no.1: 63.

57. Hall, "Origins of U.S. Space Policy," pp. 20-24; Bulkeley, *Sputniks Crisis*, pp. 179-181; McDougall, ...*the Heavens and the Earth*, pp. 118-123.

58. House Report, *Government Operations in Space*, pp. 27-29; Paul B. Stares, *The Militarization of Space: U.S. Policy, 1945-1984* (Ithaca, NY: Cornell University Press, 1985), pp. 33-35; Perry, "Origins of the USAF Space Program," p. 48; Futrell, *Ideas, 1907-1960*, pp. 547-548; Bulkeley, *Sputniks Crisis*, pp. 127-128. Bulkeley points out that during the summer of 1955 Project Orbiter added the JPL's radio link, then under development and later named Microlock, to its specifications in order to enhance its competitive position. Like Minilock, which would become NASA's primary tracking and telemetry system, Microlock was a radio interferometer tracking system. Less accurate than Minilock, the JPL system produced a peak

accuracy of 3 to 4 minutes of arc, in contrast to Minitrack's 20 to 30 seconds of arc. See Bulkeley, *Sputniks Crisis*, pp. 128, 206, 244. Minitrack operational characteristics are also described in Green and Lomask, *Vanguard*, pp. 146-148.

59. House Report, *Government Operations in Space*, pp. 27-29; Stares, *The Militarization of Space*, pp. 33-35; Perry, "Origins of the USAF Space Program," p. 48; Futrell, *Ideas, 1907-1960*, pp. 547-548; Bulkeley, *Sputniks Crisis*, pp. 127-128.

60. National Security Council, "U.S. Scientific Satellite Program," NSC 5520, drafted 20 May, approved 26 May 1955, quoted in Bulkeley, *Sputniks Crisis*, p. 135.

61. Bulkeley, *Sputniks Crisis*, pp. 132-136; Vernon Van Dyke, *Pride and Power: The Rationale of the Space Program* (Urbana, IL: University of Illinois Press, 1964), p. 14; Green and Lomask, *Vanguard*, pp. 41-56; Roger D. Launius, *NASA: A History of the U.S. Civil Space Program* (Malabar, FL: Krieger Publishing Company, 1994), p. 22.

62. Perry, "Origins of the USAF Space Program," pp. 49-55.

63. *Ibid.*

64. *Ibid.*

65. *Ibid.*

66. Perry, "Origins of the USAF Space Program," pp. 42-43; Davies, *RAND's Role*

... *Satellite Observation Systems*, p. 64.

67. Hall, "Origins of U.S. Space Policy," pp. 21-22; Perry, "Origins of the USAF Space Program," pp. 55-57; Stares, *Militarization of Space*, pp. 30-31; *Space and Missile Systems Organization: A Chronology 1954-1976*, AFSC Historical Publications (SAMSO, Chief of Staff, History Office), p. 36; Kenneth E. Greer, "Corona," *Studies in Intelligence*, Supplement, 17 (Spring 1973): 6, reprinted in Kevin C. Ruffner, ed., *Corona: America's First Satellite Program* (CIA History Staff, Center for the Study of Intelligence, Washington, D.C., 1995).

68. Davies, *RAND's Role... Satellite Observation Systems*, pp. 23-94; Bilstein, *Orders of Magnitude*, pp. 42-44; Swenson, *This New Ocean*, pp. 55-74.

69. Bulkeley, *Sputniks Crisis*, pp. 136-142.

70. *Ibid.*; Green and Lomask, *Vanguard*, pp. 130-131.

71. Divine, *Sputnik Challenge*, pp. 29-30.

72. Hall, "Origins of U.S. Space Policy," p. 22; Perry, "Origins of the USAF Space Program," pp. 55-57.

73. Quoted in Stares, *Militarization of Space*, p. 32.

74. Hall, "Origins of U.S. Space Policy," p. 22; Futrell, *Ideas, 1907-1960*, p. 545.

75. Bulkeley, *Sputniks Crisis*, p. 42.

Chapter 2. From Eisenhower to Kennedy

1. Robert A. Divine, *The Sputnik Challenge* (New York: Oxford University Press, 1993), pp. xiii-xiv.

2. *Ibid.*, pp. xiii-xviii; Walter A. McDougall, *...the Heavens and the Earth: A Political History of the Space Age* (New York: Basic Books, 1985), pp. 141-156; Lee Bowen, *The Threshold of Space: The Air Force in the National Space Program, 1945-1959* (Washington, D.C.: USAF Historical Division Liaison Office, September 1960), pp. 8-15; Paul B. Stares, *The Militarization of Space:*

U.S. Policy, 1945-1984 (Ithaca, NY: Cornell University Press, 1985), pp. 38-40.

3. Particularly unfortunate was the comment of presidential chief of staff Sherman Adams, who said America had no plans to enter "an outer space basketball game" with the Soviets. Divine, *Sputnik Challenge*, p. xv.

4. Divine, *Sputnik Challenge*, p. 6; R. Cargill Hall, "The Origins of U.S. Space Policy: Eisenhower, Open Skies, and Freedom of Space," *Colloquy* (December 1993): 23.

5. Divine, *Sputnik Challenge*, pp. 47-52;

James R. Killian, Jr., *Sputnik, Scientists and Eisenhower: A Memoir of the First Special Assistant to the President for Science and Technology* (Cambridge: The MIT Press, 1977), pp. 26-27.

6. Maj John B. Hungerford, Jr., *Organization for Military Space: A Historical Perspective, Report No. 82-1235* (Maxwell AFB, AL: Air Command and Staff College, 1982), pp. 22-23; Maj Gen John B. Medaris, *Countdown for Decision* (New York: G. P. Putnam's Sons, 1960), pp. 155-167; McDougall, *...the Heavens and the Earth*, pp. 131, 150, 168. The intrepid von Braun initially promised a launch within 60 days, but Medaris countered with 90, while the official Army estimate became 120 days. The first attempt to launch Vanguard on 6 December 1957 proved embarrassingly unsuccessful. See Divine, *Sputnik Challenge*, pp. 26-27.

7. U.S. House, Committee on Government Operations, *Government Operations in Space (Analysis of Civil-Military Roles and Relationships)*, House Report No. 445, 89th Congress, 1st Session, June 4, 1965, p. 31.

8. Robert Kipp, *Space Detection and Tracking: A Chronology* (Peterson Air Force Base, CO: Air Force Space Command Office of History), March 1990; Bruno W. Augenstein, *Evolution of the U.S. Military Space Program, 1945-1960: Some Key Events in Study, Planning, and Program Management* (Rand Corporation, September 1982), p. 11; Thomas A. Sturm, *The USAF Scientific Advisory Board: Its First Twenty Years, Office of Air Force History Special Studies* (Washington, D.C.: Government Printing Office, 1986; reprint of 1967 edition), pp. 80-82.

9. Memorandum, Col V. A. Adduci, Assistant Director, Legislative Liaison to Assistant Deputy Chief of Staff, Plans and Programs, subj: Policy Coordination Section Activities, 7 November 1957. Col Adduci and his staff seemed most alarmed about high congressional interest in the Army's

NIKE-ZEUS ballistic missile defense system.

10. General Thomas D. White, "At the Dawn of the Space Age," *The Air Power Historian* v, no. 1 (January 1958): 15-19.

11. Robert Frank Futrell, *Ideas, Concepts, Doctrine: Basic Thinking in the United States Air Force, 1907-1960*. Vol. I. (Maxwell Air Force Base, AL: Air University Press, 1989), pp. 553-554 (hereafter cited as Futrell, *Ideas, 1907-1960*).

12. Augenstein, *Evolution of the U.S. Military Space Program*, p. 11; Bowen, *The Threshold of Space*, pp. 20-22.

13. Bowen, *The Threshold of Space*, pp. 21-22.

14. Hall, "Origins of U.S. Space Policy," p. 22.

15. Bowen, *The Threshold of Space*, p. 22; USAF Scientific Advisory Board, *Report of the Scientific Advisory Board Ad Hoc Committee on Space Technology*, 6 December 1957. Committee members included David T. Griggs, Clark B. Milligan, Mark M. Mills, W. H. Radford, H. Guyford Stever, Edward Teller, and C. S. White.

16. Bowen, *The Threshold of Space*, pp. 22-24; Futrell, *Ideas, 1907-1960*, p. 590; Divine, *Sputnik Challenge*, p. 98. The grandstanding by Air Force generals could not convince their audience that lunar bases could play a strategic role, an issue disposed of earlier by the Killian Committee. See Killian, *Sputnik, Scientists, and Eisenhower*, p. 129.

17. Memorandum, SAFGC to Assistant Secretary of Defense (International Security Affairs), subj: Proposal for a National Policy on Outer Space, 18 March 1958.

18. The following discussion of ARPA is based on: Bowen, *The Threshold of Space*, pp. 24-34; Futrell, *Ideas, 1907-1960*, pp. 590-594; House Report, *Government Operations in Space*, pp. 31-55; Hungerford, *Organization for Military Space*, pp. 25-28; History, Air Research and Development Command, Vol I, 1 July-31 December 1959, Chapter 1.

19. This discussion of NASA is based on the following: Bowen, *The Threshold of*

Space, pp. 24-34; House Report, *Government Operations in Space*, pp. 31-55; Futrell, *Ideas, 1907-1960*, pp. 594-606; McDougall, ... *the Heavens and the Earth*, pp. 157-176; Divine, *Sputnik Challenge*, pp. 104-105, 111-112, 145-154.

20. Roger E. Bilstein, *Orders of Magnitude. A History of the NACA and NASA, 1915-1990*. The NASA History Series. NASA SP-4406 (Washington, D.C.: National Aeronautics and Space Administration, 1989), p. 47.

21. See Loyd S. Swenson Jr., James M. Grimwood, and Charles C. Alexander, *This New Ocean. A History of Project Mercury*. The NASA Historical Series. NASA SP-4201 (Washington, D.C.: National Aeronautics and Space Administration, 1966), pp. 75-77.

22. Stares, *Militarization of Space*, pp. 41-43.

23. Quoted in Futrell, *Ideas, 1907-1960*, pp. 594-595.

24. Divine, *Sputnik Challenge*, pp. 81, 104.

25. Deputy Secretary of Defense Quarles to Director, Bob Stans, April 1, 1958.

26. House Report, *Government Operations in Space*, p. 39; Killian, *Sputnik, Scientists, and Eisenhower*, p. 134.

27. See especially, House Report, *Government Operations in Space*, pp. 39, 46.

28. Divine, *Sputnik Challenge*, pp. 147-148.

29. *Ibid.*, pp. 105-107; Stares, *Militarization of Space*, p. 47; Killian, *Sputnik, Scientists, and Eisenhower*, pp. 123-124.

30. Stares, *Militarization of Space*, pp. 47-57; Hall, "Origins of U.S. Space Policy," p. 23-24.

31. For example, see Gen Bernard A. Schriever, "Does the Military Have a Role in Space?" in *Space: Its Impact on Man and Society*, ed. Lillian Levy (New York: W. W. Norton & Co., 1965), pp. 59-68.

32. J. D. Hunley, ed., *The Birth of NASA: The Diary of T. Keith Glennan*. Vol. NASA SP-4105. The NASA History Series (Washington, D.C.: NASA History Office, 1993), pp. 9-15; House Report, *Government Operations in Space*, pp. 49-53.

33. ARPA's FY 1959 budget totaled

\$331,726,000 and NASA's \$384,073,532. The remaining funds appeared against the military service budgets and those of the AEC and DoD agencies. The Air Force maintained no space budget as such. See Bowen, *The Threshold of Space*, pp. 38-43.

34. Memorandum, Under Secretary of the Air Force to Secretary of Defense, subj: Space Programs, 17 September 1958; Memorandum, Director ARPA to Under Secretary of the Air Force, subj: Space Programs, 31 October 1958.

35. House Report, *Government Operations in Space*, pp. 51-52.

36. On broader aspects of the Defense Reorganization Act of 1958, which created the DDR&E, see Futrell, *Ideas, 1907-1960*, pp. 573-586. See also House Report, *Government Operations in Space*, pp. 53-55.

37. Memorandum, Col C. R. Roderick, Chief, Committee Liaison Division, Office of Legislative Liaison to Assistant Director, Legislative Liaison, September 1958. Although NASA received the meteorological satellite mission in 1958, and would achieve success with its TIROS I satellite, the Air Force continued to seek responsibility for its own weather satellite. In the 1960s, NASA relinquished its meteorological satellite mission to the Air Force, which developed the Defense Meteorological Satellite Program as a classified project in support of the Strategic Air Command and the NRO. Gen Thomas S. Power, CINCSAC, to Gen Thomas D. White, CSAF, 1 December 1960, Thomas D. White Papers, Library of Congress, Manuscript Division, Box 34, "2-15 SAC."

38. Memorandum, AF/DCS Plans to AF/DCS Development, subj: Air Force Objectives in Space, 5 February 1959.

39. *Ibid.*; Memorandum, AFDAT, subj: Background Information on Current Air Force Position in Space, n.d. [March 1959].

40. Less sympathetic observers might point out that Symington's charges were

without merit, and he as Secretary of the Air Force a decade earlier did considerable damage to military space activities.

41. *Ibid.*

42. *Ibid.* Interestingly, the AFDAT analysis noted that the problem with ARPA would remain if DDR&E were to follow the same procedures.

43. AFBMD, *Relationship between Ballistic Missile Programs and Space*, January 1959. On 25 April 1959, shortly after the Symington Committee hearings, Maj Gen Schriever relinquished his Ballistic Missile Division command for command of ARDC and promotion to Lt Gen.

44. *Ibid.*

45. U.S. Senate, *Investigation of Governmental Organization for Space Activities*, Hearings Before the Subcommittee on Governmental Organization for Space Activities of the Committee on Aeronautical and Space Sciences, 86th Congress, 1st Session, March 24-May 7, 1959, pp. 413-418. MacIntyre and Schriever testimony also appears on pp. 352, 354, 360-361, 396-403, 405, 409, 426-428, 448-49, and 461-62.

46. The following descriptions of systems and programs are based on: Department of Defense, *Annual Report of the Secretary of Defense and the Reports of the Secretary of the Army, Secretary of the Navy, Secretary of the Air Force, July 1, 1958 to June 30, 1959* (Washington, D.C.: U.S. Government Printing Office, 1960), pp. 20-25, 334-335; James Baar and William E. Howard, *Spacecraft and Missiles of the World, 1962* (New York: Harcourt, Brace & World, Inc., 1962), Chapter 3, Chapter 4; Horace Jacobs and Eunice Engelke Whitney, *Missile and Space Projects Guide 1962* (New York: Plenum Press, 1962); Bowen, *The Threshold of Space*, pp. 43-48; Max Rosenberg, *The Air Force in Space, 1959-1960*, Vol. SHO-S-62/112 (Washington, D.C.: USAF Historical Division Liaison Office, June 1962), pp. 31-49.

47. Samos had long been considered an acronym for Satellite and Missile Observation System. It seems that WS 117L Project Director Col Fritz Oder adopted the name only to signify the island home of Midas. For background on the reconnaissance program, see Jeffrey T. Richelson, *America's Secret Eyes in Space: The U.S. Keyhole Spy Satellite Program* (New York: Harper Business, 1990), pp. 44-64.

48. Bowen, *The Threshold of Space*, pp. 46-47. For a discussion of the recently declassified Project CORONA, see Kenneth E. Greer, "Corona," *Studies in Intelligence*, Supplement, 17 (Spring 1973): 6, reprinted in Kevin C. Ruffner, ed., *Corona: America's First Satellite Program* (CIA History Staff, Center for the Study of Intelligence, Washington, D.C., 1995); Robert A. MacDonald, "CORONA: Success for Space Reconnaissance, A Look into the Cold War, and Revolution for Intelligence," *PE&RS*, Vol. LXI, No. 6, June 2, 1995, pp. 689-720; Message from Roger Bossart to Bob Peterson, "CORONA Program Profile," Lockheed Press Release, May 24, 1995; Jeffrey T. Richelson, *America's Secret Eyes in Space: The U.S. Keyhole Spy Satellite Program* (New York: Harper Business, 1990), Chapters 1 and 2; Dwayne A. Day, "CORONA: America's First Spy Satellite," *Quest* (Summer 1995): 4-21; Jonathan McDowell, "US Reconnaissance Satellite Programs. Part I: Photoreconnaissance," *Quest* (Summer 1995): 22-33.

49. *Ibid.*, pp. 36-38. Initially the Air Force and Army shared responsibility for Notus, a two-part satellite communications program consisting of 24-hour synchronous satellites in equatorial orbit (Decree), and the Courier delayed repeater satellite. By May 1959, Air Force requests for a system that would fulfill SAC's long range communications needs in polar regions resulted in the addition of Steer, a one-channel communications satel-

lite, and Tackle, a multichannel system. Later in the fall, DDR&E, citing technical, funding, and schedule problems, would eliminate Steer and Tackle, leaving only Decree, which was transferred to the Army under the name Advent. The Air Force continued to lobby for a feasible polar system.

50. Kipp, *Space Detection and Tracking: A Chronology*.

51. The following discussion is based on: Space Systems Division (AFSC), *Chronology of Early Air Force Man-In-Space Activity*, AFSC Historical Publications Series 65-21-1, January 1965; Swenson, *This New Ocean*, pp. 33-97; Jean Evans, "History of the School of Aviation Medicine," *The Air Power Historian*, October 1958, pp. 245-261; Bowen, *The Threshold of Space*, pp. 31-49; Rosenberg, *The Air Force in Space, 1959-1960*, pp. 46-49; Clarence J. Geiger, *History of the X-20A Dyna-Soar*. Vol. 1. AFSC Historical Publications Series 63-50-1. (Wright-Patterson AFB, OH: Air Force Systems Command, Aeronautical Systems Division, October 1963).

