Space Vehicle Mockup Facility (SVMF) – Building 9

The Space Vehicle Mockup Facility (SVMF) is a large facility located in the high–ceiling northern portion of building 9. It develops, operates and maintains the mockup and trainer facilities to support astronaut training and engineering activities at Johnson Space Center in Houston, Texas. The SVMF consists mainly of International Space Station Trainers (SSMTF) and Space Shuttle Orbiter Trainers, but also some special training facilities.

SSMTF (Space Station Mockup and Training Facility)
The purpose of the SSMTF is to develop and validate flight crew interfaces and designs and to train flight crew members, controllers and instructors on the International Space Station operations, crew systems, maintenance and crew health care. This facility is also used to develop and validate specific procedures.

In keeping with its purpose, this facility provides the environments, the people and the programs that are required to achieve as much realism as possible to match conditions that will be experienced upon the orbiting Space Station. Through effective crew training, hardware evaluation and procedure validation at one-g, the facility strives to ensure maximum safety and mission success on orbit.

To meet the many requirements of the flight crews, engineers and scientists, the facility provides simulated work and living spaces, equipped with hardware and systems of varying degrees of realism. This realism, termed fidelity, ranges from cardboard facades with instrument panels drawn in, to fully operational flight-like equipment panels and systems suitable for real-time simulation exercises.

U.S. Lab (Destiny)
Mockup with high-fidelity components, primary training module for ISS expedition crews. The Destiny Laboratory Module is the centerpiece of the International Space Station, where science experiments will be performed in the near zero gravity of space. The lab consists of three cylindrical sections and two endcones with hatches that will be mated to other station components. A 50.9-centimeter-(20-inch diameter) window is located on one side of the center module segment. This pressurized module is designed to accommodate

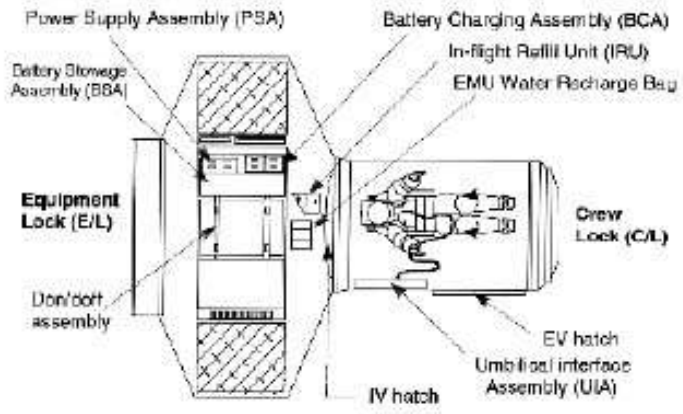
pressurized payloads. It has a capacity of 24 rack locations. Payload racks will occupy 13 locations specially designed to support experiments. Destiny was launched into space aboard shuttle mission STS-98, station assembly flight 5A, on Feb. 7, 2001.

JEM (Japanese Experiment Module)
Low-fidelity mockup of the Japanese research module. Japanese-developed pressurized logistics module is delivered carrying four systems racks, one stowage rack and three experiment racks to be used for Japanese laboratory, the Japanese Experiment Module, to be delivered on flight 1J by the US Space Shuttle.

COF (Columbus Orbital Facility)
Low-fidelity European Space Agency ISS module mockup. Delivers the European Space Agency's primary contribution to the station, the Columbus Orbital Facility laboratory, provides additional research capability.

Joint Airlock (Quest)
High-fidelity ISS airlock mockup with working and simulated components including battery chargers, MetOx C02 scrubbing cartridges and EVA com system. The airlock consists of two separate chambers. The equipment lock, the larger of the two, has room for spacesuits and environment equipment, which will be used by spacewalkers to suit up and prepare for their excursion outside the station. The crew lock, which is separated from the equipment lock by a hatch, is the portal from which the spacewalkers will open the outer hatch to begin their excursions. The crew lock contains lighting, handrails and internal umbilical assemblies to provide power and communications for the spacewalkers until they put their suits on internal battery power. It is similar in size than the shuttle's airlock. Pre and Post-EVA training takes place in the Quest airlock mockup.

