SHRP-P-642

Distress Interpretation from 35mm Film for the LTPP Experiments

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ABSTRACT

Distress surveys are one element of the monitoring effort currently underway by the Strategic Highway Research Program (SHRP) for the Long Term Pavement Performance (LTPP) study. To achieve the objectives of this effort, SHRP is making use of photographic distress survey technology, which provides for high resolution 35mm black and white photographs and photographic transverse-profile measurements. The reduction of distress data from film is accomplished through a computer assisted interpretation process. The film interpretations and the initial quality assurance (QA) of the interpretations are performed under close supervision of experienced engineers and technicians in an office environment. Further QA of the film interpretations is performed at the SHRP regional coordination offices (RCO's) by the personnel most knowledgeable of the actual conditions at the sites. This report presents a detailed description of the film distress interpretation procedure for the SHRP LTPP experiments.

INTRODUCTION

SHRP's efforts to monitor surface distress on the test sections under study in the Long-Term Pavement Performance (LTPP) research serve two primary purposes. The first is to provide a permanent, objective, high resolution record of pavement condition over the full length and width of the sections under study; the second is to provide detailed, distress-specific condition data for use in the development of pavement performance prediction models.

To achieve these objectives, SHRP is making use of photographic distress survey technology, which provides for high resolution 35-mm black and white photographs. The reduction of distress data from the film is accomplished through a computer assisted interpretation process. The film interpretations and the initial quality assurance (QA) of the interpretations are performed under close supervision of experienced engineers and technicians in an office environment. Further QA of the film interpretations is performed at the SHRP regional coordination offices (RCO's) by the personnel most knowledgeable of the actual conditions at the sites.

The distress film interpretation equipment is called the PAvement DIstress Analysis System (PADIAS). The main components of the system are an IBM compatible 386 computer, a Film Motion Analyzer (FMA) for viewing and digitizing the images from the 35mm films, and a printer for preparing the reports. Each roll of distress film interpreted is composed of many individual strips spliced together. Typically all sections in a given state or province that were photographed during a period of time are contained on a roll. The individual section film contains a leader with detailed identification information followed by the section photograph. Extra film is spliced onto each roll to allow easy handling.

GENERAL DISTRESS INTERPRETATION PROCEDURE

The organization chart shown in Figure 1 provides a general outline of the distress monitoring program. The filming contractor is directed by SHRP to film certain sections during the contract period, process the film and forward one copy to the interpretation (PADIAS) contractor and state copies to the appropriate Regional Coordination Office Contractors (RCOC's). A flow diagram of the distress interpretation procedure is illustrated in Figure 2. After receipt of the film, the PADIAS operator performs a quality review of each film roll to establish whether or not the images are satisfactory. The operator records the results of the review in designated film logs. Any irregularities in the pavement test sections noted during the review of the film are brought to the attention of the responsible personnel for resolution. A copy of the film logs is then forwarded to SHRP.

After the film quality review is completed, the distress interpretation process is initiated. The distress interpretation process is completed on the basis of a roll of film, to simplify film

