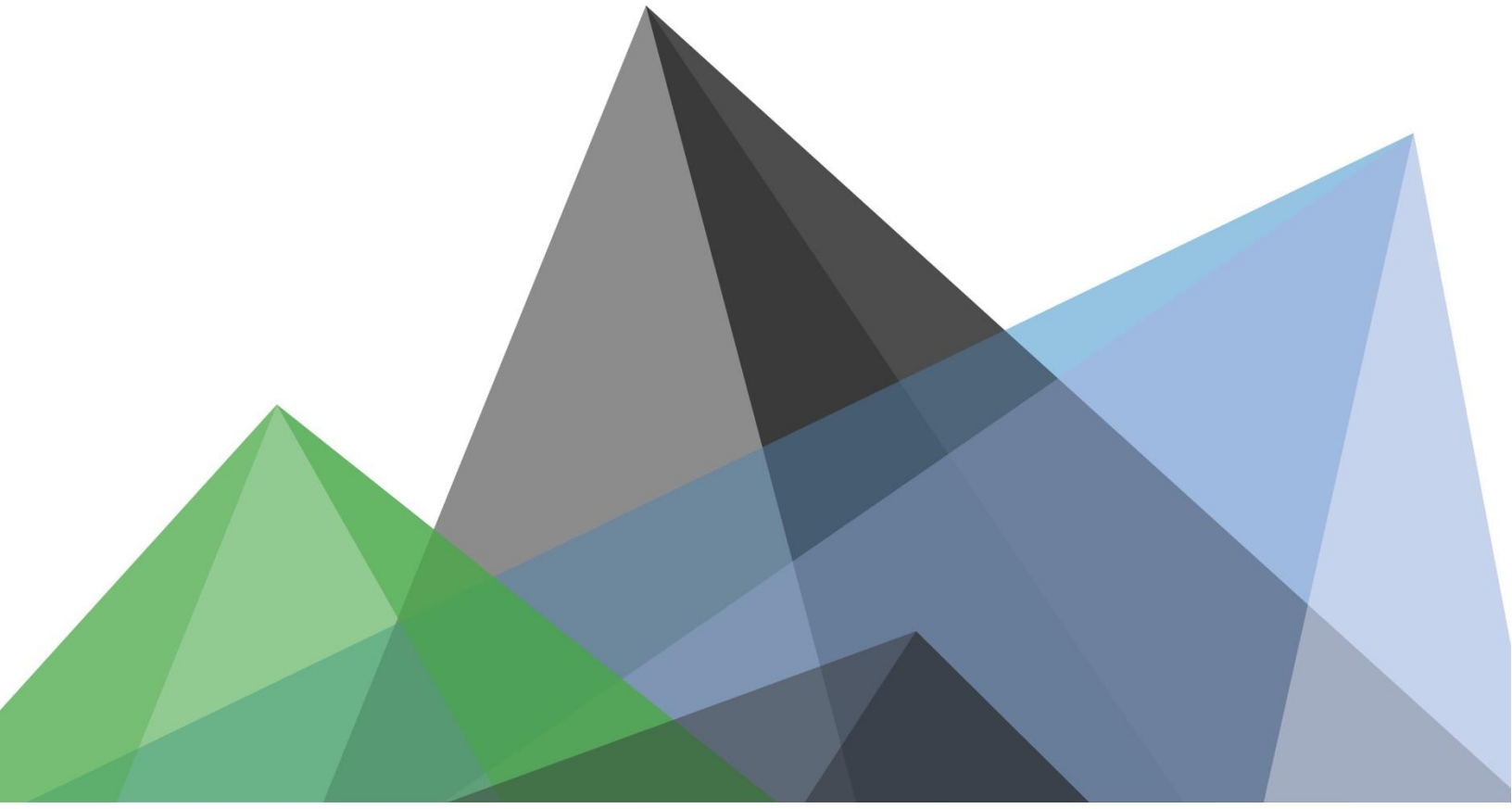
March 2024

Business Systems Toll Plaza Manual

ILLINOIS STATE TOLL HIGHWAY AUTHORITY



Illinois Tollway

INTRODUCTION

Business Systems Toll Plaza Manual

The Business Systems Toll Plaza Manual provides the details and direction for the Illinois Tollway's standard mainline and ramp plaza configurations. The manual outlines the geometric and technological arrangement to effectively maintain and capture customer information through the tolls. The information contained herein is to be utilized by the Designers and applied to each specific plaza locations' needs.

The Business System Toll Plaza Manual dated March 2024 replaces the Business System Toll Plaza Manual March 2023 version.

Major Revision Highlights:

Section 7.0 Tolling Equipment Infrastructure Design Criteria	
Article 7.1.1	Revised All Electronic Tolling (AET) Layout description for clarity.
Article 7.1.2	Revised Loop Junction Box description for clarity.
Article 7.2	Revised Violation Enforcement System Wiring Layout Description for clarity.
Article 7.3	Revised VES Wash System description: The VES Wash System with Nitrogen Generator has been redesigned as a single cabinet to be installed inside a remote control plaza building located in close proximity to the monotube as part of the tolling system.
Article 7.3.1	Functionality of main components: The VES Wash Single cabinet includes the washing liquid reservoir, manifold, pressure regulator, particulate filter, nitrogen generator, nitrogen reservoir, and all the tubing that distribute the mix of washing liquid and nitrogen gas to each VES cameras mounted on the monotubes as part of the Business System tolling system.
Article 7.3.2	Reference to M-BUS-2539 VES Wash System material list and name of the approved manufacturer of the VES Wash System
Article 7.3.3	Reference to M-BUS-2540 for the VES Wash System flow diagram and system and to M-BUS-2541 for the suggested conduit routing details
Article 7.3.5	Added: The manufacturer of the VES Wash System may choose to provide a simplified control system that may differ to M-BUS-2543 system to supply the desired amount of washing fluid and nitrogen gas to the VES cameras when required
Article 7.4	New Article to describe the Automatic Vehicle Identification (AVI) requirement

TABLE OF CONTENTS

TABLES

APPENDICES

SECTION 1.0 INTRODUCTION

1.1 Purpose and Use

A toll plaza is a facility built to collect tolls on the Illinois Tollway system.

The objective of this *Business Systems Manual* is to provide guidance for building new and maintaining existing Illinois Tollway plaza assets to the highest quality and in the most efficient way. The information contained herein shall be reviewed and utilized by designers to meet the needs of each specific plaza.

This *Business Systems Manual* is divided into two primary parts. First, an overview of the Illinois Tollway's toll plaza project development process and universal deployment considerations is provided. Then, it provides guidance for Design Section Engineers (DSEs) for developing contract documents for bid and construction support of toll plaza improvements, as well as for each of the unique elements that make up a toll plaza.

1.1.1 Project Development Process

The Illinois Tollway process for originating, designing, and building a toll plaza project is as follows. After the systems engineering process as outlined in Section 2.1 and a consistent quality assurance program, the Illinois Tollway conceives a toll plaza project during its regular planning cycle or during a review of a major roadway construction project with known or anticipated tolling needs. For example, there are some cases, such as new interchanges, in which new toll plaza needs are directly created by roadway construction.

After developing a pre-concept design that further defines the project, the Illinois Tollway solicits the participation of a DSE to perform the conceptual and detailed project design, either as a toll plaza–specific project or as complement to a roadway project. Several facets of the detailed design process are universal across most of the Illinois Tollway's toll plaza projects, including tolling infrastructure construction and system integration. This standardization is outline in this manual and shall be coordinated during design with the Illinois Tollways business systems department.

Once final contract documents have been created by the DSE and approved by the Illinois Tollway, the documents are issued for contractor bid. The DSE may provide support during the bid stage, as well as the construction stage and system integration that follow. The Construction Manager (CM) acts as the Illinois Tollway's agent during this process, verifying that the design requirements are met by the contractor. The Illinois Tollway business systems department and its agents may install Tollway material, loops and coordinate with the contractor during this time.

In addition to requirements set forth in this manual, the *DSE Manual* shall be followed with regard to submittal requirements for toll plaza design stages and contract documents.

1.1.2 Toll Plaza Elements and Site Design

The subsequent sections of this manual provide general design guidance applicable to all toll plaza elements. These cover the detailed design of the elements listed below, all of which are currently utilized by the Illinois Tollway:

- General design

- Civil design
- Site electrical and mechanical design
- Toll plaza building design
- Tolling equipment infrastructure design
- Communications design

The principles used in each of these elements shall be reviewed for applicability before being used for any new toll plazas.

1.2 Abbreviations and Acronyms

ºF	degrees Fahrenheit
A	amperes
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AET	All Electronic Tolling
AGA	American Gas Association
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials International
AVI	Automatic Vehicle Identification
CADD	Computer-Aided Drafting and Design
CAT 6	Category 6
Cisco	Cisco Systems Inc.
CM	Construction Manager
CNC	Coilable Nonmetallic Conduit
ComEd	Commonwealth Edison Company
DCM	Design Corridor Manager
DSE	Design Section Engineer
GEC	Illinois Tollway General Engineering Consultant
HVAC	heating, ventilation, and air conditioning
IDOT	Illinois Department of Transportation
IECC	International Energy Conservation Code
Illinois Tollway	Illinois State Toll Highway Authority
IP	Internet Protocol
IT	information technology
ITS	Intelligent Transportation Systems
LED	Light-Emitting Diode
MOT	Maintenance of Traffic
MSS	Manufacturers Standardization Society
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NI	Network Integrator
PM	Project Manager
PSI	pounds per square inch
RDC	Illinois Tollway's Roadway Design Criteria
RFI	Request for Information
RSPMG	Roadway Signing and Pavement Marking Guidelines
SMFO	single mode fiber optic

SMFOC	single mode fiber optic cable
TIMS	Traffic Incident Management System
UPS	uninterruptible power supply
V	volts
VES	Violation Enforcement System
VPJB	video power junction box
WBPM	Web-Based Program Management

1.3 Definitions

All Electronic Tolling (AET): All Electronic Tolling is a system of tolling that does not incorporate manual cash lanes.

American Association of State Highway and Transportation Officials (AASHTO): AASHTO is a nonprofit, nonpartisan association representing highway and transportation departments in the 50 states, the District of Columbia, and Puerto Rico. It represents all five transportation modes: air, highways, public transportation, rail, and water. Its primary goal is to foster the development, operation, and maintenance of an integrated national transportation system.

Barrier warrant analysis: The process in which a roadside obstacle is analyzed to determine whether or not it can be removed, relocated, reduced in severity, or shielded. The term also refers to the collective document consisting of all the locations within the contract limits, which contains all of the information needed for the analysis.

Base sheets: A sample set of detail drawings available from the Illinois Tollway to aid the DSE in preparing contract documents. These drawings generally describe the installation requirements of the Illinois Tollway for the device being described. The base sheets shall be utilized in close coordination with the guide special provisions. The base sheets are located on the Illinois Tollway website, similar to the Illinois Tollway standard drawings.

Clear Zone: The clear zone is defined by the AASHTO Roadside Design Guide as “the unobstructed, traversable area provided beyond the edge of the through traveled way for the recovery of errant vehicles.” See Illinois Tollway Traffic Barrier Guidelines, Article 5.4 for detailed definition and application of the clear zone by the Illinois Tollway.

Computer-Aided Drafting and Design (CADD): Computer-aided drafting is the creation of engineering or architectural construction plans through the use of computers and associated software (e.g., MicroStation). Computer-aided drafting and design leverages design tools within CADD software to improve efficiency.

Construction Manager (CM): The Engineer or firm of engineers and their duly authorized employees, agents, and representatives engaged by the Illinois Tollway to observe the work to determine whether or not it is being performed and constructed in compliance with the contract for construction.

Customer Work Agreement: An agreement with a utility provider associated with obtaining utility service connections.

Datalogger Camera: Closed circuit television cameras used for tolling audit purposes.

