Appendix: Presentations Made at the Maintenance Management Workshop

Members of the conference steering committee believed presentations offered by speakers at the conference were of significant value to be included with papers that had been formally reviewed and prepared for publication before the workshop. Five speakers accepted the Chairman's invitation and prepared written versions of their verbal remarks and they are included in this Appendix.

Maintenance Management in the Countries Belonging to PIARC

HENRI DeLANNOY

Every 4 years the Permanent International Association of Road Congresses (PIARC) organizes a world congress with the general purpose of fostering progress in the construction, improvement, maintenance, use, and economic development of roads. The next congress will take place in Brussels, Belgium, and you are all invited.

In addition to organizing congresses the PIARC, through its 11 technical committees, is working in collaboration with other organizations with similar interests to set standards of design, construction, and improve communications between countries and within developing countries about developments in maintenance management.

PIARC invites a representative from each country to ensure that the principal academic and research organizations, the laboratories of construction companies, and public authorities with transport responsibilities receive a copy of the basic documents of its work. Almost all European countries are members of PIARC, also Canada, Mexico, Australia, Japan, and many African and Asian countries. To our regret, the United States of America is not, but I am glad to have Adrian Clary of the Transportation Research Board as a dynamic, corresponding member of my committee on maintenance.

At the start our committee on maintenance was mainly interested in winter maintenance and general maintenance of roads. After a few years we began to study maintenance management also.

In most of the countries the models are in different stages of development with each country using the approach that functions best for its problems. Consequently, I am deeply impressed by that I hear in this workshop about the situation in the United States.

Now I am going to give you a general view on maintenance management in the countries belonging to PIARC, based on the reports of the Sydney World Congress.

As a beginning we are studying the assessment of pavement quality.

PARTIAL CRITERIA

The criteria used most widely for evaluating pavement condition by almost all the countries that are members of PIARC are deflection, evenness, skid resistance, cracking, and rutting. Among these parameters, sometimes one is used as the sole criterion or almost as the sole criterion for making decisions and is often included in an overall criterion.

The measuring apparatuses used to quantify objectively these parameters are numerous. The most important are as follows:

1. For deflection the falling weight deflectometer, the Dynaflect, the Benkelman beam, and the deflectograph (adjusted to measure very small deflections) are used frequently on modern roads with semirigid surfacing.
2. New profilometers have been developed for measuring the characteristics of rutting, such as cross profile and depth; among these is the laser profilometer from the Transportation Road Research Laboratory (TRRL). It is a high speed profilometer with a laser sensor that is able to measure, without contact, the vertical elevation of surface asperities and the longitudinal and transverse profile characteristics.
3. For evaluating evenness the goniograph, the accelerations integrator, and the longitudinal profile analyzer are used.
4. The locked-wheel procedure is still used for measuring skid resistance, as well as the Stuttgart

rugometer and the NAASRA roughness meter, the British skid resistance tester, the American skid tester, and the SCRIM.

5. As mentioned previously, TRRL developed the laser profilometer to measure surface texture and also constructed a small manual machine with a laser sensor to measure constantly the macrotexture of the rolling surface.

Global Criteria

Several countries have been using present serviceability index (PSI) values for many years as an overall criterion for evaluating pavement condition (both the original formula and derived formulas adapted to local conditions). However, some countries are developing their own evaluation methods, which are different from PSI but are based on similar concepts. Overall these assessment procedures can be grouped into two categories: ratings and weightings.

1. Ratings. Values obtained from measuring campaigns are added directly; and after fixing different amounts of points (of merit and nonmerit) to each measured situation or parameter, a rating score is obtained.
2. Weightings. Each parameter is given a weight in the context of the overall formula, and the result is an overall condition value as a weighted average of the particular values obtained for different parameters.

The increasing complexity of methods for assessing pavement condition (such as systematic surveying campaigns and visual inspection procedures) and the area covered by road networks and their evolution lead to the generation of great masses of data that must be stored, classified, and processed so it will be readily available for follow-up studies and management analysis. Therefore data banks become necessary, and many countries are working this way, with remarkable results. The development of visual procedures also leads to the extension of damage catalogs.

STRATEGIES OF MAINTENANCE

As a rule, three types of strategies are considered.

Strategy 1: With the Current

This strategy consists of letting the process of road deterioration continue, while trying to avoid its acceleration by immediate interventions aimed at repairing damage as it occurs and eventually by laying surface dressings at given intervals.

Strategy 2: Progressive Improvement

This strategy initially implements a reduced design (during construction or strengthening) and then makes, at regular and relatively short intervals, interventions of a structural character to strengthen the road structure. This limits the initial investment but entails risks to the road that may develop from traffic and, in some regions, frost.

It implies (a) strict follow-up of the evolution of the road and (b) the respect of maintenance sequences, which presupposes that the corresponding funds are available at the appointed time. Some countries stress a limitation of the roads on which this strategy can be used (for example only for lightly-trafficked or average-trafficked roads).

Progressive strategies lead to a higher overall consumption of materials, particularly bituminous coated macadams; and this conflicts with the efforts made toward limiting the consumption of bitumen and developing the use of hydraulic binders.

Strategy 3: Heavy Construction

In this strategy road structures and strengthening are designed in such a way that future interventions consist mainly of restoring surface qualities (evenness, adhesion, and waterproofness). The interventions of a structural type are limited to adapting the road to the evolution of heavy traffic.

OPTIMIZATION

The need to optimize road strategies poses a new urgency as a result of financial restrictions and the need to manage, in the best possible way, the existing networks. This optimization problem is being studied by all the countries that are members of PIARC; but unlike the situation in the United States of America, where many maintenance management systems are operational, the models are only in the process of being drawn up. An exception is Canada where several systems of optimization are in action, especially in Ontario and Alberta. The most recent one used in Alberta (since 1983) is called Rehabilitation Information and Priority Programming Systems (RIPPS) and includes two subsystems: the Rehabilitation Analysis Subsystem (REHAB) and the Priority Programming Subsystem (PRIORITY). Optimization is realized by the technique of linear programming, which allocates the costs of investments and maintenance over a period of 25 years.

In Australia research has been done on implementing a pavement management model, which takes into account both the infrastructure costs and the general costs of use. Also Great Britain is developing further its well-known Chart system.

The Federal Republic of Germany has prepared cost-benefit studies including user costs for different strategies. Papers on these subjects were given earlier.

In France maintenance management is comprised of three steps: collecting information, defining needs, and choosing a solution, which is as the case may be, preventive maintenance (surface dressings or thin overlays) or a road strengthening by thick overlays or reconstruction. Economic analysis of the intervention program is the basis of optimization in Finland. The following aspects are considered: costs of reinforcement, costs of maintenance, user costs, and the residual value of the road after the considered period.

The target in Sweden is to achieve optimization of all costs to the community from both the user's and the road manager's point of view (i.e., maintenance, investment, accidents, travel time, and vehicle operating costs). A cost-benefit analysis is performed in which the marginal benefit to society is calculated for various changes in the present surfacing strategy. In Denmark the maintenance model consists of four main elements: the road standards, the road data bank, a number of administrative procedures (which thoroughly describe how and when the various activities must be carried out and by whom), and a priority model for maintenance needs.

In Italy information in the data bank, which is based on periodic inspections, is used to assess maintenance needs. When a road section is indicated for repair, a punctual auscultation is performed to

determine the necessary maintenance. The adopted optimal solution takes into consideration the financial and technical aspects as well as disruptions in traffic.

The Netherlands selects maintenance and rehabilitation activities for the near future. The choice of the adequate intervention measure is based on the cost to assure a given service level. A research project for an optimization concept has been started. It considers two questions: the first examines the minimum yearly maintenance budget when the set of quality standards is prescribed; the second is how to adjust quality standards to a given yearly maintenance budget.

Finally in my own country, Belgium, a road network assessment and monitoring methodology is being developed. It is based on a comparison of assessment parameters with the visual inspection of the road, which is carried out every 5 years.

Implementing Use of Microcomputers in the Highway Maintenance Program of New York State

GEORGE R. RUSSELL

I appreciate this opportunity to report briefly on some success with a management technique for introducing microcomputers to an organization and developing their use within the organization.

The New York State Department of Transportation (NYSDOT) Highway Maintenance Program is organized into 68 residency organizations that are county size. They are the lowest highway maintenance organizational element that has administrative and clerical responsibilities. Although they are the lowest organizational elements, they still have a significant amount of such work. For example, a residency clerical staff of two is expected to provide all payroll, personnel, and purchase support for a work force of approximately 80 people and a budget of approximately $1.5 million.

NYSDOT has had reasonably contemporary computer support at the main office level for 25 years, however, no significant computer support has been extended down to the residencies. In the late 1970s, the low-cost microcomputer became available, and many people, who previously had no access to computers, became proficient in microcomputer use.

This was true in our department, and I began to receive ideas from the field and from my own staff on how microcomputers might help in the administration of the program. Their responses were rather intriguing because the same people who had always spurned the printouts from the main office computer as being worthless now seemed to be saying that printouts from their own microcomputer would be priceless.

In any event, they got my attention; and when I learned that at least two residencies had acquired use of privately owned micros (Apple IIs) and were using them for state business, I knew I was hearing some truth. To further my own knowledge, I completed a home study course for managers on the microcomputer. This course reinforced what I had been told by several computer people; that is, that potential microcomputer users, in this case our resident engineers, should define carefully the problems they think can be solved by using micros. Next, they should find software that might be used to solve the problem, and then hardware that would run the software. We decided to follow this course.

It was obvious that the people best suited to define the problems were the people who had the problems, that is, our resident engineers. We have a significant advantage here, because all of our 68 resident engineers are licensed professional engineers. Therefore, it was easy to find four competent ones who had a strong interest in computer technology to form a committee to carry out a pilot project. To these we added a man from my office, who had had computer experience at the main office. He acted as secretary for the committee and kept me informed of their progress.

The next step was to require each member of the committee to take the same home study course on micros that I had taken so that everyone would start with a common understanding of the management problems. As a result all committee members quickly accepted the premise that they would have to define potential uses for the micro, find the software, and then the hardware. Between October 1982 and March 1983, they isolated six significant uses for the microcomputer:

1. Payroll changes,
2. Word processing,
3. Financial account keeping,
4. Personnel information,
5. Material inventories, and
6. Accident damage collection.

