

AD-A079 591

YANG (NAI C) AND ASSOCIATES NEW YORK
NONDESTRUCTIVE EVALUATION OF AIRPORT PAVEMENTS. VOLUME III. OPE--ETC(U)
SEP 79 D YANG

F/G 1/5

DOT-FA77-WA-3964

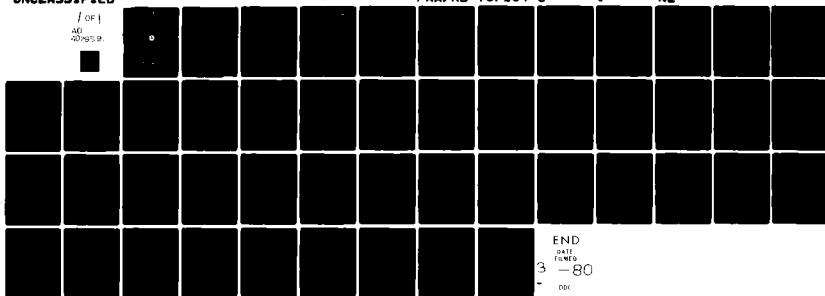
UNCLASSIFIED

FAA/RD-78/154-3

NL

1 OF 1

AD
A079591



LEVEL *II*

12

NONDESTRUCTIVE EVALUATION OF AIRPORT PAVEMENTS

VOLUME III

OPERATION MANUAL FOR MLGPAV PROGRAM AT TCC

BY

DAVID YANG

NAI C. YANG & ASSOCIATES, ENGINEERS

ADA 079591



DDC
RECEIVED
JAN 16 1980
E

SEPTEMBER 1979

Document is available to the U.S. public through
the National Technical Information Service,
Springfield, Virginia 22161.

DDC FILE COPY

Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Systems Research & Development Service
Washington, D.C. 20590

THIS DOCUMENT IS BEST QUALITY PRACTICABLE.
THE COPY FURNISHED TO DDC CONTAINED A
SIGNIFICANT NUMBER OF PAGES WHICH DO NOT

80 1 15 020

NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof.

DISCLAIMER NOTICE

**THIS DOCUMENT IS BEST QUALITY
PRACTICABLE. THE COPY FURNISHED
TO DDC CONTAINED A SIGNIFICANT
NUMBER OF PAGES WHICH DO NOT
REPRODUCE LEGIBLY.**

1. Report No. FAA-RD-78-154 III	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle NONDESTRUCTIVE EVALUATION OF AIRPORT PAVEMENTS, VOLUME III, OPERATION MANUAL FOR MLGPAV PROGRAM AT TCC		5. Report Date Sept 1979	6. Performing Organization Code
7. Author(s) David Yang		8. Performing Organization Report No.	
9. Performing Organization Name and Address Nai C. Yang & Associates, Engineers, P.C. 60 East 42nd Street New York, N.Y. 10017		10. Work Unit No. (TRAIS)	
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration Systems Research & Development Service Washington, D.C. 20590		11. Contract or Grant No. DOT-FA77-WA-3964	13. Type of Report and Period Covered Final Report
15. Supplementary Notes FAA/RD 78/154-3		14. Sponsoring Agency Code ARD-430	
16. Abstract Sensitivity analysis of aircraft parameters on functional pavement design is the primary goal of the MLGPAV program at the Transportation Computer Center (TCC) in Washington, D.C. The program is an integrated system which is data independent based on defined mathematical models and operational logic. The input data is divided into job and universal default inputs. The job inputs consists of only the aircraft data such as: (1) forecast of aircraft movements; (2) maximum takeoff weight; (3) natural frequency of aircraft at tire pavement interface; (4) tire pressure of main landing gear wheel; (5) wheel configuration of main landing gear and (6) gear spacing. The default system contains all of the data independent of the aircraft, such as: (1) regional cost values; (2) types of facility, runway, taxiway, apron; (3) navigation system; (4) operation speed; (5) roughness and maintenance standards; (6) sub-grade conditions and (7) airport traffic distribution. A unified mechanistic method is used to design five types of functional pavements for identical service requirements on riding quality and maintenance needs. They are: (1) asphalt pavements in southern or northern region; (2) concrete pavements on stabilized or aggregate base and (3) full depth stabilized base pavement. The MLGPAV program operation involves extensive use of data storage and filing techniques. The current operational program and this manual are prepared for execution on the computer hardware system at TCC.			
17. Key Words Computer Design Airport Pavements Cost Benefit Landing Gear		18. Distribution Statement Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161.	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 48	22. Price

410 069

METRIC CONVERSION FACTORS

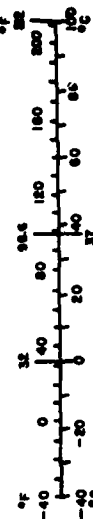
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
AREA				
sq in	square inches	6.5	square centimeters	cm ²
sq ft	square feet	0.09	square meters	m ²
sq yd	square yards	0.8	square meters	m ²
sq mi	square miles	2.6	square kilometers	km ²
acre	acres	0.4	hectares	ha
MASS (weight)				
ounce	ounces	28	grams	g
pound	pounds	0.45	kilograms	kg
short ton	short tons	0.9	tonnes	t
(2000 lb)				
VOLUME				
teaspoon	teaspoons	5	milliliters	ml
fluid ounce	fluid ounces	30	milliliters	ml
cup	cups	0.24	liters	l
pint	pints	0.47	liters	l
quart	quarts	0.95	liters	l
gallon	gallons	3.8	liters	l
cubic foot	cubic feet	0.03	cubic meters	m ³
cubic yard	cubic yards	0.76	cubic meters	m ³
TEMPERATURE (exact)				
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 exactly. For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weight and Measure, Price \$2.35, SO Catalog No. C13.10-286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
km	kilometers	0.6	miles	mi
AREA				
cm ²	square centimeters	0.16	square inches	sq in
m ²	square meters	1.2	square yards	sq yd
km ²	square kilometers	0.4	square miles	sq mi
ha	hectares (10,000 m ²)	2.5	acres	acre
MASS (weight)				
g	grams	0.005	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	short tons
VOLUME				
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m ³	cubic meters	36	cubic feet	ft ³
m ³	cubic meters	1.3	cubic yards	yd ³
TEMPERATURE (exact)				
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



OPERATION MANUAL FOR MLGPAV PROGRAM AT TCC

CONTENTS	Page
OPERATION LOGIC, PROGRAM LANGUAGE AND COMPUTER SYSTEM	1
FORMAT OF USER'S INPUT	2
JOB INPUTS	3
Job Card	3
Aircraft Data Group	3
LISTING OF DEFAULT INPUTS	5
Program Control Cards	5
Regional Cost Values	5
Facility Types	5
Bandwidth for Traffic Distribution	6
Dynamic Increment of Aircraft Vibration	6
Velocity of Aircraft	6
Financial Cost Data	6
Demand Forecast	6
PFLDI, Smoothness of Existing Pavements	6
Class, Identification for Design Coefficients	7
Layer, Identification for E-value and Poisson's Ratio	7
Layer Cost Data Group	7
Pavement Data Group	8
Design Charts - Layer Thickness	8
New Pavement ESUB Grid Values	8
Codes of Keel and Side	8
Existing Pavement Data Group	9
PFLPAV ESUB grid Values	9
PFLPAV Design Charts Control Group Data	9
PFLPAV in Aircraft Equivalency for PFL	9
PAVEMENT in Aircraft Equivalency for Thickness Design	9
Design Charts for Limiting Deflection and Stress	10
Facility and Station Identifications	10
Statistically Processed NDT Group Data	10
Average Daily Movements	10
Airport Traffic Distribution	11
GELS/NDT3 Design Charts	11
Pavement Design	11

Accession For	
NTIS GR&I	☒
DDC TAB	☐
Unannounced	☐
Justification	☐
By	
Signature	
Date	
Initial	
23	
CP	

	Page
DESCRIPTION OF SYSTEM OUTPUTS	
Title Page	17
Print/Input	17
GELS/FAMD	17
GELS/FAM Page Counter MWFPR	17
GELS/HDES Page Counter MWPRT	17
Run/PAVDES Page Counter ATM	17
Page Counter OPWGT	17
Page Counter AND/ANS	17
Page Counter CED:	17
Page Counter PAV:	18
ERROR MESSAGES AND DIAGNOSTICS	18
REFERENCES	18
APPENDIX 1 OS 360 JOB CONTROL CARDS FOR OPERATION AT TCC	30
APPENDIX 2 BASIC FORTRAN LISTING	32
Subroutine NDT3	33
Subroutine CALC(1)	34
Subroutine CALC(2)	35
Subroutine PAVDES	36
Subroutine FAM	37
Subroutine HDES	39
Subroutine PCVCAL	42

OPERATION LOGICS, PROGRAM LANGUAGE, AND COMPUTER SYSTEM

Sensitivity analysis of aircraft parameters on functional pavement design is the primary goal of the MLGPAV program at the Transportation Computer Center (TCC) in Washington, D.C. The program is an integrated system for the functional design of airport pavements. The integrated programs are data independent, based on defined mathematical models and operational logic.

The model parameters, operational details and values to be processed, form a set of input data which is defined through the use of natural language heading statements and requires no programming experience on the part of the user. For the operational program at TCC, the input data is divided into job and universal default inputs. The job inputs consists of only the aircraft data. The default system contains all of the data, independent of the aircraft data.

The primary subsystem is the PAVDES subsystem from the PAVBEN operational program at TCC. The primary output from the PAVDES subsystem is the thickness design of pavements of various compositions. In the PAVBEN operation the aircraft data is in the universal default file and all the associated design charts are in the computed data inputs. For MLGPAV operation, the aircraft data is in the job input file, requiring the necessary design charts to be computed for every execution.

The MLGPAV program is operational on the IBM 360/65 at TCC. The program is written in the high level language FORTRAN IV. The program accepts input in the form of cards and needs several temporary files on auxiliary storage.

FORMAT OF USER'S INPUT

The program accepts input in the form of 80 character cards. The input cards are divided into two types: program control cards and cards in data groups. The control cards specify the program sections to be executed. The data groups provide the actual data values for program processing. Unless otherwise specified, each card is logically divided into eight fields of ten characters each. Each control card has a single keyword in field on which identifies itself both to the program and the user as a control card. Additional fields on a control card are used to provide related information.

Logically related input cards are placed together in data groups. The first card or cards are descriptive heading cards. The number of heading cards is fixed and the user should not add or delete any heading card. One of the heading cards is usually a field identifier card. On this card, each field has an acronym which identifies the data values on subsequent cards in that field. For more detail description, the particular field identifier can be found in the dictionary. Following the heading cards are the cards containing the actual data values corresponding to the field identifier. The order of cards in the group is important. The last card of data group is a delimiter card containing, * * in columns 1 and 2.

Values in a field have three definitions: integer, floating point or alphanumeric. They are expressed respectively by blanks and numbers, 0 to 9; blanks, the minus or plus sign, decimal point and the numbers 0 to 9; and all characters. Certain fields have only specific values allowable. Unless otherwise specified all values should be left justified in a field. This is especially important for alphanumeric fields. Blanks in floating point fields are interpreted as zeros. If a decimal point is omitted in a floating point field, the decimal is assumed to be after the rightmost column in that field. Certain field has subfields. The subfields are separated by slashes, /. The slash must appear in the exact column, as specified. To ensure proper recognition of the control cards and the data groups, the spelling and the spacing of the control keywords and heading descriptions must be correct.

JOB INPUTS

JOB CARD

JOB Starting from column 11 is a 70-character space for job name.
 Usually SENSITIVITY ANALYSIS OF AIRCRAFT and 9-letter air-
 craft code.

AIRCRAFT DATA GROUP

FIELD	IDENTIFIER	DESCRIPTION
1	AIRCRAFT	defines index, 1 to 20
2	CODE	defines 9 char. AIRCRAFT code
3	MTOW	max. take-off weight, lbs.
4	MLRW	max. landing roll weight, lbs.
5	OEW	operational empty weight, lbs.
6	RANGE	range of aircraft, XLONG, LONG, MEDIUM, or SHORT
1	BLANK	
2	BLANK	
3	MLG	main landing gear weight as fraction of MTOW
4	WGT	single wheel weight as fraction of MTOW
5	PSI	tire pressure, psi
6	FREQ	natural frequency of rubber tire, Hz
7	NWHEEL	number of wheels of MLGS
8	XMAX	distance between outer wheels, inches
1	BLANK	
2	BLANK	
3	WHEEL	NWHEEL transverse coordinates
4	X-COORD	number of cards is the integer of (NWHEEL-1)/6 plus 1.
5		
6		
7		
8		
1	BLANK	
2	BLANK	
3	WHEEL	NWHEEL longitudinal coordinates
4	Y-COORD	number of cards is the integer of (NWHEEL-1)/6 plus 1.
5		
6		
7		
8		

[illegible]

LISTING OF DEFAULT INPUTS

PROGRAM CONTROL CARDS

The user controls the data processing by means of card inputs. All MLGPAV control cards have two portions (1) control keyword field in columns 1 to 10 and (2) specification field or fields in columns 11 to 80 containing values or additional keywords required by the particular control card being used. There are six control keywords which have been programmed in the listing:

1. SITE Starting from column 11 is 4-character site code.
For TCC operation, this card is in the default system.
2. LINE In column 11 is a single digit number indicates the lines
skipped by the operating system on a printed page. For
TCC operation, this card is in the default system.
3. USER Starting from column 11 is a 12-character user name.
4. JOBCODE Starting from column 11 are 7 characters to be printed
in block letter on title page.
5. RUN Field 2 identifies the program to be executed.
6. PRINT There are 2 allowable keywords in field 2:
DICTIONARY - prints all dictionary items in sorted groups.
INPUT - prints control cards and job inputs.

REGIONAL COST VALUES

FIELD	IDENTIFIER	DESCRIPTION
1	COST	defines cost index 1 to 25
2	CODE	defines 6 character cost code
3	DATE	date of cost values, month/date/year
4	REGION CODE	cost value for the region coded
5	REGION CODE	
6	REGION CODE	
7	REGION CODE	
8	REGION CODE	

There may be more than one data group. Each data group may have one or more regions. The region code is 4 characters long. The cost values of the last region on the last data group will be used in the computations.

