5.0 NASA-WIDE SIGNIFICANT HISTORIC PROPERTIES

5.1 Overview of Survey Results

Field survey and evaluation of 335 SSP-related assets located at 13 NASA Centers and component facilities resulted in the identification of 70 (20.9%) assets assessed as individually eligible for listing in the NRHP solely in the context of the SSP. Summary statements of significance for these facilities and properties are provided in Appendix B. Of the 70 significant assets, 24 were previously listed or determined eligible for inclusion in the NRHP under other historic contexts, and 46 (13.7%) were assessed as newly eligible in the context of the SSP (Table 5.1). It should be stressed that NASA owns other properties which are listed or determined eligible for listing in the NRHP. However, because they lack association with the SSP, they were not included as part of this study. Also, the counts for KSC in Table 5.1 are exclusive of assets which are contributing to a historic district, but not individually eligible.

Table 5.1. Previously and Newly Eligible Assets for all NASA Centers.

NASA Center	Total Assets Surveyed	Total NRHP Eligible	Previously Listed/Eligible	Newly Eligible
ARC	11	2	0	2
Canoga Park	5	1	0	1
DFRC	6	1	0	1
GRC	8	2	1	1
JSC	30	11	1	10
KSC	112	26	8	18
LaRC	14	1	0	1
MAF	8	4	1	3
MSFC	41	13	8	5
Palmdale	5	2	1	1
SSC	44	4	4	0
SSFL	37	2	0	2
WSFC/WSSH	14	1	0	1
TOTALS	335	70	24	46

Seven of the 24 previously listed or determined eligible historic properties are designated NHLs:

- Structural Dynamic Test Facility at MSFC
- Multi-Purpose High Bay Facility and Neutral Buoyancy Simulator at MSFC
- Propulsion Test Stand A1 at SSC
- Propulsion Test Stand A2 at SSC
- Propulsion Test Stand B1 at SSC
- Propulsion Test Stand B2 at SSC
- Mission Control Center at JSC

5.2 Distribution by Property Type

As described in Chapter 2, 12 property types were identified for this study:

- Type 1: Resources Associated with Transportation
- Type 2: Vehicle Processing Facilities
- Type 3: Launch Operation Facilities
- Type 4: Mission Control Facilities
- Type 5: News Broadcast Facilities
- Type 6: Communications Facilities
- Type 7: Engineering and Administrative Facilities
- Type 8: Space Flight Vehicle (Space Shuttle)
- Type 9: Manufacturing and Assembly Facilities
- Type 10: Resources Associated with the Training of Astronauts
- Type 11: Resources Associated with Space Flight Recovery
- Type 12: Resources Associated with Processing Payloads

Twenty-four of the historic properties are classified into more that one property type. As a result, the 70 individually NRHP-listed or eligible historic properties represent a total of 98 property type affiliations (Tables 5.2 and 5.3). Twenty-one assets are classified into two property types, two have three property type affiliations, and one is classified into four property groups.

The most commonly occurring property type is Type 7: Engineering and Administrative Facilities (Table 5.2). A total of 26 facilities are classified within this group, of which almost half are located at the MSFC. In descending order of frequency, the other most common property type affiliations are Type 1: Resources Associated with Transportation (N=17); Type 2: Vehicle Processing Facilities (N=12); Type 3: Launch Operation Facilities (N=10); Type 10: Resources Associated with the Training of Astronauts (N=10); Type 11: Resources Associated with Space Flight Recovery (N=7); and Type 9: Manufacturing and Assembly Facilities (N=6). The remaining property types (4, 5, 6, 8, and 12) have less than four affiliations each.

The following section contains summary evaluations of the 70 NRHP-listed and eligible historic properties, arranged by property type. In the cases where NASA assets have multiple affiliations, the historic property is described under its primary functional type.

Table 5.2. Summary Distribution of Property Types by NASA Center.

NASA Center	Assets Surveyed	NRHP Listed/ Eligible	Property Type													Total
				1	2	3	4	5	6	7	8	9	10	11	12	
ARC	11	2								1			1			2
Canoga Park	5	1										1				1
DFRC	6	1		1										1		2
GRC	8	2								2						2
JSC*	30	11				1	1		2	4	3		5			16
KSC	112	26		13	7	9		1	1			4		5	3	43
LaRC	14	1								1						1
MSFC	41	13		1					1	11			1			14
MAF	8	4			4											4
Palmdale	5	2		1	1					1		1				4
SSFL	37	2								2						2
SSC	44	4								4						4
WSTF**	14	1		1									1	1		3
Totals	335	70		17	12	10	1	1	4	26	3	6	8	7	3	98

* Includes Ellington Field
** Includes White Sands Space Harbor (WSSH)

Table 5.3. NRHP-listed and eligible historic properties by property type.

NASA CENTER	FACILITY NO.	FACILITY NAME	APPLICABLE PROPERTY TYPE*											
			1	2	3	4	5	6	7	8	9	10	11	12
ARC	N238	Arc Jet Laboratory							X					
ARC	N243	Flight & Guidance Sim Lab/VMS										X		
CANOGA PARK	N/A	Pacific Scientific Furnace									X			
DFRC	4860	Mate-Demate Device	X										X	
GRC	85-94, 113-114	Abe Silverstein 10 by 10 SWT							X					
GRC	39, 46, 53-57, 59, 61, 138	8 by 6 SWT							X					
JSC	5	Jake Garn Mission Simulator and Training Facility										X		
JSC	7	Crew Systems Laboratory							X			X		
JSC	9	Systems Integration Facility										X		
JSC	16	Avionics Systems Laboratory							X					
JSC	30	Mission Control Center (MCC)			X	X		X				X		
JSC	44	Communications and Tracking Development Lab						X	X					
JSC	222	Atmospheric Reentry Materials and Structures Evaluation Facility (ARMSEF)							X					
JSC	920N	Sonny Carter Training Facility/ NBL										X		
JSC	OV-103	*Discovery*								X				
JSC	OV-104	*Atlantis*								X				
JSC	OV-105	*Endeavour*								X				
KSC	K6-848	Vehicle Assembly Building (VAB)		X										
KSC	K6-900	Launch Control Center (LCC)			X			X						
KSC	N/A	Crawler Transporter (#1)	X		X									
KSC	N/A	Crawler Transporter (#2)	X		X									
KSC	N/A	Crawlerway	X		X									
KSC	N/A	Press Site: Clock and Flag Pole					X							
KSC	J8-1708	LC 39: Pad A			X									
KSC	J7-0337	LC 39: Pad B			X									
KSC		Shuttle Landing Facility (Runway)	X										X	
KSC	J6-2313	Landing Aids Control Building	X										X	

NASA CENTER	FACILITY NO.	FACILITY NAME	APPLICABLE PROPERTY TYPE*											
			1	2	3	4	5	6	7	8	9	10	11	12
KSC	J6-2262	Mate-Demate Device	X										X	
KSC	K6-894	Orbiter Processing Facility (OPF)		X										
KSC	K6-696	Orbiter Processing Facility High Bay 3 (OPF-3)		X							X			
KSC	K6-794	Thermal Protection System Facility									X			
KSC	K6-494	Rotation/Processing Building		X										
KSC	L6-247	SRB ARF Manufacturing Building		X							X			
KSC	M7-961	Hypergol Module Processing (North)		X										
KSC	M7-657	Parachute Refurbishment Facility									X			
KSC	M7-777	Canister Rotation Facility		X										X
KSC	N/A	Payload Canister (#1)	X											X
KSC	N/A	Payload Canister (#2)	X											X
KSC	N/A	Retrieval Ship *Liberty Star*	X										X	
KSC	N/A	Retrieval Ship *Freedom Star*	X										X	
KSC	N/A	Mobile Launcher Platform (MLP) (#1)	X		X									
KSC	N/A	MLP (#2)	X		X									
KSC	N/A	MLP (#3)	X		X									
LaRC	1257, 1257N/S, 1258, 1258A, 1261, 1262	Aircraft Landing Dynamics Facility (ALDF)							X					
MSFC	4436	SSME – HSL Block II Facility							X					
MSFC	4540	Acoustic Model Engine Test Facility 116 (TF 116)							X					
MSFC	4550	Structural Dynamic Test Facility							X					
MSFC	4583	Test and Data Recording Facility							X					
MSFC	4612	Materials and Processes Laboratory							X					
MSFC	4619	Structures, Dynamics and Thermal Vacuum Lab							X					
MSFC	4663	HOSC/NDC						X						
MSFC	4670	Advanced Engine Test Facility							X					
MSFC	4674	Control Facility							X					
MSFC	4705	Multi-Purpose High Bay Facility and NBS							X			X		
MSFC	4707	National Center for Advanced Manufacturing							X					
MSFC	4732	Office and Wind Tunnel Facility (14" Trisonic Wind Tunnel only)							X					
MSFC	N/A	NASA Barge *Poseidon*	X											

NASA CENTER	FACILITY NO.	FACILITY NAME	APPLICABLE PROPERTY TYPE*											
			1	2	3	4	5	6	7	8	9	10	11	12
MAF	110	Vertical Assembly Building		X										
MAF	114	High Bay Addition		X										
MAF	451	Pneumatic Test Facility		X										
MAF	452	Control Building (for 451)		X										
PALM-DALE	150	Shuttle Orbiter Final Assembly Building		X					X		X			
PALM-DALE	N/A	Orbiter Lifting Frame (OLF)	X											
SSFL	218	Coca Control Center (for 733)							X					
SSFL	733	Coca I Test Stand (A-3)							X					
SSC	4120	Propulsion Test Stand A-1							X					
SSC	4122	Propulsion Test Stand A-2							X					
SSC	4210	Propulsion Test Stand B-1							X					
SSC	4220	Propulsion Test Stand B-2							X					
WSSH	N/A	Shuttle Landing Facility (SLF) Runways 17/35, 23/05, and 22/02	X									X	X	
TOTALS			***17***	***12***	***10***	***1***	***1***	***4***	***26***	***3***	***6***	***8***	***7***	***3***

Property Types:
1 Resources Associated with Transportation
2 Vehicle Processing Facilities
3 Launch Operation Facilities
4 Mission Control Facilities
5 News Broadcast Facilities
6 Communications Facilities
7 Engineering and Administrative Facilities
8 Space Flight Vehicle (Space Shuttle)
9 Manufacturing and Assembly Facilities
10 Resources Associated with the Training of Astronauts
11 Resources Associated with Space Flight Recovery
12 Resources Associated with Processing Payloads

5.3 Description of Significant Historic Properties by Property Type

5.3.1 Type 1: Resources Associated with Transportation

A total of 17 NASA-owned historic properties are classified as Type 1 resources:

- SLF Runway at KSC
- SLF Runways at WSSH
- OLF at Palmdale
- MDD at DFRC
- MDD at KSC
- Three MLPs at KSC
- Two Crawler Transporters at KSC
- Two Payload Canisters at KSC
- NASA Barge *Poseidon* (a MSFC asset located at SSC)
- Retrieval ship *Liberty Star* at KSC
- Retrieval ship *Freedom Star* at KSC
- Landing Aids Control Building at KSC
- Crawlerway at KSC

Of these 17 assets, 13 are located at the KSC. The other four transportation-related assets are located at DFRC, SSC, Palmdale, or WSSH. Property Type 1 subsumes a variety of air, land, and water-related buildings, structures and objects such as landing facilities (runways) at KSC and WSSH; mate-demate devices at KSC, DFRC and Palmdale; specialized equipment and vehicle transporters; plus two ships and a barge. Among the multiple resources, the two Payload Canisters, two retrieval ships, and three MLPs, all at KSC, were designed and built to the same specifications (within their group), are identical or near identical in configuration, and are functionally interchangeable. On the other hand, neither the SLF runways at KSC and WSSH, nor the two MDDs and OLF, are identical.

Air-related resources: Subtype Runways

- SLF Runway at KSC
- SLF Runways at WSSH

 KSC SLF Runway, looking north. (Source: Archaeological Consultants, Inc., 2006)	**The KSC SLF Runway** • Built in 1976 to support the SSP • NASA's preferred shuttle landing site, since 1984 • The return from landing site following landing at Edwards AFB • Site where all five orbiters originally arrived from the assembly plant in Palmdale • Used as a practice facility by Shuttle astronauts • Eligible under Criterion A as the primary landing site for the SSP, and under Criterion C for its design and construction. It is one of the largest runways in the world.
 White Sands Space Harbor, Runway 23/05, looking southwest. (Source: White Sands Test Facility, wstf0606e04460)	**The SLF Runways at WSSH** • The three runways, built or modified between the late 1940s and 1986, replicate the shuttle landing runways at KSC (Runway 17/35), Edwards AFB (Runway 23/05), and the Transoceanic Abort Landing (TAL) sites (Runway 20/02). • Runway 17/35 was originally constructed in the late 1940s, and modified for the SSP in 1976. Runway 23/05 was built in 1978 and Runway 20/02 dates to 1986. • Serves as a contingency landing site for the Shuttle orbiter • Provides 70-80% of the Shuttle pilot's Shuttle Training Aircraft (STA) training • Eligible under Criterion A as the only facility in the history of the SSP used on a contingency basis when *Columbia* (STS-3) could not land at Edwards AFB. Also significant as the primary training location for Shuttle pilots and commanders. Under Criterion C, the runways are eligible for their design and construction.

Air-related resources: Subtype Mate/Demate Devices (MDD)

- OLF at Palmdale
- MDD at DFRC
- MDD at KSC

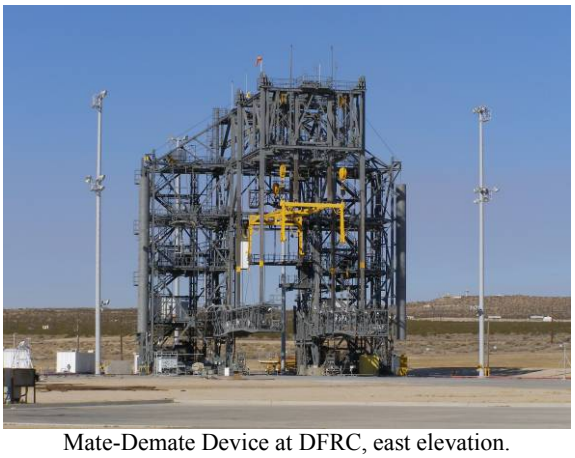
Four MDDs were configured by NASA to support the attachment and detachment of the Shuttle orbiter and SCA. The OLF in Palmdale complements permanent MDDs erected at DFRC and at KSC. It was originally designed to be quickly disassembled, moved, and reassembled at a contingency landing site. NASA also constructed a mobile, derrick-and-crane MDD at the MSFC in Huntsville, Alabama (1976), reusing a stiff-legged derrick from an early 1960s engine test stand. Used at MSFC from 1976 through 1979, NASA subsequently disassembled the improvised mobile MDD in Huntsville and transported its derrick to the WSMR in New Mexico to support the third Shuttle landing in 1982. The mobile MDD, no longer extant, was the precursor to the OLF. The KSC, and its architectural-engineering contractor Connell Associates of Miami, were responsible for the DFRC, KSC, and MSFC/WSMR MDDs of the 1970s. The JSC developed the underlying concept for the OLF.

The MDDs at DFRC and KSC were both designed by Connell Associates. While nearly identical in appearance, the MDD at DFRC is more complex than its counterpart at the KSC, mainly due to some unique personnel safety features required as part of the ALT program. These features include an access/egress route for SCAPE-suited personnel, two personnel hoists, a compressed air system, emergency showers and eye-face wash features, wash down stations, and a deluge system to protect personnel in the event of a hypergol spill or ground-level fire. The DFRC MDD is also distinguished by a personnel elevator located to the west of the south tower, and a ladder with safety cage in the north tower, for access to the 100-foot level.

Orbiter Lifting Frame, looking northwest.
(Source: Archaeological Consultants, Inc., 2006)

The Orbiter Lifting Frame at Palmdale

- Originally built at Vandenberg; reassembled at Palmdale in late 1990/ early 1991
- First used to mate *Endeavour* to the SCA for transport to the KSC
- Used between 1991-2001 to mate-demate the orbiters for transport between KSC and Palmdale for major overhaul and maintenance
- Eligible under NRHP Criteria A and C as the SSP's only demountable MDD, and for its operational use in the maintenance, overhaul, and upgrading of the orbiters *Columbia*, *Discovery*, *Atlantis* and *Endeavour* during the 1990s. Under Criterion C, notable for its unique design and engineering as a lightweight demountable device.

 Mate-Demate Device at DFRC, east elevation. (Source: Archaeological Consultants, Inc., 2006)	**The MDD at Dryden** • Completed in 1976 as NASA's first MDD built exclusively for the SSP • Supported the ALT program in 1977 • Used following Shuttle landings on the runways of Rogers Dry Lakebed and Edwards AFB • Eligible under NRHP Criteria A and C for its association with the early test programs at DFRC, for its continued operational use, and for its special design and engineering. This MDD incorporates several unique features required for the early shuttle testing program.
 Mate-Demate Device at KSC, south and west elevations. (Source: Archaeological Consultants, Inc., 2006)	**The MDD at KSC** • Completed in 1978 • Used to mate-demate the *Enterprise* and all five operational orbiters upon their original delivery to KSC; for end of mission returns from Edwards AFB; and for ferry flights between KSC and Palmdale for maintenance and modifications. • Eligible under NRHP Criterion A as one of two permanent MDDs built specifically to enable the attachment and detachment of the Shuttle orbiter and SCA • Eligible under NRHP Criterion C for the distinctive characteristics of its design and method of construction

Land-related resources: Subtype Transporters

- Three MLPs at KSC
- Two Crawler Transporters at KSC
- Two Payload Canisters at KSC

These large and mobile personal property assets, all at KSC, are used to transport the shuttle and its payload to the launch pad. While the MLPs and Crawler Transporters were originally constructed in the 1960s to support the Apollo Program and subsequently modified for the SSP, the two Payload Canisters were built specially for the SSP in 1978.

 Mobile Launcher Platform. (Source: Archaeological Consultants, Inc., 2006)	**Three MLPs at KSC** • Originally built between 1963 and 1968 for the Apollo Program; converted for the SSP between 1976 and 1983. • Eligible under Criterion A for their unique function in supporting the build-up of the Space Shuttle vehicle in the VAB and its transport to the launch pad • Eligible under Criterion C in the area of Engineering for their specialized design and modifications to support the SSP
 Crawler Transporter. (Source: Archaeological Consultants, Inc., 1996)	**Two Crawler Transporters at KSC** • Built by the Marion (Ohio) Power Shovel Company in 1965-1967 in support of the Apollo Program; modified in 1978-1979 for the SSP. • Since the beginning of the SSP, used to move the fully-assembled Space Shuttle vehicle, mounted on the MLP, from the VAB to the launch pad • Listed in the NRHP in 2000 • Eligible under Criteria A and C for their vital role in moving the Space Shuttle in preparation for launch, as well as for their engineering. In 1997, the Crawler Transporters were designated National Historic Mechanical Engineering Landmarks.
 Payload Canister on Canister Transporter in the Space Shuttle Processing Facility. (Source: Archaeological Consultants, Inc., 2006)	**Two Payload Canisters at KSC** • Built in 1978 for the SSP • Large, environmentally-controlled containers used to transport fully-integrated shuttle payloads from the processing/assembly facilities at KSC to the launch pad • Matches the capacity of the orbiter's payload bay • Eligible under Criteria A and C for their unique payload transport capabilities as well as design and construction

Water-related resources:

- NASA barge *Poseidon*
- Retrieval ship *Liberty Star*
- Retrieval ship *Freedom Star*

These large and mobile personal property assets are used to transport the ET and SRBs. While the barge *Poseidon* was modified from its original design to support the SSP, the two retrieval ships were built specially for the SSP.

