

System Engineering Checklist Instructions

Background



The Final Rule on Intelligent Transportation Systems (ITS) Architecture and Standards Conformity (Final Rule) and the Final Policy on Architecture and Standards Conformity (Final Policy) were enacted by the FHWA on January 8, 2001. The Final Rule/Final Policy ensures that ITS projects or ITS elements within a project carried out using funds from the Highway Trust Fund including the Mass Transit Account conform to the National ITS Architecture and applicable ITS standards. Section 23 CFR 940.11 specifies seven activities, identified in Section 3.0 of the ITS Checklist, that are to be performed to accomplish a systems engineering analysis. **These activities must be completed prior to approval of Federal funds (23 CFR 940.13).**

A person or entity who desires to deploy an ITS device/element as a project or part of a project is a project champion for that deployment. Project champions are required to complete a systems engineering analysis for "...any project in whole or in part that funds the acquisition of technologies or systems of technologies, that provide or significantly contribute to the provision of one or more ITS [user services](#), as defined in the [National ITS Architecture](#)." This means an ITS project is any project that may provide an opportunity for integration at any point during its life. This applies to all projects or portions of projects. Systems that stand alone, that are not and will not integrate with another system are not subject to a systems engineering analysis.

Instructions for Completing the Systems Engineering Checklist

Project champions are required to use the SE Checklist to show that their ITS project(s) or ITS element within a project were developed using a systems engineering approach. The checklist is included as an Appendix to Project Concept Report for projects that include ITS and require a PCR. Ideally the checklist is completed during the Scoping phase of the project. It is very beneficial to complete the checklist during the Scoping phase as it assures all of the Systems Engineering processes are completed prior to specification and plan development.

The SE checklist can be found at <http://mydot.nd.gov/divdist/maintenance/its.htm> or <http://www.dot.nd.gov/divisions/maintenance/its.htm>.

For larger projects, there may be separate documents that cover one or more of the systems engineering requirements. In those cases, a summary of the relevant information should be included in the SE Checklist and the document should be referenced in Section 3 under "Project Matrix – Documentation". References should include: the full name of the plan or document; date and year the document was prepared; and the heading/heading number of the section within the document where the information is provided. Upon entering the reference, enter the date the information was verified in the far right column.

If documents or plans do not exist for the necessary information, all the relevant information must be entered in the SE Checklist. For minor or straightforward projects, the required information may only be one or two paragraphs for each of the seven required systems engineering elements. For complex projects, documentation for some of the elements will likely be much longer and a separate document that can be attached to the checklist may be in order.

More detailed instructions for documenting each of the required systems engineering elements is provided in this document, on the following pages, including the checklist and a sample checklist.

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Following are step by step procedures and explanations for completing the checklist.

SECTION 1 Project Information

Project Champion – this is the name of the person who desires the ITS deployed. This is not necessarily the project manager/engineer, but actually the person desiring the technology.

Brief Description/Purpose of ITS project including list of ITS elements – explain the ITS project only even though it is part of another project (e.g. paving, CPR, etc.) and the purpose of the ITS project. List ITS elements not devices (i.e. cameras, fiber, etc.). Elements for the specific ITS being deployed can be found in the Regional Architecture.

Project Number and PCN – if available place project number and PCN. If the checklist is created for advanced planning or scoping, this may not be available at the time the checklist is complete. If a project number is created later for a checklist that was created for a planning or scoping phase, then the checklist must be amended to include the project number and PCN along with any other changes.

New Project or Modification – if this is a new project check “New Project”. If there is an ITS project that has already had a checklist created and there is a modification (e.g. new/additional devices added, etc.) then check “Modification to existing project”.

Project Location – enter highway and reference point or other description for location of ITS project.

Total Fund (ITS only) – this area is for cost of ITS portion of a project if it is part of another project or total cost of a standalone ITS project. Check funding sources and amount. The “Other” is for additional project participation (e.g. city, MPO, etc.)

Nature of Work – check appropriate box for nature of work involving the ITS using the following examples;

- Scoping – if the ITS checklist is part of a scoping process
- Design Software / Integration – if the ITS checklist involves design or integration of software. Further Systems Engineering documentation may be required beyond the ITS Checklist. Contact the ITS Engineer for assistance.
- Construction – ITS checklist is for upcoming construction of ITS
- Operations – ITS checklist is for an ITS project that involves system management (e.g. asset tracking, vehicle maintenance, operation centers, etc.)
- Evaluations – ITS checklist is for evaluation of several ITS components
- Planning – ITS checklist is completed if part of planning of future ITS project
- Maintenance – ITS checklist is completed for maintenance or replacement of ITS components
- Other – for other work not covered above. Must be explained in comments

More than one checkbox can be checked if the work involves more than one area.

Relationship to Other ITS Projects and Phases – some ITS projects can be standalone while other ITS projects are add-ons or supplemental to larger construction projects. Include a brief description of how this ITS project ties to other ITS projects including project phases.

