



National Transportation Safety Board

Washington, D.C. 20594

Railroad Accident Brief

Accident No.: DCA-09-FR-008
Location: Lake Buena Vista, Florida
Date: July 5, 2009
Time: 2:00 a.m., eastern daylight time¹
Railroad/Property: Walt Disney World Resort
Property Damage: \$24 million
Injuries: 0
Fatalities: 1
Type of Accident: Collision

The Accident

About 2:00 a.m. on Sunday, July 5, 2009, two monorails² collided on a fixed guideway system³ referred to as the Epcot beam⁴ near the Concourse station within Walt Disney World Resort in Lake Buena Vista, Florida. The accident occurred when the Pink monorail backed through an improperly aligned switch-beam⁵ and struck the Purple monorail. An operator and six passengers were on board the Purple monorail at the time of the collision. The operator was fatally injured; the passengers were not injured. The only occupant of the Pink monorail, the operator, was taken to a nearby hospital and treated and released. At the time of the accident, weather conditions were clear with light winds and a temperature of 76° Fahrenheit. One operating cab from each of the monorails was destroyed.⁶ (See figure 1.) Total damages were estimated at \$24 million.

¹ All times in this brief are eastern daylight time.

² The Walt Disney World Resort typically uses the term “monorail” to refer to its trains that move passengers to and from locations within its resorts.

³ A *rail fixed guideway system* is defined by Title 49 *Code of Federal Regulations* Part 659 as any light, heavy, or rapid rail system, monorail, inclined plane, funicular, trolley, or automated guideway.

⁴ The Walt Disney World Resort monorails operate along elevated tracks referred to as “beams.” The individual beam sections are precast concrete supported by uprights called “pylons.”

⁵ A *switch-beam* is a moveable section of the beam that is used to divert a monorail from one beam to another.

⁶ Each monorail had an operating cab at both ends to allow for movement in either direction.



Figure 1. The accident monorails after the collision. The rear operating cab of the Pink monorail (unoccupied at the time of the accident) is on the left, and the front operating cab of the Purple monorail is on the right.

Monorail Operations

The Walt Disney World Resort monorail system has two designated service areas: Magic Kingdom Park and Epcot. The Magic Kingdom Park service area consists of two monorail beams that run generally parallel and that form a complete loop. The inside beam is the Resort/Lagoon beam; the outside beam is the Express beam. The Epcot service area consists of a single monorail beam, called the Epcot beam, which also forms a complete loop. At the time of the accident, Walt Disney World Resort was operating five monorails identified by the following colors: Pink, Purple, Silver, Red, and Coral.

The Epcot beam is located to the south of the Magic Kingdom Park beam system. The Epcot beam is connected to the Magic Kingdom Express beam through a spur-beam. Switch-beams 8 and 9 at either end of the spur-beam⁷ can be repositioned to allow a monorail access from the Epcot beam to the Express beam or vice versa. (See figure 2.)

⁷ The Walt Disney World Resort uses the term “spur-beam” for the section of beam that connects switch-beam 8 and switch-beam 9.

