

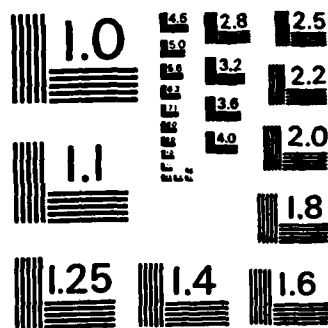
KWIK SMOKE OBSCURATION MODEL: USER'S GUIDE(U) ARMY
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**KWIK SMOKE OBSCURATION MODEL:
USER'S GUIDE**

by

Ricardo Peña

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A
US Army Electronics Research and Development Command
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White Sands Missile Range, NM 88002

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The KWIK smoke obscuration model, developed by the Atmospheric Sciences Laboratory, is available in eight versions. The following desktop computers are used to run the KWIK algorithms: HP9830A, HP9825A (with three versions), HP85, HP9845, and the APPLE II. A FORTRAN IV version is also available. All of these versions are basically the same, with the exception of the volume of fire table version, which runs on the HP9825A. This version produces munition		

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INTRODUCTION

The KWIK smoke obscuration model has been described in an earlier report.¹ The algorithm has been developed from well-known and easily used principles of micrometeorology, atmospheric optics, turbulence, and diffusion. The general approach for formulating the model is based upon a study by Downs² for the atmospheric optics portion, Gaussian plume and puff hypotheses as discussed by Gifford³ and Pasquill,⁴ and atmospheric stability criteria extracted from Pasquill,⁵ Turner,⁶ and Smith.⁷

The KWIK algorithm is designed to calculate munition expenditures for finite screen lengths and times, based upon ambient meteorological conditions, as a function of the optical pathlength from observer to target. The diffusion portion of the model treats both semi-continuous point source plumes and quasi-instantaneous point source puffs. Chemically generated military smokes considered are hexachloroethane (HC) and bulk white phosphorus (WP).

Munition expenditure estimates are presented in terms of the following parameters:

Weapons system/number,
Screen length in meters,
Screen duration in minutes,
Rate of fire (in rounds/minute),

¹Umstead, R. K., R. Pena, and F. V. Hansen, KWIK: An Algorithm for Calculating Munition Expenditures for Smoke Screening/Obscuration in Tactical Situations, ASL-TR-0030, US Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM, 1979.

²Downs, A. R., A Review of Atmospheric Transmission Information in the Optical and Microwave Spectral Regions, Report 2710, Ballistic Research Laboratory, Aberdeen Proving Ground, MD, 1976.

³Gifford, F. A., Jr., "An Outline of Theories of Diffusion in the Lower Layers of the Atmosphere," Meteorology and Atomic Energy (D. H. Slade, ed), US Atomic Energy Commission, Washington, DC, 1968.

⁴Pasquill, F., Atmospheric Diffusion, 2nd Ed., Halsted Press, Division of John Wiley & Sons, New York, 1974.

⁵Pasquill, F., "The Estimation of the Dispersion of Windborne Material," Meteorol Mag, Vol, 90, 1961.

⁶Turner, D. B., "A Diffusion Model for Urban Area," J Appl Meteorol, 3:83, 1964.

⁷Smith, F. B., "A Scheme for Estimating the Vertical Dispersion of a Plume from a Source Near Ground-Level," 1973 (unpublished Meteorological Office Note).

Impact separations from adjustment point,
Number of rounds to establish screen,
Number of rounds to maintain screen, and
Total expenditures.

The KWIK algorithm is available in eight versions:

HP 9830A with printer output
HP 9825A with printer output,
HP 9825A CRT version,
Fortran IV version,
HP 85 with printer output,
HP 9845 with printer output,
HP 9825A volume of fire table, and
APPLE II version.

All the algorithms except the volume of fire table version are very similar.

The specifications of the storage medium required by each computer that uses the KWIK algorithms are as follows:

(a) The HP 9830A uses a Hewlett-Packard digital cassette number 9162-0050 or equivalent. The data or program storage capacity is 64,000 bytes. The information on the cassette tape may be protected by removing or sliding both tabs to the top of the cassette so that an opening at each end is created.

(b) The HP 9825A uses a Hewlett-Packard tape cartridge number 9162-0061 or equivalent. The tape is structured with two tracks (0 and 1), which may be used to store programs, data, and instructions for special function keys. The storage capacity of the tape cartridge is 225,000 bytes. To prevent erasures, the record slide tab must be in the leftmost position.

(c) On the UNIVAC 1108 or equivalent (FORTRAN IV Version) the KWIK algorithm may be stored on standard IBM computer cards, card image mass storage, or magnetic tape units compatible with the computer being used.

(d) The HP 85 and 9845 use the same tape cartridge used with the HP 9825. Programs are stored in 256-byte physical records. The maximum number of bytes per record is 32,767.

(e) On the APPLE II a 5-in floppy disk (capacity 931,000 bits) is used to load and store the KWIK algorithm. An APPLE computer with APPLE Disk II, DOS Version 3.2.1 is used.

USER'S INSTRUCTIONS

This section of the user's guide is divided into eight parts, to provide instructions for calculating munition expenditure estimates for the eight versions of the KWIK algorithm.

Part 1: HP 9830A Version

The algorithm has been prepared in BASIC language for the HP 9830A programmable desk calculator, which must contain a String Variable Read Only Memory (ROM) and a minimum of 3808 words of Random Access Memory (RAM). The KWIK program is recorded on cassette tape files 0 through 3. After inserting the cassette in the loader and rewinding the tape, the first file (file 0) is loaded by executing the command "LOAD 0." When the file has been loaded, press the "RUN" and "EXECUTE" buttons. The type of format used for the required inputs is query/response. The "EXECUTE" button is depressed after each program input entry. At the end of each file execution the calculator display will show "LINK (File No.)." The "LINK (File No.)" command will load the corresponding file, conserving the values of the parameters in common throughout the program.

The program inputs are in the following query/response sequence:

SITE PARAMETERS

- (1) Site identification, four characters;
- (2) Latitude, in degrees and tenths;
- (3) Direction from equator, North (N) or South (S);
- (4) Longitude, in degrees and tenths;
- (5) Direction from Greenwich, East (E) or West (W);
- (6) Altitude above MSL, kilometers and tenths;
- (7) Julian date, three digits;
- (8) Greenwich Civil time, nearest hour;

METEOROLOGICAL PARAMETERS

- (9) Ceiling height, feet;
- (10) Cloud cover, percent;
- (11) Visibility, miles;
- (12) Precipitation (Yes = 1; No = 0);
- (13) Ambient air temperature, degrees Fahrenheit;

- (14) Dewpoint temperature, degrees Fahrenheit
- (15) Wind direction, degrees;
- (16) Windspeed, knots;

SCENARIO PARAMETERS

- (17) Average roughness element, centimeters;
- (18) Slant range to target, kilometers;
- (19) Angle (with the horizontal) of sight to target, degrees;
- (20) Direction (from north) of line of sight, degrees;
- (21) Smoke screen length, meters; and
- (22) Smoke screen duration, minutes.

All English input units are converted by the program to the metric system. The algorithm also calculates the relative humidity in percent and the Pasquill stability category (A through F).

The program outputs are displayed on the HP9866A printer after the execution of each file. The output sequence is listed in the sample computation shown in tables 1 through 5. For visible and near infrared wavelengths the munition expenditures (impact separations for initial and sustaining volleys for the 105- and 155-mm howitzers) are displayed on the printer for HC and WP smoke. The mid and far infrared wavelength expenditures are printed only for WP smoke. The output will also list the number of guns required for initial and sustaining volleys, the rate of fire in rounds per minute, and the total rounds required. The number rounds required per 60-m unit screen length are printed for the mid and far infrared wavelengths.

Appendix A lists a glossary of mnemonics for identifying the BASIC language symbology used by the HP-9830A KWIK program. Given in Appendix B is the BASIC program listing.

Part 2: HP 9825A Printer Output Version

The KWIK algorithm has also been programmed in the Hewlett-Packard Language (HPL) for the HP 9825A programmable calculator. The site, meteorological and scenario input parameters are identical to those of part 1, with the following exceptions:

- (9) Ceiling height, meters;
- (11) Visibility, kilometers;
- (13) Ambient air temperature, degrees Celsius; and
- (14) Dewpoint temperature, degrees Celsius.

In order to execute the program, the HP 9825A calculator must contain the following ROMs: String, Advanced Programming, and General I/O; also a minimum of 23,228 bytes of RAM is required. The KWIK program is recorded on data cartridge track 0, file 3. It may be recorded on other files of track 0 or 1 as a redundancy backup option.

After the cartridge is inserted in the loader, the program is loaded by depressing the "LOAD" and then the number 3 or by typing in the characters "ldf3" and then depressing the "EXECUTE" key. Once the program file has been loaded, press the "RUN" key. The query/response method is used for the input parameters. The "CONTINUE" key must be depressed after each entry. The program outputs are displayed on the paper tape printer, integral to the HP 9825A calculator, in the same sequence as shown in tables 1 through 5. A glossary of mnemonics appears in appendix C, and the program listing as appendix D.

Part 3: The HP 9825A CRT Version

The CRT version program is designed for solution on the HP 9825A programmable calculator using the following peripherals: (1) HP 1350A Graphics Translator and HP 1311A Display (CRT) and (2) HP 9871 Impact Printer. The input parameters are identical to those listed for the HP 9830A (part 1).

In order to execute the algorithm, the calculator must contain the String, Advanced Programming, and General I/O ROMs and a minimum of 23,228 bytes of RAM. As in the HP 9825A Printer version, the algorithm for the CRT version of KWIK is recorded on tape cartridge track 0, file 3. It may also be recorded on other files of tracks 0 or 1 as a redundancy backup option. The tape cartridge is loaded and the algorithm executed in the same manner as described in part 2.

The output of the KWIK program is displayed on the HP 1311A Display (CRT) and the HP 9871A printer. First to be displayed on the CRT are the list of inputs and the calculated stability category and relative humidity value. To continue viewing the output simply press "CONTINUE." (The calculator will display "CONTINUE WHEN READY.") For visible and near infrared wavelengths, the munition expenditure data (shell spacing for initial and sustaining volleys for 105- and 155-mm howitzers) is displayed for HC and WP smoke. The mid and far infrared wavelength data are displayed for WP smoke only. The output will also display the number of guns required for initial and sustaining volleys, the rate of fire in rounds per minute, and the total number of smoke rounds required. The number of rounds required per 60-m shell spacing (for 105- and 155-mm howitzers) are displayed for mid and far infrared wavelengths. At the end of the displayed output, the operator has the option of ending the program output or printing it on the HP 9871A printer. (The calculator will display, "0 TO EXIT - 1 to PRINT.") Pressing a "1" will cause the printer to print the same output displayed on the CRT. A sample of this output is listed in tables 1 through 5. Appendices E and F contain the HPL CRT KWIK glossary of mnemonics and the HPL program listing, respectively.

Part 4: The FORTRAN Version

The FORTRAN version of the KWIK algorithm is programmed in FORTRAN IV language and can be executed on most FORTRAN V compatible computers. The 22 inputs are

identical to those described in Part 1. The format for all input parameters (IBM card or card image input) is F10.0, with the following exceptions, which have a character format (a maximum of four characters):

- (1) Site identification,
- (3) Direction from equator,
- (5) Direction from Greenwich, and
- (12) Precipitation.

All inputs are converted by the program to the metric system. The algorithm also calculates the relative humidity in percent and the Pasquill stability category (A through F).

The computer output is displayed in the same fashion as shown for the HP 9825A CRT KWIK in tables 1 through 5. Appendix G shows a glossary of the FORTRAN mnemonics and appendix H contains a listing of the FORTRAN algorithm.

Part 5: HP 85 Version

The HP 85 desktop computer is the most compatible with the KWIK algorithm. It is fully integrated (keyboard, CRT display, CPU, magnetic tape unit, and thermal printer) in one small package, with 32K bytes of extended memory. The KWIK version for the HP85 is programmed in BASIC language.

The program is loaded into memory from an HP 200 or equivalent data cartridge by pressing the "LOAD" key and then typing "KWIK0" (or "KWIK1"), followed by pressing the "END LINE" key. To run the program, press the "RUN" key. The query/response method is then used to enter the 22 program inputs, as listed in part 1.

The output is displayed on the HP 85's own 4.5-in wide printer in the same fashion as shown in tables 1 through 5. Appendix I lists a glossary of mnemonics for identifying the BASIC language symbology used by the HP 85 KWIK algorithm. Appendix J shows the corresponding KWIK BASIC program listing.

Part 6: HP 9845 Version

The HP 9845 KWIK version is a BASIC algorithm similar to the HP 85 version. The program may be loaded into memory from a mass storage device, such as T15, the standard mass storage device for the HP 9845. Insert the magnetic tape cartridge in the T15 slot, press the "LOAD" key, type the "KWIK 45" file name, and press the "EXECUTE" key. To run the program, press the "RUN" key, and the query/response method is then used to enter the 22 program inputs, as listed in part 1.

The output is printed on the internal 80-character line printer unless a "PRINTER IS select code [, HP-IB device address]" command is executed from either the program or the keyboard. (The select code identifies the type of device at the specified address.) Select code 16 is used for the CRT. If an

external printer is desired, its corresponding select code and HP-IB device address must be used. Appendix I contains a glossary of mnemonics for the BASIC HP 9845 algorithm, and appendix K contains the corresponding KWIK program listing.

Part 7: The APPLE II version of KWIK is programmed in Applesoft BASIC language. It is almost identical to the HP85 and HP9845 versions. The APPLE Disk II, with 931,000 bits capacity, is used to load the algorithm in the APPLE computer memory (65K bytes capacity). This is done by typing the words "LOAD KWIK" and depressing the "RETURN" key. To run the program, "RUN" and "RETURN" are pressed. As with the other versions, the query/response method is used to enter the 22 inputs listed in part 1, with the following exceptions: (3) North = 1 and South = -1, and (5) West = 1 and East = -1.

The output may be displayed on any CRT screen or printer external to the APPLE II.

Appendix I lists a glossary of mnemonics identifying the APPLE II BASIC language symbology. Some minor differences between APPLE II and HP BASIC are noted. Appendix L contains a listing of the APPLE II BASIC algorithm.

Part 8: Volume of Fire Tables

The algorithm that produces munition expenditure tables is programmed (in HPL) for the HP 9825A programmable calculator. The algorithm requires the use of the same RAM and ROMs used for the other HP 9825A versions of KWIK (see part 3). The volume of fire tables algorithm is recorded on tape cartridge track 0, file 6. It may also be recorded on other files of tracks 0 or 1 as a backup option.

The tape cartridge is loaded and the algorithm executed in the same manner as described in part 2. The only required inputs are those for ambient temperature (degrees Fahrenheit) and relative humidity. Seven other meteorological and site parameters are fixed, but can easily be changed. The choices of relative humidity input values are 15, 40, and 80. After entering the relative humidity value (15 is the default if none is entered) and depressing the "CONTINUE" key, volume of fire tables for 105- and 155-mm howitzers are printed on the HP 9871 Impact Printer for HC WP smoke for visible and near infrared wavelengths.

The tables printed for HC smoke contain seven screen lengths ranging from 200 to 2,000 m and duration of effective smoke screen ranging from 5 to 35 min. For WP smoke the tables show five screen lengths ranging from 100 to 600 m and the duration of effective smoke from 5 to 25 min. Each Pasquill stability category (A through F) is shown with its respective windspeed in knots. The munition expenditures (volume of fire) data are computed in number of (105 or 155-mm howitzer) rounds for quartering wind. Rounds in area shown as \$\$\$ exceed rate of fire of weapon or battery. Tables 6 through 8 show samples of the output produced by the volume of fire algorithm for HC and WP smoke (for 72°F temperature and 15, 40, and 80 percent relative humidity). Appendices M and N, respectively, show a list of the algorithm mnemonics and the program listing in HPL language for the volume of fire tables version.

ADDENDUM

SPECIAL NOTE

Under certain atmospheric conditions, an output of "0 rounds" may result. This output indicates that no smoke munitions are required for screening, due to such conditions as atmospheric absorption, haze and fog, or precipitation. When certain versions of the KWIK algorithm are used in these situations, a warning signal may be encountered as the computer attempts to print the output. The following additions to the indicated KWIK algorithms will avert such warning signals.

HP 9830A: Line "455 L(I,K) = 0" on file 3 (shell spacing - WP smoke)

HP 85: Line "4975 L(I,K) = 0"

HP 9845: Line "4195 L(I,K) = 0"

APPLE II: Line "2765 L(I,K) = 0"

TABLE 1. BASIC INPUT PARAMETERS FOR KWIK ALGORITHM

MUNITION EXPENDITURES
FOR HC AND WP SMOKE

TD		=	WSD
LATITUDE	- DEG	=	N 32.00
LONGITUDE	- DEG	=	W106.00
ALTITUDE	- KM	=	1.30
JULIAN DATE	- DAY	=	236
ZULU TIME	- HOUR	=	15
CEILING	- METERS	=	3040.00
CLOUD COVER	- PERCENT	=	20.00
VISIBILITY	- KM	=	40.25
PRECIPITATION		=	NO
TEMPERATURE	- DEG C	=	22.22
DEW POINT	- DEG C	=	18.61
WIND DIRECTION	- DEG	=	270.00
WIND SPEED	- KNOTS	=	15.00
AVE ROUGHNESS ELEMENT	- CM	=	74.00
PASQUILL STABILITY CATEGORY		=	D
RELATIVE HUMIDITY		=	80.03

TABLE 2. MUNITION EXPENDITURES FOR VISIBLE WAVELENGTHS

VISIBLE:

		METERS	MINUTES
SCREEN LENGTH/DURATION.	400		10

HC SMOKE SCREEN

105MM HOWITZER

VOLLEY	GUNS	RATE/ MIN	SPACING METERS	ROUNDS
INITIAL	19		21	
SUSTAINING	19	0.5	21	95

155MM HOWITZER

VOLLEY	GUNS	RATE/ MIN	SPACING METERS	ROUNDS
INITIAL	3		138	
SUSTAINING	3	0.5	138	15

WP SMOKE SCREEN

105MM HOWITZER

VOLLEY	GUNS	RATE/ MIN	SPACING METERS	ROUNDS
INITIAL	5		90	
SUSTAINING	5	3.0	90	150

155MM HOWITZER

VOLLEY	GUNS	RATE/ MIN	SPACING METERS	ROUNDS
INITIAL	2		269	
SUSTAINING	2	3.0	269	30

TABLE 3. MUNITION EXPENDITURES FOR NEAR INFRARED WAVELENGTHS

SCREEN LENGTH/DURATION. METERS MINUTES
400 10

HC SMOKE SCREEN

105MM HOWITZER

VOLLEY	GUNS	RATE/ MIN	SPACING METERS	ROUNDS
INITIAL:	50		8	
SUSTAINING:	50	0.5	8	250

155MM HOWITZER

VOLLEY	GUNS	RATE/ MIN	SPACING METERS	ROUNDS
INITIAL:	8		52	
SUSTAINING:	8	0.5	52	40

WP SMOKE SCREEN

105MM HOWITZER

VOLLEY	GUNS	RATE/ MIN	SPACING METERS	ROUNDS
INITIAL:	6		77	
SUSTAINING:	6	3.0	77	180

155MM HOWITZER

VOLLEY	GUNS	RATE/ MIN	SPACING METERS	ROUNDS
INITIAL:	2		230	
SUSTAINING:	2	3.0	230	30

TABLE 4. MUNITION EXPENDITURES FOR MID INFRARED WAVELENGTHS

MID IR:

	METERS	MINUTES
SCREEN LENGTH/DURATION:	400	10

WP SMOKE SCREEN

	ROUNDS/ 60 METERS	RATE/ MINUTE	TOTAL ROUNDS
105MM:	4	3.0	890
155MM:	2	3.0	445

TABLE 5. MUNITION EXPENDITURES FOR FAR INFRARED WAVELENGTHS

FAR IR:

	METERS	MINUTES
SCREEN LENGTH/DURATION:	400	10

WP SMOKE SCREEN

	ROUNDS/ 60 METERS	RATE/ MINUTE	TOTAL ROUNDS
105MM	6	3.0	1334
155MM:	2	3.0	445

TABLE 6A. VOLUME OF FIRE TABLES AS A FUNCTION OF RELATIVE HUMIDITY AND PASQUILL CATEGORY

[illegible]

1. CALCULATED FOR VISIBLE LIGHT WAVELENGTHS: 0.4 TO 0.7 MICROMETERS.
2. DATA COMPUTED IN NUMBER OF ROUNDS FOR QUARTERING WIND. FOR CROSSWIND MULTIPLY THE EXTRACTED NUMBER OF ROUNDS BY 0.7. FOR HEADWIND OR TAIL WIND CONDITION, MULTIPLY EXTRACTED NUMBER OF ROUNDS BY 2.6
3. NUMBERS ASSOCIATED WITH PASQUILL STABILITY CATEGORY; WIND SPEED IN KNOTS.
4. ROUNDS IN SHADED (SHOWN AS \$\$\$) AREA EXCEED RATE OF FIRE OF WEAPON/BATTERY.
5. MINUTES INDICATE DURATION OF EFFECTIVE SMOKE.

TABLE 6B. VOLUME OF FIRE TABLES AS A FUNCTION OF
RELATIVE HUMIDITY AND PASQUILL CATEGORY

SCREEN(M) MINUTES STABILITY		VOLUME OF FIRE TABLE - WP SMOKE SCREEN; 10% < RELATIVE HUMIDITY < 20%																			
		100				200				300				400				600			
		5	10	15	20	5	10	15	20	5	10	15	20	10	15	20	25	10	15	20	25
		105mm HOWITZER																			
A/ 5	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
B/ 8	90	180	270	360	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
C/10	60	120	180	240	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
D/15	45	90	135	180	75	150	225	300	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
E/ 8	20	40	60	80	30	60	90	120	40	80	120	160	100	150	200	250	140	210	280	350	
F/ 6	20	40	60	80	30	60	90	120	40	80	120	160	100	150	200	250	140	210	280	350	

SCREEN(M) MINUTES STABILITY		VOLUME OF FIRE TABLE - WP SMOKE SCREEN; 10% < RELATIVE HUMIDITY < 20%																			
		100				200				300				400				600			
		5	10	15	20	5	10	15	20	5	10	15	20	10	15	20	25	10	15	20	25
		155mm HOWITZER																			
A/ 5	23	45	68	90	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
B/ 8	30	60	90	120	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
C/10	30	60	90	120	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
D/15	15	30	45	60	30	60	90	120	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
E/ 8	8	16	23	31	11	21	31	41	14	27	39	52	32	47	62	77	43	63	83	103	
F/ 6	8	16	23	31	11	21	31	41	14	27	39	52	32	47	62	77	43	63	83	103	

1. CALCULATED FOR VISIBLE LIGHT WAVELENGTHS: 0.4 TO 0.7 MICROMETERS.
2. DATA COMPUTED IN NUMBER OF ROUNDS FOR QUARTERING WIND. FOR OTHER WIND DIRECTIONS THERE IS NO SIGNIFICANT DIFFERENCE IN NUMBER OF ROUNDS REQUIRED.
3. NUMBERS ASSOCIATED WITH PASQUILL STABILITY CATEGORY; WIND SPEED IN KNOTS.
4. ROUNDS IN SHADED (SHOWN AS \$\$\$) AREA EXCEED RATE OF FIRE OF WEAPON/BATTERY.
5. MINUTES INDICATE DURATION OF EFFECTIVE SMOKE.

TABLE 6C. VOLUME OF FIRE TABLES AS A FUNCTION OF
RELATIVE HUMIDITY AND PASQUILL CATEGORY

SCREEN (M) MINUTES STABILITY	VOLUME OF FIRE TABLE - HC SMOKE SCREEN; 10% < RELATIVE HUMIDITY < 20%											
	200				400				600			
	5	10	15	20	10	15	20	25	10	15	20	25
A/ 5	90	180	270	360	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
B/ 8	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
C/10	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
D/15	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
E/ 8	43	85	128	170	165	248	330	413	\$\$\$	\$\$\$	\$\$\$	\$\$\$
F/ 6	18	35	53	70	65	98	130	163	95	143	190	238

SCREEN (M) MINUTES STABILITY	VOLUME OF FIRE TABLE - 105mm HOWITZER											
	200				400				600			
	5	10	15	20	10	15	20	25	10	15	20	25
A/ 5	20	40	60	80	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
B/ 8	20	40	60	80	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
C/10	23	45	68	90	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
D/15	25	50	75	100	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
E/ 8	8	15	23	30	25	38	50	63	35	53	70	88
F/ 6	4	6	9	11	11	16	21	26	17	25	32	40

1. CALCULATED FOR NEAR IR WAVELENGTHS: .75 TO 2.5 MICROMETERS.
2. DATA COMPUTED IN NUMBER OF ROUNDS FOR QUARTERING WIND. FOR CROSSWIND MULTIPLY THE EXTRACTED NUMBER OF ROUNDS BY 0.7. FOR HEADWIND OR TAIL WIND CONDITION, MULTIPLY EXTRACTED NUMBER OF ROUNDS BY 2.6
3. NUMBERS ASSOCIATED WITH PASQUILL STABILITY CATEGORY; WIND SPEED IN KNOTS.
4. ROUNDS IN SHADED (SHOWN AS \$\$\$) AREA EXCEED RATE OF FIRE OF WEAPON/BATTERY.
5. MINUTES INDICATE DURATION OF EFFECTIVE SMOKE.

TABLE 6D. VOLUME OF FIRE TABLES AS A FUNCTION OF
RELATIVE HUMIDITY AND PASQUILL CATEGORY

SCREEN(M) MINUTES STABILITY	VOLUME OF FIRE TABLE - WP SMOKE SCREEN; 10% RELATIVE HUMIDITY <20%											
	100				200				300			
	5	10	15	20	5	10	15	20	5	10	15	20
A/ 5	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
B/ 8	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
C/10	75	150	225	300	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
D/15	45	90	135	180	90	180	270	360	\$\$\$	\$\$\$	\$\$\$	\$\$\$
E/ 8	30	60	90	120	50	100	150	200	70	140	210	280
F/ 6	30	60	90	120	50	100	150	200	70	140	210	280

SCREEN(M) MINUTES STABILITY	VOLUME OF FIRE TABLE - WP SMOKE SCREEN; 10% RELATIVE HUMIDITY <20%											
	100				200				300			
	5	10	15	20	5	10	15	20	5	10	15	20
A/ 5	30	60	90	120	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
B/ 8	30	60	90	120	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
C/10	30	60	90	120	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
D/15	15	30	45	60	30	60	90	120	\$\$\$	\$\$\$	\$\$\$	\$\$\$
E/ 8	10	20	30	40	15	30	45	60	20	40	60	80
F/ 6	10	20	30	40	15	30	45	60	20	40	60	80

1. CALCULATED FOR NEAR IR WAVELENGTHS: .75 TO 2.5 MICROMETERS.

2. DATA COMPUTED IN NUMBER OF ROUNDS FOR QUARTERING WIND.
FOR OTHER WIND DIRECTIONS THERE IS NO SIGNIFICANT
DIFFERENCE IN NUMBER OF ROUNDS REQUIRED.

