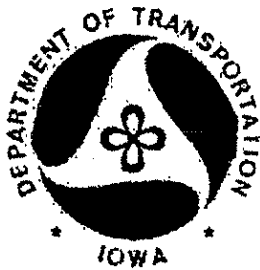


M.O. Federle, C.T. Jahren

# Implementation of Benchmark Project Recommendations for Iowa DOT Offices of Construction

Sponsored by the  
Iowa Department of Transportation Project Development Division  
and the Iowa Highway Research Board

Iowa DOT Project HR-381  
ISU-ERI-Ames-97401 Continuation



Iowa Department  
of Transportation

Addendum to

# report

Final

Construction Engineering Program  
College of Engineering  
Iowa State University

## TABLE OF CONTENTS

	Page
TABLE OF TABLES .....	iv
TABLE OF FIGURES .....	v
ABSTRACT .....	vi
INTRODUCTION .....	1
Background .....	1
Objectives .....	2
Tasks .....	2
RESULTS .....	3
Steering Team .....	3
Offices of Construction Employee Survey .....	3
Contractor Survey .....	7
National Motor Carrier Survey .....	10
Law Enforcement Survey .....	10
Comments on Survey Results .....	11
Personal Interviews .....	11
Temporary Traffic Control Zone Process Improvement Team .....	12
Non-survey data .....	13
Other Accomplishments of the Benchmark Steering Team .....	16
OBSERVATIONS AND RECOMMENDATIONS .....	18
Phase III .....	18
ACKNOWLEDGMENTS .....	19
REFERENCES .....	19
APPENDIX A: Key Functions and Measures .....	20
APPENDIX B: Iowa DOT Offices of Construction Steering Team Members .....	22
APPENDIX C: Offices of Construction Employee Survey .....	23
and Written Responses to Fall 1996 Employee Survey .....	31
APPENDIX D: Survey Comments from National Motor Carrier Drivers .....	49
APPENDIX E: Survey Comments from Law Enforcement Officials .....	51
APPENDIX F: Charter for Safe Traffic Control Process Improvement Team .....	53
APPENDIX G: Patching Fact Sheet .....	54

## TABLE OF TABLES

	Page
Table 1a: Offices of Construction Employee Survey Results - Page 1 .....	5
Table 1b: Offices of Construction Employee Survey Results - Page 2 .....	6
Table 2a: Contractors' Survey Results - Page 1 .....	8
Table 2b: Contractors' Survey Results - Page 2 .....	9
Table 3: National Motor Carrier Survey Results .....	10
Table 4: Law Enforcement Officers Survey Results .....	11

## TABLE OF CONTENTS

	Page
Figure 1: Direct Cost of Inspection (As a Percentage of Contract Volume) .....	13
Figure 2: Closeout Time (Days) .....	14
Figure 3: Number of Accidents Reported .....	15

## **ABSTRACT**

This report describes the continuation of the development of performance measures for the Iowa DOT Offices of Construction. Those offices are responsible for administering transportation construction projects for the Iowa DOT. Researchers worked closely with the Benchmark Steering Team which was formed during Phase I of this project and is composed of representatives of the Offices of Construction.

The research team conducted a second survey of Offices of Construction personnel, interviewed numerous members of the Offices and continued to work to improve the eight key processes identified during Phase I of this research. The eight key processes include Inspection of Work, Resolution of Technical Issues, Documentation of Work Progress and Pay Quantities, Employee Training and Development, Continuous Feedback for Improved Contract Documents, Provide Safe Traffic Control, External/Public Communication, and Providing Pre-Letting Information. Three to four measurements were specified for each key process. Many of these measurements required opinion surveys of employees, contractors, and others.

During Phase II, researchers concentrated on conducting surveys, interviewing respondents to improve future surveys, and facilitating Benchmark Steering Team monthly meetings.

Much effort was placed on using the information collected during the first year's research to improve the effectiveness and efficiency of the Offices of Construction. The results from Process Improvement Teams that studied Traffic Control and Resolution of Technical Issues were used to improve operations.

## **INTRODUCTION**

### **Background**

This is the final report to the Iowa Highway Research Board and the Iowa Department of Transportation for Phase II of research project HR 381 - Implementation of Benchmark Project Recommendations for Iowa DOT Offices of Construction. This project was initiated by the leadership of the Offices of Construction of the Iowa DOT, which wanted to develop ways to measure the effectiveness of the organization's performance. Included are all the construction offices, i.e., the Central Office in Ames, the six Transportation Centers, and the twenty Construction Residencies.

This project continues the efforts started in 1995. The Phase I project was entitled "Development of Benchmark Data for the Iowa Department of Transportation (Chase, et al., 1996). The Iowa DOT Offices of Construction Benchmark Steering Team successfully developed a performance measuring system with the assistance of researchers from Iowa State University. The performance measuring system includes eight key processes (1. Inspection of work; 2. Resolution of Technical Issues; 3. Documentation of Work Progress and Pay Quantities; 4. Employee Training and Development; 5. Continuous Feedback for Improved Contract Documents; 6. Provide Safe Traffic Control; 7. External/Public Communication; and 8. Providing Pre-letting Information) and between two and four performance measures for each process (See appendix A for a complete listing). It serves as the foundation for continuous improvement within the Offices of Construction.

During Phase I, two types of data have been collected: baseline data and benchmark data. Baseline data represents the first collection of performance data for the Iowa DOT; it shows the current status of the organization. Future improvement or lack of improvement will be detected by comparing new performance data with the baseline. Benchmark data was also collected; benchmark data is collected from organizations that perform similar functions and serves as a target for improvement.

After reviewing the baseline and benchmark data, the benchmark steering committee chose two areas that had high priority for improvement: "Providing Preletting Information" and "Resolving Technical Issues." A process improvement team was formed to study each of the high

priority areas. The teams were staffed with Offices of Construction employees. During Phase II the recommendations from those process improvement teams were implemented.

The Phase I effort was required to develop the infrastructure that was needed to begin continuous improvement. Implementation of continuous improvement represents a fundamental change in the way the organization approaches its business. Continued implementation effort was necessary to reap the rewards of higher quality, safety, and efficiency.

The proposal for Phase II was presented to the Iowa Highway Research Board on September 27, 1996 which approved it on the same date. The contract between Iowa State University and the Iowa DOT was approved on October 22, 1996.

Phase II was intended to continue the efforts started under Phase I focusing on internal measurement and communication. A third process improvement team was formed to develop methods for "Improving Contractor's Concern for Safe Traffic Control". (The first two process improvement teams were launched under Phase I.) This team's focus was identified by examining survey results from Phase I. Based on lessons learned from Phase I process improvement teams, a special effort was made to develop a focused charter.

As was true in the Phase I effort, the Benchmark Steering Team comprised a vertical slice of the Offices of Construction; Dr. Charles T. Jähren continued as one of the Principal Investigators, while Dr. Mark O. Federle replaced Gerald W. Chase as the other Principal Investigator. Throughout Phase II, monthly meeting of the Benchmark Steering Team continued. The two principal investigators acted as facilitators for the steering team.

## **Objectives**

The objective for this project was to assist the Iowa DOT Offices of Construction as they continued to apply continuous improvement concepts.

## **Tasks**

The following tasks were required to accomplish the objective:

- Co-facilitate monthly meetings of the Benchmark Steering Committee. Assist Iowa DOT participants in developing techniques to increase meeting participation and efficiency and provide minutes of the meetings.

- Revise, collect and analyze the previously listed surveys. By having the surveys collected and analyzed by ISU, the anonymity of the respondent was assured.
- Report analysis of survey data to the Benchmark Steering Committee.
- Review baseline and benchmark data. Work jointly with the Benchmark Steering Committee to identify high priority areas for improvement.
  
- Facilitate discussions to develop charters for future process improvement teams.
- Assist in the development of cover letters and reports regarding benchmark steering committee activities.
- Distribute, collect, and analyze the following surveys for the second time:
  - Offices of Construction Employee Survey
  - Contractor Survey
  - Law Enforcement Official Survey
  - Truck Driver Survey

## **RESULTS**

### **Steering Team**

The steering team had been established during Phase I. To help ensure that the steering team had adequate representation from the whole organization, personnel from a variety of positions and geographical locations throughout Iowa were selected. The steering team helped guide the research and the continuous improvement efforts within the Offices of Construction. The team met monthly during the project. The team members and the offices they represent are listed in Appendix B.

### **Offices of Construction Employee Surveys**

Offices of Construction personnel were asked to complete the second annual employee survey to provide an employee evaluation of the performance of key functions. Open ended questions were also included in the survey to provide information for the Traffic Control process improvement teams and the Benchmark Steering Team. The survey instrument for the internal



customer (employee) survey of Offices of Construction personnel is provided in Appendix C. Representative comments from the respondents are provided in Appendix D.

The Offices of Construction Employee Survey was sent to all Offices of Construction Employees throughout the state. The surveys were distributed at the height of the construction season (September 1996) so the respondents would be aware of the challenges of that time period. The responses were returned directly to the research team at Iowa State University. The Phase II responses totaled 114 respondents, down from 161 responses received during Phase I.

Survey results were tabulated in an Excel spreadsheet and tables were developed to compare the results obtained from Phase I with results obtained from Phase II (Tables 1a and 1b). Table 1 provides survey results from the Offices of Construction employee survey. The results show very small changes in attitudes for most items. The largest positive changes in the employees' attitudes were in:

- Amount of non-productive work (from an average score of 2.74 in 1995 to 3.15 in 1996);
- Timeliness of resolution of technical issues (from an average score of 2.74 in 1995 to 3.01 in 1996);
- Amount of non-productive work in documentation of work progress and pay quantities (from an average score of 3.02 in 1995 to 3.29 in 1996); and
- Overall quality in the resolution of technical issues (from an average score of 2.89 in 1995 to 3.10 in 1996).

Negative changes in attitude were limited to less than 0.15 point changes.