 NASA Barge *Poseidon* carrying External Tank. (Source: Taylor, November 25, 2003)	**NASA barge *Poseidon*** • Originally built in 1945 as a Navy supply barge; converted in 1965 for NASA • From the mid-1970s until 1999, used to transport the ET from MAF to KSC • Eligible under NRHP Criterion A. It transported the first ET flown on a Space Shuttle mission and continued to provide service to the on-going operations of the SSP until 1999. It is the only remaining covered barge still in NASA ownership. • Eligible under Criterion C. It was specially designed and modified to protect the ETs during transport, and has the largest cargo hangar of any NASA barge.
 Looking east at Retrieval ships *Liberty Star* and *Freedom Star.* (Source: Archaeological Consultants, Inc., 2007)	**Retrieval ships *Liberty Star* and *Freedom Star*** • Built in 1980 and 1981 at the Atlantic Marine Shipyard, Ft. George Island, Florida • Used to recover expended SRBs and their components (including parachutes) after splashdown. The ships tow the SRBs to the dock at the disassembly complex at CCAFS • Since 1998, the ships support towing of NASA's ET barge *Pearl River* from MAF to KSC • Eligible under Criterion A for their vital role in the recovery of the SRBs, facilitating the reuse of this major Shuttle component

Other resources associated with transportation:

- Landing Aids Control Building at KSC
- Crawlerway at KSC

Both of the assets in the "Other" category support shuttle operations at the KSC. The Landing Aids Control Building at the SLF was built specially for the SSP, while the Crawlerway dates to the Apollo era.

 Landing Aids Control Building, control room looking southwest. (Source: Archaeological Consultants, Inc., 2006)	**Landing Aids Control Building (Facility J6-2313) at KSC** • Built between 1975-1976 for the SSP • Houses the equipment and personnel who operate the KSC SLF • Eligible under Criterion A as the control center for flight operations which support the landing of the Shuttle orbiter, and for managing the transport of the orbiter on the SCA when it lands at another NASA Center or needs to travel to another site for rehabilitation.
 Space Shuttle *Atlantis* en route to VAB via the Crawlerway, 2001. (Source: NASA John F. Kennedy Space Center, KSC-01PP-0140)	**Crawlerway at KSC** • Built between 1963 and 1965 to support the Apollo Program • Provides the roadway for transport of the Space Shuttle vehicle from the VAB to the launch pad • NRHP listed in 2000 • Eligible under Criteria A and C. The Crawlerway has a unique dual-lane surface capable of supporting the weight of the launch vehicle, MLP, and Crawler Transporter as they move from the VAB to the launch pad.

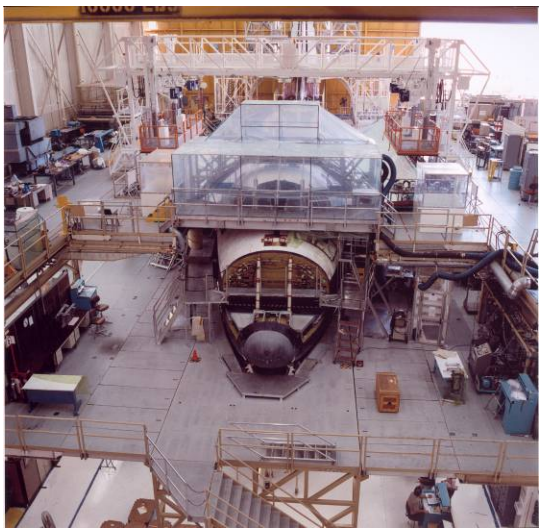
5.3.2 Type 2: Vehicle Processing Facilities

A total of 12 NASA-owned historic properties are classified as Type 2 resources:

- Shuttle Orbiter Final Assembly Facility at Palmdale
- Vehicle Assembly Building at KSC
- Orbiter Processing Facility (OPF), High Bays 1 and 2 at KSC
- OPF High Bay 3 at KSC
- SRB ARF Manufacturing Building at KSC
- Rotation/Processing Building at KSC
- Canister Rotation Facility at KSC
- Hypergol Module Processing (North) at KSC
- Vertical Assembly Building at MAF
- High Bay Addition at MAF
- Pneumatic Test Facility at MAF
- Control Building at MAF

Of these 12 assets, seven are located at the KSC, four at MAF, and one at Palmdale. All were specifically designed for processing the Shuttle vehicle and its major components, including the orbiter, ET, SRB, and SSME. Collectively, they support a variety of pre-launch and post-landing processing operations, including assembly, testing, checkout, refurbishment, and storage. All 12 historic properties are eligible under NRHP Criterion A for their exceptionally significant associations with the SSP; some are also distinguished by their design and construction, and thus, are eligible under Criterion C.

Four of the 12 Type 2 assets have multiple type affiliations. The Shuttle Orbiter Final Assembly Facility at Palmdale is also assigned to Types 7 and 9; the SRB ARF Manufacturing Building, as well as the OPF High Bay 3, are also Type 9: Manufacturing and Assembly Facilities; and the Canister Rotation Facility is also classified as a Type 12: Resource Associated with Processing Payloads.

 *Columbia* in Orbiter Bay 2 of Building 150 during modifications, looking north, 1991. (Source: NASA Lyndon B. Johnson Space Center, S91-53142)	**Shuttle Orbiter Final Assembly Facility (Building 150) at Palmdale** • Built in 1958 by the Air Force; acquired by NASA on a lease basis beginning in 1973 • Modified between 1973 and 1975 for Space Shuttle orbiter assembly, integration, test and checkout • OMMs were accomplished here through 2001 • Determined NRHP eligible by the California SHPO • Eligible under NRHP Criterion A as the birthplace of the Space Shuttle's full-scale test vehicle (*Enterprise*) and the five operational orbiters • Eligible under Criterion C for its adaptation as the only Space Shuttle orbiter assembly hangar in the United States
 Vehicle Assembly Building, south elevation. (Source: Archaeological Consultants, Inc., 2007)	**Vehicle Assembly Building (VAB) (Facility K6-848) at KSC** • Built in 1964 for the Apollo Program; reconfigured in 1976 to support the SSP • NRHP listed in 2000 • Supports the integration and stacking of the complete Space Shuttle vehicle on the MLP • Eligible under Criteria A and C. Uniquely designed to support the build up of the Space Shuttle vehicle. One of the world's largest buildings, by volume, it is also distinguished by its design and engineering.

 Orbiter Processing Facility High Bay 1 interior, looking southwest. (Source: Archaeological Consultants, Inc., 2006)	**Orbiter Processing Facility (OPF) (Facility K6-894) at KSC** • Built in 1977 for the SSP • Designed exclusively to prepare the Shuttle orbiter for flight • High Bays 1 and 2 are currently dedicated to the processing of *Atlantis* and *Endeavour*, respectively • Eligible under NRHP Criterion A as one of two NASA facilities built exclusively to support pre-flight and post-landing processing of the Shuttle orbiter. Each of the five orbiters was processed for its first operational flight in this facility. • Eligible under Criterion C. The design embodies the specific requirements of the SSP. Internal components, such as work platforms, were specially designed around the shape of the orbiter.
 Orbiter Processing Facility High Bay 3, south and west elevations. (Source: Archaeological Consultants, Inc., 2006)	**OPF High Bay 3 (Facility K6-696) at KSC** • Originally built in 1987, and converted to an OPF between 1989 and 1991. • Expanded KSC's capabilities for pre-flight and post-landing orbiter processing. • Currently dedicated to processing *Discovery.* • The Space Shuttle Main Engine Processing Facility (SSMEPF), added in 1996-1998, consolidates both SSME assembly and flight inspection. • Eligible under NRHP Criteria A and C, as noted for the OPF.

 SRB ARF Manufacturing Building, north and west elevations. (Source: Archaeological Consultants, Inc., 2006)	**SRB Assembly and Refurbishment Facility (ARF) Manufacturing Building (Facility L6-247) at KSC** • Built in 1986 for the SSP as part of the SRB ARF complex • Inert or non-propellant SRB elements, including the forward and aft skirts, frustums, and nose caps are fabricated, refurbished and assembled here • Eligible under NRHP Criterion A. Manufacture, processing and assembly of the SRB non-motor components are vital in preparing the Space Shuttle launch vehicle for flight.
 Rotation/Processing Building, north work area. (Source: Archaeological Consultants, Inc., 2006)	**Rotation/Processing Building (Facility K6-494) at KSC** • Built in 1984 to support the SSP as part of the Rotation, Processing and Surge Facility complex • SRB segments are inspected and rotated here, following their arrival from the Thiokol plant in Utah • Eligible under NRHP Criterion A. Rotation of the SRB segments is an operation vital to the preparation of the launch vehicle for its mission.

 Canister Rotation Facility, south and east elevations. (Source: Archaeological Consultants, Inc., 2007)	**Canister Rotation Facility (Facility M7-777) at KSC** • Constructed in 1993 for the SSP • Specifically designed to accommodate payload canister rotation • Eligible under NRHP Criteria A and C. Designed and built exclusively to provide for the horizontal and vertical rotation of the payload canister in support of the SSP. This building made possible a more efficient performance of this operation, previously conducted in the VAB.
 Hypergol Module Processing (North), south elevation. (Source: Archaeological Consultants, Inc., 2006)	**Hypergol Module Processing (North) (Facility M7-961) at KSC** • Originally built in 1964 for the Apollo Program; extensively modified in the late 1970s for the SSP • Used for the checkout, refurbishment and revalidation of the hypergolic fuel modules of the OMS, the RCS, and the APU • Eligible under NRHP Criterion A. It is a one-of-a-kind facility critical to the successive launch of the Space Shuttle vehicle.

 Vertical Assembly Building, north and west sides, looking southeast. (Source: Cleveland 2007: Figure 27, page 35)	**Vertical Assembly Building (Building 110) at MAF** • Constructed in 1963 for the Apollo Program; modified to support the SSP. • Components of the ET are washed, primed, sprayed with SOFI, assembled, pressure treated, and inspected here. • Eligible under NRHP Criteria A and C. Every ET for every Space Shuttle mission ever flown has been processed in this building. Under Criterion C, it is noteworthy for its design and construction, particularly the size of uninterrupted interior space.
 High Bay Addition, south side, looking north. (Source: Cleveland 2007: Figure 43, page 48)	**High Bay Addition (Building 114) at MAF** • Constructed in 1982 for the SSP • The liquid oxygen tank and intertank components of the ET are machined, primed, sprayed with SOFI, and assembled here • Eligible under NRHP Criteria A and C. Every oxygen tank and intertank for every Space Shuttle mission flown since 1982 has been processed in this building Under Criterion C, the five cells are significant for their design and construction.
 Pneumatic Test Facility, south and east sides, looking northwest. (Source: Cleveland 2007: Figure 79, page 79)	**Pneumatic Test Facility (Structure 451) and Control Building (Building 452) at MAF** • Both built in 1976 for the SSP • Structure 451 is used to pressure test the ET's liquid hydrogen tank component • Building 452 administers and monitors the tests that occur in Structure 451 • Both are eligible under NRHP Criteria A and C. Every hydrogen tank for every Space Shuttle mission ever flown has been tested here. Under Criterion C, the testing apparatus within Structure 451 is the only test unit of its size in the U.S. The blast-proof construction of Building 452 is also significant.

5.3.3 Type 3: Launch Operation Facilities

Ten historic properties are classified as launch operations facilities:

- Launch Control Center at KSC
- LC 39: Pad A at KSC
- LC 39: Pad B at KSC
- Mission Control Center at JSC
- Two Crawler Transporters at KSC
- Crawlerway at KSC
- Three MLPs at KSC

All but one of the 10 assets, the MCC at JSC, is located at the KSC. All play a vital role in the SSP, from the control of prelaunch operations to the launch of the Space Shuttle vehicle. All are eligible under NRHP Criterion A for their exceptionally significant associations with the SSP; some are also distinguished by their design and construction, and thus, are eligible under Criterion C. Of the 10 assets affiliated with this property type, only Launch Complex (LC) 39 Pad A and Pad B are classified solely as a Type 3 property. The two Crawler Transporters, the Crawlerway, and the three MLPs are also classified as Resources Associated with Transportation (Type 1), and are described in Section 5.3.1. The LCC is also classified as a Communication Facilities (Type 6), while the MCC is affiliated with Property Type 4 (Mission Control Facilities), Type 6 (Communication Facilities), and Type 10 (Resources Associated with the Training of Astronauts), in addition to Type 3. The MCC is foremost a Type 4: Mission Control Facility, and thus, is described in Section 5.3.4.

Launch Control Center, looking south.
(Source: Archaeological Consultants, Inc., 1996)

Launch Control Center (Facility K6-900) at KSC

- Built in 1966 to support the Apollo. Program; no structural changes made for the SSP
- Listed in the NRHP in 2000
- Controls the checkout processes during preparation for launch, as well as the initial Space Shuttle launch sequence
- Eligible under NRHP Criteria A for the vital operations performed here, integral to the prelaunch preparation and launch of the shuttle
- Eligible under Criterion C (Architecture) for its design and construction

 Aerial view of Space Shuttle *Discovery* at LC 39A, 2000. (Source: NASA John F. Kennedy Space Center, KSC-00PP-1297)	**LC 39 Pad A (Facility J8-1708) at KSC** • Originally built between 1963 and 1965 for the Apollo Program; modified for the SSP between 1976 and 1979. • Listed in the NRHP in 2000 as a contributing resource within the LC 39: Pad A Historic District • Served as the first active launch pad for the SSP • Launched the first 23 Shuttle missions between 1981 and 1986 • Individually eligible under NRHP Criteria A and C (Engineering) as one of two NASA properties specifically designed and constructed to launch the Space Shuttle vehicle
 STS-112, Space Shuttle *Atlantis*, surrounded by RSS, at LC 39B, 2002. (Source: NASA John F. Kennedy Space Center, KSC-02PD-1371)	**LC 39 Pad B (Facility J7-337) at KSC** • Originally built between 1964 and 1968 for the Apollo Program; modified for the SSP between 1978 and 1985. • Listed in the NRHP in 2000 as a contributing resource within the LC 39: Pad A Historic District • First used to launch *Challenger* on January 28, 1986, which ended in disaster approximately one minute after launch • Became NASA's primary launch facility in 1988 with the September 29 launch of *Discovery* (STS-26) • Individually eligible under NRHP Criteria A and C (Engineering) as one of two NASA properties specifically designed and constructed to launch the Space Shuttle vehicle

5.3.4 Type 4: Mission Control Facilities

The Mission Control Center (MCC) at JSC is the sole NASA facility classified as Type 4.

Mission Control Center, White Flight Control Room, looking west.
(Source: Archaeological Consultants, Inc., 2006)

Mission Control Center (Building 30) at JSC

- Built between 1963 and 1964 to support the Apollo Program; numerous additions and modifications made between 1982-2004
- Designated a NHL as part of the Man in Space theme study
- Housed the control room for the ALT program during the early development phase, and also was used to monitor simulations for Orbital Test Flight missions
- Eligible under NRHP Criteria A and C. Derives its exceptional significance from Wings M and S which include both Apollo-era and SSP flight control rooms.
- Eligible under Criterion A as the support center critical to full control of Space Shuttle missions, from liftoff to landing
- Eligible under Criterion C for its design which reflects the key function as a spacecraft mission control center. Also reflects the progression of engineering and adaptive reuse from the Apollo-era to the SSP.

5.3.5 Type 5: News Broadcast Facilities

The Press Site: Clock and Flag Pole at KSC is the only NASA facility classified as Type 5.

 Press Site: Clock and Flag Pole. (Source: Archaeological Consultants, Inc., 2007)	**Press Site: Clock and Flag Pole at KSC** • Constructed ca. 1969 during the Apollo Program. • Featured in every broadcast of a launch, the flagpole flies the U.S. flag during countdown and liftoff; the clock was specially made to mark the time to liftoff. • Listed in the NRHP in 2000. • Eligible under NRHP Criterion A. Historically associated with Space Shuttle launches in the minds of people worldwide, the clock and flag pole framed the vehicle during televised broadcasts of the launch sequence. Also serves as an integral facility in the dissemination of information to the public about Space Shuttle missions.

5.3.6 Type 6: Communication Facilities

Four historic properties are classified as communication facilities:

- Huntsville Operations Support Center/NASA Data Center (HOSC/NDC) at MSFC
- Communication and Tracking Development Laboratory at JSC
- Mission Control Center at JSC
- Launch Control Center at KSC

Of these four facilities, two are located at JSC, one at MSFC, and one at KSC. The HOSC/NDC in Building 4663 at the MSFC is the only property classified solely as a Communication Facility (Type 6). The LCC at KSC is also a Launch Operations Facility (Type 3), as described in Section 5.3.3; the MCC at JSC, with multiple affiliations (Types 3, 4, 6, and 10), is described in Section 5.3.4; and the Communications and Tracking Development Laboratory at JSC is also classified as an Engineering and Administration Facility (Type 7). The latter is described below, along with the HOSC/NDC. All four properties are eligible under NRHP Criterion A for their exceptionally significant associations with the SSP; some are also eligible under Criterion C for their distinguished design and construction.

 HOSC during STS-78 mission, 1996. (Source: NASA Marshall Space Flight Center, MSFC-9610972)	**HOSC in Building 4663 at MSFC** • Building 4663 was constructed in 1959; the HOSC was added in 1968 • The Shuttle Engineering Support Center (SESC) in the HOSC is used every six weeks for simulations of the Shuttle countdown. Certification runs for contingencies are performed by all the engineers responsible for the major elements of the STS, including the SRBs, SSMEs, and ET. • Eligible under NRHP Criterion A. Since 1980, this computer command center has played a key role in support of major launch preparation tests run at KSC, and for assisting in problem-solving throughout the SSP.
 Test control center in Building 44, looking south. (Source: Archaeological Consultants, Inc., 2006)	**Communications and Tracking Development Laboratory (Building 44) at JSC** • Built between 1965 and 1966 in support of the Apollo Program • Contains the Electronics Systems Test Laboratory (ESTL), a one-of-a-kind NASA facility used for system verification testing of Shuttle communication systems. Also used for the investigation and resolution of communication anomalies, as well as to create communication systems scenarios. • Eligible under NRHP Criterion A for the vital role in testing the Space Shuttle communication systems and interfaces, plus for real-time communications trouble-shooting • Eligible under Criterion C for housing equipment uniquely designed and engineered to perform its specialized functions in support of the SSP

5.3.7 Type 7: Engineering and Administrative Facilities

Twenty-six assets are classified as Type 7 resources. The Engineering and Administrative Facilities group includes test stands and associated control centers, wind tunnels, arc jet facilities, and R&D facilities.

- Propulsion Test Stand A-1 at SSC
- Propulsion Test Stand A-2 at SSC
- Propulsion Test Stand B-1 at SSC
- Propulsion Test Stand B-2 at SSC
- Coca I Test Stand at SSFL
- Coca Control Center at SSFL
- Acoustic Model Engine Test Facility (TF 116) at MSFC
- Structural Dynamic Test Facility at MSFC
- Test and Data Recording Facility (TF 115) at MSFC
- Advanced Engine Test Facility at MSFC
- Control Facility at MSFC
- Materials and Processes Laboratory at MSFC
- Structures, Dynamics and Thermal Vacuum Laboratory at MSFC
- National Center for Advanced Manufacturing at MSFC
- Arc Jet Laboratory at ARC
- Atmospheric Reentry Materials and Structures Evaluation Facility (ARMSEF) at JSC
- 14-inch Trisonic Wind Tunnel at MSFC
- Abe Silverstein (10 by 10) Supersonic Wind Tunnel (SWT) at GRC
- 8 by 6 SWT at GRC
- Aircraft Landing Dynamics Facility (ALDF) at LaRC
- SSME Hardware Simulation Laboratory (HSL) Block II Facility at MSFC
- Crew Systems Laboratory at JSC
- Avionics Systems Laboratory at JSC
- Multi-Purpose High Bay Facility and Neutral Buoyancy Simulator (NBS) at MSFC
- Shuttle Orbiter Final Assembly Building at Palmdale
- Communications and Tracking Development Laboratory at JSC

Eleven of the 26 assets are located at MSFC, four each are at JSC and SSC, two each are located at GRC and SSFL, and one each is at ARC, LaRC, and Palmdale. All are eligible under NRHP Criterion A for their exceptionally significant associations with the SSP; some are also distinguished by their design and construction, and thus, are eligible under Criterion C in the area of Engineering.

Four of the 26 historic properties are affiliated with more than one property type. Those whose primary function is as Engineering and Administrative Facility are described below. Properties with a secondary Type 7 affiliation include the Shuttle Orbiter Final Assembly Building (150) at Palmdale, described as a Type 2: Vehicle Processing Facility

in Section 5.3.2; the Communications and the Tracking Development Laboratory at JSC, described as a Type 6: Communication Facility in Section 5.3.6; and the Multi-Purpose High Bay Facility and NBS at MSFC, described in Section 5.3.10 as a Type 10: Resources Associated with the Training of Astronauts.

