Intelligent Transportation Systems

Construction Engineering and Inspection Training, for Closed-Circuit Television Cameras

Lesson 1

Welcome to the Intelligent Transportation Systems Construction Engineering and Inspection Training, for Closed-Circuit Television Cameras, Lesson 1: Types of Cameras.

This training was developed to show Construction Engineering and Inspection, or CEI, Firms:

- What a Closed-Circuit Television, or CCTV, Camera is,
- What it does,
- How it is commonly used on transportation projects,
- How to inspect a completed installation of Closed-Circuit Television Cameras on Florida Department of Transportation, or FDOT, Intelligent Transportation System, or ITS, projects,
- and how to ensure that the contractors have provided an approved and properly configured device.

You will be able to apply this training to differing conditions in the field. However, not all FDOT ITS projects will deploy the same type of camera or mounting hardware. For example, some projects may require the use of Camera Lowering Devices, or CLDs, to mount the cameras while others may utilize fixed brackets on strain poles.

This training will also cover:

- Terminology, Standards, Basic inspection,
- Documentation that is needed before final acceptance,
- Testing, and other requirements that are relevant to Closed-Circuit Television cameras;
- And how to ensure CCTV cameras are acceptable and properly installed on an FDOT project.

The Closed-Circuit Television cameras are described in FDOT Standard Specification section 682-1. The CCTV shall support the National Transportation Communications for ITS Protocol, or NTCIP, Section 1205 v1.08. The CCTV shall conform to the Open Network Video Interface Forum, or ONVIF, the IP-based Security Standard.

The applicable National Electrical Manufacturer Association, or NEMA, Standards involve the CCTV housing. For example, the pressurized dome has a rating of NEMA 4X/IP-67 versus the non-pressurized dome which has a NEMA 4/IP-66 rating.

Pressurization is an important step in ensuring protection of the CCTV camera. Extreme environments, such as rain, snow, salty air, strong winds, high humidity, and dust are hard on CCTV hardware and increase the likelihood of affecting inner mechanisms. Pressurization helps prevent foreign matter from entering the CCTV housing. Dry nitrogen is commonly used for this.

The FDOT Traffic Engineering Research Lab, or TERL, requires that the CCTV cameras be environmentally tested by an independent lab to check if they comply with NEMA TS2, Sections 2.2.7, 2.2.8, and 2.2.9. The FDOT TERL has verified that all of the CCTV cameras on the FDOT Approved Products List, or APL, have met the material requirements listed in the FDOT Standard

Specifications for Road and Bridge Construction as well as other Industry Specifications. As a result, the CEI personnel will just need to verify whether the proposed CCTV camera is listed on the FDOT APL.

Closed-circuit Television cameras are used by Regional Transportation Management Centers, or RTMCs, to view the traffic on various freeways, arterials and express lanes. CCTV cameras are used to observe all types of traffic including vehicular, pedestrian, and bicycle traffic. The real-time camera images are available to the traveling public via FL511.com which is Florida's official source for real-time traffic information.

CCTV cameras are used for incident verification, after the RTMC operators have received notification that the traffic has slowed. You should be aware that not all cameras are being actively monitored at the same time. And finally, CCTV cameras are used by the RTMC operators to verify that correct messages are being displayed on a nearby dynamic message sign.

The main purpose of CCTV camera video feed is to observe current traffic conditions. These videos are not typically saved or archived. Videos that are saved are for training purposes only and are subject to public record requests.

There are 3 types of video streams generated by the Closed-Circuit Television cameras: Analog; Internet Protocol, or IP; and Infrared.

Analog CCTV cameras are older Legacy Devices, which means that they are being phased out, and being replaced with newer models. They utilize a video mode known as Phase Alternating Line, and National Television System Committee. These CCTV cameras utilize coaxial cables for their video output. The camera control uses serial communications over a pair of twisted copper wires. Since the FDOT communication network is digital, these analog cameras require an additional piece of equipment called a digital video encoder to convert the analog signals into digital Ethernet packet signals.

Internet Protocol, or IP, is the current technology adopted by the FDOT. These CCTV cameras have more advanced features such as High Definition, or HD, as well as H.264 video compression. Both video and communications occur over Category 5, or CAT5, / Category 6, or CAT6, type cables. A separate encoder is not required since the video is already digitally formatted.

Infrared CCTV Cameras use thermal imaging, which is used for special cases such as low visibility or nighttime conditions. Infrared cameras also have HD capability.