Table 1a: Offices of Construction DOT Employee Survey Results - Page 1

<b>Offices of Construction Employee's Survey Results</b>				
	<u>Average</u>	<u>Standard</u>	<u>Count</u>	<u>Last Year's</u>
		<u>Deviation</u>		<u>Average</u>
<b>Yrs. of experience</b>	18.66	11.19	114	
<b>Work Inspection</b>				
(1) Clarity of duty	3.74	0.89	104	3.77
(2) Understanding priority	3.77	0.84	104	3.81
(3) Ability of inspection influence quality	3.37	1.05	102	3.43
(4) Amount of duplication	2.63	0.91	95	2.59
(5) Amount of nonproductive activity	3.46	1.03	97	2.94
(6) Overall quality	3.35	0.89	100	3.37
<b>Resolution of Technical Issues</b>				
(1) Confidence in supervisor support decision	3.57	1.18	111	3.59
(2) Communication w/in DOT Office of Const.	3.18	1.06	111	3.13
(3) Communication with Contractor	3.25	0.88	110	3.25
(4) Timeliness of resolution	3.01	0.90	109	2.74
(5) Amount of nonproductive activity	3.15	0.90	105	2.74
(6) Overall quality	3.10	0.96	108	2.89
<b>Documentation of work progress and pay quantities</b>				
(1) Amount of Time spend documenting	3.35	1.14	85	3.25
(2) Amount of duplicative activity	3.05	1.08	88	2.77
(3) Amount of nonproductive activity	3.29	1.12	82	3.02
(4) Overall Quality	3.25	0.93	84	3.23
<b>Provide Safe Traffic Control</b>				
(1) Contractor knowledge	3.24	0.89	102	3.05
(2) Contractor concern	2.78	0.94	102	2.73
(3) Quality of specifications and plans	3.49	0.86	104	3.51
(4) Overall quality	3.42	0.64	102	3.33

Table 1b: Offices of Construction DOT Employee Survey Results - Page 2

<b>Offices of Construction Employee's Survey Results</b>				
	<u>Average</u>	<u>Standard</u>	<u>Count</u>	<u>Last Year's</u>
		<u>Deviation</u>		<u>Average</u>
<b>Employee Training &amp; Development</b>				
(1) Ability with training	3.78	0.71	111	3.80
(2) Structured classroom training and session	3.42	0.88	109	3.40
(3) On-the-Job Training	3.90	0.88	110	3.69
(4) Trained w. other divisions of DOT?				
(5) Rating for (4)	3.32	0.82	100	3.44
(6) Training applicable?	3.36	0.87	108	3.51
(7) Request ability for specific training	3.42	1.12	109	3.23
(8) Ability to obtain specific training.	3.15	1.06	109	3.03
(9) Scheduling of training sessions.	2.92	0.96	109	2.81
(10) Overall quality	3.18	0.77	110	3.24
<b>Continuous Feedback For Improved Contract Documentation</b>				
(1) Clarity of Instruction.	2.74	0.96	88	Not Asked
(2) Amount of time allotted	2.41	1.04	92	Not Asked
(3) Respond to plan review suggestion	2.87	0.91	83	Not Asked
(4) Opportunity to make suggestions	2.97	1.11	91	Not Asked
(5) Respond to suggestions	2.79	0.97	86	Not Asked
(6) Number of repeat problems	3.00	1.73	3	Not Asked
(7) Overall quality	2.76	0.82	87	Not Asked
<b>Providing pre-Letting Information.</b>				
(1) Explanations of why information is needed	3.43	0.98	86	3.34
(2) Clarity of instruction	3.23	0.92	86	3.20
(3) Time Allotted to gather information	2.72	1.00	86	2.69
(4) # feedback about my performance	2.56	0.93	85	2.42
(5) Defined procedures for handling requests	2.80	0.81	81	2.80
(6) Overall quality	2.86	0.82	81	2.85

**Contractor Survey**

The second contractor survey elicited almost fifty responses. Contractors felt that the Iowa DOT Offices of Construction and their personnel were making improvements in some areas while losing ground in others (Table 2). The largest positive changes in the contractors' attitudes were in:

- Offices of Construction DOT employee competence (from an average score of 3.51 in 1995 to 4.00 in 1996)
- Qualifications of personnel (from an average score of 3.68 in 1995 to 3.98 in 1996)

Negative changes in attitudes were in these areas:

- Overall quality of public communication (from an average score of 3.71 in 1995 to 3.21 in 1996)
- Communications with the media (from an average score of 3.72 in 1995 to 3.28 in 1996)

Based upon their review of this survey, the Benchmark Steering Team members felt that no changes to current practices were required at this time. It was decided that the Benchmark Steering Team should continue to monitor this survey for possible future action.

Table 2a: Contractor's Survey Results - Page 1

<b>Contractor's Survey Results</b>				
	<u>Average</u>	<u>Standard</u>	<u>Count</u>	<u>Last Year's</u>
<b><u>Work Inspection</u></b>		<u>Deviation</u>		<u>Average</u>
(1) Inspector competence	3.96	0.97	46	3.91
(2) RCE competence	4.07	0.78	45	4.11
(3) Availability of inspector	4.24	0.85	46	4.1
(4) Availability of RCE	3.91	0.75	43	3.95
(5) Empowerment to make field decision	3.54	1.03	46	3.37
(6) Ability to influence final quality	3.58	0.99	45	3.65
(7) Overall quality of inspection	3.74	0.93	46	3.8
<b><u>RESOLUTION OF TECHNICAL ISSUES</u></b>				
(1) Communication w/ inspector	3.98	0.89	43	3.89
(2) Communication w/ RCE	3.95	0.75	44	3.85
(3) Timeliness of resolution	3.60	0.95	43	3.57
(4) Fair judgment of DOT Office of Construction	3.71	0.83	42	3.68
(5) Overall quality of resolving process.	3.69	0.78	42	3.67
<b><u>SAFE TRAFFIC CONTROL</u></b>				
(1) DOT personnel knowledge about regulation	4.10	0.79	42	4.19
(2) DOT concern for traffic control	4.26	0.73	42	4.48
(3) The quality of plans and spec by DOT	3.38	1.21	42	3.67
(4) Overall quality of the process	3.83	0.96	42	3.89
<b><u>EMPLOYEE TRAINING &amp; DEVELOPMENT</u></b>				
(1) DOT employee competence	4.00	0.89	39	3.51
(2) Qualification	3.98	0.73	40	3.6
(3) Thoroughness	3.65	0.92	34	3.58
(4) Understanding of procedure	3.76	1.03	33	3.44
(5) Knowledge about the project.	3.72	0.79	39	3.5
(6) Overall quality of DOT employee training	3.69	0.80	39	3.53

Table 2b: Contractor's Survey Results - Page 2

<b>Contractor's Survey Results</b>				
	<u>Average</u>	<u>Standard</u>	<u>Count</u>	<u>Last Year's</u>
		<u>Deviation</u>		<u>Average</u>
<b><u>PRE-LETTING INFORMATION</u></b>				
(1) Adequacy	3.45	1.12	33	3.59
(2) Repetitive problems	3.64	1.03	33	3.32
(3) Quality of information	3.32	0.83	31	3.52
(4) Accuracy	3.28	0.96	32	3.45
(5) Timeliness of information	3.39	0.88	31	3.60
(6) Overall quality of pre-letting information	3.38	0.94	32	3.43
<b><u>CONTINUOUS FEEDBACK</u></b>				
(1) Opportunity to improve spec.	3.63	0.89	30	Not Asked
(2) Responsive to the suggestion.	3.21	0.92	28	Not Asked
(3) Opportunity to improve other documentation	3.30	0.91	27	Not Asked
(4) Responsive to (3)	3.11	0.93	27	Not Asked
(5) Repeat problems.	3.12	0.71	26	Not Asked
(6) Overall quality	3.44	0.87	25	Not Asked
<b><u>COMMUNICATION</u></b>				
(1) Media	3.28	0.96	32	3.72
(2) Utilities	3.28	0.99	32	3.58
(3) Fire and rescue	3.86	0.79	29	3.99
(4) Law enforcement	3.90	0.75	31	4.00
(5) General public	3.75	0.72	32	3.68
(6) Land owner	3.64	0.91	25	3.58
(7) Overall quality of public communication.	3.21	0.98	24	3.71

### National Motor Carrier Survey:

A survey of drivers for national motor carriers was conducted. This was identified in Phase I as a measure for the key function "Provide Safe Traffic Control." These surveys were sent directly to the dispatchers who distributed them to drivers as they came through the dispatch office. Three motor carriers participated, Schneider National, Heartland Express, and Barr-Nunn Transportation. Fifty-six responses were obtained. In addition to the numerical results in Table 3, a summary of written comments is provided in Appendix D. The survey results indicated general improvement in traffic control. The largest increases in perceptions of the drivers were in "Visibility of Workers" and "Travel Space Allotted."

**Table 3: National Motor Carriers Survey Results**

<b>National Motor Carriers Survey Results</b>			
	<u>Average</u>	<u>Standard</u>	<u>Last Year's</u>
		<u>Deviation</u>	<u>Average</u>
<b>Traffic control</b>			
Signage & markings	3.90	0.62	3.70
Delay experience	3.28	1.18	3.06
Visibility of workers	3.80	1.01	3.29
Travel space allotted	3.63	0.93	3.04
Safety	3.63	1.03	3.31
Overall quality	3.61	1.05	3.27
n=56 respondents			

### Law Enforcement Survey

A survey of law enforcement officials from a variety of state, county, and municipal agencies was conducted. The survey was sent to six Iowa Highway Patrol District Offices and six County Sheriffs. Eleven responses were obtained. Numerical results are presented in Table 4 and a summary of written comments is provided in Appendix E. Large improvements of law enforcement officer perceptions for "Delays Experienced" and "Travel Space Allotted" are clearly evident. Based upon the strong positive perceptions of these two groups, the steering team

decided that these surveys would only be conducted every other year. Therefore, they will be conducted next in the Spring of 1999.

**Table 4: Law Enforcement Officers Survey Results**

<b>Law Enforcement Officers Survey Results</b>			
	<u>Average</u>	<u>Standard</u>	<u>Last Year's</u>
		<u>Deviation</u>	<u>Average</u>
<b>Traffic control</b>			
Signage & markings	4.36	0.67	4.40
Delay experience	4.45	0.69	3.60
Visibility of workers	4.18	0.40	3.80
Travel space allotted	4.09	0.70	3.50
Safety	3.91	0.70	3.90
Overall quality	4.09	0.70	4.00
<b>Communication</b>			
Advance notification	4.18	0.75	NA
Level of detail	4.18	0.75	NA
Accuracy of information	4.09	0.54	NA
Responsiveness to Questions	4.10	0.74	NA
Overall quality	4.09	0.70	NA
n = 11 respondents			

### **Comments on Survey Results**

In general, one can see there are slight improvements, or no changes in many areas within the survey for both Offices of Construction employees and contractors. This is not surprising because attitudinal survey data are not expected to change dramatically from one year to the next.