3. NUMBERS ASSOCIATED WITH PASQUILL STABILITY CATEGORY;
WIND SPEED IN KNOTS.

4. ROUNDS IN SHADED (SHOWN AS \$\$\$) AREA EXCEED RATE OF
FIRE OF WEAPON/BATTERY.

TABLE 7A. VOLUME OF FIRE TABLES AS A FUNCTION OF RELATIVE HUMIDITY AND PASQUILL CATEGORY

SCREEN(M)		VOLUME OF FIRE																												TABLE - HC SMOKE SCREEN; 218< RELATIVE HUMIDITY <59%																											
MINUTES		200							400							600							800							1000							1500							2000													
STABILITY		5	10	15	20	10	15	20	25	10	15	20	25	10	15	20	25	30	15	20	25	30	20	25	30	35	20	25	30	35	20	25	30	35																							
		105mm HOWITZER																																																							
A/ 5	30	60	90	120	115	173	230	288	175	263	350	438	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$																							
B/ 8	33	65	98	130	130	195	260	325	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$																							
C/10	35	70	105	140	140	210	280	350	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$																							
D/15	43	85	128	170	170	255	340	425	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$																							
E/ 8	13	25	38	50	45	68	90	113	65	98	130	163	128	170	213	255	158	210	263	315	310	388	465	543	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$																								
F/ 6	5	10	15	20	15	23	30	38	25	38	50	63	45	60	75	90	54	71	89	106	110	138	165	193	141	176	211	246																													
		155mm HOWITZER																																																							
A/ 5	8	15	23	30	25	38	50	63	40	60	80	100	75	100	125	150	90	120	150	180	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$																							
B/ 8	8	15	23	30	25	38	50	63	40	60	80	100	75	100	125	150	98	130	163	195	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$																							
C/10	8	15	23	30	25	38	50	63	40	60	80	100	75	100	125	150	90	120	150	180	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$																						
D/15	8	15	23	30	30	45	60	75	40	60	80	100	83	110	138	165	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$																							
E/ 8	4	6	9	11	11	16	21	26	12	17	22	27	25	32	40	47	26	33	41	48	54	67	79	92	65	80	95	110																													
F/ 6	4	6	9	11	7	10	12	15	9	12	14	17	13	15	18	20	15	17	20	22	29	34	39	44	33	38	43	48																													
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1. CALCULATED FOR VISIBLE LIGHT WAVELENGTHS: 0.4 TO 0.7 MICROMETERS.
2. DATA COMPUTED IN NUMBER OF ROUNDS FOR QUARTERING WIND. FOR CROSSWIND MULTIPLY THE EXTRACTED NUMBER OF ROUNDS BY 0.7.FOR HEADWIND OR TAIL WIND CONDITION, MULTIPLY EXTRACTED NUMBER OF ROUNDS BY 2.6
3. NUMBERS ASSOCIATED WITH PASQUILL STABILITY CATEGORY; WIND SPEED IN KNOTS.
4. ROUNDS IN SHADED (SHOWN AS \$\$\$)AREA EXCEED RATE OF FIRE OF WEAPON/BATTERY.
5. MINUTES INDICATE DURATION OF EFFECTIVE SMOKE.

TABLE 7B. VOLUME OF FIRE TABLES AS A FUNCTION OF
RELATIVE HUMIDITY AND PASQUILL CATEGORY

SCREEN(M) MINUTES STABILITY		VOLUME OF FIRE TABLE - WP SMOKESCREEN; 21% < RELATIVE HUMIDITY < 59%															
		100				200				300				400			
		5	10	15	20	5	10	15	20	5	10	15	20	10	15	20	25
		105mm HOWITZER															
A/ 5	\$\$\$ \$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
B/ 8	75 150	225	300	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
C/10	45 90	135	180	90	180	270	360	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
D/15	30 60	90	120	60	120	180	240	90	180	270	360	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
E/ 8	20 40	60	80	30	60	90	120	40	80	120	160	100	150	200	250	140	210
F/ 6	20 40	60	80	30	60	90	120	40	80	120	160	100	150	200	250	140	210

SCREEN(M) MINUTES STABILITY		VOLUME OF FIRE TABLE - WP SMOKESCREEN; 21% < RELATIVE HUMIDITY < 59%															
		100				200				300				400			
		5	10	15	20	5	10	15	20	5	10	15	20	10	15	20	25
		155mm HOWITZER															
A/ 5	23 45	68	90	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
B/ 8	15 30	45	60	23	45	68	90	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
C/10	8 15	23	30	15	30	45	60	23	45	68	90	60	90	120	150	\$\$\$	\$\$\$
D/15	15 30	45	60	30	60	90	120	30	60	90	120	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
E/ 8	8 16	23	31	11	21	31	41	14	27	39	52	32	47	62	77	43	103
F/ 6	8 16	23	31	11	21	31	41	14	27	39	52	32	47	62	77	43	103

1. CALCULATED FOR VISIBLE LIGHT WAVELENGTHS: 0.4 TO 0.7 MICROMETERS.
2. DATA COMPUTED IN NUMBER OF ROUNDS FOR QUARTERING WIND. FOR OTHER WIND DIRECTIONS THERE IS NO SIGNIFICANT DIFFERENCE IN NUMBER OF ROUNDS REQUIRED.
3. NUMBERS ASSOCIATED WITH PASQUILL STABILITY CATEGORY; WIND SPEED IN KNOTS.
4. ROUNDS IN SHADED (SHOWN AS \$\$\$) AREA EXCEED RATE OF FIRE OF WEAPON/BATTERY.

TABLE 7C. VOLUME OF FIRE TABLES AS A FUNCTION OF
RELATIVE HUMIDITY AND PASQUILL CATEGORY

SCREEN (M) MINUTES STABILITY		VOLUME OF FIRE TABLE - HC SMOKE SCREEN; 218< RELATIVE HUMIDITY <59%																							
		200						400						600						800					
		5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120
		105mm HOWITZER																							
A/ 5	68	135	203	270	337	404	471	538	605	672	739	806	873	940	1007	1074	1141	1208	1275	1342	1409	1476	1543	1610	1677
B/ 8	80	160	240	320	400	480	560	640	720	800	880	960	1040	1120	1200	1280	1360	1440	1520	1600	1680	1760	1840	1920	2000
C/10	88	175	263	350	438	525	613	700	788	875	963	1050	1138	1225	1313	1400	1488	1575	1663	1750	1838	1925	2013	2100	2188
D/15	98	195	292	389	486	583	680	777	874	971	1068	1165	1262	1359	1456	1553	1650	1747	1844	1941	2038	2135	2232	2329	2426
E/ 8	30	60	90	120	150	180	210	240	270	300	330	360	390	420	450	480	510	540	570	600	630	660	690	720	750
F/ 6	13	25	38	50	63	75	88	100	113	125	138	150	163	175	188	200	213	225	238	250	263	275	288	300	313

SCREEN (M) MINUTES STABILITY		155mm HOWITZER																							
		5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120
A/ 5	15	30	45	60	75	90	105	120	135	150	165	180	195	210	225	240	255	270	285	300	315	330	345	360	375
B/ 8	15	30	45	60	75	90	105	120	135	150	165	180	195	210	225	240	255	270	285	300	315	330	345	360	375
C/10	18	35	53	70	88	105	123	140	158	175	193	210	228	245	263	280	298	315	333	350	368	385	403	420	438
D/15	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400	420	440	460	480	500
E/ 8	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125
F/ 6	4	6	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53

1. CALCULATED FOR NEAR IR WAVELENGTHS: .75 TO 2.5 MICROMETERS.

2. DATA COMPUTED IN NUMBER OF ROUNDS FOR QUARTERING WIND. FOR CROSSWIND MULTIPLY THE EXTRACTED NUMBER OF ROUNDS BY 0.7. FOR HEADWIND OR TAIL WIND CONDITION, MULTIPLY EXTRACTED NUMBER OF ROUNDS BY 2.6

3. NUMBERS ASSOCIATED WITH PASQUILL STABILITY CATEGORY: WIND SPEED IN KNOTS.

4. ROUNDS IN SHADED (SHOWN AS \$\$\$) AREA EXCEED RATE OF FIRE OF WEAPON/BATTERY.

5. MINUTES INDICATE DURATION OF EFFECTIVE SMOKE.

TABLE 7D. VOLUME OF FIRE TABLES AS A FUNCTION OF
RELATIVE HUMIDITY AND PASQUILL CATEGORY

SCREEN (M) MINUTES STABILITY		VOLUME OF FIRE TABLE - WP SMOKE SCREEN; 21% RELATIVE HUMIDITY <55%											
		100			200			300			400		
		5	10	15	20	5	10	15	20	5	10	15	20
		105mm HOWITZER											
A/ 5	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
B/ 8	90	130	270	360	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
C/10	60	120	180	240	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
D/15	45	90	135	180	75	150	225	300	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
E/ 8	30	60	90	120	50	100	150	200	70	140	210	280	360
F/ 6	30	60	90	120	50	100	150	200	70	140	210	280	360

SCREEN (M) MINUTES STABILITY		155mm HOWITZER											
		100			200			300			400		
		5	10	15	20	5	10	15	20	5	10	15	20
A/ 5	23	45	68	90	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
B/ 8	30	60	90	120	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
C/10	30	60	90	120	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
D/15	15	30	45	60	30	60	90	120	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
E/ 8	10	20	30	40	15	30	45	60	20	40	60	80	100
F/ 6	10	20	30	40	15	30	45	60	20	40	60	80	100

1. CALCULATED FOR NEAR IR WAVELENGTHS: .75 TO 2.5 MICROMETERS.

2. DATA COMPUTED IN NUMBER OF ROUNDS FOR QUARTERING WIND. FOR OTHER WIND DIRECTIONS THERE IS NO SIGNIFICANT DIFFERENCE IN NUMBER OF ROUNDS REQUIRED.

3. NUMBERS ASSOCIATED WITH PASQUILL STABILITY CATEGORY; WIND SPEED IN KNOTS.

4. ROUNDS IN SHADED (SHOWN AS \$\$\$) AREA EXCEED RATE OF FIRE OF WEAPON/BATTERY.

5. MINUTES INDICATE DURATION OF EFFECTIVE SMOKE

TABLE 8A. VOLUME OF FIRE TABLES AS A FUNCTION OF RELATIVE HUMIDITY AND PASQUILL CATEGORY

SCREEN(M) MINUTES		VOLUME OF FIRE TABLE - HC SMOKE SCREEN; RELATIVE HUMIDITY >60%																												
		200				400				600				800				1000				1500				2000				
STABILITY		5	10	15	20	10	15	20	25	10	15	20	25	15	20	25	30	15	20	25	30	20	25	30	35	20	25	30	35	
		105mm HC W/ 12ER																												
A/ 5	18	35	53	70	70	105	140	175	105	153	210	263	210	280	350	420	263	350	438	525	555	555	555	555	555	555	555	555	555	555
B/ 8	20	40	60	80	80	120	160	200	115	173	230	283	233	310	388	465	555	555	555	555	555	555	555	555	555	555	555	555	555	555
C/10	20	40	60	80	80	120	160	200	120	180	240	300	240	320	400	480	555	555	555	555	555	555	555	555	555	555	555	555	555	555
D/15	25	50	75	100	95	143	190	236	140	210	280	350	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555	555
E/ 8	8	15	23	30	25	38	50	63	35	53	70	88	68	90	113	135	83	110	138	165	170	213	255	298	220	275	330	385		
F/ 6	4	6	9	11	11	16	21	26	17	25	32	40	26	33	41	48	34	44	54	64	65	80	95	110	87	107	127	147		
		155mm HC W/ 12ER																												
		200				400				600				800				1000				1500				2000				
STABILITY		5	10	15	20	10	15	20	25	10	15	20	25	15	20	25	30	15	20	25	30	20	25	30	35	20	25	30	35	
		155mm HC W/ 12ER																												
A/ 5	5	10	15	20	16	24	31	39	26	39	51	64	46	61	76	91	61	81	101	121	112	140	167	195	555	555	555	555	555	555
L/ 8	5	10	15	20	15	23	30	38	25	38	50	63	45	60	75	90	60	80	100	120	110	138	165	193	555	555	555	555	555	555
C/10	5	10	15	20	15	23	30	38	25	38	50	63	45	60	75	90	53	70	88	105	110	138	165	193	555	555	555	555	555	555
D/15	5	10	15	20	15	23	30	38	25	38	50	63	45	60	75	90	60	80	100	120	110	138	165	193	555	555	555	555	555	555
E/ 8	4	6	9	11	7	10	12	15	8	11	13	16	18	23	28	33	19	24	29	34	36	44	51	59	47	57	67	77		
F/ 6	4	6	9	11	7	10	12	15	9	12	14	17	13	15	18	20	15	17	20	22	20	23	25	28	24	27	29	32		

1. CALCULATED FOR VISIBLE LIGHT WAVELENGTHS: 0.4 TO 0.7 MICROMETERS.
2. DATA COMPUTED IN NUMBER OF ROUNDS FOR QUARTERING WIND. FOR CROSSWIND MULTIPLY THE EXTRACTED NUMBER OF ROUNDS BY 0.7. FOR HEADWIND OR TAIL WIND CONDITION, MULTIPLY EXTRACTED NUMBER OF ROUNDS BY 2.6
3. NUMBER ASSOCIATED WITH PASQUILL STABILITY CATEGORY; WIND SPEED IN KNOTS.
4. ROUNDS IN SHAPED (SHOWN AS \$\$\$) AREA EXCEED RATE OF FIRE OF WEAPON BATTERY.
5. MINUTES INDICATE DURATION OF EFFECTIVE SMOKE.

TABLE 8B. VOLUME OF FIRE TABLES AS A FUNCTION OF
RELATIVE HUMIDITY AND PASQUILL CATEGORY

SCREEN(M) MINUTES STABILITY		VOLUME OF FIRE TABLE - 105mm HOWITZER												RELATIVE HUMIDITY >60%												
		100				200				300				400				500				600				
		5	10	15	20	5	10	15	20	5	10	15	20	5	10	15	20	5	10	15	20	5	10	15	20	25
A/ 5	38	75	113	150	75	150	225	300	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
B/ 8	45	90	135	180	90	180	270	360	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
C/10	30	60	90	120	60	120	180	240	90	180	270	360	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
D/15	30	60	90	120	45	90	135	180	60	120	180	240	150	225	300	375	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
E/ 8	20	40	60	80	30	60	90	120	40	80	120	160	100	150	200	250	350	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
F/ 6	20	40	60	80	30	60	90	120	40	80	120	160	100	150	200	250	350	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$

SCREEN(M) MINUTES STABILITY		155mm HOWITZER												400												
		100				200				300				400				500				600				
		5	10	15	20	5	10	15	20	5	10	15	20	5	10	15	20	5	10	15	20	5	10	15	20	25
A/ 5	10	20	30	40	15	30	45	60	25	50	75	100	60	90	120	150	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
B/ 8	8	15	23	30	15	30	45	60	23	45	68	90	60	90	120	150	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
C/10	8	15	23	30	15	30	45	60	15	30	45	60	45	68	90	113	60	90	120	150	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
D/15	15	30	45	60	8	15	23	30	15	30	45	60	30	45	60	75	45	68	90	113	60	90	120	150	\$\$\$	
E/ 8	8	16	23	31	11	21	31	41	14	27	39	52	32	47	62	77	43	63	83	103	63	83	103	\$\$\$	\$\$\$	
F/ 6	8	16	23	31	11	21	31	41	14	27	39	52	32	47	62	77	43	63	83	103	63	83	103	\$\$\$	\$\$\$	

1. CALCULATED FOR VISIBLE LIGHT WAVELENGTHS: 0.4 TO 0.7 MICROMETERS.
2. DATA COMPUTED IN NUMBER OF ROUNDS FOR QUARTERING WIND. FOR OTHER WIND DIRECTIONS THERE IS NO SIGNIFICANT DIFFERENCE IN NUMBER OF ROUNDS REQUIRED.
3. NUMBERS ASSOCIATED WITH PASQUILL STABILITY CATEGORY; WIND SPEED IN KNOTS.
4. ROUNDS IN SHADED (SHOWN AS \$\$\$) AREA EXCEED RATE OF FIRE OF WEAPON/BATTERY.
5. MINUTES INDICATE DURATION OF EFFECTIVE SMOKE.

TABLE 8D. VOLUME OF FIRE TABLES AS A FUNCTION OF
RELATIVE HUMIDITY AND PASQUILL CATEGORY

SCREEN(M) MINUTES STABILITY	VOLUME OF FIRE TABLE - OF SCREENS SCREEN; RELATIVE HUMIDITY >60%											
	100				200				300			
	5	10	15	20	5	10	15	20	5	10	15	20
A/ 5	45	90	135	180	90	180	270	360	105mm HOWITZER	105mm HOWITZER	105mm HOWITZER	105mm HOWITZER
B/ 8	60	120	180	240	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$
C/10	45	90	135	180	75	150	225	300	\$\$\$	\$\$\$	\$\$\$	\$\$\$
D/15	30	60	90	120	45	90	135	180	60	120	180	240
E/ 8	30	60	90	120	50	100	150	200	70	140	210	280
F/ 6	30	60	90	120	50	100	150	200	70	140	210	280

SCREEN(M) MINUTES STABILITY	VOLUME OF FIRE TABLE - OF SCREENS SCREEN; RELATIVE HUMIDITY >60%											
	100				200				300			
	5	10	15	20	5	10	15	20	5	10	15	20
A/ 5	15	30	45	60	30	60	90	120	155mm HOWITZER	155mm HOWITZER	155mm HOWITZER	155mm HOWITZER
B/ 8	8	15	23	30	15	30	45	60	23	45	68	90
C/10	8	15	23	30	15	30	45	60	15	30	45	60
D/15	15	30	45	60	8	15	23	30	15	30	45	60
E/ 8	10	20	30	40	15	30	45	60	20	40	60	80
F/ 6	10	20	30	40	15	30	45	60	20	40	60	80

1. CALCULATED FOR NEAR IR WAVELENGTHS: .75 TO 2.5 MICROMETERS.
2. DATA COMPUTED IN NUMBER OF ROUNDS FOR QUARTERING WIND. FOR OTHER WIND DIRECTIONS THERE IS NO SIGNIFICANT DIFFERENCE IN NUMBER OF ROUNDS REQUIRED.
3. NUMBERS ASSOCIATED WITH PASQUILL STABILITY CATEGORY; WIND SPEED IN KNOTS.
4. ROUNDS IN SHADED (SHOWN AS \$\$\$) AREA EXCEED RATE OF FIRE OF WEAPON/BATTERY.

5. MINUTES INDICATE DURATION OF SCREENING SHOWS

REFERENCES

1. Umstead, R. K., R. Pena, and F. V. Hansen, KWIK: An Algorithm for Calculating Munition Expenditures for Smoke Screening/Obscuration in Tactical Situations, ASL-TR-0030, US Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM, 1979.
2. Downs, A. R., A Review of Atmospheric Transmission Information in the Optical and Microwave Spectral Regions, Report 2710, Ballistic Research Laboratory, Aberdeen Proving Ground, MD, 1976.
3. Gifford, F. A., Jr., "An Outline of Theories of Diffusion in the Lower Layers of the Atmosphere," Meteorology and Atomic Energy (D. H. Slade, ed), US Atomic Energy Commission, Washington, DC, 1968.
4. Pasquill, F., Atmospheric Diffusion, 2nd Ed., Halsted Press, Division of John Wiley & Sons, New York, 1974.
5. Pasquill, F., "The Estimation of the Dispersion of Windborne Material," Meteorol Mag, Vol, 90, 1961.
6. Turner, D. B., "A Diffusion Model for Urban Area," J Appl Meteorol, 3:83, 1964.
7. Smith, F. B., "A Scheme for Estimating the Vertical Dispersion of a Plume from a Source Near Ground-Level," 1973 (unpublished Meteorological Office Note).

APPENDIX A

KWIK ALGORITHM GLOSSARY OF MNEMONICS (BASIC/HP 9830A)

1. CO	Ceiling - feet
2. C1	Cloud cover - percent
3. VO	Visibility - miles
4. TO	Temperature - degrees Fahrenheit
5. T1	Dewpoint - degrees Fahrenheit
6. DO	Wind direction - degrees
7. SO, S3	Windspeed - knots, meters per second
8. PO	Atmospheric stability category
9. H3	Slant range to target - kilometers
10. RO	Relative humidity - percent
11. XO	Smoke screen length - meters
12. T2	Smoke screen duration - minutes
13. S	Angle of sight to target - degrees
14. AO	Direction of line of sight - degrees
15. Y	Average roughness element - centimeters
16. Z	Roughness length - centimeters
17. P(7,9)	Table of stability categories depending upon solar altitude and windspeed
18. T(4,4)	Table of transmittances resulting from water vapor, haze/fog precipitation and smoke for visual, near, mid, and far infrared wavelengths
19. C(4,2)	Table of smoke concentration values for HC and WP smoke (by wavelengths)
20. B(4)	Absorption coefficient error function
21. G(4)	Scale height for Mie scattering
22. H(4)	Haze and fog attenuation coefficients
23. R(4)	Precipitation attenuation coefficients
24. D(2)	Table of extinction coefficients for calculating HC and WP smoke concentrations for visible, near, mid, and far infrared wavelengths
25. A (6)	Coefficients to compute sigma y
26. S(6,3), D(6,3)	Coefficients of roughness correction factor used in calculating sigma z for the various roughness lengths
27. Y1, Y2	Yield factors for HC and WP
28. LO,L1,ZO,J0,H0	Latitude, longitude, altitude, Julian date and Zulu time data
29. J(4,2),P(4,2)	Total number of rounds required (initial and sustaining) to maintain HC and WP smoke screen
30. E(4,2), F(4,2) G(4,2), Q(4,2)	Number of guns (initial and sustaining volleys) for 105- and 155-mm howitzers, for HC and WP smokes (by wavelengths)
31. R1, R(4,2)	Rate of fire for HC and WP smokes (by wavelengths)
32. H(2,2)	Unit (per gun) source strength

33. Q(2)	Munition efficiency for 105- and 155-mm howitzers for HC smoke
34. U(2,2)	WP volume source sigmas (σ_{y0} and σ_{z0}) for 105- and 155-mm howitzers
35. V(2)	Stability dependent crosswind integrated concentration for WP smoke
36. W(6)	Constant (K) related to stability category for WP
37. X(4)	Wavelength threshold levels
38. I(4,2), Y(4,2)	Shell spacing for 105- and 155-mm howitzers (initial and sustaining) for HC smoke
39. Z(4,2), L(4,2)	Shell spacing for 105- and 155-mm howitzers for WP smoke
40. I\$(4)	Met site identifier
41. Q\$(6)	Stability category indicator
42. A\$(8)	Wavelength indicator
43. P	Precipitation indicator
44. H\$(1), J\$(1)	Direction from equator (N-S) and direction from Greenwich (E-W) indicators
45. I	Index for wavelength algorithms
46. J	Index for smoke algorithms
47. K	Index for gun (105- and 155-mm howitzers) algorithms

APPENDIX B
BASIC/HP9830A ALGORITHM

```

10 COM P,Y,DO,PO,RO,SO,T1,T2,VO,XO,C[4,2],T[4,4],V[2],W[6],Y[4,2],Z[4,2]
20 REM KWIK SMOKE ALGORITHM - FILE 0 (09/14/81).
30 REM KWIK: METEOROLOGICAL INPUTS AND METEOROLOGICAL CALCULATIONS.
40 DIM I$[4],P[7,9],Q$[6],H$[1],J$[1]
50 FIXED 2

```

```

60 PRINT
70 PRINT
80 PRINT "
90 PRINT "
100 PRINT
110 PRINT

```

MUNITION EXPENDITURES"
FOR HC AND WP SMOKE"

```

120 DISP "MET SITE ID";
130 INPUT I$
140 DISP "LATITUDE OF MET SITE- DEG";
150 INPUT LO
160 DISP "DIRECTION FROM EQUATOR- N OR S";
170 INPUT H$
180 DISP "LONGITUDE OF MET SITE - DEG";
190 INPUT L1
200 DISP "DIRECTION FROM GREENWICH- E OR W";
210 INPUT J$
220 DISP "ALTITUDE OF MET SITE-KILOMETERS";
230 INPUT ZO
240 DISP "JULIAN DATE OF MET OBSERVATION";
250 INPUT JO
260 DISP "ZULU TIME OF MET OBSERVATION-hr";
270 INPUT HO
280 DISP "CEILING - FEET";
290 INPUT CO
300 CO=CO*0.3048
310 DISP "CLOUD COVER - PERCENT";
320 INPUT C1
330 DISP "VISIBILITY - MILES";
340 INPUT VO
350 VO=VO*1.61
360 DISP "PRECIPITATION - 1=YES 0=NO";
370 INPUT P
380 DISP "TEMPERATURE - DEG F";
390 INPUT TO
400 TO=(5/9)*(TO-32)
410 DISP "DEW POINT - DEG F";
420 INPUT T1
430 T1=(5/9)*(T1-32)
440 DISP "WIND DIRECTION - DEGS";
450 INPUT DO
460 DISP "WIND SPEED KNOTS";
470 INPUT SO
480 DISP "WAVE ROUGHNESS ELEMENT - CM";
490 INPUT Y
500 PRINT "
510 PRINT "
520 PRINT "
530 PRINT "
540 PRINT "
550 PRINT "

```

ID
LATITUDE
LONGITUDE
ALTITUDE
JULIAN DATE
ZULU TIME

- DEG
- DEG
- KM
- DAY
- HOUR

= ";I\$
= ";H\$[1];LO
= ";J\$[1];L1
= ";ZO
= ";JO
= ";HO

```

560 PRINT "          CEILING          - METERS          = ";CO
570 PRINT "          CLOUD COVER      - PERCENT          = ";C1
580 PRINT "          VISIBILITY        - KILOMETERS       = ";VO
590 PRINT "          PRECIPITATION          = ";P
600 PRINT "          TEMPERATURE            - DEG C           = ";TO
610 PRINT "          DEWPOINT                - DEG C           = ";T1
620 PRINT "          WIND DIRECTION            - DEG             = ";DO
630 PRINT "          WIND SPEED                - KNOTS           = ";SO
640 PRINT "          AVE ROUGHNESS ELEMENT - CM                = ";Y
650 FOR J=1 TO 9
660 FOR I=1 TO 7
670 READ P[I,J]
680 NEXT I
690 NEXT J
700 READ Q[1]
710 IF J//="E" THEN 740
720 L1=-L1
730 REM NET CALCULATIONS.
740 IF C1.100 THEN 790
750 IF CO>2133.6042 THEN 790
760 I1=0
770 I2=0
780 GOTO 1400
790 REM CALCULATE ANGULAR FRACTION OF A YEAR FOR A GIVEN JULIAN DATE (AO)
800 R9=PI/180
810 D9=180/PI
820 LO=LO*R9
830 AO=((JO-1)*360)/365.242
840 REM CALCULATE SOLAR DECLINATION ANGLE (A4).
850 A1=AO*R9
860 A2=279.9348+AO
870 A2=A2+(1.914827*SIN(A1))-(0.079525*COS(A1))
880 A2=A2+(0.019938*SIN(2*A1))-(0.00162*COS(2*A1))
890 A2=A2*R9
900 A3=23.4438*R9
910 A4=SIN(A3)*SIN(A2)
920 A4=ATN(A4/SQR(1-A4*A4+1E-99))
930 REM CALCULATE THE TIME OF MERIDIAN PASSAGE - TRUE SOLAR NOON (A5).
940 A5=12+(0.12357*SIN(A1))-(0.004289*COS(A1))
950 A5=A5+(0.153809*SIN(2*A1))+(0.060783*COS(2*A1))
960 REM CALCULATE SOLAR HOUR ANGLE (A6)
970 A6=15*(HO-A5)-L1
980 A6=A6*R9
990 REM CALCULATE SOLAR ALTITUDE (A7)
1000 A7=SIN(LO)*SIN(A4)+COS(LO)*COS(A4)*COS(A6)
1010 A7=ATN(A7/SQR(1-A7*A7+1E-99))
1020 A7=A7*D9
1030 REM CALCULATE INSOLATION CLASS NUMBER.
1040 I2=0
1050 IF A7 <= 60 THEN 1080
1060 I2=4
1070 GOTO 1160
1080 IF A7 <= 35 THEN 1110
1090 I2=3
1100 GOTO 1160
1110 IF A7 <= 15 THEN 1140