The software selected to solve these problems was D-Base II, PeachCalc, and Wordstar. This software, at that time, required a control program for microcomputers (CP/M) operating system in the computer. The computer selected was the Tandy TRS-80 Model 12 Computer with Anadex Model 9500A printers.

We acquired a set of software and hardware for each of the four resident engineers on the committee for use in their offices, which were scattered throughout the state. Also each committee member agreed to develop by November 30, 1983, a computer program to solve one or two of the six uses, and

they all agreed to implement all six programs by December 30, 1983.

These assignments and deadlines were put in writing to them so that their tasks and deadlines were clear. All six programs were written and implemented by the deadline of December 30, 1983.

At this point, we ran into a bit of a delay in that NYSDOT as a whole had not stood still concerning microcomputers. There was great interest in micros by other program areas and several different micros were being acquired by different programs. This forced our administrative staff, who have overall responsibility for computer support, to insist on a common operating system for micros to facilitate the exchange of computerized information. They decided on the MS/DOS operating system, which runs the IBM PC and several other makes. Up to that point all the committee's work had been based on the CP/M operating system.

Therefore, the committee had to convert the software they had developed and acquire hardware that could use the MS/DOS operating system. The committee decided to use a new microcomputer on the market, the Tandy TRS-80, Model 2000. This machine uses the required MS/DOS operating system and is a faster machine than the older Model 12. At the same time, it was decided to adopt a new printer, the Okidata Microline, Model 93P.

The committee modified their programs so they could be used with the Tandy TRS-80 and eight useful menu driven programs have been developed for direct application at residency level. Six more are being developed.

One example of a useful program is the payroll change program. Our payroll system is set up to print out the same checks to the same people unless it is instructed to change. The residency is responsible for initiating changes for their staff; this is a large, repetitious, and tedious task, especially in the winter when all of the blue-collar employees are earning overtime on snow and ice control. It was common for residency clerks to spend 15 man-hours per biweekly pay period on this task. With the micro, this work is reduced to 1 man-hour. We feel this one program application will pay back the cost of the hardware in a year.

The committee's work showed that micros can be used successfully at the residency level, so successfully, that once installed, they become almost indispensible. Consequently, we plan to install micros in 38 residencies this year and the remainder in 1985.

In summary, we have been successful by following the procedure of defining possible applications, finding software that should do the job, and then matching hardware to the software.

We were also successful because the users developed the programs to meet their needs; nothing was imposed from above. We were fortunate in having intelligent, technically trained, enthusiastic users, who had the capability of effectively putting micros to work.

In closing, I would like to give credit to the members of the committee. They are

David Palma, Saratoga residency;
Richard Bassler, Cortland residency;
Fred Ames, Steuben-Chemung residency;
Chet Moody, Cattaraugus residency;
Albert DiCesare, Niagara residency; and
William Dixon, main office.

Merging Construction and Maintenance Activities in South Dakota

WILLIAM M. GERE

South Dakota is responsible for maintaining some 18,500 single-lane miles of highway and administering the activities of contractors on an average of 250 construction projects annually.

In the fall of 1980 because of continued pressure to reduce the number of department employees, it became obvious that we were going to have to reorganize to provide adequately staffed and trained construction inspection and maintenance crews to handle the work assignments.

We reviewed the last 8 to 10 years of our maintenance activities and determined that we were adequately staffed in the rural areas at the rate of 20 two-lane miles per maintenance worker including a foreman and 15 two-lane miles per worker in urban areas. The construction inspection and engineering staff need was being planned by a construction engineering management system that had been initiated in 1979 and a 5-year construction program that we were reasonably comfortable with.

The South Dakota Department of Highways was established in the late 1930s. It was organized into five districts with a district engineer in charge of each district, and the mileage assignment among the districts was reasonably equitable. In 1974 the South Dakota Department of Transportation was created.

As a general rule the maintenance work was assigned on a county basis with at least one maintenance crew with a foreman in charge in each county. In some of the more densely populated counties with a greater number of miles of road there were two or three maintenance crews.

Construction engineering and inspection was assigned to an individual identified as the resident engineer with a crew of professionals and subprofessionals varying in number depending on the amount of work. In the early 1950s we had 30 to 35 of these residencies looking after construction work and 90 to 100 maintenance crews. With the advent of Inter-

state highway construction, construction engineering unit staffs were increased substantially; and by 1969 our field staff numbered 1,100 people. This included the engineering construction crews, the maintenance crews, and administrative and support staff for the five district headquarters.

In 1961 the district engineer in concert with the central office management decided that there was a need for another level of supervision in the field headquarters office; this was provided by appointing two assistant district engineers, one in charge of construction and the other in charge of maintenance. This was our organization until 1980. An increasing awareness that construction activities would have to be curtailed because of dollar inflation made it necessary for us to assess the efficiency of the existing organization. A full-time equivalent ceiling, imposed by the budget, required a change that would allow placement of construction or maintenance personnel at a project site.

We started at the top in the central office merging functions and reassigning supervision. The central office staff administering the construction and maintenance programs, which had been two separate offices for many years, was merged into one Operations Support Office with one engineer in charge of both construction and maintenance. Along with the personnel from the former maintenance and construction offices, other personnel from property management, traffic operations, billboard control, labor compliance, utility, and railroad operations were transferred into this office. The result was that the total department staff was reduced by 10 to 12 full-time employees.

At this time we transferred some of the responsibility that had been in the construction office to the field offices (e.g., construction change orders, price adjustments, and claims). District engineers (later region managers) were given the responsibility for administering these requests without central office approval. Some apprehension went along with this reassignment of responsibility but after 3 years of operating in this fashion it is working satisfactorily.

A vacant assistant district engineer position was created in making the changes. Instead of appointing someone to fill that position, we looked at some of the other states and decided to merge construction and maintenance activities in that district.

We organized that district into three separate areas with an area engineer, who is responsible directly to the district engineer, in charge of each. The maintenance units and construction crews were made directly responsible to the area engineer. Some of the resident engineers were reidentified as project engineers. Each one is in charge of one or more construction projects and is responsible directly to the area engineer.

The same thing was done with the maintenance foreman. The field management organization now has four levels: district engineer, area engineer, project engineer or foreman, and construction technician or maintenance worker. The previous assistant district engineer and resident engineer or maintenance superintendent positions were abolished, eliminating two levels of authority.

We operated in this way until the spring of 1983 with one of the five districts organized into three areas and the other four districts still operating with both a district engineer and an assistant district engineer. Observation of the area concept with a reduced supervisory staff indicated that district was functioning as well as the other four. We were encouraging all of the field districts to reassign both maintenance workers and construction technicians to the greatest degree possible to give them an opportunity to learn each other's trades and skills, especially for supplementing each other's units as seasonal personnel shortages occurred. There was some resistance to this melding together of maintenance worker and highway technician assignments; however, an increased awareness of the benefit in doing this developed as time passed and more multiple work assignment activity was under way.

Late in 1982 a new secretary took charge of the department. His first message was that there would be a substantial reorganization. At this same time the passage of the 1982 Surface Transportation Assistance Act seemed imminent, and thus we were faced with an increase in construction, whereas 2 years before a decrease had been expected.

The first 6 months of 1983 were spent in brainstorming and putting together a reorganized department plan that completely eliminated one of five district headquarters. In the new department organization that was implemented on July 1, 1983, the field units were organized into four regions with a region manager in charge of each.

All four regions were organized into three areas as the experimental district had been in 1980 with an area engineer responsible directly to the region manager and the project engineers and the maintenance foreman responsible directly to the area engineers. Closing the district office created a surplus of 35 to 40 personnel. All of these people were offered opportunities to transfer to other parts of the state, but by and large they elected not to move. A number of them took early retirement and others found different employment.

In 1972 we had started to eliminate those field maintenance units with low mileage. This was based on the decision that there was no operational or economical benefit in trying to operate maintenance crews responsible for fewer than 100 two-lane miles. Units were closed as personnel retired and equipment wore out. By 1983 14 units remained in the elimination plan. The July 1, 1983, reorganization addressed this plan immediately. Notice was sent to each unit with a limited mileage responsibility that it was being closed and its responsibility transferred to neighboring units. This was done with some amount of complaint from local communities and some objection on the part of the maintenance workers; however the closures were accomplished by year's end and the surplus property and equipment was disposed of.

The construction engineering stations that were not located at the 12 area headquarters were also put on a list for elimination. There are 10 of these engineering stations, 4 of which will be closed by January 1985. The others are scheduled for closing as the construction work in their area is completed or at least reduced. With the current construction program and assuming that increased funding will continue, it appears that it will be near the end of the decade before these engineering stations are closed.

On July 1, 1984, the department will have a field staff of 930 people (down from 1,100 in 1969). This includes the four region headquarters and their administrative and operations staff, the 12 areas with their construction engineering crews, and 75 maintenance units. The maintenance units are organized into crews of from 5 to 10 people charged with the responsibility of looking after from 100 to 200 two-lane miles of highway.

With the reduced staff of field personnel and a highway system that requires as much if not more maintenance attention than when the staff was larger and an increasing construction program, the department found itself in a bind. There were two obvious courses of action: (a) some of the maintenance work

and the construction inspections could be neglected, which is not a viable alternative, or (b) some of the work could be done by contract.

For a number of years now the department has been contracting 25 to 30 percent of its maintenance needs, and we are going to have to continue at that level or higher. Also, agreements are being drawn up with consulting engineers to do construction inspections. Other tasks that could be done by contract include material testing, plant inspection, grading inspection, surveying, and it is possible that we will hire a consultant to look after an entire construction project.

I had hoped to report a complete reclassification and merging of the highway maintenance worker and construction technician grades into a new position description combining the knowledge, skill, and ability required for both job assignments. Although this is being done, it has not been completed. As previously indicated, work assignments frequently cross between maintenance and construction, and I am sure that all of the employees understand this to be our goal.

The area organization, with its reduction in middle management supervision, is functioning better than I anticipated and appears to be enjoying good acceptance.

A Maintenance Management System for Road Markings

PER SIMONSEN

The Danish Road Directorate has recently issued provisional specifications for marking traffic lanes of main roads beginning in 1984. Simultaneously recommendations on materials for, and maintenance of, marking were issued. Specifications and maintenance strategy are based exclusively on the functional requirements of the markings. It is to be expected that the introduction of the recommendations will result in a higher standard of marking and thus contribute to increased road safety.