Subtype: Test Stands

A total of nine test stands located at SSC, MSFC, and SSFL, and two associated control centers at MSFC and SSFL, comprise this subgroup:

- Propulsion Test Stand A-1 at SSC
- Propulsion Test Stand A-2 at SSC
- Propulsion Test Stand B-1 at SSC
- Propulsion Test Stand B-2 at SSC
- Coca I Test Stand at SSFL
- Coca Control Center at SSFL
- Acoustic Model Engine Test Facility (TF 116) at MSFC
- Structural Dynamic Test Facility at MSFC
- Test and Data Recording Facility (TF 115) at MSFC
- Advanced Engine Test Facility at MSFC
- Control Facility at MSFC

The test stands and support buildings, originally constructed in the 1950s and 1960s, were structurally modified to support testing of the SSME, SRB, ET, and various shuttle systems. They are all eligible for listing in the NRHP under Criteria A and C. Five of the historic properties are designated NHLs; three were previously determined NRHP-eligible.

A-1 Test Stand Configured for SSME Testing.
(Source: Stennis Space Center 2007:32)

B-1 (left) and B-2 (right) Positions Configured for SSME Testing.
(Source: Stennis Space Center 2007:32)

Propulsion Test Stands A-1 (Building 4120), A-2 (Building 4122), B-1 (Building 4210) and B-2 (Building 4220) at SSC

- All were built in 1965 and 1966 to support flight certification of the Saturn V (Apollo). Test hardware at each stand has been modified to support the SSP.
- All are designated NHLs
- All accommodate full-scale, liquid propellant rocket engine and systems testing
- A-1, A-2, and B-2 are single position test stands; B-1 is a dual-position stand
- Test stands A-2 and B-1 can simulate altitude conditions encountered by the SSME during ascent
- B-2, the largest test stand of its type in the country, can accommodate the static firing of all three SSMEs at one time. It was used during the test firing of the MPTA on April 21, 1978.
- The four test stands are eligible under NRHP Criterion A. They are the only structures in the world that can support the type and level of testing required by the SSME. Every SSME that has flown in space was certified at the SSC Rocket Propulsion Test Complex.
- All are also eligible under NRHP Criterion C for their unique capabilities, configuration and method of construction

The Coca I (A-3) Test Stand, looking north.
(Source: Norman Betz, The Boeing Company, September 2006)

Coca Control Center, east elevation.
(Source: Norman Betz, The Boeing Company, September 2006)

Coca I Test Stand (A-3) (Building 733) and Coca Control Center (Building 218) at SSFL

- The Coca I Test Stand was built in 1956-1957, and modified in 1963-1964 (Saturn/Apollo) and 1973-1975 and 1978 (SSP)
- Engine component testing on A-3 in 1974 marked the beginning of the SSME test program
- Supported tests for SSME components (1974-1978), static firings of single SSMEs (1978-1988), and SSME turbopump acceptance tests (1978-1988)
- Eligible under NRHP Criteria A and C for the crucial role it played in the certification of the main engines for the first flight of *Columbia.* Also significant for its specialized engineering and design.

- The Coca Control Center, built in 1956, supported SSME component and complete engine testing between 1974 and 1988
- The Control Center is eligible under Criteria A and C for the vital role it played in controlling and monitoring the test firings at Coca I. Under Criterion C, it is an excellent example of blockhouse design and engineering.

 Acoustic Model Engine Test Facility, aerial view, 1976. (Source: NASA MSFC - 777250)	**Acoustic Model Engine Test Facility (TF 116) (Building 4540) at MSFC** • Built in 1964 to support the Apollo Program; used since 1974 for the SSP. • Associated with very early and continuous acoustic model testing for the initial development of the Shuttle, from 1974 to 1981 • Eligible under NRHP Criteria A and C for the instrumental role it played in the development of propulsion systems for the Space Shuttle, and for its design and engineering
 Structural Dynamic Test Facility; *Enterprise* being lifted by crane, 1978. (Source: NASA MSFC - 7890776)	**Structural Dynamic Test Facility (Building 4550) at MSFC** • Built in 1964; modified in 1975 for the SSP • Designated a NHL as part of the Man in Space theme study • Associated with the MVGVT (May 1978-February 1979) which verified that the Shuttle could withstand the vibrating forces encountered during powered flight • Eligible under NRHP Criteria A and C for its unique capability to dynamically test the Space Shuttle, and for its design and engineering which allowed for vibration testing of an assembled launch vehicle.

 Test Cell 115 at Building 4583. (Source: Archaeological Consultants, Inc., 2006)	**Test and Data Recording Facility (TF 115) (Building 4583) at MSFC** • Originally built in 1957, with TF 115 added in 1964 • Previously determined NRHP-eligible under non-SSP context. • Associated with scale model tests to improve the SRB following the *Challenger* accident in 1986 • Eligible under NRHP Criteria A and C for its key role leading to improvements in the SRBs, and for its design and engineering to support tests of an improved SRB launch deflector
 AETF, west elevation. (Source: Archaeological Consultants, Inc., 2006) Control Facility (Building 4674), west elevation. (Source: Archaeological Consultants, Inc., 2006)	**Advanced Engine Test Facility (AETF) (Building 4670) and Control Facility (Building 4674) at MSFC** • Originally built in 1965 for Apollo Program; modified in 1974 and 1986 for SSP. • Previously determined NRHP-eligible under non-SSP context • Used to test ETs and SSMEs between 1976 and 1999 • Eligible under NRHP Criterion A for its key role in testing the liquid hydrogen tank of the ET during the SSP development phase. It is also distinguished for its role in full-scale testing of advanced technologies for the SSME in the 1990s. • Eligible under Criterion C in the area of Engineering for its design and construction • The Control Facility was built in 1964 • Previously determined NRHP-eligible under non-SSP context • It is eligible under Criteria A and C for its support of important tests for the ET (1974-1980) and SSME (1986-1990s). It is also noteworthy for its blockhouse design and construction.

Subtype: R&D Facilities

Three historic properties at MSFC are exceptionally significant in the context of the SSP as premier R&D facilities. These include:

- Materials and Processes Laboratory
- Structures, Dynamics and Thermal Vacuum Laboratory
- National Center for Advanced Manufacturing

 Materials and Processes Laboratory, west elevation. (Source: Archaeological Consultants, Inc., 2006)	**Materials and Processes Laboratory (Building 4612) at MSFC** • Originally built in 1959; 1965 addition • Previously determined NRHP-eligible under non-SSP context • Premier testing facility for materials science and analysis in support of the SSP • Eligible under NRHP Criterion A. Research here has contributed significantly to the development and improvement of materials which constitute the major components of the Space Shuttle vehicle. Also played a key role in Return to Flight after the *Challenger* and *Columbia* accidents.
 Load Test Annex in Building 4619. (Source: Archaeological Consultants, Inc., 2006)	**Structures, Dynamics and Thermal Vacuum Laboratory (Building 4619) at MSFC** • Originally built in 1959, with additions in 1962 and 1964 • Previously determined NRHP-eligible under non-SSP context • Eligible under NRHP Criterion A as a premier testing facility for the major components of the Space Shuttle vehicle. Since 1972, it has played a key role in the validation of the SRB, ET, and SSME which qualified the Shuttle for flight. • Eligible under NRHP Criterion C for the design and construction of its specialized equipment, including vacuum chambers and one of the world's three Gilmore machines

 National Center for Advanced Manufacturing, east and north elevations. (Source: Archaeological Consultants, Inc., 2006)	**National Center for Advanced Manufacturing (Building 4707) at MSFC** • Originally built in 1956, with a 1962 south addition • Previously determined NRHP-eligible under non-SSP context • Eligible under NRHP Criteria A as a premier R&D facility responsible for the development of many key materials for the Space Shuttle, including the composite nose cone for the ET, SOFI, and a super lightweight ET • Eligible under Criterion C for its design and engineering

Subtype: Arc Jet Facilities

Two arc jet facilities, located at ARC and JSC, are of exceptional significance in the context of the SSP. These include:

- Arc Jet Laboratory at ARC
- ARMSEF at JSC

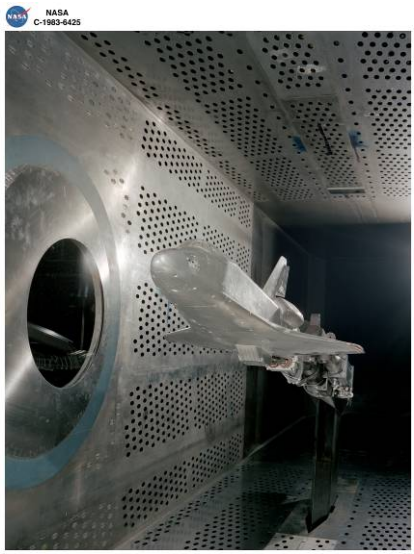
 Arc Jet Laboratory, north façade. (Source: Page & Turnbull, Inc. 2007: Page IV-37)	**Arc Jet Laboratory (N-238) at ARC** • Constructed in 1964 • The 60-MW Interaction Heating Facility was added in 1974 for the SSP • Used for shuttle panel and leading edge TPS tests • Conducted more arc jet testing for Shuttle TPS than all the other arc jets in the U.S. • Eligible under Criterion A for the advancement of the Shuttle TPS. Enabled the development of reusable TPS in use on the Space Shuttle orbiters. • Eligible under Criterion C. The 60-MW heating facility is an important engineering achievement since it was capable of producing heat three times hotter and on larger models than any other arc jet.
 Arc Jet in ARMSEF, looking northeast. (Source: Archaeological Consultants, Inc., 2006)	**Atmospheric Reentry Materials and Structures Evaluation Facility (ARMSEF) (Building 222) at JSC** • Built between 1965 and 1966; upgraded with a 10-MW arc heater in 1972 to support the SSP. Equipment upgrades in 1989-1990. • Used to test TPS materials, including sections of RCC, tile systems, and wing leading edge segment models • Eligible under NRHP Criterion A as one of only two NASA-owned arc jet facilities capable of testing all types of Shuttle TPS. Has contributed significantly to improvements in TPS technology. • Eligible under Criterion C in the area of Engineering for its unique design and construction to produce sustained high temperatures to simulate the conditions associated with entry into the Earth's atmosphere.

Subtype: Wind Tunnels

Three wind tunnels, located at GRC and MSFC, were evaluated as of exceptional significance in the context of the SSP:

- 14" Trisonic Wind Tunnel at MSFC
- Abe Silverstein 10 by 10 SWT at GRC
- 8 by 6 SWT at GRC

 Overall view of 14x14 Trisonic Wind Tunnel, 1988. (Source: NASA Marshall Space Flight Center, MSFC-8891417)	**14-inch Trisonic Wind Tunnel (in the Office and Wind Tunnel Facility, Building 4732) at MSFC** • Building 4732 was constructed in 1943; the 14-inch trisonic wind tunnel dates to 1957. • Previously determined NRHP-eligible under non-SSP context • Used to test models of the orbiter, SSME, ET, and SRB • Eligible under NRHP Criteria A and C. Under Criterion A, it is significant for its association with a variety of Shuttle tests using percent-scale models. Tests were underway by early 1976, and continued during the early development period from 1976 to 1981. It allowed NASA to test concepts relatively cheaply. • Under Criterion C, it is distinguished by its design and engineering. The small wind tunnel has been a workhorse at MSFC, due, in part, to the high quality of its design.

 An engineer checks a scale model of the transportation system before testing in NASA Glenn's 10 by 10-foot wind tunnel in 1975. (Source: NASA Glenn Research Center, 1975-02610)	**Abe Silverstein 10 by 10 SWT at GRC** • Built in 1955 • One of only two dual-cycle wind tunnels owned by NASA • Was used throughout the 1970s and 1980s for aerodynamic tests on the SRBs; aerodynamic pressure data and base heating studies on the complete Shuttle launch configuration; air speed and angle-of-attack data on the orbiter; and engine-out loads studies. • Eligible under NRHP Criteria A and C • Under Criteria A, it provides simulation of high speed atmospheric flight used to verify the design and performance of Space Shuttle systems. It also played a vital role in Shuttle component design improvements and innovations during post-*Challenger* and *Columbia* Return to Flight. • Under Criterion C, the 10 by 10 SWT is distinguished for its design and engineering
 1983 Test in the 8 by 6-foot SWT. (Source: NASA Glenn Research Center, 1983-6425)	**8 by 6 SWT at GRC** • Originally constructed in 1946-1949, with additions made in 1950, 1957 and 1968 • One of the first wind tunnels specially designed and built for propulsion testing • Currently, the only transonic propulsion wind tunnel owned by NASA, and one of two NASA-owned wind tunnels capable of either aerodynamic or propulsion cycle testing • Eligible under NRHP Criteria A and C, as noted for the 10 by 10 SWF

Other Type 7 Historic Properties

Four assets are classified as "Other" Engineering and Administrative Facilities. These exceptionally significant R&D facilities, located at LaRC, MSFC, and JSC, include:

- ALDF at LaRC
- SSME HSL Block II Facility at MSFC
- Crew Systems Laboratory at JSC
- Avionics Systems Laboratory at JSC

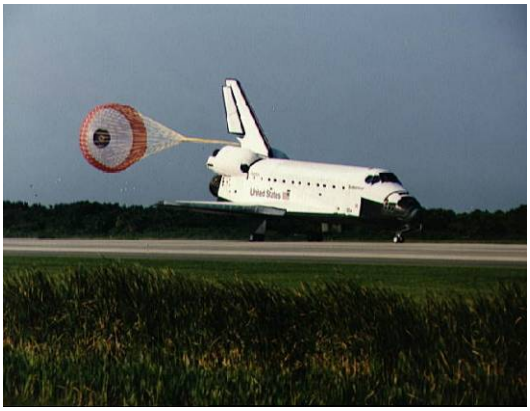
 ALDF Carriage on the Test Track, 2004. (Source: Science Applications International Corporation 2006:61)	**Aircraft Landing Dynamics Facility (ALDF) at LaRC** • Originally constructed in 1956; major upgrade in 1985 and renaming to ALDF • A multi-component facility comprised of seven structures, buildings and objects • Used in the 1980s and early 1990s to test Shuttle tire performance, tire-failure wheel tests, and the effects of runway modifications • Eligible under NRHP Criteria A and C. It is the only facility in the world that could provide Space Shuttle braking and landing tests required for the Space Shuttle development program. Also distinguished by its design and construction.
 SSME HSL, interior, 1999. (Source: NASA Marshall Space Flight Center, MSFC-9904407)	**SSME HSL Block II Facility (Building 4436) at MSFC** • Building 4436 was originally constructed in 1962; converted to HSL in 1985 to support the SSP. • Eligible under Criterion A as a unique facility responsible for hardware and software design and development, real time launch support, and quality assurance of the computer software that controls the main engines for all Space Shuttle flights

 Integrated Life Support Test Facility in Building 7. (Source: Archaeological Consultants, Inc., 2006)	**Crew Systems Laboratory (Building 7) at JSC** • Built between 1962 and 1964 to support the Apollo Program; additions made between 1967 and 1995. • Wing E high bay (Environmental Test Area [ETA]) was constructed specifically for the SSP • The ETA supports performance testing of spacesuit and backpack systems • Eligible under Criterion A as the performance testing site for primary life support equipment critical to the health and safety of the Space Shuttle mission crew. Also plays a key role in maintaining the habitability of the orbiter environment. • Eligible under Criterion C in the area of Engineering for its specialized equipment such as vacuum chambers, which simulate the extreme environment of space
 "Big Rig" orbiter forward bay in Building 16, looking north. (Source: Archaeological Consultants, Inc., 2006)	**Avionics Systems Laboratory (Building 16) at JSC** • Built between 1962 and 1964; additions made in 1965 and between 1975 and 1993. • In 1974, the SAIL was developed in Wing N to provide integration and verification of Space Shuttle hardware and software for flight. It has been modified to match the configuration of each orbiter. • Eligible under NRHP Criterion A for the SAIL facility, which played a vital role in testing and hardware and software certification, for the first flight of each orbiter. • Eligible under Criterion C for its special design and construction to test and evaluate Space Shuttle avionics systems, including a full-scale replica of the orbiter's payload bay.

5.3.8 Type 8: Space Flight Vehicle (or Space Shuttle)

The three extant Space Shuttle orbiter vehicles, *Discovery*, *Atlantis* and *Endeavour* comprise the Type 8 property group.

 Discovery during rollout ceremony at Palmdale, 1984. (Source: NASA Lyndon B. Johnson Space Center, S84-30898)	***Discovery* (OV-103)** • Constructed between 1979 and 1983 as NASA's third orbiter built for operational use • First flight was STS-16 in 1984 • Oldest of the remaining orbiters, with 33 missions through 2006 • First orbiter to complete 20 missions, with STS-63 in 1995 • Served as the Return to Flight vehicle after both the *Challenger* and *Columbia* accidents • Eligible under NRHP Criteria A and C as one of three remaining orbiter vehicles of the SSP, and as an exceptional work of design and engineering. Its various components are specially designed for the environment of space.
 Launch of Space Shuttle *Atlantis*, 1989. (Source: NASA John F. Kennedy Space Center, KSC-89PC-1049)	***Atlantis* (OV-104)** • Constructed between 1980 and 1985 as NASA's fourth orbiter built for operational use • First flight was STS-28 in 1985 • Completed 28 missions (as of June 2007) • First orbiter to fly with the new MEDS "glass cockpit" (STS-101 in 2000) • Eligible under NRHP Criteria A and C as one of three remaining orbiter vehicles of the SSP, and as an exceptional work of design and engineering. Its various components are specially designed for the environment of space.

 Landing of *Endeavour* at Kennedy Space Center, Florida, 1992. (Source: NASA Lyndon B. Johnson Space Center, STS057(S)082)	***Endeavour* (OV-105)** • Completed in 1990 as NASA's fifth orbiter built for operational use • First flight was STS-49 in 1992 • As of June 2007, has flown 19 missions • Carried the Spacehab module on its first mission, completed the first HST servicing mission, and was the first orbiter to fly with TUFI tiles • Eligible under NRHP Criteria A and C as one of three remaining orbiter vehicles of the SSP, and as an exceptional work of design and engineering. Its various components are specially designed for the environment of space.

5.3.9 Type 9: Manufacturing and Assembly Facilities

Six historic properties are classified as Type 9: Manufacturing and Assembly Facilities:

- Thermal Protection System Facility at KSC
- Parachute Refurbishment Facility at KSC
- Pacific Scientific Furnace at Canoga Park
- OPF High Bay 3 at KSC
- SRB ARF Manufacturing Building at KSC
- Shuttle Orbiter Final Assembly Building at Palmdale

Four properties are located at KSC, and one each is located at the Canoga Park Facility and Palmdale. All six Type 9 assets are eligible under NRHP Criterion A as significant places where major Space Shuttle flight components, including the SRBs, SSMEs, and TPS materials, were manufactured or assembled; some are also eligible under Criterion C for their design and construction. The Shuttle Orbiter Final Assembly Building, also classified as Types 2 and 7, is described in Section 5.3.2. The OPF High Bay 3 and SRB ARF Manufacturing Building also are both described in Section 5.3.2 as Type 2: Vehicle Processing Facilities. The three facilities, whose primary function is as a Manufacturing and Assembly Facility, are described as follows.

Thermal Protection System Facility, south and east elevations.
(Source: Archaeological Consultants, Inc., 2006)

Thermal Protection System Facility (Facility K6-794) at KSC

- Built in 1988
- Used for the manufacture and repair of the Space Shuttle's thermal protection and thermal control systems, including tiles, gap fillers and insulation blankets, as well as coatings and adhesives
- Eligible under NRHP Criterion A as one of only two NASA-owned assets constructed exclusively to house the manufacture and repair of the Space Shuttle's thermal protection and thermal control systems, essential to the success of the SSP

 Parachute Refurbishment Facility, work area. (Source: Archaeological Consultants, Inc., 2006)	**Parachute Refurbishment Facility (Facility M7-657) at KSC** • Constructed in 1964; modified between 1978 and 1979 for the SSP • Since 1979, used to receive, clean, refurbish, pack and store the pilot, drogue and main parachutes. Pilot parachutes and replacements for parachute/drogue chute deployment bay assemblies are also made. • Eligible under NRHP Criterion A. The main, drogue and pilot parachutes are essential components of the Space Shuttle SRBs, essential for space flight recovery and component reuse.
 06PWR-00599-021D Pacific Scientific Furnace, with control room to right, 2006. (Source: Pratt & Whitney Rocketdyne, Canoga Park, CA, 06-PWR-00599-021D)	**Pacific Scientific Furnace at the Canoga Park Facility** • Purchased by NASA in 1966, the furnace is located inside Building 001 owned by PWR • Originally used for the Apollo Program • Used to braze the SSMEs • Eligible under NRHP Criterion A for its exceptionally significant role in the manufacturing process for every main engine which powers the Shuttle vehicle • Eligible under Criterion C for its specialized engineering and design which makes possible the brazing of major SSME components. It is further distinguished as the largest furnace of its type in the world.

