U.S. Department
of Transportation

**Federal Aviation
Administration**

Office of the Administrator

800 Independence Ave., S.W.
Washington, D.C. 20591

June 12, 2019

The Honorable Richard Shelby
Chairman, Committee on Appropriations
United States Senate
Washington, DC 20510

Dear Chairman Shelby:

The Federal Aviation Administration (FAA) prepared the enclosed Nighttime Airport Surface Vehicle Conspicuity Report to Congress to respond to the language that was included in Senate Report 114-243 and House of Representatives Report 114-606 of the 2nd Session of 114th Congress of the United States. These reports requested that the FAA study the effectiveness of national standards for marking and lighting airport ground vehicles and equipment that operate in busy nighttime conditions.

The Nighttime Airport Surface Vehicle Conspicuity report is fulfilling the requirement for both the Appropriations requirement as well as the report required by section 313 of Public Law 115-254. The report contains information assessing FAA standards that govern the conspicuity of vehicles operating at airports and makes recommendations to modify related FAA Advisory Circulars. Specifically, the report includes information from:

- A review of current FAA advisory circulars, Air Traffic Organization orders, and the Code of Federal Regulations;
- Interviews with air traffic control personnel;
- Interviews with airport operations personnel; and
- Findings and recommendations.

We have sent identical letters to Chairwoman Lowey, Chairmen Wicker and DeFazio, Senators Leahy and Cantwell, Congresswoman Granger, and Congressman Graves.

Sincerely,

Daniel K. Elwell
Acting Administrator

Enclosure

U.S. Department
of Transportation

**Federal Aviation
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Office of the Administrator

800 Independence Ave., S.W.
Washington, D.C. 20591

June 12, 2019

The Honorable Patrick Leahy
Vice Chairman, Committee on Appropriations
United States Senate
Washington, DC 20510

Dear Vice Chairman Leahy:

The Federal Aviation Administration (FAA) prepared the enclosed Nighttime Airport Surface Vehicle Conspicuity Report to Congress to respond to the language that was included in Senate Report 114-243 and House of Representatives Report 114-606 of the 2nd Session of 114th Congress of the United States. These reports requested that the FAA study the effectiveness of national standards for marking and lighting airport ground vehicles and equipment that operate in busy nighttime conditions.

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We have sent identical letters to Chairwoman Lowey; Chairmen Shelby, Wicker, and DeFazio; Senator Cantwell; Congresswoman Granger; and Congressman Graves.

Sincerely,

DK Elwell

Daniel K. Elwell
Acting Administrator

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800 Independence Ave., S.W.
Washington, D.C. 20591

June 12, 2019

The Honorable Roger Wicker
Chairman, Committee on Commerce,
Science, and Transportation
United States Senate
Washington, DC 20515

Dear Chairman Wicker:

The Federal Aviation Administration (FAA) prepared the enclosed Nighttime Airport Surface Vehicle Conspicuity Report to Congress to respond to the language that was included in Senate Report 114-243 and House of Representatives Report 114-606 of the 2nd Session of 114th Congress of the United States. These reports requested that the FAA study the effectiveness of national standards for marking and lighting airport ground vehicles and equipment that operate in busy nighttime conditions.

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Sincerely,

DKElwell

Daniel K. Elwell
Acting Administrator

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Office of the Administrator

800 Independence Ave., S.W.
Washington, D.C. 20591

June 12, 2019

The Honorable Maria Cantwell
Committee on Commerce,
Science, and Transportation
United States Senate
Washington, DC 20515

Dear Senator Cantwell:

The Federal Aviation Administration (FAA) prepared the enclosed Nighttime Airport Surface Vehicle Conspicuity Report to Congress to respond to the language that was included in Senate Report 114-243 and House of Representatives Report 114-606 of the 2nd Session of 114th Congress of the United States. These reports requested that the FAA study the effectiveness of national standards for marking and lighting airport ground vehicles and equipment that operate in busy nighttime conditions.

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Sincerely,

DKElwell

Daniel K. Elwell
Acting Administrator

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**Federal Aviation
Administration**

Office of the Administrator

800 Independence Ave., S.W.
Washington, D.C. 20591

June 12, 2019

The Honorable Nita Lowey
Chairwoman, Committee on Appropriations
House of Representatives
Washington, DC 20515

Dear Chairwoman Lowey:

The Federal Aviation Administration (FAA) prepared the enclosed Nighttime Airport Surface Vehicle Conspicuity Report to Congress to respond to the language that was included in Senate Report 114-243 and House of Representatives Report 114-606 of the 2nd Session of 114th Congress of the United States. These reports requested that the FAA study the effectiveness of national standards for marking and lighting airport ground vehicles and equipment that operate in busy nighttime conditions.

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Sincerely,

DKElwell

Daniel K. Elwell
Acting Administrator

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**Federal Aviation
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Office of the Administrator

800 Independence Ave., S.W.
Washington, D.C. 20591

June 12, 2019

The Honorable Kay Granger
Ranking Member, Committee on Appropriations
House of Representatives
Washington, DC 20515

Dear Congresswoman Granger:

The Federal Aviation Administration (FAA) prepared the enclosed Nighttime Airport Surface Vehicle Conspicuity Report to Congress to respond to the language that was included in Senate Report 114-243 and House of Representatives Report 114-606 of the 2nd Session of 114th Congress of the United States. These reports requested that the FAA study the effectiveness of national standards for marking and lighting airport ground vehicles and equipment that operate in busy nighttime conditions.

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Sincerely,

DKElwell

Daniel K. Elwell
Acting Administrator

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**Federal Aviation
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Office of the Administrator

800 Independence Ave., S.W.
Washington, D.C. 20591

June 12, 2019

The Honorable Peter A. DeFazio
Chairman, Committee on Transportation
and Infrastructure
House of Representatives
Washington, DC 20515

Dear Chairman DeFazio:

The Federal Aviation Administration (FAA) prepared the enclosed Nighttime Airport Surface Vehicle Conspicuity Report to Congress to respond to the language that was included in Senate Report 114-243 and House of Representatives Report 114-606 of the 2nd Session of 114th Congress of the United States. These reports requested that the FAA study the effectiveness of national standards for marking and lighting airport ground vehicles and equipment that operate in busy nighttime conditions.

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Sincerely,

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800 Independence Ave., S.W.
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June 12, 2019

The Honorable Sam Graves
Committee on Transportation
and Infrastructure
House of Representatives
Washington, DC 20515

Dear Congressman Graves:

The Federal Aviation Administration (FAA) prepared the enclosed Nighttime Airport Surface Vehicle Conspicuity Report to Congress to respond to the language that was included in Senate Report 114-243 and House of Representatives Report 114-606 of the 2nd Session of 114th Congress of the United States. These reports requested that the FAA study the effectiveness of national standards for marking and lighting airport ground vehicles and equipment that operate in busy nighttime conditions.

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Sincerely,

DK Elwell

Daniel K. Elwell
Acting Administrator

Enclosure

Federal Aviation Administration
William J. Hughes Technical Center
Aviation Research Division
Atlantic City International Airport
New Jersey 09405

# Nighttime Airport Surface Vehicle Conspicuity Report to Congress

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# EXECUTIVE SUMMARY

As part of the Federal Aviation Administration Reauthorization Act of 2018 (Pub. L. 115-254) and the Consolidated Appropriations Act, 2017 (Pub. L. 115-31), the House of Representatives Report 114-606 and Senate Report 114-243, Congress noted the lack of national standards for markings on airport vehicles and equipment that operate in busy nighttime conditions. Pub. L. 115-254, House Report 114-606, and Senate Report 114-243 requested the Federal Aviation Administration (FAA) determine if updated standards for the conspicuity of these vehicles are necessary. In response, the FAA's Office of Airport Safety and Standards (AAS) sponsored a study of the effectiveness of current FAA standards for the painting, marking, and lighting of all ground vehicles that operate on the airport air operations area (AOA), air traffic control (ATC) procedures for monitoring and controlling these ground vehicles, and airport operations procedures for meeting FAA standards. This report fulfills the requirement under Section 313 of the Pub. L. 115-254, and House Report 114-606 and Senate Report 114-243.

In this study, the FAA's Airport Safety Research and Development Section (ANG-E261) at the William J. Hughes Technical Center reviewed relevant FAA advisory circulars (AC), Air Traffic Organization (ATO) orders, and the Code of Federal Regulations (CFR). The study also included a survey of ATC and airport operations procedures at 10 airports in the National Airspace System (NAS) regarding the conspicuity of ground vehicles on the AOA.

A review of current standards revealed a detailed set of requirements and guidance for the painting, marking, and lighting of all ground vehicles and equipment that operate within the AOA. These requirements and guidance are tailored to the physical locations where specific types of vehicles are allowed to operate. They are applicable for the entire AOA.

