

HOURLY CALCULATION OF THE FINE FUEL MOISTURE CODE, INITIAL SPREAD INDEX, AND
FIRE WEATHER INDEX WITH THE TEXAS INSTRUMENTS MODEL 59 HAND-HELD CALCULATOR

by

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INTRODUCTION

The Canadian Forest Fire Weather Index (FWI) System ratings determined from fire weather observations taken at 1200 local standard time are projected to apply to the peak fire danger period which generally occurs shortly after mid-day (say 1600 h)¹. The components of the FWI System that undergo the greatest change during the 24-h diurnal cycle are the Fine Fuel Moisture Code (FFMC), Initial Spread Index (ISI), and the Fire Weather Index (FWI). The FFMC diurnal adjustment table (Van Wagner 1972; Alexander 1982) provides a simplistic means of estimating the FFMC, and in turn the ISI and FWI for different times throughout the day. Its ability to use current weather readings is very limited. Van Wagner (1977) has developed a method which provides the basis for round-the-clock assessment of total forest fire danger if continuous hourly weather observations and a computer or programmable calculator are available.

The introduction of programmable hand-held calculators into fire management planning and decision making has made it possible to conveniently perform complex calculations that formerly required main-frame computers. For example, Kourtz (1980) programmed the 1978 version of the FWI System equations for the Texas Instruments Model 59 (TI-59) hand-held calculator².

The equations for calculation of the FFMC, ISI, and FWI (Van Wagner 1977; Van Wagner and Pickett 1984) on an hourly basis have been programmed for the TI-59. The purpose of this report is to provide: (1) a summary of the equations and procedures used in the program; (2) a program flow diagram; and (3) a listing of the program statements. The documentation of operating instructions and data registers can be found in Table 1³.

¹Simard, A.J. 1970. Normal diurnal variation of the Canadian Forest Fire Weather Index in New Brunswick. Can. Dep. Fish. and For., Can. For. Serv., For. Fire Res. Instit., Ottawa, Ont. Unpubl. Rep. 6 p.

²The exclusion of certain manufactured products does not imply rejection nor does the mention of other products imply endorsement by the Canadian Forestry Service.

³Mk. III version.

A proposed NoFRC Forest Management Note entitled "Hourly Computation of Forest Fire Danger with a Programmable Hand-held Calculator" is currently in preparation by the authors. This publication will detail the procedures required for field application of the TI-59 program.

Table 1. Operating instructions for hourly computation of the Fine Fuel Moisture Code, Initial Spread Index, and Fire Weather Index with the Texas Instruments Model 59 hand-held calculator.

Step	Procedure	Enter	Press	Display
1	Turn calculator on.			0
2	Clear memory.		2 2nd Op 1 7	799.19
3	Read program Side 1 (Card 1).	1	INV 2nd Write and insert card Side 1	1.
4	Read program Side 2 (Card 1).	2	INV 2nd Write and insert card Side 2	2.
5	Read program Side 3 (Card 2).	3	INV 2nd Write and insert card Side 3	3.
6	Read program Side 4 (Card 2).	4	INV 2nd Write and insert card Side 4	4.
7	Initiate program.	A		4.
8	Enter initial Fine Fuel Moisture Code (FFMC).	nn.n ¹	R/S	nn.n
9	Enter dry-bulb temperature ($^{\circ}$ C) ² .	nn.n	R/S	nn.n
10	Enter relative humidity (%).	nnn	R/S	nnn.n
11	Enter wind speed (km/h). ^{2,3}	nn.n	R/S	nn.n
12	Enter 1-h rain amount (mm) ² .	nn.n	R/S	nn.n
13	Enter Buildup Index (BUI).	nnn	R/S	Flickering C
14	FFMC calculated for the hour is displayed.			nn.n
15	Display Initial Spread Index (ISI).		R/S	nn.n
16	Display Fire Weather Index (FWI).		R/S	nnn.n
17	To compute FFMC, ISI, and FWI for next hour, press 2nd A and begin at Step 9.			
	Return to Step 7 for a new case. ⁴			

¹The label n refers to any user-defined input number.

²Fire weather observations can be converted from English to SI units using the TI-59 Master Library Module as follows:

⁰F to ⁰C: press 2nd Pgm 25, enter ⁰F and press A, ⁰C is displayed.

mi/hr to km/h: press 2nd Pgm 24, enter mi/hr and press D, km/h is displayed.

in. to mm: press 2nd Pgm 24, enter in. and press X 10 = A, mm is displayed.

³As measured at a height of 10 m in the open on level terrain.