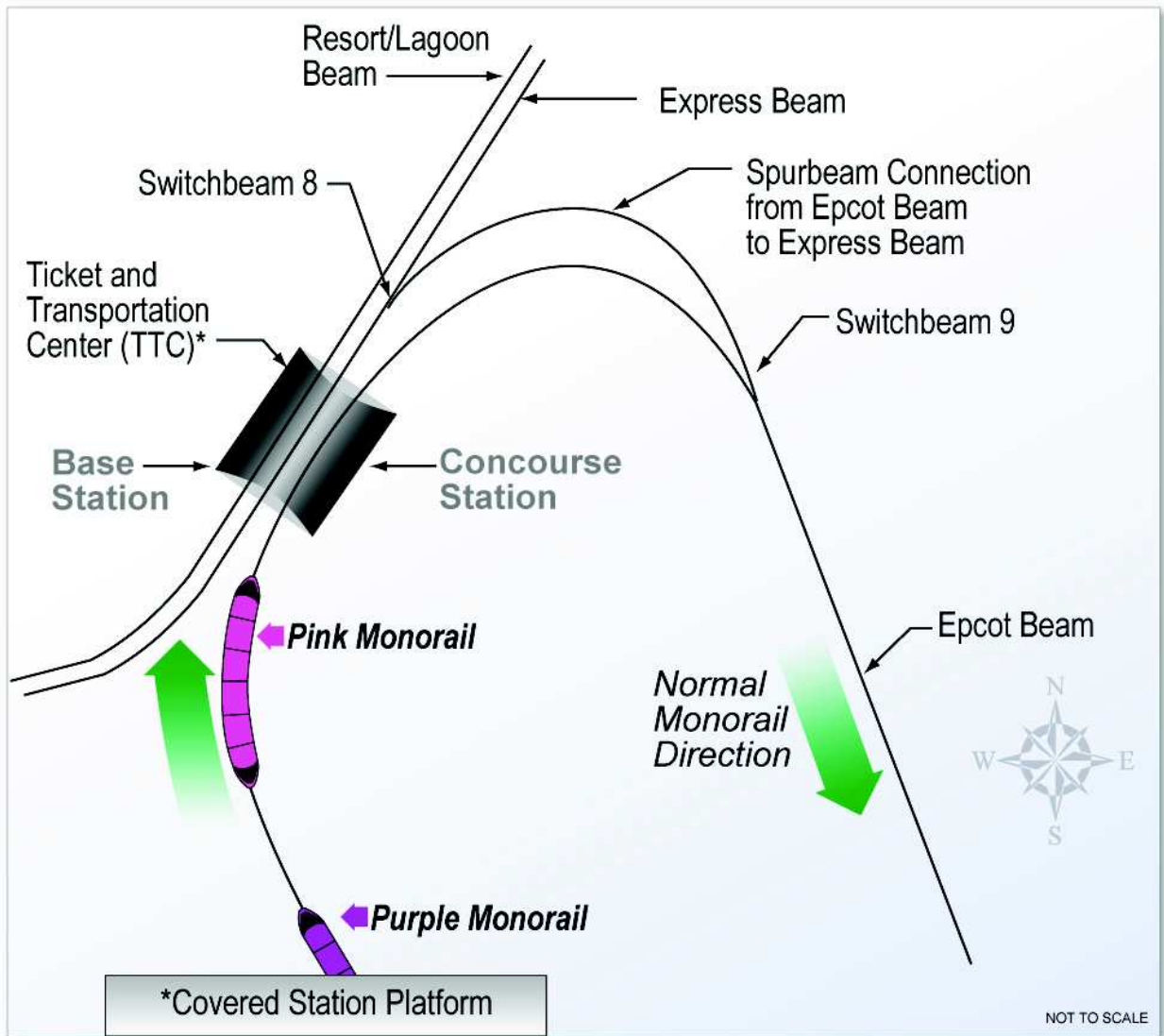


Figure 2. Junction of the Epcot beam with the Resort/Lagoon beam and the Express beam near the Ticket and Transportation Center. Normal direction of monorail travel on the Epcot beam is indicated by green arrows.

When the Magic Kingdom Park closes, the monorails continue to operate for a period of time to transport park guests to the parking areas or to their lodging. Generally, the monorails on the Express beam operate for 1 hour after the park closes; the monorails on the Resort beam typically discontinue service 2 hours after closing. At that point, designated monorails are returned, via the Express beam, to the mechanical facility for nightly maintenance.

Accident Sequence

At the time of the accident, the Pink, Purple, and Coral monorails, in that order, were operating along the Epcot beam. Because it had no passengers on board, the Pink monorail was the first monorail scheduled to divert onto the Express beam for return to the mechanical facility,

which is accessible via the Express beam. About 1:53 a.m., the monorail central coordinator transmitted the following instruction to the operator of the Pink monorail: “Normal visual to pylon 30,^[8] hold and notify.” This was a routine instruction intended to move the Pink monorail past switch-beam 9 on the Epcot beam so that, after switch-beams 8 and 9 were aligned for the spur-beam, it could back onto the spur-beam and then onto the Express beam for return to the mechanical facility. The operator of the Pink monorail stopped the monorail beyond switch-beam 9. He then notified the central coordinator that he had cleared switch-beam 9 and was awaiting further instructions. (See figure 3.)