This review also revealed that national standards and recommendations are consistent in their distinction between aircraft movement and nonmovement areas. Movement areas, like runways and taxiways, are under the direct control of ATC. Nonmovement areas, like ramps, gates, and aircraft parking areas, are the responsibility of the airline and airport management.

Surveys with ATC and airport operations management at 10 airports did not identify any conspicuity issues related to the movement of ground vehicles in the movement area during normal operating conditions. Airfield incidents and accidents may result in situations where emergency response vehicles create busy ground vehicle conditions. However, no conspicuity issues related to movement of ground vehicles were reported regarding these incidents. The "busy nighttime conditions" referenced in the reports are more likely to occur on nonmovement areas like ramps, gates, and aircraft parking areas. Vehicles operating in this nonmovement area are typically owned by airlines, vendors, or contractors and are not under the control of ATC.

This report to Congress determined that the FAA has national standards for marking and lighting of vehicles operating within the AOA (i.e., movement area), and those standards are satisfactory. The researchers recommended only minor edits to the advisory circulars that define those standards.

This report does not provide recommendations for the conspicuity of vehicles operating in the nonmovement area, since these areas are typically highly lighted areas with flood lighting and are the responsibility of airport management and airline ramp crews.

# 1. INTRODUCTION

Section 313 of the Federal Aviation Administration Reauthorization Act of 2018 (Pub. L. 115-254) and the Consolidated Appropriations Act, 2017 (Pub. L. 115-31), the House of Representatives Report 114-606 and Senate Report 114-243, included language requesting that the FAA study the effectiveness of national standards for marking and lighting airport ground vehicles and equipment that operate in busy nighttime conditions.

This language from the Appropriations Reports is shown below in its entirety:

> *Tarmac Vehicle Safety—The Committee notes that there is no national standard that requires markings on airport vehicles and equipment that operate in busy night time conditions. The Committee directs the FAA to study one large hub airport, one medium hub airport, and one small hub airport to determine whether national standards for conspicuity of surface vehicles operating at airports are necessary. The FAA is directed to report to the House and Senate Committees on Appropriations its finding and recommendations within one year after enactment of this act.*

The requirement from P.L. 115-254, Section 313, is also shown below:

*(a) Study Required.—The Administrator shall carry out a study on the need for the FAA to prescribe conspicuity standards for surface vehicles operating on the airside of the categories of airports that air carriers serve as specified in subsection (b).*

*(b) Covered Airports.—The study required by subsection (a) shall cover, at a minimum, 1 large hub airport, 1 medium hub airport, and 1 small hub airport, as those terms are defined in section 40102 of title 49, United States Code.*

*(c) Report To Congress.—Not later than July 1, 2019, the Administrator shall submit to the appropriate committees of Congress a report setting forth the results of the study required by subsection (a), including such recommendations as the Administrator considers appropriate regarding the need for the Administration to prescribe conspicuity standards as described in subsection (a).*

AAS responded to this request by sponsoring a study of current FAA standards for the painting, marking, and lighting of all ground vehicles that operate on the airport AOA, and ATC procedures for monitoring and controlling these ground vehicles, and airport operations procedures for meeting FAA standards.

The study included a literature search of relevant FAA standards for painting, marking, and lighting of airport ground vehicles, a fact-finding outreach to 24 airports within the NAS, and onsite in-depth interviews with ATC and airport operations personnel at 10 airports. During these onsite interviews, researchers discussed ATC and airport operations procedures related to the painting, marking, and lighting of ground vehicles and any associated conspicuity issues.

## 1.1 Objectives

The objectives were to assess FAA standards that apply to the conspicuity of vehicles operating at airports and make recommendations to improve these standards, especially as they relate to airport ground vehicles operating on the movement area of the AOA.

## 2. LITERATURE SEARCH

The FAA maintains a series of ACs that provide guidance and recommendations to airport owners and operators related to the use and movement of ground vehicles on the AOA. Foremost among these is AC 150/5210-5D, Painting, Marking, and Lighting of Vehicles Used on an Airport, dated April 1, 2010. (See 7.3 References.) In general, the guidance in this AC is not mandatory, except for vehicles funded with Federal grant monies through Airport Improvement Program (AIP) funds or Passenger Facility Charges (PFC). Order 5190.2, "*List of Public Airports Affected by Agreements with the Federal Government*", dated April 30, 1990, stated that there are 2,967 obligated airports in the US. The number of obligated airports has remained around 3,000 airports. Order 5190.2 is currently being updated. (See 7.3 References.)

The FAA also requires airports to follow regulations found in title 14 Code of Regulations (CFR), Part 139, in order to receive operating certificates. (See 7.4 References.) Finally, ATO issues orders that provide direction and guidance for the day-to-day operations of the ATO.

### 2.1 AC 150/5210-5D Painting, Marking, and Lighting of Vehicles Used on an Airport

AC 150/5210-5D has two specific recommendations, which enhance the recognition of ground vehicle during busy nighttime operations at the airport.

1) Section 4c(5) of the AC: "To further improve night-time recognition of vehicles, a minimum 8 inch (200 mm) wide horizontal band of high gloss white paint or white reflective tape (Retroreflective, ASTM-D 4956-09, *Standard Specification for Retroreflective Sheeting for Traffic Control*, Type III & above) must be used around the vehicle's surface;" and

2) Recommendations of steady and flashing yellow lights to enhance the recognition of ground vehicles in nonmovement and movement areas as defined in section 5.a(1): "The standard for identification lighting is a yellow flashing light that is mounted on the uppermost part of the vehicle structure. A steady yellow light designates vehicles limited to nonmovement areas."

This AC identifies and defines six different types of vehicles, each with different painting, marking, and lighting recommendations. The following definitions are extracted verbatim from the AC:

- Airport Emergency Vehicles - Vehicles that are authorized in the AOA for emergency purposes (e.g., ambulances, aircraft rescue and firefighting (ARFF) vehicles and emergency response vehicles) as authorized by the airport traffic control tower (ATCT) or an authorized onsite accident/incident commander.

- Airport Operations Vehicles - Vehicles routinely used by airport operations personnel for airport inspection and duties associated with airfield operations (such as airfield condition reporting and Incident Command) on the AOA and movement area.

- Airport Security Vehicles - Vehicles that are authorized in the AOA for security purposes, as needed (e.g. police cars, Transportation Security Administration cars, U.S. Customs cars, etc).

- Airfield Service Vehicles - Vehicles that are routinely used in the AOA for airfield service, maintenance, or construction (e.g. snow blowers, snowplows, maintenance trucks, and tractors).

- Aircraft Support Vehicles - Vehicles that are routinely used in the AOA to support aircraft operations (e.g. aircraft pushback tractors, baggage/cargo tractors or trucks, air conditioning and aviation fuel trucks). These vehicles are typically owned by airlines, vendors, or contractors.

- Other Vehicles - Vehicles that are not routinely authorized in the AOA (e.g. construction vehicles). These vehicles are typically owned by airlines, vendors, or contractors. (See 7.3 References.)

- Towbarless Tow Vehicle (TLTV) – a type of aircraft support vehicle whose main purpose is to tow aircraft in the AOA by way of nose gear capture.

The AC also provides a specific painting, marking, and lighting scheme for each type of vehicle. Table 1 is a compilation matrix of these schemes.

Table 1. Painting, Marking, and Lighting Specification Matrix

| Vehicle Type | AC Section 3. Vehicle Painting | AC Section 4. Vehicle Marking | AC Section 4. Vehicle Lighting[1] |
|---|---|---|---|
| Airport Emergency Vehicles Ambulances | Federal Specification KKK-A-1822, Federal Specification for the Star-of-Life Ambulance. | Federal Specification KKK-A-1822 | Should be identified during periods of low visibility by light when not escorted by a properly lighted vehicle. |
| ARFF | Yellowish green is the vehicle color standard. | Marked with the letters "ARFF," "Fire," or "Rescue" Section 4.c.(1)-(5) | Should be identified during periods of low visibility by light when not escorted by a properly lighted vehicle. |
| Airport Operations Vehicle | As designated by airport operations and coordinated with ATCT in the LOA. | As designated by airport operations and coordinated with ATCT in the LOA. | Yellow flashing light on the uppermost part of the vehicle. A steady yellow light for vehicles limited to nonmovement areas. |
| Airport Security Vehicles | Specific state or local requirements. | A readily visible flag if not under escort and in communication with ATCT. | Should be identified during periods of low visibility by light when not escorted by a properly lighted vehicle. |
| Airfield Service Vehicles | Chrome yellow is the vehicle color standard. | ID numbers on side and roof. Name of airport or insignia. Reflective horizontal bands around vehicle surface. | Yellow flashing light on the uppermost part of the vehicle. A steady yellow light for vehicles limited to nonmovement areas. |
| Aircraft Support Vehicles | Any color or combination of colors other than yellowish-green or chrome yellow. | ID numbers on side and roof. Name of airport or insignia. Reflective horizontal bands around vehicle surface. | Yellow flashing light on the uppermost part of the vehicle. A steady yellow light for vehicles limited to nonmovement areas. |
| TLTV | International orange is the vehicle color standard. | ID numbers on side and roof. Name of airport or insignia. Reflective horizontal bands around vehicle surface. | TLTVs may use a light emitting diode (LED) light bar in place of the rotating yellow flashing light. |
| Other Vehicles | Any color or combination of colors other than solid black or white. | Provided with a flag 3-foot by 3-foot square having a checkered pattern of international orange and white squares at least 1 foot on each side. | Should be identified during periods of low visibility by light when not escorted by a properly lighted vehicle. |

[1]Characteristics for all lighting requirements are addressed in paragraph 5c., AC 150/5210-5D, Characteristics of Flashing Lights.