⁴The input data, intermediate calculations, and output data are contained in the following storage registers and can be recalled simply by pressing RCL followed by the appropriate two-digit register number:

Register number	Symbol	Contents
00	-	Not used.
01	F	FFMC calculated for the hour
02	T	Dry-bulb temperature (⁰ C)
03	H	Relative humidity (%)
04	W	Wind speed @ 10 m in the open (km/h)
05	r _o	1-h rain amount (mm)
06	U	BUI
07	R	ISI
08	S	FWI
09	m	Fine fuel moisture content after drying (%)
10	E _d	Equilibrium moisture content for drying (%)
11	E _w	Equilibrium moisture content for wetting (%)

SUMMARY OF EQUATIONS AND PROCEDURES

Fine Fuel Moisture Code (FFMC) Drying Routine:

$$[1] \quad m_0 = 147.2 (101 - F_0) / (59.5 + F_0)$$

$$[2a] \quad E_d = 0.942 H^{0.679} + 11 e^{(H - 100)/10} + 0.18(21.1 - T)(1 - e^{-0.115 H})$$

$$[2b] \quad E_w = 0.618 H^{0.753} + 10 e^{(H - 100)/10} + 0.18(21.1 - T)(1 - e^{-0.115 H})$$

$$[3a] \quad k_a = 0.424 [1 - (H/100)^{1.7}] + 0.0694 W^{0.5} [1 - (H/100)^8]$$

$$[3b] \quad k_d = 0.0579 k_a e^{0.0365 T}$$

$$[4a] \quad k_b = 0.424 [1 - ((100 - H)/100)^{1.7}] + 0.0694 W^{0.5} [1 - ((100 - H)/100)^8]$$

$$[4b] \quad k_w = 0.0579 k_b e^{0.0365 T}$$

$$[5a] \quad m = E_d + (m_0 - E_d) e^{-2.303 k_d}$$

$$[5b] \quad m = E_w - (E_w - m_0) e^{-2.303 k_w}$$

$$[6] \quad F = 59.5(250 - m) / (147.2 + m)$$

(Equations [1] and [6] are equations (1) and (10) from Van Wagner and Pickett 1984; Equations [2] to [5] are from Van Wagner 1977)

where m_0 = initial fine fuel moisture content, %

m = final fine fuel moisture content, %

F_0 = initial FFMC

F = final FFMC

E_d = equilibrium moisture content for drying, %

E_w = equilibrium moisture content for wetting, %

k_a = intermediate step to k_d

k_b = intermediate step to k_w

k_d = log drying rate for hourly computation, log to base 10

k_w = log wetting rate for hourly computation, log to base 10

H = relative humidity, %

W = wind speed at a height of 10 m in the open on level terrain, km/h

T = dry-bulb temperature, °C

Fine Fuel Moisture Code (FFMC) Rainfall Routine:

$$[7a] \quad m_r = m_0 + 42.5 r_o (e^{-100/(251 - m_0)}) (1 - e^{-6.93/r_o}) \quad , m_0 \leq 150$$

$$[7b] \quad m_r = m_0 + 42.5 r_o (e^{-100/(251 - m_0)}) (1 - e^{-6.93/r_o}) \\ + 0.0015(m_0 - 150) r_o^{0.5} \quad , m_0 > 150$$

(Equations [7a] and [7b] are equations (3a) and (3b) from Van Wagner and Pickett 1984)

where m_0 = fine fuel moisture content from previous hour, %

m_r = fine fuel moisture content after rain, %

r_o = 1-h total rainfall measured in the open, mm

The FFMC is calculated as follows:

1. Previous hour's F becomes F_o .
2. Calculate m_0 from F_o by Equation [1].
3. If rain observed, calculate m_r from r_o by Equation [7a] or

[7b]

- a. If $m_0 \leq 150$, use Equation [7a]; if $m_r > 250$, let $m_r = 250$
- b. If $m_0 > 150$, use Equation [7b]; if $m_r > 250$, let $m_r = 250$.

4. Calculate E_d by Equation [2a].
5. If $m_0 > E_d$, calculate k_d by Equations [3a] and [3b]. Calculate m by Equation [5a].
6. If $m_0 < E_d$, calculate E_w by Equation [2b].
- 7a. If $m_0 < E_w$, calculate k_w by Equations [4a] and [4b]. Calculate m by Equation [5b].

⁴In the standard daily FFMC rainfall routine, the first 0.5 mm of rain is discarded (CFS 1984; Van Wagner and Pickett 1984). For the hourly FFMC rainfall routine, it is better not to discard the first 0.5 mm, but to use the entire hourly bits of rain every hour (C.E. Van Wagner, pers. comm., 5 April 1983).

