Florida Department of TRANSPORTATION

WEIGH STATION
BEST PRACTICES

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Weigh Station Best Practices

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Overview

The US Code of Federal Regulations Title 23 (23 CFR) requires states to administer a program of vehicle size and weight enforcement for the Interstate System as well as Federal-aid systems. The US Department of Transportation (USDOT) Federal Highway Administration (FHWA) establishes truck size and weight limits. Individual states may further define truck weight limits for vehicles in regular operations, with exemptions for trucks authorized by permit.

The Federal Motor Carrier Safety Administration (FMCSA), a division of USDOT, further supports commercial vehicle operations by encouraging state DOTs and law enforcement agencies to leverage technology to enforce regulations, reduce crashes involving large trucks, and improve data sharing between agencies. In support of their mission, FMCSA administers various grant and funding programs including the Innovative Technology Deployment (ITD) Program, which is available to states to improve commercial motor vehicle safety, through integration of systems for increased data accuracy and efficiency in enforcement.

Weigh stations serve a critical role in the preservation of state infrastructure by enforcing size and weight limits of commercial vehicles. When combined with safety screening of drivers and vehicles, weigh stations serve a broader role as inspection stations. Inspection stations can be used for a variety of purposes, depending on the priorities and needs of each jurisdiction. Typical purposes include safety enforcement, data collection, security, and size and weight enforcement. Staffing inspection stations with trained personnel to carry out the critical roles is vital to increasing compliance and enhancing the overall safety and mobility on the state's roadway network.

The following sections outline best practices and considerations in weigh station facility development for two common inspection scenarios: fixed inspection stations and mobile or virtual inspection stations. An overview of the technology used at these facilities, as well as best practices in site selection, data management, asset maintenance, policies, and procedures is also provided.

Fixed Inspection Stations

Fixed inspection stations (weigh stations) are generally located within the State Department of Transportation (DOT) maintained right of way and include permanent installation of infrastructure necessary to perform inspection activities. The inspection stations are staffed by the State Highway Patrol, DOT, or a combination of the two.

Figure 1. Overhead view of weigh station entrance ramp.

Fixed inspection stations include a mixture of technology and active traffic management to sort vehicles along the roadway mainline. An overview of fixed inspection station operations is outlined below:

- The technology electronically screens vehicles, at established roadway speed, to validate criteria, which can include vehicle classification, height, weight, and other credentials such as safety scores available from federal databases including FMCSA's Safety and Fitness Electronic Records (SAFER) system.
- Commercial motor vehicle (CMV) carrier information is obtained using fixed cameras that provide optical character recognition for reading USDOT numbers as well as license plate information to validate compliance using these databases.
- High speed connectivity to data sets provides low latency lookup and compliance checks using software within the facility or at a centralized server.
- Upon approach to the inspection facility, roadside devices (mainline screening) provide an initial comparison of the vehicle characteristics against state and federal criteria. If the CMV is found compliant, bypass signals are provided to allow the vehicle to continue past the facility.
- If additional checks are required, the vehicle is directed into the facility. These signals are provided via roadside dynamic message signs with opportunities to provide in-cab messaging through established third-party vendor products.

Modern inspection stations include a secondary screening opportunity within the internal roadway network to further screen the CMV at reduced speeds. This secondary screening can include additional

technology devices to further verify safety information, such as tire pressure and brake performance. The secondary screening locations provide increased accuracy of information obtained through roadside devices and supports further bypass for compliant carriers, enhancing mobility.

Figure 2. Commercial vehicle passing over Weigh in Motion (WIM) and size detection screening.

Similar to mainline screening, sorting information is provided, allowing trucks to bypass on internal ramp lanes or to continue to the static scales for interaction with inspection staff. This sorting is typically provided by signals affixed to overhead structures, similar to a traffic signal installation. The final process for CMVs that do not receive a bypass, includes certified static weighing of the vehicles as well as other safety inspection activities, including verification of International Fuel Tax Association (IFTA) and International Registration Plan (IRP) credentials, tire and brake systems and permit compliance.