### **Personal Interviews**

There were concerns expressed regarding the lower participation rate for the Fall of 1996 survey relative to the Fall of 1995. Because of this, the Principal Investigators interviewed the field inspection personnel to find ways to improve the response rates for future surveys. The



respondents for the most part remembered receiving the survey, but commented that it came at a time of year that was very busy, as they were in the middle of the busiest part of the construction season. The anecdotal information collected by the researchers resulted in the following recommendations:

- Send the survey out later in the season. It was felt that a December/January time frame would have been better.

- Provide reminders with a second copy of the survey. Some inspectors said that they received the survey when they had too many other things to do, and by the time they found the survey in their "to do" stack, they felt it was too late to respond.

- Make some questions more clear. For certain questions within the survey, the respondents were unclear what information the survey was asking for.

#### **Temporary Traffic Control Zone Process Improvement Team**

The Safe Traffic Control Process Improvement Team was chartered because contractor concern for traffic control was identified as an area that required improvement in Phase I. Its members were from offices that were less than 100 miles from Waterloo. The charter for this team is provided in Appendix F. The Traffic control PIT team recommendations were as follows:

- A certified traffic control coordinator should be employed by the contractor and should be present on the project during work hours
- Noncompliance notices should be issued on a more uniform basis and the notices should be track for each contractor by the Offices of Construction in Ames.
- A separate contractor evaluation on traffic control will be made periodically during the project and used to communicate expectations between the Iowa DOT and contractors.
- Work zone safety training will be provided to all Iowa DOT and Contractor Employees. Employees will be trained every three years.
- A traffic control directory will be added to the construction manual

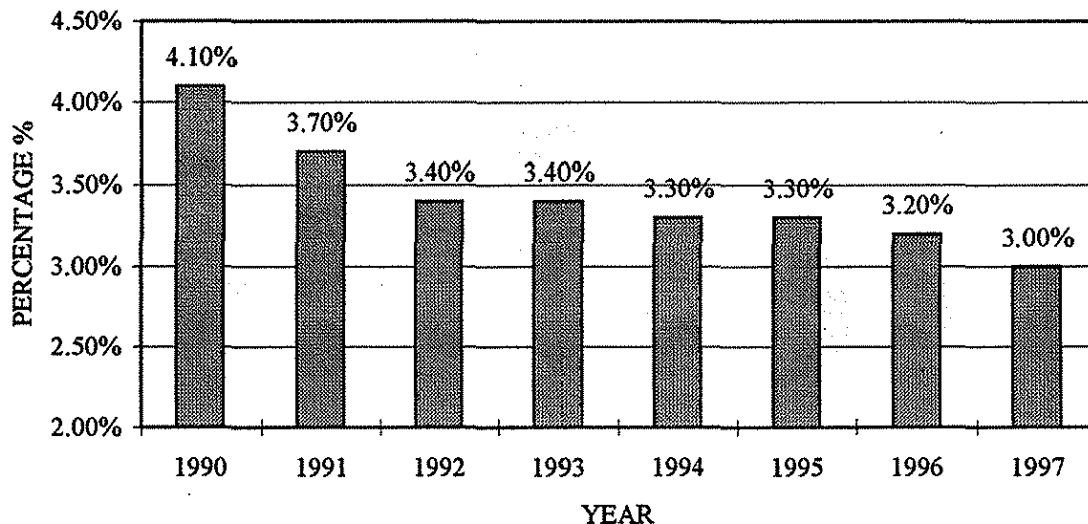
Because of a clear charter and the geographical concentration, as well as a team committed to working the problem, a special provision for a Certified Worksite Supervisor has been presented to the specification committee, with implementation expected for the 1998 construction season. Other recommendations have been implemented in the Construction Manual.

#### **Non-Survey Data:**

Non-survey data collected from Offices of Construction records includes information related to inspection costs, litigation cases and payouts, average time from project acceptance to final payment, cost overruns as a percent of contract volume, and number of accidents. These items were identified in Phase I as measures for certain key functions. The key function related to the measure is shown in parenthesis. The most recent data available for each is provided below along with historical comparisons.

#### ***Inspection Costs (Inspection of Work)***

The inspection costs, as a percentage of contract volume, are continuing to drop significantly on a year to year basis (Figure 1). Direct costs are salaries and expenses charge to a specific project:



**Figure 1: Direct Cost of Inspection (As a Percentage of Contract Volume)**

*Litigation (Resolution of Technical Issues)*

- Number of litigation cases last year - 3

This compares with:

1993: 0

1994: 0

1995: 1

*Litigation Payout (Resolution of Technical Issues)*

A claim for \$90,000 is currently under appeal to the Iowa Supreme Court. This compares with

1993: \$0

1994: \$ 0

1995: \$ 0

*Project Closeout (Continuous Feedback of Work Progress and Pay Quantities)*

Iowa DOT Construction Offices project closeout time (time from project acceptance to final payment), was (Figure 2):

- First 11 months of 1997 – 130 days.
- 1996 -- 142 days
- 1995 -- 126 days (this was erroneously reported in the Phase I report as 62 days.).

The figure below shows this information graphically.

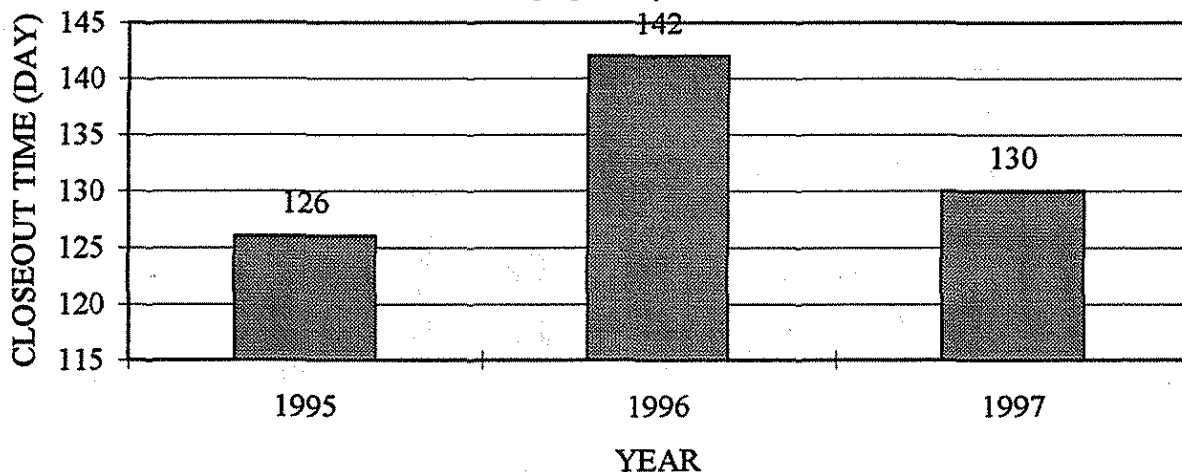


Figure 2: Closeout Time (Days)

*Cost Overruns (Continuous Feedback for Improved Contract Documents)*

Poor quality contract documents may cause cost overruns. Improving feedback to DOT

personnel should reduce the amounts of cost overruns on projects by increasing the quality of the contract documents. Cost overruns may include (Chase, et al. 1996):

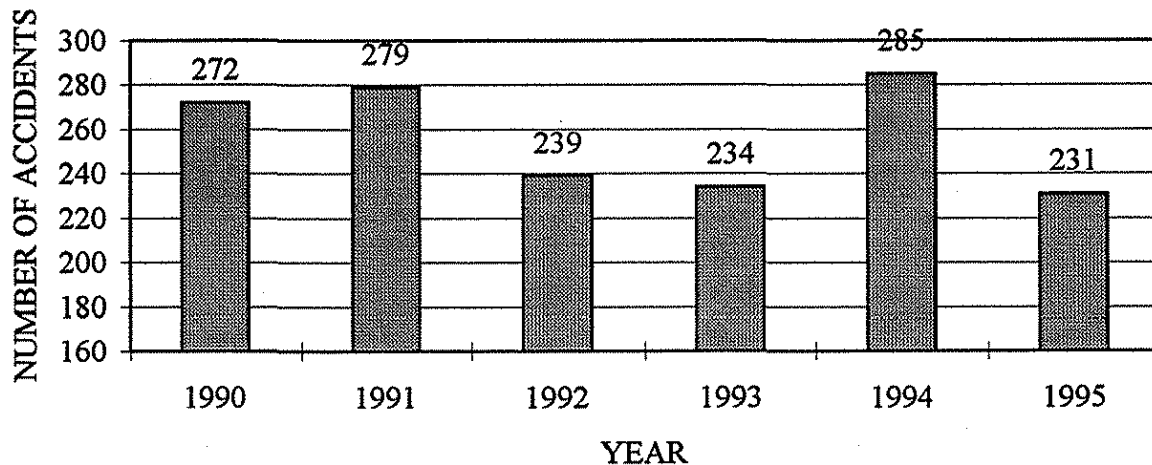
- Change orders - changes to existing contract items which require management authorization,
- Extra work orders - newly created contract items which require management authorization, and
- Overruns / underruns - changes in contract quantities that result in higher or lower contract costs.

The cost overruns, as a percent of contract volume was:

- 4.72% in 1996
- 4.93% in 1995
- 3.77% in 1994
- 4.68% in 1993.

#### *Numbers of Accidents in Construction Work Zones (Provide Safe Traffic Control)*

Accident information is slow coming out; however, the following data are available:



**Figure 3: Number of Accidents Reported**

These items comprise the non-survey data that the Offices of Construction uses to measure its performance. All of these areas in general show improvements over past years, yet also show opportunities for improvement in future activities. The steering team receives this information and uses it to guide its decision making process.

### **Other Accomplishments of the Benchmark Steering Team**

While the majority of the effort for this research project has been summarized above, there were other significant accomplishments that are described below.

#### **Patching Fact Sheet:**

With Mark Bortle assuming the lead, the Benchmark Steering team developed a Patching Fact Sheet for use by the field inspection staff during the 1997 construction season (Appendix G). This combines the information from the specifications, the construction manual, and the expertise of a variety of the field inspectors. The Benchmark Steering Team suggested that similar fact sheets be developed as needs are identified.