FACILITY TYPES

FIELD	IDENTIFIER	DESCRIPTION
1	TYPE	defines index 1 to 5
2	FACILITY	defines 2 character code
3	FACILITY	defines additional 2 character code
4	FACILITY	for example, the first two characters
5	FACILITY	of RUNWAY is the facility type code
6	FACILITY	

BANDWIDTH FOR TRAFFIC DISTRIBUTION

FIELD	IDENTIFIER	DESCRIPTION
1	BANDWIDTH	defines bandwidth index 1 to 5
2+3	CODE	defines 12 character BANDWIDTH code
4	RW	bandwidth in feet
5	TW	bandwidth in feet
6	SH	bandwidth in feet

DYNAMIC INCREMENT OF AIRCRAFT VIBRATION

FIELD	IDENTIFIER	DESCRIPTION
1	DI	facility type location, keel or side
2	RW	dynamic increment, in g
3	TW	dynamic increment, in g
4	SH	dynamic increment, in g

VELOCITY OF AIRCRAFT

FIELD	IDENTIFIER	DESCRIPTION
1	VEL	facility type location, keel or side
2	RW	aircraft velocity in knots
3	TW	aircraft velocity in knots
4	SH	aircraft velocity in knots

FINANCIAL COST DATA

FIELD	IDENTIFIER	DESCRIPTION
1	FINANCE	blank
2	AIRB	annual interest rate of bond
3	ARCD	annual rate of cash discount
4	ASCCC	annual escalation rate of construction cost
5	ASCMC	annual escalation rate of maintenance need
6	NBL	maturity of revenue band in years
7	NSLP	mortgage payments of bond, in years

DEMAND FORECAST

FIELD	IDENTIFIER	DESCRIPTION
1	FORECAST	defines 6 char. FORECAST Code
2	ADM	defines 6 char. ADM code
3	ATD	defines 6 char. ATD code

PFLDI, smoothness of pavement surface

FIELD	IDENTIFIER	DESCRIPTION
1	col. 1-10	defines DI for deflection analysis
2	Col. 11-50	defines 40 char. smoothness description

CLASS, identification for design coefficients

FIELD	IDENTIFIER	DESCRIPTION
1	CLASS	defines CLASS index 1 to 20
2	CODE	defines 6 char. CLASS code
3	OVSFKL	overstress factor for keel
4	OVSFSD	overstress factor for side
5	STRESS	conversion factor from E-value to tensile stress
6	FATIST	coef. of fatigue stress
7	COVAR	coef. of variance
8	Al	coef. of transfer function (trans. to long def.)
1	BLANK	
2	BLANK	
3	A2	coef. of transfer function (trans. to long def.)
4	D1	coef. of transfer function (elastic to cumulative)
5	D2	coef. of transfer function (elastic to cumulative)
6	DC	coef. of contact rigidity

LAYER, identification for default E-value and Poisson's Ratio

FIELD	IDENTIFIER	DESCRIPTION
1	LAYER	defines LAYER index 1 to 25
2	CODE	defines 6 char. LAYER code
3	EVALUE	default E-value of layer
4	POISSON	default Poisson ratio of layer
5	MOD(S)	mob. and demobilization cost for small job
6	MOD(N)	mob. and demobilization cost for normal work

LAYER COST DATA GROUP

FIELD	IDENTIFIER	DESCRIPTION
1	LAYER	defines LAYER index
2	PCBT	coef. for computing unit price of the layer
3	FIAGT	
4	COAGT	
5	ASCLT	
6	HLBT	
7	POZBT	
8	SFST	

Continuation Card

1	BLANK	
2	IWFAT	coef. for computing unit price of the layer
3	RSWLB	
4	LBBR	
5	CLHR	
6	SLEHR	

PAVEMENT DATA GROUP

FIELD	IDENTIFIER	DESCRIPTION
1	PAVEMENT	defines PAVEMENT index 1 to 20
2	CODE	defines 6 char. PAVEMENT code
3	LAYER	defines code of layer composition
4	THICKNESS	default thickness of layer, inches
5	EVALUE	if blank, use default E-value
6	POISSON	if blank, use default poisson

Last card in each defined pavement must have a layer code of SUB, PAV or PFLPAV. SUB defines new pavement on subgrade; PAV defines overlay pavement on existing pavement which is treated as one layer; PFLPAV defines overlay pavement on actual existing pavement.

DESIGN CHARTS - LAYER THICKNESSES

FIELD	IDENTIFIER	DESCRIPTION
1	ITERATE	blank
2	PAVEMENT	PAVEMENT index
3	LAYER	LAYER code
4	HMIN	min. thickness of design chart, inches
5	HMAX	max. thickness of design chart, inches
6	HSTEP	thickness increment of design chart, inches

NEW PAVEMENT ESUB GRID VALUES

FIELD	DESCRIPTION
1 to 8	subgrade E-values of design charts for new pavement and overlay pavements on actual existing pavement.

Continuation card also has same format.

number of cards = the integer of (number of E-values -1)/8 plus 1.

max. number of E-values = 20.

CODES OF KEEL AND SIDE

FIELD	IDENTIFIER	DESCRIPTION
1	PAVEMENT	blank
2	NUMBER	blank
3	KEEL	defines pavement index for keel
4	SIDE	defines pavement index for side

EXISTING PAVEMENT DATA GROUP

FIELD	IDENTIFIER	DESCRIPTION
1	PFLPAV	defines PFLPAV index, 1 to 20
2	CODE	defines 6 char. PFLPAV code
3	LAYER	LAYER code
4	THICKNESS	thickness of layer, inches
5	EVALUE	if blank, default value is used
6	POISSON	if blank, default value is used

Each PFLPAV must end with a LAYER code SUB.

PFLPAV ESUB GRID VALUES

FIELD	DESCRIPTION
1 to 8	subgrade E-value for PFLPAV deflection and stress chart.

Continuation card also has same format.

number of cards = the integer of (number of E-values -1)/8 plus 1.

max. number of E-values = 20.

PFLPAV DESIGN CHARTS CONTROL GROUP DATA

FIELD	IDENTIFIER	DESCRIPTION
1	PFLPAV	PFLPAV index
2	CLASS	CLASS code for design coefficients
3	LAYER FOR STR/MT	LAYER code for governing stress condition

PFLPAV IN AIRCRAFT EQUIVALENCY FOR PFL

FIELD	IDENTIFIER	DESCRIPTION
1	CLASS	CLASS index
2	PFLPAV FOR AND/ANS	PFLPAV index

PAVEMENT IN AIRCRAFT EQUIVALENCY FOR THICKNESS DESIGN

FIELD	IDENTIFIER	DESCRIPTION
1	CLASS	CLASS index
2	PAVEMENT	PAVEMENT index
3	PFLPAV FOR AND/ANS	PFLPAV index, (0 indicates subgrade)

Both PAVEMENT and PFLPAV indexes are used to define the representative pavement to be used in aircraft equivalency for thickness design.

DESIGN CHARTS FOR LIMITING DEFLECTION AND STRESS

FIELD	IDENTIFIER	DESCRIPTION
1	PAVEMENT	PAVEMENT index
2	PFLPAV	PFLPAV index
3	CLASS	CLASS code
4	LAYER FOR STR/MT	LAYER code for governing stress condition.

FACILITY AND STATION IDENTIFICATIONS

FIELD	IDENTIFIERS	DESCRIPTIONS
1	FACILITY	defines FACILITY index, 1 to 50
2	CODE	defines 9 char. FACILITY code, first 2 char. identify facility type code
3	STA-FROM	min. 5 char. station code in hundreds of feet
4	STA-TO	max. 5 char. station code in hundreds of feet

STATISTICALLY PROCESSED NDT GROUP DATA

FIELD	IDENTIFIERS	DESCRIPTIONS
1	FACILITY	FACILITY index
2	STA-FROM	min. 5 char. station code
3	STA-TO	max. 5 char. station code
4	SUMZ	blank
5	EVALUE	NDT E-value from NDT2 AREA-E, psi
6	DRAINAGE	DRAINAGE code, NORM or WET
7	TEMP.	temperature
8	PFLPAV	2 subfields, PFLPAV index, PFLPAV code

Max. number of STA-FROM and STA-TO is 7.

AVERAGE DAILY MOVEMENTS

Heading Card 1, Columns 11 to 20 contain the 6 char. ADM code.
 Heading Card 2, defines aircraft movements.

FIELD	IDENTIFIER	DESCRIPTION
1	AIRCRAFT	AIRCRAFT index
2	year	previous year's traffic
3	year + 1	current year's traffic
4	year + 6	5 year ADM
5	year + 11	10 year ADM
6	year + 16	15 year ADM
7	year + 21	20 year ADM

All aircraft indexes must appear. If aircraft does not have any traffic than leave columns under the years blank.

AIRPORT TRAFFIC DISTRIBUTION

Heading card 1, columns 11 to 20 contain the 6 char. ATD code.

FIELD	IDENTIFIER	DESCRIPTION
1	FACILITY	FACILITY index
2	STA-FROM	min. 5 char. station code
3	STA-TO	max. 5 char. station code
4	YEAR	year + 1 as defined in ADM
5	TOW%	percentage of take-off
6	LRW%	percentage of landing roll
7	TDW%	percentage of touchdown

YEAR should match the one defined in ADM.

GELS/NDT3 for each PFLPAV in design charts control group data.

FIELD	DESCRIPTION
1	number of thickness
2	number of PFLPAV E-values

Continuation card or cards

1 to 8 surface deflection of PFLPAV under a single wheel having tire pressure = 200 psi and radius 9 inches
number of cards = the integer of (number of E-values -1)/8 plus 1.

Continuation card or cards

1 to 8 tensile stress in the governing layer under the same single wheel for deflection.
number of cards = the integer of (number of E-values -1)/8 plus 1.

PAVDES PAVEMENT DESIGN

FIELD	IDENTIFIER	DESCRIPTION
1	FACILITY	FACILITY index
2	SERVYR	service year in 5, 10, 15 or 20 years
3	BANDWIDTH	BANDWIDTH index
4	FORECAST	FORECAST code

Controls the number of facilities which will be printed when the PAVDES program is run. Facility number may be repeated to get several different designs for the same facility.

DATE: 17:41:11 DEC 13, 1978

```

1 SITE TCC
2 LINE 1
3 USER D. YANG
4 JFACODE MLG-PAV
5 RUN GELS FAMO
6 RUN GELS FAM
7 RUN GELS HDES
8 RUN PAVDES
9 PRINT INPUT
10 REGIONAL COST VALUES
11 COST CODE DATE ACE
12 1 PCPT 11/09/78 43.90
13 2 FIAGT 11/09/78 4.91
14 3 CMACT 11/09/78 5.35
15 4 ASCLT 11/05/78 80.00
16 5 HLRT 11/10/78 75.00
17 6 PD7RT 11/10/78 3.50
18 7 SEST 11/10/78 3.00
19 8 IWFAT 11/10/78 2.00
20 9 RSWLR 11/10/78 .36
21 10 LRRM 11/05/78 .368
22 11 CLWP 11/02/78 7.03
23 12 SLEHR 11/02/78 10.07
24 **
25 TYPE FACILITY FACILITY FACILITY FACILITY FACILITY
26 1 RW RUNWAY
27 2 TW TAXIWAY XTW
28 3 SH
29 **
30 BANDWIDTH CODE1 CODE2 RW TW SH
31 1 NORM/VISUAL 40. 16. 16.
32 2 LIGHTS/ILS 20. 10. 16.
33 **
34 DJ RW TW SH
35 KEEL .12 .12 .30
36 SIDE .18 .18 .30
37 **
38 VFL RW TW SH
39 KEEL 145. 50. 50.
40 SIDE 145. 50. 50.
41 **
42 FINANCE AIRB ARCD ASCCC ASCMC NBL NSLP
43 .08 .10 .09 .02 30. 20.
44 **
45 FORECAST ADM ATD
46 FAMSUG ADMSUG ATDSUG
47 **
48 PFLDI
49 .12 SMOOTH PAVEMENT SURFACE
50 .18 OPERATIONAL SURFACE
51 .25 UPPER LIMIT OF ROUGHNESS TOLERANCE
52 .30 MAJOR REHABILITATION REQUIRED
53 **
54 CLASS CODE DVSEKL DVSFSD STRESS FATIST COVAR A1
55 A2 D1 D2 DC
56 1 AC/NOR .9 1.2 .65 .086 .12 2.30
57 .0170 .46 2.00 1.00
58 2 AC/SMH .9 1.2 .65 .086 .12 2.30
59 .0170 .46 2.00 1.00
60 3 CC/CTR 1.0 1.3333 .40 .082 .10 2.95
61 .0104 .61 2.00 .52
62 4 CC/AGR 1.0 1.3333 .40 .082 .10 2.95
63 .0104 .61 2.00 .52
64 5 LCF 1.0 1.3333 .38 .042 .15 2.80
65 .0125 .54 2.00 .90
66 **

```

67	LAYER	CODE	EVALUE	POISSON	MOD(S)	MOD(N)		
68	1	ASTOP	200000.		.0029	.0016		
69	2	LCFA	1100000.		.0064	.0019		
70	3	LCFR	600000.		.0051	.0015		
71	4	LCFC	400000.		.0051	.0015		
72	5	SUR	8000.		.0009	.0005		
73	6	PAV	60000.		.0009	.0005		
74	7	PCFP	5000000.		.0065	.0032		
75	8	PCF	4000000.		.0054	.0027		
76	9	RIC	1500000.		.0043	.0022		
77	10	CTR	200000.		.0038	.0019		
78	11	ASRS	150000.		.0026	.0014		
79	12	ASTR	60000.		.0020	.0011		
80	13	AGRS	40000.		.0017	.0010		
81	14	SSRS	20000.		.0015	.0008		
82	15	LTSUR	15000.		.0028	.0015		
83	16	FXPCNV	4500000.		.0	.0		
84	17	FXACNV	180000.		.0	.0		
85	18	EXPC	3000000.		.0	.0		
86	19	EXAC	140000.		.0	.0		
87	20	EXRSC	70000.		.0	.0		
88	21	EXRSA	50000.		.0	.0		
89	22	PFLPAV	60000.		.0009	.0005		
90	**							
91	LAYER	PCRT	FIAGT	CCAGT	ASCLT	HLBT	POZBT	SFST
92		IMFAT	RSWLR	LBBM	CLHR	SLEHR		
93	1	.0102						
94								
95	2	.0102						
96								
97	3	.0102						
98								
99	4	.0102						
100								
101	5	.0102						
102								
103	6	.0102						
104								
105	7	.0102						
106								
107	8	.0102						
108								
109	9	.0102						
110								
111	10	.0102						
112								
113	11	.0102						
114								
115	12	.0102						
116								
117	13	.0102						
118								
119	14	.0102						
120								
121	15	.0102						
122								
123	16	.0102						
124								
125	17	.0102						
126								
127	18	.0102						
128								
129	19	.0102						
130								
131	20	.0102						
132								
133	21	.0102						
134								
135	22	.0102						
136								
137	**							