Layout

On limited access, multi-lane roadways, fixed inspection stations are located on the outside of the roadway for each direction of travel. On arterial roadways, fixed inspection stations can also support bi-directional traffic by locating the facilities within the median of a divided section. Median installations are generally utilized for locations with lower daily traffic volumes where a full station for each direction and additional associated features, such as internal bypass lanes, are not required.

Roadway Features

The fixed inspection stations should include the following roadway features:

- Entrance and exit ramps with adequate deceleration and acceleration length. Entrance ramp lengths should be sized to prevent queueing of CMV onto the mainline lanes.
- Internal lanes for electronically screened and compliant commercial vehicles to bypass the fixed or "static" scales which require vehicles to come to a complete stop.
- Adequate parking for further inspection of commercial vehicles, including those placed out of service. This is generally located away from the static scales and bypass ramps for safety.
- General truck parking accommodations with rest room facilities for required Hours of Service breaks.
- Roadway and pathway lighting with illumination levels that meet standard criteria, including adequate roadway lighting upstream and downstream of the facility.
- Standardized signing and pavement markings with sufficient advance notification per Manual of Uniform Traffic Control Devices (MUTCD) criteria. An electronically controlled "Open / Closed" sign should be provided prior to the inspection station. Regulatory signs directing all commercial vehicles to the appropriate lane for screening should be provided with sufficient distance for associated lane changes.
- Safety barriers to separate moving and stopped vehicles in areas where sufficient clearance cannot be provided.

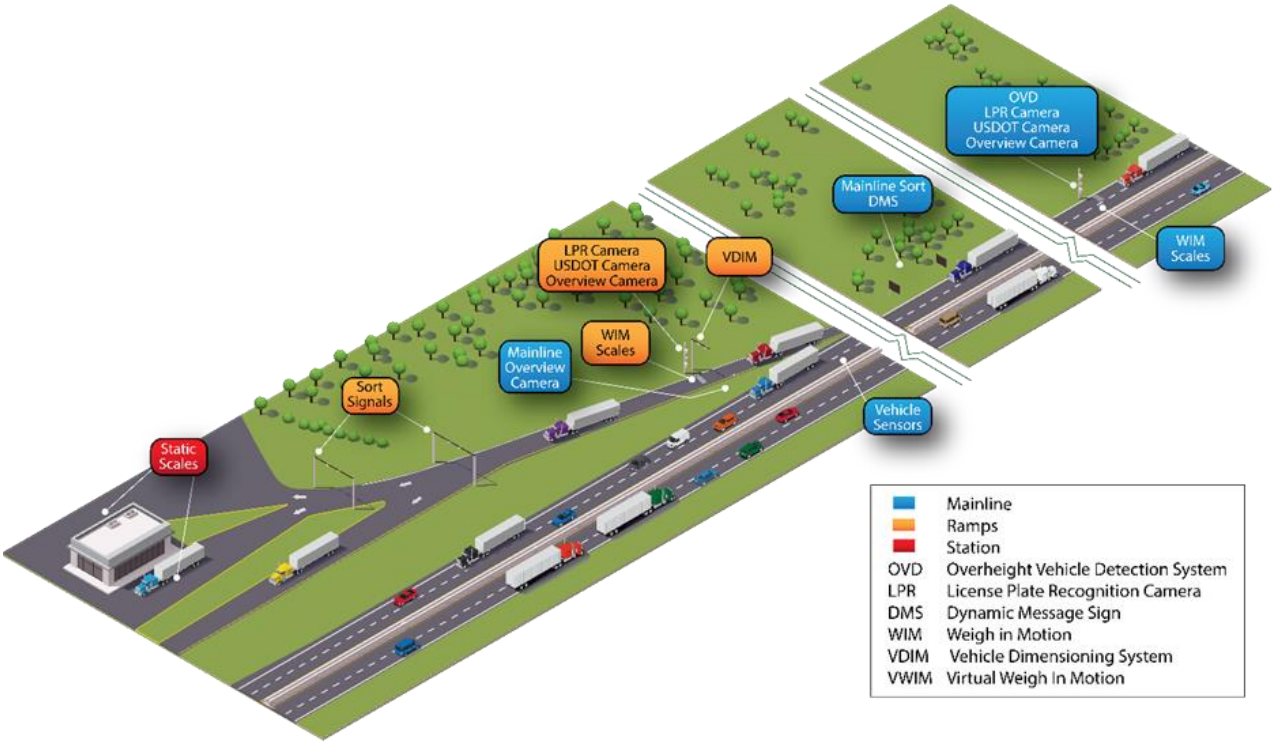

Figure 3. Typical limited access inspection facility.