52. Less ambitious space medicine programs took place at the Navy School of Aviation Medicine at Pensacola, Florida, and NACA's Lewis Flight Propulsion Laboratory in Cleveland.

53. Bowen, *The Threshold of Space*, p. 31.

54. See Senate, *Investigation of Governmental Organization for Space Activities*, pp. 484-493, 271-272B.

55. For the Navy proposal, see "General Proposal for Organization for Command and Control of Military Operations in Space," [n.d.], Eisenhower Library, White House Office, Office of the Special Assistant for Science and Technology, Records (James R. Killian and George B. Kistiakowsky, 1957-1961). Box 15 "Space [July-December 1959] (7)." Rosenberg, *The Air Force in Space, 1959-1960*, pp. 18-21.

56. Lt Gen B. A. Schriever, Commander, ARDC to Lt Gen R. C. Wilson, Deputy Chief

of Staff, Development, 18 May 1959, w/attach, draft letter to Secretary of Defense Neil H. McElroy.

57. Rosenberg, *The Air Force in Space 1959-1960*, pp. 18-21; Carl Berger, *The Air Force in Space, Fiscal Year 1961*, Vol. SHO-S-66/142 (Washington: USAF Historical Division Liaison Office, April 1966), pp. 29-30.

58. *Ibid.*; Futrell, *Ideas, 1907-1960*, pp. 593, 601.

59. AFBMD, *Impact of the OSD 'Space Operations' Memorandum on the AFBMD Space Program*, October 1959.

60. Memorandum, AF/CS to Secretary of the Air Force, subj: Proposed Assignment of ABMA to Department of the Air Force, 29 September 1959.

61. Rosenberg, *The Air Force in Space, 1959-1960*, pp. 15-18; Derek W. Elliott, "Finding an Appropriate Commitment: Space Policy Development Under Eisenhower and Kennedy, 1954-1963," unpublished dissertation (Washington, D.C.: The George Washington University, 10 May 1992), pp. 95-97; Hunley, *The Birth of NASA*, pp. 18-24; Medaris, *Countdown to Decision*, pp. 265-300.

62. Memorandum, AFDAT to AFCCS, subj: Statement of Critical Problem Concerning SATURN, DYNA SOAR, and Air Force Space Responsibilities, 30 October 1959. General Wilson's failure to have General Boushey's focal point office for Air Staff space activities redesignated from Director of Advanced Technology to Assistant for Astronautic Systems served as a reminder that the administration remained sensitive to the term "astronautics" and any suggestion of a higher military profile that might call attention to the nation's military space program.

63. Rosenberg, *The Air Force in Space, 1959-1960*, pp. 27-31; House Report, *Government Operations in Space*, pp. 53-55.

64. Rosenberg, *The Air Force in Space, 1959-1960*, pp. 27-31; House Report, *Government Operations in Space*, pp. 53-55.

65. Bowen, *The Threshold of Space*, pp. 38-43.

66. Rosenberg, *The Air Force in Space, 1959-1960*, pp. 1-3.

67. *Ibid.*, pp. 3-4; Stares, *Militarization of Space*, pp. 47-57; Hall, "Origins of U.S. Space Policy," p. 24; Elliott, "Finding and Appropriate Commitment," pp. 100-101.

68. White House to Congress, subj: Proposed Amendments to the National Aeronautics and Space Act of 1958, 14 January 1960.

69. House Report, *Government Operations in Space*, pp. 55-58; Rosenberg, *The Air Force in Space, 1959-1960*, pp. 4-10.

70. House Report, *Government Operations in Space*, pp. 55-58; Rosenberg, *The Air Force in Space, 1959-1960*, pp. 4-10.

71. U.S. Senate, *NASA Authorization for Fiscal Year 1961*, Hearings Before the NASA Authorization Subcommittee of the Committee on Aeronautical and Space Sciences, Pt 1, 86th Congress, 2nd Session, 28-30 March 1960, p. 505.

72. Rosenberg, *The Air Force in Space, 1959-1960*, pp. 21-26. Begun in October 1959, the 120-page document provided the detailed planning necessary to achieve the objectives and capabilities prescribed in the two unapproved papers.

73. Berger, *The Air Force in Space, FY 61*, pp. 26-29. This monograph has been declassified except for a number of pages in the section on Samos. Part of the Air Force's dilemma is apparent in the terminology used at this time. Air Force leaders and government historians who examined this era often refer to Air Force space policy and policy guidance, even though space policy is established by the President and the National Security Council and the service is charged with implementing that policy.

74. Rosenberg, *The Air Force in Space, 1959-1960*, p. 13.

75. *Ibid.*, pp. 20-21. Gates replaced Neil

McElroy in December 1959.

76. The following discussion is based on: Berger, *The Air Force in Space, FY 61*, pp. 34-35, 41-43; R. Cargill Hall, "The Air Force in Space," Unpublished classified draft chapter, May 1984, information used is unclassified; Richelson, *America's Secret Eyes in Space*, Chapter 2; Stares, *Militarization of Space*, pp. 44-46. Despite the passage of time, Berger remains one of the most convincing sources for Samos developments.

77. Albert D. Wheelon, the directed Project CORONA from 1963 to 1966, has noted that critics of Samos also doubted whether the camera's small focal length and the microwave downlink's narrow bandwidth would be capable of achieving the 60-foot resolution forecast by the planners. Although the Air Force continued to focus on film readout for the first phase of Samos (Project 101A-E2), it pursued a recovery capability for the second phase (Project 101B-E5). The third phase (Program 201-E6), also involved film recovery. The Samos project concluded, unsuccessfully, in 1962, and it would be another fifteen years before digital technology made possible effective film readout from high magnification satellite camera systems. Albert D. Wheelon, "CORONA: A Triumph of American Technology," Presentation given at Piercing the Curtain, a joint symposium held by the CIA's Center for Study of Intelligence and the George Washington University's Space Policy Institute at the George Washington University on May 23-24, 1995; Message from Roger Bossart to Bob Peterson, "CORONA Program Profile," Lockheed Press Release, May 24, 1995; R. Cargill Hall, "The Eisenhower Administration and the Cold War: Framing American Astronautics to Serve National Security" *Prologue* (Spring 1995), Vol. 27, no.1, pp. 67-68; McDowell, "US Reconnaissance Satellite Programs," pp. 28-29.

78. General Greer's west coast Samos office included both the national Project CORONA and the Air Force Samos satellite programs. The term National Reconnaissance Office (NRO) remained classified. Memorandum, Secretary of the Air Force Dudley C. Sharp to Chief of Staff Thomas D. White, 13 September 1960, w/atch, "Organization and Functions of the Office of Missile and Satellite Systems and Satellite Reconnaissance Advisory Council," Box 36, Thomas D. White Papers, Manuscript Division, Library of Congress.

79. The Aerospace Corporation, *The Aerospace Corporation. Its Work: 1960-1980* (Los Angeles: Times Mirror Press, 1980), pp. 15-25.

80. Rosenberg, *The Air Force in Space, 1959-1960*, p. 30.

81. Berger, *The Air Force in Space, FY 61*, p. 2.

82. Lt Gen B. A. Schriever, ARDC/CC, to Trevor Gardner, Chairman and President, Hycon Manufacturing Co, subj: [committee on space development program], 11 October 1960.

83. Berger, *The Air Force in Space, FY 61*, pp. 3-5; Stares, *Militarization of Space*, pp. 60-62; Memorandum, Department of the Air Force, Memorandum for Chief of Staff, USAF, subj: Report to the President-Elect of the Ad Hoc Committee on Space, January 1961.

84. *Ibid.*, pp. 29-31.

85. Berger, *The Air Force in Space, FY 61*, pp. 5-6, 30-31. In his 15 December 1959 letter, General White said: "I would like every member of the Air Force to do everything within his power to maintain the same degree of harmony and cooperation with NASA [as had existed with the National Advisory Committee for Aeronautics]." Quoted in Rosenberg, *The Air Force in Space, 1959-1960*, pp. 13-14.

86. Gen Thomas D. White, CSAF to Overton Brooks, Chairman, Science and

Astronautics Committee, House of Representatives, 19 January 1961; Overton Brooks to Dr. T. Keith Glennan, President, Case Institute of Technology, 14 February 1961, Box 47, Thomas D. White Papers, Manuscript Division, Library of Congress.

87. *Ibid.*; Futrell, *Ideas, 1907-1960*, pp. 604-606; Space Systems Division (AFSC), *Chronology of Early Air Force Man-In-Space Activity*, p. 41.

88. Berger, *The Air Force in Space, FY 61*, pp. 5-6.

89. DoD Directive 5160.32, "Development of Space Systems," 6 March 1961.

90. For the background of the reorganization see, Berger, *The Air Force in Space, FY 61*, pp. 6-10; History, Air Research and Development Command, Vol I, 1 January-31 March 1961, History of Air Force Systems 1 April-30 June 1961, I-22 to I-52; U.S. Air Force Oral History Interview, Gen Bernard A. Schriever, (USAF, Ret) with Maj Lyn R. Officer and Dr. James C. Hasdorff, Albert F. Simpson Historical Research Center, Air University, Montgomery, Alabama, No. K239.0512-676, 20 June 1973, pp. 23-25; Rick W. Sturdevant, "The United States Air Force Organizes for Space: The Operational Quest", in *Organizing for the Use of Space: Historical Perspectives on a Persistent Issue*, ed. Roger D. Launius (San Diego, CA: American Astronautical Society, 1995).

91. Berger, *The Air Force in Space, FY 61*, pp. 10-14; Memorandum, Trevor Gardner, et al to Secretary of the Air Force Eugene M. Zuckert, 23 April 1961.

92. Berger, *The Air Force in Space, FY 61*, pp. 15-25.

93. *Ibid.*, pp. 23-24.

94. *Ibid.*, pp. 24-25, 59-66. These enormous boosters represented an important commitment to large-scale space operations. While NASA's liquid propellant Saturn clustered rocket and single-chamber F-1 Nova rocket motor would be capable of

producing 1.5-million pounds of thrust, the Air Force's large, segmented solid rocket motor development plan called for a 3-million pound thrust capability. Later, a Webb-McNamara agreement of November 1961 would eliminate the large solid motors as backup to the Nova and Saturn, and the Air Force would focus on using the solid-propellant motors in its Minuteman ICBM project. See Carl Berger, *The Air Force in Space, Fiscal Year 1962*, Vol. SHO-6-66/198 (Washington, D.C.: USAF Historical Division

Liaison Office, June 1966), pp. 54-60; James Baar and William E. Howard, *Spacecraft and Missiles of the World, 1962* (New York: Harcourt, Brace & World, 1962), pp. 30-31.

95. Interview, Secretary of the Air Force Eugene Zuckert. Oral History Interview for the Kennedy Memorial Library by Lawrence McQuade, File No. 168.7050-1, Albert F. Simpson Historical Research Center (Maxwell AFB, AL: Air University, May-June 1964), part 6, pp. 5-6, 14-15.

Chapter 3. The Air Force in the Era of Apollo

1. Message from the President of the United States, *United States Aeronautics and Space Activities, 1961* (Washington, D.C.: Government Printing Office), p. 1.

2. *Ibid.*, p. iii.

3. U.S. House, *Committee on Government Operations, Government Operations in Space (Analysis of Civil-Military Roles and Relationships)*, House Report No. 445, 89th Congress, 1st Session, 4 June 1965, p. 61. Total funding for Project Apollo amounted to just over \$16 billion. See Courtney G. Brooks, James M. Grimwood, and Loyd S. Swenson, *Chariots for Apollo: A History of Manned Lunar Spacecraft*, The NASA History Series, NASA SP-4205 (Washington, D.C.: NASA, 1979), pp. 409-411.

4. Carl Berger, *The Air Force in Space, Fiscal Year 1961*, Vol. SHO-S-66/142 (Washington, D.C.: USAF Historical Division Liaison Office, April 1966), pp. 24-25.

5. Air Force leaders seldom discussed their views on space leadership with uniformity and precision during the Kennedy and Johnson years. Clearly they always advocated greater Air Force space responsibilities, but at times their pretensions embraced leadership not only of the military space effort, but the national space program—this despite the large, recognized mission responsibilities of NASA and the NRO. Indeed,

despite NASA's manned lunar mission, the Air Force continued to pursue a mission for military man-in-space, while service leaders refused to forego proposals for an offensive military space capability despite national policy to the contrary. Air Force space pretensions did not normally find widespread support among civilian Air Force officials. Indeed, uniformed service leaders and their civilian counterparts often differed over a greater Air Force space role in the national program.

6. *United States Aeronautics and Space Activities, 1961*.

7. DoD Directive 5160.32, "Development of Space Systems," 6 March 1961; Department of Defense, "Annual Report for Fiscal Year 1961," p. 20. House Report, *Government Operations in Space*, pp. 70-71. The so-called Wiesner Report asserted that 90 percent of space resources within the military belonged to the Air Force. Memorandum, Secretary of the Air Force to Chief of Staff, USAF, subj: Report to the President-Elect of the Ad Hoc Committee on Space, January 1961. During congressional testimony on 16 January 1961, Director of Defense Research and Engineering Herbert F. York stated that "the total amount of money spent in the Department of Defense on space programs, either directly by the Air Force or through the Air Force,

is 91 percent.” U.S. House, *Hearings before the Committee on Science and Astronautics*, 37th Congress, 1st Session, February 16, 1961 (Washington, D.C.: Government Printing Office), p. 9.

8. As noted in the previous chapter, Air Force space advocates like General Schriever favored a larger military space program and one that would include offensive weapons in space regardless of national policy to the contrary. More accurately described as a policy of “freedom of space” and the “peaceful uses of space,” the Eisenhower administration encouraged passive military space missions but not offensive platforms and weapons that could threaten the valuable national space reconnaissance mission. Although service leaders were aware of the administration’s concern, they nevertheless pursued the characteristic approach to defense that called for preparing for potential threats regardless of the venue. They would likely argue that the only way to ensure “peaceful overflight” and the reconnaissance space flight would be to deploy weapons in space that would deny the Soviets space supremacy. Continued Air Force pressure would lead the Kennedy administration to reaffirm the Eisenhower policy and stymie service efforts to achieve “space supremacy.”

9. Carl Berger, *The Air Force in Space, Fiscal Year 1962*, Vol. SHO-S-66/198 (Washington, D.C.: USAF Historical Division Liaison Office, June 1966), p. 4.

10. Berger, *The Air Force in Space, FY 62*, pp. 4-5.

11. *Ibid.*, pp. 5-6.

12. *Ibid.*, p. 6.

13. Quoted in *Ibid.*, p. 8. For Schriever’s speech, see the *Washington Post*, 13 October 1961.

14. Quoted in Berger, *The Air Force in Space, FY 62*, pp. 7-8. General LeMay became Chief of Staff in June 1961 following Gen Thomas D. White’s retirement.

15. *Ibid.*, p. 8.

16. *Ibid.*, p. 18; Air Force Space Plan (Draft), Headquarters USAF, September 1961.

17. Air Force Space Plan (Draft), September 1961, p. 7.

18. *Ibid.*, p. 83.

19. *Ibid.*, “Summary of Conclusions and Recommendations,” pp. 83-88.

20. *Ibid.*, pp. 20-21, 83-88.

21. Berger, *The Air Force in Space, FY 62*, pp. 19-20; Col Harry L. Evans, Deputy for Satellite Systems, SSD to Col Appold, SSD/DCL, subj: USAF Space Program FY 63-64, 2 January 1962. Later, on 8 September 1962, Air Force headquarters designated Ferguson’s office, DCS/R&D, the focal point for Air Force space issues.

22. Berger, *The Air Force in Space, FY 62*, pp. 20-21; Presentation, Lt Gen James Ferguson, Deputy Chief of Staff, Research & Technology, USAF. Statement before the House Committee on Armed Services, February 1962, SAMSO Archives, Space, General, 1962. The Ferguson address is also found in *Aviation Week and Space Technology*, 5 March 1962, pp. 75, 77, 79, 83, 87, 89, 91-92, 94, 96.

23. Presentation, Statement by Lt Gen James Ferguson, Deputy Chief of Staff, Research & Technology, USAF, before the House Committee on Armed Services, February 1962.

24. *Ibid.* The eleven areas included improved boosters, in-space propulsion, power supplies required, communications technology, re-entry and recovery, and, most importantly, man’s space role.

25. *Ibid.*; AFXPD-PA-LRP, *Air Force Space Program FY 1963*, Panel One, Ferguson Task Force, 22 December 1961.

26. Presentation, Statement by Lt Gen James Ferguson, Deputy Chief of Staff, Research & Technology, USAF, before the House Committee on Armed Services, February 1962.

27. Memorandum, Secretary of Defense to Secretary of the Air Force, "The Air Force Manned Military Space Program," 23 February 1962.
28. Berger, *The Air Force in Space, FY 62*, pp. 22-23; Presentation, Address by Gen Curtis E. LeMay, Chief of Staff, United States Air Force, Assumption College, Worcester, Massachusetts, 28 March 1962, SAMSO Archives, Space, General, 1962.
29. Berger, *The Air Force in Space, FY 62*, pp. 21-25. The McNamara-LeMay meeting is also described in, Presentation, Address to Space Technical Objectives Group, by Lt Gen Howell M. Estes, Jr., DCAS, Los Angeles California, 16 April 1962, p. 2.
30. The other panels are: Unmanned Spacecraft Panel, Space Flight Ground Environment Panel, Supporting Space Research and Technology Panel, Aeronautics Panel. U.S. House, Subcommittee on NASA Oversight of the Committee on Science and Astronautics, *The NASA-DoD Relationship*, 88th Congress, 2nd Session, 1964, pp. 11-15; House Report, *Government Operations in Space*, p. 65.
31. House Report, *Government Operations in Space*, pp. 65-66, 126-127; Berger, *The Air Force in Space, FY 62*, pp. 54-60; Arnold S. Levine, *Managing NASA in the Apollo Era*. The NASA History Series. NASA SP-4102 (Washington, D.C.: National Aeronautics and Space Administration, 1982), pp. 225-228.
32. Berger, *The Air Force in Space, FY 62*, pp. 10-12; House Report, *Government Operations in Space*, p. 66.
33. Berger, *The Air Force in Space, FY 62*, pp. 12-14.
34. DoD Directive 5030.18, "Department of Defense Support of National Aeronautics and Space Administration (NASA)," 24 February 1962.
35. House Report, *Government Operations in Space*, pp. 65-67; Report, "Air Force/NASA Space Program Management Panel 3 Report

(Ferguson Task Force) USAF Space Program FY 63-64," n.d. [December 1961-January 1962]; Levine, *Managing NASA*, pp. 211-214; House Report, *NASA-DoD Relationship*, pp. 3-6. Despite NASA's interest in the Navy's Transit system, the agency never developed a navigation satellite.