GENERAL SPECIFICATIONS FOR MATERIALS AND EXECUTION

Marking performed by contractors is required to meet a number of conditions [referred to in Denmark as the AAB (1,2)] before delivery and before the expiration of the guarantee period. These fall into three general categories: (a) optical properties, (b) skid resistance, and (c) durability. The required minimum values are stated in Table 1.

Optical Properties

A recently developed reflectoscope (i.e., a small box with white opal glass plates) is used for measuring optical properties (see Figure 1). The measurement is made by comparing the road line with a number of filters placed in front of the opal glass plate.

For unlighted roads, the reflection of the road marking in the dark, which is indicated by the specific luminance (SL), is determined in the light of the main beams of the headlights of an automobile. The reflectoscope is placed behind the road marking with the measuring face turned toward the spot of observation, which is chosen to be about 50 m in front of the reflectoscope at a height of 1.2 to 1.5 m above the carriageway (see Figure 2). The reflection is determined by comparing the road marking with the different reference surfaces.

For lighted roads and in daylight the reflection properties of the carriageway markings are deter-

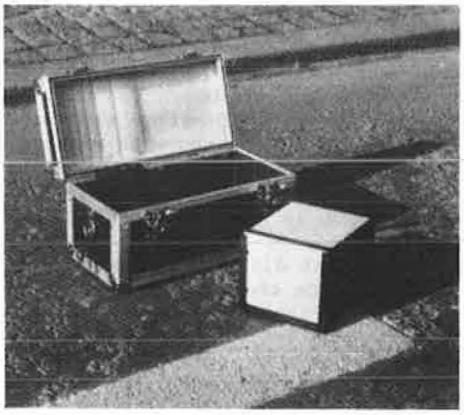

FIGURE 1 Reflectoscope with storage box and filters.

TABLE 1 Functional Requirements for Road Markings

Time	Mean Luminance Coefficient, Qo ($cd/m^2/lx$)	Specific Luminance, SL ($cd/m^2/lx$)	Skid Resistance (srt)	Maximum Wearing (% of area)
At delivery	0.16	0.16	55	0
Expiration of guarantee period	0.13	0.13	55	30

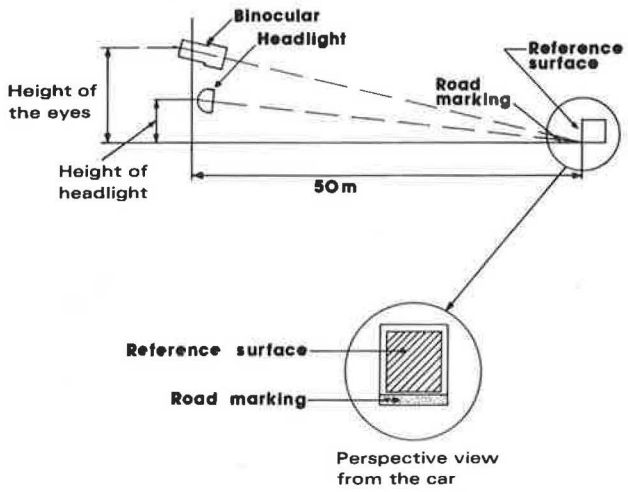

FIGURE 2 Geometrical conditions for observation of reference surfaces of a reflectoscope.

mined in terms of the mean luminance coefficient (Qo). This parameter is measured by the other face of the reflectoscope. A quantity of light emitted via a mirror corresponds to the light intensity by which the line is lighted from the surroundings (see Figure 3); and by assessing which filter corresponds to the line, the Qo-value is determined. The use of the reflectoscope is illustrated in Figure 4. It was developed by a working party set up by the Danish Road Directorate along with the firm of Hansen & Henneberg as consultants in the field of reflection. It is manufactured by Brüel and Kjaer and costs less than U.S. $500.

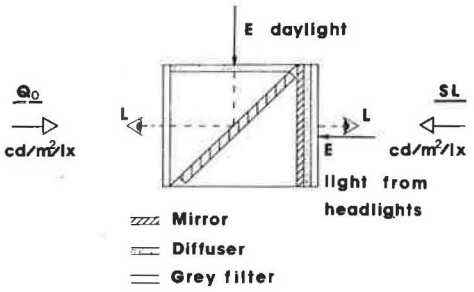

FIGURE 3 Reflectoscope for determining the mean luminance coefficient (Qo) and the specific luminance (SL). Different grey filter densities give different values of Qo and SL.

Other Requirements

Skid resistance is measured by a pendulum roughness indicator, and wearing is assessed visually. The guarantee period depends on the type and material of the marking and is given in Table 2.

TABLE 2 Guarantee Period (years) for Carriageway Marking

	Linear and Arrow Markings	Transverse and Other Markings
Thermoplast	4	2
Paint and foil	1	0.5

Painting

Lines are often painted by the road authority itself and demands of elasticity, durability, and ability for storage of the paint are determined by current testing methods.

MAINTENANCE STRATEGY

The objectives of a maintenance strategy for road lines are to reduce costs of construction as well as operation at a given standard level.

Functional Criteria

The standard level is determined by the criteria of remarking as given in Table 3. The general specifications for remarking are also based on functional requirements. The main roads are classified in two groups: groups A and B. Group B has the greatest need for optical guidance for road safety reasons and therefore places higher demands on the optical properties of the lines. The classification is

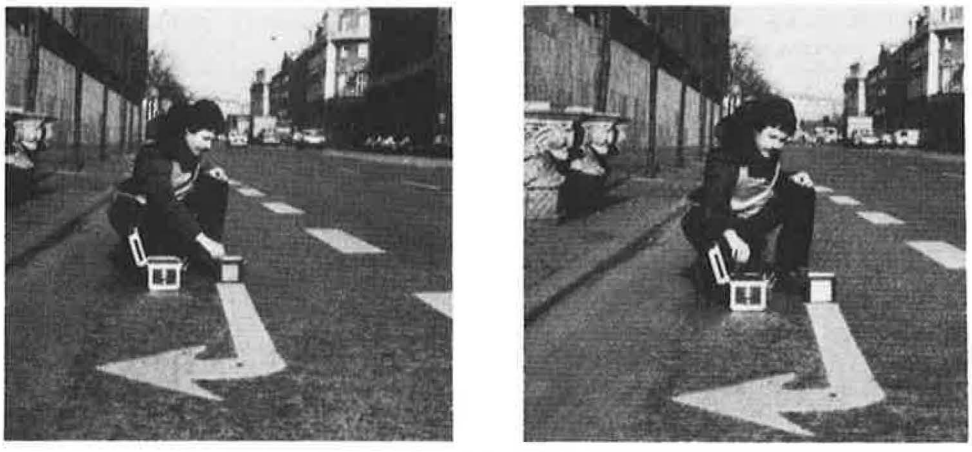

FIGURE 4 Measuring the mean luminance coefficient (Qo).

TABLE 3 Criteria of Remarking

Group	Mean Luminance Coefficient, Qo ($cd/m^2/lx$)	Specific Luminance, SL ($cd/m^2/lx$)	Maximum Wearing (% of area)
A	0.10	0.06	50
B	0.13	0.10	50

based on information on road alignments, which is stored in the road data bank of the Danish Road Directorate.

Annual Marking Costs

As in the Danish road standards for pavements, annual costs, which are calculated from the capital recovery factor, are used as a basis for choosing marking materials (i.e., when deciding whether to use thermoplast or paint in a given case). At the present time the rate of interest used in the capital recovery factor is 7 percent.

The maintenance strategy is summarized below. Then two examples are given for determining which marking material is the most economical.

- General: On unlighted roads, beads are applied; on lighted roads, beads are not applied.
- New Marking: Thermoplastic material is applied on new wearing courses; marking is carried out by contractors, and the AAB applies.
- Remarking: An assessment of wearing is made in both the daylight and dark. Different remarking criteria apply for roads in group A and group B. The average annual maintenance costs are calculated, and the material is chosen. The AAB applies.

Example 1

Ten thousand square meters are to be remarked; the initial price of thermoplastic material and line painting is D.kr. 65 per m^2 and 15 per m^2, respectively. It is assumed that the interest (r) is 7 percent a year.

In the first case the renewed marking with thermoplastic material lasted 4 years. It is expected that line painting will last 1 year, and it is assumed that the remaining life of the pavement will be at least 4 years. A calculation x) of the average annual costs (G) gives:

G for thermoplastic material = D.kr. 191,750 and
G for line paint = D.kr. 160,500.

In this case it would be better from a purely economic view to renew the marking by line painting. x) G is determined as the product of the initial price of the marking renewal and the capital recovery factor a(n):

$$a(n) = [r(1 + r)^n]/[(1 + r)^n - 1]$$

where n is the expected life of the renewed marking, which is assessed on the basis of the experience derived from the marking renewal on the section in question, and r is the interest.

A table of a(n) is shown below for n between 1 and 10 years and for r equal to 7 percent and 9 percent per annum.

r = 7 percent		r = 9 percent	
n(year)	a(n)	n(year)	a(n)
1	1.070	1	1.090
1.5	0.725	1.5	0.742
2	0.553	2	0.568
3	0.381	3	0.395
4	0.295	4	0.309
5	0.244	5	0.257
6	0.210	6	0.223
7	0.186	7	0.199
8	0.167	8	0.181
9	0.153	9	0.167
10	0.142	10	0.156

Example 2

The conditions are similar to those given in example 1, except that the renewed marking has lasted 5 years and the pavement is expected to have a remaining life of 9 years. Because surface renewal of the road is to be made within the coming year it is expected that the remarking with thermoplastic material will last 10 years, whereas marking with line paint is assumed to last 1.5 years. In this example

G for thermoplastic material = D.kr. 99,450 and
G for line paint = D.kr. 108,750.

Therefore it would be better to renew the marking with thermoplastic material.

CLOSING REMARKS

It is the intention of the Danish Road Directorate to obtain an improved and more uniform standard of the carriageway marking on the main roads by issuing new provisional recommendations. Increased road safety is the expected result. Copies of the recommendations are available from the Danish Road Directorate on request.

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Performance Indicators

PHILIP W. AMOS

The Pennsylvania Department of Transportation has developed three systems for indicating performance in the field of maintenance activities. They are management objectives reports, county accreditations, and quality assurance evaluations.

