AAMVA

American Association of
Motor Vehicle Administrators

privacy
regulations
COMPLIANCE
IDENTIFICATION
Technology
safety
ENFORCEMENT

License Plate Reader Program
Best Practices Guide

Edition 2

August 2025

LAW ENFORCEMENT COMMITTEE

Contents

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Executive Summary

Since their inception more than a century ago, license plates have primarily been used to display information for fast and accurate identification of motor vehicles and to demonstrate compliance with motor vehicle registration laws.

In support of their roadway and public safety missions, License Plate Readers (LPRs) provide law enforcement with the ability to check license plates against various databases. Tolling and parking enforcement authorities also rely on LPR technology for the collection of tolls and enforcing parking regulations.

More than a decade ago, it was recognized that inconsistent business rules used by license plate issuing authorities were resulting in alarmingly high "misreads," diminishing law enforcement's ability to identify and apprehend suspected criminals and terrorists, recover stolen vehicles, and assist people in need of assistance. Similarly, tolling and parking authorities are hampered in their revenue collection mandates, which are critical to maintaining infrastructure and ensuring parking regulations are not flouted. In addition, license plate misreads hamper Customs and Border Protection's ability to correctly identify vehicles crossing international borders.

In response to this issue, AAMVA has published a License Plate Standard (2016) and kept it current via publication of an Edition 2 (2020) and Edition 3 (2023).

In 2020, the AAMVA Law Enforcement Committee recognized the expanded use of LPR technology among AAMVA's law enforcement membership and recommended the creation of a License Plate Reader Program Best Practices document. An LPR Working Group was created, and the License Plate Reader Best Practices document was published in October 2021. Recognizing the rapidly changing technology in this space and to keep this document leading edge, a new LPR Working Group was created in 2024, and Edition 2 of this document was created. In addition to all chapters being updated and refreshed, here is an outline of updates included in Edition 2:

- Chapter One: Advantages and Challenges subsection has been added.
- Previous Chapters 4 and 7 (LPR Benefits and Success Stories) have been combined into a single chapter.
- New Chapter 7, Considerations for License Plate Reader Acquisition, has been added.
- New Chapter 8, Ethical Use of Artificial Intelligence in License Plate Reader Operations, has been added.

Although Edition 2 is primarily meant to serve state and provincial law enforcement, much of the content is applicable to local law enforcement as well as tolling and parking enforcement authorities.

Law enforcement agencies can build meaningful LPR system policies that respect individuals' privacy rights while providing authorized users with the information necessary to ensure the public's safety.

AAMVA has four policy statements addressing license plates, all of which impact LPR readability (see Appendix B).

Chapter 1 Introduction

License Plate Readers (LPRs) are an effective law enforcement and traffic safety tool and are critical to government entities. Modern systems are capable of functioning in diverse conditions and handling challenges such as high vehicle speeds, poor lighting, and weather-related obstructions. As a result, LPR systems are now commonly relied on technology in toll collection, parking management, and urban planning, in addition to their growing role in law enforcement. LPRs enhance public safety and security by providing law enforcement with the ability to check license plates against databases such as the National Crime Information Center. The databases searched are at the discretion of each law enforcement agency using LPR technology.

Federal, state, local, and tribal public safety agencies rely on accurate and timely license plate information to effectively and efficiently perform the multiple tasks required in the performance of their duties. Information is available in multiple formats, including hot lists (e.g., stolen vehicle), Be On the Look Out (BOLO), Attempt to Locate (ATL), officer safety information, AMBER Alerts for at-risk children, SILVER Alerts for at-risk adults, and more. Much of this information can be, and often is, associated with a vehicle's license plate. The ability of LPRs to quickly and accurately scan thousands of license plates is critical to the men and women of law enforcement who contact hundreds of thousands of people throughout the U.S. and Canada every day, as well as to Customs and Border Protection officers and agents monitoring international ports of entry. When LPRs misread license plates, law enforcement is hampered in its mission to protect and to serve, and government entities lose revenue from uncollected tolls.

LPR systems rely on several critical components that work together to capture, process, and use license plate data:

1. **Cameras**
   High-resolution cameras, often equipped with infrared technology, capture clear images of license plates regardless of lighting conditions. These cameras are deployed strategically at fixed locations such as traffic intersections and toll booths or integrated into police vehicle mobile units. Advanced cameras can handle high-speed vehicles and capture images from multiple angles, ensuring accuracy even in challenging environments.

2. **Processing units**
   After a license plate image is captured, it is processed using Optical Character Recognition (OCR) software. This software isolates the license plate within the image, extracts its characters, and converts them into digital text. Modern OCR systems are robust, accommodating a wide variety of fonts, plate designs, and regional differences.

3. **Database integration**
   The extracted license plate data is compared against databases to identify flagged vehicles, such as stolen vehicles and other criminal activities. These databases may be local, national, or international, depending on the system's application. For example, in toll collection, the data are matched to billing accounts, and law enforcement systems check against criminal hotlists.

4. **Communication networks**
   Efficient data transmission is vital to LPR systems. Communication networks, often using wired and wireless technologies, connect cameras, processing units, and databases to ensure seamless operation.

Advantages and Challenges

Advantages include:

Efficiency: Automating license plate recognition reduces the time and labor needed for tasks such as vehicle identification and enforcement.

Accuracy: Modern systems deliver high levels of accuracy, even in adverse conditions such as poor weather or damaged license plates.

Scalability: LPR systems can be deployed in various settings, from small parking lots to high-speed interstate operations.

Challenges include:

Cost: Implementing and maintaining LPR infrastructure, including cameras, networks, and personnel, requires significant investment.

Technical limitations: Weather, lighting conditions, plate obstructions, or plates not in alignment with the AAMVA License Plate Standard can reduce system effectiveness.

Privacy concerns: The continuous collection of vehicle data raises questions about surveillance, data usage, and data storage. Regulatory frameworks are needed to ensure transparency and outline proper LPR system use

A completely effective "ecosystem" is needed to ensure an accurate license plate read rate is achieved by LPRs. Multiple stakeholders share the responsibility for maintenance of the ecosystem. Motor vehicle agencies having license plate design and manufacture administration oversight responsibility should ensure their issued license plates align with the AAMVA License Plate Standard, Edition 3 (2023). LPR manufacturers have a responsibility to develop and implement state-of-the-art technology to accurately read the multivariant license plates that exist. Law enforcement and other government entities using LPR are responsible for ensuring they have policies and training that align with the most current best practices available.

This LPR Program Best Practices document, combined with the AAMVA License Plate Standard, Edition 3; License Plate Policy Statements; and License Plate Verification Program all serve to assist jurisdictions in shaping of jurisdiction laws and regulations and operational policies ensuring license plate readability and integrity.

One of the most critical aspects of LPR effectiveness is the "readability" of the license plate, which is made more reliable through alignment with the AAMVA License Plate Standard. In 2020, AAMVA launched the License Plate Verification Program (LPVP). The LPVP allows jurisdictions to submit up to four license plates per fiscal year for examination and comparison with the AAMVA License Plate Standard, at no cost to the jurisdiction. Jurisdictions may submit more than four license plates but must bear the cost for the additional license plates. The examination is conducted by an independent third-party laboratory under contract with AAMVA. A written report is provided to the submitting jurisdiction outlining areas where the license plate(s) do, or do not, align with the License Plate Standard. The report identifies for jurisdictions areas for potential improvement in the readability of their license plates.

Chapter 2 License Plate History

Introduction

Since their inception more than a century ago, license plates have primarily been used to display information for fast and accurate identification of motor vehicles and to demonstrate compliance with motor vehicle registration laws. The advancement of manufacturing technology has resulted in more colorful and detailed graphics on plates, which can be used to promote a jurisdiction or organization. If license plate designs and manufacturing do not align with the AAMVA License Plate Standard, they can be a readability challenge for the camera technologies used. Most jurisdictions now have numerous plate types and designs available to the public.

Hand-Made, Horse-Drawn

The first record of a registration plate in the U.S. was in Philadelphia, Pennsylvania, in the 1850s. Even then, legibility of plates was a concern, and horse-drawn vehicles required registrations to be identified with numbers "not less than four inches high." Among other things, these numbers provided a means of identification when reporting an incident involving inappropriate or reckless driving. Today, only the state of Indiana still requires license plates on horse-drawn carriages.

The construction of these early registration plates was left to the innovation of the vehicle owner; wood, brass, or other metals affixed to leather backings were common materials used. During the next 50 years, many cities required registration, and they frequently required payment of a modest registration fee.

Plate Production and Issuance

In the early 1900s with the advent of motorized vehicles, jurisdictions took responsibility for registration and standardization of plate issuance.

In 1901, New York became the first state to require license numbers on motor vehicles. These plates were made by individual owners (with the owner's initials) rather than being issued by state agencies as they are in modern times. The very first license plates were typically handcrafted on leather or metal (iron) and were meant to denote ownership via the initials. In 1903, Massachusetts was the first state to issue a standard statewide plate. The very first plate, featuring just the number "1," was issued to Frederick Tudor, who was working with the highway commission. One of his relatives still holds an active registration on the 1 plate. Others soon followed, but issuance of plates remained inconsistent.

Starting in 1903, "mouse ear" plates were sold for $1 by the Automobile Club of Southern California.

California also began requiring plates in 1903 but did not produce them; the Automobile Club of Southern California (an early AAA organization) issued license plates—called mouse ears—to members for $1.00. The state assumed this responsibility in 1910.

On March 22, 1905, the Maine senate debated House Document 552, which required automobiles to be registered and plates to be issued. A senator argued in favor of the plate by stating:

> The matter of registration does not prevent the violation of the law, but the matter of registration, and the law compelling the carrying in a conspicuous position, of a certain number, which leads to the registration and which may lead to the detection or recognition of a violation of the law, is all that registration can amount to as to guarding the safety of the public against accidents from automobiles.

As the debate continued, another senator voiced his support for the display of a number on automobiles so that the operator could be identified when it frightened a horse. In part he stated:

> I do not own an automobile, and do not ever expect to. I do own a cheap horse and have a wife and three girls that drive it. What is the result now? They do not dare to go out. I have a safe horse, but when one of those reckless fellows comes along (*in an automobile*), they are likely to get tipped out, as many have in the State of Maine.

The debate continued, and the bill passed and became public law Chapter 147. It required the Secretary of State to license operators, to register automobiles and motorcycles, and to issue plates. The law also required the Secretary of State to "furnish the applicant two enameled iron plates containing the word 'Maine' and the number of the registration in Arabic numerals not less than four inches in height. The number plates must be attached to the front and back of the automobile and one number plate must be attached to the back of motorcycles."

Maine license plate, 1905 to 1911. The width changed based on the number of characters on the plate.

By 1915, nearly all jurisdictions issued license plates on an annual basis and charged a registration fee that allowed a vehicle to be driven on public roads. Government officials recognized early on that a registration system provided for vehicle identification and a source of transportation revenue. However, license plate design continued down an inconsistent path. It wasn't until 1956 that a standard plate size (12" × 6") was introduced at the request of automobile manufacturers to make it easier to incorporate license plates.

Integrating Safety Concepts

With the rapid increase in the motor vehicle population in the 1920s and 1930s, traffic crashes increased dramatically, leading to the need to improve not only vehicle identification but also vehicle safety. License plates became one means to improve safety by providing a device that improved the night visibility of motor vehicles. The first retro-reflective license plates in the U.S. were issued by New Mexico in 1936.

As retro-reflective technology advanced, fully retro-reflective plates became possible, and the first was issued by Connecticut in 1947 followed by Maine in 1949. Delaware followed suit in 1950 followed by Rhode Island and Oregon in 1951.

During the 1950s, relatively new sheeting gave retro-reflective plates their biggest boost. Minnesota had the distinction of being the first state to use the sheeting on automobile license plates.

The effect that retro-reflective plates had on nighttime motor vehicle crashes was dramatic, and it did not go unnoticed. In 1956, the first year of use in Minnesota, deaths caused by automobile crashes in rural areas dropped from 24% to 9%. Urban area fatalities involving parked vehicles decreased from 28% to 7%.