Design Section Engineer (DSE): The Engineer, or firm of engineers, and their duly authorized employees, agents, and representatives engaged by the Illinois Tollway to prepare the plans, special provisions, and itemized cost estimates for a Design Section.

Design Corridor Manager (DCM): The Engineer, or firm of engineers, contracted by the Illinois Tollway to act as the duly authorized agent of the Chief Engineer to manage other DSE's, in accordance with the scope of the particular duties delegated to them by the terms of their agreement.

Designer: The person (or consultant team) responsible for performing a design task for an Illinois Tollway project. Although this is typically the DSE, it may also include a person (or consultant team) hired by a contractor to perform design as part of a value engineering proposal or part of a performance-based design. This document uses the term "designer" to cover anyone performing design and only uses the term "DSE" when discussing tasks specific to the Design Section Engineer.

Downstream: The direction going with the flow of traffic.

Edge of Pavement: The longitudinal joint between roadway pavement and shoulder pavement.

Electronic Toll Collection: A wireless system to automatically collect tolls from vehicles using a toll road. Illinois Tollway's electronic toll collection system, known as I-PASS, uses in-vehicle transponders and overhead gantry readers to automatically deduct tolls from instrumented vehicles.

Federal Highway Administration: Agency of the United States Department of Transportation that oversees the maintenance and improvement of America's roads and highways.

Gore: An area between a ramp and the mainline (or between two ramps), generally triangular in shape.

Guide special provisions: A sample set of specifications available from the Illinois Tollway to aid the DSE in preparation of contract plans. These special provisions outline technical requirements for device performance criteria, testing procedures, integration requirements, warranty requirements, and other critical requirements to be met for the device being described. The guide special provisions shall be utilized in close coordination with the base drawings. Special provisions are only available by request from the Illinois Tollway. Special provisions from past projects shall not be carried forward to future contracts as the Illinois Tollway's preferred device or requirements may have changed between contracts. Only the latest special provisions shall be used by the DSE for each new contract.

I-PASS: The Illinois Tollway's prepaid, electronic tolling system (see Electronic Toll Collection). I-PASS is interoperable with the EZ-PASS system.

Intelligent Transportation Systems (ITS): The application of advanced electronic technologies and communications infrastructure in transportation to improve traveler information, increase motorist safety, speed incident response, enhance productivity, and reduce congestion. ITS must be explicitly integrated with operations to be effective.

Internet Protocol: The method or protocol by which data is sent from one device or computer to another.

National Electrical Code: A regionally adoptable standard for the safe installation of electrical wiring and equipment in the United States.

Network Integrator (NI): The NI is responsible for configuring new ITS equipment for use on the Illinois Tollway communications network ahead of contractor installation and system testing.

Open Road Tolling: A combination of back-office, roadside, and overhead gantry electronic equipment and database applications that allows electronic toll collection to occur at highway speeds, eliminating mainline barrier plazas and reducing congestion.

Preferential lane: A lane established on shoulder(s) for special uses per the Manual of Uniform Traffic Control Devices, Section 3D.01.

Project Manager (PM): Representative of either the Illinois Tollway or DSE that is responsible for design components of an ITS project and coordinating with the other project managers.

Request for Information (RFI): A question posed by the contractor to the CM to provide clarification or further information about a design component. RFI responses often require assistance from the DSE.

Roadway: A roadway consists of all lanes, auxiliary lanes, and shoulders in one direction of travel.

The Work: The improvement described in the construction contract, including all references, authorized change orders, extra work orders, and supplemental agreements.

Traffic and Incident Management System: Computerized central traffic management system housed at Illinois Tollway Headquarters that integrates and manages data from ITS tools to support the Traffic Operations Group.

United States Department of Transportation: A federal executive department of the United States government concerned with transportation.

Upstream: The direction going against the flow of traffic.

Web-based Program Management: Web-based system for use on all Illinois Tollway projects for interpersonal correspondence and record keeping. DSE and CM resources may be found on this system as well.

NOTE:

This manual follows the traditional definitions for **shall**, **should**, and **may**. **Shall** is used to mean something that is required or mandatory, while **should** is used to mean something that is recommended, but not mandatory, and **may** is used to mean something that is optional and carries no requirement or recommendation.

SECTION 2.0 PROJECT DEVELOPMENT

2.1 Toll Plaza Project Development

Designing and constructing toll plazas involves many unique parameters, multiple interested parties, and ever-evolving technologies, all of which can increase the technical risk inherent in a project. To reduce this risk, the Federal Highway Administration promotes the use of the systems engineering process. Systems engineering is defined as “an interdisciplinary approach and means to enable the realization of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, and then proceeding with design synthesis and system validation while considering the complete problem.”

Systems engineering requires a high-level definition of user needs and functional requirements in the earlier stages of a project, which is generally carried out by Illinois Tollway staff when programming improvements. The DSE then refines the required improvements and develops contract requirements for construction. During construction, the CM oversees the construction and installation of the toll plaza and its assets, verifying that contract requirements are met to satisfy the functional tolling needs that the Illinois Tollway identified at the start of the development process. Upon construction completion, the Illinois Tollway continues to evaluate the performance and operational needs for the life cycle of the toll plaza.

2.2 Planning and Pre-Concept Design

Pre-concept design may be performed by the Illinois Tollway, Design Corridor Manager (DCM) or the DSE depending on the nature of the project. On Illinois Tollway business systems projects, the Illinois Tollway is responsible for developing the initial planning and pre-concept design in which various project alternatives are analyzed. A DCM may provide pre-concept design for larger projects with multiple design sections. This is not traditionally part of a DSE contract as a thorough pre-concept design is needed to adequately scope the final design phase.

The result of the planning and pre-concept design typically serves as the basis for a scope of services negotiated with a design firm for execution. For toll plaza projects, the scope shall include the following parameters, at a minimum:

- Project name, limits, and other contractual details necessary to formulate an effective bid
- Project goals and objectives
- Proposed toll plaza locations
- Requirements for maintaining the tolling operations
- Design tasks to be performed by the DSE

Design section project goals may occasionally be generalized without identifying specific toll plaza deployment locations. Larger projects with DCM oversight of multiple design sections may necessitate the DSE coordinating design objectives through the DCM. For such projects, the DCM rather than the Illinois Tollway may be responsible for the planning and pre-concept design.

It is important to note that the Illinois Tollway is responsible for maintaining consistency with the systemwide tolling infrastructure when developing toll plaza projects.

2.3 Concept of Operations

A concept of operations describes how a proposed system is intended to work from the perspective of system users. It should include the identification of user needs, stakeholder roles and responsibilities, operational scenarios, and general procedures for system operation. The preparation of a concept of operations serves to clarify the Illinois Tollway's needs for a system that supports their goals and objectives.

2.4 System Requirements

The identification of system requirements is a critical step in any business systems project. These requirements must build from the goals and objectives identified by the Illinois Tollway in the pre-concept design, with each of the requirements being linked to a corresponding need defined in the concept of operations. It is critical to the success of the business systems project that the requirements are created from, and are very specifically referenced back to, these goals and objectives. It is important to document these linkages so that design changes and field changes can remain consistent with the requirements.

2.5 Conceptual Design

Conceptual Design is the initial design phase of a Project. The Scope of Work first developed in the Master Plan serves as the basis for the project design. Concept of operations and systems requirements are developed by the Illinois Tollway. Occasionally, the Illinois Tollway may engage consultants for master planning to help develop pre-concept design, concept of operations, or system requirements, which are not traditionally part of a DSE contract. The DSE shall meet with the Illinois Tollway to discuss the pre-concept design, concept of operations, and system requirements before developing the project scope or commencing any detailed project development. Everything provided to the DSE leading up to the project scoping is considered pre-concept design unless otherwise identified by the Illinois Tollway prior to project scoping.

2.6 Detailed Design

Conceptual design for business systems projects is followed by the detailed design stage, which encompasses the preliminary, pre-final, and final design phases. During detailed design, the DSE is responsible for developing contract plans, specifications, and cost estimates for construction of the toll plaza contract.

2.7 Design Submittals

The design submittals shall follow the documented process described in the Illinois Tollway's DSE Manual. The DSE shall comply with the requirements that apply to each business systems project, as described in their scope of services.

2.8 Bid and Construction Support

Bid and construction support by the DSE shall follow the documented process as described in the Illinois Tollway's *DSE Manual* and/or CM Manual. While bid and construction support is typical for all projects, there are several aspects specific to toll plaza projects that the DSE and CM should address. These include requests for information (RFIs) and shop drawing reviews for technology that is continually evolving, contractor's testing reports, as-built drawing preparation, coordination

with numerous Illinois Tollway departments, and coordination of adjacent and overlapping projects.

2.9 Operations and Maintenance

As part of the design process, the DSE shall consider how the operation and maintenance of the toll plaza and its devices will impact the design. The Illinois Tollway has established a maintenance process for each type of equipment in its inventory, including the management of manufacturer warranties. Standard warranty requirements are specified in the applicable special provision for each type of equipment. If the DSE proposes a new type of equipment, the Illinois Tollway may require the DSE to develop specific requirements for how the assets are to be operated and maintained, as well as measures and considerations for the initial installation. However, no change to any of the tolling equipment is allowed without Illinois Tollway Business System approval. These include system integration, system testing and acceptance, asset management, and warranty requirements, each of which is discussed in detail below. In such cases, the DSE shall develop the new special provision detailing all of these requirements in addition to the functional and environmental performance of the equipment. Likewise, the CM shall take into account the operations and maintenance aspects of construction and installation (e.g., accessibility, maintenance personnel safety) before approving tolling infrastructure or equipment installations.

2.9.1 System Integration

System integration involves configuring proposed plaza buildings and introducing them into the Illinois Tollway network. System testing and acceptance is performed to confirm that new plaza building equipment functions properly, transmits data in the format and at the accuracy level that is required, and ensures that this data is properly received by the business systems tolling equipment and Traffic Incident Management System (TIMS). System integration and system testing/acceptance for plaza building projects are performed in a logical process and are the responsibility of the contractor, including proper and timely coordination with the Illinois Tollway.

For plaza building construction contracts, the contractor is required to install and fully test the business systems equipment. The Illinois Tollway has invested in a wide-area tolling network. The core components of this network are already installed and operational. As such, most contracts will be construction “extensions” of this network unless otherwise scoped.

The integration of plaza building tolling elements into the business systems wide-area network shall only be in accordance with the following process:

- Only pre-approved plaza building equipment types shall be included.
- Only Information Technology (IT) Department–approved equipment manufactured by Cisco Systems Inc. (Cisco) shall be deployed and attached to the business systems digital network.
- All network components, including switches, associated software licenses, and network peripherals requiring configuration, shall be delivered to the business systems prior to their installation in the field. Upon receipt, the Business Systems NI will assign internet protocol (IP) addresses, perform other network configuration work, test the configured units, and affix required identifying labels that uniquely specify the plaza building equipment identification and location where each component is to be installed in the field.

- The contractor will be notified that network configuration work is complete and shall pick up the configured components from the Illinois Tollway Central Administration building and install them in the field in the correct location.

2.9.2 Network Integration

The Network Integrator (NI) maintains “Network Communication Diagrams and Communication Details” for all roadside plaza building equipment installed at plaza location. The DSE shall request a copy of the relevant Network Communication Diagram sheets covering the project’s construction limits from the NI by sending an email specifying the contract number, roadway, and mileposts at all limits of construction. The DSE shall include these sheets as an appendix to the 60%, 95%, and 100% construction designs, as well as the advertised plan set. These sheets document the logical connections among existing plaza building equipment within the contract limits. The NI and business systems will review the Network Communication diagrams for project impact after the 60% design review and inform the DSE of any expected impact to toll plazas, maintenance facilities or any other Illinois Tollway facilities or equipment within or nearby the construction limits.

