FHWA INTERNATIONAL TECHNOLOGY EXCHANGE PROGRAMS

BRIDGE EVALUATION QUALITY ASSURANCE

SUMMARY REPORT—July 2007

Overview

One of the primary goals of the U.S. transportation community is to improve safety on our nation's roadways. In response to that goal, Federal, State and local transportation agencies consider the inspection of our nearly 600,000 bridges to be vitally important. These agencies invest significant funds into bridge inspection activities each year. There is high interest in making sure that the quality of our bridge inspection program is maintained at the highest level, and that our funds are utilized as effectively as possible.

Towards that end the National Bridge Inspection Standards (NBIS) were established to set minimum standards for a nationwide bridge inspection program. This program has become very successful at preventing failures and assuring the public that the bridges they cross remain safe. However, at the State and local levels, quality control/quality assurance programs (QC/QA) associated with bridge inspection are quite disparate, and there has been little focus on QC/QA programs from the federal level in the past. The January 2005 revision to the NBIS specifically requires State and federal agencies to assure that QC/QA procedures are used to maintain a high degree of accuracy and consistency in the bridge inspection program. In addition, many bridge owners have elected to collect data beyond that required by the NBIS. Better knowledge of QC/QA programs and data types collected abroad should provide meaningful advice to our transportation community.

The Federal Highway Administration (FHWA) and most bridge owners also have strategic goals related to improving the overall condition of our bridges and tactical programs aimed at extending service life. These goals are commonly derived from the interpretation of bridge deficiency data identified and documented through the bridge inspection program. Additionally, FHWA utilizes the inspection data as one of the factors for allocation and distribution of Highway Bridge Program funds. Improving the overall quality and determining the right data is reported through our inspection program will aid in maintaining a high level of safety for the traveling public, ensuring effective use of limited funds, equitable distribution of funds and helping bridge owners achieve their safety and mobility goals.

The results of this Scan are intended to assist bridge owners and the FHWA in implementing provisions of the 2005 NBIS regulation. Although many QC/QA programs exist within the U.S., there was significant interest in exploring the most effective bridge inspection systems in other countries. FHWA is also obligated to satisfy the guidelines provided through the Data Quality Act passed by the U.S. Congress in 2001. The data that is collected through the U.S. bridge inspection program not only ensure that our bridges are safe for the traveling public but, also help form the basis for programming bridge maintenance, repair, rehabilitation, and replacement activities.

The Scan Team was co-sponsored by the American Association of State Highway and Transportation Officials (AASHTO), the FHWA, an agency of the U.S. Department of Transportation and, the National Cooperative Highway Research Program (NCHRP). The Scan was organized by American Trade Initiatives, Inc

Scan Team Topics of Interest included:

1. Organizational Structure and Background
2. Inspection Data
3. Personnel Qualifications
4. Process Control
5. Equipment
6. Documentation

The team conducted a series of meetings and site visits with representatives of government agencies and private sector organizations abroad during the period of 1 – 17 June 2007. The ten-member team included three representatives from FHWA, four representatives from State DOTs, one representative from county engineers, one university representative, and one representative from industry. The panel visited Finland, Denmark, Germany, and France and met with representatives from Sweden and Norway while in Denmark. The countries were selected because of their advanced activities in Bridge Evaluation, Bridge Management and Quality Assurance in their practices.