Building Features

The fixed inspection stations should include the following *building features*:

Main Inspection Building (Weigh Station) is the main staff building where inspectors and officers will monitor activities throughout the facility. The *Main Inspection Building* should include the following ergonomic considerations for efficiency of inspection staff as well as safety:

- Staff access should facilitate ease of transition from the building to the vehicles without the need for unnecessary travel or climbing of stairs.
- Truck Parking adjacent to the building for temporary driver interaction with staff.
- A driver access area that allows for separation and security of the staff for transactions.
- Rest room facility in the driver area.
- Bullet resistant glass that provides clear line of site to all roadway elements to protect staff.
- Staff parking locations should be provided that allow for ease of access and security.
- Dedicated office and meeting space to separate working staff from supervisors and other facility activities.
- Exterior lighting that provides the necessary illumination of vehicles on the static scales to visually check credentials and provide safe access to parked vehicles.
- Method of communication between the staff and drivers without the need to exit the building. This allows the staff to provide directions to the drivers to pull ahead on the static scales or perform other actions.
- Clear line of sight to the static scales, ramp bypass signals and mainline. Consideration for facility orientation should account for annual sunlight penetration and include adequate roof extensions to reduce glare and impacts to the bullet resistant glass.
- The facility hours of operation should be based on performance measure evaluation and not solely on normal working hours.
- Kitchen area, break room and rest room facilities for staff use.
- Server room or closet with climate control.
- Backup power generation suitable for use with electronic components and able to run full facility.

Inspection Barn allows inspectors/officers to conduct commercial motor vehicle inspections, which include a subsurface "pit" for undercarriage inspections of CMV. In general, the inspection barns are steel framed and sheathed with open ends to promote air circulation. This area will often have general office space.

Comfort/Rest Area provides restrooms and other comfort features like vending machines for use by the public.

Figure 4. Inspection facility and inspection barn with lighting.

Other Inspection Stations

Virtual inspection stations can include locations that have fixed or permanent installations of equipment and technology as well as locations that allow for safe pull off for commercial vehicles for roadside safety inspection. These locations are not routinely staff but are served on an ad-hoc basis as a response to identified needs. Three types of locations are described below:

Virtual Inspection Stations, otherwise known as Virtual Weigh in Motion (VWIM), leverage electronic screening utilizing roadside devices as described in the Fixed Inspection Station section. Integrated software solutions obtain commercial motor vehicle information as they travel through the VWIM location and provide notifications to an officer positioned downstream of the roadside devices. This alert notifies the officer that further inspection of the vehicle, including static weighing on portable scales or semi portable scales is necessary due to a noted violation. VWIM installations can be provided in combination with static inspection stations or paved pull-over areas to increase the efficiency and safety of operations.

Static Inspection Stations include permanent pull-over locations with static scales for weighing of CMVs. These stations differ from Fixed Inspection Stations in that they are smaller in size and do not contain any building infrastructure. Generally, a paved area for enforcement staff parking and commercial vehicle screening and inspection is provided, often with a computer terminal connection for data collection. Static inspection stations can also include a mainline WIM application with sorting criteria to screen for non-compliant CMVs.

Pull-Over Areas are paved locations adjacent to the shoulder of the roadway that allow for inspection and weighing of CMVs using portable or semi-portable scale equipment. These areas provide the benefit of a safe location for inspection without the investment in permanent installation of equipment and the associated maintenance costs. These areas are generally located within an area of existing right of way where there is an increase in CMV volume but does not warrant further investment in fixed or permanent equipment.