- Allows for EVA from ISS (configured for US spacesuits but can also be configured for Russian spacesuits)
- Can hold 2 spacesuits plus storage bin for third suit
- Provides 2 tanks of emergency oxygen to ISS
- Provides 2 tanks of nitrogen to ISS
- Attached to starboard side of Unity



Node 1 (Unity Module)
High-fidelity mockup. The Unity Node is a connecting passageway to living and work areas of the International Space Station. It is the first major U.S.-built component of the station. Unity serves as a passageway to the U.S. Laboratory Module and an airlock. It has six hatches that serve as docking ports for the other modules.

Node 2
Low-fidelity mockup. The second of three station connecting modules, Node 2. attaches to end of U.S. Lab and provides attach locations for the Japanese laboratory, European laboratory, the Centrifuge Module and later Multipurpose Logistics Modules. Primary docking location for the shuttle will be a pressurized mating adapter
attached to Node 2.

PDL (Payload Development Laboratory)
Full scale US Lab mockup used for Human Research Facility Rack (racks HRF1 & HRF2) training with working power and utilities at the rack level.

PDLII (Payload Development Laboratory II)
Full scale US Lab mockup used for Payload Training, ARIS Rack and EXPRESS Rack training with working power, data connections and utilities.

MPLM (Multi purpose Logistics Module mockup)
High-fidelity storage and transfer module with rack attachment points. The MPLM, a reusable logistics carrier, is the primary delivery system used to resupply the International Space Station (ISS) and return Station cargo requiring a pressurized environment. It is one of Italy's major contributions to the Station program. The cylindrical module is approximately 21 feet long, 15 feet in diameter, and weighs almost 4.5 tons. Leonardo will be carried to the International Space Station aboard the Space Shuttle and will be temporarily docked to the Station once on orbit, providing a working environment for two crew members. It can carry up to 20,000 pounds of supplies, science experiments, spare parts and other logistical components.

FGB (Functional Cargo Block)
Medium-fidelity Russian cargo and storage module. Zarya (FGB) is a self-supporting active vehicle. It provides propulsive control capability and power through the early assembly stage (Phase two). It provides fuel storage capability and rendezvous and docking capability to the Service Module. Soyuz TM/A and Progress M/M1 spacecraft may dock to the FGB.

SM (Service Module)
Russian SM mockup, primary living quarters for ISS crew. Used for storage and integration, environmental control group emergency and ISS familiarization classes. The Service Module is the primary Russian station contribution and an early station living quarters. It provides life support system functions to all early elements, a docking port for Progress-type cargo resupply vehicles. Provides propulsive attitude control and reboost capability.

Soyuz
Russian high-fidelity hardware mockup of a Soyuz TMA capsule currently used as the primary escape vehicle on the ISS. The orbital module is in the fore part of the ship and is connected with the descent capsule. The service module is placed behind the descent capsule. When the ship is being placed into orbit, it is protected against aerodynamic and thermal overloads by a nose faring, which is jettisoned after the passage through the dense layers of the atmosphere. The cosmonaut's cabin [descent module] is covered on the outside by a heat-resistant covering to protect it from intensive aerodynamic heating during descent to Earth. After the vehicle has been slowed down by the atmosphere in its re-entry from orbit, the braking parachute opens, then the main parachute which is used for landing opens. Directly before landing, at a height of about 1 meter above the Earth, the solid-fuel braking engines of the soft-landing system are switched on.

E-Wing Solar Array Trainer
The E-Wing is a engineering and training model of one ISS Mast Canister and two Solar Array Blanket Boxes. One Blanket Box contains a deployable array blanket with several rows of solar cells. This trainer allows crew members to train on the various cable, motor and tension assemblies used to deploy the ISS Solar arrays.

