DEVELOPMENT OF DIURNAL ADJUSTMENTS TABLE FOR THE FINE FUEL MOISTURE CODE

by

S. J. Muraro and R. N. Russell

(Appendix by B. D. Lawson)

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FORESTRY BRANCH
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Abstract

Fuel moisture data for various periods of the day were subjected to regressional analysis using 1200 hours calculated moisture content and 1600 hours actual moisture content per cent and relative humidity per cent at time "t" as independent variables. Because of the nonlinear relations between the dependent variable, MC at time "t", and the independent variables, stratification of the data by classes of moisture content was selected as the best method of analysis. The curves developed for various time periods and the moisture contents converted to FFM Code values are included.

Development of Diurnal Adjustments Table for the Fine Fuel Moisture Code

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Introduction

One feature of the revised Canadian National Fire Danger rating system is a table for determining the diurnal variation in the moisture content of the fine surface fuels. This feature supplements the fine fuel moisture code (FFM Code) and allows the user to apply the rating system at time periods other than noon, thus enhancing the flexibility and general usefulness of the rating system for specialized applications such as prescribed burning and wildfire suppression. Diurnal adjustment tables are by no means new in Canadian fire danger rating history because Beall (1938), incorporated an adjustment that adhered to the principle of predicting the maximum daily FFM Code from weather parameters existing at various times of day. For the rather limited application of the rating systems in use at that time, knowledge of a daily maximum was quite adequate. The more specialized use envisaged for the revised system requires the capability of determining the code value at a particular time of day while still retaining the ability to determine the daily maximum.

To achieve this goal a fine fuel moisture code was proposed to yield a corrected fine fuel moisture code for various hours of the day according to the current relative humidity. In 1967, Lawson produced a table of FFM Codes for 0600, 0800, 1000, 1200, 1400, 1600 and 1800 hours (Appendix D) utilizing data gathered by Russell et al. (1967) during the course of a fire danger rating study in the Prince George area. This

system was designed to yield current FFM code using current RH and an initial code value determined at the preceding extreme of the diurnal cycle. For example, FFM Code at 1600 hours would entail entering a table using current RH and the FFM Code calculated at 0600 hours of the same day. The 1600-hour code thus determined would serve to determine moisture codes during the period of rising humidities throughout the night. The next morning a new FFM Code was calculated according to the previously calculated 1600 FFM Code and the 0600 hour RH; this code was subsequently used to determine moisture codes during the period of decreasing humidities through the day until 1600 hours.

Although this approach enhanced the ability to determine a FFM Code throughout the day, the operational difficulties of twice-a-day weather readings and the rather complicated rainfall compensations precluded recommendation for operation implementation.

Subsequently, a simpler approach was attempted whereby the FFM Code calculated on a daily basis at noon, but applicable to the peak burning period (1300 - 1600 hr), would be used as the operational reference point for bi-hourly adjustments. Unlike Beall's (1938) adjustment, the adjustment proposed in this paper would provide the adjusted FFM Code for the period of interest rather than the expected daily maximum code value from weather parameters measured at times other than noon.

Fuel moisture data for this study were obtained from field work conducted in the Prince George area in 1966, 67 and 68, by Russell and Pech from composite destructive samples of the uppermost layer of needles and litter under a dry lodgepole pine (Pinus contorta Dougl. var. latifolia

Engelm.) site, sampled at intervals throughout the 24-hour period as described by Russell (1968). Temperature-corrected FFM Codes, Van Wagner (1968) were calculated at noon of each day that samples were obtained, from on site measurements of RH and temperature. Relative humidity at the time of sample collection was also obtained from the on site weather station.

For operational use, the FFM Code adjustment table required a daily FFM Code calculated according to standard practice at noon (1200 hr) and current RH at the required time of adjustment as independent parameters. To accomplish this, stepwise regressions were calculated for each time period using the general equation of

$$Y = A + B\,(X_1) + B_2\,(X_2) + B_3\,(X_3)$$

first when Y = MC% at time "t" and secondly when Y = MC% at time "t"

X_1 = 101 - FFM Code	X_1 = MC% at 1600 hr.
X_2 = (101 - FFM Code)^3	X_2 = (MC% at 1600 hr)^3
X_3 = RH% at time "t"	X_3 = RH% at time "t"

Only those variables that either increased the value of R^2 by at least 1 percent and reduced the residual mean sum of squares were included in the final regression equation for each time period. The regression and the value of R^2 so developed are shown in Appendix B. The equations using 1000 MC% were then used to develop the table shown as Appendix C after converting from MC% to FFM Code and making the assumption later discussed that noon calculated FFM Code = 101 - 1600 MC%. In Appendix C the code values for the 1400 hr time period were adjusted by subtracting 1 from all values greater than 90. This was required because from the equation

MC% at 1400 hours was lower than MC% at 1600 hours when MC 1600 hours is less than 8%. In addition the 1400 hr FFM Codes were adjusted downward to conform with the 1200 and 1600 hr values. For other time periods and within the range of data the 1600 hour equations provide acceptable values of MC%, however in general little confidence should be placed in values for noon codes below 25. A graphical approach with the aid of computer stratification of the data was then employed as a means of fitting the regression for each time period. Because the regressions indicated a better correlation with 1600 MC rather than the noon calculated FFM Code, MC% and RH for each time period were stratified by the classes of 1600 hr MC% shown in Table I.

For the time periods of 1200, 1400, 1800 and 2000 hr MC% and RH were stratified by the 1600 hr MC% of the same day, whereas MC% and RH for the time periods of 0600, 0800 and 1000 hr were stratified by the preceding days 1600 hr MC%.

The population of MC% at time "t" within each 1600 MC% stratification was further stratified into three classes of RH to establish the effect, if any, of variations in MC% due to deviations from the normal diurnal RH regime. This stratification yielded the sample population mean RH and MC% plus the mean RH and MC% for the samples obtained during times of the upper, middle and lower thirds of the RH regime at the particular time period.

To reduce the effect of skewness, means were obtained by calculating the arithmetic means of the logarithm of the numbers. Standard deviations and 95% confidence intervals for each stratified population

were also calculated.

Table I - P. 10-11

The mean moisture content and 95% confidence limits for each time period were plotted on log-log scale as a dependent of the 1600 hr MC% and a line of best fit drawn through the points (Fig. 1). Upon examination of the hourly moisture contents further stratified by the three RH classes, it was apparent that a relative humidity adjustment (in addition to the RH effect already introduced by association with time of day and the initial 1600 hr MC%) was valid only for the 0600, 0800, and 1000 hr time periods. For each of these three periods, the mean MC% occurring during periods of

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Figure 1 - P. 13

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the highest and lowest 1/3 of the total range of RH was plotted against the 1600 hr MC% as in Figure I. Humidity classes for the three curves for each of these time periods were then assigned on an exclusive basis. The three pairs of curves showing the relative humidity adjustment are shown in Figure 2.

Figure 2 - P. 14

The FFM Code was designed to increase with decreasing fuel moisture content, and in the revised danger rating system the code value calculated from weather parameters measured at noon is theoretically equal to the daily

minimum MC subtracted from 101. These analyses showed the minimum daily moisture contents occurred during the 1600 hr time period; therefore, theoretically 101 - FFM Code = 1600 actual MC%. Because the code value was to be used as the main independent variable to determine the adjusted FFM Code at time t, and since all previous stratifications were by 1600 MC%, a calibration curve was required to relate the 1600 hr actual MC% to the FFM Code calculated at the standard time of observation. To accomplish this the 1600 hr MC% were stratified by noon FFM Codes. This resulted in the slightly sinusoidal curve shown in Figure 3. From the data shown on Figure 3 there is obviously some doubt as to the best fit of the upper portion of this curve.

Figure 3 - P. 15

The curve in Figure 3 showed beyond doubt that 101 - FFM Code did not equal 1600 MC% and that the disagreement was not uniform throughout the range of the population of 144 samples. A choice between these alternatives had to be made:

(a) Accept, ad hoc, the theoretical relation of 101 - FFM Code = 1600 hr MC% and construct a table from the curves shown in Figures 1 and 2 by substituting 101 - FFM Code for the 1600 hr MC%, reading the appropriate MC% and converting to code value for each time period.