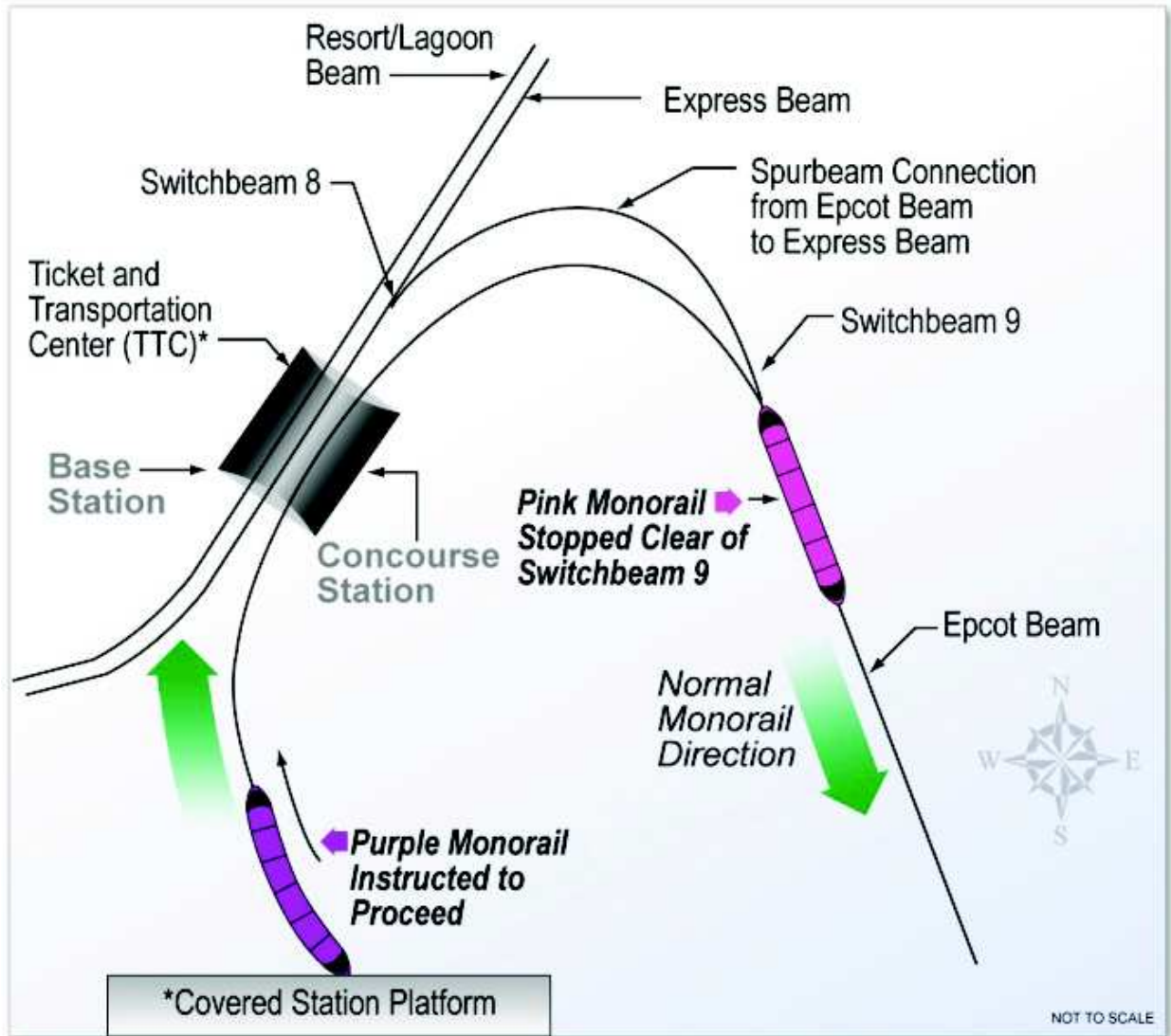


Figure 3. The Pink monorail has cleared switch-beam 9 and is awaiting further instructions.

⁸ Each pylon is numbered, and the central coordinators and monorail operators use these numbers to designate specific locations along the beams.

The central coordinator contacted the shop panel operator⁹ and instructed him to line “switch-beams 8 and 9 to the spur-line with power.” At 1:54 a.m., the shop panel operator confirmed that the central coordinator had requested that switch-beams 8 and 9 be aligned for the spur-beam. The operator then removed power from that section of the Epcot beam in preparation for the switch-beam realignment. Under normal operating conditions, graphical prompts appear on the Power Distribution and Monitor System (PDMS) screen that permit the switch-beams to be realigned. (See figure 4.) Without operator input, the system will “time out,” and the prompts for changing the switch-beam alignment will disappear.



Figure 4. Power Distribution and Monitor System switch panel for controlling switch-beams 8 and 9.

The investigation determined that after cutting power to the beam, the shop panel operator did not immediately initiate the switch-beam realignment. He explained that, “there’s a little bit of time lapse before the switch—you know, it takes time for the switches to move.” About this same time, at 1:55 a.m., the operator of the Silver monorail called the shop panel operator and advised him that the monorail had experienced a left side door alert as it traversed

⁹ The shop panel operator was in charge of the Power Distribution and Monitor System (PDMS), which provides power to the monorail beams and contains the controls for changing the positions of the switch-beams.

the switches inside the mechanical facility. During postaccident interviews, the shop panel operator recalled leaving the switch panel to enter in his logbook that the Silver monorail had entered the maintenance facility. The shop panel operator said he also remembered that about this time another operator called him for instructions for entering the mechanical facility. Radio transcripts confirmed that at 1:56 a.m., the Red monorail operator called the shop panel operator about entering the facility and was told to hold at a designated location.