#### **More Participation by the Technical Staff:**

Employees throughout the Offices of Construction have been provided the opportunity to contribute to the improvements of the organization by their involvement. Through the Benchmark Steering Team numerous members of the organization contributed to the improvement of the DOT through informal and formal discussions of methods and improvements. Facilitators made specific efforts to increase the involvement of the technical staff during Steering Team meetings. The following actions were taken:

- They were asked to collect, then share, specific input from their peers.
- Small group discussion over issues important to the overall Steering team was used frequently. Members of the small groups reported a summary of their discussion back to the large group.
- Members were asked to give specific examples of good and bad situations from their work experiences. In other words they were called to openly share their personal experiences regarding field operation and administration.

#### **Temporary Traffic Control Zone Process Improvement Team:**

The Benchmark Steering Team chartered the Temporary Traffic Control Zone Process Improvement Team that was able to develop proposed specification changes that will improve the

safety and traffic control within construction zones. Many of the proposed changes are to be pilot tested during the 1998 construction season.

#### Benchmark Steering Team Issues:

The facilitators assisted with discussions to resolve a number of issues that were of great concern to Steering Team members. After the Steering Team had a common understanding of these issues, productivity improved. These included assurances that quality improvement efforts are supported by upper management of the DOT. Discussion of the need to consider changes to items within the team's control and not lose momentum discussing items outside the team's control (like state politics) was an important break through for the team.

The Benchmark Steering team spent considerable time discussing how to charter Process Improvement Teams in a way that would maximize their effectiveness and efficiency. These suggestions have been documented in this report and will be used to encourage the development of residency-based work-unit teams. Development of Residency-based work-unit improvement teams is an objective of Phase III of this project (described later in this report).

### **OBSERVATIONS AND RECOMMENDATIONS**

This research project has provided the foundation for the Iowa DOT Offices of Construction to continue their cultural change toward an organization that embraces and emphasizes continuous improvement and employee involvement. The following observations and recommendations can be made based upon the past years research activities:

- Attitudinal data shows that there were improvements in attitudes of the DOT personnel and the perceptions of others who depend upon the DOT for contracts and safe roads.
- Surveys should continue to be taken on a yearly basis
- To change the culture of an organization as large as the Offices of Construction will take a long time and a significant amount of effort.
- Process improvement teams successfully make improvements.

- Effort is required to involve the technical staff in discussions. It is necessary to identify their unique areas of expertise and ask them to share their knowledge. They enthusiastically share concrete examples of good and bad processes from their actual field experience.
- Better information is gathered by visiting the field staff in the field. Specific examples of problems, project documentation, and examples of how they use information, are readily available for them to share. Also the interviewees are more comfortable in their own environment.
- The Benchmark Steering Team needs to be active in process improvement so they can empathize with process improvement teams in their efforts to complete their tasks.
- Leaders must provide periodic reinforcement of their support of the improvement process.

**Phase III:**

Phase III of this research project was launched on February 1, 1998. It has three objectives: The first objective is to provide the construction residencies with proper support so they can launch their own quality improvement efforts. The second objective is to continue to measure the performance of the Offices of Construction according to the previously developed framework. The third objective is to continue to provide facilitation for the Benchmark Steering Committee in the Offices of Construction. This same steering team and research team will continue in Phase III. This project is funded with operating funds, from the Project Development Division.

## ACKNOWLEDGMENTS

This study was funded by research contract (HR-381 Continuation) from the Iowa Highway Research Board and the Project Development Division of the Iowa DOT. The authors are grateful to the Highway Research Board and the Iowa DOT for their financial support.

A steering team of employees representing various levels and geographical jurisdictions of the Offices of Construction (see Appendix B for listing) helped guide this project throughout the year. The research team thanks the steering team for their guidance, support, and ideas.

Many people and agencies were involved in providing information for this project. We thank all those who participated in interviews and surveys, including the DOT employees that the who spoke with researchers in their offices and on their jobsites. Everyone was very willing to share their true feelings and ideas for improvement. This sharing has been an important contribution to the efforts to improve the Offices of Construction.

Thanks also to Siew-Chin Yeong for her assistance in data entry and analysis, as well as her help in completing this project.

## REFERENCES

Chase, G.W., Jahren, C.T., Carlson, E.L., and McCollough, L.A., *Development of Benchmark Data for the Iowa Department of Transportation Construction Offices, Final Report*, A report to the Iowa DOT and the Iowa Highway Research Board (HR-381), July 1996.



**APPENDIX A  
KEY FUNCTIONS AND MEASURES  
OFFICES OF CONSTRUCTION IOWA DOT**

The final list of key processes (underlined) and their corresponding performance measures (bulleted) follow:

Inspection of Work

- Offices of Construction employee evaluation
- Contractor evaluation
- Cost of inspection as a percentage of contract volume, statewide, on an annual basis (direct inspection costs, not including supervisory or overhead costs)

Resolution of Technical Issues (a technical issue is one, that at any level of inspection, must go to a higher level of inspection, e.g., interpretation of plans and specifications)

- Offices of Construction employee evaluation
- Contractor evaluation
- Number of litigation cases per year
- Litigation pay-out per year
- Number of claims per year (a claim is a formal complaint from the contractor that has not yet gone to court)
- Number of repeat problems with plans and specifications (to be developed as a measure in "Continuous Feedback for Improved Contract Documents in the future)

Documentation of Work Progress and Pay Quantities

- Offices of Construction employee evaluation
- Time from project acceptance to final payment (project close-out)

Provide Safe Traffic Control

- Offices of Construction employee evaluation
- Contractor evaluation
- External customer (national motor carriers and law enforcement officials) evaluation
- Number of accidents in interstate and highway construction zones

Employee Development and Training

- Offices of Construction employee evaluation
- Contractor evaluation

Continuous Feedback for Improved Contract Documents

- Cost over-runs as a percentage of total contract volume
- Offices of Construction employee evaluation of the number of repeat problems
- Contractor evaluation of the contract documents and the associated number of repeat problems

Providing Pre-Letting Information (survey information, patch estimates, clearing and grubbing estimates, etc.)

- Offices of Construction employee evaluation

External / Public Communication

- External customer evaluation

**APPENDIX B**

**Iowa Department of Transportation Offices of Construction Steering Team**

John Smythe, Chair, Offices of Construction

Mark Bortle, Offices of Construction

Mark Brandl, Davenport Residency, Construction

Pete DeBok, Chariton Residency, Construction

Carl Fenceroy - Sioux City Residency, Construction

Norman Gillihan, Manchester Residency, Construction

Roger Gould - Creston Residency, Construction

Glen Miller - Southwest Iowa Transportation Center, Construction

Keith Norris, Northeast Iowa Transportation Center, Materials

Steve Staebler, Decorah Residency, Construction

John Vu - Offices of Construction

Warren Wassmer - Cedar Rapids Residency, Construction

**APPENDIX C**  
**CONSTRUCTION OFFICES EMPLOYEE SURVEY**  
**1996**

Position of person completing form: \_\_\_\_\_

Number of years experience with the Iowa DOT: \_\_\_\_\_

Please evaluate the performance of the Iowa DOT Construction Offices in the following areas by circling your response using the following scale:

5= Excellent 4= Good 3= Satisfactory 2= Marginal 1= Poor NA= Not Applicable U= Unknown

NOTE: This survey has been designed for all construction office employees. If a particular question does not apply to you, please circle NA. Please attach additional pages if necessary.

**INSPECTION OF WORK**

- |  |   |   |   |   |   |    |   |
|--|---|---|---|---|---|----|---|
| (1) the clarity of your duties   | 5 | 4 | 3 | 2 | 1 | NA | U |
| (2) your understanding of the priority of your duties  | 5 | 4 | 3 | 2 | 1 | NA | U |
| (3) the ability of the inspection process to influence the final quality of Iowa DOT construction projects | 5 | 4 | 3 | 2 | 1 | NA | U |
| (4) the amount of duplication of effort in the paperwork you complete                                      | 5 | 4 | 3 | 2 | 1 | NA | U |
| (4a) Please list items of duplicated effort that should be eliminated:                                     |   |   |   |   |   |    |   |

---



---



---



---

- |  |   |   |   |   |   |    |   |
|--|---|---|---|---|---|----|---|
| (5) the amount of nonproductive activity that occurs during the inspection process (5 = small amount of nonproductive activity, 1 = a lot of nonproductive activity) | 5 | 4 | 3 | 2 | 1 | NA | U |
| (6) the overall quality of the inspection process as it is now   | 5 | 4 | 3 | 2 | 1 | NA | U |

What is particularly good about the inspection process as it is now?

How may the inspection process be improved?

**RESOLUTION OF TECHNICAL ISSUES**

(1) your confidence that your supervisors will support your decisions which you are qualified to make	5	4	3	2	1	NA	U
(2) communications within the Iowa DOT construction offices during the resolution of technical issues	5	4	3	2	1	NA	U
(3) communications with contractors during the resolution of technical issues	5	4	3	2	1	NA	U
(4) the timeliness of resolution of technical issues	5	4	3	2	1	NA	U
(5) the amount of nonproductive activity that occurs during the resolution of technical issues (5 = small amount of nonproductive activity, 1 = large amount of nonproductive activity)	5	4	3	2	1	NA	U
(6) the overall quality of the process of resolving technical issues as it is now	5	4	3	2	1	NA	U

What is particularly good about the process of resolving technical issues as it is now?

How may the process of resolving technical issues be improved?

**DOCUMENTATION OF WORK PROGRESS AND PAY QUANTITIES**

(1) the amount of time you spend documenting work progress and pay quantities (5 = a reasonable amount, 1 = too much)	5	4	3	2	1	NA	U
(2) the amount of duplication of effort in the paperwork you complete (5 = a small amount, 1 = a large amount)	5	4	3	2	1	NA	U
(3) the amount of nonproductive activity that occurs during the process of documenting work progress and pay quantities	5	4	3	2	1	NA	U
(4) the overall quality of the process of documenting work progress and pay quantities as it is now	5	4	3	2	1	NA	U

What is particularly good about the process of documenting work progress and pay quantities as it is now?

How may the process of documenting work progress and pay quantities be improved?