(b) Use the calibration curve to relate code value and 1600 MC% entering Figures 1 and 2 with the calibrated 1600 MC% to determine MC for each time period.

(c) Reconstruct the FFM Code table so that 101 - FFM Code = 1600 hr MC%.

There was insufficient basis to accept alternative "c" and reconstruct a table developed from years of data on the basis of sampling from one locality; however, if data to substantiate the relation are available or becomes available from other locales then alternate "c" should receive further consideration. Acceptance of alternate "b" would obviate the generally accepted meaning of the FFM Code because the calculated MC% would be significantly different from the actual minimum MC%.

In view of the pressures to initiate the revised system and to allow time to give further consideration to alternate "b" and "c" alternate, "a" was considered to be the most expeditious course. After deciding upon this course of action, Table II, FFMC was produced by entering Figures 1 and 2 with the 1600 hr MC% and RH values shown and converting to FFM Codes by subtracting MC% from 101.

Table II - P. 12

Observations

If straight lines are balanced through the moisture contents shown in Table I (Appendix A), the diurnal variations of moisture content and the influence of the 1600 hr MC may be visualized as parallel lines on the surface of a cylindrical tube. If the tube is slit longitudinally and each end twisted in opposite directions allowing the ends to flare, the visual pattern when viewed from the side would correspond to that shown in Appendix A.

The straight line relations shown on Appendix A are valid representations of the diurnal moisture change throughout the sample population for all time periods except 1200 hr where a definite simusoidal relation is apparent (Fig. 1). In all other cases the balanced portion of the straight line was maintained well within the 95% confidence limits shown in Table I. The curvatures shown in Figure 1 are largely logical extrapolations beyond the range of the data.

The diurnal drying cycles shown in Figure 4 illustrate the shape

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Figure 4 - P. 16

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of the diurnal fuel moisture cycle from Table II initiated at various FFM Codes. Interpolation of the location of points for missing time periods along a low, moderate and high initial code value curve and transference of these points to Figure 1 would allow adjustment for the missing time periods. An effort to provide the additional data in this manner only showed the obvious, since the daily extremes were already indicated, additional curves would tend to duplicate already existing curves, e.g., the 2400-hr time period would for the most part duplicate the 0800 curve except at the wet extremity. The deviation of the 1600 hr MC from the expected trend is due to the choice of alternate "a", that of using a straight line relation between the 1600 hr MC% determined by the code and actual 1600 hr MC%. The effect of this assumption is also reflected in the low code values for especially the 1400 hr adjustments in Appendix C.

Conclusions

Computer analysis of the data verified the representation that

moisture contents for any time period were better related to the actual 1600-hr moisture content than to the predicted 1600-hr moisture content calculated by the FFM Code. More accurate forecasts of MC for the time periods tested were obtained using the 1600 actual MC than from using actual 1200 MC as independent variables, verifying the former approach of using a twice daily FFM Code calculation.

The diurnal adjustment of FFM Code shown in Table II will allow the user to determine the FFM Code with at least the same sensitivity as the Fine Fuel Moisture Code table, that is, ± 1 drying code number at codes above 76 or ± 5 drying code numbers below code 76 at least 80% of the time.

The non-agreement of 101-FFM Codes and the daily minimum actual fuel moisture content should receive further consideration along the lines of the three alternatives on page 6.

References

Beall, H. W. 1939. "Table for Diurnal Hazard Variation". Canada Dept. of Mines and Resources. Supplement to Forest Fire Research Note #5, Ottawa.

Lawson, B. L. 1967. Fine Fuel Moisture Tables for 0600 and 1600 hours with supplementary tables for 1000, 1200, 1400, 1800, 2000 and 2400 hours. Unpublished.

Russell, R. N. and G. Pech. 1968. "Development of Burning Index Tables for White Spruce-Alpine Fir and Lodgepole Pine Forest Covertypes in the Prince George Forest District." (An Establishment and Progress Report.) B.C. Forest Research Lab. Victoria Int. Rept. B.C. 8. 35 pp.

Van Wagner, C. E. 1968. Memo to Fire Danger Working Group, May 14, 1969.

TABLE I. Mean moisture Content (%) with 95 Confidence limits and mean current RH (%) stratified according to classes of 1600 hr Mean % moisture content and relative humidity % by time periods

1600 M.C.% classes	1200 n = 22	1400 n = 97	1600 n = 144	1800 n = 140	2000 n = 137	0600 n = 121	0800 n = 122	1000 n = 101
<8	9.9 ± .9	8.1 ± .3	7.5 ± .2	8.4 ± .5	10.8 ± 1.0	21.7 ± 2.6	17.1 ± 2.2	12.8 ± 1.4
RH	29	25	23	26	33	67	48	34
8.1 - 10.0	11.7 ± .6	9.8 ± .3	9.2 ± .2	10.1 ± .3	12.2 ± .6	24.0 ± 1.8	19.7 ± 1.7	15.0 ± 1.4
RH	33	29	28	29	38	77	55	40
10.1 - 13.0	13.1 ± 1.3	11.7 ± .8	11.3 ± .3	13.2 ± .9	15.8 ± 1.1	29.7 ± 2.7	23.1 ± 1.6	14.6 ± 1.5
RH	34	32	30	33	43	84	61	43
13.1 - 17.0	17.9 ± 3.0	16.3 ± 2.5	14.9 ± .5	17.1 ±1.0	19.9 ± 1.2	35.5 ± 5.0	29.1 ± 3.5	19.3 ± 3.5
RH	38	36	35	37	50	84	66	45
17.1 - 23.0	33.4 ± 6.4	24.8 ± 2.7	20.3 ± .8	21.5 ±1.5	24.0 ± 1.9	40.0 ± 6.8	36.2 ± 5.8	25.2 ± 8.0
RH	39	33	36	39	56	84	67	53.5
23.1 - 30.0	44.7 ±11.3	30.5 ± 5.5	26.0 ±1.0	26.0 ±2.6	28.8 ± 3.5	45.6 ± 8.1	41.3 ± 7.5	29.1 ± 9.4
RH	40	33	36	43	53	87	67	44
30.1 - 40.0	60.3 ±41.3	42.9 ±14.8	34.1 ±2.4	32.8 ±3.2	37.3 ± 6.4	48.9 ±14.1	41.3 ±18.3	26.6 ±36.5
RH	45	37	36	40	51	87	59	40
40.1 - 52.0	53.5 ±24.9	47.5 ± 7.1	44.2 ±2.6	42.9 ±7.8	42.9 ±12.6	71.5 ± 5.8	61.6 ± 9.8	47.0 ±13.4
RH	47	49	49	54	70	94	70	52

TABLE I. (Continued)

1600 M.C.% classes	1200 n = 22	1400 n = 97	1600 n = 144	1800 n = 140	2000 n = 137	0600 n = 121	0800 n = 122	1000 n = 101
52.1 - 70.0	74.4 ± 20.4	65.4 ± 6.5	57.4 ± 3.3	46.5 ± 6.6	45.1 ± 7.7	65.4 ± 33.7	50.4 ± 24.8	35.9 ± 15.2
RH	52	34	48	53	63	92	70	50
70.1 - 90.0	91.8 ± 23.2	73.0 ±48.1	78.3 ± 9.4	67.3 ±13.6	75.9 ± 3.8	91.8 ± 14.4	81.4 ± 15.0	64.7 ± 30.8
RH	47	40	43	50	65	87	70	45
90.1 - 120.0								
RH								
>120.1								
RH								