The shop panel operator told the investigator that when he returned to the switch panel, he thought that he had completed the switch-beam realignment; he restored power to the Epcot beam. At 1:57 a.m., the shop panel operator contacted the central coordinator and said, “Switch-beams 8 and 9 are on the spur-line with power.” The central coordinator confirmed this message and contacted the Pink monorail. He told the operator of the Pink monorail, “Clear in reverse MAPO override^[10] in reverse through 8, through 9, then you’ll be cleared through Base all the way to Grand Floridian,^[11] switch ends.”¹²

The operator of the Pink monorail began backing up the monorail. However, switch-beams 8 and 9 had not been repositioned. This resulted in the Pink monorail backing up on the Epcot beam, the same beam on which it had just been traveling and the same beam on which the Purple was following.

At 1:59 a.m., the central coordinator gave the operator of the Purple monorail (the monorail following the Pink monorail on the Epcot beam loop) the following instruction: “Normal visual 385, MAPO override into Concourse^[13]....” The MAPO system had to be placed in override to allow the Purple monorail to enter the station while the Pink monorail should have been backing through the spur-beam just beyond the station. (See figure 5.)

¹⁰ Disney uses the term “MAPO system” for its moving blocklight system. The system is designed to automatically stop a monorail if there is not enough distance between two monorails. The system must be operated in MAPO override mode for a monorail to enter the spur-beam.

¹¹ “Grand Floridian” refers to the Grand Floridian Resort and Spa station on the Express beam, north of the Ticket and Transportation Center.

¹² The instruction “switch ends” meant to change the operating end of a monorail from the control cab at one end of the monorail to the control cab at the opposite end. Then, the operator would no longer be operating backwards.

¹³ Concourse referred to the Concourse station on the Epcot beam within the Ticket and Transportation Center.

