



---

/s/ Harold Peterfeso  
State Design Engineer

Effective Date: December 30, 2005

## **Systems Engineering for Intelligent Transportation Systems**

### **I. Introduction**

#### **A. Purpose**

To revise Washington State Department of Transportation (WSDOT) policies to address the Systems Engineering process for all future Intelligent Transportation System (ITS) projects.

#### **B. References**

23 Code of Federal Regulations (CFR), Part 940

*Building Quality Intelligent Transportation Systems Through Systems Engineering*, USDOT, FHWA-OP-02-046, April 2002

#### **C. Background**

System Engineering has been in existence for a long time and is used heavily by the Department of Defense to deliver unique contracts that are highly technical. Systems Engineering is a good fit for ITS projects because they are also highly technical. Title 23, Part 940 of the CFR states “all ITS projects receiving federal money from the Highway Trust Fund shall utilize the Systems Engineering process.”

#### **D. Discussion**

FHWA expressed their concern that WSDOT policy needed to be revised to comply with 23 CFR 940 regarding the Systems Engineering process. WSDOT acknowledges the need and is implementing policy changes to address the issue by this supplement to *Design Manual* Chapter 860.

This policy will have very little impact on program delivery due to current adherence to Systems Engineering type practices. The introduction of this policy will formalize the process and documentation practices.

While Systems Engineering is not required for State funded projects, it should be employed to ensure compliance with the regional ITS architecture.

Current construction management methods will not validate and verify all aspects of the Systems Engineering process. Verification and validation requires expertise in ITS technology that is generally not available from a Construction Office. Testing, acceptance, and approval of the ITS would be performed by those with the appropriate knowledge as designated by the Region Traffic Engineer. Verification of traditional construction portions of the ITS contract (i.e. cantilevers, foundations, guardrail) should remain with the Construction Office. For example, a video surveillance installation could have the pole and foundation installed under the approval of a Construction Project Engineer, but the CCTV camera, video server, and software would go through an ITS representative as designated by the Regional Traffic Engineer for approval and acceptance. For ITS software acquisition projects, the entire process would go through the ITS representative.

#### **E. Implementation**

This change is effective on the date of this supplement and will expire when the changes are incorporated in the *Design Manual*.

These changes apply to *Design Manual* Chapter 860, “Intelligent Transportation Systems”.

All projects using federal money that are currently under development must be evaluated to determine if the Systems Engineering process is being followed.

## **II. Instructions**

### **A. Add the following after 860.05 Motorist Information**

#### **860.06 Systems Engineering**

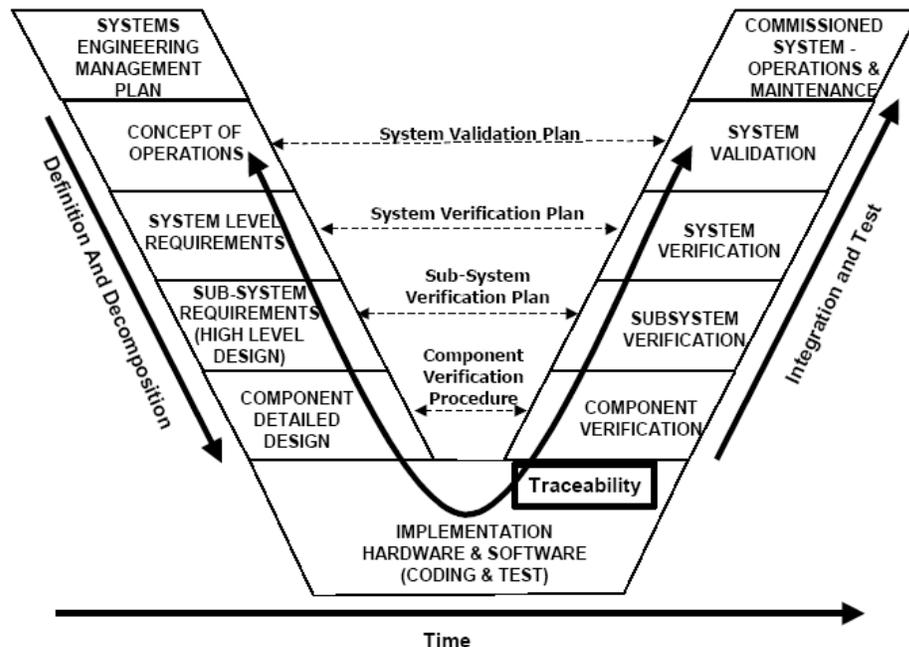
Conduct a Systems Engineering analysis on a scale commensurate with the project scope. As a minimum, the Systems Engineering process includes:

- Identification of portions of the regional ITS Architecture being implemented. Refer to the ITS Architecture or regional planning document.
- Identification of participating agencies roles and responsibilities
- Definition of Requirements
- Analysis of alternative system configurations and technology options to meet requirements
- Procurement options
- Identification of applicable ITS standards and testing procedures
- Procedures and resources necessary for operations and management of the system

For additional information, refer to:

[http://www.itsdocs.fhwa.dot.gov/JPODOCS/REPTS\\_TE/13620.html](http://www.itsdocs.fhwa.dot.gov/JPODOCS/REPTS_TE/13620.html).

Systems Engineering is a structured process for arriving at a final design of a system. The “V” Diagram in Figure 860-1 provides a pictorial description of Systems Engineering. An ITS project begins in the upper left side of the “V” Diagram and progresses down the “V” and up the right hand side. Upon reaching the upper right corner, reverse the process to ensure that a project is being completed that meets the initial requirements.