TABLE II - FFMC DIURNAL ADJUSTMENT TABLE

TIME OF DAY (ST)	RELATIVE HUMIDITY %	NOON FINE FUEL MOISTURE CODE																																											
		0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	78	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99							
		ADJUSTED FINE FUEL MOISTURE CODE																																											
1200		0	0	0	0	0	0	0	3	9	15	21	27	33	40	47	57	63	68	71	73	75	78	81	82	83	85	86	87	88	89	90	91	92	93	94	95	96							
1400		0	4	8	12	16	21	25	29	33	38	43	47	52	57	64	70	74	77	78	80	81	82	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98							
1600		0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	78	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99							
1800		35	36	38	40	41	43	46	48	50	52	56	59	63	67	70	74	77	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98							
2000		39	40	42	44	45	46	47	48	50	52	55	58	61	64	68	72	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95							
0600	<67%	36	36	36	37	37	37	38	39	40	42	44	46	48	51	54	59	62	64	65	66	67	68	70	71	72	73	75	77	78	79	80	82	84	86	88	90	91							
	68-87%	21	21	22	23	24	26	27	29	31	33	36	38	42	46	50	55	58	61	62	63	64	65	67	68	69	71	72	74	75	77	79	80	82	84	86	88								
	>88%	2	4	5	8	10	12	15	17	20	24	28	31	36	40	44	49	52	55	56	57	58	59	61	62	64	66	67	69	71	72	74	76	78	80	82	84	86							
0800	<47%	46	46	46	46	47	47	48	48	49	50	51	53	55	58	61	65	68	70	71	72	73	74	75	76	77	78	80	81	82	84	85	86	88	89	90	92	93							
	48-67%	28	28	29	29	30	31	32	34	36	38	41	44	47	51	55	61	64	66	68	69	70	71	72	74	75	76	77	79	80	81	83	84	86	87	88	90	91							
	>68%	8	9	9	12	14	16	18	21	23	27	30	35	38	44	48	53	57	60	61	62	63	65	66	68	69	71	72	74	76	78	79	81	83	85	87	88	90							
	<37%	62	62	62	62	62	62	63	64	64	65	66	67	69	71	74	76	78	79	80	81	81	82	83	84	84	85	86	87	88	89	89	90	91	92	93	94	95							
	38-57%	46	47	48	49	51	52	53	54	54	58	60	63	65	68	70	74	75	77	78	78	79	80	81	82	82	83	84	85	86	87	88	89	90	91	92	93	94							
	>58%	41	41	41	42	42	42	44	45	46	47	49	51	53	54	59	63	65	67	68	69	70	71	72	74	75	76	78	79	80	82	83	84	86	87	88	89	90							

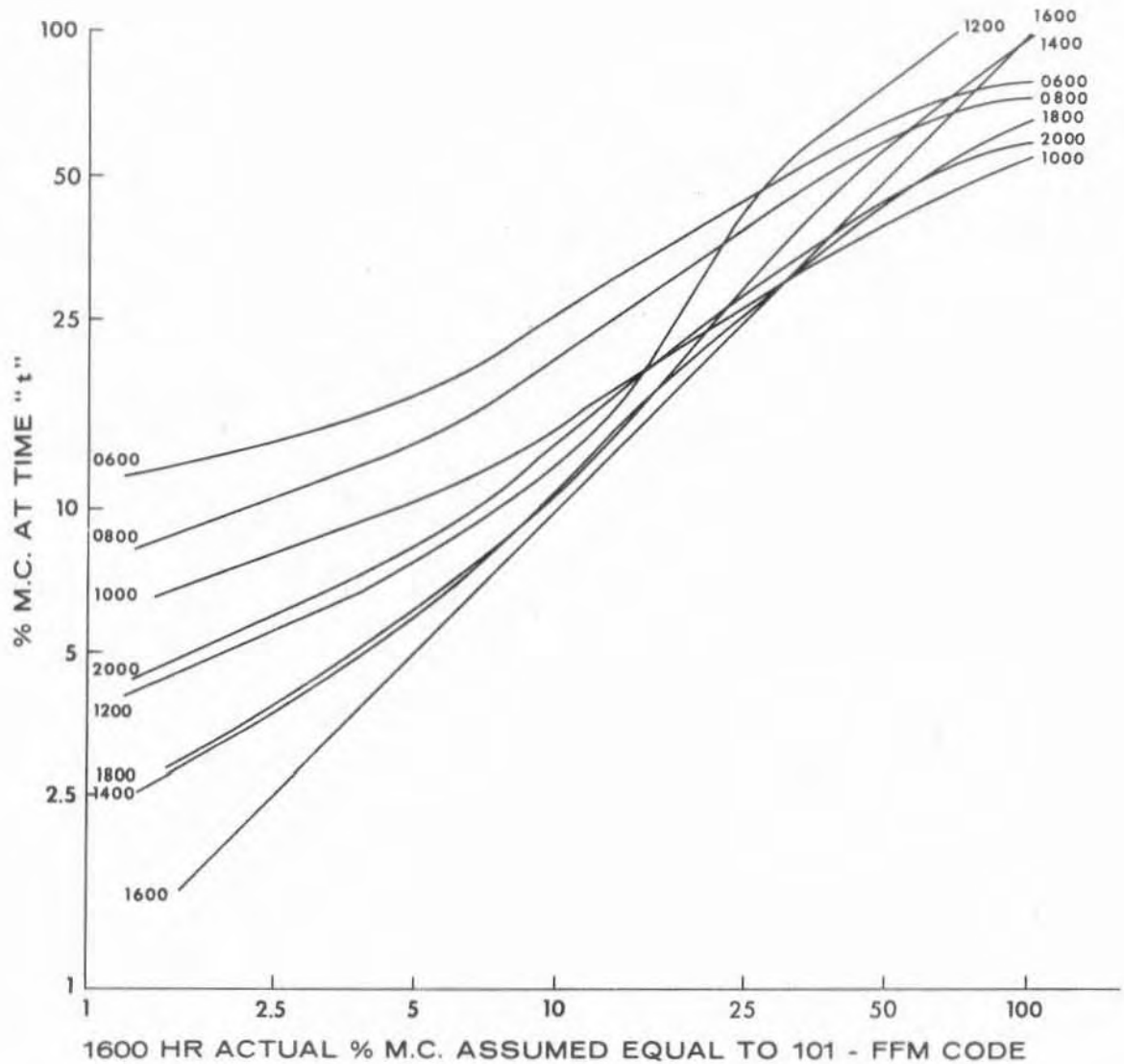


FIGURE 1 - PERCENT MOISTURE CONTENT AT TIMES "t" AS A DEPENDENT OF ACTUAL 1600 MC %, ASSUMED TO BE EQUAL TO 101-FFM CODE.