```

```

1120 I2=2
1130 GOTO 1160
1140 IF A7 <= 0 THEN 1350
1150 I2=1
1160 REM CALCULATE NET RADIATION INDEX FOR DAYTIME.
1170 I3=0
1180 IF C1>50 THEN 1210
1190 I3=I2
1200 GOTO 1290
1210 IF C0 >= 2133.6042 THEN 1240
1220 I3=I2-2
1230 GOTO 1290
1240 IF C0 >= 4876.8096 THEN 1270
1250 I3=I2-1
1260 GOTO 1290
1270 IF C1#100 THEN 1290
1280 I3=I2-1
1290 IF I3#0 THEN 1310
1300 I3=I2
1310 IF I3>1 THEN 1330
1320 I3=1
1330 I1=I3
1340 GOTO 1400
1350 REM CALCULATE NET RADIATION INDEX FOR NIGHTTIME
1360 IF C1>40 THEN 1390
1370 I1=-2
1380 GOTO 1400
1390 I1=-1
1400 REM CALCULATE PASQUILL STABILITY CATEGORY.
1410 I4=0
1420 I5=0
1430 IF I1#4 THEN 1450
1440 I4=1
1450 IF I1#3 THEN 1470
1460 I4=2
1470 IF I1#2 THEN 1490
1480 I4=3
1490 IF I1#1 THEN 1510
1500 I4=4
1510 IF I1#0 THEN 1530
1520 I4=5
1530 IF I1#-1 THEN 1550
1540 I4=6
1550 IF I1#-2 THEN 1570
1560 I4=7
1570 IF S0 >= 2 THEN 1600
1580 I5=1
1590 GOTO 1820
1600 IF S0 >= 4 THEN 1630
1610 I5=2
1620 GOTO 1820
1630 IF S0 >= 6 THEN 1660
1640 I5=3
1650 GOTO 1820
1660 IF S0 >= 7 THEN 1690
1670 I5=4

```

```

1680 GOTO 1820
1690 IF S0 >= 8 THEN 1720
1700 I5=5
1710 GOTO 1820
1720 IF S0 >= 10 THEN 1750
1730 I5=6
1740 GOTO 1820
1750 IF S0 >= 11 THEN 1780
1760 I5=7
1770 GOTO 1820
1780 IF S0 >= 12 THEN 1810
1790 I5=8
1800 GOTO 1820
1810 I5=9
1820 PO=P[I4,I5]
1830 REM CALCULATE RELATIVE HUMIDITY
1840 IF TO>0 THEN 1880
1850 AO=9.5
1860 BO=265.5
1870 GOTO 1900
1880 AO=7.5
1890 BO=237.3
1900 IF T1>0 THEN 1940
1910 A1=9.5
1920 B1=265.5
1930 GOTO 1960
1940 A1=7.5
1950 B1=237.3
1960 EO=6.11*10^((AO*TO)/(BO+TO))
1970 E1=6.11*10^((A1*T1)/(B1+T1))
1980 RO=(E1/EO)*100
1990 PRINT " PASQUILL STABILITY CATEGORY = ";QS[PO,PO]
2000 PRINT " RELATIVE HUMIDITY = ";RO
2010 PRINT
2020 PRINT
2030 DISP "DONE - LINK 1"
2040 REM PASQUILL STABILITY CATEGORY DATA
2050 DATA 1,1,2,3,4,6,6
2060 DATA 1,2,2,3,4,6,6
2070 DATA 1,2,3,4,4,5,6
2080 DATA 2,2,3,4,4,5,6
2090 DATA 2,2,3,4,4,4,5
2100 DATA 2,3,3,4,4,4,5
2110 DATA 3,3,4,4,4,4,5
2120 DATA 3,3,4,4,4,4,4
2130 DATA 3,4,4,4,4,4,4
2140 DATA "ABCDEF"
2150 END

```

```

10 COM P,Y,DO,PO,RO,SO,T1,T2,VO,XO,C[4,2],T[4,4],V[2],W[6],Y[4,2],Z[4,2]
20 REM KWIK:  ATMOSPHERIC OPTICS AND SMOKE CONCENTRATION CALCULATIONS (FILE 1).
30 DIM B[4],G[4],H[4],R[4],D[2],X[4]
40 FIXED 2
50 FOR I=1 TO 4
60 READ B[I],G[I],X[I]
70 NEXT I
80 V1=LOG(VO)
90 V2=V1*V1
100 V3=V2*V1
110 H[1]=1.5551-(0.9811*V1)-(0.0197*V2)+(0.0041*V3)
120 H[1]=EXP(H[1])
130 H[2]=1.50381511-(0.992319519*V1)-(0.015972801*V2)+(0.00368583*V3)
140 H[2]=EXP(H[2])
150 H[3]=1.2394-(1.0436*V1)+(0.0099*V2)-(0.0016*V3)
160 H[3]=EXP(H[3])
170 H[4]=1.5176-(1.7147*V1)+(0.0001*V2)+(0.0428*V3)
180 H[4]=EXP(H[4])
190 R[1]=1.3306-(0.8825*V1)-(0.0753*V2)+(0.0129*V3)
200 R[1]=EXP(R[1])
210 R[2]=1.481951707-(0.922595829*V1)-(0.065509417*V2)+(0.013680422*V3)
220 R[2]=EXP(R[2])
230 R[3]=1.5556-(0.9013*V1)-(0.0773*V2)+(0.0173*V3)
240 R[3]=EXP(R[3])
250 R[4]=1.5928-(0.9396*V1)-(0.0627*V2)+(0.0168*V3)
260 R[4]=EXP(R[4])
270 H0=0
280 DISP "SLANT RANGE TO TARGET - KM";
290 INPUT H3
300 DISP "ANGLE OF SIGHT TO TARGET - DEG";
310 INPUT S
320 IF S >= 0 THEN 340
330 S=-S
340 S=S*(PI/180)
350 S=SIN(S)
360 H4=0
370 IF S=0 THEN 400
380 H4=1/S
390 REM CALCULATE PRECIPITABLE WATER.
400 W=0.4477+(0.0328*T1)+(1.2E-03*T1*T1)+(1.84E-05*T1*T1*T1)
410 REM CALCULATE AMOUNT OF WATER IN PATH.
420 DEF FNA(A)=EXP(-S*A/2)
430 L0=H3
440 L1=H0
450 L2=L0
460 L3=0.5*(L1+L2)
470 L4=L2-L1
480 L5=0.2886751*L4
490 W0=0.5*L4*(FNA(L3+L5)+FNA(L3-L5))
500 W1=W*W0
510 REM CALCULATE TRANSMITTANCES FOR VISUAL, NEAR, MID AND FAR IR WAVELENGTHS.
520 FOR I=1 TO 4
530 REM CALCULATE TRANSMITTANCES OWING TO ABSORPTION BY WATER VAPOR.
540 IF I=4 THEN 570
550 T[I,1]=EXP(-0.0681*W1)

```

```

560 GOTO 670
570 DEF FNB(B)=EXP(-B^2)
580 L0=(B[I]*SQR(PI*PI))/2)
590 L1=H0
600 L2=L0
610 L3=0.5*(L1+L2)
620 L4=L2-L1
630 L5=0.2886751*L4
640 M2=0.5*L4*(FNB(L3+L5)+FNB(L3-L5))
650 T[I,1]=(2/SQR(PI))*M2
660 T[I,1]=1-T[I,1]
670 REM CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY HAZE AND FOG.
680 IF P=0 THEN 710
690 T[I,2]=1
700 GOTO 990
710 IF V0 >= G[I] THEN 910
720 DEF FNC(C)=EXP(C*S*LOG(0.1/H[I]))
730 L0=H4
740 L1=H0
750 L2=L0
760 L3=0.5*(L1+L2)
770 L4=L2-L1
780 L5=0.2886751*L4
790 T3=0.5*L4*(FNC(L3+L5)+FNC(L3-L5))
800 T4=EXP(-H[I]*T3)
810 DEF FND(D)=EXP(-D*S/4.1)
820 L1=H4
830 L2=H3
840 L3=0.5*(L1+L2)
850 L4=L2-L1
860 L5=0.2886751*L4
870 T5=0.5*L4*(FND(L3+L5)+FND(L3-L5))
880 T6=EXP(-0.128*T5)
890 T[I,2]=T4*T6
900 GOTO 990
910 L0=H3
920 L1=H0
930 L2=L0
940 L3=0.5*(L1+L2)
950 L4=L2-L1
960 L5=0.2886751*L4
970 T7=0.5*L4*(FND(L3+L5)+FND(L3-L5))
980 T[I,2]=EXP(-H[I]*T7)
990 REM CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY PRECIPITATION.
1000 IF P=1 THEN 1030
1010 T[I,3]=1
1020 GOTO 1050
1030 IF V0>20 THEN 1010
1040 T[I,3]=EXP(-H3*R[I])
1050 REM CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY SMOKE.
1060 T[I,4]=X[I]/(T[I,1]*T[I,2]*T[I,3])
1070 IF T[I,4] <= 1 THEN 1090
1080 T[I,4]=1
1090 REM CALCULATE LINE OF SIGHT INTEGRATED CONCENTRATION.
1100 FOR K=1 TO 2
1110 READ D[K]

```

```

1120 NEXT K
1130 IF T[I,4]#1 THEN 1180
1140 FOR J=1 TO 2
1150 C[I,J]=0
1160 NEXT J
1170 GOTO 1240
1180 FOR K=1 TO 2
1190 IF D[K]#0 THEN 1220
1200 C[I,K]=0
1210 GOTO 1230
1220 C[I,K]=LOG(T[I,4]]/-D[K]
1230 NEXT K
1240 NEXT I
1250 DISP "DONE - LINK 2"
1260 DATA 0.118,26.7,0.05
1270 DATA 0.18,7.5,0.05
1280 DATA 0.55,5.1,0.05
1290 DATA 0.5,0.05
1300 DATA 3.3,2.46
1310 DATA 1.5,2
1320 DATA 0,0.25
1330 DATA 0,0.32
1340 END

```

```

10 DIM P,Y,DO,PO,RO,SO,T1,T2,VO,XO,C[4,2],T[4,4],V[2],W[6],Y[4,2],Z[4,2]
20 REM K/IK: ATMOSPHERIC DIFFUSION CALCULATIONS (FILE2)
30 DIM S[6,3],A[6],Q[2],H[2,2],D[6,3],U[2,2]
40 FIXED 2
50 DISP "DIRECTION OF LINE OF SIGHT-DEG";
60 INPUT AO
70 REM ATMOSPHERIC DIFFUSION CALCULATIONS.
80 FOR I=1 TO 6
90 READ A[I]
100 NEXT I
110 FOR I=1 TO 6
120 FOR J=1 TO 3
130 READ S[I,J]
140 NEXT J
150 NEXT I
160 FOR I=1 TO 6
170 FOR J=1 TO 3
180 READ D[I,J]
190 NEXT J
200 NEXT I
210 READ H[1,1],H[1,2],H[2,1],H[2,2]
220 READ U[1,1],U[2,1],U[1,2],U[2,2]
230 A1=-1.24+1.19*LGT(Y)
240 Z=10^A1
250 A2=ABS(AO-DO)*(PI/180)
260 R2=SQR(13.69/(13.69*SIN(A2)*SIN(A2)+COS(A2)*COS(A2)))
270 Y1=1.09521547+(0.02906894*RO)-(4.9575E-04*RO*RO)+(4.82E-06*RO*RO*RO)
280 Y2=3.364059144+(0.060502571*RO)-(1.15301E-03*RO*RO)+(1.33942E-05*RO*RO*RO)
290 S2=S[PO,1]+S[PO,2]*Z+S[PO,3]*Z^2
300 D1=D[PO,1]+D[PO,2]*Z+D[PO,3]*Z^2
310 D2=1/D1
320 IF SO=0 THEN 340
330 SO=1
340 S3=0.515*SO
350 DISP "SCREEN LENGTH - METERS";
360 INPUT XO
370 DISP "DURATION - MINUTES";
380 INPUT T2
390 FOR N=1 TO 6
400 READ J[N]
410 NEXT N
420 FOR I=1 TO 4
430 REM CALCULATE CROSSWIND INTEGRATED CONCENTRATION FOR WP SMOKE.
440 FOR K=1 TO 2
450 IF I<3 AND PO>4 THEN 490
460 S1=U[K,1]+0.74*A[PO]*100^0.9
470 S2=U[K,2]+0.667*C2*100^D1
480 V[K]=(W[PO]*Y2*H[K,2])/(PI*S1*S2)
490 REM MUNITION EXPENDITURES (HC SMOKE).
500 REM MUNITION EFFICIENCY:
510 C[1]=0.4
520 C[2]=0.4
530 REM SUSTAINING SHELL SPACING FOR HC SMOKE.
540 IF I>2 THEN 610
550 IF J[I,1] NO THEN 580

```

```

560 Y[I,K]=0
570 GOTO 610
580 Y[I,K]=1/R2*(0.731*Q[K]*Y1*H[K,1]/(C2*S3*C[I,1]))^D2
590 IF Y[I,K]<X0 THEN 610
600 Y[I,K]=X0
610 NEXT K
620 NEXT I
630 DISP "DONE - LINK 3"
640 REM DATA USED TO CALCULATE SIGMA Y FOR CONTINUOUS SOURCE.
650 DATA 0.4,0.32,0.22,0.144,0.102,0.076
660 REM DATA USED TO CALCULATE SIGMA Z FOR CONTINUOUS SOURCE.
670 DATA 0.139085297,0.015017284,-1.02581E-04
680 DATA 0.122097643,0.01097037,-6.80135E-05
690 DATA 0.110104377,0.010962963,-6.73401E-05
700 DATA 0.097649832,0.010418519,-6.83502E-05
710 DATA 0.070772166,7.27284E-03,-4.50056E-05
720 DATA 0.055487093,6.55309E-03,-4.01796E-05
730 DATA 0.944814815,-4.85185E-03,3.7037E-05
740 DATA 0.894803591,-4.83951E-03,3.59147E-05
750 DATA 0.854792368,-4.82716E-03,3.47924E-05
760 DATA 0.816026936,-6.07407E-03,4.7138E-05
770 DATA 0.786026936,-6.07407E-03,4.7138E-05
780 DATA 0.726015713,-6.06173E-03,4.60157E-05
790 REM UNIT (PER GUN) SOURCE STRENGTHS.
800 DATA 18.7,1737.3,77.1,7076.2
810 REM WP VOLUME SOURCE SIGMAS (U(2,2)).
820 DATA 5.4,7.9,1.8,2.6
830 REM STABILITY CONSTANTS FOR WP SMOKE.

```

```

10 COM P,Y,DO,PO,RO,SO,T1,T2,VO,XO,C[4,2],T[4,4],V[2],W[6],Y[4,2],Z[4,2]
20 REM REM: MUNITION EXPENDITURES (CONTINUATION) (FILE 3).
30 DIM R[4,2],I[4,2],J[4,2],P[4,2],E[4,2],F[4,2],G[4,2],H[2,2],Q[4,2],L[4,2]
40 DIM A[3]
50 FIXED 2
60 S3=SO*0.515
70 REM UNIT SOURCE STRENGTH.
80 READ H[1,1],H[1,2],H[2,1],H[2,2]
90 FOR I=1 TO 4
100 FOR K=1 TO 2
110 IF I>2 THEN 430
120 REM CALCULATE INITIAL SHELL SPACING FOR HC SMOKE.
130 I[I,K]=S3*45
140 IF Y[I,K]#0 THEN 180
150 I[I,K]=1
160 P[I,K]=1
170 GOTO 330
180 REM CALCULATE INITIAL VOLLEY FOR HC SMOKE.
190 IF I[I,K]>Y[I,K] THEN 210
200 GOTO 220
210 I[I,K]=Y[I,K]
220 Q[I,K]=XO/I[I,K]
230 Q5=INT(Q[I,K])
240 Q6=Q[I,K]-Q5
250 IF Q6=0 THEN 270
260 Q[I,K]=Q5+1
270 REM CALCULATE NUMBER OF GUNS FOR SUSTAINING VOLLEYS (HC SMOKE).
280 F[I,K]=XO/Y[I,K]
290 Q5=INT(F[I,K])
300 Q6=F[I,K]-Q5
310 IF Q6=0 THEN 330
320 F[I,K]=Q5+1
330 REM CALCULATE RATE OF FIRE FOR HC SMOKE.
340 R1=0.5
350 IF C[I,1]#0 THEN 370
360 R1=0
370 REM CALCULATE TOTAL NUMBER OF ROUNDS REQUIRED (HC SMOKE).
380 J[I,K]=J[I,K]+(R1*T2-1)*F[I,K]
390 Q5=INT(J[I,K])
400 Q6=J[I,K]-Q5
410 IF Q6=0 THEN 430
420 J[I,K]=Q5+1
430 IF I<3 AND PO>4 THEN 950
440 REM SHELL SPACING <L( ) & Z( )> & VOLLEYS <G( ) & Q( )> - WP SMOKE.
450 IF C[I,2]#0 THEN 500
460 E[I,K]=0
470 G[I,K]=0
480 Q[I,K]=0
490 GOTO 530
500 IF I>2 THEN 550
510 L[I,K]=V[K]/C[I,2]*100
520 A[I,K]=L[I,K]
530 G[I,K]=XO/Z[I,K]
540 GOTO 560
550 G[I,K]=0.6*C[I,2]/V[K]

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560 Q5=INT(G[I,K])
570 Q6=G[I,K]-Q5
580 IF Q6=0 THEN 610
590 G[I,K]=Q5+1
600 GOTO 620
610 G[I,K]=Q5
620 Q[I,K]=G[I,K]
630 REM RATE OF FIRE FOR WP SMOKE.
640 IF Q[I,2]#0 THEN 680
650 R[I,K]=0
660 GOTO 820
670 IF I>2 THEN 700
680 R[I,K]=(Z[I,K]+60)/S3
690 GOTO 710
700 R[I,K]=120/S3
710 R[I,K]=R[I,K]/20
720 R5=INT(R[I,K])
730 R6=R[I,K]-R5
740 IF R6<0.5 THEN 760
750 R5=R5+1
760 IF R5#0 THEN 780
770 R5=1
780 R[I,K]=R5*20/60
790 R[I,K]=1/R[I,K]
800 IF R[I,K] >= 1 THEN 820
810 R[I,K]=1
820 REM CALCULATE TOTAL NUMBER OF ROUNDS REQUIRED (WP SMOKE).
830 IF Q[I,2]#0 THEN 860
840 P[I,K]=0
850 GOTO 1030
860 IF I>2 THEN 890
870 P[I,K]=G[I,K]+Q[I,K]*(T2*R[I,K]-1)
880 GOTO 900
890 P[I,K]=Q[I,K]*(X0/60+1)*(T2*R[I,K]-1)
900 Q5=INT(P[I,K])
910 Q6=P[I,K]-Q5
920 IF Q6=0 THEN 940
930 P[I,K]=Q5+1
940 GOTO 1290
950 REM CALCULATIONS FOR WP SMOKE E & F STABILITY CATEGORIES (STABLE FLOW).
960 REM INITIAL SHELL SPACING
970 IF I=1 AND K=1 THEN 1000
980 IF I<3 AND K=2 THEN 1000
990 IF I=2 AND K=1 THEN 1020
1000 L[I,K]=100
1010 GOTO 1030
1020 L[I,K]=50
1030 REM SUSTAINING SHELL SPACING
1040 IF I=1 AND K=1 THEN 1080
1050 IF I=2 AND K=2 THEN 1080
1060 IF I=1 AND K=2 THEN 1100
1070 IF I=2 AND K=1 THEN 1120
1080 Z[I,K]=100
1090 GOTO 1130
1100 Z[I,K]=200
1110 GOTO 1130

```

```

1130 Z[I,K]=50
1130 REM INITIAL VOLLEY - WP SMOKE.
1140 G[I,K]=XO/L[I,K]+1
1150 REM SUSTAINING VOLLEY.
1160 Q[I,K]=XO/Z[I,K]+1
1170 REM RATE OF FIRE - WP SMOKE.
1180 IF K=1 THEN 1200
1190 IF K=2 THEN 1220
1200 R[I,K]=2
1210 GOTO 1230
1220 R[I,K]=1
1230 REM TOTAL NUMBER OF WP ROUNDS REQUIRED.
1240 P[I,K]=G[I,K]+G[I,K]*(T2*R[I,K]-1)
1250 Q5=INT(P[I,K])
1260 Q6=P[I,K]-Q5
1270 IF Q6=0 THEN 1290
1280 P[I,K]=Q5+1
1290 NEXT K
1300 NEXT I
1310 FOR I=1 TO 4
1320 PRINT
1330 PRINT
1340 PRINT
1350 PRINT
1360 PRINT
1370 PRINT
1380 READ A$
1390 PRINT "                                ";A$
1400 PRINT
1410 PRINT
1420 PRINT "                                METERS MINUTES"
1430 WRITE (15,1440)XO,T2
1440 FORMAT "                                SCREEN LENGTH/DURATION: ",F5.0,4X,F3.0
1450 PRINT
1460 PRINT
1470 IF I>2 THEN 1980
1480 PRINT "                                HC SMOKE SCREEN"
1490 PRINT
1500 PRINT
1510 PRINT "                                105MM HOWITZER"
1520 PRINT
1530 PRINT "                                VOLLEY      GUNS RATE/ SPACING ROUNDS"
1540 PRINT "                                MIN      METERS"
1550 WRITE (15,1560)E[I,1],I[I,1]
1560 FORMAT "                                INITIAL: ",F5.0,6X,F8.0
1570 WRITE (15,1580)P[I,1],R1,Y[I,1],J[I,1]
1580 FORMAT "                                SUSTAINING:",F5.0,F5.1,F9.0,F7.0
1590 PRINT
1600 PRINT
1610 PRINT
1620 PRINT "                                155MM HOWITZER"
1630 PRINT
1640 PRINT "                                VOLLEY      GUNS RATE/ SPACING ROUNDS"
1650 PRINT "                                MIN      METERS"
1660 WRITE (15,1670)E[I,2],I[I,2]
1670 FORMAT "                                INITIAL: ",F5.0,6X,F8.0

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1680 WRITE (15,1690)F[I,2],R1,Y[I,2],J[I,2]
1690 FORMAT "          SUSTAINING:",F5.0,F5.1,F9.0,F7.0
1700 PRINT
1710 PRINT
1720 PRINT
1730 PRINT "          WP SMOKE SCREEN"
1740 PRINT
1750 PRINT
1760 PRINT "          105MM HOWITZER"
1770 PRINT
1780 PRINT "          VOLLEY          GUNS RATE/ SPACING ROUNDS"
1790 PRINT "          MIN          METERS"
1800 WRITE (15,1810)G[I,1],L[I,1]
1810 FORMAT "          INITIAL: ",F5.0,6X,F8.0
1820 WRITE (15,1830)Q[I,1],R[I,1],Z[I,1],P[I,1]
1830 FORMAT "          SUSTAINING:",F5.0,F5.1,F9.0,F7.0
1840 PRINT
1850 PRINT
1860 PRINT
1870 PRINT "          155MM HOWITZER"
1880 PRINT
1890 PRINT "          VOLLEY          GUNS RATE/ SPACING ROUNDS"
1900 PRINT "          MIN          METERS"
1910 WRITE (15,1920)G[I,2],L[I,2]
1920 FORMAT "          INITIAL: ",F5.0,6X,F8.0
1930 WRITE (15,1940)Q[I,2],R[I,2],Z[I,2],P[I,2]
1940 FORMAT "          SUSTAINING:",F5.0,F5.1,F9.0,F7.0
1950 PRINT
1960 PRINT
1970 IF I<3 THEN 2070
1980 PRINT "          WP SMOKE SCREEN"
1990 PRINT
2000 PRINT
2010 PRINT "          ROUNDS/    RATE/    TOTAL"
2020 PRINT "          60 METERS  MINUTE  ROUNDS"
2030 WRITE (15,2040)Q[I,1],R[I,1],P[I,1]
2040 FORMAT "          105MM: ",F5.0,5X,F3.0,5X,F7.0
2050 WRITE (15,2060)Q[I,2],R[I,2],P[I,2]
2060 FORMAT "          155MM: ",F5.0,5X,F3.0,5X,F7.0
2070 NEXT I
2080 PRINT
2090 PRINT
2100 PRINT
2110 PRINT
2120 PRINT
2130 PRINT
2140 PRINT "DONE"
2150 REM UNIT (PER GUN) SOURCE STRENGTHS.
2160 DATA 18.7,1737.3,77.1,7076.2
2170 DATA "VISIBLE:"
2180 DATA "NEAR IR:"
2190 DATA "MID IR:"
2200 DATA "FAR IR:"
2210 END

```

APPENDIX C

KWIK ALGORITHM (PRINTER)

GLOSSARY OF MNEMONICS (HPL/HP 9825A)

1. A	Ceiling - meters
2. B	Cloud cover - percent
3. C	Visibility - kilometers
4. D	Temperature - degrees Celsius
5. E	Dewpoint - degrees Celsius
6. F	Wind direction - degrees
7. G	Windspeed - knots
8. H	Atmospheric stability category
9. O	Slant range to target - kilometers
10. Q	Relative humidity - percent
11. R	Smoke screen length - meters
12. T	Smoke screen duration - minutes
13. U	Angle of sight to target - degrees
14. V	Direction of line of sight - degrees
15. Y	Average roughness element - centimeters
16. Z	Roughness length - centimeters
17. A(7,9)	Table of stability categories depending upon solar altitude and windspeed
18. B(4,4)	Table of transmittances resulting from water vapor, haze/fog precipitation and smoke for visual, near, mid, and far infrared wavelengths
19. C(4,2)	Table of smoke concentration values for HC and WP smoke (by wavelengths)
20. D(4)	Absorption coefficient error function
21. E(4)	Scale height for Mie scattering
22. F(4)	Haze and fog attenuation coefficients
23. G(4)	Precipitation attenuation coefficients
24. H(2,4)	Table of extinction coefficients for calculating HC and WP smoke concentrations for visible, near, mid and far infrared wavelengths
25. I(7)	Graphics scaling factors
26. J(6)	Coefficients to compute sigma y
27. K(6,3),L(6,3)	Coefficients of roughness correction factor used in calculating sigma z for the various roughness lengths
28. M(2)	Yield factors for HC and WP
29. N(5)	Latitude, longitude, altitude, Julian date and Zulu time data
30. O(3)	Graphics translator files
31. P(4,2,2)	Total number of rounds required (initial and sustaining) to maintain HC and WP smoke screen
32. Q(4,2,2,2)	Number of guns (initial and sustaining volleys) for 105- and 155-mm howitzer, for HC and WP smokes (by wavelengths)

33. P, R(4,2)	Rate of fire for HC and WP smokes (by wavelengths)
34. S(2,2)	Unit (per gun) source strength
35. T(2)	Munition efficiency for 105- and 155-mm howitzer, for HC smoke
36. U(2,2)	WP volume source sigmas (σ_{y0} and σ_{z0}) for 105- and 155-mm howitzer
37. V(2)	Stability dependent crosswind integrated concentration for WP smoke
38. W(6)	Constant (K) related to stability category for WP smoke
39. X(4)	Wavelength threshold levels
40. Y(4,2,2)	Shell spacing for 105- and 155-mm howitzer (initial and sustaining) for HC smoke
41. Z(4,2,2)	Shell spacing for 105- and 155-mm howitzer for WP smoke
42. A\$(4)	Met site identifier
43. B\$(6)	Stability category indicator
44. C\$(4,8)	Wavelength indicator
45. D\$(3)	Precipitation indicator
46. E\$(2,2)	HC or WP smoke indicator
47. G\$(1)	105-mm howitzer indicator
48. G\$(2)	155-mm howitzer indicator
49. E\$(2)	Direction from equator (N-S) and direction from Greenwich (E-W) indicators
50. I	Index for wavelength algorithms
51. J	Index for smoke algorithms
52. K	Index for gun (105- and 155-mm howitzer) algorithms