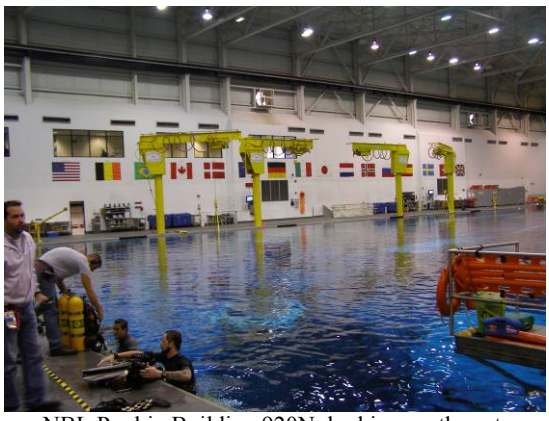
5.3.10 Type 10: Resources Associated with the Training of Astronauts

Eight historic properties are classified as Type 10 resources:

- Jake Garn Mission Simulator and Training Facility at JSC
- Systems Integration Facility at JSC
- Sonny Carter Training Facility/NBL at JSC
- Multi-Purpose High Bay Facility and NBS at MSFC
- Flight and Guidance Simulation Laboratory at ARC
- Crew Systems Laboratory at JSC
- Mission Control Center at JSC
- SLF Runways at WSSH

Five properties are located at JSC, and one each is located at ARC, MSFC, and WSTF. All are eligible under NRHP Criterion A as astronaut training sites in support of the SSP, and under Criterion C for their design and engineering. Four of the historic properties are classified solely as Type 10 resources: the Flight and Guidance Simulation Laboratory (Building N-243) at ARC; the Jake Garn Mission Simulator and Training Facility (Building 5) at JSC; the Systems Integration Facility (Building 9) at JSC; and the Sonny Carter Training Facility/NBL (Building 920-N) at JSC. The other four assets have multiple property type affiliations. Both the Multi-Purpose High Bay and NBS (Building 4705) at MSFC and the Crew Systems Lab (Building 7) at JSC are also classified as Type 7: Engineering and Administrative Facilities. The latter is described in Section 5.3.7. The MCC (Building 30) at JSC, also classified as Types 3, 4 and 6, is described in Section 5.3.4 for its primary affiliation as a Mission Control Facility; the SLF at WSSH, also classified as Types 1 and 11, is described in Section 5.3.1 under its primary classification, a Resource Associated with Transportation (Type 1). The five facilities, whose primary function is as an astronaut training facility, are described as follows.

 Motion-based Simulator in Building 5, looking northwest. (Source: Archaeological Consultants, Inc., 2006)	**Jake Garn Mission Simulator and Training Facility (Building 5) at JSC** • Built between 1964 and 1965; additions made in 1992 and 1993 • Mockups housed here are used to train astronauts in vehicle operations, including launch, landing, payload and ISS operations, as well as rendezvous activities • The Motion-based Simulator was first used as a training tool during the ALT program in 1977. In 1978, it was modified to become the motion-based portion of the Shuttle Motion Simulator (SMS). • Eligible under NRHP Criterion A as a premier NASA facility for preparing astronauts for Space Shuttle missions, including launch and landing situations, and critical on-orbit operations. • Eligible under Criterion C. The simulators, which provide realistic sensory feedback to the astronauts, were uniquely designed to replicate the Shuttle vehicle and its launch, orbit, and landing environments.
 Crew Compartment Trainer I in Building 9N, looking southwest. (Source: Archaeological Consultants, Inc., 2006)	**Systems Integration Facility (Building 9) at JSC** • Built between 1965 and 1967; additions made in 1975, 1988 and 1992. • Wing N houses the Space Vehicle Mockup Facility (SVMF) which contains three large Space Shuttle mockups, each built at full scale, and each of which is multi-functional in support of astronaut training and certification, flight control training, and engineering evaluation. • Eligible under NRHP Criteria A and C. Building 9 derives its exceptional significance from the SVMF which contains unique tools which provide astronauts with more "real" training experiences not found anywhere else. Astronaut testing has resulted in important improvements to the orbiter vehicle design.

 NBL Pool in Building 920N, looking northwest. (Source: Archaeological Consultants, Inc. 2006)	**Sonny Carter Training Facility/NBL (Building 920N) at JSC** • Building 920N was constructed between 1992 and 1993; the NBL within it was built between 1995 and 1996. • The NBL allows for the simultaneous performance of multiple training activities in a simulated space environment. It contains full-scale working models of both the orbiter and ISS components in the pool and high bay areas. • Used to train astronauts for EVAs and real-time problem solving during missions • Building 920N derives its exceptional significance from the NBL pool and high bay located in Wing N • Under NRHP Criterion A, the abilities perfected here by the astronauts are critical to the success of space missions involving spacewalks, and are fundamental to the construction of the ISS • Under Criterion C, the NBL is the world's largest indoor pool, and a one-of-a-kind facility designed to simulate the environment of space
 NBS Facility in Building 4705, exterior of NBS tank. (Source: Archaeological Consultants, Inc., 2006)	**Multi-Purpose High Bay Facility and NBS (Building 4705) at MSFC** • Building 4705 dates to 1952; the NBS was constructed in the high bay in 1968. It closed for use in 1997. • Designated a NHL as part of the Man in Space theme study • Used in the late 1970s to prepare Shuttle astronauts for assembling large structures in space • In the 1980s and 1990s, it was used to conduct test flight simulations and to practice assembly techniques • Eligible under NRHP Criterion A as an early SSP facility for astronaut EVA training which paved the way for the first structures built in space • Under Criterion C, the NBS was uniquely designed to simulate the space environment. It marks the beginning of the evolutionary line leading to the WETF and the NBL at the JSC.

 Flight and Guidance Simulation Laboratory, east façade. (Source: Page & Turnbull, Inc. 2007:VI-59)	**Flight and Guidance Simulation Laboratory (Building N-243) at ARC** • Built between 1965 and 1967 for the Apollo Program • Derives its significance from the VMS, constructed by 1979 • Since 1980, the VMS has provided training to prepare Shuttle commanders and pilots with a wide array of possible landing failures. • Eligible under NRHP Criterion A for its contributions to the training of SSP astronauts. The VMS is the world's largest motion-base simulator, and the sole training simulator for landing and rollout of the Shuttle orbiter. It is the only NASA facility that can simulate final descent and landing of the orbiter. Almost every pilot astronaut involved in the SSP has trained on the VMS.

5.3.11 Type 11: Resources Associated with Space Flight Recovery

Seven historic properties are classified as Type 11 resources:

- MDD at DFRC
- SLF Runways at WSSH
- SLF Runway at KSC
- Landing Aids Control Building at KSC
- MDD at KSC
- Retrieval ship *Liberty Star* at KSC
- Retrieval ship *Freedom Star* at KSC

All are eligible under NRHP Criterion A as exceptionally significant facilities that facilitated the recovery and reuse of the spacecraft and its major components after their return to Earth. Some are also distinguished by their design and construction, and thus, are eligible under Criterion C. Five properties are located at KSC, and one each is located at DFRC and WSSH. All seven historic properties are also classified as Type 1: Resources Associated with Transportation, and are described and illustrated in Section 5.3.1.

5.3.12 Type 12: Resources Associated with Processing Payloads

Three properties at KSC, the Canister Rotation Facility and the two Payload Canisters, are classified as Type 12 resources. The two Payload Canisters are described and illustrated in Section 5.3.1 as Type 1: Resources Associated with Transportation; the Canister Rotation Facility is described and depicted in Section 5.3.2 as a Type 2: Vehicle Processing Facility.

6.0 CONCLUSIONS AND MANAGEMENT RECOMMENDATIONS

6.1 Overview of Significant Historic Properties

As a result of NASA's agency-wide survey and assessment of SSP-related historic facilities, 70 assets were identified which individually meet the NRHP criteria of eligibility. This number includes 19 personal property assets (the three orbiters, two retrieval ships, two payload canisters, two SLF runways, two Crawler Transporters, three MLPs, the barge *Poseidon*, the Pacific Scientific Furnace, the OLF, the Crawlerway, and the Clock and Flag Pole). All surveyed real and personal property assets are NASA-owned. The WSSH SLF runways are located on property leased by NASA from the U.S. Army, and the OLF and Shuttle Orbiter Final Assembly Building are on property leased from the U.S. Air Force at AFP 42 in Palmdale. The Pacific Scientific Furnace is housed in PWR's Canoga Park Facility.

Collectively, these buildings, structures, and objects embody the historical developments of the U.S. Space Shuttle Program, from the early period of development through the near final years of operation. Many of the historic properties were originally built to support the Apollo Program, and were modified and adaptively reused for the SSP. Others were specially built as new facilities to meet the unique needs of the SSP.

6.1.1 Chronology of Infrastructure Development

The 70 exceptionally important SSP-related historic properties were first constructed between 1943 and 1996. Fourteen were originally built prior to 1960, and 34 were constructed in the 1960s, largely in support of Saturn/Apollo. The other 22 historic properties were designed and built exclusively for the SSP during the 1970s, 1980s, and 1990s.

The oldest facilities used in support of the SSP predate the birth of NASA. The historic properties built before 1960 include Runway 17/35 at WSSH (late 1940s); the 8 by 6 SWT (1949) and the 10 by 10 SWT (1955) at GRC; the ALDF (1956) at LaRC; the Coca I Test Stand and associated Coca Control Center (both 1956) at SSFL; Building 150 at Palmdale (1958); and seven facilities at MSFC, including the Office and Wind Tunnel Facility (1943), as well as the late 1950s Materials and Processes Laboratory; Structures, Dynamics and Thermal Vacuum Laboratory; HOSC/NDC; Multi-Purpose High Bay Facility and NBS; and the National Center for Advanced Manufacturing. To varying degrees, all were modified to support operations for the SSP. Similarly, with few exceptions, facilities constructed during the 1960s, including large rocket engine test stands and Apollo-era launch facilities, were adapted for use in support of the SSP during the 1970s and 1980s. Modifications included large building additions, as well as upgrades to equipment, without alteration to the physical structure. A chronology of selected facility modifications, additions and upgrades is provided in Table 6.1

Table 6.1. Timeline of selected NASA agency-wide building modifications.

Year	Modification
1972	• 10 MW arc jet added to ARMSEF (Building 222) at JSC • Modifications to Building 4619 (Structures, Dynamics and Thermal Vacuum Laboratory) at MSFC
1973	• Begin modifications to Coca I test stand at SSFL • Begin modifications to Building 150 (Shuttle Orbiter Final Assembly Building) at Palmdale (1975 completion) • Modifications to Building 4540 (TF 116) at MSFC
1974	• SAIL developed in Wing N of Building 16 (Avionics Systems Laboratory) at JSC • 60 MW arc jet added in Building N-238 at ARC • Modifications to Building 4670 (AETF) at MSFC to support ET structural verification testing
1975	• Building 4550 (Structural Dynamic Test Facility) at MSFC modified for the MVGVT • Crew Compartment Trainer I (CCT I) added to Building 9 (Systems Integration Facility) at JSC
1976	• Reconfiguration of the VAB at KSC begins • Beginning of modifications to the three MLPs at KSC, including removal of launch umbilical towers (LUTs) and addition of tail service masts (TSMs) • Modification to Runway 17/35 at WSSH • Beginning of major modifications to LC 39 Pad A at KSC (completed in 1979) • Internal modifications to Building M7-961 (Hypergol Module Processing (North)) at KSC • Motion-based Simulator added in Building 5 (Jake Garn Mission Simulator and Training Facility) at JSC
1978	• Beginning of major modifications to LC 39 Pad B at KSC (completed in 1985) • Beginning of major additions and modifications to convert Building M7-657 at KSC into the Parachute Refurbishment Facility (completed in 1979)
1979	• Shuttle EMU/Airlock/Life Support Test Facility added in Building 7 (Crew Systems Laboratory) at JSC
1980	• Opening of the Vertical Motion Simulator (VMS) in Building N-243 at ARC to test designs of the Shuttle cockpit and to support Shuttle pilot training • Full Fuselage Trainer (FFT) added to Building 9 (Systems Integration Facility) at JSC
1985	• Building 4436 at MSFC converted into the SSME HSL • Major upgrades to the Landing Loads Track at LaRC to create the ALDF
1986	• Addition of a third static fire position to the B-1 test stand at SSC • Modifications to Building 4670 (AETF) at MSFC to support SSME testing
1987	• Modifications to Test Cell 103 of Building 4583 (TS 115) at MSFC to support scale-model tests of the SRB • Mission Operations Wing (MOW) of the MCC (Building 30) at JSC added
1989	• Building K6-696 at KSC converted into the OPF-3 (completed in 1991)
1992	• Wing S (including the White Flight Control Room) of the MCC (Building 30) at JSC added • Wing 5 South and High Bay added to Building 5 (Jake Garn Mission Simulator and Training Facility) at JSC (completed in 1993)
1993	• CCT II added to Building 9 (Systems Integration Facility) at JSC
1996	• NBL added to Building 920N at JSC • SSMEPF added to the OPF-3 at KSC (completed in 1998)
2004	• Mission Evaluation Room (MER) in MCC (Building 30) at JSC added

Of the 70 significant NASA-wide historic properties, approximately one-third were built exclusively for the SSP. Included in this group are the three MDDs, the two SLFs, the two SRB retrieval ships, the two payload canisters, the two orbiter processing facilities, and the three extant orbiter vehicles. Thirteen of the new constructions are located at the KSC. A chronology of new construction (using the date of completion) is provided in Table 6.2.

Table 6.2. Timeline of selected SSP-related new facility construction.

Year	Facility
1976	• MDD at DFRC • Shuttle Runway and Building J6-2313 (Landing Aids Control Building) at KSC • Buildings 451 and 452 (Pneumatic Test Facility and Control Building) at MAF
1977	• Building K6-894 (OPF) at KSC
1978	• Two Payload Canisters at KSC • Runway 23/05 at WSSH • MDD at KSC
1980	• Retrieval ship *Liberty Star*
1981	• Retrieval ship *Freedom Star*
1982	• Building 114 (High Bay Addition) at MAF
1983	• Orbiter *Discovery*
1984	• Building K6-494 (Rotation/Processing Building) at KSC
1985	• Orbiter *Atlantis*
1986	• Building L6-247 (SRB ARF Manufacturing Facility) at KSC • Runway 20/02 (TAL) at WSSH
1987	• Building K6-696 (OPF-3) at KSC
1988	• Building K6-794 (Thermal Protection System Facility) at KSC
1990	• Orbiter *Endeavour*
1991	• OLF at Palmdale
1993	• Building 920N (Sonny Carter Training Facility) at JSC • Building M7-777 (Canister Rotation Facility) at KSC
1996	• NBL in Building 920N at JSC

Photo 6.1. Construction of the Shuttle Orbiter Modification and Refurbishment Facility (later OPF-3), September 25, 1986.
(Source: NASA KSC, ID No. KSC-86PC-0302)

6.1.2 Evolutionary Developments

Evolutionary advancements in technology are showcased in a number of NASA-owned historic properties, including arc jet facilities, wind tunnels, and test stands. Equipment upgrades and structural modifications to existing facilities served to integrate improved technologies to meet the needs of NASA's new SSP. In other cases, new facilities were constructed which embodied the cumulative progression of ideas and innovations since the beginning of the U.S. Space Program. Major modifications to the launch pads at KSC's LC 39 illustrate the adaptive reuse process; the succession of water training facilities developed at the MSFC and JSC reflect the overall evolutionary changes in new facility constructions.

Launch Complex 39: Beginning in 1976, major modifications were made to facilities and properties at KSC in preparation for the first Space Shuttle launch. At LC 39 Pad A, modifications were started in 1976 and completed in mid-1978; work progressed at Pad B between 1978 and 1985. With the exception of the six fixed pedestals which support the MLP, all of the structures on the hardstands of each pad were removed or relocated. Fuel, oxidizer, high-pressure gas, electrical, and other service lines were rerouted. New hypergolic fuel and oxidizer support areas were constructed at the southwest and southeast corners, respectively, of the pads; the unneeded Saturn fuel support area was removed, a new FSS was erected using the original Apollo-era LUT, a RSS was added with a Payload Changeout Room (PCR) and Payload Ground Handling Mechanism (PGHM), and the Saturn flame deflectors were replaced. A sound suppression water system was installed on the pads to reduce the acoustical levels within the orbiter's payload and thus, to protect it and its payloads from damage. The sound suppression system includes a 300,000 gallon capacity water tank. A related system, the Overpressure Suppression System, was installed to reduce the pressure pulse at SRB ignition.

Photo 6.2. Aerial view of Apollo 11 spacecraft on Pad A, LC 39, KSC, July 1, 1969. (Source: NASA, Johnson Space Center, ID No. S69-38660)

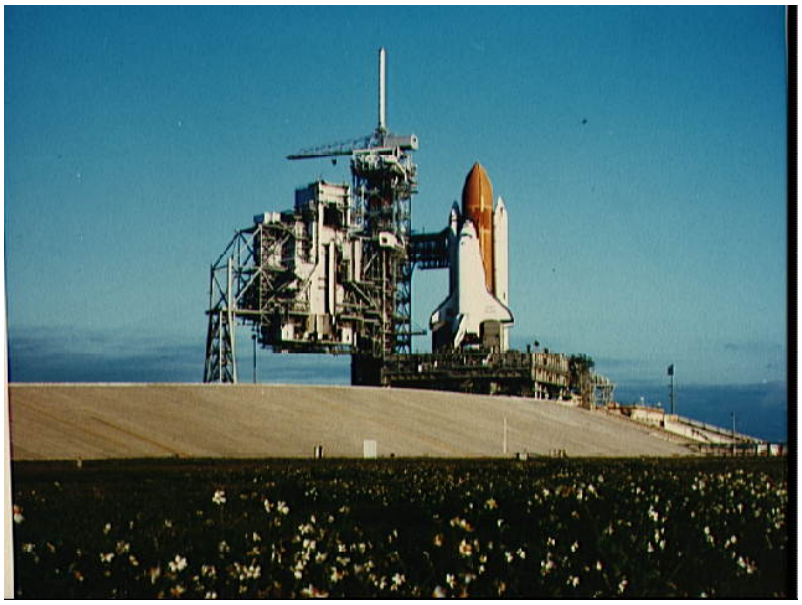


Photo 6.3. *Discovery* arrives at Pad A for STS 51-C, January 24, 1985.
(Source: NASA, Johnson Space Center, ID No. S85-25985)

Water Training Facilities: The history of development of water training facilities at both the MSFC and JSC illustrates a succession of new facility construction, beginning in the pre-SSP period. The first facility used for neutral buoyancy training, in 1965, was an existing tank at MSFC (Hickam 1993). Made from sheet metal, the small 8-feet diameter by 8-feet deep tank was used during early attempts to approximate zero-gravity working conditions (Hickam 1993:47). Operations at the MSFC's NBS began in 1968. The earliest use of this facility was in the design of Skylab. In the late 1970s, the NBS was used to prepare Shuttle astronauts for assembling large structures in space. Following a reorganization of NASA in the late 1970s, and the opening of the Weightless Environmental Training Facility (WETF) in 1980 within Building 29 at the JSC, the center for astronaut EVA training shifted from MSFC to the JSC. The WETF itself represented an evolutionary leap in the line of facilities at the JSC, which started in 1966 with the Water Immersion Facility (WIF) in Building 5. Both the NBS and WIF were deep tanks (Photos 6.4 and 6.5); the WETF (Photo 6.6), as well as the NBL which followed, were large pools.

Despite the addition of the WETF, the MSFC's NBS continued to be used. In the 1980s, it was the only NASA facility large enough to hold a mockup of both the HST and the Shuttle cargo bay (Hickam 1993:53). In 1985, following the perfection of techniques in the NBS, NASA astronauts constructed EASE (Experimental Assembly of Structures in Extravehicular Activity) and ACCESS (Assembly Concept for Construction of Erectable Space Structures), the first structures built in space. Throughout the 1980s and 1990s, the NBS was used to conduct test flight simulations, as well as to practice assembly and handling techniques. A full-scale mockup of the HST was used in both 1979 and 1981 to determine the methods needed to service the actual spacecraft. In 1993, a new and improved Remote Manipulator System (RMS-II), an underwater version of the Shuttle Orbiter RMS, replaced the old RMS components in the NBS.