Cupola
Will provide a pressurized observation and work area to control SSRMS, enable general viewing observations capabilities, EVA visual support, and spacecraft visual inspection capabilities. The cupola contains 7 windows (1 top and 6 in hexagon pattern) with Micro-meteoroid and orbital Debris Protection System (MDPS aka shutters). SSRMS Robotic Workstation (RWS) will be moved from Destiny Laboratory to the Cupola upon arrival. It will initially be attached to the port side of Unity Node 1, then moved to the forward hatch of Node 3 upon arrival (Flight 20A).

VOT (Vestibule Operations Trainer)
High-fidelity, used for ISS ingress/egress timeline, common berthing mechanism training and thermal vestibule blanket installation and removal. The VOT consists of two main sections. The CBM Active and CBM passive hardware rings provide the latching mechanisms for all modules for the ISS.

ODS (Orbiter Docking System)
Used with VOT for shuttle/station docking, hatch and centerline docking camera training.

PMA 1 (Pressurized Mating Adapter)
Low-fidelity mockup, used with ODS and VOT. Used to connect Unity Node 1 with Zarya FGB.

PMA 2 (Pressurized Mating Adapter)
High-fidelity mockup, used with ODS and VOT. Primary docking port for space shuttles (later also H-IIA Transfer Vehicles). Attached to forward end of Destiny Laboratory.

ZSR Rack (Zero-G Storage Rack)
Flight-like cloth storage rack, used as standalone trainer or in conjunction with the MPLM module for storage transfer training and timeline.

RSP Rack (Re-supply Storage Platform)
Used as standalone trainer or in conjunction with the MPLM module for storage transfer training and timeline.

LWT (Lab Window Trainer)
High fidelity mockup of the US Lab window.

WORF Rack (Window Observational Research Facility mockup)
High-fidelity training rack used in conjunction with the US lab window trainer.

TUSS REEL (Trailing Umbilical Sub System)
Located on the S-Zero truss. The TUSS Reel provides power, data and video to the Mobile Base System (railcar). The reel will feed cables as the MBS moves down the truss segments and retract the cable as it returns.

ISS Assembly Sequence (completed components)

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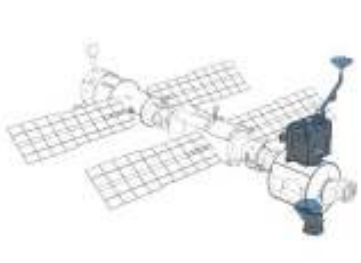

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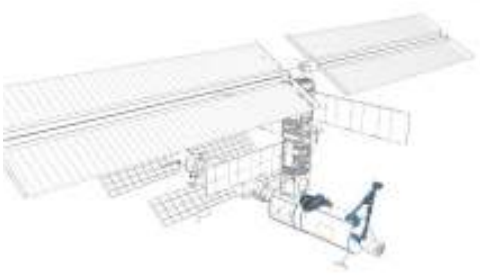

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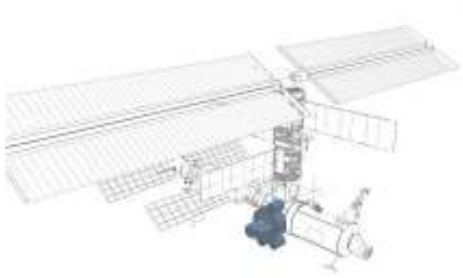

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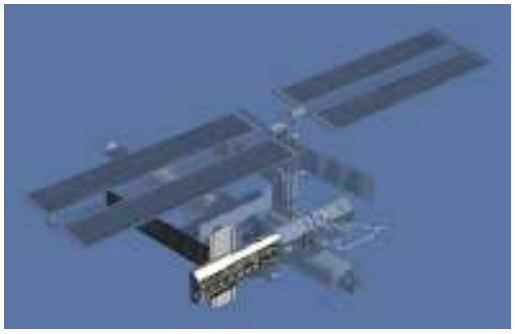