7b. If $m_o = E_d$ or E_w , $m = m_o$.

c. If $E_d > m_o > E_w$, $m = m_o$.

8. Calculate F by Equation [6].

Initial Spread Index (ISI):

$$[8] \quad f(W) = e^{0.05039 W}$$

$$[9] \quad f(F) = 91.9 e^{-0.1386 m} [1 + m^{5.31} / (4.93 \times 10^7)]$$

$$[10] \quad R = 0.208 f(W) f(F)$$

(Equations [8] to [10] are equations (24) to (26) from Van Wagner and Pickett 1984)

where $f(W)$ = wind function

W = wind speed at a height of 10 m in the open on level terrain, km/h

$f(F)$ = fine fuel moisture function

m = fine fuel moisture content after drying, %

R = ISI

The ISI is calculated as follows:

1. Calculate $f(W)$ and $f(F)$ by Equations [8] and [9].

2. Calculate R by Equation [10].

Fire Weather Index (FWI):

$$[11a] \quad f(D) = 0.626 U^{0.809} + 2 \quad , U \leq 80$$

$$[11b] \quad f(D) = 1000 / (25 + 108.64 e^{-0.023 U}) \quad , U > 80$$

$$[12] \quad B = 0.1 R f(D)$$

$$[13a] \quad \ln S = 2.72(0.434 \ln B)^{0.647} \quad , B > 1$$

$$[13b] \quad S = B \quad , B \leq 1$$

(Equations [11] to [13] are equations (28) to (30) from Van Wagner and Pickett 1984).

where $f(D)$ = duff moisture function

R = Initial Spread Index (ISI)

U = Buildup Index (BUI)

B = FWI (intermediate form)

S = FWI (final form)

The FWI is calculated as follows:

1. Calculate $f(D)$ by Equation [11a] for values of U up to 80. If $U > 80$, use Equation [11b].
2. Calculate B by Equation [12].
3. If $B > 1$, calculate S from its logarithm, given by Equation [13a]. If $B \leq 1$, let $S = B$ according to Equation [13b].

A flow diagram of the TI-59 hourly forest fire danger program is given in Figure 1.