36. House Report, *Government Operations in Space*, pp. 80-83; Paul B. Stares, *The Militarization of Space: U.S. Policy, 1945-1984* (Ithaca, NY: Cornell University Press, 1985), pp. 77-78.

37. House Report, *Government Operations in Space*, pp. 80-83; Stares, *Militarization of Space*, pp. 77-78.

38. House Report, *Government Operations in Space*, pp. 80-84; Stares, *Militarization of Space*, pp. 77-78, 65-66, 69-70. Although these projects were removed from public scrutiny, the government officially announced all launches and the trade press continued to discuss DoD space issues and activities.

39. The most comprehensive treatment of the 156 Committee deliberations is: Raymond L. Garthoff, "Banning the Bomb in Outer Space," *International Security*, Winter 1980/81 (Vol. 5, No. 3), pp. 25-40. Although Garthoff describes persistent JCS opposition to a unilateral declaration without verification strictures, he at no point refers to Air Force actions as precipitating Kennedy's decision to establish the committee. For a discussion of disarmament space developments during the 1960s, see Stares, *Militarization of Space*, pp. 59-105.

40. House Report, *Government Operations in Space*, p. 73; Roger E. Bilstein, *Orders of Magnitude. A History of the NACA and NASA, 1915-1990*. The NASA History Series. NASA SP-4406 (Washington, D.C.: National Aeronautics and Space Administration, 1989), p. 63.

41. Berger, *The Air Force in Space, FY 62*, p. 9.

42. *Ibid.*, pp. 19-20.

43. *Ibid.*, pp. 23-25.
44. *Ibid.*, pp. 14-17; Levine, *Managing NASA*, pp. 217-225. The two sides settled the range dispute through an agreement of 14 January 1963, but the reimbursement issue dragged on for six years.
45. For data on the Samos program, see Jonathan McDowell, "US Reconnaissance Satellite Programs. Part I: Photoreconnaissance," *Quest* (Summer 1995): 22-33. Despite continued Air Force concerns in the 1960s about a possible Soviet orbiting weapon threat, détente became the order of the day and a sense of urgency about Soviet space threats diminished.
46. Testimony of DoD Comptroller Charles J. Hitch, quoted in Levine, *Managing NASA*, p. 217.
47. DoD Directive 5160.32, "Development of Space Systems," 6 March 1961.
48. House Report, *Government Operations in Space*, pp. 70-71.
49. *Ibid.*
50. For coverage of Titan III development, see Berger, *The Air Force in Space, FY 62*, pp. 43-53, and Robert F. Piper, *History of the Titan III, 1961-1963*. Vol.1, AFSC Historical Publications Series 64-22-1 (Washington, D.C.: Air Force Systems Command, Space Systems Division, June 1964). The new, rigorous review process in the McNamara Pentagon was part of the comprehensive Planning, Programming, Budgeting System management procedures adopted by DoD.
51. Berger, *The Air Force in Space, FY 62*, p. 45. Although involved in a variety of important projects as Assistant Secretary of the Air Force, Brockway McMillan's most important responsibility involved his position as Director of the National Reconnaissance Office.
52. *Ibid.*
53. *Ibid.*, pp. 45-53. The Titan IIIA comprised a basic Titan II with transtage capable of launching a 5,8000-pound payload into a 100-mile orbit, while the Titan III consisted of a Titan A booster with two strap-on solid rockets designed to place a 25,000-pound payload into low earth orbit.
54. *Ibid.*, pp. 50-51.
55. Report to the Congress from the President of the United States, *United States Aeronautics and Space Activities, 1962*, (Washington, D.C.: National Aeronautics and Space Council, 1963), p. 33.
56. Cantwell, *The Air Force in Space, Fiscal Year 1964*, pp. 21-23; Gen Bernard A. Schriever, et al, *Reflections on Research and Development in the United States Air Force*, Jacob Neufeld, ed. (Washington, D.C.: Center for Air Force History, 1993), pp. 72-73.
57. Berger, *The Air Force in Space, FY 62*, pp. 77-78; Stares, *Militarization of Space*, p. 79.
58. The most comprehensive analysis of the three initiatives is found in the critique by Launor F. Carter, Chief Scientist of the Air Force. See Launor F. Carter, *An Interpretive Study of the Formulation of the Air Force Space Plan*, (Washington, D.C.: Headquarters USAF, 4 February 1963), SAMSO Archives.
59. Memorandum, Secretary of Defense to Secretary of the Air Force, subj: The Air Force Manned Military Space Program, 23 February 1962.
60. Presentation, Address to Space Technical Objectives Group by Lt Gen Howell M. Estes, Jr., DCAS, Los Angeles California, 16 April 1962. Nineteen separate Air Force or Air Force related organizations were represented in the Estes-directed effort.
61. Briefing, SSD, "Briefing on Task Group Capabilities vs Space Plan Objectives," 1 June 1962, SAMSO Archives; Carter, *Formulation of the Air Force Space Plan*, pp. 3-5.
62. The remaining programs listed are: Lifting Body Re-entry Vehicle, Manned Hypersonic Test Vehicle, Manned Maneuverable Spacecraft, Strategic Earth Orbiting Base, Space Logistic Support System,

Manned Satellite Interceptor, Required Reconnaissance System, Advanced Interceptor System, Orion, and Nuclear Rocket. Moreover, only MODS and Blue Gemini represented new programs, and neither received funding approval. See Carter, *Formulation of the Air Force Space Plan*, pp. 5-12; Memorandum, Secretary of the Air Force to Secretary of Defense, subj: Five Year Space Program, 9 November 1962; Col N. C. Appold, AFSC/STP to Col K. W. Schultz, DCS/DevPlanning, subj: Data for Section I of USAF Five-Year Space Program, 27 August 1962; Briefing, AFSC Task Group, "Status Briefing, USAF 5 Year Space Program," 20 August 1962; Briefing, SSD/SSEH, "Briefing for Dr. Launor F. Carter. Evolution of the 5 Year Space Program," 27 November 1962; Briefing, SSD, "USAF Five Year Space Program Briefing," September 1962; Briefing, SSD, "USAF Five Year Space Program Briefing, AFSC Recommended Program," September 1962, SAMSO Archives, AF Space Program, 1962-63.

63. USAF Space Plan (Draft Working Paper), Revised July 1962.

64. The stated requirements were: strategic earth orbital base, strategic aerospace vehicle (aerospace plane), unmanned space reconnaissance system, manned space reconnaissance system, ballistic missile interceptor, space surveillance-missile detection, aerospace surveillance and warning system, space surveillance-satellite inspection, satellite interceptor system, command control, earth based, communications satellites, space logistic support system, astro tug. *Ibid.*, pp. 30-34; Carter, *Formulation of the Air Force Space Plan*, pp. 2-3; Paper, SSD, "Preliminary Remarks on Military Technical Objectives in Space for use by the Systems Requirements Panel of the Technical Objectives Task Group (AFSC)," 2 May 1962.

65. Carter, *Formulation of the Air Force Space Plan*, pp. 13-15.

66. The National Aeronautics and Space

Act of 1958 (Public Law 58-568), Section 102(c)(6).

67. Levine, *Managing NASA*, pp. 211-214.

68. *NASA Data Book*, table 3-26.

69. House Report, *Government Operations in Space*, pp. 65-67; Levine, *Managing NASA*, pp. 217-221. The extensive AF/DoD-NASA organizational interfaces are described in House Report, *NASA-DoD Relationship*. Descriptions of formal agreements are found in House Report, *Government Operations in Space*, pp. 123-133.

70. Increased cooperation between the Air Force and NASA is described in Gerald T. Cantwell, *The Air Force in Space, Fiscal Year 1964*, Vol. SHO-S-67/52 (Washington, D.C.: USAF Historical Division Liaison Office, June 1967), pp. 8-14. Early in 1964 at NASA's request, Air Force Brig Gen Samuel C. Phillips received responsibility for managing Project Apollo as NASA's Deputy Director of the Apollo Program.

71. Berger, *The Air Force in Space, FY 62*, pp. 36-41.

72. Air Force Space Plan (Draft), September 1961, pp. 36-37.

73. Presentation, Statement by Lt Gen James Ferguson, Deputy Chief of Staff, Research & Technology, USAF, before the House Committee on Armed Services, February 1962, SAMSO Archives; Berger, *The Air Force in Space, FY 62*, p. 40.

74. Maj Timothy D. Killebrew, *Military Man in Space: A History of Air Force Efforts to Find a Manned Space Mission*. Air Command and Staff College Report No. 87-1425 (Maxwell AFB, AL: Air University Press, 1987), pp. 25-26; Stares, *Militarization of Space*, p. 79; Berger, *The Air Force in Space, FY 62*, pp. 41-42; Cantwell, *The Air Force in Space, Fiscal Year 1964*, pp. 15-16; Jeffrey T. Richelson, *America's Secret Eyes in Space* (New York: Harper Collins, 1990), pp. 83-84; Barton C. Hacker and James M. Grimwood, *On the Shoulders of Titans: A History of*

Project Gemini, The NASA History Series, NASA SP-4203 (Washington, D.C.: NASA, 1977), pp. 117-122.

75. Levine, *Managing NASA*, pp. 230-231; W. Fred Boone, NASA Office of Defense Affairs, *The First Five Years, December 1, 1962, to January 1, 1968*, Historical Division, Office of Policy (Washington, D.C.: NASA, December 1970), pp. 83-87; Killebrew, *Military Man in Space*, pp. 25-26.

76. Boone, *The First Five Years*, pp. 83-87; House Report, *Government Operations in Space*, pp. 84-85, 129; Cantwell, *The Air Force in Space, Fiscal Year 1964*, pp. 15-16.

77. Boone, *The First Five Years*, pp. 83-87.

78. House Report, *Government Operations in Space*, pp. 86-87; U.S. Senate, Hearing before the Subcommittee of the Committee on Appropriations, *Department of Defense Appropriations for 1964*, 88th Congress, 1st Session, 24 April 1963.

79. House Report, *Government Operations in Space*, pp. 85-88.

80. Maj Barkley G. Sprague, USAF, *Evolution of the Missile Defense Alarm System (MIDAS) 1955-1982*, Report No. 85-2580 (Maxwell AFB, AL: Air Command and Staff College, 1985), pp. 15-19. For discussion of the MIDAS program, see Chapter 4.

81. *Ibid.*, pp. 78-80; Stares, *Militarization of Space*, pp. 71-82; Report to the Congress from the President of the United States, *United States Aeronautics and Space Activities, 1963*, pp. 39-60; Report to the Congress from the President of the United States, *United States Aeronautics and Space Activities, 1964*, pp. 41-67.

82. U.S. House, Committee on Armed Services, *Hearings on Military Posture*, 88th Congress, 1st Session, January-February 1963, pp. 467-471.

83. Cantwell, *The Air Force in Space, Fiscal Year 1964*, p. 24.

84. Levine, *Managing NASA*, pp. 231-232.

85. Cantwell, *The Air Force in Space, Fiscal*

Year 1964, pp. 24-25.

86. *Ibid.*, pp. 16-18; Boone, *The First Five Years*, pp. 88-93.

87. *Ibid.*

88. Boone, *The First Five Years*, pp. 88-93.

89. Cantwell, *The Air Force in Space, Fiscal Year 1964*, pp. 16-18.

90. *Ibid.*; Boone, *The First Five Years*, pp. 94-96.

91. Cantwell, *The Air Force in Space, Fiscal Year 1964*, p. 18. ASSET provided the acronym for the Aerothermodynamic/Elastic Structural Systems Environmental Test program. Launched by single-stage THOR boosters, ASSET non-orbiting, unmanned, glide-reentry vehicles conducted a broad range of reentry experiments.

92. Cantwell, *The Air Force in Space, Fiscal Year 1964*, pp. 18-20.

93. *Ibid.*, pp. 25-28; Levine, *Managing NASA*, p. 232; Killebrew, *Military Man in Space*, pp. 22-24; House Report, *Government Operations in Space*, pp. 87-88. Dyna-Soar received the X-20 designation on 26 June 1962.

94. Cantwell, *The Air Force in Space, Fiscal Year 1964*, pp. 28-30.

95. House Report, *Government Operations in Space*, pp. 88-89; Report to the Congress from the President of the United States, *United States Aeronautics and Space Activities, 1963*, pp. 41-42; Killebrew, *Military Man in Space*, pp. 27-28.

96. Quoted in House Report, *Government Operations in Space*, pp. 88-89.

97. *Ibid.* Because the space station could not change orbit, its reconnaissance and surveillance capability was limited to objects when in view.

98. Boone, *The First Five Years*, pp. 97-99; House Report, *Government Operations in Space*, pp. 88-89.

99. Levine, *Managing NASA*, pp. 232-233; Cantwell, *The Air Force in Space, Fiscal Year 1964*, p. 21.

100. Cantwell, *The Air Force in Space, Fiscal Year 1964*, pp. 21-23.
101. *Ibid.*
102. House Report, *Government Operations in Space*, pp. 88-89; Killebrew, *Military Man in Space*, pp. 27-28; Richelson, *America's Secret Eyes in Space*, pp. 84-86, 90-92.
103. Richelson, *America's Secret Eyes in Space*, pp. 84-86, 90-92. For a listing of the specific experiments, see Killebrew, *Military Man in Space*, pp. 31-33.
104. Richelson, *America's Secret Eyes in Space*, pp. 90-92; Killebrew, *Military Man in Space*, pp. 31-33; Robert Frank Futrell, *Ideas, Concepts, Doctrine: Basic Thinking in the United States Air Force, 1961-1984*, Vol. II (Maxwell Air Force Base, AL: Air University Press, December 1989), p. 681 (hereafter cited as Futrell, *Ideas, 1961-1984*). See also The Aerospace Corporation, *The Aerospace Corporation: Its Work: 1960-1980* (Los Angeles: Times Mirror Press, 1980), pp. 87-89.
105. Cantwell, *The Air Force in Space, Fiscal Year 1964*, pp. 1-5.
106. *Ibid.*, p. 5.
107. *Ibid.*, pp. 5-6. Schriever's comments are found in Gen Bernard A. Schriever, *et al, Reflections on Research and Development in the United States Air Force*, Jacob Neufeld, ed. (Washington, D.C.: Center for Air Force History, 1993), pp. 72-73. For the general impact of *Project Forecast* on Air Force scientific development, see Michael H. Gorn, *Harnessing the Genie: Science and Technology Forecasting for the Air Force, 1944-1986*. Air Staff Historical Study (Washington, D.C.: Office of Air Force History, 1988), pp. 87-130.
108. Boone, *The First Five Years*, pp. 97-103.
109. Futrell, *Ideas, 1961-1984*, pp. 681-682; Richelson, *America's Secret Eyes in Space*, pp. 88-92; Killebrew, *Military Man in Space*, pp. 31-33; Stares, *Militarization of Space*, p. 98. Harold Brown moved from DDR&E to become Secretary of the Air Force in October 1965.
110. Futrell, *Ideas, 1961-1984*, pp. 682-683; Richelson, *America's Secret Eyes in Space*, pp. 101-103; Killebrew, *Military Man in Space*, pp. 34-39; Stares, *Militarization of Space*, pp. 98-99.
111. Levine, *Managing NASA*, pp. 234-235; House Report, *Government Operations in Space*, pp. 88-91; Futrell, *Ideas, 1961-1984*, pp. 682-683; Richelson, *America's Secret Eyes in Space*, pp. 101-103; Killebrew, *Military Man in Space*, pp. 34-39; Stares, *Militarization of Space*, pp. 98-99. NASA began with an ambitious post-Apollo space station concept similar to DDR&E's choice in late 1963, but ended with Skylab, a mini orbiting space station similar to the Air Force's MOL that would involve experiments with three astronauts in 1973-74.
112. Futrell, *Ideas, 1961-1984*, pp. 682-683; Richelson, *America's Secret Eyes in Space*, pp. 101-103; Killebrew, *Military Man in Space*, pp. 34-39; Stares, *Militarization of Space*, pp. 98-99.
113. Quoted in Stares, *Militarization of Space*, pp. 159-160.
114. Quoted in Futrell, *Ideas, 1961-1984*, p. 683. According to Richelson, Laird did not take part in the initial decision to cancel the MOL. Rather, that decision involved President Nixon, National Security Advisor Henry Kissinger, and Robert Mayo, Bureau of the Budget director—with the support of CIA Director Richard Helms, whose agency considered manned reconnaissance platforms potentially intolerable to the Soviets. Laird opposed canceling the MOL. See Richelson, *America's Secret Eyes in Space*, pp. 102-103.
115. Futrell, *Ideas, 1961-1984*, p. 683; Richelson, *America's Secret Eyes in Space*, p. 103. After spending nearly \$8 billion over a twenty year period, the Vandenberg space shuttle and launch complex, known as SLC-6, was "abandoned in place." For discussion of the Vandenberg project, see Roger G.