PAVEMENT	CODE	LAYER	THICKNESS	EVALUE	POISSON
1	AC/NOR	ASTOP	2.		
		ASRS	16.		
		AGRS	8.		
		SUR			
2	AC/SOU	ASTOP	2.	100000.	
		ASRS	20.	85000.	
		AGRS	8.		
		SUB			
3	CC/CTR	PCC	12.		
		CTD	6.		
		SUB			
4	CC/AGR	PCC	14.		
		AGRS	8.		
		SSBS	8.		
		SUR			
5	LCF	ASTOP	4.		
		LCFA	6.		
		LCFR	8.		
		LCFC	8.		
		SUR			

ITERATE	PAVEMENT	LAYER	HMIN	HMAX	HSTEP
1		ASRS	4.	37.	3.
2		ASBS	4.	37.	3.
3		PCC	8.	19.	1.
4		PCC	8.	19.	1.
5		LCFA	2.	14.5	1.5

NEW PAVEMENT ESUR GRID EVALUES	3000.	5000.	9000.	15000.	21000.	35000.
PAVEMENT NUMBER						
1						
2						
3						
4						
5						

PFLPAV	CODE	LAYER	THICKNESS	EVALUE
1	AC1	EXAC	3.	
		EXBSA	6.	
		SUR		

PFLPAV ESUR GRID EVALUES	2000.	3000.	4000.	6000.	8000.	12000.	16000.	25000.
CLASS <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>								
1								
2								
3								
4								
5								

PFLPAV	CLASS	LAYER FOR STR/MT
1	AC/NOR	EXBSA

CLASS	PFLPAV FOR AND/ANS
1	1

CLASS	PAVEMENT	PFLPAV FOR AND/ANS
1	1	0
2	2	0
3	3	0
4	4	0
5	5	0

PAVEMENT	PFLPAV	CLASS	LAYER FOR STR/MT
1	0	AC/NOR	ASRS
2	0	AC/SOU	ASRS
3	0	CC/CTR	PCC
4	0	CC/AGR	PCC
5	0	LCF	LCFC

FACILITY AND STATION IDENTIFICATIONS								
	FACILITY	CODE	STA-FROM	STA-TO				
206								
207								
208	1	RW 5	000.0	090.0				
209	2	RW 15	000.0	090.0				
210	3	RW 35	000.0	090.0				
211	4	TW 5	000.0	090.0				
212	5	TW 15	000.0	090.0				
213	6	TW 35	000.0	090.0				
214	7	SH 5	000.0	090.0				
215	8	SH 15	000.0	090.0				
216	9	SH 35	000.0	090.0				
217	**							
STATISTICALLY PROCESSED NOT GROUP DATA								
	FACILITY	STA-FROM	STA-TO	SUMZ	EVALUE	DRAINAGE	TEMP.	PFLPAV
219								
220	1	000.0	030.0		5000.	NORM		0/SUB
221		030.0	060.0		5000.	NORM		0/SUB
222		060.0	090.0		5000.	NORM		0/SUB
223	2	000.0	030.0		15000.	NORM		0/SUB
224		030.0	060.0		15000.	NORM		0/SUB
225		060.0	090.0		15000.	NORM		0/SUB
226	3	000.0	030.0		35000.	NORM		0/SUB
227		030.0	060.0		35000.	NORM		0/SUB
228		060.0	090.0		35000.	NORM		0/SUB
229	4	000.0	030.0		5000.	NORM		0/SUB
230		030.0	060.0		5000.	NORM		0/SUB
231		060.0	090.0		5000.	NORM		0/SUB
232	5	000.0	030.0		15000.	NORM		0/SUB
233		030.0	060.0		15000.	NORM		0/SUB
234		060.0	090.0		15000.	NORM		0/SUB
235	6	000.0	030.0		35000.	NORM		0/SUB
236		030.0	060.0		35000.	NORM		0/SUB
237		060.0	090.0		35000.	NORM		0/SUB
238	7	000.0	030.0		5000.	NORM		0/SUB
239		030.0	060.0		5000.	NORM		0/SUB
240		060.0	090.0		5000.	NORM		0/SUB
241	8	000.0	030.0		15000.	NORM		0/SUB
242		030.0	060.0		15000.	NORM		0/SUB
243		060.0	090.0		15000.	NORM		0/SUB
244	9	000.0	030.0		35000.	NORM		0/SUB
245		030.0	060.0		35000.	NORM		0/SUB
246		060.0	090.0		35000.	NORM		0/SUB
247	**							
ADM AVERAGE DAILY MOVEMENTS, SUGGESTED								
	ADM	ADMSUG	NUMBER OF AIRCRAFT MOVEMENTS					
	AIRCRAFT	1977	1978	1983	1988	1993	1998	
249								
250								
251	1	15.	15.	20.	25.	30.	35.	
252	**							
ATO AIRCRAFT TRAFFIC DISTRIBUTION, SUGGESTED								
	FACILITY	STA-FROM	STA-TO	YEAR	TOW%	LRW%	TOW%	
253								
254	1	000.0	030.0	1978	1000.	1000.	1000.	
255		030.0	060.0	1978	100.	100.	100.	
256		060.0	090.0	1978	10.	10.	10.	
257	2	000.0	030.0	1978	1000.	1000.	1000.	
258		030.0	060.0	1978	100.	100.	100.	
259		060.0	090.0	1978	10.	10.	10.	
260	3	000.0	030.0	1978	1000.	1000.	1000.	
261		030.0	060.0	1978	100.	100.	100.	
262		060.0	090.0	1978	10.	10.	10.	
263	4	000.0	030.0	1978	1000.	1000.	1000.	
264		030.0	060.0	1978	100.	100.	100.	
265		060.0	090.0	1978	10.	10.	10.	
266	5	000.0	030.0	1978	1000.	1000.	1000.	
267		030.0	060.0	1978	100.	100.	100.	
268		060.0	090.0	1978	10.	10.	10.	
269	6	000.0	030.0	1978	1000.	1000.	1000.	
270		030.0	060.0	1978	100.	100.	100.	
271		060.0	090.0	1978	10.	10.	10.	
272		090.0		1978				

273	7	030.0	030.0	1978	1.
274		030.0	060.0	1978	.1
275		060.0	090.0	1978	.01
276	8	000.0	030.0	1978	1.
277		030.0	060.0	1978	.1
278		060.0	090.0	1978	.01
279	9	000.0	030.0	1978	1.
280		030.0	060.0	1978	.1
281		060.0	090.0	1978	.01
282	**				
283	GFLS	NDT3			
284	1	12			
285	0.484788	0.367159	0.301377	0.228033	0.187158 0.142052 0.117210 0.087903
286	0.071678	0.067120	0.049477	0.042216	
287	329.908	779.614	243.886	194.094	159.736 113.800 83.746 42.653
288	16.847	0.648	-21.661	-34.545	
289	**				
290	PAVDES	PAVEMENT DESIGN			
291	FACILITY	SFRVYR	BANDWIDTH	FCRECAST	
292	1	20	2	FAMSUG	
293	2	20	2	FAMSUG	
294	3	20	2	FAMSUG	
295	1	20	1	FAMSUG	
296	2	20	1	FAMSUG	
297	3	20	1	FAMSUG	
298	4	20	1	FAMSUG	
299	5	20	1	FAMSUG	
300	6	20	1	FAMSUG	
301	7	20	1	FAMSUG	
302	8	20	1	FAMSUG	
303	9	20	1	FAMSUG	
304	**				

DESCRIPTION OF SYSTEM OUTPUTS

TITLE PAGE Print the name of user, MLG-PAV, job name and TCC site. The top and bottom margin of title page is 2 and 1 inch respectively.

PRINT/INPUT Head card of input data groups

1. Listing of Default Inputs
2. Aircraft Data Group

GELS/FAMD For aircraft 1; with weight, MTOW; pavements AC/NOR, AC/SOU, CC/CTB, CC/AGB, LCF; all wheels and 1 wheel; prints the maximum horizontal stress at the bottom of each pavement layer, and the surface deflection at wheel 0., 0.

GELS/FAM Same as GELS/FAMD except all weights, MTOW, MLRW, MTDW. Under the MWFPRT page counter, a table of stresses at the critical layer and the surface deflection for all pavements is printed. GELS/FAMD and GELS/FAM are used to get a single equivalent operation of aircraft 1, weight MTOW.

GELS/HDES For aircraft 1; weight MTOW; pavements AC/NOR, AC/SOU, CC/CTB, CC/AGB, LCF; different thicknesses of design layer; different E-VALUE of subgrade support; all wheels and one wheel; prints the maximum horizontal stress at the bottom of each pavement layer and the surface deflection at wheel 0., 0. Under the MWPRT page counter, a table of stresses at the critical layer and the surface deflection for all pavements is printed.

RUN/PAVDES

1. Under ATM page counter, listing of aircraft movements which is equal to the product of average daily movements and airport distribution for each facility segment during the 20 year design service life. ATM for RW and TW stations 0. - 30., 30. - 60., and 60. - 90. is 1825000., 182500. and 18250. respectively. ATM for SH stations 0. - 30., 30. - 60., and 60. - 90. are 1825., 182.5 and 18.25 respectively.
2. Under the OPWPT page counter, lists the MTOW, MLRW and MTDW for aircraft 1.
3. Under the AND/ANS page counter, equivalent single type aircraft operation will be listed for each pavement and facility. For each pavement only the first two facility segments are printed.
4. Under the CED page counter for each pavement, the computed engineering data relating to aircraft load repetition, E-value of subgrade, deflection and stress limits, and thickness analysis for two drainage and three traffic conditions are tabulated. There are five new pavements AC/NOR, AC/SOU, CC/CTB, CC/AGB and LCF. For each new pavement there are three RW, three TW and three SH facilities having respective E-value of subgrade. Under the NORM drainage condition, the associated ESUB NORM values are 5000., 15000., and 35000. psi. The corresponding ESUB WET values are 3000., 9000., and 21000. psi respectively.

5. Under the PAV page counter, the pavement data relating to functional requirements and governing condition of design are tabulated, similar to the CED listing.

ERROR MESSAGES AND DIAGNOSTICS

The input goes through two stages of processing:

1. Identification stage in which the input data group or control card must be recognized. If it is not, then, an error message is printed. All cards are printed and the error is temporarily ignored until the next delimiter ** is encountered. If a control card is misspelled, the next data group will be flagged in error yet the program will assume as if the last card of a data group is in error.
2. Data verification in which the program prints a limited number of self-explanatory error messages. FORTRAN will print messages if the characters do not match the field, such as type of integer or floating point. FORTRAN will also print execution error messages, such as misspelled, incorrect or missing data.

Error messages printed in the system log at the beginning of each job listing can be referred to the OS 360 Manual. These messages help identify whether the program, JCL or hardware caused the error.

REFERENCES

1. Yang, Nai C., DESIGN OF FUNCTIONAL PAVEMENTS, McGraw Hill Book Co., New York, 1972.
2. Yang, Nai C., Nondestructive Evaluation of Civil Airport Pavements, FAA-RD-76-83, September 1976.
3. Yang, Nai C., Nondestructive Evaluation of Airport Pavements, Volume I, Program References, FAA-RD-78-154 I, September 1979.

AA	MM	LL	GGGGGGG	PPPPPPPPP	AAAAAA	VV
AA	MM	LL	GGGGGGGGG	PPPPPPPPP	AAAAAA	VV
AA	MM	LL	GG	PP	AA	VV
AA	MM	LL	GG	PP	AA	VV
AA	MM	LL	GG	PP	AA	VV
AA	MM	LL	GG	PP	AA	VV
AA	MM	LL	GG	PPPPPPPPP	AAAAAA	VV
AA	MM	LL	GG	PPPPPPPPP	AAAAAA	VV
AA	MM	LL	GG	PP	AA	VV
AA	MM	LL	GG	PP	AA	VV
AA	MM	LL	GG	PP	AA	VV
AA	MM	LL	GG	PP	AA	VV
AA	MM	LL	GGGGGGGGG	PP	AA	VV
AA	MM	LL	GGGGGGGGG	PP	AA	VV
AA	MM	LL	GG	PP	AA	VV
AA	MM	LL	GG	PP	AA	VV
AA	MM	LL	GGGGGGGGG	PP	AA	VV
AA	MM	LL	GGGGGGGGG	PP	AA	VV

SENSITIVITY ANALYSIS OF AIRCRAFT L-1011-1

NONDESTRUCTIVE PAVEMENT EVALUATION

A PARTIAL FULFILLMENT OF THE FAA VALIDATION PROGRAM BY NAI C. YANG AND ASSOCIATES, ENGINEERS, P. C.

THIS IS A PROPRIETARY PROGRAM DEVELOPED BY NAI C. YANG AND ASSOCIATES, ENGINEERS, PC PRIOR TO FAA VALIDATION. THE USE OF THIS COMPUTER PROGRAM SHALL BE CONFINED TO THOSE APPROVED BY NAI C. YANG, AND ALSO, THE FAA UNTIL THE PROGRAM OF NONDESTRUCTIVE EVALUATION OF CIVIL AIRPORT PAVEMENTS IS OFFICIALLY ADOPTED AND IMPLEMENTED.