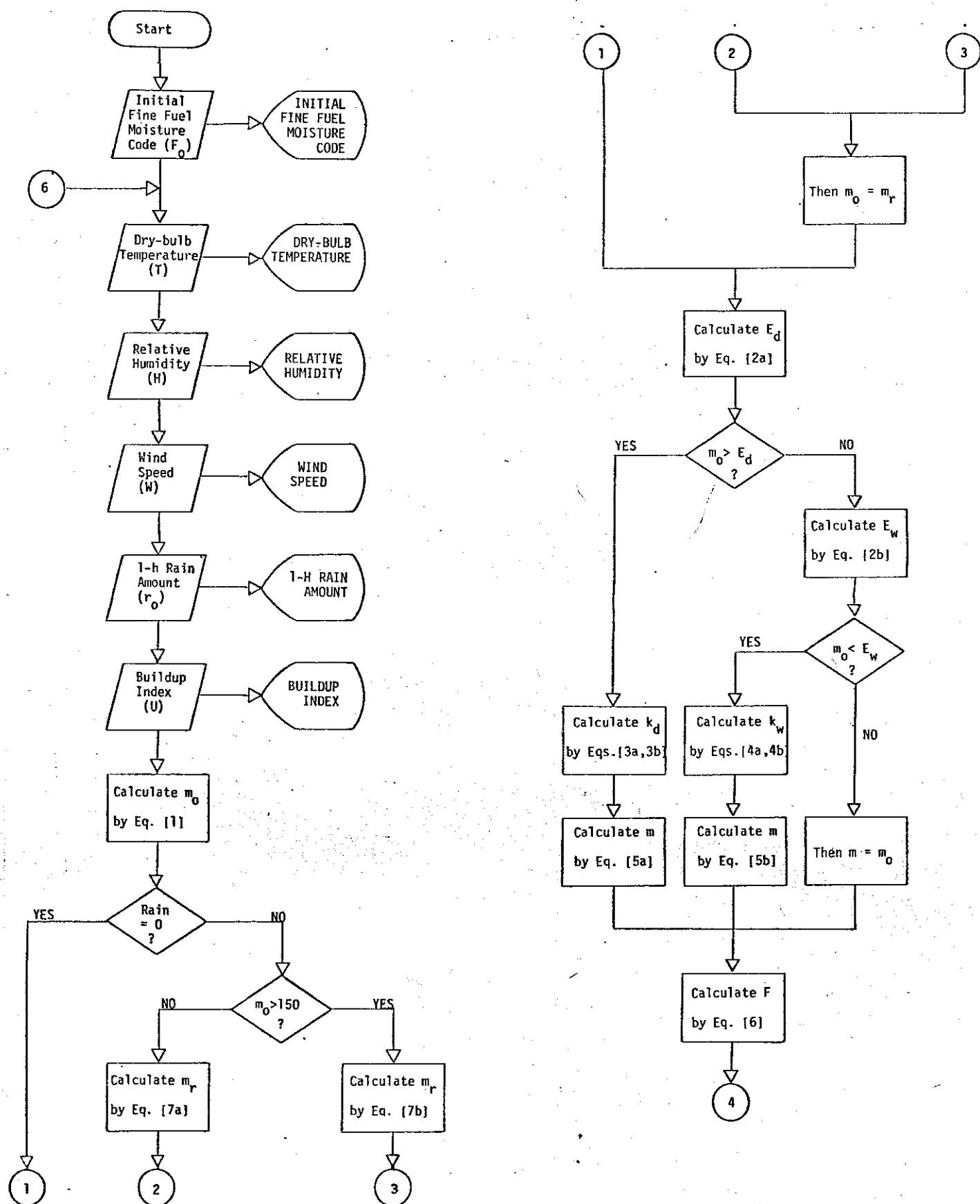


Figure 1a. Flow diagram for the TI-59 hourly forest fire danger program (FFMC subprogram).