The NI has the capability (along with the Illinois Tollway Business Systems Department) to remotely monitor plaza building equipment in the field and determine whether it is communicating through the wide-area network. The contractor shall verify that the plaza building equipment has been properly installed, calibrated, and successfully integrated into the business systems network. When corrective actions are required in the field, the Engineer shall contact the Illinois Tollway Business Systems Department directly to verify whether the problem has been corrected.

2.9.3 Testing and Acceptance

Business Systems equipment is not considered accepted until they have undergone complete system testing, as documented by the Engineer.

2.9.3.1 Factory Acceptance Test

For the most complex plaza building equipment as listed in the Plaza Electrical Work Special Provision and VES Camera High Pressure Wash System Special Provision, the Illinois Tollway may require a factory acceptance testing be performed on each main building equipment prior to shipment from the factory to the field site. If some of the building equipment can only be tested after installation into the plaza building then the manufacturer shall be present during the completion of the factory acceptance testing after installation into the plaza building. This is to allow much of the complex functional testing to be performed in a laboratory environment, when possible, instead of in an uncontrolled, highway work zone.

2.9.3.2 Field Install and Test

For each plaza building equipment, the Business Systems Special Provisions define the requirements for field testing as well as the testing related submittals. A test data sheet form with instructions may also be included in the special provision. Test plans and test reports shall be reviewed by the Engineer and the Business Systems Team during construction.

The contractor shall perform dry runs of the field tests to ensure that the plaza equipment shall pass on the first attempt. If the contractor identifies a configuration problem during the dry run, the Engineer shall be notified. The Engineer then notifies the project team.

2.9.3.3 Standalone/Local Field Test

Standalone and local field testing shall consist of the contractor verifying that plaza equipment has been installed, connected, and configured properly and can be operated as intended from the site. Prior to connection with the rest of the Business System network, the contractor shall ensure that all components of the plaza building equipment function properly after installation. The standalone/local field test shall be witnessed by the Engineer and the test results recorded on a site testing checklist that is signed off by both the contractor and the Engineer.

2.9.3.4 System Test

Upon passing the standalone/local field tests, the contractor shall submit, in writing, notice of devices that have completed the test and are ready for integration to the Engineer. The Engineer shall forward the device list through the appropriate chain of communication to the Illinois Tollway Business Systems Team.

The Business Systems Team will contact the NI to verify that the plaza equipment is communicating to the Business Systems network. If it fails, the Business Systems Team will notify the project team, and the Engineer will notify the contractor, who shall address and fix the problem. If it passes, the Illinois Tollway Project Manager (PM) will inform the contractor and the plaza equipment integration will progress to the next testing phase.

2.9.3.5 Burn-In Period

The requirements of the burn-in period are described in the Business Systems Special Provisions. In general, the 30-Day Burn-in Period allows the Business Systems Team to monitor the operation of the plaza equipment over an extended period of time and a variety of conditions. In general, the burn-in period shall demonstrate the monitoring capabilities of the plaza equipment. The burn-in period starts once the Business Systems Team has approved the “end to end” system test of the plaza equipment. For every one day the contractor is required to mitigate/fix a problem, an additional one day of testing will be added to the 30-day test.

The contractor shall maintain a date and time-stamped log of all failures occurring during the burn-in period and what was done to correct each problem. The burn-in clock is stopped each time a failure occurs and restarted where it stopped when the problem is corrected. The reset or extension of the burn-in period is defined in the business system special provisions for the equipment in question. The contractor shall demonstrate that the failure was successfully corrected for the burn-in period to commence and final acceptance ultimately to be granted.

2.9.4 Asset Identification

The contractor shall provide the Illinois Tollway asset management documentation, including model number and serial number of each serialized plaza equipment, as part of their as-built documentation. The asset identification shall be listed on the warranty documents provided. Information required as part of the asset management process includes, but is not limited to, the following:

- Plaza equipment identification
- Model and serial number of the equipment
- IP address

- Firmware version installed
- Warranty information
- Site photos, including a general site photo, inside and outside of the plaza building, and equipment cabinet photos

2.9.5 Warranty

Manufacturers' warranties are for equipment only and the manufacturer's labor associated with repairing the equipment, but not for labor needed in the field to remove and replace the equipment. The physical replacement of equipment will be performed by the Illinois Tollway or the Illinois Tollway's Tolling Maintenance Contractor or the contractor if the equipment is covered under surety. Warranty requirements shall be documented in the contract special provisions (or as found in the guide special provisions as applicable). For most equipment, the standard equipment manufacturer's warranty will be transferred to the Illinois Tollway upon contract closeout. For some equipment, an extended warranty will be required and defined in the special provisions. Additional aspects of the contractor's work will be covered by surety, as further described in the Illinois Tollway Supplemental Specifications to the Illinois Department of Transportation (IDOT) Standard Specifications.

2.10 Continuation of Tolling During Construction

The disposition of existing toll plazas and equipment shall be considered as part of any construction contract. This will generally fall into one of two categories: conflicts with general road and bridge construction (e.g., widening projects) or allowance for continuous maintenance of tolling within a construction zone. Because Illinois Tollway Operations relies on tolling revenue generation, continuous availability of tolling is a critical component that shall be accounted for in contract documents.

2.10.1 Construction Conflicts

Any type of construction has the potential to impact the existing tolling deployment. Impacts on tolling may result from any or all of the following:

1. Impacts on the source of power and power lines feeding the toll plaza
2. Impacts on the source of communications (plazas) or the communications cables feeding a plaza
3. Impacts on the toll plaza (tolling zone/equipment/monotubes)

2.10.2 Existing System Verification

The Illinois Tollway will provide all available as-built drawings, system drawings, and inventories. However, the availability and accuracy of all information varies. The DSE shall develop a clear understanding of the information available for the existing system during scoping and include effort to field verify information as appropriate. Contract documents shall clearly identify existing toll plazas and, to the extent possible, underground infrastructure supporting tolling, power, communications, and utility services.

2.10.3 Mitigation Plan Development

Toll plaza conflict mitigation may be performed as part of an advance contract to the main roadway contracts or as part of the main roadway contracts with interim completion dates. In both cases, the intent is to allow for relocated or new equipment to be operational prior to the first major stage changes to allow continuous tolling operations. As part of the overall design process, the DSE shall coordinate closely with roadway and other civil infrastructure designers to identify impacts on any of the above and design mitigation measures as appropriate. These may include, but are not limited to, any or all the following:

- Temporary relocation with permanent relocation to follow
- Permanent relocation
- Temporary fiber optic communications
- Temporary utility power
- Portable generator to mitigate extended outages of utility power

The Illinois Tollway's general design requirement is to maintain the existing functionality of the tolling equipment in the construction corridor. Depending on the extent of the construction, location, and size of existing toll plaza, the Illinois Tollway may direct temporary tolling measures to be deployed to maintain tolling operations. This direction will be provided at scoping as part of the pre-concept design or general design criteria (system requirements).

New tolling equipment deployed for maintaining tolling operations may be installed through a combination of applications. This may include permanent tolling locations such that the Illinois Tollway can receive a permanent benefit if construction operations allow. This may also include temporary tolling locations with automatic vehicle identification (AVI) antennas, violation enforcement system (VES) cameras, and infrared illuminators on temporary support structures or wood poles with mast arms. It is the DSE's responsibility to identify the most appropriate design solution to meet the functionality required by the Illinois Tollway's system requirements in an economical fashion.

2.10.4 Maintenance

In addition to mitigation of any impacts on and conflicts with existing toll plaza equipment, the Illinois Tollway must be able to maintain the existing tolling system when required. This may include routine maintenance, specific repairs, or replacement to address a particular operational issue. This maintenance may be addressed through multiple means, depending on the nature of the construction project.

2.10.4.1 Illinois Tollway Maintenance

The Illinois Tollway typically maintains the existing tolling system and toll plaza through a combination of Illinois Tollway resources and support contractors. The Tolling Maintenance Contractor is responsible for maintenance of the tolling electronic equipment. As the long-term operators and maintainers of the system, these parties often provide the best solution to address maintenance needs. The Illinois Tollway typically retains the right to maintain its equipment within the construction zone. As part of contract documents development, appropriate provisions shall be included to ensure that Illinois Tollway is provided access to the work zone in a timely manner to perform needed repairs. Alternate methodologies shall be considered to mitigate construction coordination issues such as site access and disruptions to construction operations.

2.10.4.2 Contractor-Provided On-Call Maintenance

Contractor-provided on-call maintenance can be used to supplement Illinois Tollway resources when needed. Contracts may include special provisions and pay items that allow a contractor to respond on an on-call basis when the Illinois Tollway determines this arrangement to be most efficient. The Illinois Tollway retains general responsibility for the equipment except when the contractor is actively responding to a call. This may be employed as part of a toll plaza construction contract or included in a general construction contract. It should be noted that coordination issues may still exist if a dedicated toll plaza contract (which includes the plaza maintenance) overlaps with a general construction contract. The DSE shall consider which application is best and may need to coordinate with other designers to ensure that appropriate provisions are included in a general roadway contract to allow for access by other contractors.

2.10.4.3 Maintenance Transfer

The Illinois Tollway may transfer some maintenance responsivity of the toll plaza within the construction zone to the contractor, in which the contractor would be solely responsible for the continued operation of the toll plaza (except the tolling electronics) for the duration of the contract. This methodology is typically not employed unless the entire toll plaza is being replaced. The DSE shall discuss this methodology at the 30% design meeting with the Illinois Tollway if it is to be considered. Due to the requirement for the Tolling Maintenance Contractor to always be responsible for maintenance of the tolling electronics, that portion is never transferred to other parties for maintenance. Therefore, the Illinois Tollway will not typically transfer all maintenance responsibility as part of construction; however, it may be considered based on contract scope.

The DSE shall evaluate the general impact of a construction project on the existing toll plaza in the area. Based on the potential impact, duration of the project, and other project-specific considerations, the DSE in consultation with the Illinois Tollway shall select the appropriate methodology for ensuring that the tolling system can be adequately maintained during construction.

SECTION 3.0 GENERAL DESIGN GUIDANCE

3.1 Functionality and Toll Plaza Siting

All toll plaza equipment must be designed and sited to perform its intended functionality. To enable this, the DSE shall understand the overall goals and objectives of the Illinois Tollway's traffic and incident management strategy. Additionally, the DSE shall comprehend the specific project goals, objectives, and other information presented in the system requirements or pre-concept designs provided by the Illinois Tollway to ensure that the design of the system effectively supports each as applicable. These are clearly stated in the Illinois Tollway's concept of operations and system requirements, documents introduced in Articles 2.3 and 2.4 of this manual. The DSE shall validate these requirements as part of the design process in order to translate them into a detailed system design. Critical elements such as, but not limited to, right-of-way, roadway grade, superelevation, and geometry shall be evaluated when identifying the toll plaza site location to ensure that it satisfies the design criteria described herein.

All new tolling sites or rehabilitations of existing tolling sites shall have All Electronic Tolling (AET). This manual does not address any improvements to existing plazas where ground-mounted or island-mounted tolling equipment or accessories are needed or are to remain in operation. For those instances, the Illinois Tollway PM, with assistance from the Illinois Tollway General Engineering Consultant (GEC), will provide guidance.

When developing alternatives for toll site locations, the DSE shall provide details for each alternative that include the following:

a. Outline of the toll site with elements such as plaza building, parking, communication tower, number of toll lanes, etc.
b. Coordination with Illinois Tollway when preferred toll site layout is not feasible
c. Identification of the design deviations required for the recommended toll site
d. The maximum AVI coax cable length from the equipment rack inside the building to the most extreme end of the tolling zone shall not exceed 150 feet. This length is inclusive of all vertical and horizontal distances required for the cable to travel up the monotubes, three feet of cable slack at the equipment rack, six feet of cable slack at the antenna, as well as any underground conduit runs.

3.1.1 Toll Plaza at the Mainline Requirements

New toll plazas shall accommodate the approach roadway and shoulder width, and gutter width where applicable. If directed by the Illinois Tollway, provisions shall be made for additional lanes for future use. New mainline toll plaza roadway design shall follow the criteria stated in Article 4.1, Table 4.1.1.