Standards Materialize

Tiny San Marino—the smallest republic in Europe, with an area of only 24 square miles—had the

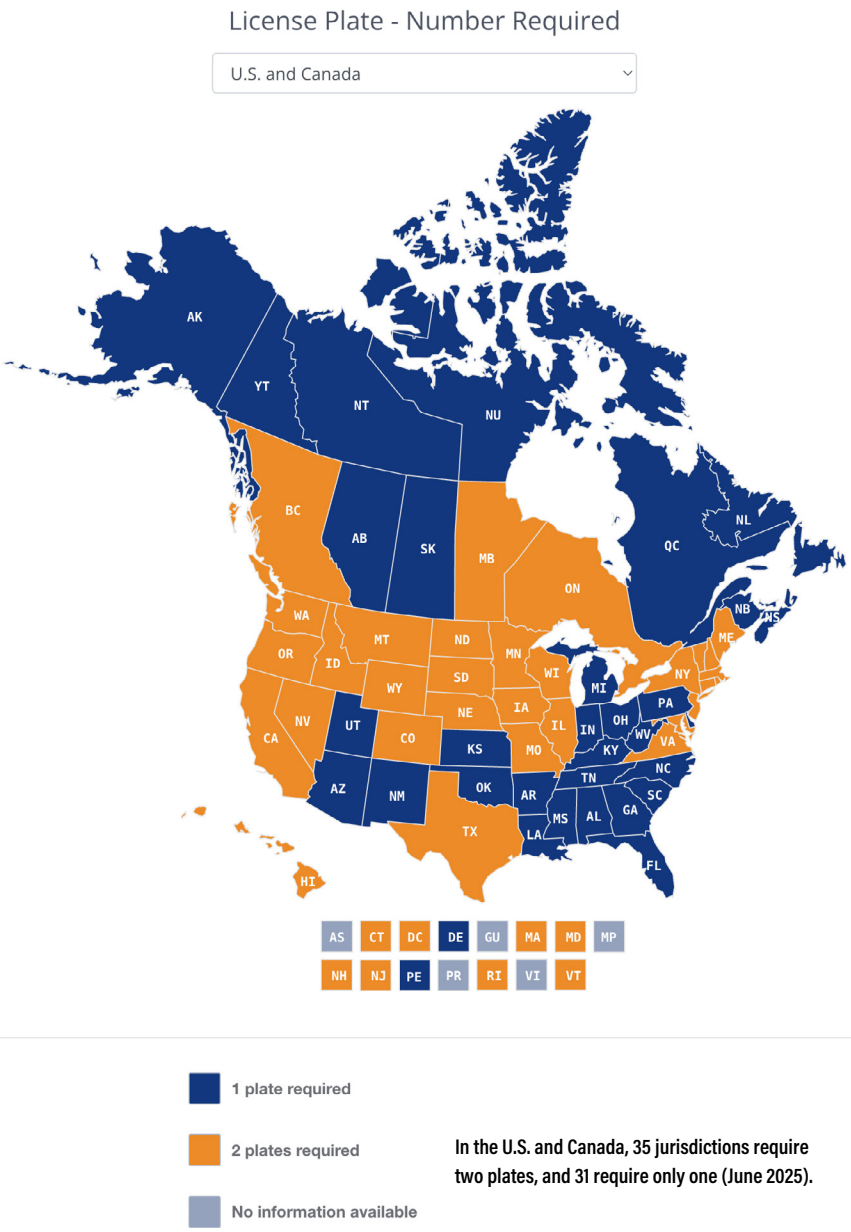
distinction of being the first country on that continent to make reflective license plates mandatory on all 2,500 of its automobiles. In the other hemisphere, the South and Central American countries of Peru and Costa Rica also became pioneers in retro-reflective license plates. In Canada, the provinces of Newfoundland and Alberta led the way. Today, all 50 U.S. states and most other countries in the world use retro-reflective plates.

With the advent of retro-reflective license plates, law enforcement realized a benefit in improved legibility. Although one of the original intents of a vehicle registration number was to aid law enforcement, the reality was that non-reflective plates could only be easily read during daylight hours. Retro-reflection provided greatly improved legibility at night, and even today fully retro-reflective plates continue to have strong endorsement from U.S. law enforcement officials, who advocate fully retro-reflective plates on both the front and rear of vehicles for improved safety and law enforcement efficiency.

Although early license plates were often homemade or devised of porcelain, steel became the predominant base material for plates during the first half of the 20th century. Today, aluminum dominates as the material used in license plate manufacture.

After 1945, most states returned to the pre-war practice of requiring two plates per vehicle. Since then, some states have moved from two plates to one or vice versa. States typically move to one plate with the intent to save on the cost of the second plate. During the late 1980s, Connecticut was the last state to move from one plate to two plates. Law enforcement effectiveness was cited as the primary reason for the change. The U.S. and Canada are two of a small number of countries that allow one plate. The following chart identifies the North American jurisdictions that require either one or two license plates.

Within the U.S. and Canada, each jurisdiction is responsible for issuing license plates for vehicles registered in its jurisdiction. To create a plate unique and easily recognizable to that jurisdiction, combinations of colors were originally used. Plate background color and alphanumeric colors were varied, along with the characters, to create the necessary combinations needed for vehicle classifications and to differentiate plates among the



In the U.S. and Canada, 35 jurisdictions require two plates, and 31 require only one (June 2025).

jurisdictions. With increases in vehicle populations and registration classifications, color alone was not enough. Graphic technology became available in the early 1970s that allowed another level of differentiation of license plates. In 1973, Illinois was the first state to use graphics preprinted on the reflective sheeting, for a special plate for disabled veterans. South Dakota quickly followed with the first general issue graphic of Mount Rushmore National Monument. Today all jurisdictions use graphic plate design. When first introduced, graphic design plates were viewed as attractive and as a mechanism to enhance the image of the jurisdiction.

However, since the proliferation of graphic plate designs, law enforcement is no longer able to easily recognize the issuing jurisdiction. The widespread use of graphics and colors frequently makes legibility of the plate characters a challenge for law enforcement.

Modern Features, Security, and Function

Until the 1990s, all of the U.S. and Canada and most of the rest of the world produced license plates with raised (embossed) alphanumeric characters. In the late 1990s, digital printing technology was introduced, resulting in flat, digitally printed license plates. Today many states are issuing flat plates. Some jurisdictions issue a combination of embossed and flat plates.

As a result of increasing concern with the use of counterfeit license plates used to perpetrate crimes, security features were added to license plate. These security features allow for easy recognition of fraudulent plates and provide one more obstacle for criminals to overcome.

The following functions of a license plate have been, and continue to be, the most important over the past century:

- Display of information necessary for fast and accurate identification of a motor vehicle and compliance with motor vehicle registration laws
- A validation sticker is issued in most jurisdictions, often rotating the color, to indicate a current and valid registration
- Provide an added margin of visibility and safety by making vehicles more visible

More recently, additional functions of license plates have emerged to

- Provide revenue for highway funds and sponsoring organizations (specialty and vanity plates).
- Use images of plates to improve and increase toll collection, parking fees, and fines.
- Provide a way for individuals to express their pride or to promote various causes.
- Provide access control to parking, facilities, and gated communities.

Alternative Vehicle License Plates

Two nontraditional license plate technologies have recently emerged: digital license plates and front license plate wraps. These alternative vehicle license plates are intended to replace traditional aluminum and metal license plates.

Digital License Plate

A **digital license plate** is mounted on the rear of a vehicle and electronically displays the license plate number and all other required data fields. In states requiring two license plates, a standard (metal) plate is affixed to the front. It also emits a wireless signal so real-time license plate information can be displayed. Digital license plates may be equipped with Global Positioning System (GPS) technology that determines and stores vehicle navigation and location. Digital license plates may also be equipped with radiofrequency identification (RFID) technology, which uses radio waves to a receiver that

identifies a vehicle, such as when passing under a tolling gantry. RFID, when installed, may be active or passive. Jurisdictions should consult their statutes regarding privacy in relation to this technology.

Digital license plates were first introduced in California in 2018.The adoption rate in North America has been slow but steady, and these plates are in the pilot phase in many jurisdictions. Some Canadian provinces, including Ontario and Alberta, have initiated pilot programs to explore their feasibility. Fleet operators are among the early adopters of digital plates because these plates simplify the management of large vehicle inventories by allowing real-time tracking and streamlined registration updates.

Digital license plates are reflective[1] but not retro-reflective, creating readability challenges for License Plate Readers (LPRs). Although technology continues to improve, most currently deployed LPR systems can be programmed to read either the standard license plate or the digital license plate but cannot read both, particularly at night.

License Plate Wrap

A **license plate wrap** is an adhesive license plate applied to a vehicle's bumper. Wraps, where currently authorized for purchase, are only allowed to be applied to the front of a vehicle. A curved, indented, or otherwise nonflat surface could render the wrap unreadable to LPRs or the human eye.

For a fuller explanation of both the benefits and challenges associated with nontraditional license plates, see the AAMVA License Plate Standard, Edition Three, Chapter 5 – Alternative Vehicle License Plates Displays and Appendix D – Benefits and Challenges of Alternative License Plates

The Future of License Plates

Digital license plates represent a transformative step in vehicle identification, blending technology with tradition. Although widespread adoption is still in its early stages, the integration of wireless connectivity, geolocation, and dynamic displays suggests a future in which license plates serve not only as identifiers but also as multifunctional communication tools.

In the U.S. and Canada, the adoption of digital plates reflects broader trends in modernization and connectivity. Although traditional metal plates will likely remain the standard for the foreseeable future, over time, digital plates will become more mainstream.

From handmade leather tags to cutting-edge digital displays, the evolution of license plates illustrates the ever-changing relationship between technology and mobility. These innovations ensure that license plates remain an indispensable part of the transportation landscape, adapting to meet the needs of a modern world.

1 Whereas retro-reflective materials reflect light back to its source with minimal scattering, reflective materials, scatter light in various directions.

Chapter 3 License Plate Reader Fundamentals

Introduction

As the demand for License Plate Reader (LPR) systems expands in both law enforcement and commercial applications, LPR technology continues to evolve. LPR systems provide cost-effective approaches in various applications.

Typical applications for LPR technology by law enforcement, motor vehicle administrations, and other entities include but are not limited to:

- Stolen vehicles
- Wanted or missing persons alerts
- AMBER, BLUE (violent criminal who has killed or injured a law enforcement officer), and SILVER alerts
- Open road tolling (pay by plate)
- Congestion pricing
- Parking enforcement
- Access control
- Traffic studies
- Automated enforcement
- On-street parking enforcement
- Travel or journey time calculations

The reads from LPR systems, namely the license plate characters and in some applications the license plate jurisdiction, are primarily used as input into downstream systems to support the intended application. For example, in open road tolling systems, the license plate characters and jurisdiction are used to support the collection of toll revenues. In federal and state law enforcement systems, the license plate characters and jurisdiction are used to support law enforcement queries against data sources.

In most applications, manual verification or certification of LPR results is required at some point in the process. The most significant challenge to maximizing license plate read rate accuracy is the ability of LPR system vendors to quickly adapt to the introduction of numerous jurisdictional license plates.

License Plate Reader Systems

LPR systems include deployment of fixed, portable, mobile, and mobile device application platforms.

Fixed Platforms

Fixed LPR platforms are permanently mounted on fixed infrastructure such as overhead gantries or roadside bollards. LPR fixed platforms are commonly used in open road tolling, commercial vehicle weigh station operations, and some federal and local law enforcement applications.

Fixed LPR in weigh station operations.

Fixed LPR in Customs and Border Protection inbound.

Patrol vehicle roof-mounted LPR.

Portable Platforms

Portable LPR systems can be transported between locations, assembled, operated, and then disassembled. After being deployed, they operate as a fixed platform. Examples include portable trailers, traffic barrels, and other platforms configured with or containing LPR equipment.

Parking enforcement roof-mounted LPR.

Portable Department of Transportation Trailer with LPR.

Speed trailer with LPR.

Mobile Platforms

Mobile LPR systems are defined as any LPR system that is mounted on a vehicle, whether a police car, tow truck, street sweeper, parking enforcement vehicle, or other vehicle platform. These systems are typically mounted on the roof or trunk.

Typical components of mobile systems include cameras that obtain images of the plate and vehicle, which in turn are passed to a processor mounted in the trunk. The processor locates the license plate in the image and extracts the license plate number. It then compares the textual license plate read against selected data sources and sends the output in the form of an alert to a mobile data terminal (screen) and an operator in the vehicle. The alert typically contains the name of the data source to which the image was compared such as an expired license or registration system, an infrared (IR) image of the license plate, and a color overview image of the vehicle in question. Data generated from mobile LPR systems can also be stored or transmitted via a back-office software application.

Mobile LPR Applications (Apps)

Mobile LPR applications are defined as LPR systems that are held and operated by individuals using devices such as barcode readers, tablets, and smart phones that provide other capabilities (e.g., communications, internet access). These technologies provide mobile LPR capabilities and rely on the user to point the imager toward the location of the license plate.

Use of these devices is limited to speed applications typically less than 45 mph and are subject to unique challenges such as shadows, low ambient light,

LPR application on a mobile device.

distance or angle to the license plate surface, and non-reflective surfaces. These limits can be overcome using techniques to light or IR illuminators resident in the device. Because IR imagers are not typically available on commercial general-purpose handheld devices, overcoming readability of non-reflective surfaces using a color imager generally requires special Optical Character Recognition (OCR) techniques. The accuracy of these OCR devices is dependent on the specific device and environment in which it is being used.

Handheld platforms are useful because they are easily deployed and can be used in parking enforcement, covert applications, portable checkpoints, and more. Benefits include portability, relatively low cost, and tactical use. The biggest drawback is that when the LPR application is used, it drains the device battery much faster than normal usage.

LPR Camera Technology

Two primary approaches are used to capture images from which the license plate information can be extracted. One approach is to capture a single still image of the license plate at an "optimal" distance from the camera, where the illumination, lens settings, and field of view can all be controlled to yield the best possible images under any ambient lighting and weather conditions. Another approach is to capture multiple images as the vehicle travels through the field of view of the camera. In this approach, near-instantaneous adjustments to the flash, shutter, and gain settings are performed to optimize the license plate image for different environmental conditions.