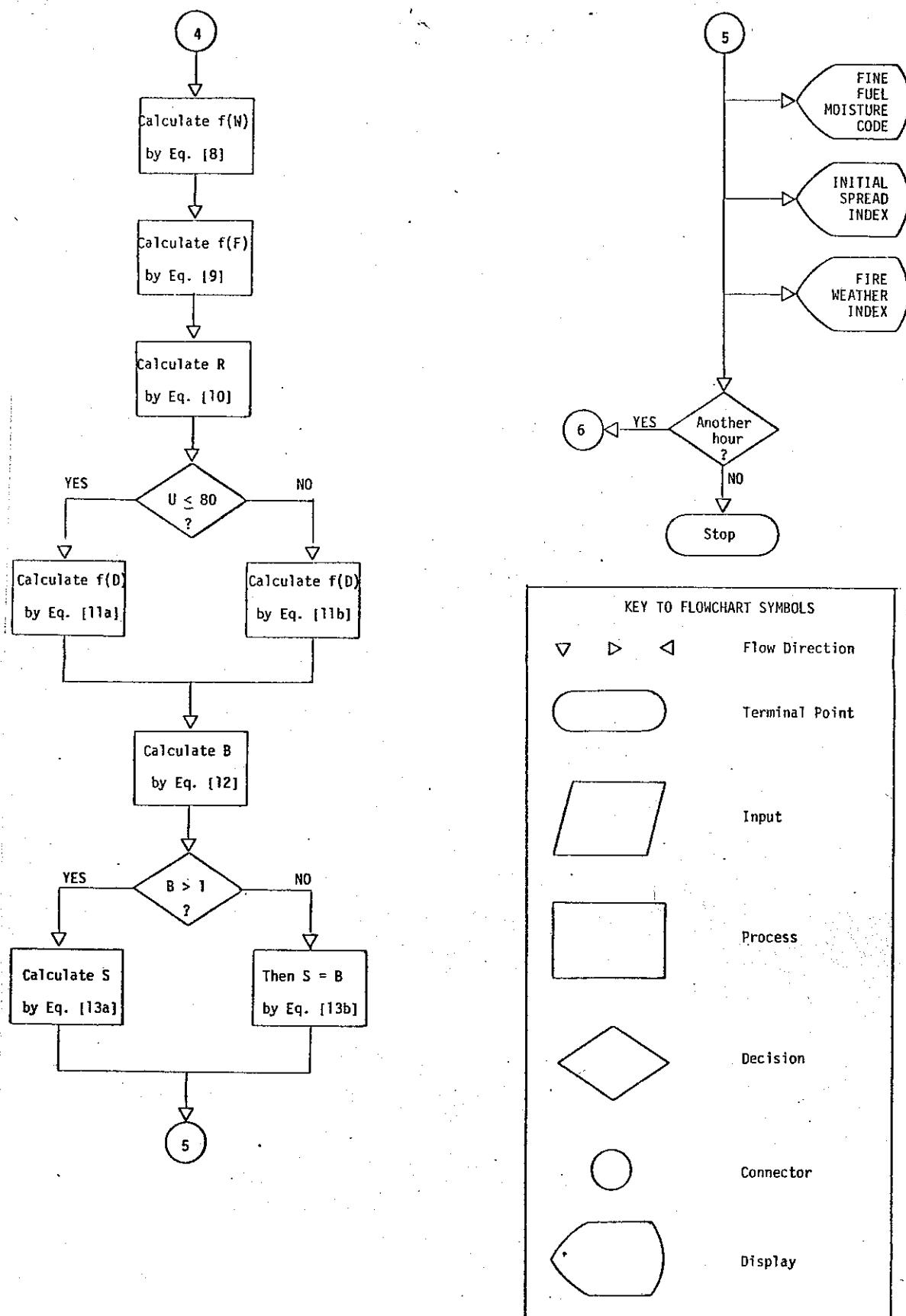


Figure 1b. Flow diagram for the TI-59 hourly forest fire danger program (fire behavior indexes subprogram) and symbol key.

LISTING OF PROGRAM STEPS

The program can be stored on four sides of two magnetic cards and should be labeled "HOURLY FOREST FIRE DANGER - Mk. III" and "CARDS 1 and 2" with fast-drying ink. The four sides should be labeled as well (sides 2 and 4 inverted):



Users are referred to sections IV-10, IV-21, V-52, VI-4, and VII-2 of the TI-59 Personal Programming Manual for programming and editing instructions, program key locations and codes, program listings and magnetic card writing.

In order to verify the program listing, the following example is provided. The fire weather observations and fire danger ratings (from Stocks 1975) are for a day (July 13) of major fire activity in 1974 near the town of Red Lake in northwestern Ontario.

From Table 5 of Stocks (1975): 1300 CDT FFMC on July 12 is 89.
0900 CDT Relative Humidity on July 13 is 35%.
Initial FFMC is 82 using the FFMC Diurnal Adjustment Table (Van Wagner 1972; Alexander 1982).

From Table 6 of Stocks (1975): Hourly weather data given in Table 2. No rain.

Table 2. Hourly computations of forest fire danger at Red Lake, Ontario, between 1000-1800 CDT on July 13, 1974.

Hour (CDT)	Dry-bulb temperature (°C)	Relative humidity (%)	Wind speed ¹ (km/h)	1-h rain (mm)	BUI	FFMC	ISI	FWI	m (%)
0900	23.9	35	22.5	0.0	32	82.0	-	-	-
1000	25.0	30	25.7	0.0	32	84.1	6.7	13.1	17.4
1100	25.6	32	25.7	0.0	32	85.7	8.4	15.5	15.6
1200	25.6	29	29.0	0.0	32	87.1	12.2	20.5	14.0
1300	25.6	28	32.2	0.0	36	88.4	17.1	27.5	12.6
1400	25.6	28	32.2	0.0	36	89.3	19.6	30.2	11.6
1500	25.0	29	29.0	0.0	36	90.0	18.3	28.9	10.9
1600	25.0	31	25.7	0.0	36	90.4	16.5	26.8	10.5
1700	24.4	34	19.3	0.0	36	90.6	12.2	21.8	10.3
1800	24.4	34	16.1	0.0	36	90.7	10.6	19.7	10.1

¹ As measured at a height of 10 m in the open on level terrain.