USER: D. YANG SITE: TCC CREATED AT: 23:48:55 DEC 13, 1978

THE FAA UNDER THE PRESENT CONDITION ASSUMES NO RESPONSIBILITIES NOR OBLIGATIONS FROM THE USE OF THE PROGRAM AND THE INTERPRETATION OF ITS OUTPUTS

REGIONAL COST VALUES

TYPE	FACILITY	FACILITY	FACILITY	FACILITY	FACILITY	FACILITY
LANDWIDTH	CCOE1	CCOE2	RW	TH	SH	
DA	RW	TH	SH			
VEL	RW	TH	SH			
FAIRING	AIRB	ARCD	ASCCC	ASCMC	NBL	NSLP
FOURCAST	ACM	ATC				
PFLD1						
CLASS	CCOE	DVSFKL	DVSFSD	STRESS	FATIST	CGVAR
LAYCN	CCOE	EVALUE	POISSON	MGO(S)	MDO(N)	A1
LAYER	PCBT	FIAGT	CGAGT	ASCLT	HLBT	PQZBT
PAVEMENT	CCOE	LAYER	THICKNESS	EVALUE	POISSON	SFST
ITERATE	PAVEMENT	LAYER	HMIN	HMAX	HSTEP	
NEW PAVEMENT ESUB GRID EVALUES						
PAVEMENT	NUMBER	KEEL	SIDE			
PFLPAV	CCOE	LAYER	THICKNESS	EVALUE		
PFLPAV ESUB GRID EVALUES						
PFLPAV	CLASS	LAYER FOR	STR/MT			
CLASS	PFLPAV FOR	AND/ANS				
CLASS	PAVEMENT	PFLPAV FOR	AND/ANS			
PAVEMENT	PFLPAV	CLASS	LAYER FOR	STR/MT		
FACILITY AND STATION IDENTIFICATIONS						
STATISTICALLY PROCESSED NOT GROUP DATA						
ADM	ACMSUG	AVERAGE DAILY MOVEMENTS, SUGGESTED				
ATU	ATUSUG	AIRPORT TRAFFIC DISTRIBUTION, SUGGESTED				
AIRCRAFT	CCOE	MTOW	MLRW	OEW	RANGE	

HAI C. YANG, ENGINEERING CONSULTANT

MWPRT 1

SENSITIVITY ANALYSIS OF AIRCRAFT L-1011-1

MODEL PAVEMENT: AC/NOR		ASTUP	2.0	200000.	0.23
		ASBS	16.0	150000.	0.24
		AGBS	8.0	40000.	0.28
		SUB	INFI	8000.	0.34
AIRCRAFT	SURFACE DEFLECTION, WZ			STRESS AT LAYER: ASBS	
	TCW	LRW	TDW	TCW	LRW
L-1011-1	0.16022	0.13417	0.19673	64.4	55.4
	0.06957	0.05905	0.08465	66.8	57.3
				76.1	79.1
MODEL PAVEMENT: AC/SOU		ASTUP	2.0	100000.	0.25
		ASBS	20.0 <td>85000. <td>0.26</td> </td>	85000. <td>0.26</td>	0.26
		AGBS	8.0 <td>40000. <td>0.28</td> </td>	40000. <td>0.28</td>	0.28
		SUB	INFI	8000. <td>0.34</td>	0.34
AIRCRAFT	SURFACE DEFLECTION, WZ			STRESS AT LAYER: ASBS	
	TCW	LRW	TDW	TCW	LRW
L-1011-1	0.16923	0.14345	0.20628	30.6	26.0
	0.07906	0.06872	0.09418	32.4	27.5
				38.5	38.8
MODEL PAVEMENT: CC/CTB		PCC	12.0	4000000.	0.12
		CTB <td>6.0 <th>200000.</th> <th>0.23</th> </td>	6.0 <th>200000.</th> <th>0.23</th>	200000.	0.23
		SUB <td>INFI <td>8000. <td>0.34</td> </td></td>	INFI <td>8000. <td>0.34</td> </td>	8000. <td>0.34</td>	0.34
AIRCRAFT	SURFACE DEFLECTION, WZ			STRESS AT LAYER: PCC	
	TCW	LRW	TDW	TCW	LRW
L-1011-1	0.11715	0.09778	0.14462	388.8	330.8
	0.03510	0.02478	0.04264	326.3	279.2
				467.6	389.8

SENSITIVITY ANALYSIS OF AIRCRAFT L-1011-1

DESIGN CHART - DEFLECTION CRITERIA

AIRCRAFT: L-1011-1

WEIGHT: 388800.

PAVEMENT: AC/NCR	ASTCP	2.0	200000.	0.23
	ASBS	****	150000.	0.24
	AGUS	8.0	40000.	0.28
	SUB	INFI	****	

THICK./EVALUE

	3000.	5000.	9000.	15000.	21000.	35000.
4.0	0.47305	0.31089	0.19514	0.12310	0.10499	0.07537
7.0	0.43175	0.26289	0.17635	0.11950	0.09393	0.06716
10.0	0.39987	0.26228	0.16327	0.11029	0.08648	0.06169
13.0	0.37436	0.24644	0.15395	0.10425	0.08183	0.05847
16.0	0.35265	0.23295	0.14613	0.09916	0.07795	0.05573
19.0	0.33383	0.22123	0.13932	0.09491	0.07478	0.05367
22.0	0.31772	0.21136	0.13374	0.09163	0.07250	0.05235
25.0	0.30368	0.20287	0.12907	0.08901	0.07069	0.05140
28.0	0.29105	0.19529	0.12491	0.08645	0.06890	0.05040
31.0	0.27943	0.18819	0.12093	0.08396	0.06710	0.04930
34.0	0.26848	0.18144	0.11701	0.08160	0.06538	0.04820
37.0	0.25837	0.17521	0.11341	0.07933	0.06369	0.04713

SENSITIVITY ANALYSIS OF AIRCRAFT L-1011-1

DESIGN CHART - STRESS CRITERIA, LAYER ASBS

AIRCRAFT: L-1011-1

WEIGHT: 388800.

PAVEMENT: AC/NCR	ASTCP	2.0	200000.	0.23
	ASBS	****	150000.	0.24
	AGUS	8.0	40000.	0.28
	SUB	INFI	****	

THICK./EVALUE

	3000.	5000.	9000.	15000.	21000.	35000.
4.0	149.1	134.8	119.4	107.3	100.4	91.8
7.0	145.3	129.6	113.7	101.7	94.8	86.2
10.0	124.2	108.9	93.9	83.1	77.0	69.5
13.0	104.2	89.9	75.9	66.1	60.6	54.0
16.0	88.1	74.9	62.1	52.9	48.0	42.0
19.0	75.6	63.5	51.7	43.2	38.7	33.1
22.0	66.0	54.8	43.9	36.1	31.8	26.7
25.0	58.4	48.0	38.0	30.7	26.7	21.9
28.0	52.4	42.7	33.3	26.6	22.9	18.3
31.0	47.5	38.5	29.7	23.4	19.9	15.6
34.0	43.6	35.0	26.8	20.9	17.6	13.5
37.0	40.2	32.2	24.4	18.8	15.7	11.9

SENSITIVITY ANALYSIS OF AIRCRAFT L-1011-1

ATM, AIRCRAFT TRAFFIC MOVEMENTS

FACILITY	SERVYR	FORECAST	STATION FROM-TO	L-1011-1
KN 15	20	FAMSUG	0.- 30.	TCW:1.825E 06 LRW:1.825E 06 TDW:1.825E 06
KN 15	20	FAMSUG	30.- 60.	TCW:1.825E 05 LRW:1.825E 05 TDW:1.825E 05
KN 15	20	FAMSUG	60.- 90.	TCW:1.825E 04 LRW:1.825E 04 TDW:1.825E 04
KN 35	20	FAMSUG	0.- 30.	TCW:1.825E 06 LRW:1.825E 06 TDW:1.825E 06
KN 35	20	FAMSUG	30.- 60.	TCW:1.825E 05 LRW:1.825E 05 TDW:1.825E 05
KN 35	20	FAMSUG	60.- 90.	TCW:1.825E 04 LRW:1.825E 04 TDW:1.825E 04
IN 5	20	FAMSUG	0.- 30.	TCW:1.825E 06 LRW:1.825E 06 TDW:0.0
IN 5	20	FAMSUG	30.- 60.	TCW:1.825E 05 LRW:1.825E 05 TDW:0.0
IN 5	20	FAMSUG	60.- 90.	TCW:1.825E 04 LRW:1.825E 04 TDW:0.0
IN 15	20	FAMSUG	0.- 30.	TCW:1.825E 06 LRW:1.825E 06 TDW:0.0
IN 15	20	FAMSUG	30.- 60.	TCW:1.825E 05 LRW:1.825E 05 TDW:0.0
IN 15	20	FAMSUG	60.- 90.	TCW:1.825E 04 LRW:1.825E 04 TDW:0.0

SENSITIVITY ANALYSIS OF AIRCRAFT L-1011-1

OPERATIONAL AIRCRAFT WEIGHTS

AIRCRAFT	CODE	RANGE	LOAD FACTOR	TOW	LRW	TOW
1	L-1011-1	LGNG		388800.	322200.	483300.

HAI L. YANG, ENGINEERING CONSULTANT

AND/AAS 1

SENSITIVITY ANALYSIS OF AIRCRAFT L-1011-1

EQUIVALENT SINGLE TYPE AIRCRAFT OPERATION

E-0 AIRCRAFT: L-1011-1
 WEIGHT: 388000. LBS
 CLASS: L/AC/NCR
 FACILITY: R4 5
 FORECAST: FAMSUG
 YEAR: 2C

STATIONS C. TO 30. LOCATION: KEEL

L-1011-1	DEFLECTION CRITERIA			AND			STRESS CRITERIA			AANS		
	TDW	LRW	TCW	TDW	LRW	TCW	TDW	LRW	TCW	TDW	LRW	TCW
1-CE 00 5.2E-01 1.8E 00 7.2E 05 9.5E 04 1.2E 04	1.0E 00	5.2E-01	1.8E 00	7.2E 05	9.5E 04	1.2E 04	1.0E 00	2.6E-01	5.8E 00	7.2E 05	1.7E 05	1.2E 04
										7.2E 05	1.7E 05	1.2E 04

STATIONS 30. TO 40. LOCATION: KEEL

L-1011-1	DEFLECTION CRITERIA			AND			STRESS CRITERIA			AANS		
	TDW	LRW	TCW	TDW	LRW	TCW	TDW	LRW	TCW	TDW	LRW	TCW
1-CE 00 5.2E-01 1.8E 00 7.2E 04 9.5E 03 8.0E 02	1.0E 00	5.2E-01	1.8E 00	7.2E 04	9.5E 03	8.0E 02	1.0E 00	2.6E-01	5.8E 00	7.2E 04	1.7E 04	1.2E 03
										7.2E 04	1.7E 04	1.2E 03

SENSITIVITY ANALYSIS OF AIRCRAFT L-1011-1

SUMMARY OF AIRCRAFT FORECAST, FUNCTIONAL LIMITS AND THICKNESS ANALYSIS

EQUIVALENT AIRCRAFT OPERATION: L-1011-1 WEIGHT: 388000. LBS

PAVEMENT MODEL: CODE LAYER THICKNESS EVALUATION POISSON UNIT-PRICE

AC/NOR ASTOP 2.0 200000. C.23
ASBS *** 150000. C.24
AGBS 8.0 40000. C.28
SUB INFI *** C.34

FOR ESUB NORM AND FAN DEFINED

FACILITY	STATION FROM-TO	LOC	ESUB NCRM	AANS	AAND	LIMIT DEF/MZ	LIMIT STRESS ASBS	DESIGN SERVICE YEARS	THICKNESS OF ASUS LAYER			
									FAN/2	FAN/2	FAN/2	FAN/2
									NCRM	NCRM	NCRM	NET
									NCRM	NCRM	NCRM	NET
KM 5	0-30	KEEL	5000.	902088.	828211.	0.2243	86.8	20	18.2	16.7	15.8	28.4
	30-60	KEEL	5000.	90209.	82444.	0.2461	102.2	20	13.1	11.6	14.7	22.0
	60-90	KEEL	5000.	9021.	8210.	0.2757	117.5	20	8.8	8.1	9.5	15.5
	0-30	SIDE	5000.	9539.	8282.	0.4115	148.2	20	4.0	4.0	4.0	7.4
	30-60	SIDE	5000.	954.	824.	0.4770	167.6	20	4.0	4.0	4.0	4.0
KM 15	0-30	KEEL	15000.	902088.	828211.	0.1295	86.8	20	5.4	8.7	10.2	11.2
	30-60	KEEL	15000.	90209.	82444.	0.1421	102.2	20	6.7	4.3	7.7	8.7
	60-90	KEEL	15000.	9021.	8210.	0.1592	117.5	20	4.0	4.0	4.0	5.0
	0-30	SIDE	15000.	9539.	8282.	0.2376	148.2	20	4.0	4.0	4.0	4.0
	30-60	SIDE	15000.	954.	824.	0.2754	167.6	20	4.0	4.0	4.0	4.0
KM 35	0-30	KEEL	35000.	902088.	828211.	0.0848	86.8	20	6.7	4.2	7.7	8.3
	30-60	KEEL	35000.	90209.	82444.	0.0950	102.2	20	4.0	4.0	4.0	4.0
	60-90	KEEL	35000.	9021.	8210.	0.1042	117.5	20	4.0	4.0	4.0	4.0
	0-30	SIDE	35000.	9539.	8282.	0.1555	148.2	20	4.0	4.0	4.0	4.0
	30-60	SIDE	35000.	954.	824.	0.1803	167.6	20	4.0	4.0	4.0	4.0
KM 55	0-30	KEEL	5000.	529556.	486555.	0.2288	90.4	20	17.1	15.5	19.6	27.0
	30-60	KEEL	5000.	52996.	48376.	0.2521	105.7	20	11.9	10.3	13.5	20.6
	60-90	KEEL	5000.	5300.	4820.	0.2843	121.0	20	8.2	7.6	8.9	14.0
	0-30	SIDE	5000.	5604.	4866.	0.4242	152.7	20	4.0	4.0	4.0	4.0
	30-60	SIDE	5000.	560.	484.	0.4972	172.0	20	4.0	4.0	4.0	4.0
KM 75	0-30	KEEL	5000.	56.	48.	0.6275	151.4	20	4.0	4.0	4.0	4.0
	30-60	KEEL	5000.	56.	48.	0.6275	151.4	20	4.0	4.0	4.0	4.0
	60-90	KEEL	5000.	56.	48.	0.6275	151.4	20	4.0	4.0	4.0	4.0
	0-30	SIDE	5000.	56.	48.	0.6275	151.4	20	4.0	4.0	4.0	4.0
	30-60	SIDE	5000.	56.	48.	0.6275	151.4	20	4.0	4.0	4.0	4.0