**PROVIDE SAFE TRAFFIC CONTROL**

(1) contractor knowledge of traffic control regulations and specifications	5	4	3	2	1	NA	U
(2) contractor concern for traffic control	5	4	3	2	1	NA	U
(3) the quality of plans and specifications provided by the Iowa DOT for traffic control	5	4	3	2	1	NA	U
(4) the overall quality of the process for providing safe traffic control as it is now	5	4	3	2	1	NA	U

What is particularly good about the process of providing safe traffic control as it is now?

How may the process of providing safe traffic control be improved?

**This winter, a process improvement team will investigate ways to improve the process of providing safe traffic control. Please help this team by answering the following:**

Recall a project that had good traffic control. List some of the things that made it good.

2. Recall a project that had poor traffic control.

a) List some of the things that made it poor.

b) How could this project be improved?

3. Recalling some of your own experiences, list some things that DOT personnel can do to work with contractors and motivate them to provide safe traffic control.

**EMPLOYEE TRAINING & DEVELOPMENT**

(1) my ability to do my job with the training I have	5	4	3	2	1	NA	U
(2) the extent to which structured classroom training and development sessions have been beneficial	5	4	3	2	1	NA	U
(3) the extent to which on-the-job training (from supervisor or co-workers) has been beneficial	5	4	3	2	1	NA	U
(4) Have you had training/development sessions in which employees from other divisions of the DOT were present in the same training group?	yes				no		
(5) If yes, rate your experience when in training with employees from other divisions	5	4	3	2	1	NA	U
(6) the extent to which the training you receive is applicable to your job	5	4	3	2	1	NA	U
(7) your ability to request a specific training session	5	4	3	2	1	NA	U
(8) your ability to obtain a specific training session	5	4	3	2	1	NA	U
(9) scheduling of training sessions	5	4	3	2	1	NA	U
(10) the overall quality of training as it is now	5	4	3	2	1	NA	U

Please list any additional training you would like to receive:

List any training you suggest be discontinued:

What training has been particularly good? (please list specific courses if possible)



How may training be improved?

**CONTINUOUS FEEDBACK FOR IMPROVED CONTRACT DOCUMENTS**

- |  |   |   |   |   |   |    |   |
|--|---|---|---|---|---|----|---|
| (1) the <i>clarity of instruction</i> you receive before reviewing plans (what to review and how to review it)   | 5 | 4 | 3 | 2 | 1 | NA | U |
| (2) my level of satisfaction with the amount of <i>time allotted</i> to review the plans   | 5 | 4 | 3 | 2 | 1 | NA | U |
| (3) the responsiveness of the Iowa DOT to your plan review suggestions   | 5 | 4 | 3 | 2 | 1 | NA | U |
| (4) your opportunity to make suggestions for improved specifications   | 5 | 4 | 3 | 2 | 1 | NA | U |
| (5) responsiveness to your suggestions for improved specifications   | 5 | 4 | 3 | 2 | 1 | NA | U |
| (6) The number of repeat problems that occur during construction (repeat problems are those that have occurred in previous construction projects and still occur in subsequent projects) |   |   |   |   |   |    |   |
| (6a) List some examples of repeat problems below:  |   |   |   |   |   |    |   |

---



---



---



---

- |   |   |   |   |   |   |    |   |
|---|---|---|---|---|---|----|---|
| (7) the overall quality of the process of providing feedback for continuous improvement of contract documents | 5 | 4 | 3 | 2 | 1 | NA | U |
|---|---|---|---|---|---|----|---|

What is particularly good about the process of providing continuous feedback for improved contract documents?

How may the process of providing continuous feedback for improved contract documents be improved?

**PROVIDING PRE-LETTING INFORMATION** (obtaining and furnishing data for plan development: surveying, patch estimates, clear & grub estimates, etc.)

(1) my level of satisfaction with explanations regarding <i>why</i> information is needed	5	4	3	2	1	NA	U
(2) the <i>clarity of instruction</i> I receive on what information is needed and how to obtain it	5	4	3	2	1	NA	U
(3) my level of satisfaction with the amount of <i>time allotted</i> to gather the information	5	4	3	2	1	NA	U
(4) my level of satisfaction with the amount of <i>feedback I receive</i> regarding my performance	5	4	3	2	1	NA	U
(5) my level of satisfaction with the <i>defined procedures</i> for handling requests for pre-letting information	5	4	3	2	1	NA	U
(6) the overall quality of the process of providing pre-letting information	5	4	3	2	1	NA	U

What is particularly good about the process of providing pre-letting information as it is now?

How may the process of providing pre-letting information be improved?

**SUMMARY**

What question(s) should we have included on this evaluation form? What would your response be?

Did this evaluation form effectively address the key points of the areas mentioned?  
If not, what can be done to improve the evaluation form?

## Written Responses to Fall 1996 Employee Survey

Each response is numbered with the respondents survey number that was assigned by the research team at Iowa State. The specific number has no meaning, however the numbering is consistent in that number 5 is always the same respondent. Some of the responses were selected so the reader could see patterns in the respondents written responses. Several responses under each category are provided which best represent the sentiments of the entire group of respondents and are provided for background support material.

Please note that the responses are typed as found on the actual surveys. There are instances where typographical errors have been preserved in this document as this is what the writer actually put down on their survey.

### **Q 4a: Please list items of duplicated effort that should be eliminated:**

2. As manpower and time on project declines, I think some distinct parameters are needed as to priorities in inspection.
11. I feel that the electronic field book occupies more time than the previous record keeping method. By enlarging this system causes more additional work and time than giving useful benefits.
35. A part of my job as it is currently structured involves auditing and checking the work of others. By definition this could be considered a duplication of effort. I prefer to consider it as striving for excellence. I also think that a certain amount of this type of work is necessary to assure that our projects are administered in a uniform manner.
43. AA/EEO forms. wage rates, material certification.
57. Down size amount of paper work, DOT is down sizing amount of inspectors, but the amount of paper work has not been down sized.
64. T.C. gets 10 sets of plans and proposals, only need 2 or 3. Sometimes not sure who get copies of letter so we forward to the county or RCE only to find they received already.
101. EEO project site reviews- if same crew once for commits season payroll wage review- have contractor give new notice or wage rates to their employees and any complaints reviewed by inspectors continue to combine small projects into one big order since there is cost saving in inspection and paper works.

103. Plant documentation-Asphalt, concrete. Materials- we have a certified copy of materials used then we have to copy this and send to the district office.

**Comment on " Inspection of work--#5 The amount of nonproductive activity the occurs during the inspection process."**

10. This is an extremely unique question where as the particular type of construction sets and dictates this inspection schedule. I have previously worked constant sunrise to sunset, 6 days a week. I have also worked by spot checks, say twice a day. I feel that the DOT has already started to take measures which are going to refine and sharpened a system that is now goes, but which only get much better in the future.
57. The amount of nonproductive time depends on the quality of the inspector and what type of construction project the person is working on.

**Q: What is particular good about the inspection process as it is now?**

7. We are acting like a team in order to cover the scope of work we administer.
9. If something does not get caught that should have seen by our inspectors, we can truly say we were doing something else and were too busy to catch the mistakes. (On our \$8.4 million urban reconstruction job, we only had 2 total inspectors.)
10. Putting the responsibility for material from A.C. and P.C. plants on the contractor.
11. It allows for monitoring of work to allow for good workmanship, and the best quality for the money spent to do the work. Overall quality and workmanship would drop, if this inspection was to slack on be eliminated. I have always felt that our inspection was always money well spent.
21. That the D.O.T. has their own people, with an average of several years of experience, on projects observing, documenting, and making sure that specification are adhered to. I've noticed over past several years that contractors help is constantly changing, thus a lot of non-experienced people that need guidelines.
36. We currently have an knowledgeable inspection force which is motivated by the desire to obtain the best possible product for the traveling public, and not by the incentive for profit. A knowledgeable inspector force is capable of recognizing the potential for problems and act to resolve issues before they become too large to resolve at this level. This type of pro-

active effort generally benefits both the contractor and the contracting authority.

- 57. The majority of inspectors want a quality job, as long as the DOT hires a quality employees, the DOT will save a lot of money in the long run. Contractors have a larger majority of employees who either don't know what they are doing or don't really care.
- 73. Nothing.
- 75. If the inspector had any teeth to do the job, he was hired for this might be good but if an inspector sees something not to spec. and he tells contractor then contractor will bypass resident personnel and go to Ames. Ames will not ask field personnel opinions they will usually side with contractors. This makes us look not good.

**Q: How may the inspection process be improved?**

- 2. By prioritizing inspection duties.
- 7. By spending more time training employees with the electronic think pad field book. Develop some self instruction metric courses.
- 10. (a) By communicating in writing, even what seem like small problem.  
(b) We still have several minority subcontractors that have to be led around and told what to do. This is very time consuming on the inspectors part.
- 11. Incentives to keep and obtain more experienced, and committed full time employees. Get the management more involved with us. It keeps us all working effectively. I have a very good supervisor and a engineer who keeps tabs on the on going work.
- 21. By not farming out the inspection duties to private companies who are hired by the contractor. To me this is a direct conflict of interest, and serves the contractor first, then the taxpayer, who are our main employers.
- 26. Uniform enforcement of the specifications and contract documents state wide. Empowering inspectors to act on problems---not just report them. Reduce the paperwork so that inspectors have the time to inspect.
- 29. The non compliance is currently not enforced which weakens our authority out in the field.

These need to be enforce to enable us to keep the quality of work where it should be.

31. Better plans, more local decision making, less politics, disqualification of poor contractors, more stringent and more equal enforcement of spec. form Ames, better access to information by inspectors, more in depth training for inspectors, more field time for designers, more involvement and more unity on the T.C. staff, equipment (vehicles) more suited to the job; Escorts are next to useless for serious inspectors.
36. The trend toward hiring freezes, down-sizing efforts, and budget constraints during a period of increased work load in our area have left us with an inspection force that is stretched very thin. In the absence of any commitment to staff projects to a level insuring compliance with the current specifications, there may be a need to review the specifications. Some efforts has been made to officially prioritize inspection duties.(Obviously this has already unofficially taken place with the reduction in the inspection force.), but this is a very difficult task, as priorities may change from project to project, even involving the same type of work.
81. Remove some of the upper layers of management . Contractors tend to go up the line until they find someone agree with them. More modern testing equipment.
82. Give more responsibility to contractors, however make penalties greater when DOT find that the contractors not following proper procedures and specifications.
92. On large projects---more inspectors are needed to cover all areas. Hire contractors who know what the rules are, as inspectors, don't have to baby-sit them, this would save the state a lot of money, because if you have a contractor that you can trust to do a job properly, less inspection is needed. Some things don't have to be inspected, end products can be looked at and from them you can tell if it was done properly.