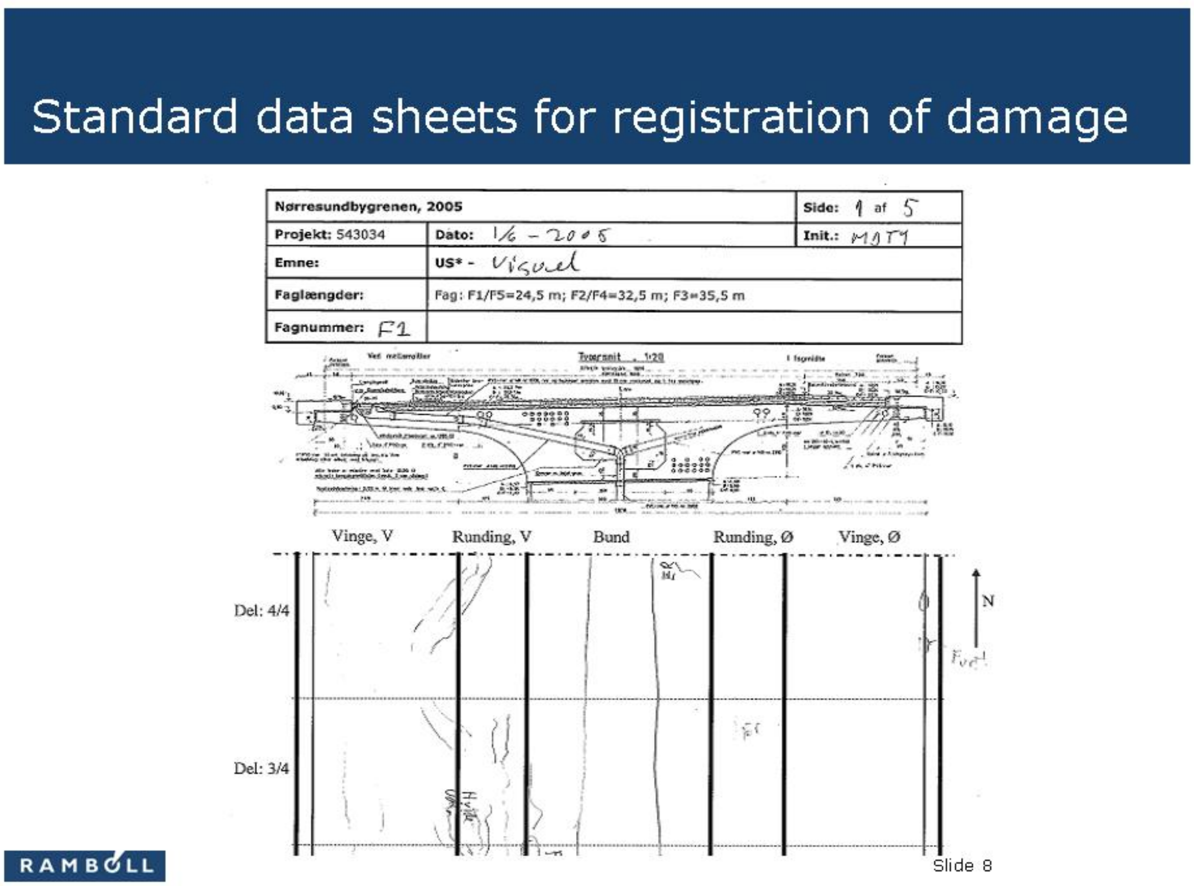
Summary of Initial Findings

Generally speaking, the team found that the European host agencies put a tremendous value in their bridge inspection programs not only to insure highway user safety but also to insure that durability and serviceability expectations were met and to enhance capital investment decisions regarding their existing bridge inventory. As such major emphasis was placed on providing for quality assurance through well-defined inspector qualifications, periodic calibration of inspectors, data collection processes, and the use of appropriate equipment to evaluate their structures. Most all of the agencies visited had major programs aimed at inspection uniformity, developed a multi-tiered inspection program and had procedures for performing damage assessment and programming maintenance and repair thru their inspection process.

The Scan Team identified 101 bridge inspection practices and technologies related to the previously stated topics of interest. Of these 101 items, the team determined 41 items organized into ten topic areas that supported the scan team's topics of interest that might significantly enhance bridge inspection practices within the U.S. Those topic areas are as follows.