Site Selection

Inspection station locations are generally governed by several factors, including topography, alignment, and controlling criteria as outlined in the technology section below for weigh in motion. Stations should be considered in locations which exhibit high frequency of commercial vehicle traffic as reported in State Freight Plans or other freight studies. Avoidance of areas that can be easily bypassed through an alternate route should be an additional consideration when determining station locations.

Analysis of the site should include a traffic impact analysis, with consideration given to impacts at adjacent interchanges or other access locations. Noise and other criteria of the National Environmental Policy Act (NEPA) should be evaluated early in the site selection process. Accessibility to utilities, including fiber optic communication, potable water, sanitary sewer and electricity should also be considered.

Locating inspection stations adjacent to state border crossings is beneficial to validate inbound criteria, including permits, jurisdictional agreements such as the IRP and IFTA credentials, while outbound locations allow states to retain revenue for those overweight or oversize vehicles that may cause impacts to state owned infrastructure. The opportunities to share data between states may streamline the need for adjacent stations across state lines.

The selection of fixed or other station types should consider the evaluation of current and future commercial motor vehicle data, including traffic volumes and commodity flows, as documented in state transportation or freight plans. The initial installation of other infrastructure (virtual or other) can be provided until there is a need for a full facility installation. Safety of enforcement personnel should be considered during the evaluation.

Technology

Technology applications and equipment play a critical role in the efficient and effective enforcement of size and weight regulations and safety screening at both fixed and other types of inspection stations. The following technology includes the latest adopted devices and operating systems, as well as communication opportunities to increase the efficiency and effectiveness of operations. While the technology all has application to increase the safety and efficiency of the transportation network, the deployment can occur with variable configurations to address the need of the location. The scalable nature of the technology allows for future enhancements to support the overall system.

Static Scales are composed of rigid concrete slabs supported by load cells that are standardized throughout the state at all inspection stations, which allows for stockpiling of inventory for increased efficiency in repair. The static scales should be located on either side of the inspection facility with one static scale of increased length (the "oversize" side or lane) to allow for single weighing of longer loads without the need for the vehicle to reposition. The static scales should be installed over a "pit" that allows for sufficient access to manage the scale systems. Static scales at weigh stations and inspection sites should be calibrated to meet enforcement criteria.

Weigh-in-Motion (WIM) consists of devices embedded in the roadway, which allow for weighing of CMV at established speeds. There are various types of WIM, like quartz piezoelectric technology that is widely accepted due to accuracy, low maintenance and ease of installation. The WIM technology requires sufficient roadway thickness for installation with degree of accuracy highly dependent on the pavement condition to facility linear motion across the device. The American Society for Testing and Materials (ASTM) Standard E1318 provides specifications for WIM systems and FHWA has developed comprehensive WIM "Pocket Guides" for additional information (https://www.fhwa.dot.gov/policyinformation/knowledgecenter/wim_guide/).

The use of Portland cement concrete pavement adjacent to the WIM location has shown to increase the service life of WIM as compared to asphaltic concrete pavement. Orientation of devices, spacing and other considerations should be coordinated with the specific vendor requirements. Calibration should follow specifications and can be supported through data sharing with vehicle specific information obtained at the static scale location using integrated software.

Figure 5. USDOT reader camera and illumination devices.

Cameras are used to identify specific CMV information and to provide overview of traffic conditions. Information identification is obtained through fixed cameras with infrared lighting and associated software that provides analysis of the image for subsequent use. These cameras include the ability to provide license plate recognition (LPR), and USDOT readers and placard identification. The cameras are located to provide the best viewing angles through roadside or overhead rigid structures. The cameras are specifically triggered by in-pavement inductive loops or other roadway monitoring devices. The cameras are arranged to read the front license plate for CMV as well as the USDOT numbers located along the sides of the cab.

Figure 6. LPR and USDOT reader.