Program Steps 000-164

LOC	CODE	KEY	COMMENTS	LOC	CODE	KEY	COMMENTS	LOC	CODE	KEY	COMMENTS
0001	76	LBL		055	93	-		110	32	X:T	
001	11	A	Initiate Program	056	77	GE		111	43	RCL	
002	91	R/S		057	12	B		112	19	19	
003	42	STO	Enter F	058	06	6	Equation 7a calculate	113	22	INV	
004	01	01		059	93	-		114	77	GE	
005	76	LBL	Restart Program	060	08	9	m	115	22	INV	
006	14	R'		061	03	3		116	43	RCL	Equation 7b calculate
007	58	FIX		062	55	÷		117	05	05	
008	01	01		063	43	RCL		118	45	YX	
009	91	R/S	Enter data	064	05	05		119	93	-	
010	42	STO	- Temp (T)	065	94	+/-		120	05	5	
011	02	02		066	95	=		121	65	x	
012	91	R/S		067	22	INV		122	53	(
013	42	STO	- RH (H)	068	23	LNX		123	43	RCL	
014	03	03		069	94	+/-		124	19	19	
015	91	R/S		070	85	+		125	75	-	
016	42	STO	- Wind (W)	071	01	1		126	01	1	
017	04	04		072	85	=		127	05	5	
018	91	R/S		073	65	x		128	00	0	
019	42	STO	- Rain (r)	074	43	RCL		129	54	>	
020	05	05		075	05	05		130	65	x	
021	91	R/S		076	65	x		131	93	-	
022	42	STO	- BUI (U)	077	04	4		132	00	0	
023	06	06		078	02	2		133	00	0	
024	43	RCL	Equation 1 calculate	079	93	-		134	01	1	
025	01	01		080	05	5		135	05	5	
026	94	+/-		081	95	=		136	95	=	
027	85	+	m	082	42	STO		137	44	SUM	
028	01	1		083	07	07		138	00	00	
029	00	0		084	01	1		139	76	LBL	
030	01	1		085	00	0		140	22	INV	
031	95	=		086	00	0		141	43	RCL	
032	65	x		087	94	+/-		142	00	00	
033	01	1		088	55	÷		143	95	=	
034	04	4		089	53	x		144	44	SUM	
035	07	7		090	02	2		145	19	19	
036	93	.		091	05	5		146	76	LBL	Equation 2a
037	02	2		092	04	1		147	12	B	calculate
038	55	÷		093	75	-		148	43	RCL	E_d
039	53	x		094	43	RCL		149	03	03	
040	05	5		095	19	19		150	94	+/-	
041	03	9		096	54	2		151	65	x	
042	93	.		097	95	=		152	93	-	
043	04	5		098	22	INV		153	04	1	
044	85	+		099	23	LNX		154	01	1	
045	43	RCL		100	95	=		155	05	5	
046	01	01		101	65	x		156	95	=	
047	54	2		102	43	RCL		157	23	INV	
048	95	=		103	07	07		158	23	LNX	
049	42	STO		104	95	=		159	94	+/-	
050	19	19		105	42	STO		160	85	+	
051	43	RCL	Test for rain occurrence	106	00	00		161	01	1	
052	05	05		107	01	1	Test for m > 150	162	95	=	
053	32	X:T		108	05	5		163	65	x	
054	00	0		109	00	0		164	53	(

Program Steps: 165-329

LOC	CODE	KEY	COMMENTS	LOC	CODE	KEY	COMMENTS	LOC	CODE	KEY	COMMENTS
165	02	2	Equation 2a	220	67	EQ		275	43	RCL	
166	01	1	(continued)	221	13	C		276	03	.03	
167	93	.		222	77	GE		277	45	YX	
168	01	1		223	14	D		278	93	.	
169	75	-		224	43	RCL	Equation 2b	279	07	7	
170	43	RCL		225	03	03	calculate	280	05	5	
171	02	02		226	65	X	E	281	03	3	
172	54	Y		227	93	.	w	282	95	=	
173	65	X		228	01	1		283	65	X	
174	93	.		229	01	1		284	93	.	
175	01	1		230	05	5		285	06	6	
176	08	8		231	95	=		286	01	1	
177	95	=		232	94	+/-		287	08	8	
178	42	STD		233	22	INV		288	95	=	
179	10	10		234	23	LNX		289	44	SUM	
180	43	RCL		235	94	+/-		290	11	11	
181	03	03		236	85	+		291	43	RCL	Test for
182	75	-		237	01	1		292	11	11	m < E
183	01	1		238	95	=		293	32	XIT	o w
184	00	0		239	65	X		294	43	RCL	
185	00	0		240	53	<		295	19	19	
186	95	=		241	02	2		296	77	GE	
187	55	÷		242	01	1		297	13	C	
188	01	1		243	93	.		298	43	RCL	Equation 4a
189	00	0		244	01	1		299	03	03	calculate
190	95	=		245	75	-		300	94	+/-	k _b
191	22	INV		246	43	RCL		301	85	+	
192	23	LNX		247	03	02		302	01	1	
193	65	X		248	54	)		303	00	0	
194	01	1		249	65	X		304	00	0	
195	01	1		250	93	.		305	95	=	
196	95	=		251	01	1		306	55	÷	
197	44	SUM		252	08	8		307	01	1	
198	10	10		253	95	=		308	00	0	
199	43	RCL		254	42	STD		309	00	0	
200	03	03		255	11	11		310	95	=	
201	45	YX		256	43	RCL		311	45	YX	
202	93	.		257	03	03		312	08	8	
203	08	6		258	75	-		313	95	=	
204	07	7		259	01	1		314	94	+/-	
205	09	9		260	00	0		315	85	+	
206	95	=		261	00	0		316	01	1	
207	65	X		262	95	=		317	95	=	
208	93	.		263	55	÷		318	65	X	
209	09	9		264	01	1		319	53	<	
210	04	4		265	00	0		320	43	RCL	
211	02	2		266	95	=		321	04	04	
212	95	=		267	22	INV		322	45	YX	
213	44	SUM		268	23	LNX		323	93	.	
214	10	10		269	65	X		324	05	5	
215	43	RCL	Test for	270	01	1		325	54	÷	
216	10	10	m > E	271	00	0		326	65	X	
217	32	XIT	o d	272	95	=		327	93	.	
218	43	RCL		273	44	SUM		328	00	0	
219	19	19		274	11	11		329	06	6	