Monochrome (black and white), color, and IR cameras are used in various solutions. Monochrome cameras tend to yield the best resolution, can work with most types of visible light illumination, and are generally less costly. Color cameras are useful when the color information can be used to improve the separation between characters and background and for identification of the jurisdiction. Color cameras require white light to produce accurate color information and are of very limited value at night without the use of additional illumination.

IR cameras are tuned to respond to IR illumination. IR cameras tend to be most sensitive at night and tend to be fitted with a band-pass filter designed to block visible light (to limit the effect of headlights and sunlight). This tuned IR illumination is effective at reflecting off the reflective background finish of the plate and not reflecting off the non-reflective characters (or vice versa).

Additional cameras are often used as part of the solution so that both a plate image and a vehicle image can be simultaneously captured to provide context and for investigative purposes. Multiple cameras are also useful when multiple bandwidths of light are used. For example, the fusing of white light and NIR (near-IR) light imagery adds significant information during the OCR and jurisdiction determination.

License Plate Recognition Process

The license plate recognition process begins when a vehicle is detected by an LPR system and ends when an LPR system information has been collected, analyzed, and handed off to backend systems for further processing.

The key steps of the LPR process are to

- Detect the vehicle and/or license plate.
- Locate the license plate in the image(s).
- Extract license plate characters from the background.

- Identify the license plate character.
- Determine the license plate jurisdiction *(optional)*.
- Hand off LPR results to backend systems.

The following paragraphs describe each of the LPR steps in detail.

Detecting the Vehicle and/or License Plate

External triggers such as through-beam IR sensors, retro-reflective license plate sensors, ground-based induction loops, laser range sensors, and so on can be used to detect the presence of a vehicle in the field of view of the LPR system. These types of triggers are primarily used in fixed-platform LPR systems. Alternatively, the LPR system detects the presence of a license plate by analyzing the camera's video signal (which may capture up to 60 images per second) and looking for potential license plate candidates. This type of detection is primarily used in mobile platform LPR systems and can support vehicle speeds up to 140 mph. When the vehicle is detected, the LPR captures one or more images containing the license plate that will be used to support the subsequent license plate number and jurisdiction determination.

The readability of license plates is significantly impacted by design elements such as sheeting type and graphics. Ensuring proper design and manufacturing practices is essential for optimal readability. Reflective sheeting plays a crucial role in enhancing visibility, particularly at night, thereby improving readability for scanners and IR camera systems. This is especially important for automated license plate recognition (ALPR) systems, which depend on high contrast between the plate background and raised alphanumeric characters. Dark or full-color images behind dark alphanumerics can reduce readability.

ALPR systems rely on infrared light sources, making the contrast between the plate background and numbers critical for system accuracy. Although plates may be visible to the human eye, they may not be IR-readable, highlighting the importance of IR readability for system precision. A proper design approach involves evaluating how the inks in the background design and roll coat alphanumerics perform in IR conditions and making necessary adjustments to background inks or printing methods to enhance IR contrast and camera readability.

To enable LPR systems to read license plates, jurisdictions are encouraged to adopt and adhere to the AAMVA License Plate Standard, Edition 3.

Locating the License Plate in the Image

After one or more images containing a license plate are captured, an algorithm is used to determine the exact location of the license plate in the image. This may be accomplished by searching for license plate characteristics (e.g., high-contrast objects) or character strings in the image that indicate the presence of a license plate. This process is one of the most difficult steps of the LPR process because the license plate must be located in potentially conflicting images that contain other information that may appear as license plates (e.g., bumper stickers, other writing,

Camera Arrangement	Resulting Image with Unchanged Ambient Conditions
Flash Duration = 130 µs Shutter Duration: = 200 µs Gain = 2	
Flash Duration = 390 µs Shutter Duration: = 500 µs Gain = 2	
Flash Duration = 780 µs Shutter Duration: = 1000 µs Gain = 2	

As shown in the picture above, LPR cameras can vary flash, shutter, and gain settings to capture multiple images per vehicle over a wide range of ambient and environmental conditions.

License plate that has been located in the larger vehicle image captured by an LPR camera.

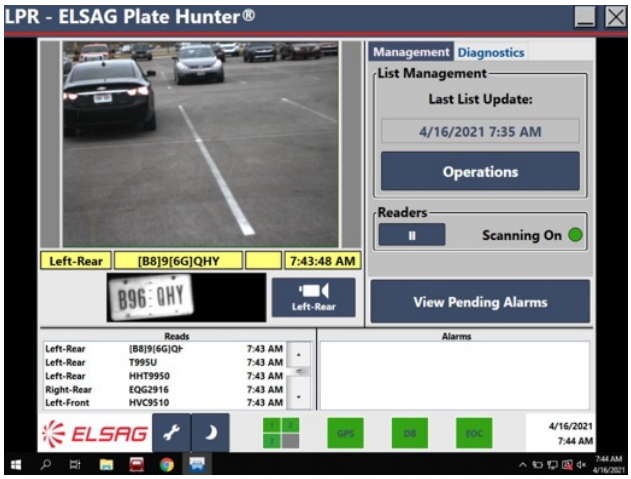
contrasting graphic designs). In addition, the type and condition of the license plate (e.g., retro-reflective, non-reflective, license plate frames and covers, license plate orientation) may require the use of special lighting and camera technologies to both locate and present the optimal license plate image to the character recognition algorithms.

By varying camera settings and controlling illumination, the ability to locate a license plate within an image can be greatly improved. In addition, the "best" image can also be used to improve the accuracy of the subsequent character extraction and license plate character determination.

Extracting the Characters from the Background (Segmentation)

After the license plate is identified in the images(s), the region around the license plate may be further analyzed to extract the characters from the background. In the following example, pixels making up the candidate region are separated into foreground and background pixels to provide a more suitable candidate image used by the OCR algorithms to translate a character string image into an alphanumeric value that constitutes the license plate characters. This is made more difficult when there is little contrast between the license plate characters and the plate background. The segmented or preprocessed license plate image is then passed off to OCR software, where the images are converted to individual alphanumeric characters.

Determining the License Plate Character



In the above example, you can see that the software cannot discern whether the first character is a "B" or and "8" and whether the third character is a "6" or a "G."

Variations in fonts, additional symbols, half-height characters, location of registration stickers, license plate frames and covers, and holograms on characters all increase the complexity of OCR algorithms used to determine the alphanumeric characters of a license plate. Background graphics can also challenge the ability of LPR systems to recognize characters.

As seen above, when characters are located too close to the plate's edge, license plate frames can easily prevent the plate number from being read by an LPR.

In the following license plate examples, the ascender and descender of the letter "Q" takes on different characteristics that may require specifically tuned or trained OCR engines depending on the region or jurisdiction in which the LPR system is deployed. The number "4" in the first license plate compared with the "4" in the second photo below provides another example of inconsistent fonts used between jurisdictions, making the same number look different. Note that the image processing and segmentation steps described must discern the actual license plate number from other alphanumeric information such as vehicle registration tabs and jurisdiction names and logos.

Determining the License Plate Types and Jurisdiction

Some LPR systems can identify the license plate type and the jurisdiction of origin by recognizing key features on the plate such as the jurisdiction logo, background graphics, special symbols, and fonts.

Temporary License Plates

Temporary license plates pose a challenge to LPR systems. Lack of retro-reflectivity results in temporary license plates only being readable during daylight hours or in scenarios where artificial illumination in the visible spectrum is available. In addition to illumination challenges, LPR systems are often hindered by illegible characters. Often, temporary license plates do not align with the AAMVA License Plate Standard.

Handing Off LPR Results to Backend System

After the license plate characteristics are determined, the information is handed off to backend systems in support of the intended LPR system application. These systems may compare the license plates with hot lists or other data sources. Sometimes these actions are not for enforcement purposes but to allow vehicles access to secure locations, such as parking garages.

In some cases, the LPR data, along with supplemental data such as scene and vehicle images, vehicle location, and date and time stamps, are stored in highly scalable and searchable data sources to support analysis.

LPR systems are often configured to automatically transmit all the collected data to a backend data archive or server for retention. In many cases, this transmission occurs in the background without any effort from the system user.

After the data have been inserted into the server, they are immediately available for search. These systems are generally web based and can support numerous workstations simultaneously. Often the software solutions used to manage data sources allow information to be queried in a multitude of ways, such as by location, time, and license plate characters.

In addition, the image captured and the results generated by the LPR system can be digitally signed and encrypted. This process provides a chain of custody for evidence purposes.

Chapter 4 License Plate Reader Benefits and Success Stories

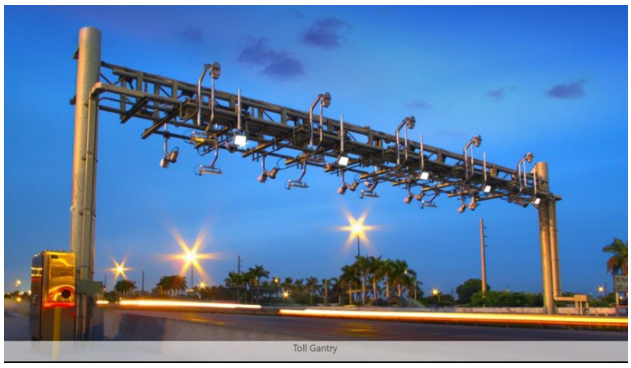
Introduction and Background

Prior to the introduction of License Plate Reader (LPR) technology, a law enforcement officer could query a limited number of license plates per shift. LPR systems are **exponentially** more efficient than manual reads by a law enforcement officer on the street,[2] enhancing the efficiency of investigations and officer safety. LPR systems are used to identify vehicles, not people. These systems assist law enforcement in identifying stolen vehicles and obtaining valuable information of vehicles that may be involved in criminal activity. Moreover, by eliminating the manual query, officer efficiency is increased, and officers can focus more on their surroundings, which improves both officer and public safety.

In studies supported by the National Institute of Justice, research was conducted about the effectiveness of LPR use for law enforcement patrol and investigations. The first study was conducted in a large suburban jurisdiction in designated hot spots for a period of 4 months. Officers who used LPR were found to be much more likely to recover stolen vehicles than officers who did not use LPR. The second study examined how LPR could be used for investigations and was focused on a large city with nearly 100 LPRs in fixed locations. After 2 years, researchers noted 4,000 incidents were documented, including auto theft, missing persons, and homicide cases. LPRs were found to provide information that contributed somewhat to resolving roughly one in five incidents.[3]

Although LPR read rates are extremely high, misreads and no reads of license plates do occur. When they do occur, the potential exists for missing an alert related to a suspected criminal, terrorist, or stolen vehicle. Additionally, there is the potential for missed toll revenue. Research conducted by the Colorado E470 Public Highway Authority from December 2023 indicated that 8% of toll revenue was lost because of unbillable revenue from misread or illegible license plates.[4] Some tolling authorities rely on the front plate for both revenue collection and enforcement. Without a front license plate, tolling authorities may be unable to collect the required revenue and make enforcement action a challenge.

Research conducted by the Colorado E470 Public Highway Authority from December 2023 indicated that 8% of toll revenue was lost because of unbillable revenue from misread or illegible license plates.



Gantry-mounted LPR technology commonly used for automated toll collection.

A sampling of seven states illustrates the significant growth in the number of license plate designs in circulation in the U.S.

2 https://www.ojp.gov/pdffiles1/nij/nlectc/238827.pdf

3 Christopher S. Koper and Cynthia Lum, "Effectiveness of License Plate Readers for Patrol and Investigations," Research in Brief, Police Chief 85, no. 9 (2018): 14–15.

4 E470 Public Highway Authority Quarterly Dashboard Report December 31, 2023.

In the past, a law enforcement officer could be familiar with all 50 states' license plates. Today with the proliferation of license plate designs, specialty, and vanity plates—in some cases into the hundreds in a single jurisdiction—it is virtually impossible for instant visual recognition for today's police officers. The issue is exacerbated by the introduction of additional new license plate designs each year. Moreover, novelty plates that closely resemble official license plates have added to the difficulty law enforcement contends with in determining plate validity.

The following table represents a sample of the growth in license plate designs.

Jurisdiction	2009	2012	2021	2024
Arizona	52	64	75	105
California	106	117	167	167
Maryland	800	935	1,365	1,175
Montana	152	177	350	493
Pennsylvania	245	310	582	584
South Carolina	385	417	429	583
Texas	225	376	499	590
7 state totals	1,965	2,396	3,467	3,697
% Increase from 2009 to 2024				88%

Officer Safety Benefits

Safety is of paramount concern for any law enforcement officer initiating a traffic stop. Officers in patrol vehicles not equipped with LPR technology may not be as informed about the vehicle information as those who have the technology.

LPR technology provides the ability to check the vehicle license plate characters automatically and rapidly against selected databases. License plates are often "flagged" when the owner is associated with certain information (e.g., wanted, attempt to locate, be on the lookout for, stolen car). With LPR technology, officers stopping vehicles for sometimes minor traffic offenses can be made aware of this type of information. This allows them to use the appropriate officer safety tactics given the information they have instead of unknowingly walking into a dangerous encounter. Prior to enforcement activity, information obtained through an LPR read must be validated by the officer.