Management objectives reports are distributed monthly and summarized at three levels in the department. The first level, statewide, is called the Blue Book. Each activity is compared by the amount expended or performed last year, the amount budgeted for this year, and the amount accomplished or expended to date. This is recorded on a cumulative monthly basis for our fiscal year (July 1 to June 30). Figure 5 shows examples of expenditures, and Figures 5 and 6 show examples of maintenance activities by contract and department forces. Figure 7 summarizes our truck weight enforcement program.

The second level of management objectives reports is the district management summary (the Green Book). This report summarizes district activities, including maintenance, by fiscal year-to-date versus planned year-to-date as a percent and fiscal year-to-date versus last year-to-date. Figure 8 is an example of this summary.

The third level of management objectives reports is the county management summary (the Red Book). This report provides comparisons for each major maintenance activity between amounts completed in the preceding year, planned, completed to date, and the percentages. It also compares county costs with statewide average costs. Figure 9 shows examples. Another portion of this county report addresses county equipment utilization compared with statewide averages. Figure 10 shows an example.

The county accreditation program was developed as an indicator of the counties' performance. The program includes an independent review of field operations, equipment, personnel, and office operations. Each function is weighted along with weighted items within the function, and an overall accreditation rank is established. In this way the county maintenance manager knows where improvements are needed. An example of the program is shown in Figure 11.

The maintenance quality assurance evaluation systems were developed to evaluate statistically the quality of our major maintenance activities and improve our policies and procedures, thereby improving the quality of our product. The system developed for manual patching is shown in Figures 12-14; the figures show the evaluation form, the rating form, and the indicators used for the evaluation, respectively. An important function of the question and answer evaluations is the analysis, which determines needs for basic training of our maintenance forces.

PERSON RESPONSIBLE: DEPUTY SECRETARY FOR HIGHWAY ADMINISTRATION
DAVID C SIMS, PE

1983-84 CUMULATIVE PERIOD: YEAR TO DATE

NO	ITEM	UNIT OF MEASURE	L B A	JULY LAST YR BUDGET ACTUAL	AUG LAST YR BUDGET ACTUAL	SEP LAST YR BUDGET ACTUAL	OCT LAST YR BUDGET ACTUAL	NOV LAST YR BUDGET ACTUAL	DEC LAST YR BUDGET ACTUAL	JAN LAST YR BUDGET ACTUAL	FEB LAST YR BUDGET ACTUAL	MAR LAST YR BUDGET ACTUAL	APR LAST YR BUDGET ACTUAL	MAY LAST YR BUDGET ACTUAL	JUNE LAST YR BUDGET ACTUAL
	EXPENDITURES														
			L	25.1	56.4	81.8	108.2	136.2	163.3	188.7	215.0	247.8	273.2	300.7	321.2
	SALARIES AND FRINGES	$	B	23.4	56.0	80.1	104.0	130.9	154.6	181.0	209.1	234.3	261.3	285.0	312.8
1	OBJ 100 (84-86, 87, 89)	MILLIONS	A	24.2	56.4	80.0	103.9	130.3	154.0	186.1	205.6	239.5			
	OPERATING EXPENSES		L	.6	1.2	2.3	2.7	2.7	3.2	3.4	3.6	3.9	4.2	4.6	5.0
	HWY PROJS	$	B	1.0	1.8	2.8	3.8	4.5	4.9	5.7	6.2	7.5	8.9	9.9	13.9
2	(OBJ 301, 327, 392, 394)	MILLIONS	A	.5	1.0	1.4	1.8	2.2	2.5	2.8	3.0	3.3			
			L	2.9	4.4	8.6	12.8	15.6	19.5	21.8	24.3	28.3	31.5	35.1	38.1
	ENGINEERING CONSULTANTS	$	B	3.9	8.3	14.7	18.2	21.5	24.2	26.3	27.6	28.7	29.4	31.0	32.4
3	(84, 85, 86, 87, 89)	MILLIONS	A	4.4	7.6	9.8	13.2	16.6	19.5	22.0	25.7	28.8			
			L	2.9	6.1	7.1	8.9	10.5	11.4	12.9	14.2	15.2	16.2	16.8	18.4
	RIGHT-OF-WAY	$	B	3.0	4.5	6.2	7.7	9.4	10.9	12.6	14.0	15.5	17.2	19.3	20.8
4	(APPN 85, 89)	MILLIONS	A	1.6	2.7	* 5.4	6.6	7.6	9.4	10.1	12.0	14.4			
	PAYMENTS TO CONTRACTORS		L	30.9	68.2	101.8	134.6	168.9	191.1	203.4	218.5	225.8	240.6	253.0	272.2
	CONSTRUCTION	$	B	22.2	51.9	79.4	103.8	127.4	147.1	161.2	172.7	182.4	199.9	225.7	260.0
5	(84, 85, 89)	MILLIONS	A	22.9	50.7	86.5	118.8	136.9	158.1	167.7	181.0	192.9			
	PAYMENTS TO CONTRACTORS		L	41.1	90.0	134.6	186.6	221.8	241.1	252.5	260.3	265.4	270.6	280.9	299.3
	HWY MAINTENANCE	$	B	19.5	44.2	75.2	100.6	120.9	136.4	147.7	153.4	158.9	168.7	182.1	199.7
6	(86, 87)	MILLIONS	A	22.3	45.7	73.0	91.6	112.7	124.1	130.4	134.2	136.8			
			L	-	-	-	-	-	-	-	-	-	-	-	-
	ROAD TURNBACK GRANTS	$	B	-	-	-	-	-	-	-	-	-	-	-	-
7	(APPN 86)	MILLIONS	A	-	-	-	-	-	.3	1.3	4.1	6.2			

*INCLUDES REPAYMENT OF ADVANCES ON INTERSTATE PROJECTS IN THE PITTSBURGH AREA.

FIGURE 5 Management objectives report: Examples of statewide (Blue Book) expenditures.

1983-84 CUMULATIVE
PERIOD: YEAR TO DATE

NO	ITEM	UNIT OF MEASURE	L B A	JULY LAST YR BUDGET ACTUAL	AUG LAST YR BUDGET ACTUAL	SEP LAST YR BUDGET ACTUAL	OCT LAST YR BUDGET ACTUAL	NOV LAST YR BUDGET ACTUAL	DEC LAST YR BUDGET ACTUAL	JAN LAST YR BUDGET ACTUAL	FEB LAST YR BUDGET ACTUAL	MAR LAST YR BUDGET ACTUAL	APR LAST YR BUDGET ACTUAL	MAY LAST YR BUDGET ACTUAL	JUNE LAST YR BUDGET ACTUAL
	EXPENDITURES (CON'T)														
	MAINTENANCE MATERIALS														
			L	.1	.2	.2	1.9	6.8	9.7	11.1	12.6	13.3	13.4	13.5	13.6
	WINTER MAINT. MATERIALS	$	B	0	0	0	1.0	5.0	8.0	11.0	14.0	14.6	14.9	15.0	15.0
8	**(APPN 87)**	MILLIONS	A	.1	.1	.1	.4	2.1	5.4	7.3	11.3	14.6			
			L	8.0	18.1	27.6	34.1	38.4	41.8	44.0	45.4	46.5	48.0	49.9	55.1
	ROUTINE MAINT MATERIALS	$	B	6.9	13.8	21.6	28.5	33.7	37.4	39.6	41.2	42.4	44.0	47.1	51.6
9	**(APPN 87)**	MILLIONS	A	4.6	14.6	23.5	32.0	37.8	41.6	43.9	45.0	46.9			
			L	2.5	4.8	7.3	9.5	12.4	15.1	17.9	20.6	23.5	25.7	27.8	29.4
	MAINT EQUIP & SUPPLIES	$	B	2.6	5.2	7.8	10.4	13.0	15.6	18.2	20.8	23.4	26.0	28.6	31.1
1	(APPN 87)	MILLIONS	A	1.9	4.2	6.5	8.7	10.8	13.4	16.0	19.2	22.5			
			L	2.1	4.7	9.4	13.6	17.0	20.5	23.8	26.5	30.5	32.8	34.6	37.6
	OTHER	$	B	5.0	10.6	14.9	19.4	25.3	30.7	36.5	30.3	41.5	45.0	51.9	60.0
2	(APPN 87, OBJS 300, 400)	MILLIONS	A	3.2	9.8	19.7	24.5	27.8	32.6	36.7	41.2	45.1			
			L	116.2	254.2	380.3	512.5	630.3	716.7	779.5	841.0	900.2	956.2	1016.9	1092.9
		$	B	87.5	196.3	302.7	397.4	491.6	569.8	639.8	697.3	749.2	815.3	895.6	997.3
3	TOTAL EXPENDITURES	MILLIONS	A	85.7	192.8	305.9	401.5	484.8	560.9	624.3	682.3	751.0			
			L	442	2441	3620	4493	5181	6107	7318	8804	10532	11161	11744	12208
		$	B	-	-	-	-	-	-	-	-	-	-	-	-
4	OVERTIME	THOUSAND	A	750	1488	2409	3119	3791	4996	7248	9359	11319			
	CONTRACT LETTINGS														
			L	54	84	131	158	184	226	263	299	324	367	447	524
			B	59	137	239	261	329	403	467	531	592	667	727	796
5	TOTAL PROJECTS LET	NUMBER	A	59	137	239	261	331	404	445	478	551			
			L	40.8	56.8	107.6	131.5	138.5	154.4	166.6	180.1	185.7	213.8	246.3	277.1
		$	B	36.0	138.0	236.1	254.6	304.9	405.2	584.7	712.6	773.6	815.4	841.0	906.6
6	TOTAL PROJECTS LET	MILLIONS	A	36.0	139.2	237.3	254.6	293.4	378.8	435.8	456.4	533.3			
	BILLION $ BRIDGE PROG														
	NOT DOABLE	NUMBER	A	14	19	25	27	28	31	36	38	41			
	NO WORK STARTED	NUMBER	A	600	560	523	501	472	448	400	385	366			
7	IN DESIGN	NUMBER	A	289	316	321	334	330	308	341	350	349			
			L	-	-	-	-	-	-	-	-	-	-	-	*57
			B	-	-	-	-	-	-	-	-	-	-	-	#196
8	PROJECTS LET	NUMBER	A	70	76	95	99	126	163	164	168	184			

*SOME PROJECTS WERE LET PRIOR TO THE BRIDGE BILL PASSAGE.
#ANNUAL ELEMENT.