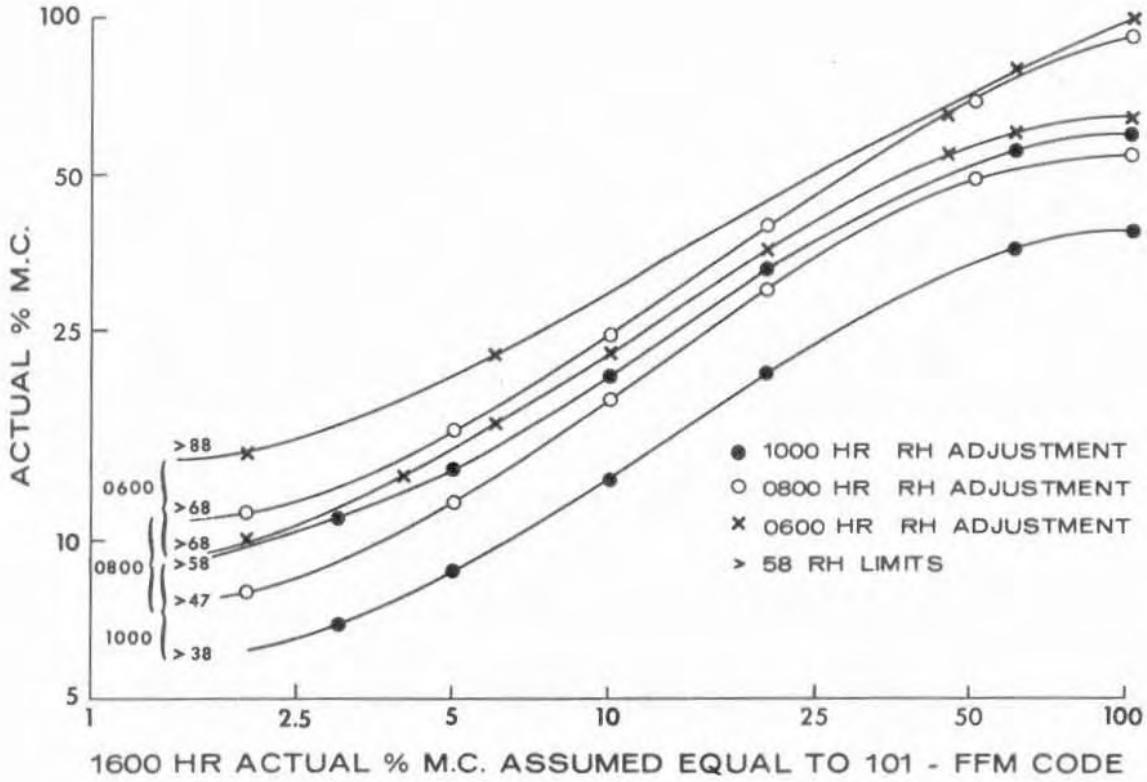


FIGURE 2 - ADJUSTMENT OF 0600, 0800 AND 1000 HR MC % AS A DEPENDENT OF CALCULATED 1600 MC % ASSUMED TO BE EQUAL TO 101-FFM CODE