Traffic Safety Benefits

One significant example of a traffic safety benefit involves *suspended, revoked,* or *otherwise ineligible* drivers. Problem drivers (i.e., habitual traffic offenders) pose a significant threat to roadway safety. LPR technology has the capability to quickly identify vehicles whose registered owners have suspended or revoked licenses or registrations, making it much faster and easier for law enforcement officers to detect and apprehend suspended drivers.

Benefits to Law Enforcement: Beyond Traffic Safety

LPRs are at the forefront of discussions about the impact of technology on improving traffic and public safety. In the field of auto theft recovery and investigation, LPR technology is a force multiplier for law enforcement. The technology enables reading and checking the status of thousands of license plates in a single shift, all while the investigator can watch his or her surroundings for activity, malevolent or benign. The LPR is a tireless partner, constantly on the watch for stolen vehicles and wanted subjects, AMBER alerts, and more. LPR technology is more effective when a vehicle has a front and a rear license plate.

LPR technology is more effective when a vehicle has a front and a rear license plate.

Many police agencies use LPR-equipped vehicles to collect plate information as they respond to major crimes to capture plate numbers of vehicles leaving the area as police respond to the scene of the crime. There have been many instances when these reads have led to the identification of suspect vehicles and suspect arrests.

Public Safety Benefit

As mentioned in the previous benefits subsections, LPR-equipped law enforcement vehicles can scan thousands of plates an hour, thus increasing the chances of finding a particular vehicle quickly, enhancing roadway and public safety. Between April and September 2024, LPR readers at the Denver International Airport read millions of license plates and helped law enforcement arrest more than 100 suspects and recover 11 weapons and approximately 99 stolen vehicles.

Homeland Security Enhancements

LPR technology has also become an important national security tool. LPR technology is used to query the license plate characters of vehicles entering and departing the U.S. to identify potential threats to national security. LPR units are also set up in locations in proximity to critical infrastructure to identify potential threats.

License Plate Reader Success Stories

What follows are documented examples of how LPR technology has benefited law enforcement in the performance of their public safety mission.

March 2025: A Nevada Highway Patrol trooper using LPR received an alert on a commercial vehicle for two Florida subjects wanted for sexual assault of a minor and conspiracy. The driver initially failed to stop, but after short pursuit, both subjects were apprehended.

February 2025: A Florida man wanted for murder was identified by a Highway Patrol trooper using LPR. During a pursuit, the suspect fired shots at pursuing troopers before crashing and fled on foot. A shootout ensued, and the suspect was killed.

January 2025: While flying in support of ground trooper operations, a Colorado State Patrol Trooper Pilot received an LPR notification for a stolen U-Haul van in the Colorado Springs Area. The trooper pilot trained the aircraft camera to the intersection of the LPR hit and was able to quickly locate the vehicle within seconds of receiving the notification. He followed the vehicle until it came to a stop at a residence, where officers were able to take the subject into custody and recover the stolen van.

October 14, 2024: LPR technology aided in a large-scale motor vehicle theft operation. Between April and September 2024, LPR readers at the Denver International Airport read millions of license plates and helped law enforcement arrest more than 100 suspects and recover 11 weapons and approximately 99 stolen vehicles.

October 01, 2024: The Florida Highway Patrol (FHP) was monitoring traffic on Interstate 75 when an alert came out for a vehicle with Georgia license plates associated with an individual with an arrest warrant for kidnapping. The FHP located the vehicle based on the LPR alert and was able to successfully identify the wanted individual as the driver. The driver was arrested without incident, and the two children were turned over to the Department of Children and Families.

September 11, 2024: Virginia State Police Troopers were alerted to a vehicle via a fixed site LPR as having been involved in a firearm brandishing on the interstate. A traffic stop was attempted, a pursuit ensued, and troopers observed the driver throw a handgun out the window. The 17-year-old driver subsequently stopped and was taken into custody. The driver had outstanding court petitions, and the recovered handgun had an extended ammunition magazine.

May 2024: Nevada Department of Motor Vehicles (DMV) Investigators received information about two possible stolen vehicles (a 2023 Cadillac Escalade and a 2023 Chevrolet Tahoe) in the Las Vegas area. The vehicles were entered into the LPR database as "hot plates." The following day, DMV investigators received a notice the 2023 Chevrolet Tahoe was in Northern Las Vegas. DMV investigators responded to the area and located the vehicle. The investigators conducted physical surveillance and were able to track it to a residential address. Investigators also observed the second vehicle, the 2023 Cadillac Escalade, parked in the driveway of the residence and were able to obtain a search warrant. Both stolen vehicles were discovered to have fraudulent Vehicle Identification Numbers. During the execution of the search warrant, investigators also uncovered a lab to perpetuate multiple forms of fraud.

February 2024: A Nevada DMV sergeant conducted a traffic stop on a vehicle bearing California license plates. The driver gave false information about his identity. When asked to exit the vehicle, he fled the scene, leading officers on a high-speed pursuit, which was terminated. DMV investigators used LPR to create a "hot plate" for the suspect vehicle. Investigators were able to positively identify the suspect, who they discovered was wanted for rape. Investigators located the vehicle using LPR. They conducted surveillance and identified and arrested the suspect for his outstanding warrant.

Chapter 5 License Plate Readers as a Tool to Improve Tolling Systems and Other Uses

Introduction

This chapter discusses how License Plate Reader (LPR) systems benefit public mobility but also have become core to the way many electronic toll systems collect tolls and enforcing payment. LPR has made it possible for the toll industry to move increasingly toward all-electronic cashless toll operations, which are permitting free-flow traffic to pay tolls at highway speeds, improving roadway efficiency, improving the customer experience, and mitigating adverse environmental impacts. Road and bridge toll collection helps provide revenue assurance for highway lane management, maintenance, and improvement.

LPR systems are also effective in commercial vehicle enforcement, which results in efficiencies in safety and traffic flow near weigh station and inspection facilities. These systems help officers identify and focus resources on the vehicles and drivers that are most likely to present safety risks.

LPR systems are also deployed by Customs and Border Protection along the U.S. borders with Canada and Mexico to improve and enhance traveler mobility across these borders.

Mobility and Toll Collection

Collection of user fees on roads, bridges, and tunnels—or tolls—has served as an important means of financing key transportation projects and funding ongoing operations and maintenance for as long as roads have existed. Tolls provide a direct approach to funding highways, bridges, and tunnels without increasing local or state taxes, and they ensure that those who use and benefit the most from these projects pay for them directly.

For toll facilities to be effective, however, tolls must be collected. Historically, toll collection involved staff at a gate or in a toll booth collecting cash directly from motorists and making change at strategic points along the roadway. This process required each vehicle to stop in the tolling zone for a brief period to tender a cash toll payment. But when the collection site becomes a chokepoint, risks of rear-impact and chain-reaction crashes increase. Toll chokepoints also reduce the efficiency of the corridor where collection takes place. Additionally, when toll collection slows traffic, reduced efficiency adds emissions into the environment and increases the time required to move people and commercial goods.

Over the past three decades, most toll operators modernized their toll collection systems with technology that allows prepaid toll accounts using in-vehicle transponders to identify valid toll account holders. The introduction of electronic toll collection (ETC) has reduced the dependence on toll collection personnel and manual cash transactions at toll points. Although ETC has improved traffic flow and efficiency, it has also introduced a new challenge—toll evasion and revenue loss. Toll violators include motorists who travel through an ETC-only lane without a transponder or unfunded toll account, creating unpaid toll transactions. This not only reduces the funding available for roadway operations and maintenance but also adversely affects fairness to those who pay their tolls, potentially eroding public support for tolling. In an ETC environment, there is a cash payment option for motorists without

transponders and prepaid toll accounts. LPR technology is used to capture license plate images of vehicles without toll transponders in ETC toll lanes to enforce the toll payment from the registered vehicle owner.

The introduction of electronic toll collection (ETC) has reduced the dependence on toll collection personnel and manual cash transactions at toll points. Although ETC has improved traffic flow and efficiency, it has also introduced a new challenge—toll evasion and revenue loss.

In recent years, toll operators are increasingly adopting all-electronic tolling (AET) operations, in which the cash payment option is eliminated entirely. Cashless AET operations offer the benefit of allowing free-flow tolling, often permitting all vehicles to move through the tolling point at the posted speed limit without stopping or slowing. AET operations are reducing the need to separate cash payment and ETC vehicles and the associated roadside infrastructure required to do so. Instead, AET operations often use overhead gantries with electronic toll equipment (e.g., antennas, transponder readers, and LPR cameras) to process the toll transaction with all vehicles. Vehicles with in-vehicle transponders pay their tolls through their toll accounts, just as they do in an ETC environment. Vehicles without toll transponders in an AET environment have their license plate images captured, and toll bills are sent to the registered owners of the vehicles to arrange payment of the toll due. In an AET tolling environment, more transactions are being processed based on LPR technology. For commercial motor vehicles, the Federal Motor Carrier Safety Administration estimates a truck will save approximately $10 per facility each time it is able to legally bypass a weight station or inspection facility.

According to the Federal Highway Administration, jurisdictions throughout the U.S. are installing managed lanes (e.g., high occupancy/toll lanes) in response to increased congestion. Managed lanes are intended to lessen congestion and provide greater mobility than the adjacent general-purpose lanes of state highways or interstate highways located in urban areas. In some cases, it is also used to enforce high occupancy vehicle violations automatically, without the need for a law enforcement officer to visually detect violations. LPR also assists transportation officials to understand and influence traffic patterns and set flexible pricing based on traffic levels to reduce congestion, resulting in fewer roadway incidents and increased mobility.

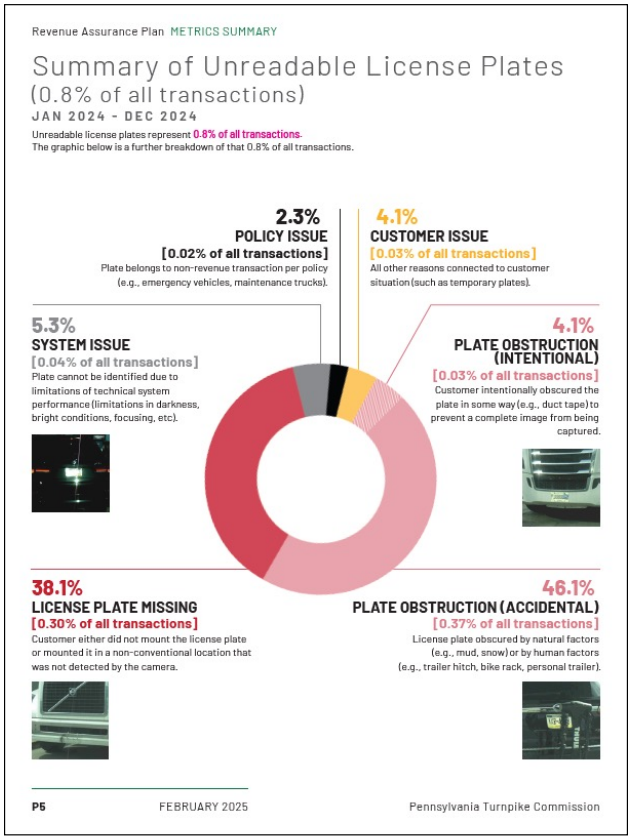
Today as motor vehicle transportation solutions orient their designs toward improved mobility, reduced congestion, and more reliable levels of service, the use of LPR technologies has increased substantially. The conundrum in this development is that as LPR technologies improve, license plates continue to take on increasingly complex designs, making accurate license plate reading problematic.

Another feature of the move to LPR-related open road tolling is the use of enforcement-intended data access for revenue collection that is not law enforcement related. In jurisdictions where overhead tolling is introduced, the department of motor vehicles should be consulted in the means by which vehicle and vehicle operator data may be obtained.

Revenue Loss

License plate designs, license plate obstruction, and purposeful avoidance to register and title vehicles are the most significant contributors to revenue losses for authorities using LPR systems. License plates that align with AAMVA License Plate Standards will ensure accurate identification, support roadway safety, and increase revenue collection by ensuring that license plates are easily readable.

The following chart depicts significant revenue loss from unreadable license plates from a single turnpike authority.[5]



Mobility at U.S. Borders with Canada and Mexico

Currently, Customs and Border Protection (CBP) has three programs that use LPR to expedite entry to the U.S.—NEXUS, Secure Electronic Network for Travelers Rapid Inspection (SENTRI), and Free And Secure Trade (FAST). NEXUS is used at the Canadian border, and SENTRI is used at the Mexican border. FAST is a commercial clearance program for low-risk shipments entering the U.S. from Canada and Mexico. Each of these programs has dedicated lanes, and users are vetted.

All vehicles and persons entering the U.S. are subject to inspection. Every vehicle and every person entering at a land border port must be queried through various law enforcement databases before they can enter the U.S. Although the inspection process encompasses more than just queries, each query takes time to perform, and time is a factor in vehicle wait times. LPR reduces manual entry by CBP agents and officers, resulting in focused attention on the vehicle and occupants. CBP, through the Western Hemisphere Travel Initiative, has installed technology at most ports of entry that automates many functions previously done manually. This automation has resulted in reduced vehicle inspection times while maintaining the integrity of the inspection process.

