

## **Appendix F:**

### **Brief Chronology of Facilities Buildup Relating to History of Marshall Space Flight Center (Early 1950s through 1990)**

**1951: The Static Test Tower** (Facility Number 4572) was constructed. It was initially used to conduct 487 tests involving the Army's Jupiter missile. It contained two test positions, and because of its appearance was sometimes called the "T-Tower." It was designed to test rocket systems with a maximum thrust of 500,000 lb. In 1961, the test stand was modified to permit static firing of the Saturn I and Saturn IB stages, which produced a total thrust of 1.6 million pounds. The name of the stand was then changed to the S-IB Static Test Stand and it has also been referred to as the Propulsion and Structural Test Facility. The west side of the stand was used to test the S-I stage. The east side was used to test the S-IB stage. A total of 24 tests were performed on 10 S-I stages while 32 tests were performed on 12 S-IB stages. The west side was also used to test the F-1 engine; 75 F-1 engine tests were performed through July 1968. In 1984, the west side of the test stand was again modified to permit structural tests on the Space Shuttle solid rocket booster. Since its original construction and activation in 1951, a total of 649 tests have been conducted at the facility. The 140-foot-high facility was selected as a National Historic Landmark because it was the first test stand to fire rocket engines in a cluster. The name of the facility was later changed to the Hazardous Structural Test Complex. (MSFC Pamphlet "Propulsion Laboratory, Marshall Space Flight Center," 1989; Memorandum from Grady S. Jobe to Michael D. Wright, January 23, 1997, "Appendix for MSFC History"; Memorandum from B.R. McCullar to Michael Wright, March 10, 1997, "MSFC History, 1960 to 1990.")

**1952: The Redstone Interim Test Stand** (Facility Number 4665), originally called the Ignition Test Stand, was constructed. Now a National Historic Landmark, this is the site where testing was conducted on the modified Redstone missile that launched America's first astronaut, Alan Shepard, into space. This dual position test structure was utilized as a Redstone vehicle center section cold flow facility on one side, and a vehicle hot firing position on the other. A total of 364 static firings were performed, including acceptance testing of Explorer I, Juno I, and Mercury-Redstone launch vehicle stage assemblies. The stand has its own control and instrumentation center which is housed in an earth-covered tank and trailer. The facility is noted for its simplicity when compared to test stands used to fire later generation of rocket engines. The stand is no longer active and was declared a National Historic Landmark in 1977. The steel support tower has a reinforced concrete base. The stand had a thrust capacity of 78,000 lb. (MSFC Pamphlet "Propulsion Laboratory, Marshall Space Flight Center," 1989; Memorandum from Grady S. Jobe to Michael D. Wright,

January 23, 1997, "Appendix for MSFC History"; Memorandum from B.R. McCullar to Michael Wright, March 10, 1997, "MSFC History, 1960 to 1990.")

**1956: The Combustion Test Cells Facility** (Facility Number 4583) was constructed to test liquid rocket engine components. Model rocket engines were fired in all the cells to develop design data for static and launch deflectors. Subscale 1–20 models used in testing included an RL–10 engine, an H–1 engine, an F–1 engine, and a J–2 engine. Tests were also conducted using a 1:56 scale F–1. Full-scale model tests were also conducted for the H–1 and S–3D engine. Modifications followed in 1983 and 1989. In 1987, Cell 103 was modified to support solid rocket ballistic testing. (MSFC Pamphlet "Propulsion Laboratory, Marshall Space Flight Center," 1989)

**1956: The Cold Calibration Test Stand** (Facility Number 4588) was constructed to cold flow test the Redstone engine and associated engine hardware. In 1957, a second test position was added to test the S–3D engine under cold flow conditions. In 1959, the stand was modified to add larger tanks to permit testing of the H–1 engine. At the same time, the north side of the stand was modified to conduct cold flow tests involving the Saturn I. (MSFC Pamphlet "Propulsion Laboratory, Marshall Space Flight Center," 1989)

