Countdown to Launch:
What Happens When

Photo Credit: NASA

At T minus 6 hours, NASA begins filling the external tank with liquid oxygen and hydrogen gets underway. Communications checks are made with elements of the Air Force's Eastern Space and Missile Center. Gimbal profile checks of the Orbital Maneuvering System (OMS) engines are made. Preflight calibration of the Inertial Measurement Units (IMU) is made, and tracking antennas at the nearby Merritt Island Tracking Station are aligned for liftoff.

At launch minus 5 hours, 20 minutes -- T minus 5 hours, 20 minutes -- a 2-hour built-in hold occurs. During this hold, an ice inspection team goes to the launch pad to inspect the external tank's insulation to insure that there is no dangerous accumulation of ice on the tank caused by the super-cold liquids. Meanwhile, the closeout crew is preparing for the arrival of the flight crew.

Meanwhile, the flight crew, in their quarters at the Operations and Checkout (O&C) Building, eat a meal and receive a weather briefing. After suiting up, they leave the O&C Building at about T minus 2 hours, 30 minutes for the launch pad -- the countdown having resumed at T minus 3 hours.

Upon arriving at the white room at the end of the orbiter access arm, the crew, assisted by white room personnel, enters the orbiter. Once on board they conduct air-to-ground communications checks with the LCC (Launch Control Center-Kennedy Space Center) and MCC (Mission Control Center-Johnson Space Center). Meanwhile, the orbiter hatch is closed and hatch seal and cabin leak checks are made. The IMU preflight alignment is made and closed-loop tests with Range Safety are completed. The white room is then evacuated and the closeout crew proceeds from the launch pad to a fallback area. At this time, primary ascent guidance data is transferred to the backup flight system.

At T minus 20 minutes a planned 10-minute hold begins. When the countdown is resumed on-board computers are commanded to their

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launch configuration and fuel cell thermal conditioning begins. Orbiter cabin vent valves are closed and the backup flight system transitions into its launch configuration.

At T minus 9 minutes another planned 10-minute hold occurs. Just prior to resuming the countdown, the NASA Test Director gets the "go for launch" verification from the launch team. At this point, the Ground Launch Sequencer (GLS) is turned on and the terminal countdown starts. All countdown functions are now automatically controlled by the GLS computer located in the Firing Room Integration Console.

At T minus 7 minutes, 30 seconds, the orbiter access arm is retracted. Should an emergency occur requiring crew evacuation from the orbiter, the arm can be extended either manually or automatically in about 15 seconds.

At T minus 5 minutes, 15 seconds the MCC transmits a command that activates the orbiter's operational instrumentation recorders. These recorders store information relating to ascent, on-orbit and descent performance during the mission. These data are analyzed after landing.

At T minus 5 minutes, the crew activates the Auxiliary Power Units (APU) to provide pressure to the Shuttle's three hydraulic systems which move the main engine nozzles and the aerosurfaces. Also at this point, the firing circuit for SRB (Solid Rocket Boosters) ignition and the range safety destruct system devices are mechanically enabled by a motor-driven switch called the safe and arm device.

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At about T minus 4 minutes, 55 seconds, the liquid oxygen vent on the external tank is closed. It had been open to allow the super-cold liquid oxygen to boil off, thus preventing over pressurization while the tank remained near its full level. Now, with the vent closed, preparations are made to bring the tank to its flight pressure. This occurs at T minus 2 minutes, 55 seconds.

At T minus 4 minutes the final helium purge of the Shuttle's three main engines is initiated in preparation for engine start. Five seconds later, the orbiter's elevons, speed brakes and rudder are moved through a pre-programmed series of maneuvers to position them for launch. This is called the aerosurface profile.

At T minus 3 minutes, 30 seconds, the ground power transition takes place and the Shuttle's fuel cells transition to internal power. Up to this point, ground power had augmented the fuel cells. Then, 5 seconds later, the main engine nozzles are gimballed through a pre-programmed series of maneuvers to confirm their readiness.

At T minus 2 minutes, 50 seconds, the external tank oxygen vent hood -- known as the beanie cap -- is raised and retracted. It had been in place during tanking operations to prevent ice buildup on the oxygen vents. Fifteen seconds later, at T minus 2 minutes, 35 seconds, the piping of gaseous oxygen and hydrogen to the fuel cells from ground tanks is terminated and the fuel cells begin to use the on board reactants.

At T minus 1 minute, 57 seconds, the external tank's liquid hydrogen is brought to flight pressure by closing the boil off vent, as was done earlier with the liquid oxygen vent. However, during the hydrogen boil off of, the gas is piped out to an area adjacent to the launch pad where it is burned off.

At T minus 31 seconds, the Shuttle's on-board computers start their terminal launch sequence. Any problem after this point will require

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calling a "hold" and the countdown recycled to T minus 20 minutes. However, if all goes well, only one further ground command is needed for launch. This is the "go for main engine start," which comes at the T-minus-10-second point. Meanwhile, the Ground Launch Sequencer (GLS) continues to monitor more than several hundred launch commit functions and is able automatically to call a "hold" or "cutoff" if a problem occurs.

At T minus 28 seconds the SRB booster hydraulic power units are activated by a command from the GLS. The units provide hydraulic power for SRB nozzle gimballing. At T minus 16 seconds, the nozzles are commanded to carry out a pre-programmed series of maneuvers to confirm they are ready for liftoff. At the same time -- T minus 16 seconds -- the sound suppression system is turned on and water begins to pour onto the deck of the MLP and pad areas to protect the Shuttle from acoustical damage at liftoff.

At T minus ll seconds, the SRB range safety destruct system is activated.

At T minus 10 seconds, the "go for main engine start" command is issued by the GLS. (The GLS retains the capability to command main engine stop until just before the SRBs are ignited.) At this time flares are ignited under the main engines to burn away any residual gaseous hydrogen that may have collected in the vicinity of the main engine nozzles. A half second later, the flight computers order the opening of valves which allow the liquid hydrogen and oxygen to flow into the engine's turbopumps.

At T minus 6.6 seconds, the three main engines are ignited at intervals of 120 milliseconds. The engines throttle up to 90 percent thrust in 3 seconds. At T minus 3 seconds, if the engines are at the required 90 percent, SRB ignition sequence starts. All of these split-second events are monitored by the Shuttle's four primary flight computers.

At T minus zero, the holddown explosive bolts and the T-O umbilical explosive bolts are blown by command from the on-board computers and the SRBs ignite. The Shuttle is now committed to launch. The mission elapsed time is reset to zero and the mission event timer starts. The Shuttle lifts off the pad and clears the tower at about T plus 7 seconds. Mission control is handed over to JSC after the tower is cleared.


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