All Closed-Circuit Television cameras are housed in an enclosure, protecting them from the harsh Florida weather. These housings shall conform to National Electrical Manufacturer Association, or NEMA, TS2 environmental standards. The NEMA TS2 standards ensures that the housing is designed to withstand intense environmental conditions.

There are three types of CCTV cameras:
Fixed; Dome Pan Tilt Zoom, or PTZ; and External Positioner PTZ.

The fixed housing provides limited views of the roadway. They are best utilized for areas with limited visibility such as tunnels and bridges, or at a fixed location like a door or cabinet for security. Occasionally, they are also deployed near dynamic message signs to verify that the appropriate messages are being displayed on the sign.

The Pan/Tilt/Zoom housing, or PTZ, offers more flexibility than the fixed housing because the CCTV camera is capable of rotating to a desired position. A benefit of the PTZ camera is that it's position can be "pre-set" to go directly to areas programmed by the RTMC operator. The "pre-set" feature is typically tested during the Field Acceptance Test.

The PTZ CCTV cameras come in two variations,
the dome style and the external positioner.

There are a number of dome styles available but they all resemble each other from one vendor to another. The external positioner style, however, differs in look from vendor to vendor. The Forward Looking Infrared, or FLIR, model is an infrared CCTV camera. There are two-camera lenses, one is for the regular camera, the other for the infrared camera. The infrared CCTV cameras are ideally used during heavy fog or at night.

The benefit of the external positioner is that the camera can be tilted above the dome horizon. Due to the upper cap of the dome housing, the dome camera has an upper tilt limit and cannot see above the rim of the housing.

Closed-Circuit Television camera cables carry power, camera control data, and video to and from the camera.

For analog cameras, traditional multiconductor cables consist of power conductors, shielded twisted pair conductors, and a shielded coax cable. Both the coax cable and the twisted pair conductors are shielded with a metal jacket to prevent electrical interference from adjacent conductors. The coax cable and twisted pair conductors terminate onto the encoder. The power conductors terminate onto the surge suppressor.

Internet Protocol, or IP, cameras use ethernet cables, sometimes called CAT5 cables, for their communications. They consist of four pairs of conductors. Each pair is twisted around each other to minimize inductance. They are terminated with a Registered Jack (RJ) 45 connector. Modern IP cameras are utilizing the CAT5 cables as their source of power.

Power over Ethernet, or POE, is a technology that lets network cables carry electrical power. Power over Ethernet is injected onto the cable at a voltage between 44 and 57 volts Direct Current, or DC, but typically 48 volts. This relatively high voltage allows efficient power transfer along the cable, while still being low enough to be regarded as safe. Refer to your plans, Request for Proposal, or RFP, and/or submittals for the applicable devices and voltage to be used.

There are two types of camera mounting schemes. These are described in the FDOT Standard Plans on Camera Mounting Details, Index 659-020. The first type is a camera lowering device, or CLD. The second is a fixed bracket. Each District will have their own criteria of when to utilize each type of mounting. Characteristics which factor into this decision include site access, maintenance costs, and height of pole.

The details of the camera lowering device are provided in FDOT's Standard Plans titled Camera Mounting Details, Index 659-020, Sheet 1 of 2.

When the camera is being lowered and raised, everyone in the vicinity should be cautious because of the risk of the camera falling. The camera and its mounting unit are very heavy. The FDOT Standard Specifications for Road and Bridge Construction allows up to a 17-pound limit for domed CCTV and

up to a 35-pound limit when an external positioner is used. The metallic camera junction box will also contribute to the total weight of the camera.

The Construction Engineering Inspection personnel should note the following CCTV cabinet attributes:

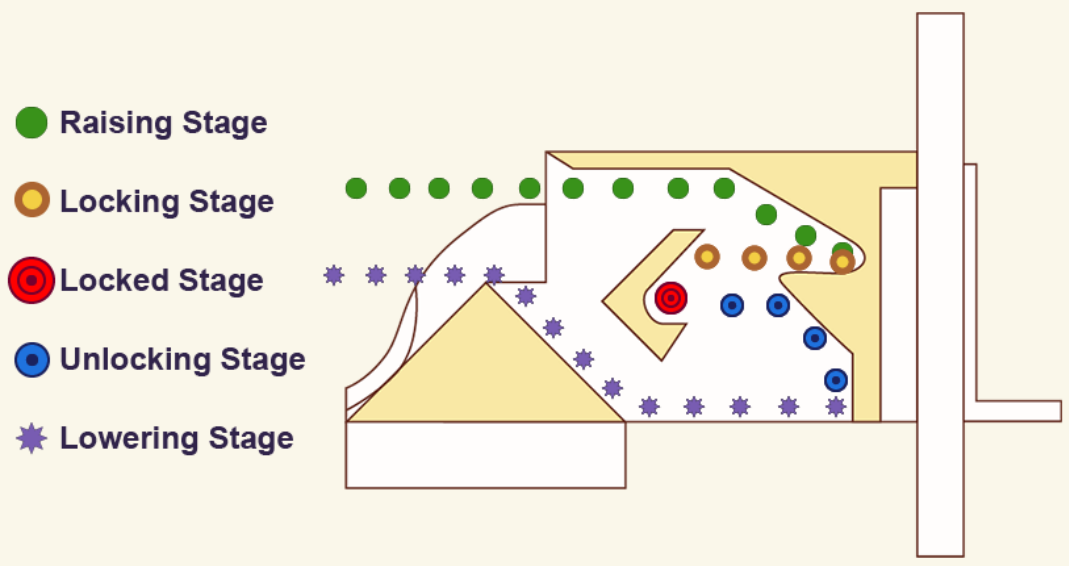
- When the cabinet is being mounted to the pole, make sure it is not positioned below the camera.
- Ensure that when the cabinet's front door is opened, personnel will be facing oncoming traffic.
- Ensure that when the cabinet's back door is opened, personnel's back will be facing the oncoming traffic.

The inspector should note that a 24" air terminal measurement, if required, is above the pole cap or the camera lowering device junction box. Air terminals, if required, should be anchored (mechanically connected) to the CCTV pole with a mounting bracket, and not connected to the pole with straps.

The camera lowering device is equipped with a special multiconductor cable that connects the camera directly to the surge suppressors inside the cabinet. Various types of cables are specially made to accommodate analog as well as high definition IP cameras. The cables are made to length for each specific project location; therefore, the inspector should ensure that the length of the camera lowering device cable is appropriate for each site. Splicing of this special cable is not allowed. The list of approved camera lowering device manufacturers can be found on the FDOT Approved Product List. A link to this list is on the resources page.

The next few slides show the operation stages of a camera lowering device.

This picture shows the 5 Operation Stages for lowering a camera.



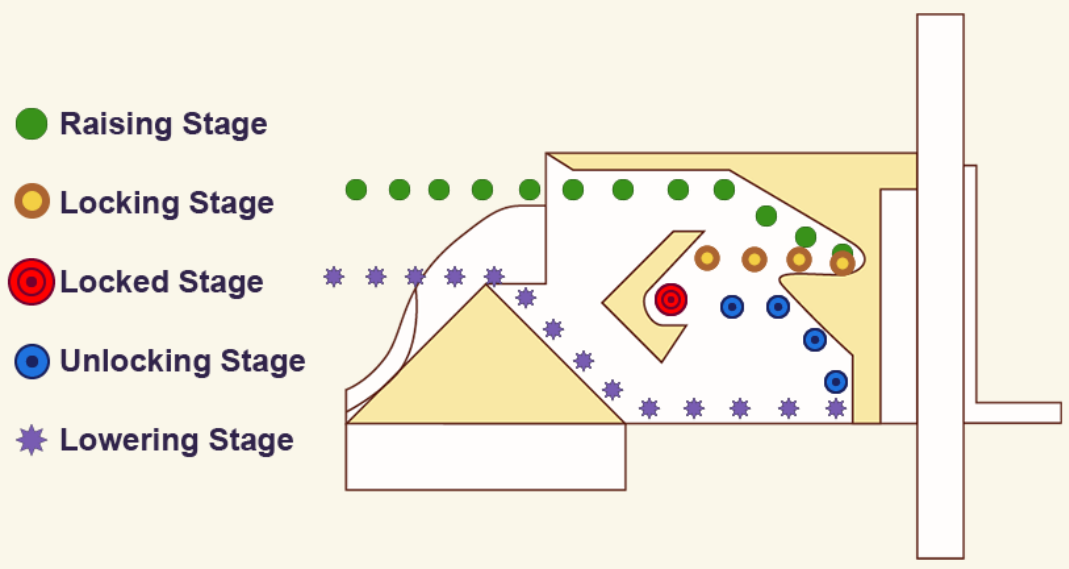
The disconnect assembly operates according to 5 basic stages:

Raising, shown in green; Locking, in yellow; Locked, in red;
Unlocking, in blue; and Lowering, in purple.