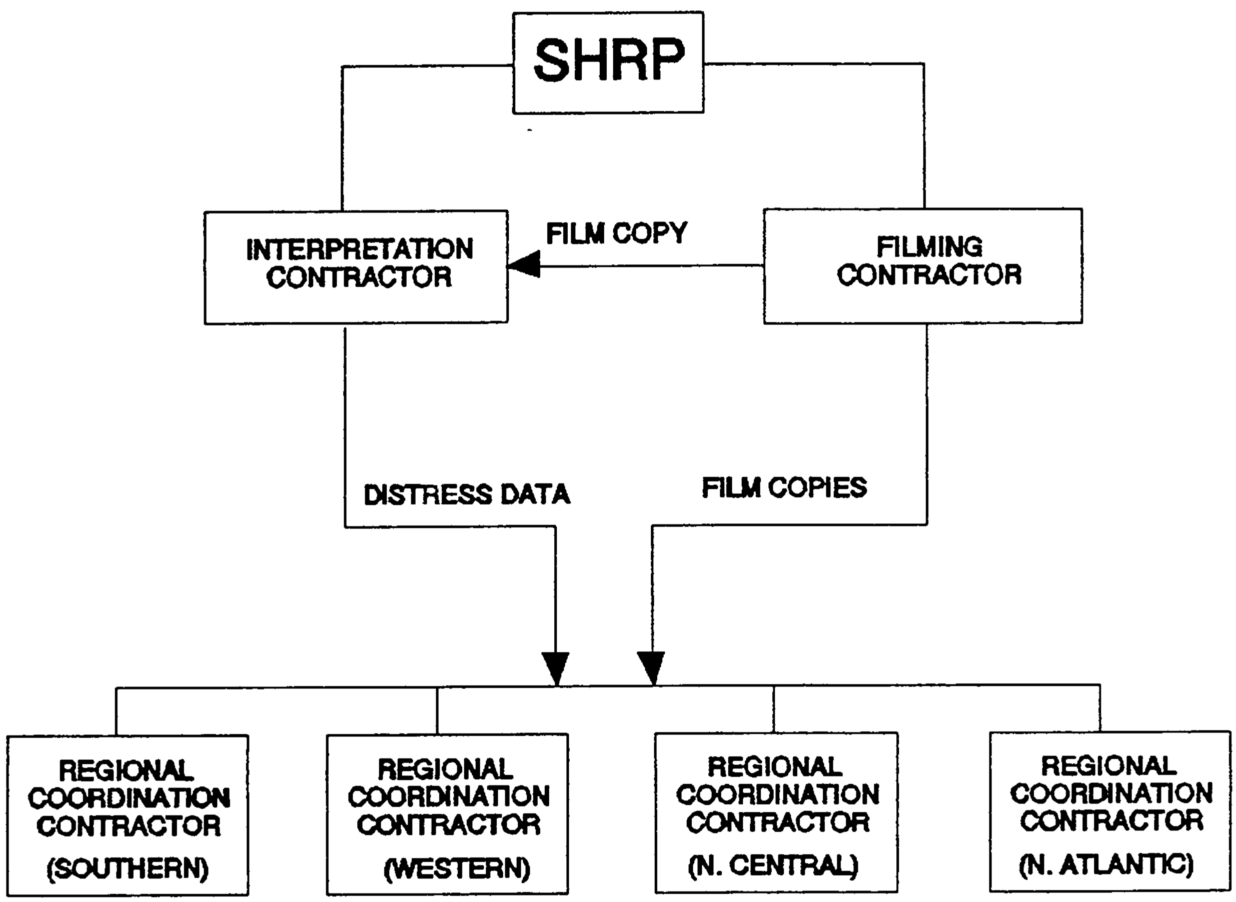

Figure 1. Organization Chart for Distress Data

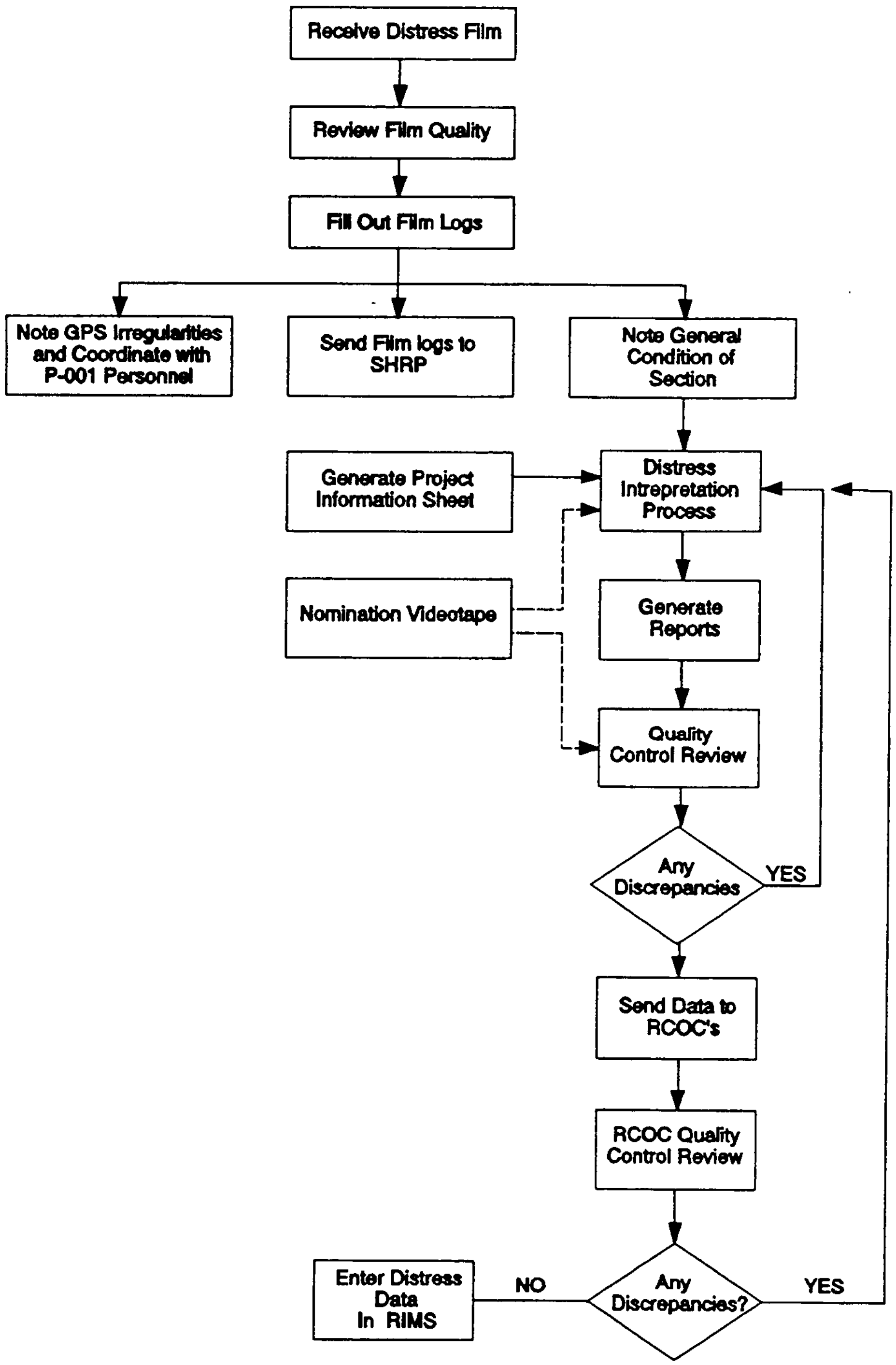

Figure 2. Distress Interpretation Process

handling. This results in interpretations being completed on a state by state (province by province) basis, as one state (province) is typically contained on a single roll of film. Data from the LTPP nomination database are reviewed to provide pertinent information on pavement type, lane width, underlying layers, etc. LTPP section site verification videos are also reviewed, as needed, to enhance the interpretation process. Upon completion of the interpretation process, the operator generates reports summarizing type, amount, and severity level of the distresses found in the section. This process is repeated for each section included on a state (province) film roll.

Section summary reports are provided to the QA/QC reviewer on a state-by-state (film roll) basis after interpretations are completed. After the QA/QC review has been completed, the processed data is forwarded to the RCOC's. The RCOC's apply a regional QA/QC review of the film and distress reports. If any discrepancies are noted, the RCOC and PADIAS team will review the section and mutually resolve any discrepancies. Upon completing the QA/QC regional review process, the distress data is entered into the Regional Information Management System (RIMS).

FILM ACCEPTANCE

Once the filming, film developing, and compilation of the film rolls for each state is completed, the filming contractor forwards positive prints to the PADIAS contractor, SHRP, and the RCOC's. The transmittal package generally includes the 35mm distress film, rut depth film, and plots generated from interpretations of the rut depth films.

The PADIAS operator reviews all of the distress film using either the FMA or a slide projection system to establish the quality of the film processing, as outlined in Appendix A. A film inventory is then completed which denotes the film quality for each section and describes any irregularities or problems using criteria for rating film quality contained in Appendix A. The PADIAS operator completes the film inventory using the format shown in Figure 3.

Any irregularities observed within the test sections during the film quality review are documented and referred to the responsible personnel for resolution. Some of the irregularities that have been encountered include the presence of AVC counters, core sampling or WIM instruments within the 500 foot section. A copy of the completed film logs, using the form shown in Figure 3, is then forwarded to SHRP.

ROUND No.______ DATE:______________________

State	SHRP ID #	GPS Experiment	FMA Films		Quality Remarks	Video On Hand	Manual Survey
			RR-70	RR-75			
Alabama	011001	1					
	011011	2					
	011019	1					
	011021	1					
	013028	3					
	013998	5					
	014007	4					
	014072	2					
	014073	2					
	014084	4					
	014125	1					

Figure 3. Film Inventory Form

DESCRIPTION OF THE INTERPRETATION PROCESS

The interpretation process is initiated following acceptance of the films. Seven steps are identified in this process:

Step 1: Header Entry

The main menu screen for PADIAS is illustrated in Figure 4. The Header Entry and Edit field of the PADIAS program is accessed from the main menu and is illustrated in Figure 5. When this step is undertaken, the operator should have the following documents and information available to correctly complete the header information field of the PADIAS program.

1. Summary information for all LTPP sections at each site.
2. Factorials for each LTPP experiment.
3. Documentation supplied by the filming contractor concerning date of filming and the survey unit that performed the filming.
4. Access to the nomination database.

The information required to complete the header file includes:

Control Section Number: This number is identical to the LTPP Section ID Number. This is used by the program as the file root name for the three files created during interpretation of a section; the header, data, and frame control files.

LTPP Section ID Number: This is the LTPP section number. The redundancy with the control section number occurs because at one time each number had a separate function in the PADIAS program. This is no longer the case but it is critical that the numbers are accurate and identical.

Pavement Type: The pavement type help menu box may be displayed over the header screen as illustrated in Figure 6. The pavement type can then be selected by highlighting the appropriate pavement type using the arrow keys and pressing "enter". The corresponding experiment number for each pavement type is as follows:

1 - AC on Granular Base
2 - AC on Bound Base
3 - Jointed Plain Concrete
4 - Jointed Reinforced Concrete
5 - Continuously Reinforced Concrete
6A - Existing AC Overlay of AC
6B - Planned AC Overlay of AC
7AJ - Existing AC Overlay of JCP