APPENDIX D
PRINTER (HPL/HP9825A) ALGORITHM

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0: "KWIK SMOKE PROGRAM - PAPER TAPE VERSION (08/20/80)":
1: dim A[7,9],D[4],E[4],H[2,4],J[6],K[6,3],L[6,3]
2: dim B[4,4],C[4,2],F[4],G[4],I[7],M[2],N[5]
3: dim O[6],P[4,2,2],Q[4,2,2,2],R[4,2],S[2,2]
4: dim T[2],U[2,2],V[2],W[6],X[4],Y[4,2,2],Z[4,2,2]
5: dim AS[4],BS[6],CS[4,8],DS[3],ES[2],FS[2,2],GS[2,5],HS[2]
6: "INITIALIZATION":
7: let I,A[*],D[*],E[*],H[*],J[*],K[*],L[*]
8: "  UNIT SOURCE STRENGTHS":
9: 18.7+S[1,1];1737.3+S[1,2];77.1+S[2,1];7076.2+S[2,2]
10: .4+T[1]+T[2]
11: 5.4+U[1,1];7.9+U[2,1];1.8+U[1,2];2.6+U[2,2]
12: .016+W[1]+W[2]+W[3]+W[4]+W[5]+W[6]
13: "  WAVELENGTH THRESHOLD LEVELS":
14: .05+X[1]+X[2]+X[3]+X[4]
15: "  PASQUILL STABILITY CATEGORY INDICATOR":
16: "ABCDEF"+BS
17: "  WAVELENGTH INDICATOR":
18: "VISIBLE:"+CS[1];"NEAR IR:"+CS[2];"MID IR: "+"CS[3];"FAR IR: "+"CS[4]
19: "  LATITUDE/LONGITUDE DEFAULT DIRECTIONS":
20: "NW"+ES
21: "  SMOKE TYPES":
22: "HC"+FS[1];"WP"+FS[2]
23: "  SMOKE DELIVERY SYSTEM NAMES":
24: "105MM"+GS[1];"155MM"+GS[2]
25: "MET SITE INFORMATION":
26: ent "MET SITE ID",AS
27: cap(AS)+AS
28: ent "LATITUDE OF MET SITE - DEG",N[1]
29: "DIRECTION FROM EQUATOR - N OR S":
30: "N"+LS[1,1]
31: cap(ES[1,1])+ES[1,1]
32: ent "LONGITUDE OF MET SITE - DEG",N[2]
33: ent "DIRECTION FROM GREENWICH- E OR W",ES[2,2]
34: cap(LS[2,2])+ES[2,2]
35: if ES[2,2]="E";-N[2]+N[2]
36: ent "ALTITUDE OF MET SITE - KM",N[3]
37: ent "JULIAN DATE OF MET OBSERVATION",N[4]
38: ent "ZULU TIME OF MET OBSERVATION",N[5]
39: "MET INPUTS":
40: ent "CEILING - METERS",A
41: ent "CLOUD COVER - PERCENT",B
42: ent "VISIBILITY - KM",C
43: ent "PRECIPITATION - YES OR NO",DS
44: cap(DS)+DS
45: ent "TEMPERATURE - DEG C",D
46: ent "DEW POINT - DEG C",E
47: ent "WIND DIRECTION - DEG",F
48: ent "WIND SPEED - KNOTS",G
49: ent "AVERAGE ROUGHNESS ELEMENT - CM",Y
50: ent "SLANT RANGE TO TARGET - KM",O
*21332

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51: ent "ANGLE OF SIGHT TO TARGET - DEG",U
52: if U<0;-U+U
53: sin(U)+U
54: ent "DIRECTION OF LINE OF SIGHT - DEG",V
55: ent "LENGTH OF SMOKE SCREEN - METERS",K
56: ent "DURATION OF SMOKE SCREEN - MIN",T
57: "MET CALCULATIONS":
58: if B#100;gtc "K1000"
59: if A>2133.6042;gtc "K1000"
60: U+U
61: U+U
62: gtc "K1400"
63: "K1000":
64: "CALCULATE ANGULAR FRACTION OF A YEAR FOR A GIVEN JULIAN DATE":
65: (N[4]-1)*360/365.242+U
66: "CALCULATE SOLAR DECLINATION ANGLE":
67: 279.9348+U+U
68: U+1.914827*sin(U)-.079525*cos(U)+U
69: U+1.019938*sin(2*U)-.00162*cos(2*U)+U
70: 23.4438+U
71: sin(U)*sin(U)+U
72: asn(U)+U
73: "CALCULATE TIME OF MERIDIAN PASSAGE - TRUE SOLAR NOON":
74: 12+.12357*sin(U)-.004289*cos(U)+U
75: U+.153609*sin(2*U)+.060783*cos(2*U)+U
76: "CALCULATE SOLAR HOUR ANGLE":
77: 15*(N[5]-U)-N[2]+U
78: "CALCULATE SOLAR ALTITUDE":
79: sin(N[1])*sin(U)+cos(N[1])*cos(U)*cos(U)+U
80: asn(U)+U
81: "CALCULATE INSOLATION CLASS NUMBER":
82: U+U
83: if U>60;4+U;gtc "K1100"
84: if U>35;3+U;gtc "K1100"
85: if U>15;2+U;gtc "K1100"
86: if U<=0;gtc "K1300"
87: 1+U
88: "K1100":
89: "CALCULATE NET RADIATION INDEX FOR DAYTIME":
90: U+U
91: if U<=50;U+U;gtc "K1200"
92: if A<2133.6042;U-2+U;gtc "K1200"
93: if A<4876.8096;U-1+U;gtc "K1200"
94: if B=100;U-1+U
95: "K1200":
96: if U=0;U+U
97: if U<1;1+U
98: U+U;gtc "K1400"
99: "K1300":
100: "CALCULATE NET RADIATION INDEX FOR NIGHTTIME":
101: if B<40;-2+U;gtc "K1400"
*16402

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102: -1+r0
103: "K1400":
104: "CALCULATE PASQUILL STABILITY CATEGORY":
105: 0+r4;0+r5
106: if r0=4;1+r4
107: if r0=3;2+r4
108: if r0=2;3+r4
109: if r0=1;4+r4
110: if r0=0;5+r4
111: if r0=-1;6+r4
112: if r0=-2;7+r4
113: if G<2;1+r5;gtc "K1500"
114: if G<4;2+r5;gtc "K1500"
115: if G<6;3+r5;gtc "K1500"
116: if G<7;4+r5;gtc "K1500"
117: if G<8;5+r5;gtc "K1500"
118: if G<10;6+r5;gtc "K1500"
119: if G<11;7+r5;gtc "K1500"
120: if G<12;8+r5;gtc "K1500"
121: 9+r5
122: "K1500":
123: A(r4,r5)*H
124: "CALCULATE RELATIVE HUMIDITY":
125: if D>0;gtc "K1600"
126: 9.5+r0;265.5+r1
127: gtc "K1700"
128: "K1600":
129: 7.5+r0;237.3+r1
130: "K1700":
131: if L>0;gtc "K1800"
132: 9.5+r2;265.5+r3
133: gtc "K1900"
134: "K1800":
135: 7.5+r2;237.3+r3
136: "K1900":
137: 0.11*10^((r0*D/(r1+D))+r4
138: 0.11*10^((r2*E/(r3+E))+r5
139: r5/r4*100+Q
140: lxd 2
141: prt " "
142: prt " "
143: prt " NONFION"
144: prt " EXPENDITURES"
145: prt " FOR"
146: prt " HC AND WP"
147: prt " SMOKE"
148: prt " "
149: prt " "
150: prt "ID = "&A$
151: prt "LAT = "&E$(1,1)&str(N(1))
152: prt "LONG = "&E$(2,2)&str(abs(N(2)))
*10090

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153: prt "ALT"      ="&str(N[3])
154: prt "DATE"     ="&str(N[4])
155: prt "TIME"     ="&str(N[5])
156: prt "CELL"     ="&str(A)
157: prt "SKY"      ="&str(B)
158: prt "VIS"      ="&str(C)
159: prt "PRECIP"   ="&D$
160: prt "TEMP"     ="&str(D)
161: prt "Td"       ="&str(E)
162: prt "WD"       ="&str(F)
163: prt "WS"       ="&str(G)
164: prt "AKB"      ="&str(Y)
165: prt "PSC"      ="&D$(N,H)
166: prt "RH"       ="&str(Q)
167: prt " "
168: prt " "
169: "ATMOSPHERIC OPTICS CALCULATIONS":
170: ln(C)+r0
171: r0*r0+r1
172: r1*r0+r2
173: 1.5551-.9811*r0-.0197*r1+.0041*r2+F[1]
174: exp(F[1])+F[1]
175: 1.50381511-.992319519*r0-.015972801*r1+.00368583*r2+F[2]
176: exp(F[2])+F[2]
177: 1.2394-1.0436*r0+.0099*r1-.0016*r2+F[3]
178: exp(F[3])+F[3]
179: 1.5176-1.7147*r0+.0001*r1+.0428*r2+F[4]
180: exp(F[4])+F[4]
181: 1.3306-.8825*r0-.0753*r1+.0129*r2+G[1]
182: exp(G[1])+G[1]
183: 1.481951707-.9225589*r0-.065509417*r1+.013680422*r2+G[2]
184: exp(G[2])+G[2]
185: 1.5556-.9013*r0-.0773*r1+.0173*r2+G[3]
186: exp(G[3])+G[3]
187: 1.5928-.9396*r0-.0627*r1+.0168*r2+G[4]
188: exp(G[4])+G[4]
189: 0+r0
190: 11 0#0;1/0+r0
191: "CALCULATE PRECIPITABLE WATER":
192: .4477+.0328*E+1.2e-3*E^2+1.84e-5*E^3+r11
193: "CALCULATE AMOUNT OF WATER VAPOR IN PATH":
194: 0+r0;0+r1;r0+r2;.5*(r1+r2)+r3
195: r2-r1+r4;.2586751*r4+r5
196: .5*r4*( 'FNA'(r3+r5)+ 'FNA'(r3-r5))+r9
197: r11*r9+r10
198: "CALCULATE TRANSMITTANCE FOR VISIBLE - NEAR, MID AND FAR IR":
199: for i=1 to 4
200: "CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY WATER VAPOR.":
201: if i=4;exp(-.0681*r10)+D[1,1];goto "K2600"
202: D[1]*v(r10*pi)/2+r0;0+r1;r0+r2
203: .5*(r1+r2)+r3
*12715

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204: r2-r1+r4
205: .2086751*r4+r5
206: .5*r4*( 'FND'(r3+r5)+ 'FND'(r3-r5)) +r12
207: 2/ym*r12+b[1,1]
208: 1-b[1,1]+b[1,1]
209: "K2600":
210: "CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY HAZE AND FOG.":
211: if DS="YES";1+b[1,2];gtc "K2900"
212: if C>=E[1];gtc "K2800"
213: r6+r0;0+r1;r0+r2
214: .5*(r1+r2)+r3
215: r2-r1+r4
216: .2086751*r4+r5
217: .5*r4*( 'FND'(r3+r5)+ 'FND'(r3-r5)) +r13
218: exp(-r[1]*r13)+r14
219: 0-r6+r0;r8+r1;r8+r0+r2
220: .5*(r1+r2)+r3
221: r2-r1+r4
222: .2086751*r4+r5
223: .5*r4*( 'FND'(r3+r5)+ 'FND'(r3-r5)) +r15
224: exp(-.128*r15)+r16
225: r14*r16+b[1,2];gtc "K2900"
226: "K2800":
227: 0+r0;0+r1;r0+r2;.5*(r1+r2)+r3
228: r2-r1+r4;.2086751*r4+r5
229: .5*r4*( 'FND'(r3+r5)+ 'FND'(r3-r5)) +r17
230: exp(-r[1]*r17)+b[1,2]
231: "K2900":
232: "CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY PRECIPITATION":
233: if DS="NO";1+b[1,3];gtc "K3100"
234: if C>20;1+b[1,3];gtc "K3100"
235: exp(-J*G[I])+b[1,3]
236: "K3100":
237: "CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY SMOKE.":
238: A[1]/(b[1,1]*b[1,2]*b[1,3])+b[1,4]
239: if b[1,4]>1;1+b[1,4]
240: "CALCULATE LINE OF SIGHT INTEGRATED CONCENTRATION.":
241: if b[1,4]#0;gtc "K3400"
242: for J=1 to 2;0+C[1,J]
243: next J;gtc "K3475"
244: "K3400":
245: for J=1 to 2
246: if n[J,1]=0;0+C[1,J];gtc "K3450"
247: ln(b[1,4])/ -n[J,1]+C[1,J]
248: "K3450":
249: next J
250: "K3475":
251: next I
252: "ATMOSPHERIC DIFFUSION CALCULATIONS":
253: 10^(-1.24+1.19*log(Y))+z
254: ads(v-r)+r8
*10460

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255:  $v(13.69/(13.69*\sin(r8)*\sin(r8)+\cos(r6)*\cos(r8)))+r15$ 
256:  $1.09521547+.02906894*Q-4.9575e-4*Q*Q+4.82e-6*Q*Q*Q+M[1]$ 
257:  $3.364059144+.060502571*Q-1.15301e-3*Q*Q+1.33942e-5*Q*Q*Q+M[2]$ 
258:  $K[n,1]+K[n,2]*Z+K[n,3]*Z^2+r9$ 
259:  $L[n,1]+L[n,2]*Z+L[n,3]*Z^2+r10$ 
260:  $1/r10+r11$ 
261: if C=J; 1+C
262: .515*G+r10
263: for i=1 to 4
264: "CALCULATE CROSSWIND INTEGRATED CONCENTRATION FOR WP SMOKE":
265: for k=1 to 2
266: if i<3; if h>4; gtc "K3500"
267:  $U[k,1]+.74*U[h]*100^{.9+r4}$ 
268:  $U[k,2]+.667*r9*100^{r10+r5}$ 
269:  $W[h]*M[2]*S[k,2]/(\pi*r4*r5)+v[k]$ 
270: "K3500":
271: "MONITION EXPENDITURE CALCULATIONS":
272: if i>2; gtc "K4100"
273: "CALCULATE INITIAL SHELL SPACING FOR HC SMOKE":
274:  $r16*45+Y[1,1,K]$ 
275: "CALCULATE SUSTAINING SHELL SPACING FOR HC SMOKE":
276: if C[1,1]#0; gtc "K3600"
277:  $U+Y[1,2,K]$ ; gtc "K3700"
278: "K3600":
279:  $1/r15*(.731*1[K]*M[1]*S[K,1]/(C[1,1]*r16*r9))^{r11}+Y[1,2,K]$ 
280: if  $Y[1,2,K]>R$ ;  $R+Y[1,2,K]$ 
281: "K3700":
282: if  $Y[1,2,K]=0$ ;  $1+Q[1,1,K,1]+Q[1,2,K,1]$ ; gtc "K4000"
283: "CALCULATE INITIAL VOLLEY FOR HC SMOKE":
284: if  $Y[1,1,K]>Y[1,2,K]$ ;  $Y[1,2,K]+Y[1,1,K]$ 
285:  $R/Y[1,1,K]+Q[1,1,K,1]$ 
286: if  $\text{irc}(Q[1,1,K,1])>0$ ;  $\text{int}(Q[1,1,K,1])+1+Q[1,1,K,1]$ 
287: "CALCULATE NUMBER OF GUNS FOR SUSTAINING VOLLEYS (HC)":
288:  $R/Y[1,2,K]+Q[1,2,K,1]$ 
289: if  $\text{irc}(Q[1,2,K,1])>0$ ;  $\text{int}(Q[1,2,K,1])+1+Q[1,2,K,1]$ 
290: "K4000":
291: "RATE OF FIRE FOR HC SMOKE":
292: .5+P; if C[1,1]=0; 0+P
293: "CALCULATE TOTAL NUMBER OF ROUNDS REQUIRED (HC)":
294:  $Q[1,1,K,1]+Q[1,2,K,1]*(P*T-1)+P[1,K,1]$ 
295: if  $\text{irc}(P[1,K,1])>0$ ;  $\text{int}(P[1,K,1])+1+P[1,K,1]$ 
296: "K4100":
297: if i<3; if h>4; gtc "K4300"
298: "SHELL SPACING (Z[ ]) & VOLLEYS (Q[ ]) - WP":
299: if C[1,2]#0; gtc "K4120"
300:  $U+Z[1,1,K]+Z[1,2,K]$ 
301:  $U+Q[1,1,K,2]+Q[1,2,K,2]$ 
302: gtc "K4180"
303: "K4120":
304: if i>2; .6*C[1,2]/v[K]+Q[1,1,K,2]; gtc "K4140"
305:  $v[K]/C[1,2]*100+Z[1,1,K]$ 
*2556

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```

306: Z[1,1,K]→Z[1,2,K]
307: R/Z[1,2,K]→Q[1,1,K,2]
308: "K4140":
309: int(Q[1,1,K,2])→r1
310: if frc(Q[1,1,K,2])>0;r1+1→r1
311: r1→Q[1,1,K,2]→Q[1,2,K,2]
312: "K4180":
313: "RATE OF FIRE FOR WP SMOKE":
314: if C[1,2]=0;0→R[1,K];gto "K4200"
315: if 1>2;120/r16→R[1,K];gto "K4190"
316: (Z[1,2,K]+60)/r16→R[1,K]
317: "K4190":
318: R[1,K]/20→κ[1,K]
319: int(R[1,K])→r0
320: if frc(R[1,K])>=.5;int(R[1,K])+1→r0
321: if r0=0;1→r0
322: r0*20/60→R[1,K]
323: 1/R[1,K]→R[1,K]
324: if R[1,K]<1;1→R[1,K]
325: "K4200":
326: "CALCULATE TOTAL NUMBER OF ROUNDS REQUIRED (WP)":
327: if C[1,2]=0;0→P[1,K,2];gto "K4500"
328: Q[1,1,K,2]+Q[1,2,K,2]*(T*R[1,K]-1)→P[1,K,2]
329: if 1>2;Q[1,2,K,2]*(R/60+1)*(T*R[1,K]-1)→P[1,K,2]
330: if frc(P[1,K,2])>0;int(P[1,K,2])+1→P[1,K,2]
331: gto "K4500"
332: "K4300":
333: "CALCULATIONS FOR WP E & F STABILITY CATEGORIES":
334: "INITIAL SHELL SPACING - WP SMOKE":
335: if I=1;if K=1;100→Z[1,1,K]
336: if I=2;if K=1;50→Z[1,1,K]
337: if 1<3;if K=2;100→Z[1,1,K]
338: "SUSTAINING SHELL SPACING - WP SMOKE":
339: if I=1;if K=1;100→Z[1,2,K]
340: if I=1;if K=2;200→Z[1,2,K]
341: if I=2;if K=1;50→Z[1,2,K]
342: if I=2;if K=2;100→Z[1,2,K]
343: "INITIAL VOLLEY - WP SMOKE":
344: R/Z[1,1,K]+1→Q[1,1,K,2]
345: "SUSTAINING VOLLEY - WP SMOKE":
346: R/Z[1,2,K]+1→Q[1,2,K,2]
347: "RATE OF FIRE - WP SMOKE":
348: if K=1;2→κ[1,K]
349: if K=2;1→κ[1,K]
350: "TOTAL NUMBER OF WP ROUNDS REQUIRED":
351: Q[1,1,K,2]+Q[1,2,K,2]*(T*R[1,K]-1)→P[1,K,2]
352: "K4500":
353: next K
354: next I
355: txd 0
356: for I=1 to 4
*7502

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```

357: prt " "
358: prt " "
359: prt "*****"
360: prt "      "&CS[1]
361: prt " "
362: prt " "
363: prt "SCREEN"
364: prt "      LENGTH: "&str(int(R))
365: prt "      DURATION:"&str(int(T))
366: for J=1 to 2
367: if J=1; if 1>2; goto "FIRST K"
368: prt " "
369: prt " "
370: prt FS[J]&" SMOKE SCREEN"
371: "FIRST K":
372: for K=1 to 2
373: if J=1; if 1>2; goto "NEXT K"
374: if 1>2; goto "M&F 1R"
375: prt " "
376: prt " "
377: prt "      "&GS[K]
378: prt " "
379: prt "VOLLEY"
380: prt " "
381: prt "INITIAL:      "
382: prt "      GUNS"
383: prt "      "&str(Q[1,1,K,J])
384: prt " "
385: prt "      SPACING"
386: prt "      METERS"
387: if J=1; prt "      "&str(Y[1,1,K])
388: if J=2; prt "      "&str(Z[1,1,K])
389: prt " "
390: prt "SUSTAINING: "
391: prt "      GUNS"
392: prt "      "&str(Q[1,2,K,J])
393: prt " "
394: fix 1
395: prt "      RATE/"
396: prt "      MIN"
397: if J=1; prt "      "&str(P)
398: if J=2; prt "      "&str(R[1,K])
399: prt " "
400: fix 0
401: prt "      SPACING"
402: prt "      METERS"
403: if J=1; prt "      "&str(Y[1,2,K])
404: if J=2; prt "      "&str(Z[1,2,K])
405: prt " "
406: prt "      ROUNDS"
407: prt "      "&str(P[1,K,J])
*18000