1. **Detailed and Illustrated Inspection References and Tools**

Many very detailed, heavily illustrated manuals and references were available as tools for bridge inspectors. To focus inspectors and to provide more uniform ratings, types of damage with performance indices were quantified. Several countries had implemented standards to quantify concrete cracking in inspection reports. European inspectors were observed to have photographs from past inspections with them on site for their use in current inspections. Inspection vehicles in Germany were fully equipped with field equipment, office space and bridge records to support activities at the inspection site.



2. **Reports and Data Management**

Standardization of Inspection reports, forms, terms and ratings was practiced by all countries visited. Noteworthy practices included the generation of customized bridge inspection forms by

Bridge Management Systems, standardization of terms and rating criteria for inspectors, embedment of digital photographs in inspection reports and requiring designers to identify critical areas of a structure to be inspected. In the field, the inspectors include a level of urgency for any required repair in their assessment of damage found. This level of urgency is used to determine annual allocations of funds, programming maintenance repairs, and tracking repair backlogs.

In Germany, a computer program in which inspectors select a structural condition from a pull down menu allowing a program to generate a rating is in use. In Denmark separate Asset Management policies, systems, and practices have been established for major structures to allow better decision making for capital investments. The Finnish index their Bridge Management Data in a GIS system.

Sétra service d'Études techniques des routes et autoroutes

IQOA grades

BRIDGES IN APPARENTLY GOOD CONDITION	*need nevertheless common maintenance* **CLASS 1**
BRIDGES WITH DEFECTS ON EQUIPMENTS OR PROTECTION ELEMENTS OR MINOR STRUCTURAL DAMAGES	*need specialized maintenance* without urgency to repair **CLASS 2**
	need specialized maintenance with urgency to repair in order to prevent increase of defects in the structure **CLASS 2E**
DAMAGED STRUCTURE	*needs repair* without urgency to repair **CLASS 3**
	needs repair with urgency to repair **CLASS 3U**

Asset management 4

3. Bridge Inspector training and certification

A variety of approaches are taken by countries in Europe to train and certify inspectors. All had technical educational requirements for inspectors; most requiring inspectors have a degree in engineering. Many had specialized training requirements for inspectors to insure the quality of the inspection and the data it provided. In France, training is targeted at the Inspector, Team leader and Program manager through six modules of training. Individuals must pass an exam to fill a position in each level. Several countries match the experience of the inspector with the complexity of bridge being inspected. Maintaining a core of in-house staff, expert in bridge inspection, is a high priority for European owners. .

4. **Defined Inspection Types**

All of the countries visited had very clear definitions of inspection types, however a major finding was that the frequency of detailed inspections was typically five to six years with minor inspections focused on areas of interest identified in the detailed inspection conducted in the interim. There was a much greater dependence on road maintenance supervisors to routinely monitor and report issues of structural condition. European road agencies typically require inspection of structures starting at spans of two meters.