**Systems Engineering “V” Diagram**  
**Figure 860-1**

During the “Component Level Design”, specific subsystems and/or components (i.e. wireless communications, VMS, ESS, cameras, software) should be identified as requiring specialized knowledge and skills. These issues should be coordinated between the Project Engineer and the Regional Traffic Engineer.

Construction oversight and approvals are taken care of in the Systems Engineering process as you validate/verify the right side of the “V” diagram with the left side. The key to successful construction oversight is traceability. Trace each step on the right side of the “V” diagram back to a requirement on the left side.

System engineering costs shall be estimated and incorporated in the Construction Engineering (CE) and Project Engineering (PE) portions of the construction estimate. It is estimated that the total cost to conduct Systems Engineering is 15% of the ITS construction estimate.

**B. Renumber 860.06 Documentation to:**

**860.07 Documentation**

**C. Add the following to 860.07 Documentation**

The entire Systems Engineering process shall be documented in the Project File. If the project is a stand-alone ITS project, the Systems Engineering documentation shall be filed with the ITS Design File. If the ITS project is part of a larger project, the Systems Engineering documentation shall be filed with the Design Documentation Package for the project. Completion of the "ITS Project Systems Engineering Review Form", Figure 860-2a, meets the FHWA requirements for system engineering documentation. Systems Engineering documentation shall be approved by the Region Traffic Engineer or authorized representative. Completion of each of phase of the systems engineering shall be reported to the Region Traffic Engineer.

**ITS PROJECT SYSTEMS ENGINEERING REVIEW FORM**

This form, or a reasonable facsimile, must be completed for all ITS projects. It is to be submitted to FHWA with the construction authorization request for all Federal oversight projects that include ITS. Otherwise, it is to become part of the project record and maintained by the project sponsor.

Name of Project: \_\_\_\_\_

Regional ITS Architecture: \_\_\_\_\_

1. Identify the portions of the Regional ITS Architecture being implemented:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Is the project consistent with the architecture? Are revisions to the architecture required?

\_\_\_\_\_  
\_\_\_\_\_

2. Identify the participating agencies, and their roles and responsibilities:

\_\_\_\_\_  
\_\_\_\_\_

3. Definition of Requirements:

\_\_\_\_\_  
\_\_\_\_\_

4. Analysis of alternative system configurations and technology options to meet requirements:

\_\_\_\_\_  
\_\_\_\_\_

5. Procurement options:

\_\_\_\_\_  
\_\_\_\_\_

6. Identification of applicable ITS standards and testing procedures:

\_\_\_\_\_  
\_\_\_\_\_

7. Procedures and resources necessary for operations and management of the system:

\_\_\_\_\_  
\_\_\_\_\_

## ITS PROJECT SYSTEMS ENGINEERING REVIEW FORM INSTRUCTIONS

1. Identify the portions of the Regional ITS Architecture being implemented:  
[Identify which user services; physical subsystems, information flows, and market packages are being completed as part of the project and how these pieces are part of the regional architecture.]
2. Identify the participating agencies, their roles and responsibilities, and concept of operations:  
[For the user services to be implemented, define the high-level operations of the system, including where the system will be used, functions of the system capabilities, performance parameters, the life cycle of the system, and who will operate and maintain the system. Establish requirements or agreements on information sharing and traffic device control responsibilities. The regional architecture operational concept is a good starting point for discussion.]
3. Requirements definitions:  
[Based on the above concept of operations, define the “what” and not “how” of the system. During early stages of the systems engineering process, they will be broken down into detailed requirements for eventual detailed design. The applicable high-level functional requirements from the regional architecture are a good starting point for discussion. A review of the requirements by the project stakeholders is recommended.]
4. Analysis of alternative system configurations and technology options to meet requirements:  
[The analysis of system alternatives should outline the strengths and weaknesses, technical feasibility, institutional compatibility, and life cycle costs of each alternative. The project stakeholders should have input in choosing the preferred solution.]
5. Procurement options:  
[Some procurement (contracting) options to consider include: consultant design/low bid contractor, systems manager, systems integrator, task order, and design/build. Deciding on the best procurement option should consider the level of agency participation, compatibility with existing procurement methods, role of system integrator, and life cycle costs.]  
[There are different procurement methods for different types of projects. If the project significantly meets the definition of construction, then construction by low-bid contract would be used. If the project significantly meets the definition of software development/hardware acquisition, in other words an information technology project, then follow the acquisition processes outlined in Chapters 2 and 4 of the WSDOT *Purchasing Manual*. This option includes services for systems integration, systems management, and design.]  
[Contact the WSDOT Headquarters Traffic Office for additional guidance and procurement options.]

**ITS Project Systems Engineering Review Form Instructions**  
**Figure 860-2b**

6. Identification of applicable ITS standards and testing procedures:

[Include documentation on which standards will be incorporated into the system design and justification for any applicable standards not incorporated. The standards report from the regional architecture is a good starting point for discussion.]

7. Procedures and resources necessary for operations and management of the system:

[In addition to the above concept of operations, document any internal policies or procedures necessary to recognize and incorporate the new system into the current operations and decision-making processes. Resources necessary to support continued operations, including staffing and training must also be recognized early and be provided for. Such resources must also be provided to support necessary maintenance and upkeep to ensure continued system viability.]