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408: prt " "
409: if 1<3;gtc "NEXT K"
410: "M&F 1K":
411: prt " "
412: prt " "
413: prt G$[K]&":"
414: prt "          ROUNDS/"
415: prt "          60 METERS"
416: prt "          "&str(Q[1,2,K,J])
417: prt " "
418: fxd 1
419: prt "          RATE/"
420: prt "          MINUTE"
421: prt "          "&str(R[1,K])
422: prt " "
423: fxd 0
424: prt "          TOTAL"
425: prt "          ROUNDS"
426: prt "          "&str(F[1,K,J])
427: prt " "
428: "NEXT K":
429: next K
430: next J
431: next I
432: prt " "
433: prt " "
434: asp "DONE"
435: end
436: "FUNCTIONS":
437: "FNA":ret exp(-U*pl/2)
438: "FNB":ret exp(-pl^2)
439: "FNC":ret exp(pl*U*ln(.1/F[1]))
440: "FND":ret exp(-pl*U/4.1)
*32707

```

APPENDIX E

CRT KWIK ALGORITHM GLOSSARY OF MNEMONICS (HPL/HP 9825A)

1. A	Ceiling - feet
2. B	Cloud cover - percent
3. C	Visibility - miles
4. D	Temperature - degrees Fahrenheit
5. E	Dewpoint - degrees Fahrenheit
6. F	Wind direction - degrees
7. G	Windspeed - knots
8. H	Atmospheric stability category
9. O	Slant range to target - kilometers
10. Q	Relative humidity - percent
11. R	Smoke screen length - meters
12. T	Smoke screen duration - minutes
13. U	Angle of sight to target - degrees
14. V	Direction of line of sight degrees
15. Y	Average roughness element - centimeters
16. Z	Roughness length - centimeters
17. A(7,9)	Table of stability categories depending upon solar altitude and windspeed
18. B(4,4)	Table of transmittances resulting from water vapor, haze/fog precipitation and smoke for visual, near, mid, and far infrared wavelengths
19. C(4,2)	Table of smoke concentration values for HC and WP smoke (by wavelengths)
20. D(4)	Absorption coefficient error function
21. E(4)	Scale height for Mie scattering
22. F(4)	Haze and fog attenuation coefficients
23. G(4)	Precipitation attenuation coefficients
24. H(2,4)	Table of extinction coefficients for calculating HC and WP smoke concentrations for visible, near, mid and far infrared wavelengths
25. I(7)	Graphics scaling factors
26. J(6)	Coefficients to compute sigma y
27. K(6,3),L(6,3)	Coefficients of roughness correction factor used in calculating sigma z for the various roughness lengths
28. M(2)	Yield factors for HC and WP
29. N(5)	Latitude, longitude, altitude, Julian date and Zulu time data
30. O(3)	Graphics translator files
31. P(4,2,2)	Total number of rounds required (initial and sustaining) to maintain HC and WP smoke screen
32. Q(4,2,2,2)	Number of guns (initial and sustaining volleys) for 105- and 155-mm howitzers, for HC and WP (by wavelengths)

33.	R(4,2); L, M	Rate of fire for WP smokes (by wavelengths) for 105- and 155-mm howitzers
34.	P	Rate of fire for HC smoke
35.	S(2,2)	Unit (per gun) source strength
36.	T(2)	Munition efficiency for 105-mm howitzers, for HC smoke
37.	U(2,2)	WP volume source sigmas (σ_{y0} and σ_{z0}) for 105- and 155-mm howitzers
38.	V(2)	Stability dependent crosswind integrated concentration for WP smoke
39.	W(6)	Constant (K) related to stability category for WP smoke
40.	X(4)	Wavelength threshold levels
41.	Y(4,2,2)	Shell spacing for 105- and 155-mm howitzers (initial and sustaining) for HC smoke
42.	Z(4,2,2)	Shell spacing for 105- and 155-mm howitzer for WP smoke
43.	A\$(4)	Met site identifier
44.	B\$(6)	Stability category indicator
45.	C\$(32)	Wavelength indicator
46.	D\$(3)	Precipitation indicator
47.	E\$(2)	HC or WP smoke indicator
48.	F\$(3)	105-mm howitzer indicator
49.	G\$(3)	155-mm howitzer indicator
50.	H\$(2,2)	Direction from equator (N-S) and direction from Greenwich (E-W) indicators
51.	I	Index for wavelength algorithms
52.	J	Index for smoke algorithms
53.	K	Index for gun (105- or 155-mm howitzers) algorithms

APPENDIX F
CRT (HPL/HP9825A) ALGORITHM

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0: "AWIK SMOKE PROGRAM - CRT VERSION (9/10/81)":
1: dim A[7,9],D[4],E[4],H[2,4],J[6],K[6,3],L[6,3]
2: dim B[4,4],C[4,2],F[4],G[4],I[7],M[2],N[5]
3: dim O[6],P[4,2,2],Q[4,2,2,2],R[4,2],S[2,2]
4: dim T[2],U[2,2],V[2],W[6],X[4],Y[4,2,2],Z[4,2,2]
5: dim AS[4],BS[6],CS[4,8],DS[3],ES[2],FS[3],GS[3],HS[2]
6: "INITIAL.":
7: for I=1,A[*],D[*],E[*],H[*],J[*],K[*],L[*]
8: "  GRAPH. TRANS. FILE SIZES":
9: 43+O[1];905+O[2];1100+O[3]
10: "  UNIT SRC. STREN.":
11: 18.7+S[1,1];1737.3+S[1,2];77.1+S[2,1];7076.2+S[2,2]
12: "  MON. EFF. FOR HC SMOKE":
13: .4+T[1]+T[2]
14: "  VOL. SRC. SIC. FOR WP SMOKE":
15: 5.4+U[1,1];7.9+U[2,1];1.8+U[1,2];2.6+U[2,2]
16: "  CONSTS. RELATED TO STAB. FOR WP SMK":
17: .016+W[1]+W[2]+W[3]+W[4]+W[5]+W[6]
18: "  WVL THRES LEVELS":
19: .05+X[1]+X[2]+X[3]+X[4]
20: "  STABLY. CAT. IND.":
21: "ABCDEF"+BS
22: "  WVL INDICATOR":
23: "VISIBLE:"+CS[1];"NEAR IR:"+CS[2];"MID IR:"+CS[3];"FAR IR:"+CS[4]
24: "  SMK DLVRY SYS NAMES":
25: "105"+FS
26: "155"+GS
27: "  LAT/LONG DEFLT DRCINS.":
28: "NW"+HS
29: "INITIAL. DISP.":
30: cli 7
31: wtb 716,3,20,13,10,"em::en::ex::sn::sx::um::"
32: imt 1,14.0,""
33: wrt 716,"f1 0000,"
34: for I=1 to 3
35: I-I+J
36: wrt 716.1,"n1",J
37: for K=1 to O[1]
38: wrt 716,"pe0,::pa0,0;"
39: next K
40: wrt 716,"sn"
41: next I
42: "SCL DISP":
43: I1+I[1]
44: 3.5+I[2]
45: 1022/I[1]+I[3]
46: 1023/I[2]+I[4]
47: "DSPLY0":
48: wrt 718,"ei0,::if0,::bf0,"
49: cli 'TITLE'(0,8)
50: wtb 716,"pe1,::txmonition EXPENDITURES",3,13,10
*21223

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51: cll 'NEXLINE'(1.5)
52: wrt 718,"pel,::tx FOR HC AND WP SMOKE ",3,13,10
53: wrt 718,"uf0,"
54: "MET SITE INFO":
55: ent "MET SITE ID",A$
56: cap(A$)+A$
57: ent "LATITUDE OF MET SITE - DEG",N[1]
58: "DIRECTION FROM EQUATOR- N or S":
59: "N"→E$[1,1]
60: cap(H$[1,1])+H$[1,1]
61: ent "LONGITUDE OF MET SITE - DEG",N[2]
62: ent "DIRECTION FROM GREENWICH- E or W",H$[2,2]
63: cap(H$[2,2])+H$[2,2]
64: if H$[2,2]="E";-N[2]+N[2]
65: ent "ALTITUDE OF MET SITE-KILOMETERS",N[3]
66: ent "JULIAN DATE OF MET OBSERVATION",N[4]
67: ent "ZULU TIME OF MET OBSERVATION-HR",N[5]
68: "MET INPUTS":
69: ent "CLILING - FEET",A
70: A*.3048→A
71: ent "CLOUD COVER - PERCENT",S
72: ent "VISIBILITY - MILES",C
73: C*1.61→C
74: ent "PRECIPITATION - YES OR NO",D$
75: cap(D$)+D$
76: ent "TEMPERATURE - DEG F",D
77: 5/9*(D-32)→D
78: ent "DEW POINT - DEG F",E
79: 5/9*(E-32)→E
80: ent "WIND DIRECTION - DEGS",F
81: ent "WIND SPEED - KNOTS",G
82: ent "AVE ROUGHNESS ELEMENT - CM",Y
83: ent "SLANT RANGE TO TARGET - KM",O
84: ent "ANGLE OF SIGHT TO TARGET - DEG",U
85: if U<0;-U→U
86: sin(U)→U
87: ent "DIRECTION OF LINE OF SIGHT - DEG",V
88: ent "SCREEN LENGTH - METERS",R
89: ent "DURATION - MINUTES",T
90: "DSPLY1":
91: lmt 1,i6.2,1b
92: lmt 2,i7.2,1b
93: lmt 3,i3.0,1b
94: wrt 718,"bf0,::e11,::ff1,::bf1,"
95: cll 'LINE'(0,5)
96: wrt 718,"pel,::txid = ",A$,3,13,10
97: cll 'NEXLINE'(1.5)
98: wrt 718.2,"pel,::txLATITUDE - DEG = ",H$[1,1],N[1],3
99: cll 'NEXLINE'(1.5)
100: wrt 718.2,"pel,::txLONGITUDE - DEG = ",H$[2,2],N[2],3
101: cll 'NEXLINE'(1.5)
*26210

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102: wrt 718.2,"pel,::txALTITUDE           - KM           = ",N[3],3
103: cll 'NEXTLINE'(1.5)
104: wrt 718.3,"pel,::txJULIAN DATE         - DAY           = ",N[4],3
105: cll 'NEXTLINE'(1.5)
106: wrt 718.3,"pel,::txZULU TIME           - HOUR          = ",N[5],3
107: cll 'NEXTLINE'(1.5)
108: wrt 718.2,"pel,::txCEILING             - METERS        = ",A,3
109: cll 'NEXTLINE'(1.5)
110: wrt 718.2,"pel,::txCLOUD COVER          - PERCENT       = ",B,3
111: cll 'NEXTLINE'(1.5)
112: wrt 718.2,"pel,::txVISIBILITY          - KM            = ",C,3
113: cll 'NEXTLINE'(1.5)
114: wrt 718,"pel,::txPRECIPITATION         = ",D$,
115: wrt 718,3,13,10
116: cll 'NEXTLINE'(1.5)
117: wrt 718.2,"pel,::txTEMPERATURE         - DEG C         = ",D,3
118: cll 'NEXTLINE'(1.5)
119: wrt 718.2,"pel,::txDEWPOINT            - DEG C         = ",E,3
120: cll 'NEXTLINE'(1.5)
121: wrt 718.2,"pel,::txWIND DIRECTION      - DEG           = ",F,3
122: cll 'NEXTLINE'(1.5)
123: wrt 718.2,"pel,::txWIND SPEED          - KNOTS         = ",G,3
124: cll 'NEXTLINE'(1.5)
125: wrt 718.2,"pel,::txAVE ROUGHNESS ELEMENT - CM           = ",Y,3
126: if HS[2,2]="E".-N[2]*N[2]
127: "MET CALC":
128: if B#100;gto "K1000"
129: if A>2133.6042;gto "K1000"
130: 0+r0
131: 0+r1
132: gto "K1400"
133: "K1000":
134: "CALC ANGL FRAC OF A YR FOR A GIVN JULN DATE":
135: (N[4]-1)*360/365.242+r9
136: "CALC SOLAR DECL ANGLE":
137: 279.9348+r9+r11
138: r11+1.914827*sin(r9)-.079525*cos(r9)+r11
139: r11+.019938*sin(2*r9)-.00162*cos(2*r9)+r11
140: 23.4438+r12
141: sin(r12)*sin(r11)+r13
142: asn(r13)+r13
143: "CALC TIME OF MERID PASS - TRUE SOLAR NOON":
144: 12+.12357*sin(r9)-.004289*cos(r9)+r14
145: r14+.153809*sin(2*r9)+.060783*cos(2*r9)+r14
146: "CALC SOLAR HR ANGLE":
147: 15*(N[5]-r14)-N[2]+r15
148: "CALC SOLAR ALT":
149: sin(N[1])*sin(r13)+cos(N[1])*cos(r13)*cos(r15)+r16
150: asn(r16)+r16
151: "CALC INSOL CLASS NUM":
152: 0+r1
*20456

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153: if r16>60;4→r1;gtc "K1100"
154: if r16>35;3→r1;gtc "K1100"
155: if r16>15;2→r1;gtc "K1100"
156: if r16<=0;gtc "K1300"
157: 1→r1
158: "K1100":
159: "CALC NET RAD INDX FOR DYTIME":
160: 0→r2
161: if B<=50;r1→r2;gtc "K1200"
162: if A<2133.6042;r1-2→r2;gtc "K1200"
163: if A<4876.8096;r1-1→r2;gtc "K1200"
164: if B=100;r1-1→r2
165: "K1200":
166: if r2=0;r1→r2
167: if r2<1;1→r2
168: r2→r0;gtc "K1400"
169: "K1300":
170: "CALC NET RAD INDX FOR NTTIME":
171: if B<40;-2→r0;gtc "K1400"
172: -1→r0
173: "K1400":
174: "CALC STABLTY CAT":
175: 0→r4;0→r5
176: if r0=4;1→r4
177: if r0=3;2→r4
178: if r0=2;3→r4
179: if r0=1;4→r4
180: if r0=0;5→r4
181: if r0=-1;6→r4
182: if r0=-2;7→r4
183: if G<2;1→r5;gtc "K1500"
184: if G<4;2→r5;gtc "K1500"
185: if G<6;3→r5;gtc "K1500"
186: if G<7;4→r5;gtc "K1500"
187: if G<8;5→r5;gtc "K1500"
188: if G<10;6→r5;gtc "K1500"
189: if G<11;7→r5;gtc "K1500"
190: if G<12;8→r5;gtc "K1500"
191: 9→r5
192: "K1500":
193: A[r4,r5]→H
194: "CALC REL HUMDTY":
195: if D>0;gtc "K1600"
196: 9.5→r0;265.5→r1
197: gtc "K1700"
198: "K1600":
199: 7.5→r0;237.3→r1
200: "K1700":
201: if L>0;gtc "K1800"
202: 9.5→r2;265.5→r3
203: gtc "K1900"
*17300

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204: "K1800":
205: 7.5+r2;237.3+r3
206: "K1900":
207: 0.11*10^(r0*L/(r1+L))+r4
208: 0.11*10^(r2*L/(r3+L))+r5
209: r5/r4*100+Q
210: cll "NEXTLINE"(1.5)
211: wto 718,"pel,::txPASQUILL STABILITY CATEGORY" = ",BS[H,H],3,13,10
212: cll "NEXTLINE"(1.5)
213: wrt 718.2,"pel,::txRELATIVE HUMIDITY" =",Q,3
214: wrt 718,"ufl,"
215: gsp "CONTINUE WHEN READY";stp
216: "ATMOSPHERIC OPTICS CALCULATIONS":
217: ln(C)+r0
218: r0*r0+r1
219: r1*r0+r2
220: 1.5551-.9811*r0-.0197*r1+.0041*r2+F[1]
221: exp(r[1])+F[1]
222: 1.50381511-.992319519*r0-.015972801*r1+.00368583*r2+F[2]
223: exp(r[2])+r[2]
224: 1.2394-1.0436*r0+.0099*r1-.0016*r2+F[3]
225: exp(r[3])+r[3]
226: 1.5176-1.7147*r0+.0001*r1+.0428*r2+F[4]
227: exp(r[4])+r[4]
228: 1.3306-.8825*r0-.0753*r1+.0129*r2+G[1]
229: exp(G[1])+G[1]
230: 1.481951707-.9225589*r0-.065509417*r1+.013680422*r2+G[2]
231: exp(G[2])+G[2]
232: 1.5556-.9013*r0-.0773*r1+.0173*r2+G[3]
233: exp(G[3])+G[3]
234: 1.5928-.9396*r0-.0627*r1+.0168*r2+G[4]
235: exp(G[4])+G[4]
236: 0+r8
237: if u#0;1/u+r8
238: "CALCULATE PRECIPITABLE WATER":
239: .4477+.0328*E+1.2e-3*E^2+1.84e-5*E^3+r11
240: "CALCULATE AMOUNT OF WATER VAPOR IN PATH":
241: 0+r0;0+r1;r0+r2;.5*(r1+r2)+r3
242: r2-r1+r4;.2886751*r4+r5
243: .5*r4*( 'FNA'(r3+r5)+ 'FNA'(r3-r5))+r9
244: r11*r9+r10
245: "CALCULATE TRANSMITTANCE FOR VISIBLE - NEAR, MID AND FAR IR":
246: for i=1 to 4
247: "CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY WATER VAPOR.":
248: if i=4;exp(-.0681*r10)+B[1,1];gtc "K2600"
249: B[1]*v(r10*pi)/2+r0;0+r1;r0+r2
250: .5*(r1+r2)+r3
251: r2-r1+r4
252: .2886751*r4+r5
253: .5*r4*( 'FNB'(r3+r5)+ 'FNB'(r3-r5))+r12
254: 2/v*pi*r12+B[1,1]
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255: 1-B[1,1]+B[1,1]
256: "K2600":
257: "CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY HAZE AND FOG.":
258: if D$="YES";1+B[1,2];gtc "K2900"
259: if C>=E[1];gtc "K2800"
260: r3+r0;0+r1;r0+r2
261: .5*(r1+r2)+r3
262: r2-r1+r4
263: .2386751*r4+r5
264: .5*r4*( 'FNC'(r3+r5)+'FNC'(r3-r5))+r13
265: exp(-r[1]*r13)+r14
266: 0-r8+r0;r8+r1;r8+r0+r2
267: .5*(r1+r2)+r5
268: r2-r1+r4
269: .2686751*r4+r5
270: .5*r4*( 'FND'(r3+r5)+'FND'(r3-r5))+r15
271: exp(-.128*r15)+r16
272: r14*r16+B[1,2];gtc "K2900"
273: "K2300":
274: 0+r0;0+r1;r0+r2;.5*(r1+r2)+r3
275: r2-r1+r4;.2686751*r4+r5
276: .5*r4*( 'FND'(r3+r5)+'FND'(r3-r5))+r17
277: exp(-F[1]*r17)+B[1,2]
278: "K2900":
279: "CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY PRECIPITATION":
280: if D$="NO";1+B[1,3];gtc "K3100"
281: if C>20;1+S[1,3];gtc "K3100"
282: exp(-O*G[1])+B[1,3]
283: "K3100":
284: "CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY SMOKE.":
285: A[1]/(B[1,1]*B[1,2]*B[1,3])+B[1,4]
286: if B[1,4]>1;1+B[1,4]
287: "CALCULATE LINE OF SIGHT INTEGRATED CONCENTRATION":
288: if B[1,4]#0;gtc "K3400"
289: for J=1 to 2;0+C[1,J]
290: next J;gtc "K3475"
291: "K3400":
292: for J=1 to 2
293: if A[J,1]=0;0+C[1,J];gtc "K3450"
294: ln(B[1,4])/(-A[J,1]+C[1,J])
295: "K3450":
296: next J
297: "K3475":
298: next I
299: "ATMOSPHERIC DIFFUSION CALCULATIONS":
300: 10^(-1.24+1.19*log(Y))+Z
301: abs(v-r)+r8
302: v(13.69/(13.69*sin(r8)*sin(r8)+cos(r8)*cos(r8)))+r15
303: 1.09521547+.02906894*Q-4.9575e-4*Q*Q+4.82e-6*Q*Q*Q+M[1]
304: 3.364059144+.060502571*Q-1.15301e-3*Q*Q+1.33942e-5*Q*Q*Q+M[2]
305: A[n,1]+K[n,2]*Z+K[n,3]*Z^2+r9
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306: L[n,1]+L[n,2]*z+L[n,3]*z^2+r10
307: 1/r10+r11
308: if G=0;1+G
309: .515*G+r10
310: for i=1 to 4
311: "CALCULATE CROSSWIND INTEGRATED CONCENTRATION FOR WP SMOKE":
312: for K=1 to 2
313: if i<3;if n>4;goto "K3500"
314: U[K,1]+.74*U[n]*100^.9+r4
315: U[K,2]+.667*r9*100^r10+r5
316: W[n]*M[2]*S[K,2]/(pi*r4*r5)+V[K]
317: "K3500":
318: "MUNITION EXPENDITURE CALCULATIONS":
319: wrt 718,"df1,"
320: if i>2;goto "K4100"
321: "CALCULATE INITIAL SHELL SPACING FOR HC SMOKE":
322: r16*45+Y[1,1,K]
323: "SUSTAINING SHELL SPACING FOR HC SMOKE":
324: if C[1,1]#0;goto "K3600"
325: U+Y[1,2,K];goto "K3700"
326: "K3600":
327: 1/r15*(.731*F[K]*M[1]*S[K,1]/(C[1,1]*r16*r9))^r11+Y[1,2,K]
328: if Y[1,2,K]>R;R+Y[1,2,K]
329: "K3700":
330: if Y[1,2,K]=0;1+Q[1,1,K,1]+Q[1,2,K,1];goto "K4000"
331: "CALCULATE INITIAL VOLLEY FOR HC SMOKE":
332: if Y[1,1,K]>Y[1,2,K];Y[1,2,K]+Y[1,1,K]
333: R/Y[1,1,K]+Q[1,1,K,1]
334: if 1rc(Q[1,1,K,1])>0;int(Q[1,1,K,1])+1+Q[1,1,K,1]
335: "CALCULATE NUMBER OF GUNS FOR SUSTAINING VOLLEYS (HC)":
336: R/r[1,2,K]+Q[1,2,K,1]
337: if 1rc(Q[1,2,K,1])>0;int(Q[1,2,K,1])+1+Q[1,2,K,1]
338: "K4000":
339: "RATE OF FIRE FOR HC SMOKE":
340: .5+P;if C[1,1]=0;0+P
341: "CALCULATE TOTAL NUMBER OF ROUNDS REQUIRED (HC)":
342: Q[1,1,K,1]+Q[1,2,K,1]*(P*F-1)+P[1,K,1]
343: if 1rc(P[1,K,1])>0;int(P[1,K,1])+1+P[1,K,1]
344: "K4100":
345: if i<3;if n>4;goto "K4300"
346: "SHELL SPACING (z[1]) & VOLLEYS (Q[1]) - WP SMOKE":
347: if C[1,2]#0;goto "K4120"
348: U+z[1,1,K]+z[1,2,K]
349: U+z[1,1,K,2]+z[1,2,K,2]
350: goto "K4180"
351: "K4120":
352: if i>2;.6*C[1,2]/V[K]+Q[1,1,K,2];goto "K4140"
353: V[K]/C[1,2]*100+z[1,1,K]
354: z[1,1,K]+z[1,2,K]
355: R/z[1,2,K]+Q[1,1,K,2]
356: "K4140":

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357: int(Q[1,1,K,2])+r1
358: if irc(Q[1,1,K,2])>0;r1+1+r1
359: r1+Q[1,1,K,2]+Q[1,2,K,2]
360: "K4180":
361: "RATE OF FIRE FOR WP SMOKE":
362: if C[1,2]=0;0+R[1,K];gtc "K4200"
363: if 1>2;120/r16+R[1,K];gtc "K4190"
364: (Z[1,2,K]+60)/r16+R[1,K]
365: "K4190":
366: R[1,K]/20+R[1,K]
367: int(R[1,K])+r0
368: if irc(R[1,K])>=.5;int(R[1,K])+1+r0
369: if r0=0;1+r0
370: r0*20/60+R[1,K]
371: 1/R[1,K]+R[1,K]
372: if R[1,K]<1;1+R[1,K]
373: "K4200":
374: "CALCULATE TOTAL NUMBER OF ROUNDS REQUIRED (WP)":
375: if C[1,2]=0;0+P[1,K,2];gtc "K4500"
376: Q[1,1,K,2]+Q[1,2,K,2]*(T*R[1,K]-1)+P[1,K,2]
377: if 1>2;Q[1,2,K,2]*(R/60+1)*(T*R[1,K]-1)+P[1,K,2]
378: if irc(P[1,K,2])>0;int(P[1,K,2])+1+P[1,K,2]
379: gtc "K4500"
380: "K4300":
381: "CALCULATIONS FOR WP STABLE FLOW (E AND F STABILITY CATEGORIES)":
382: "INITIAL SHELL SPACING FOR WP SMOKE":
383: if 1=1;if K=1;100+Z[1,1,K]
384: if 1=2;if K=1;50+Z[1,1,K]
385: if 1<3;if K=2;100+Z[1,1,K]
386: "SUSTAINING SHELL SPACING FOR WP SMOKE":
387: if 1=1;if K=1;100+Z[1,2,K]
388: if 1=1;if K=2;200+Z[1,2,K]
389: if 1=2;if K=1;50+Z[1,2,K]
390: if 1=2;if K=2;100+Z[1,2,K]
391: "INITIAL VOLLEY FOR WP SMOKE":
392: R/Z[1,1,K]+1+Q[1,1,K,2]
393: "SUSTAINING VOLLEY FOR WP SMOKE":
394: R/Z[1,2,K]+1+Q[1,2,K,2]
395: "RATE OF FIRE FOR WP SMOKE":
396: if K=1;2+R[1,K]
397: if K=2;1+R[1,K]
398: "CALCULATE TOTAL NUMBER OF WP ROUNDS REQUIRED":
399: Q[1,1,K,2]+Q[1,2,K,2]*(T*R[1,K]-1)+P[1,K,2]
400: "K4500":
401: R[1,1]+L
402: R[1,2]+M
403: next K
404: "DISPLAY2":
405: int 4,f5.0,4x,f3.0,1D
406: int 5,f5.0,6x,f8.0,1E
407: int 6,f5.0,f5.1,f9.0,f7.0,1D
*21524

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408: lmt 7,f5.0,5x,f3.0,5x,f5.0,1b
409: "HC"→E$;if 1>2;"WP"→E$
410: cll 'HEADING'
411: if 1>2;cll 'M1K/F1R';gto "K5000"
412: cll 'GUN1'(1,1,P,Y[1,1,1],Y[1,2,1])
413: cll 'GUN2'(2,1,P,Y[1,1,2],Y[1,2,2])
414: wrt 718,"uf2,"
415: dsp "CONTINUE WHEN READY";stp
416: "WP"→E$
417: cll 'HEADING'
418: cll 'GUN1'(1,2,R[1,1],Z[1,1,1],Z[1,2,1])
419: cll 'GUN2'(2,2,R[1,2],Z[1,1,2],Z[1,2,2])
420: "K5000":
421: wrt 718,"uf2,"
422: dsp "CONTINUE WHEN READY";stp
423: next 1
424: wrt 718,"bf2,"
425: ent "0 TO EXIT - 1 TO PRINT",w
426: if w=0;gto "K7000"
427: gsb "PRINTER 0"
428: for 1=1 to 4
429: cll 'PRINTER 1'
430: if 1>2;cll 'PRINTER 3';gto "K6000"
431: "HC"→E$
432: cll 'PRINTER 2'(1,P,P,Y[1,1,1],Y[1,2,1],Y[1,1,2],Y[1,2,2])
433: "WP"→E$
434: cll 'PRINTER 2'(2,L,M,Z[1,1,1],Z[1,2,1],Z[1,1,2],Z[1,2,2])
435: lmt 5;/wrt 701
436: "K6000":
437: next 1
438: "K7000":
439: dsp "DONE"
440: end
441: "FUNCTIONS":
442: "rNA":ret exp(-u*p1/2)
443: "rNs":ret exp(-p1^2)
444: "rNC":ret exp(p1*u*ln(.1/F[1]))
445: "rND":ret exp(-p1*u/4.1)
446: "SUBROUTINES":
447: "XPOS":ret 1[4]*p1*1[5]
448: "YPOS":ret 1[4]*(1[2]-1[5]*p1)
449: "YPOS1":ret 1[7]-p1*1[4]*1[5]
450: "TITL":
451: .5+1[5]
452: 'XPOS'(p1)+1[6]
453: 'YPOS'(p2)+1[7]
454: lmt 1,f4.0,"","f4.0,","
455: wrt 718.1,"cs2,::pe0,::pa",1[6],1[7]
456: ret
457: "LINE":
458: .25+1[5]
*29007

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459: 'XPOS'(p1)+1[6]
460: 'YPOS'(p2)+1[7]
461: int 1,14.0,"",14.0,";"
462: wrt 718.1,"cs1,::pe0,::pa",1[6],1[7]
463: ret
464: "NEXTLINE":
465: 'YPOS1'(p1)+1[7]
466: int 1,14.0,"",14.0,";"
467: wrt 718.1,"pe0,::pa",1[6],1[7]
468: ret
469: "HEADING":
470: wrt 718,"ef2,::if2,::bf2,"
471: cll 'LINE'(2,4)
472: wtd 718,"pel,::tx",CS[1],3,13,10
473: cll 'NEXTLINE'(2)
474: wtd 718,"pel,::tx",METERS MINUTES",3,13,10
475: cll 'NEXTLINE'(1.5)
476: wrt 718.4,"pel,::txSCREEN LENGTH/DURATION:",R,T,3
477: cll 'NEXTLINE'(4)
478: wtd 718,"pel,::tx",E$, " SMOKE SCREEN",3,13,10
479: ret
480: "GUN1":
481: cll 'NEXTLINE'(3)
482: wtd 718,"pel,::tx",r$, "MM HOWITZER",3,13,10
483: cll 'NEXTLINE'(3)
484: wtd 718,"pel,::txVOLLEY",GUNS RATE/ SPACING ROUNDS",3,13,10
485: cll 'NEXTLINE'(1.25)
486: wtd 718,"pel,::tx",MIN METERS",3,13,10
487: cll 'NEXTLINE'(1.5)
488: wrt 718.5,"pel,::txINITIAL:",Q[1,1,p1,p2],p4,3
489: cll 'NEXTLINE'(1.25)
490: if E$="WP";if H>4;2+p3
491: wrt 718.6,"pel,::txSUSTAINING:",Q[1,2,p1,p2],p3,p5,P[1,p1,p2],3
492: ret
493: "GUN2":
494: cll 'NEXTLINE'(3)
495: wtd 718,"pel,::tx",G$, "MM HOWITZER",3,13,10
496: cll 'NEXTLINE'(3)
497: wtd 718,"pel,::txVOLLEY",GUNS RATE/ SPACING ROUNDS",3,13,10
498: cll 'NEXTLINE'(1.25)
499: wtd 718,"pel,::tx",MIN METERS",3,13,10
500: cll 'NEXTLINE'(1.5)
501: wrt 718.5,"pel,::txINITIAL:",Q[1,1,p1,p2],p4,3
502: cll 'NEXTLINE'(1.25)
503: if E$="WP";if H>4;1+p3
504: wrt 718.6,"pel,::txSUSTAINING:",Q[1,2,p1,p2],p3,p5,P[1,p1,p2],3
505: ret
506: "MIR/FIR":
507: cll 'NEXTLINE'(3)
508: wtd 718,"pel,::tx",ROUNDS/ RATE/ TOTAL",3,13,10
509: cll 'NEXTLINE'(1.125)
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510: wtd 718,"pel,::tx          60 METERS MINUTE ROUNDS",3,13,10
511: cil 'NEXTLINE'(1.25)
512: wrt 718.7,"pel,::tx",f$,"MM:  ",q[1,2,1,2],R[1,1],P[1,1,2],3
513: cil 'NEXTLINE'(1.25)
514: wrt 718.7,"pel,::tx",g$,"MM:  ",q[1,2,2,2],R[1,2],P[1,2,2],3
515: ret
516: "PRINTER 0":
517: lmt 21/wrt 701
518: lmt 55x,"AMMUNITION EXPENDITURES";wrt 701
519: lmt 50x,"FOR HC AND WP SMOKE";wrt 701
520: lmt 2/wrt 701
521: lmt 45x,"ID                      = ",c4;wrt 701,A$
522: lmt 45x,"LATITUDE                - DEG          = ",c1,f6.2
523: wrt 701,h$[1,1],N[1]
524: if N[2]<0;N[2]*-1+N[2]
525: lmt 45x,"LONGITUDE              - DEG          = ",c1,f6.2
526: wrt 701,h$[2,2],N[2]
527: lmt 45x,"ALTITUDE                - KM           = ",f7.2;wrt 701,N[3]
528: lmt 45x,"JULIAN DATE              - DAY          = ",f4.0;wrt 701,N[4]
529: lmt 45x,"ZULU TIME                - HOUR         = ",f4.0;wrt 701,N[5]
530: lmt 45x,"CEILING                  - METERS        = ",f7.2;wrt 701,A
531: lmt 45x,"CLOUD COVER              - PERCENT       = ",f7.2;wrt 701,B
532: lmt 45x,"VISIBILITY               - KM           = ",f7.2;wrt 701,C
533: lmt 45x,"PRECIPITATION             = ",c3;wrt 701,D$
534: lmt 45x,"TEMPERATURE              - DEG C        = ",f7.2;wrt 701,D
535: lmt 45x,"DEW POINT                 - DEG C        = ",f7.2;wrt 701,E
536: lmt 45x,"WIND DIRECTION            - DEG         = ",f7.2;wrt 701,F
537: lmt 45x,"WIND SPEED                - KNOTS        = ",f7.2;wrt 701,G
538: lmt 45x,"AVE ROUGHNESS ELEMENT     - CM           = ",f7.2;wrt 701,Y
539: lmt 45x,"PASQUILL STABILITY CATEGORY = ",c1;wrt 701,B$(h,n)
540: lmt 45x,"RELATIVE HUMIDITY         = ",f7.2;wrt 701,Q
541: lmt 21/wrt 701
542: ret
543: "PRINTER 1":
544: lmt 4/wrt 701
545: lmt 62x,c0;wrt 701,C$(1)
546: lmt 3/wrt 701
547: lmt 47x,"                      METERS MINUTES";wrt 701
548: lmt 47x,"SCREEN LENGTH/DURATION:",f5.0,4x,f3.0;wrt 701,R,T
549: ret
550: "PRINTER 2":
551: lmt 2/wrt 701
552: lmt 59x,c2," SMOKE SCREEN";wrt 701,E$
553: lmt 2/wrt 701
554: lmt 59x,c3,"MM HOWITZER";wrt 701,f$
555: lmt /wrt 701
556: lmt 47x,"VOLLEY                GUNS RATE/ SPACING ROUNDS";wrt 701
557: lmt 47x,"                      MIN METERS";wrt 701
558: lmt 47x,"INITIAL:                ",f5.0,6x,f8.0;wrt 701,q[1,1,1,p1],p4
559: lmt 47x,"SUSTAINING:",f5.0,f5.1,f9.0,f7.0
560: if L$="WP";if n>4;2+p2

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561: wrt 701,Q[1,2,1,p1],p2,p5,P[1,1,p1]
562: lmt 2;/wrt 701
563: lmt 59x,c3,"M1 HOWITZER";wrt 701,G$
564: lmt /;wrt 701
565: lmt 47x,"VOLLEY      GUNS RATE/ SPACING ROUNDS";wrt 701
566: lmt 47x,"              MIN  METERS";wrt 701
567: lmt 47x,"INITIAL:   ",f5.0,6x,f8.0;wrt 701,Q[1,1,2,p1],p6
568: lmt 47x,"SUSTAINING:",f5.0,f5.1,f9.0,f7.0
569: if E$="WP";if n>4;l→p3
570: wrt 701,Q[1,2,2,p1],p3,p7,P[1,2,p1]
571: ret
572: "PRINTER 3":
573: lmt 2;/wrt 701
574: lmt 59x,c2," SMOKE SCREEN";wrt 701,E$
575: lmt 2;/wrt 701
576: lmt 47x,"          ROUNDS/   RATE/   TOTAL";wrt 701
577: lmt 47x,"          60 METERS MINUTE ROUNDS";wrt 701
578: lmt 47x,c3,"MM:   ",f5.0,5x,f3.1,5x,f5.0
579: wrt 701,E$,Q[1,2,1,2],R[1,1],P[1,1,2]
580: lmt 47x,c3,"MM:   ",f5.0,5x,f3.1,5x,f5.0
581: wrt 701,G$,Q[1,2,2,2],R[1,2],P[1,2,2]
582: lmt 42;/wrt 701
583: ret
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APPENDIX G

KWIK ALGORITHM GLOSSARY OF MNEMONICS (FORTRAN IV)

1. CO	Ceiling - feet
2. C1	Cloud cover - percent
3. VO	Visibility - miles
4. TO	Temperature - degrees Fahrenheit
5. TI	Dewpoint - degrees Fahrenheit
6. DO	Wind direction - degrees
7. SO	Windspeed - knots
8. PO	Atmospheric stability category
9. H3	Slant range to target - kilometers
10. RO	Relative humidity - percent
11. XO	Smoke screen length - meters
12. TIME	Smoke screen duration - minutes
13. AST	Angle of sight to target - degrees
14. DLS	Direction of line of sight - degrees
15. ARE	Average roughness element - centimeters
16. Z1	Roughness element - centimeters
17. PSCTAB	Table of stability categories depending upon solar altitude and windspeed
18. T(4,4)	Table of transmittances resulting from water vapor, haze/fog, precipitation and smoke for visual, near, mid, and far infrared wavelengths
19. C(4,2)	Table of smoke concentration values for HC and WP smoke (by wavelengths)
20. B(4)	Absorption coefficient error function
21. E(4)	Scale height for Mie scattering
22. F(4)	Haze and fog attenuation coefficients
23. G(4)	Precipitation attenuation coefficients
24. CS(4,2)	Table of extinction coefficients for calculating HC and WP smoke concentrations for visible, near, mid and far infrared wavelengths
25. A(6)	Coefficients to compute sigma y
26. S(6,3),D(6,3)	Coefficients of roughness correction factor used in calculating sigma z for the various roughness lengths
27. Y1, Y2	Yield factors for HC and WP
28. SLAT, SLONG SALT, SJDATE, SJHOUR	Latitude, longitude, altitude, Julian date and Zulu time data
29. P(4,2,2)	Total number of rounds required (initial and sustaining) to maintain HC and WP smoke screen
30. R1, Q(4,2,2,2)	Number of guns (initial and sustaining volleys) for 105- and 155-mm howitzers, for HC and WP smokes (by wavelengths)
31. R(4,2)	Rate of fire for HC and WP smokes (by wavelengths)
32. H(2,2)	Unit (per gun) source strength

33. ME(2)	Munition efficiency for 105- and 155-mm howitzer for HC smoke
34. U(2,2)	WP volume source sigma (σ_{y0} and σ_{z0}) for 105- and 155-mm howitzer
35. V(2)	Stability dependent crosswind integrated concentration for WP smoke
36. W(6)	Constant (K) related to stability category for WP smoke
37. X(4)	Wavelength threshold levels
38. Y(4,2,2)	Shell spacing for 105- and 155-mm howitzer (initial and sustaining) for HC smoke
39. Z(4,2,2)	Shell spacing for 105- and 155-mm howitzer for WP smoke
40. SITE	Met site identifier
41. PSC(6)	Stability category indicator
42. WLNTH(4,2)	Wavelength indicator
43. PRECIP	Precipitation indicator
44. SMOKE(2)	HC or WP smoke indicator
45. GUN(1)	105-mm howitzer indicator
46. GUN(2)	155-mm howitzer indicator
47. DFE, DFG	Direction from equator (N-S) and direction from Greenwich (E-W) indicators
48. I	Index for wavelength algorithms
49. J	Index for smoke algorithms
50. K	Index for gun (105- and 155-mm howitzer) algorithms

APPENDIX H
FORTRAN IV ALGORITHM

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BLOCK DATA
INTEGER FO
COMMON /KWIK/ PRECIP,ARE,CO,C1,C2,DO,D2,PJ,R0,R2,SO,S7,T0,T1,
2      Y1,VC,H7,AST,DLS,XC,TIME,H(2,2),C(4,2),T(4,4),
7      U(2,2),V(2),Y(4,2,2),Z(4,2,2)
COMMON /MSITE/ SITE,SLAT,SLONG,SALT,SJDATE,SZHOURL,DFE,DFG
CHARACTER*8 WLNTH
COMMON /CLTPLT/ WLNTH(4),SMOKE(2),GUN(2),PSC(5),R1,
2      R(4,2),O(4,2,2,2),P(4,2,2)
DATA ((H(I,J),J=1,2),I=1,2)/19.7,177.7,77.1,7075.2/
DATA U/5.4,7.9,1.9,2.5/
DATA WLNTH /9HVISIBLE:9HNEAR IR:9HMD IR:9HFAR IR: /
DATA SMOKE /2HHC,2HWP/
DATA GUN /7F105,7H155/
DATA PSC(1)/4HA /,PSC(2)/4HB /
DATA PSC(3)/4HC /,PSC(4)/4HD /
DATA PSC(5)/4HE /,PSC(5)/4HF /
END
C*KWIK SMOKE PROGRAM.
INTEGER FO
COMMON /KWIK/ PRECIP,ARE,CO,C1,C2,DO,D2,PJ,R0,R2,SO,S7,T0,T1,
2      Y1,VC,H7,AST,DLS,XC,TIME,H(2,2),C(4,2),T(4,4),
7      U(2,2),V(2),Y(4,2,2),Z(4,2,2)
COMMON /MSITE/ SITE,SLAT,SLONG,SALT,SJDATE,SZHOURL,DFE,DFG
C*METEOROLOGICAL INPUTS.
READ(5,10500) SITE
READ(5,10500) SLAT
READ(5,10500) DFE
READ(5,10500) SLONG
READ(5,10500) DFG
READ(5,10500) SALT
READ(5,10500) SJDATE
READ(5,10500) SZHOURL
READ(5,10500) CO
CO=CO*0.7049
READ(5,10500) C1
READ(5,10500) VO
VC=VC*1.51
READ(5,10500) PRECIP
READ(5,10500) TC
TO=(5./9.)*(T)-32.)
READ(5,10500) T1
T1=(5./9.)*(T1-32.)
READ(5,10500) DO
READ(5,10500) SO
READ(5,10500) ARE
READ(5,10500) H7
READ(5,10500) AST
READ(5,10500) DLS
READ(5,10500) XC
READ(5,10500) TIME

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C*METEOROLOGICAL CALCULATIONS.
    CALL KWIK1
C*ATMOSPHERIC OPTICS.
    CALL KWIK2
C*ATMOSPHERIC DIFFUSION.
    CALL KWIK3
C*FUNCTIONS EXPENDITURES.
    CALL KWIK4
C*PRINTOUT
    CALL KWIK5
    STOP
C*FORMAT STATEMENTS.
10500 FCFMAT(A4)
10600 FORMAT(F10.0)
    END
    SUBROUTINE KWIK1
    COMMON /KWIK/ PRECIP, AFE, CO, C1, C2, LO, D2, FC, FC, R2, SO, S1, TO, T1,
2          Y1, VO, H1, ASI, DLS, XJ, TIME, H(2,2), C(4,2), T(4,4),
3          U(2,2), V(2,2), Y(4,2,2), Z(4,2,2)
    CHARACTER*9 WLENGTH
    COMMON /CLTFLT/ WLENGTH(4), SMCKE(2), GUN(2), FSC(3), R1,
2          R(4,2), Q(4,2,2,2), P(4,2,2)
    COMMON /MSITE/ SITE, SLAT, SLONG, SAL1, SJDATE, SZHOLR, DFE, DFG
    INTEGER PD
    INTEGER PSCTAB
    DIMENSION PSCTAB(7,9)
    DATA PI /3.141592654/
    DATA ((PSCTAB(I,J), I=1,7), J=1,9)/
1      1,1,2,3,4,5,6,
2      1,2,2,3,4,5,6,
3      1,2,3,4,4,5,6,
4      2,2,3,4,4,5,6,
5      2,2,3,4,4,4,6,
6      2,3,3,4,4,4,5,
7      3,3,4,4,4,4,5,
8      3,3,4,4,4,4,4,
9      3,4,4,4,4,4,4/
C*METEOROLOGICAL CALCULATIONS.
    IF(C1 .NE. 100.) GO TO 1000
    IF(CO .GT. 2133.5042) GO TO 1000
    I1=0
    I2=0
    GO TO 2300
1000 CONTINUE
C CALCULATE ANGLAR FRACTION OF A YEAR FOR A GIVEN JULIAN DATE.
    R9=PI/180.
    D9=180./PI
    SLAT1=SLAT*R9
    AG=((SJDATE-1.)*360.)/755.242
C CALCULATE SOLAR DECLINATION ANGLE (A1).
    A1=AG*R9

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A2=279.9349+A0
A2=A2+(1.914927*SIN(A1))-(0.079525*COS(A1))
A2=A2+(0.019979*SIN(2*A1))-(0.00152*COS(2*A1))
A2=A2*R9
A7=27.4479*R9
A4=SIN(A7)*SIN(A2)
A4=ASIN(A4)
C CALCULATE THE TIME OF MERIDIAN PASSAGE - TRUE SOLAR NOON (A5).
A5=12.+(0.12757*SIN(A1))-(0.004287*COS(A1))
A5=A5+(0.157509*SIN(2*A1))+(0.00757*COS(2*A1))
C CALCULATE SOLAR HOUR ANGLE (A5).
A5=15.*(SZHOUR-A5)-CLONG
A5=A5*R9
C CALCULATE SOLAR ALTITUDE (A7).
A7=SIN(SLAT1)*SIN(A4)+COS(SLAT1)*COS(A4)*COS(A5)
A7=ASIN(A7)
1100 CONTINUE
A7=A7*R9
C CALCULATE INSOLATION CLASS NUMBER.
I2=0
IF(A7 .LE. 50.) GO TO 1200
I2=4
GO TO 1500
1200 CONTINUE
IF(A7 .LE. 75.) GO TO 1300
I2=7
GO TO 1500
1300 CONTINUE
IF(A7 .LE. 15.) GO TO 1400
I2=2
GO TO 1500
1400 CONTINUE
IF(A7 .LE. 0.) GO TO 2200
I2=1
C CALCULATE NET RADIATION INDEX FOR DAYTIME.
1500 CONTINUE
I7=0
IF(C1 .GT. 50.) GO TO 1600
I7=I2
GO TO 1900
1600 CONTINUE
IF(C1 .GT. 217.5042) GO TO 1700
I7=I2-2
GO TO 1900
1700 CONTINUE
IF(C1 .GE. 4975.5055) GO TO 1800
I7=I2-1
GO TO 1900
1800 CONTINUE
IF(C1 .NE. 100.) GO TO 1900
I7=I2-1

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1900  CONTINUE
      IF(I7 .NE. 0) GO TO 2000
      I7=I2
2000  CONTINUE
      IF(I7 .GT. 1) GO TO 2100
      I7=1
2100  CONTINUE
      I1=I7
      GO TO 2300
C COMPUTE NET RADIATION INDEX FOR NIGHTTIME.
2200  CONTINUE
      IF(C1 .GT. 40.) GO TO 2250
      I1=-2
      GO TO 2300
2250  CONTINUE
      I1=-1
C CALCULATE PASQUILL STABILITY CATEGORY.
2300  CONTINUE
      I4=0
      I5=0
      IF(I1 .NE. 4) GO TO 2400
      I4=1
2400  CONTINUE
      IF(I1 .NE. 3) GO TO 2420
      I4=2
2420  CONTINUE
      IF(I1 .NE. 2) GO TO 2440
      I4=3
2440  CONTINUE
      IF(I1 .NE. 1) GO TO 2450
      I4=4
2450  CONTINUE
      IF(I1 .NE. 0) GO TO 2480
      I4=5
2480  CONTINUE
      IF(I1 .NE. -1) GO TO 2500
      I4=6
2500  CONTINUE
      IF(I1 .NE. -2) GO TO 2520
      I4=7
2520  CONTINUE
      IF(SJ .GE. 2.) GO TO 2540
      I5=1
      GO TO 2700
2540  CONTINUE
      IF(SJ .GE. 4.) GO TO 2550
      I5=2
      GO TO 2700
2550  CONTINUE
      IF(SJ .GE. 5.) GO TO 2590
      I5=3

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        GO TO 2700
2580  CONTINUE
        IF(S0 .GE. 7.) GO TO 2530
        I5=4
        GO TO 2700
2590  CONTINUE
        IF(S0 .GE. 9.) GO TO 2520
        I5=5
        GO TO 2700
2620  CONTINUE
        IF(S0 .GE. 10.) GO TO 2540
        I5=6
        GO TO 2700
2640  CONTINUE
        IF(S0 .GE. 11.) GO TO 2550
        I5=7
        GO TO 2700
2660  CONTINUE
        IF(S0 .GE. 12.) GO TO 2590
        I5=8
        GO TO 2700
2680  CONTINUE
        I5=9
        GO TO 2700
2700  CONTINUE
        P7=PSCTAB(I4,I5)
C  CALCULATE RELATIVE HUMIDITY.
        IF(T0 .GT. 0.) GO TO 2830
        A0=9.5
        B0=255.5
        IF(T0 .LE. 0.) GO TO 2850
2800  CONTINUE
        A0=7.5
        B0=277.7
2850  CONTINUE
        IF(T1 .GE. 0.) GO TO 2930
        A1=9.5
        B1=255.5
        IF(T1 .LE. 0.) GO TO 2950
2900  CONTINUE
        A1=7.5
        B1=277.7
2950  CONTINUE
        E0=5.11*10.**((A0*T0)/(B0+T0))
        E1=5.11*10.**((A1*T1)/(B1+T1))
        RH=(E1/E0)*100.
10999  FORMAT(F5.1,'X',F7.0)
        RETURN
      END

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```

SUBROUTINE KWIK2
INTEGER P0
COMMON /KWIK/ PRECIP, ARE, CO, C1, C2, J0, D2, P0, R0, R2, S0, S7, T0, T1,
2      Y1, VC, H7, AST, DLS, XC, TIME, H(2,2), C(4,2), T(4,4),
3      U(2,2), V(2), Y(4,2,2), Z(4,2,2)
DIMENSION E(4), E(4), F(4), G(4), C(4,2), X(4)
REAL LO, L1, L2, L3, L4, L5
REAL NO
DATA B/0.118, 0.18, 0.55, 0.0/
DATA E/25.7, 7.5, 5.1, 5.0/
DATA CS(1,1)/3.7, CS(1,2)/2.45, CS(2,1)/1.53/
DATA CS(2,2)/2.00, CS(3,1)/0.0, CS(3,2)/0.25/
DATA CS(4,1)/3.0, CS(4,2)/0.32/
DATA X/.05, .05, .05, .05/
DATA PI /3.141592654/
DATA NO/2+NO/
DATA YES/3YES/
FNA(A)=EXP(-AST*A/2)
FNB(B)=EXP(-B**2)
FAC(C)=EXP(-C*AST*ALOG(0.1/F(J)))
FND(D)=EXP(-D*AST/4.1)
C*ATM(SPHERIC OPTICS.
V1=ALOG(V0)
V2=V1*V1
V3=V2*V1
F(1)=1.5551-(0.9511*V1)-(0.0197*V2)+(0.0041*V3)
F(1)=EXP(F(1))
F(2)=1.50781511-(0.992719519*V1)-(0.0155725(1*V2)+(0.00758587*V3)
F(2)=EXP(F(2))
F(3)=1.2794-(1.0475*V1)+(0.0059*V2)-(0.0015*V3)
F(3)=EXP(F(3))
F(4)=1.5175-(1.7147*V1)+(0.0001*V2)+(0.0425*V3)
F(4)=EXP(F(4))
G(1)=1.7705-(0.9925*V1)-(0.0757*V2)+(0.0125*V3)
G(1)=EXP(G(1))
G(2)=1.491951707-(0.922595929*V1)-(0.055505417*V2)+
2      (0.017590422*V3)
G(2)=EXP(G(2))
G(3)=1.5555-(0.9013*V1)-(0.0773*V2)+(0.0173*V3)
G(3)=EXP(G(3))
G(4)=1.5929-(0.7395*V1)-(0.0527*V2)+(0.0153*V3)
G(4)=EXP(G(4))
H0=0.0
IF(AST .LT. 0.) AST=-AST
AST=AST*(PI/180.)
AST=SIN(AST)
H4=0.
IF(AST .NE. 0.) H4=1./AST
C CALCULATE PRECIPITABLE WATER.
W=0.4477+(0.0729*T1)+(1.2E-07*T1*T1)+(1.84E-05*T1*T1*T1)
C CALCULATE AMOUNT OF WATER VAPOR IN PATH.

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      L0=H3
      L1=H0
      L2=L0
      L3=0.5*(L1+L2)
      L4=L2-L1
      L5=0.2885751*L4
      W0=0.5*L4*(FNA(L3+L5)+FNA(L3-L5))
      W1=W*W0
C  CALCULATE TRANSMITTANCES FOR VISIBLE, NEAR, MID, FAR IR WAVELENGTHS.
      DO 5200 I=1,4
      IF (I.NE.4) GO TO 3500
      T(I,1)=EXP(-0.0591*W1)
      GO TO 3700
C  CALCULATE TRANSMITTANCE OWING TO ABSORPTION BY WATER VAPOR.
3500  CONTINUE
      L0=(B(I)*SQRT(W1*PI))/2.
      L1=H0
      L2=L0
      L3=0.5*(L1+L2)
      L4=L2-L1
      L5=0.2885751*L4
      T2=0.5*L4*(FNB(L3+L5)+FNB(L3-L5))
      T(I,1)=(2./SQRT(PI))*T2
      T(I,1)=1-T(I,1)
3700  CONTINUE
C  CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY HAZE AND FOG.
      IF (PRECIP.EG. NO) GO TO 3900
      T(I,2)=1.0
      GO TO 4100
3900  CONTINUE
      IF (VC.GE.E(I)) GO TO 4000
      L0=H4
      L1=H0
      L2=L0
      L3=0.5*(L1+L2)
      L4=L2-L1
      L5=0.2885751*L4
      T3=0.5*L4*(FNC(L3+L5)+FNC(L3-L5))
      T4=EXP(-F(I)*T3)
      L1=H4
      L2=H3
      L3=0.5*(L1+L2)
      L4=L2-L1
      L5=0.2885751*L4
      T5=0.5*L4*(FNC(L3+L5)+FNC(L3-L5))
      T5=EXP(-0.129*T5)
      T(I,2)=T4*T5
      GO TO 4100
4000  CONTINUE
      L0=H3
      L1=H0

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      L2=L0
      L3=0.5*(L1+L2)
      L4=L2-L1
      L5=0.2895751*L4
      T7=0.5*L4*(FND(L3+L5)+FND(L3-L5))
      T(I,2)=EXP(-F(I)*T7)
4100  CONTINUE
C  CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY PRECIPITATION.
      IF(PRECIP .EQ. YES) GO TO 4400
4200  CONTINUE
      T(I,3)=1.
      GO TO 4500
4300  CONTINUE
      IF(VC .GT. 20.) GO TO 4200
      T(I,3)=EXP(-H3*G(I))
4500  CONTINUE
C  CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY SMOKE.
4600  CONTINUE
      T(I,4)=X(I)/(T(I,1)*T(I,2)*T(I,3))
      IF(T(I,4) .LE. 1.) GO TO 4700
      T(I,4)=1.
4700  CONTINUE
C  CALCULATE LINE OF SIGHT INTEGRATED CONCENTRATION.
      IF(T(I,4) .NE. 0.) GO TO 5000
      DO 4900 J=1,2
      C(I,J)=0.
4900  CONTINUE
      GO TO 5200
5000  CONTINUE
      DO 5100 K=1,2
      IF(CS(I,K) .NE. 0.) GO TO 5050
      C(I,K)=0.
      GO TO 5100
5050  CONTINUE
      C(I,K)=ALOG(T(I,4))/(-CS(I,K))
5100  CONTINUE
5200  CONTINUE
      RETURN
      END