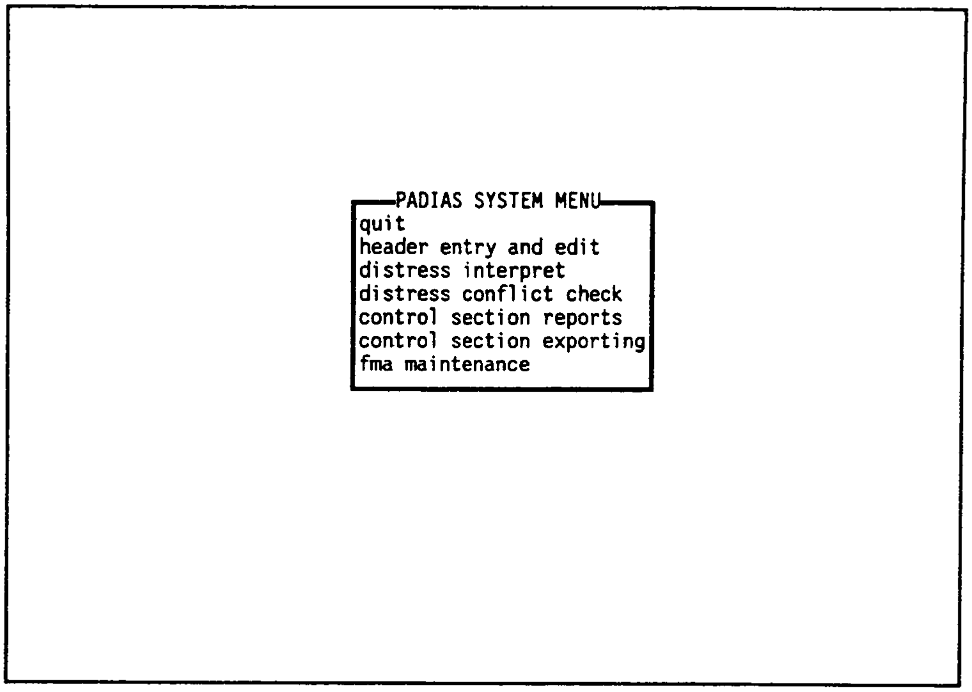

Figure 4. PADIAS Main Menu

7AC - Existing AC Overlay of CRCP
7BJ - Planned AC Overlay of JCP
7BJ - Planned AC Overlay of CRCP
9JJ - Unbonded Overlay of JCP on JCP
9JC - Unbonded Overlay of JCP on CRCP
9CJ - Unbonded Overlay of CRCP on JCP
9CC - Unbonded Overlay of CRCP on CRCP

Pavement type information can be obtained from the project information sheet from the nomination database as shown in Figure 7. The first part of the design cell ID number is the experiment number defined above. For experiments 7 and 9 the operator must determine the appropriate experiment factorial grid (Figures 8 and 9) to establish the underlying pavement type.

As an example of this process, Section 175423 is selected for distress interpretation purposes. The LTPP section summary identifies the cell ID for this section to be 7A-24. The first portion of the number defines Section 175423 as an existing overlay of some type of PCC. The second part of the cell ID number (i.e., 24) is then utilized to identify the underlying pavement type from cell 24 of the factorial for experiment number 7A (Figure 8). This cell corresponds with an "existing" AC overlay over a CRCP. Thus the pavement type for this section is 7AC, Existing AC Overlay of CRCP.

```
                   PADIAS HEADER DATA ENTRY & EDIT
Strategic Hwy Research Program                     padiasl 1.1  PASCO USA, Inc.

                         control section #s
                              NEW FILE
                              231001
                              231009
                              231028
                              281001
                              282807
                              283083
                              283089
                              283091
                              284024
                              285805

                    Highlight desired selection,
                    press <F1> for help,
                          <enter> to select control #,
                          <Pg Dn> for the next page,
                          <Pg Up> for the prev page,
                          <F8> to change file path,
                          <Esc> to escape this program.
```

Figure 5. Header Entry and Edit Screen

Date of Filming: This is a critical item and must be properly entered. The correct information can be found on the film leader at the beginning of each section or on the film container.

Time of Filming: This is not a mandatory item and therefore may be ignored. The correct information may be available from the film crew logs.

Filming Operator: There are two survey units in operation and the unit number that performed the filming is recorded on the film leader for each section. The unit number should be recorded here.

Weather Conditions: This information is not readily available and is not considered mandatory since the filming is completed at night only under dry conditions. An "unknown" entry can be inserted here.

Measuring Speed: This is not a mandatory entry. A suggested entry is "40 mph" since this is the speed at which the survey crews try to conduct the filming procedure.

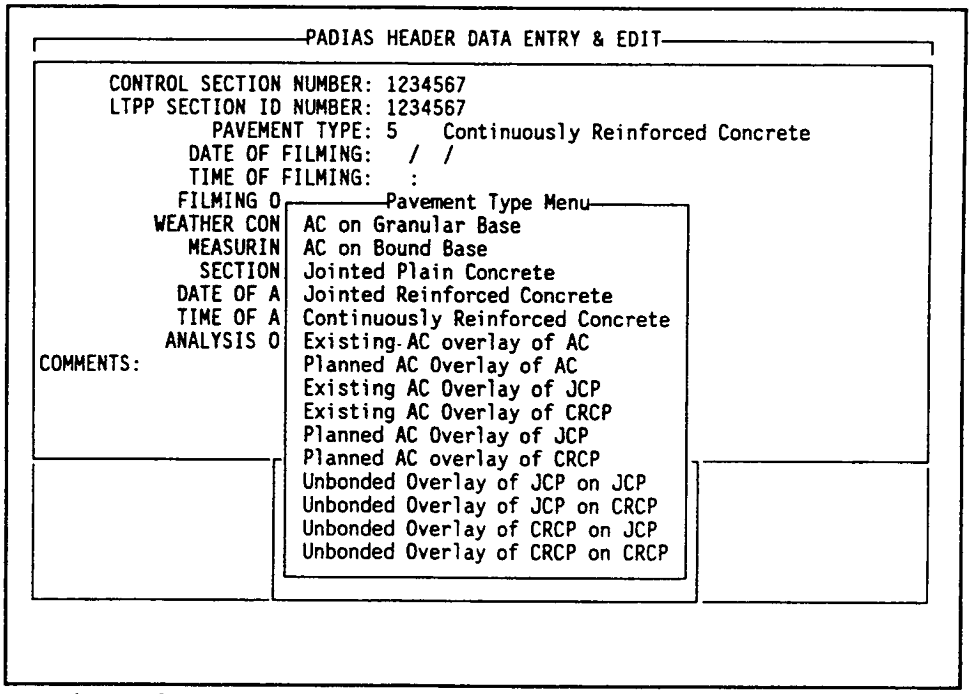

Figure 6. Header Entry Screen with Pavement Type Help Menu

Section Length: A section length must be entered because the PADIAS program will not run if a length is omitted. A typical GPS section, for example, is 500 feet long; however, there are three sections in Florida which are only 475 feet long.

Date of Analysis: The computer system clock automatically inputs the date of analysis.

Time of Analysis: The computer clock automatically inputs the time of analysis.

Analysis Operator: The name or initials of the PADIAS operator should be entered here.

A completed header file for section 1234567 is shown in Figure 10.

Step 2: Film Interpretation

During this phase of the distress interpretation procedure, the operator reviews the entire section to assess the general condition of the pavement section. This is done to provide an indication of distress types and expected interpretation time requirements.

The actual film interpretation is comparable to performing a standard (i.e., manual) pavement condition survey; that is, the type, amount and severity of the distresses existing in the section are observed and recorded. In film interpretation, distresses are observed and identified in the

STRATEGIC HIGHWAY RESEARCH PROGRAM
GENERAL PAVEMENT STUDIES
Long-Term Pavement Performance Monitoring
Project Information Sheet

REGION: North Central   PAVEMENT TYPE: Existing AC Overlay of PCC
STATE: Illinois

SHRP Assigned ID:	175423	District:	3	Year Open:	1966
State Assigned ID:	74	Highway:	I.H.- 74	Year Traffic:	1987
Design Cell ID:	7A- 24	Length:	5.0 miles	AADT:	11800
Year Overlaid:	1981	Lanes:	2	Trucks:	24.0 %

Project Status: Approved

DESIGN FACTORS - Moisture:	Wet		
Temperature:	Freeze		
Subgrade:	53 - Silty Clay	Fine	
Traffic:	505 KESAL/Yr	High	(300)
Overlay Thickness:	5.0 in.	High	(3.5)
AC Stiffness:	1132 ksi	High	(650)
Original Pavement:	CRCP		