5. Frequency of inspection determination

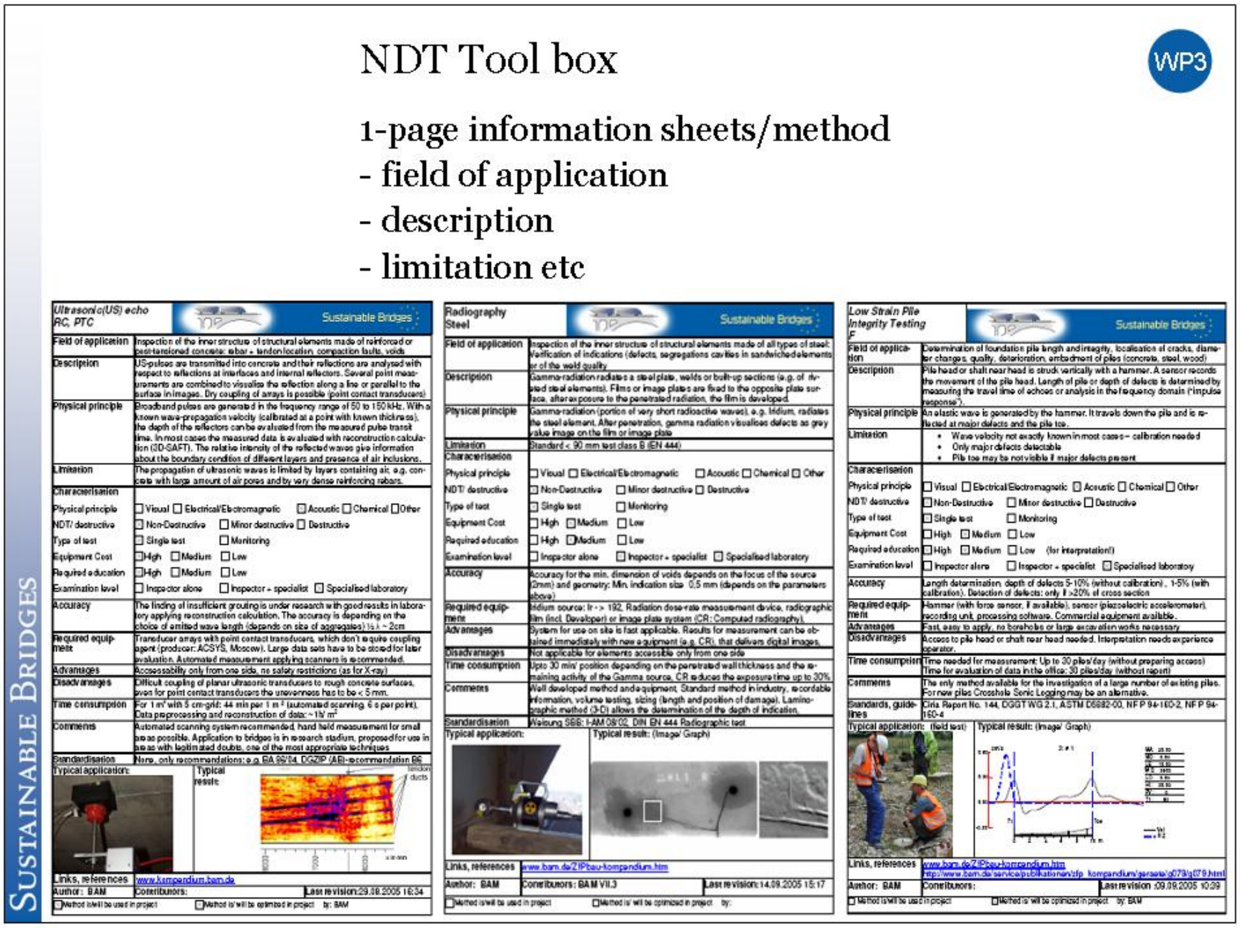
A typical finding was that European agencies had developed a technical decision making process for determining inspection frequency. Usually included in this process was the competency of the inspection crew. Inspector qualifications and experience requirements by agencies provided confidence in allowing inspectors to determine the duration between cycles of inspections typically up to five or six years but up to nine years in France. The use of risk acceptance criteria for structural condition of elements determined during inspection to drive agency rehabilitation and maintenance actions was being practiced in Denmark and France.

6. **Use of Reference Bridges**

The Finnish Road Administration (Finnra) uses a sampling of 106 bridges and 26 steel culverts as a control sample or set of Reference Bridges. Baseline data is gathered from these bridges by experienced in-house bridge inspection staff to provide consistency. Data gathered is used to fulfill a variety of needs. These needs include:

A. Gather data on bridge serviceability and durability over time.
B. Trend analysis of data gathered on similar bridges and updating of deterioration models in their bridge management system
C. Quality Control of inspection data from non Reference Bridges by providing baseline data for comparison
D. Training and Refresher Training of Inspectors and evaluation of inspector condition ratings against condition ratings provided by in-house staff. This evaluation is also used to provide “quality points” for selection of consultant inspectors.

Several agencies also use bridges to be demolished to evaluate the effectiveness of NDT methods when possible.