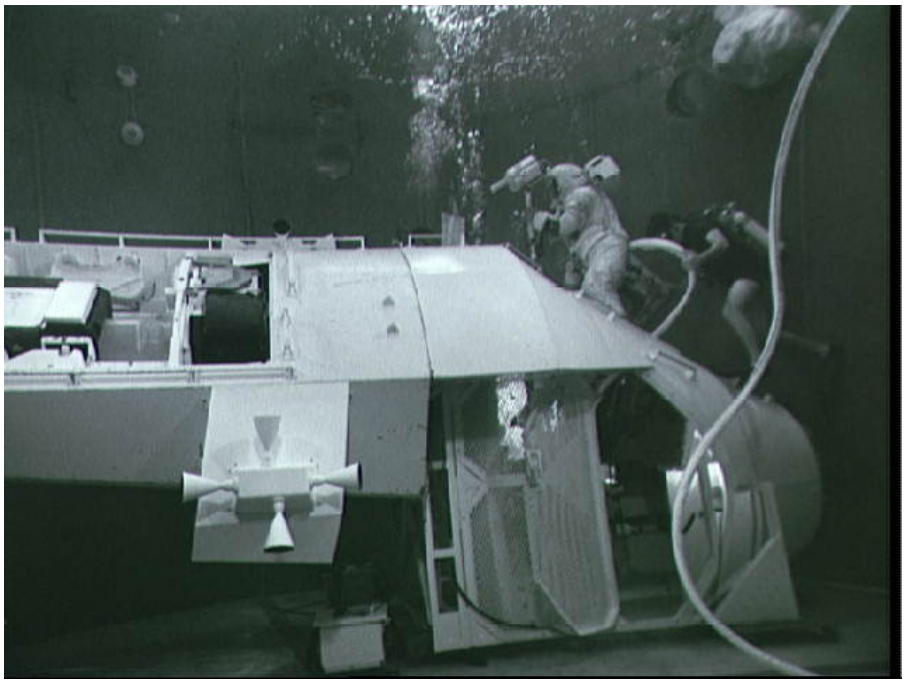


Photo 6.4. EVA simulation in the water facility tank in Building 5, December 1, 1971. (Source: NASA, Johnson Space Center, ID No. S71-58148)

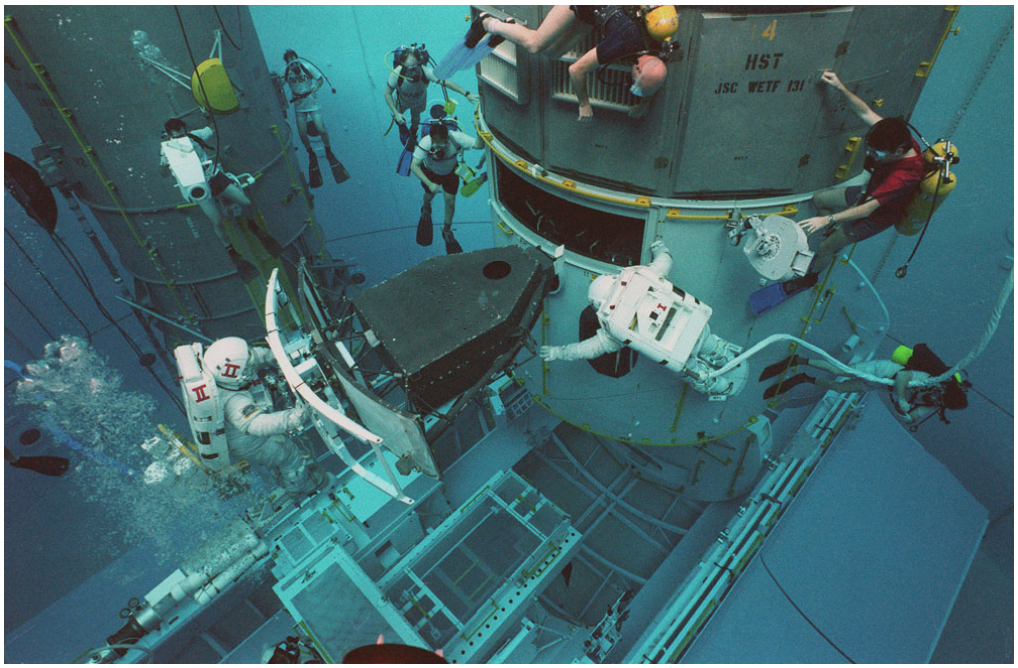


Photo 6.5. Hubble Space Telescope training in the NBS, 1992. (Source: NASA Marshall Space Flight Center, MSFC-9263351)

Photo 6.6. Water egress training at the WETF Building 29 pool, December 1, 1991. (Source: NASA, Johnson Space Center, ID No. S91-52074)

NASA officially closed the NBS for use on July 1, 1997. It was functionally replaced by the new NBL at the JSC. The following year, some equipment needed at the NBL was removed from the NBS. The transferred artifacts included the Spacelab Pallet (SLP) Mock-up, the Shuttle Payload Bay Mock-up, the Manipulator Foot Restraint (MFR) Mock-up, the Aft Flight Deck Crew Station (AFDCS), the RMS simulator, and the Extravehicular Mobility Unit (EMU) components and support equipment (Allen 2001). Subsequently, the SLP mockup, the AFDCS, and the RMS simulator were returned to MSFC; the SLP mockup, MFR, and EMU were retained by JSC. The NBS is currently in mothballed status.

The NBL was designed to allow for the simultaneous performance of multiple training activities in a simulated space environment. The pool contains full-scale working models of both the Space Shuttle orbiter and ISS components, including robotic arms. The abilities perfected here are critical to the success of space missions involving EVAs, including those required to assemble the ISS and to service and maintain the HST. The NBL is also used for real-time problem-solving during active missions to work out solutions for the in-orbit crew. The NBL contains the world's largest indoor pool which was specially designed and built to simulate the environment of space. This one-of-a kind, world class facility reflects the zenith in the four decade evolutionary progression of weightless training facility design, construction and use.

6.2 Significant Facilities and the Space Shuttle Story

The "historicity" of the Space Shuttle Program, including key themes, is reflected in its tangible elements – NASA's historic buildings and structures located across the nation. Collectively, these tell the story of the SSP from the early period of **development and testing** to its past and present **operational phase.** Among the key themes are those relating to the early testing of Space Shuttle components and systems; research and development efforts leading to the creation and improvements of parts and materials, from TPS tiles to life support systems; construction, assembly, and integration of the Space Transportation System; and astronaut training, among others. NASA's historic properties which illustrate some of the major achievements in testing, R&D, and astronaut training are noted in Sections 6.2.1, 6.2.2, and 6.2.3, respectively.

6.2.1 Test Facilities

Many NASA Centers played a key role in shuttle components and systems testing during both the developmental and operational phases of the SSP. Wind tunnels, arc jets, vacuum chambers, test stands, and other NASA facilities and equipment were used to design, improve, and validate the Space Transportation System. NASA's wind tunnels were used for development tests of the orbiter, SSMEs, ET, and SRBs, using percent-scale models, and were fundamental to understanding the aerodynamics of the orbiter/SCA ferry configuration. A variety of candidate TPS materials for the shuttle orbiter were evaluated in NASA's arc jet facilities at the ARC and JSC. Every SSME flown in space was tested at the SSC propulsion test stand complex.

Among the numerous agency-wide test facilities, five historic properties located within the East and West Test Areas of the MSFC, for example, made exceptional contributions to the SSP through the testing of major Space Shuttle components, including the ET, SRBs, and SSMEs. These historic properties include the Acoustic Model Engine Test Facility (TF 116) (Building 4540), the Structural Dynamic Test Facility (4550), the Test and Data Recording Facility (4583), the Advanced Engine Test Facility (4670), and the Control Facility (4674). Among the primary testing programs conducted at these facilities were various structural tests on SRB assemblies; acoustic model testing (1974-1980) at TF 116, which was instrumental to the development of the Space Shuttle propulsion system; the MVGVT series of 1978-1979 at Building 4550, used to verify that the Shuttle could withstand the forces encountered during powered flight; and structural verification testing of the LH2 tank of the ET (1974-1980) at Building 4670 during the buildup to the first Space Shuttle launch in April 1981.

TF 116, for example, was in active use between 1974 and 1981 during the developmental period of the SSP. Using 6.4-percent scale models prepared at the MSFC, the first tests used to gather acoustical data vital to program design and development activities were conducted here on September 4, 1974 (Wright 2001:15). The following year, acoustic tests of a 6.4-percent scale model of the Space Shuttle, including the SSMEs and SRMs, as well as a scaled down version of the Shuttle launch pad at the KSC, allowed MSFC engineers to study the effects of sound waves on the Shuttle vehicle and the launch pad.

The data derived from these tests contributed directly to launch pad design concepts. Between 1974 and July 1976, 150 test firings were conducted at TF 116. Between July and November 1976, a second phase of testing was initiated using a 6.4-percent model of the launch pad at Vandenberg along with the same scale model of the Shuttle. A total of 24 test firings were conducted, and these data were planned to be used in redesigning the launch pad at Vandenberg as an alternate Space Shuttle launch site. During tests conducted in April 1979 as part of the acoustic test program, Tomahawk missile motors were used to substitute for SRBs. A new series of tests for an uprated Space Shuttle configuration, conducted in December 1979, included strap-on rocket motors to augment the thrust of the SRBs. These tests featured 6.4-percent scale models simulating the launch pads at the KSC and Vandenberg. In July 1981, firing tests attempted to reproduce the stress loads detected on the *Columbia* during its April launch with a view towards finding a method for reducing those loads.

In addition to components and systems testing during the ca. 1974-1981 developmental phase of the SSP, the 32 month stand-down period following the *Challenger* accident of January 1986 was a time of significant testing activities and advancements. In accordance with the Rogers Commission recommendations, one focus of the Return to Flight work was the redesign and recertification of a Redesigned Solid Rocket Motor (RSRM). In response, MSFC engineers performed tests for the SRB joint and seal to evaluate design changes under all relevant environmental and loading conditions. During the post-*Challenger* period, other test programs at MSFC included the full scale testing of the SSME, plus tests of the thermal protection system for the SRB and ET, SRM O-rings, and SSME injectors, bearings and seals. In the 1990s, the Advanced Engine Test Facility (Building 4670) played a key role in the full-scale testing of advanced technologies for the SSME. Also at this time, Building 4670 was used to test other hardware, including the Space Shuttle liquid hydrogen pressure valve. The Control Facility, or "blockhouse," (Building 4674), controlled the testing at Building 4760, including important tests for the SSME (1986-1990s).

6.2.2 Research and Development (R&D)

Several historic properties at both the JSC and the MSFC exemplify NASA's R&D accomplishments in support of the SSP. These include four facilities at the JSC which have supported the SSP since the 1970s: the Crew Systems Laboratory (Building 7), the Avionics System Laboratory (Building 16), the Communications and Tracking Development Laboratory (Building 44) and the ARMSEF (Building 222). First used in the early developmental phase of the program, these facilities contain unique equipment, such as simulators and thermal vacuum chambers, which continue to provide performance testing of primary life support system equipment, Space Shuttle avionics systems, and spacecraft flight-equivalent communications systems and their interfaces. Equipment vital to the success of all Shuttle missions, including spacesuits and backpacks, as well as software and spaceflight hardware, are performance tested, validated, and certified in these facilities.

Research and development at the JSC generally falls into four categories: materials testing, electrical systems testing, life systems testing, and life sciences testing. In the area of materials testing, a variety of Shuttle components, including the OMS pods, the TPS systems, and the active thermal control systems are tested in JSC facilities. Thermal tests at the ARMSEF verify the heat collection and rejection properties of various TPS components. Such tests analyze the various temperature control techniques, as well as their operational limits and life spans. This facility also aided in the Return to Flight efforts after the *Columbia* accident, including damage assessments of the RCC and the HRSI.

Facilities at the JSC involved in electrical systems testing include the SAIL in Building 16 and the ESTL in Building 44 (known as the Electronic Systems Compatibility Facility until 1980). These facilities conduct testing on the Shuttle's hardware and software to determine if they are interfacing properly. The orbiter's wiring and electronics are also tested to confirm procedures and to locate any anomalies within the systems. In addition, these facilities test the communication systems of the orbiter, and their ability to connect with relay satellites and ground stations. Any modifications or upgrades were tested within these buildings prior to being installed on the orbiter. These facilities also perform contingency simulations and conduct post-flight anomaly resolutions.

The JSC has unique facilities used to develop and test the orbiter's life support systems, including spacesuits and backpacks. Since at least 1979, the Crew Systems Laboratory (Building 7) has supported performance testing of spacesuit backpack systems, including the Manned Maneuvering Unit (MMU) and the EMU, designed to provide astronauts the ability to move around and work in space. Other JSC facilities are used to test the Portable Life Support System (PLSS) backpack, unique to the SSP, or to develop the food that astronauts eat while in space.

At the MSFC, the Material and Processes Laboratory (4612), the Structures, Dynamics and Thermal Vacuum Laboratory (4619), the Multi-Purpose High Bay Facility and NBS (4705), and the National Center for Advanced Manufacturing (4707) are premier facilities for materials science and analysis focused on the materials which comprise the major components of the Space Shuttle, including the SSMEs, SRBs, and ET. Research conducted here has contributed significantly to the design, development and improvement of new materials, including a composite nose cone for the ET, SOFI for the ET, and a super lightweight external tank. During the early developmental phase of the SSP, these facilities played a key role in qualifying the major Shuttle vehicle components for flight. They are also significantly associated with NASA's Return to Flight efforts in the aftermath of the *Challenger* and *Columbia* accidents. The facilities embody unique design elements and equipment, including two of the world's three Gilmore machines which were used for testing programs in support of the SSP.

The Structures, Dynamics and Thermal Vacuum Laboratory (Building 4619), for example, played a key role in the validation of major vehicle components which qualified the Shuttle for flight. Space Shuttle components testing at Building 4619 started in early 1973 with testing of a simulated 77-percent model of an SRB. The Fabrication Division

of the Test Laboratory manufactured and assembled SRB components for a full-scale mockup of the propulsion system. MSFC personnel installed the SRB mockup in Building 4619 to serve as an engineering and tooling aid. The Fabrication Division also prepared an all-aluminum 1/15th-scale model of the Space Shuttle used for antenna testing. By the end of 1974, Test Lab personnel had completed three significant tests for the SSME, including the first ignition of a 40,000 pound thrust engine pre-burner. In March 1977, the first major test articles for the Shuttle's ET were installed in Building 4619 in a huge steel truss test fixture for structural testing. This work complemented tests run in 1977-1978 using the intertank and a LOX tank mounted in Building 4550. Between 1977 and 1979, a series of vibration and structural tests were conducted in the high bay using the LOX intertank test article of the Shuttle ET. These tests were followed by structural tests of the SRB in September 1979, and vibration tests on a modified SSME nozzle in October 1980.

6.2.3 Astronaut Training Facilities

Three historic properties at NASA JSC are premier facilities dedicated to astronaut training: the Jake Garn Mission Simulator and Training Facility (Building 5), the Systems Integration Facility (Building 9), and the NBL at the Sonny Carter Training Facility (Building 920N). Collectively, these have provided continuous support to the SSP from the early developmental phase in the 1970s to today. Buildings 5 and 9, for example, were used as training aides for the test pilots during the ALT Program.

The three historic properties include a variety of unique training facilities and equipment, such as full-scale mockups and computerized simulators, which replicate components and systems of the Space Shuttle orbiter vehicle and its effective environments. For example, full-scale mockups of the orbiter flight deck provide astronauts with more "high fidelity" training experiences not found anywhere else. A variety of simulators provide realistic sensory feedback to the astronauts; and the world's largest indoor pool, the NBL in Building 920N, replicates the environmental conditions of space. In these facilities the astronauts work through flight plans, including failure scenarios, and practice the activities they will engage in while in space. These hands-on learning experiences are critical to the success of Space Shuttle missions, including launch and landing situations, and on-orbit operations. These facilities are in active use today, providing training for on-going Shuttle mission operations, including assembly of the ISS.

In addition to these JSC facilities, the VMS in Building N-243 at ARC, which can simulate final descent and landing of the orbiter, is used for shuttle pilot astronaut training. The VMS provides the opportunity to practice landing scenarios or critical maneuvers involving the orbiter, as well as provides worst-case scenarios for pilots, such as blown tires, crosswinds, or failed auxiliary power units. It continues to be used twice a year to study landing and rollout of the orbiter (Page & Turnbull, Inc. 2007).

6.3 National Historic Landmarks

In 1984, the Man in Space NHL Theme Study (Phases I and II) was completed by the NPS (Butowsky 1984). The Theme Study considered the Space Program in an integrated fashion, and attempted "to identify, inasmuch as is possible, the surviving resources of those that were necessary to accomplish the goals of landing a man on the moon and exploring the earth, planets and solar system" (Butowsky 1984). The selected resources represented the best and most important surviving examples of the technological resources that were necessary to support the American space program (Gemini through Space Shuttle Program). Resources were related to four general subthemes: 1) Technical Foundations before 1958; 2) The Effort to Land a Man on the Moon; 3) The Exploration of the Planets and Solar System; and 4) The Role of Scientific and Communications Satellites.

Twenty-four NASA historic properties were evaluated as nationally significant in the context of the manned spacecraft program of the U.S., and subsequently designated as NHLs in October 1985. Of these, seven were identified in the current nationwide study as of exceptional significance in the context of the SSP:

- MCC at JSC
- Structural Dynamic Test Facility (Building 4550) at MSFC
- NBS (in Building 4705) at MSFC
- A-1, A-2, B-1 and B-2 Test Stands (Propulsion Test Stand Complex) at SSC

Compared with historic properties that meet the eligibility criteria for listing in the NRHP, NHLs are those recognized by the Secretary of the Interior as nationally significant properties which "help us to understand the history of the Nation and illustrate the nationwide impact of events or persons associated with the property, its architectural type or style, or information potential. A nationally significant property is of exceptional value in representing or illustrating an important theme in the history of the Nation" (NPS n.d.). Before a property can be designated as a NHL, it must be evaluated by the NPS's National Historic Landmark Survey, reviewed by the National Park System Advisory Board, and recommended by the Secretary of the Interior.

While all NHLs are included in the NRHP, the criteria for Landmark designation are different from the eligibility criteria for listing in the NRHP. The criteria used to select NHLs are as follows:

> *The quality of national significance is ascribed to districts, sites, buildings, structures, and objects that possess exceptional value or quality in illustrating or interpreting the heritage of the United States in history, architecture, archeology, technology and culture; and that possess a high degree of integrity of location, design, setting, materials, workmanship, feeling and association, and :*

(1) That are associated with events that have made a significant contribution to, and are identified with, or that outstandingly represents, the broad national patterns of United States history and from which an understanding and appreciation of those patterns may be gained; or

(2) That are associated importantly with the lives of persons nationally significant in the history of the United States; or

(3) That represent some great idea or ideal of the American people; or

(4) That embody the distinguishing characteristic of an architectural type specimen exceptionally valuable for the study of a period, style or method of construction, or that represent a significant, distinctive and exceptional entity whose components may lack individual distinction; or

(5) That are composed of integral parts of the environment not sufficiently significant by reason of historical association or artistic merit to warrant individual recognition but collectively compose an entity of exceptional historical or artistic significance, or outstandingly commemorate or illustrate a way of life or culture; or

(6) That have yielded or may be likely to yield information of major scientific importance by revealing new cultures, or by shedding light upon periods of occupation over large areas of the United States. Such sites are those which have yielded, or which may reasonably be expected to yield, data affecting theories, concepts and ideas to a major degree.

For properties that have achieved significance within the past 50 years, such properties will qualify as NHLs if they of "*extraordinary national importance*."