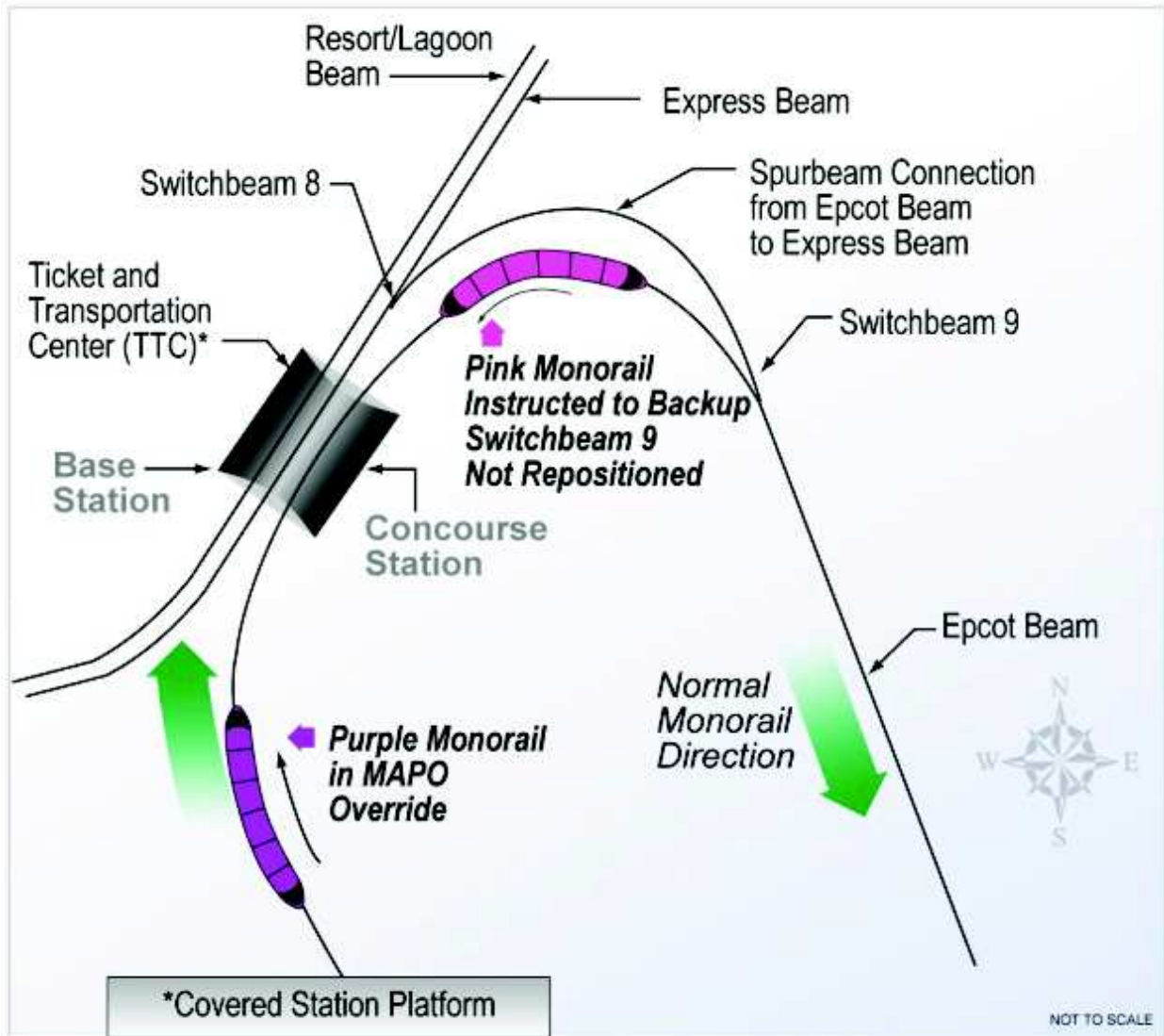


Figure 5. The Pink monorail is backing up on the same beam as the incoming Purple monorail, instead of on the spur-beam.

The Purple monorail proceeded toward the Concourse station within the Ticket and Transportation Center. According to the onboard Local Monitoring and Control Unit, which captures and logs data during operations, the operator of the Purple monorail stopped the monorail and placed the controls in reverse, but before the Purple monorail could be moved, it was struck by the Pink monorail (See figure 6.). The occupied operating cab of the Purple monorail was crushed, and the operator was fatally injured.