Commercial Vehicle Enforcement

Commercial vehicle enforcement entities use LPR. Several specialized companies have emerged that use LPRs to read license plates and compare the plate numbers with federal safety data sources to ensure trucks are in compliance with federal and state motor carrier safety programs. Some systems also verify various state and federal credentials required to operate in the jurisdiction, check for out-of-service violations, and check for wants or warrants associated with vehicles.

Increasingly, LPR systems, along with Department of Transportation number recognition and transponders, are used extensively at weigh stations to conduct electronic screening of commercial vehicles. By automating this process, there are significant time savings for both drivers and law enforcement. Additionally, modern LPR systems integrate artificial intelligence (AI) and machine learning to enhance image processing and character recognition, enabling accurate identification even under challenging conditions such as poor lighting or obstructions.

Automated license plate recognition camera in use at a roadside truck scale.

5 From the Pennsylvania Turnpike Commission, Revenue Assurance Plan, Metrics Summary, February 2025.

Parking Enforcement

LPR has become an essential tool in modern parking enforcement, leveraging automated technology to improve efficiency and compliance. By streamlining on-street parking enforcement, LPR technology has significantly improved operations. For example, data on parking scofflaws—individuals who fail to pay citations or fines—is uploaded to LPR-equipped vehicles. These systems quickly identify offenders, enabling parking authorities to take corrective actions, such as booting vehicles, to recover lost parking revenues.

LPR systems, mounted on enforcement vehicles, allow officers to scan thousands of license plates per shift, efficiently detecting violations like expired permits or overtime parking. Beyond enforcement, these systems also provide valuable insights, including peak occupancy periods and high-traffic zones, which help optimize resource allocation, justify infrastructure improvements, and refine enforcement strategies.

Intelligent Parking Solutions

LPR systems are integral to smart parking management, enabling automated entry and exit, real-time occupancy tracking, and efficient fee collection. By recognizing license plates, these systems can guide drivers to available spaces, reduce search times, and enhance the overall parking experience.

How a Popular Tourist Destination Automates Parking Enforcement

In the City of Fort Lauderdale, Florida, there are more than 15,000 parking spaces. Within the first 8 months of using an LPR system, the City of Fort Lauderdale was able to boot more than 600 scofflaw vehicles and collect more than $200,000 in unpaid fines. Because of a 1,400% increase in scofflaw identification, the city recouped its investment on the LPR system after only 2 months.

Enhanced Traffic Monitoring and Management

Modern LPR systems equipped with AI capabilities provide real-time data on traffic flow, vehicle counts, and congestion patterns. This information enables traffic authorities to implement dynamic traffic control measures, such as adjusting signal timings and managing traffic diversions, to alleviate congestion and improve road safety.

Data-Driven Urban Planning

The data collected by LPR systems offer valuable insights into traffic patterns and vehicle movements, aiding urban planners in designing infrastructure improvements, optimizing traffic flow, and developing sustainable transportation policies.

LPR technology has revolutionized commercial vehicle enforcement, border operations, and parking management. By automating processes, improving compliance, and streamlining operations, LPR systems have enhanced efficiency, safety, and revenue collection. With ongoing advancements, LPR technology will continue to drive innovation across transportation and public safety systems.

Chapter 6 License Plate Reader Program Best Practices for Law Enforcement

Introduction

A properly organized and managed License Plate Reader (LPR) program can greatly enhance the effectiveness of patrol operations and criminal investigations. The best LPR programs are built on a foundation of good policy and training.

The measurement of success for an LPR program is subjective. Recovering stolen vehicles; arresting subjects with active warrants; and recovering AMBER, SILVER, and BLUE alert subjects are some measures of success. However, in an era of transparency and civilian oversight, a true measure of success should include an agency's ability to collect, store, and delete millions of LPR reads in an efficient and secure manner. It should also be noted that LPR systems are only as good as the data they rely on. Ensuring that the hot lists they access are kept current is critical to limiting the possibility that users will act on erroneous information.

Policy

Law enforcement agencies can build meaningful LPR system policies that respect individuals' privacy rights while providing authorized users with the information necessary to ensure the public's safety. Policies should include LPR program goals and objectives and should not be too restrictive as to limit operators' ability to perform law enforcement functions yet still be protective of the massive amounts of data an LPR system collects.

Because LPR equipment and accounts can have broad permissions, policies should contain language defining what functions an operator can and cannot perform with an assigned LPR account or LPR equipment. Having operators sign an acceptable use statement is a method of tracking and ensuring each user has been made aware of the policies set forth. In addition to the policies already explained, the following specific topics and their relationship to the use of LPRs should also be reflected in policy:

- **Data retention and dissemination** – Data usage policies should conform with jurisdictional laws governing the agency's legal authority to collect, retain, disseminate, and dispose of LPR data. Agencies should have a lawful data retention period defined in policy (whether it is included in jurisdictional law or not).
- **Freedom of Information Act** – An agency's public records policy should be examined to ensure compliance with the legal requirements of the applicable jurisdiction. This policy should address retention and purging of LPR-collected data.
- **Data security** – Operator passwords, system lockouts, system audits, and user audits should all be addressed in policy. Many of these are already established within an agency or by an overarching governing body. Assurances should be made to maintain compliance with these existing policies.
- **Memorandums of understanding (MOUs)** – Many agencies and jurisdictions may decide to work together to establish one large LPR network. This reduces the cost per agency, and the burden of responsibility is shared. An established MOU identifies the roles and responsibilities between the agencies.

See Appendix (C) for sample LPR policies from Ohio, and Virginia.

Training

In addition to having sound policy, formalized training should be in place that conveys legal requirements of LPR systems and use, as well as the policy content to LPR system operators. Training is a fundamental component of an LPR system. Without properly documented training, operators have no direction regarding properly setting up, using, and troubleshooting LPR equipment. Training should emphasize policy (and case law) surrounding data retention. This can serve to assure the public that data are being collected, stored, used, and deleted in a manner consistent with established legal guidelines and policy. Proper training will provide for a legally defensible use of the LPR system.

LPR training can be divided into three sections: operations, data analysis, and technical support. All sections of training should be recurring and culminate in a test. This ensures new contemporary material is incorporated into the curriculum for presentation and that operators remain vigilant in the use of the LPR system.

Operations training should focus on the daily operator of an LPR-equipped vehicle. Like speed-measuring devices, the operator of an LPR-equipped vehicle should be able to set up, operate, and troubleshoot a vehicle-mounted LPR system.

Data analytics could be considered the second most important function of an LPR system. (The most important function is data collection.) Having the training necessary to analyze a target vehicle across a network of LPR cameras relies on consistent and thorough training.

The last section of training that should be included in an LPR program is technical support. This section of training encompasses the logistical support staff most agencies will use to up-fit LPR patrol vehicles, monitor fixed sites, perform server maintenance, and perform system upgrades.

LPR Program Staffing

An LPR program should be adequately staffed to provide proper program planning, support, and oversight. Prior to determining staffing levels, a decision should be made if the LPR program will fall under the management and leadership of an existing police hierarchy (e.g., Operations or Investigations) or if it will be autonomous (specialty unit).

If an agency has fixed LPR equipment in its program, the program should be staffed sufficiently to maintain 24-hour operations to respond to any alert received, such as AMBER Alerts.

An LPR program needs enough employees to install and fix the equipment and employees who can manage both the system and equipment. If agency staffing is limited, employees can effectively multitask and meet the needs of multiple positions at once. If an agency does not have the number of employees or expertise to complete all the required aspects of running an efficient program, contractors can be employed to conduct one or more critical functions of the LPR program.

Equipment

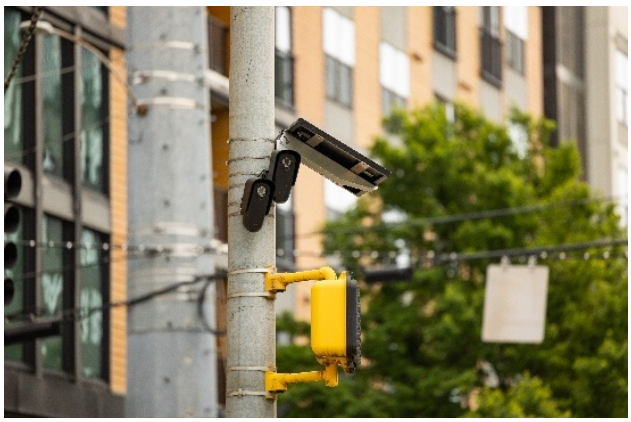
Like staffing, LPR equipment needs to encompass all aspects of the program. A comprehensive, but not all-inclusive, list of equipment needed for an effective LPR program follows (mobile, fixed, and portable platforms):

Mobile LPR	Fixed-Site LPR	Portable Platform
Vehicle-mounted readers	Overhead or pole-mounted readers	Platform: commonly a trailer
Connecting wires from readers to trunk box	Continuous power supply	Continuous power supply (solar combined with battery)
Trunk box	Cellular or fiberoptic network	Cellular network
Mobile systems software	Systems software	Systems software
Mobile computer capable of operating mobile systems software		
GPS-capable antenna		

Trunk-mounted LPRs.

Trailer-mounted LPR.

Roof-mounted LPRs.



Pole-mounted LPR.

Live Feed Access to LPR Information

LPR information can be live fed to other apparatuses such as shown by the law enforcement pilot viewing on a tablet as shown below.

A well-thought-out and well-executed LPR program provides law enforcement with an additional tool in providing essential public safety services. Establishing an LPR program is a task that should be completed with careful consideration, planning, and organization.

Tablet for viewing LPR information (shown being used in a rotary wing aircraft platform environment)

Chapter 7 Considerations for License Plate Reader Acquisition

To be the best stewards of funds and ensure License Plate Reader (LPR) system effectiveness, agencies should determine the best type of LPR system (and equipment) to suit their needs. This chapter recommends some discussion points for agencies to consider before purchasing LPR equipment or signing an LPR contract.

One of the many factors to consider when determining which LPR system an agency will use is the cost. The total cost of a system includes, but is not limited to, the initial purchase and installation, possible expansion, and ongoing costs. Ongoing costs include maintenance, contracted services (cloud storage), application licensing, and other tangential costs. The cost of the system should be weighed against the ability of the system to satisfy the needs of the agency.

The cost of an LPR system is influenced by many different factors. One such factor is the type of system—mobile, portable, or fixed. The three types of LPR systems consist of similar hardware but in different configurations. Agencies should research which type of system, or combination thereof, best fulfills their needs. A fixed LPR system typically requires less maintenance than a mobile system. A series of fixed LPRs at strategic locations offers excellent static LPR coverage but lacks the advantage of portability. A mobile LPR system not only requires the initial installation but also removal and reinstallation when patrol cars cycle out and into the fleet. Additionally, some mobile systems require additional hardware housed in the patrol car, such as an additional computer. Portable systems may be disguised to serve as a covert investigative tool. Portable LPRs are easily moved from one location to the next with minimal effort, allowing agencies to adjust to their needs, but do require more employee involvement. Portable LPR systems also require secure storage facilities when not in use.

Another factor that influences the cost is the technical abilities of the system. Image quality, analytical tools, data capacity, speed rating, and record retention ability vary between vendors and their products. Image quality plays a large role in the accuracy of the license plate reads. Closely related to the image quality, some vendors can manage the parameters of license plate reads as they are queried against hot lists. This, along with other read settings and filtering options, should be considered when looking at the cost of the system and agency needs, including:

- **Vehicle speed** – What is the designed capture speed of the LPR device?
  - A highway patrol agency may desire LPRs capable of higher speeds versus a city municipality with lower speed limits.
- **Traffic capacity** – What is the designed capacity of the LPR device?
  - Coordinate with the highway department to obtain traffic counts. Is the LPR designed to maintain operations consistent with the traffic count? Will a high traffic count at high-speed interrupt the device?

- **Weather rating** – What is the designed weather rating of the device?
  - Many LPRs are solar powered. Will the device operate continuously for several days and nights with limited or no sunlight?
  - Will the LPR maintain operations in extreme cold weather?
- **Portable LPRs** – If the agency chooses portable LPRs, are there fleet vehicles capable of transporting portable LPR units?
- **Mobile LPRs** – If the agency chooses mobile LPRs, can the vehicle support the equipment?
  - Many mobile LPRs have additional hardware that needs to be installed in the patrol vehicles. This commonly involves sharing trunk space with additional police equipment (e.g., radio, emergency lights, siren).

Analytical tools, to include search functions, will vary depending on the vendor. Some have a robust analytical tool set, which can greatly enhance investigations. Other vendors may have a more minimalistic approach to analytical tool availability. Additional analytical tools, such as advanced search features, may be available from various vendors for an additional cost.

When considering the purchase of integrated LPR equipment, agencies should weigh the value of an integrated system against the possibility of a reduced number of LPR reads.

Retention of records is important for compliance with public record laws and for investigative purposes. Vendors have the ability to store records for various time frames. Additionally, agencies may consider the cost and labor of housing their own records versus paying a vendor to provide that service. Regardless of the type of retention method selected, it must be compliant with Federal Bureau of Investigation Criminal Justice Information System requirements.