All 70 historic properties identified in the SSP study are considered significant at the national level, and all have reached significance within the past 50 years; they all qualify for the NRHP because of their "*exceptional"* importance to the SSP. Among these 70 NRHP-listed, determined eligible, and eligible properties are some (in addition to the seven previously designated NHLs) which potentially may be considered of *extraordinary* national importance, and which best represent the historical and engineering values of the SSP on the national level (e.g., the three extant orbiter vehicles, the VAB). While the evaluation of potential NHLs was beyond the scope of this agency-wide survey and evaluation of SSP-related facilities, the new survey data may provide useful information for a future update of the NPS's Man in Space Theme Study.

6.4 A Programmatic Approach to Historic Property Management

"A great deal of latitude is afforded in the modification of such highly technical and scientific facilities to accommodate NASA's ongoing mission" (ACHP 1991).

As the U.S. Space Program continues to unfold, the transition from the SSP to the Constellation Program will require the modification of existing facilities to support new program activities. Major construction of new buildings is not anticipated at any NASA Center. Decisions regarding which facilities will provide the infrastructure in support of the Constellation Program are currently being decided. Whether selected for adaptive reuse and modification, or excessed at the end of the SSP, NASA undertakings involving the 70 NRHP-listed or eligible properties identified as part of this study (in addition to the historic properties at the KSC which are contributing resources to NRHP-listed and eligible historic districts), as well as historic properties listed or determined eligible under previous NASA programs, will require review and consultation under Section 106 of the NHPA.

In 1991, a Programmatic Agreement (PA) was executed among NASA, the National Council of State Historic Preservation Officers (NCSHPO) and the Advisory Council on Historic Preservation (Council) for the management of NASA's NHLs resulting from the Man in Space Theme Study. The PA (Appendix C) provides guidance for NASA managers regarding the treatment of these landmark properties. This agreement was promulgated pursuant to the regulations (36 CFR Part 800) implementing Sections 106 and 110(f) of the NHPA, as amended, in order to take into account the effect of ongoing NASA programs and specific undertakings on 20 of NASA's NHLs (as of February 24, 1989). Stipulation I specified the actions which would require consultation with the appropriate SHPO, and, as necessary, the Council, as well as mitigation measures (Stipulation I.A); actions that required the development and implementation of mitigation measures, but no consultation (Stipulation I.B); and actions whereby NASA could proceed without consultation or the implementation of mitigation measures (Stipulation I.C). The consultation process is described in Stipulation II of the PA, and two mitigation measures, recordation and salvage, are defined in Stipulation III. The final part of the agreement (Stipulation IV) includes administrative stipulations, such as provisions for continuing coordination, and the termination of the agreement. This PA is currently used by the NASA Centers to meet their Section 106 responsibilities.

Since the execution of this agreement more than 17 years ago, the number of historic properties under NASA's jurisdiction has grown with the addition of designated NHLs and dozens of facilities which are listed or determined eligible for listing in the NRHP. In addition, since 1989, NASA policy changes (e.g., the replacement of NASA Management Instruction [NMI] 4310.4 with NASA Procedural Requirement [NPR] 43100.1), and the increased roster of generally accepted mitigation measures, as encouraged by the NPS and Council, suggest the need for a new agency-wide programmatic agreement.

In consideration of the number and complexity of potential NASA undertakings engendered by the retirement of the SSP and transition to Constellation, a new PA should be procedural in approach, establishing a streamlined and rationalized process through which NASA will meet its compliance responsibilities for different categories of projects. It is recommended that the new PA broaden its scope to include not only designated NHLs, but all NRHP-listed and determined eligible properties. Further, the agreement document should establish categorical exclusions and standard treatments and programs

for the mitigation of adverse effects, as well as standard administrative stipulations for dispute resolution, amendments, and termination.

The Shuttle Transition HPWG has considered an agency-wide programmatic agreement. However, in view of the varying degree in which Centers anticipate they will support the new Constellation Program, the HPWG currently encourages more Center-specific PAs be executed to support the management of the expanded inventory of historic resources.

6.4.1 Classification of Undertakings

Consistent with the intent of Stipulation I of the original PA, two broad categories of undertakings are proposed for the new PAs: undertakings requiring Section 106 consultation, and undertakings which are categorically excluded from Section 106 review. The latter category is defined as undertakings presumed to have minimal potential to cause effects on historic properties, and therefore, which will not require public notification or consultation with the Council, NCSHPO, or individual SHPOs. Such undertakings will be reviewed for Section 106 purposes within NASA without further review by the Council, NCSHPO, or SHPO. Table 6.4 provides a provisional list of example undertakings defined for each of the two categories.

Table 6.3. Classification of NASA Undertakings Relative to Section 106 Review.

Undertakings Requiring Section 106 Consultation	
Action	***Conditions/Examples***
Demolition and dismantlement	Physical destruction of, or damage to, all or part of the historic property
Alterations	Includes, but is not limited to, the replacement of building materials with non-compatible materials, additions to historic properties, removal or excessing of significant elements/equipment, significant changes to floor plans, and partial demolition
New construction	Applicable if the new construction is within or proximate to the boundaries of the historic property where such construction creates a visually intrusive element, or is of non-compatible design and placement
Repair/maintenance	If such actions result in a change in the existing structural integrity, operational function, or visual integrity of the historic property
Neglect/abandonment-in-place	If maintenance is reduced or withdrawn from a historic property, resulting in deterioration
Transfer, sale or lease	To another agency or non-federal entity
Moving/Relocation	Removal of the historic property from its historic setting
Changes in function, purpose, or use of a facility	Structural alterations or the introduction of new elements which result in the loss of continuity in historic function, and the loss of features that define why and when the property was significant
Undertakings Categorically Excluded from Section 106 Review	
Removal or replacement of existing equipment or facility components	Applicable only where the equipment or component itself is not a feature which contributes to the significance of the historic property
General maintenance, repair, or direct in-kind replacement	Includes, but not limited to, painting; siding; roofing; door, ceiling, wall, window, floor covering repair/replacement; elevator repair; filter and light replacement; and repairs to existing equipment. Includes in-kind emergency repairs to maintain structural integrity. Replacement in-kind should match the configuration, material, size, detail, and

	construction of the historic fabric. Cleaning and replacing in-kind must comply with the *Secretary of the Interior's Standards for Rehabilitation*
Retrofitting	May include siting, installation, maintenance, repair, removal or replacement of communications and computer systems, including public address systems, facsimile systems, microwave/radio systems, fiber-optic cables, and phone systems. Not applicable if the historic property is significant in the area of communications. In such cases, consultation will be required
Changes to fire detection/ suppression systems	Includes routine upgrades and modifications to fire alarm systems, smoke detectors, and sprinkler systems
Changes to interior and exterior lighting systems	Includes replacement of or modification to lighting systems that do not alter or detract from the qualities that contribute to the significance of the historic property
Changes to electrical systems	Includes installation, maintenance, repair, removal, or replacement of plant and building electrical systems (e.g., building conduit, wiring and lighting, emergency lighting, etc.)
Changes to water systems	Includes siting, installation, maintenance, repair, removal, and operation of plant water systems including, but not limited to: water wells, cooling water systems, potable water systems, storm sewers, waste water treatment systems, plant drainage, and plumbing
Energy conservation measures	Includes installation, replacement and modifications to the heating, ventilation, and air conditioning (HVAC) control systems and conversions to alternative fuels (provided that these elements do not detract from the qualities that make the historic property eligible)
Health and safety activities	Includes clean-up, encapsulation, and removal/disposal of asbestos-containing materials and lead paint from buildings and structures
New construction of non-permanent facilities	Applicable where the construction process is reversible and does not physically alter significant historic properties. Includes fencing and sheds
Temporary parking or placement	Includes mobile homes, tents, and portable structures on extant parking lots or launch pads where the original surface remains essentially the same
Road maintenance	Includes paving extant roads or parking lots with asphalt or concrete or placing marl or shell on dirt roads or lots; small-scale road, sidewalk, and parking lot repair; and minor relocation of access roads
Landscaping	Includes mowing and trimming of grass, shrubs, or trees; routine vegetation and erosion control activities; maintenance, repair or installation of fencing or signs

6.4.2 Identification of Character-defining Elements

In accordance with NPS requirements, "Parts of buildings, such as interiors, facades, or wings, are not eligible independent of the rest of the existing building. The whole building must be considered, and its significant features must be identified" (NPS 1995:4). The 70 exceptionally significant historic properties identified at the 13 NASA Centers and component facilities include several large, multi-functional buildings where additions and modifications are common. For many of these, the building derives its exceptional significance under Criterion A and/or C from specialized facilities and/or equipment located within only a portion of the overall building; the remaining areas of the building have no significant historical associations. Thus, the respective NRHP-listed

or eligible building is a "shell" distinguished neither by its architecture, design or engineering. Identifying and understanding the character-defining elements or features of these historic properties is a fundamental consideration when determining the effects of a proposed undertaking. As a result of the agency-wide historic facilities survey, efforts were made by the contractors to identify these character-defining elements or features within the historic properties, as identified in Table 6.4.

Table 6.4. Significant Features Identified within NASA's Historic Properties.

Center	Building No.	Significant Area(s)/Elements
ARC	N-238	60 MW Interaction Heating Facility
ARC	N-243	Vertical Motion Simulator
JSC	5	North wing, Room 117D; South wing, Room 1150
JSC	7	North wing high bay, Room 1000
JSC	9	North wing SVMF, Room 1191
JSC	16	Wing N – SAIL, Rooms 1004A, 1008, 1010, 1012, 1016, 1040, and 2005; South wing, Rooms 147 and 147A
JSC	30	Wing M, Rooms 313, 316, 330, 331, 332, 332A, 332B; Wing S, Rooms 2306 and 2300
JSC	44	Rooms 119, 120, 121, 122, 123, 124, 126, 127, 143, 143A, 143B, 144, 144C, 152, 154, and 156
JSC	222	Arc Jet Test Complex, Rooms 116, 117, 120, 120A, and 10N
JSC	920N	NBL in North wing, Rooms 1300, 2300, 3350, 3353, 3355 and 3357)
MSFC	4663	HOSC/NDC - nine rooms on the second floor: A264, A280, A280B, A281, A282, A283, A284, A285, and A286)
MSFC	4705	Multi-purpose High Bay Facility and NBS
MSFC	4732	14" Trisonic Wind Tunnel
MAF	114	Test cells only
MAF	451	Testing apparatus only
Palmdale	150	Work platforms and related equipment

6.4.3 Mitigation Options

Where preservation (including maintenance and interpretation) of a historic facility is not feasible, one or more mitigation measures may be appropriate, depending upon the applicable NRHP criteria of eligibility (Criterion A, B, and/or C). While all 70 of NASA's SSP-related historic properties have exceptionally significant associations with historical events (Criterion A), some are also distinguished by their engineering or architecture, as well as specialized features and equipment. These are important considerations in the selection of mitigation measures. Some of the suggested mitigation measures, such as an oral history program, are already in place at some NASA Centers. Standard treatments may include, but not be limited to, the following:

Documentation: A standard treatment for most historic properties which will be adversely affected by NASA undertakings is documentation of the "end stage" condition of the historic property to Historic American Building Survey/Historic American Engineering Record (HABS/HAER) standards, in accordance with the *Secretary of the Interior's Standards for Architectural and Engineering Documentation* (Federal Register,

48 FR 190:44730-44734, September 29, 1983). The kind and amount of documentation should be appropriate to the nature and significance of the building or structure being documented. Determination of the level of documentation should be made in consultation with the NPS. In general, documentation efforts should focus on the character-defining elements (e.g., innovative structural and mechanical systems; noteworthy architectural features; specialized equipment; etc.). In accordance with the selected level of documentation, a combination of measured drawings depicting existing and historic conditions; reproduction of as-built drawings and site plans; black and white archival photographs with large-format negatives of exterior and interior views; photographs of selected existing drawings or historic views, where available; and/or a historic narrative, may be required. An original documentation package will be provided to the Secretary of the Interior for incorporation into the National Historic Architectural and Engineering Records in the Library of Congress; archival or non-archival copies should also be provided to the appropriate SHPO as well as the NASA History Office and Center-specific archives.

Salvage and Preservation of Significant Artifacts: The 1989 PA stipulated that NASA will apply its agreement with the Smithsonian Institution (NASA Management Instruction [NMI] 4310.4) to determine appropriate retention and curation activities with respect to significant artifacts. NMI 4310.4 was replaced with NPR 4310.1 which provides procedures and guidance for the identification, reporting, transfer, and disposal of NASA artifacts of great historical and educational or other value. It includes (as Appendix A) the "Agreement Between the National Aeronautics and Space Administration and the Smithsonian Institution Concerning the Transfer and Management of NASA Historical Artifacts, May 28, 1998." Salvage of architectural or scientific/engineering elements from NRHP-listed or eligible properties, should not be carried out without prior documentation, as described above. In cases of facility demolition, dismantlement, or removal of significant elements, NASA may apply its agreement with the Smithsonian Institution to determine appropriate retention and curation activities with respect to significant artifacts.

On-site Public Interpretation: Objects which embody historicity vis a vis the SSP, such as tools, instruments, scale models, spacesuits, etc., can be identified, collected, preserved, interpreted and made available for on-site public display. Other forms of public interpretation may include web-based information, including virtual tours and 3-D views of unique facilities; videos and audiotapes; publications including brochures, pamphlets, and books; and markers and kiosks.

Creation of an archival record: This mitigation option includes, but is not limited to, the location and archiving of as-built drawings and site plans, historic photographs, video and movie footage, test schedules and related data from selected scientific tests or research programs that relate to the SSP.

Oral histories: The systematic collection of oral histories from long-term NASA employees and contractors who designed, tested, built, assembled, controlled and flew the Space Shuttle will serve to capture the stories of the SSP. Oral histories provide an

important source of information regarding worker life and social history not available in publications. Such stories can be popularized and made available to the public.

Off-site mitigation: In keeping with the provisions of the National Aeronautics and Space Act of 1958, which charges NASA with the development of public education and outreach programs, NASA may direct its mitigation efforts to provide support for research and written popular and technical histories and other accounts; support for the existing offices of Agency historians and archivists to further the increased dissemination of historical documentation and official agency histories already available but little known outside of NASA; and to encourage increased private and public participation in an effort to preserve the tangible elements of America's manned space program.

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APPENDIX A: Space Shuttle Program Milestones

Space Shuttle Program Milestones

YEAR	EVENT
1969	• President Nixon's Space Task Group endorses concept of a reusable space shuttle • Contracts for design concept studies of the Integral Launch and Reentry Vehicle (ILRV) are awarded to General Dynamics/Convair, Lockheed, McDonnell Douglas, and North American Rockwell
1970	• Space Shuttle concept is formally designated the "Space Transportation System" • Contracts for Phase B studies on the Space Shuttle Main Engine (SSME) are awarded to Aerojet-General Corp., Rocketdyne Division of Rockwell Division of North America, and Pratt & Whitney Aircraft • NASA selects McDonnell Douglas and North American Rockwell for definition and preliminary design studies for a reusable Space Shuttle
1971	• President Nixon announces that NASA will begin the Space Transportation System (STS) program • Mississippi Test Facility (now Stennis Space Center) selected as site for sea-level testing of the SSME
1972	• President Nixon formally endorses plans for the Space Shuttle • NASA Administrator Dr. James Fletcher announces that the Space Shuttle will be powered by recoverable, reusable solid rocket motors in a parallel burn configuration • Space Division of North American Rockwell Corp. is selected by NASA as prime contractor for design, development and production of the orbiter vehicles and for integration of all elements of the Space Shuttle system • NASA signs contract with Rocketdyne for the design, development and testing of the SSME • NASA announces that the Kennedy Space Center (KSC) and Vandenberg Air Force Base will be the two Shuttle launch sites.
1973	• Rocketdyne conducts the first preburner test for the developmental SSME at Santa Susana Field Laboratory (SSFL), California • NASA signs contract with Martin Marietta Corporation for the design, development and testing of the External Tank (ET) • NASA signs contract with the Thiokol Chemical Corporation for the design, development and testing of the solid rocket motor
1974	• Structural assembly of the Orbiter *Enterprise* (OV-101) starts in Palmdale, California • NASA announces that Edwards AFB will be used as the landing site for the first several Shuttle missions.
1975	• Martin Marietta Aerospace awards subcontract to Avco for the manufacture of the ET intertank • Rocketdyne completes the first SSME; first full thrust-chamber ignition test at the National Space Technology Laboratory (NSTL, now Stennis Space Center)
1976	• Assembly of the first ET is underway at the Michoud Assembly Facility (MAF) in Louisiana • Structural assembly of the *Enterprise* (OV-101) is completed • Structural assembly of the Orbiter *Columbia* (OV-102) starts • The first 747 is modified for use as a Shuttle Carrier Aircraft (SCA) at Boeing facilities in Washington • United Space Booster, Inc. of Sunnyvale, California is selected as the solid rocket booster (SRB) assembly contractor

YEAR	EVENT
1977	• SRB testing begins at Marshall Space Flight Center (MSFC), and development tests of a solid rocket motor are first performed in Utah • Wind tunnel tests on integrated Shuttle components begin • Phased Approach and Landing Tests (ALT) are conducted at NASA Dryden using the Orbiter *Enterprise* mated with the SCA. • First development test firing of a solid rocket motor (Development Motor-1) performed in Utah • The first completed ET rolls off the assembly line at MAF
1978	• *Enterprise* and a complete ET arrive at MSFC for vertical ground vibration tests • First major test of the Shuttle's main propulsion system at MSFC • Flight test program with the *Enterprise* (OV-101) is completed • Assembly of the Orbiter *Columbia* (OV-102) is completed
1979	• Orbiter *Columbia* arrives at KSC for two years of assembly and modification work • First complete assembly of the Shuttle configuration (*Enterprise*) in the KSC VAB • Assembly of *Challenger* (OV-099) starts • First series of tests preliminary to flight certification of the SSME is completed • First flight ET is delivered to KSC from MAF
1980	• SSME flight certification tests are completed • *Columbia* (STS-1) arrives at Pad 39A in preparation for first Space Shuttle Program test flight • Structural assembly of the Orbiters *Discovery* (OV-103) and *Atlantis* (OV-104) starts
1981	• First Flight Readiness Firing (FRF) of STS-1 main engines • April 12 launch of *Columbia* marks the first orbital test flight by a winged spacecraft
1982	• STS-3 lands at White Sands due to flooding of Edwards AFB landing site • STS-5 launch marks the first operational Shuttle flight and the first flight with a four-person crew • First flight of mission specialist astronauts (STS-5) • Orbiter *Challenger* (OV-099) is completed • *Columbia* (STS-4) makes first landing on a concrete runway at Edwards AFB • Assembly of *Endeavour* (OV-105) starts
1983	• First flight of *Challenger* (STS-6) • First Shuttle-based extra-vehicular activity (EVA) (STS-6) • Assembly of Orbiters *Discovery* (OV-103) and *Atlantis* (OV-104) is completed • First five-person (STS-7) and six-person (STS-9) crews • First flight by an American woman astronaut, Sally Ride (STS-7) • First flight by an African-American astronaut, Guion "Guy" Bluford (STS-8) • First night launch and first night landing (STS-8) • First Spacelab mission (STS-9)
1984	• First use of the Manned Maneuvering Unit (MMU) (STS-41-B) • First flight of *Discovery* (STS-41-D) • First seven-person crew (STS-41-G) • First Shuttle landing at KSC is made by *Challenger* (STS-41-B) • First flight to include a non-astronaut crewman, Charles D. Walker (STS-41-D) • First on-orbit satellite retrieval (STS-19)