Guillemette, "Vandenberg: Space Shuttle Launch and Landing Site. Part 1—Construction of Shuttle Launch Facilities" *Spaceflight*, Vol 36 (October 1994), pp. 354-357; Roger G. Guillemette, "Vandenberg: Space Shuttle Launch and Landing Site: Part 2—Abandoned in Place" *Spaceflight*, Vol 36 (November 1994), pp. 378-381.

116. Killebrew, *Military Man in Space*, p. 36.

117. Futrell, *Ideas, 1961-1984*, p. 683.

118. Maj John B. Hungerford, Jr.,

Organization for Military Space: A Historical Perspective. Air Command and Staff College Report 82-1235 (Maxwell AFB, AL.: Air University Press, 1982), pp. 47-49; John T. Greenwood, "The Air Force Ballistic Missile and Space Program (1954-1974)," *Aerospace Historian* 21 (Winter 1974):199. Although the Air Staff on 16 January 1967 created a new agency to provide a focus for developing space policy and plans, its responsibilities

proved far less inclusive than General Schriever had desired. Outside its purview remained the sensitive national reconnaissance program, while other Air Force agencies either retained or acquired a portion of space systems responsibilities. See Gerald T. Cantwell, *The Air Force in Space, Fiscal Year 1967*, Part I (Washington, D.C.: USAF Historical Division Liaison Office, May 1970), pp. 5-6. See also Rick W. Sturdevant, "The United States Air Force Organizes for Space: The Operational Quest," in *Organizing for the Use of Space: Historical Perspectives on a Persistent Issue*, ed. Roger D. Launius (San Diego, CA: American Astronautical Society, 1995).

119. Futrell, *Ideas, 1961-1984*, pp. 684-686. The role of the Space Shuttle in Air Force space developments is examined in Chapter 5.

120. Futrell, *Ideas, 1961-1984*, p. 683.

Chapter 4. From the Ground Up

1. The Aerospace Corporation, *The Aerospace Corporation: Its Work: 1960-1980* (Los Angeles: Times Mirror Press, 1980), p. 46 (hereafter cited as *AerospaceCorp*). See also David Spires and Rick W. Sturdevant, "From Advent to Milstar: The United States Air Force and the Challenges of Military Satellite Communications," in *Proceedings of the NASA Conference. Beyond the Ionosphere: The Development of Satellite Communications* (Washington, D.C.: NASA, 1996).

2. *Ibid.*; Maj Robert E. Lee, *History of the Defense Satellite Communications System (1964-1986)*. Air Command and Staff College Report No. 87-1545 (Maxwell AFB, AL: Air University Press, 1987), pp. 1-4 (hereafter cited as Lee, *History of DSCS*); David K. van Keuren, "Moon in Their Eyes: Moon Communication Relay (MCR) at the Naval Research Laboratory, 1951-1962," in *Proceedings of the NASA Conference. Beyond the Ionosphere: The Development of Satellite Commu-*

nications (Washington, D.C.: NASA, 1996).

3. Carl Berger, *The Air Force in Space, Fiscal Year 1961*, Vol. SHO-S-66/142 (Washington, D.C.: USAF Historical Division Liaison Office, April 1966), pp. 84-93; *AerospaceCorp*, pp. 47-49; Lee, *History of DSCS*, pp. 5-8.

4. *AerospaceCorp*, pp. 47-49; Lee, *History of DSCS*, pp. 5-8, Berger, *The Air Force in Space, FY61*, pp. 84-93.

5. *AerospaceCorp*, p. 48.

6. Carl Berger, *The Air Force in Space, Fiscal Year 1962*, Vol. SHO-S-66/198 (Washington, D.C.: USAF Historical Division Liaison Office, June 1966), pp. 61-70.

7. Berger, *The Air Force in Space, FY62*, pp. 65-68; *AerospaceCorp*, pp. 48-52.

8. Military and commercial capabilities would not share the same satellite until the Navy contracted with COMSAT in 1973 for "Gapfiller" service pending completion of its FLTSATCOM system. See Michael Kinsley,

Outer Space and Inner Sanctums: Government, Business, and Satellite Communication (New York: John Wiley & Sons, 1976), pp. 199-200; Anthony Michael Tedeschi, *Live Via Satellite: The Story of COMSAT and the Technology that Changed World Communication* (Washington, D.C.: Acropolis Books, 1989), p. 150; Martin, *Communication Satellites, 1958-1992*, pp. 104-105, 183-186.

9. *AerospaceCorp*, pp. 48-52; Lee, *History of DSCS*, pp. 8-10; U.S. House, Committee on Government Operations, *Government Operations in Space (Analysis of Civil-Military Roles and Relationships)*, House Report No. 445, 89th Congress, 1st Session, 4 June 1965, pp. 78-79.

10. Gerald T. Cantwell, *The Air Force in Space, Fiscal Year 1964*, Vol. SHO-S-67/52 (Washington, D.C.: USAF Historical Division Liaison Office, June 1967), pp. 69-76; Gerald T. Cantwell, *The Air Force in Space, Fiscal Year 1965*, Vol. SHO-S-68/186 (Washington, D.C.: USAF Historical Division Liaison Office, April 1968), pp. 42-51; *AerospaceCorp*, pp. 48-52; Thomas Karas, *The New High Ground* (New York: Simon and Schuster, 1983), p. 73.

11. Lee, *History of DSCS*, pp. 10-13; *AerospaceCorp*, p. 51.

12. Lee, *History of DSCS*, pp. 10-13; *AerospaceCorp*, pp. 50-52; Chronology, AFSC/Space Division, *Space and Missile Systems Organization: A Chronology, 1954-1979* (Los Angeles, CA: Space Systems Division, n.d.), pp. 173-174, 176, 182, 193 (hereafter cited as *SAMSO Chronology*).

13. Lee, *History of DSCS*, pp. 13-14; *AerospaceCorp*, pp. 50-52; Horace Jacobs and Eunice Engelke Whitney, *Missile and Space Projects Guide 1962* (New York: Plenum Press, 1962), pp. 190-191.

14. Lee, *History of DSCS*, pp. 11-13.

15. Lee, *History of DSCS*, pp. 13-14; *AerospaceCorp*, pp. 52-55; Thomas Karas, *The New High Ground: Strategies and Weapons of*

Space-Age War (New York: Simon and Schuster, 1983), pp. 73-75.

16. Lee, *History of DSCS*, pp. 15-21; *AerospaceCorp*, pp. 55-57; Karas, *The New High Ground*, pp. 75-76; Jacob Neufeld, *The Air Force in Space, 1970-1974* (Washington, D.C.: Office of Air Force History, August 1976), pp. 15-19.

17. Lee, *History of DSCS*, pp. 15-21; *AerospaceCorp*, pp. 55-57; Karas, *The New High Ground*, pp. 75-76; Neufeld, *The Air Force in Space, 1970-1974*, pp. 15-19.

18. Lee, *History of DSCS*, pp. 15-28; *AerospaceCorp*, pp. 55-57; Karas, *The New High Ground*, pp. 75-76; Neufeld, *The Air Force in Space, 1970-1974*, pp. 15-19; Donald H. Martin, *Communication Satellites, 1958-1992* (El Segundo, CA: Aerospace Corporation, 1991), pp. 100-102.

19. *AerospaceCorp*, p. 59; Neufeld, *The Air Force in Space, 1970-1974*, pp. 19-23.

20. *AerospaceCorp*, p. 59; Neufeld, *The Air Force in Space, 1970-1974*, pp. 19-23; *SAMSO Chronology*, pp. 154, 187-188, 194.

21. *AerospaceCorp*, p. 59; Neufeld, *The Air Force in Space, 1970-1974*, pp. 19-23.

22. *AerospaceCorp*, p. 59; Neufeld, *The Air Force in Space, 1970-1974*, pp. 19-23; *SAMSO Chronology*, p. 196.

23. *AerospaceCorp*, pp. 59-61; Neufeld, *The Air Force in Space, 1970-1974*, pp. 19-23; Karas, *The New High Ground*, pp. 76-77.

24. Project RAND, *Preliminary Design of an Experimental World-Circling Spaceship* (Santa Monica, CA: Douglas Aircraft Co, 2 May 1946), Introduction, p. 11.

25. A good, concise background sketch is found in *AerospaceCorp*, pp. 73-74.

26. Maj Michael D. Abel, *History of the Defense Meteorological Satellite Program: Origin Through 1982*. Air Command and Staff College Report No. 87-0020 (Maxwell AFB, AL: Air University Press, 1987), pp. 3-5, (hereafter cited as Abel, *History of DMSP*). The Nimbus satellite weighed 650 pounds.

Along with its cloud-mapping RCA video cameras, its infrared radiometer provided night pictures for the first time. Between 1964 and 1978, the space agency launched seven Nimbus satellites, which provided a 24-hour observation capability. See Jacobs and Whitney, *Missile and Space Projects Guide* 1962, p. 121; Roger D. Launius, *NASA: A History of the U.S. Civil Space Program* (Malabar, FL: Krieger Publishing Company, 1994), p. 130.

27. Abel, *History of DMSP*, pp. 3-5, 19-20; *AerospaceCorp*, pp. 73-74. Although an additional declassification decision in 1975 released more information, much of DMSP's early development remained classified.

28. Neufeld, *The Air Force in Space, 1970-1974*, pp. 27-30.

29. *Ibid.*; *AerospaceCorp*, p. 74; Abel, *History of DMSP*, pp. 31-38.

30. Neufeld, *The Air Force in Space, 1970-1974*, pp. 27-30; *AerospaceCorp*, pp. 74-77; Abel, *History of DMSP*, pp. 31-38. Meanwhile the Air Force continued to support NASA's Nimbus ("Observer") satellites with booster and range support.

31. Maj Dennis L. Alford, *History of the Navstar Global Positioning System (1963-1985)*, Air Command and Staff College Report No. 86-0050 (Maxwell AFB, AL: Air University Press, 1986), pp. 1-3, (hereafter cited as Alford, *History of Navstar/GPS*); *AerospaceCorp*, pp. 63-64; The Aerospace Corporation, *The Global Positioning System. A Record of Achievement* (Los Angeles, CA: The Aerospace Corporation, 1994), pp. 3-4 (hereafter cited as *AeroCorp/GPS*); Ivan A. Getting, "The Global Positioning System," *IEEE Spectrum*, December 1993, pp. 36-37. Also see Karas, *The New High Ground*, pp. 124-134.

32. Alford, *History of Navstar/GPS*, pp. 2-4; *AerospaceCorp*, pp. 63-64; *AeroCorp/GPS*, pp. 5-6; Getting, "The Global Positioning System," pp. 37-38.

33. Getting, "The Global Positioning System," p. 37.

34. Alford, *History of Navstar/GPS*, pp. 4-8; *AerospaceCorp*, pp. 64-65; *AeroCorp/GPS*, pp. 6-8; Getting, "The Global Positioning System," pp. 38-39; Neufeld, *The Air Force in Space, 1970-1974*, pp. 24-27. Planners also referred to the project as the Defense Navigation Satellite System (DNSS).

35. Alford, *History of Navstar/GPS*, pp. 4-8; *AerospaceCorp*, pp. 64-65; *AeroCorp/GPS*, pp. 6-8; Getting, "The Global Positioning System," pp. 38-44; Neufeld, *The Air Force in Space, 1970-1974*, pp. 24-27.

36. Alford, *History of Navstar/GPS*, pp. 4-8; *AerospaceCorp*, pp. 64-67; *AeroCorp/GPS*, pp. 6-9; Getting, "The Global Positioning System," pp. 38-44; Neufeld, *The Air Force in Space, 1970-1974*, pp. 24-27.

37. I am indebted to R. Cargill Hall for use of his unpublished article, "The Air Force in Space," May 1984.

38. As Hall points out, the reconnaissance satellites initially embraced photographic requirements through low-resolution area cameras, which developed film on board and radioed the results to read-out stations on earth, and high resolution or so-called "close-look" cameras, whose film capsules were sent earthward by means of reentry capsules for ocean recovery. Hall, "The Air Force in Space," pp. 6-7. For an unclassified account of the nation's space reconnaissance effort, see Jeffrey T. Richelson, *America's Secret Eyes in Space* (New York: Harper Collins, 1990); CORONA Program Profile, Lockheed Press Release, 24 May 1995.

39. It should be noted that the Air Force also conducted operations involving electronic surveillance with so-called ferret satellites. These spacecraft would record radio and radar frequencies and transmit to earth from 300-mile altitude polar orbits. They proved especially valuable for determining the operational status of various

weapons and developing appropriate electronic countermeasures. See Hall, "The Air Force in Space," pp. 8-9.

40. *AerospaceCorp*, p. 69.

41. *AerospaceCorp*, pp. 69-70. Vela is Spanish for "watchman" and Hotel signified the participating agencies: ARPA, AEC, USAF. See Hall, "The Air Force in Space," pp. 9-10.

42. Berger, *The Air Force in Space, FY61*, pp. 102-103; Berger, *The Air Force in Space, FY62*, pp. 106-107; Cantwell, *The Air Force in Space, FY64*, pp. 87-88; *AerospaceCorp*, pp. 70-71.

43. Cantwell, *The Air Force in Space, FY65*, pp. 81-83; *AerospaceCorp*, pp. 70-71.

44. *AerospaceCorp*, pp. 70-71; Neufeld, *The Air Force in Space, 1970-1974*, pp. 41-42; Hall, "The Air Force in Space," pp. 9-10.

45. Cantwell, *The Air Force in Space, FY64*, p. 51; Alec Galloway, "A Decade of US Reconnaissance Satellites," *International Defense Review*, June 1972, pp. 249-253.

46. Berger, *The Air Force in Space, FY61*, pp. 44-48.

47. *Ibid.* With the March 1961 reorganization, the Space Division assumed planning responsibilities for MIDAS.

48. Berger, *The Air Force in Space, FY62*, pp. 72-82.

49. *Ibid.*

50. *Ibid.*

51. *Ibid.* The "other" available early warning system was the Over-the-Horizon-Backscatter (OTH-B) radar that, despite its potential, would experience considerable deployment delays because of technical challenges.

52. Cantwell, *The Air Force in Space, FY64*, pp. 51-59.

53. *Ibid.*

54. *Ibid.*

55. *Ibid.*

56. Cantwell, *The Air Force in Space, FY65*, pp. 36-39; Curtis Peebles, *High Frontier: The United States Air Force and the Military Space*

Program (Washington, D.C.: Government Printing Office, 1997), pp. 34-36.

57. Neufeld, *The Air Force in Space, 1970-1974*, pp. 31-40.

58. *Ibid.* The politically sensitive Woomera site soon prompted officials to consider alternatives elsewhere.

59. *Ibid.*; Galloway, "A Decade of US Reconnaissance Satellites," pp. 249-253.

60. Neufeld, *The Air Force in Space, 1970-1974*, pp. 31-40; Galloway, "A Decade of US Reconnaissance Satellites," pp. 249-253.

61. Chronology, AFSPACECOM/HO, *Space Detection and Tracking: A Chronology, 1957-1983*; Berger, *The Air Force in Space, FY61*, pp. 76-83; Rick W. Sturdevant, "The United States Air Force Organizes for Space: The Operational Quest," in *Organizing for the Use of Space: Historical Perspectives on a Persistent Issue*, ed. Roger D. Launius (San Diego, CA: American Astronautical Society, 1995), pp. 172-174. The NORAD Combat Operations Center became operational in April 1966.

62. Chronology, AFSPACECOM/HO, *Space Detection and Tracking: A Chronology, 1957-1983*; Berger, *The Air Force in Space, FY61*, pp. 76-83.

63. Cantwell, *The Air Force in Space, FY65*, pp. 71-75; *Aerospace Defense: A Chronology of Key Events, 1945-1990* (Peterson AFB, CO: AFSPACECOM/HO, 1991);

64. Cantwell, *The Air Force in Space, FY65*, pp. 71-75; *Aerospace Defense: A Chronology of Key Events*; Chronology, AFSPACECOM/HO, *Space Detection and Tracking: A Chronology, 1957-1983*.

65. Cantwell, *The Air Force in Space, FY65*, pp. 71-75; *Aerospace Defense: A Chronology of Key Events*; Chronology, AFSPACECOM/HO, *Space Detection and Tracking. A Chronology, 1957-1983*; Peebles, *High Frontier: The United States Air Force and the Military Space Program*, pp. 32-34.

66. *AerospaceCorp*, p. 95.

67. *Ibid.*, pp. 95-96, 104-113; Hall, "The Air Force in Space," pp. 15-16; Air Command and Staff College, *Space Handbook* (Maxwell AFB, AL: Air University, 1977), Chapter 6; Air Force Space Command, "Titan" (Peterson AFB, CO: AFSPC/HO, n.d.).

68. *AerospaceCorp*, pp. 95-96, 104-113; Hall, "The Air Force in Space," pp. 16-21; Air Command and Staff College, *Space Handbook* (Maxwell AFB, AL: Air University, 1977), Chapter 6; James Baar and William E. Howard, *Spacecraft and Missiles of the World, 1962* (New York: Harcourt, Brace & World, Inc., 1962), p. 33.

69. *AerospaceCorp*, pp. 104-113.

70. *Ibid.*

71. *Ibid.*; Air Force Space Command, "Titan" (Peterson AFB, CO: AFSPC/HO, n.d.).

72. *Ibid.*

73. *Ibid.*, pp. 117-119; Memorandum, Patrick AFB, FL/OI, subj: The Eastern Test Range, September, 1969.

74. *AerospaceCorp*, pp. 117-119; Memorandum, Patrick AFB, FL/OI, subj: The Eastern Test Range, September, 1969; Hall, "The Air Force in Space," pp. 21-22.

75. *AerospaceCorp*, pp. 120-121; Hall, "The Air Force in Space," pp. 21-22.