When considering the cost of an LPR system, agencies should also weigh the costs and benefits of a vendor-contracted system versus an agency-owned system. A vendor contracted system will come with the convenience of maintenance, but at a cost. A vendor contract system may also provide vendor hosted record retention. An agency owned system may appear to be less of a financial burden, but personnel are required to maintain, test, and repair the system.

While considering the costs of the LPR system, the agency also needs to determine the funding source. Potential sources include existing budgetary funds, grants, and legislative or other governmental body requests. Agency leadership should be familiar with the various funding sources available, as well as the procurement laws relevant to their jurisdiction. The availability of an adequate funding source will often dictate the type and size of the LPR system obtained by an agency. The funding source, cost, and needs of the agency should align.

The ability to share LPR reads across agencies is a common feature for LPR technology. At the time of this writing, many vendors are exploring the possibility of cross-vendor compatibility, but it is still not commonplace. However, regional compatibility or mission-oriented compatibility is another option to explore when purchasing LPR systems. A coordinated effort of fixed site installation can help with reducing the duplication of efforts. The ability to share LPR reads with neighboring jurisdictions may be seen as beneficial to your agency and something that should be considered.

LPR integration with other systems is commonplace and is expanding to incorporate more types of technologies. LPR integration can occur with patrol car dash cameras, photo speed enforcement cameras, and even traditional surveillance cameras.

Although integration is an excellent display of technological advancements, agencies must conduct thorough research for legal compliance. As an example, in the Commonwealth of Virgina (46.2-882.1 section I), photos generated from photo speed enforcement technology "shall be limited exclusively to that information that is necessary for the enforcement of vehicle speed violations."

Prior to the acquisition of an LPR system, an agency should consider many factors, some of which were discussed earlier. The agency should be willing to devote the time and personnel to conduct the research to make an educated decision. The research should include conversations with various vendors, other agency representatives, and internal stakeholders to include the agency legal representative. Vendor demonstrations or pilot projects should also be conducted.

Whichever type of system an agency adopts, the agency should have a dedicated LPR program manager who understands the requirements to manage the program.

Chapter 8 Ethical Use of Artificial Intelligence in License Plate Reader Operations

Ethical Considerations for AI in Law Enforcement LPR Operations

What follows are categories to consider when developing policies and practices to ensure ethical use of artificial intelligence (AI) in Licence Plate Reader (LPR) operations.

Human oversight – AI is a tool used to assist decision making, not to make decisions for the user.

Accountability and transparency – Policies define roles and responsibilities for LPR system users and are made available to stakeholders and the interested public.

Training – Initial and ongoing training should be conducted for LPR system users to effectively and ethically use AI.

Regular audits and compliance checks – LPR records regularly evaluated for compliance and to identify needed improvement.

Note: The remainder of this chapter was written from an AI-generated "outline."

Understanding AI and Machine Learning in LPR Systems

LPR systems increasingly incorporate AI and machine learning to enhance their core functions while maintaining essential operational boundaries. For law enforcement leadership implementing these systems, understanding how AI contributes to LPR operations is important for ethical deployment and effective oversight.

For LPR systems, AI refers to computer systems that help optimize plate reading accuracy and reduce errors. The AI components work within strictly defined parameters to enhance image processing, character recognition, and alert reliability. These capabilities serve as a support layer for the core LPR functions, helping officers work more efficiently but with the officer maintaining full control over enforcement decisions.

Machine learning, a specific type of AI used in LPR, enables gradual improvement in reading accuracy through verified results. When the system encounters variations in plate designs, lighting conditions, or character recognition challenges, it refines its performance based on confirmed readings. This learning process occurs within carefully controlled bounds and always requires human verification of results.

- AI in LPR systems focuses on improving read accuracy and reducing false positives.
- AI technology serves to enhance (but never replace) officer judgment and experience.

AI technology serves to enhance (but never replace) officer judgment and experience.

What AI Does and Does Not Provide

AI components improve core system reliability by helping compensate for challenging conditions, providing confidence ratings for potential matches, and reducing false positives that would require manual review. This enhanced accuracy helps officers focus their attention on verified alerts while maintaining their essential role in enforcement decisions.

These systems operate within clear functional boundaries. **They DO NOT make independent enforcement decisions.** The AI components specifically support the basic LPR functions. Agency leadership must ensure all personnel understand that although AI improves system accuracy, it does not change the fundamental nature of LPR systems as decision support tools.

Success in ethical implementation requires direction from agency leadership and establishing agency policy emphasizing maintaining human oversight of all enforcement decisions.

By understanding both the specific capabilities and limitations of AI in LPR systems, agencies can leverage these advances appropriately while maintaining operational integrity. This balanced approach helps achieve public safety objectives while ensuring AI enhances, rather than complicates, law enforcement operations.

LPR Technology: Core Functions and Boundaries

Core Functions and AI Support

Modern LPR systems perform several essential functions that benefit from AI support while maintaining clear operational boundaries. Understanding how AI enhances these core capabilities helps agency leadership implement these systems ethically and effectively.

The foundation begins with image capture, and AI helps optimize camera performance across varying conditions. Advanced cameras, designed specifically for license plate photography, adjust automatically to different lighting conditions, vehicle speeds, and weather situations. AI enhancement helps select optimal images for processing by compensating for environmental variables, though the system still operates best within designed parameters.

The character recognition process represents the primary area where AI provides measurable benefits. The system converts captured images into searchable text through Optical Character Recognition (OCR), with AI helping handle variations in plate designs and challenging conditions. Although modern systems achieve high accuracy rates, they don't reach 100% accuracy even in optimal conditions, reinforcing the continued importance of human verification for enforcement actions.

Database matching completes the core functionality, comparing processed reads against connected databases to generate hits or alerts. AI assists this process by helping filter potential false positives and providing confidence ratings for matches. **These capabilities enhance operational efficiency while preserving officer discretion in enforcement decisions.**

Performance Optimization

AI integration improves LPR performance while maintaining appropriate operational scope. Understanding these enhancements helps agencies optimize system deployment while ensuring ethical use.

Read accuracy represents the primary benefit, with AI helping systems handle complex plate designs and challenging environmental conditions. This improvement occurs through carefully controlled learning processes, with regular validation ensuring proper operation. The system provides confidence ratings for potential matches, helping officers prioritize their attention while maintaining full discretion over enforcement decisions. AI helps maintain and promote public trust by improving read accuracy and limiting the number of false positives. No LPR system is 100% accurate, and officer validation and judgment are always required for every single hit or alert.

The relationship between system capabilities and operational requirements deserves careful consideration. Although AI enhances core LPR functions, success depends on clear protocols

for ethical use. Agency leadership must establish guidelines that leverage improved accuracy while maintaining appropriate human oversight of enforcement decisions.

These capabilities provide law enforcement agencies with valuable tools for enhancing public safety operations. Success depends on leadership's commitment to ethical implementation through proper training, clear protocols, and regular system validation. By maintaining this balance of capability and control, agencies can maximize the benefits of AI-enhanced accuracy while ensuring appropriate use and maintaining public trust.

No LPR system is 100% accurate, and officer validation and judgment are always required for every hit or alert.

AI's Role in LPR Decision Support

Decision Framework

The ethical implementation of AI in LPR systems depends on a clear understanding of decision-making responsibilities. Agency leadership must establish frameworks that leverage technological benefits while preserving officer judgment.

When the LPR system generates a hit or alert, it initiates a structured sequence that combines technological assistance with human expertise. The AI components contribute by providing confidence ratings and relevant details about potential matches, but this information serves only as a starting point. Officers must verify plate readings, confirm database matches, and assess the current situation before determining an appropriate response. This process ensures that all enforcement decisions stem from officer judgment.

Operational Integration

Translating decision frameworks into daily operations requires careful attention to workflow design and implementation. Success depends on clear protocols that officers can apply while maintaining appropriate discretion. Agency leadership plays an important role in establishing guidelines that balance system benefits while ensuring ethical use. Protecting both public safety and privacy can be accomplished simultaneously. The improved accuracy provided by AI-enhanced LPR systems provides better initial information. Officer judgment remains paramount in all enforcement decisions.

Documentation is particularly important with AI-enhanced systems. Clear documentation of each alert, verification steps, and officer decision helps demonstrate proper usage while supporting continuous improvement. Agency leadership should establish straightforward procedures that maintain accountability while supporting efficient operations.

By maintaining clear focus on AI's role in decision support, agencies can maximize the benefits of enhanced accuracy while ensuring appropriate oversight of all enforcement actions. This balanced approach helps achieve public safety objectives while maintaining community trust.

Appendix A Significant License Plate Reader Court Cases and Applicable Federal Statutes

NOTE: This Appendix was developed using artificial intelligence with only some human intervention (editing).

Foundational Cases Related to LPR Operations

UNITED STATES SUPREME COURT

United States v. Knotts

- **Citation:** 460 U.S. 276 (1983)
- **Link:** https://supreme.justia.com/cases/federal/us/460/276/
- **Key Facts:** Law enforcement placed a radio transmitter (beeper) inside a container of chemicals sold to a suspected drug manufacturer. They used signals from the beeper to track the container's movement via car on public roads to Knotts' property.
- **Court's Ruling:** The U.S. Supreme Court held that monitoring the location of a car on public streets using the beeper was not a "search" under the Fourth Amendment. A person traveling on public thoroughfares has no reasonable expectation of privacy in their movements from one place to another.
- **Significance for LPR Operations:**
  - Provides foundational Supreme Court precedent often cited to support the argument that observing vehicles (and thus license plates) on public roads does not invade a reasonable expectation of privacy
  - Underpins the legality of tracking movements visible to the public, a principle applied to LPR scans

Kansas v. Glover **(New to Edition 2)**

- **Citation:** 140 S.Ct. 1183 (2020)
- **Link:** https://supreme.justia.com/cases/federal/us/589/18-556/ or https://www.supremecourt.gov/opinions/19pdf/18-556_e1pf.pdf
- **Key Facts:** A deputy sheriff ran a license plate check on a pickup truck, discovering the registered owner's driver's license was revoked. Without observing any traffic violation or confirming the driver's identity, the deputy initiated a traffic stop based on the assumption the owner was driving.
- **Court's Ruling:** The U.S. Supreme Court held that it is reasonable under the Fourth Amendment for an officer to suspect the registered owner of a vehicle is the one driving it when the owner's license is revoked and there is no information negating that inference. This provides sufficient reasonable suspicion for an investigatory stop.
- **Significance for LPR Operations:**
  - Supports traffic stops based on database information (e.g., LPR alerts) indicating the registered owner has a revoked or suspended license, absent contrary evidence
  - Validates the use of automated checks against registration or DMV databases as a basis for reasonable suspicion
  - Reinforces using LPR alerts for owner status violations to initiate enforcement action

New York v. Class (New to Edition 2)

- **Citation:** 475 U.S. 106 (1986)
- **Link:** https://supreme.justia.com/cases/federal/us/475/106/
- **Key Facts:** After lawfully stopping a driver for traffic violations, a police officer opened the car door and reached inside to move papers obscuring the Vehicle Identification Number (VIN) located on the dashboard. While doing so, the officer observed a gun under the driver's seat.
- **Court's Ruling:** The U.S. Supreme Court held that because of the important role of VINs in governmental regulation of vehicles, there is no reasonable expectation of privacy in VINs themselves. The Court found the officer's limited action of reaching into the vehicle specifically to view the VIN (which is required by law to be visible) was not an unreasonable search under the Fourth Amendment. The discovery of the gun during this permissible action was lawful.
- **Significance for LPR Operations:**
  - Establishes Supreme Court precedent that key vehicle identifiers required by law and visible (or meant to be visible) from outside the car carry a significantly reduced expectation of privacy
  - Supports the fundamental principle, often applied by analogy to license plates (which are also legally required and publicly displayed for identification), that there is no reasonable expectation of privacy in such identifiers
  - Underpins the argument that the act of observing or electronically reading a license plate, which is even more exposed than a dashboard VIN, does not constitute a Fourth Amendment search

FEDERAL CIRCUIT COURTS OF APPEALS

United States v. Curtis Ellison

- **Citation:** 462 F.3d 557 (6th Cir. 2006)
- **Link:** https://caselaw.findlaw.com/us-6th-circuit/1031532.html
- **Key Facts:** A police officer ran the license plate of a parked vehicle through a telecommunication system. The system indicated the registered owner was a "wanted person." Ellison, a passenger, was identified and arrested. Ellison challenged the initial plate check.
- **Court's Ruling:** The Sixth Circuit Court of Appeals determined that observing a license plate displayed in plain view does not constitute a search. What a person knowingly exposes to the public is not subject to Fourth Amendment protection.
- **Significance for LPR Operations:**
  - Reiterates that visually observing or electronically scanning a publicly displayed license plate is not a search
  - Supports checks on plates of parked vehicles as well as moving vehicles

United States v. Ismael Diaz-Castaneda

- **Citation:** 494 F.3d 1146 (9th Cir. 2007)
- **Link:** https://caselaw.findlaw.com/court/us-9th-circuit/1468527.html
- **Key Facts:** An officer ran a license plate check on a pickup truck. The check indicated the registered owner's driver's license was suspended. Believing the driver fit the owner's description, the officer stopped the vehicle. The passenger, Diaz-Castaneda, was found to have an immigration detainer. Diaz-Castaneda argued the initial plate check violated the Fourth Amendment.