Selection of mainline toll plaza locations shall avoid placement in high lane-change areas, such as weaving sections, exit ramp terminal areas, and entrance ramp terminal areas.

3.1.2 Toll Plaza at Ramp Requirements

Placement of the ramp toll plazas should strive to be equidistant from the beginning and end of the ramps. Locations near the beginning of ramps shall be avoided so that the ramp gores do not have any barriers or barrier protection, as unexpected movements can occur here. In the case of

exit ramps, plazas shall be placed away the queuing area approaching the intersection. New ramp toll plaza roadway designs shall follow the criteria stated in Article 4.1, Table 4.1.2.

For plaza lane adds and lane drops:

- Tapers shall start no less than 200 feet past the monotubes on the departure end.
- Tapers shall start no less than 500 feet ahead of the monotubes on the approach end.

3.2 Constructability and Phasing Requirements

Toll plaza constructability and phasing will require that the DSE address specific site conditions. Therefore, special provisions may be used to meet project-specific needs. The Illinois Tollway website can be referred to for applicable special provisions.

3.2.1 Construction and Staging

Construction staging shall be designed to satisfy the following requirements:

a. The DSE shall maintain existing building and electrical systems so that they remain operational during construction of new toll plaza facilities. Coordination with Business Systems will be required.
b. Demolition of an existing toll plaza can only begin once the new toll system in the replacement toll plaza is installed, commissioned, tested, and activated, so that it is functional to the satisfaction of Business Systems.
c. The final pavement surface with proposed striping needs to be constructed at all toll lanes and shoulders and the site needs to be turned over to the Illinois Tollway Maintenance before the tolling integrator starts the toll equipment installation.
d. The tolling integrator shall certify lanes prior to shifting tolling to the new facility, at which point the final portion of the existing tolling can be removed.

3.2.2 Maintenance of Traffic Plan

The DSE shall develop a Maintenance of Traffic (MOT) Plan in accordance with Article 4.5.6 of the *DSE Manual* for all construction activities associated with toll site construction, toll equipment installation, tolling integration, commissioning, and testing. Toll operations shall be maintained with no interruptions to toll collection during construction, unless otherwise approved by the Illinois Tollway Business Systems. In cases where lane shifts or temporary lane closures are required, the DSE shall follow the guidelines and procedures outlined in Articles 5.3.17 through 5.3.19 of the Illinois Tollway Roadway Traffic Control and Communications Manual. Where appropriate, run arounds using existing or temporary toll plazas can be evaluated. Turning off tolling may be allowed for short-duration projects, where justified by savings in construction costs and approved by the Illinois Tollway Chief of Finance.

3.2.3 Detours

Detours for ramp plaza construction are not allowed. In cases where ramp detouring is the only feasible alternative, the DSE shall submit a design deviation for approval prior to implementing the detour. The DSE shall present to the Illinois Tollway Detour Committee the proposed detour route and state reasons on why the detour is needed. The presentation shall include options that

reduce impacts on customers. Double tolling should be avoided, if possible, as it results in a complicated back-office procedure.

3.2.4 Testing

During the commissioning and testing of the installed toll equipment, approach and departure roadway segments shall be available to allow testing vehicles to accelerate to the final roadway condition posted speed prior to entering the tolling pavement area. Approach and departure pavement limits are as follows:

- 3,000 feet of roadway at each mainline tolling gantry (minimum 1,500-foot approach and 1,500-foot departure)
- 3,000 feet of roadway at each ramp tolling gantry (minimum 1,500-foot approach and 1,500-foot departure) or as the length of ramp permits for the tolling integrator testing activities

3.3 Maintainability and Access

It is important to consider how a site will be maintained following deployment. Maintenance will typically consist of two primary activities:

1. Access by technicians on foot to a ground- or pole-mounted equipment cabinet
2. Access by technicians to pole- or truss-mounted equipment via standard lift trucks or material handling lift trucks

Site access will be needed on a regular basis for both routine maintenance (cleaning, adjustments, etc.) and repairs. Ease of access for both technicians and vehicles must be considered, as well as the limitations of specialized equipment such as longer reach lift trucks and/or the need for lane closures.

To provide access, pull-off areas shall be provided to toll plaza control buildings and roadside toll infrastructure. The requirements for maintenance and pull-off areas are as follows:

- Pull-off areas shall allow for entry and exit, maintenance vehicle parking, and staging of a minimum of two maintenance vehicles.
    - Maintenance vehicles include box vans, lift trucks, bucket trucks, and scissor lift trucks.
- Maintenance areas shall be stabilized and physically protected from traffic by concrete barriers.
- The toll plaza control building shall be protected by bollards from accidental maintenance vehicle damage.
- Maintenance and pull-off pavement shall match the pavement design of the adjacent roadway.
- Maintenance pull-off parking shall be restricted to Illinois Tollway Maintenance use only.
- Maintenance pull-off areas shall be designed to allow for vehicle outriggers of the bucket truck or scissor lift truck to be deployed adjacent to the accessible gantry and ITS devices.

3.4 Toll Plaza Facilities

The toll plaza site shall include a control building to house electrical and electronic equipment that supports tolling operations. The DSE shall design the control building, location, and layout in coordination with the Illinois Tollway PM and GEC. For mainline toll plazas, each direction of travel shall have two separate control buildings with maintenance access in the same direction of travel. The main control building shall be large enough to house the emergency generator and receive the incoming electric and natural gas services. The remote control building does not have a generator as it receives power from the main control building. For ramp toll plazas, the control building arrangement should be optimized based on the interchange type. Typical diamond interchanges shall have one main and one remote control building on two ramps. Interchanges with two tolling zones in proximity could share a common control building, subject to approval by the Illinois Tollway. The DSE shall ensure that AVI antenna cable distances are within the maximum allowed when considering shared control buildings. Control buildings may also be shared between a mainline and ramp plaza if the tolling zones are in proximity.

3.5 Labeling Guidelines

The DSE shall be made aware of the “Plaza Electrical Work” special provision labeling requirements, available on the Illinois Tollway WBPM system. The ITS Labeling Guidelines also apply for toll plaza work and are available on the Illinois Tollway website. The DSE shall comply with this special provision and the ITS Labeling Guidelines to include labeling for the following cabling and equipment via the contract documents, as coordinated with Illinois Tollway:

1. Cabinet/equipment racks
2. Communications/network equipment
3. Fiber termination shelves
4. Fiber optic and copper cables (backbone and drop)
5. Fiber optic and copper patch cords
6. Copper patch panels
7. Copper building entrance terminals
8. Ground bus bars
9. Bonding conductors
10. Terminal panel boards
11. Field/site space

The Engineer shall review the contractor’s “labeling plan” for conformity with the contract documents and Illinois Tollway’s ITS Labeling Guidelines prior to the start of construction of any cabinet, rack, raceway, cable, or wire requiring labeling per the Illinois Tollway special provisions and the Labeling Guide.

3.6 Standard Drawings, Base Sheets, Special Provisions, and Reference Documents

Many Standard Drawings and Special Provisions for toll plaza design work are available on the Illinois Tollway website and WBPM system. The DSE shall be responsible for final development of all details and special provisions for use in the contract documents. Structural details for toll plaza monotubes and building foundations shall be designed and detailed by the DSE, based on the guide and standard drawings. All referenced manufacturers, models, and functional requirements of any equipment specified or shown shall be verified by the DSE to be commercially

available and meet the intended functional requirement of that piece of equipment, as specified or shown in the guide document. Any equipment found to be obsolete or incapable of meeting the intended functional requirement shall be identified by the DSE. The DSE shall then notify their Illinois Tollway PM of such findings and make a recommendation for replacement.

3.7 Topographic Survey

A topographic survey is required for each deployment site and for every device deployed along the roadside. The survey allows for a cross-sectional view of the site to determine the appropriate functional parameters that may be met (i.e., a proper detector mounting height that is achievable) and provide data for clear zone calculations. For mounting height analysis, additional information for elevated items, such as aerial lines, bridges, or tree cover, is required. Items that are not accessible using normal survey methods can be surveyed using LiDAR or direct reflex technology. If using LiDAR, the point cloud along with the feature extraction file shall be included in submittals. Topographic information shall be provided for all items within a 100-foot radius of every deployed device.

Additionally, potential design flaws (such as drainage, grading, and maintenance access for vehicles and technicians) shall be evaluated. For widening and reconstruction contracts, additional topographic surveys generally will not be required.

When an area proposed for equipment has not been surveyed previously, a full topographic survey shall be performed based on the project control, or State Plane coordinates when project control is unavailable. The survey shall be performed in accordance with the Illinois Professional Land Surveyor Act Minimum Standards of Practice and the State of Illinois Survey Manual.

3.8 Temporary Tolling Equipment or Site

The DSE shall design the tolling sites and systems to minimize temporary tolling equipment or sites required during construction. In many cases, the proposed toll plaza can be built off-line or adjacent to the existing toll plaza to maintain tolling operations during construction. Once the proposed toll plaza is operational, traffic or tolling can then be shifted to the new plaza. When that is not possible, the DSE may be required to design temporary tolling equipment or sites. Temporary tolling equipment shall be designed to maintain tolling operations of active traffic lanes, in coordination with Illinois Tollway Business System requirements. The DSE may be required to design a temporary off-line tolling site if the proposed toll plaza cannot be constructed before the existing toll plaza is removed. For temporary tolling sites, the DSE shall optimize the design by considering lower-cost options like temporary structures or wood poles with mast arms for temporary support of overhead tolling equipment. Temporary outdoor cabinets to house power, communications, and tolling equipment should also be considered for temporary tolling sites.

SECTION 4.0 CIVIL DESIGN CRITERIA

4.1 Toll Plaza Roadway and Pavement Design

The geometric design of plazas varies with location, traffic volumes, queue length, deceleration diverges, and acceleration merges. Each location shall be individually analyzed and designed. The criteria for new mainline and ramp toll plazas are summarized in the tables below. For rehabilitation of existing toll plazas, contact Illinois Tollway Engineering for design guidelines.

Table 4.1.1 - Illinois Tollway Mainline Criteria
(RDC refers to Illinois Tollway Roadway Design Criteria Manual)

Design Element	Minimum		Notes
Design Speed	Refer to RDC Article 2.2		
Horizontal Curvature	None		Entire length of the plaza pavement needs to be placed on a tangent section.
Vertical Grade	Refer to RDC Article 2.5.1 and Article 2.5.2		
Vertical Curves	Not Preferred		If plaza pavement is located on a curve, the minimum grade shall be no less than 0.3%.
Pavement Width	Refer to RDC Article 2.6.1		
Pavement Cross Slope	Refer to RDC Article 2.6.2		If plaza pavement is on a superelevation transition section, the maximum cross slope shall be no greater than 3%.
Paved Shoulder Width	Left	Refer to RDC Article 2.6.3	14 feet maximum width
	Right		
Paved Shoulder Cross Slope	Left	Refer to RDC Article 2.6.4	See Maximum Rollover Criteria
	Right		
Maximum Rollover	Refer to RDC Article 2.4.9		If plaza pavement is on a superelevation transition section, the maximum rollover shall be no greater than 5%.
Use of Gutters and Curbs	Refer to RDC Article 2.6.6		