NO	ITEM	UNIT OF MEASURE	L B A	JULY LAST YR BUDGET ACTUAL	AUG LAST YR BUDGET ACTUAL	SEP LAST YR BUDGET ACTUAL	OCT LAST YR BUDGET ACTUAL	NOV LAST YR BUDGET ACTUAL	DEC LAST YR BUDGET ACTUAL	JAN LAST YR BUDGET ACTUAL	FEB LAST YR BUDGET ACTUAL	MAR LAST YR BUDGET ACTUAL	APR LAST YR BUDGET ACTUAL	MAY LAST YR BUDGET ACTUAL	JUNE LAST YR BUDGET ACTUAL
	AWARDS														
			L	45.9	65.9	77.8	83.2	90.1	95.9	110.2	114.6	121.3	124.0	130.3	154.7
		$	B	15.6	34.7	93.3	99.2	120.0	129.0	132.0	140.0	152.0	161.0	172.0	200.0
1	MAINTENANCE TOTAL	MILLIONS	A	15.6	34.7	93.3	99.2	105.7	108.3	123.2	135.9	152.1			
			L	10.1	27.9	36.5	61.3	81.2	96.2	100.5	105.3	108.5	110.8	130.5	144.6
		$	B	15.6	34.7	123.4	124.3	186.8	224.9	293.3	307.9	340.7	374.6	376.4	400.3
2	CONSTRUCTION TOTAL	MILLIONS	A	15.7	24.8	142.4	144.2	144.3	157.7	171.1	246.3	261.2			
			L	-	-	-	-	-	-	-	-	-	-	-	-
		$	B	4.3	8.3	19.0	20.1	28.2	33.1	46.7	80.1	89.3	103.4	133.6	199.7
3	BRIDGE PROGRAM	MILLIONS	A	.0	.3	4.7	9.4	12.1	16.0	28.5	54.7	59.7			
			L	56.0	93.8	114.3	144.5	171.3	192.1	210.7	219.9	229.8	234.8	260.8	299.3
		$	B	35.5	77.7	235.7	243.6	335.0	387.0	472.0	528.0	582.0	639.0	682.0	800.0
4	TOTAL AWARDS	MILLIONS	A	31.3	59.8	240.4	252.8	262.1	282.0	322.8	436.9	473.0			
	BRIDGE PREVENTATIVE MAINTENANCE		L	47	389	942	1254	1488	1548	1698	1797	3330	4845	5513	*5747
			B	1314	2598	3626	4705	5348	5556	5688	5828	7326	10255	12483	14251
5	(711-414, 415, 416, 417)	SITES	A	2303	2932	3241	3669	3928	4111	4150	4387	4791			
	SURFACE IMPROV PRODUCTION														
			L	29	91	178	588	588	588	588	588	588	588	599	624
			B	21	63	121	392	392	392	392	392	392	392	401	418
6	3R CONTRACT	MILES	A	22	81	84	314	314	314	314	314	314			
			L	11	15	16	129	129	129	129	129	129	129	133	145
	CONCRETE PATCHING		B	3	4	5	28	28	28	28	28	28	28	29	32
7	(CONTRACT)	MILES	A	1	2	3	7	7	7	7	7	7			
			L	330	968	1740	2480	2480	2480	2480	2480	2480	2480	2480	2592
	SURFACE TREATMENT		B	81	711	953	1072	1072	1072	1072	1072	1072	1072	1261	1480
8	(CONTRACT)	MILES	A	56	342	731	997	997	997	997	997	997			

*THE LAST YEAR BRIDGE PREVENTATIVE MAINTENANCE FIGURE WAS REPORTED UNDER ONE COST FUNCTION.
THE BUDGET AND THE ACTUAL HAVE BEEN REDEFINED THIS YEAR UNDER FOUR SEPARATE ACTIVITIES.

FIGURE 5 (continued)

1983-84 CUMULATIVE PERIOD: YEAR TO DATE

NO	ITEM	UNIT OF MEASURE	L B A	JULY LAST YR BUDGET ACTUAL	AUG LAST YR BUDGET ACTUAL	SEP LAST YR BUDGET ACTUAL	OCT LAST YR BUDGET ACTUAL	NOV LAST YR BUDGET ACTUAL	DEC LAST YR BUDGET ACTUAL	JAN LAST YR BUDGET ACTUAL	FEB LAST YR BUDGET ACTUAL	MAR LAST YR BUDGET ACTUAL	APR LAST YR BUDGET ACTUAL	MAY LAST YR BUDGET ACTUAL	JUNE LAST YR BUDGET ACTUAL
	SURFACE TREATMENT		L	560	1648	2011	2021	2021	2021	2021	2021	2021	2021	2055	2225
			B	457	1409	1661	1661	1661	1661	1661	1661	1661	1661	1731	1775
1	(DEPARTMENT FORCES)	MILES	A	449	1321	1530	1592	1592	1592	1592	1592	1592			
			L	930	2722	3945	5218	5218	5218	5218	5218	5218	5218	5267	5586
	SURFACE IMPROV PROD		B	562	2187	2740	3153	3153	3153	3153	3153	3153	3153	3422	3705
2	TOTAL	MILES	A	528	1746	2348	2910	2910	2910	2910	2910	2910			
	MUNICIPAL CONTRACTS														
			L	2	3	5	6	7	9	11	12	12	12	12	12
			B	2	3	5	6	7	9	11	12	12	12	12	12
3	POTHOLE PATCHING	NUMBER	A	4	5	5	5	5	5	5	5	5			
			L	3	4	6	7	9	9	11	13	15	18	21	24
			B	3	4	6	7	9	9	11	13	15	18	21	24
4	COMPREHENSIVE MAINTENANCE	NUMBER	A	7	14	16	16	16	16	16	18	22			
	ROUTINE MAINTENANCE														
			L	2638	5639	8311	11001	12245	12779	13000	13077	13736	14908	17223	20239
	SHOULDERS CUT		B	2335	5148	8429	11129	11806	11881	11895	11920	12356	13644	16137	18688
5	(711-215)	MILES	A	2672	5992	9067	11194	12089	12291	12296	12351	12446			
	PIPE & CULVERT REPAIRED/		L	30	62	91	116	133	147	157	169	210	250	285	312
	REPLACED/INSTALLED	FEET	B	32	67	105	148	165	170	171	173	194	232	269	302
6	(711-324)	THOUSAND	A	29	69	105	149	171	182	183	189	203			
			L	34	66	90	110	119	129	137	147	168	188	209	233
		TONS	B	22	42	59	73	81	88	93	101	123	152	175	198
7	MANUAL PATCHING (711-121)	THOUSAND	A	23	43	63	74	84	89	94	115	132			
			L	23	58	96	186	269	321	371	398	450	490	532	567
		GALLONS	B	31	89	184	337	440	459	468	477	520	583	632	652
8	CRACK SEALING (711-128)	THOUSAND	A	36	93	148	265	346	382	387	425	452			
			L	8	33	61	129	181	229	253	263	288	310	341	396
		GALLONS	B	17	24	65	161	230	241	248	254	283	313	333	347
1	JOINT SEALING (711-147)	THOUSAND	A	9	18	52	112	155	183	186	201	220			
			L	10619	22128	33968	44414	49899	51904	52100	52111	52363	55758	61035	65083
			B	8776	19729	30472	39894	45761	47070	47070	47070	47872	54211	62686	72878
2	LINE PAINTING	MILES	A	8655	23137	36884	50212	57619	60304	60314	60314	60363			
	WINTER TRAFFIC SERVICES														
			L	0	0	0	1	19	193	407	703	806	828	828	828
			B	-	-	-	-	-	-	-	-	-	-	-	-
3	WINTER STORM OCCURRENCES	NUMBER	A	0	0	0	0	59	299	460	645	884			
			L	0	0	0	0	111	965	2485	4001	4290	4504	4504	4504
	SNOW & ICE CONTROL	MILES	B	-	-	-	-	-	-	-	-	-	-	-	-
4	(712-521 & 522)	THOUSAND	A	0	0	0	0	220	2085	4972	6087	8221			
			L	32	30	53	181	275	236	189	130	114	106	105	106
		TONS	B	106	106	106	180	275	235	200	100	100	50	50	50
5	SALT INVENTORY	THOUSAND	A	106	106	106	179	249	175	96	101	31			
			L	0	0	0	0	4	60	138	216	232	239	242	242
		TONS	B	0	0	0	0	46	139	325	441	465	465	465	465
6	SALT USAGE	THOUSAND	A	0	0	0	0	10	112	310	375	473			
			L	0	0	0	0	94	1508	3551	5600	5989	6167	6420	6420
		$	B	0	0	0	0	1242	3753	8775	11907	12555	12555	12555	12555
7	SALT USAGE	THOUSAND	A	0	0	0	0	235	2792	7942	9506	12024			
			L	0	0	0	2	11	171	411	607	659	671	671	671
		TONS	B	0	0	0	0	120	360	840	1140	1200	1200	1200	1200
8	ANTI-SKID USAGE	THOUSAND	A	0	0	0	0	38	317	803	970	1203			
			L	0	0	0	13	64	1032	2474	3676	4007	4067	4067	4067
		$	B	0	0	0	0	720	2160	5040	6840	7200	7200	7200	7200
9	ANTI-SKID USAGE	THOUSAND	A	0	0	0	0	235	1876	4630	5579	6931			
			L	0	1	1	1	1	3	19	34	61	63	66	66
		HOURS	B	-	-	-	-	-	-	-	-	-	-	-	-
1	EQUIPMENT LEASED	THOUSAND	A	1	1	1	1	1	2	30	68	89			
			L	2	23	25	27	38	98	762	1321	2435	2510	2637	2645
		$	B	-	-	-	-	-	-	-	-	-	-	-	-
2	EQUIPMENT LEASED	THOUSAND	A	7	18	20	23	28	83	1229	2837	3725			
			L	0	0	6	17	52	236	768	1422	1551	1700	1762	1764
		HOURS	B	-	-	-	-	-	-	-	-	-	-	-	-
3	EQUIPMENT DOT	THOUSAND	A	1	2	3	14	78	302	1264	1942	2500			
			L	1	1	88	220	648	2550	7643	14099	15407	16902	17578	17601
		$	B	-	-	-	-	-	-	-	-	-	-	-	-
4	EQUIPMENT DOT	THOUSAND	A	7	32	44	176	856	3013	12334	19029	24379			
			L	19	244	527	668	736	747	749	752	753	754	754	754
	MUNICIPAL SNOW REMOVAL		B	19	244	527	668	736	747	749	752	753	754	754	754
5	AGREEMENTS	NUMBER	A	27	188	268	634	708	755	766	767	769			
			L	230	339	358	365	414	445	695	705	751	782	917	976
	EQUIPMENT (PIECES)		B	235	279	285	305	355	495	1077	1192	1212	1272	1332	1362
6	DELIVERED TO THE FIELD	NUMBER	A	250	386	554	630	814	960	1077	1191	1276			

FIGURE 6 Management objectives report: Examples of statewide (Blue Book) maintenance activities.