LAYER CONFIGURATION

LAYER NO.	LAYER DESCRIPTION	LAYER THICKNESS	LAYER MATERIAL TYPE
6	9 - Porous Friction	.6	2 - HMAC, Open, (Porous Frictn Course)
5	1 - Overlay	1.5	1 - HMAC, Dense Graded
4	4 - HMAC Below Surf	3.0	28 - Bituminous Base, Dense, Hot, CPM
3	3 - Orig Surface	7.0	6 - Portland Cement Concrete (CRCP)
2	5 - Base Layer	4.0	28 - Bituminous Base, Dense, Hot, CPM
1	7 - Subgrade		53 - Silty Clay

PAVEMENT LAYER INFORMATION

ASPHALT CONCRETE LAYERS

LAY NUM	-- GRADE --- VISC	PENETR	AC CONT	AC DENS	S	ACVIS 140	ACVIS 275	PEN 77	AC TRBF	AC VOID	AGG SPGR	AC STIFF
5	20		5.0	92						3.3		1015
4	20		4.6	95						2.3		1191

Figure 7. Example Project Information Sheet

MOISTURE			WET								DRY							
TEMPERATURE			FREEZE				NO FREEZE				FREEZE				NO FREEZE			
SUBGRADE TYPE			F		C		F		C		F		C		F		C	
TRAFFIC RATE			L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H
OL THICKNESS	**OL STIFFNESS**	**EXIST. PVT. TYPE**																
L	L	JPCP	1	13	25	37	49	61	73	85	97	109	121	133	145	157	169	181
		JRCP	2	14	26	38	50	62	74	86	98	110	122	134	146	158	170	182
		CRCP	3	15	27	39	51	63	75	87	99	111	123	135	147	159	171	183
	H	JPCP	4	16	28	40	52	64	76	88	100	112	124	136	148	160	172	184
		JRCP	5	17	29	41	53	65	77	89	101	113	125	137	149	161	173	185
		CRCP	6	18	30	42	54	66	78	90	102	114	126	138	150	162	174	186
H	L	JPCP	7	19	31	43	55	67	79	91	103	115	127	139	151	163	175	187
		JRCP	8	20	32	44	56	68	80	92	104	116	128	140	152	164	176	188
		CRCP	9	21	33	45	57	69	81	93	105	117	129	141	153	165	177	189
	H	JPCP	10	22	34	46	58	70	82	94	106	118	130	142	154	166	178	190
		JRCP	11	23	35	47	59	71	83	95	107	119	131	143	155	167	179	191
		CRCP	12	24	36	48	60	72	84	96	108	120	132	144	156	168	180	192

Factor Midpoints:

Traffic Rate 300 KESAL/Year
Overlay Stiffness 650 ksi
Overlay Thickness 3.5 inches

Figure 8. Sampling Design and Cell Identification Numbers for GPS-7A, Existing AC Overlay of PCC

OL TYPE	ORIG. PVT. TYPE	OL THICKNESS	WET		DRY	
			F	NF	F	NF
JPCP	JPCP	L	1	19	37	55
		H	2	20	38	56
	JRCP	L	3	21	39	57
		H	4	22	40	58
	CRCP	L	5	23	41	59
		H	6	24	42	60
JRCP	JPCP	L	7	25	43	61
		H	8	26	44	62
	JRCP	L	9	27	45	63
		H	10	28	46	64
	CRCP	L	11	29	47	65
		H	12	30	48	66
CRCP	JPCP	L	13	31	49	67
		H	14	32	50	68
	JRCP	L	15	33	51	69
		H	16	34	52	70
	CRCP	L	17	35	53	71
		H	18	36	54	72

(MOISTURE: WET / DRY; TEMPERATURE: F / NF)

Factor Midpoints:
Overlay Thickness . 7.5 inches

Figure 9. Sampling Design and Cell Identification Numbers for GPS-9, Unbonded Overlay of PCC

projected image. They are recorded on a one foot by one foot grid within the area bounded by the pavement centerline and shoulder and the length of the pavement in the projected image. Operation of the PADIAS distress interpretation program is described in the PADIAS Pavement Distress Analysis System User's Guide and Reference (Ref 1). Distress definitions and measurement guidelines are described in the SHRP Distress Identification Manual (Ref 2). Differences between the manual survey procedures and those in the PADIAS system are summarized in Appendix B.

The function of the PADIAS distress interpretation program is to interpret and record pavement distresses within a test section from the 35-mm film using the film motion analyzer (FMA). This is accomplished by displaying the road surface on a frame by frame basis. In the film, a frame represents a 12.2 foot length of pavement, and there are normally 41 frames within a 500-foot section. The FMA screen pointer (cursor) is used to designate and record distresses existing in the portion of the pavement section illustrated by the frame. After identifying all pavement distresses within a frame, the software- controlled FMA advances the film to the next frame. The distress identification process is continued until all frames have been interpreted.

Within the PADIAS program there are three main menus to perform the needed functions including the entry menu (used for entering distresses), the edit menu (used for reviewing and changing existing distresses), and the frame control menu (used for frame advancing, reversing, and other miscellaneous functions).

```
PADIAS HEADER DATA ENTRY & EDIT

      CONTROL SECTION NUMBER: 1234567
      LTPP SECTION ID NUMBER: 1234567
               PAVEMENT TYPE: 5    Continuously Reinforced Concrete
            DATE OF FILMING: 02/02/90
            TIME OF FILMING: 01:00
          FILMING OPERATOR: pj
        WEATHER CONDITIONS:
            MEASURING SPEED:
             SECTION LENGTH: 00500
           DATE OF ANALYSIS: 09/23/91
           TIME OF ANALYSIS: 13:08
          ANALYSIS OPERATOR: jm
COMMENTS:

                    press <F1> for help,
                          <F2> to update the record,
                          <F6> to update and interpret
                          <F9> to abort the changes,
                          <Esc> to escape this program.
```

Figure 10. Example of Completed Header Screen

The program formats the monitor into the five following areas (Figure 11):

1. The header information from the control section (top),
2. The grid cell area (middle left),
3. The work area (middle right),
4. The status line (2nd window from bottom), and
5. The bar menu line (bottom window).

After the header file has been completed, the DISTRESS INTERPRET function is selected from the main menu (Figure 4). Before the actual interpretation can begin, the road width and frame alignment must be defined on the FMA screen using the cursor. After the frame is aligned, the starting point is defined using the "START PT" command in the "frame control menu" accessed via the bar menu in the bottom window of the interpretation screen, shown in Figure 11. This starting point corresponds to the starting mark of the LTPP section.

The actual film interpretation begins with the first frame. The first distress identified in that frame is selected and assigned a severity level (if applicable). The location of that distress is also recorded by locating the cursor at the appropriate location on the image, with the corresponding location depicted in the grid cell area of the monitor. The distress is then saved using the "SAVE" command on the bar menu line. The same procedure is used to define and record the next distress type existing within the same frame. When the first frame is completed, the second frame is selected and the interpretation is continued. This process continues until all frames are completed.

During the interpretation process the operator must maintain an interpretation log in a format similar to Figure 12. Comments concerning; a) irregularities observed in the section, b) problems with interpretation related to film quality clarity and/or the nature of the pavements, and c) any questions related to distress type, severity and extent, should be recorded and discussed with a senior pavement engineer and investigated by the QA/QC reviewer. The comments should be referenced to the appropriate frame number so that the QA/QC engineer can quickly locate the problem area. This log will represent the principal source of information used by the QA/QC engineer in pinpointing sections requiring a detailed film review.