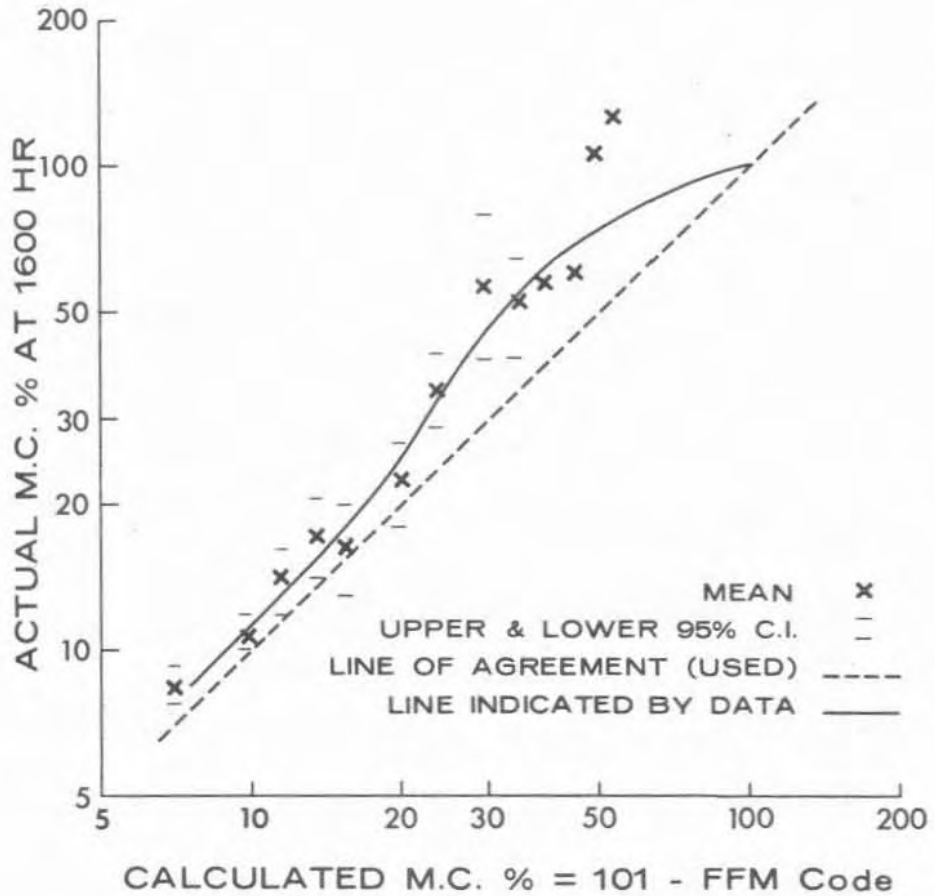


FIGURE 3 - 1600 HR MC % STRATIFIED BY CLASSES OF 101-FFMC SHOWING 95% CONFIDENCE INTERVALS AND LINE OF PERFECT AGREEMENT

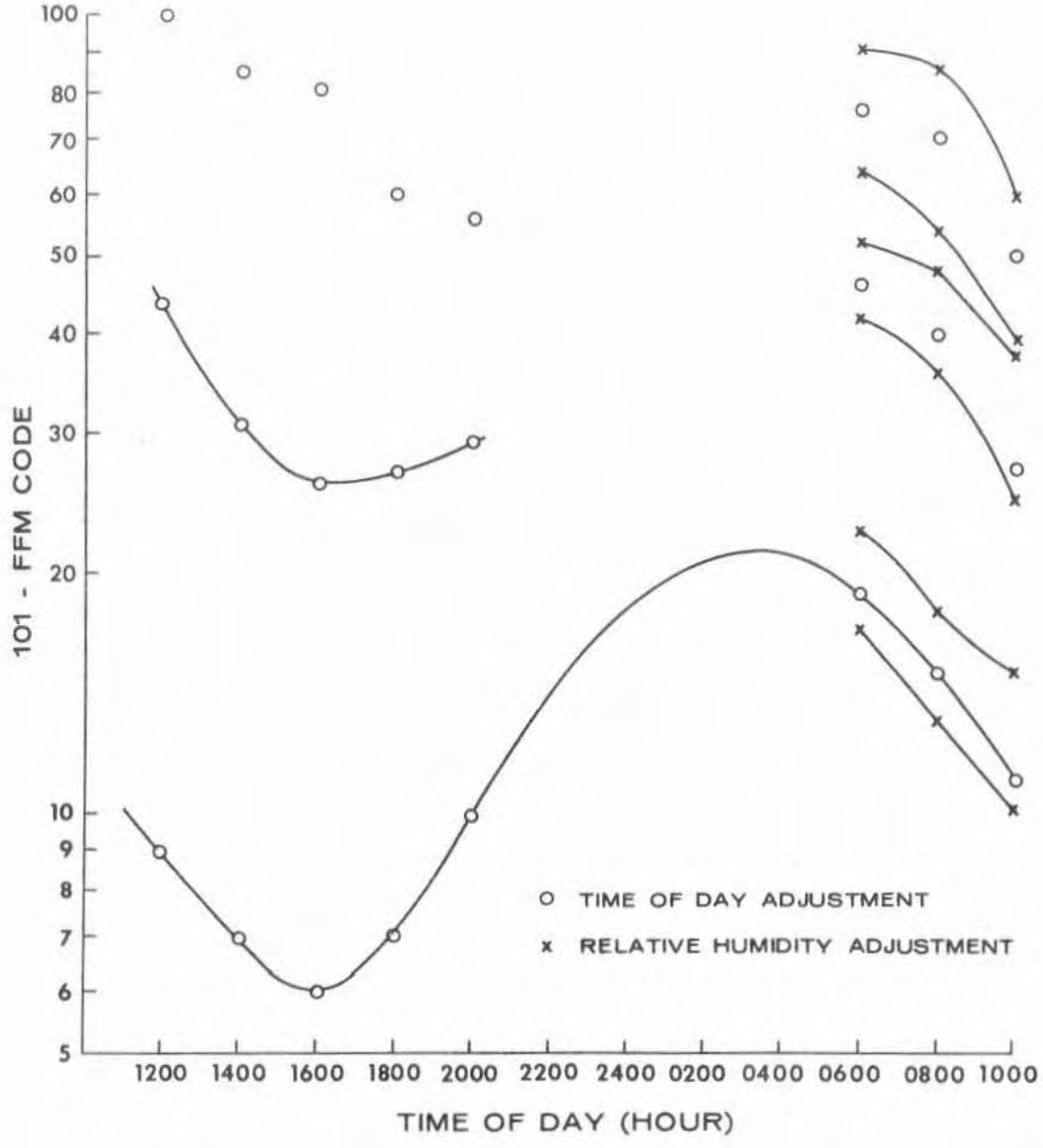
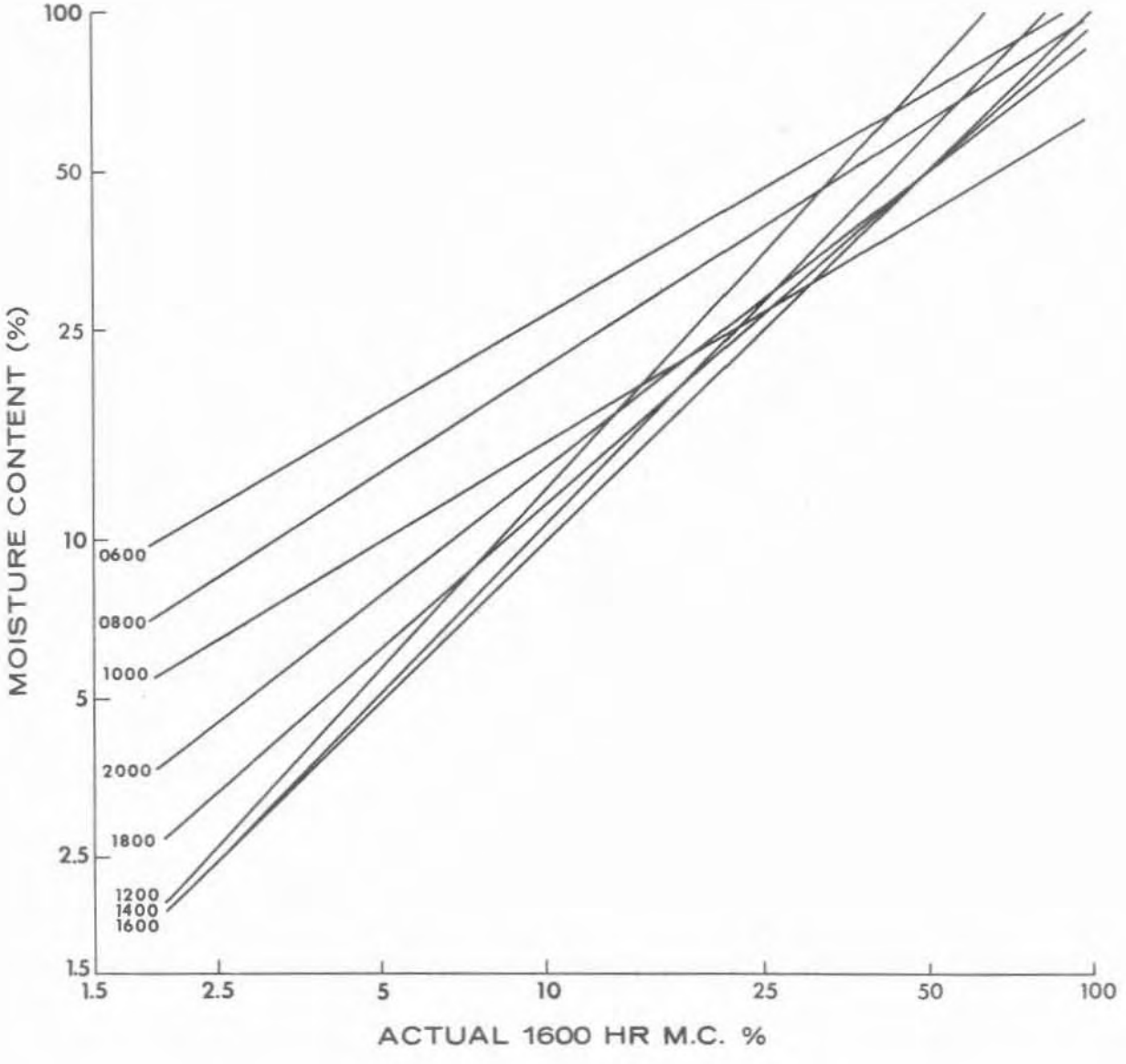


FIGURE 4 - DIURNAL FUEL MOISTURE REGIMES INITIATED AT CALCULATED 1600 HR MC(101-FFM CODE) OF 6, 26 AND 81% MC WITH EARLY MORNING R.H. ADJUSTMENTS



APPENDIX A

STRAIGHT LINE OF BEST FIT THROUGH POINTS SHOWN IN TABLE I SHOWING RELATION OF MC % AT TIME "t" TO 1600 HR MC %

Appendix B

	DF	R^2
$MC\%_{1200} = -23.39 + 3.64\ (101\text{-}CODE) - .000099\ (101\text{-}CODE)^3$	146	.78
$MC\%_{1400} = -9.60 + 2.33\ (101\text{-}CODE) - .00038\ (101\text{-}CODE)^3$	98	.51
$MC\%_{1600} = -2.39 + 1.44\ (101\text{-}CODE) + .00027\ (101\text{-}CODE)^3$	148	.85
$MC\%_{1800} = 1.46 + 1.20\ (101\text{-}CODE) + .00024\ (101\text{-}CODE)^3$	145	.84
$= -3.33 + .91\ (101\text{-}CODE) + .00026\ (101\text{-}CODE)^3 + .24(RH_{1800})$	144	.85
$MC\%_{2000} = 3.02 + 1.30\ (101\text{-}CODE) + .00018\ (101\text{-}CODE)^3$	140	.80
$= -3.95 + .99\ (101\text{-}CODE) + .00021\ (101\text{-}CODE)^3 + .23\ (RH_{2000})$	139	.82
$MC\%_{0600} = 11.88 + 1.70\ (101\text{-}CODE) + .00033\ (101\text{-}CODE)^3$	122	.86
$= -5.48 + 1.52\ (101\text{-}CODE) + .00036\ (101\text{-}CODE)^3 + 24\ (RH_{0600})$	121	.87
$MC\%_{0800} = 10.47 + 1.41\ (101\text{-}CODE) + .00023\ (101\text{-}CODE)^3$	124	.82
$= -8.28 + 1.21\ (101\text{-}CODE) + .00025\ (101\text{-}CODE)^3 + .34\ (RH_{0800})$	123	.85
$MC\%_{1000} = -8.89 + 1.40\ (101\text{-}CODE) + .28\ (RH_{1000})$	102	.63
$= -6.37 + 1.06\ (101\text{-}CODE) + .32\ (RH_{1000}) + .000089\ (101\text{-}CODE)^3$	101	.64
$MC\%_{1200} = -2.03 + 1.33\ (MC\%_{1600})$	126	.85
$MC\%_{1400} = -3.55 + 1.43\ (MC\%_{1600}) - .00075\ (MC\%_{1600})^3$	94	.94
$MC\%_{1800} = 3.44 + .84\ (MC\%_{1600})$	145	.95
$MC\%_{2000} = 6.64 + .81\ (MC\%_{1600})$	140	.95
$MC\%_{0600} = -1.80 + .99\ (MC\%_{1600}) + .24\ (RH_{0600}) + .0000046\ (MC\%_{1600})^3$	120	.93
$MC\%_{0800} = .59 + .90\ (MC\%_{1600}) + .21\ (RH_{0800})$	122	.91
$MC\%_{1000} = -.85 + .74\ (MC\%_{1600}) - .0000049\ (MC\%_{1600})^3 + .21\ (RH_{1000})$	100	.83