The assembly's design allows the unit to self-align, which enables attached components such as a camera, light fixture, or other device to lock into the same specified position every time the assembly

is raised back into the locked stage. In the locked stage, twin tracking support arms sustain the weight of the mounted components without any cable tension or braking device.

The principal part responsible for moving the support arms through the 5 stages is the tracking guide. This guide is a precision cast series of angular surfaces strategically located to push the support arms in the required direction toward the center “L” notch. The two “L” notches support the entire load of the camera and components when the support arms are in the locked stage. The drawing shows the path the support arms take through the tracking guide. Each Symbol represents one of the 5 stages.



Stage 1: Locked, or Latched, Stage

The first and most important stage is Locked, also called “Latched”. Generally, all aspects of the operation of the Disconnect Unit will begin and end in the locked stage. In the locked position, the twin support arms hold all the weight of the surveillance camera. There is no tension on the operating cable, no locking of gears, and no pressure on braking devices to hold the camera secure in its operating position. The electrical and signal contacts are fully engaged and fully insulated and all camera functions are operational when the Disconnect Unit is Locked, or Latched.

Stage 2: Unlocking Stage

The second stage is Unlocking. Before lowering the camera, the Disconnect Unit must first be raised approximately ¾ inch. During this slight raising operation, the support arms will be pushed to one side by the tracking guide to clear the support notches. Springs inside the socket half of the connector compress as the Disconnect Unit is raised. Electrical and signal contacts are still engaged during this stage. Each Disconnect Unit has a built-in positive stop that, when reached, will alert the operator to begin lowering the camera. Every time the Disconnect Unit is raised from the “locked” position, the support arms will move and unlock the Disconnect Unit.

Stage 3: Lowering, or Release, Stage

With the Disconnect Unit unlocked, or released, Lowering is the next stage. As the camera is lowered, the bottom portion of the Disconnect Unit begins to separate from the tracking guide and the top portion of the Disconnect Unit. Next, the electrical and signal connector disconnects, followed by the separation of all stabilizing guides. All the weight of the camera and equipment now hangs from the control cable. There are no live electrical contacts to contend with as the camera is lowered to the

desired height above the ground for maintenance. Cleaning and repair work can be accomplished at ground level.

Stage 4: Raising

After maintenance to the camera, Raising is the fourth of the operating stages. During this part, the camera and moveable portion of the Disconnect Unit are raised to the top. As the camera slowly approaches the upper portion of the Disconnect Unit, the control cable initially pre-positions the main guide post in the center hole of the tracking guide. With continued raising, the guide post centers itself in the tracking guide and rotates into its original orientation as the guide post's cast-in-place key follows the inclined helical surface of the tracking guide.

Sustained raising of the camera will engage the next stabilizing key and guide slot of the Disconnect Unit as the support arms toggle through the tracking guide. Electrical and signal pins and sockets of the connector engage as the last step before the lower portion of the Disconnect Unit reaches the very top. The worker can now proceed to the final stage: Locking.

Stage 5: Locking, or Latching

The final phase of the 5 operating stages is Locking, or Latching. During this stage, the camera must be lowered approximately ¾ inch so that the support arms of the lower portion of the Disconnect Unit move toward the center "L" notches of the tracking guide. Springs within the "socket" half of the connector that were compressed during the final part of the raising stage are now extending and exerting force on the "pin" half of the connector to assure complete isolation and insulation of the contacts. After the slight lowering operation, the dual support arms are secured in the "L" notches. The Disconnect Unit is now in the Locked stage.

Operating stages 1 through 5 may now be repeated with the camera returning to its original operating position each time. The operating stages of the Disconnect Unit always begin and end with the Disconnect Unit in the Locked, or Latched, position.

The alternative mounting scheme for a camera is the fixed bracket. The details of a camera mount with a fixed bracket are provided in FDOT Standard Plans, Index 659-020, Sheet 2 of 2 titled Camera Mounting Details. The standard drawing shows a circular pole. However, the mounting bracket has also been used on square poles. Cameras that are mounted with fixed brackets are accessed using a bucket truck. As a result, the cost of maintaining cameras with fixed bracket is more than that of a camera lowering device.

The picture shows a fixed bracket used on a round concrete pole. Here is a fixed bracket on a square concrete pole. Both mounts show the use of stainless steel straps.

This concludes the Intelligent Transportation Systems Construction Engineering and Inspection Training, for Closed-Circuit Television Cameras, Lesson 1: Types of Cameras.

Please continue to Lesson 2: Documentation.