Program Steps: 330-494

LOC	CODE	KEY	COMMENTS	LOC	CODE	KEY	COMMENTS	LOC	CODE	KEY	COMMENTS
330	09	9	Equation 4a	385	95	=		440	65	X	
331	04	4	(continued)	386	42	STO	Equation 5b	441	53	(
332	95	=		387	15	15	calculate	442	43	RCL	
333	42	STO		388	65	X	m	443	04	04	
334	14	14		389	02	2		444	45	YX	
335	43	RCL		390	93	.		445	93	.	
336	03	03		391	03	3		446	05	5	
337	94	+/-		392	00	0		447	54)	
338	85	+		393	03	3		448	65	X	
339	01	1		394	94	+/-		449	93	.	
340	00	0		395	95	=		450	00	0	
341	00	0		396	22	INV		451	06	6	
342	95	=		397	23	LNX		452	09	9	
343	55	÷		398	65	X		453	04	4	
344	01	1		399	53	(		454	95	=	
345	00	0		400	43	RCL		455	42	STO	
346	00	0		401	11	11		456	16	16	
347	95	=		402	75	-		457	43	RCL	
348	45	YX		403	43	RCL		458	03	03	
349	01	1		404	19	19		459	55	÷	
350	93	.		405	54	)		460	01	1	
351	07	7		406	95	=		461	00	0	
352	95	=		407	94	+/-		462	00	0	
353	94	+/-		408	85	+		463	95	=	
354	85	+		409	43	RCL		464	45	YX	
355	01	1		410	11	11		465	01	1	
356	95	=		411	95	=		466	93	.	
357	65	X		412	42	STO		467	03	7	
358	93	.		413	09	09		468	95	=	
359	04	4		414	61	GTO		469	94	+/-	
360	02	2		415	17	B		470	85	+	
361	04	4		416	76	LBL	If $m_0 > E$	471	01	1	
362	95	=		417	13	C	then w	472	95	=	
363	44	SUM		418	43	RCL	$m = m_0$	473	65	X	
364	14	14		419	09	09		474	93	.	
365	43	RCL	Equation 4b	420	42	STO		475	04	4	
366	04	02	calculate	421	09	09		476	02	2	
367	65	X	k_w	422	61	GTO		477	04	4	
368	93	.		423	17	B		478	95	=	
369	00	0		424	76	LBL	Equation 3a	479	44	SUM	
370	03	3		425	14	D	calculate	480	16	16	
371	06	6		426	43	RCL	k_a	481	43	RCL	Equation 3b
372	05	5		427	03	03		482	02	02	calculate
373	95	=		428	55	÷		483	65	X	k_d
374	22	INV		429	01	1		484	93	.	
375	23	LNX		430	00	0		485	00	0	
376	65	X		431	00	0		486	03	3	
377	43	RCL		432	95	=		487	06	6	
378	14	14		433	45	YX		488	05	5	
379	65	X		434	08	8		489	95	=	
380	93	.		435	95	=		490	22	INV	
381	00	0		436	94	+/-		491	23	LNX	
382	05	5		437	85	+		492	65	X	
383	07	7		438	01	1		493	43	RCL	
384	09	9		439	95	=		494	16	16	