Overview cameras are used for a variety of applications. These cameras can provide information to enforcement personnel when a vehicle does not follow sort information (for example, bypasses an inspection facility when directed to pull in). The cameras can also provide information for traffic incidents as well as potential queuing of vehicles. Cameras should be located at a height that provides unrestricted viewing of the entire roadway network without obstruction from adjacent vehicles. The cameras should be able to pan, tilt and zoom (PTZ) as managed by the inspection staff.

Figure 7. Ramp WIM with size verification devices mounted on overhead structure.

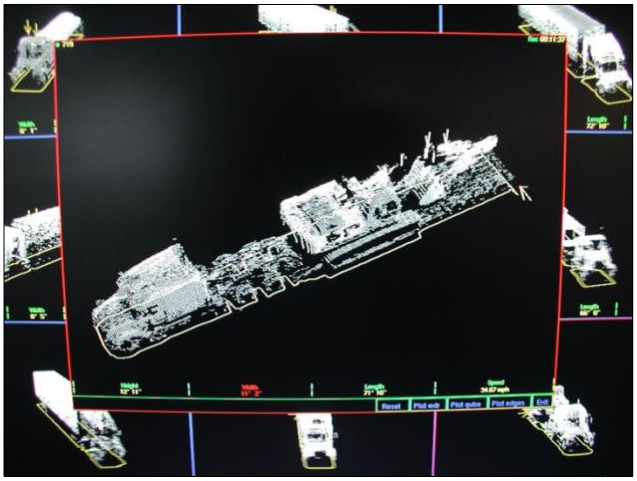

Figure 8. Image of size verification.

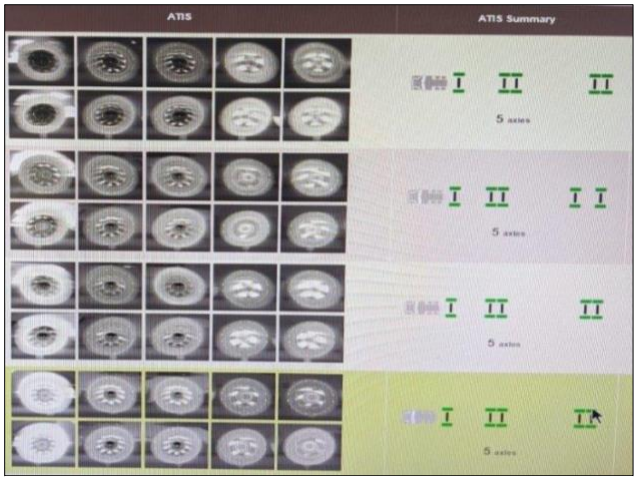

Figure 9. Sample image of tire pressure monitoring.

Size Verification should be provided through roadside devices to either detect or measure for over height or over length vehicles. Over height detection can be accomplished with a fixed measuring laser that triggers a notification when the plane is broken. Virtual three-dimensional (VDIM) scanners can be used to create detailed imagery of the CMV and further alert the inspection personnel to the location of over dimension. Modern advances in light detection and ranging (LiDAR) equipment allow for capturing of vehicle size at operating speeds.

Tire Pressure Screening Systems can be a reliable solution to identify underinflated, missing, or flat tires utilizing sensors in conjunction with the operating software. The sensors are installed in the road pavement and identify irregularities in the CMV tires. The combination of multiple sensors in a specified layout delivers the required data to analyze the state of the tires.

Thermal Brake Inspection Systems measure the heat produced from braking action and can identify irregularities between wheels, indicating potential points of failure. These devices are generally located adjacent to the roadway and are located with WIM and other devices.

Figure 10. Commercial vehicle approaching static scale.

Sorting devices consist of dynamic message signs (DMSs) or directional signal heads. The DMSs can display variable messaging which is controlled by the operating system or manually over-ridden by the inspection staff. The ability to display variable messaging allows for information such as “pull in”, “bypass”, “closed” or other to be displayed as deemed appropriate.

Generally, the DMSs consist of a smaller inserted panel encased within a static sign. Larger DMS require greater power requirements as well as support structures and are generally not required. The DMS are typically located beyond the shoulder and are aligned to provide directional sight to specific vehicles for sorting. Location of the DMS relative to the WIM and other devices is governed by the required time to process information and send the sort decision (see the high-speed communication section).

