NASAfacts

Crawler-Transporter

A pair of behemoth machines called crawler-transporters have carried the load of taking rockets and spacecraft to the launch pad for more than 40 years at NASA's Kennedy Space Center in Florida. Each the size of a baseball infield and powered by locomotive and large electrical power generator engines, the crawler-transporters stand ready to keep up the work for the next generation of launch vehicles projects to lift astronauts into space.

The crawlers are unique in the world, having been built in 1965 to move the massive Saturn V rocket from Kennedy's Vehicle Assembly Building to Launch Complex 39. After the moon landing and Skylab programs ended, the crawlers continued their work, taking space shuttles to their launch pads for 30 years.

With the shuttle fleet retired in 2011, the crawlers are envisioned as critical elements of future launch operations at Kennedy. One is expected to take commercially operated rockets and spacecraft to the launch pad. The other is being strengthened to handle the Space Launch System (SLS), a rocket and launch tower combination heavier than even the Saturn V moon rockets the crawlers were designed for.

Able to raise and lower its sides and corners independently, the crawlers are designed to roll underneath a launch platform, pick it up and steadily carry it 3.4 miles to Launch Pad 39A or 4.2 miles to Launch Pad 39B. Because each pad is built atop a sloping pyramid, the crawler uses its hydraulic suspension to keep the platform level all the way to the top where it sets the platform in place so the vehicle can lift off safely.

Roller Bearing History

In a July 1965 test, the crawler moved a launch umbilical tower about one mile on two short stretches of road. During the operation, metal fragments were discovered on the crawlerway. A thorough search disclosed pieces of bearing races, rollers and retainers from the crawler's traction-support roller assembly. A roller bearing and associated assembly redesign was undertaken in the fall of 1965.

By December 1965 Marion Power Shovel had implemented and installed the redesigned support roller shafts and new sleeve bearings.

Present modifications will redesign and upgrade the roller bearings and assemblies on crawler-transporter 2 (CT-2). Existing bearings will be removed and replaced with a redesigned assembly that can carry a greater load, is better lubricated and has a longer operational life. These redesigns will enable the crawler to carry the greater loads anticipated with the SLS.

Current Development

Each crawler is having its four trucks, the part of the crawler that holds and drives the tracks, modified and strengthened with structural reinforcements. AC power generators also are being replaced on both crawlers to increase available power from 750 kW to 1,500 kW to increase reliability and supportability.

CT-2 is being further modified to extend the lifetime of the systems that operate the crawler. Some of these system modifications include redesigned roller bearings, jacking, equalization and leveling (JEL) cylinders to increase load carrying capacity and reliability, electronics replacement, cable replacement, tubing replacement, hydraulic component replacement, cleaning of fuel tanks, and cleaning of hydraulic systems.

The crawler-transporter modifications are being directed by NASA's Ground Systems Development and Operations Program based at Kennedy.

Crawler-Transporter Systems

The crawler-transporter consists of these systems and subsystems:

AC Power	DC Power	Pneumatic
Hydraulic Steering	Engine Monitor	DC Propel
Belt Pin Lube	Lincoln Lube	

Strain and Temperature System
Condition Monitoring System
Integrated Monitor and Control
Hydraulic Jacking, Equalizing and Leveling
Fire Detection, Alarm and Protection

Other crawler-transporter facts

Height

Minimum (JEL cylinders retracted) .....20 feet
Maximum (JEL cylinders extended) .....26 feet

Size

Overall .....131 feet long, 114 feet wide
The mobile launcher platform contacts the crawler at four points, arranged in a 90-foot square (same as the base line on a professional baseball field).

Cylinders

JEL Hydraulic .....20-inch bore diameter CT-1, 23-inch bore max diameter CT-2 (16 each)

Steering Hydraulic .....14.5-inch diameter (16 each)

Guide Tube (4 each) .....40-inch diameter

Weight

Overall .....6.3 million pounds
Chassis .....2.2 million pounds
(lifted by hydraulic system)

Speed

Loaded .....1 mph
Unloaded .....2 mph

Loads

Mobile Launch Platform and
Space Shuttle.....12.6 million pounds
Mobile Launch Platform.....9.87 million pounds

Trucks

Traction Motors
(16 each/4 per truck).....375 hp each
Belts.....8 each (2 per truck)

Hydraulic System

Reservoir Capacity.....2,500 gallons
Steering .....4 pumps, 34.4 GPM
@ 1200 RPM, per pump
Steering Pressure.....5,000 PSI maximum
Jacking, Equalizing, Leveling (JEL).....8 pumps, 60 GPM Max, 15-20 GPM nominal @ 1200 RPM per pump
JEL Pressure .....3,000 PSI Maximum

Electrical Systems
DC Power System

16 locomotive traction motors .....375 hp
Diesel Engines .....Alco, 16 cylinders
2 @ 2,750 hp each, for DC power
Generators (DC) .....4 @1,000 kW each