```

```

SUBROUTINE KWIK3
  INTEGER PO
  COMMON /KWIK/ PRECIP,ARE,CO,C1,C2,D0,D2,P0,R0,R2,S0,S1,T0,T1,
2          Y1,VC,H*,AST,DLS,XC,TIME,H(2,2),C(4,2),T(4,4),
3          U(2,2),V(2),Y(4,2,2),Z(4,2,2)
  DIMENSION A(5),S(5,3),D(5,3)
  DIMENSION W(5)
  DATA A/0.4,0.72,0.22,0.144,0.102,0.075/
  DATA ((S(I,J),J=1,3),I=1,5)/
1      0.179095257,0.015017294,-1.02591E-04,
2      0.122097543,0.01097037,-5.95135E-05,
3      0.110104777,0.010942953,-5.73401E-05,
4      0.097549932,0.010419519,-5.43502E-05,
5      0.070772155,7.27254E-03,-4.50055E-05,
6      0.055497093,5.55303E-03,-4.01795E-05/
  DATA ((D(I,J),J=1,3),I=1,5)/
1      0.944914915,-4.95195E-03,3.7037E-05,
2      0.994907551,-4.93951E-03,3.59147E-05,
3      0.954792358,-4.92715E-03,3.47924E-05,
4      0.915025935,-5.07407E-03,4.7139E-05,
5      0.785025935,-5.07407E-03,4.7139E-05,
6      0.725015713,-5.05173E-03,4.50157E-05/
  DATA W/0.015,0.015,0.015,0.015,0.015,0.015/
  DATA PI /3.141592654/
  C*ATMOSPHERIC DIFFUSION CALCULATIONS.
  A1=-1.24+1.19*ALOG10(ARE)
  Z1=10.**A1
  A2=ABS(DLS-DC)*(PI/180.)
  R2=SQRT(13.59/(13.59*SIN(A2)*SIN(A2)+COS(A2)*COS(A2)))
  Y1=1.09521547+(0.02505394*R0)-(4.9575E-04*(R0)*
2      (4.92E-05*R0*R0*R0))
  Y2=3.754059144+(0.040502571*R0)-(1.15301E-03*(R0)*R0)*
2      (1.73942E-05*(R0)*R0*R0)
  C2=S(P0,1)+S(FC,2)*71+S(FC,3)*71**2
  J1=D(P0,1)+D(P0,2)*71+D(PJ,3)*71**2
  D2=1/D1
  IF(S0.NE.0.) GO TO 5200
  S0=1.0
5200  CONTINUE
  S1=S0*0.515
  J0=5400 I=1,4
  C*CALCULATE CROSSWIND INTEGRATED CONCENTRATION FOR WP SMOKE.
  DO 5300 K=1,2
  IF(I.LT.3.AND.FC.GT.4) GO TO 5300
  S1=U(K,1)+0.74*A(PJ)*100.**0.7
  S2=U(K,2)+0.447*(C2*100.**C1
  V(K)=(W(PJ)*Y2*H(K,2))/(PI*S1*S2)
5300  CONTINUE
5400  CONTINUE
  RETURN
  END

```

```

SUBROUTINE KWIK4
INTEGER PO
REAL ME
COMMON /KWIK/ PRECIP,ARE,CJ,C1,C2,D0,D2,D3,D4,R2,S0,S3,T0,T1,
2      Y1,VC,H3,AST,CLS,XC,TIME,H(2,2),C(4,2),T(4,4),
3      U(2,2),V(2),Y(4,2,2),Z(4,2,2)
CHARACTER*8 WLNTH
COMMON /OUTPUT/ WLNTH(4),SMOKE(2),GUN(2),PSC(5),R1,
2      R(4,2),Q(4,2,2,2),F(4,2,2)
DIMENSION ME(2)
DATA ME/C.4,C.4/
C* MUNITIONS EXPENDITURES.
DO 5900 I=1,4
C* CALCULATE INITIAL SHELL SPACING FOR HC SMOKE
DO 5900 K=1,2
IF(I.GT. 2) GO TO 5100
Y(I,1,K)=45.*S3
C* CALCULATE SUSTAINING SHELL SPACING FOR HC SMOKE
IF(C(I,1).NE. 0.) GO TO 5500
Y(I,2,K)=0.
GO TO 5400
5500 CONTINUE
Y(I,2,K)=1/R2*((C.1)*1*PE(K)*Y1+F(K,1))/(C2+S3*C(I,1))*D2
IF(Y(I,2,K).GT. X3) Y(I,2,K)=X3
5600 CONTINUE
IF(Y(I,2,K).NE. 0.) GO TO 5700
Q(I,1,K,1)=1.
Q(I,2,K,1)=1.
GO TO 5900
5700 CONTINUE
C* CALCULATE INITIAL VOLLEY FOR HC SMOKE
IF(Y(I,1,K).GT. Y(I,2,K)) Y(I,1,K)=Y(I,2,K)
Q(I,1,K,1)=XC/Y(I,1,K)
Q5=AINT(Q(I,1,K,1))
Q5=Q(I,1,K,1)-Q5
IF(Q5.EQ. 0.) GO TO 5800
Q(I,1,K,1)=Q5+1.
5800 CONTINUE
C* CALCULATE NUMBER OF GUNS FOR SUSTAINING VOLLEYS (HC)
Q(I,2,K,1)=X3/Y(I,2,K)
Q5=AINT(Q(I,2,K,1))
Q5=Q(I,2,K,1)-Q5
IF(Q5.EQ. 0.) GO TO 5900
Q(I,2,K,1)=Q5+1.
5900 CONTINUE
C* CALCULATE RATE OF FIRE FOR HC SMOKE
R1=0.5
IF(C(I,1).NE. 0.) GO TO 5000
R1=0.
5000 CONTINUE
C* CALCULATE TOTAL NUMBER OF ROUNDS REQUIRED (HC SMOKE)

```

```

P(I,K,1)=Q(I,1,K,1)+(R1*TIME-1)*Q(I,2,K,1)
Q5=AINT(P(I,K,1))
Q5=P(I,K,1)-Q5
IF(Q5 .EQ. 0.) GO TO 5100
P(I,K,1)=Q5+1.
5100 CONTINUE
IF(I .LT. 3 .AND. P3 .GT. 1) GO TO 5900
C* SHELL SPACING (Z(I)) AND VOLLEYS (G(I)) - WP SMOKE
IF(C(I,2) .NE. 0.) GO TO 5200
Z(I,1,K)=0.
Z(I,2,K)=0.
G(I,1,K,2)=0.
Q(I,2,K,2)=0.
GO TO 5400
5200 CONTINUE
IF(I .LT. 3) GO TO 5250
IF(I .GT. 2) Q(I,1,K,2)=0.5*C(I,2)/V(K)
GO TO 5300
5250 CONTINUE
Z(I,1,K)=V(K)/C(I,2)*100.
Z(I,2,K)=Z(I,1,K)
V(I,1,K,2)=X0/Z(I,2,K)
5300 CONTINUE
Q5=AINT(G(I,1,K,2))
Q5=Q(I,1,K,2)-Q5
IF(Q5 .EQ. 0.) GO TO 5350
Q(I,1,K,2)=Q5+1.
5350 CONTINUE
Q(I,2,K,2)=Q(I,1,K,2)
5400 CONTINUE
C* RATE OF FIRE FOR WP SMOKE
IF(C(I,2) .NE. 0.) GO TO 5425
R(I,K)=0.
GO TO 5500
5425 CONTINUE
IF(I .GT. 2) GO TO 5450
R(I,K)=(Z(I,2,K)+50.)/53
GO TO 5475
5450 CONTINUE
R(I,K)=120./53
5475 CONTINUE
R(I,K)=R(I,K)/20.
R5=AINT(R(I,K))
R5=R(I,K)-R5
IF(R5 .LT. 0.5) GO TO 5500
R5=R5+1.
5500 CONTINUE
IF(R5 .NE. 0.) GO TO 5550
R5=1.
5550 CONTINUE
R(I,K)=R5*20./50.