The distress data consists of three basic parts: (1) the distress type; (2) the severity level; and (3) the area location. The distress type identifies the distress based on the pavement type and film interpretation. The distress menu for each pavement type appears in the work area when the cursor (in the entry mode) is moved to the right side of the screen. The severity level is established by a message window in the work area after the distress is identified. The "Low," "Moderate," "High," and "Unknown" levels are offered with check boxes and one must be selected. If no severity level is necessary, the program recognizes this situation and prompts for a cursor button "press" to continue. Following the severity level selection, the operator will record the grid cell location of the distress by positioning the cursor over the FMA screen where

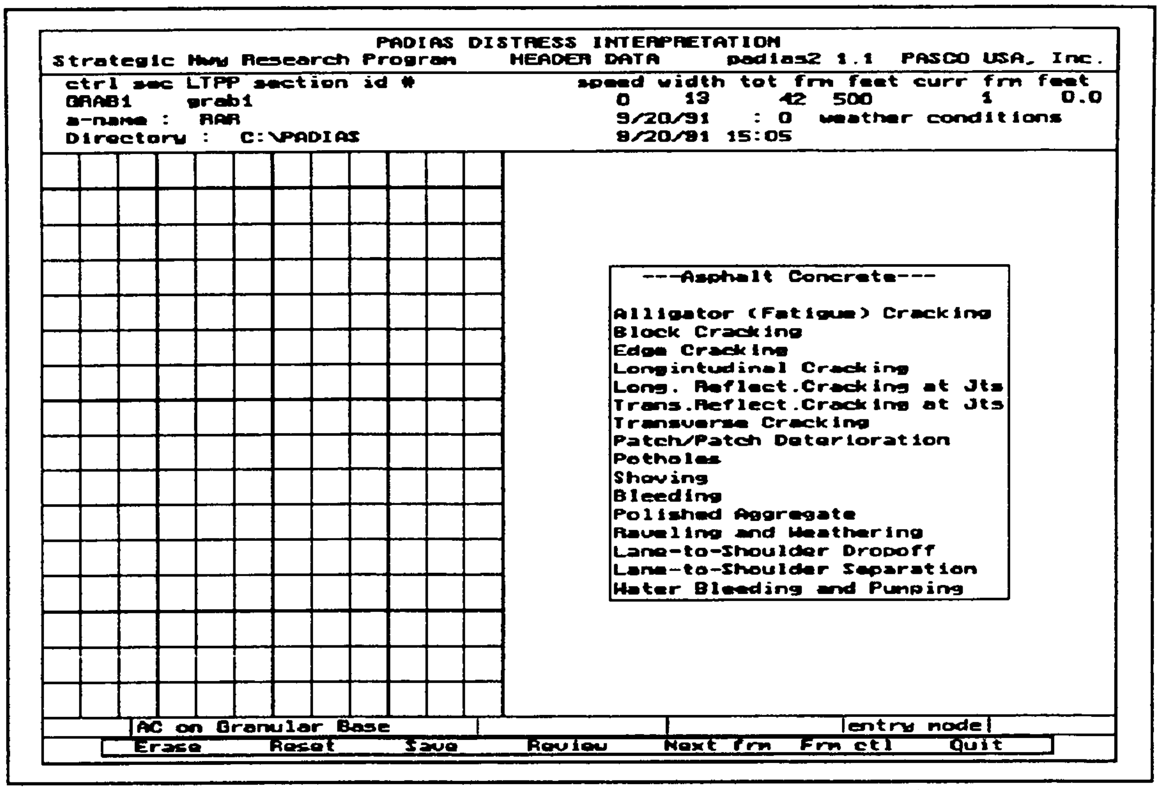

Figure 11. PADIAS Interpretation Screen Configuration

the distress occurs. The distress is represented in the grid area on the monitor by blackened grid cells.

Before exiting the program, the stopping point should be defined in the "frame control menu" using the "STOP PT" command. This point is used to define the end of the LTPP sections being interpreted. To finish the interpretation process, the "QUIT" command in the "entry control menu" is selected.

Experience on the part of the operator and an awareness of the system limitations are required to accurately perform film interpretation using the PADIAS system. Some distresses are difficult to perceive due to the nature of some pavements and other factors. Appendix B presents current capabilities of the PADIAS with respect to identifying distresses and severity levels as defined in the SHRP Distress Identification Manual, while Appendix C summarizes the current limitations of the PADIAS system. Review of the site verification data and any videotape or photographs of the section may be necessary to calibrate the distress in the film images. This is sometimes necessary to discern distresses which rely on color or textural differences, which are difficult to detect in the black and white images.

PADIAS FMA INTERPRETATION LOG

ROUND _____ **Filming Date: _______________**

SHRP ID # : ____________
GPS/SPS Experiment : ____________

Pavement Type : ____________

Date of Analysis : ____________

Time of Analysis

- Start : ____________

- Stop : ____________

Analysis Operator : ____________

Remarks:

Figure 12. PADIAS Interpretation Log Form

Step 3: Consistency Check

Immediately after completing a distress interpretation for a test section, the operator may run a consistency check using the PADIAS consistency checking program from the main PADIAS menu to assure that each frame presents only those distresses that could, in practice, co-exist for the type of pavement structure being analyzed. If the PADIAS operator encounters a condition that appears to be a conflict, it should be noted on the interpretation log form for possible review by the QA/QC reviewer and brought to the attention of a pavement engineer.

Step 4: Output of the PADIAS

The output of the PADIAS consists of a series of: (1) raw data files (2) summary reports that describe the section condition, and (3) graphical reports that depict the location, type and severity level of the distresses recorded in the interpretation. The raw data files -- *.DAT, *.FRM, *.HDR, and *.NUM -- are in binary code. The *.DAT file contains the distress data interpreted using the FMA/PADIAS System. Frame information, including scaling factors to convert film measurements to field measurements, is stored in the *.FRM file. Header information, such as section I.D. number, pavement type, date of filming, etc..., is stored in the *.HDR file. Finally, the *.NUM file includes the number of occurrences for D-Cracking (PCC pavements) and water bleeding and pumping (all pavement types).

Both the summary and graphical reports may be viewed on screen, printed to a local printer, or saved to a file for later viewing or printing. The Control Section Reports program from the main menu produces this output in four distinct formats including:

1. Section Map Report - produces a graphic representation of each frame of film in which a distress was recorded for a section. The location and severity level of each distress is shown on a grid pattern using a letter or number code. A maximum of three distress types can be depicted within any one grid, which is usually sufficient. Since one page per frame is required, a complete section frame map printout can include as many as 42 pages. It should be noted that the time required to print a section map can take as much as 30 minutes using the existing equipment and set-up defaults. It is suggested that this report be saved to a file for on-screen viewing.

2. Grid Summary Report - a one page summary of the distresses in a section, which indicates the total number of grid cells affected by a particular distress at each severity level.

3. Section Summary Report - (Figure 13) is a one page summary of the distresses in a section listed by type and severity level in units appropriate to the type of distress. This report corresponds to the input data required for the LTPP-IMS.

Control Section ID: 891127
LTPP GPS Section ID: 891127
Pavement Type : 1
Date of Filming : 8/22/89
Time of Filming : 13:39
Filming Operator :
Weather Condition :
Measuring Speed : 0 m.p.h.
Section Length : 500 feet
Date of Analysis : 7/25/91
Time of Analysis : 13:39
Analysis Operator : rag

Comments:

AC on Granular Base

Distress Type	Reduced Extent of Each Severity				
	Unit	High	Moderate	Low	Unknown
Alligator (Fatigue) Cracking					
Block Cracking					
Edge Cracking					
Longitudinal Cracking	Lin. Ft.	0.00	129.81	494.32	0.00
Long. Reflect.Cracking at Jts					
Trans.Reflect.Cracking at Jts					
Transverse Cracking	Lin. Ft. Number	3.12 0	32.19 2	16.62 1	0.00 0
Patch/Patch Deterioration					
Potholes					
Shoving					
Bleeding	Sq. Ft.	0.00	0.00	76.85	0.00
Polished Aggregate					
Raveling and Weathering					
Lane-to-Shoulder Dropoff					
Lane-to-Shoulder Separation					
Water Bleeding and Pumping					

Figure 13. Example Section Summary Report

4. Frame Map Report - a printout of a particular frame within a section selected by the operator.

After the distress interpretation of a test section is completed, the PADIAS operator should print out a Section Summary report. The Section Summary Report should be attached to the interpretation log form for the section and submitted to the QA/QC reviewer. This should provide pertinent information regarding information the condition of a pavement section and details of the film interpretation which can be used in the QA/QC review process.