Table 4.1.1 - Illinois Tollway Mainline Criteria (RDC refers to Illinois Tollway Roadway Design Criteria Manual)			
Design Element	Minimum		Notes
Horizontal Clearance to Barrier	Median Shoulder Side	Clearance shall match the approach roadway shoulder width or the minimum shoulder width—whichever is greater—plus gutter if applicable.	
	Outside Shoulder Side		
Vertical Clearance	21.5 feet to centerline of the monotube 18 feet to the lowest object attached on the monotube		
Plaza Pavement	Longitudinal Length	100 feet	Refer to Illinois Tollway base sheet M-RDY-417.
	Material	Continuously Reinforced Concrete (CRC)	
	Thickness	14.25 inches	
	Diamond Grinding	Yes	Refer to Illinois Tollway Base Sheet M-RDY-413.
Transition Pavement (Approach and Departure)	Length	15 feet	Refer to Illinois Tollway base sheet M-RDY-417. Contact Illinois Tollway Materials regarding these design elements to confirm the requirements listed here.
	Material	Portland Cement Concrete (PCC)	
	Thickness	10 inches (Varies to meet plaza pavement thickness)	
	Diamond Grinding	Yes	Refer to Illinois Tollway Base Sheet M-RDY-413.
Shoulder Transition Pavement (Approach and Departure)	None		Shoulder area in the transition pavement section shall match the approach or departure shoulder pavement structure.
Barrier Type	Left	Double face concrete carrier	Refer to Illinois Tollway Base Sheet M-RDY-417 and Standard Drawing F-13 (Overhead Sign Structure Monotube Type (Steel) Mainline Structures Details)
	Right	Single face concrete barrier	
Barrier Taper (Approach and Departure)	30:1		

Table 4.1.2 - Illinois Tollway Ramp Criteria (RDC refers to Illinois Tollway Roadway Design Criteria Manual)			
Design Element	Minimum		Notes
Design Speed	Refer to RDC Article 2.2		
Horizontal Curvature	Not Preferred		If plaza pavement is located on a curve, the maximum cross slope shall be no greater than 3%.
Vertical Grade	Maximum	3%	
	Minimum	Refer to RDC Article 2.5.2	
Vertical Curves	Not Preferred		If plaza pavement is located on a curve, the minimum grade shall be no less than 0.3%.
Tolled Lane Width	Minimum	12 feet	
	Maximum	14 feet	
Pavement Cross Slope	Refer to RDC Article 2.6 (see notes)		If the toll plaza pavement is placed on a horizontal curve, the minimum cross slope shall be 0.3% and the maximum cross slope shall be 3%.
Paved Shoulder Width	Left	Refer to RDC Article 2.6.3	Either a full tolled lane width shall be provided or shall not have shoulders greater than 2 feet and less than 10 feet.
	Right		
Paved Shoulder Cross Slope	Left	Refer to RDC Article 2.6.4	The cross slope should preferably match the adjacent plaza lane cross slope. If not, the cross slope shall be as per RDC Article 2.6.4.
	Right		
Paved Traveled Path (face to face of barrier)	One Lane Ramp	36’ Typical (3 – 12’ tolled lane width) 34’ minimum	
	Two Lane Ramp	48’ Typical (4 – 12’ tolled lane width) 42’ minimum	
Maximum Rollover	5%		
Use of Gutters and Curbs	Refer to RDC Article 2.6.6		

Table 4.1.2 - Illinois Tollway Ramp Criteria (RDC refers to Illinois Tollway Roadway Design Criteria Manual)			
Design Element	Minimum		Notes
Horizontal Clearance to barrier	Median Shoulder Side	Clearance shall match the approach roadway shoulder width or the minimum shoulder width, whichever is greater, plus gutter if applicable.	
	Outside Shoulder Side		
Vertical Clearance	21.5 feet to centerline of the monotube 18 feet to the lowest object attached to the monotube		
Plaza Pavement	Longitudinal Length	100 feet	Refer to Illinois Tollway base sheet M-RDY-418.
	Material	Continuously Reinforced Concrete (CRC)	Contact Illinois Tollway Materials regarding these design elements to confirm requirements listed here.
	Thickness	13.25 inches	
	Diamond Grinding	Yes	Refer to Illinois Tollway Base Sheet M-RDY-413 (sheet to be added).
Transition Pavement (Approach and Departure)	Length (feet)	15 feet	Refer to Illinois Tollway base sheet M-RDY-418.
	Material	Portland Cement Concrete (PCC)	Contact Illinois Tollway Materials regarding these design elements to confirm requirements listed here.
	Thickness	10 inches (Varies with plaza pavement thickness)	
	Diamond Grinding	Yes	Refer to Illinois Tollway Base Sheet M-RDY-413.
Shoulder Transition Pavement (Approach and Departure)	None		Shoulder area in the transition pavement section shall match the approach or departure shoulder pavement structure
Barrier Type (If needed)	Left	Single Face Concrete Barrier	Refer to Illinois Tollway Standard Drawing F-15 (Overhead Sign Structure Monotube Type (Steel) Structure Details for AET Ramp)
	Right		
Barrier Taper (Approach and Departure)	Refer to AASHTO Roadside Design Guide Table 5-9		

4.2 Toll Plaza Drainage

Toll plaza drainage shall be designed and detailed in accordance with *Section 11.0 of the Illinois Tollway Drainage Design Manual*.

4.3 Toll Plaza Monotube Overhead Sign Structure

Monotube type sign structures shall be designed and detailed in accordance with *Article 24.6 of the Illinois Tollway Structure Design Manual*.

4.4 Toll Plaza Site Layout

4.4.1 General Requirements

Toll plaza is a facility built to collect tolls on the Illinois Tollway system. A typical toll plaza layout should include a parking area, control building, communication tower, and toll equipment. The parking area is used for Illinois Tollway maintenance/inspection or state police vehicles access. Sidewalks and concrete pathways shall meet American Disability Act requirements.

All proposed utilities, mechanically stabilized earth (MSE) walls, drainage structures, box culverts, and bridge foundations within the vicinity of the toll plaza must be located at least 10 feet from the Illinois Tollway right-of-way.

4.4.2 Security Fencing

Security fencing shall be designed and detailed in accordance with *Article 2.17.5 of the Illinois Tollway Roadway Design Criteria* manual.

4.4.3 Building Sites

Building sites shall be located such that entering or departing maintenance personnel will have a clear view of the approaching traffic. They also need to have acceleration/deceleration space along the shoulder. Parking for maintenance vehicles shall normally be located beyond the plaza control building/monotubes and be off the shoulder and/or behind a barrier.

Building sites shall allow for snow clearing and snow storage. Crash investigation sites, when incorporated nearby, shall follow the requirements in the Illinois Tollway *Roadway Design Criteria*.

Site selection shall accommodate the need for communication towers and any needs of the Illinois State Police.

4.4.4 Location of Plaza Control Building

Construction, maintenance, and repair access shall be provided for:

- Control building and associated equipment
- Parking (at least one vehicle), preferably downstream of the control building or otherwise shielded from traffic
- Emergency generator when required
- Electrical equipment and transformers

- Control building lighting; heating, ventilation, and air conditioning (HVAC) units; ITS equipment; security cameras; and portable generator hookups

A barrier shall be constructed along any elevated edge of the building site when accessible to maintenance vehicles or fencing/handrails shall be provided when the site is accessible by maintenance personnel.

4.5 Toll Plaza Barriers

4.5.1 Barrier Requirements

Barriers on both the right and left sides of the roadway shall be provided on the approach to each tolling site to prevent and discourage toll evaders. These barriers shall be concrete barriers, guardrails when justified, or high-tension cable median barriers in grass medians. The barrier requirements are as follows:

- Barriers installed to shield the control building, monotube structures, tolling or associated equipment shall meet the requirements of the Traffic Barrier Guidelines.
- When used, concrete barriers shall be a minimum of 54 inches high at monotubes and adjacent to plaza control buildings. They shall be designed in accordance with Illinois Tollway Standard Drawings, Section F.
- When concrete barriers increase in height in the direction of traffic, the barrier height transition shall be 1V:10H or flatter.
- Barrier tapers, when their offset is decreasing in the direction of traffic, shall meet (at a minimum) the AASHTO Roadside Design Guide, Table 5-9 (Suggested Flare Rates for Barrier Design) flare rates.
- Consideration shall be given to future MOT running on the shoulder when determining the barrier location.
- Monotube (Open Road Tolling/AET) installation shall be performed in accordance with Illinois Tollway Standard Drawings, Section F.
- Foundations for barrier-mounted monotubes shall follow Illinois Tollway Standard Drawing F13.
- Adequate room shall be provided for equipment cabinets, including space to open and maintain them, located where it is naturally inaccessible to traffic or shielded from traffic with a barrier warrant analysis.
- No conduits, cables, or equipment are allowed on top of or on the traffic face of the concrete barriers.
- The left side mainline foundation shall be centered on the roadway and aligned with the existing concrete median barrier when present.
- The left side mainline foundations shall be centered on the roadway centerline when a grass median is present. Median drainage shall be considered when locating the monotube foundation. When a center barrier location is not feasible, the face of the left side barrier shall be located no closer than 2 feet from the edge of the paved shoulder.
- The minimum distance from the face of the barrier to the left edge of pavement shall be no less than the shy-line offset as shown in AASHTO Roadside Design Guide, Table 5-7.

4.5.2 Barrier Warrant Analysis Requirements

Roadside safety shall be considered in all elements of design. The designer shall prepare a Barrier Warrant Analysis Report and obtain approval of such a report from the Illinois Tollway in accordance with the Illinois Tollway's *Traffic Barrier Guidelines*. Overall submittal requirements shall conform to the current Illinois Tollway *Traffic Barrier Guidelines*.

4.6 Toll Plaza Pavement Marking

For pavement markings at toll plazas, refer to *Roadway Signing and Pavement Marking Guidelines (RSPMG), Article 12.6 Plaza Pavement Markings*.

4.7 Toll Plaza Signage

For signing at toll plazas, refer to *RSPMG, Articles 3.2.16 through 3.2.20*.

4.8 Toll Plaza Computer-Aided Design and Drafting

For all CADD requirements, refer to the Illinois Tollway *Computer-Aided Design and Drafting (CADD) Standards Manual*.

SECTION 5.0 SITE ELECTRICAL AND MECHANICAL DESIGN CRITERIA

5.1 Toll Plaza Site Electric Service and Power Distribution

The DSE is responsible for electric service installation infrastructure design and electric service request coordination with Commonwealth Edison Company (ComEd). Toll plazas shall use 208/120 volt, three-phase, four-wire electric services. The main toll plaza control building receives electric service and distributes power within the building. The main control building also distributes power and communication to the remote control building(s) across the mainline or on other ramps. The DSE shall design the site power distribution to include step-up/down transformers if required to account for voltage drop, per National Electrical Code (NEC) requirements. The Illinois Tollway contractor will furnish and install a meter socket, conduit, secondary wiring, and transformer concrete pad (when applicable) for ComEd. ComEd will furnish and install a transformer, ground rods/wire, and primary wiring. All work for electric service shall conform to ComEd standards.

5.2 Toll Plaza Site Natural Gas Service

The DSE is responsible for natural gas utility service installation infrastructure design and for coordinating service requests with the natural gas utility company to fulfill the building's total capacity requirements. The DSE shall design the natural gas utility service to supply the main toll plaza control building and to distribute natural gas to the generator and heating system appliances. Refer to base sheet M-BUS-2509 for connection to the gas meter and sleeve interface to the main plaza building.

The DSE shall coordinate with the natural gas utility company to ensure the availability of gas service to the required main plaza building location or to provide an alternate solution for gas service connection to the main plaza building.

5.2.1 Natural Gas Piping and Fittings

Low-Pressure Piping

Above-grade, the piping within main plaza building shall meet the following:

a. Steel pipe – ASTM International (ASTM) A53, Type "S", seamless, Grade "B", Schedule 40, black
b. Fittings/Joints – 3 inches and less: malleable iron, threaded, American Society of Mechanical Engineers (ASME) B16.3, Class 150, standard pattern fittings, and threaded joints
c. Unions and Flanges – 3 inches and less: malleable iron, threaded, ASME B16.39, Class 150, unions, female pattern, brass-to-iron seat, ground joints

Natural Gas Hose Connector

The strip wound natural gas hose connector is specified as a fully interlocking strip wound hose assembly used for connecting standby generators to a permanent gas piping system. This hose has the ability to absorb the vibration from the generator. The hose requires a minimum 12 foot installation parallel to the generator.