APPENDIX C - FFM CODE DIURNAL ADJUSTMENT TABLE

TIME	RELATIVE HUMIDITY CLASS	MIDPOINT	NOON FINE FUEL MOISTURE CODE 0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	78	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99
			ADJUSTED FINE FUEL MOISTURE CODE																																				
1200			**	-14	-8	-3	3	9	15	21	27	33	39	45	51	56	62	68	72	74	75	77	78	79	80	81	82	84	85	86	87	88	90	91	92	93	94	95	97
1400			-8	-3	1	6	11	17	23	28	34	38	44	50	55	61	66	71	75	77	78	79	80	81	82	83	85	86	88	89	90	91	92	93	94	95	96	97	98
1600			0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	78	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99
1800			13	17	21	25	30	34	38	42	46	51	55	59	63	67	72	76	78	80	81	82	82	83	84	85	86	87	87	88	89	90	91	92	93	93	94	95	96
2000			13	17	21	25	29	33	37	41	45	49	53	57	61	65	69	73	76	77	78	79	80	81	81	82	83	84	85	85	86	87	88	89	90	90	91	92	93
0600	RH-<67%	34	-10	-4	1	7	12	17	23	28	33	38	44	49	54	59	64	69	72	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93
	RH-68-87%	78	-21	-15	-9	-4	1	7	12	17	23	28	33	38	43	48	53	58	61	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82
	RH>88%	94	-24	-19	-13	-8	-2	3	8	14	19	24	29	34	39	44	49	54	57	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78
0800	RH-<47%	24	5	9	14	18	23	27	32	36	41	45	50	54	59	63	68	72	75	77	77	78	79	80	81	82	83	84	85	86	86	87	88	89	90	91	92	93	94
	RH-48-67%	58	-3	2	6	11	15	20	24	29	33	38	42	47	51	56	60	65	68	69	70	71	72	73	74	75	76	77	78	78	79	80	81	82	83	84	85	86	87
	RH>68%	84	-8	-4	1	5	10	14	19	23	28	32	37	41	46	50	55	59	62	64	65	66	67	67	68	69	70	71	72	73	74	75	76	76	77	78	79	80	81
1000	RH-<37%	19	28	31	34	37	41	44	47	51	54	57	61	64	68	72	75	79	81	82	83	84	85	85	86	87	88	88	89	90	91	91	92	93	94	94	95	96	96
	RH-38-57%	48	22	25	28	31	35	38	41	44	48	51	55	58	62	65	69	73	75	76	77	78	79	79	80	81	82	82	83	84	84	85	86	87	87	88	89	90	90
	RH->58%	79	16	19	22	25	28	31	34	38	41	45	48	52	55	59	62	66	68	70	70	71	72	73	73	74	75	76	76	77	78	79	79	80	81	82	82	83	84
original values from equation for 1400 hr time period			37	34	31	29	29	29	30	32	34	38	42	46	51	57	62	69	73	75	77	78	79									92	93	95	96	97	99	100	101

APPENDIX D- FINE FUEL MOISTURE CODE FOR 0600 HOURS

STARTING VALUE - YESTERDAY'S FINE FUEL MOISTURE CODE - 1600 HOURS

TODAY'S FINE FUEL MOISTURE CODE - 0600 HOURS

0600 HR R.H.%	0	5	10	15	20	25	30	35	40	45
UNDER 16	9	13	16	20	24	28	31	36	40	44
16 - 21	7	11	14	18	22	26	30	34	38	42
22 - 27	5	9	13	16	20	24	28	32	35	40
28 - 37	3	7	11	14	18	22	26	30	34	38
38 - 47	1	5	9	12	16	20	24	28	31	36
48 - 57	0	3	7	11	15	18	22	26	29	34
58 - 67	0	0	4	8	12	16	20	23	27	31
68 - 77	0	0	1	4	9	13	17	21	25	29
78 - 87	0	0	0	2	5	10	14	18	22	26
OVER 87	0	0	0	0	4	5	11	16	20	24
RAIN 1600-0600 HR										
.01 - .03 IN.	0	1	6	11	16	21	26	31	36	41
.04 - .09	0	0	4	10	14	19	23	26	33	38
.10+	0	0	1	7	11	14	18	22	26	29

0600 HR R.H.%	50	55	60	65	70	75	78	80	81	82	83	84
UNDER 16	48	52	57	61	66	70	72	74	75	77	78	79
16 - 21	46	50	55	59	64	69	71	73	74	76	77	78
22 - 27	44	48	53	57	62	67	69	71	72	74	75	76
28 - 37	42	46	51	55	60	65	67	69	70	72	74	75
38 - 47	40	44	49	53	58	63	65	67	68	70	72	73
48 - 57	38	42	47	51	56	61	63	65	67	68	70	71
58 - 67	35	40	44	49	54	59	61	63	64	65	68	69
68 - 77	33	37	42	47	52	57	59	61	62	64	66	67
78 - 87	30	35	39	44	49	55	57	59	60	62	64	65
OVER 87	28	33	37	42	47	53	55	57	58	60	61	63
RAIN 1600-0600 HR												
.01 - .03 IN.	46	51	56	61	66	71	74	76	77	78	79	79
.04 - .09	42	47	52	56	61	66	69	71	71	72	73	74
.10+	33	37	40	43	46	49	51	52	53	53	54	55

0600 HR R.H.%	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99
UNDER 16	80	82	83	84	85	86	87	89	90	91	93	94	96	98	99
16 - 21	79	80	82	83	84	85	86	88	89	90	91	92	94	96	97
22 - 27	77	79	81	82	83	84	85	87	88	89	90	91	92	94	95
28 - 37	69	78	79	80	82	83	84	85	87	88	89	90	91	92	93
38 - 47	74	76	77	79	80	81	82	84	85	87	88	89	90	91	92
48 - 57	72	74	76	77	78	80	81	82	84	85	87	88	89	90	91
58 - 67	70	73	74	75	76	78	79	81	82	84	86	87	88	89	90
68 - 77	68	71	72	73	75	76	78	79	81	83	84	86	87	88	89
78 - 87	66	69	70	71	73	74	76	78	79	81	83	85	86	87	88
OVER 87	65	67	68	70	71	73	75	76	78	80	82	84	85	86	87
RAIN 1600-0600 HR															
.01 - .03 IN.	80	81	82	83	83	84	85	86	87	87	88	89	90	90	91
.04 - .09	75	75	76	77	77	78	79	80	81	81	82	83	83	84	85
.10+	55	56	56	57	58	58	59	59	60	60	61	62	62	63	63

CONTINUED

APPENDIX D- FINE FUEL MOISTURE CODE FOR 1600 HOURS

STARTING VALUE - TODAY'S FINE FUEL MOISTURE CODE - 0600 HOURS

TODAY'S FINE FUEL MOISTURE CODE - 1600 HOURS

1600 HR R.H.%	0	5	10	15	20	25	30	35	40	45
UNDER 16	71	73	75	76	78	80	81	83	85	86
16 - 21	67	70	72	74	76	78	79	81	83	85
22 - 27	65	68	70	72	74	76	78	80	82	84
28 - 37	62	64	67	69	71	74	76	78	80	82
38 - 47	53	56	59	62	65	68	71	74	76	79
48 - 57	47	50	54	57	60	63	66	69	72	76
58 - 67	42	46	50	53	56	59	63	66	69	71
68 - 77	38	43	46	49	53	56	60	63	66	69
78 - 87	35	40	44	47	50	53	57	60	63	66
OVER 87	33	37	41	43	47	50	53	56	59	63
RAIN 0600-1600 HR										
.01 - .03 IN.	0	0	5	10	15	20	25	30	35	40
.04 - .09	0	0	0	0	10	15	20	25	30	35
.10+	0	0	0	0	5	10	10	15	15	20

1600 HR R.H.%	50	55	60	65	70	75	78	80	81	82	83	84
UNDER 16	88	89	91	92	93	94	94	95	95	95	95	95
16 - 21	86	88	89	91	92	93	93	94	94	94	94	94
22 - 27	85	87	88	90	91	92	92	93	93	94	94	94
28 - 37	84	86	87	89	90	91	92	92	92	93	93	93
38 - 47	81	84	86	88	89	91	91	92	92	92	92	92
48 - 57	78	81	83	85	87	89	90	90	90	91	91	91
58 - 67	75	78	80	83	85	87	88	89	89	89	90	90
68 - 77	71	75	78	81	83	86	86	87	88	88	88	89
78 - 87	69	73	75	78	81	84	84	85	86	86	86	87
OVER 87	66	69	72	75	78	81	82	83	83	83	84	84
RAIN 0600-1600 HR												
.01 - .03 IN.	45	50	55	60	65	70	71	72	72	72	73	73
.04 - .09	40	40	45	45	50	55	55	55	60	60	60	60
.10+	25	25	30	30	35	35	35	35	40	40	40	40