AC 150/5210-5D makes an important distinction between the AOA and the movement area:

- AOA - The portion of airport that encompasses the landing, takeoff, taxiing, and parking areas for aircraft.
- Movement Area - The runways, taxiways, and other areas of an airport/heliport that are used for taxiing/hover taxiing, air taxiing, takeoff, and landing of aircraft, exclusive of loading ramps and parking areas. At those airports/heliports with an operating ATCT, specific approval for entry onto the movement area must be obtained from ATC. (See 7.3 References.)

Because ATC does not control vehicle movement on nonmovement area surfaces like ramps, gates, and parking areas, this study focused on airport operations and airfield service vehicles that operate on the movement area under the control of ATC. These vehicles are highlighted in table 1 above. Similarly, this study focused on normal airport operations and excluded emergency events like accident responses and security actions. These emergency operations are authorized by the ATCT or an authorized onsite accident/incident commander on a case-by-case basis. (See 7.3 References) The emphasis of the study was on the conspicuity of ground vehicles to ATC during nighttime operations.

Most aircraft support vehicles, including TLTVs and other vehicles, do not operate[2] on the movement area. They are typically owned by airlines, vendors, or contractors. Airport security vehicles, like police cars, are used for emergency or security purposes and are not typically federally funded. As a result, the guidance in AC 150/5210-5D is not typically mandatory for these three types of vehicles and their respective recommendations were not included in this study.

Airport emergency vehicles, like ambulances and ARFF vehicles, are authorized in the AOA for emergency purposes, are not part of normal airport operations, and therefore are not included in this study.

## 2.2 PART 139 – Airport Certification Manual

Title 14 CFR Part 139, section 329, Pedestrians and ground vehicles, limits access to the movement area and safety areas to ground vehicles necessary for airport operations. (See 7.5 References.) Section 329 also requires that the Airport Certification Manual (ACM) include procedures for controlling ground vehicles in the movement area and safety area[3] and provide a description of the movement area and safety areas.

Section 139.5 of title 14, CFR, Definitions, includes the following descriptions:

- **Movement area** means the runways, taxiways, and other areas of an airport that are used for taxiing, takeoff, and landing of aircraft, exclusive of loading ramps and aircraft parking areas. (See 7.5 References.)

[2]On occasions where these type vehicles must enter the movement area, they are escorted by vehicles with a rotating beacon and a two-way radio or as indicated in the Letters of Agreement (LOA).
[3]The safety area is not specifically called out in AC 150/5210-5D.

- **Safety area** means a defined area comprised of either a runway or taxiway and the surrounding surfaces that is prepared or suitable for reducing the risk of damage to aircraft in the event of an undershoot, overshoot, or excursion from a runway or the unintentional departure from a taxiway. (See 7.5 References.)

2.3 AC 150/5210-20A, Ground Vehicle Operations to Include Taxiing or Towing an Aircraft on Airports

- AC 150/5210-20A provides guidance to airport operators on training programs for ground vehicle operations, taxiing or towing an aircraft, and pedestrian control on the movement and safety areas of an airport. (See 7.6 References.) The term "vehicle" includes aircraft being taxied under their own power by a nonpilot or being towed with no intention for flight. (See 7.6 References.) The AC states that airport operators are ultimately responsible for establishing procedures and policies for vehicle access and operation on the movement and safety areas of the airport. (See 7.6 References.) These responsibilities are usually incorporated into tenant leases and agreements and construction projects funded through the AIP.

- Section 3.1.3, Vehicle Marking and Lighting, refers to AC 150/5210-5D for the painting, marking, and lighting of vehicles that routinely operate on the movement area and safety areas of the airport. However, this section also includes the following passage:

    - Vehicles that routinely operate on the movement and safety areas will be marked or flagged for high daytime visibility and, if appropriate, lighted for nighttime operations. The term "if appropriate" implies that lighting is optional. AC 150/5210-5D is clear that vehicles that routinely operate on the movement area and safety areas must have yellow rotating beacons.

- AC 150/5210-20A provides specific information about LOAs. An LOA is recommended at each towered airport and should include the airport operator, local ATC, FAA Technical Operations, and any other airport tenant permitted to operate on the runway safety area (RSA)[4]. (See 7.6 References.) Part 139 certificated airports must include this LOA in the ACM.

- Chapter 4 of this AC, Emergency Operations and Other Non-Routine Operations, includes guidance to airport operators for nonroutine operations like emergency responses, airfield construction, airshows, and other special events. Snow/ice removal and low visibility operations are mentioned but without any specific guidance.

- Appendix C of AC 150/5210-20A includes a sample LOA. This is the same LOA referenced in AC 150/5210-5D for the painting and marking of airport operations vehicles, as shown in table 1. However, the sample LOA does not include a placeholder for the painting and marking of these vehicles. Additionally, the sample LOA only calls out the RSA and not the movement area.

[4]Part 139 requires that the LOA address the movement area, as well as the safety area.

## 2.4 Air Traffic Organization Policy Orders

ATO Policy Order JO 7117.65X, Air Traffic Control, Section 3−7−1, Ground Traffic Movement, includes the following language:

> Issue by radio or directional light signals specific instructions which approve or disapprove the movement of aircraft, vehicles, equipment, or personnel on the movement area except where permitted in an LOA. (See 7.7 References.)

The Pilot/Controller Glossary of JO 7117.65X includes the following definition for the movement area, and, is noteworthy that AC 150/5210-5D adopted this exact definition for the movement area.

> The runways, taxiways, and other areas of an airport/heliport which are utilized for taxiing/hover taxiing, air taxiing, takeoff, and landing of aircraft, exclusive of loading ramps and parking areas. At those airports/heliports with a tower, specific approval for entry onto the movement area must be obtained from ATC. (See 7.7 References.)

Section 3−7−2, Taxi and Ground Movement Operations, includes Note 2 that states:

> Movement of aircraft or vehicles on nonmovement areas is the responsibility of the pilot, the aircraft operator, or the airport management. (See 7.7 References.)

ATO Order JO 7210.3AA, Facility Operation and Administration, includes information regarding the preparation and content of LOAs between ATC and airport management. (See 7.8 References) These LOAs typically include descriptions of the movement area and safety areas and may include specific guidance, adopted by a State or local airport, for the painting and marking of airport operations vehicles as indicated in table 1.

## 2.5 Previous FAA Research

In May 2004, the FAA Airport Technology Research and Development Section issued Technical Note DOT/FAA/AR-TN04/9, Development of Airport Active Runway Vehicle Lighting. (See 7.9 References.) This effort studied the concept of equipping airport ground vehicles with supplemental beacons that would illuminate only when the vehicle was on an active runway. The report concluded that the concept was not feasible due to difficulties with color configurations and added workload to both airport operators and ATC facilities.

The report included a summary of lighting configurations from a survey of major airports relevant to this study:

- Yellow (Amber) - Used by virtually all airports on service, maintenance, and construction vehicles.
- Red - Used for fire operation vehicles and rescue vehicles at most airports. Red is also used on aircraft as anti-collision beacons.
- Blue - Used for law enforcement and rescue vehicles at many airports.

- White - Used on aircraft as anti-collision beacons and, at a few airports, on operations vehicles.
- Green - Used increasingly, with local airport authority authorization, for identifying incident command or public information officers at an accident scene.

The report also makes a reference to FAA Report FAA-RD-73-196, Evaluation of Identification Beacons for Airport Emergency Vehicles, dated January 1974. (See 7.10 References.) The focus of this 1974 report is on emergency vehicle lighting.