1983-84 CUMULATIVE PERIOD: YEAR TO DATE

NO	ITEM	UNIT OF MEASURE	L B A	JULY LAST YR BUDGET ACTUAL	AUG LAST YR BUDGET ACTUAL	SEP LAST YR BUDGET ACTUAL	OCT LAST YR BUDGET ACTUAL	NOV LAST YR BUDGET ACTUAL	DEC LAST YR BUDGET ACTUAL	JAN LAST YR BUDGET ACTUAL	FEB LAST YR BUDGET ACTUAL	MAR LAST YR BUDGET ACTUAL	APR LAST YR BUDGET ACTUAL	MAY LAST YR BUDGET ACTUAL	JUNE LAST YR BUDGET ACTUAL
	WINTER TRAFFIC SERVICES (CON'T)														
	AUTOS, TRUCKS AND ROAD EQUIPMENT		L	114	223	380	501	565	740	893	948	1039	1106	1225	1370
			B	-	-	-	-	-	-	-	-	-	-	-	-
7	REMOVED FROM INVENTORY	NUMBER	A	117	266	426	550	665	722	799	904	1070			
	TRUCK WEIGHT PROGRAM														
			L	32.8	68.0	102.2	138.0	164.6	195.1	223.1	239.1	280.9	315.7	347.6	390.6
		NUMBER	B	34.5	71.7	107.7	145.4	173.6	205.7	235.2	265.6	296.1	332.8	366.4	400.0
8	WEIGHED	THOUSAND	A	31.2	72.5	107.8	146.4	172.3	198.9	223.6	255.5	280.6			

FIGURE 6 (continued)

1983-84 CUMULATIVE PERIOD: YEAR TO DATE

NO	ITEM	UNIT OF MEASURE	L B A	JULY LAST YR BUDGET ACTUAL	AUG LAST YR BUDGET ACTUAL	SEP LAST YR BUDGET ACTUAL	OCT LAST YR BUDGET ACTUAL	NOV LAST YR BUDGET ACTUAL	DEC LAST YR BUDGET ACTUAL	JAN LAST YR BUDGET ACTUAL	FEB LAST YR BUDGET ACTUAL	MAR LAST YR BUDGET ACTUAL	APR LAST YR BUDGET ACTUAL	MAY LAST YR BUDGET ACTUAL	JUNE LAST YR BUDGET ACTUAL
	TRUCK WEIGHT PROGRAM														
			L	525	1071	1548	2047	2421	2827	3274	3585	4213	4706	5133	5662
			B	516	1073	1613	2179	2601	3083	3525	3908	4439	4990	5493	6000
1	IN VIOLATION	NUMBER	A	451	974	1439	1836	2222	2593	2965	3486	3971			
			L	331.5	734.1	1072.9	1386.7	1695.2	1967.7	2317.3	2492.2	2896.4	3192.0	3476.2	3886.0
		$	B	343.1	713.5	1072.6	1449.0	1729.6	2050.2	2344.1	2648.0	2951.9	3318.3	3652.8	3990.0
2	FACE VALUE OF FINES	THOUSAND	A	274.6	681.6	1046.8	1321.9	1547.6	1783.6	2024.7	2412.6	2692.6			
			L	221.0	405.2	614.2	747.2	931.4	1088.9	1196.4	1279.3	1390.6	1463.3	1463.3	1604.4
		$	B	-	-	-	-	-	-	-	-	-	-	-	-
3	COLLECTIONS	THOUSAND	A	47.5	136.6	236.9	296.5	335.2	423.4	426.4	612.8	810.4			
			L	6	559	2226	2798	7826	7920	9864	14651	18106	21900	23839	27817
	DESIGN AND COSTRUCTION	$	B	6	559	2000	3500	4900	6500	7900	9500	10700	12300	13500	15500
4	VALUE ENGINEERING SAVINGS	THOUSAND	A	138	2477	2693	3733	9685	10085	12909	13586	15207			
	OPERATIONS REVIEW														
			L	1398	2605	3535	4814	5813	6262	6308	6333	6683	7418	8195	9248
		MILES	B	728	1403	2258	3113	3991	4363	4388	4413	4438	5248	6058	6868
5	TRAINED OBSERVER	OBSERVED	A	728	1439	2286	3142	3981	4364	4364	4364	4653			

FIGURE 7 Management objectives report: Example of summary statewide truck weight enforcement program.

DISTRICT MANAGEMENT SUMMARY
AS OF March 31, 1984

DISTRICTS:	1	2	3	4	5	6	8	9	10	11	12	Total (All Districts)
(34) Cumulative Bridges Inspected (Fiscal Year to Date)/Total Bridges in District	1094/2437	713/2149	1189/2894	807/2121	798/2246	1475/2945	1330/3506	1048/2426	950/1805	990/1612	968/2789	11362/26930
(35) Traffic Line Miles Painted Calendar Year 1984 to Date vs. 1984 Calendar Year Plan	0/7700	0/7700	0/6200	0/5250	0/8000	0/9200	59/11708	0/8523	0/6500	0/7000	0/5390	59/83171
(36) Road Miles Under Bond/Total Miles in District	133*/4423	255**/3955	5/5051	1/3921	0/3707	4/3811	0/5792	174/3959	793***/3646	30/1978	222****/3914	1617/44157
(37) Road Miles Weight Restricted/ Total Miles in District	950/4423	799/3955	59/5051	13/3921	24/3707	21/3811	0/5792	690/3959	2011/3646	187/1978	858/3914	5612/44157
(38) Shoulder Cutting Fiscal Year to Date vs. Planned Year to Date (As a Percent)	93	54	118	109	104	96	122	78	104	107	82	100
(38a) Shoulder Cutting Fiscal Year to Date vs. Last Year Fiscal Year to Date (Miles)	1320/1408	962/1032	1569/1083	1105/1868	1105/875	1126/1003	1165/1377	1332/1307	1186/1274	516/514	1060/1995	12446/13736
(39) Pipe Replacement Fiscal Year to Date vs. Planned Year to Date (As a Percent)	117	82	107	130	129	87	106	98	102	117	85	104

*District 1-0 has 104 Type 3 agreements.
**District 2-0 has 60 Type 3 agreements.
***District 10-0 has 153 Type 3 agreements.
****District 12-0 has 32 Type 3 agreements.

-7-

FIGURE 8 Management objectives report: Example of district management summary (Green Book).

COUNTY MANGEMENT SUMMARY — RUNDATE 04/09/84 — PAGE 1
REDBOOK
ACTIVITY PRODUCTION/COST REPORT

MONTH MARCH,1984

ACTIVITY/UNITS			TOTAL	12-1	12-2	12-3	12-4	12-5	12-6	12-7	12-8	12-9
711-121 ROADS-PAVED	PRIOR YTD ACTUAL		27252	3161	2448		7201	14442				
TONS PATCHING	TOTAL ANNUAL PLAN		23398	3516	2256		9267	8359				
MANUAL	YTD PLAN		15910	2143	1491		6267	6009				
	YTD ACTUAL		17513	2131	1879		7326	6177				
	% YTD PLAN COMPLETE		110	99	126		116	102				
	% TTL PLAN COMPLETE		74	60	83		79	73				
	% WORK BY CONTRACT											
STATE AVG 176.44	DEPT $ COST/UNIT		157.92	179.26	154.34		163.65	144.91				
711-122 ROADS-PAVED	PRIOR YTD ACTUAL		15012	1916			6785	6311				
TONS PATCHING	TOTAL ANNUAL PLAN		13926	5101	1511		6714	600				
MECHANIZED	YTD PLAN		13379	5101	1164		6714	400				
	YTD ACTUAL		13210	5077	1182		6522	429				
	% YTD PLAN COMPLETE		98	99	101		97	107				
	% TTL PLAN COMPLETE		94	99	78		97	71				
	% WORK BY CONTRACT											
STATE AVG 48.42	DEPT $ COST/UNIT		49.00	45.16	55.33		49.65	67.13				
711-124 ROADS-PAVED	PRIOR YTD ACTUAL		2430847	579603	401516		559828	889900				
GALS SURF TREAT	TOTAL ANNUAL PLAN		469159	46357	119437		303365					
LIQ BIT	YTD PLAN		455451	46357	119437		289657					
	YTD ACTUAL		504260	46537	112363		342360	3000				
	% YTD PLAN COMPLETE		110	100	94		118					
	% TTL PLAN COMPLETE		107	100	94		112					
	% WORK BY CONTRACT		52	100	100		30					
STATE AVG 1.24	DEPT $ COST/UNIT		1.37				1.37	0.63				
711-127 ROADS-PAVED	PRIOR YTD ACTUAL		448122	80968	59060		164884	143210				
GALS SKIN PATCH	TOTAL ANNUAL PLAN		1187646	275100	210050		257153	445343				
LIQ BIT	YTD PLAN		748646	145100	121050		197153	285343				
	YTD ACTUAL		851365	145631	139744		198147	367843				
	% YTD PLAN COMPLETE		113	100	115		100	128				
	% TTL PLAN COMPLETE		71	52	66		77	82				
STATE AVG 2.04	DEPT $ COST/UNIT		1.50	1.47	1.81		1.48	1.41				
711-128 ROADS-PAVED	PRIOR YTD ACTUAL		58546	14869	22215		17101	4361				
GALS CRACKSEAL	TOTAL ANNUAL PLAN		92891	21331	5900		31800	33860				
BIT SURF	YTD PLAN		57291	12731	3900		19800	20860				
	YTD ACTUAL		61012	10314	5621		21913	23164				
	% YTD PLAN COMPLETE		106	81	144		110	111				
	% TTL PLAN COMPLETE		65	48	95		68	68				
	% WORK BY CONTRACT											
STATE AVG 6.67	DEPT $ COST/UNIT		4.91	5.50	6.45		3.63	5.49				