1600 HR R.H.%	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99
UNDER 16	95	95	96	96	96	96	96	97	97	97	97	97	98	98	99
16 - 21	94	95	95	95	95	95	96	96	96	96	96	96	97	97	98
22 - 27	94	94	95	95	95	95	95	95	95	96	96	96	97	97	97
28 - 37	93	93	94	94	94	94	94	95	95	95	95	95	96	96	96
38 - 47	92	92	93	93	93	93	93	94	94	94	94	94	95	95	95
48 - 57	91	91	92	92	92	92	92	93	93	93	93	93	94	94	94
58 - 67	90	90	91	91	91	91	91	91	92	92	92	92	92	93	93
68 - 77	89	89	90	90	90	90	90	91	91	91	91	91	92	92	92
78 - 87	87	87	88	88	88	88	88	89	89	89	89	89	90	90	90
OVER 87	85	85	85	85	86	86	86	87	87	87	87	88	88	88	88
RAIN 0600-1600 HR															
.01 - .03 IN.	74	74	74	74	75	75	75	76	76	76	76	78	78	78	78
.04 - .09	60	65	65	65	65	65	65	65	70	70	70	70	70	70	70
.10+	40	45	45	45	45	50	50	50	50	50	55	55	55	55	55

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APPENDIX D- FINE FUEL MOISTURE CODE FOR 1000 HOURS

1000 HR R.H.%	STARTING VALUE - TODAY'S FINE FUEL MOISTURE CODE - 0600 HOURS 0 5 10 15 20	25 30 35 40 45	50 55 60 65 70	75 78	80 81 82 83 84	85 86 87 88 89	90 91 92 93 94	95 96 97 98 99
	TODAY'S FINE FUEL MOISTURE CODE - 1000 HOURS							
UNDER 16	20 27 33 38 44	50 54 60 64 69	73 77 81 84 87	90 91	91 92 92 93 93	94 94 94 95 95	95 95 96 96 96	96 96 97 98 99
16 - 21	18 25 31 37 43	49 53 59 63 68	72 76 80 83 86	89 90	91 91 91 92 92	93 93 93 94 94	94 94 95 95 95	95 95 96 97 98
22 - 27	17 23 29 35 41	47 52 57 62 66	71 75 79 82 85	88 89	90 90 91 91 92	92 92 93 93 93	94 94 94 95 95	95 95 95 96 97
28 - 37	15 21 27 33 39	44 49 54 59 64	68 73 77 80 84	87 88	89 89 90 90 91	91 91 92 92 93	93 93 93 94 94	94 94 95 95 96
38 - 47	12 18 24 30 35	41 46 51 56 61	66 70 76 79 82	85 86	87 88 89 90 90	90 90 91 91 92	92 92 92 93 93	93 93 94 94 95
48 - 57	11 17 23 29 34	40 45 50 55 60	65 70 75 78 82	85 86	87 88 89 89 89	90 90 90 90 90	91 91 91 92 92	92 92 93 93 94
58 - 67	9 15 20 27 33	38 44 49 54 59	64 68 73 77 80	83 84	85 86 87 87 87	88 88 89 89 89	89 89 89 90 90	90 90 91 92 93
68 - 77	7 14 19 26 31	37 42 47 52 57	62 66 71 74 77	81 82	83 83 84 84 85	85 85 86 86 86	86 86 86 87 87	87 87 88 89 90
78 - 87	6 12 17 23 28	33 39 44 49 54	59 63 68 72 75	79 80	81 81 82 82 83	83 83 83 83 83	83 83 84 84 84	84 84 85 86 87
OVER 87	5 11 15 21 26	31 36 42 47 51	56 61 65 69 73	76 78	79 79 80 80 80	80 80 80 80 80	81 81 81 81 81	81 81 82 83 84

APPENDIX D- FINE FUEL MOISTURE CODE FOR 1200 HOURS

1200 HR R.H.%	STARTING VALUE - TODAY'S FINE FUEL MOISTURE CODE - 0600 HOURS 0 5 10 15 20	25 30 35 40 45	50 55 60 65 70	75 78	80 81 82 83 84	85 86 87 88 89	90 91 92 93 94	95 96 97 98 99
	TODAY'S FINE FUEL MOISTURE CODE - 1200 HOURS							
UNDER 16	35 40 47 52 57	61 66 70 74 78	81 84 87 89 91	92 93	93 93 93 94 94	94 94 95 95 95	95 96 96 96 96	97 97 98 98 99
16 - 21	33 38 44 50 55	60 64 69 73 76	80 83 86 88 90	91 92	92 93 93 93 93	93 94 94 94 94	94 95 95 95 95	96 96 97 97 98
22 - 27	30 36 42 48 53	58 63 67 71 75	79 82 83 87 89	91 91	92 92 92 92 92	93 93 93 93 94	94 94 94 95 95	96 96 96 97 97
28 - 37	30 34 39 44 49	53 59 64 68 72	76 79 82 83 87	89 90	91 91 92 92 92	93 93 93 93 93	93 93 93 94 94	95 95 95 96 96
38 - 47	26 32 37 43 48	53 56 62 66 70	74 77 80 83 86	88 89	90 90 91 91 91	92 92 92 92 92	92 92 92 93 93	94 94 94 95 95
48 - 57	23 29 35 40 45	50 55 60 64 68	72 76 79 82 84	87 88	89 89 90 90 90	91 91 91 91 91	91 91 91 92 92	93 93 93 94 94
58 - 67	22 27 33 38 43	48 53 57 61 65	69 73 77 80 82	85 85	87 87 88 88 88	89 89 89 89 89	89 89 89 90 90	91 91 91 92 93
68 - 77	20 25 30 35 40	45 49 54 58 62	66 70 74 77 80	82 83	85 85 86 86 86	86 86 86 86 87	87 87 87 88 88	88 88 88 89 90
78 - 87	18 23 27 33 37	42 46 52 55 59	63 67 71 74 77	80 81	82 82 83 83 83	83 83 83 83 83	83 83 84 84 84	84 84 85 86 87
OVER 87	16 21 25 30 35	39 43 48 52 56	60 64 68 71 74	77 78	79 79 80 80 80	80 80 80 80 80	81 81 81 81 81	81 81 82 83 84

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APPENDIX D- FINE FUEL MOISTURE CODE FOR 2000 HOURS

2000 HR R.H.%	STARTING VALUE - TODAY'S FINE FUEL MOISTURE CODE - 1600 HOURS 0 5 10 15 20	25 30 35 40 45	50 55 60 65 70	75 78	80 81 82 83 84	85 86 87 88 89	90 91 92 93 94	95 96 97 98 99
	TODAY'S FINE FUEL MOISTURE CODE - 2000 HOURS							
UNDER 16	21 25 29 32 36	40 43 47 51 55	58 62 66 70 74	78 80	82 83 84 84 85	86 87 88 89 89	90 91 92 93 94	95 96 97 98 99
16 - 21	20 24 27 31 34	38 42 45 49 53	57 61 65 69 73	77 79	81 82 83 83 84	85 86 87 88 89	90 91 91 92 93	94 95 96 97 98
22 - 27	19 22 25 29 33	36 41 44 48 52	56 60 64 68 72	76 78	80 81 82 82 83	84 85 86 87 88	89 90 91 92 93	94 95 96 96 97
28 - 37	17 19 24 25 31	35 39 43 47 11	55 59 63 67 71	76 77	79 80 81 82 83	84 85 86 87 88	89 90 91 92 93	94 95 96 96 97
38 - 47	15 18 22 24 29	33 37 41 45 49	52 57 62 66 70	75 76	78 79 80 81 82	83 84 85 86 87	88 89 90 91 92	93 94 96 96 96
48 - 57	12 16 20 24 28	32 35 39 44 48	52 56 60 65 69	74 76	78 78 79 80 81	82 83 84 85 86	87 89 90 91 92	93 94 95 95 95
58 - 67	11 15 19 21 27	30 34 38 43 47	51 55 59 64 68	73 75	77 78 79 80 81	82 83 84 85 86	87 88 89 90 91	93 94 95 95 95
68 - 77	9 13 17 21 25	29 33 37 41 45	49 54 58 63 67	72 74	76 77 78 79 80	81 82 83 84 85	86 88 89 90 91	92 93 95 95 95
78 - 87	8 12 16 20 24	28 32 36 40 44	48 53 57 62 66	71 73	75 76 77 78 79	80 81 82 84 85	86 88 88 89 90	92 93 94 94 94
OVER 87	7 11 15 19 23	27 31 35 39 43	47 52 56 61 65	70 72	74 75 77 78 79	80 81 82 83 84	85 86 88 89 90	91 93 94 94 94