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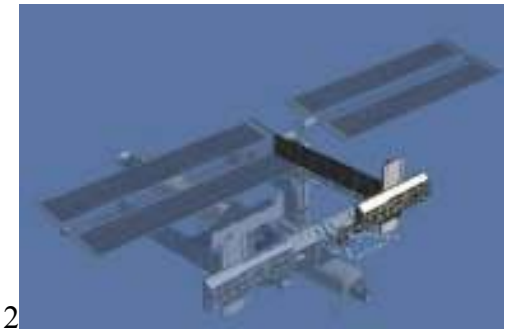

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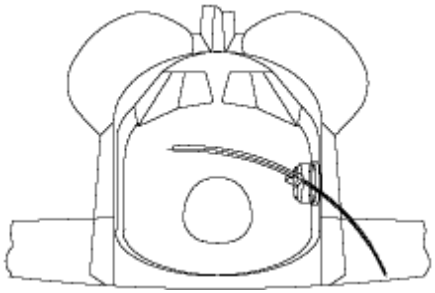
1. FGB (Zarya)	**Nov 20, 1998**	**7. SSRMS**	**Apr 19, 2001**
2. Unity Node 1	**Dec 4, 1998**	**8. Quest Airlock**	**Jul 12, 2001**
3. Zvezda	**Jul 12, 2000**	**9. Docking Compartment 1**	**Sep 14, 2001**
4. Z1 Truss and PMA-3	**Oct 12, 2000**	**10. Integrated S0 Truss**	**Apr 8, 2002**
5. Integrated P6 Truss	**Dec 1, 2000**	**11. S1 Truss**	**Oct 7, 2002**
6. Destiny Lab	**Feb 7, 1002**	**12. P1 Truss**	**Nov 23, 2002**

Aft-Door Shroud
Hubble Space Telescope lower section aft-door trainer.

PABF (Precision Air Bearing Floor)
Used for EVA hardware, large tools and equipment training in a 2-D simulated microgravity environment by floating the objects on a thin cushion of air. The PABF's 32-ft by 24-ft (10-m by 7-m) metal surface provides a two-dimensional simulation (three degress of freedom) of a weightless environment. The PABF is useful as an engineering tool and crew training device, particularly in developing and teaching mass handling techniques.

CES (Crew Escape System)
Escape pole that can be deployed out the side hatch of the shuttle if the shuttle can not safely reach a landing site. The hatch may be blown off by pyrotechnic bolts, then the pole extends. The pole allows the astronauts to jump out of the hatch and be released under the wing to prevent striking the orbiter, after which the astronauts parachute down to the ocean. The CES may only be used in gliding flight around Mach 1 at an altitude of approximately 30,000 ft.



POGO (Partial Gravity Simulator)
Used for EVA hardware and large tools and equipment training in a 2-D simulated microgravity environment by suspending large pieces of hardware from an air-controlled piston that rides on an air-bearing overhead rail. The POGO consists of servos, air bearings and gimbals to provide accurate simulations of reduced gravity. It is used for astronaut training and for evaluating their ability to perform tasks in simulated partial and microgravity.

FFT (Full Fuselage Trainer)
Full scale high-fidelity shuttle mockup/with payload bay. Functional Cameras, galley, com and emergency egress hardware. The 65.8-cubic-meter (2,325-cubic-foot) crew station module is a three-section pressurized working, living and stowage compartment in the forward portion of the orbiter. It consists of the flight deck, the middeck/equipment bay and an airlock. Outside the aft bulkhead of the crew module in the payload bay, a docking module and a transfer tunnel with an adapter can be fitted to allow crew and equipment

transfer for docking, Spacelab and extravehicular operations. Nonfunctional mid-deck and flight deck, and full-scale payload bay. It is used for onboard systems orientation and habitability training. Astronauts practice meal preparation, equipment stowage, trash management, use of cameras, and experiment familiarization. This trainer is also used for emergency egress training after Shuttle landings.