## 2.6 Literature Review Discussion

AC 150/5210-5D is the governing FAA standard regarding painting, marking, and lighting of airport ground vehicles. During normal airport operations, only two types of vehicles regularly travel on the movement area - airport operations and airfield services vehicles. In general, airport operations vehicles are typically used for inspecting and assessing surface conditions, lighting, signage, and other assignments related to continued operational readiness. Conversely, airfield service vehicles and equipment typically tend to the maintenance of the surface of the airfield, including unpaved areas. This includes snow removal operations, turf management, and routine maintenance and repair. There may be instances where the distinction between these two types of vehicles is not apparent or necessary. For example, the same vehicle may be used to perform inspections and conduct maintenance. The AC permits such a vehicle to be classified into either vehicle type. More importantly, lighting recommendations are the same for both vehicle types. The difference is that the painting and marking of the airfield service vehicle is specified by the AC. The painting and marking for the airport operations vehicle is designated by the airport operator and coordinated with the ATCT via the LOA.

For the purpose of this report, the movement area is considered to include the safety area. By definition, the safety area includes portions of the airport that are often not suitable for most ground vehicles, like the unpaved areas between runways and taxiways. (See 7.5 References.) These areas do require regular maintenance, usually mowing, that requires airfield service equipment access.

ATO orders, Part 139 requirements, AC 150/5210-5D, and AC 150/5210-20A are in agreement regarding the distinction between the movement area and nonmovement areas. Equally important, they are in agreement that movement of ground vehicles on nonmovement areas is the responsibility of the airport management, not ATC. Likewise, all concur that ATC use two-way radio communications (or light signals) to approve or disapprove the movement of ground vehicles onto and around the movement area. Any exceptions to these procedures should be identified in LOAs between ATC facilities and the airport.

Certain sections of AC 150/5210-20A include ambiguous language regarding the recommendation for a rotating yellow beacon on vehicles that routinely operate on the movement area. Section 3.1.3 is inconsistent with the recommendations in AC 150/5210-5D. Furthermore, the sample LOA in Appendix C of this AC does not include specific placeholders for the painting and marking of airport operations vehicles recommended by AC 150/5210-5D. It is also noted that the LOA is the optimal document for airport management to introduce new

painting, marking, and lighting technologies that may exceed the minimum requirements or recommendations in FAA standards and ACs and gain ATC concurrence.

## 3. PRELIMINARY AIRPORT FACTFINDING

The research study included a preliminary outreach to 24 airports in the NAS to gain information on current practices regarding the painting, marking, and lighting of vehicles operating on the AOA. The outreach also requested operational documentation, such as LOAs between ATC and airport management. The purpose of this outreach was to provide a basis for selecting 10 airports for onsite in-depth interviews. Airports were considered for this outreach based on the following criteria:

- Listed in the Runway Incursion Mitigation Program Preliminary Inventory of Airport Locations, based on data available on September 29, 2017. (See 7.11 References.);
- Five large hub airports;
- Five medium hub airports;
- Five small hub airports;
- Five nonprimary or general aviation airports, including both Part 139 and non-Part 139 airports; and
- At least one nontowered airport.

Hub airports are defined by FAA's National Plan of Integrated Airport Systems (NPIAS). (See 7.12 References.) A nontowered airport was included to provide some insight regarding airport operations procedures that are independent of ATC needs.

## 4. ONSITE AIRPORT INTERVIEWS

The research study selected 10 airports for onsite in-depth interviews with ATC and airport operations. These airports are shown in table 2 along with relevant information. Airport selection criteria required the inclusion of at least two airports from primary large, medium, and small hub categories. This requirement is a reflection of the provisions in the House and Senate reports requesting the FAA research task.

Table 2. Airport Site Visit List (Names Redacted)

| Airport | Airport Part 139 Classification | ATCT Level | Primary Large Hub | Primary Medium Hub | Primary Small Hub | Nonhub | ASDE-X |
|---|---|---|---|---|---|---|---|
| Airport XX1 | Class I | 7 | | | X | | No |
| Airport XX2 | Class I | 5 | | X | | | Yes |
| Airport XX3 | Class I | 10 | X | | | | Yes |
| Airport XX4 | Class I | 6 | | | X | | No |
| Airport XX5 | Class I | 8 | | | X | | No |
| Airport XX6 | Class I | 5 | | | X | | No |
| Airport XX7 | Class I | 12 | X | | | | Yes |
| Airport XX8 | Class I | 8 | | X | | | Yes |
| Airport XX9 | Class IV | 9 | | | | X | No |
| Airport XX10 | Not Part 139 | No ATCT | | | | X | No |

- The airport code is assigned by the FAA per ATO Order JO 7350.8X, Location Identifiers, dated August 22, 2013. (See 7.13 References.)

- Classification of airports is based on information from the FAA's Office of Airports' Web site: (See 7.14 References.)
  - Airports serving all types of scheduled operations of air carrier aircraft designed for at least 31 passenger seats (large air carrier aircraft) and any other type of air carrier operations are Class I airports.
  - Class IV airports are those airports that serve only unscheduled operations of large air carrier aircraft.
- ATCT levels were provided by individual ATC personnel.
- Primary hub designations are based on the FAA's NPIAS documentation. (See 7.12 References.)

Researchers prepared 12 questions for the ATC facilities and 11 questions for airport operations. A summary of responses for each question is shown in table 3. The full text of the questions and responses is included in Appendix B.

## 4.1 ATC Questions and Summary of Responses

Table 3 provides a list of questions posed to ATC and a summary of their responses.

Table 3. ATC Facilities Questions and Summary of Responses

| Question | | Summary of Responses |
|---|---|---|
| 1. | Do you distinguish between airport operations vehicles, airfield support vehicles, and aircraft support vehicles for visual tracking purposes? | Seven of nine said no. They do not differentiate between different types of ground vehicles, except for ARFF and tugs. |
| 2. | Do you use vehicle ID numbers during the day? | Seven of nine said no; two said they are useful. |
| 3. | Would vehicle ID numbers be useful at night? | Seven of nine said no; one said not sure; and one said yes depending on location |
| 4. | Do you consider the visibility of ground vehicles to be an issue? | Eight of nine said no; one said colors of vehicles help. |
| 5. | Can conspicuity of vehicles be improved? | Three said no; four others would like brighter lights; one indicated brighter colors; and one would like illuminated numbers. |
| 6. | Do the numbers on the tops of vehicles provide assistance with conspicuity? | Seven of nine said no; one said yes if right below tower; and one said yes. |
| 7. | Has visibility of vehicles been an issue in any runway incursions that you can recall? | Six of nine said no; three recalled incidents but were unclear on the role of vehicle visibility to ATC. |

| Question | | Summary of Responses |
|---|---|---|
| 8. | Are radio communications more or less important than visual identification? | Seven of nine said more; two said they are equal. |
| 9. | Are there areas of the movement area that the ground controller cannot see? | Five of nine said no; non-visible areas addressed with Airport Surface Detection Equipment, Model X (ASDE-X), cameras, or positive radio control. |
| 10. | Besides ASDE-X, what system do you use for tracking ground vehicles on movement area? | Four airports use ASDE-X; all non-ASDE-X airports rely solely on two-way radio communications; and two airports reported positive experience with Low Cost Ground Surveillance systems pilot study. |
| 11. | What do you see as the biggest challenge with ground vehicles operating within the movement area? | Radio congestion; too much radio chatter; sheer volume of vehicles especially in snow conditions. |
| 12. | Is there anything you would like to add regarding vehicle conspicuity in the movement area? | Four said no; three said brighter flashing (strobe) lights; one said better training; and one nonresponsive. |

#### 4.1.1 Findings from ATC Survey

Seven of nine ATC respondents do not differentiate between different types of ground vehicles under normal operational conditions, nor do they rely on vehicle numbers. ATC relies exclusively on two-way radio communications with ground vehicles entering, exiting, and operating on the movement area. Visual identification is used as verification that the vehicle location matches the radio communication. Equally noteworthy, eight of nine ATC respondents did not identify the visibility of airport vehicles operating on the movement area as an issue.

## 4.2 Airport Operations Questions and Summary of Responses

Table 4 provides a list of questions posed to airport operations and a summary of their responses.