MONTH MARCH,1984 — RUNDATE 04/09/84 — PAGE 2

ACTIVITY/UNITS			TOTAL	12-1	12-2	12-3	12-4	12-5	12-6	12-7	12-8	12-9
711-131 ROADS-PAVED	PRIOR YTD ACTUAL		177246	27977	12723		55717	80829				
TONS SCRATCH COAT	TOTAL ANNUAL PLAN		70438	8374	19022		23338	19704				
TOH/PVR/FIN	YTD PLAN		67638	8374	19022		23338	16904				
	YTD ACTUAL		70773	8767	19152		23423	19431				
	% YTD PLAN COMPLETE		104	104	100		100	114				
	% TTL PLAN COMPLETE		100	104	100		100	98				
	% WORK BY CONTRACT		57	100	100		51					
STATE AVG 33.93	DEPT $ COST/UNIT		45.60				28.37	40.61				
711-147 ROADS-CONC	PRIOR YTD ACTUAL		14386		585		5382	8419				
GALS JOINT SEAL	TOTAL ANNUAL PLAN		42369	4450	1500		16850	19569				
	YTD PLAN		26619	2650	1500		9800	12669				
	YTD ACTUAL		27020	1445	691		11560	13324				
	% YTD PLAN COMPLETE		101	54	46		117	105				
	% TTL PLAN COMPLETE		63	32	46		68	68				
	% WORK BY CONTRACT											
STATE AVG 8.40	DEPT $ COST/UNIT		5.93	7.30	10.48		4.95	6.40				
711-212 SHOULDERS	PRIOR YTD ACTUAL		494	77	3		329	85				
MILES UNPAVED	TOTAL ANNUAL PLAN		1134	75			555	504				
GRADING	YTD PLAN		819	55			375	389				
	YTD ACTUAL		968	60			458	450				
	% YTD PLAN COMPLETE		118	109			122	115				
	% TTL PLAN COMPLETE		85	80			82	89				
STATE AVG 397.56	DEPT $ COST/UNIT		405.64	286.30			319.69	509.03				
711-215 SHOULDERS	PRIOR YTD ACTUAL		1995	567	426		422	580				
MILES UNPAVED	TOTAL ANNUAL PLAN		2294	649	408		677	560				
CUTTING	YTD PLAN		1298	423	248		467	160				
	YTD ACTUAL		1060	325	154		487	94				
	% YTD PLAN COMPLETE		81	76	62		104	58				
	% TTL PLAN COMPLETE		46	50	37		71	16				
STATE AVG 622.31	DEPT $ COST/UNIT		588.98	524.92	591.62		640.24	540.62				
711-312 DRAIN	PRIOR YTD ACTUAL		564944	134263	89504		162750	178427				
FEET CLEAN DITCH	TOTAL ANNUAL PLAN		568565	191360	104300		191510	81395				
DRAIN CHAN	YTD PLAN		381665	151360	70400		148510	11395				
	YTD ACTUAL		432882	126163	77644		175770	53305				
	% YTD PLAN COMPLETE		113	83	110		118	467				
	% TTL PLAN COMPLETE		76	65	74		91	65				
STATE AVG 0.99	DEPT $ COST/UNIT		0.73	0.61	0.61		0.84	0.79				
711-324 REPLACE PIPES	PRIOR YTD ACTUAL		39460	12289	12939		8205	6027				
FEET PIPES	TOTAL ANNUAL PLAN		51058	11688	12531		15110	12529				
CULVERTS	YTD PLAN		37548	8178	9231		10910	9229				
	YTD ACTUAL		32179	6292	8323		10206	7358				
	% YTD PLAN COMPLETE		85	76	90		93	79				
	% TTL PLAN COMPLETE		62	53	66		67	58				
STATE AVG 31.00	DEPT $ COST/UNIT		30.77	31.31	29.41		27.40	36.52				

FIGURE 9 Management objectives report: Example of county management summary (Red Book).

MONTHLY AVG/UNIT/USE

DISTRICT	UTILIZATION HOURS/UNIT	ST AVG	121	122	124	125
12	TRUCKS,DUMP	141.5	126.5	99.3	115.3	120.7
	PAVERS	1.3	4.0	***	0.0	0.0
	ROLLERS, 8-15 TONS	3.7	0.5	4.9	2.1	0.2
	SPREADERS,CHIP	1.2	0.0	0.0	0.0	***
	EXCAVATORS	60.8	88.5	53.5	85.2	60.7
	GRADERS	45.1	43.8	17.5	38.1	29.0
	LOADERS	91.6	77.2	63.2	76.3	105.1
	TRACTORS,BACKHOE	51.3	34.8	26.2	36.1	45.5
	COMPRESSORS	33.7	30.7	17.1	74.2	42.1
	ATHEY LOADERS	3.0	68.5	0.0	0.0	0.0
	MAINTAINERS	3.8	***	14.5	32.6	***
	ROLLERS, 0-6 TONS	39.1	34.1	28.6	71.5	57.7
	YEAR-TO-DATE					
	TRUCKS,DUMP	1002.5	097.5	056.0	967.8	1046.1
	PAVERS	239.8	264.4	20.5	411.4	478.5
	ROLLERS, 8-15 TONS	223.5	169.5	179.6	212.1	339.3
	SPREADERS,CHIP	245.9	178.0	151.5	475.2	***
	EXCAVATORS	712.5	850.0	692.5	785.7	936.1
	GRADERS	434.2	361.7	279.4	459.7	488.1
	LOADERS	618.7	431.3	383.9	590.9	782.8
	TRACTORS,BACKHOE	494.5	444.2	472.0	637.1	504.4
	COMPRESSORS	298.7	196.0	111.2	435.2	364.9
	ATHEY LOADERS	308.6	631.0	349.5	394.3	307.5
	MAINTAINERS	146.4	324.5	125.8	261.8	***
	ROLLERS, 0-6 TONS	368.2	361.8	302.8	474.7	431.3

*** - NO EQUIPMENT OF THIS TYPE IN COUNTY FLEET

FIGURE 10 Management objectives report: Example of key equipment utilization report from county management summary (Red Book).

COUNTY ACCREDITATION PROGRAM

1.	FIELD OPERATIONS	50%	3.	PERSONNEL	10%
	Redbook	10%		Sick Leave	3%
	Q/A review	10%		Hmms Training	2%
	Inspec. Rpts.	10%		Disabling Injury	3%
	M-681 vs. M-650	10%		MBO Use	2%
	Field Safety	10%			
			4.	OFFICE OPERATIONS	10%
2.	EQUIPMENT	30%		Inventory Control	2%
	P.M.'s	10%		Cash Advancement	2%
	Utilization	4%		Material Usage	4%
	Garage Safety	4%		Hmms Error Rate	2%
	Eq. Work Order	4%			
	Fleet Accidents	4%			
	Repair vs. utiliz.	4%			

1. CATEGORY: FIELD OPERATIONS

A. REDBOOK ACTIVITIES

Standard: Percent of activities within 80-120% plan adherence

Score:
0 = 0-49%
1 = 50-59%
2 = 60-69%
3 = 70-79%
4 = 80-89%
5 = 90-100%

B. QUALITY ASSURANCE

Standard: Average score received for minimum of 3 Q/A reviews conducted during the fiscal year on redbook activities.

Score:
0 = less than 1
1 = greater than or = 1
2 = greater than or = 2
3 = greater than or = 3
4 = greater than or = 4
5 = 5

C. MAINTENANCE PRODUCTION INSPECTION REPORTS

Standard: Number of inspection reports prepared during April 1 through October 31 by the COUNTY MANAGER.

Score:
0 = less than 10
1 = 11-14
2 = 15-19
3 = 20-24 (minimum of one per foreman)
4 = 20-34 (minimum of one per foreman)
5 = 35 (minimum of one per foreman)

D. MAINTENANCE ROADWAY INSPECTION REPORT

Standard: Form M-681 or (approved) equivalent corresponds to six activities scheduled on Form M-650 or(approved) equivalent. Select five examples of each of the following: pipe replacement, shoulder cutting, skin patching, seal coat, joint sealing and mechanized patching.

Score:
0 = less than 15 matches
1 = 15-17
2 = 18-20
3 = 21-23
4 = 24-26
5 = 27-30

E. FIELD SAFETY

Standard: Safety compliance determined through visual inspection in following five areas: proper signing, protective equipment, tailgate safety talks, certified operators, backing alarms.

Score:
0 = total non-compliance
1 = compliance achieved in 1 of 5 areas
2 = " " in 2 of 5 areas
3 = " " in 3 of 5 areas
4 = " " in 4 of 5 areas
5 = " " in 5 of 5 areas

2. CATEGORY: EQUIPMENT

A. EQUIPMENT PREVENTATIVE MAINTENANCE

Standard: Number of pieces of equipment out of 20 (ten #1's, ten #2's) randomly selected pieces that had PM performed within five days of the scheduled date.

Score:
0 = unintelligible records
1 = 11 or less
2 = 12-13
3 = 14-16
4 = 17-18
5 = 19-20

B. EQUIPMENT UTILIZATION

Standard: Extract equipment usage from EMIS files for trucks, rollers, graders, excavators, backhoes, loaders and compressors and compute the percentage of pieces which meet the District/County recommended utilization goals. (equip. must be in the Dept. fleet min. 1 year)

FIGURE 11 Example of county accredition program.

Score: 0 = 0-49%
1 = 50-59%
2 = 60-69%
3 = 70-79%
4 = 80-89%
5 = 90-100%

C. GARAGE SAFETY

Standard: Compliance, determined through visual inspection in the following areas: material handling, ventilation, protective equipment, working conditions and fire hazards.

Score: 0 = total non-compliance
1 = compliance achieved in 1 of 5 areas
2 = " " in 2 of 5 areas
3 = " " in 3 of 5 areas
4 = " " in 4 of 5 areas
5 = " " in 5 of 5 areas

D. EQUIPMENT REPAIR WORK ORDER

Standard: Total points accumulated for 20 randomly selected equipment work orders (same 20 used for PM check) completed within original estimated time frame.