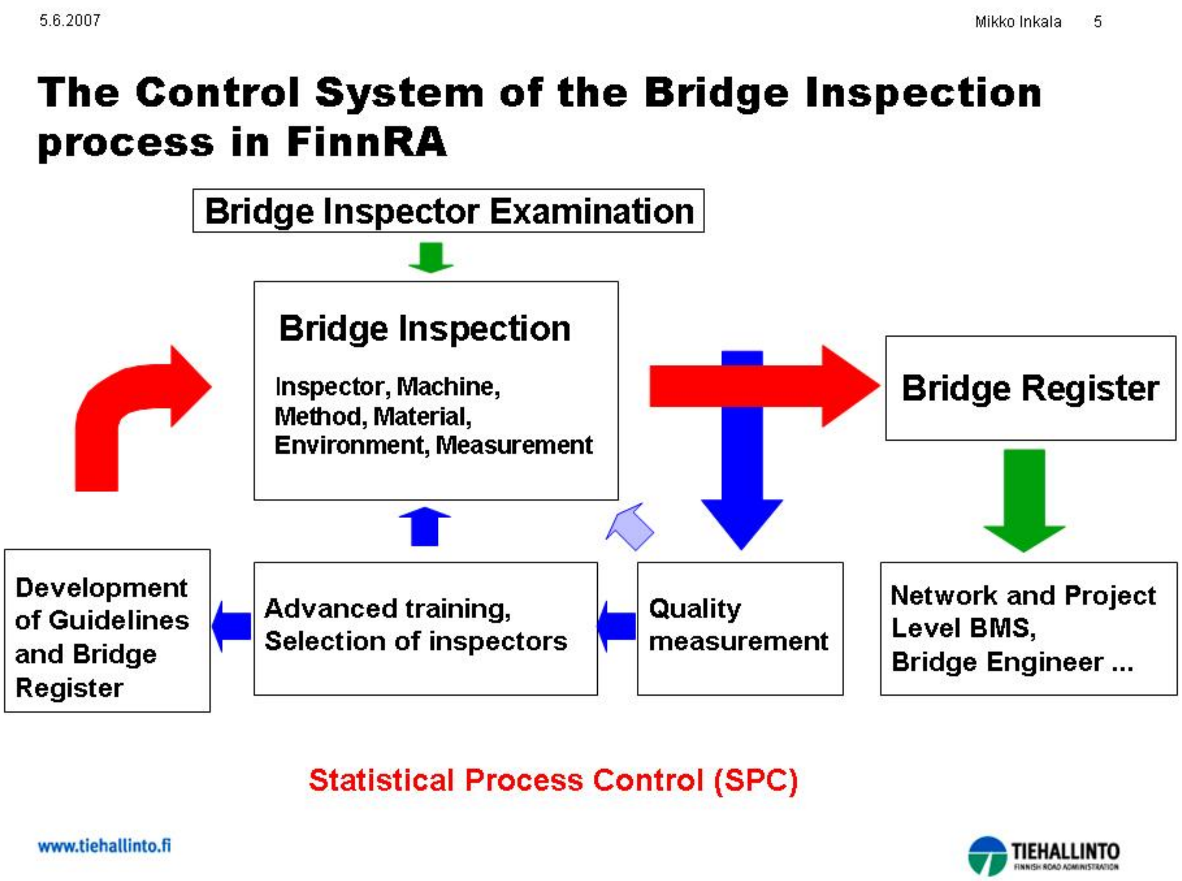


7. **Non Destructive Testing (NDT)**

European bridge inspection practices use NDT primarily during less frequent in-depth inspections. Several agencies had detailed references outlining the appropriate use of NDT devices and methods including terms and definitions, defects for which they are applicable and, in Germany, independent evaluations of NDT products by users. Also, several very unique applications of NDT technology such as the Germans use of a specially configured Ultrasonic Shear Wave Transducer for use in identifying defects was observed.