Program Steps: 495-695

LOC	CODE	KEY	COMMENTS	LOC	CODE	KEY	COMMENTS	LOC	CODE	KEY	COMMENTS
495	65	X	Equation 3b	550	93	.		605	00	0	
496	93	.	(continued)	551	02	2		606	00	0	
497	00	0		552	85	+		607	00	0	
498	05	5		553	43	RCL		608	00	0	
499	07	7		554	09	09		609	00	0	
500	09	9		555	54	)		610	95	=	
501	95	=		556	95	=		611	85	+	
502	42	STO	Equation 5a	557	42	STO		612	01	1	
503	17	17	calculate	558	01	01		613	95	=	
504	65	X	m	559	43	RCL	Equation 8	614	65	X	
505	02	2		560	04	04	calculate	615	43	RCL	
506	93	.		561	65	X	f(w)	616	13	13	
507	03	3		562	93	.		617	95	=	
508	00	0		563	00	0		618	65	X	Equation 10
509	03	3		564	05	5		619	43	RCL	calculate
510	94	+/-		565	00	0		620	07	07	R (ISI)
511	95	=		566	03	3		621	65	X	
512	22	INV		567	09	9		622	93	.	
513	23	LNX		568	95	=		623	02	2	
514	65	X		569	22	INV		624	00	0	
515	53	(		570	23	LNX		625	08	8	
516	43	RCL		571	42	STO		626	95	=	
517	19	19		572	03	07		627	42	STO	
518	75	-		573	43	RCL	Equation 9	628	07	07	
519	43	RCL		574	09	09	calculate	629	43	RCL	Test for
520	10	10		575	94	+/-	f(F)	630	06	06	U < 80
521	54	)		576	65	X		631	95	=	
522	95	=		577	93	.		632	32	XIT	
523	65	+		578	01	1		633	08	8	
524	43	RCL		579	03	3		634	00	0	
525	10	10		580	08	8		635	77	GE	
526	95	=		581	06	6		636	15	E	
527	42	STO		582	95	=		637	43	RCL	Equation
528	09	09		583	22	INV		638	06	06	11b
529	76	LBL	Equation 6	584	23	LNX		639	65	X	calculate
530	17	B*	calculate	585	65	X		640	93	.	f(D)
531	43	RCL	F	586	09	9		641	00	0	
532	09	09		587	01	1		642	02	2	
533	94	+/-		588	93	.		643	03	3	
534	85	+		589	09	9		644	94	+/-	
535	02	2		590	95	=		645	95	=	
536	05	5		591	42	STO		646	22	INV	
537	00	0		592	13	13		647	23	LNX	
538	95	=		593	43	RCL		648	65	X	
539	65	X		594	09	09		649	01	1	
540	05	5		595	45	YX		650	00	0	
541	09	9		596	05	5		651	08	8	
542	93	.		597	93	.		652	93	.	
543	05	5		598	03	3		653	06	6	
544	95	=		599	01	1		654	04	4	
545	55	+		600	95	=		655	95	=	
546	53	(		601	55	+		656	85	+	
547	01	1		602	04	4		657	02	2	
548	04	4		603	09	9		658	05	5	
549	07	7		604	03	3		659	95	=	

Program Steps: 660-746

LOC	CODE	KEY	COMMENTS	LOC	CODE	KEY	COMMENTS
660	35	1/X	Equation	715	06	6	
661	65	X	11b	716	04	4	
662	01	1	(continued)	717	07	7	
663	00	0		718	95	=	
664	00	0		719	65	X	
665	00	0		720	02	2	
666	95	=		721	93	.	
667	42	STO		722	02	7	
668	08	08		723	02	2	
669	18	C'		724	95	=	
670	76	LBL	Equation	725	22	INV	
671	15	E	11a	726	23	LNX	
672	43	RCL	calculate	727	42	STO	
673	08	06	f(D)	728	08	08	
674	45	YX		729	10	E'	
675	93	.		730	76	LBL	Equation
676	08	8		731	19	D'	13b
677	00	0		732	32	X:T	S=B (FWI)
678	09	9		733	42	STO	
679	95	=		734	08	08	
680	65	X		735	76	LBL	Display
681	93	.		736	10	E'	results
682	08	6		737	43	RCL	
683	02	2		738	01	01	
684	06	6		739	95	=	- FFMC
685	85	+		740	91	R/S	
686	02	2		741	43	RCL	
687	95	=		742	07	07	- ISI
688	42	STO		743	91	R/S	
689	08	08		744	43	RCL	
690	76	LBL	Equation	745	08	08	- FWI
691	18	C'	12	746	91	R/S	
692	43	RCL	calculate				
693	08	08	B				
694	65	X					
695	43	RCL					
696	07	07					
697	65	X					
698	93	.					
699	01	1					
700	95	=					
701	32	X:T	Test for				
702	01	1	B > 1				
703	77	GE					
704	19	D'					
705	32	X:T	Equation				
706	23	LNX	13a				
707	65	X	calculate				
708	93	.	S (FWI)				
709	04	4					
710	03	3					
711	04	4					
712	95	=					
713	45	YX					
714	93	.					

Card No. Side No. Step Nos.

- | | | |
|---|---|---------|
| 1 | 1 | 000-239 |
| 1 | 2 | 240-479 |
| 2 | 3 | 480-719 |
| 2 | 4 | 720-746 |

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NOTE

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