Directional signal heads are used to direct vehicles within the facility and generally consist of “green arrows” or “red x’s” indicating the required direction of travel. The signal heads are mounted above the internal ramp travel lanes.

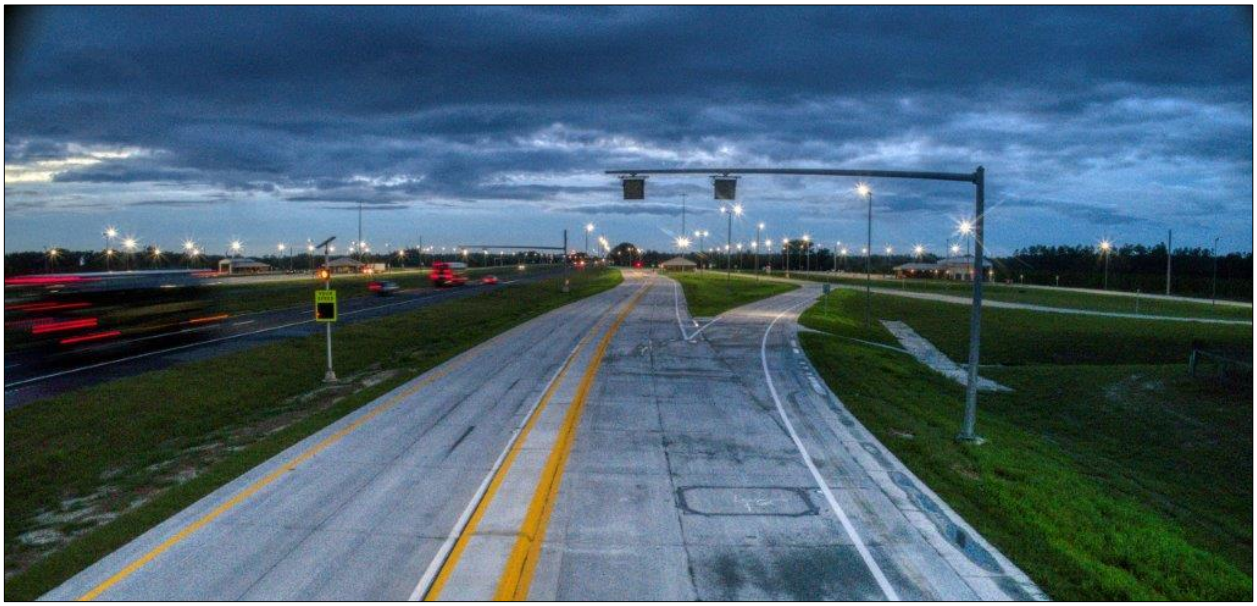

Figure 11. Sort signals directing vehicles to static scale

Electrical power should be provided from a fixed source with separate meters for financial management. The electrical power should consider the ability to "clean" the source to prevent damage to sensitive equipment. Power distribution to the devices should include appropriately sized conductors to meet voltage drop requirements and may require the use of step-up and step-down transformers. The use of these transformers should be considered when specifying the traffic control cabinets.

Backup generators that can support both the technology and the overall facility, including lighting systems, should be provided with adequate on-site fuel capacity for a pre-determined duration. This backup system allows the inspection stations to serve as command posts during disaster recovery efforts.

High speed communication leverages fiber-optic communication cable to provide high transmission speeds with low latency rates between devices and the facility. Fiber-optic cable should include additional strands for future expansion within the facility and effectively develops the secure local area network for each location. The use of fiber-optic cable allows for devices to capture data at the field location, transmit to the building servers for analysis and then provide sort decisions within reasonable time frames to keep the overall system compact. Low speed data transmission results in slower response time and further spacing between the screening and sorting devices.

Connecting adjacent facilities (for example on either side of the roadway) together can allow for redundancy in system management and performance. Consideration for the development of a wide area network through the interconnection of multiple facilities should be considered as part of larger agency broadband communications strategy. Given the sensitive nature of the data acquired at inspection stations, it is suggested that the fiber strands be dedicated to the owning agency and not accessible to outside parties.