8. **Statistical Modeling applications to determining inspection quality**

As mentioned under Reference Bridges, the Finnish Road Administration certifies bridge inspectors in Finland annually. Inspectors are required to perform a field inspection of a minimum of two reference bridges and their resulting condition assessment is compared against ratings determined by Finnra staff. Consultant inspectors desiring to inspect more bridges annually may be required to inspect and be evaluated on as many as four reference bridges. The results of these Quality Control Inspections are then used to determine personal quality points to be assigned to an inspector. These quality points are then used in two ways of interest to the team. First they are used as part of their procurement process for Finnra to select inspectors for their bridges. Second, they are used to develop refresher training for inspectors when large differences from control ratings are noted.   Finland also has a defined QC/QA plan that is made a part of their agreement for consultant bridge inspection services.



Another item of interest in European agencies is the practice of review of a sampling of reports by senior office staff. Several agencies have processes for the office review and field check of reports submitted by senior in house inspectors.

9. Cause of Failure Determination

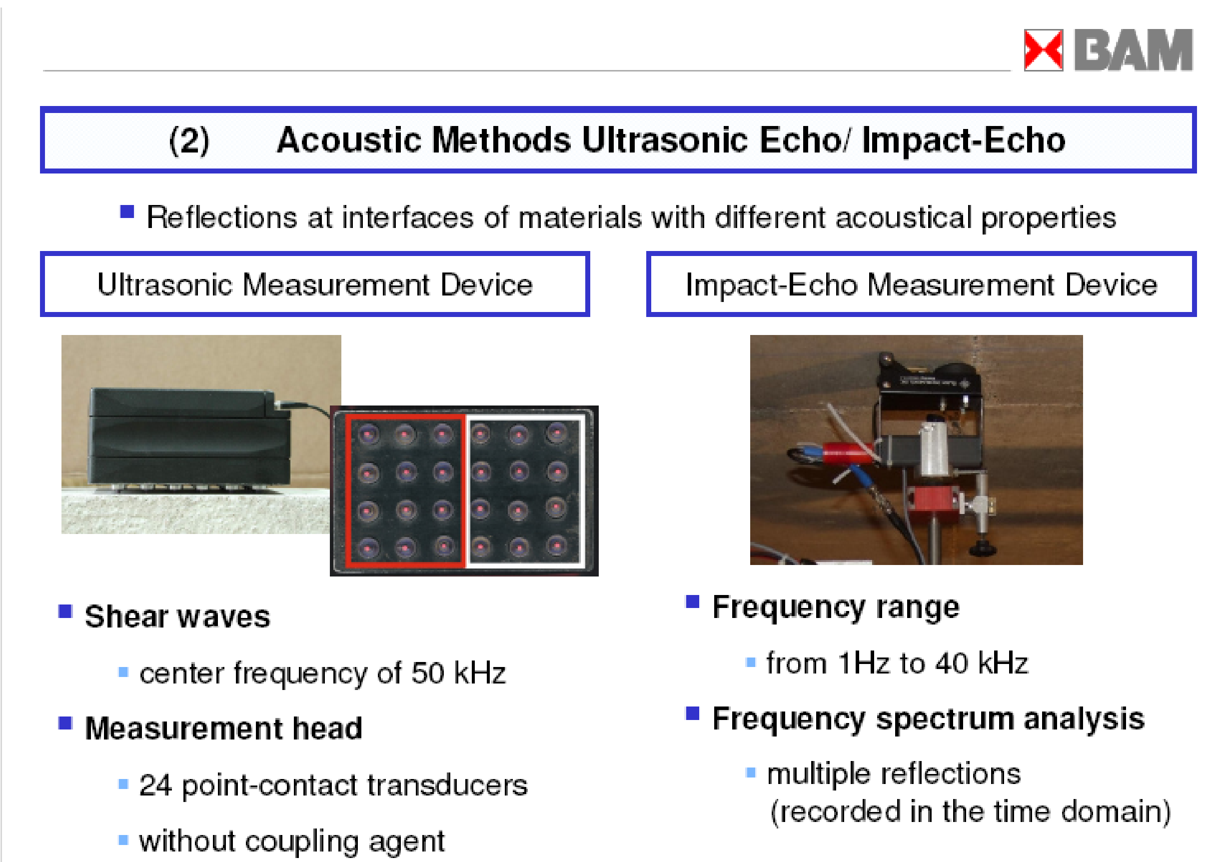
Most of the agencies visited include a cause of failure investigation by the inspector as part of their bridge inspection procedure. Inspectors are trained to assess damage to a structural element based on structural stability, user safety and effect on the damaged component's durability and recommend action. Using the inspector's knowledge of structures, coupled with a determination of urgency, an agency can calculate the immediate and short term programming levels required. All agencies had procedures that would initiate actions based on the severity of the condition found with or without a higher level of review and approval. Maintenance activities were generally tracked by all agencies in their bridge records.