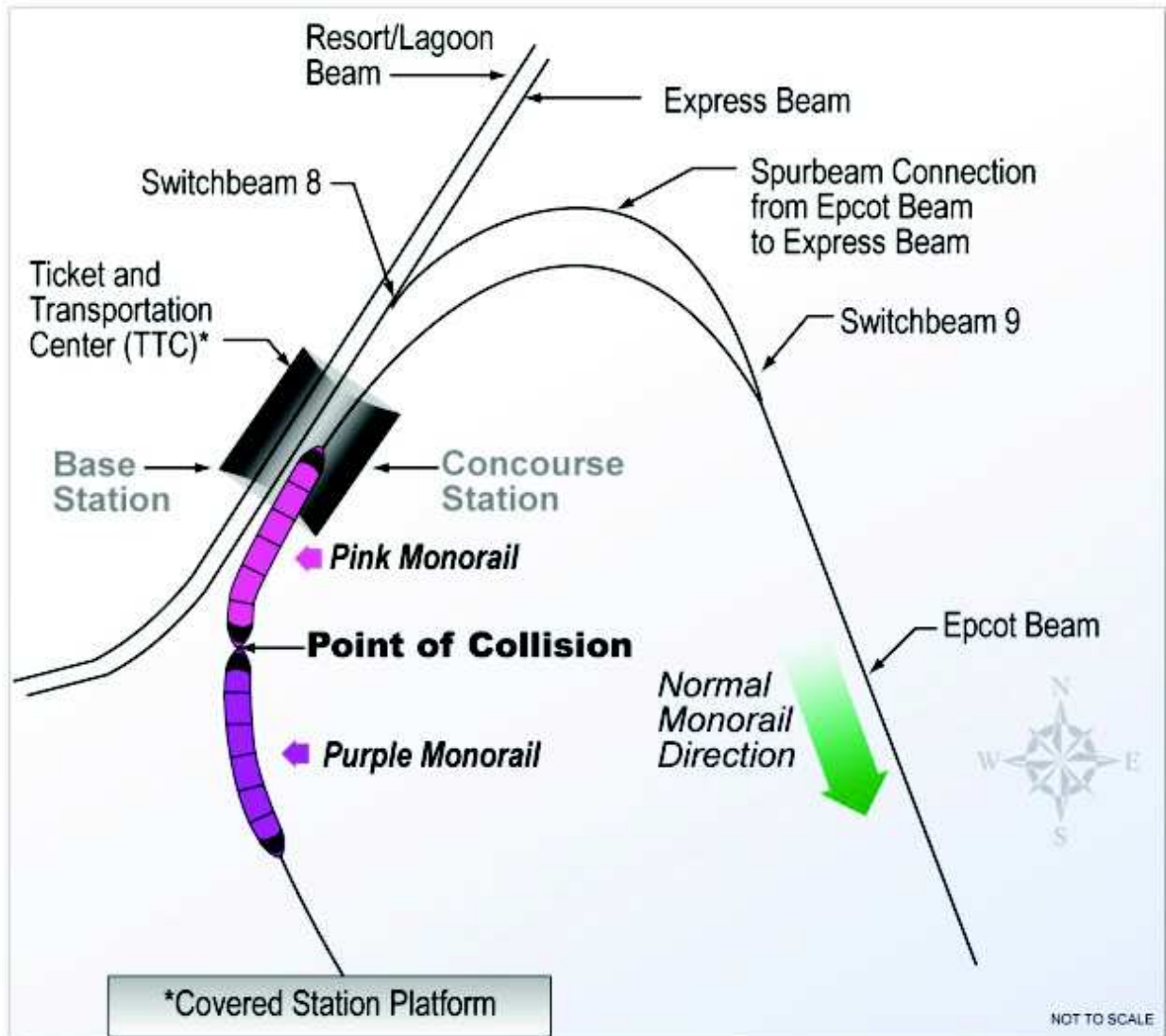


Figure 6. The unoccupied rear operating cab of the Pink monorail strikes the occupied operating cab of the Purple monorail.

Monorail Operations

Radio Procedures and Instructions

Although they were not mandatory at the time of the accident, Disney's *Operating Guide*¹⁴ for monorail operations provided specific radio communications guidelines and procedures that were to be used to instruct monorail operators in movements. The scripted radio examples provided in the operating guide included a procedure for bringing a monorail on the

¹⁴ Walt Disney World Resort, Monorail Operations, *Operating Guide* (Lake Buena Vista, FL: Walt Disney World Resort, Inc., May 1, 2009).

Epcot beam through switch-beams 9 and 8 to the Express beam. The scripted radio transmissions state the following:

Central: NORMAL VISUAL TO CONCOURSE DEADHEAD^[15] AND SWITCH ENDS.

Train: 10-4, NORMAL VISUAL TO CONCOURSE DEADHEAD AND SWITCH ENDS.

After Deadheading and Switching Ends Inside Concourse

Train: MONORAIL CENTRAL, MONORAIL (COLOR) FOR A CAB SIX RADIO DEVICE CHECK, HOW DO YOU READ?

Central: I READ YOU 10- (1 OR 2) HOW ME?^[16]

Train: 10- (1 OR 2) ALSO, BE ADVISED, DEADHEADED AND SWITCHED ENDS AT CONCOURSE.

Central: 10-4, PLACE YOUR TRAIN IN REVERSE, CLEAR IN REVERSE TO PYLON 27, HOLD AND NOTIFY CENTRAL.

Train: 10-4 CLEAR TO PLACE TRAIN IN REVERSE, CLEAR IN REVERSE TO PYLON 27, HOLD AND NOTIFY CENTRAL.

As shown, the scripted radio procedure for bringing a monorail on the Epcot beam through switch-beams 9 and 8 to the Express beam called for the monorail operator to stop at the Concourse station and switch operating cabs (from the forward cab to the rear) before pulling the train beyond switch-beam 9. This would place the operator at the rear of the monorail as it advanced past switch-beam 9, but it would place him in the forward-facing operating cab as the monorail “backed” across repositioned switch-beam 9 onto the spur-beam and across repositioned switch-beam 8 onto the Express beam. In this case, the Pink monorail operator was instructed to switch ends only after backing onto the Express beam and reaching the Grand Floridian Resort and Spa station.

During postaccident interviews, the operator of the Pink monorail said that where and when a monorail operator changed ends of the monorail was determined by the instructions from the central coordinator. He also stated that it was not an uncommon practice to back through switch-beam 9 onto the spur-beam and then through switch-beam 8 onto the Express beam before switching ends.

¹⁵ The Walt Disney World Resort uses the term “deadhead” to describe operating a monorail without passengers.

¹⁶ This is slang. After responding to how well the radio was heard, the central coordinator would ask how well his or her radio could be heard.

Central Coordinator

The central coordinator was normally stationed at Concourse Tower, which is an enclosure at Concourse station. The tower is equipped with a display screen showing the monorail beams on the Epcot loop. The tower also has a display of the PDMS switch panel showing switch-beams 8 and 9 and their respective alignments and a web-based¹⁷ video monitor of switch-beam 9. These displays allowed the central coordinator to monitor the repositioning of the switch-beams from the tower.