YEAR	EVENT
1985	• First flight of *Atlantis* (STS-51-J) • Most (nine) Shuttle flights in a single year • First Shuttle flight dedicated to the Department of Defense (DoD) (STS-51-C) • First member of Congress, Senator Jake Garn, to fly in space (STS-51-D) • First "abort to orbit" of the Space Shuttle Program (STS-51-F) • First crosswind landing (STS-51-B) • First eight-person crew (STS-61-A) • First Shuttle mission (STS-61-A) managed by a foreign country (West Germany)
1986	• January 28 *Challenger* accident (STS-51-L) marks the first in-flight accident involving a Space Shuttle • First Shuttle launch from LC 39B (STS-51-L) • Rogers Commission established to identify the cause of the *Challenger* accident. Presents report to the President in June.
1987	• Remains of the *Challenger* are sealed underground at Cape Canaveral Air Force Station. • NASA awards contract to Rockwell for construction of OV-105 (*Endeavour*) to replace *Challenger*
1988	• Return to Flight by *Discovery* (STS-26) • Vandenberg Launch Site (VLS) is placed in mothball status
1989	• Space Shuttle Program at VLS is officially terminated • First (Magellan, STS-30) and second (Galileo, STS-34) launches of planetary spacecraft
1990	• Hubble Space Telescope (HST) deployment (STS-31) • Last classified military Shuttle flight (STS-38)
1991	• First spacewalk by U.S. astronauts since 1985 (STS-37) • First unclassified defense-related mission (STS-39) • First mission dedicated entirely to understanding the physiological effects of space flight (STS-40) • First scheduled landing at KSC since January 1986 (STS-43)
1992	• First flight of *Endeavour* (STS-49), which included four spacewalks, the most, to date, on a single mission • First landing with new synthetic tread tires (STS-50) • First operational use of drag chute • Fiftieth flight of the Space Shuttle Program (STS-47) • Last Shuttle flight carrying a DoD payload (STS-53)
1993	• First flight of Spacehab (STS-57) • First nighttime landing at KSC (STS-51) • First servicing of the HST (STS-61)
1994	• MSFC begins development of new super lightweight ET • First flight of a Russian cosmonaut on the Space Shuttle (STS-60) • First flight of improved thermal protection tile, Toughened Uni-Piece Fibrous Insulation (TUFI) (STS-59)
1995	• First docking with *Mir*, and first time an American lives aboard the Russian space station (STS-71) • *Discovery* (STS-63) is the first orbiter to complete 20 missions • First use of the new Mission Control Center at Johnson Space Center (JSC) for *Discovery* mission STS-70 • First flight of the new Block I SSME (STS-70) • Second docking with *Mir* (STS-74)

YEAR	EVENT
1996	• STS-75 marks the seventy-fifth Shuttle flight • First U.S. and world human spaceflight record set by astronaut Shannon Lucid (STS-79) • Third (STS-76) and fourth (STS-76) docking with *Mir*
1997	• Fifth (STS-81), sixth (STS-84), and seventh (STS-86) docking with *Mir* • Second HST servicing mission (STS-82) • First joint US-Russian spacewalk during a Shuttle mission (STS-86)
1998	• Eighth (STS-89) and ninth (STS-91) docking with *Mir* • First U.S. built component of the International Space Station (ISS) is delivered by the Shuttle (STS-88) • STS-91 marks the debut of the new aluminum lithium super lightweight ET • STS-95 marks John Glenn's return to flight after 36 years • First flight of the SSME Block II (STS-95)
1999	• First woman Shuttle commander, Eileen Collins (STS-93) • First Shuttle docking with the ISS (STS-96) • Third HST servicing mission (STS-103)
2000	• The 100th flight of the Space Shuttle Program (STS-92) • Inaugural flight of *Atlantis'* new Multifunction Electronic Display Subsystem (MEDS), also known as the "glass cockpit" (STS-92)
2001	• On March 5, for the first time two Shuttle orbiters were ferried simultaneously – *Atlantis* returning from Edwards AFB and *Columbia* returning from Palmdale after modifications.
2002	• Fourth HST servicing mission (STS-109)
2003	• February 1 *Columbia* disaster (STS-107) marks the first reentry accident involving a Space Shuttle. Spacecraft destroyed 16 minutes before scheduled landing • Columbia Accident Investigation Board (CAIB) is formed to determine both technical and root causes accounting for the loss of *Columbia.*
2004	• President George W. Bush announces that after assembly of the ISS is completed, the Space Shuttle Program will be retired in 2010.
2005	• July 26 Return to Flight with the 31st launch of the Orbiter *Discovery* (STS-114) • First on-orbit repair of the Shuttle heat shield (STS-114)
2006	• STS-115 delivers the largest payload to date for installation in the ISS • NASA announces plans to conduct a HST servicing mission

(Sources: Ezell 1988; Green 2006; Jenkins 2002; Rumerman and Garber 2000; and Wright 2001)

APPENDIX B:
Summary of NASA-wide Significant Historic Properties

FACILITY NO.	NAME	SIGNIFICANCE TO SSP	EXISTING ELIGIBILITY	NEWLY ELIGIBLE
AMES RESEARCH CENTER (ARC), CA				
N-238	Arc Jet Laboratory	The 60-MW Interaction Heating Facility, added to Building N-238 in 1974, is used for tests of the Shuttle's TPS. It has enabled the development of reusable TPS for the orbiters. It is an important engineering achievement, capable of producing heating three times hotter and on larger models than any other NASA arc jet.	No	Yes
N-243	Flight and Guidance Simulation Laboratory/Vertical Motion Simulator (VMS)	Building N-243 derives its significance from the VMS, which has provided training to prepare Shuttle astronauts with an array of possible landing failures. It is the world's largest motion-based simulator. It is the only NASA facility that can simulate final descent and landing of the orbiter, and has been used by almost every pilot astronaut involved in the SSP.	No	Yes
CANOGA PARK, CA.				
n/a (located inside Building 001)	Pacific Scientific Furnace	Used to braze every Space Shuttle Main Engine (SSME) built for the SSP, the Pacific Scientific Furnace has played an exceptionally significant role in the SSP. It is also distinguished as the largest furnace of its type in the world.	No	Yes
DRYDEN FLIGHT RESEARCH CENTER (DFRC), CA.				
4860	Mate-Demate Device	Completed in 1976, this is NASA's first MDD built exclusively for the SSP. It is significant for its support of the ALT program in 1977, and for its continued operational use following landings at Edwards AFB. Unlike the MDD at the KSC, the DFRC structure incorporates several unique personnel safety features. It is distinguished by its specialized design and engineering.	No	Yes
GLENN RESEARCH CENTER (GRC), OH				
85-94, 113-114	Abe Silverstein 10 by 10 foot Supersonic Wind Tunnel (SWT)	Opened in 1955 as one of only two dual-cycle wind tunnels owned by NASA. It provides simulation of high speed atmospheric flight used to verify the design and performance of Space Shuttle systems. It also played a vital role in Shuttle component design improvements and innovations during the post-*Challenger* and *Columbia* Return to Flight. It is also distinguished for its design and engineering.	Yes	No
39, 46, 53-57, 59, 61, 138	8 by 6 foot SWT	Opened in 1949, it is one of the first wind tunnels specially designed and built for propulsion testing. It is currently the only transonic propulsion wind tunnel owned by NASA, and one of two NASA-owned wind tunnels capable of either aerodynamic or propulsion cycle testing. It is also distinguished for its design and engineering.	No	Yes
JOHNSON SPACE CENTER (JSC), TX				
OV-103	*Discovery*	The third orbiter built for operational use, it is the oldest extant vehicle of the Space Shuttle fleet. It was the first orbiter to complete 20 missions, and has the distinction of being the Return to Flight vehicle after both the *Challenger* and *Columbia* accidents. It is also significant as an exceptional feat of engineering.	No	Yes
OV-104	*Atlantis*	The fourth orbiter built for operational use, it is significant as one of three remaining orbiting vehicles of the SSP. It is also significant as an exceptional feat of engineering.	No	Yes

FACILITY NO.	NAME	SIGNIFICANCE TO SSP	EXISTING ELIGIBILITY	NEWLY ELIGIBLE
OV-105	*Endeavour*	The fifth orbiter built for operational use, it is significant as one of three remaining orbiting vehicles of the SSP It is associated with a number of "firsts." It carried the Spacehab module on its first mission, completed the first HST servicing mission, and was the first orbiter to fly with TUFI tiles. *Endeavour* is also significant as an exceptional feat of engineering.	No	Yes
30	Mission Control Center (MCC)	The MCC, a designated NHL, is exceptionally significant as the support center critical to full control of Space Shuttle missions. It also supports the control of simulated flight missions used during training. Its unique design features reflect its historic mission of manned spaceflight control, as well as the distinctive progression of engineering and adaptive reuse from the Apollo era.	Yes	No
5	Jake Garn Mission Simulator and Training Facility	Building 5 is a premier NASA facility for preparing astronauts for Space Shuttle missions. It derives its exceptional significance from the training simulators which were uniquely designed to replicate the Shuttle vehicle and its launch, orbit, and landing environments.	No	Yes
9	Systems Integration Facility	Building 9 derives its exceptional significance from the Space Vehicle Mockup Facility (SVMF) in Wing N. The mockups contained here are unique tools which provide astronaut training, and contribute significantly to astronaut-tested design improvements to the Shuttle orbiter vehicle.	No	Yes
920N	Sonny Carter Training Facility and Neutral Buoyancy Laboratory (NBL)	Building 940N derives its exceptional significance from the NBL, a unique training facility used to prepare astronauts for missions involving spacewalks. Maintenance and assembly operations learned and practiced here are critical to mission success, and fundamental to the construction of the International Space Station. This one-of-a-kind facility contains the world's largest indoor pool which was specially designed and built to simulate the environment of space.	No	Yes
7	Crew Systems Laboratory	The Crew Systems Laboratory derives its exceptional importance from the Environmental Test Area in Wing E., a performance testing site for primary life support equipment, including spacesuits and backpacks, which are critical to the health and safety of the Shuttle mission crew. It also plays a key role in maintaining the orbiter proper as a habitable environment. The vacuum chambers which simulate the space environment provide valuable engineering data on the long-term performance of Shuttle spacesuits and other equipment needed for long duration missions.	No	Yes
16	Avionics Systems Laboratory (SAIL)	The significance of Building 16 is embodied in the Shuttle Avionics Integration Laboratory (SAIL) located within Wing N. This facility is distinguished for providing the highest fidelity Shuttle simulations for all flight phases. It played a key role in the testing and hardware and software certification for the first flight of each orbiter, and is a unique facility which continues to provide software verification and new flight hardware integration and verification in support of the SSP. It contains one-of-a-kind test articles and simulators.	No	Yes

FACILITY NO.	NAME	SIGNIFICANCE TO SSP	EXISTING ELIGIBILITY	NEWLY ELIGIBLE
44	Communications and Tracking Development Lab	This is a unique NASA facility used for system performance verification testing of Space Shuttle communications systems, including interfaces with satellites and ground stations. It plays a key role in the investigation and resolution of flight and post-flight communications anomalies. It has the unique capability to help plan missions and to create communications systems scenarios used for contingencies.	No	Yes
222	Atmospheric Reentry Materials and Structures Evaluation Facility (ARMSEF)	The ARMSEF is one of only two NASA-owned arc jet facilities with the capability to test and verify the thermal performance of every type of TPS material used on the Shuttle. It has contributed significantly to improve-ments in TPS technology, and played a key role in NASA's Return to Flight efforts in the aftermath of the *Columbia* accident. The arc jet facility was uniquely designed and constructed to produce sustained high temperatures needed to conduct TPS performance evaluations.	No	Yes
KENNEDY SPACE CENTER (KSC), FL				
K6-0848	Vehicle Assembly Building (VAB)	The NRHP-listed VAB, one of the world's largest buildings by volume, is a unique facility which supports the integration and stacking of the complete Space Shuttle vehicle on the Mobile Launcher Platform (MLP). It is also distinguished by its design and engineering.	Yes	No
K6-0900	Launch Control Center (LCC)	The NRHP-listed LCC performs the vital operations integral to the prelaunch preparation and launch of the Space Shuttle. It is also distinguished by its architectural design.	Yes	No
UK-0008	Crawlerway	The NRHP-listed Crawlerway is a unique dual-lane surface capable of supporting the weight of the Shuttle vehicle, the MLP, and the Crawler Transporter as they move from the VAB to the launch pad. It has provided continuous service to the nation's space program since the 1960s.	Yes	No
n/a	Crawler Transporters (2)	The two NRHP-listed Crawler Transporters are unique vehicles used to transport the Space Shuttle vehicle, mounted on the MLP, to the launch pad. They have provided continuous service to the nation's manned space program since the 1960s. The Crawler Transporters are designated National Historic Mechanical Engineering Landmarks.	Yes	No
n/a	Press Site: Clock and Flagpole	The NRHP-listed Press Site: Clock and Flag Pole are historically associated with Space Shuttle launches in the minds of people worldwide, as they framed the vehicle during televised broadcasts. The site is an integral facility in the dissemination of information to the public about the Shuttle missions.	Yes	No
J8-1708	Launch Complex 39: Pad A	This site is of exceptional significance as one of only two facilities used to launch the Space Shuttle vehicle. It is distinguished as the site for the launch of the first 23 Shuttle missions between 1981 and 1986. It is also significant for its design and engineering.	Yes	No
J7-0337	Launch Complex 39: Pad B	This site is of exceptional significance as one of only two facilities used to launch the Space Shuttle vehicle. In the aftermath of the *Challenger* accident, it became the primary launch site at KSC. It is also significant for its design and engineering.	Yes	No

FACILITY NO.	NAME	SIGNIFICANCE TO SSP	EXISTING ELIGIBILITY	NEWLY ELIGIBLE
M7-657	Parachute Refurbishment Facility	This manufacturing and assembly facility is used to fabricate and repair a variety of parachute types (main, drogue, and pilot), and keeps the parachute flight sets in excellent working condition. Essential components of the SRBs, the parachutes deploy sequentially to slow the fall of the SRBs, thus facilitating space flight recovery efforts and subsequent reuse of the SRBs.	No	Yes
M7-777	Canister Rotation Facility (CRF)	The CRF was designed and built exclusively to provide for the horizontal and vertical rotation of the Payload Canister in support of the SSP. It made possible a more efficient performance of this operation, previously conducted in the VAB.	No	Yes
n/a	Payload Canisters (2)	The two Payload Canisters are environmentally-controlled cargo containers used to transport fully-integrated Shuttle payloads from various processing or assembly facilities to the launch pad. They were uniquely designed and constructed to match the orbiter cargo bay, and embody the distinctive method of for the transportation of payloads in support of the SSP.	No	Yes
n/a	Retrieval Ships *Liberty Star* and *Freedom Star*	The two retrieval vessels were designed and constructed specifically for the task of SRB recovery, thus facilitating space flight recovery efforts and subsequent reuse of the SRBs, an essential component of the Space Shuttle vehicle. Also, since 1998 have been used to transport ETs from the MAF to KSC.	No	Yes
n/a	Mobile Launcher Platforms (3) (MLP)	The three MLPs are of exceptional importance for their unique function in supporting build-up of the Shuttle vehicle in the VAB and its transport to the launch pad. They are also distinguished by their design and engineering.	No	Yes
n/a	Shuttle Landing Facility (SLF) Runway	The SLF Runway was built in 1976 for the SSP. Since 1981, it is NASA's primary landing site for the SSP. It is also significant as a practice facility for the astronauts. One of the world's longest runways, it is distinguished by its design and construction.	No	Yes
J6-2313	Landing Aids Control Building (LACB)	As the control center for flight operations which support the landing of the Shuttle orbiter, this facility is an exceptionally significant component in the SSP. It plays a key role in the Orbiter's safe return to Earth.	No	Yes
J6-2262	Mate-Demate Device (MDD)	The KSC MDD is one of only three extant devices used to attach and detach the Shuttle orbiter and the SCA. It was used to detach the *Enterprise* and all five operational orbiters upon their delivery from the assembly plant in Palmdale, and is also used for ferry flights between KSC and Palmdale for maintenance and modifications. It is also distinguished by its design and construction.	No	Yes
K6-894	Orbiter Processing Facility (OPF)	The OPF is one of two structures at KSC built exclusively for Shuttle orbiter pre-flight and post-landing processing. Each orbiter was processed for its first operational flight in this facility. The structural components of the OPF, including work platforms, were specifically designed and engineered to be compatible with the orbiter's access points.	No	Yes

FACILITY NO.	NAME	SIGNIFICANCE TO SSP	EXISTING ELIGIBILITY	NEWLY ELIGIBLE
K6-696	Orbiter Processing Facility High Bay 3 (OPF-3)	The OPF-3 is one of two structures at KSC built exclusively for Shuttle orbiter pre-flight and post-landing processing. The structural components of this building, including work platforms, were specifically designed and engineered to be compatible with the orbiter's access points. The Space Shuttle Main Engine Processing Facility (SSMEPF) within this building is also distinguished as a one-of-a-kind facility designed specifically for the SSME.	No	Yes
K6-794	Thermal Protection System Facility (TPSF)	The TPSF is significant as one of only two NASA-owned assets constructed exclusively to house the manufacture and repair of the Shuttle's thermal protection and thermal control systems, essential to the success of the SSP.	No	Yes
K6-494	Rotation/Processing Building	The Rotation/Processing Building was specifically designed for the purpose of rotating the SRB segments, an operation vital to the preparation of the launch vehicle for its mission	No	Yes
L6-247	SRB Assembly and Refurbishment (ARF) Manufacturing Building	As a manufacturing, processing, and assembly facility for SRB non-motor components, the Manufacturing Building plays a vital role in preparing the Shuttle vehicle for flight.	No	Yes
M7-961	Hypergol Module Processing (North)	This one-of-a-kind facility is used for the checkout, refurbishment and revalidation of the hypergolic fuel modules of the orbital maneuvering system (OMS) pods, with the incorporated reaction control system (RCS).	No	Yes
LANGLEY RESEARCH CENTER (LaRC), VA.				
1257, 1257N/S, 1258, 1258A, 1261, 1262	Aircraft Landing Dynamics Facility (Track, Carriage Arresting System, Command Center, Propulsion Center, Calibration Building, Main Support Building)	This facility was used since 1985 to test Shuttle tire performance, tire failure wheel tests, and the effects of runway modifications. It is the only facility in the world that could provide Space Shuttle braking and landing tests required for the Shuttle development program. It is also distinguished by its design and construction.	No	Yes
MARSHALL SPACE FLIGHT CENTER (MSFC), AL				
4436	SSME Hardware Simulation Laboratory (HSL) Block II Facility	Unique facility responsible for both hardware and software design and development, real time launch support, and quality assurance of the computer software that controls the main engines for all Space Shuttle flights.	No	Yes
4540	Test Facility 116	Test Facility 116 derives its primary importance for its role in the development of propulsion systems for the Space Shuttle. It is uniquely designed and engineered to support acoustic model testing for the Shuttle.	No	Yes
4550	Structural Dynamic Test Facility	Built in 1964 and modified in 1975 to support the SSP, this NHL is distinguished by its unique capability to dynamically test the Space Shuttle. It is historically associated with the Mated Vertical Ground Vibration Test (MVGVT) program of 1978-79 which served to verify that the Shuttle could withstand the forces encountered during powered flight. It is also distinguished by its unique design and engineering.	Yes	No
4583	Test and Data Recording Facility (TF 115)	This facility is significantly associated with scale model tests to improve the SRB following the Challenger accident of January 1986. It is also significant for its design modifications made to support tests of an improved SRB launch deflector.	Yes	No

FACILITY NO.	NAME	SIGNIFICANCE TO SSP	EXISTING ELIGIBILITY	NEWLY ELIGIBLE
4612	Materials and Processes Laboratory	Building 4612 is a premier facility for materials science and analysis in support of the SSP. Since the mid-1990s, it has played a critical role in the development and improvement of materials which constitute the main components of the Shuttle vehicle, including the SSME, ET and SRBs. Research here also played a key role in NASA's Return to Flight efforts in the aftermath of the *Challenger* and *Columbia* accidents.	Yes	No
4619	Structures, Dynamics and Thermal Vacuum Laboratory	Since 1972, Building 4619 has played a key role in the validation of major vehicle components which qualified the Shuttle for flight. It also played a key role NASA's Return to Flight efforts in the aftermath of the *Challenger* and *Columbia* accidents. The facility embodies unique design elements and equipment, including one of the world's three Gilmore machines.	Yes	No
4663	Huntsville Operations Support Center (HOSC)/NASA Data Center (NDC)	Since 1980, the HOSC computer command center has supported major launch preparation tests run at KSC and assists in problem-solving during operational launches throughout the SSP.	No	Yes
4670	Advanced Engine Test Facility (AETF)	Constructed in 1964, Building 4670 was first modified in the mid-1970s for the structural verification testing of the ET, and later adapted in the mid-1980s to support the 1990s full-scale testing of advanced technologies for the SSME. It is one of two large test stands at MSFC adapted to support Shuttle testing. It is also a major engineering achievement, and was designated a National Historic Mechanical Engineering Landmark.	Yes	No
4674	Control Facility	This building is functionally associated with Building 4670 (AETF) which played a key role in the testing of major Shuttle components. It is also distinguished as an excellent example of major blockhouse design and engineering.	Yes	No
4705	Multi-purpose High Bay Facility and Neutral Buoyancy Simulator (NBS)	The NBS, a designated NHL, was uniquely designed to simulate the weightless space environment. It is significantly associated with the development and refinement of hardware and assembly techniques which paved the way for the first structures built in space. It continues to have application in today's construction of the ISS.	Yes	No
4707	National Center for Advanced Manufacturing	Building 4707 is significant as a premier research and development facility responsible for the development of key materials which support Shuttle missions, including the composite nose cone for the ET, spray-on foam insulation (SOFI), and a super lightweight ET. It is also significant for its design and engineering.	Yes	No
4732	Office and Wind Tunnel Facility (14-inch Trisonic Wind Tunnel)	The 14-inch Trisonic Wind Tunnel in Building 4732 is significant for its association with important developmental tests of the orbiter, SSMEs, ET, and SRBs using percent-scale models. Use of this tunnel allowed NASA to test concepts cheaply. It is also distinguished by its design and engineering.	Yes	No
n/a	NASA Barge *Poseidon*	Specifically designed to transport large space vehicle hardware, *Poseidon* is the only remaining covered barge still in NASA ownership. It is distinguished as the NASA barge used to transport the first ET flown on a Shuttle orbital	No	Yes