SECTION 2 Needs Assessment

This section begins to address the Federal requirements for ITS projects as stated in 23 CFR 940.11. The Federal regulations require that project stakeholders be asked to define what the needs of the system are. The needs can be simple to complex and involve a wide range of stakeholders (e.g. ESS versus a traffic operations center). To ensure the Federal regulations are met this section asks you to describe what the needs of the system are and how you arrived at those needs to ensure all stakeholders were involved.

NOTE: Some of the needs may have already been identified in previously document materials, such as the ITS Strategic Plan.

What is/are the current problem(s) with the current situation? – describe what the problem(s) are that affect the safety of efficiency of a particular highway segment or corridor.

What needs does this project address? – describe how the ITS being implemented will address the needs identified above.

How were the needs identified? – describe how the needs were identified (e.g. meetings, workshops etc.) with stakeholders; identified in a previously documented report, etc.

SECTION 3 Regional ITS Architecture

The development of an ITS Architecture is a Federal requirement for all ITS projects using Federal funds. The NDDOT and all MPO's have regional architectures they have developed. This section asks you to identify the portions of the architecture you are implementing to ensure you are using the ITS architecture as a planning tool and follow the Systems Engineering process. Refer to the corresponding ITS Architecture to determine which user services and inventory elements you are implementing.

NOTE: *In some cases a project may be within the scope of two architectures, statewide and regional (MPO), or even across state borders. In either case, it is important to examine all architectures to ensure the project will meet the needs of all stakeholders and related ITS projects.*

Portions of the Regional ITS Architecture being implemented – check the appropriate box(es) of the User Service being implemented. If there is a new ITS project or element not on the list, describe it in the area provided. The Regional ITS Architecture will also need to be updated and the NDDOT ITS Architecture Form shall be attached.

Market Packages – identify the appropriate Market Packages being implemented from the User Service identified above.

Inventory elements from the Architecture being implemented – list the elements being implemented, keeping in mind elements are **not** necessarily devices (i.e. cameras, ESS, fiber, DMS, etc.)

Participating Agency Roles and Responsibilities – list the roles and responsibilities of all participating stakeholders. Some of these stakeholders may be the same ones identified in the Needs Assessment.

Regional Architectures impacted by the project – check the appropriate box(es) of the architecture(s) being impacted. If your project is within the boundaries of an MPO, be sure to review the architecture and check the appropriate MPO box if necessary. If the project crosses state boundaries, make sure that architecture is reviewed and check the appropriate state architecture box of necessary.

Changes recommended to NDDOT/Regional Architectures due to the project – after review of the architecture(s), any changes to the architecture(s) from the project must be noted here. Some examples might be, that during the review of an architecture a “Planned” data flow now becomes an “Existing” data flow after the project is completed, then the architecture **must** be updated. If it is noted that a stakeholder was eliminated in the architecture or a new stakeholder was involved with this project, then the architecture **must** be updated. Whatever the update is, the Architecture Update Form must be completed and attached to the checklist.

National ITS Standards Incorporated – all standards that will be incorporated into the ITS project must be attached to the ITS checklist. The standards for the ITS project being deployed can be found in the Regional Architecture based on the Market Package being utilized and the system interfaces.

Project Matrix – Documentation – the information for the Project Matrix can be found documented in the Systems Engineering analysis conducted earlier for the ITS system being deployed. This information should be documented and referred to when completing this section. If documentation does not exist, then it must be created for this ITS project. For most ITS projects that use COTS, this documentation can probably be covered with a few paragraphs/pages. For more complex ITS projects (e.g. software development, Traffic Operations Centers, Transportation/Traffic Management Centers, etc.) fairly comprehensive Systems Engineering documentation is required. Whatever the case maybe, once the documentation is created, it can be used for reference on future ITS projects and deployments.

The following information is required for all ITS projects:

Concept of Operations – also referred to as the ConOps, describes the operation of the system being developed or deployed from the various stakeholder's viewpoints. The ConOps is defined as:

- WHO – stakeholders roles and responsibilities (refer to Regional Architecture(s))
- WHAT – system elements and high-level capabilities
- WHERE – geographic and physical extent of system (e.g. if you are installing a single signal, this must describe the geographic/extent of the entire signal system that this signal is part of)
- WHEN – describes the sequence of events that will deploy the entire system
- HOW – describes the development, operation and maintenance of the system

The ConOps will show agreement among stakeholders on:

- Goals, objectives and expectations
- Project scope
- Stakeholder responsibilities
- Operational needs
- How the system will operate
- Operational and support environment

Benefits of the ConOps is stakeholder agreement on system capabilities, roles and responsibilities, key performance measures and basic plan for system validation.

Requirements – this is the basis for building the ITS project. The Requirements determine WHAT the system must do and drives the system development; **Requirements are not specifications.** The requirements define the functions, performance and environment the system is to be built.