Table 4. Airport Operations Questions and Summary of Responses

| Question | | Summary of Responses |
|---|---|---|
| 1 | What color are your operations vehicles? | These vary depending on LOA. See Appendix A for details. |
| 2 | Do you have preferences regarding colors? | No preference in general. |
| 3a | Do you use numbers on roofs of vehicles? | Five of 10 have roof numbers. |
| 3b | Are vehicle numbers connected to call sign with ATC? | Not always. |
| 3c | Are vehicle numbers visible at night? | No. |
| 4 | What systems or procedures do you use for tracking vehicles operating within the AOA/movement area? | Some airports use iPads to view ASDE-X feed. |
| 5 | Is conspicuity of vehicles in the AOA/movement area an issue for you? | Nine airports said no; one airport said that vehicles on one end of runway can't see vehicles on the other end of runway. |
| 6 | How do you think visibility can be improved? | More reflective tape, brighter lights and light bars, and lighted numbers. |
| 7 | Has visibility of vehicles been an issue in any runway incursions that you can recall? | Eight of 10 said no; one said none in last 10 years; and one said a sweeper was forgotten about. |
| 8 | Anything you would like to add regarding vehicle conspicuity in the AOA/movement area? | Three of 10 said no; two mentioned training; three mentioned light bars; and one mentioned lighted numbers. |
| 9 | What are you currently using to improve vehicle visibility? | Light bars, reflective tape, and two airports use lighted numbers. |
| 10a | What kind of lights, paint, or reflective tape are you using? | See full responses in Appendix A. |
| 11 | Are there any solutions you have tried in the past? | See full responses in Appendix A. |

### 4.2.1 Findings from Airport Operations Surveys

The information acquired through interviews with 10 airports indicates that they follow the recommendations set forth in AC 150/5210-5D for their ground vehicles. Many of the interviewed airports are obligated. However, airports who do not receive federal funds, may consider the guidance set forth in AC 150/5210-5D as best practice. The airport operations respondents did not express a preference for painting schemes on vehicles. Half of the

respondents reported that they have roof numbers on vehicles but that the numbers are not always the same as the call sign. In general, the respondents said that light bars, reflective tape, and lighted numbers are under consideration for improved visibility. However, 9 of 10 respondents did not report visibility of ground vehicles as an issue.

### 4.3 Letters of Agreement

All 10 airports selected for onsite interviews had LOAs in place with ATC. AIP funds received by an airport does not require an obligated airport to establish an operational agreement with air traffic control through a LOA. The LOAs were reviewed to extract details regarding vehicle conspicuity and specific requirements for vehicles operating on the AOA. Topics of interest included use of two-way radios, ASDE-X, painting, marking, lighting, headlights, and low visibility. Table 5 presents a matrix of LOA topics of interest and a summary of information in the LOAs. Only four airports have ASDE-X and the one airport without an ATCT does not have an LOA.

Table 5. Letters of Agreement Information

| LOA Topic | Summary of Responses |
|---|---|
| Radio | All nine airports with ATC include language regarding radio contact while operating on the movement area. |
| ASDE-X | One airport required ASDE-X squitters in all vehicles operating on the movement area. |
| Vehicle Painting | Not addressed. |
| Vehicle Marking | Not addressed. |
| Vehicle Lighting | Two airports mentioned rotating beacons. One airport mentioned headlights must be aimed away from runway approach to avoid pilots' vision. |
| Low Visibility | Four airports had special radio instructions for Instrument Landing System areas during low visibility or Visual Flight Rules conditions. |

All LOAs included information regarding radio procedures. Two LOAs addressed rotating beacons and one addressed visual conspicuity during low visibility. It is noteworthy that none of the LOAs included information regarding painting or marking of ground vehicles. This is likely due to the absence of painting and marking placeholders in the sample LOA included as part of AC 150/5210-20A.

### 4.4 Airport Interview Discussion

ATC has strict control for ground vehicle access to the movement area through the use of two-way radio communication. Visual acquisition of the vehicle is secondary. Therefore, it is not likely that ATC would intentionally create a "busy nighttime condition" on the movement

area. Conversely, it is likely at many larger airports that "busy nighttime conditions" may occur on ramps, gates, and parking areas, especially during high volume operations, or "pushes." These areas are part of the nonmovement area and are the responsibility of airport management, not ATC. The aircraft support vehicles that operate on these nonmovement areas are typically owned by airlines, vendors, or contractors.

Neither ATC nor airport operations respondents identified the conspicuity of ground vehicles as an issue under normal operating conditions. ATC respondents indicated that over time they become familiar with the difference between the types of vehicles that operate on the movement area but they treat them exactly the same. Airport operations respondents indicated that their maintenance vehicles and snow removal fleet are painted yellow per the AC.

5. FINDINGS

- AC 150/5210-5D includes a detailed set of recommendations for the painting, marking, and lighting of all ground vehicles and equipment that operate on the AOA. These recommendations are tailored to type of vehicle and the physical locations where specific types of vehicles are allowed to operate. They are applicable for the entire AOA. Compliance with these recommendations is mandatory for vehicles and equipment funded with Federal grant monies.
  - Only two types of vehicles routinely operate on the movement area - airport operations vehicles and airfield service vehicles;
  - Painting and marking recommendations for these two types of vehicles differ; and
  - Lighting recommendations for these two types of vehicles are identical.

- AC 150/5210-5D, ATO orders, and Part 139 requirements are in agreement:
  - Regarding the distinction between the movement area and nonmovement areas;
  - That ATC use two-way radio communications (or light signals) to approve or disapprove of the movement of ground vehicles onto and around the movement area. Any exceptions to these procedures must be identified in LOAs between ATC and the airport; and
  - That movement of ground vehicles on nonmovement areas is the responsibility of the airport management and not the ATC facilities.

- ATC respondents concurred that they rely on two-way radio communications for the movement of ground vehicles on the movement area. They do not rely on vehicle numbers as much as they do on vehicle call signs.

- ATC respondents did not identify ground vehicle conspicuity as an issue on the movement area.

- Airport operators did not identify ground vehicle conspicuity as an issue on the movement area.

- It is likely that the “busy nighttime conditions” referenced in the congressional language occur on nonmovement areas like ramps, gates, and aircraft parking. These nonmovement areas are the responsibility of the pilot and airport management, not the ATC facilities.

## 6. RECOMMENDATIONS

Specific recommendations for revisions to ACs:

- AC 150/5210-5D
  - Clarify the distinction between airport operations vehicles and airfield service vehicles in AC 150-5210-5D for the purposes of painting and marking;
  - Include a reference in this AC to the LOA recommendations that are found in AC 150/5210-20A, especially as it relates to painting and marking of airport operations vehicles; and
  - Add an RSA definition. Specific approval for entry onto the RSA should be obtained from the ATC and addressed in the LOA.

- AC 150/5210-20A
  - Add RSA definition to main body of AC.
  - Section 3.1.4.2 - add "movement area" to the first sentence.
  - Appendix C, Sample Letter of Agreement Guidance and Details
    - Add "movement area" to all references to RSA; and
    - Add specific placeholders for vehicle painting and marking.

General Recommendations

- Consider reorganizing the overall format of AC 150/5210-5D. Each of the six different types of vehicles should have a separate listing of all applicable painting, marking, and lighting recommendations. This can be accomplished in a table format;
- Emphasize improved and recurrent driver training for all vehicle operators on the movement area; and
- Encourage more detailed information in LOAs regarding painting, marking, and lighting of airport ground vehicles.

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Appendix A – Comprehensive Tally (ATC Facilities and Airport Operations) (Names Redacted)

| **QUESTIONS FOR ATC FACILITIES** | |
|---|---|
| **1.a) Do you distinguish between airport operations vehicles, airfield support vehicles, and aircraft support vehicles for visual tracking purposes? b) In what ways?** | |
| XX1 | a) They don't look at numbers, just listen for call signs. Just call sign and location. Treat them all the same, know what they're doing out there. Schedule, routine. No need to distinguish types.<br>b) Basically, they know vehicles based on color and vehicle type. Van, truck, etc. When they call, you know where they are coming from. |
| XX2 | a) No.<br>b) Don't really care. Kind of know already. |
| XX3 | a) Tower does not care, vehicle is a vehicle. Airport operations uses green light on their trucks. First wanted blue, but police said no. |
| XX4 | a) Maintenance vehicles are T (Tango vehicles), 456 are sweepers, tow behind brooms. Avoid runway designation numbers on vehicles. Numbers on vehicles match what they say to the tower.<br>b) No difference visually for airport vehicles, all yellow vehicles. |
| XX5 | a) Tugs are different; slower; airport vehicles (maintenance) have less communications needed; airport operations call signs are trusted. |
| XX6 | a) No.<br>b) They distinguish between crash/fire and airport operations. Tugs don't go on movement area other than one "Hassinger" tug. Pushbacks do and that one tug talks to ground. All others talking to airplane during pushback, not tug. |
| XX7 | a) Sort of care to know the difference between fire and airport operations.<br>b) Gives us an idea of what to expect. |
| XX8 | a) No. They don't really care.<br>b) They know by call sign. Airport operations call signs start with the word wagon and then the number. FAA maintenance is call sign for FAA technical operations. Weather has their own. Just vehicle and where they are is important. |
| XX9 | a) No.<br>b) Same concerns for all vehicles. |
| XX10 | No ATC at airport. |
| | |