SENSITIVITY ANALYSIS OF AIRCRAFT L-1011-1

SUMMARY OF AIRCRAFT FORECAST, FUNCTIONAL LIMITS AND THICKNESS ANALYSIS

EQUIVALENT AIRCRAFT OPERATION: L-1011-1 WEIGHT: 388800. LBS

PAVEMENT MODEL: CCCE LAYER THICKNESS EVALUATION PCISSON UNIT-PRICE

AC/SOU ASTUP 2.0 100000. C.25
 ASBS *** 85000. C.20
 AGBS 8.0 40000. C.28
 SUB INFI **** C.34

FALLITY	STATION FROM-TO	LOC	ESUB NCRM	AANS	AAND	DEF/WZ	LIMIT STRESS ASBS	DESIGN SERVICE YEARS	THICKNESS OF ASBS LAYER							
									FAM		FAM/2		FAM/2		FAM/2	
									NCRM	NET	NCRM	NET	NCRM	NET	NCRM	NET
FOR ESUB NCRM AND FAM DEFINED																
RM 5	0.- 30.	KEEL	5000.	993644.	861637.	0.2129	64.9	20	31.2	28.7	33.5	38.5	38.5			
RM 5	30.- 60.	KEEL	5000.	993644.	85845.	0.2335	76.4	20	22.6	20.1	25.2	34.1	34.1			
RM 5	60.- 90.	KEEL	5000.	99364.	8554.	0.2615	87.9	20	14.6	12.2	17.0	24.6	24.6			
RM 5	0.- 30.	SIDE	5000.	10477.	8616.	0.3503	111.0	20	4.0	4.0	4.0	4.0	4.0			
RM 5	30.- 60.	SIDE	5000.	1048.	858.	0.4521	125.5	20	4.0	4.0	4.0	4.0	4.0			
RM 5	60.- 90.	SIDE	5000.	105.	86.	0.5571	140.1	20	4.0	4.0	4.0	4.0	4.0			
RM 15	0.- 30.	KEEL	15000.	993644.	861637.	0.1229	64.9	20	10.7	9.3	12.4	16.4	16.4			
RM 15	30.- 60.	KEEL	15000.	99364.	85845.	0.1348	76.4	20	6.5	5.3	7.6	12.0	13.5			
RM 15	60.- 90.	KEEL	15000.	9936.	8554.	0.1510	87.9	20	4.0	4.0	4.0	6.5	8.0			
RM 15	0.- 30.	SIDE	15000.	10477.	8616.	0.2254	111.0	20	4.0	4.0	4.0	4.0	4.0			
RM 15	30.- 60.	SIDE	15000.	1048.	858.	0.2610	125.5	20	4.0	4.0	4.0	4.0	4.0			
RM 15	60.- 90.	SIDE	15000.	105.	86.	0.3216	140.1	20	4.0	4.0	4.0	4.0	4.0			
RM 35	0.- 30.	KEEL	35000.	993644.	861637.	0.0805	64.9	20	5.7	4.7	6.7	7.5	9.1			
RM 35	30.- 60.	KEEL	35000.	99364.	85845.	0.0882	76.4	20	4.0	4.0	4.0	4.3	5.5			
RM 35	60.- 90.	KEEL	35000.	9936.	8554.	0.0588	87.9	20	4.0	4.0	4.0	4.0	4.0			
RM 35	0.- 30.	SIDE	35000.	10477.	8616.	0.1475	111.0	20	4.0	4.0	4.0	4.0	4.0			
RM 35	30.- 60.	SIDE	35000.	1048.	858.	0.1705	125.5	20	4.0	4.0	4.0	4.0	4.0			
RM 35	60.- 90.	SIDE	35000.	105.	86.	0.2106	140.1	20	4.0	4.0	4.0	4.0	4.0			
RM 5	0.- 30.	KEEL	5000.	583743.	506192.	0.2171	67.6	20	25.3	26.7	31.6	38.5	38.5			
RM 5	30.- 60.	KEEL	5000.	58374.	50382.	0.2391	79.1	20	20.7	18.2	23.2	32.0	34.7			
RM 5	60.- 90.	KEEL	5000.	5837.	5022.	0.2696	90.6	20	12.8	10.4	15.2	22.2	25.3			
RM 5	0.- 30.	SIDE	5000.	6155.	5062.	0.4023	114.3	20	4.0	4.0	4.0	4.0	4.0			
RM 5	30.- 60.	SIDE	5000.	616.	504.	0.4711	128.9	20	4.0	4.0	4.0	4.0	4.0			
RM 5	60.- 90.	SIDE	5000.	62.	50.	0.5937	143.5	20	4.0	4.0	4.0	4.0	4.0			

SENSITIVITY ANALYSIS OF AIRCRAFT L-1011-1

SUMMARY OF AIRCRAFT FORECAST, FUNCTIONAL LIMITS AND THICKNESS ANALYSIS

EQUIVALENT AIRCRAFT OPERATION: L-1011-1 WEIGHT: 308000. LBS

PAVEMENT MODEL: CODE LAYER THICKNESS EVALUATE POISSON UNIT-PRICE

CC/CTB PCC **** 4000000. C.12
 CTB 6.0 200000. C.23
 SUB INFI ***** G.34

FOR ESUB NORM AND FAP DEFINED

FACILITY	STATION FROM-TO	LOC	ESUB NCRM	AANS	AAND	DEF/WZ	LIMIT	DESIGN STRESS PCC	SERVICE YEARS	THICKNESS OF PCC LAYER			
										FAM NCRM	FAM#2 NCRM	FAM WEI	FAM#2 WEI
M# 5	0- 30.	KEEL	5000.	840312.	825781.	0.3564	330.6	20	15.9	15.2	16.6	18.5	17.7
	30- 60.	KEEL	5000.	84031.	82169.	0.3511	383.3	20	13.8	13.3	14.4	16.0	15.4
	60- 90.	KEEL	5000.	8403.	8180.	0.4483	436.0	20	12.2	11.8	12.7	14.1	13.7
	0- 30.	SIDE	5000.	8429.	8258.	0.7314	551.7	20	5.7	9.3	10.0	11.2	10.8
	30- 60.	SIDE	5000.	843.	822.	0.8478	618.4	20	8.6	8.3	8.5	9.5	9.6
M# 5	60- 90.	SIDE	5000.	84.	82.	1.0466	685.1	20	8.0	8.0	8.0	8.5	8.6
M# 15	0- 30.	KEEL	15000.	840312.	825781.	0.2058	330.6	20	11.9	11.4	12.4	13.5	12.5
	30- 60.	KEEL	15000.	84031.	82169.	0.2258	383.3	20	10.4	10.0	10.8	11.8	11.4
	60- 90.	KEEL	15000.	8403.	8180.	0.2531	436.0	20	9.1	8.8	9.5	10.5	10.1
	0- 30.	SIDE	15000.	8429.	8258.	0.4223	551.7	20	8.0	8.0	8.0	8.2	8.0
	30- 60.	SIDE	15000.	843.	822.	0.4895	618.4	20	8.0	8.0	8.0	8.0	8.0
M# 15	60- 90.	SIDE	15000.	84.	82.	0.6043	685.1	20	8.0	8.0	8.0	8.0	8.0
M# 35	0- 30.	KEEL	35000.	840312.	825781.	0.1347	330.6	20	5.7	5.3	10.1	10.5	11.4
	30- 60.	KEEL	35000.	84031.	82169.	0.1478	383.3	20	8.4	8.0	8.7	5.5	5.2
	60- 90.	KEEL	35000.	8403.	8180.	0.1657	436.0	20	8.0	8.0	8.0	8.4	8.1
	0- 30.	SIDE	35000.	8429.	8258.	0.2764	551.7	20	6.0	8.0	8.0	6.0	6.0
	30- 60.	SIDE	35000.	843.	822.	0.3205	618.4	20	8.0	8.0	8.0	8.0	8.0
M# 35	60- 90.	SIDE	35000.	84.	82.	0.4956	685.1	20	8.0	8.0	8.0	6.0	6.0
M# 5	0- 30.	KEEL	5000.	493864.	485127.	0.3636	342.7	20	15.3	14.7	16.0	17.6	17.1
	30- 60.	KEEL	5000.	49386.	48210.	0.4006	359.4	20	13.4	12.9	13.9	15.6	15.0
	60- 90.	KEEL	5000.	4937.	4802.	0.4519	448.2	20	11.9	11.5	12.3	13.8	13.2
	0- 30.	SIDE	5000.	4952.	4851.	0.7535	567.1	20	5.4	9.1	9.8	10.5	10.3
	30- 60.	SIDE	5000.	495.	482.	0.8837	633.8	20	8.3	8.1	8.6	9.7	9.3
M# 5	60- 90.	SIDE	5000.	50.	48.	1.1163	700.5	20	8.0	8.0	8.0	8.7	8.5

SENSITIVITY ANALYSIS OF AIRCRAFT L-1011-1

SUMMARY OF AIRCRAFT FORECAST, FUNCTIONAL LIMITS AND THICKNESS ANALYSIS

EQUIVALENT AIRCRAFT OPERATION: L-1011-1 WEIGHT: 386800. LBS

PAVEMENT ACCEL: CCDE LAYER THICKNESS EVALUATION PCISSON UNIT-PRICE

CC/AGB PCC *** 4000000. C-12
AGBS 8.0 40000. C-28
SSBS 8.0 20000. C-31
SUB INFI +++ C-34

FOR ESUB NUMM AND FAN DEFINED

FACILITY	STATION	LOC	ESUB	AANS	AAND	DEF/MZ	LIMIT	DESIGN	SERVICE	THICKNESS OF PCC				THICKNESS OF PCC			
										FAM	FAM/2	FAM/2	FAM/2	FAM	FAM/2	FAM/2	FAM/2
										NGRM	NGRM	NGRM	NGRM	NGRM	NGRM	NGRM	NGRM
AM 5	0.- 30.	KEEL	5000.	838646.	826953.	0.3648	330.6	20	20	16.5	15.6	17.2	18.5	16.5	16.2	15.5	15.5
AM 5	30.- 60.	KEEL	5000.	83865.	82300.	0.4003	383.3	20	20	14.4	13.5	15.0	16.6	15.5	15.5	17.2	17.2
AM 5	60.- 90.	KEEL	5000.	8386.	8194.	0.4486	436.0	20	20	12.9	12.5	13.3	14.7	14.2	14.2	15.2	15.2
AM 5	0.- 30.	SIDE	5000.	8551.	8270.	0.7486	551.2	20	20	10.4	10.1	10.8	11.8	11.4	11.4	12.2	12.2
AM 5	30.- 60.	SIDE	5000.	855.	823.	0.8678	617.9	20	20	5.4	9.1	9.7	10.6	10.3	10.3	10.5	10.5
AM 5	60.- 90.	SIDE	5000.	86.	82.	1.0711	684.7	20	20	8.5	8.3	8.8	9.6	9.2	9.2	9.5	9.5
AM 15	0.- 30.	KEEL	15000.	838646.	826953.	0.2106	330.6	20	20	12.5	12.4	13.4	14.2	13.7	13.7	14.5	14.5
AM 15	30.- 60.	KEEL	15000.	83865.	82300.	0.2311	383.3	20	20	11.5	11.1	11.6	12.6	12.2	12.2	13.1	13.1
AM 15	60.- 90.	KEEL	15000.	8386.	8194.	0.2540	436.0	20	20	10.3	10.0	10.6	11.3	11.0	11.0	11.7	11.7
AM 15	0.- 30.	SIDE	15000.	8551.	8270.	0.4322	551.2	20	20	8.5	8.2	8.7	9.2	8.5	8.5	9.5	9.5
AM 15	30.- 60.	SIDE	15000.	855.	823.	0.5010	617.9	20	20	8.0	8.0	8.0	8.4	8.1	8.1	8.6	8.6
AM 15	60.- 90.	SIDE	15000.	86.	82.	0.6184	684.7	20	20	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
AM 35	0.- 30.	KEEL	35000.	838646.	826953.	0.1379	330.6	20	20	11.4	11.0	11.8	12.2	11.6	11.6	12.1	12.1
AM 35	30.- 60.	KEEL	35000.	83865.	82300.	0.1513	383.3	20	20	10.2	9.8	10.5	10.8	10.5	10.5	11.2	11.2
AM 35	60.- 90.	KEEL	35000.	8386.	8194.	0.1646	436.0	20	20	9.2	8.5	9.5	9.8	9.5	9.5	10.1	10.1
AM 35	0.- 30.	SIDE	35000.	8551.	8270.	0.2825	551.2	20	20	8.0	8.0	8.0	8.1	8.0	8.0	8.3	8.3
AM 35	30.- 60.	SIDE	35000.	855.	823.	0.3280	617.9	20	20	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
AM 35	60.- 90.	SIDE	35000.	86.	82.	0.4048	684.7	20	20	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
AM 5	0.- 30.	KEEL	5000.	492686.	485816.	0.3722	342.8	20	20	15.9	15.3	16.6	18.3	17.6	17.6	18.5	18.5
AM 5	30.- 60.	KEEL	5000.	49269.	48289.	0.4101	395.5	20	20	14.0	13.6	14.6	16.1	15.5	15.5	16.7	16.7
AM 5	60.- 90.	KEEL	5000.	4927.	4810.	0.4625	448.2	20	20	12.6	12.2	13.0	14.3	13.5	13.5	14.8	14.8
AM 5	0.- 30.	SIDE	5000.	5023.	4858.	0.7717	566.6	20	20	10.2	9.8	10.5	11.3	11.1	11.1	11.5	11.5
AM 5	30.- 60.	SIDE	5000.	502.	483.	0.9044	633.4	20	20	5.2	8.9	9.5	10.3	10.3	10.3	10.7	10.7
AM 5	60.- 90.	SIDE	5000.	50.	48.	1.1424	700.1	20	20	8.4	8.1	8.6	9.4	9.4	9.4	9.7	9.7