Conduit consists of underground infrastructure necessary to carry the electric and communication cables between the building facility and roadside cabinets and devices. Conduit should be sized for future expansion and should be delineated through specific color combinations to differentiate weigh station

infrastructure from other systems, including Intelligent Transportation Systems (ITS) or lighting. In-ground boxes used to pull or splice cable associated with the conduit should also contain information that identifies the use and maintaining agency to differentiate from other systems.

Traffic cabinets should be located to contain the power, communications, and other devices necessary to integrate the systems together. The traffic cabinets should be sized to accommodate existing components as well as future expansion capabilities. Cabinet should be located to minimize the number while maintaining requirements for communication and power, such as loop lead-in, voltage drop and other considerations.

Backup power sources should be considered for inclusion in cabinets where critical functions occur. This should include the open closed signs as well as sorting locations to alert CMV where queue issue exist for safety considerations.

Control operating software is located within the facility building and controls the processing of all devices. The operating software is generally vendor based and requires configuration based on site specific variables. The operating software should have the ability to be customized to fit the specific devices available as well as future expansion options. Interoperability between the control software and citation systems as well as federal and state databases should be incorporated for efficient data transfer.

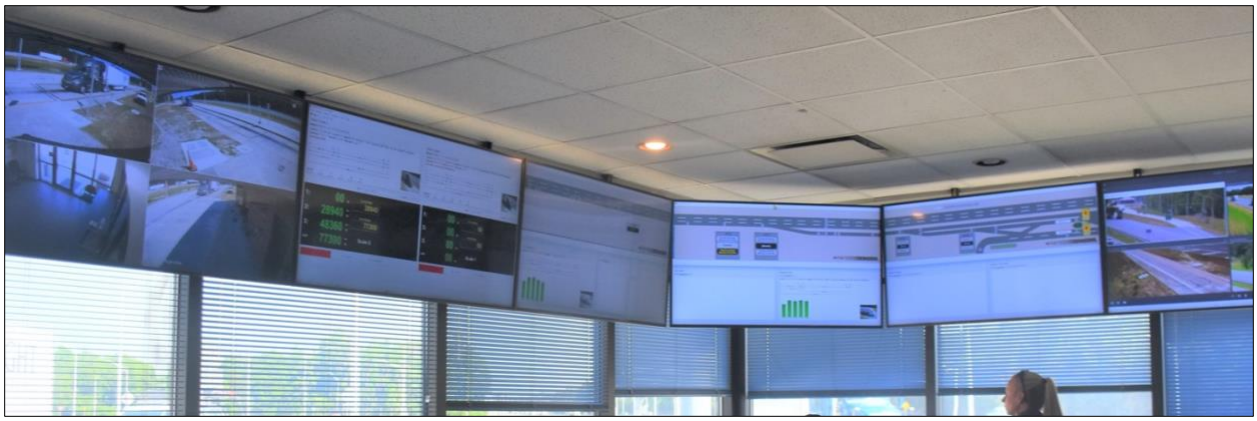

Figure 12. Main inspection facility and monitoring system.

Testing of new technologies should be considered in the development and deployment of site infrastructure. The ability to temporarily add new components within the facility can facilitate verification of operating parameters for new equipment. During the development of technology infrastructure, potential power supply needs as well as communication to the main inspection facility through network switches should be evaluated and included in the final installation. This testing allows for “real world” evaluation of new equipment and enhances collaboration between the owning agencies and vendors developing new solutions for size, weight and other commercial vehicle validation devices.

Centralized Data Collection, Storage and Management

Inspection stations process vehicle specific information used for validation of criteria. The minimum data includes time, day, weight by tire, number of axles, axle spacing, overall vehicle length, vehicle classification, speed and gross weight. Through information obtained by LPR, specific vehicle information is obtained including state of registration. Through USDOT number readers, information on carrier safety scores and general commodity information from SAFER can be obtained. Advanced technology such as

light detection and ranging deployments can provide vehicle height information and other dimensional information.

