NASA Facts

# Crawler Transporters

A credit to the individuals who designed the Kennedy Space Center crawler transporters is the fact they did not embark on exotic schemes that might have taken years to develop and would have cost many times more. Instead, they used existing and proven concepts that were modified and ingeniously applied to the Apollo program requirements.

Construction of the crawlers as separate and independent of the mobile launch platform structures proved both prudent and visionary in light of future requirements of the transporters. Spanning multiple programs, the crawlers have truly become the workhorses of the Complex 39 area. They continue to function well in the 21st century using the basic design initiated in 1962.

## Crawler Transporter Tread Belt Shoes

Each transporter travels on eight tracked tread belts, each containing 57 tread belt “shoes.” Each shoe is 7.5 feet long, 1.5 feet wide and weighs approximately 2,100 pounds. More than 1,000 shoes (456 per crawler, plus spares) were provided by Marion Power Shovel Co. in Ohio when the crawlers were initially built in 1965.

In the early 1980s, this original shoe quantity was supplemented with 228 new shoes per crawler from foundries in Bay City, Mich., and Kobe, Japan. These additional shoes permitted the implementation of a shoe refurbishment program in the late 1980s, as each transporter approached 1,000 miles of use. To date, more than 500 shoes have been refurbished and placed into operation. The crawlers performed well for nearly 40 years supported by the shoe refurbishment program, which was designed to extend shoe life indefinitely.

However, in September 2003, a crack was found on an original Marion shoe. In the following months, additional inspections revealed that this crack was not an isolated occurrence, prompting the acceleration of new shoe procurement activities. Subsequent NASA/United Space Alliance analysis revealed the existing shoes were experiencing fatigue failures due to internal manufacturing flaws that dramatically reduced the service life of the shoes.

In December 2003, the development of more restrictive design specifications was initiated to prevent the manufacturing flaws found in the existing shoes. ME Global of Duluth, Minn., was the only domestic supplier that proposed to manufacture all of the required shoes within both the quality and schedule requirements. In mid-May 2004, ME Global was contracted to produce all of the required replacement shoes pending successful qualification of the company’s production process.

In time to support the shuttle’s return to flight, the first of 53 shipments (19 shoes) arrived at KSC in early September 2004, with others following shortly after.

## The Crawlers at Work

One of the two crawlers transports the assembled space shuttle, sitting atop the mobile launcher platform, from the Vehicle Assembly Building to Launch Pads 39A and 39B.

The transporter lifts the mobile launcher platform from its parking site pedestals at the refurbishment area, carries it into the Vehicle Assembly Building, and lowers it onto the pedestals in the high bay.

When the orbiter has been mated to the external tank and solid rocket boosters (thus becoming the space shuttle), the crawler lifts the mobile launcher with the space shuttle, and carries it to the launch pad using a laser guidance system and a leveling system on the crawler.

Once at the pad, the crawler lowers the mobile launcher onto the pad pedestals. The transporter then moves to a park site away from the pad to avoid possible damage from launch. After the space shuttle is launched, the crawler lifts the mobile launcher from the pad and returns it to the parking location for refurbishment.

The crawler transporter consists of these systems and subsystems:

| | | |
|---|---|---|
| AC Power | DC Power | Auxiliary Power |
| Hydraulic | Pneumatic | Steering |
| Engine Monitor | DC Propel | Lubrication |
| Instrumentation | Integrated Monitor and Control | |

Jacking, Equalizing and Leveling

Fire Detection, Alarm and Protection

# Crawler Transporter Facts

### *Height*

Minimum (Cylinders retracted) ......................20 feet
Maximum (Cylinders extended) .....................26 feet

### *Size*

Overall .............................131 feet long /113 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 major league baseball field).

### *Cylinders*

Jacking Hydraulic ............20-inch diameter (16 each)
Steering Hydraulic .......14.5-inch diameter (16 each)
Guide Tube (4 each) .........................40-inch diameter

### *Weight*

Overall .............................................5.5 million pounds
Chassis ............................................2.2 million pounds
(lifted by hydraulic system)

### *Speed*

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

### *Loads*

Mobile Launcher Platform and Space Shuttle
...............................................................12 million pounds
Mobile Launcher Platform............8.8 million pounds

### *Trucks*

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

### *Hydraulic System*

Overall Capacity.................................3,700 gallons
Steering ...................................4 pumps, 35.5 GPM
@ 1200 RPM, per pump
Pressure.....................................5,200 PSI maximum
Jacking, Equalizing, Leveling (JEL).........8 pumps

### *Electrical System*

**DC Power System**

For 16 traction motors .................................375 hp
Diesel Engines .............................Alco, 16 cylinders
2 @ 2,750 hp each
Generators (DC) ....................4 @1,000 KW each

**AC Power System**

Runs all onboard systems
Diesel Engines ..........White-Superior, 8 cylinders,
2 @ 1,065 hp each, for A/C power
Generators .................................2 @ 750 KW each
Diesel Fuel Capacity .......................... 5,000 gallons
Fuel Consumption ...................1 gallon per 42 feet
(approximately 125.7 gallons per mile)
Drive System Gear Ratio.................................168:1

# Historical Timeline

- *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.
- *January 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 1.6 kilometers 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.
- *January 28, 1966* – The crawler successfully transported a mobile launcher approximately 1.6 kilometers to the Vehicle Assembly Building.
- *Early 1966* – Both crawlers became operational.
- *August 26, 1967* – The first Saturn V rocket was moved to the launch pad for the unmanned Apollo 4 launch.
- *October 9, 1968* – A Saturn V rocket was moved to the launch pad for Apollo 8, the first manned Saturn V launch.
- *February 27, 1973* – The crawler carried first Saturn IB to 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.
- *December 29, 1980* – A crawler moved space shuttle Columbia out to Launch Pad 39A for STS-1 flight.
- *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 53 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.

The Crawler transporter (foreground) sits behind the Vehicle Assembly Building after its road test of new shoes. The crawlcr transporter that will move space shuttle Discovery to the launch pad for return to flight is taking its first road test following the replacement of all its shoes.

NASA **Facts**

## Crawler Costs

***Initial Study in 1962***

- $7,300,000 -- Initial study indicating the costs for the two crawlers
- Contract awarded to Marion Power Shovel Co. (cost-plus-incentive fee contract)
- $9.1 million for both crawlers

***Actual Costs***

- About $14 million for both crawlers