On the day of the accident, shortly before the collision, the on-duty central coordinator reported to his supervisor, the monorail manager, that he had become ill. The monorail manager authorized the ill employee to leave work early and contacted another employee to work in his place. Until such time as the relief coordinator could assume duties in the Concourse Tower, the monorail manager filled in as central coordinator; he authorized the reverse switching move for the Pink monorail. He also had communicated by radio with the monorail operator and with the shop panel operator with regard to the move.

When the monorail manager issued these instructions, he was not in the Concourse Tower, but was instead at a local restaurant. He was not in the tower and could not use the display screens to monitor or confirm any of the movements. Walt Disney World Resort's procedures for the central coordinator did not specify that the central coordinator should observe the display at the Concourse Tower when directing the monorail movements. Procedures also did not require that the central coordinator be in the Concourse Tower when directing monorail movements.

Switch-beam Operation

The PDMS was operated by the shop panel operator, who had been trained on the job. The operator was familiar with the operations and maintenance manual,¹⁸ which explained the steps for operating the shop panel when moving monorails from the Epcot beam to the Express beam. The procedural steps did not require that the shop panel operator ensure that the switch-beam position had changed after making the request through the switch panel.

The shop panel operator also had access to the web-based video display of switch-beam 9. During postaccident interviews, the shop panel operator was asked how the video camera was used. He explained:

Basically, I look at that before I move the switch to make sure that there's no monorail...on the switch. When I was in training, that's what they told me. They said just make sure that there's no train on that switch before you move it.

¹⁷ The image was sometimes slow to refresh because of the web-based source. The company has changed this to a direct feed.

¹⁸ Walt Disney World Resort, *Mark VI Monorail Power Distribution Monitoring System Operations and Maintenance Manual* (Lake Buena Vista, FL: Walt Disney World Resort, Inc., February 1992).

Asked if he ever looked at the monitor to verify that the switch is moved, he replied:

I do. [But]...I mainly look at that camera to make sure there's no monorail on the switch.

When asked if he recalled if he had looked at the video to verify the position of the switch on the night of the accident, he said that he could not remember if he had looked at it and restated that his concern was whether the monorail was on the movable portion of the beam before he made the initial change to the switch-beam.

Performance of the Operator of the Pink Monorail

During the NTSB postaccident investigation, a reenactment of the critical monorail movements was performed with a qualified monorail operator for the purposes of observing the procedural actions likely to be involved in the accident scenario. Immediately prior to the accident location, the NTSB investigator observed that the monorail entered a slight downhill grade into the station and the monorail speed accelerated. With this track geometry, the NTSB investigator observed that the monorail operator focused his attention on the speedometer and on manually controlling the speed of the monorail. During postaccident interviews, the operator of the Pink monorail confirmed that it was important not to let the monorail exceed 15 mph while in MAPO override or the monorail would stop.

Also, during the postaccident investigation, the NTSB investigator noted the lighting environment and physical configurations of the Concourse and Base stations. From the vantage point of a monorail operator entering either station, the physical configuration of the Concourse station closely resembled that of the Base station. Moreover, the monorail control actions required to enter each station were observed to be nearly identical. Furthermore, at the time of the accident, the monorail windows were fogged and the ambient illumination surrounding switch-beam 9 was low, causing the exterior wayside environment to appear dark. These conditions were observed to degrade the monorail operator's line-of-sight to the exterior wayside environment.

Because the operator focused attention on controlling the monorail speed, the similar visual appearance of the two monorail stations, and the degraded visibility of track wayside conditions, the NTSB concludes that the operator of the Pink monorail did not detect that he was on the wrong beam. Toxicological tests of the operator of the striking monorail were negative for alcohol and illegal drugs. Likewise, fatigue was determined not to be a factor, based on a review of the Pink monorail operator's work schedule for the 72-hour period immediately prior to the accident.

Government Oversight of Walt Disney World Resort

The Occupational Safety and Health Administration (OSHA), within the U.S. Department of Labor, is responsible for the safety oversight of the employees who work at Walt Disney World Resort.

From 2000 until the day of the accident in 2009, OSHA inspectors had been on the Walt Disney World Resort 27 times. Fifteen of the visits were in response to complaints, six were related to accidents, four were planned, one was a referral, and one was a nonprogrammed visit. None of the visits involved the monorail operations.