In general, there is a greater emphasis on characterizing a particular defect in the bridge. This is in contrast to the U.S. approach of characterizing the element or component, which essentially characterizes the effect of the defect rather than the defect itself. As a result of this focus on defect characterization, there is a greater integration of mitigation strategies, i.e. specific repair and rehabilitation activities specified by the inspector.

10. **Other**

Two additional items of interest were identified for consideration in the U.S. by the team. First was a DVD developed for use in Germany, “Inspection According to German Industrial Standard (DIN) No 1076”. The DVD is intended for viewing by the general public and outlines the reasons for bridge and structure inspection. The DVD not only provides an informative overview of the inspection process, it appears to be a useful mechanism for maintaining support for bridge inspection activities from its audience.

Second, the general practice of European agencies was not to use dedicated inspectors on the same bridge but to rotate Inspectors on subsequent inspections. This practice provides a fresh assessment of the bridge’s condition, which in turn should provide for a more reliable or at least confirmation of its true condition.



Recommendations

Based on the above findings, the preliminary general recommendations of the team are as follows:

1. Develop a basis for determining bridge inspection frequencies combining different levels of inspection intensity with clear standards for inspector education, training and qualification based on factors such as safety, condition, age of the structure and engineering judgment.

2. Draft Guidelines for Developing QC/QA procedures for consideration by States for use by in-house staff as well as similar guidelines to be made a part of bridge inspection services contracts.

3. Development of Integrated Inspection-Repair Approaches to be used by bridge inspectors

4. Development of a detailed coding guide complete with Illustrations and reference photos

5. Development of a web-based library (wiki library) of references and technologies identified by the scan team that are potentially ready to implement within the U.S.. Potential references and technologies include:

    i. Crack Mapping used keys and 2-D scaled representations
    ii. Method for quantifying map cracking
    iii. NDE toolbox data sheets from the sustainable bridges project
    iv. Expanded inventory of access equipment for bridge inspection
    v. Available data from the EU Sustainable Bridge Project
    vi. NDT compendium
    vii. Silko Manual from Finra

6. Initiate a Demonstration Project around the Ultrasonic Shear Wave Transducer for use in identifying defects in concrete.

7. Develop additional Technical Interchange with the Finnish Roads Administration on their work applying Statistical Methods to Bridge Inspection Quality Assurance including reference bridges.

8. Develop additional Technical Interchange with other EU countries on sharing of information on the long-term performance of bridges as the new Long Term Bridge Performance program being initiated by FHWA's Turner Fairbanks Laboratory progresses.

Planned implementation actions

The scanning team has already scheduled many presentations at national technical meetings sponsored by FHWA, AASHTO, and other organizations to disseminate information from the scanning tour beginning the second week of July 2007. In addition, the team has formed a group that prepared a draft Scanning Technology Implementation Plan that also served as the basis for the recommendations described above. An initial draft of these implementation items was prepared and approved for final development by the entire team at its final meeting in Germany.