The Section Map Report for a section should be generated when the interpretation is going to be subjected to detailed QA/QC review as determined by the QA/QC reviewer. The distress interpretation results depicted on the section map are compared to the film image or to existing manual survey results.

Step 5: Quality Control Review

The summary reports and interpretation logs are compiled and submitted on a state by state (province by province) basis to the QA/QC engineer for review. The QA/QC reviewer examines all of the reports and selects sections requiring a detailed QA/QC review based on operator comments, pavement type and requirements for random quality control checks. All sections are looked at by the QA/QC reviewer, using the FMA, with a minimum of 25% of the interpreted sections being reviewed in detail. The selection procedure for the detailed QA/QC reviews is based on PADIAS operator comments concerning difficulty in interpretation, distress report complexity or anomalies, and film condition and clarity. If any discrepancies are noted in the quality control review, the section is corrected by the operator and discrepancies in interpretation resolved. If there are systematic discrepancies observed in the QA/QC review then an increasingly higher percentage of the film (i.e., 30, 40, etc.) is reviewed in detail by the QA/QC reviewer.

The section's nomination videotape may be reviewed to confirm the PADIAS operator's interpretation of the section. If discrepancies exist, the differences are listed and the PADIAS operator will apply corrections to the section interpretation. For each section satisfactorily interpreted the following reports are generated to disk storage (NOT hardcopy) for transmittal to the RCOC's:

1. Section Summary Report
2. Section Map Report

Each of these reports uses the section number as a root file name along with an appropriate file name extension, e.g. 1234567.RPT, 1234567.MAP.

Step 6: RCOC Quality Control Review

Upon satisfactory completion of the PADIAS distress QA/QC review, the distress data is forwarded to the appropriate RCOC on a state by state (province by province) basis. The RCOC distress quality control team reviews the reports and utilizes a combination of projection viewing of the film, the nomination verification videotape, and/or spot checking of the actual section conditions in the field to confirm the PADIAS operator's interpretation of the section. If discrepancies exist, the differences are documented and transmitted to the PADIAS contractor. Upon receiving the list of discrepancies, the PADIAS operator may edit the distress data to resolve the discrepancies. Disagreements which cannot be resolved between the PADIAS contractor and the RCOC should be referred to the cognizant SHRP staff or other designated representatives for resolution. The films for LTPP sections which have been edited by PADIAS operator should subsequently be fully reviewed by the RCOC's. Reports for edited sections are generated by the PADIAS contractor to replace the original reports sent to the RCOC's.

Step 7: Enter Data Into RIMS

Upon satisfactory completion of the RCOC distress quality control team review, the distress data is entered in the RIMS data ıse. This is accomplished by uploading the ASCII Section Summary Report. In addition, the detailed binary data files (*.DAT, *.FRM, *.HDR, and *.NUM) are also loaded into the RIMS.

REFERENCES

1. PASCO USA, Inc., "PADIAS Pavement Distress Analysis System User's Guide and Reference", New Jersey, May 1990.

2. SHRP-LTPP/FR-90-001, "Distress Identification Manual for the Long-Term Pavement Performance Studies", Washington, DC, October 1990.

APPENDIX A

ACCEPTANCE CRITERIA FOR 35mm DISTRESS FILM

APPENDIX A

ACCEPTANCE CRITERIA FOR 35mm DISTRESS FILM

DEFINITION OF THE QUALITY CLASSIFICATION

The following possible film problems should be investigated during the acceptance process:

1. The film is out of focus.
2. Film development problems.
3. Lane is incomplete on the film.
4. Section is incomplete on the film.
5. Film perforations are damaged.
6. Film leaders are not long enough to allow loading the film in the film motion analyzer (FMA).
7. Identification number of the film is not the same as the actual section.

Quality classifications are as follows:

Good - All attributes are acceptable
Marginal - Some small problems on attributes 2, 5, 6; that is, the distress interpretations is possible and it does not affect the final results.
Unacceptable - Serious problems on attributes 1, 2, 3, 4, 5, 6, or 7.

APPENDIX B

DISTRESS IDENTIFICATION CAPABILITIES OF PADIAS

APPENDIX B

DISTRESS IDENTIFICATION CAPABILITIES OF PADIAS

The attached tables detail the specific distress types included in both the SHRP Distress Identification Manual (DIM) and in the PADIAS program. Also listed are the units used to measure the distresses and whether severity levels are defined. Differences between the manual survey procedures and those in the PADIAS system relate to the inability of making physical measurements of faulting, precise crack width, depth of potholes, shoulder drop-off, etc. Notes explaining the differences between the SHRP DIM and the PADIAS software follow each table.

AC PAVEMENT DISTRESS INTERPRETATION

Distress Type	Included		Unit of Measurement		Defined Severity Level	
	SHRP DIM	PADIAS 1.1	SHRP DIM	PADIAS 1.1	SHRP DIM	PADIAS 1.1
Cracking						
1. Alligator (Fatigue) Cracking	Yes	Yes	Square Feet	Square Feet	Yes	Yes
2. Block Cracking	Yes	Yes	Square Feet	Square Feet	Yes	Yes
3. Edge Cracking	Yes	Yes	Linear Feet	Linear Feet	Yes	Yes
4. Longitudinal Cracking	Yes	Yes	Linear Feet	Linear Feet	Yes	Yes
5. Reflection Cracking at Joints	Yes	Yes	No., Linear Feet	No., Linear Feet	Yes	Yes
6. Transverse Cracking	Yes	Yes	No., Linear Feet	No., Linear Feet	Yes	Yes
Patching and Potholes						
7. Patch/Patch Deterioration	Yes	Yes	Square Feet, No.	Square Feet, No.	Yes	Yes
8. Potholes	Yes	Yes	Number	Square Feet, No.	Yes	No[1]
Surface Deformation						
9. Transverse Profile	Yes	No[2]	Inches	N/A	No	N/A
10. Shoving	Yes	Yes	No., Square Feet	No., Square Feet	No	No
Surface Defects						
11. Bleeding	Yes	Yes	Square Feet	Square Feet	Yes	Yes
12. Polished Aggregate	Yes	Yes	Square Feet	Square Feet	No	No
13. Raveling and Weathering	Yes	Yes	Square Feet	Square Feet	Yes	Yes
Miscellaneous Distress						
14. Lane-to-Shoulder Dropoff	Yes	Yes	Inches	Linear Feet[3]	No	No
15. Lane-to-Shoulder Separation	Yes	Yes	Linear Feet	Linear Feet	Yes	Yes
16. Water Bleeding and Pumping	Yes	Yes	No., Linear Feet	No., Linear Feet	Yes	Yes

Notes:
1 - Depth of pothole cannot be determined from film
2 - Transverse profile data derived from separate film
3 - Height of dropoff cannot be determined from film, however, height difference is sometimes discernable