FACILITY NO.	NAME	SIGNIFICANCE TO SSP	EXISTING ELIGIBILITY	NEWLY ELIGIBLE
		mission. It continued to contribute significantly to the SSP by transporting the ET, the only non-reusable major Shuttle component, during river and open sea journeys.		
MICHOUD ASSEMBLY FACILITY (MAF), LA				
110	Vertical Assembly Building (VAB)	Since the beginning of the SSP, Building 110 is where the components of the Shuttle's ET are washed, primed, sprayed with SOFI, assembled, pressure treated, and inspected. Every ET for every Space Shuttle mission ever flown has been processed in this building. It is also significant for its design and construction.	Yes	No
114	High Bay Addition	Built in 1982 for the SSP, this assembly facility is where the liquid oxygen tank and intertank components of the ET are machined, primed, sprayed with SOFI, and assembled. Every oxygen tank and intertank for every Space Shuttle mission ever flown has been rocessed in this building. The five cells inside the building also are significant for their design and construction.	No	Yes
451	Pneumatic Test Facility	Constructed in 1976 for the SSP, Structure 451 is a pressure test facility for the ET's liquid hydrogen tank component. It is responsible for the pneumatic pressure and leak testing of the hydrogen tank component of the ET, and has processed every hydrogen tank for every Space Shuttle mission ever flown. The testing apparatus within Building 451 is significant for its design and construction, and is the only test unit of its size in the U.S.	No	Yes
452	Control Building	Building 452 is the control center for the testing that occurs in Structure 451. It has served the SSP since its beginnings by administering and monitoring the hydrogen tank testing process. The hydrogen tank is an element of the ET, a major component of the Space Shuttle. It is also significant for its blast-proof design and construction.	No	Yes
PALMDALE, CA.				
150	Shuttle Orbiter Final Assembly Building	Building 150 is the site where the first full-scale test vehicle (*Enterprise*) and all five operational orbiters were assembled, upgraded and maintained, from 1973 through 2001. It is the only orbiter assembly hangar in the U.S.	Yes	No
	Orbiter Lifting Frame (OLF)	The OLF is NASA's only extant demountable mate-demate device. It was used to mate the *Endeavour*, the last orbiter of the Shuttle fleet, from its manufacturing site to the KSC for its maiden voyage. It also supported major modifications to four of the operational orbiters. It is distinguished by its specialized design and engineering.	No	Yes
SANTA SUSANA FIELD LABORATORY (SSFL), CA.				
733	Coca I Test Stand	The Coca I test stand is where NASA's SSME component testing program was first started in April 1974. It is associated with the early development testing of the SSME components and complete engine, critical to the design and of and subsequent improvements to the Shuttle propulsion system. It played a key role leading to the certification of the main engines for the first flight of *Columbia,* and is also significant for its specialized design and engineering.	No	Yes

FACILITY NO.	NAME	SIGNIFICANCE TO SSP	EXISTING ELIGIBILITY	NEWLY ELIGIBLE
218	Coca Control Center	Used to control and monitor the test firings of the Coca I stand, it played a key role leading to the certification of the SSME.	No	Yes
STENNIS SPACE CENTER (SSC), LA.				
4120	Propulsion Test Stand A-1 Complex	All designated NHLs, Test Stands A-1, A-2, B-1, and B-2 are exceptionally significant for their role in the pre-launch testing and verification of every Space Shuttle Main Engine (SSME) flown in space. They represent the only structures in the world that could support the type and level of testing required by the SSME. The test stands were uniquely designed and built such that the SSP could not have operated without their contribution	Yes	No
4122	Propulsion Test Stand A-2 Complex		Yes	No
4210	Propulsion Test Stand B-1		Yes	No
4220	Propulsion Test Stand B-2		Yes	No
WHITE SANDS SPACE HARBOR (WSSH), NM				
n/a	Shuttle Landing Facility (SLF) Runways (17/35, 23/05, and 22/02)	Built or modified between the late 1940s and 1986, the three runways replicate those at KSC (Runway 17/35), Edwards AFB (Runway 23/05), and the TAL sites (Runway 20/02). The runways represent the only facility in the history of the SSP used on a contingency basis, when STS-3 could not land at Edwards AFB due to adverse weather conditions. The runways are also significant as the primary training location for Shuttle pilots and commanders.	No	Yes

APPENDIX C:
NASA's Programmatic Agreement for NHLs

PROGRAMMATIC AGREEMENT
AMONG THE
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION,
THE NATIONAL CONFERENCE OF STATE HISTORIC PRESERVATION OFFICERS,
AND THE
ADVISORY COUNCIL ON HISTORIC PRESERVATION

WHEREAS, the National Aeronautics and Space Administration (NASA) undertakes research, development, space mission operations, and management use of its facilities which have been designated as National Historic Landmarks (Landmarks) (Attachment 1); and

WHEREAS, such facilities require frequent modification over the life of agency missions to adapt them to meet the requirements of ongoing NASA programs; and

WHEREAS, NASA has determined that such modifications may have an effect on those Landmarks, and has consulted with the National Conference of State Historic Preservation Officers (NCSHPO) and the Advisory Council on Historic Preservation (Council) pursuant to the regulations (36 CFR Part 800) implementing Sections 106 and 110(f) of the National Historic Preservation Act, as amended (16 U.S.C. 470f and 470h-2(f)); and

WHEREAS, the Department of the Interior, National Park Service (NPS) was invited and participated in the consultation;

NOW, THEREFORE, NASA, the NCSHPO, and the Council agree that the programs shall be implemented in accordance with the following stipulations in order to take into account the effect of the programs and specific undertakings on the Landmarks.

Stipulations

NASA will ensure that the following measures are carried out.

I. Categories of Activities

A. When the proposed undertaking involves any of the following activities, NASA shall consult with the appropriate SHPO and, as necessary, the Council in accordance with Stip. II:

1. Demolition, dismantling, or relocation of original engineering structures, or of buildings housing facilities;
2. Removal or excessing of significant elements of the Landmarks specifically named on the National Register nomination forms;
3. New construction not compatible with major portions of the original structure or which alter the characteristics of the

facility which were specified as the reason for its Landmark designation; or

4. Changes in function, purpose, or use of a facility.

B. When the proposed undertaking is limited to the following activities that will not alter the characteristics of the facility which were specified as the reason for its landmark designation, NASA shall develop and implement mitigation measures in accordance with Stipulation III:

1. Replacement of historic hardware or components;
2. Modification of the original structure or equipment used in engineering structures, or buildings housing facilities; or
3. New construction compatible with existing structure, purpose, and operation of the facility.

NASA shall include a description of such activities and mitigation measures in the annual summary of its activities prepared pursuant to Stipulation IV.A.

C. When the proposed undertaking involves none of the activities specified above, NASA may proceed without consultation or the implementation of mitigation measures.

II. Consultation Process

A. Consultation required under Stip. I.A. shall be conducted as follows:

1. NASA shall provide the following documentation to the SHPO for review:
a. a description of the undertaking, with photos, maps, and drawings;
b. a description of the affected Landmark;
c. a description of the effects of the undertaking on the affected Landmark;
d. a description of alternatives to the proposed action, which were considered if any, and reasons not chosen;
e. a description of any mitigation measures proposed;
f. a description of NASA's effort, if appropriate, to obtain and consider views of affected interested persons on the proposed undertaking, including a copy of any comments received; and
g. the planning and approval schedule for the proposed undertaking.

Whenever feasible, NASA shall give the SHPO advance notice that such documentation is under preparation, and advise the SHPO of a date certain that it intends to submit the documentation to the SHPO.

2. The SHPO shall respond to a written request for consultation (accompanied by the documentation specified in Stip. II.A.1) within 20 working days, and agree, conditionally agree, or disagree with NASA's proposal.

3. If NASA does not accept the SHPO's conditions, or if NASA and the SHPO disagree, NASA shall notify the Council and forward copies of the documentation specified in Stip.II.A.1, above, along with other information relevant to the dispute.

4. Within 20 working days, the Council shall either: (1) attempt to resolve the dispute; (2) provide NASA with recommendations to be taken into account in implementing the activity; or (3) decide to comment, and comment within 45 working days of that decision. At NASA's request, the time periods in Stips. II.A.2. and II.A.4. will run concurrently. In exceptional circumstances NASA may request accelerated consideration under Stip. II.A.4. and the Council will make a good faith effort to accommodate such requests. The Council may consult with the National Park Service of the Department of the Interior during its review period.

B. The Council and the NCSHPO recognize that operational emergency situations may arise where NASA must take immediate action without prior consultation with the appropriate SHPO or the Council. In such situations, NASA shall notify the Council and the SHPO of such actions as soon as practicable.

III. Mitigation

Mitigation measures shall be carried out prior to undertaking actions specified in Stips. I.A. and I.B.

A. Recordation

1. Recordation shall be done in accordance with the Secretary of the Interior's "Standards for Architectural and engineering Documentation" (Standards) (Federal Register, 48 FR 190, pp. 44730-44734, September 29, 1983).

2. Because original "as-built" drawings and other records are on file at the installations containing Landmark facilities, documentation will normally include the following: (1) reproduction of existing "as-built" drawings and site plans modified on standard size (19 x 24 or 24 x 36) mylar; and (2) provision of black and white archival quality photos with large format negatives of exterior and interior views, as appropriate, as well as special technological features or engineering details.

3. Original copies of all documentation shall be provided to the Secretary of the Interior in accordance with the Standards for incorporation into the National Architectural and Engineering Records in the Library of Congress as provided in Section 101 of the National Historic Preservation Act and implementing procedures. Copies of the documentation shall also be provided to the appropriate SHPO.

B. Salvage

NASA will apply its agreement with the Smithsonian Institution (NASA Management Instruction 4310.4) to determine appropriate retention and curation activities with respect to significant artifacts.

IV. Continuing Coordination

A. On or about December 1, 1990, and annually thereafter, NASA will provide a summary of its activities under this Agreement to the Council and to the NCSHPO.

B. In consultation with the appropriate SHPO, the Council may review and comment upon individual undertakings when it determines that historic preservation issues warrant such action.

C. NASA will provide appropriate public information about activities under Stip.I.A. to interested parties upon request.

D. Any party to this Agreement may terminate it by providing 60 days notice to the other parties, provided that the parties will consult during the period prior to termination to seek agreement on amendments or other actions that would avoid termination.

Execution of this Programmatic Agreement and carrying out its terms evidences that NASA has afforded the Council and the NCSHPO a reasonable opportunity to comment on its programs affecting Landmarks under Sections 106 and 110(f) of the National Historic Preservation Act, and that NASA has taken into account the effects of its programs on these Landmarks.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

By: _____ 9/20/89
Associate Administrator for Management — Date

NATIONAL CONFERENCE OF STATE HISTORIC PRESERVATION OFFICERS

By: _____ 10/6/89
President — Date

ADVISORY COUNCIL ON HISTORIC PRESERVATION

By: _____ September 18, 1989
Chairman — Date

ATTACHMENT 1

NASA's NATIONAL HISTORIC LANDMARKS

(as of 2/24/89)

1. Variable Density Tunnel (Langley Research Center, Hampton, VA)
2. Full Scale Tunnel (Langley Research Center, Hampton, VA)
3. Eight-Foot High Speed Tunnel (Langley Research Center, Hampton, VA)
4. Unitary Plan Wind Tunnel (Ames Research Center, Moffett Field, CA)
5. Rocket Engine Test Facility (Lewis Research Center, Cleveland, OH)
6. Zero-Gravity Research Facility (Lewis Research Center, Cleveland, OH)
7. Spacecraft Propulsion Research Facility (Lewis Plum Brook Operations Facility)
8. Redstone Test Stand (George C. Marshall Space Flight Center, AL)
9. Propulsion and Structural Test Facility (George C. Marshall Space Flight Center, AL)
10. Rocket Propulsion Test Complex (Stennis Space Center, MS)
11. Saturn V Dynamic Test Stand (George C. Marshall Space Flight Center, AL)
12. Lunar Landing Research Facility (Langley Research Center, Hampton, VA)
13. Rendezvous Docking Simulator (Langley Research Center, Hapmton, VA)
14. Neutral Bouyancy Space Simulator (George C. Marshall Space Flight Center, AL)
15. Space Environment Simulation Laboratory (Lyndon B. Johnson Space Center, Houston, TX)
16. Spacecraft Magnetic Test Facility (Goddard Space Flight Center, Greenbelt, MD)
17. Twenty-Five-Foot Space Simulator (Jet Propulsion Laboratory, Pasadena, CA)
18. Pioneer Deep Space Station (Goldstone Deep Communications Complex, CA)
19. Space Flight Operations Facility (Jet Propulsion Laboratory, Pasadena, CA)
20. Apollo Mission Control Center (Lyndon B. Johnson Space Center, Houston, TX)

APPENDIX D: Qualifications of Key Personnel

QUALIFICATIONS OF KEY PERSONNEL

Joan Deming

Joan Deming, co-principal and Vice President of Archaeological Consultants, Inc., has more than 30 years of Cultural Resource Management experience. A Registered Professional Archaeologist (RPA), she received an M.A. in Anthropology/Public Archaeology from the University of South Florida in 1976, and has completed advanced training in Section 106 Agreement Document Preparation, Cultural Resource Management Plans: Preparation and Implementation, and Integrating NEPA and Section 106. She also has specialized training and experience in Native American coordination under the Native American Graves Protection and Repatriation Act (NAGPRA), as well as archaeological collections and records management.

Since 1990, Ms. Deming has managed all ACI's work on behalf of the National Aeronautics and Space Administration (NASA) at the Kennedy Space Center (KSC) and for the U.S. Air Force at Cape Canaveral Air Force Station. These investigations include a multi-year KSC-wide archaeological survey and preparation of one site location predictive model; archaeological surveys of several proposed development parcels conducted in compliance with Section 106 of the National Historic Preservation Act; the development of standard operating procedures for the management of NASA's records pertaining to cultural resources; an inventory and assessment of archaeological collections and the evaluation of curatorial facilities; survey and evaluation of NASA-controlled facilities within the KCS; and preparation of a Cultural Resource Management Plan (CRMP) for the KSC. She is currently managing a NASA-wide survey and evaluation of historic facilities in the context of the Space Shuttle Program, including work on behalf of NASA's Glenn Research Center in Ohio; Dryden Flight Research Center in California; the Marshall Space Flight Center in Alabama; the Johnson Space Center in Texas; the White Sands Flight Facility in New Mexico; and the KSC in Florida.

Patricia Slovinac

Patricia (Trish) Slovinac is an Architectural Historian for Archaeological Consultants, Inc. (ACI). She attended The University of Virginia (UVA) where she completed course work for the degree of Master of Architectural History, with a Certificate in Historic Preservation. Prior to joining ACI, Ms. Slovinac was employed by the National Architectural Trust in Washington, D.C., focusing on the donation of Conservation Easements. This involved evaluating historic structures for the purpose of determining their significance as part of a National Register of Historic Places (NRHP) historic district. Ms. Slovinac has experience in the preparation of historic contexts, historical/architectural field survey and site documentation, National Register nominations, and mitigation measures for historic resources, including HABS/HAER documentation. She has experience in hand drafting to HABS/HAER standards, and is skilled in black and white photography.

As part of ACI's NASA-wide survey and evaluation of historic facilities in the context of the Space Shuttle Program, Ms. Slovinac is assisting in the development of a historic context, and has taken the lead on the field survey at various NASA Centers including the KSC, the Marshall Space Flight Center, the Johnson Space Center (JSC), the Glenn Research Center, the Dryden Flight Research Center, and the White Sands Flight Facility. Work consists of a review of the facilities in terms of eligibility for the National Register of Historic Place, and for KSC, the preparation of National Register nominations and updating KSC's Multiple Property cover nomination.

KAREN J. WEITZE *Architectural-Engineering Research, Analysis, and Documentation*
Aerospace and Military History

Weitze Research
708 Bristol Avenue 209.943.1142
Stockton, California 95204

Expertise and Education

Ph.D. Architectural History, Stanford University, 1978
M.A. Architectural History, Stanford University, 1976
B.A. History and Architectural History, University of Texas, 1973

Employment

2001- Weitze Research
Sole Proprietor / President
1998-2001 KEA Environmental, Inc., San Diego, California
Principal Investigator / Project Manager
1994-1997 Geo-Marine, Inc., Plano, Texas
Principal Investigator /Project Manager
1989-1994 Dames & Moore, Inc., Austin, Texas.
Senior Architectural Historian / Principal Investigator / Project Manager
1978-1988 Assistant Professor, Kansas State University
Assistant Professor, University of California, Davis
Associate Environmental Planner, Caltrans, Sacramento (California DOT)
Architectural Historian, California Office of Historic Preservation, Sacramento

Representative Government Projects

United States Air Force

2007 *Historic Range Context Air Armament Center Eglin Air Force Base (1936/1939-1996)*. Two volumes. Volume I: *Narrative and Appendix A (Radar and Instrumentation Sites / Santa Rosa Island / Water Ranges)*. Volume II: *Land Test Areas*.
2006 *Mountain Home Air Force Base Historic Building Inventory and Evaluations*.
2006 *Historic Buildings and Structures Inventory Douglas Missile Test Facility*.
2006 *PAVE PAWS Beale Air Force Base HAER No. CA-319*
2005-2006 *Air Combat Command Data Base, Phase I.*
2005 *Historic Facilities Groups at Air Combat Command Installations: A Comparative Evaluation*
2005 *Strategic Air Command (SAC) Alert Historic District Request for Determination of Eligibility Eglin Air Force Base*
2003 *Keeping the Edge: Air Force Materiel Command Cold War Context (1945-1991)* Three volumes. Volume I: *Command Lineage, Scientific Achievement, and Major Tenant Missions*. Volume II: *Installations and Facilities*. Volume III: *Index*. Partner, EDAW, Inc.
2003 *Eglin Air Force Base Inventory of Historic Properties 2001-2003. Parts I, II, and III.*
2001 *Eglin Air Force Base, 1931-1991: Installation Buildup for Research, Test, Evaluation, and Training*
2001 *Eglin Air Force Base Inventory of Historic Properties FY 2000.*
1999 *Cold War Infrastructure for Air Defense: The Fighter and Command Missions*

1999 *Cold War Infrastructure for Strategic Air Command: The Bomber Mission*
1998 *PAVE PAWS Large Phased-Array Radar Historic Evaluation and Context*
1997 *Guided Missiles at Holloman Air Force Base: Test Programs of the United States Air Force in Southern New Mexico, 1947-1970*
1996 *Inventory of Cold War Properties. Andrews, Charleston, Dover, Grand Forks, McChord, Scott, and Travis Air Force Bases*
1996 Architectural Inventory and Evaluation of Cold War Structures at Minot Air Force Base
1994 *Aeromedical Evacuation Annotated Bibliography*
1994 *National Register of Historic Places Evaluation Peacekeeper Rail Garrison Vandenberg Air Force Base*
1993 *Historic Architectural Engineering Survey Atlas ABRES-A Vandenberg Air Force Base*
1993 *Request for Determination of Eligibility Atlas 576 G Vandenberg Air Force Base*
1992 *Re-evaluation of the NRHP Eligibility for the White Alice Installations at Bethel, Middleton Island, and Pedro Dome, Alaska* (tropospheric communications network)
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Public Service and Affiliations

Society of Architectural Historians, 1975 to the present
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