**1959:** Facilities were completed that would house Marshall's **Structural Test Facilities** (Facility Number 4619). Large high- and low-bay facilities were constructed for structural static and dynamic tests of large and small vehicle components. A load test annex was constructed and later extended. The west end of the building was designed to include a Teleoperator and Robotic Evaluation Facility. Portions of the building have also housed a high-fidelity *Skylab* mock-up, an automated beam building machine, and a large vacuum chamber. The name of the Structural Test Facilities was changed to the Structural and Dynamics Research & Development Test Complex. (Memorandum from Grady S. Jobe to Michael D. Wright, January 23, 1997; MSFC 1996 Facilities Data Book, pages 50–52)

**1963 and 1964:** In 1963 the Marshall Center began construction on the first of a series of buildings in its **Headquarters Complex**. (Facility Numbers, 4200, 4201, 4202). In the early 1990s, construction began on a fourth portion of the complex. This facility would be designated as Building 4203. (1994 Facilities Data Book, p. 26)

**1964: The Saturn V Dynamic Test Stand** (Facility Number 4550) was constructed for low-frequency dynamic testing of the complete Saturn V launch vehicle to evaluate structural frequencies and assure decoupling from the vehicle control system. Various flight configurations were evaluated, including, the complete vehicle, the vehicle less the S-IC stage, S-II stage, etc. In the years that followed the tower was utilized to structurally qualify the *Skylab* orbital workshop and the meteoroid shield deployment for *Skylab*. The facility was modified in 1977 to perform low-frequency vibration tests on the mated Space Shuttle using the orbiter *Enterprise*. The facility was later modified to contain a drop tower and drop tube to provide a low-gravity environment for approximately three seconds. The overall height of the tower was 475 feet. The steel structure was 98 feet wide by 122 feet long by 360 feet high. The stiff leg overhead derrick was 115 feet high with a 200-ton capacity main hook and a 40-ton capacity auxiliary hook. The facility has been referred to as the Saturn V Dynamic Test Stand (Vacuum Drop Tube Facility/Low Gravity Materials Science Facility). (MSFC Pamphlet "Propulsion Laboratory, Marshall Space Flight Center," 1989; Memorandum from Grady S. Jobe to Michael D. Wright, January 23, 1997, "Appendix for MSFC History"; Memorandum from B.R. McCullar to Michael Wright, March 10, 1997, "MSFC History, 1960 to 1990")

**1964: Test Stand 300** (Facility Number 4530) was constructed at the Marshall Center as a gas generator and heat exchanger test facility to support the Saturn/Apollo program. Deep space simulation was provided by a 1969 modification that added a thermal vacuum chamber and a 1981 modification that added a 12-foot vacuum chamber. The facility was again modified in 1989 when 3-foot- and 15-foot-diameter chambers were added to support *Space Station Freedom* and technology programs. The multiposition test stand was used to test a wide range of rocket engine components, systems, and subsystems. It was designed with the capability to simulate launch thermal and pressure profiles. The Marshall Center has used the stand in connection with solid rocket booster/external tank thermal protection system evaluations, solid rocket motor O-ring tests, Space Shuttle main engine injector evaluation tests, Space Station water electrolysis testing, and other programs and projects. (MSFC Pamphlet "Propulsion Laboratory, Marshall Space Flight Center," 1989)

**1964: Test Stand 116** (Facility Number 4540) was constructed and activated as an acoustical research technology model test facility. It was first used to support the Saturn/Apollo program, and then the Space Shuttle program. The stand

was later modified to serve as a multiposition component test stand for programs requiring high-pressure (up to 15,000 psi) ambient and cryogenic propellants. (MSFC Pamphlet “Propulsion Laboratory, Marshall Space Flight Center,” 1989)

**1964:** The Marshall Center constructed the **S-IC Stage Static Test Stand** (Facility Number 4670) to develop and test the first stage of the Saturn V launch vehicle which used five F-1 engines. Each F-1 engine developed 1.5 million pounds of thrust for a total lift-off thrust of 7.5 million pounds. The stand contains 12 million pounds of concrete in its base legs and could accept an engine configuration generating thrusts to that level. Eighteen tests were completed on the S-IC-T stage between April 1965 and August 1966. During 1966, testing was completed on the first three S-IC flight stages.