APPENDIX D- FINE FUEL MOISTURE CODE FOR 2400 HOURS

2400 HR R.H.%	STARTING VALUE - TODAY'S FINE FUEL MOISTURE CODE - 1600 HOURS 0 5 10 15 20	25 30 35 40 45	50 55 60 65 70	75 78	80 81 82 83 84	85 86 87 88 89	90 91 92 93 94	95 96 97 98 99
	TODAY'S FINE FUEL MOISTURE CODE - 2400 HOURS							
UNDER 16	21 24 27 30 34	37 41 44 49 52	55 59 63 67 71	75 77	79 80 80 81 82	83 84 85 86 87	88 89 90 91 92	93 94 95 96 97
16 - 21	19 22 25 29 32	36 39 43 46 50	54 58 61 65 69	74 76	78 78 79 80 81	82 83 84 85 86	87 88 89 90 91	92 94 95 95 96
22 - 27	18 21 24 27 31	35 38 41 45 49	52 56 60 64 68	73 75	77 77 78 79 80	81 82 83 84 85	86 87 88 90 91	92 93 94 94 95
28 - 37	16 19 22 25 29	33 36 40 44 47	51 55 59 63 67	72 74	76 76 77 78 79	80 81 82 83 84	85 87 88 89 90	91 93 94 94 95
38 - 47	15 18 21 24 27	31 35 38 42 46	49 53 58 62 66	71 72	74 75 76 77 78	79 90 81 83 84	85 86 87 88 90	91 92 94 94 94
48 - 57	13 16 19 22 26	28 33 36 41 44	48 52 56 60 65	69 71	73 74 75 76 77	78 79 80 82 83	84 85 86 88 89	90 91 93 93 93
58 - 67	11 14 17 20 25	27 31 35 39 42	46 51 55 59 63	68 70	72 73 74 75 76	77 78 79 80 82	83 84 85 87 88	90 91 92 92 92
68 - 77	9 12 15 18 23	25 29 33 37 41	45 49 53 57 62	66 68	70 72 73 74 75	76 77 78 79 81	82 83 84 86 87	88 90 92 92 92
78 - 87	7 10 14 17 21	23 27 31 35 39	43 47 51 55 60	65 67	69 70 71 72 73	75 76 77 78 79	81 82 83 85 86	88 89 91 91 91
OVER 87	5 8 11 14 18	21 25 29 33 37	41 45 49 53 58	63 65	67 68 69 71 72	73 74 75 76 78	79 80 82 83 85	86 88 90 90 90

CONTINUED

APPENDIX D- FINE FUEL MOISTURE CODE FOR 1400 HOURS

	STARTING VALUE - TODAY'S FINE FUEL MOISTURE CODE - 0600 HOURS																								
	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	78	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99
1400 HR R.H.%	TODAY'S FINE FUEL MOISTURE CODE - 1400 HOURS																								
UNDER 16	49	54	59	63	67	72	75	78	81	84	86	88	90	92	93	94	94	94	94	95	95	95	95	95	96	96	96	96	96	97	97	97	97	97	98	98	99
16 - 21	47	52	56	61	65	69	72	76	79	81	84	86	87	90	92	93	93	93	93	94	94	94	94	95	95	95	95	96	96	96	96	96	96	96	97	97	98
22 - 27	46	51	55	59	63	67	70	73	76	79	82	85	87	89	91	92	92	93	93	94	94	94	94	94	95	95	95	95	95	95	95	96	96	96	96	97	97
28 - 37	44	49	53	57	61	65	68	72	75	78	81	84	86	88	90	91	91	92	93	93	93	93	93	93	94	94	94	94	94	95	95	95	95	95	96	96	96
38 - 47	41	46	50	55	59	63	66	69	73	76	79	82	84	86	88	90	90	91	91	92	92	92	92	92	93	93	93	93	93	94	94	94	94	94	94	95	95
48 - 57	39	43	48	52	56	60	64	67	71	74	77	80	83	85	87	89	89	90	90	90	90	90	91	91	91	91	91	91	91	92	92	92	93	93	93	94	94
58 - 67	35	39	43	47	51	55	59	62	66	70	73	76	79	82	84	86	87	87	88	88	88	89	89	89	89	89	89	89	89	90	90	90	91	91	91	92	93
68 - 77	34	37	41	46	49	53	57	60	64	67	71	74	77	79	82	84	84	85	85	86	86	87	87	87	87	87	87	88	88	88	89	89	89	89	90	91	92
78 - 87	29	33	38	41	45	49	53	56	60	63	67	70	73	76	79	81	82	83	83	83	84	84	84	84	84	84	84	85	85	85	86	86	86	86	87	88	89
OVER 87	25	29	33	37	41	44	48	51	55	58	62	65	69	72	75	77	78	79	80	80	80	81	81	81	81	81	81	82	82	82	83	83	83	83	84	85	85

APPENDIX D- FINE FUEL MOISTURE CODE FOR 1800 HOURS

	STARTING VALUE - TODAY'S FINE FUEL MOISTURE CODE - 1600 HOURS																								
	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	78	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99
1800 HR R.H.%	TODAY'S FINE FUEL MOISTURE CODE - 1800 HOURS																								
UNDER 16	17	21	25	29	33	37	41	45	50	54	58	62	67	71	75	79	81	83	84	85	85	86	87	88	89	90	90	91	92	93	94	95	96	97	97	98	99
16 - 21	15	19	23	27	31	36	40	44	48	52	57	61	65	69	74	78	80	81	82	83	84	85	86	87	88	88	89	90	91	92	93	94	95	96	97	98	98
22 - 27	14	18	22	26	30	35	39	43	47	51	56	60	64	69	73	77	79	81	82	83	84	85	85	86	87	88	89	90	91	92	93	94	95	96	97	97	98
28 - 37	13	17	21	25	29	34	38	42	46	50	55	59	63	68	72	77	78	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	97	97
38 - 47	12	16	20	24	28	33	37	41	45	49	54	58	62	67	71	76	78	80	81	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	96	96
48 - 57	11	15	19	23	27	32	36	40	44	48	53	57	61	66	70	75	77	79	80	81	82	83	83	85	86	87	88	89	90	91	92	93	94	95	96	96	96
58 - 67	10	14	18	22	26	30	34	39	43	45	52	56	60	65	70	74	76	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	96	96	96
68 - 77	9	13	17	21	25	29	33	38	42	46	51	55	59	64	69	73	75	77	78	79	80	81	82	83	84	85	86	88	89	90	91	92	93	94	95	95	95
78 - 87	8	12	16	20	24	28	32	36	41	45	49	54	58	63	67	72	74	76	77	78	79	80	81	82	83	84	85	87	88	89	90	91	92	94	95	95	95
OVER 87	7	10	14	18	22	26	30	34	39	43	47	52	56	61	66	71	73	75	76	77	78	79	80	81	82	83	84	86	87	88	89	90	92	93	94	94	94