- **Court's Ruling:** The Ninth Circuit Court of Appeals held that a license plate check itself (running the plate through databases) does not constitute a Fourth Amendment search.
- **Significance for LPR Operations:**
  - Directly supports the legality of officers running license plate checks, whether manually or via automated LPR systems, without needing prior suspicion
  - Affirms that the act of checking a plate against databases is not constitutionally restricted

United States v. Larry Lamar Wilcox

- **Citation:** 415 F. App'x 990 (11th Cir. 2011) *(Note: Unpublished opinion)*
- **Link:** https://law.justia.com/cases/federal/appellate-courts/ca11/10-13031/201013031-2011-02-28.html
- **Key Facts:** Larry Wilcox argued that the use of LPR technology by an Atlanta police officer amounted to unconstitutional surveillance violating his reasonable expectation of privacy and his Fourth Amendment right against unreasonable search.
- **Court's Ruling:** The Eleventh Circuit Court of Appeals, citing Supreme Court precedent, ruled that visual surveillance of vehicles in plain view does not constitute an unreasonable search. Therefore, Wilcox did not have a reasonable expectation of privacy in his publicly visible license plate, and the officer's use of LPR did not violate the Fourth Amendment.
- **Significance for LPR Operations:**
  - Affirms that scanning publicly visible license plates with LPR technology is generally not considered a search under the Fourth Amendment
  - Supports the routine use of LPR by patrol officers without needing separate justification for the scan itself

United States v. Marcus White

- **Citation:** 504 F. App'x 168 (3d Cir. 2012) *(Note: Unpublished opinion)*
- **Link:** https://law.justia.com/cases/federal/appellate-courts/ca3/11-4035/11-4035-2015-04-29.html
- **Key Facts:** Marcus White was convicted of robberies. His vehicle, previously reported stolen, was detected by a Maryland state trooper's LPR system. During a suppression hearing, the validity of the LPR technology was noted.
- **Court's Ruling:** The Third Circuit Court of Appeals noted that the District Court had found "the technology used by the license [plate] reader is verifiable and acceptable technology," a conclusion White did not challenge on appeal.
- **Significance for LPR Operations:**
  - Although not a direct ruling on LPR validity by the appellate court, it documents a lower court finding that LPR technology is considered reliable and acceptable.
  - Suggests a level of judicial acceptance of LPR technology's basic functionality

Denise Green v. City and County of San Francisco

- **Citation:** 751 F.3d 1039 (9th Cir. 2014)
- **Link:** https://caselaw.findlaw.com/us-9th-circuit/1666208.html
- **Key Facts:** An LPR operated by a San Francisco police officer incorrectly alerted that the license plate on Denise Green's vehicle belonged to a stolen vehicle (a misread). Based on this alert, officers conducted a high-risk felony stop, detaining Green at gunpoint. Officers later ran the correct plate and determined the vehicle was not stolen.

- **Court's Ruling:** The Ninth Circuit Court of Appeals ruled that an *unconfirmed* LPR "hit" does not automatically provide reasonable suspicion to justify an investigatory detention. SFPD policy required officers to verify LPR hits before stopping a vehicle, which was not done here.
- **Significance for LPR Operations:**
  - Establishes that an LPR alert alone may be insufficient for reasonable suspicion; verification is critical
  - Highlights the importance of agency policies requiring confirmation of LPR hits before taking enforcement action, especially for high-risk stops
  - Underscores the potential liability and constitutional issues arising from actions based on inaccurate LPR reads

United States v. Jay Yang

- **Citation:** 958 F.3d 851 (9th Cir. 2020)
- **Link:** https://law.justia.com/cases/federal/appellate-courts/ca9/18-10341/18-10341-2020-05-04.html
- **Key Facts:** Jay Yang was observed driving a rented vehicle past its contract due date during mail theft surveillance. His license plate was observed and searched in an LPR database, aiding investigators in locating his home. Yang argued that the LPR data were invalid because the rental contract had expired.
- **Court's Ruling:** The Ninth Circuit Court of Appeals ruled that there is no expectation of privacy in a license plate, regardless of rental contract status. The court found the LPR database did not reveal all of the defendant's movements and therefore did not infringe upon a reasonable expectation of privacy.
- **Significance for LPR Operations:**
  - Reinforces the principle that license plates displayed publicly do not carry a reasonable expectation of privacy
  - Supports the use of LPR databases to locate vehicles, even if associated contracts (like rentals) have expired
  - Indicates that LPR data use is permissible when it doesn't constitute comprehensive tracking of all movements

STATE AND OTHER FEDERAL COURTS

(Includes State Supreme/Appellate/Superior Courts and Federal District Courts)

People of the State of New York v. Luis Davila, Jr.

- **Citation:** 27 Misc.3d 921, 901 N.Y.S.2d 787 (N.Y. Sup. Ct. 2010), *aff'd*, 137 A.D.3d 655, 26 N.Y.S.3d 862 (N.Y. App. Div. 2016)
- **Link:** https://law.justia.com/cases/new-york/other-courts/2010/2010-20111.html (Trial Court)
- **Key Facts:** A New York Police Department LPR alerted officers to a vehicle with a suspended registration. The vehicle was stopped, and an occupant was found possessing a firearm. Davila argued the stop was unlawful because the officer didn't follow department policy by first verifying the LPR data against the department database or ensuring the data had been updated within 24 hours.
- **Court's Ruling:** The New York Supreme Court (trial court, affirmed on appeal) ruled that the department policies were guidelines and not legally required preconditions for a valid stop based on the LPR alert. The use of LPR to detect the suspended registration was lawful, providing reasonable suspicion for the stop.

- **Significance for LPR Operations:**
  - Indicates that failure to strictly follow internal agency guidelines regarding LPR data verification might not automatically invalidate a stop if the LPR alert itself provided sufficient reasonable suspicion
  - Supports the legality of stops based directly on LPR alerts for registration violations

Hernandez-Lopez v. The State of Georgia

- **Citation:** 319 Ga. App. 662, 738 S.E.2d 116 (Ga. Ct. App. 2013)
- **Link:** https://caselaw.findlaw.com/ga-court-of-appeals/1622591.html
- **Key Facts:** An LPR alerted an officer that the license plate on a vehicle belonged to a "wanted person" (an adult male). The officer noted the driver was an adult male, matching the warrant information, and initiated a traffic stop. The driver turned out to be Salomon Hernandez-Lopez, who was arrested for driving without a license. He argued the stop lacked reasonable suspicion.
- **Court's Ruling:** The Georgia Court of Appeals held that the LPR information indicating the license plate belonged to a wanted person provided the officer with reasonable suspicion to justify the investigatory stop, similar to if the officer had manually run the plate.
- **Significance for LPR Operations:**
  - Supports the use of LPR hits indicating a "wanted person" associated with the plate as providing reasonable suspicion for a stop
  - Treats verified LPR alert information similarly to information obtained through traditional police database checks

Commonwealth of Massachusetts v. McCarthy

- **Citation:** 484 Mass. 493, 142 N.E.3d 1090 (Mass. 2020)
- **Link:** https://law.justia.com/cases/massachusetts/supreme-court/2020/sjc-12750.html
- **Key Facts:** Law enforcement used LPRs deployed on bridges to track Jason McCarthy's movements over several weeks as part of a drug investigation, receiving real-time alerts when his vehicle crossed. McCarthy argued this violated his constitutional right to privacy regarding his public movements.
- **Court's Ruling:** The Massachusetts Supreme Judicial Court held that the *specific, limited* use of LPRs in this investigation (targeted suspect, fixed locations over weeks) did not violate the defendant's privacy rights under the state constitution. However, the court explicitly warned that more pervasive or long-term LPR surveillance creating a detailed record of anyone's movements *could* constitute a search requiring a warrant.
- **Significance for LPR Operations:**
  - Supports the use of LPRs for targeted investigations over limited periods
  - Crucially, it signals judicial concern about the potential for widespread, long-term LPR surveillance to infringe on privacy rights, setting a potential threshold
  - Advises consideration of the scope and duration of LPR use regarding privacy implications

Harrison Neal v. Fairfax County Police Department, et al.

- **Citation:** 299 Va. 253, 849 S.E.2d 123 (Va. 2020)
- **Link:** https://law.justia.com/cases/virginia/supreme-court/2020/191127.html
- **Key Facts:** Harrison Neal challenged the Fairfax County Police Department's passive collection and storage of LPR data under the Virginia Data Act, arguing it was unlawful gathering of personal information. An earlier ruling had found the LPR data was subject to the Act.
- **Court's Ruling:** The Supreme Court of Virginia reversed the earlier ruling, holding that the LPR system did *not* qualify as restricted "information system" under the Virginia Data Act because it primarily collected plate or vehicle photos, date and time, and Global Positioning System (GPS) location, not name or personal identifying details directly linked to a subject within the LPR system itself. Therefore, the passive collection was legal under that specific state statute.
- **Significance for LPR Operations:**
  - Provides an example of how LPR data collection may be viewed under specific state data privacy laws (distinct from the Fourth Amendment)
  - Illustrates that LPR data (plate number, location, time) might not be considered "personal information" under certain statutory definitions if not immediately linked to an identified individual within the LPR system

Related Federal Statutes

28CFR PART 23 CRIMINAL INTELLIGENCE SYSTEMS OPERATING POLICIES

28 CFR Part 23 contains policy standards for law enforcement agencies operating federally funded multijurisdictional criminal intelligence systems. The standards specifically provide guidance for the submission, entry, security, inquiry, dissemination, review, and purge of criminal intelligence information.

2 CFR § 200.79 PERSONALLY IDENTIFIABLE INFORMATION (PII)

LPR information is NOT PII. PII is information considered capable of identifying an individual either by itself or with other identifying information. LPR systems contain information consisting of vehicle license plates, vehicle photos, dates, times, and GPS locations—information generally not considered PII. Therefore, LPR information may not be restricted by statutes concerning maintaining PII but can become PII if additional information is included that is defined as PII. Case-by-case assessment is recommended when developing LPR system data maintenance and use.

DRIVER'S PRIVACY PROTECTION ACT (DPPA) OF 1994, 18 U.S.C. 2721

The Driver's Privacy Protection Act (DPPA), 18 U.S.C.A. §§ 2721-25, also supports the premise that a license plate number alone is not PII. Enacted in 1994, the DPPA is a federal law that regulates how state motor vehicle departments release information contained in their records. DPPA addresses the prohibition on release and use of certain personal information from state motor vehicle records. Collected LPR information contains no PII that may be used to connect a license plate detection to an individual. It is only with permissible purpose that law enforcement may make this connection (using motor vehicle records).

Appendix B Additional License Plate Reader Resources

American Association of Motor Vehicles (AAMVA)

AAMVA License Plate Standard

- License Plate Standard, Edition 3 (2023)

AAMVA – AAMVA Policy Positions

- Alternative License Plates Policy Statement (Adopted 2020)
- License Plates Policy Statement (Amended 2020)
- License Plates Should Not Be Obscured Policy Statement (Amended 2024)
- Temporary License Plates Policy Statement (Amended 2020)

International Association of Chiefs of Police (IACP)

You must be an IACP member with log-in credentials to access these resources:

https://www.theiacp.org/resources/policy-center-resource/license-plate-readers

- IACP License Plate Reader Model Policy (2025)[6]
- IACP License Plate Reader Concepts and Issues Paper (2025)[7]

These IACP resources are publicly accessible:

https://www.theiacp.org/projects/automated-license-plate-recognition

- IACP License Plate Reader Privacy Impact Assessment (2009)
- IACP License Plate Reader Policy & Operational Guidance (2012)
- IACP Resolution: Retro-Reflective Front and Rear Plates (2023)
- IACP Resolution: Digital License Plates (2025)
- IACP Technology Policy Framework (2014)

RAND Corporation

https://www.rand.org/pubs/research_reports/RR467.html

- License Plate Readers for Law Enforcement – Opportunities and Obstacles (2014)

6 The IACP License Plate Reader Model Policy was revised with input from the AAMVA LPR Working Group.

7 The IACP License Plate Reader Concepts and Issues Paper was revised with input from the AAMVA LPR Working Group.

Appendix C Sample License Plate Reader Policies

Introduction

The core business values that License Plate Reader (LPR) promises can only be achieved through proper planning, implementation, training, deployment, use, and management of the technology and the information it provides. Like all tools and technologies available to law enforcement, LPR must also be carefully managed. Agencies must clearly articulate their strategic goals and tactical objectives for the technology, and this strategy should be tightly aligned with the broader strategic plans of the agency. Thorough and ongoing training is required to ensure that the technology performs effectively and that users are well versed in the operational policies and procedures defined and enforced by the agency.

Policies must be developed and strictly enforced to ensure the quality of the data, the security of the system, compliance with applicable laws and regulations, and the privacy of information gathered. Building robust auditing requirements into agency policies will help enforce proper use of the system and reassure the public that their privacy interests are recognized and respected.