SENSITIVITY ANALYSIS OF AIRCRAFT L-1011-1

SUMMARY OF AIRCRAFT FORECAST, FUNCTIONAL LIMITS AND THICKNESS ANALYSIS

EQUIVALENT AIRCRAFT OPERATION: L-1011-1 WEIGHT: 388000. LBS

PAVEMENT MODEL: CODE LAYER THICKNESS EVALUATION POISSON UNIT-PRICE

LCF ASTOP 4.0 230000. C.23
 LCFA 8.0 1100000. C.17
 LCFB 8.0 600000. C.19
 LCFC 8.0 400000. C.20
 SUB INFI +++ G.34

FACILITY	STATION FROM-TO	LOC	ESUB NCRM	AANS	AAND	LIMIT DEF/WZ	LIMIT STRESS LCFC	DESIGN SERVICE YEARS	THICKNESS OF LCFA LAYER							
									FAM		FAM/2		FAP		FAP/2	
									NORM	NCRM	NORM	NCRM	NORM	NCRM	NORM	NCRM
Km 5	0- 30	KEEL	5C00	848840	835636	0.3015	82.9	20	5.2	8.1	10.5	13.2	11.5	14.6		
Km 5	30- 60	KEEL	5C00	848840	83209	0.3308	99.7	20	6.0	5.1	6.8	5.3	6.3	10.3		
Km 5	60- 90	KEEL	5C00	848840	8288	0.3707	116.5	20	3.5	3.0	4.2	6.4	5.6	7.2		
Km 5	0- 30	SIDE	5C00	8839	8356	0.6032	147.0	20	2.0	2.0	2.0	2.7	2.0	3.3		
Km 5	30- 60	SIDE	5C00	884	832	0.6591	168.3	20	2.0	2.0	2.0	2.0	2.0	2.0		
Km 5	60- 90	SIDE	5000	88	83	0.8625	189.5	20	2.0	2.0	2.0	2.0	2.0	2.0		
Km 15	0- 30	KEEL	15C00	848840	835636	0.1741	82.9	20	2.7	2.0	3.5	5.5	4.6	6.5		
Km 15	30- 60	KEEL	15C00	848840	83209	0.1510	99.7	20	2.0	2.0	2.0	2.8	2.2	3.5		
Km 15	60- 90	KEEL	15C00	848840	8288	0.2140	116.5	20	2.0	2.0	2.0	2.0	2.0	2.0		
Km 15	0- 30	SIDE	15C00	8839	8356	0.3483	147.0	20	2.0	2.0	2.0	2.0	2.0	2.0		
Km 15	30- 60	SIDE	15C00	884	832	0.4036	168.3	20	2.0	2.0	2.0	2.0	2.0	2.0		
Km 15	60- 90	SIDE	15000	88	83	0.4580	189.5	20	2.0	2.0	2.0	2.0	2.0	2.0		
Km 35	0- 30	KEEL	35C00	848840	835636	0.1140	82.9	20	2.0	2.0	2.0	2.0	2.0	2.0		
Km 35	30- 60	KEEL	35C00	848840	83209	0.1250	99.7	20	2.0	2.0	2.0	2.0	2.0	2.0		
Km 35	60- 90	KEEL	35C00	848840	8288	0.1401	116.5	20	2.0	2.0	2.0	2.0	2.0	2.0		
Km 35	0- 30	SIDE	35C00	8839	8356	0.2280	147.0	20	2.0	2.0	2.0	2.0	2.0	2.0		
Km 35	30- 60	SIDE	35C00	884	832	0.2642	168.3	20	2.0	2.0	2.0	2.0	2.0	2.0		
Km 35	60- 90	SIDE	35000	88	83	0.3260	189.5	20	2.0	2.0	2.0	2.0	2.0	2.0		
Km 5	0- 30	KEEL	5000	498674	490917	0.3076	86.8	20	8.4	7.4	9.5	12.2	10.5	13.5		
Km 5	30- 60	KEEL	5C00	498674	48828	0.3388	103.6	20	5.3	4.6	6.2	8.5	7.6	5.5		
Km 5	60- 90	KEEL	5000	4987	4866	0.3821	120.3	20	3.1	2.5	3.7	5.8	5.1	6.5		
Km 5	0- 30	SIDE	5000	5193	4909	0.6218	151.9	20	2.0	2.0	2.0	2.2	2.0	2.0		
Km 5	30- 60	SIDE	5000	519	488	0.7286	173.2	20	2.0	2.0	2.0	2.0	2.0	2.0		
Km 5	60- 90	SIDE	5000	52	49	0.9197	194.5	20	2.0	2.0	2.0	2.0	2.0	2.0		

SENSITIVITY ANALYSIS OF AIRCRAFT L-1011-1

LISTING OF PAVEMENT DESIGN AND COST ANALYSIS

EQUIVALENT AIRCRAFT OPERATION: L-1011-1 WEIGHT: 388800. LBS

PAVEMENT MODEL: CCCE LAYER THICKNESS EVALUATE POISSON UNIT-PRICE

AC/NOR ASTOP 2.0 200000. C.23
ASBS *** 150000. C.24
AGBS 8.0 40000. C.28
SUB INF1 **** C.34

FACILITY	STATION FROM-TU	LCC	DI	VEL	ESUR NCRM	AIRPORT NAVIGATION SYSTEM	FORECAST DESIGN			ICC	PCV THICKNESS
							AIRCRAFT MOVEMENT	SERVICE YEARS	FUNCTION GOVERNED		
RM 5	0.- 30.	KEEL 0.12	145.	145.	5000.	LIGHTS/ILS	FAMSUG	20	DEF/DI		12.2
	30.- 60.	KEEL 0.12	145.	145.	5000.	LIGHTS/ILS	FAMSUG	20	DEF/DI		13.1
	60.- 90.	KEEL 0.12	145.	145.	5000.	LIGHTS/ILS	FAMSUG	20	STR/MT		8.8
	0.- 30.	SIDE 0.18	145.	145.	5000.	LIGHTS/ILS	FAMSUG	20	STR/MT		4.0
	30.- 60.	SIDE 0.18	145.	145.	5000.	LIGHTS/ILS	FAMSUG	20	STR/MT		4.0
RM 5	60.- 90.	SIDE 0.18	145.	145.	5000.	LIGHTS/ILS	FAMSUG	20	STR/MT		4.0
	0.- 30.	KEEL 0.12	145.	145.	15000.	LIGHTS/ILS	FAMSUG	20	STR/MT		9.4
	30.- 60.	KEEL 0.12	145.	145.	15000.	LIGHTS/ILS	FAMSUG	20	STR/MT		6.7
	60.- 90.	KEEL 0.12	145.	145.	15000.	LIGHTS/ILS	FAMSUG	20	STR/MT		4.0
	0.- 30.	SIDE 0.18	145.	145.	15000.	LIGHTS/ILS	FAMSUG	20	STR/MT		4.0
RM 5	30.- 60.	SIDE 0.18	145.	145.	15000.	LIGHTS/ILS	FAMSUG	20	STR/MT		4.0
	60.- 90.	SIDE 0.18	145.	145.	15000.	LIGHTS/ILS	FAMSUG	20	STR/MT		4.0
	0.- 30.	KEEL 0.12	145.	145.	35000.	LIGHTS/ILS	FAMSUG	20	STR/MT		6.7
	30.- 60.	KEEL 0.12	145.	145.	35000.	LIGHTS/ILS	FAMSUG	20	STR/MT		4.0
	60.- 90.	KEEL 0.12	145.	145.	35000.	LIGHTS/ILS	FAMSUG	20	STR/MT		4.0
RM 5	0.- 30.	SIDE 0.18	145.	145.	35000.	LIGHTS/ILS	FAMSUG	20	STR/MT		4.0
	30.- 60.	SIDE 0.18	145.	145.	35000.	LIGHTS/ILS	FAMSUG	20	STR/MT		4.0
	60.- 90.	SIDE 0.18	145.	145.	35000.	LIGHTS/ILS	FAMSUG	20	STR/MT		4.0
	0.- 30.	KEEL 0.12	145.	145.	5000.	NORM/VISUAL	FAMSUG	20	DEF/DI		17.1
	30.- 60.	KEEL 0.12	145.	145.	5000.	NORM/VISUAL	FAMSUG	20	DEF/DI		11.9
RM 5	60.- 90.	KEEL 0.12	145.	145.	5000.	NORM/VISUAL	FAMSUG	20	STR/MT		8.2
	0.- 30.	SIDE 0.18	145.	145.	5000.	NORM/VISUAL	FAMSUG	20	STR/MT		4.0
	30.- 60.	SIDE 0.18	145.	145.	5000.	NORM/VISUAL	FAMSUG	20	STR/MT		4.0
	60.- 90.	SIDE 0.18	145.	145.	5000.	NORM/VISUAL	FAMSUG	20	STR/MT		4.0
	0.- 30.	KEEL 0.12	145.	145.	5000.	NORM/VISUAL	FAMSUG	20	STR/MT		4.0

APPENDIX 1 OS 360 JOB CONTROL CARDS FOR OPERATION AT TCC

The program set-ups consist of a single procedure, MLGPAV. The procedure may be stored on a permanent data set and referenced through use of the PROCLIB DD card. If not stored, then an instream procedure on cards is necessary. The following is the deck necessary for executing the MLGPAV program at TCC:

```
//JOBNAME JOB
Instream procedure or //PROCLIB DD
// EXEC MLGPAV, TIME.MLGPAV=150
//MLGPAV.INPUT DD *
Job card
Aircraft data group
/*
```

The procedures assume the load module data set, DYLM and the default input data set, DYDT are on a single removable 3330 disk pack D0012. Several temporary data sets, as required, are allocated on any 2 available scratch packs. The temporary data sets may be placed on the pack, D00012, but the wall clock execution time will increase due to arm contention.

JOB CONTROL CARDS

```
//MLGPAV PROC
//MLGPAV EXEC PGM=GOL,REGION=290K
//STEPLIB DD DSN=SYSDA,DISP=SHR,UNIT=3330,
// VOL=(PRIVATE,RETAIN,,,SER=D00012)
//FT03F001 DD DSN=DYDT,DISP=SHR,UNIT=3330,VOL=SER=D00012
//FT04F001 DD DDNAME=INPUT
//FT05F001 DD UNIT=(SYSDA,SEP=STEPLIB),VOL=(PRIVATE,RETAIN),
// SPACE=(CYL,(2,2)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT06F001 DD SYSOUT=A
//FT07F001 DD UNIT=SYSDA,VOL=REF=*.FT05F001,
// SPACE=(CYL,(2,2)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT08F001 DD UNIT=SYSDA,VOL=REF=*.FT05F001,
// SPACE=(CYL,(2,2)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT09F001 DD UNIT=(SYSDA,SEP=(STEPLIB,FT05F001)),VOL=(PRIVATE,RETAIN),
// SPACE=(CYL,(1,1)),DCB=(RECFM=VSB,LRECL=1284,BLKSIZE=2572)
//FT10F001 DD UNIT=SYSDA,VOL=REF=*.FT05F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=VSB,LRECL=1284,BLKSIZE=2572)
//FT11F001 DD UNIT=3330,VOL=SER=D00012,
// SPACE=(CYL,(2,2)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT12F001 DD UNIT=SYSDA,VOL=REF=*.FT09F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=VSB,LRECL=1284,BLKSIZE=2572)
//FT13F001 DD UNIT=3330,VOL=SER=D00012,
// SPACE=(CYL,(2,2)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT14F001 DD UNIT=SYSDA,VOL=REF=*.FT05F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=VSB,LRECL=1284,BLKSIZE=2572)
//FT15F001 DD DUMMY
```

```

//FT16F001 DD UNIT=SYSDA,VOL=REF=*.FT09F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=VSB,LRECL=1284,BLKSIZE=2572)
//FT17F001 DD UNIT=SYSDA,VOL=REF=*.FT09F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=VSB,LRECL=1284,BLKSIZE=2572)
//FT18F001 DD UNIT=SYSDA,VOL=REF=*.FT09F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=VSB,LRECL=1284,BLKSIZE=2572)
//FT19F001 DD UNIT=SYSDA,VOL=REF=*.FT09F001,
// SPACE=(CYL,(2,2)),DCB=(RECFM=VSB,LRECL=1284,BLKSIZE=2572)
//FT20F001 DD UNIT=SYSDA,VOL=REF=*.FT09F001,
// SPACE=(CYL,(2,2)),DCB=(RECFM=VSB,LRECL=1284,BLKSIZE=2572)
//FT21F001 DD UNIT=SYSDA,VOL=REF=*.FT09F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT22F001 DD UNIT=SYSDA,VOL=REF=*.FT09F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT23F001 DD UNIT=SYSDA,VOL=REF=*.FT09F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT24F001 DD UNIT=SYSDA,VOL=REF=*.FT09F001,
// SPACE=(CYL,(2,2)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT25F001 DD UNIT=SYSDA,VOL=REF=*.FT09F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT26F001 DD UNIT=SYSDA,VOL=REF=*.FT09F001,
// SPACE=(CYL,(2,2)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT27F001 DD UNIT=SYSDA,VOL=REF=*.FT09F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT28F001 DD UNIT=SYSDA,VOL=REF=*.FT09F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT29F001 DD UNIT=SYSDA,VOL=REF=*.FT09F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT30F001 DD UNIT=SYSDA,VOL=REF=*.FT09F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT31F001 DD UNIT=SYSDA,VOL=REF=*.FT05F001,
// SPACE=(CYL,(1,1)),DCB=(RECFM=FB,LRECL=80,BLKSIZE=800)
//FT32F001 DD UNIT=SYSDA,VOL=REF=*.FT05F001,
// SPACE=(CYL,(4,4)),DCB=(RECFM=VSB,LRECL=1284,BLKSIZE=2572)
// PEND