Modifications to the stand were initiated in 1974 to add a liquid hydrogen capability for testing liquid hydrogen tankage on the Space Shuttle external tank. These tests were completed in 1980. The facility was again modified in 1986 and its name was changed to the Advanced Engine Test Facility. These modifications were made to accommodate the technology test-bed engine that was intended to be a derivative of the Space Shuttle main engine. (MSFC Pamphlet “Propulsion Laboratory, Marshall Space Flight Center,” 1989; Memorandum from Grady S. Jobe to Michael D. Wright, January 23, 1997, “Appendix for MSFC History”; Memorandum from B.R. McCullar to Michael Wright, March 10, 1997, “MSFC History, 1960 to 1990”)

**1964:** Marshall completed and activated the **F-1 Turbopump Test Stand** (Facility Number 4696). The facility was used to perform checkout, calibration, qualification, and research and development tests on the F-1 engine turbopumps for the first stage of the Saturn V. A gas generator-driven F-1 turbopump was attached to an F-1 “bobtail” engine to constitute the test-bed for the reference testing. Testing continued on a regular basis through 1968 at which time the facility was placed on stand-by status. (MSFC Pamphlet “Propulsion Laboratory, Marshall Space Flight Center,” 1989)

**1965:** The Marshall Center activated the **S-IVB Test Stand** (Facility Number 4520) in its East Test Area. The S-IVB served as the second stage of the Saturn IB and the third stage of the Saturn V. The stage utilized the J-2 engine which burned liquid hydrogen as fuel and liquid oxygen as the oxidizer. The S-IVB Test Stand was a liquid oxygen/liquid hydrogen facility designed to static fire

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the S-IVB stage in a vertical mode. The stand was used in 117 static firings. It was designed as an open steel structure capable of accepting stages 22 feet in diameter and 60 feet long, developing thrusts up to 300,000 lb. It was last used for the static firing in 1971 but later utilized for Space Shuttle external tank tests using a 10-foot-diameter tank for thermal protection system development. It was also used for inflatable nozzle technology tests. (MSFC Pamphlet "Propulsion Laboratory, Marshall Space Flight Center," 1989)

**1966: Test Stand 500** was constructed to test liquid hydrogen/liquid oxygen turbopumps and combustion devices for the J-2 engine. The facility was modified in 1980 to support Space Shuttle main engine bearing testing. (MSFC Pamphlet "Propulsion Laboratory, Marshall Space Flight Center," 1989)

**1968:** The Center completed the **Neutral Buoyancy Simulator**. The facility was designed to provide a simulated zero-gravity environment in which engineers, designers, and astronauts could perform, for extended periods of time, the various phases of space development to gain a first-hand knowledge of design problems and operational characteristics. The tank is 75 feet in diameter and 40 feet deep and designed to hold 1.5 million gallons of water. There are four observation levels for underwater audio and video communications. The southwest corner of Building 4705 that houses the facility has a completely equipped test control center for directing, controlling, and monitoring the simulation activities. The simulator was used extensively to prepare astronauts for the *Skylab* missions. It was a vital element in defining rescue procedures for the crippled *Skylab* orbital workshop.

**1968:** In 1964, the Marshall Center instituted a Launch Information Exchange Facility (LIEF) linking Marshall and Kennedy Space Center. LIEF began operating in December 1964 to provide instantaneous launch data concerning the Saturn vehicle. By 1968, the Marshall Center had established the **Huntsville Operations Support Center** located in a portion of its Computation Laboratory (Facility Number 4663). During the Saturn/Apollo missions Marshall Center engineers were stationed at the facility to monitor data received from KSC. The data was evaluated and advice and guidance given through a series of engineering consoles. Engineers monitored the flights in order to deal with any malfunctions or failures in propulsion, navigation, or electrical control. The same facility was a critical element of mission support during the *Skylab* missions. Years later, extensive modifications were made to the facility in Building 4663 in

order to support Space Shuttle missions. (“Marshall Historical Monograph Number 9, History of the George C. Marshall Space Flight Center, January 1–June 30, 1964”; *Marshall Star*, January 10, 1968, “Operations Support Center Helps in Saturn Launches”; Marshall Space Flight Center 25<sup>th</sup> Anniversary Report, p. 27)