Gaskets and Joining Materials

Gaskets and joining materials shall meet the following:

a. Joint Compound and Teflon Tape: Approved for natural gas usage and to be applied to male pipe threads only. Lamp wick is not permitted.
b. Gasket Material: Thickness, material, and type suitable for natural gas

Valves

There are two types of values applicable to natural gas piping:

a. Shut-Off Valves:
    i. Manual Valves: Valves shall meet the standards of American National Standards Institute (ANSI) Z21.15 and ANSI Z21.15A
    ii. Automatic Valves: Valves shall meet the standards of ANSI Z21.21 or ANSI Z21.21A, which require 2 inches and smaller with threaded ends and 2 1/2 inches and larger with flanged ends
b. Low-Pressure Gas Stop Valves: 2 inches and smaller; American Gas Association (AGA) certified and stamped, plug or ball type; bronze body and plug or chrome-plated brass ball; with flat head, square head, or lever handle and threaded ends; with locking (tamperproof) feature

Supports and Hangers

Supports and hangers shall comply with Manufacturers Standardization Society (MSS) SP-58 and meet utility company requirements.

Natural Gas Detectors

Natural gas detectors with local audio and visual alarms must be included with each installation.

Codes and standards whose requirements must be met include:

a. Illinois State Codes:
    i. 2009 International Building Code (or most current adopted code version)
    ii. 2012 International Energy Conservation Code (or most current adopted code version)
    iii. 2009 International Fire Code (or most current adopted code version)
    iv. 2009 International Fuel Gas Code (or most current adopted code version)
    v. 2009 International Mechanical Code (or most current adopted code version)
b. Local Jurisdiction Codes and Ordinances (most current adopted codes and ordinances versions)
c. Local Utility Requirements
d. National Fire Protection Association (NFPA) 54: National Fuel Gas Code (most current adopted code version)
e. ASME:
    i. A13.1 “Scheme for the Identification of Piping Systems”
    ii. B16.3 - "Malleable Iron Threaded Fittings"
    iii. B16.39 - "Malleable Iron Threaded Unions"
    iv. B31.9 - "Building Services Piping"
f. ASTM:

i. A53 - "Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless"

g. ANSI:
   i. Z21.15 - "Manually Operated Gas Valves for Appliances, Appliance Connector Valves, and Hose End Valves"
   ii. Z21.21 - "Automatic Valves for Gas Appliances"

h. AGA

i. Listing and Labeling Requirements of NEC and Occupational Safety and Health Administration Regulation 1910.7

5.3 Toll Plaza Site Lightning Protection

Lightning protection systems consist of interconnected electrical grounding outside and inside the toll plaza building. A ground ring around the building is connected to the monotube grounding, ComEd transformer grounding, interior ground bus bars, interior ground halo, and interior equipment/rack grounding. This ground network provides an effective low resistance path to earth ground in the event of a lightning strike to dissipate energy. Surge protection shall also be included at the main service disconnect switch to protect the toll plaza equipment from utility power surges or lightning strikes coming from the utility lines. Electronic components or equipment shall also include surge protection as required by the toll plaza electrical base sheets and special provision to prevent damage from surges or lightning strikes.

5.4 Cable Distance Limitations

The toll plaza communications and AVI antenna cables have specific distance limitations that the DSE shall take into account during the design. All CAT6 Ethernet cables shall have a maximum designed cable length of 275 feet, including vertical distances and slack. This reduced length (compared to the theoretical maximum of 328 feet) is desired to provide a safety buffer in the event that cable run lengths change in the field and to accommodate future changes. The AVI antenna cables shall have a maximum designed length of 150 feet, including vertical distances and slack. The control building shall be located sufficiently close to the monotubes to accommodate this AVI antenna cable length requirement.

5.5 Electrical Site Plan

5.5.1 Underground Routing

All underground conduit routing and equipment placement shall be coordinated with the various design elements and infrastructure at the toll plaza site. The conduit routing and placement in the base sheet drawings is a suggestion and may need to be modified to suit toll plaza configuration and avoid conflicts with drainage, retaining walls, foundations, etc. Underground conduit routing should minimize cable lengths and provide adequate separation from other utilities per NEC or other code requirements. For the tolling zone with in-pavement vehicle detector loops, only conduits for loop lead-in cabling should be routed near the loops. All other conduit supporting other systems shall be routed away from the pavement area containing loops.

5.5.2 Conduit Proofing

The DSE shall use the Articles below and prepare a Project Special Provision for the contractor to proof test all the conduits:

- All conduits shall be cleaned by wire-brush mandrel to remove all dirt and other foreign materials and install compression plugs on both ends of the conduit until conductors are installed. The contractor shall record the results on a conduit test form and provide it to the Engineer for review and acceptance.
- The selection of the wire-brush mandrel and solid aluminum mandrel shall be approved by both the contractor and the Engineer and the documentation shall be submitted via the Web-Based Program Management (WBPM) system for approval.
- Performance Tests: Conduit test procedures and test results shall meet the requirements of National Electrical Manufacturers Association (NEMA) Standard No. TC 7 and ASTM F2160 Sections 4 and 5. Certified copies of the test report shall be submitted to the engineer prior to installation of the conduit.
- For all conduits installed under this contract, the contractor shall proof the conduit system with a solid aluminum mandrel, as per the table below, to remove any obstruction or debris. The contractor shall perform the conduit proofing in the presence of the Engineer. The contractor shall apply a pressure of 100 to 110 pounds per square inch (psi) to the conduit, close the air output valve and stop the compressor, and measure air pressure loss. The maximum allowable air pressure loss within 2 minutes of pressurization is 20 psi. The contractor shall record results on the Conduit Testing Form attached to this special provision. The form is signed by the Engineer and submitted via the WBPM system.

Table 5.5.1 Conduit Nominal Dimensions

Conduit Size (in)	Mandrel Diameter (in)	Minimum Mandrel Length (in)	Maximum Mandrel Length (in)	Proof (%)
1	0.60	1.0	4	80
1 ¼	0.86	1.5	4	80
1 ½	1.12	1.8	4	80
2	1.62	2.4	6	80
2 ½	2.0	2.75	7	80
3	2.5	3.25	8	80
4	3.5	4.25	8	85
6	5.5	6.25	10	85

Key: in = inches

5.5.3 Underground Casing

All underground conduit crossings of mainline or ramp pavement shall include conduit casings for physical protection and to facilitate future replacement. Coilable nonmetallic conduit (CNC) shall typically be used for casings that are of a sufficient size to allow easy installation of ducts inside. The DSE shall perform conduit fill calculations to ensure that the total area of the ducts inside the casing does not exceed 40% of the area inside the casing. Fusion splices of CNC ducts or casings may increase the conduit diameter by 0.5 inches and reduce the casing diameter by 0.5 inches due to the melting of CNC ducts together. When innerducts are pulled through a casing, the pulling head may also expand the duct diameter by 0.25 inch.

5.5.4 Plaza Lighting

Toll plaza lighting shall use roadway style light poles and light-emitting diode (LED) luminaires. Plaza canopy lighting (when present) shall also use LED luminaires. At toll plazas, the first lighting unit on each side of the roadway on both the approach and departure sides of the plaza shall be connected to the standby generator of the plaza via the lighting contactor and main distribution panel. Light poles shall be located a minimum of 20 feet away from other poles or structures. For existing toll plazas with canopies, light poles shall be located at least 50 feet away from the canopy. For more details on toll plaza lighting, the DSE shall refer to the *Illinois Tollway Guidelines for Roadway Illumination.*

5.5.5 Transformers

The DSE shall account for working space, clearances, and concrete pads required for utility and Illinois Tollway-owned transformers (if present) at the toll plaza. The DSE shall coordinate with ComEd for utility transformer infrastructure requirements and standards. The contractor shall install and furnish the proposed transformer concrete pad and conduit for ComEd, then ComEd will furnish and install the transformer, primary wiring, and ground wiring. For any Illinois Tollway-owned transformers (if present for step-up/step-down power feeds between main and remote control buildings), the design shall include the transformer, concrete pad (if needed), conduit, wiring, grounding, and disconnect switches. The DSE shall design the Illinois Tollway-owned transformers in accordance with NEC requirements and use stainless-steel NEMA 3R enclosures when installed outdoors.

5.5.6 Single-Line Power Diagram

Toll plaza electrical designs shall include an accurate single-line power diagram based on the unique configuration of the main and remote (when present) control buildings. The DSE shall modify and design the single-line power diagram based on the sample provided in the Illinois Tollway base sheets. Wire, conduit, circuit breaker, panels, and all other equipment sizing shall meet NEC requirements.

5.5.7 Grounding

The toll plaza grounding system shall be designed by the DSE in accordance with the Illinois Tollway base sheets, special provisions, and NEC requirements. Proper grounding of the toll plaza control buildings and sites contributes to the overall electrical safety of the system and resiliency to electrical faults and disturbances. The toll plaza shall be designed with single-point grounding for effective bonding and grounding, transient voltage surge suppression, and structural lightning protection. The single-point ground electrical potential reference design shall connect all toll plaza site equipment to the grounding system at a single point. The design shall bond all toll plaza site equipment to the grounding system so that all the equipment references ground potential at only one point.

5.5.8 Data Logger Camera Poles

The AET toll plazas include data logger cameras utilized by Illinois Tollway Business Systems. These data logger cameras shall be mounted at approximately 20 feet above the pavement on galvanized steel ITS poles and shall not be mounted on aluminum light poles. The camera pole design shall follow the ITS standard base sheets and special provisions. For 22.5-foot-tall poles, the poles shall have a 15-inch diameter bolt circle with 1-inch-diameter anchor bolts and utilize

lighting standard style foundations. For poles ranging from 35 to 50 feet tall, the poles shall have a 17.5-inch-diameter bolt circle with 1.75-inch-diameter anchor rods and utilize ITS standard style foundations. The conduit and cabling running from the toll plaza to the camera pole shall follow the Illinois Tollway base sheets. The DSE shall design the pole placement and conduit routing based on the unique site conditions to achieve the recommended distance from the AET tolling zone with a clear field of view for the camera.

SECTION 6.0 TOLL PLAZA BUILDING DESIGN CRITERIA

6.1 Toll Plaza Building Architectural

6.1.1 General Requirements for Prefabricated Control Buildings

Design of buildings and building sites, including all plans, specifications, and other contract documents, must comply with the latest adopted edition and supplements of the *Illinois Tollway Design Manuals and Standards Drawings* and the adopted building codes of the local municipality, at the time of obtaining the permit. Under no circumstances shall the requirements in effect at the time of obtaining the permit be reduced because of code changes that occur during design.

6.1.2 Prefabricated Control Building Roof, Floors, and Exterior Wall Construction

In addition to the general requirements above, the building roof, floor, and exterior walls shall comply with the *Illinois Tollway-BUS-2500* series base sheets, and special provision shall be used for the basis of design.

6.1.3 Prefabricated Main Plaza Control Buildings – Dimensions

Main plaza control buildings (with generators) shall have outside dimensions of 12 by 30 feet, with a 9-foot clear inside height. These buildings will have two rooms—a main room that contains all equipment except the generator, and a smaller room that contains the generator—and will have an 8-foot clear width minimum.

6.1.4 Prefabricated Remote Plaza Control Buildings – Dimensions

Remote plaza control buildings (without generators) shall have outside dimensions of 12 by 20 feet, with a 9-foot clear inside height. These buildings will have one room, which will contain all equipment.

6.1.5 Plaza Building Concrete Foundation

Foundation and structural plans shall be provided by the DSE. Foundations shall have a flat top slab and a length of 32 feet for a main toll plaza building with a generator, or 22 feet for a remote toll plaza building without a generator. Information shown in base sheet *Illinois Tollway M-BUS-2544* shall be included. The designer shall design the top slab, footers, walls, and reinforcing details as necessary to support the building and meet local codes.