| QUESTIONS FOR ATC FACILITIES | |
|---|---|
| **2. Do you use vehicle ID numbers during the day?** | |
| XX1 | No. |
| XX2 | They come into play when multiple vehicles on the field. |
| XX3 | Never. |
| XX4 | Yes, numbers help them. They need to know which vehicles are in which areas. |
| XX5 | No. They use call signs mostly. They do use numbers when they report back to airport operations (Example: OPS-22). Tower doesn't care though unless there are multiple vehicles of the same type out at the same time. |
| XX6 | They use vehicle numbers when calling tower. If vehicle has 31 on it, they say "Airport 31." For talking to airport operations, they use call signs (Granite 24, etc.). They may use either though when talking to airport operations or other vehicles on the field. Granite 24 might also be in vehicle 24. No set rule for how airport operations talks to other airport operations. Just tower, use vehicle number. They have LOA. |
| XX7 | No. |
| XX8 | They just listen to call sign and location. They don't care about numbers. Just take their word for it. They care about flashing lights, not numbers. |
| XX9 | No, not as primary identification; only when there is a need to distinguish between multiple vehicles in the same area or verification of location. |
| XX10 | No ATC at airport. |
| | |

| QUESTIONS FOR ATC FACILITIES | |
|---|---|
| **3. Would vehicle ID numbers be useful at night?** | |
| XX1 | No. |
| XX2 | Can't hurt. Cost/benefit? Not sure. |
| XX3 | No. ASDE-X facility, transponders used. |
| XX4 | Yes, depending on where the vehicle is they will use visual confirmation when they see it, but they also associate area with where they say they will be. |
| XX5 | Not useful for the tower. The verbal communication is trusted. |
| XX6 | Both visual and radio used. Twenty-four-inch numbers on the roof. Not useful at night though. Can't see roof numbers. |
| XX7 | No. |
| XX8 | No. Nice visual, but don't care about number. Usually just care about orange light. Handy when they have incidents. Several wagons come out at same time. Differentiate between vehicles on east/west side. NOTE: Airport operations and the ATC facility felt that the lighted numbers on the sides of vehicles are very helpful in a congested scene, such as an incident in order to identify individual vehicles. |
| XX9 | No. |
| XX10 | No ATC at airport. |
| | |

| 4. Do you consider the visibility of vehicles (OPS, Maintenance, ARFF, and Police) on the AOA to be an issue? Day? Night? | |
|---|---|
| XX1 | No, never had trouble seeing vehicles. They can see entire movement area. Some nonmovement areas hard to see, but they aren't tracking. |
| XX2 | No. |
| XX3 | No. |
| XX4 | No general issues. They have procedures that accommodate for it. |
| XX5 | No from the tower. They have bright lights and are easy to find. All controllers know the pattern of vehicle movement, it is routine. |
| XX6 | No. |
| XX7 | Colors of vehicle help. Dark brown and black are harder to pick up. |
| XX8 | Nonwagon vehicles have issue. They don't have orange flashing lights. Not distinguishable enough. Light bars are super helpful. Wagon super easy to see. Otherwise, they have to use binoculars to locate and verify vehicles. |
| XX9 | Not necessarily but we must "positively" confirm location. In other words, we don't have to see them to control them, i.e. Instrument Flight Rule conditions. |
| XX10 | No ATC at airport. |

| QUESTIONS FOR ATC FACILITIES | |
|---|---|
| **5. Do you think conspicuity of vehicles can be improved upon and if so, how?** | |
| XX1 | As long as yellow flashing light is on, they are fine. They can see it. Some people turn off light for helping them see lighting inspections, but right back on after. Light bar has improved. Some trucks have big LED light bar on top, sticks out more than others. LEDs are really nice. Much preferred. |
| XX2 | No. Flashing four ways and light bars are great. |
| XX3 | Not to their knowledge. |
| XX4 | Illuminated numbers, they like those, a definite plus. Vehicle out at day time, binoculars would allow to see numbers, they'd love that. Not making blanket broadcast in the blind to figure out who's who. Thought vehicles were clear but weren't because of snow. Anything that could illuminate them more would be great. |
| XX5 | Brighter lights would be nice. |
| XX6 | Yes, but maybe it doesn't need to be. |
| XX7 | Brighter colors. |
| XX8 | More flashing bars for all vehicles. |
| XX9 | Yes, very small white strobe light on top of vehicle other than rotating beacon. |
| XX10 | No ATC at airport. |
| | |

| QUESTIONS FOR ATC FACILITIES | |
|---|---|
| **6. Do the numbers on the tops of vehicles provide assistance with conspicuity?** | |
| XX1 | Have to be right below to see them. |
| XX2 | No. |
| XX3 | No. |
| XX4 | Have numbers on tops. Yes, they help. FAA vehicles only have them on side. |
| XX5 | No. |
| XX6 | No. |
| XX7 | No. |
| XX8 | No. They know when vehicles will be out there. Schedule, pattern, routine. If out for incident, then you can still see them when they start and know where they are going based on radio. |
| XX9 | No. |
| XX10 | No ATC at airport. |
| | |

| QUESTIONS FOR ATC FACILITIES | |
|---|---|
| **7. Has visibility of vehicles been an issue in any runway incursions that you can recall?** | |
| XX1 | No |
| XX2 | No. |
| XX3 | No. |
| XX4 | Yes.<br>Low visibility conditions, couldn't see vehicles. Lead vehicles report clear, trailing vehicles were not clear though. Better visibility could have helped, but it was whiteout conditions; ASDE-X would have helped. |
| XX5 | A sweeper was at the far end of the runway once. It was forgotten about and considered an ATC error. It was a mile and a half away (far end of airport from tower), and it only had the standard circular warning light on top of the vehicle. |
| XX6 | No. |
| XX7 | One vehicle several years back ran through a fence and breached AOA. |
| XX8 | No. |
| XX9 | No, not to my recollection. |
| XX10 | No ATC at airport. |
| | |

| QUESTIONS FOR ATC FACILITIES | |
|---|---|
| **8. Is reliance on radio communications more or less important than visual identification?** | |
| XX1 | Much more. |
| XX2 | Way more. |
| XX3 | More on radio. |
| XX4 | More on radio but they use visual confirmation of the radio. Human factors involved, have to have the visual confirmation. Tugs only allowed while escorted on runways. Guards will be allowed to tug F-16s. Tugs have a beacon, but maybe not F16s. Commercial aircraft sometimes have to do it though. |
| XX5 | More. |
| XX6 | Both equal. Need to know where they are. Need to visually confirm. Surface Movement Guidance and Control System (SMGCS) Plan: If they can't visually confirm, then different procedure outlined in SMGS. They give them reporting points to give updates as they move through the movement area. |
| XX7 | More. |
| XX8 | Equal. |
| XX9 | More. |
| XX10 | No ATC at airport. |
| | |

| QUESTIONS FOR ATC FACILITIES | |
|---|---|
| **9.a) Are there areas of the AOA/movement area that the ground controller can't get eyes on? b) How do you address this?** | |
| XX1 | a) Yes, some of the nonmovement area. NOTE: Level 7 tower. 24/7 |
| XX2 | None on movement area, ramps yes. Some tugs authorized on movement area. |
| XX3 | a) Two small areas. b) Cameras and transponders ASDE-X. Camera on taxiway J. |
| XX4 | a) Downhill on Taxiway K, with a building. b) Provide positive control one in one out, pass behind. Only one vehicle there at any time. |
| XX5 | End of 25 right. End of Taxiway A. Small part of Taxiway K. All around, very small line of sight issues. |
| XX6 | a) Yes, taxiway G.<br>b) Address with additional radio confirmation to verify they are still there. |
| XX7 | a) Yes.<br>b) Deep in alleyways off movement area we don't have visibility but that doesn't matter, only movement areas. |
| XX8 | a) No. |
| XX9 | a) No. |
| XX10 | No ATC at airport. |
| | |

| QUESTIONS FOR ATC FACILITIES | |
|---|---|
| **10.a) For those with ASDE-X, do you use ASDE-X or other systems for ground movement situational awareness of airport ground vehicles? b) For those without ASDE-X, what if any system do you use?** | |
| XX1 | a) No ASDE-X.<br>b) No other systems being used. |
| XX2 | a) Yes. ASDE-X. |
| XX3 | a) Yes, they use ASDE-X. Procedures, standard operating procedures, radio call for taxiway and runway. |
| XX4 | a) No, they have a funding request in for it.<br>b) When targets blend with other targets, hard to tell which is which. Can get confused and assign tag to wrong vehicle. Go with squitters (communication devices) instead. Strategic plan for squitters on certain vehicles. Standard training protocol used for now. In tower, they have a board that slides mica chips back and forth to tell you what vehicles are on what surfaces. Flight progress strips. Memory aide. Throw them back and forth, placed in front of controllers. Board for winter, strips for summer mostly. Vehicles call in for taxiways and runway. |
| XX5 | a) No ASDE-X.<br>b) They use radio communications. They were in the low-cost surveillance program, but didn't get it. They really wish they did get it though. |
| XX6 | a) No ASDE-X.<br>b) Pilot study for low cost ground surveillance. Never got off the ground. As system was implemented, had too many false signals, too many bugs, six test facilities, doing six different things. Couldn't get rid of false targets and blind spots. They visually confirm that folks are off runway, but also radio. |
| XX7 | No reply. |
| XX8 | a) Yes, they have ASDE-X. |
| XX9 | a) No ASDE-X. b) No comment. |
| XX10 | No ATC at airport. |
| | |