76. *AerospaceCorp*, pp. 123-127; Hall, "The Air Force in Space," pp. 22-27; AFSC/SCFHO, *Air Force Satellite Control Facility: Historical Brief and Chronology, 1954-Present* (Sunnyvale, CA: AFSCF/HO, n.d.) (hereafter cited as *SCF Chronology*).

77. *AerospaceCorp*, pp. 123-127; Hall, "The Air Force in Space," pp. 22-27; *SCF Chronology*.

78. *AerospaceCorp*, pp. 123-127; Hall, "The Air Force in Space," pp. 22-27; *SCF Chronology*.

79. *AerospaceCorp*, pp. 123-127; Hall, "The Air Force in Space," pp. 22-27; *SCF Chronology*.

80. *AerospaceCorp*, pp. 123-127; Hall, "The Air Force in Space," pp. 22-27; *SCF Chronology*.

81. Rick W. Sturdevant, "The United States Air Force Organizes for Space: The Operational Quest," in *Organizing for the*

Use of Space: Historical Perspectives on a Persistent Issue, ed. Roger D. Launius (San Diego, CA: American Astronautical Society, 1995), pp. 172-175; Maj John B. Hungerford, Jr., *Organization for Military Space: A Historical Perspective*, Report No. 82-1235 (Maxwell AFB, AL: Air Command and Staff College, 1982), pp. 46-47 (hereafter cited as Hungerford, *Organization for Military Space*). In the next decade the launch sites themselves were placed directly under SSD's successor SAMSO.

82. Rick W. Sturdevant, "The United States Air Force Organizes for Space: The Operational Quest," in *Organizing for the Use of Space: Historical Perspectives on a Persistent Issue*, ed. Roger D. Launius (San Diego, CA: American Astronautical Society, 1995), pp. 172-175; Hungerford, *Organization for Military Space*, pp. 46-49; *SCF Chronology*.

83. Maj Ernie R. Dash and Maj Walter D. Meyer, "The Meteorological Satellite: An Invaluable Tool for the Military Decision-Maker," *Air University Review*, Vol. xxix, No. 3 (March-April 1978), p. 13.

84. Henry W. Brandli, "The Use of Meteorological Satellites in Southeast Asia Operations," *Aerospace Historian*, Vol. 29, No. 3 (September 1982), pp. 172-175; Gen William W. Momyer, *Air Power in Three Wars* (Washington, D.C.: Office of Air Force History, 1978), pp. 228-231; Neufeld, *The Air Force in Space, 1970-1974*, pp. 27-28.

85. Lt Col John J. Lane, Jr., *Command and Control and Communications Structures in Southeast Asia* (Maxwell AFB, AL: Air University, 1981), pp. 113-114. The DoD quest for inexpensive SATCOM during the Vietnam War gave rise to the "30 circuits" episode. When several carriers learned in summer 1966 that COMSAT Corporation intended to lease 30 circuits directly to DoD, in direct violation of the FCC's recently promulgated Authorized Users decision, they formally protested. In February 1967,

the FCC ordered a “composite” rate of \$7,100 per half-circuit and split the traffic evenly three ways among ITT, RCA, and WUI. The FCC required COMSAT Corporation to sell the circuits to the carriers at \$3,800. See Michael Kinsley, *Outer Space and Inner Sanctums: Government, Business, and Satellite Communication* (New York: John

Wiley & Sons, 1976), pp. 60-62.

86. Lane, *Command and Control and Communications Structures in Southeast Asia*, pp. 113-114; Kinsley, *Outer Space and Inner Sanctums*, pp. 60-62.

87. DoD Directive 5160.32, “Development of Space Systems,” 8 September 1970.

Chapter 5. Organizing for Space

1. Paul B. Stares, *The Militarization of Space: U.S. Policy, 1945-1984* (Ithaca, NY: Cornell University Press, 1985), p. 176; Walter A. McDougall, *...the Heavens and the Earth: A Political History of the Space Age* (New York: Basic Books, 1985), pp. 421-422.

2. Robert Kipp, AFSPACECOM/HO, “Trends in Military Space: Organizational Growth and Maturity,” 30-31 May 1990.

3. DoD Directive 5160.32, “Development of Space Systems,” 8 September 1970.

4. Gen Jacob E. Smart, “Strategic Implications of Space Activities,” *Strategic Review* (Fall 1974), pp. 19-21.

5. Working Paper, AF/XO, “Outline for ‘White Paper’ on Space Management and Planning Initiatives,” n.d. [September 1978].

6. For a detailed discussion of the Soviet buildup and comparison of American and Soviet nuclear arsenals, see the yearly issues of *The Military Balance*, especially *The Military Balance, 1975-1976* (London: The International Institute of Strategic Studies, 1975), pp. 3-4, 73, and Lawrence Freedman, *US Intelligence and the Soviet Strategic Threat* (Boulder, CO: Westview Press, 1977). The number of American launchers had remained constant since 1967 at 1,054 ICBMs and 656 SLBMs. By contrast, in 1967 the Soviet inventory consisted of 460 ICBMs and 130 SLBMs. These figures, to be sure, do not reflect evolving capabilities in terms of missile size, range, throw-weight, and MIRV technology. Characteristic of concern by American officials about the Soviet build-up

is Secretary of Defense Melvin Laird’s comment in early 1970 warning of the “continuing rapid expansion of Soviet strategic offensive forces.” Quoted in Freedman, *US Intelligence and the Soviet Strategic Threat*, p. 153. Such worries continued unabated through the decade.

7. Freedman, *US Intelligence and the Soviet Strategic Threat*, pp. 129-168.

8. Report of Secretary of Defense James R. Schlesinger to the Congress on the FY 1976 and FY 1977T (transition) Budgets, 5 February 1975 (Washington: Government Printing Office, 1975), pp. I-13, 14; II-1 to II-11; II-18.

9. John Newhouse, *War and Peace in the Nuclear Age* (New York: Alfred A. Knopf, 1989), p. 233.

10. For discussion of SALT I and the ABM treaty, see John Newhouse, *Cold Dawn: The Story of SALT* (New York: Holt, Rinehart and Winston, 1973). Both agreements are reproduced in full in the appendix, pp. 273-281. Also see Newhouse, *War and Peace in the Nuclear Age*, pp. 209-265; Freedman, *US Intelligence and the Soviet Strategic Threat*, pp. 166-168.

11. Owen E. Jensen, “The Years of Decline: Air Defense from 1960 to 1980,” in Stephen J. Cimbala, ed., *Strategic Air Defense* (Wilmington, DE: Scholarly Books, 1989), pp. 40-41.

12. Summary Report, *Joint DoD/NASA Study of Space Transportation Systems*, 16 June 1969; Jacob Neufeld, *The Air Force in*

Space, 1970-1974 (Washington, D.C.: Office of Air Force History, August 1976), pp. 1-14; McDougall, ... *the Heavens and the Earth*, p. 421.

13. Neufeld, *The Air Force in Space, 1970-1974*, pp. 1-15; Roger D. Launius, "Toward an Understanding of the Space Shuttle: A Historiographical Essay," *Air Power History* (Winter 1992), pp. 3-10. As noted in Chapter 3, the Dyna-Soar, despite its multi-purpose mission profile and reusable launch capability, fell victim in the early 1960s to the triple threat of high costs, technical uncertainty, and low priority. For a detailed treatment of Shuttle development, see Dennis R. Jenkins, *Space Shuttle: The History of Developing the National Space Transportation System* (Marceline, Missouri: Walsworth Publishing Company, 1993).

14. Quoted in Robert Frank Futrell, *Ideas, Concepts, Doctrine: Basic Thinking in the United States Air Force, 1961-1984*, Vol. II (Maxwell Air Force Base, AL: Air University Press, December 1989), p. 685 (hereafter cited as Futrell, *Ideas, 1961-1984*). Later, when officials canceled the payload retrieval mission, the rationale for NASA's ambitious annual flight schedule no longer applied.

15. Roger D. Launius, "Toward an Understanding of the Space Shuttle: A Historiographical Essay," *Air Power History* (Winter 1992), pp. 3-10; As Neufeld points out, the Air Force supplied development costs in the "token amount" of \$4 million or less per year from 1971 to 1974. See Neufeld, *The Air Force in Space, 1970-1974*, p. 3.

16. History, Space and Missile Systems Organization, 1 July 1972-30 June 1973, pp. 201-206; Working Papers, DoD/DRE, "Space and Space-Related Program Data, Fiscal Years 1979-1986," March 1981, pp. 169-174; Neufeld, *The Air Force in Space, 1970-1974*, pp. 4-5. Lockheed's designer of the Space Tug was Saunders B. Kramer.

17. Neufeld, *The Air Force in Space, 1970-*

1974, pp. 4-8; see also John Logsdon, "The Decision to Develop the Space Shuttle," *Space Policy* (May 1986), pp. 103-118. In the wake of the *Challenger* disaster, Logsdon argues that NASA's focus on costs from the beginning compromised crucial technology and allowed budget priorities to degrade the project.

18. Logsdon, "The Decision to Develop the Space Shuttle," pp. 103-118; Working Papers, DoD/DRE, "Space and Space-Related Program Data, Fiscal Years 1979-1986," March 1981, pp. 169-174; Neufeld, *The Air Force in Space, 1970-1974*, pp. 8-9. In the mid-1970s, Shuttle planners predicted that each Shuttle flight would cost \$15.4 million, based on use of five orbiters and an average of 60 flights yearly. By contrast, Titan IIC flight costs were estimated to average \$35 million per flight. See GAO Report, "Issues Concerning the Future of the Space Transportation System," GAO/MASAD-83-6, 28 December 1982, pp. i-iii; Edgar Ulsamer, "Space. High-Flying Yankee Ingenuity," *Air Force Magazine* (September 1976), pp. 98-104.

19. Neufeld, *The Air Force in Space, 1970-1974*, pp. 9-10; History, Space and Missile Systems Organization, 1 July 1972-30 June 1973, pp. 201-206. For discussion of the Vandenberg project, see Roger G. Guillemette, "Vandenberg. Space Shuttle Launch and Landing Site: Part 1—Construction of Shuttle Launch Facilities" *Spaceflight*, Vol 36 (October 1994), pp. 354-357; Roger G. Guillemette, "Vandenberg. Space Shuttle Launch and Landing Site: Part 2—Abandoned in Place" *Spaceflight*, Vol 36 (November 1994), pp. 378-381.

20. McDougall, ... *the Heavens and the Earth*, p. 423.

21. Neufeld, *The Air Force in Space, 1970-1974*, pp. 11-13; History, Space and Missile Systems Organization, 1 July 1973-30 June 1975, pp. 160-192.

22. History, Space and Missile Systems

Organization, 1 July 1973–30 June 1975, pp. 160-192.

23. CINCNORAD to CSAF, subj: Operational Responsibility for Space Transportation System, 25 November 1974, w/atch, Background Paper, "Operation of the Space Transportation System"; Talking Paper, ADCOM/XPDQ, "The Space Transportation System (STS)," 26 April 1978; Neufeld, *The Air Force in Space, 1970-1974*, pp. 13-14.

24. Col Morgan W. Sanborn, "National Military Space Doctrine," *Air University Review*, Vol. xxvii, No. 2, (January-February 1977), pp. 75-79.

25. Working Papers, DoD/DRE, "Space and Space-Related Program Data, Fiscal Years 1979-1986," March 1981, pp. 29-33; Maj Robert E. Lee, *History of the Defense Satellite Communications System (1964-1986)*. Air Command and Staff College Report No. 87-1545 (Maxwell AFB, AL: Air University Press, 1987); The Aerospace Corporation, *The Aerospace Corporation: Its Work: 1960-1980* (Los Angeles: Times Mirror Press, 1980), pp. 56-57; *Aeronautics and Space Report of the President. 1980 Activities* (Washington, D.C.: NASA, 1981), pp. 37-38.

26. Working Papers, DoD/DRE, "Space and Space-Related Program Data, Fiscal Years 1979-1986," March 1981, pp. 145-149; Maj Dennis L. Alford, *History of the Navstar Global Positioning System (1963-1985)*. Air Command and Staff College Report No. 86-0050 (Maxwell AFB, AL: Air University Press, 1986); Lt Col John F. Scheerer and Maj Joseph Gassmann, "Navstar GPS: Past, Present, and Future," *The Navigator* (Winter 1983).

27. Maj Barkley G. Sprague, *Evolution of the Missile Defense Alarm System (MIDAS) 1955-1982*. Air Command and Staff College Report No. 85-2580 (Maxwell AFB, AL: Air University Press, 1985), pp. 27-33.

28. Maj Michael D. Abel, *History of the Defense Meteorological Satellite Program: Origin Through 1982*. Air Command and

Staff College Report No. 87-0020 (Maxwell AFB, AL: Air University Press, 1987), pp. 31-60. Abel describes specific problems encountered by each of the series 5D-1 satellites.

29. Robert Kipp, "Background Paper on Space Detection and Tracking System (SPADATS)," 16 March 1988; AFSPACECOM/HO, "Space Detection and Tracking: A Chronology, 1957-1983," March 1990; Col James E. Strub and Col Thomas S. Moorman, Jr., "Space Surveillance and Detection," Presentation before the American Institute of Aeronautics and Astronautics, 20-21 May 1982.

30. Maj John B. Hungerford, Jr., *Organization for Military Space: A Historical Perspective*. Report No. 82-1235 (Maxwell AFB, AL: Air Command and Staff College, 1982), pp. 57-64.

31. For details on Project 437, see Wayne R. Austerman, *Program 437: The Air Force's First Antisatellite System*, AFSPACECOM/HO, April 1991; Stares, *Militarization of Space*, pp. 120-128; 201-209.

32. Quoted in Stares, *Militarization of Space*, p. 173.

33. Memorandum, DDR&E to Asst SECAF/R&E, subj: Space Surveillance Program Planning, 20 April 1976; Talking Paper, NORAD/XPDQ, "Space Defense," 10 June 1976; Memorandum, SECAF/R&D to ODDR&E, subj: Plan for the Evolution of Space Surveillance Capabilities, 1 June 1976, w/atch, Initial Report. The most important studies included: *A Study of Future Air Force Space Policy and Objectives* (Washington, D.C.: Headquarters USAF, July 1977); *Space Missions Organizational Planning Study (SMOPS)* (Washington, D.C.: Headquarters USAF, February 1979); USAF Scientific Advisory Board (SAB), *The Air Force in Space*, Summer Study (Washington, D.C.: SAB, August 1980); and *Space Policy and Requirements Study (SPARS)* (Washington, D.C.: Headquarters USAF, May 1981).

34. Memorandum, Secretary of Defense to Secretaries of the Military Departments, *et al*, subj: Space Defense Working Group, 4 November 1976.

35. On the Carter administration and defense, see Newhouse, *War and Peace in the Nuclear Age*, pp. 292-332; Gregg Herken, *Counsels of War* (New York: Alfred A. Knopf, 1985), pp. 279-302; Thomas Powers, "Choosing a Strategy for World War III," *The Atlantic Monthly* (November 1982), pp. 82-110.

36. On the "countervailing strategy," see Department of Defense, *Report of Defense Secretary Harold Brown to the Congress on the FY 1981 Budget, FY 1982 Authorization Request and FY 1981-1985 Defense Programs, January 29, 1980* (Washington, D.C.: Government Printing Office, 1980), pp. 65-68.

37. Stares, *Militarization of Space*, pp. 180-182.

38. *Ibid.*, pp. 185-186; Futrell, *Ideas, 1961-1984*, p. 688.

39. One study asserts that the real problem lay not in the directives themselves, but in their enforcement by the always hesitant bureaucracy. While the civilian side moved effectively to implement the elements of PD 42, those on the military side did not. Other institutional issues affecting DoD and the Air Force are also discussed in LTC Neal E. Lamping and LTC Richard P. MacLeod, *Space—A National Security Dilemma: Key Years of Decision* (Washington, D.C.: National Defense University, June 1979).

40. Briefing, AF/XO, "Air Force Space Policy," November 1976.

41. AF/XO to AF/CV, subj: Air Force Space Policy, 29 January 1977.

42. AF/CC to ALMAJCOM/CC, subj: Air Force Space Policy, 9 May 1977; Futrell, *Ideas, 1961-1984*, p. 688. As noted in Chapters 3 and 4, Air Force leaders referred to service policy despite the fact that policy is established by the President and, technically,

DoD sets objectives to achieve that policy.

43. *Future Air Force Space Policy and Objectives*, July 1977.

44. Members of the Space Operations Steering Group included several elements within the Plans and Operations Office: the Director of Operations, Director of Concepts, as well as the Director of Space from the Research and Development office. Although Air Force leaders would continue in future to pursue the "sole agent" objective, by the end of the Carter administration in 1981 enthusiasm had waned considerably. Ultimately, the Air Force would witness the establishment of the a unified command for military space, which it had opposed since the Eisenhower administration.

45. Rick W. Sturdevant, "The United States Organizes for Space: The Operational Quest," in *Organizing for the Use of Space: Historical Perspectives on a Persistent Issue*, ed. Roger D. Launius (San Diego, CA: American Astronautical Society, 1995), pp. 174-175.

46. Robert Kipp, AFSPACECOM/HO, "The Reorganization of 1979 and the Space Organization Issue," 8 March 1988.

47. Under Secretary of the Air Force to CINCNORAD, 9 May 1978.

48. Background Paper, ADCOM/SPDQ, "Need for a USAF Space Operations Command," 8 June 1978.

49. ADCOM Staff Meeting Notes, 11 October 1978.

50. Interview Transcript, Maj Gen Thomas S. Moorman, Jr., with Robert Kipp and Thomas Fuller, 27 July 1988. The nine general officers were Lt Gen A.B. Anderson, Jr., USAF DCS/Operations, Plans and Readiness, Maj Gen H.S. Vandenberg, Jr., USAF DCS/XO, Maj Gen J.R. Bickle, USAF DCS/RD, Maj Gen S.H. Sherman, Jr., USAF DCS/MPM, Maj Gen B.K. Brown, ADCOM DCS/DO, Maj Gen J.E. Kulpa, Jr., SAFSP, Maj Gen L.A. Skantze, AFSC DCS/SD, Maj Gen

D.L. Gray, SAC DCS/XP, and Brig Gen J.R. McCarthy, AFLC DCS/XP.