**1968:** The Marshall Center built the **High Reynolds Number Wind Tunnel Facility** (Facility Number 4732) later known as the Wind Tunnel Complex. This facility was designed to simulate winds up to Mach 3.5. (1994 MSFC Facilities Data Book, 64; 1996 MSFC Facilities and Equipment Catalog)

**1974:** The Marshall Center was nearing completion of **the Space Shuttle Main Engine Hardware Simulation Laboratory** in Building 4436. The facility was designed to test and verify the SSME avionics and software, control system, and mathematical models. It would serve for years as an invaluable tool in the design and development of the SSME. (*Marshall Star*, October 9, 1974, “SSME Simulation Facility Being Prepared at MSFC”; MSFC Open House Brochure, May 3, 1997)

**1975: The Hot Gas Facility** (Facility Number 4554) was originally built for solid rocket booster and external tank thermal protection system material evaluations. The facility was designed to simulate flight vehicle environments of heating rates, pressures, shear, and other factors. The facility was modified in 1985 to extend the maximum run time from 60 to 180 seconds. Approximately 2,000 tests were performed in the qualification of external tank thermal protection system materials. These tests included testing MSFC sprayable ablative materials used on the solid rocket motors for thermal protection. (MSFC Pamphlet “Propulsion Laboratory, Marshall Space Flight Center,” 1989)

**April 1976:** Marshall’s original X-ray Test Facility was completed. The facility, the only one of its size and type at the time was used for x-ray verification testing and calibration of x-ray mirrors, telescope systems, and instruments. It was initially used to test instruments for Marshall’s High Energy Astronomy Observatory (HEAO) program. The facility was designed with a 1,000-foot-long stainless steel x-ray path guide tube, almost 3 feet in diameter. The tube was connected to a chamber 20 feet in diameter to house the telescopes or other instruments to be tested. In the early 1990s, construction was completed on an improved **X-Ray Calibration Facility** for evaluating the mirrors for the Advanced X-Ray Astrophysics Facility. The facility is designated as Building

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4718. (*Marshall Star*, March 31, 1976, “Huge X-Ray Test Facility to Be Completed Tomorrow”; Memorandum from Grady S. Jobe to Michael D. Wright, January 23, 1987, “Appendix for MSFC History”; Marshall Space Flight Center Master Plan 1992: MSFC Fact Sheet, August 1991, “Marshall X-Ray Calibration Facility”)

**1979:** The Marshall Center began training science crews for missions involving Spacelab. The **Payload Crew Training Complex** in Building 4612 was designed to provide a simulated environment for training Spacelab payload crews in hands-on interaction with Spacelab systems and experiments including Spacelab command and data management systems operations and procedures and timeline verification. (*Marshall Star*, March 26, 1997, “Marshall’s Payload Training Team...”; MSFC Fact Sheet, April 1990, “Payload Crew Training Complex Used for Spacelab Experiment Training”; “Marshall Space Flight Center Open House brochure, May 3, 1997)

**1987: The Transient Pressure Test Article** (Facility Number 4564) test stand was built to provide data to verify the sealing capacity of the redesigned solid rocket motor (SRM) field and nozzle joints. The facility was designed to apply pressure, temperature, and external loads to a short stack of solid rocket motor hardware. The simulated solid rocket motor ignition pressure and temperature transients were by firing approximately 500 pounds of specially configured solid propellant. Approximately 1 million pounds of dead weight on top of the test article simulated the weight of the other Shuttle elements. The steel structure was designed to be 14 feet wide, 26 feet long, and 33 feet high. (MSFC Pamphlet “Propulsion Laboratory, Marshall Space Flight Center”, 1989; Memorandum from Grady S. Jobe to Michael D. Wright, January 23, 1997, “Appendix for MSFC History”; Memorandum from B.R. McCullar to Michael Wright, March 10, 1997, “MSFC History, 1960 to 1990”)

**1990:** Teams of controllers and researchers began controlling all NASA Spacelab missions from Marshall’s new **Spacelab Mission Operations Control Facility**. The new facility was located on two floors of Building 4663 at Marshall and replaced the payload operations control center formerly situated at the Johnson Space Center in Houston from which previous Spacelab missions were operated. (Marshall Space Flight Center Fact Sheet, “Spacelab Mission Operations Control Facility,” May 1990)