| QUESTIONS FOR ATC FACILITIES | |
|---|---|
| **11. What do you see as the biggest challenge with ground vehicles operating within the AOA/movement area?** | |
| XX1 | Sheer number of vehicles can be overwhelming. Airport electrician, wildlife, national guard operations, airport operations, five to six vehicles in morning. Lots of radio chatter. Sometimes lose track of which one is which, but mostly radio tracking. |
| XX2 | Sometimes the volume of vehicles especially in snow. |
| XX3 | Frequency congestion with repetitive events. Working midfield while also doing regular airport operations. |
| XX4 | Sheer number of vehicles and prevailing visibility. Mostly during snow removal or construction, they get these clumps of vehicles. |
| XX5 | Certain vehicle operators talk too much. Too much radio chatter. Mostly visiting vehicles/operators. In this case, the Goodyear blimp folks. Need more radio training prior to operation on the runway. Airport operations always calls before they enter the movement area and have great audio communications. |
| XX6 | Used to have call sign issues, but fine now. They do annual internal evaluations that help improve their process. Runway Safety Action Team. An example is B8 was changed to Broom 8 to make it clearer. |
| XX7 | Just volume during snow or emergencies. |
| XX8 | Radio communications. Clear communications. Changed rule that you can only cross runway one at time. Now they have to give two short instructions. Change to air traffic manual. Can do it with aircraft, but not vehicle. Must finish one crossing before you do the next. They don't like this. Like the old way. |
| XX9 | Ensuring no runway incursions or vehicles show up in an unexpected area impeding aircraft movement. |
| XX10 | No ATC at airport. |
| | |

| QUESTIONS FOR ATC FACILITIES | |
|---|---|
| **12. Anything you'd like to add regarding vehicle conspicuity in the AOA/ movement area?** | |
| XX1 | No. All white vehicles work for them. Some flashing lights better than others. Prefer the LED lights. |
| XX2 | No. |
| XX3 | No. |
| XX4 | Not a 24/7 tower, shut down at midnight, open at 5 a.m. Fully rely on the radio at that point. ATC level 6. Class C airspace. Landing under hard conditions and making announcement on frequency. Pilots can sometimes forget. Huge bonus for vehicle conspicuity when tower is down so pilots can see. Helicopter operations here, but no helipad. |
| XX5 | They train all people that drive on perimeter roads. Controller communications are good. Enhancing driver training with a simulator soon. They don't require any new technology for visibility. |
| XX6 | Install corner strobes on operations trucks, headlights and taillights, alternating. In low visibility, they love having them on for snow removal work. Helps others see you and they use them to indicate that they are on the runway. They don't think LEDs are as bright as old incandescent strobes. Corner strobes on all pickups. Mostly helps them avoid each other. ATC doesn't follow vehicles with eyes. Just verify they are at locations when radio in. Different lighting for operations vehicles when on/off runway to help identify that they are there. |
| XX7 | No. |
| XX8 | Would love the long, bright LED flashing lights that you can see from anywhere. Put it on all vehicles. Tugs are basically invisible. Have to have binoculars out to see them. NOTE: Airport operations escort tugs across runways. |
| XX9 | Only the strobe lights on ground vehicles. |
| XX10 | No ATC at airport. |
| | |

| QUESTIONS FOR AIRPORT OPERATIONS | |
|---|---|
| **1. What color are your airport operations vehicles, snow vehicles, maintenance vehicles, police vehicles and ARFF vehicles?** | |
| XX1 | Airport Operations – white with numbers on sides and top. Maintenance – White with number on side. Police – state police, none have airfield access though (escort only). ARFF – lime green, structural is red, snow removal is yellow. |
| XX2 | Airport Operations – blue. Maintenance – yellow. Snow - yellow. Police – gray (not on movement area without escort). ARFF – lime green. |
| XX3 | Airport Operations – white. Maintenance – white. Snow - yellow. Police – blue and black (not on movement area without escort). ARFF – lime green. |
| XX4 | Airport Operations – yellow. Maintenance – yellow. Police – black. ARFF – red. NOTE: Airport utilizes Vermont Air National Guard ARFF vehicles, which are red, not lime green. |
| XX5 | Airport Operations – white. Maintenance – yellow. |
| XX6 | Airport Operations – yellow. Maintenance – yellow. Police – service roads and ramps, escort to movement area; ARFF – lime green. Airport operations vehicles are yellow. Some older airport operations vehicles are blue. |
| XX7 | Airport Operations – yellow. Maintenance – yellow and a few black. Snow – yellow. Police – blue and white. ARFF – lime green. |
| XX8 | Airport Operations – blue and white. Maintenance – orange and white. Police – black and white, deputy; Airport police service - all white. ARFF – lime green. |
| XX9 | Airport Operations – white. Maintenance (this includes snow vehicles) – a mix of white and yellow. Police – blue and white. ARFF – lime green. |
| XX10 | Airport Operations – white (passenger). Maintenance – (various colors, John Deer – green, Holland – blue). Police – depends on department. |
| | |

| QUESTIONS FOR AIRPORT OPERATIONS | |
|---|---|
| **2. Do you have preferences regarding colors and why?** | |
| XX1 | Fine with existing colors. Port authority buys vehicles and owns them. |
| XX2 | Like the blue for airport operations because contrast of white numbers and reflective tape stands out more. |
| XX3 | No. |
| XX4 | Kept police vehicle as black because law enforcement standard |
| XX5 | No preference. |
| XX6 | No response. |
| XX7 | The yellow does stand out vs. other vehicles like FAA Technical Operations and construction vehicles. |
| XX8 | Once tried airport operations with reflective yellow stripes on backs, but it faded in 2 months. Reflective materials didn't last. Liked the look, however, need longer lasting. |
| XX9 | Not really; white is less expensive. |
| XX10 | No response. |
| | |

| QUESTIONS FOR AIPORT OPERATIONS | |
|---|---|
| **3.a) Do you use any numbers on roofs of vehicles? b) Are these numbers connected to the call sign of the individual operating the vehicle? c) Are they visible at night?** | |
| XX1 | a) Yes.<br>b) OPS-4 matches number on roof. Same with tower and airport operations communications. No call signs here. Call signs only used for upper management. Otherwise, use call sign of truck. Examples: A-1 or E-1 are call signs for management, but the vehicle won't have that number on it.<br>c) No reply. |
| XX2 | a) Yes.<br>b) Call sign is always tied to vehicle number for talking to ATCT and airport operations.<br>c). Yes. |
| XX3 | a) No.<br>b) Mostly. They strive for call signs to match for talking to airport operations and ATCT. They worked with Harris Corporation up front to have vehicles preset and tagged with vehicle numbers before deploying ASDE-X. If the vehicle is not available, then use call sign when talking to airport operations and vehicle number when talking to ATCT.<br>c) No. |
| XX4 | a) Yes.<br>b) Yes, they are the call sign. If vehicle is labeled OPS-2, they call it OPS-2.<br>c) Black numbers with some reflectivity, but not much. |
| XX5 | a) No. They use call signs mostly. They do use numbers when they report back to airport operations (OPS-22). Tower doesn't care though, unless there are multiple vehicles of the same type out at the same time. |
| XX6 | a) Yes. b) Yes. c ) No. |
| XX7 | a) Yes.<br>b) No. ASDE-X squitter number is not the same as the vehicle number. When calling ATCT, they use ASDE-X squitter number and when calling airport operations or others, they use call signs associated with position being filled. Most of the time, the duty officer (lead airport operations person) and the transponder (squitter) number matches the vehicle number. Need to check their LOA. Two years now this way and no issues, although not all vehicles have transponders (squitters), and ATCT pushes back on this.<br>c) No. |
| XX8 | a) No numbers on roof. Used to use numbers, not anymore.<br>b) No. Wagon 61. John Wayne wagon, 61. Vehicle number to talk to tower only. They have ASDE-X. Talked to airport operations or anyone other than ATC; they use their call sign for position being filled.<br>c) No reply. |
| XX9 | a) No.<br>b) For the maintenance department, yes but for airport operations they use their call signs.<br>c) No. Possible interest in using lighted numbers on just one or two vehicles, maybe lead airport operations vehicle and lead snow vehicle. Not necessary for entire fleet only. |
| XX10 | a) No. On hoods, reflective. |
| | |