#### **WHAT IS PARTICULARLY GOOD ABOUT THE PROCESS OF RESOLVING TECHNICAL ISSUES AS IT IS NOW?**

1. I feel technical issues are looked at from a variety of viewpoints and decisions are tried to be made consistent.
5. Turn around time when asking about problems.

12. Iowa DOT office are authorized more of their employees to make direction to resources persons who can best assist. Additional communication tools (cellular phones, fax machine, etc.) are being made available for direct access.
27. People in central office are normally polite and try to be as helpful as possible. The best way to resolve technical issues is to try and review plans before letting using experience. This minimizes down time during the projects and also expensive Extra Work Order's.
32. At the level that I deal with problems, there is much freedom in dealing with issues, it is important, however, to maintain a good support system of information form which the resolution of similar problems can be shared.
36. Probably the majority of the technical issues which arise during a project are currently being resolved at the project or residency level. Only the more difficult issues are generally referred to higher authority. Since these are the only issues that are widely known about, I believe that we tend to judge our performance on resolving issues based on the expertise of the various divisions within the department to obtain the most well thought solution.
106. Generally speaking---the experts respond quickly with the technical advice. They know answers are needed quickly, and are even willing to visit the field.

#### **HOW MAY THE PROCESS OF RESOLVING TECHNICAL ISSUES BE IMPROVED?**

5. Have design people go to the field or have construction work in design during winter months.
7. Many times on Friday afternoons it is hard to reach a number of construction staff. Problems in the field can occur anytime, requiring resolution. This has improved from last year.
12. Authorization for direct access to people and information resources expanded. Increase availability of communication tools. Review the process improvement reports on "timely resolution of technical issues".
17. Resolving some issues at a lower level, which would speed up the process. As a uncovered issues arise, make it known through out the state, along with the solution.
24. Almost every time a contractor and inspector disagree on a technical issue, if the contractor calls Ames, he can do about anything he wants. I have never seen a contractor that went



over the inspector and RCE to Ames, and not get his way.

33. If design and ROW did their job better in the first place, there would be far fewer technical issues to resolve. Plans and X-sections are not the place to save paper. Plans should be checked in details, by an outside party before letting. Additional and multiplication errors should never make it out of Ames. Computers are no substitution for critical thinking, well trained, professional human beings.
50. Set guidelines on timelines on the importance of the situation. Speedy resolution to one manager may be (the same day) to another it may be (the same month). The same problem or similar occurs with their judgment on which problems need more speedy resolution.
58. Eliminate some of the endless steps one sees between road design-- central engr.-Dist. Engr-Maintenance Engr--Resident Engr--Supervisor--Coordinator--Inspector--Contractor foreman--Construction VP of Construction President--DOT--Supervisor and Darrel.
76. Perhaps a data base could be record technical issues that have come up on statewide projects. This data base could also include the resolution of the technical issues. A similar data base on metric question is presently available.
113. Do as if a partnering concept i.e. timeless set a goal of the time per each step i.e. from the field all the way to Ames also limit the contractor to not going over your head if he doesn't get an answer he wants to hear.

**WHAT IS PARTICULARLY GOOD ABOUT THE PROCESS OF DOCUMENTING WORK PROGRESS AND PAY QUANTITIES AS IT IS NOW?**

7. We feel comfortable with this process, have used it for years.
9. We are using the field book computer working days are fast.
13. The documentation forms have been revised and only very pertinent information is now recorded.
23. Accurate records and quantities are initiated at the resident level and sent to the transportation center for processing and eventually forwarded to Ames. This results in records actually kept in 3 separate locations.

- 36. The work has been done with the loose leaf book system and the electronic field book has gone along way toward standardizing the most efficient methods of recording this information.
- 85. The use of the computer field books has helped greatly with pay vouchers and working day reports. However, I do not see the elimination of keeping field book as they are more readily accessible to find information quickly when you do not always have a field office to work in. It is very uncomfortable to work on the computers in a truck.
- 100. The 3 ring binder for quantities was a big improvement. I believe the computer with electronic field book will simplify the process.

**HOW MAY THE PROCESS OF DOCUMENTING WORK PROGRESS AND PAY QUANTITIES BE IMPROVED?**

- 20. Don't use the laptop and go back to the old system.
- 30. Integrate laptops so each inspector can keep his records of the pay item they are in charge of.
- 36. Priority should be given to simplifying these procedures so that the amount of time on this activity can be minimized allowing the inspectors to maximize time spent actually inspecting work.
- 73. Set up computer programs correctly.
- 74. Make more item plan quantity.
- 88. More cooperation between accounting and construction office as far as laptop process.
- 101. Training for EFB and cover changes and update. Training is scheduled for 1997 so a entire office can be trained at the same time.
- 110. Decide on one method, commit to it, implement and have the equipment needed to make it work.

**WHAT IS PARTICULARLY GOOD ABOUT THE PROCESS SAFE TRAFFIC**

### **CONTROL AS IT IS NOW?**

1. I feel that the standards which were developed are helpful. The standards allows the designers to be more uniform and consequently the construction department more uniform.
11. I feel we have safe specifications and do very well to protect the workers and travelling public.
12. Standard and application are well developed and founded on experience and performance. Applications are flexible, to a degree and can be modified to fit specific field conditions.
32. When unusual or complicated situation exists within a project, often times a specific traffic control sheet will be included in the plans. This type of thing is very helpful for our inspecting staff.
36. This is an area where great improvements have been over the years. All players in the process are generally more aware of the necessity of providing safe traffic control than was the case in the past.

### **HOW MAY THE PROCESS OF PROVIDING SAFE TRAFFIC CONTROL BE IMPROVED.**

7. Discuss at greater length at the pre-con meeting.
10. Have the job superintendent get more training in recognizing what traffic is needed in a variety of situations. The inspectors is still, many times, telling the contractor what is needed.
24. Require certification of contractors personnel. Provide incentives and disincentives for installing and maintaining traffic control.
25. Stiffer penalties, contractor are not bothered a bit by non compliance, on smaller job you write 2 or 3, and contractors goes on to the next job, make the penalty for the construction season, not just one job.
36. More standardization of enforcement and penalty for non-compliance would be beneficial. The penalty should be sufficient to offset any gain that would promote continued or future non-compliance.

- 76. A through review of the project site prior to the development of the plans for specific traffic control requirement.
- 81. Uniform requirements met by all contracting bodies. (state, county, city, utilities, and commercial).
- 102. Get the engineer out of their Ames office and go through projects unannounced and crack down on inspection personnel.
- 115. Making it against the law for farmers to move through construction zones w/o removing combine heads and also get these humongous 2 wheel charts off the road that carry as much as a semi trailer rig with 5 axels.

**RECALL A PROJECT THAT HAD GOOD TRAFFIC CONTROL. LIST SOME OF THE THINGS THAT MADE IT GOOD.**

- 1. Proper signing. Proper sight distances for the layout. Proper flaggers.
- 11. Adequate, clean signing, mandatory to assume placement and set up or damage signing. Reduce speed limit within construction zone. Daily traffic control and work not done. Notifying the media of traffic situation.
- 52. Good, clean, reflective signs, placed on firm well placed posts. Attentive supervisor who wanted the traffic control to be correct and function as its suppose to. Inspector who informed contractors when something was not correct "Awareness".
- 64. The prime contractor hired a subcontractor who cared about the job. This sub had 1 person on the project at all times monitoring signs and traffic flows.
- 91. Good multi-discipline interaction in traffic control plan development is essential. The preliminary traffic control committee is very helpful. The time and effort that is spent in the development stage is very important. More field inspector should be helpful.
- 113. Contractor was very knowledgeable —made it much easier. Road standards were to the point. Contractor wanted a safe job as much as I did.

**LIST SOMETHING THAT MADE A POOR TRAFFIC CONTROL.**

1. A maintenance and construction project was adjustment to one another on the same section of roadway. The signing overlapped. Also, traffic had to be stopped by pilot cars twice in a very short section.
36. Not making traffic control a priority item, inconsistent administration, lack of forethought, inexperience.
43. Contractor disregard limits, distance, time. Contractor did not have enough personnel to fix a monitor traffic control, contractor personnel and other cement trucks ignored traffic control.
60. Contractor who had no concern for traffic control. Always wanted to be told where problems were.
74. Confusing detour routed and lack of any flexibility included in the plans for modification of the traffic control and detour routes. Special signs required for the project had to be supplied by the subcontractor in advance of the start of the project and any changes required a substantial lead time for its completion.

#### **HOW COULD THIS PROJECT BE IMPROVED.**

7. Possible meet with RCE and contractor on traffic control issues. If problems persists shut down project until agree measures are reached and complied too.
11. I realize that it is not realistic to add message signs as part of all project. However, in high volume, these signs spell out the situation that the motorist is about to encounter. This with the standard traffic control should be adequate to inform and carry the traffic safely through the projects.
52. Attitude adjustment, for supervisor and inspector, reject bad signs and bad placement, noncompliance forms written at every turn.
76. Better review by the design of the traffic control needs of the project. Incorporating suggestions of the field staff during the development of the traffic control plans.
98. Reduce speed prior to the work zone. Sign accordingly to traffic volume. Coordinate with surrounding states so signing would be uniform accross the state lines.

115. Schedule some of the overlays early in the year so that you aren't out there during harvest. Do the interstate jobs in the fall.

**RECALLING SOME OF YOUR OWN EXPERIENCES, LIST SOME THINGS THAT DOT PERSONNEL CAN DO TO WORK WITH CONTRACTORS AND MOTIVATED THEM TO PROVIDE SAFE TRAFFIC CONTROL.**

12. Perform joint reviews periodically for evaluation of traffic flows and drivers reaction. Share ideas on adjustment to improve awareness and guidance.
29. More classes for them. Flaggers should learn how to flag, Have one person in charge of traffic control who knows what to do.
33. Fine contractors with substandard traffic control setups. Designate one inspector per T.C. to drive the project and note deficiencies at random intervals. On the third offense, fine the contractor in proportion to the deficiency. Money is the only way to motivate all contractors.
54. Provide mandatory penalties for non complying situation which are not corrected within 24 hours of notification.
94. Take a positive approach and point out the good things the contractor is doing instead of just telling him when something needs correcting.
110. People in the field have their reputations at stake. They are well motivated. Our policies are too rigid, they are not the answer to every situation.
111. Significant price adjustment.