```

APPENDIX 2

BASIC FORTRAN LISTING

- A2.05 SUBROUTINE NDT3
 Compute NDT inventory file
- A2.06 SUBROUTINE CALC(1)
 Compute Poisson's Ratio, and aircraft operational weights
- A2.07 SUBROUTINE CALC(2)
 Longitudinal and transverse wheel probability distribution
- A2.08 SUBROUTINE PAVDES
 Equivalent single type aircraft operation and unit price
 of pavement components
- A2.09 SUBROUTINE FAM
 Forecast of aircraft movement for equivalency computation
- A2.10 SUBROUTINE HDES
 Limiting stress and deflection in pavement thickness design
- A2.11 SUBROUTINE PCVCAL
 Compute present cash value

A2.05 Subroutine NDT3

```

101      DO 600 J=1,ISEPAV
102      IF(K.NE.1PFL(J))GO TO 600

104      WZ=2.*200.*S.*VALC(KP,10)/SEVAL(J)
105      IF(WZ.LT.WZH(1,1))GO TO 520
106      EV=PFLESG(1)*.75
107      GO TO 540
108  520 DO 530 I=2,NFLESG
109      IF(WZ.LT.WZH(1,I))GO TO 520
110      EV=(PFLESG(I)-PFLESG(I-1))*(WZ-WZH(1,I-1))
111      +/(WZH(1,I)-WZH(1,I-1))+PFLESG(I-1)
112      GO TO 540
113  530 CONTINUE
114      EV=PFLESG(NFLESG)*1.25
115  540 IF(MDRAIN(J).EQ.MNORM)GO TO 550
116      IS=J
117      IP=ISEPAV+J
118      EPAV(IP)=SEVAL(J)
119      ESUB(IP)=EV
120      ESUB(J)=EV/.6
121      GO TO 560
122  550 IS=ISEPAV+J
123      EPAV(J)=SEVAL(J)
124      ESUB(J)=EV
125      IP=ISEPAV+J
126      ESUB(IP)=.6*EV
127  560 IF(ESUB(IS).GT.PFLESG(1))GO TO 570
128      WZA=WZH(1,1)+.25*(WZH(1,1)-WZH(1,2))
129      GO TO 590
130  570 DO 580 I=2,NFLESG
131      IF(ESUB(IS).GT.PFLESG(I))GO TO 580
132      WZA=(WZH(1,I)-WZH(1,I-1))*(ESUB(IS)-PFLESG(I-1))
133      +/(PFLESG(I)-PFLESG(I-1))+WZH(1,I-1)
134      GO TO 590
135  580 CONTINUE
136      WZA=WZH(1,NFLESG)+.25*(WZH(1,NFLESG)-WZH(1,NFLESG))
137  590 EPAV(IS)=SEVAL(J)*WZ/WZA
138  600 CONTINUE

```

A2.06 Subroutine CALC(1)

```

123 C *** APY
124 APY(I)=0.
125 N=NHHEEL(I)
126 DO 420 J=1,N
127 IF(WHEELX(I,J).NE.0.)GO TO 420
128 APY(I)=APY(I)+EXP(-(WHEELY(I,J)/(12.*450.))**2/2.)
129 420 CONTINUE
130 DO 450 J=1,3
131 C *** RADIUS FACTOR
132 RADIUS(I,J)=SQRT(.31820987EC*DPWGT(L,J)*AIRC(I,5)/AIRC(I,6))
133 FACTOR(I,J)=0.
134 T1=(3./8.)**2
135 T2=(15./48.)**2
136 DO 440 K=1,N
137 WX=SQRT(ABS(WHEELX(I,K)**2)+ABS(WHEELY(I,K)**2))
138 IF(WX.NE.0.)GO TO 430
139 FACTOR(I,J)=FACTOR(I,J)+1.
140 GO TO 440
141 430 YK=(RADIUS(I,J)/WX)**2
142 WK=1.5708*(1.+25*YK+T1*YK**2+T2*YK**3)
143 WE=1.5708*(1.-25*YK-T1*YK**2/3.-T2*YK**3/5.)
144 FIRM=2./3.14159*WX/RADIUS(I,J)*(WE-(1-YK)*WK)
145 FACTOR(I,J)=FACTOR(I,J)+FIRM
146 440 CONTINUE
147 450 CONTINUE
148 APY(I)=APY(I)*.00157*RADIUS(I,2)/12.
149 460 CONTINUE
150 ID=IDLSI(1)
151 RADIUS(ID,1)=SQRT(.31820987EC*QJPWGT(1)*AIRC(ID,5)/AIRC(ID,6))
152 C *** APX
153 DO 560 K=1,NBAND
154 IAPX=NTYPE*(K-1)
155 DO 550 LA=1,NTYPE
156 L=IAPX+LA
157 DO 540 M=1,NCPWGT
158 I=IAIRC(M)
159 IF(I.LE.0)GO TO 540
160 NW=NHHEEL(I)
161 DO 530 J=1,3
162 APX(I,J,L)=0.
163 DO 520 N=1,NW
164 APX(I,J,L)=APX(I,J,L)+EXP(-10.8167*
165 +(WHEELX(I,N)/(12.*BAND(K,LA)))**2)
166 520 CONTINUE
167 APX(I,J,L)=APX(I,J,L)*3.2884*RADIUS(I,J)/(12.*BAND(K,LA))
168 530 CONTINUE
169 540 CONTINUE
170 550 CONTINUE
171 560 CONTINUE

```

A2.07 Subroutine CALC(2)

```

56 C *** PAVE CODE LAYE
57 DO 230 I=1,NPAVL
58 230 N=N(LAYER(I))
59 DO 230 J=1,N
60 DO 240 K=1,NLAY
61 IF(LAYER(I,J,1).NE.NLAY(K,1))GO TO 240
62 IF(LAYER(I,J,2).NE.NLAY(K,2))GO TO 240
63 ILAYER(I,J)=K
64 IF(EVAL(I,J).LT.1.)EWAL(I,J)=VALAY(K,1)
65 IF(PCIS(I,J).LT.0.001)PCIS(I,J)=.65-.08*ALOG10(EVAL(I,J))
66 GO TO 250
67 240 CONTINUE
68 C *** ERROR
69 250 CONTINUE
70 260 CONTINUE
71 C *** AIRC CODE TOW
72 DO 255 I=1,NAIRC
73 IALF(I)=0
74 IRANGE(I)=0
75 255 CONTINUE
76 DO 270 K=1,NOPWGT
77 I=IAIRC(K)
78 IF(I.LE.0)GO TO 270
79 IRANG(I)=1
80 IF(IRANG(K,1).NE.IPLANK)GO TO 261
81 LRANGE(K,1)=MRANG(I,1)
82 LRANGE(K,2)=MRANG(I,2)
83 261 DO 262 J=1,4
84 IF(LRANGE(K,1).NE.MRANG(J))GO TO 262
85 IRANG(I)=J
86 GO TO 262
87 262 CONTINUE
88 265 IALF(I)=1
89 IF(LALF(K,1).EQ.MALF(2))IALF(I)=2
90 I=IALF(I)
91 J=IRANGE(I)
92 IF(LALF(K,1).EQ.IBLANK.AND.TOW(J,I,L).GT.1.
93 +.AND.OPWGT(K,1).LT.1.)IALF(K,1)=MALF(I)
94 IF(TOW(J,I,L).LT.1..AND.OPWGT(K,1).LT.1.)OPWGT(K,1)=AIRC(I,1)
95 IF(OPWGT(K,1).LT.1.)OPWGT(K,1)=TOW(J,I,L)
96 IF(OPWGT(K,2).LT.1.)OPWGT(K,2)=(AIRC(I,2)-AIRC(I,3))
97 +*(OPWGT(K,1)-AIRC(I,3))/(AIRC(I,1)-AIRC(I,3))+AIRC(I,3)
98 IF(OPWGT(K,3).LT.1.)OPWGT(K,3)=1.5*OPWGT(K,2)
99 270 CONTINUE

```

A2.08 Subroutine PAVDES

```

350 1317 ELAY=EVAL(KM,IHSA)
351      EBOT=EVAL(KM,NL)
352 1318 CONSTA=VALC(KB,2)*SQRT(ELAY)*VALC(KB,3)*(1.-VALC(KB,4))
353      DO 1330 IA=1,NOPWGT
354      I=IAIRC(IA)
355      IF(I.LE.0)GO TO 1330
356      DO 1320 J=1,3
357      ANS(I,J)=-(ABS(STRFD(KAA))-ABS(STRFAM(I,J)))/CONSTA
358 1320 CONTINUE
359 1330 CONTINUE
360      ANS(20,1)=0.
361      DO 1350 IA=1,NOPWGT
362      I=IAIRC(IA)
363      IF(I.LE.0)GO TO 1350
364      DO 1340 J=1,3
365      FACTOR(I,J)=WZFM(I,J)/WZW(I,J)
366      PRESS=AIRC(I,6)*FACTOR(I,J)
367      WQ=2.*PRESS*RADIUS(I,J)*VALC(KB,10)/EBOT
368      D4=1./VALC(KB,8)
369      DCDEF=WQ**(1.-D4)*WZFM(I,J)**D4*VALC(KB,7)**(-D4)
370      AND(I,J)=DCDEF
371 1340 CONTINUE
372 1350 CONTINUE
373      FACTOR(20,1)=WZFD(KAA)/WZWF(KAA)
374      PRESS=AIRC(10,6)*FACTOR(20,1)
375      WQ=2.*PRESS*RADIUS(20,1)*VALC(KB,10)/EBOT
376      AND(20,1)=WQ**(1.-D4)*WZFD(KAA)**D4*VALC(KB,7)**(-D4)
377      DO 1375 I=1,NPAVHD
378      IF(IPAVL(I).EQ.ICL)GO TO 1374
379      IF(IPAVL(I).GT.ICL)GO TO 1372
380      REWIND 9
381      ICL=0
382 1372 ICL=ICL+1
383      IF(IFAMDS(ICL,1).LE.0)GO TO 1372
384      READ(9)((ANS(IA,J),AND(IA,J),FACTOR(IA,J),IA=1,20),J=1,3)
385      IF(IPAVL(I).NE.ICL)GO TO 1372
386 1374 WRITE(12)((ANS(IA,J),AND(IA,J),FACTOR(IA,J),IA=1,20),J=1,3)
387 1376 CONTINUE
388      ENDFILE 12
389      REWIND 12
390      REWIND 9
391      REWIND L18
392      NSLP=FINA(6)
393      ASCM=(FINA(4)+FINA(3)-FINA(2))-FINA(2)*(FINA(3)+FINA(4))
394      PCVAMC=FLOAT(NSLP-1)*(1.+FLOAT(NSLP-2)*ASCM/2.*
395      +(1.+FLOAT(NSLP-3)*ASCM/3.))
396      AIRBV=1.-1./(1.+FINA(1))
397      PCVICC=1.-((FINA(5)-2.)*(FINA(2)-AIRBV)/2.*
398      +(1.-FINA(5)-3.)*FINA(2)/3.))

```

A2.09 Subroutine FAM

```

90      DO 415 J=1,3
91      ARSA(I,J)=10.**((ANS(I,J)/(OVERSF/(1.+DI(LOC,ITYP))))
92      415 CONTINUE
93      DO 420 J=1,3
94      C      CONST=2.28
95      C      C1=.01
96      C      DD=SQRT(DI(LOC,ITYP)/(1.+DI(LOC,ITYP)))
97      C      VV=DD*VEL(LOC,ITYP)+60.*(1.-DD)
98      C      XX=8.5*FACTOR(I,J)+XNZ(I)/RADIUS(I,J)
99      C      AK=CONST/VV*DI(LOC,ITYP)/SQRT(AIRC(I,7))
100     C      AAK=10.**((VALC(KP,5)*ALOG10(AK/VALC(KP,6)))
101     C      DN=12.*AAK*SQRT(XX*RADIUS(I,J)/12.)
102     C      ANDB(I,J)=(DN-C1)/AND(I,J)
103     C      ANDA(I,J)=10.**((1-AND(I,J)-AND(20,1))/AND(I,J))
104     420 CONTINUE
105     C      IF(KPAV(KP).LE.1)WRITE(6,40)DI(LOC,ITYP),VEL(LOC,ITYP),
106     C      +(FACTOR(I,J),J=1,3),XNZ(I),(RADIUS(I,J),J=1,3),AIRC(I,7),
107     C      +VALC(KP,5),VALC(KP,6)
108     C      40 FORMAT(1X,12F11.5)
109     425 CONTINUE
110     C      XX=8.5*FACTOR(20,1)+XNZ(10)/RADIUS(20,1)
111     C      AK=CONST/VV*DI(LOC,ITYP)/SQRT(AIRC(10,7))
112     C      AAK=10.**((VALC(KP,5)*ALOG10(AK/VALC(KP,6)))
113     C      DN=12.*AAK*SQRT(XX*RADIUS(20,1)/12.)
114     C      ANDB(20,1)=(DN-C1)/AND(20,1)
115     C      ANDA(20,1)=1.
116     C      IF(KPAV(KP).LE.1)
117     C      +WRITE(6,30)((AND(I,J),J=1,3),I=1,12)
118     C      IF(KPAV(KP).LE.1)
119     C      +WRITE(6,30)AND(20,1)
120     C      30 FORMAT(1X,12PE13.5)
121     DO 600 K=1,NST1
122     C      DO 440 IA=1,NCPWT
123     C      I=1AIRC(IA)
124     C      IF(I.LE.0)GO TO 440
125     C      DO 450 J=1,3
126     C      ANDA(I,J)=1.
127     C      IF(ATH(K,IA,J).LE.0.0001)GO TO 430
128     C      ANDA(I,J)=10.**((1-AND(20,1)-AND(1,J))
129     C      +1)
130     C      +ALOG10(ATA(K,IA,J)*APX(I,J,IAPX))/AND(20,1))
131     C      430 CONTINUE
132     C      440 CONTINUE
133     C      *** AARG
134     DO 450 J=1,3
135     450 S=MOV(J)=0.
136     DO 470 IA=1,NCPWT
137     C      I=1AIRC(IA)
138     C      IF(I.LE.0)GO TO 470
139     DO 460 J=1,3
140     C      ANDA(I,J)=ATH(K,IA,J)*ARSA(I,J)*APX(I,J,IAPX)