| QUESTIONS FOR AIPORT OPERATIONS | |
|---|---|
| **4. Do you use any systems or procedures for tracking vehicles operating within the AOA/movement area?** | |
| XX1 | No, nothing special. |
| XX2 | Yes, ASDE-X have Harris Mobile (Symphony) view and deploying iPads for viewing in field. Same feed as in the ATCT. |
| XX3 | Yes, ASDE-X have Symphony view and deploying iPads for viewing in field. |
| XX4 | Operations uses positive control when tower is closed and they are doing maintenance airport operations. The airport operations manager keeps track of what's where so he/she can let incoming aircraft know when it's clear. |
| XX5 | No. |
| XX6 | Radio with visual confirmation from tower. |
| XX7 | Yes, ASDE-X have Harris view. |
| XX8 | Airport operations does not; however, the ATC facility has ASDE-X. |
| XX9 | Specific procedure in use for entering onto and off movement area. |
| XX10 | Radio as needed, not always necessary though. |
| | |

| QUESTIONS FOR AIRPORT OPERATIONS | |
|---|---|
| **5. In your opinion, is conspicuity of vehicles in the AOA/movement area an issue for you or the ATC?** | |
| XX1 | Not really. Air National Guard, different color vehicles (dark blue), use beacon only. Signs aren't that great on their vehicles. USDA wildlife has white pickups, fine there. Technical Operations are mostly white. |
| XX2 | No. NOTE: ATCT can see ramps on ASDE-X screen and airport operations escort tugs on runway crossings. |
| XX3 | No. |
| XX4 | Yes, vehicle on one end of runway can't see vehicles on other end. They also have line-of-sight issues with radio on the field. |
| XX5 | No. |
| XX6 | No. |
| XX7 | No. |
| XX8 | No. Especially since they've gotten the new numbers. Received positive comments from pilots and other airport controllers flying out. |
| XX9 | No. |
| XX10 | No. |
| | |

| QUESTIONS FOR AIRPORT OPERATIONS | |
|---|---|
| **6. How do you think visibility can be improved upon?** | |
| XX1 | Better standard for National Guard folks. Different color, brighter lights. |
| XX2 | Always room for improvement but overall in a good place with this issue. |
| XX3 | Looking at a new tape. |
| XX4 | Would love lighted numbers. Transponder system (ASDE-X) with laptops in vehicles. Easier to track other vehicles while operating. |
| XX5 | Brighter lights would be nice. |
| XX6 | No Response. |
| XX7 | No Response. |
| XX8 | More reflective tape, more durable tape. Tower is able to see numbers fine. |
| XX9 | Consistent markings on vehicles across the fleet and perhaps two light bars on larger vehicles like Suburbans. |
| XX10 | Not applicable. |
| | |

| QUESTIONS FOR AIRPORT OPERATIONS | |
|---|---|
| **7. Has visibility of airport vehicles been an issue in any runway incursions that you can recall?** | |
| XX1 | No. |
| XX2 | No. |
| XX3 | No. |
| XX4 | Yes. |
| XX5 | A sweeper was at the far end of the runway once. It was forgotten about and considered an ATC error. It was a mile and a half away (far end of airport from tower) and it only had the standard circular warning light on top of the vehicle. |
| XX6 | No. |
| XX7 | No. |
| XX8 | None in the last 10 years (airport operations vehicles). Majority of other vehicles have wing walkers. Tug operators move airplanes. |
| XX9 | No. An incident here was mentioned but no details. |
| XX10 | No. |
| | |

| QUESTIONS FOR AIRPORT OPERATIONS | |
|---|---|
| **8. Anything you'd like to add regarding vehicle conspicuity in the AOA/movement area?** | |
| XX1 | Light bar is most important. |
| XX2 | No. |
| XX3 | Use green light bars for airport operations vehicles helps. |
| XX4 | Lit numbers would be nice. Anything that would help tower visibility. |
| XX5 | Training is critical. They train all people that drive on perimeter roads. Controller communications are good. Enhancing driver training with a simulator soon. They don't require any new technology for visibility. |
| XX6 | Install corner strobes on airport operations trucks, headlights and taillights, alternating. In low visibility, they love having them on for snow removal work. Helps others see you, and they use them to indicate that they are on the runway. They don't think LEDs are as bright as old incandescent strobes. Corner strobes on all pickups. Mostly helps them avoid each other. |
| XX7 | No. NOTE: Tugs on movement area are all escorted by airport operations. |
| XX8 | No. |
| XX9 | No. |
| XX10 | Training is critical. |
| | |

| QUESTIONS FOR AIRPORT OPERATIONS | |
|---|---|
| **9. What are you currently using to improve vehicle visibility?** | |
| XX1 | Tried to get a triangular flood light - light bar, fog lamps for runway inspection, helps a bit, but not as good as they'd like. Would love bumper lights for foreign object debris at nighttime. |
| XX2 | No response. |
| XX3 | Use green light bars for airport operations vehicles helps. |
| XX4 | Exploring for lighted numbers. They always go for higher powered light bars. All LED bars. Not too many issues with snow stuck on tops of vehicles. Keep vehicles running, they clear them off. Concentrate on more lights and flashing tail lights. Some vehicles have yellow strobes on front and back. They like those. |
| XX5 | Lighted numbers. |
| XX6 | Airport is installing Automatic Dependent Surveillance Broadcast (ADSB) receivers in vehicles. Utilize ADSB system for tracking vehicle movement (future). Not used for control. |
| XX7 | Reflective tape works well. |
| XX8 | Lighted numbers. |
| XX9 | Nothing really but they are using an incursion warning system in mowers and Port Authority is testing two tracking systems. |
| XX10 | Lights/light bars and training of all drivers including local police/fire department. Amber lights, retroreflective tape and numbers on hood. Keep new vehicles, relatively low mileage trade in, fleet management comes from authority. |
| | |

| QUESTIONS FOR AIRPORT OPERATIONS | |
|---|---|
| **10. What kind of lights, paint, or reflective tape are you using?** | |
| XX1 | Information not available at time of interview. |
| XX2 | Information not available at time of interview. |
| XX3 | N/A |
| XX4 | Airport operations and maintenance vehicle lights depend on funding. Some vehicles bought through state bids, some leased. Snow removal PFC funded. Follow AIP procurement. Police vehicle is an AIP security grant. Sometimes they spec out what they want, and they put on their own lights and reflective; sometimes they get them as is. They put on their own lights on some vehicles. Standard reflective tape. LED bars on new vehicles. They always use new lights on new vehicles; no recycled lights. |
| XX5 | Information not available at time of interview. |
| XX6 | They use reflective tape, nothing special. Airport is enterprise account of city. Anything spent here is earned here. They buy smaller equipment out of pocket. Mauler bought with AIP funding. Airports spec out and buys out all equipment. They have their own specialists to help out with subsystems. |
| XX7 | LEDs on light bars. |
| XX8 | Yellow version of vehicle. They get vehicle as fleet from county. They just tell them the specifications for vehicle. |
| XX9 | Information not available at time of interview. |
| XX10 | N/A |
| | |

| QUESTIONS FOR AIRPORT OPERATIONS | |
|---|---|
| **11. Are there any solutions you've tried in the past?** | |
| XX1 | Not recently. |
| XX2 | Not recently. Updating AC might prove useful. |
| XX3 | Not recently. |
| XX4 | Not recently. |
| XX5 | Use of lighted numbers. |
| XX6 | Technology just gets better. Like the new LEDs. They have Forward Looking Infrared cameras on some trucks. Like the lighted number technology. |
| XX7 | Directional spot lights were used on airport operations vehicles and were very helpful for inspections; however, police policy stopped their use. |
| XX8 | Use of lighted numbers. Curvature with bigger numbers wasn't working because it didn't adhere well. |
| XX9 | Not recently. |
| XX10 | Not recently. |

Appendix B - List of Acronyms

| | |
|---|---|
| **AAS** | Office of Airport Safety and Standards |
| **AC** | Advisory Circular |
| **ACM** | Airport Certification Manual |
| **ADSB** | Automatic Dependent Surveillance Broadcast |
| **AIP** | Airport Improvement Program |
| **AOA** | Air Operations Area |
| **ARFF** | Aircraft Rescue and Fire Fighting |
| **ASDE-X** | Airport Surface Detection Equipment, Model X |
| **ATC** | Air Traffic Control |
| **ATCT** | Airport Traffic Control Tower |
| **ATO** | Air Traffic Organization |
| **CFR** | Code of Federal Regulations |
| **FAA** | Federal Aviation Administration |
| **LED** | Light Emitting Diode |
| **LOA** | Letter of Agreement |
| **NAS** | National Airspace System |
| **NPIAS** | National Plan of Integrated Airport Systems |
| **PFC** | Passenger Facility Charge |
| **RSA** | Runway Safety Area |
| **SMGCS** | Surface Movement Guidance and Control System |
| **TLTV** | Towbarless Tow Vehicle |