51. Interview Transcript, Moorman, pp. 3-5; Futrell, *Ideas, 1961-1984*, pp. 689-690; LTC Neal E. Lamping and LTC Richard P. MacLeod, *Space—A National Security Dilemma: Key Years of Decision* (Washington: National Defense University, June 1979), pp. 79-81.

52. Interview, Gen James E. Hill, USAF (Ret.), USAF Oral History Interview by James C. Hasdorff, No. K239.0512-1324, Albert F. Simpson Historical Research Center (Maxwell AFB, AL: Air University, 3-4 May 1982), p. 106.

53. Hungerford, *Organization for Military Space*, pp. 52-55; Kipp, "Trends in Military Space;" History, Space Division, 1 October 1981-30 September 1982, pp. 1-15; Newhouse, *War and Peace in the Nuclear Age*, pp. 304, 318-323.

54. Hungerford, *Organization for Military Space*, pp. 52-55; Kipp, "Trends in Military Space;" History, Space Division, 1 October 1981-30 September 1982, pp. 1-15. See also Chapter 4, pp. 167-168, 170-171, this study.

55. Talking Paper, AF/XOXFD, Space Related Initiatives, 22 October 1979; Hungerford, *Organization for Military Space*, pp. 52-55; Kipp, "Trends in Military Space;" History, Space Division, October 1981-September 1982, pp. 1-15.

56. History, Space Division, 1 October 1981-30 September 1982, pp. 110-115.

57. Paper, AF/XOXFD, Space Related Initiatives, 22 October 1979; History, ADCOM/ADC, 1 January-31 December 1979, pp. 111-115.

58. Hungerford, *Organization for Military Space*, p. 63.

59. Point Paper, AF/XPDS, USAF/XO Corona Fall Briefing, 21 August 1981; Point Paper, AF/XOXFD, Organization for Space, 26 April 1981.

60. John L. McLucas to Dr. Raymond Bisplinghoff, Chairman, Scientific Advisory

Board, 13 August 1980, w/atch, Conclusions and Recommendations.

61. *Ibid.*

62. AF/XO to AF/RD, subj: USAF Scientific Advisory Board Summer Study on Space, 2 January 1981; Interview Transcript, Brig Gen Earl S. Van Inwegen, with Rick W. Sturdevant, 1 November 1995. Van Inwegen provides an insider's account of the evolution of the Air Force's Space Command from his position on General Chain's staff in the Directorate of Operations and Readiness and, from September 1981, the Directorate of Space. According to Van Inwegen, Chain provided much of the momentum behind O'Malley's efforts for space operational reform. Shortly after O'Malley became Deputy Chief of Staff for Operations, Plans and Readiness, Chain had his staff prepare what he called the "Fester" Briefing, which recommended how the Air Force should organize for space and would sit on O'Malley's desk and fester until the latter took action on it.

63. Interview (tape recording), Secretary of the Air Force John L. McLucas, by the author, Washington, D.C., 30 March 1995.

64. Gen Lew Allen, Jr., CSAF, to Dr. Raymond E. Bisplinghoff, Chairman, USAF Scientific Advisory Board, 15 April 1981. General Allen, a physicist, also served in the National Reconnaissance Office. For General Allen's cautious approach to space organizational initiatives, see Interview, General Lew Allen, Jr., USAF (Ret.), USAF Oral History Interview by Dr. James C. Hasdorff, Albert F. Simpson Historical Research Center, No. K239.0512-1694 (Maxwell AFB, AL: Air University, 8-10 January 1986), pp. 163-165.

65. Interview, Lt Gen Richard C. Henry, in *Air Force Magazine*, Vol. 65, No. 6 (June 1982), p. 41.

66. Hungerford, *Organization for Military Space*, pp. 67-68; Futrell, *Ideas, 1961-1984*, pp. 690-691.

67. HQ USAF/XO, *Space Policy and*

Requirements Study (SPARS), 18 May 1981.

68. *Ibid.*; Interview (tape recording), Col Samuel Beamer, ADCOM/XO, USAF (Ret.), by the author, Colorado Springs, CO, 10 July 1991.

69. Point Paper, AF/XPDS, USAF/XO Corona Fall Briefing, 21 August 1981; Point Paper, AF/XOXFD, "Organization for Space," 26 April 1981.

70. Staff Summary Sheet, AF/J5SX, CSAF Tasking on Space Policy and Organization, 15 January 1982; History, Space Command, ADCOM, ADC, 1982, pp. 6-7; Thomas Karas, *The New High Ground: Strategies and Weapons of Space-Age War* (New York: Simon and Schuster, 1983), p. 19; Edward C. Aldridge, Jr., "Defense in the Fourth Dimension," *Defense* 83 (January 1983), pp. 3-10.

71. Staff Summary Sheet, AF/J5SX, CSAF Tasking on Space Policy and Organization, 15 January 1982; History, Space Command, ADCOM, ADC, 1982, pp. 6-7; Thomas Karas, *The New High Ground: Strategies and Weapons of Space-Age War* (New York: Simon and Schuster, 1983), p. 19; Edward C. Aldridge, Jr., "Defense in the Fourth Dimension," *Defense* 83 (January 1983), pp. 3-10; Interview Transcript, Van Inwegen. Although Van Inwegen served as one of the staff officers directed to prepared the "Navajo Blanket," he mistakenly places the event in 1977 during the controversy over ADCOM's demise.

72. Karas, *New High Ground*, p. 19; Futrell, *Ideas, 1961-1984*, pp. 695-696.

73. Henry M. Narducci, *Strategic Air Command and the Space Mission, 1977-1984*, (Offutt AFB, NE: SAC, 10 October 1985), pp. 24-33; History, Space Command, ADCOM, ADC, 1982, pp. 6-11; Aldridge, "Defense in the Fourth Medium," pp. 3-10; Kipp, "Trends in Military Space." In later years, General Hartinger would often cite the West Point connection and friendship with Marsh and Henry as responsible for

important personal initiatives and a relatively smooth decision-making process. See Interview, Gen James V. Hartinger, USAF (Ret.), USAF Oral History Interview by Capt Barry J. Anderson, No. K239.0512-1673, Albert F. Simpson Historical Research Center (Maxwell AFB, AL: Air University, 5-6 September 1985).

74. Narducci, *Strategic Air Command and the Space Mission, 1977-1984*, pp. 24-33; History, Space Command, ADCOM, ADC, 1982, pp. 6-11; Aldridge, "Defense in the Fourth Medium," pp. 3-10; Kipp, "Trends in Military Space." The ad hoc working group found particularly difficult the issue of how to integrate the Consolidated Space Operations Center (CSOC) into the organization structure.

75. Narducci, *Strategic Air Command and the Space Mission, 1977-1984*, pp. 24-33; History, Space Command, ADCOM, ADC, 1982, pp. 6-11; Aldridge, "Defense in the Fourth Medium," pp. 3-10; Kipp, "Trends in Military Space." General O'Malley became Vice Chief of Staff on 1 June 1982.

76. Interview Transcript, Allen, p. 164.

77. Narducci, *Strategic Air Command and the Space Mission, 1977-1984*, pp. 24-33; History, Space Command, ADCOM, ADC, 1982, pp. 6-11; Aldridge, "Defense in the Fourth Medium," pp. 3-10; Kipp, "Trends in Military Space."

78. Narducci, *Strategic Air Command and the Space Mission, 1977-1984*, pp. 24-33; History, Space Command, ADCOM, ADC, 1982, pp. 6-11; Aldridge, "Defense in the Fourth Medium," pp. 3-10; Kipp, "Trends in Military Space."

79. The official news release stated the following: "Creation of Space Command will further consolidate USAF operational space activities, provide a link between the space-related research and development process and operational users, and retain North American Aerospace Defense Com-

mand authority and responsibilities as currently organized. It is the Air Force's hope and belief that Space Command will develop quickly into a unified command." Quoted in History, Space Command, ADCOM, ADC, 1982, pp. 9-10. For details of the O'Malley-Nagler meeting, see Interview Transcript, Van Inwegen. A member of the Space Operations Steering Committee, Van Inwegen noted that, after the proposed public announcement had been taken to General O'Malley for his final review, he was

seen coming out of his office "with his arm around Admiral Nagler's shoulder."

80. Futrell, *Ideas, 1961-1984*, p. 696; Stares, *Militarization of Space*, pp. 180-182.

81. AFM 1-6, Aerospace Basic Doctrine: Military Space Doctrine, 15 October 1982; Futrell, *Ideas, 1961-1984*, p. 696; Stares, *Militarization of Space*, pp. 180-182.

82. History, Space Command, ADCOM, 1983, pp. 51-54; *Space Surveillance Architecture Study*, (Washington, D.C.: Headquarters USAF, 10 June 1983).

Chapter 6. From Star Wars to the Gulf War

1. "Normalize" and "operationalize" become frequently used "buzz" words in the late 1980s and early 1990s to buttress the case for creating an operational focus for military space. For a useful discussion of the space "normalization" movement, see History, Air Force Space Command, January-December 1990, pp. 107-114.

2. History, Space Command, ADCOM, January-December 1983, pp. 2-12; History, Air Force Space Command, January-December 1987, pp. 1-2; Rick W. Sturdevant, "The United States Air Force Organizes for Space: The Operational Quest," in *Organizing for the Use of Space: Historical Perspectives on a Persistent Issue*, ed. Roger D. Launius (San Diego, CA: American Astronautical Society, 1995), pp. 180-181.

3. At this time, DSP was being used operationally but had not been formally turned over from Air Force Systems Command. History, Space Command, ADCOM, January-December 1983, pp. 2-12; History, Air Force Space Command, January-December 1987, pp. 1-2; Sturdevant, "The United States Air Force Organizes for Space," pp. 180-183.

4. History, Space Division, 1 October 1983-30 September 1984, pp. 242-262; *Aeronautics and Space Report to the President, 1983 Activities* (Washington, D.C.: NASA,

1984), pp. 29-30; *Aeronautics and Space Report to the President, 1984 Activities* (Washington, D.C.: NASA, 1985), pp. 39-40.

5. History, Space Division, 1 October 1983-30 September 1984, pp. 211-238.

6. *Aeronautics and Space Report to the President, 1983 Activities* (Washington, D.C.: NASA, 1984), pp. 27-29; *Aeronautics and Space Report to the President, 1984 Activities* (Washington, D.C.: NASA, 1985), pp. 37-39; United States General Accounting Office Report, DoD Acquisition. *Case Study of the MILSTAR Satellite Communications System*, 31 July 1986; Point Paper, AFSPACECOM/KRQS, "MILSTAR," 27 March 1984; Background Paper, AFSPACECOM/SIMRS, "MILSTAR Issues," 18 November 1985; "Milstar Satellite Project Under Watchful Eye," *Defense Electronics* (June 1986), p. 64.

7. History, Space Division, 1 October 1983-30 September 1984, pp. 179-205; *Aeronautics and Space Report to the President, 1983 Activities* (Washington, D.C.: NASA, 1984), p. 29; *Aeronautics and Space Report to the President, 1984 Activities* (Washington, D.C.: NASA, 1985), p. 39. NASA's PAM-DII comprised one of three solid-fueled upper stage vehicles under development at this time. NASA built the PAM for relatively light payloads designed for flight aboard the Shuttle or Delta booster. The other two were

the Air Force's Inertial Upper Stage (IUS) for heavier payloads, and the jointly procured modified Centaur upper stage for use with the heaviest payloads and interplanetary missions. History, Space Division, 1 October 1983–30 September 1984, pp. 98-99; History, Space Division, October 1985–September 1986, p. 73.

8. Following a reassessment of space system requirements after the *Challenger* tragedy, on 17 February 1988, Secretary of Defense Frank Carlucci authorized an expansion of the GPS space segment to 24 satellites, consisting of 21 active and three on-orbit spares. History, Air Force Space Command, January–December 1988, p. 148.

9. Commander, Space Command to Commander-in-Chief, SAC, 20 January 1983; Memorandum, AFSPACECOM, Director, Space to DCS/Plans, subj: Resource Management, 22 March 1984; Commander-in-Chief, SAC to Commander, Space Command, 26 April 1984, w/Point Paper, "Command Missions and Resource Management."

10. Commander, Space Command to Commander-in-Chief, SAC, 18 June 1984.

11. History, Space Division, October 1984–September 1988, pp. 11-12; Sturdevant, "The United States Air Force Organizes for Space," p. 180.

12. History, Air Force Space Command, January–December 1987, pp. 144-148; AFSPACECOM/HO, *Aerospace Defense: A Chronology of Key Events, 1945–90*, 1 October 1991, p. 68.

13. In 1987 DoD issued a new policy on space launch that designated expendable launch vehicles rather than the Shuttle the primary military launch vehicles. As a result, the Shuttle Operations and Planning Complex in the CSOC was no longer needed. In December 1986, Air Force headquarters had decided to delete funding for the CSOC, and in early 1987 directed complete phaseout of the development program by October of

that year. History, Air Force Space Command, January–December 1987, pp. 144-148, 162-163; History, Air Force Space Command, January–December 1990, pp. 181-84.

14. History, Space Command, ADCOM, ADC, 1982, p. 10.

15. History, United States Space Command, September 1985 to December 1986, pp. 1-5. See Chapter 5, this study, pp. 196-207 for discussion of events and issues leading to establishment of Space Command.

16. *Ibid.*; Paper, USSPACECOM/HO, "United States Space Command," 17 August 1987; Sturdevant, "The United States Air Force Organizes for Space," p. 184.

17. For the political background to SDI see B. Bruce-Briggs, *The Shield of Faith* (New York, 1988); Sanford Lakoff and Herbert F. York, *A Shield in Space?* (Berkeley, 1989); Stephen J. Cimbala, ed., *Strategic Air Defense* (Wilmington, DE, 1989); Philip M. Boffey and others, *Claiming the Heavens* (New York, 1988); Robert C. Richardson III, USAF (Ret), "High Frontier: 'The Only Game in Town,'" *Journal of Social, Political and Economic Studies* VII, nos. 1 and 2 (1982): 55-66; Speech, Brig Gen Robert R. Rankine, Jr., USAF, Special Assistant for Strategic Defense Initiative, Address to the National Defense Institute, Lisbon, Portugal, 3 June 1985.

18. History, United States Space Command, September 1985 to December 1986, pp. 1-5; Paper, USSPACECOM/HO, "United States Space Command," 17 August 1987; Sturdevant, "The United States Air Force Organizes for Space," p. 184. Air Force Space Command gained responsibility for the SDI Test Facility when DoD in 1985 decided to locate the National Test Facility in the CSOC at Falcon Air Station. History, Air Force Space Command, January–December 1986, pp. 91-92.

19. History, United States Space Command, September 1985 to December 1986, pp. 1-5; Background Paper, USSPACECOM/

HO, "United States Space Command," 17 August 1987.

20. Gen Robert T. Herres replaced the retiring Hartinger on 30 July 1984. With the formation of U.S. Space Command, Herres briefly wore four hats, as Space Command commander and Aerospace Defense Command, NORAD, and U.S. Space Command commander-in-chief. Shortly thereafter, on 1 October 1986, Air Force Space Command received a separate commander, Maj Gen Maurice C. Padden, while on 19 December 1986, Aerospace Defense Command was inactivated. Air Force Space Command and U.S. Space Command would remain separated until 23 March 1992. AFSPACECOM/HO, *Aerospace Defense: A Chronology of Key Events, 1945-90*, 1 October 1991, pp. 63-66; History, Air Force Space Command, January-December 1993, pp. 14-15.

21. History, Air Force Space Command, January-December 1989, pp. 15-16.

22. History, Space Command, ADCOM, January-December 1983, pp. 52-54; History, Space Command, ADCOM, January-December 1984, pp. 87-88; Point Paper, AFSPACECOM/XPXX, "USAF Space Plan," 20 January 1988.

23. For a comprehensive discussion of the Space Plan before and after the *Challenger* accident, see History, Air Force Space Command, January-December 1986, pp. 79-91.

24. *Ibid.*

25. *Ibid.* A revised mission statement did not receive approval until 14 May 1990.

26. History, Air Force Space Command, January-December 1986, pp. 128-132; History, Space Division, October 1985-September 1986, pp. xxxiii, 55-56, 60, 132. See also John M. Logsdon and Ray A. Williamson, "U.S. Access to Space," *Scientific American*, Vol. 260, No. 3 (March 1989), pp. 34-40.

27. History, Space Division, October 1985-September 1986, pp. 60-67; "Challenger Panel is Seen Rebuking NASA Officials," *Wall*

Street Journal, 12 May 1986, p. 2. For literature focusing on the Shuttle tragedy, see Roger D. Launius, "Toward an Understanding of the Space Shuttle: A Historiographical Essay," *Air Power History* (Winter 1992), pp. 15-18.

28. History, Space Division, October 1985-September 1986, pp. 60-67; History, Air Force Space Command, January-December 1986, pp. 128-132; Logsdon and Williamson, "U.S. Access to Space," pp. 34-36.

29. GAO Report, Report to the Chairman, Committee on Government Operations, House of Representatives, *Implications of Joint NASA/DoD Participation in Space Shuttle Operations*, GAO/NSIAD-84-13, 7 November 1983, pp. 3-21; Edgar Ulsamer, "Space. High-Flying Yankee Ingenuity," *Air Force Magazine* (September 1976), pp. 98-104.