6.1.6 Reinforcement Bars

Reinforcement bars must conform to requirements of IDOT Standard Specifications Section 508 and Article 1006.10. Bending of reinforcement bars must be in accordance with the latest edition of American Concrete Institute (ACI) 315, “Manual of Standard Practice for Detailing Reinforced Concrete Structures.” Concrete reinforcement detailing shall be per the *Illinois Tollway Structure Design Manual Article 6.7.*

6.1.7 Construction Specifications

Construction specifications shall be included in the plans as follows:

- Illinois Tollway Supplemental Specifications to the Illinois Department of Transportation Standard Specifications for Road and Bridge Construction **[Latest edition]**
- Illinois Department of Transportation Supplemental Specifications and Recurring Special Provisions **[Latest edition]**
- Illinois Department of Transportation Standard Specifications for Road and Bridge Construction **[Latest edition]**

6.1.8 Stresses for Reinforced Concrete

Concrete shall be Class SI with a compressive strength of 3,500 psi. Reinforcement bars shall conform to the requirements of AASHTO M-31 (ASTM A706), Grade 60, deformed bars epoxy coated.

6.1.9 Design Specifications

Design Specifications shall be included in the plans as follows:

- Illinois Tollway *Structure Design Manual* **[Latest edition]**
- International Building Code **[Latest edition]**
- ASCE 7 Minimum Design Loads and Associated Criteria for Buildings and Other Structures **[Latest edition]**
- ACI 318 Building Code Requirements for Structural Concrete **[Latest edition]**
- Illinois Department of Transportation Bridge Manual **[Latest edition]**
- Illinois Tollway *Geotechnical Engineer Manual* **[Latest edition]**

6.2 Main and Remote Plaza Electrical and Mechanical

6.2.1 Underground Conduit Plan

The DSE shall reference the Illinois Tollway Toll Plaza Base Sheets to view sample underground conduit plans for the site and toll plaza. Each toll plaza site shall be designed by the DSE and may have slight variations of layout and arrangement to accommodate the unique roadway geometry and available space within the right-of-way. The underground conduit for utility transformers, natural gas service, service feeds to the main control building, and other toll plaza supporting elements shall be designed and routed in coordination with the site constraints. The DSE shall design feeders for communication and power to remote control building(s) as required, considering conduit/cable sizing, voltage drop, conduit sleeves under roads, and future usage.

6.2.2 Exterior Elevations

The Illinois Tollway toll plaza base sheets should be referenced to view sample exterior elevations for the toll plaza control buildings. The designer shall use these elevations and modify them according to the unique requirements of the toll plaza. One common modification is to mirror the elevations because the building is located on the inside of a ramp, instead of the outside as shown on the base sheets. Careful consideration of the entire toll plaza layout is required when mirroring a plaza building. The designer shall also modify the elevations to show applicable barrier walls,

noise walls, or other adjacent features, as well as their minimum clearance distances. The separate electric service for an interior roadway lighting controller (where present) shall also be shown on the exterior elevations or removed where not applicable. Generator receptacles attached to the outside of the building shall be easily accessible for connection of a portable generator by the Illinois Tollway. Exterior lighting on the building shall be located for the safety and security of maintenance personnel and the facility.

6.2.3 Control Building Equipment Layout

The DSE shall reference the Illinois Tollway toll plaza base sheets to view sample equipment layout drawings for the toll plaza control buildings. The designer shall use these layouts and modify them according to the unique requirements of the toll plaza. One common modification is to mirror the layout because the building is located on the inside of a ramp, instead of the outside as shown on the base sheets. Careful consideration of the entire toll plaza layout is required when mirroring a plaza building. The main distribution electrical panel used as service entrance equipment must be located near the point where the supply conductors enter the building. All equipment shall be located to meet NEC requirements for working space and allow the enclosure doors to open at least 90 degrees. The designer shall coordinate with the Illinois Tollway for the latest equipment requirements and verify whether certain elements (like indoor roadway lighting controllers or ITS components) are required.

6.2.4 Interior Elevations

For the interior of the plaza, the DSE shall include and modify the interior elevations shown on the Illinois Tollway base sheets to fit the requirements of a specific toll plaza. The design shall add or delete interior equipment shown on the elevations as needed. The elevations should give the contractor a general layout of the equipment, note which items are wall or floor mounted, and provide an approximate scale of the equipment. Considerations shall include equipment working space, heat dissipation/ventilation requirements, and installing equipment at a comfortable working height.

6.2.5 Mechanical Plan

6.2.5.1 Natural Gas

The arrangement and alignment of piping shall be parallel to walls and ceilings; horizontal piping shall be run at right angles to walls and shall not run diagonally across the room or other services.

- Pipes shall be sized in accordance with the required gas flow rate.
- At least 6-inch-long dirt pockets shall be provided at low points of the system, at the bottom of risers, and at each equipment connection.
- Unions shall be shown in threaded piping to permit accessibility to accessory items for service and repair.
- Natural gas standard details shall be provided.

6.2.5.2 HVAC Heating Ventilating and Air Conditioning

Codes and standards:

a. The codes and standards covering mechanical work include, but are not limited to:

i. ANSI
ii. ASTM
iii. American Society of Heating, Refrigeration and Air Conditioning Engineers
iv. ASME
v. NEMA
vi. NFPA
    A. NFPA 30 Flammable and Combustible Liquids Code
    B. NFPA 58 Storage and Handling of Liquified Petroleum
    C. NFPA 90A Installation of Air Conditioning and Ventilating Systems
    D. NFPA 90B Installation of Warm Air heating and Air Conditioning Systems
    E. NFPA 101 Life Safety Code
vii. National Sanitation Foundation
viii. Sheet Metal and Air Conditioning Contractors National Association
ix. Codes, regulations, ordinances, and similar regulations

General HVAC Requirements:

a. Provide two-stage air conditioners with a solid-state dual unit lead/lag controller. The second air conditioner shall be a 100% backup. Each air conditioner shall be a one-piece packaged unit, factory assembled, pre-charged, prewired, UL-listed, ARI-certified, and designed for outdoor application, The DSE is responsible to size the units to meet the desired ambient temperature inside the building in summer/winter conditions.
    i. Materials: The units shall be constructed with a minimum of 20-gauge galvanized steel cabinet, 1-inch-thick glass fiber insulation, and painted rolled steel or galvanized steel fans.
    ii. Cabinet, casing, and frame: All shall have access openings for all fan motors, compressors and controls; insulated cooling section; top of cabinet that is sloped away from building; rain flashing at top of cabinet; full-length side-mounting bracket, and steel bottom-mounting bracket. Each unit shall be finished with beige-color baked enamel that can withstand 1,000-hour salt spray exposure testing.
    iii. Refrigerant section: Compressors shall be high-efficiency scroll two-stage hermetic type, with suction and discharge gauge ports and internal vibration isolation. Coils shall have seamless copper mechanically bonded to aluminum fins.
    iv. Condenser fan motors: All shall have heavy-duty, inherently protected, non-reversing, permanently lubricated bearings. Controls shall have anti-cycle relay (5 minute), compressor control module shall have adjustable 30 second to 5-minute delay on break, lockout for high and/or low-pressure controls, and 2-minute time bypass of low-pressure control. Each unit shall have low ambient control capable for operation down to 0 degrees Fahrenheit (ºF) and outdoor thermostat with compressor cut-off; adjustable from 0ºF to 50ºF.
    v. Supply fan section: Supply fans shall be double-width, double-inlet, centrifugal type, and forward curved and have solid steel shafts. Motors shall be variable speed electronically commutated motor type.
    vi. Filter section: This shall have an adjustable filter rack for the installation of 2-inch fiberglass pleated throwaway filters and shall be provided with access doors for filter removal.
    vii. Supply air grille: This shall be of aluminum construction, with individually adjustable vertical and horizontal blades.
    viii. Return air grille: This shall be of aluminum construction, with 30-degree horizontal fixed blades.

ix. HVAC Unit Controller: Air conditioners shall operate from a two-stage wall-mounted controller furnished with the unit. The heating setpoint shall be 40ºF (adjustable), and the cooling setpoint shall be 85ºF (adjustable). The controller shall operate both air conditioning units and utilize 24 volts (V) of power from the HVAC units. The controller shall provide lead/lag operation of each air conditioning unit with runtime. The controller shall include Ethernet CAT6 patch cable connection to the Cisco network switch (switch provided by others).
x. Electrical: This shall be factory wired in accordance with NEC requirements, and shall have a 240V, 1 PH single-point power terminal strip, a system service switch, a control circuit fuse, individually fused supply and return fan motors, compressor and condenser fan motor branch circuits, a 24V control transformer, and a disconnect switch.

b. Provide sufficient exhaust fan in the generator room, UL listed and designed for outdoor application and complying with the details of the exhaust system, as shown on the *Illinois Tollway M-BUS-2500 series*.
c. Provide sufficient unit heaters in the generator room to maintain the desired temperature inside the building in winter conditions.

Insulation:

a. Floor: The floor shall be insulated for a minimum total value of R-35, or the current International Energy Conservation Code (IECC) requirements (at the time of the design phase), whichever is the most stringent. This shall include the following or other approved method:
   i. Blown-in cellulose insulation (equivalent thickness to provide R-30)
   ii. 1-inch expanded polystyrene rigid insulation board with R-5.2
b. Walls: Walls shall be insulated for a minimum total value of R-22.5, or the current IECC requirements (at the time of the design phase), whichever is the most stringent. This shall include the following or other approved method:
   i. 3 ½-inch HD Fiberglass Batt - R15
   ii. Continuous rigid board insulation (installed outside of studs) with R-7.5
   iii. Continuous polyethylene sheet vapor barrier with 6-mil thickness (vapor barrier is located on the inside of the building framework).
c. Roof: The roof shall be insulated for a minimum total value of R-40, or the current IECC requirements (at the time of the design phase), whichever is the most stringent. This shall include the following or other approved method:
   i. Blown-in cellulose Insulation (equivalent thickness to provide R-34)
   ii. 2-inch fiberglass wall blanket insulation with R-6 (thermal block between steel framing)
   iii. Continuous polyethylene sheet vapor barrier with 6 mil thickness (vapor barrier is located on the inside of the building framework)

6.2.6 Control Building Lighting and Receptacle

Control building lighting shall be designed in accordance with the *Illinois Tollway Base Sheets* and Illuminating Engineering Society recommendations for interior and exterior lighting levels. Convenance receptacles of 20 amperes (A), 120V shall be located around the perimeter of the rooms and exterior for maintenance of the building and equipment. A heavy-duty 30A, 240V service receptacle shall be located outside near the generator connections for larger maintenance equipment. Generator receptacles attached to the outside of the building shall allow the Illinois Tollway easy access for connection of a portable generator. All lighting shall be designed using LED sources. A photocell shall be placed outside the building to control the exterior lighting

through a lighting contactor. The photocell-controlled exterior lights shall not be connected to any form of light switch but rather directly from the panelboard and lighting contactor. LED emergency battery backup lighting in each room shall be designed in accordance with NFPA 101 – Life Safety Code requirements.

6.2.7 Control Building Grounding Details

Control buildings shall include single-point grounding of the site and building. They shall include a master ground bus bar, an internal perimeter ground bus conductor (halo), and ground bus bars around the rooms and above the equipment racks. Ground bus bars shall be mounted horizontally approximately 8 feet above finished floors using a mounting bracket with insulator. All equipment cabinets shall be bonded to the internal ground bus conductors or bus bars. The internal-perimeter ground bus conductors shall be mounted 2 inches from the wall on insulated standoffs and include a 4-inch gap between the two ends of the conductors to prevent creating a ground loop. Polyvinyl chloride (PVC) conduit sleeves 1 inch in diameter shall be used for any ground cables that are underground entering the building.

6.2.8 Panelboard Schedules

The panelboard schedule shall be correct and updated by the DSE based on the toll plaza's electrical needs. The panel schedule shall indicate the voltage, phase, number of wires, main circuit breaker rating, bus rating, and mounting. Panels shall include 20% spare single-pole and multi-pole circuit breakers (or space) and shall be appropriately labeled per NEC for future use and effective troubleshooting. Panel loading shall not exceed 80% of the main circuit breaker rating.