JC PAVEMENT DISTRESS INTERPRETATION

Distress Type	Included		Unit of Measurement		Defined Severity Level	
	SHRP DIM	PADIAS 1.1	SHRP DIM	PADIAS 1.1	SHRP DIM	PADIAS 1.1
Cracking						
1. Corner Breaks	Yes	Yes	Number	Number	Yes	Yes
2. Durability "D" Cracking	Yes	Yes	No., Square Feet	No., Square Feet	Yes	Yes
3. Longitudinal Cracking	Yes	Yes	Linear Feet	Linear Feet	Yes	Yes
4. Transverse Cracking	Yes	Yes	No., Linear Feet	No., Linear Feet	Yes	Yes
Joint Deficiencies						
5. Joint Seal Damage of Transverse Joints	Yes	Yes	No., Linear Feet	No., Linear Feet	Yes	Yes
6. Spalling of Longitudinal Joints	Yes	Yes	Linear Feet	Linear Feet	Yes	Yes
7. Spalling of Transverse Joints	Yes	Yes	No., Linear Feet	No., Linear Feet	Yes	Yes
Surface Defects						
8. Map Cracking and Scaling	Yes	Yes	Square Feet	Square Feet	Yes	Yes
9. Polished Aggregate	Yes	Yes	Square Feet	Square Feet	No	No
10. Popouts	Yes	Yes	Number	Number	No	No
Miscellaneous Distress						
11. Blowup	Yes	Yes	Number	Number	No	No
12. Faulting of Transverse Joints & Cracks	Yes	No	Inches	N/A[1]	No	N/A
13. Lane-to-Shoulder Dropoff	Yes	Yes	Inches	Linear Feet[2]	No	No
14. Lane-to-Shoulder Separation	Yes	Yes	Inches	Linear Feet[3]	No	Yes
15. Patch/Patch Deterioration	Yes	Yes	Square Feet, No.	Square Feet, No.	Yes	Yes
16. Water Bleeding and Pumping	Yes	Yes	No., Linear Feet	No., Linear Feet	Yes	Yes

Notes:
1 - Faulting cannot be discerned from film, other measurement means are used
2 - Height of dropoff cannot be determined from film, however, height difference is sometimes discernable
3 - Width of separation cannot be measured

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CRC PAVEMENT DISTRESS INTERPRETATION

Distress Type	Inclusion		Unit of Measurement		Defined Severity Level	
	SHRP DIM	PADIAS 1.1	SHRP DIM	PADIAS 1.1	SHRP DIM	PADIAS 1.1
Cracking						
1. Durability "D" Cracking	Yes	Yes	No., Square Feet	No., Square Feet	Yes	Yes
2. Longitudinal Cracking	Yes	Yes	Linear Feet	Linear Feet	Yes	Yes
3. Transverse Cracking	Yes	Yes	No., Linear Feet	No., Linear Feet	Yes	Yes
Surface Defects						
4. Map Cracking and Scaling	Yes	Yes	Square Feet	Square Feet	Yes	Yes
5. Polished Aggregate	Yes	Yes	Square Feet	Square Feet	No	No
6. Popouts	Yes	Yes	Number	Number	No	No
Miscellaneous Distress						
7. Blowups	Yes	Yes	Number	Number	No	No
8. Construction Joint Deterioration	Yes	Yes	Number	Number	Yes	Yes
9. Lane-to-Shoulder Dropoff	Yes	Yes	Inches	Linear Feet[1]	No	No
10. Lane-to-Shoulder Separation	Yes	Yes	Inches	Linear Feet[2]	No	Yes
11. Patch/Patch Deterioration	Yes	Yes	Square Feet, No.	Square Feet, No.	Yes	Yes
12. Punchouts	Yes	Yes	Number	Number	Yes	Yes
13. Spalling of Longitudinal Joint	Yes	Yes	Linear Feet	Linear Feet	Yes	Yes
14. Water Bleeding and Pumping	Yes	Yes	No., Linear Feet	No., Linear Feet	Yes	Yes

Notes: 1 - Height of dropoff cannot be determined from film, however, height difference is sometimes discernable
2 - Width of separation cannot be measured

APPENDIX C

CURRENT LIMITATIONS OF THE PADIAS SYSTEM

APPENDIX C

CURRENT LIMITATIONS OF THE PADIAS SYSTEM

A number of limitations associated with the PADIAS/FMA system were identified during the initial rounds of GPS and SPS section distress interpretations. These limitations can be grouped into following general categories:

1. Viewing limitations
2. Recording limitations

Viewing limitations are related to what an operator can (and can not) see, with acceptable confidence, via the projected film image. Recording limitations, on the other hand, are related to the FMA set-up and PADIAS software, which affect counting the number of occurrences for certain distress types. A detailed summary of the these limitations is provided below.

Viewing Limitations

Due to the limited viewing angle, resolution, clarity, and reduced scale, certain distress types can not be identified using the PADIAS/FMA system. Furthermore, even when certain distress types can be identified, the measurement of the distress and/or the determination of severity levels is, in many cases, either impossible or difficult.

The viewing limitations are summarized for each pavement type in the attached tables, which include a description of the limitation(s) and the degree to which it affects each distress type. This information is included to aid in assessing the impact of the FMA limitations on the quality of the collected distress data. Three rating levels were used to assess the degree of limitation: MINOR, MODERATE, and MAJOR. The following is a general description of each rating level:

MINOR	-	The limitation is mainly related to assigning severity levels; the distress can usually be identified.
MODERATE	-	The limitation significantly affects the identification of the distress and/or the assignment of severity levels.
MAJOR	-	The limitation inhibits or prevents the positive identification of the distress.

The relative number of occurrences of the limitations and the resulting debates (between operators and engineers) during the initial LTPP distress interpretations were considered when rating the degree of limitation. Since not all distress types were encountered during the initial interpretations, FMA limitations for some distresses (e.g., blowups, punchouts, shoving, etc.) were identified and rated based on the experience of the PADIAS contractor.

The majority of the viewing limitations rated as MINOR and MODERATE do not significantly affect the quality of the collected distress data. These limitations have been identified and accepted as inherent to the FMA system. Modifications to the existing FMA for interpreting distress types with limitations rated as MINOR and MODERATE are not recommended at this time. Instead, distress operators should only identify these distresses and assign severity levels based on what they can actually see or "unknown" otherwise. Comments should be provided in the PADIAS file as needed to clarify any problems encountered.

The viewing limitations rated as MAJOR represent distress types which can not be or are extremely difficult to identify and assign severity levels using the FMA. In the interim, it is recommended that these distress types be disregarded in the interpretation process for all sections. A summary of the distress types which should be disregarded is provided below:

AC Pavements:

1. Shoving
2. Bleeding
3. Polished Aggregate
4. Ravelling and Weathering
5. Lane-to-Shoulder Dropoff
6. Lane-to-Shoulder Separation
7. Water Bleeding and Pumping

JPC Pavements:

1. Transverse Joint Seal Damage
2. Map Cracking and Scaling
3. Polished Aggregate
4. Lane-to-Shoulder Dropoff
5. Lane-to-Shoulder Separation
6. Water Bleeding and Pumping

CRC Pavements:

1. Map Cracking and Scaling
2. Polished Aggregate
3. Lane-to-Shoulder Dropoff
4. Lane-to-Shoulder Separation
5. Water Bleeding and Pumping

Recording Limitations

Recording limitations are mainly associated with problems in counting the number of occurrences of a distress. A description of each recording limitation that has been identified to date is provided below.

1. PADIAS correctly records the number of potholes, patches, shoving, punchouts, etc., when the distress crosses a frame boundary, but not when 2 or more separate occurrences are recorded within adjacent grids. However, this situation is rare and can be avoided by the FMA operator.

2. PADIAS does not correctly record the number of corner breaks when 2 corner breaks are recorded within adjacent grids (i.e. both sides of a joint are cracked at the corner). However, this situation is rare and can be avoided by the FMA operator.