SCORE: 0 = 0-49%
1 = 50-59% 5 = (+ or -) 1 hour of est. (sub) points
2 = 60-69% 4 = (+ or -) 1-1/2 hr. of est.
3 = 70-79% 3 = (+ or -) 2 hr. of est.
4 = 80-89% 2 = (+ or -) 2-1/2 hr. of est.
5 = 90-100% 1 = (+ or -) 3 hr. of est.

E. FLEET ACCIDENT RATE

Standard: Must meet established Department goal (4.0) for preventable accidents.

Score: 0 = 8.00 or more
1 = 7.00-7.99
2 = 6.00-6.99
3 = 5.00-5.99
4 = 4.00-4.99
5 = 0.00-3.99

F. EQUIPMENT REPAIR COST VERSUS UTILIZATION

Standard: Compare cost per hour of utilization for trucks, rollers, excavators, graders, loaders and backhoes with the state average.

Score: 0 = 31.1% or more above the state average
1 = 25.1 - 30.0% above
2 = 20.1 - 25.0% above
3 = 10.1 - 20.0% above
4 = (+ or -) 10% of previous f.y. end average
5 = 10.1% or more below the state average

3. CATEGORY: PERSONNEL

A. SICK LEAVE PERCENTAGE

Standard: Must meet established Department goal (3.35%)

Score: 0 = greater than 4.30
1 = 3.06-4.30
2 = 3.66-3.95
3 = 3.36-3.65
4 = 3.01-3.35
5 = 3.00 or less

B. HMMS TRAINING COMPLETION

Standard: Percent of supervisor/management employees with at least one year of service who have completed either "Managing Highway Maintenance" training or "Foreman's Orientation Program."

Score: 0 = 59% or less
1 = 60-69%
2 = 70-79%
3 = 80-89%
4 = 90-99%
5 = 100%

C. DISABLING INJURY RATE

Standard: Must meet established Department goal (10.00)

Score: 0 = greater than 26.00
1 = 22.01-26.00
2 = 18.01-22.00
3 = 14.01-18.00
4 = 10.00-14.00
5 = less than 10.00

D. MBO USE AND EFFECTIVENESS

Standard: MPER's meet approval in these areas: timeliness, specific objectives, results achieved, training/developmental needs and progress reviews.

Score: 0 = unsatisfactory
1 = incomplete
2 = needs improvement
3 = meets some standards, but needs improvement
4 = meets most standards, but needs improvement
5 = meets all standards

4. CATEGORY: OFFICE OPERATIONS

A. INVENTORY CONTROL

Standard: Total inventory value per lane mile (on-hand value equals the average results of four quarterly reviews)

Score: 0 = $500.00 or more
1 = $421.00 - $499.00
2 = $371.00 - $420.00
3 = $311.00 - $370.00
4 = $261.00 - $310.00
5 = $260.00 or less

B. CASH ADVANCEMENT

Standard: Must meet established Department goal (1.0%)

Score: 0 = less than 0.1%
1 = 0.1%
2 = 0.2 - 0.29
3 = 0.3 - 0.69
4 = 0.7 - 1.00
5 = more than 1.0

C. MATERIAL USAGE

Standard: Percent of total number of activities within (+ or -) 10% variance on the HMMS/AIMS redbook report.

Score: 0 = less than 20%
1 = 20-39%
2 = 40-59%
3 = 60-79%
4 = 80-99%
5 = 100%

D. HMMS ERROR RATE PERCENTAGES

Standard: Must meet established Department goal. (based on error rates for all twelve months)

Score: 0 = greater than 5%
1 = 5%
2 = 4%
3 = 3%
4 = 2%
5 = 1%

FIGURE 11 (continued)

BUREAU OF MAINTENANCE & OPERATIONS

QUALITY ASSURANCE EVALUATION

MANUAL PATCHING

Evaluator _____ District_____
Date _____ County_____
LR _____Sta_____ Sta_____ Foreman_____ #_____

---

1. PROGRAM PLANNING
Units, FY 81-82 AWP _____ Actual _____
Units, FY 82-83 AWP _____ Actual _____
Units, FY 83-84 AWP _____ YTD _____

	Yes	No
M-650 (or equal)	_____	_____

Comments:

2. PROJECT COORDINATION

Training: A/V _____ VCR _____ Other _____ None _____

Material Available	_____	_____
Cutting Equipment	_____	_____
Compaction Equipment	_____	_____

Comments:

3. SCHEDULING

Weekly Schedule to Media	_____	_____
M-6146 Complete	_____	_____
Secondary Activities Identified	_____	_____

FIGURE 12 Example of system developed for quality assurance of manual patching.

3. SCHEDULING(cont'd)

PERSONNEL	Perf. Stand.	M-6146	Job Site	Payroll
Operators	1-2			
Highway Maintenance Workers	3			
Foremen	1			
EQUIPMENT				
Crew Cab	1			
Dump Truck	1-2			
Cutting Equipment & Power Source	1			
Tack Coat Appl.	1*			
Compaction Equipment				
Hand tools, Brooms, lutes, S/P shovels				
OTHER				

Comments:

4. MATERIALS

	AIMS		Payroll	
Plant Mix				
Type	_____	Tons	_____	Tons
Type	_____	Tons	_____	Tons
Tack Coat*	_____	Gallons		
Aggregate	_____	Tons		
	_____	Tons		

Comments:

5. OPERATIONAL EFFICIENCY

PERSONNEL Demonstrated Performance of-	Very Effective	Adequate	Requires Training
Asst. Co. Mgr.	_____	_____	_____
Foreman	_____	_____	_____
Crew	_____	_____	_____

Comments: (Training required)

EQUIPMENT	Yes	No
No Breakdowns	_____	_____
Sufficient Backup Equipment	_____	_____
M-614	_____	_____
OPERATIONS		
Activities Coordinated	_____	_____

Comments:

6. PROJECT OPERATIONS

Normal Starting Time _____ Activity Ending Time _____
Safety Starting Time _____ Safety Ending Time _____
Activity Starting Time _____ Normal Ending _____
Start Delay: <14 min ___ 15-29 ___ 30-44 ___ 45-59 ___ >60 ___

Comments:

FIGURE 12 (continued)

MANUAL PATCHING

Evaluator_____ District_____
Date_____ County_____
LR_____Sta___Sta___ Foreman_____#_____

PROJECT EVALUATION

	Raw Score	Weighted Score
A. Drainage	_____	
Base Repair	_____	
Cutting	_____	
Cleaning	_____	
Tacking*	_____	
Filling	_____	
Material Condition	_____	
Compaction	_____	
Total Raw Score =	_____	
Average Score =	_____ x 0.70 =	_____

*Where applicable
The activity is unsatisfactory if any one of the above is less than 3.

B. Marking	_____	
Sealing (Optional)	_____	
Clean Up	_____	
Rideability	_____	
Safety	_____	
Total Raw Score =	_____	
Average Score =	_____ x 0.30 =	_____

Activity Rating = _____

Very Good: 4.75 - 5.0 ___ Good: 3.65 - 4.7_____
Poor: 2.30 - 3.64 _____ Unsatisfactory: <2.30___
Comments:

FIGURE 13 Example of summary sheet for quality assurance of manual patching.

Drainage (not rated if not required)

1 - Obvious water problem, no corrective action taken
2 - No skin patch, or crack sealing done where patching is done
3 - Hand work done to correct deficiencies
4 - Skin patching and/or crack sealing done to protect pavement from water. Also minor corrections made
5 - U-Drain, subgrade drain, shoulders cut, problem corrected

Base Repair(not rated if not required)

1 - Obvious base failure, no corrective action taken
2 - Surface repairs made. Base repairs are programmed
3 - Partial base repair made
4 - Base repair full depth with other than BCBC
5 - Problem corrected, base repair full depths w/BCBC

Cutting

1 - Not cut mechanically
2 - Cut from outside in, cut on curved lines
3 - Cut from inside out to sound material (depth & width)
4 - Cut from inside out, most edges vertical
5 - Cut from inside out, all edges vertical

Cleaning

1 - Water, loose material or debris in hole
2 - Incomplete cleaning
3 - Broomed out - no loose material in corners, clean, damp
4 - Same as #5 except damp surface
5 - No water, loose material or debris, compressed air used. Dry surfaces

Tacking (where applicable)

1 - Not tacked where required
2 - Too much or used when not required, improperly applied
3 - Non-uniform film, 80% coverage
4 - Uniform thin film, brushed 100% coverage
5 - Uniform thin film, pressure sprayed. 100% coverage.

Filling

1 - Lifts > 3", rake used for distribution
2 - Non-uniform lifts, material raked, corners not filled
3 - 3" uniform lifts, corners filled, spillage on pavement
4 - 3" uniform lifts, corners filled, no spillage, no material added
5 - 1" - 3" uniform lifts shoveled in hole, corners filled, no spillage, no segregation, no material added after compaction

Material Condition

1 - Hard, lumpy, frozen, stripped, crusted or cold hot mix
2 - XXX
3 - Useable with reduced workability
4 - XXX
5 - Within temperature specifications, workable

NOTE: Non-uniform material conditions can reduce rating

Compaction

1 - No compaction
2 - Compacted, corners and edges not tamped, spillage not removed prior to compaction
3 - Finished patch < 1/8" higher than existing surface
4 - XXX
5 - Finished patch 1/8" - ¼" high, compaction equipment appropriate for conditions, corners and edges tamped, first pass made against traffic

Marking

1 - Not marked
2 - Some holes marked
3 - General areas to be cut outlined
4 - Marked by other crew member
5 - Foreman marks areas to be cut with chalk keil, paint, etc.

Sealing(optional)-not rated when not performed

1 - Wrong material
2 - XXX
3 - Proper material, non-uniform application
4 - XXX
5 - Uniform application, proper material

Clean Up

1 - Debris left on pavement and/or piled on shoulders
2 - Waste material piled on shoulders
3 - No debris on pavement. Evidence remains on shoulder of material removed from hole
4 - No debris on pavement, minor debris on shoulder
5 - No debris evident on shoulder or pavement

Rideability

1 - Any depression or bump > ½"
2 - > ¼" bump
3 - No depression, < 1/8" high
4 - 1/8" - ¼" above pavement, non-uniform across patch
5 - 1/8" - ¼" above pavement, uniform across the patch

Safety

1 - Improper traffic control and personal protective devices
2 - XXX
3 - Same infractions noted
4 - XXX
5 - Proper traffic control and personal protective devices

FIGURE 14 Quality assurance evaluation indicators for manual patching.