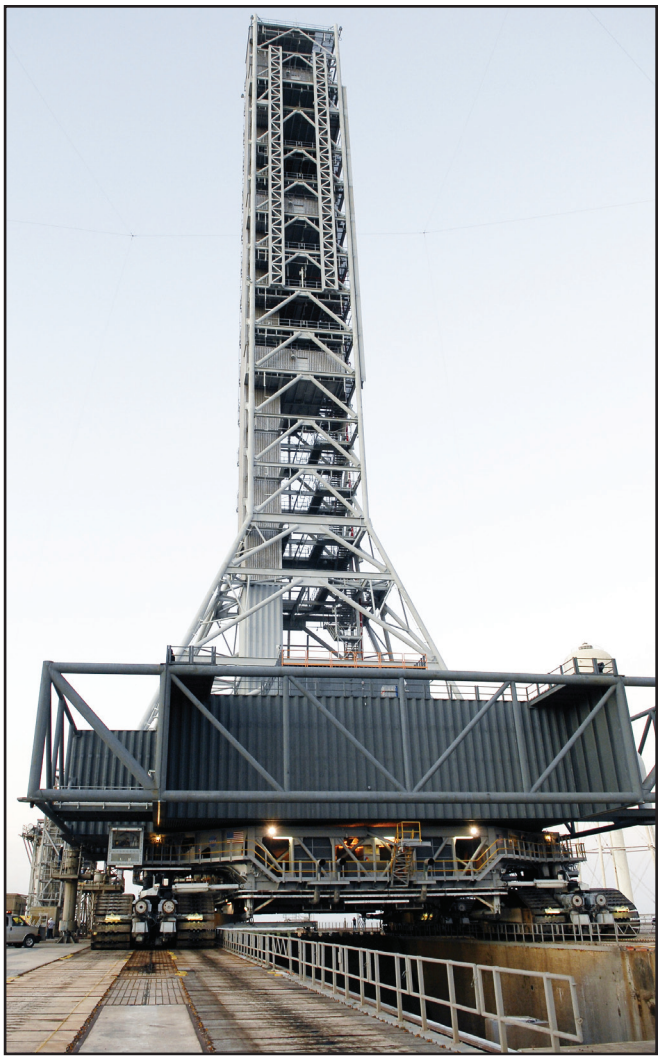
AC Power System

Runs all onboard systems
Diesel Engines .....Cummins Power, 16 cylinders,
2 @ 2,220 hp each, for A/C power
Generators (AC).....2 @ 1,500 kW each

Capacity

Diesel Fuel Capacity .....5,000 gallons
Fuel Consumption .....1 gallon per 32 feet
(approximately 165 gallons per mile)
Drive System Gear Ratio.....168:1

Historical timeline



The crawler-transporter, carrying the mobile launcher (ML), completes a 4.2-mile trek Nov. 16, 2011, to Launch Pad 39B at NASA's Kennedy Space Center in Florida.

March 1963 – Fabrication began on the crawler-transporters in Ohio.

April 1963 – NASA decided to separate the launcher from its transporter and build only two crawlers.

June 13, 1963 – NASA officially decided to use the crawler concept.

September 1963 – The Corps of Engineers asked for a thorough analysis of the wind-load factors on the crawler.

December 1963 – Marion had completed 90 percent of the design and promised that parts of the vehicle would begin to arrive at the launch area in March 1964.

November 1964 – Assembly of the first crawler-transporter was completed on Merritt Island, Fla.

November 1964 – The crawlerway was ready for testing.

Jan. 23, 1965 – The crawler moved under its own power for the first time.

March 1965 – Road tests, mating, and modifications were completed.

June 22, 1965 – The hydraulic jacking and leveling system was ready for testing when the crawler picked up its first load, a mobile launcher.

July 24, 1965 – In a test, the crawler moved a launch umbilical tower about one mile on two short stretches of road. One was surfaced with washed gravel and the other with crushed granite.

July 27, 1965 – Metal fragments were discovered and a thorough search disclosed pieces of bearing races, rollers and retainers from the crawler's traction-support roller assembly.

December 1965 – Marion reinstalled the support roller shafts.

Jan. 28, 1966 – The crawler successfully transported a mobile launcher approximately one mile to the Vehicle Assembly Building.

Early 1966 – Both crawlers became operational.

Aug. 26, 1967 – The first Saturn V rocket was moved to the launch pad for the unmanned Apollo 4 mission.

Oct. 9, 1968 – A Saturn V rocket was moved to the launch pad for Apollo 8, the first manned Saturn V mission.

Feb. 27, 1973 – The crawler carried the first Saturn IB to the launch pad for the Skylab 2 mission.

May 1, 1979 – A crawler transported space shuttle Enterprise, with external tank and two inert solid rocket boosters, to Launch Pad A for fit check.

Early 1980 – The original shoe quantity was supplemented with 228 new shoes per crawler from foundries in Bay City, Mich., and Kobe, Japan.

Dec. 29, 1980 – A crawler moved space shuttle Columbia out to Launch Pad 39A for STS-1 mission.

September 2003 – A crack was found on an original Marion shoe.

December 2003 – The development of more restrictive design specifications was initiated to prevent the manufacturing flaws found in the existing shoes.

Mid-May 2004 – ME Global was contracted to produce all of the required replacement shoes pending successful qualification of the company's production process.

September 2004 – The first 1,060 new shoes arrived from ME Global.

April 6, 2005 – A crawler, with new shoes and modifications, moved space shuttle Discovery to Launch Pad 39B for its STS-114 return-to-flight mission.

Nov. 16, 2011 – Moved Space Launch System's (SLS) mobile launcher from the park site beside the Vehicle Assembly Building (VAB) to Launch Pad 39B.

Nov. 30, 2011 – Returned SLS mobile launcher from Launch Pad 39B the park site beside the VAB.

The crawler-transporters are seen from the tower of NASA's mobile launcher, or ML, at NASA's Kennedy Space Center in Florida on Aug. 12, 2010.

The crawler-transporter, carrying the mobile launcher (ML), is being prepared for a journey Nov. 15, 2011, to Launch Pad 39B at NASA's Kennedy Space Center in Florida.

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