CCT I (Crew Compartment Trainer)
High-fidelity mockup of shuttle crew compartment with internal airlock (Columbia). Training classes conducted in vertical (launch) and horizontal (landing/on-orbit) configurations. The 65.8-cubic-meter (2,325-cubic-foot) crew station module is a three section pressurized working, living and stowage compartment in the forward portion of the orbiter. It consists of the flight deck, the middeck/equipment bay and an airlock. The Crew Compartment Trainer (CCT) is a high-fidelity representation of the orbiter crew station that is used primarily for on-orbit crew training and engineering evaluations. Here astronauts learn how to operate many of the orbiter sub-systems in more than 20 different classes. The CCT tilts to the launch (nose up) position to support training in pre-launch operations.

The CCT's crew module, which consists of a flight deck and a mid-deck, contains high-fidelity components, such as panels, seats and lights, visible to or used by the flight crew. Non-functional switches, connections, guards and protective devices have the same physical characteristics, operating force, torque and movement as flight design. A fully functional, flight-like, closed circuit TV (CCTV) system enables high-fidelity crew training.

CCT II (Crew Compartment Trainer II)
High fidelity mockup of Shuttle crew compartment with external airlock (Discovery, Atlantis and Endeavour). Training classes conducted in vertical (launch) and horizontal (landing/on-orbit) configurations. The 65.8-cubic-meter (2,325-cubic-foot) crew station module is a three-section pressurized working, living and stowage compartment in the forward portion of the orbiter. It consists of the flight deck, the middeck/equipment bay and an airlock.

The Orbiter Crew Compartment Trainer II (CCT II) is the newest Orbiter trainer. It is the highest fidelity of the Orbiter mockup trainers, was manufactured to flight specifications and is equipped with a removable nose. The CCT II's unique design features, such as an all

aluminum flight-like structure, edge-lit displays and coated, lead glass windows make it well suited for a variety of human/spacecraft and interface training.

The CCT II is built on two 8" by 12" keel beams that provide the structural attachment points to the tilting base. The trainer is attached to a table that allows rotation about a fixed axis. The crew module may be oriented into seven unique positions that simulate specific flight, as well as contingency attitudes:

- Launch (nose up)
- Runway position (nose at -3 degrees 56 minutes)
- Nose down (with nose section removed)
- Side hatch up
- Side hatch down
- Horizontal
- Landing (10 degrees nose up)

ET Door Trainer
External Tank umbilical door trainer. The mockup represents the area under the shuttle fuselage where the external fuel line connects to the shuttle main engine bay. It's used to teach contingency closure procedures to EVA crew members if the doors should fail to close after ET separation.

DMT (Dexterous Manipulator Trainer)
DMT will be used on the end of the ISS arm (SSRMS) and it's primary function is to do maintenance on-orbit. The DMT with its two "hands" is designed to change ORU's (Orbital Replacement Units) on the ISS.

Tile Repair Training Area
TPS (thermal protection system) is a key component in the return to flight activities. Crew members and flight controllers are taught how to repair any damage to the tiles, TPS Blankets and RCC (reinforced Carbon Carbon Panels) that protect the leading edge of the wings and the nose of the orbiter at it encounters the ~2,300+ degrees during re-entry.

Vehicle Approach Skills Trainer (Flip-a-roo)
A mock shuttle orbiter used for tile or TPS (thermal protection system) inspection. As the orbiter approaches the ISS it will stop at 600 feet and perform a slow end over end maneuver to allow the ISS crew members to take high resolution photographs of the shuttle TPS.

MRMDF (Multi-use Remote Manipulator Facility)
ISS robotic arm trainer. Canadarm2, a longer, stronger and more flexible cousin to the Canadian built robotic arm used on the Shuttle, is a critical addition to the space station. Canadarm2 is the centerpiece of Canada's contribution to the International Space Station and the robotic arm has a unique ability to switch ends as it works, "inchworming" along the station's exterior. The arm's operation aboard the station is crucial to the continued assembly of the orbiting complex.

APDS (Androgynous Peripheral Docking System)

The Space Shuttle was fitted with a new docking configuration for the STS-71 flight. The Russian developed (2) Androgynous Peripheral Docking System (APDS) is used to link the Shuttle Orbiter to the MIR Kristall module. The APDS was mounted atop a U.S. developed external airlocks. The APDS was used in all seven shuttle dockings with the Russian Space Station MIR.