30. GAO Report, *Implications of Joint NASA/DoD Participation in Space Shuttle Operations*, pp. 3-21; History, Space Division, 1 October 1982-30 September 1983, pp. 68-72.

31. GAO Report, *Implications of Joint NASA/DoD Participation in Space Shuttle Operations*, pp. 3-21; Statement by Dr. William J. Perry, Under Secretary of Defense for Research and Engineering before the Senate Subcommittee on Science, Technology, and Space, 4 June 1979; Edgar Ulsamer, "Space Shuttle Mired in Bureaucratic Feud," *Air Force Magazine* (September 1980), pp. 72-77; GAO Report, *Issues Concerning the Future Operation of the Space Transportation System*, GAO/MASAD-83-6, 28 December 1982, pp. i, iii, 3, 12.

32. Interest Paper, USSPACECOM/J5SX, "Mixed Fleet," 7 October 1987.

33. History, Space Division, 1 October 1982-30 September 1983, pp. 68-72; Ulsamer, "Space Shuttle Mired in Bureaucratic Feud," pp. 72-77; Interest Paper, ADCOM/NORAD, "Liquid Upper Stage (Centaur)," 7 June 1982.

34. GAO Report, *Issues Concerning the Future Operation of the Space Transportation*

System, pp. i, iii, 3, 12.

35. Interest Paper, USSPACECOM/J5SX, "Mixed Fleet," 7 October 1987; Presentation, Edward C. Aldridge, Jr., Under Secretary of the Air Force, Address to the National Space Club, 18 November 1981; "NASA Shouldn't Operate Shuttle, AF Under Secretary Says," *Aerospace Daily*, Vol. 112, No. 14, 20 November 1981, p. 105.

36. History, Space Division, 1 October 1983–30 September 1984, pp. 88–95; Point Paper, AFSPACECOM/XPSS, "Space Transportation System, 13 February 1984." The Atlas II would have the capability of launching 14,5000 pounds to a 100-nautical mile easterly orbit, and 6,100 pounds into a geosynchronous transfer orbit. GAO Fact Sheet, "Military Space Programs: An Unclassified Overview of Defense Satellite Programs and Launch Activities," GAO/NSIAD-90-154FS, p. 54.

37. Memorandum, Secretary of Defense for the Secretaries of the Military Departments, *et al*, subj: Defense Space Launch Strategy, 7 February 1984.

38. History, Space Division, 1 October 1983–30 September 1984, pp. 88–95; Draft Memorandum, Glynn Lunney to General Beer, 2 December 1983. On the issue of "militarization," see for example, "A New Image for the Space Shuttle," *Science*, 18 January 1985, pp. 276–277; William J. Broad, "As Shuttle Orbits, a Debate Grows Over Military's Role," *The New York Times*, 6 October 1985.

39. Logsdon and Williamson, "U.S. Access to Space," pp. 34–40; Tom Dworetzky, "The Launch Gap," *Discover* (July 1988), pp. 54–62; William J. Broad, "Pentagon Leaves the Shuttle Program," *The New York Times*, 7 August 1989, pp. 5–6.

40. History, Space Division, 1 October 1983–30 September 1984, pp. 88–95; Memorandum, Secretary of the Air Force to Secretary of Defense, subj: DoD Space

Launch Vehicles—Decision Memorandum," May 1994.

41. U.S. House, *Assured Access to Space During the 1990s*, Joint Hearings Before the Subcommittee on Space Science and Applications of the Committee on Armed Services, 99th Congress, 1st Session, 23, 24, 25 July 1985, pp. 43–46, 52–54, 91–98, 143–145.

42. History, Space Division, October 1986–September 1987, pp. 69–75.

43. For example, see the articles under the general heading, "National Security and the U.S. Space Program After the *Challenger* Tragedy," by Albert D. Wheelon, "Pete" Aldridge, Richard R. Colino, Richard L. Garwin, Hans Mark, Bruce Murray, and James A. Van Allen in *International Security*, Vol. 11, No. 4 (Spring 1987), pp. 141–186.

44. The booster companies found it difficult to retool quickly for production. History, Space Division, October 1985–September 1986, pp. 60–67; Dworetzky, "The Launch Gap," pp. 54–62.

45. History, Space Division, October 1985–September 1986, pp. 60–67; Dworetzky, "The Launch Gap," pp. 54–62; Logsdon and Williamson, "U.S. Access to Space," pp. 34–40; Air Staff Transition Papers, HQ USAF/DOSS, "DoD Space Launch Systems," 16 December 1988; William Welling, "Questions Remain for Space Command," *Advanced Propulsion* (February/March 1986), pp. 26–30.

46. History, Space Division, October 1987–September 1988, pp. 49–51; History, Space Division, October 1985–September 1986, pp. 60–67; History, Space Division, October 1986–September 1987, pp. xli–xliii; History, Air Force Space Command, January–December 1986, pp. 128–132; Dworetzky, "The Launch Gap," pp. 54–62; Logsdon and Williamson, "U.S. Access to Space," pp. 34–40; Air Staff Transition Papers, "DoD Space Launch Systems," 16 December 1988; Welling, "Questions

Remain for Space Command,” pp. 26-30. The Air Force awarded a Delta II contract to McDonnell Douglas in January 1987. The first of 13 Titan IIs were expected to be operational in 1988. The Delta II, with PAM D upper stage, would prove capable of launching nearly 1900 pounds to Navstar GPS’s 10,900-nautical mile altitude transfer orbit, and 11,100 pounds to an 100-nautical mile easterly orbit. GAO Fact Sheet, “Military Space Programs, p. 58; Edward H. Kolcum, “First USAF/McDonnell Douglas Delta 2 Launch Begins New Military Space Era.” *Aviation Week & Space Technology*, 20 February 1989.

47. History, Space Division, October 1987–September 1988, pp. 49-51; History, Space Division, October 1985–September 1986, pp. 60-67; History, Space Division, October 1986–September 1987, pp. xli-xliii; History, Air Force Space Command, January–December 1986, pp. 128-132; Dworetzky, “The Launch Gap,” pp. 54-62; Logsdon and Williamson, “U.S. Access to Space,” pp. 34-40; Air Staff Transition Papers, “DoD Space Launch Systems,” 16 December 1988; Welling, “Questions Remain for Space Command,” pp. 26-30.

48. History, Air Force Space Command, January–December 1987, pp. 98-100; Memorandum, HQ USAF/Chief Space C3 & EC Division, Directorate of Programs & Eval, subj: Air Force Space Policy White Paper, 6 July 1987, w/atch, “White Paper on Air Force Space Policy.” It should be noted that other important studies appeared at this time to help generate support for space in the Air Force. For example, the Chief of Staff in 1985 established an Aerospace Forum consisting of major command plans chiefs to examine whether the “aerospace force should perform its roles and missions with space fully integrated.” After an initial report in May 1986, the Aerospace Forum seemed to succumb to later, more important

initiatives. HQ USAF/XO, Aerospace Forum Report, 22 May 1986.

49. History, Air Force Space Command, January–December 1987, pp. 98-100; Memorandum, HQ USAF/Chief Space C3 & EC Division, Directorate of Programs & Eval, subj: Air Force Space Policy White Paper, 6 July 1987, w/atch, “White Paper on Air Force Space Policy.”

50. History, Air Force Space Command, January–December 1987, pp. 98-100; Memorandum, HQ USAF/Chief Space C3 & EC Division, Directorate of Programs & Eval, subj: Air Force Space Policy White Paper, 6 July 1987, w/atch, “White Paper on Air Force Space Policy.” By the fall of 1987 the Air Force had a draft policy letter well underway, and on 19 October 1987, Air Force Space Command received a new, three-star commander, Lt Gen Donald J. Kutyna.

51. History, United States Space Command, January 1987 to December 1988, p. xvii.

52. *Ibid.*, pp. 56-60.

53. *Ibid.*, p. 245.

54. *Ibid.*, pp. 242-249; History, Air Force Space Command, January–December 1987, pp. 130-135. To assist the process, Air Force Space Command’s operations staff created STOPLIGHT, a satellite systems analysis model that would indicate coverage gaps by projecting the on-orbit satellite constellation status through 1994.

55. History, Air Force Space Command, January–December 1987, pp. 135-136; History, United States Space Command, January 1987 to December 1988, pp. 242-249; Point Paper, AFSPACECOM/XPSS, “Operational Space Launch,” 16 October 1987. Also see the discussion of launch strategy in U.S. Senate, *Air Force Space Launch Policy and Plans*, Hearing Before the Subcommittee on Strategic Forces and Nuclear Disarmament of the Committee on Armed Services, 100th Congress, 1st Session, 6 October 1987.

56. Paper, AFSPACECOM, “Point Paper on

Transfer of Space Launch Operations to AFSPACECOM," 8 October 1987; History, Air Force Space Command, January–December 1990, pp. 81-84.

57. Background Paper, AFSPACECOM/XPSS, "Military Man in Space (MMIS)," 28 September 1989, w/Briefing, same subject, 25 September 1989; History, Air Force Space Command, January–December 1986, pp. 126-128; History, Space Division, October 1987–September 1988, pp. 617-620; History, Air Force Space Command, January–December 1988, pp. 136-140; History, Air Force Space Command, January–December 1989, p. 161.

58. History, Air Force Space Command, January–December 1990, pp. 81-84.

59. History, Space Division, October 1987–September 1988, pp. 547-554.

60. *Ibid.*; History, Space Division, October 1988–September 1989, pp. 588-591, 632-635. See also Gen John L. Piotrowski, "C3I for Space Control," *Signal* (June 1987), pp. 23-33; Gen John L. Piotrowski, "The Right Space Tools," *Military Forum* (March 1989), pp. 46-48.

61. History, Air Force Space Command, January–December 1988, pp. 91-97; Point Paper, AFSPACECOM/XPXX, "CSAF Blue Ribbon Panel on Space Status Briefing," 26 November 1990, w/Briefing, "Blue Ribbon Panel Status," 27 November 1990.

62. History, Air Force Space Command, January–December 1988, pp. 91-97; Point Paper, AFSPACECOM/XPXX, "CSAF Blue Ribbon Panel on Space Status Briefing," 26 November 1990, w/Briefing, "Blue Ribbon Panel Status," 27 November 1990.

63. The "roadmap" format was a common approach taken by major Air Force commands to establish priorities and actions. History, Air Force Space Command, January–December 1988, pp. 91-97; Point Paper, AFSPACECOM/XPXX, "CSAF Blue Ribbon Panel on Space Status Briefing,"

26 November 1990, w/Briefing, "Blue Ribbon Panel Status," 27 November 1990; History, Air Force Space Command, January–December 1989, pp. 91-100; History, Space Division, October 1988–September 1989, pp. 573-574.

64. History, Air Force Space Command, January–December 1989, pp. 91-100.

65. Background Paper, AFSPACECOM/XPSS, "Transfer of Functions [From 'discussion book' senior executive offsite at USAF Academy, 9 January 1990]," 12 December 1989; History, United States Space Command, January 1987 to December 1988, pp. 207-210; History, Air Force Space Command, January–December 1988, pp. 125-129; History, Air Force Space Command, January–December 1989, pp. 15-18. Although Air Force Space Command initiated planning for the transfer of the Cheyenne Mountain operations centers, the transfer itself never took place, the action having been disapproved by U.S. Space Command.

66. For discussion of the ALS, see History, Air Force Space Command, January–December 1987, pp. 133-135; History, Air Force Space Command, January–December 1988, pp. 140-144; History, Air Force Space Command, January–December 1989, pp. 153-159; History, Air Force Space Command, January–December 1990, pp. 156-159; History, Space Division, October 1986–September 1987, pp. 69-75; History, Space Division, October 1987–September 1988, pp. 115-134; History, Space Division, October 1989–September 1990, pp. 754-805; Dworetzky, "The Launch Gap," pp. 54-62; Logsdon and Williamson, "U.S. Access to Space," pp. 34-40; Richard DeMeis, "Sweetening the orbital bottom line," *Aerospace America* (August 1988), pp. 26-30; Commander-in-Chief, USSPACECOM to Vice Chairman, JCS, [Mission Need Statement for ALS], 6 September 1989.

67. History, Air Force Space Command,

January–December 1988, pp. 142.

68. OSD/Acquisition, *Report of the Defense Science Board 1989 Summer Study on National Space Launch Strategy*, March 1990, pp. 1-38; History, Air Force Space Command, January–December 1990, pp. 156-159.

69. History, Space Division, October 1988–September 1989, pp. 55-57; Aeronautics and Space Report of the President. 1988 *Activities* (Washington: NASA, 1989), p. 71; Speech, Maj Gen Thomas S. Moorman, Jr., Director, Space and SDI Programs, Office of the Secretary of the Air Force (Acquisition) to the National Space Club, Washington, D.C., 25 January 1989.

70. Paper, AFSPACECOM, “Point Paper on Transfer of Space Launch Operations to AFSPACECOM,” 8 October 1987; History, Air Force Space Command, January–December 1990, pp. 81-84; Presentation, Maj Gen Thomas S. Moorman, Jr., Director, Space and SDI Programs, Office of the Secretary of the Air Force (Acquisition) to the National Space

Club, Washington, D.C., 25 January 1989.

71. History, Air Force Space Command, January–December 1990, pp. 84-87. For discussion of the “blue suit” issue between SAC and AFSPACECOM, see Background Paper, AFSPACECOM/HO, “Transfer of DMSP Launch Operations to AFSC,” 26 February 1990.

72. History, Air Force Space Command, January–December 1990, pp. 87-96; History, Space Division, October 1988–September 1989, pp. 14-25.

73. History, Air Force Space Command, January–December 1990, pp. 96-114; Secretary Rice is quoted on pp. 103-104.

74. Quoted in History, Air Force Space Command, January–December 1990, pp. 106-107.

75. History, Air Force Space Command, January–December 1990, p. xv.

76. AFSPACECOM/IM, “Air Force Space Command 1989 Posture Statement,” n.d. [1989].

Chapter 7. Coming of Age

1. For general military and political studies of the Gulf War, see Dilip Hiro, *Desert Shield to Desert Storm: The Second Gulf War* (New York: Routledge, 1992) and Bruce W. Watson, ed., *Military Lessons of the Gulf War* (London: Greenhill Books, 1991). Also see “Introduction” by Defense Secretary Dick Cheney to the Interim Report to Congress on the Conduct of the Persian Gulf Conflict, July 1991, reprinted in *Defense Issues*, Vol. 6, No. 32, pp. 1-8.

2. Hiro, *Desert Shield to Desert Storm*, “Part II, The Crisis;” Watson, ed., *Military Lessons of the Gulf War*, “Part II. Diplomacy.” Cheney, “Interim Report to Congress on the Conduct of the Persian Gulf Conflict;” OSAF, *Draft Report on Space Forces and National Security*, 23 September 1993; Office of the Chief of Staff of the Air Force, *Blue Ribbon Panel on the Air Force in Space in the*

21st Century, ca. February 1993, pp. 1-4 (hereafter cited as *Blue Ribbon Panel Executive Summary*).

3. *Blue Ribbon Panel Executive Summary*, pp. 1-4.

4. By 1991 defense funding in real terms had declined every year since 1986. To support the Gulf War, Congress authorized an emergency supplemental appropriation of \$3.5 billion, which would not influence continued programmed future budget reductions. Dov S. Zahkeim, “Top Guns: Rating Weapons Systems in the Gulf War,” *Policy Review* (Summer 1991), p. 14.

5. For a discussion of “Lessons Learned,” see below, pp. 262-271.

6. Shortly after the conflict, commentators referred to Desert Storm as the first space war. Although also used by Air Force leaders such as Chief of Staff General Merrill

McPeak, the phrase was largely a journalistic label used to highlight the visible use of space systems in support of warfighting during the Gulf War. The term came to be viewed as misleading, incorrect, and somewhat threatening from the military perspective. For assessment of military usage, see George W. Bradley III, AFSPACECOM/HO, *AFSPACECOM Support to Operations Desert Shield/Desert Storm*, April 1993. See the discussion in James W. Canan, "A Watershed in Space," *Air Force Magazine* (August 1991), pp. 34-37; Sir Peter Anson BT and Dennis Cummings, "The First Space War: The Contribution of Satellites to the Gulf War," *RUSI Journal* (Winter 1991), pp. 45-53.

7. *Draft Report on Space Forces and National Security*, pp. 5-6; USSPACECOM/HO, "Space Operations: A Decade of Support to Military/Humanitarian Contingencies/Operations (1983-1993)," June 1993.

8. Anson and Cummings, "The First Space War," p. 45.

9. Col Alan D. Campen, USAF (Ret), "Gulf War's Silent Warriors Bind U.S. Units Via Space," *Signal* (August 1991), pp. 81-84; Anson and Cummings, "The First Space War," pp. 46-48; "Satcoms success story," *Space Markets* Vol. 4, 1991, pp. 10-11; USSPACECOM, *United States Space Command Operations Desert Shield and Desert Storm Assessment*, January 1992, pp. 47-55 (hereafter cited as *USSPACECOM Assessment*); Center for Army Lessons Learned, *The Ultimate High Ground! Space Support to the Army/Lessons from Operations Desert Shield and Storm* (Fort Leavenworth, KS: U.S. Army Combined Arms Command, October 1991), pp. 15-17 (hereafter cited as *The Ultimate High Ground: Space Support to the Army*).

10. *USSPACECOM Assessment*, pp. 47-55; *The Ultimate High Ground: Space Support to the Army*, pp. 15-17. Two experimental polar orbiting MACSATs (Multiple Access Com-

munications Satellites) supported Marine communications requirements. Anson and Cummings, "The First Space War," p. 46.

11. *Aeronautics and Space Report of the President: 1989-1990 Activities* (Washington, D.C.: NASA, 1991), p. 62.