- Functional requirements – WHAT is the system supposed to do?
- Performance requirements – HOW well is the system suppose to do its functions?
- Environmental/Non-Functional requirements – Under what CONDITIONS (environmental, reliability, and availability) does the system have to work to meet Performance requirements?

Once these are determined and documented the specifications (Detailed Design) can be developed. The basic functional requirements can be found in the Regional Architecture for User Service being developed or deployed.

Alternatives Analysis - this includes analysis of alternative system configurations and technology options to meet the requirements. Some areas that should be explored are technology and non-technology areas. Describe all of the alternatives that were looked and document how the conclusions were arrived at for the selected system.

Test Plan – the Test Plan ensures the system requirements are verified. Ideally there should be two types of testing done on the system. Unit Testing should be conducted by the entity who fabricates the hardware and writes any software for the system (i.e. the system vendor).

The Unit Testing should be part of the specifications developed for the system and a copy of the Unit Testing procedures given to the project champion. The project champion should also ask for the test results once the vendor has completed their testing. Prior to final acceptance, the project champion should conduct their test on the system based on the requirements and specifications developed. This test plan must be attached to the ITS checklist.

Detailed Design – this is the complete specification of the software, hardware and communications components defining how the components will be developed to meet the system requirements. The specifications are described in enough detail that the software can be written (if applicable*) and the hardware components can be fabricated or purchased.

If the specification number or special provision number is known, list it here. If a specification is not available at the time the ITS Checklist is created, then state “Being Developed”

*If the software is being developed where no software currently exists, a more detailed Systems Engineering analysis is required. Contact the ITS Engineer for more information and/or assistance.

Integration Plan – this is required for more complex ITS projects. If the ITS project is adding to an existing system, an Integration Plan is not required. Contact the ITS Engineer for more information and/or assistance.

System Acceptance Plan - this is required for more complex ITS projects. If the ITS project is adding to an existing system, a System Acceptance Plan is not required. Contact the ITS Engineer for more information and/or assistance.

SECTION 4 Procurement

Considering various procurement options is a Federal requirement for federally funded ITS projects. Consider these alternatives and select all procurement methods being used.

If the ITS project will be part of a legacy system, sole source procurement may be required. If it is required, the project champion shall receive FHWA approval for sole source procurement before submitting the ITS Checklist. When approval is received from FHWA the following must be included to approve the ITS Checklist:

- Check the appropriate normal procurement method
- Attach FHWA approval
- Check the “Other” box
- Add comment stating the use of sole source

SECTION 5 Operations and Maintenance

Procedures and resources necessary for operations and maintenance (O&M) is a Federal requirement. O&M shall include a plan that involves operating the system, monitoring system performance, repairs, training, testing after repair or changes and tweaking the system.

Procedures and Resources Needed for Operation – a complete O&M plan should:

- Identify funding and policies supporting on-going operation & maintenance
- Identify the aspects of the system needing operation or maintenance
- Identify the manuals [users, administrators, and maintenance], configuration records, and procedures that are to be used in operation & maintenance
- Identify the personnel who will be responsible for operations & maintenance
- Identify initial and on-going personnel training procedures, special skills, tools, and other resources
- Identify operations & maintenance related data to be collected and how it is to be processed and reported
- Identify methods to be used to monitor the effectiveness of operations & maintenance

There will probably be not enough room on the ITS Checklist to document the O&M, so reference to the operations and maintenance plan should be placed here. The reference shall include document name, date created and where the document is housed.

If no O&M Plan exists, it is recommended one be completed, not only to satisfy the Federal requirements, but for future reference in ongoing similar ITS deployment. In the absence of an O&M Plan, please document or attach the procedures that will be developed.

Estimated Annual Operations Maintenance Costs – these costs shall include all costs associated with steps in the O&M Plan. It not only includes annual costs for communication and power, but also costs for preventive maintenance, on-going training, employee and administrative costs, costs for replacement components including all labor, admin, etc. If included in the O&M plan, reference it here.

Stakeholder(s) responsible for maintenance and funding source – the stakeholder(s) responsible for maintenance were probably identified in the ConOps and are probably in the O&M Plan which can be referenced here.

If no O&M Plan exists, it is highly recommended one be completed. If not, this area is where you will need to document who is responsible, their operating procedures, manuals, how records are kept (e.g. maintenance, configuration, etc.) and where the funding is allocated.

SECTION 6 Agreements – any agreements (written or handshake) must be documented in the ITS Architecture and you are required to list portions of the ITS architecture you are implementing (earlier in the ITS Checklist). Refer to the architecture and list agreements here.

If no agreements exist and they are required for operation, maintenance, etc. of the ITS being deployed, then the Regional Architecture must be updated to reflect these agreements and the NDDOT ITS Architecture Form must be completed and attached.

If no agreements are needed then state that here.