OSHA investigated the July 5, 2009, accident and determined (OSHA Inspection: 313585895 – Walt Disney World Co.) that

On or about 7/5/09, during the transfer of monorail Pink from the EPCOT loop to the Express loop, switch beams 8 and 9 were not locked into position and energized exposing the operators of the monorail Pink and monorail Purple to a struck by hazard resulting in the death of the operator of monorail Purple.

As a result, OSHA imposed a fine for an undisclosed amount against Walt Disney World Resort. OSHA is responsible for worker safety, not for the safety of the public.

External safety oversight of public transportation systems is critical to identifying and correcting systemic safety risks that may not be readily apparent or may not be effectively addressed at the local level by a company. There are no provisions for OSHA to oversee the safety of the public unless it comes as a result of a safety enforcement action to improve safety for employees.

Walt Disney World Resort Actions Taken Since Accident

In response to an NTSB request, the manager of safety and health for Walt Disney World Resort submitted two letters, one on March 24, 2010, and another on March 4, 2011, listing the actions that Walt Disney World Resort has taken following the accident. The actions include:

Operating procedures require that monorail drivers be in the forward facing cab when switching from one beam to another (unless a switching procedure must be terminated before completion due to a safety concern, in which case, a driver is permitted to back out of the switch so long as an observer monitors the rearward motion of the monorail).

When monorails travel in reverse from the driver's perspective, a dedicated spotter/observer is assigned to monitor such movement. These spotters/observers are in radio contact with the monorail driver or the monorail central coordinator, can be located in the non-operating cab of the train intended to travel in reverse, within a station, on the ground or in a separate monorail or monorail work tractor on a parallel beam.

Monorail drivers are required to visually confirm the correct position of switch-beams prior to switching from one beam to another.

A monorail central coordinator may only direct a monorail to operate in MAPO override when it is transferring from one beam to another during switching operations. All other movement in MAPO override requires monorail manager approval.

When monorail movement is under the direction of a monorail central coordinator, that coordinator must remain inside the designated control tower. Further, when a monorail central coordinator is directing switching operations, that coordinator must visually verify via an electronic Power Distribution and Monitoring System ("PDMS") display and

video camera monitor that the beams are in the proper switching position and that power has been applied appropriately.

In addition to verifying switch beam position and power status via the PDMS display as was required on and prior to July 5, 2009, monorail shop panel operators are required to confirm the position of the switch beams via video camera monitors prior to directing monorail movement across those switch beams.

A second monorail shop panel operator must visually verify the switching process is properly performed by the primary monorail shop panel operator.

Monorail operations employees have received additional training on measures to address condensation on monorail windshields, including rinsing the windshields and the use of the defogger on the climate control system. In addition, a glass treatment is periodically applied to the windshields to enhance visibility.

The monorail manager on duty is required to remain on the premises of the Walt Disney World Resort when monorails are under their supervision. This requirement, which is already in effect, will be confirmed in the next operating guide release.

The E-Stop button in the driver cabs have been reconfigured to remain active when the console is inactive, allowing a rear observer located in the non-operating cab to E-stop a monorail.

The set point for the cab climate control system was adjusted to reduce internal condensation on windshields. This change is intended to remain in effect until additional climate control upgrades which are currently underway are completed.

A monorail tracking board that identifies the beams on which monorails are operating was installed for used by shop panel operators during switching procedures.

The web-based video camera feed from switch-beam 9 has been changed to a direct video camera feed to both the concourse tower and monorail shop.

Direct feed video cameras were installed to monitor switch-beams 1, 2 and 8. The images are displayed at both the concourse tower and monorail shop. Currently switch-beam 8 and 9 position is verified by both the shop panel operator and monorail central coordinator via PDMS and video feed. Switch-beam 1 and 2 position is verified by the shop panel operator and a maintenance employee station at the switch-beams. The next operating guide will conform the switch-beam 1 and 2 verification procedure to the 8 and 9 procedure, (e.g., verification by the shop panel operator and the monorail central coordinator).

Monorail operations has designated a new radio signal which, when called, will direct all monorails to stop immediately.

The PDMS software has been upgraded to capture additional data related to switch-beam operation.

A design to reconfigure the monorail brake system that will mitigate the loss of signal pipe pressure is being validated.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the July 5, 2009, collision between two monorails at Walt Disney World Resort in Lake Buena Vista, Florida, was the shop panel operator's failure to properly position switch-beam 9 and the failure of the monorail manager acting as the central coordinator to verify the position of switch-beam 9 before authorizing the reverse movement of the Pink monorail. Contributing to the accident was Walt Disney World Resort's lack of standard operating procedures leading to an unsafe practice when reversing trains on its monorail system.

Adopted: October 31, 2011