3. PADIAS does not correctly records the number of transverse joints with spalling at each severity level when the joint crosses a frame boundary. However, this situation is rare and can be avoided by the FMA operator.

Other counting problems identified during the initial interpretation of SHRP distress data have been corrected.

AC PAVEMENT DISTRESS INTERPRETATION

Distress Type	FMA Limitation	Degree of Limitation
1. Alligator Cracking	Extremely difficult to identify hairline cracking.	Minor
2. Block Cracking	Very large blocks can extend across a frame; consequently, the block cracks appear as longitudinal and transverse cracks.	Minor
3. Edge Cracking	None	N/A
4. Longitudinal Cracking	Sealed Cracks: Can not always determine mean unsealed crack width and can not always determine if a crack actually exists underneath sealant.	Minor
5. Reflection Cracking at Joints	Sealed Cracks: Can not always determine mean unsealed crack width and can not always determine if a crack actually exists underneath sealant. Sometimes difficult to determine if cracks are reflective at joints or reflective at cracks in the underlying PCC; non-uniform joint spacing causes problems. Can not determine if longitudinal crack at the outer edge is reflective unless the shoulder type is known (i.e., AC/PCC lane with PCC shoulder implies reflection crack; AC/PCC lane with AC shoulder implies lane-to-shoulder separation).	Moderate
6. Transverse Cracking	Sealed Cracks: Can not always determine mean unsealed crack width and can not always determine if a crack actually exists underneath sealant.	Minor
7. Patch/Patch Deterioration	None	N/A
8. Potholes	Can not determine depth of pothole.	Moderate
9. Rutting[1]	N/A	N/A
10. Shoving	Extremely difficult to identify longitudinal displacement (suspect).	Moderate
11. Bleeding	Can not determine if surface discoloration is free asphalt. Surface treatments cause problems because the FMA projection does not clearly show if surface aggregates are removed or embedded into underlying pavement.	Major
12. Polished Aggregate	Can not determine if exposed coarse aggregates are glossy (i.e., polished)	Major

Distress Type	FMA Limitation	Degree of Limitation
13. Ravelling/Weathering	Extremely difficult to determine if pavement surface was worn away or if asphalt binder has been removed; can only reliably identify in extreme cases where the underlying pavement is visible. Extremely difficult to determine if a rough pitted surface is the result of raveling/weathering or a natural characteristic of the AC mix. Surface treatments cause problems because the FMA projection does not clearly show if surface aggregates are removed or embedded into underlying pavement.	Major
14. Lane-to-Shoulder Dropoff	Extremely difficult to identify an elevation difference between the traveled surface and the outside shoulder. Can only identify in extreme cases when a shadow is observed. Can not measure the dropoff to the nearest 0.05 inches.	Major
15. Lane-to-Shoulder Separation	Extremely difficult to distinguish the difference between an elevation difference (i.e., Lane-to-Shoulder Dropoff) and the widening of the separation between the traffic lane and the outside shoulder. This mainly applies to situations where the traffic lane and outside shoulder are constructed with different types of AC. For situations where the traffic lane and outside shoulder appear as the same AC, a crack along the outer edge can usually be identified and recorded as a lane-to-shoulder separation. Can not always determine mean unsealed crack widths.	Major
16. Water Bleeding and Pumping	Extremely difficult to identify ejected water and/or deposits of fine material	Moderate

NOTE: [1] Rut depth data are being obtained through other means.

JC PAVEMENT DISTRESS INTERPRETATION

Distress Type	FMA Limitation	Degree of Limitation
1. Corner Breaks	Can not identify faulting.	Moderate
2. Durability "D" Cracking	Extremely difficult to identify hairline cracking.	Minor
3. Longitudinal Cracking	Can not identify faulting. Difficult to identify mean unsealed crack widths for sealed cracks.	Minor
4. Transverse Cracking	Can not identify faulting. Difficult to identify mean unsealed crack widths for sealed cracks.	Minor
5. Joint Seal Damage	Can not identify hardening/adhesive failure, cohesive failure of sealant material, or intrusion of foreign material into the joint. Can only reliably identify when sealant material is completely removed or weed growth is observed.	Major
6. Spalling of Longitudinal Joints	Difficult to identify very small low severity spalls (i.e., small chippings, breaking, fraying, etc.) due to sealant material.	Minor
7. Spalling of Transverse Joints	Difficult to identify very small low severity spalls (i.e., small chippings, breaking, fraying, etc.) due to sealant material.	Minor
8a. Map Cracking	Extremely difficult to identify faint cracks.	Moderate
8b. Scaling	Difficult to identify surface deterioration due to inability to see depth.	Moderate
9. Polished Aggregate	Can not determine if exposed coarse aggregate is glossy (i.e. polished).	Major
10. Popouts	Difficult to identify small popouts due to inability to see depth.	Minor
11. Blowups	Possibly difficult to identify due to inability to see depth (suspect).	Minor
12. Faulting of Transverse Joints and Cracks	Can not identify or measure difference in elevation across a joint or crack	Major
13. Lane-to-Shoulder Dropoff	Extremely difficult to identify an elevation difference between the traveled surface and the outside shoulder. Can only identify in extreme cases when a shadow is observed. Can not measure the dropoff to the nearest 0.1 inches.	Major

Distress Type	FMA Limitation	Degree of Limitation
14. Lane-to-Shoulder Separation	Extremely difficult to distinguish the difference between an elevation difference (i.e., Lane-to-Shoulder dropoff) and the widening of the separation between the traffic lane and the outside shoulder. Can not measure separation to the nearest 0.1 inch. Extremely difficult to assess condition of joint sealant.	Major
15. Patch/Patch Deterioration	Can not identify faulting.	Minor
16. Water Bleeding and Pumping	Extremely difficult to identify ejected water and/or deposits of fine material.	Moderate

CRC PAVEMENT DISTRESS INTERPRETATION

Distress Type	FMA Limitation	Degree of Limitation
1. Durability "D" Cracking	Extremely difficult to identify hairline cracking.	Minor
2. Longitudinal Cracking	Can not identify faulting. Difficult to identify mean unsealed crack widths for sealed cracks.	Minor
3. Transverse Cracking	Extremely difficult to identify hairline cracking. Extremely difficult to identify cracks when surface has grooves or tining. Can not identify faulting.	Moderate
4a. Map Cracking	Extremely difficult to identify slightly noticeable cracks.	Moderate
4b. Scaling	Difficult to identify surface deterioration due to inability to see depth.	Moderate
5. Polished Aggregate	Can not determine if exposed coarse aggregate is glossy (i.e. polished).	Major
6. Popouts	Difficult to identify small popouts due to inability to see depth.	Minor
7. Blowups	Possibly difficult to identify due to inability to see depth.	Minor
8. Construction Joint Deterioration	None	N/A
9. Lane-to-Shoulder Dropoff	Extremely difficult to identify an elevation difference between the traveled surface and the outside shoulder. Can only identify in extreme cases when a shadow is observed. Can not measure the dropoff to the nearest 0.1 inches.	Major
10. Lane-to-Shoulder Separation	Extremely difficult to distinguish the difference between an elevation difference (i.e., Lane-to-Shoulder dropoff) and the widening of the separation between the traffic lane and the outside shoulder. Can not measure separation to the nearest 0.1 inch. Extremely difficult to assess condition of joint sealant.	Major
11. Patch/Patch Deterioration	Can not identify faulting.	Minor
12. Punchouts	Can not identify faulting or depth of punchout.	Moderate
13. Spalling of Longitudinal Joints	Difficult to identify very small low severity spalls (i.e., small chippings, breaking, fraying, etc.) due to sealant material.	Minor

Distress Type	FMA Limitation	Degree of Limitation
14. Water Bleeding and Pumping	Extremely difficult to identify ejected water and/or deposits of fine material.	Moderate