**PLEASE LIST ADDITIONAL TRAINING YOU WOULD LIKE TO RECEIVE.**

7. Employee training on electronic field book.
12. More work specified technical training, and educational of problems assessment evaluation, recommendation through use of people, information resources for field inspection personnel, increase work site safety training.

13. Grading inspector survey school, bridges inspector school, Grading inspection school, metric training.

**LIST ANY TRAINING YOU SUGGEST BE DISCONTINUED.**

5. Recertification after a certain position is held.
17. EEO-AA, harassment video.
21. Sexual harassment sensitivity
45. First aid, defensive driving.

**WHAT TRAINING HAS BEEN PARTICULARLY GOOD?**

7. Computer training, communicating effectively.
12. Working relationship, communication, listening, partnering, quality improvement, and team building.
19. Traffic zone maintenance and construction.
23. Computer training class.
40. NHS class.
60. Plan reading, math course, computer training, certification training.
98. Electronic field book and safety in traffic zones.

**HOW MAY TRAINING BE IMPROVED.**

3. Reducing the mandatory PDS course, better scheduling by the Governor office---don't take half year to develop a policy and then expect implementation in 1.5 months.
10. It is hard for the construction inspectors to get off class May thru mid November. Inspector should give priority to this class from mid November thru April.
18. Teachers that can teach.

- 20. Have at district level if at all possible or at least in area instead of Des Moines.
- 21. Break training sessions into groups; have the group do problems; then have the group debate one another.
- 33. Make it less of a priority to pass everybody and more of a priority that the material is understood. Reduce classroom time and do more training on site. Keep it practical and applicable. Don't just teach what to do but also teach why to do it and when to do it
- 48. Increase the amount of technical training available in the personnel development catalog. This catalog lists training class, but none of the classes are.
- 93. Rather than using experts that sit in the office most of the time, get some of us that are in the field that do the work and know what and how to teach the information, instead of book.
- 98. Spread training out across the state. Not always in central Iowa. Utilize area community colleges, look at using ICN for large groups.

**LIST SOME EXAMPLES OF REPEAT PROBLEMS.**

- 3. Control of air voids in ACC.
- 4. Traffic control details.
- 7. Ramp and loop paving grades, rarely tie to the main line. We usually design proper grades in house.
- 9. The spec. comm meets once per month, but its hard for us to come to Ames each month to discuss spec. A notice of upcoming spec change should be sent out to the field for renew before the meeting.
- 11. Errors not caught by plan review, some plans are not well thought out or descriptive enough.
- 13. Removal of guardrail and posts incorrect quantity.
- 18. ACC test for surface; not included in the surface quantities
- 33. Insufficient ROW, adequacy of private access. Availability of information in the field,



design of shoulder fillets on multiple overlays of ACC pavement.

36. Plans with a listing of road standards that are incomplete and contain the wrong reference; plans where tabulation of quantities do not match in various sections of the plans; there should be some better method of denoting incidental items on the plans.
49. Not uniform of addressing pavement removal and mandatory recycling on project and payment for crushing pavement.
56. Patching crew; traffic controls; need for dowel alignment need for cure time; most are slipshod workers who blow and go.
58. Overly complicated guardrail tabulation and sequence of staging; poor visibility of plan detail; bridge approach and sub-base quantities; reinforcement, barrel wall design tabulation and payment, asphalt mix design requirement and ACC testing QMA.
88. Erosion control and landscaping project schedule should be on a calendar day basis not work day.  
We have a process that is starting to reduce the repeated problems.  
Plans for resurfacing—with repair to bridges and bridge approaches seem to always have same mistakes---quantities for removal of pavement is guessed at—shoulder rock quantity is never right.
101. Consultant plan errors are common and more difficult to get resolved. Could charge consultant for EWO errors. Plan notes hidden or not placed customary or referenced to pay items.  
Stationing and quantities are always off. We had a job this summer that we did a small overlay on one side of road and it did not need it, the other side did. We heard a lot about this from the traveling public.  
Incorrect info. on road design plans---existing pavement or shoulder info. Missed items on plans. Drainage problems not thought out on plans. Incorrect sta. Or location on plans.
108. Guardrail tab problems. Lack of row to build slopes. Poor plans.  
Not enough time spent on details, especially on consultant project.  
Consultant design plans---soil information is not complete---subdrain sizes are not listed for contractor price, resulting in EWO with 10% markup.  
The loss of the contract numbers will make a project distinction very difficult in the future.  
Conflict between specification.  
No field tile item on culvert extension projects or subdrain outlet.

**What is particularly good about the process of providing continuous feedback for improved contract documents.**

- 10. The contractor department is very responsible to comments about working days, type of contract, notes, etc. The responsiveness of road design is improving, but occasionally we don't hear back anything from our requests. I rarely get any response back from the maintenance department on MP projects.
- 106. When we seek out designers with problems they help us resolve the problems ---usually quickly.

**How may the process of providing continuous feedback for improved contract documents be improved.**

- 7. Possibly implementing more positive input.
- 12. Develop an efficient or timely method of documenting, communicating, and acting on issues at the time they are raised.
- 13. Allow more input from inspectors.
- 32. More thought should be given to local access during the design phase of a project. As a minimum there should be temporary easement acquired for a contractor to work within when specified problems exist. Identifying these situations should be a shared responsibility between the field and road design.
- 58. Need design and road planners to come out to projects to see if their designs are performing by talking with field personnel.
- 101. Construction department monitor feedback questions and ideas and keep residence informed.
- 106. After project completed ---entire inspection team meet with the design team and go over good and bad aspects of plans.

**What is particularly good about the process of providing pre-letting information as it is now?**

- 7. Office administering the contract usually gather requested information.
- 23. You should or must have the source knowledge about the projects prior to letting and as

for me I would think the more you know the better.

- 32. Field exams letter with plans are sent directly to the RCE in addition to the TC. This gives them the request for information as quickly as possible. There has been developed a tracking system for this information. This should be put on line with an independent system.
- 101. Requires contracts between many DOT departments, design, contracts construction, and residential officers.
- 108. We get involved in the project early and we have time to do it if the TC gets the information to us.

**How may the process of providing pre-letting information be improved?**

- 5. More detailed requests and lead time.
- 7. By being very careful for instance with multiple projects in a general locality. When considering letting dates and pre-letting information, be sure that they are in proper order to expedite overall completion of each projects.
- 25. The Offices of design and maintenance need to provide pre-letting information to the field in a more timely and consistent manner.
- 32. The concept of what is being accomplished with the project, need to be shared better with the persons collecting this information.
- 70. Sometimes the process provides lots of lead time and items may change or possibly be forgotten. Sometimes they are short during construction season, but overall they are getting better.  
On projects such as bridge deck overlays, the first time the TCCE or RCE has a chance for input is to review final plans. This is too late. We need to be involved with projects concept or some type of field exams.
- 106. The final step appears to have major problems. More than once the information we provided didn't make it to the plan.
- 111. Contact field materials well in advance of freezing weather for pre-letting information and investigation such as pavement curing and preliminary smoothness for planning projects.

**What question(s) should we have included on this evaluation form? What would your response be?**

1. I think your questions were appropriate. I hope that next year after I have more time in the office that I will be able to complete the questions more thoroughly.
7. Is there any work presently being accomplished by our division that should be accomplished by another division? Yes. We are now doing more inspection projects with less personnel. The MP and MB projects should be transformed to maintenance. This present administration by construction office is a very negative and an overdo change is needed.
11. The DOT is very organized, we have job assignments, knowledge to accomplish our goals. By enlarge we all seem to have the same good expectations to assure quality workmanship and customer safety.
87. Do you feel this job fulfilling? No. Mostly because of the large split between management and workers. And these genuine lack of interest of what is going on. Worried most of what might look bad.
92. Are you offered opportunity to improved yourselves to be the best employee the state can get with their money? No.  
I would like to specialize in one area, that area being survey but are not allowed to because engineers rotates party chiefs from year to year to equalize overtime.
99. Morale of employees: getting tired of the central complex getting fatter and the field office getting trimmed.
113. Ask about partnering job involved in. I thought the whole process was great I wish all major jobs should have it as a requirement.

**Did this evaluation form effectively address the key points of the areas mentioned? If not, what can be done to improved the evaluation form?**

11. The field of construction inspection is so unique to situation that constantly in the hand for me to express my thought in the form of short sentences or paragraphs. It would be good to organized meetings or reviews out in the field condition.
24. No. I think most inspectors think the problems are in Ames. Too many educated idiots, not many with common sense, central office seem like it keeps getting more people but cut down in field. Let work out a evaluation on personnel in central office, and see if anyone

thinks we are getting the most out of these people. People in central office need to realized where the problems is, take a look at yourselves, get rid of the dead beats in Ames and get us some field help at a lot less cost.

75. We take sugesstions from outside consultants on how to improve the Iowa DOT but why not listen to our own people. We all work for the same outfit. There seems to be more and more seperation form white collar to blue collar or so it appears. Also there does not seem to be the trust from our superior or why would we hire so many consultants to do our job when we can probably do it better and most importnat cheaper.
81. This form did a fair job. The one point that can't be addressed by any means is the political element in this type of work. It begins with the selection and budget of a project right down to the individual treatment of all parties involved in the project corridor.

## APPENDIX D

### Survey Comments from National Motor Carrier Drivers

Each response is numbered with the respondents survey number that was assigned by the research team at Iowa State. The specific number has no meaning, however the numbering is consistent in that number 5 is always the same respondent. Some of the responses were selected so the reader could see patterns in the respondents written responses. In all cases, the responses shown are representative of those received from the entire sample.

For each of the written responses required in the Summer 1997 National Motor Carrier Drivers survey, representative responses were selected. Several responses under each category are provided which best represent the sentiments of the entire group of respondents and are provided for background support material.

Please note that the responses are typed as found on the actual surveys. There are instances where typographical errors have been preserved in this document as this is what the writer actually put down on their survey.