Advanced systems allow for linking of permits to specific vehicles as identified by license plate. By electronically screening of CMV against permit data bases, the vehicles can be verified for compliance.

Operating software should be configured such that all information obtained at a specific location (WIM, VWIM, static scale) is included as a single record. This allows for a comprehensive analysis of the various criteria listed above as it applies to the vehicle. The unique identification of the vehicle by license plate number then allows for subsequent evaluation as additional locations are encountered.

Centralized storage provides a single location for all records generated by each facility. By aggregating and comparing with data obtained from other locations, enhanced information can be derived including overweight corridor analysis, permit usage analysis, commodity flow and validation of other information. The information, used alone or with other data sets, can be used for cases including:

- Pavement design
- Federal monitoring and reporting
- Planning
- Safety analysis
- Maintenance
- Traffic operations
- Oversize / Overweight permit analysis
- Roadway design
- Freight planning and operations
- Environmental analysis
- Traffic incident management
- Emergency preparedness and response
- Managed lanes

To accommodate these expanded uses of the data, it is suggested that the state agency own and retain all data associated with the operations.

The data should be maintained in a secure method to protect company or personally identifiable information (CII or PII). Data should follow established governance practices for weigh in motion information and be recorded by siting location (mainline WIM, ramp WIM or static scale) for each record. Access to other external systems, such as permit databases, can facilitate increased analytic opportunities, such as time of day analysis for permit usage and associated oversize or overweight vehicles. Secure external access allows agencies to further evaluate CMV for activities such as validation of Electronic Logging Devices for hours-of-service compliance by verifying locations of drivers.

Asset Management

Active maintenance of inspection facilities should be carefully considered in the development and implementation of station plans. Given the importance of these facilities and associated high uptime requirements, a state of good repair is essential not only for efficiency in processing of CMV but to ensure staff safety. The nearly 100% truck traffic creates high loading conditions on roadway infrastructure, including static scale decks and in-pavement equipment. Asset management strategies should be developed that consider the following:

- Dedicated funding for maintenance and replacement (maintain, improve, expand, etc.)
- Development of Performance Measures
  - Process for inspecting assets for state of good repair based on individual component criteria.
  - Performance based payment structure
- Roadway and site features asset maintenance separated from technology allow for focused performance measures and selection of best qualified firms to complete required maintenance, including required calibration.

Policies and Procedures

The establishment of policies and procedures related to the design, construction, operations and maintenance of weigh station and inspection facilities results in consistent statewide application and long-term efficiency in operations. The policy and procedure documents should provide state and agency specific criteria for staff responsibility, station design, and operational parameters and include reference to other manuals and publications as appropriate. Standardizing features such as signing and pavement markings, in conjuction with MUTCD, increases familiarity with CMV traveling through the state and increases the efficiency in design and maintenance operations.

The inclusion of Standard Operating Procedures (SOP) for the inspection staff has been shown to result in consistency among facilities. These SOPs provide clear direction for monitoring of technology devices and the provided information, such as how to measure overheight vehicles, temporary IFTA or IRP requirements and reporting functions. Clearly developed and implemented SOPs drive uniform application and build consistency between stations.

Staffing levels should be dictated by performance measures established in alignment with 23 CFR Section 657, which outlines FHWA requirements for Certification of Size and Weight Enforcement including the development of a State Enforcement Plan (SEP). The SEP documents the approach by which each state will enforce size and weight laws. Performance monitoring of enforcement activities supports the evaluation and need for staffing resources and should include specific measures established to provide the resources and hours of operation necessary to meet thresholds for compliance and certification of the SEP. Examples of measures for staff allocation can include the number of CMV inspected per hour and the corresponding number of violations noted (citation per weigh per hour).

Staff resources should be organized with a hierarchy that allows for the processing of quality control checks on facility operations. These include designated inspectors and supervisory positions and can be further grouped into geographical or other boundaries for consistency. Quality control checks include the review of daily inspector logs, citation documentation and other daily activities. A defined hierarchy also allows for staff promotion and supports agency staff retention goals.


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