```

A2.09 Subroutine FAM (cont'd)

```

141     SEQMOV(J)=SEQMOV(J)+ATM(K,IA,J)*ANSA(I,J)*APX(I,J,IAPX)
142 460 CONTINUE
143     J=3
144     EQS(I,J)=0.
145     IF(NW.GT.2)EQS(I,J)=ATM(K,IA,J)*ANSA(I,J)*APX(I,J,IAPX)
146     +APY(I)
147     IF(NI.GT.2)SEQMOV(J)=SEQMOV(J)+ATM(K,IA,J)*ANSA(I,J)*
148     +APX(I,J,IAPX)*APY(I).
149 470 CONTINUE
150     AANS(K,LCC)=0.
151     DO 480 J=1,NW
152     AANS(K,LCC)=AANS(K,LCC)+SEQMOV(J)
153 480 CONTINUE
154     AANS(K,LCC)=AANS(K,LCC)*SPERC(LCC)
155 C *** AMND
156     DO 490 J=1,3
157 490 DECMOV(J)=0.
158     DO 510 IA=1,NBPWGT
159     I=IAIRC(IA)
160     IF(I.LE.0)GO TO 510
161     DO 500 J=1,2
162     EQD(I,J)=0.
163     ALND=1.
164     IF(ATM(K,IA,J).GT.0.1)
165     +ALND=ALND*(ATM(K,IA,J)*APX(I,J,IAPX))
166     IF(ALND.GT.3.)ALND=3.
167     IF(ATM(K,IA,J).GT.0.1)
168     +EQD(I,J)=(ANSA(I,J)**ALND)
169     +*ATM(K,IA,J)*APX(I,J,IAPX)
170     DECMOV(J)=DECMOV(J)+EQD(I,J)
171 500 CONTINUE
172     J=3
173     EQD(I,J)=0.
174     ALND=1.
175     IF(NW.GT.2.AND.ATM(K,IA,J).GT.0.1)
176     +ALND=ALND*(ATM(K,IA,J)*APX(I,J,IAPX)*APY(I))
177     IF(ALND.GT.3.)ALND=3.
178     IF(NI.GT.2.AND.ATM(K,IA,J).GT.0.1)
179     +EQD(I,J)=(ANSA(I,J)**ALND)
180     +*ATM(K,IA,J)*APX(I,J,IAPX)*APY(I)
181     IF(NW.GT.2)DECMOV(J)=DECMOV(J)+EQD(I,J)
182 510 CONTINUE
183     AAND(K,LCC)=0.
184     DO 520 J=1,NW
185     AAND(K,LCC)=AAND(K,LCC)+DECMOV(J)
186 520 CONTINUE
187     AAND(K,LCC)=AAND(K,LCC)*SPERC(LCC)

```

A2.10 Subroutine HDES

```

51 C *** STRESS LIMIT
52 NL=Nlayer(KM)
53 NL1=NL-1
54 DO 190 J=1,NL1
55 STRL(K,LOC,J)=SQRT(EVAL(KM,J))*(1.-VALC(KP,3)*
56 +ALOG10(AANS(K,LCC)))/(1.+DI(LOC,ITYP))
57 STRL(K,LOC,J)=STRL(K,LCC,J)*VALC(KP,2)
58 OVERSF=VALC(KP,1)
59 IF(LOC.GT.1)OVERSF=VALC(KP,9)
60 STRL(K,LOC,J)=STRL(K,LCC,J)*OVERSF*(1.-VALC(KP,4))
61 190 CONTINUE
62 IF(KN.LE.0)GO TO 197
63 NLA=NPSLAY(KN)
64 NLA1=NLA-1
65 DO 195 J1=1,NLA1
66 J=J1+NL1
67 STRL(K,LOC,J)=SQRT(PSLE(KN,J1))*(1.-VALC(KP,3)*
68 +ALOG10(AANS(K,LOC)))/(1.+DI(LOC,ITYP))
69 STRL(K,LOC,J)=STRL(K,LOC,J)*VALC(KP,2)
70 OVERSF=VALC(KP,1)
71 IF(LOC.GT.1)OVERSF=VALC(KP,9)
72 STRL(K,LOC,J)=STRL(K,LOC,J)*OVERSF*(1.-VALC(KP,4))
73 195 CONTINUE
74 C *** WZL
75 197 CONST=2.28
76 C1=.01
77 XX=8.6*FACTOR(20,1)+XNZ(ID)/RADIUS(20,1)
78 PRESS=AIRC(ID,6)*FACTOR(20,1)
79 DD=SQRT(DI(LOC,ITYP)/(1.+DI(LOC,ITYP)))
80 VV=DD*VEL(LOC,ITYP)+60.*(1.-DD)
81 AK=CONST/VV*DI(LOC,ITYP)/SQRT(AIRC(ID,7))
82 C WRITE(6,20)KP,AK,VALC(KP,6)
83 C 20 FORMAT(1X,I5,2F10.4)
84 AAK=10.**(VALC(KP,5)*ALOG10(AK/VALC(KP,6)))
85 DN=12.*AAK*SQRT(XX*RADIUS(20,1)/12.)
86 EBOT=EVAL(KM,NL)
87 IF(KN.GT.0)EBOT=PSLE(KN,NLA)
88 WD=2.*PRESS*RADIUS(20,1)*VALC(KP,10)/EBOT
89 D3=VALC(KP,7)*WD*(1.-VALC(KP,8))
90 IF(AAND(K,LOC).LE.10.)WZL(K,LOC)=(DN-C1)**VALC(KP,8)
91 IF(AAND(K,LOC).GT.10.)
92 +WZL(K,LOC)=((DN-C1)/ALOG10(AAND(K,LOC)))**VALC(KP,8)
93 D4=1./VALC(KP,8)
94 DODEF=VALC(KP,7)*(-D4)
95 IF(NXSL.LE.1)WZL(K,LOC)=(DN-C1)
96 C *** WD AND D3 TO BE CALCULATED LATER
97 C *** SHOULD USE ESUP

```

```

169 360 IST=IST-1
170 370 I1=IEST+IES
171     ESUP(K)=ESUB(I1)
172     NL=Nlayer(KM)
173     NL1=NL-1
174     PRESS=AIRC(ID,6)*FACTOR(20,1)
175     WU=2.*PRESS*RADIUS(20,1)*VALC(KP,10)/ESUP(K)
176     D3=VALC(KP,7)*WU**(1.-VALC(KP,8))
177     U4=1./VALC(KP,8)
178     LOC2=2
179     IF(NXSL.LE.1)GO TO 501
180     DO 373 LOC=1,LOC2
181         WZLIM(K,LOC)=D3*WZL(IST,LOC)
182         TAND(K,LOC)=AAND(IST,LOC)
183         TANS(K,LOC)=AANS(IST,LOC)
184     DO 371 J=1,NL1
185         STRLIM(K,LOC,J)=STRL(IST,LOC,J)
186 371 CONTINUE
187     IF(KN.LE.0)GO TO 373
188     DO 372 J1=1,NLA1
189         J=J1+NL1
190         STRLIM(K,LOC,J)=STRL(IST,LOC,J)
191 372 CONTINUE
192 373 CONTINUE
193 C *** INTERPOLATE EVALUE
194     IF(ESUB(I1).GT.ESUBG(1))GO TO 375
195 C *** ERROR
196 375 DO 380 I=2,NE
197     IF(ESUB(I1).EQ.ESUBG(I))GO TO 390
198     IF(ESUB(I1).LT.ESUBG(I))GO TO 410
199 380 CONTINUE
200 C *** ERROR
201     I=NE
202     GO TO 410
203 390 DO 400 N=1,NHG
204     WZ(N)=WZH(N,I)
205     STR(N)=STRH(N,I)
206 400 CONTINUE
207     GO TO 422
208 410 DO 420 N=1,NHG
209     WZ(N)=(WZH(N,I)-WZH(N,I-1))*(ESUB(I1)-ESUBG(I-1))
210     +/(ESUBG(I)-ESUBG(I-1))+WZH(N,I-1)
211     STR(N)=(STRH(N,I)-STRH(N,I-1))*(ESUB(I1)-ESUBG(I-1))
212     +/(ESUBG(I)-ESUBG(I-1))+STRH(N,I-1)
213 420 CONTINUE
214 422 DO 500 J=1,2
215     IF(WZLIM(K,J).LT.WZ(1))GO TO 425
216     HDES(K,J)=HVAL(KM,1)
217     GO TO 460

218 425 DO 430 N=2,NHG
219     IF(WZLIM(K,J).GE.WZ(N))GO TO 450
220 430 CONTINUE

```



```

221      HDES(K,J)=HVAL(KM,2)+HVAL(KM,3)/2.
222      ICRIT(K,J)=-1
223      GO TO 500
224      450 HDES(K,J)=(HGRID(KM,N)-HGRID(KM,N-1))*(WZLIN(K,J)-WZ(N-1))
225      +/(WZ(N)-WZ(N-1))+HGRID(KM,N-1)
226      460 IH=IPAVHS(KI)
227      IF(KN.GT.0)IH=IH+NL1
228      IF(STRLIN(K,J,IH).LT.STR(1))GO TO 465
229      H=HVAL(KM,1)
230      GO TO 480
231      465 DO 470 N=2,NHG
232      IF(STRLIN(K,J,IH).GE.STR(N))GO TO 475
233      470 CONTINUE
234      HDES(K,J)=HVAL(KM,2)+HVAL(KM,3)/2.
235      ICRIT(K,J)=1
236      GO TO 500
237      475 H=(HGRID(KM,N)-HGRID(KM,N-1))*(STRLIN(K,J,IH)-STR(N-1))
238      +/(STRIN-STRIN-1))+HGRID(KM,N-1)
239      480 ICRIT(K,J)=-1
240      IF(HDES(K,J).GT.H)GO TO 500
241      HDES(K,J)=H
242      ICRIT(K,J)=1
243      500 CONTINUE
244      GO TO 510
245      501 IP=IPFL(11)
246      IF(ESUP(K).GT.PFLESG(1))GO TO 502
247      WZ(IP)=WZH(IP,1)+.25*(WZH(IP,1)-WZH(IP,2))
248      STR(IP)=STRH(IP,1)+.25*(STRH(IP,1)-STRH(IP,2))
249      GO TO 504
250      502 DO 503 I=2,NFLESG
251      IF(ESUP(K).GT.PFLESG(I))GO TO 503
252      WZ(IP)=(WZH(IP,I)-WZH(IP,I-1))*(ESUP(K)-PFLESG(I-1))
253      +/(PFLESG(I)-PFLESG(I-1))+WZH(IP,I-1)
254      STR(IP)=(STRH(IP,I)-STRH(IP,I-1))*(ESUP(K)-PFLESG(I-1))
255      +/(PFLESG(I)-PFLESG(I-1))+STRH(IP,I-1)
256      GO TO 504
257      503 CONTINUE
258      WZ(IP)=WZH(IP,NFLESG)-.25*(WZH(IP,NFLESG-1)-WZH(IP,NFLESG))
259      STR(IP)=STRH(IP,NFLESG)-.25*(STRH(IP,NFLESG-1)-STRH(IP,NFLESG))
260      C 504 DCDEF=W0**((1.-D4)*WZ(IP)**D4*VALC(KP,7)**(-D4))
261      504 DCDEF=ESUB(11)/(VALC(KP,7)*EPAV(11))
262      DCDEF=W0*10.**((D4*ALOG10(DCDEF))
263      TAND(K,1)=AANC(1ST,1)
264      C TAND(K,2)=10.**((WZ(1ST,1)/DCDEF)
265      TAND(K,2)=(WZ(1ST,1)/DCDEF)
266      IF(TAND(K,2).GT.30.)TAND(K,2)=30.
267      TAND(K,2)=10.**TAND(K,2)
268      TANS(K,1)=AANS(1ST,1)
269      IH=IHS(IP)
270      SIGY=VALC(KP,1)*(1.-VALC(KP,4))*VALC(KP,2)*SQRT(EVAL(IP,IH))
271      SIGY=SIGY/(1.+DI(1,ITYP))
272      C TANS(K,2)=10.**((SIGY-STR(IP))/(VALC(KP,3)*SIGY))
273      TANS(K,2)=(SIGY-STR(IP))/(VALC(KP,3)*SIGY)
274      TANS(K,2)=10.**TANS(K,2)
275      510 CONTINUE

```

A2.11 Subroutine PCVCAL

```

42      DO 300 LDC=1,2
43      DO 200 K=1,NAST1
44      IUSA=IPATHS(K,1)
45      IF (KI,LC,0) ELAY=EVAL(KM,IHSA)
46      IF (KI,SI,0) ELAY=PSLE(KN,IHSA)
47      IF (KN,SI,0) IHSA=IISA+KLAYER(KM)-1
48      IF=IIS(K,1)
49      IL=ILAYER(KM,IH)
50      AILC(K,LDC)=LCST(KM)+HDES(K,LDC)*UL(IL)
51      ULSTR=VALC(KP,2)*SQRT(ELAY)*(1.-VALC(KP,4))
52      WLSTR=ULSTR*(1.-VALC(KP,3)*ALOG10(TANS(K,LDC)))
53      OVERSF=VALC(KP,1)
54      IF (LIC,ST,1) OVERSF=VALC(KP,2)
55      ZAC=VALC(KP,4)*OVERSF*(LLSTR-WLSTR)/(ULSTR-STRLIM(K,LDC,IHSA)
56      +ZOVERSF)
57      AMC(K,LDC)=ZAC*UL(IL)
58      PCV(K,LDC)=AMC(K,LDC)*PCVANC+AILC(K,LDC)*PCVICC
59 200 CONTINUE
60 300 CONTINUE
61      IF (ISTR(1,KAC,2).ST,0,00) GO TO 320
62      APCV(1)=PCV(1,1)
63      APCV(2)=PCV(1,2)
64      GO TO 300
65 320 DO 400 LDC=1,2
66      APCV(LDC)=0.
67      DO 250 K=1,NAST1
68      APCV(LDC)=APCV(LDC)+PCV(K,LDC)*(ASTA(K+1)-ASTA(K))
69 250 CONTINUE
70      APCV(LDC)=APCV(LDC)/(ASTA(NAST)-ASTA(1))
71 400 CONTINUE

```