```

```

      R(I,K)=1./H(I,K)
      IF(R(I,K) .GE. 1.) GO TO 5500
      R(I,K)=1.
5500  CONTINUE
C* CALCULATE TOTAL NUMBER OF POUNDS REQUIRED (WP)
      IF(C(I,2) .NE. 0.) GO TO 5550
      P(I,K,2)=0.
      GO TO 5700
5550  CONTINUE
      IF(I .GT. 2) GO TO 5700
      P(I,K,2)=Q(I,1,K,2)+Q(I,2,K,2)*(TIME*R(I,K)-1.)
      GO TO 5750
5700  CONTINUE
      P(I,K,2)=Q(I,2,K,2)*(X0/50.+1.)*(TIME*R(I,K)-1.)
5750  CONTINUE
      Q5=AIN(T(P(I,K,2)))
      Q5=P(I,K,2)-Q5
      IF(Q5 .EQ. 0.) GO TO 5900
      P(I,K,2)=Q5+1.
      GO TO 5900
5900  CONTINUE
C* CALCULATIONS FOR E AND F STABILITY CAT (STABLE FLOW)
C* INITIAL SHELL SPACING FOR WP SMOKE
      IF(I .EQ. 1 .AND. K .EQ. 1) Z(I,1,K)=100.
      IF(I .EQ. 2 .AND. K .EQ. 1) Z(I,1,K)=50.
      IF(I .LT. 3 .AND. K .EQ. 2) Z(I,1,K)=100.
C* SUSTAINING SHELL SPACING FOR WP SMOKE
      IF(I .EQ. 1 .AND. K .EQ. 1) Z(I,2,K)=100.
      IF(I .EQ. 1 .AND. K .EQ. 2) Z(I,2,K)=200.
      IF(I .EQ. 2 .AND. K .EQ. 1) Z(I,2,K)=50.
      IF(I .EQ. 2 .AND. K .EQ. 2) Z(I,2,K)=100.
C* INITIAL VOLLEY FOR WP SMOKE
      Q(I,1,K,2)=X0/Z(I,1,K)+1.
C* SUSTAINING VOLLEY FOR WP SMOKE
      Q(I,2,K,2)=X0/Z(I,2,K)+1.
C* RATE OF FIRE FOR WP SMOKE
      IF(K .EQ. 1) R(I,1)=2.
      IF(K .EQ. 2) R(I,2)=1.
C* TOTAL NUMBER OF POUNDS REQUIRED (WP)
      P(I,K,2)=Q(I,1,K,2)+Q(I,2,K,2)*(TIME*R(I,K)-1.)
      Q5=AIN(T(P(I,K,2)))
      Q5=P(I,K,2)-Q5
      IF(Q5 .EQ. 0.) GO TO 5900
      P(I,K,2)=Q5+1.
5900  CONTINUE
      RETURN
      END

```

```

SUBROUTINE KWIK5
  INTEGER PO
  COMMON /KWIK/ PRECIP,AFE,C0,C1,C2,L0,P2,FC,FC,R2,S0,S7,TO,11,
2          Y1,V0,H3,AST,DLS,X0,TIME,H(2,2),C(4,2),T(4,4),
3          U(2,2),V(2),Y(4,2,2),Z(4,2,2)
  COMMON /MSITE/ SITE,SLAT,SLONG,SALT,SJDATE,SZHOOR,DFE,JFG
  CHARACTER*5 WLNTH
  COMMON /OUTPUT/ WLNTH(4),SMOKE(2),GUN(2),PSC(5),R1,

```

2

R(1,2),G(1,2,2,2),F(1,2,2)

C* PRINT INPUT DATA

```

WRITE(5,10000)
WRITE(5,10121)
WRITE(5,10300)
WRITE(5,10400)
WRITE(5,10200)
WRITE(5,10500) SITE
WRITE(5,10600) DFE,SLAT
WRITE(5,10700) DFG,SLONG
WRITE(5,10800) SALT
WRITE(5,10900) SJDATE
WRITE(5,11000) SZHOUR
WRITE(5,11100) C0
WRITE(5,11200) C1
WRITE(5,11300) V0
WRITE(5,11400) PRECIP
WRITE(5,11500) T0
WRITE(5,11600) T1
WRITE(5,11700) D0
WRITE(5,11800) S0
WRITE(5,11900) ARE
WRITE(5,12000) FSC(PC)
WRITE(5,12100) RJ
WRITE(5,10000)

```

C* PRINT MUNITION EXPENDITURES

```

LO 7100 I=1,4
WRITE(5,10170)
WRITE(5,12200) WLNTH(I)
WRITE(5,10170)
WRITE(5,12300)
WRITE(5,12400) XJ,TIME
WRITE(5,10200)
IF(I.GT. 2) GO TO 7000
WRITE(5,12500) SMOKE(I)
WRITE(5,10200)
WRITE(5,12600) GUN(I)
WRITE(5,10100)
WRITE(5,12700)
WRITE(5,12900)
WRITE(5,12900) C(I,1,1,1),Y(I,1,1)
WRITE(5,13000) Q(I,2,1,1),R1,Y(I,2,1),P(I,1,1)
WRITE(5,10200)

```

```

WRITE(5,12500) GUN(2)
WRITE(5,10100)
WRITE(5,12700)
WRITE(5,12900)
WRITE(5,12900) C(I,1,2,1),Y(I,1,2)
WRITE(5,13000) Q(I,2,2,1),R1,Y(I,2,2),P(I,2,1)
WRITE(5,10200)
WRITE(5,12500) SMOKE(2)
WRITE(5,10200)
WRITE(5,12500) GUN(1)
WRITE(5,10100)
WRITE(5,12700)
WRITE(5,12900)
WRITE(5,12900) Q(I,1,1,2),Z(I,2,1)
IF(PC .GT. 4) R(I,1)=2.
WRITE(5,13000) Q(I,2,1,2),R(I,1),Z(I,1,1),P(I,1,2)
WRITE(5,10200)
WRITE(5,12500) GUN(2)
WRITE(5,10100)
WRITE(5,12700)
WRITE(5,12900)
WRITE(5,12900) Q(I,1,2,2),Z(I,1,2)
IF(PC .GT. 4) R(I,2)=1.
WRITE(5,13000) Q(I,2,2,2),R(I,2),Z(I,2,2),P(I,2,2)
WRITE(5,10200)
IF(I .LT. 3) GO TO 7100
7000 CONTINUE
WRITE(5,12500) SMOKE(2)
WRITE(5,10100)
WRITE(5,13100)
WRITE(5,13200)
WRITE(5,13300) GUN(1),Z(I,2,1,2),R(I,1),P(I,1,2)
WRITE(5,13300) GUN(2),C(I,2,2,2),R(I,2),P(I,2,2)
WRITE(5,10000)
7100 CONTINUE
RETURN
C* FORMAT STATEMENTS.
10000 FORMAT(1H1)
10100 FORMAT(1H )
10200 FORMAT(1H0)
10130 FORMAT(///)
10140 FORMAT(////)
10121 FORMAT(////////////////)
10300 FORMAT(55X,21HMUNITION EXPENDITURES)
10400 FORMAT(55X,15HFOR HC AND WF SMOKE)
10500 FORMAT(45X,35HID
10600 FORMAT(45X,35HLATITUDE
10700 FORMAT(45X,35HLONGITUDE
10800 FORMAT(45X,35HALTITUDE
10900 FORMAT(45X,35HJULIAN DATE

```

	=	.A7)
- DEG	=	.A2,F5.2)
- DEG	=	.A2,F5.2)
- KM	=	.F7.2)
- DAY	=	.F5.0)

11000	FORMAT(45X,75HZULU TIME	- FOUR	=	(F5.0)
11100	FORMAT(45X,75HCEILING	- METERS	=	(F7.2)
11200	FORMAT(45X,75HCLOUD COVER	- PERCENT	=	(F7.2)
11300	FORMAT(45X,75HVISIBILITY	- KM	=	(F7.2)
11400	FORMAT(45X,75HPRECIPITATION		=	(4X,A3)
11500	FORMAT(45X,75HTEMPERATURE	- DEG C	=	(F7.2)
11600	FORMAT(45X,75HDEW POINT	- DEG C	=	(F7.2)
11700	FORMAT(45X,75HWIND DIRECTION	- DEG	=	(F7.2)
11800	FORMAT(45X,75HWIND SPEED	- KNOTS	=	(F7.2)
11900	FORMAT(45X,75HAVE ROUGHNESS ELEMENT	- CM	=	(F7.2)
12000	FORMAT(45X,75HPASQUILL STABILITY CATEGORY		=	(3X,A4)
12100	FORMAT(45X,75HRELATIVE HUMIDITY		=	(F7.2)
12200	FORMAT(52X,A9)			
12300	FORMAT(47X,77H			METERS MINUTES)
12400	FORMAT(47X,27HSCREEN LENGTH/DURATION:			(1X,F5.0,4X,F7.0)
12500	FORMAT(59X,A2,17H SMOKE SCREEN)			
12600	FORMAT(59X,A3,11HMM HOWITZER)			
12700	FORMAT(47X,77HVOLLEY			GUNS RATE/ SPACING ROUNDS)
12800	FORMAT(47X,70H			MIN METERS)
12900	FORMAT(47X,11HINITIAL:			(F5.0,5X,F9.0)
13000	FORMAT(47X,11HSUSTAINING:			(F5.0,F5.1,F9.0,F1.0)
13100	FORMAT(47X,71H			ROUNDS/ RATE/ TOTAL)
13200	FORMAT(47X,72H			50 METERS MINUTE ROUNDS)
13300	FORMAT(47X,A3,54MM:			(F5.0,5X,F7.0,4X,F7.0)

END

APPENDIX I

KWIK ALGORITHM GLOSSARY OF MNEMONICS (BASIC/HP85, HP9845, AND APPLE II)

1. CO	Ceiling - feet
2. CI	Cloud cover - percent
3. VO	Visibility - miles
4. TO	Temperature - degrees Fahrenheit
5. T1	Dewpoint - degrees Fahrenheit
6. DO	Wind direction - degrees
7. SO, S3	Windspeed - knots, meters per second
8. PO	Atmospheric stability category
9. H3	Slant range to target - kilometers
10. RO	Relative humidity - percent
11. XO	Smoke screen length - meters
12. T2	Smoke screen duration - minutes
13. S	Angle of sight to target - degrees
14. AO	Direction of line of sight - degrees
15. Y	Average roughness element - centimeters
16. Z	Roughness length - centimeters
17. P(7,9)	Table of stability categories depending upon solar altitude and windspeed
18. T(4,4)	Table of transmittances resulting from water vapor, haze/fog precipitation and smoke for visual, near, mid, and far infrared wavelengths
19. C(4,2)	Table of smoke concentration values for HC and WP smoke (by wavelengths)
20. B(4)	Absorption coefficient error function
21. G(4)	Scale height for Mie scattering
22. H(4)	Haze and fog attenuation coefficients
23. R(4)	Precipitation attenuation coefficients
24. D(2)	Table of extinction coefficients for calculating HC and WP smoke concentrations for visible, near, mid, and far infrared wavelengths
25. A(6)	Coefficients to compute sigma y
26. S(6,3), D5(6,3)	Coefficients of roughness correction factor used in calculating sigma z for the various roughness lengths
27. Y1, Y2	Yield factors for HC and WP
28. LO,L1,ZO,J0,H0	Latitude, longitude, altitude, Julian date and Zulu time data
29. J(4,2), P5(4,2)	Total number of rounds required (initial and sustaining) to maintain HC and WP smoke screen
30. E(4,2), F(4,2) G5(4,2), Q9(4,2)	Number of guns (initial and sustaining volleys) for 105- and 155-mm howitzers, for HC and WP smokes (by wavelengths)
31. R1, R5(4,2)	Rate of fire for HC and WP smokes (by wavelengths)
32. H5(2,2)	Unit (per gun) source strength

33.	Q(2)	Munition efficiency for 105- and 155-mm howitzers for HC smoke
34.	U(2,2)	WP volume source sigmas (σ_{y0} and σ_{z0}) for 105- and 155-mm howitzers
35.	V(2)	Stability dependent crosswind integrated concentration for WP smoke
36.	W(6)	Constant (K) related to stability category for WP
37.	X(4)	Wavelength threshold levels
38.	I(4,2), Y(4,2)	Shell spacing for 105- and 155-mm howitzers (initial and sustaining) for HC smoke
39.	Z(4,2), L(4,2)	Shell spacing for 105- and 155-mm howitzers for WP smoke
40.	I\$(4)	Met site identifier
* 41.	O\$(6)	Stability category indicator
42.	A\$(8)	Wavelength indicator
43.	P	Precipitation indicator
* 44.	H\$(1), J\$(1)	Direction from equator (N-S) and direction from Greenwich (E-W) indicators
45.	I	Index for wavelength algorithms
46.	J	Index for smoke algorithms
47.	K	Index for gun (105- and 155-mm howitzers) algorithms

* On APPLE II these are omitted.

APPENDIX J
HP 85 (BASIC) ALGORITHM

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10 REM KNIX ALGORITHM 17-81
    RICARDO PENA (ASL)
20 REM KNIX METEOROLOGICAL INPUTS AND METEOROLOGICAL CALCULATIONS
30 CLEAR
40 OPTION BASE 1
50 PRINTER
60 DIM C(4,2), I(4,4), W(2), W(6), Y(4,2), Z(4,2)
70 DIM I$(4), P(7,9), Q$(6), H$(1), J$(1)
80 I FIXED 2
90 PRINT
100 PRINT
110 PRINT "      MUNITION EXPENDITURES"
120 PRINT "      FOR HC AND WP SMOKE"
130 PRINT
140 PRINT
150 DISP "SITE ID":
160 INPUT I$
170 DISP "LATITUDE OF SITE- DEG"
180 INPUT L0
190 REM DIRECTION FROM EQUATOR- N OR S
200 H$="N"
210 DISP "LONGITUDE OF SITE - DEG"
220 INPUT L1
230 DISP "DIRECTION FROM GREENWICH- E OR W":
240 INPUT J$
250 DISP "JULIAN DATE OF MET OBSERVATION (001-366)":
260 INPUT J0
270 DISP "ZULU TIME OF MET OBSERVATION-HR (01-24)":
280 INPUT H0
290 DISP "CEILING - FEET":
300 INPUT C0
310 C0=C0*.3048
320 DISP "CLOUD COVER - PERCENT"
330 INPUT C1
340 DISP "VISIBILITY - MILES":
350 INPUT V0
360 V0=V0*1.61
370 DISP "PRECIPITATION - 1=YES 0=NO":
380 INPUT P
390 DISP "TEMPERATURE - DEG F":
400 INPUT T0
410 T0=5/9*(T0-32)
420 DISP "DEW POINT - DEG F":
430 INPUT T1
440 T1=5/9*(T1-32)
450 DISP "WIND DIRECTION - DEGS"

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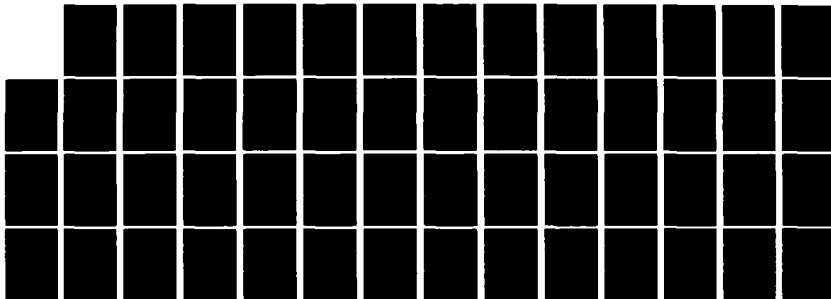
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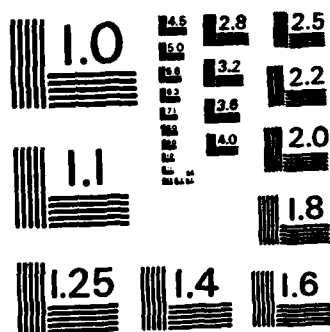
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END

FORMED

010



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

```

460 INPUT D0
470 DISP "WIND SPEED KNOTS";
480 INPUT S0
490 DISP "AVE ROUGHNESS ELEMENT
- CM";
500 INPUT Y
510 PRINT USING 520 ; I$
520 IMAGE "ID
= ",AAA
530 PRINT USING 540 ; H$C13;L0
540 IMAGE "LATITUDE DEG
= ",A,0000.0
550 PRINT USING 560 ; J$C13;L1
560 IMAGE "LONGITUDE DEG
= ",A,0000.0
570 PRINT USING 580 ; J0
580 IMAGE "JULIAN DATE DAY
= ",0000
590 PRINT USING 600 ; H0
600 IMAGE "ZULU TIME HR
= ",0000
610 PRINT USING 620 ; C0
620 IMAGE "CEILING M
= ",0000.0
630 PRINT USING 640 ; C1
640 IMAGE "CLOUD COVER %
= ",0000
650 PRINT USING 660 ; V0
660 IMAGE "VISIBILITY KM
= ",0000.0
670 P$="NO"
680 IF P=0 THEN 700
690 P$="YES"
700 PRINT USING 710 ; P$
710 IMAGE "PRECIPITATION
= ",AAA
720 PRINT USING 730 ; T0
730 IMAGE "TEMPERTURE DEG
= ",0000.0
740 PRINT USING 750 ; T1
750 IMAGE "DEWPOINT DEG
= ",0000.0
760 PRINT USING 770 ; D0
770 IMAGE "WIND DIRECTION DEG
= ",0000.0
780 PRINT USING 790 ; S0
790 IMAGE "WIND SPEED KTS
= ",0000.0
800 PRINT USING 810 ; Y
810 IMAGE "ROUGHNESS ELEMENT CM
= ",0000.0
820 FOR J=1 TO 9
830 FOR I=1 TO 7
840 READ P(I,J)
850 NEXT I
860 NEXT J
870 READ Q$
880 IF J$ > "E" THEN 910
890 L1=-L1
900 REM MET CALCULATIONS.

```

```

910 IF C1<>100 THEN 960
920 IF C0.3133.6042 THEN 960
930 I1=0
940 I2=0
950 GOTO 1570
960 REM CALCULATE ANGULAR FRACTI
    ON OF A YEAR FOR A GIVEN JUL
    IAN DATE (A0)
970 R9=PI/180
980 D9=180/PI
990 L0=L0*R9
1000 A0=(J0-1)*360/365.242
1010 REM CALCULATE SOLAR DECLINA
    TION ANGLE (A4)
1020 A1=A0*R9
1030 A2=279.9348+A0
1040 A2=A2+1.914827*SIN(A1)-.079
    525*COS(A1)
1050 A2=A2+.019938*SIN(2*A1)-.00
    162*COS(2*A1)
1060 A2=A2*R9
1070 A3=23.4438*R9
1080 A4=SIN(A3)*SIN(A2)
1090 A4=ATN(A4/SQR(1-A4*A4+1.E-9
    9))
1100 REM CALCULATE THE TIME OF M
    IDIAN PASSAGE - TRUE SOLA
    NOON (A5)
1110 A5=12+.12357*SIN(A1)-.00428
    9*COS(A1)
1120 A5=A5+.153809*SIN(2*A1)+.06
    0783*COS(2*A1)
1130 REM CALCULATE SOLAR HOUR AN
    GLE (A6)
1140 A6=15*(H0-A5)-L1
1150 A6=A6*R9
1160 REM CALCULATE SOLAR ALTITUD
    E (A7)
1170 A7=SIN(L0)*SIN(A4)+COS(L0)*
    COS(A4)*COS(A6)
1180 A7=ATN(A7/SQR(1-A7*A7+1.E-9
    9))
1190 A7=A7*D9
1200 REM CALCULATE INSOLATION CA
    LSS NUMBER
1210 I2=0
1220 IF A7<=60 THEN 1250
1230 I2=4
1240 GOTO 1330
1250 IF A7<=35 THEN 1280
1260 I2=3
1270 GOTO 1330
1280 IF A7<=15 THEN 1310
1290 I2=2
1300 GOTO 1330
1310 IF A7<=0 THEN 1520
1320 I2=1
1330 REM CALCULATE NET RADIATION
    INDEX FOR DAYTIME
1340 I3=0

```

```

1750 IF C1>50 THEN 1380
1360 I3=I2
1370 GOTO 1460
1380 IF C0>=2133.6042 THEN 1410
1390 I3=I2-2
1400 GOTO 1460
1410 IF C0>=4876.8096 THEN 1440
1420 I3=I2-1
1430 GOTO 1460
1440 IF C1<>100 THEN 1460
1450 I3=I2-1
1460 IF I3<>0 THEN 1480
1470 I3=I2
1480 IF I3>1 THEN 1500
1490 I3=1
1500 I1=I3
1510 GOTO 1570
1520 REM CALCULATE NET RADIATION
      INDEX FOR NIGHTTIME
1530 IF C1>40 THEN 1560
1540 I1=-2
1550 GOTO 1570
1560 I1=-1
1570 REM CALCULATE PASQUILL STAB
      ILITY CATEGORY.
1580 I4=0
1590 I5=0
1600 IF I1<>4 THEN 1620
1610 I4=1
1620 IF I1<>3 THEN 1640
1630 I4=2
1640 IF I1<>2 THEN 1660
1650 I4=3
1660 IF I1<>1 THEN 1680
1670 I4=4
1680 IF I1<>0 THEN 1700
1690 I4=5
1700 IF I1<>-1 THEN 1720
1710 I4=6
1720 IF I1<>-2 THEN 1740
1730 I4=7
1740 IF S0>=2 THEN 1770
1750 I5=1
1760 GOTO 1990
1770 IF S0>=4 THEN 1800
1780 I5=2
1790 GOTO 1990
1800 IF S0>=6 THEN 1830
1810 I5=3
1820 GOTO 1990
1830 IF S0>=7 THEN 1860
1840 I5=4
1850 GOTO 1990
1860 IF S0>=8 THEN 1890
1870 I5=5
1880 GOTO 1990
1890 IF S0>=10 THEN 1920
1900 I5=6
1910 GOTO 1990
1920 IF S0>=11 THEN 1950

```

```

1930 I5=7
1940 GOTO 1990
1950 IF S0>=12 THEN 1980
1960 I5=8
1970 GOTO 1990
1980 I5=9
1990 P0=P(I4,I5)
2000 REM CALCULATE RELATIVE HUMI
    DITY
2010 IF T0>0 THEN 2050
2020 A0=9.5
2030 B0=265.5
2040 GOTO 2070
2050 A0=7.5
2060 B0=237.3
2070 IF T1>0 THEN 2110
2080 A1=9.5
2090 B1=265.5
2100 GOTO 2130
2110 A1=7.5
2120 B1=237.3
2130 E0=6.11*10^(A0*T0/(B0+T0))
2140 E1=6.11*10^(A1*T1/(B1+T1))
2150 R0=E1/E0*100
2160 PRINT
2170 PRINT
2180 PRINT USING 2190 : Q$EP0,P0
    ]
2190 IMAGE "PASQUILL STABILITY C
    ATEGORY ",A
2200 PRINT USING 2210 : R0
2210 IMAGE "RELATIVE HUMIDITY
    ",DDDD.D
2220 PRINT
2230 REM PASQUILL STABILITY CATE
    GORY DATA
2240 DATA 1,1,2,3,4,6,6
2250 DATA 1,2,2,3,4,6,6
2260 DATA 1,2,3,4,4,5,6
2270 DATA 2,2,3,4,4,5,6
2280 DATA 2,2,3,4,4,4,5
2290 DATA 2,3,3,4,4,4,5
2300 DATA 3,3,4,4,4,4,5
2310 DATA 3,3,4,4,4,4,4
2320 DATA 3,4,4,4,4,4,4
2330 DATA "ABCDEF"
2340 REM KWIK: ATMOSPHERIC OPTIC
    S AND SMOKE CONCENTRATION C
    ALCULATIONS
2350 DIM B(4),G(4),H(4),R(4),D(2
    ),X(4)
2360 ! FIXED 2
2370 FOR I=1 TO 4
2380 READ B(I),G(I),X(I)
2390 NEXT I
2400 V1=LOG(V0)
2410 V2=V1*V1
2420 V3=V2*V1
2430 H(1)=1.5551-.9811*V1-.0197*
    V2+.0041*V3

```

```

2440 H(1)=EXP(H(1))
2450 H(2)=1.50381511-.992319519*
      V1-.015972801*V2+.00368583*
      V3
2460 H(2)=EXP(H(2))
2470 H(3)=1.2394-1.0436*V1+.0099
      *V2-.0016*V3
2480 H(3)=EXP(H(3))
2490 H(4)=1.5176-1.7147*V1+.0001
      *V2+.0428*V3
2500 H(4)=EXP(H(4))
2510 R(1)=1.3306-.8825*V1-.0753*
      V2+.0129*V3
2520 R(1)=EXP(R(1))
2530 R(2)=1.481951707-.922595829
      *V1-.065509417*V2+.01368042
      2*V3
2540 R(2)=EXP(R(2))
2550 R(3)=1.5556-.9013*V1-.0773*
      V2+.0173*V3
2560 R(3)=EXP(R(3))
2570 R(4)=1.5928-.9396*V1-.0627*
      V2+.0168*V3
2580 R(4)=EXP(R(4))
2590 H0=0
2600 DISP "SLANT RANGE TO TARGET
      - KM";
2610 INPUT H3
2620 PRINT USING 2630 ; H3
2630 IMAGE "SLANT RANGE TO TARGE
      T - KM ",000
2640 DISP "VERT ANGLE OF SIGHT T
      O TARGET - DEG";
2650 INPUT S
2660 PRINT USING 2670 ; S
2670 IMAGE "ANGLE OF SIGHT TO TG
      T - DEG ",000
2680 IF S>=0 THEN 2700
2690 S=-S
2700 S=S*(PI/180)
2710 S=SIN(S)
2720 H4=0
2730 IF S=0 THEN 2760
2740 H4=1/S
2750 REM CALCULATE PRECIPITABLE
      WATER
2760 W=.4477+.0328*T1+.0012*T1*T
      1+.0000184*T1*T1*T1
2770 REM CALCULATE AMOUNT OF WAT
      ER IN PATH
2780 DEF FNA(A) = EXP(-S*A/2)
2790 L0=H3
2800 L1=H0
2810 L2=L0
2820 L3= 5*(L1+L2)
2830 L4=L2-L1
2840 L5= 2886751*L4
2850 W0= 5*L4*(FNA(L3+L5)+FNA(L3
      -L5))
2860 W1=W*W0

```

```

2870 REM CALCULATE TRANSMITTANCE
      S FOR VISUAL, NEAR, MID AND
      FAR IR WAVELENGTHS
2880 FOR I=1 TO 4
2890 REM CALCULATE TRANSMITTANCE
      S OWING TO ABSORPTION BY WA
      TER VAPOR.
2900 IF I<>4 THEN 2930
2910 T(I,1)=EXP(-.0681*W1)
2920 GOTO 3030
2930 DEF FNB(B) = EXP(-B^2)
2940 L0=B(I)*SQR(W1*PI)/2
2950 L1=H0
2960 L2=L0
2970 L3=.5*(L1+L2)
2980 L4=L2-L1
2990 L5=.2886751*L4
3000 M2=.5*L4*(FNB(L3+L5)+FNB(L3
      -L5))
3010 T(I,1)=2/SQR(PI)*M2
3020 T(I,1)=1-T(I,1)
3030 REM CALCULATE TRANSMITTANCE
      OWING TO ATTENUATION BY HA
      ZE AND FOG.
3040 IF P=0 THEN 3070
3050 T(I,2)=1
3060 GOTO 3350
3070 IF V0>=G(I) THEN 3270
3080 DEF FNC(C) = EXP(C*S*LOG(.1
      /H(I)))
3090 L0=H4
3100 L1=H0
3110 L2=L0
3120 L3=.5*(L1+L2)
3130 L4=L2-L1
3140 L5=.2886751*L4
3150 T3=.5*L4*(FNC(L3+L5)+FNC(
      L3-L5))
3160 T4=EXP(-H(I)*T3)
3170 DEF FND(D) = EXP(-D*S/4.1)
3180 L1=H4
3190 L2=H3
3200 L3=.5*(L1+L2)
3210 L4=L2-L1
3220 L5=.2886751*L4
3230 T5=.5*L4*(FND(L3+L5)+FND(L3
      -L5))
3240 T6=EXP(-.128*T5)
3250 T(I,2)=T4*T6
3260 GOTO 3350
3270 L0=H3
3280 L1=H0
3290 L2=L0
3300 L3=.5*(L1+L2)
3310 L4=L2-L1
3320 L5=.2886751*L4
3330 T7=.5*L4*(FND(L3+L5)+FND(L3
      -L5))
3340 T(I,2)=EXP(-H(I)*T7)
3350 REM CALCULATE TRANSMITTANCE
      OWING TO ATTENUATION BY PR
      ECIPITATION.