12. This description of DSCS in Desert Storm is based in large part on, AFSPACECOM/HO, History of Air Force Space Command, January-December 1990, pp. 151-155. The Defense Communications Agency was renamed the Defense Information Systems Agency (DISA) on 25 June 1991.

13. Dwayne A. Day, "A Review of Recent American Military Space Operations," *Journal of the British Interplanetary Society*, Vol. 46 (1993), pp. 468-469. Unlike DSCS II, DSCS III satellites included a specific anti-jamming feature to protect the AFSATCOM transponder it carried.

14. History, Air Force Space Command, January-December 1990, pp. 153-154.

15. *Ibid.*, p. 154; *USSPACECOM Assessment*, p. 61.

16. History, Air Force Space Command, January-December 1990, pp. 154-155; Anson and Cummings, "The First Space War," p. 46; *USSPACECOM Assessment*, pp. 25-28.

17. Anson and Cummings, "The First Space War," pp. 46-48. The Leasat positions were: L1 and L2 at 105 degrees west, L3 at 177 degrees west, and L5 at 178 degrees west. Day, "A Review of Recent American Military Space Operations," p. 469.

18. History, Air Force Space Command, January-December 1990, pp. 137-139; Anson and Cummings, "The First Space War," p. 48.

19. History, Air Force Space Command, January-December 1990, pp. 137-139; Anson and Cummings, "The First Space War," p. 48; *USSPACECOM Assessment*, pp. 25-28. Two-dimensional required three satellites in view from the ground, and three-dimensional coverage necessitated four.

20. History, Air Force Space Command,

January–December 1990, pp. 137-139; *USSPACECOM Assessment*, pp. 25-28.

21. History, Air Force Space Command, January–December 1990, pp. 140-141; *The Ultimate High Ground: Space Support to the Army*, pp. 1-2; *USSPACECOM Assessment*, pp. 28-31; Anson and Cummings, "The First Space War," p. 50; Barry Miller, "GPS Proves Its Worth in Operation Desert Storm," *Armed Forces Journal International* (April 1991), pp. 16-20.

22. History, Air Force Space Command, January–December 1990, pp. 140-141; *The Ultimate High Ground. Space Support to the Army*, pp. 1-2; Anson and Cummings, "The First Space War," p. 50; Barry Miller, "GPS Proves Its Worth in Operation Desert Storm," *Armed Forces Journal International* (April 1991), pp. 16-20. Approximately 4500 receivers actually saw service during Desert Storm, and more than 90% of these were commercial sets. Of the 5000 available, the Army used 3710 commercial and 557 military receivers. For the Navy the figures are 130 and 85, respectively; for the Air Force, 150 and 190, respectively. See *USSPACECOM Assessment*, p. 29.

23. *USSPACECOM Assessment*, pp. 28-31; Dwayne A. Day, "Transformation of National Security Space Programs in the Post-Cold War Era," Presentation to the 45th Congress of the International Astronautical Federation, 9–14 October 1994, Jerusalem, Israel, 11-12; Anson and Cummings, "The First Space War," p. 50.

24. *USSPACECOM Assessment*, p. 36.

25. History, Air Force Space Command, January–December 1990, pp. 141-143.

26. *Ibid.*, pp. 143-145; Day, "A Review of Recent American Military Space Operations," p. 472; *USSPACECOM/SPJ3OS*, "Point Paper on DMSP Performance in Desert Storm," 20 February 1992.

27. History, Air Force Space Command, January–December 1990, pp. 144-145;

USSPACECOM/SPJ3OS, "Point Paper on DMSP Performance in Desert Storm," 20 February 1992; *USSPACECOM Assessment*, p. 35.

28. History, Air Force Space Command, January–December 1990, pp. 144-145.

29. *The Ultimate High Ground: Space Support to the Army*, pp. 5-8; *USSPACECOM/SPJ3OS*, "Point Paper on DMSP Performance in Desert Storm," 20 February 1992; *USSPACECOM Assessment*, pp. 35-38.

30. Department of Defense, Final Report to Congress, *Conduct of the Persian Gulf War*, Appendices A-S, April 1992, pp. K-40, K-41.

31. *The Ultimate High Ground: Space Support to the Army*, pp. 9-13; *USSPACECOM Assessment*, pp. 35-38; Anson and Cummings, "The First Space War," pp. 52-53.

32. *The Ultimate High Ground: Space Support to the Army*, pp. 9-13; *USSPACECOM Assessment*, pp. 35-38.

33. *The Ultimate High Ground: Space Support to the Army*, pp. 9-13; *USSPACECOM Assessment*, pp. 35-38. It is estimated the Pentagon spent close to \$6 million for Landsat and SPOT imagery during the conflict. "Civil Remote-Sensing Data Played Key Gulf War Role," *Space News*, 8–14 July 1991, pp. 3, 29.

34. *USSPACECOM Assessment*, p. 43.

35. Day, "A Review of Recent American Military Space Operations," pp. 465-468; John H. Cunningham, "The Role of Satellites in the Gulf War," *The Journal of Practical Applications in Space*, Vol. 2, No. 3 (Spring 1991), pp. 57-58. Prior to Desert Storm, DSP had been used to monitor Iraqi Scud launches in the Iran-Iraq War in the 1980s, and Constant Source terminals had been tested in European exercises and certified only six months prior to the Gulf conflict. Anson and Cummings, "The First Space War," p. 51.

36. Day, "A Review of Recent American Military Space Operations," pp. 465-468; John H. Cunningham, "The Role of

Satellites in the Gulf War," *The Journal of Practical Applications in Space*, Vol. 2, No. 3 (Spring 1991), pp. 57-58; Anson and Cummings, "The First Space War," p. 51.

37. Day, "A Review of Recent American Military Space Operations," pp. 465-468; John H. Cunningham, "The Role of Satellites in the Gulf War," *The Journal of Practical Applications in Space*, Vol. 2, No. 3 (Spring 1991), pp. 57-58; Anson and Cummings, "The First Space War," p. 51.

38. Cunningham, "The Role of Satellites in the Gulf War," pp. 57-58; Anson and Cummings, "The First Space War," p. 51; AFSPACECOM Draft Briefing, "Space Operations for Desert Shield/Desert Storm," January 1991.

39. Quoted in DoD, Final Report to Congress, *Conduct of the Persian Gulf War*, Appendices A-S, April 1992, p. K-30.

40. "Satcoms success story," *Space Markets* Vol. 4, 1991, p. 10; Memorandum, Deputy DSCS Program Manager, DCA, to Commander, Air Force Space Command, subj: DSCS—A Major Player in DESERT STORM, 7 August 1991.

41. Air Staff, "Space Forces," USAF Input for Defense Guidance on Space, ca. 1992; "Satcoms success story," *Space Markets* Vol. 4, 1991, p. 10; Memorandum, Deputy DSCS Program Manager, DCA, to Commander, Air Force Space Command, subj: DSCS—A Major Player in DESERT STORM, 7 August 1991.

42. *USSPACECOM Assessment*, p. 27.

43. Background Papers, "Background Paper on GPS Contributions to Desert Storm," and "GPS Activity in Desert Storm," in AFSPACECOM, *Desert Storm "Hot Wash,"* 12-13 July 1991; USSPACECOM/HO, *The Role of Space Forces: Quotes from Desert Shield/Desert Storm*, May 1993, p. 8.

44. Quoted in History, Air Force Space Command, January-December 1991, p. 4.

45. Presentation, Lt Gen Thomas S.

Moorman, Jr., "Military Space Systems Utility," Speech delivered to the 28th Space Congress, Cocoa Beach, Florida, 24 April 1991, p. 8; "Satcoms success story," *Space Markets* Vol. 4, 1991, p. 11; "Space Contribution to Weather Support," in AFSPACECOM, *Desert Storm "Hot Wash,"* 12-13 July 1991.

46. *USSPACECOM Assessment*, pp. 35-38; USSPACECOM/SPJ3OS, "DMSP Performance in Desert Storm," 20 February 1992.

47. *USSPACECOM Assessment*, pp. 44-45.

48. Day, "A Review of Recent American Military Space Operations," pp. 459-465; Day, "Transformation of National Security Space Programs in the Post-Cold War Era," pp. 8-9; Anson and Cummings, "The First Space War," pp. 50-51.

49. Day, "A Review of Recent American Military Space Operations," pp. 459-465; Day, "Transformation of National Security Space Programs in the Post-Cold War Era," pp. 8-9; Anson and Cummings, "The First Space War," pp. 50-51. On the other hand, General Schwartzkopf, in testimony before Congress, was not pleased with the bomb damage assessment reports he received from the U.S. intelligence community. See Watson, ed., *Military Lessons of the Gulf War*, "Part II. Diplomacy," p. 152.

50. Day, "A Review of Recent American Military Space Operations," pp. 465-468; Cunningham, "The Role of Satellites in the Gulf War," pp. 57-58; Anson and Cummings, "The First Space War," p. 51.

51. See for example, Watson, ed., *Military Lessons of the Gulf War*, Appendix C: Iraqi Scud Launches During the Gulf War. Watson refers to Gen Merrill McPeak's *Air Campaign* for his figures.

52. Presentation, Lt Gen Thomas M. Moorman, Jr., to Gen E.P. Rawlings Chapter, Air Force Association, Minneapolis, Minnesota, "Space...The Future is Now," 17 October 1991.

53. Day, "Transformation of National

Security Space Programs in the Post-Cold War Era,” pp. 12-13; Paul B. Stares, *The Militarization of Space: U.S. Policy, 1945-1984* (Ithaca: Cornell University Press, 1985), especially chapters 6 and 10. For the Air Force perspective in the early 1990s, see History, Air Force Space Command, January-December 1991, pp. 121-130.

54. Horner and Widnall are quoted in Day, “Transformation of National Security Space Programs in the Post-Cold War Era,” p. 13; see also History, Air Force Space Command, January-December 1991, pp. 121-130.

55. Day, “Transformation of National Security Space Programs in the Post-Cold War Era,” pp. 6-8; History, Air Force Space Command, January-December 1990, pp. 159-163; History, Air Force Space Command, January-December 1991, pp. 130-132. On the need for a ballistic missile defense, see General Horner’s 20 April 1994 testimony before the Senate Armed Services Committee, reprinted as Gen Charles A. Horner, “Space Systems: Pivotal to Modern Warfare,” *Defense* 94 (Issue 4, ca. Fall 1994), p. 24. Also, replying to a query from Senator John McCain, who asked General Horner and several other space leaders for the ten most important lessons emerging from Desert Storm, the General listed as number one the deployment of an operational BMD system. Memorandum, subj: Lessons Learned—Operation Desert Storm, ca. 1 June 1991.

56. Day, “Transformation of National Security Space Programs in the Post-Cold War Era,” pp. 6-8; History, Air Force Space Command, January-December 1990, pp. 159-163; History, Air Force Space Command, January-December 1991, pp. 130-132.

57. Day, “Transformation of National Security Space Programs in the Post-Cold War Era,” pp. 8-9.

58. *Ibid.*; Vice President’s Space Policy Advisory Board, *A Post Cold War Assessment of U.S. Space Policy: A Task Group Report*

(Advance Copy), December 1992, p. vii.

59. Presentation, Lt Gen Thomas S. Moorman, Jr., “Military Space Systems Utility,” Speech delivered to the 28th Space Congress, Cocoa Beach, Florida, 24 April 1991, p. 8; “Space Contribution to Weather Support,” in AFSPACECOM, *Desert Storm “Hot Wash,”* 12-13 July 1991; USSPACECOM/SPJ3OS, “Point Paper on DMSP Performance in Desert Storm,” 20 February 1992.

60. Day, “Transformation of National Security Space Programs in the Post-Cold War Era,” pp. 9-11.

61. *USSPACECOM Assessment*, pp. 45-46; “Need an Advanced Multi-Spectral Imagery (MSI) Capability,” in AFSPACECOM, *Desert Storm “Hot Wash,”* 12-13 July 1991.

62. *USSPACECOM Assessment*, pp. 28-32; Day, “Transformation of National Security Space Programs in the Post-Cold War Era,” pp. 11-12.

63. Day, “A Review of Recent American Military Space Operations,” pp. 465-468; Day, “Transformation of National Security Space Programs in the Post-Cold War Era,” pp. 6-8.

64. Day, “Transformation of National Security Space Programs in the Post-Cold War Era,” pp. 6-8; *USSPACECOM Assessment*, pp. 65-66; Gen Charles A. Horner, “Space Systems. Pivotal to Modern Warfare,” *Defense* 94 (Issue 4, ca. Fall 1994), p. 25; Dwayne Day, “Top Cover: Origins and Evolution of the Defense Support Program, Part 3,” *Spaceflight* Vol. 38 (March 1996), p. 99.

65. Department of Defense, *Annual Report to the President and the Congress, “Space Forces,”* January 1994, pp. 227-228; Day, “Transformation of National Security Space Programs in the Post-Cold War Era,” pp. 6-8.

66. *The Ultimate High Ground: Space Support to the Army*, p. 17; *USSPACECOM Assessment*, pp. 47-53.

67. Day, “Transformation of National Security Space Programs in the Post-Cold

War Era," pp. 3-4.

68. GAO Report, *DoD Acquisition: Case Study of the MILSTAR Satellite Communications System*, 31 July 1986.

69. Roger G. Guillemette, "Battlestar America: Milstar Survives A War With Congress," *Countdown* (November/December 1994), p. 22.

70. James W. Rawles, "Milstar Soars Beyond Budget and Schedule Goals," *Defense Electronics* (February 1989), pp. 66-72; Guillemette, "Battlestar America," p. 19; Day, "Transformation of National Security Space Programs in the Post-Cold War Era," pp. 3-4.

71. Guillemette, "Battlestar America," pp. 22-23; Day, "Transformation of National Security Space Programs in the Post-Cold War Era," pp. 3-4; "Satcoms success story," *Space Markets* Vol. 4, 1991, pp. 11-13; GAO Report, *DoD Acquisition: Case Study of the MILSTAR Satellite Communications System*,

31 July 1986; GAO Report, *Military Satellite Communications: Milstar Program Issues and Cost-Saving Opportunities*, 26 June 1992.

72. "Satcoms success story," *Space Markets* Vol. 4, 1991, p. 13. For the case against small satellites, see Col Owen E. Jensen, "Space Support to Tactical Forces," *Military Review* (November 1992), pp. 64-71.

73. *USSPACECOM Assessment*, pp. 61, 62, 64. The payloads launched between 2 August and 1 December 1990 were: three GPS, one DSP, one DMSF, and one classified.

74. "America's Future in Space," *Space Markets* (1/1991), pp. 20-25; Vice President's Space Policy Advisory Board, *The Future of the U.S. Space Launch Capability: A Task Group Report*, November 1992.

75. Department of Defense, *Annual Report to the President and the Congress, "Space Forces,"* January 1994, p. 226.

Chapter 8. An Air Force Vision for the Military Space Mission

1. Headquarters USAF, *Blue Ribbon Panel of the Air Force in Space in the 21st Century: Executive Summary* (Washington, D.C.: Headquarters USAF, 1992), p. iv, 1-2.

2. *Ibid.*, pp. 3-6.

3. *Ibid.*, pp. 7-8; Presentation, Sheila E. Widnall, Secretary of the Air Force, to the National Security Industrial Association, Washington, D.C. Chapter, 22 March 1994. See especially, Vice President's Space Policy Advisory Board, *The Future of the U.S. Space Launch Capability: A Task Group Report*, November 1992, chaired by E.C. Aldridge, Jr.; Vice President's Space Policy Advisory Board, *A Post Cold War Assessment of U.S. Space Policy: A Task Group Report*, December 1992, headed by Laurel L. Wilkening.

4. *Blue Ribbon Panel Executive Summary*, pp. 9-10.

5. *Ibid.*, pp. 14-20.

6. *Ibid.*, pp. 21-23; Also see AFSPACECOM/HO, *Establishment of the Space Warfare*

Center: A Brief History, ca. 1994.

7. History, Air Force Space Command, January 1992–December 1993, pp. 16, 19.

8. *Blue Ribbon Panel Executive Summary*, pp. 25-26.

9. *Ibid.*, p. 27.

10. Tom Cull, "GAO Frowns on USAF Bid to Lead Space as DoD Officials Pitch Idea on Hill," *Inside the Air Force*, 19 August 1994, p. 3.

11. *Ibid.*

12. Presentation, Gen Merrill A. McPeak, "Spacetalk 94," 16 September 1994, p. 1.

13. *Ibid.*, pp. 2-4.

14. *Ibid.*, pp. 4-6.

15. Office of the Secretary of the Air Force, Policy Letter, "Goals For Our Space Program," October 1994.

16. USAF Air University, *Spacecast 2020*, 22 June 1994; Speech, Gen Michael P. C. Carns, USAF (Ret), Closing Remarks to the National Security Industrial Association Spacecast 2020 Symposium, Washington,

D.C., 9–10 November 1994.

17. Speech, Gen Michael P. C. Carns, USAF (Ret), Closing Remarks to the National Security Industrial Association Spacecast 2020 Symposium, Washington, D.C., 9–10 November 1994.

18. Scientific Advisory Board, *New World Vistas: Air and Space Power for the 21st Century*, 15 vols., December 1995. See especially, “Summary Volume,” and “Space Applications Volume.”

19. Scientific Advisory Board, *New World*

Vistas: Air and Space Power for the 21st Century, “Summary Volume,” December 1995, pp. 3-4, 42-48, 57-64.

20. The report of the AFA group is condensed in, “Facing Up to Space,” *Air Force Magazine* (January 1995), pp. 50-54.

21. *Ibid.*

22. Interview, George W. Bradley, AFSPACECOM/HO, with Gen Charles A. Horner, AFSPACECOM/CC, transcript, “Space in the Gulf War,” 28 January 1993, Peterson AFB, CO.