**What is particularly good about the traffic control through Iowa highway construction work zone?**

- (4) Plenty of advanced warning.
- (9) They let you know well in advanced of the construction zone of where it will be and they have it divided between the traffic.
- (20) There are hardly any backups in construction zones due to good control.
- (44) The only improvement made over the years has been the adding of merge arrows on the pavement. Other than that, no changes have been made.
- (56) The way you let the drivers know about lane closer for enough in advance or exit ramp being closed and which one to se to take its place.

**Does any other state(s) do a better job of providing safe traffic control on its highway construction work zones? If so, which state(s) and why?**

- (1) Ohio- better job of forcing cars to form single line early

- (5) All about same
- (32) It is hard to beat the state of IA. And traffic control. PA should come to IA and take a few lessons.
- (33) Yes, Pa. Most of the time they have a trooper on two in cars, often the first couple of warning signs for lane closure, to ensure that drivers get over and stay over in open lane.
- (44) Wisconsin give you lane ending warnings up to 5 miles before major construction zones. Thus giving everyone plenty of time to get in a single lane.

**What could be improved in Iowa construction work zones?**

- (5) Fine cars and trucks for running to the barrel before merging. Require contractors to put up a view barrier between their workers and traffic to stop rubber necking. Fine trucks for holding traffic back.
- (6) Safety-Regarding those doing the construction. These people are targets more and more everyday because trucks and cars alike have no care for their presence. May be if you charged them a fee.
- (18) Do construction work in off peak hours; Open all lanes during peak hours; Raise speed limit on IA interstate highways to 75 mph.
- (36) You go a little bit over boards on concrete barriers. People drive on 2 lane roads all the time. Concrete separates are too restricted, people are scares to drive through them. I think it would flow through better and safer with less bottlenecks. Less concrete is better.
- (44) Wider work areas to maximise drive widths and require work to be completed faster. The bridge widening project at the I-80 and I-380 area is taking way too long. May be road constructors used in this state should go to Wisconsin to learn how to get in too complete road projects quickly and effectively.

## **APPENDIX E**

### **Survey Comments from Law Enforcement Officials**

Each response is numbered with the respondents survey number that was assigned by the research team at Iowa State. The specific number has no meaning, however the numbering is consistent in that number 5 is always the same respondent. Some of the responses were selected so the reader could see patterns in the respondents written responses. In all cases, the responses shown are representative of those received from the entire sample.

For each of the written responses required in the Summer 1997 Law Enforcement Officials survey, representative responses were selected. Several responses under each category are provided which best represent the sentiments of the entire group of respondents and are provided for background support material.

Please note that the responses are typed as found on the actual surveys. There are instances where typographical errors have been preserved in this document as this is what the writer actually put down on their survey.

#### **What is particularly good about the traffic control through Iowa highway construction work zone?**

- (1) The pre-site signs warn the public about the construction work zone.
- (3) The advanced notice, letting the driver have enough time to consider alternative route or allowing the driver to prepare for sudden stops.
- (5) We have very few problems with construction work zones
- (6) There seems to be plenty of advance notice of construction zones and good signs once one is in the construction zones
- (7) Electronic signing boards
- (11) Good signs, traffic flow, little congestion.

**Does any other state(s) do a better job of providing safe traffic control on its highway construction work zones? If so, which state(s) and why?**



- (1) Unknown.
- (4) I do not know. One of the major problem is when contractor provide escort pilot vehicles. The vehicles at times are junk and do not meet safety requirements. DOT needs to control escort vehicles and trained and licensed flaggers.
- (11) Not that I have travelled through.

**What is particularly good about the communication regarding Iowa highway construction work zones?**

- (1) The communication between the department of transportation and the state patrol is very good. It is always open for discussion, with the overall outcome being very favourable.
- (2) The department is always available to answer any questions in regards to construction work zones.
- (11) Notification is timely and accurate.

**Does any other state(s) do a better job of communicating about its highway construction work zones? If so, which state(s) and why?**

- (5) Not aware of any

**APPENDIX F**  
**Charter for Safe Traffic Control Process Improvement Team**

**TEMPORARY TRAFFIC CONTROL ZONE  
PROCESS IMPROVEMENT TEAM**

**OFFICES OF CONSTRUCTION**

This process improvement team is charged with improving the effectiveness of the temporary traffic control zones. Temporary traffic control zones are considered effective when they are safe for the traveling public and workers, and administratively efficient for the Iowa DOT and contractors. The cost and scope of work should be reasonable and well defined by the plans and specifications.

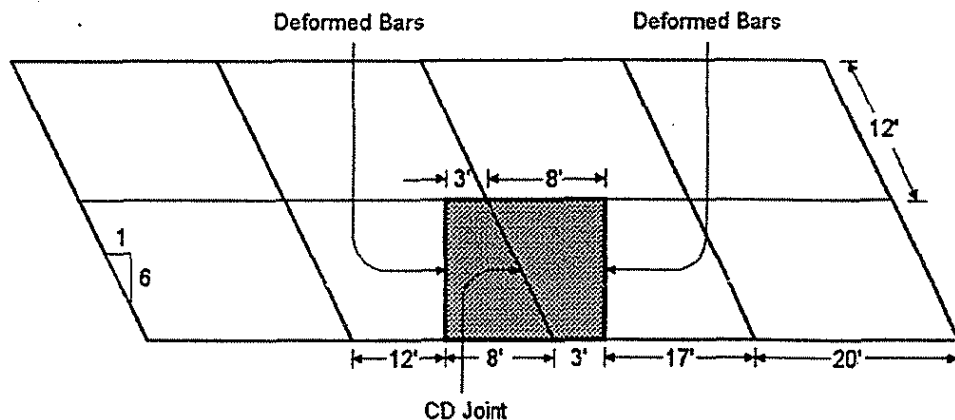
The following tasks are included:

1. Investigate methods to encourage contractors to take greater ownership in traffic control (QC Function) while Iowa DOT retains a monitor role. For example, consider possibility of requiring the contractor to provide certified personnel (*possibly limited to flaggers*) on jobsite. *Another example would be to require contractors to drive the project regularly to document sign conditions.* List possible benefits and challenges for each method.
2. Suggest a performance measuring framework that to communicate expectations and rate contractor performance on specific projects. *It is expected that document could look like the current contractor evaluation form or a group of questions in the employee survey. It is expected that the document could be used periodically during the project to communicate DOT expectations to the contractor and to reward good performance.*
3. Suggest changes to the plan development process and the contract documents that would provide a level playing field for contractors and clearly communicate Department expectations.
4. Identify best practices for communicating with contractors to prevent and resolve issues during projects. (discussions during preconstruction and progress meetings, when to issue noncompliance reports, and how to focus on critical safety issues rather than nit pick)
5. Provide recommendations resulting from the study of the above tasks by April 15, 1997.

## APPENDIX G

# Patching Fact Sheet

- Smooth Dowels vs. Deformed Tie Bars:**  
 Smooth dowels allow for load transfer at a **moveable (RD joint)** concrete joint  
 Deformed tie bars allow for load transfer at a **fixed (RT joint)** [non-moveable] PCC concrete joint
- Patch Ends:**  
 Single panel patches: **ALL** single panel full depth patches have smooth dowels (**RD joint**) at both ends.  
 Multi-panel patches: Multiple panel patches have smooth dowels (**RD joint**) at both ends, unless an end occurs at a location in a lane that is not opposite a joint/crack in the opposing lane. In that case, that end has deformed tie bars (**RT joint**).  
 Patches should end: opposite a joint or crack in the opposing lane (**RD joint**) or a minimum of 1.5 meters (5 feet) from a new or existing joint (**RT joint**) on square jointed pavements. On skewed jointed pavements, patches should end a minimum of 1 meter (3 feet) from a new or existing joint (**RT joint**) {see detail below}.



- CT Joints**  
 The **CT joint** is intended to be placed at the mid-panel location of a 20 foot, one-lane width patch that is across from an uncracked panel. If a patch extends through two or more panels, the **CT joint** is not necessary and CD joints need to be placed at maximum 6 meter (20 feet) spacing. On single panel, one-lane width patches where the opposite lane is not to be patched, the **CT joint** should be changed to a **CD joint** if the opposite lane has a working joint/crack.

- **CD Baskets**

CD baskets (for load transfer) should be located within a long patch at a spacing no greater than 6 meters (20 feet) apart.

- **Centerline Tie Steel**

Longitudinal deformed bars should be placed across the centerline or lane-line of the roadway where panels in both lanes can work as a single unit with smooth dowels at both ends of both panels. For patches less than a full panel in length, the centerline should be constructed as a B joint (mastic only without tie steel) where the single lane patch ends are not opposite from a joint/crack in the opposing lane. This will allow for pavement movement without causing cracks across the newly constructed patch.

- **Continuously Reinforced Pavement (CRC Pavement)**

CRC pavement includes one layer of reinforcing steel at mid depth in order to keep all cracks and joints in the pavement tied tightly together. This reinforcing steel is also included in the pavement to add additional strength. Patches in CRC pavement should include replacement of the reinforcing steel (tied at both ends to the exposing existing steel) in order to maintain the existing pavement's strength and integrity.

- **Sawcuts for Patches**

All patches should be sawn full depth no closer than 40 mm (1 ½ inches) from the intended end of the patch. At the actual patch limits, a partial depth sawcut [40 mm (1 ½ inch)] depth shall be sawn to ensure a clean edge for concrete finishing operations. The section of concrete between the partial depth and full depth sawcuts should be removed by lightweight (30 pound or less) air chisels to minimize the potential for undercutting of the concrete that will remain in-place. The roughened patch edge left from the air chiseled concrete contributes additional load transfer capability.

- **PCC Partial Depth Patch Edges**

PCC Partial depth **finish** patch edges shall be sawcut a minimum depth of 25 mm (1 inch) in order to provide a clean edge for finishing and maintenance.

Partial depth **repair** patch edges do **not** require a sawcut since they are overlaid with ACC concrete as the final driving surface.

- **Full Depth Patch Design Life**

Many of the above referenced construction techniques and requirements are included in the contract documents in order to enable the patches to obtain a desired design life of 15 to 20 years. These additional requirements help insure that the patch can be functional for its entire design life. Patches are **not** designed to be a '*temporary fix*', they are designed to be a permanent repair to the highway.