Two agency sample policies follow:

- Ohio State Highway Patrol
- Virginia State Police

OHIO STATE HIGHWAY PATROL POLICY

Summary of Revisions

Complete revision of the policy.

Purpose

To provide guidelines for the implementation, installation, and use of mobile and stationary Automatic License Plate Reader (ALPR) technology, databases, and equipment at selected locations to scan, detect, and identify license plate numbers appears on selected "Hot Lists."

Policy

A. **STATEMENT OF POLICY –** The Ohio State Highway Patrol will utilize ALPR technology to accurately identify license plates linked to criminal activity and/or commercial motor vehicle administrative violations. Use of these systems and the data are for official use only in the prevention and investigation of criminal activity. The privacy and civil rights of individuals and the general public is of the utmost importance and shall not be violated through the implementation or use of these systems.

1. **Sharing of Division Data** - The Superintendent may enter into an agreement to provide or receive ALPR data (including hits, non-hits, and other information contained in ALPR databases) with law enforcement agencies for the purposes of investigating criminal activity. All requests to access, share, download, or disseminate Division ALPR data shall be approved by DPS Legal and the Superintendent.

2. **Receipt or Access to Non-Division Data** – Division personnel are prohibited from accessing non-Division owned ALPR systems without the written permission and agreement of the system owner and approval from their Section Commander. Supervisors shall ensure that all access to non-Division owned ALPR systems shall be removed upon separation from the Division.

3. **Deployment of ALPR Equipment** – Deployment of ALPR equipment on Division property or in Division vehicles, either purchased by the Division or in partnership with federal, state, or local partners, shall be approved by the Office of the Superintendent and DPS Legal. No Division employee may purchase, install, or utilize ALPR equipment without the approval of the Superintendent and DPS Legal.

B. **LIMITATIONS OF USE** – All Division employees shall comply with all applicable laws, policies, contracts, and Memorandums of Understanding relating to the use of ALPRs and the applicable data systems.

1. ALPR systems shall only be used by Division-approved authorized users. Commanders shall ensure that employees are removed from both Division-owned and non-Division owned ALPR systems upon separation from employment.

2. ALPR systems may not be used to monitor members of the public regarding the exercise of their First Amendment rights, to harass or intimidate an individual or group of people, or to target a specific protected class (see OSP-203.46).

3. ALPR systems may only be accessed by authorized users for lawful official use when (1) there is an investigative need or reasonable articulable suspicion that a person or vehicle associated with a particular license plate is involved in criminal activity, (2) a missing person situation, (3) there is a need to conduct an investigative request in furtherance of a lawful purpose associated with a traffic stop, or (4) in exigent or emergency situations when there is a threat to life (e.g., medical emergencies, suicidal individuals, etc.).

Virginia Department of State Police

General Order OPR 1.20 **License Plate Reader Operating Procedures**

Purpose: To establish uniform guidelines for License Plate Reader operations by Department personnel.

1. The License Plate Reader (LPR) Program is intended to enhance law enforcement operations related to homeland security and terrorist watch lists, stolen vehicles and license plates, sex offender violators, wanted and missing persons, and other vehicle-related crimes that impact the safety of citizens.

2. The Director of the Bureau of Field Operations (BFO) shall appoint a Statewide LPR Program Coordinator who shall be responsible for the management of the LPR Program.

Guidelines for Use

3. The Department's LPR system shall be used for official law enforcement purposes only. No employee may use, or authorize the use of, the equipment or database records for any other reason. Misuse of equipment or database records may result in disciplinary action.

   a. As used in this General Order, "law-enforcement purposes" means; (i) an active criminal investigation; (ii) an effort to prevent a targeted act of violence; (iii) the enforcement of motor carrier laws and regulations; (iv) an attempt to locate missing, endangered, or wanted persons by law enforcement through the identification of a motor vehicle; (v) internal administrative investigations; (vi) administrative program management tasks (audits); or (vii) use as evidence in court.

   b. The term "law-enforcement purposes" shall not include the enforcement of speed limits, traffic regulations, tolling requirements, or high-occupancy vehicle requirements.

4. Troopers operating LPR-equipped vehicles shall have the LPR software turned on and operating when on duty and be aware of potential hot file alarms.

   a. Sworn employees out of their assigned area while traveling to special assignments, training, or other approved travel with an LPR-equipped

patrol vehicle should request assistance from local troopers for any LPR alerts. The local trooper should normally be assigned as the primary unit on any resulting law enforcement action taken whenever it is practical to do so.

b. Bureau of Criminal Investigation (BCI) special agents operating covert LPR-equipped vehicles shall request either a local trooper or local law enforcement officer to be the primary unit on any resulting law enforcement action.

5. Upon receiving an alarm or hit, the sworn employee shall verify the accuracy of the information by contacting the Communications Center per established Department policy.

a. An LPR alarm alone is NOT sufficient probable cause to warrant a stop or arrest.

b. Sworn employees are required to confirm a positive hit prior to any enforcement action being taken.

c. Sworn employees are required to document LPR events in CAD using the appropriate call type and appropriate disposition code.

6. Sworn employees are required to ensure that all positive hits on the Terrorist Watch List are reported to the Terrorist Screening Center (TSC) and Virginia Fusion Center (VFC) immediately. All Terrorist Watch List hits will be handled by MDT or telephone. There will be no radio traffic concerning terrorist hits except in the case of emergencies.

7. The LPR user who manually enters the license plate information associated with a critical incident shall notify the Virginia Fusion Center electronically at vfc@vfc.vsp.virginia.gov and/or by telephone. The VFC may assist sworn employees with the entry into all VSP LPR systems and/or provide additional resources and information sharing. The VFC will ensure the license plate information is entered into all VSP LPR systems; this includes the fixed site system and the mobile LPR system.

8. In the context of this General Order, critical incidents are defined as law enforcement events which shall be investigated by a law enforcement agency.

a. If exigent circumstances exist related to the critical incident (for example, a shooting with a license plate number of the suspect vehicle from a witness), the employee shall notify the VFC by telephone immediately.

b. Absent exigent circumstances, when any license plate is manually entered into the LPR system's "hot list," a Department-generated CAD number, a LEAMS case file, a VFC VIMS number, or applicable agency records management number shall also be entered. If the entry is on behalf of another law enforcement agency, that agency's name and case number shall be associated with the entry. All manual hotlist entries shall at a minimum contain:

(1) Vehicle description (year, make, model, color)

(2) Reason for entry

(3) Valid 24-hour contact number of entrant

(4) Relevant information for troopers, agents, or outside agency officers who may encounter the vehicle

9. Terrorist organizations have openly voiced their desire to attack venues where large crowds gather, such as major sporting events, large festivals, etc. Because of the potential of just such an incident, stationary, mobile, and covert LPR use is permitted for such events. Prior to utilizing LPRs at these venues, the affected Division Commander shall submit a letter, through channels, to the Superintendent describing the event, potential threat, and parameters under which the LPRs will be utilized. The decision to grant the approval rests with the Superintendent's Office.

10. Trailer-mounted and/or covert LPR units may be used to support on-going criminal investigations or approved venues. The use of fixed and/or covert LPR units shall be coordinated with the Statewide LPR Program Coordinator.

Data Security and Access

11. The Statewide LPR Program Coordinator is responsible for overall operation of the Program, including:

a. controlling access of sworn personnel to the LPR system and hot file data;

b. ensuring stored data are purged from the LPR system server as required;

c. approving or denying, in writing, requests to access and/or use LPR data;

d. designating personnel who will be authorized to access the server and conduct data queries;

e. completing monthly LPR reports consisting of statistical and relevant information directly related to the VSP LPR system(s); and

f. ensuring the outside agency LPR access spreadsheet stored VSP Connect remains current every 90 days.

12. The data collected by LPR readers shall be stored in a secure manner as determined by the LPR Coordinator in consultation with the Department's Information Technology Division.

a. All collected data will be maintained on a server that is not connected to, or shared with, other law enforcement databases.

b. The server will be able to provide an inquiry tool, history tracking, and reporting protocols for the entire LPR Program.

c. The server will provide a secure intranet site or internet site, allowing only approved personnel password-protected access to collected data. This access shall be restricted to:

(1) searching for a license plate or partial license plate;

(2) viewing the image and location of matches on the "hotlist";

(3) viewing maps showing the location of alarms or hits;

(4) viewing statistical reports on alarms or hits;

(5) searching for matches for a specific geographical location and/or time frame; and,

(6) performing administrative functions such as application testing, generating statistical usage reports, and application audits.

d. The internet and intranet site must be compliant with existing VITA security standards.

Operator Training

13. All users must receive standardized training prior to operating the LPR system.

a. All employees who use the LPR system shall attend training annually.

b. LPR training may be accomplished by completing on-line, video-based, or in-person training. The LPR Coordinator shall work with the Training Division to ensure the annual LPR training is current with applicable LPR legislation and relevant for employees.

c. The Training Division will be responsible for maintaining all training records associated with the LPR Program.

Data Storage and Retention

14. The Department's data retention policy shall comply with the Code of Virginia. LPR data may be retained for less than the maximum time allowed.

a. The Department may continue to use the LPRs to compare active reads to existing lists, such as stolen vehicles or Amber Alerts. Only the reads that are directly related to the intended purpose (i.e., stolen plate) may be retained beyond the use session of the LPR. All other non-relevant, passive reads are automatically deleted after 24 hours from the time the read was collected.

b. The Department may collect, store, and analyze data that relates to a specific, on-going, active investigation. That data shall be made part of the criminal investigative file and may not be used for other purposes.

c. The employee who collects, stores, and analyzes data is responsible for that data which they access. The employee shall remain aware of and balance the investigative need for LPR data with individuals' rights to privacy.

d. The Department may collect and temporarily store data that relates to special events as enumerated in paragraphs 8 and 9 of this General Order. This data will only be stored during the event and will be disposed of immediately following the event if it has been determined no applicable criminal investigation has been initiated. If an applicable criminal investigation is initiated, the data will be handled in accordance with paragraph 14.b. of this General Order.

e. Data downloaded from the LPR server (search results and alarm results) shall be attached to the appropriate case file (LEAMS, VIMS, ASPEN, etc.) for retention. Downloaded data no longer serving a purpose as described in paragraph 3.a. of this General Order shall be immediately destroyed.

f. Bulk downloads are prohibited. In the context of this General Order, a bulk download is data downloaded without a scope or duration.

g. Automated downloads are prohibited.

Non – Virginia State Police LPR systems

15. In some areas of the state, employees have been given authorization to use a local jurisdiction's LPR system.

a. Employees who have access to another jurisdiction's LPR system shall report such access to the LPR Program Coordinator by completing the spreadsheet located in VSP Connect.

b. Employees who have access to another jurisdiction's LPR system shall be prohibited from uploading or downloading any files from that system but shall be allowed "read only" privileges.

c. Any data uploads or downloads shall be directed to a representative of the host agency.

DATA SHARING

16. Data collected by the VSP LPR system may only be shared with law enforcement agencies after they have provided a valid case number. The methods for data sharing include:

a. One-to-one request: This method allows a VSP employee to share LPR data with another law enforcement agency for a particular case. The request parameters must be consistent with existing policy and legislation. The VSP employee shall document the sharing of data within the appropriate case file system (VIMS, LEAMS, ASPEN, etc.) by listing the requestor's case file number and agency.

b. MOU Agencies: Data may be directly shared with Virginia law enforcement agencies provided a written agreement (MOU) is on file with the Department.

Appendix D AAMVA License Plate Reader Working Group Roster

CHAIR AND LAW ENFORCEMENT REPRESENTATIVE

Sergeant Jonathan Zarkauskas
Virginia State Police

LAW ENFORCEMENT REPRESENTATIVES

Major Conner Cardwell
Florida Highway Patrol

Lieutenant Steven Johnson
Missouri State Highway Patrol

Maria Valencia
LPR Coordinator and Criminal Intelligence Analyst
Colorado State Patrol

MVA REPRESENTATIVES

Steven Farrell
Director, Vehicle Services
South Carolina DMV

Jennifer Tinsley
Compliance Enforcement Investigator II
Nevada DMV

IACP REPRESENTATIVE

Sergeant Joel Corralejo
California Highway Patrol and IACP Vehicle Crimes Committee Representative

TECHNICAL ADVISORS

Dennis D'Annunzio[1]
Vice President and Engineer
Leonardo US Cyber and Security Solutions, LLC

Erik Granum
Account Executive
Genetec

Kyle Hoertsch
Product Development Manager
Motorola Solutions

Jeremy Slavish
Business Development State LE
Flock Safety

AAMVA STAFF – PROJECT MANAGER

Brian Ursino
Vice President
Law Enforcement Programs and Services
American Association of Motor Vehicle Administrators

AAMVA STAFF

Tom Foster
Law Enforcement Program Manager
American Association of Motor Vehicle Administrators

1 Cyrus Thompson attended November 2024 in-person meeting on behalf of Dennis D'Annunzio.

OUR VISION

Safe drivers
Safe vehicles
Secure identities
Saving lives!

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