6.2.9 Uninterruptible Power Supply

Each toll plaza control building shall include an uninterruptible power supply (UPS) system to provide redundant backup power in the event that utility power is lost, maintain power supply to critical electronic systems until the emergency generator comes online, and filter/condition the power delivered to sensitive electronic systems. The UPS shall include power conversion modules and batteries as required for the anticipated design loading of the plaza's electronic systems. The UPS shall also include a maintenance bypass switch to allow easy maintenance or replacement of the UPS without disrupting power. Typical UPSs shall be single phase of the voltage matching the plaza electrical distribution. The UPS shall then feed a separate UPS electrical panel with circuit breakers to feed the plaza electronic systems. The DSE shall utilize the plaza electrical base sheets and special provision and modify the design as required to meet the needs of the plaza and the latest UPS model used by the Illinois Tollway. UPS placement within the control building shall include sufficient space for ventilation of the UPS to prevent overheating and for servicing the UPS.

6.2.10 Video Power Junction Box and Security Cameras

The toll plaza control building(s) shall include video power junction boxes (VPJBs) for the VES cameras and security cameras. Each type of VPJB is detailed on the Illinois Tollway base sheets for inclusion and modification by the DSE. The VPJB shall be connected to UPS power circuits. The components inside the VPJB shall be adjusted for quantity based on the number of cameras connected. The Model A VPJB shall be rated NEMA 1 for indoor locations or NEMA 4X for outdoor or underground tunnel installations. All electrical wires and CAT 6 cable going to the camera shall have surge protection. CAT 6 cabling shall be limited to 300 feet in length between the camera

and the Ethernet switch. For distances longer than 300 feet, the Model B VPJB shall include an Ethernet switch and be connected via single mode fiber optic cable back to the nearby communications room.

6.2.11 Card Access and Door Alarm System

Each toll plaza control building shall include a card access and door alarm system. The card access system shall include card readers for each door/room of the prefabricated control building. Electric door strikes shall release the door lock upon successful authentication of a key card. Each card access system shall include a card access control panel and door strike power supply panel. The system shall be connected to UPS power and the Illinois Tollway IT network switch via Ethernet cable. Plaza control building door and general alarms shall also be tied into the card access system for remote monitoring. Mechanical door locks need to be Schlage (or approved equal) with interchangeable cores and three copies of the original need to be provided to the Illinois Tollway Business Systems Team.

6.2.12 Fire Alarm System

All fire alarm system installation wiring shall be installed in compliance with Article 760 of NFPA 70, the NEC, the manufacturer's instructions, and the requirement of the authority having jurisdiction.

Cables installed next to framing members shall be protected against physical damage and penetration from screws and nails. Fire alarm circuits shall be identified at all terminal and junction locations in a manner that will prevent unintentional interference with the fire alarm circuit during testing and servicing.

To achieve the desired level of protection, a combination of smoke detectors, heat detectors, and manual poll boxes is required and shall be located on or near the ceiling above the space to be protected because that is where smoke or hot gas initially collect.

The primary rule of installation wiring is “Follow the manufacturer’s instructions.”

6.3 Exterior Cabinets

Exterior roadside cabinets are not desired, and all tolling equipment for new plazas shall be located inside the control building as shown on the toll plaza base sheets. If roadside cabinets must be placed exterior to the control building, they shall be 316 stainless steel to prevent rust and corrosion. The DSE shall consult the Illinois Tollway PM and GEC for further direction whenever exterior cabinets are proposed.

SECTION 7.0 TOLLING EQUIPMENT INFRASTRUCTURE DESIGN CRITERIA

7.1 Loops

7.1.1 All Electronic Tolling (AET) Layout

In an AET lane layout, it is required to have the four main loops, narrow loops and the Piezo strips in the middle of the lane with the loop wires spliced in the junction boxes. Quantum system loops are used in the tolled lanes, with each loop being 6 feet, 6 inches apart.

7.1.2 Loop Junction Box

Loop junction boxes shall be installed 12 inches apart, with a minimum of 3 inches of putty from the hole to the rigid galvanized steel conduit where the cables attach. The remaining void should be filled with epoxy until flush with the pavement surface. Ensure the putty has cured before filling the remaining void with epoxy. The loop junction box shall be embedded or located on the back of the barrier wall.

7.2 Violation Enforcement System Wiring Layout

In an AET lane there are two VES cameras front and rear and in an AET shoulder there is one rear camera only with CAT 6 cables running to the Business System Tolling Integrator network switch. There are also power cables going to the cabinet.

7.3 Violation Enforcement System Wash System

The VES Wash System with Nitrogen Generator shall be designed and installed as a single cabinet inside a remote control plaza building located in proximity to the monotube as part of the tolling system. The VES Wash System provides a mix of washing liquid and nitrogen gas, supplied at a pressure of 95 PSI, in front of each VES camera requiring cleaning. Nitrogen gas mixed with the washing liquid cleans the front of a VES camera without leaving a moisture film blurring the video image, ensuring consistent functionality. A remote control system monitors each VES camera's view and, if it requires cleaning, a remote command is sent to the VES Wash system activating the cleaning cycle. The washing liquid and nitrogen gas mix is sprayed through a small tube connected to the VES Wash cabinet inside the remote control plaza building.

7.3.1 Enclosure Detail

The VES Wash Single cabinet includes the washing liquid reservoir, manifold, pressure regulator, particulate filter, nitrogen generator and reservoir, and all the tubes distributing the washing liquid and nitrogen gas mix. The nitrogen generator and air filters separate the nitrogen gas from ambient air, compressing it to a nitrogen reservoir at 95 PSI. Due to the risk of washing liquid spilling while refilling the washing liquid reservoir, the VES Wash enclosure is made of a 316 stainless steel NEMA 1 cabinet. The outline and overall dimensions of the VES Wash cabinet and the location of the conduit providing fresh air to the filtration system and the drain plug at the cabinet's bottom panel (in case washing liquid spills) are shown on *Illinois Tollway M-BUS-2538*. The drain plug connects to the conduit to drain excess washing liquid outside the control building. Washing liquid spill shall not accumulate below the cabinet to protect the floor's integrity.

7.3.2 Panel Detail

Reference *Illinois Tollway M-BUS-2539* for the VES Wash System material list and approved manufacturer name.

7.3.3 Conduit Routing

Reference *Illinois Tollway M-BUS-2540* for the VES Wash System flow diagram and *M-BUS-2541* for suggested conduit routing details.

7.3.4 Power Wiring

Reference *Illinois Tollway M-BUS-2542* for the VES wash miscellaneous power wiring diagram.

7.3.5 Control Switch

Reference *Illinois Tollway M-BUS-2543* for the VES wash system control switch schematic. The VES Wash System manufacturer may provide a simplified control system differing from *M-BUS-2543* system to supply the desired amount of washing liquid and nitrogen gas to the VES cameras, when required.

7.4 Automatic Vehicle Identification (AVI)

This system reads the transponder in vehicles. The AVI antennas have RF cables going back to the reader. The antenna's RF cable length cannot exceed 150 feet from antenna to actual reader (actual cable length) and shall be Andrew LDF4-50A or LMR-600.

SECTION 8.0 COMMUNICATIONS DESIGN CRITERIA

8.1 Toll Plaza Fiber and Communications

The preferred communications media for integrating onto the Illinois Tollway IT network is fiber optic cable. Whether a ramp plaza building connects to the Illinois Tollway fiber optic backbone cable directly or through a main control building, single mode fiber optic (SMFO) lateral cable shall be considered. Main control buildings shall utilize an SMFO lateral cable for connecting to the Illinois Tollway fiber optic backbone cable.

A lateral cable is utilized to connect a toll plaza site to a backbone cable, which connects the toll plazas to the Illinois Tollway IT network. Lateral cables typically have a smaller strand count than backbone cables. The appropriate connection points to an existing backbone cable, or any new dedicated backbone fiber cables, must be coordinated with the Illinois Tollway Fiber Optic and Utilities Manager during pre-concept or concept design stages.

Communication handholes shall have a minimum of 50 feet of fiber optic cable slack and 100 feet of slack in designated splice locations and manholes.

All tolling equipment and associated devices shall utilize a Category 6 (Cat 6) cable for terminating into the Illinois Tollway IT network Cisco switch. The DSE shall provide the extra length of jumper cables that is planned to be used to allow for the movement of equipment (minimum 25 feet).

8.1.1 Main Control Building

Fiber Lateral Cable requirements for the main control building include:

- Each fiber optic lateral shall be an armored SMFOC.
- The fiber optic lateral connection shall be made via a single 48-strand SMFOC (unless the count is specified differently in the plans or by an engineer). Two 24-strand cables cannot be substituted.

Fiber Lateral Cable installation at the main control building shall follow:

- Each fiber optic lateral cable shall be installed underground inside a 1 ½-inch CNC duct.
- A handhole measuring 48 by 72 by 36 inches shall be used for all determined fiber optic cable splice locations or where five or more ducts are being installed.
- A handhole measuring 36 by 60 by 30 shall be used where fewer than five ducts are being installed.
- A minimum of 100 feet of fiber optic cable slack shall be left coiled inside of the handhole designated for splicing onto the backbone.
- A minimum of 50 feet of fiber optic cable slack shall be left coiled inside of the handhole designated for non-splicing.

Fiber Lateral Cable termination procedures include:

- All fiber splicing must be fusion splicing.

- Each fiber optic lateral cable must terminate in a rack-mounted (or wall-mounted for existing plazas) fiber optic distribution panel located inside the plaza building.
- Splicing of the fiber optic lateral cable onto the Illinois Tollway backbone shall be done so that the number of fiber strands are equally spliced going upstream and downstream.

8.1.2 Remote Ramp Plaza (Remote Building)

- Fiber Lateral Cable requirements and installation for the remote building are the same as for the main control building, described above. Fiber Lateral Cable termination is the same as the information documented for the main control building except for the following:

- An SMFO lateral cable shall be terminated between the two locations (annex and main building) in a rack-mounted fiber optic distribution panel located inside of each facility. This connection will allow for the annex's associated network devices the ability to access the Illinois Tollway's IT network via the network switch located inside of the main control building. There shall be no direct connection of a fiber optic lateral cable from an annex building to the Illinois Tollway backbone fiber cable.
- Redundancy Loop (if applicable). An SMFO lateral cable shall be terminated from the annex building and into a separate splicing handhole from the main building's SMFO lateral cable. The annex lateral cable shall be installed alongside the opposite side of the roadway from the main building's SMFO lateral cable.
- Associated Plaza's Equipment & Network Devices: All network devices shall be installed according to the manufacturer and terminated into a designated network switch in associated facility via Cat 6 cable.

APPENDIX A Illinois Tollway Conduit Testing Form

Conduit Testing Form

Date:_____ Route:_____ Direction:_____

Starting Station:_____ Ending Station:_____

Starting Mile Post:_____ Ending Mile Post:_____

Conduit #	Conduit Color Marking (Color/Stripe)	Conduit Size (In.)	Cleaned (Swabbed)	Pressure Test Starting Pressure (PSI)	Pressure Test End Pressure (PSI)	Pull Cord Installed	Capped
1						☐	☐
2						☐	☐
3						☐	☐
4						☐	☐
5						☐	☐
6						☐	☐
7						☐	☐
8						☐	☐
9						☐	☐
10						☐	☐
11						☐	☐
12						☐	☐
13						☐	☐
14						☐	☐
15						☐	☐
16						☐	☐
17						☐	☐
18						☐	☐
19						☐	☐
20						☐	☐
21						☐	☐
22						☐	☐
23						☐	☐
24						☐	☐
25						☐	☐
26						☐	☐
27						☐	☐
28						☐	☐
29						☐	☐
30						☐	☐

Contractor:_____

Engineer:_____