```

```

3360 IF P=1 THEN 3390
3370 T(I,3)=1
3380 GOTO 3410
3390 IF V0>20 THEN 3370
3400 T(I,3)=EXP(-H3*R(I))
3410 REM CALCULATE TRANSMITTANCE
      OWING TO ATTENUATION BY SM
      OKE.
3420 T(I,4)=X(I)/(T(I,1)*T(I,2)*
      T(I,3))
3430 IF T(I,4)<=1 THEN 3450
3440 T(I,4)=1
3450 REM CALCULATE LINE OF SIGHT
      INTEGRATED CONCENTRATION.
3460 FOR K=1 TO 2
3470 READ D(K)
3480 NEXT K
3490 IF T(I,4)<>1 THEN 3540
3500 FOR J=1 TO 2
3510 C(I,J)=0
3520 NEXT J
3530 GOTO 3600
3540 FOR K=1 TO 2
3550 IF D(K)<>0 THEN 3580
3560 C(I,K)=0
3570 GOTO 3590
3580 C(I,K)=LOG(T(I,4))/(-D(K))
3590 NEXT K
3600 NEXT I
3610 DATA .118,26.7,.05
3620 DATA .18,7.5,.05
3630 DATA .55,5.1,.05
3640 DATA 0.5,.05
3650 DATA 3.3,2.46
3660 DATA 1.5,2
3670 DATA 0,.25
3680 DATA 0,.32
3690 REM KWI: ATMOSPHERIC DIFFU
      SION AND SMOKE SOURCE STREN
      GTH CALCULATIONS
3700 DIM S(6,3),A(6),Q(2),H5(2,2
      ),D5(6,3),U(2,2)
3710 ! FIXED 2
3720 DISP "DIR (FR NORTH) OF LIN
      E OF SIGHT-DEG"
3730 INPUT A0
3740 PRINT USING 3750 ; A0
3750 IMAGE "DIR OF LINE OF SIGHT
      - DEG ",DDD
3760 PRINT
3770 REM ATMOSPHERIC DIFFUSION C
      ALCULATIONS
3780 FOR I=1 TO 6
3790 READ A(I)
3800 NEXT I
3810 FOR I=1 TO 6
3820 FOR J=1 TO 3
3830 READ S(I,J)
3840 NEXT J
3850 NEXT I

```

```

3860 FOR I=1 TO 6
3870 FOR J=1 TO 3
3880 READ D5(I,J)
3890 NEXT J
3900 NEXT I
3910 READ H5(1,1),H5(1,2),H5(2,1),H5(2,2)
3920 READ U(1,1),U(2,1),U(1,2),U(2,2)
3930 A1=-1.24+1.19*LGT(Y)
3940 Z=10^A1
3950 A2=ABS(A0-D0)*(PI/180)
3960 R2=SQR(13.69/(13.69*SIN(A2)*SIN(A2)+COS(A2)*COS(A2)))
3970 Y1=1.09521547+.02906894*R0-.00049575*R0*R0+.00000482*R0*R0*R0
3980 Y2=3.364059144+.060502571*R0-.00115301*R0*R0+.0000133942*R0*R0*R0
3990 C2=S(P0,1)+S(P0,2)*Z+S(P0,3)*Z^2
4000 D1=D5(P0,1)+D5(P0,2)*Z+D5(P0,3)*Z^2
4010 D2=1/D1
4020 IF S0<>0 THEN 4040
4030 S0=1
4040 S3=.515*S0
4050 DISP "SCREEN LENGTH - METER S";
4060 INPUT X0
4070 DISP "DURATION - MINUTES";
4080 INPUT T2
4090 FOR N=1 TO 6
4100 READ W(N)
4110 NEXT N
4120 FOR I=1 TO 4
4130 REM CALCULATE CROSSWIND INTEGRATED CONCENTRATION FOR W P SMOKE.
4140 FOR K=1 TO 2
4150 IF I<3 AND P0>4 THEN 4190
4160 S1=U(K,1)+.74*A(P0)*100^.9
4170 S2=U(K,2)+.667*C2*100^D1
4180 V(K)=W(P0)*Y2*H5(K,2)/(PI*S1*S2)
4190 REM MUNITION EXPENDITURES (HC SMOKE).
4200 REM MUNITION EFFICIENCY:
4210 Q(1)=.4
4220 Q(2)=.4
4230 REM SUSTAINING SHELL SPACING FOR HC SMOKE.
4240 IF I>2 THEN 4310
4250 IF C(I,1)<>0 THEN 4280
4260 Y(I,K)=0
4270 GOTO 4310
4280 Y(I,K)=1/R2*(.731*Q(K)*Y1*H5(K,1)/(C2*S3*C(I,1)))^D2
4290 IF Y(I,K)<X0 THEN 4310

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```

4300 Y(I,K)=X0
4310 NEXT K
4320 NEXT I
4330 REM DATA USED TO CALCULATE
      SIGMA Y FOR CONTINUOUS SOUR
      CE.
4340 DATA .4,.32,.22,.144,.102,.
      076
4350 REM DATA USED TO CALCULATE
      SIGMA Z FOR CONTINUOUS SOUR
      CE.
4360 DATA .139085297,.015017284,
      -.000102581
4370 DATA .122097643,.01097037,-
      .0000680135
4380 DATA .110104377,.010962963,
      -.0000673401
4390 DATA .097649832,.010418519,
      -.0000683502
4400 DATA .070772166,.00727284,-
      .0000450056
4410 DATA .055487093,.00655309,-
      .0000401796
4420 DATA .944814815,-.00485185,
      .000037037
4430 DATA .894803591,-.00483951,
      .0000359147
4440 DATA .854792368,-.00482716,
      .0000347924
4450 DATA .816026936,-.00607407,
      .000047138
4460 DATA .786026936,-.00607407,
      .000047138
4470 DATA .726015713,-.00606173,
      .0000460157
4480 REM UNIT (PER GUN) SOURCE S
      TRENGTHS.
4490 DATA 18.7,1737.3,77.1,7076.
      2
4500 REM WP VOLUME SOURCE SIGMAS
      (U(2,2)).
4510 DATA 5.4,7.9,1.8,2.6
4520 REM STABILITY CONSTANTS FOR
      WP SMOKE.
4530 DATA .016,.016,.016,.016,.0
      16,.016
4540 REM KWIK: MUNITION EXPENDIT
      URES (CONTINUATION).
4550 DIM R5(4,2),I(4,2),J(4,2),P
      5(4,2),E(4,2),F(4,2),G5(4,2
      ),Q9(4,2),L(4,2)
4560 DIM A$(8)
4570 ! FIXED 2
4580 S3=S0*.515
4590 REM UNIT SOURCE STRENGTH.
4600 READ H5(1,1),H5(1,2),H5(2,1
      ),H5(2,2)
4610 FOR I=1 TO 4
4620 FOR K=1 TO 2
4630 IF I>2 THEN 4950

```

```

4640 REM CALCULATE INITIAL SHELL
      SPACING FOR HC SMOKE.
4650 I(I,K)=S3*45
4660 IF Y(I,K)<>0 THEN 4700
4670 E(I,K)=1
4680 F(I,K)=1
4690 GOTO 4850
4700 REM CALCULATE INITIAL VOLEY
      FOR HC SMOKE.
4710 IF I(I,K)>Y(I,K) THEN 4730
4720 GOTO 4740
4730 I(I,K)=Y(I,K)
4740 E(I,K)=X0/I(I,K)
4750 Q5=INT(E(I,K))
4760 Q6=E(I,K)-Q5
4770 IF Q6=0 THEN 4790
4780 E(I,K)=Q5+1
4790 REM CALCULATE NUMBER OF GUN
      S FOR SUSTAINING VOLLEYS (H
      C SMOKE).
4800 F(I,K)=X0/Y(I,K)
4810 Q5=INT(F(I,K))
4820 Q6=F(I,K)-Q5
4830 IF Q6=0 THEN 4850
4840 F(I,K)=Q5+1
4850 REM CALCULATE RATE OF FIRE
      OR HC SMOKE.
4860 R1=.5
4870 IF C(I,1)<>0 THEN 4890
4880 R1=0
4890 REM CALCULATE TOTAL NUMBER
      OF ROUNDS REQUIRED (HC SMOK
      E).
4900 J(I,K)=E(I,K)+(R1*T2-1)*F(I
      ,K)
4910 Q5=INT(J(I,K))
4920 Q6=J(I,K)-Q5
4930 IF Q6=0 THEN 4950
4940 J(I,K)=Q5+1
4950 IF I<3 AND P0>4 THEN 5480
4960 REM SHELL SPACING <L( ) & Z
      ( )> & VOLLEYS <G( ) & Q( )
      > - WP SMOKE.
4970 IF C(I,2)<>0 THEN 5020
4980 Z(I,K)=0
4990 G5(I,K)=0
5000 Q9(I,K)=0
5010 GOTO 5170
5020 IF I>2 THEN 5090
5030 L(I,K)=V(K)/C(I,2)*100
5040 IF L(I,K)<=X0 THEN 5060
5050 L(I,K)=X0
5060 Z(I,K)=L(I,K)
5070 G5(I,K)=X0/Z(I,K)
5080 GOTO 5100
5090 G5(I,K)=.6*C(I,2)/V(K)
5100 Q5=INT(G5(I,K))
5110 Q6=G5(I,K)-Q5
5120 IF Q6=0 THEN 5150
5130 G5(I,K)=Q5+1

```

```

5140 GOTO 5160
5150 G5(I,K)=Q5
5160 Q9(I,K)=G5(I,K)
5170 REM RATE OF FIRE FOR WP SMO
      KE.
5180 IF C(I,2)<>0 THEN 5210
5190 R5(I,K)=0
5200 GOTO 5350
5210 IF I>2 THEN 5240
5220 R5(I,K)=(Z(I,K)+60)/S3
5230 GOTO 5250
5240 R5(I,K)=120/S3
5250 R5(I,K)=R5(I,K)/20
5260 R5=INT(R5(I,K))
5270 R6=R5(I,K)-R5
5280 IF R6<.5 THEN 5300
5290 R5=R5+1
5300 IF R5<>0 THEN 5320
5310 R5=1
5320 R5(I,K)=R5*20/60
5330 R5(I,K)=1/R5(I,K)
5340 IF R5(I,K)<1 THEN R5(I,K)=1
5350 REM CALCULATE TOTAL NUMBER
      OF ROUNDS REQUIRED (WP SMOK
      E)
5360 IF C(I,2)<>0 THEN 5390
5370 P5(I,K)=0
5380 GOTO 5810
5390 IF I>2 THEN 5420
5400 P5(I,K)=G5(I,K)+Q9(I,K)*(T2
      *R5(I,K)-1)
5410 GOTO 5430
5420 P5(I,K)=Q9(I,K)*(X0/60+1)*(
      T2*R5(I,K)-1)
5430 Q5=INT(P5(I,K))
5440 Q6=P5(I,K)-Q5
5450 IF Q6=0 THEN 5470
5460 P5(I,K)=Q5+1
5470 GOTO 5810
5480 REM CALCULATIONS FOR WP SMO
      KE E & F STABILITY CATEGORI
      ES (STABLE FLOW).
5490 REM INITIAL SHELL SPACING
5500 IF I=1 AND K=1 THEN 5530
5510 IF I<7 AND K=2 THEN 5530
5520 IF I=2 AND K=1 THEN 5550
5530 L(I,K)=100
5540 GOTO 5560
5550 L(I,K)=50
5560 REM SUSTAINING SHELL SPACIN
      G
5570 IF I=1 AND K=1 THEN 5610
5580 IF I=2 AND K=2 THEN 5610
5590 IF I=1 AND K=2 THEN 5630
5600 IF I=2 AND K=1 THEN 5650
5610 Z(I,K)=100
5620 GOTO 5660
5630 Z(I,K)=200
5640 GOTO 5660
5650 Z(I,K)=50

```

```

5660 REM INITIAL VOLLEY - WP SMO
      KE
5670 G5(I,K)=X0/L(I,K)+1
5680 REM SUSTAINING VOLLEY.
5690 Q9(I,K)=X0/Z(I,K)+1
5700 REM RATE OF FIRE - WP SMOKE

5710 IF K=1 THEN 5730
5720 IF K=2 THEN 5750
5730 R5(I,K)=2
5740 GOTO 5760
5750 R5(I,K)=1
5760 REM TOTAL NUMBER OF WP ROUN
      DS REQUIRED.
5770 P5(I,K)=G5(I,K)+Q9(I,K)*(T2
      *R5(I,K)-1)
5780 Q5=INT(P5(I,K))
5790 Q6=P5(I,K)-Q5
5800 IF Q6>0 THEN P5(I,K)=Q5+1
5810 NEXT K
5820 NEXT I
5830 FOR I=1 TO 4
5840 PRINT
5850 PRINT
5860 PRINT
5870 PRINT
5880 PRINT
5890 PRINT
5900 READ A$
5910 PRINT "                      ";A$
5920 PRINT
5930 PRINT
5940 PRINT "
      METERS MIN"
5950 PRINT USING 5960 ; X0,T2
5960 IMAGE "SCREEN LENGTH/DURATI
      ON:";00000,1X,000
5970 PRINT
5980 PRINT
5990 IF I>2 THEN 6500
6000 PRINT "                      HC SMOKE SC
      REEN"
6010 PRINT
6020 PRINT
6030 PRINT "                      105MM HOWIT
      ZER"
6040 PRINT
6050 PRINT "VOLLEY GUNS RATE/ SP
      ACING ROUNDS"
6060 PRINT "                      MIN    M
      ETERS"
6070 PRINT USING 6080 ; E(I,1),I
      (I,1)
6080 IMAGE "INITIAL:";000,7X,000
      0000
6090 PRINT USING 6100 ; F(I,1),R
      1,Y(I,1),J(I,1)
6100 IMAGE "SUSTAIN:";000,1X,00.
      0,2X,0000000,1X,000000
6110 PRINT

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```

6120 PRINT
6130 PRINT
6140 PRINT "          155MM HOWIT
ZER"
6150 PRINT
6160 PRINT "VOLLEY GUNS RATE/ SP
ACING ROUNDS"
6170 PRINT "          MIN    M
ETERS"
6180 PRINT USING 6190 : E(I,2),I
(I,2)
6190 IMAGE "INITIAL:",000,7X,000
0000
6200 PRINT USING 6210 : F(I,2),R
1,Y(I,2),J(I,2)
6210 IMAGE "SUSTAIN:",000,1X,00.
0,2X,0000000,1X,000000
6220 PRINT
6230 PRINT
6240 PRINT
6250 PRINT "          WP SMOKE SC
PEEN"
6260 PRINT
6270 PRINT
6280 PRINT "          105MM HOWIT
ZER"
6290 PRINT
6300 PRINT "VOLLEY GUNS RATE/ SP
ACING ROUNDS"
6310 PRINT "          MIN    M
ETERS"
6320 PRINT USING 6330 : G5(I,1),
L(I,1)
6330 IMAGE "INITIAL:",000,7X,000
0000
6340 PRINT USING 6350 : Q9(I,1),
R5(I,1),Z(I,1),P5(I,1)
6350 IMAGE "SUSTAIN:",000,1X,00.
0,2X,0000000,1X,000000
6360 PRINT
6370 PRINT
6380 PRINT
6390 PRINT "          155MM HOWIT
ZER"
6400 PRINT
6410 PRINT "VOLLEY GUNS RATE/ SP
ACING ROUNDS"
6420 PRINT "          MIN    M
ETERS"
6430 PRINT USING 6440 : G5(I,2),
L(I,2)
6440 IMAGE "INITIAL ",000,7X,000
0000
6450 PRINT USING 6460 : Q9(I,2),
R1(I,2),Z(I,2),P5(I,2)
6460 IMAGE "SUSTAIN:",000,1X,00.
0,2X,0000000,1X,000000
6470 PRINT
6480 PRINT
6490 IF I=3 THEN 6590

```

```

6500 PRINT "          WP SMOKE SC
      REEN"
6510 PRINT
6520 PRINT
6530 PRINT "          ROUNDS/  RA
      TE/  TOTAL"
6540 PRINT "          60 METERS MI
      NUTE ROUNDS"
6550 PRINT USING 6560 ; Q9(I,1),
      R5(I,1),P5(I,1)
6560 IMAGE "105MM: ",000000,4X,
      000,4X,00000
6570 PRINT USING 6580 ; Q9(I,2),
      R5(I,2),P5(I,2)
6580 IMAGE "155MM: ",000000,4X,
      ,000,4X,00000
6590 NEXT I
6600 PRINT
6610 PRINT
6620 PRINT
6630 PRINT
6640 PRINT
6650 PRINT
6660 PRINTER IS 1
6670 DISP "DONE"
6680 REM UNIT (PER GUN) SOURCE S
      TRENGTHS.
6690 DATA 18.7,1737.3,77.1,7076.
      2
6700 DATA "VISIBLE:"
6710 DATA "NEAR IR:"
6720 DATA "MID IR:"
6730 DATA "FAR IR:"
6740 END

```

APPENDIX K

HP 9845 (BASIC) ALGORITHM

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10  REM KWIK SMOKE ALGORITHM (HP 9845) SEPTEMBER 23, 1981
20  REM KWIK: METEOROLOGICAL INPUTS AND METEOROLOGICAL CALCULATIONS.
30  OPTION BASE 1
40  PRINTER IS 0
50  DIM C(4,2),T(4,4),V(2),W(6),Y(4,2),Z(4,2)
60  DIM S(6,3),A(6),Q(2),H5(2,2),D5(6,3),U(2,2)
70  DIM R5(4,2),I(4,2),J(4,2),P5(4,2),E(4,2),F(4,2),G5(4,2),Q9(4,2),L(4,2)
80  DIM B(4),G(4),H(4),R(4),D(2),X(4)
90  DIM I$(4),P(7,9),Q$(6),H$(11),J$(11)
100 DIM A$(8)
110 FIXED 2
120 PRINT
130 PRINT
140 PRINT "                                MUNITION EXPENDITURES"
150 PRINT "                                FOR HC AND WP SMOKE"
160 PRINT
170 PRINT
180 DISP "MET SITE ID";
190 INPUT I$
200 DISP "LATITUDE OF MET SITE- DEG";
210 INPUT L0
220 REM "DIRECTION FROM EQUATOR- N OR S";
230 H$="N"
240 DISP "LONGITUDE OF MET SITE - DEG";
250 INPUT L1
260 DISP "DIRECTION FROM GREENWICH- E OR W";
270 INPUT J$
280 DISP "JULIAN DATE OF MET OBSERVATION";
290 INPUT J0
300 DISP "ZULU TIME OF MET OSERVATION-HR";
310 INPUT H0
320 DISP "CEILING - FEET";
330 INPUT C0
340 C0=C0*.3048
350 DISP "CLOUD COVER - PERCENT";
360 INPUT C1
370 DISP "VISIBILITY - MILES";
380 INPUT V0
390 V0=V0*1.61
400 DISP "PRECIPITATION - 1=YES 0=NO";
410 INPUT P
420 DISP "TEMPERATURE - DEG F";
430 INPUT T0
440 T0=5/9*(T0-32)
450 DISP "DEW POINT - DEG F";
460 INPUT T1
470 T1=5/9*(T1-32)
480 DISP "WIND DIRECTION - DEGS";
490 INPUT D0
500 DISP "WIND SPEED KNOTS";

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510 INPUT S0
520 DISP "AVE ROUGHNESS ELEMENT - CM";
530 INPUT Y
540 DISP "SLANT RANGE TO TARGET - KM";
550 INPUT H3
560 DISP "ANGLE OF SIGHT TO TARGET - DEG";
570 INPUT S
580 DISP "DIRECTION OF LINE OF SIGHT-DEG";
590 INPUT A9
600 DISP "SCREEN LENGTH - METERS";
610 INPUT X0
620 DISP "DURATION - MINUTES";
630 INPUT T2
640 PRINT " ID = "; I$
650 PRINT " LATITUDE - DEG = "; H$(1); L0
660 PRINT " LONGITUDE - DEG = "; J$(1); L1
670 PRINT " JULIAN DATE - DAY = "; J0
680 PRINT " ZULU TIME - HOUR = "; H0
690 PRINT " CEILING - METERS = "; C0
700 PRINT " CLOUD COVER - PERCENT = "; C1
710 PRINT " VISIBILITY - KILOMETERS = "; V0
720 PRINT " PRECIPITATION = "; P
730 PRINT " TEMPERATURE - DEG C = "; T0
740 PRINT " DEW POINT - DEG C = "; T1
750 PRINT " WIND DIRECTION - DEG = "; D0
760 PRINT " WIND SPEED - KNOTS = "; S0
770 PRINT " AVE ROUGHNESS ELEMENT - CM = "; Y
780 FOR J=1 TO 9
790 FOR I=1 TO 7
800 READ P(I,J)
810 NEXT I
820 NEXT J
830 READ Q$
840 IF J$<>"E" THEN 870
850 L1=-L1
860 REM MET CALCULATIONS.
870 IF C1<>100 THEN 920
880 IF C0>2133.6042 THEN 920
890 I1=0
900 I2=0
910 GOTO 1530
920 REM CALCULATE ANGULAR FRACTION OF A YEAR FOR A GIVEN JULIAN DATE (A0)
930 R9=PI/180
940 D9=180/PI
950 L0=L0*R9
960 A0=(J0-1)*360/365.242
970 REM CALCULATE SOLAR DECLINATION ANGLE (A4).
980 A1=A0*R9
990 A2=279.9348+A0
1000 A2=A2+1.914827*SIN(A1)-.079525*COS(A1)

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1010 A2=A2+.019938*SIN(2*A1)-.00162*COS(2*A1)
1020 A2=A2*R9
1030 A3=23.4438*R9
1040 A4=SIN(A3)*SIN(A2)
1050 A4=ATN(A4/SQR(1-A4*A4+1E-99))
1060 REM CALCULATE THE TIME OF MERIDIAN PASSAGE - TRUE SOLAR NOON (A5).
1070 A5=12+.12357*SIN(A1)-.004289*COS(A1)
1080 A5=A5+.153809*SIN(2*A1)+.060783*COS(2*A1)
1090 REM CALCULATE SOLAR HOUR ANGLE (A6)
1100 A6=15*(H0-A5)-L1
1110 A6=A6*R9
1120 REM CALCULATE SOLAR ALTITUDE (A7)
1130 A7=SIN(L0)*SIN(A4)+COS(L0)*COS(A4)*COS(A6)
1140 A7=ATN(A7/SQR(1-A7*A7+1E-99))
1150 A7=A7*D9
1160 REM CALCULATE INSOLATION CLASS NUMBER.
1170 I2=0
1180 IF A7<=60 THEN 1210
1190 I2=4
1200 GOTO 1290
1210 IF A7<=35 THEN 1240
1220 I2=3
1230 GOTO 1290
1240 IF A7<=15 THEN 1270
1250 I2=2
1260 GOTO 1290
1270 IF A7<=0 THEN 1480
1280 I2=1
1290 REM CALCULATE NET RADIATION INDEX FOR DAYTIME.
1300 I3=0
1310 IF C1>50 THEN 1340
1320 I3=I2
1330 GOTO 1420
1340 IF C0>=2133.6042 THEN 1370
1350 I3=I2-2
1360 GOTO 1420
1370 IF C0>=4876.8096 THEN 1400
1380 I3=I2-1
1390 GOTO 1420
1400 IF C1<>100 THEN 1420
1410 I3=I2-1
1420 IF I3<>0 THEN 1440
1430 I3=I2
1440 IF I3>1 THEN 1460
1450 I3=1
1460 I1=I3
1470 GOTO 1530
1480 REM CALCULATE NET RADIATION INDEX FOR NIGHTTIME
1490 IF C1>40 THEN 1520
1500 I1=-2

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1510 GOTO 1530
1520 I1=-1
1530 REM CALCULATE PASQUILL STABILITY CATEGORY.
1540 I4=0
1550 I5=0
1560 IF I1<>4 THEN 1580
1570 I4=1
1580 IF I1<>3 THEN 1600
1590 I4=2
1600 IF I1<>2 THEN 1620
1610 I4=3
1620 IF I1<>1 THEN 1640
1630 I4=4
1640 IF I1<>0 THEN 1660
1650 I4=5
1660 IF I1<>-1 THEN 1680
1670 I4=6
1680 IF I1<>-2 THEN 1700
1690 I4=7
1700 IF S0>=2 THEN 1730
1710 I5=1
1720 GOTO 1950
1730 IF S0>=4 THEN 1760
1740 I5=2
1750 GOTO 1950
1760 IF S0>=6 THEN 1790
1770 I5=3
1780 GOTO 1950
1790 IF S0>=7 THEN 1820
1800 I5=4
1810 GOTO 1950
1820 IF S0>=8 THEN 1850
1830 I5=5
1840 GOTO 1950
1850 IF S0>=10 THEN 1880
1860 I5=6
1870 GOTO 1950
1880 IF S0>=11 THEN 1910
1890 I5=7
1900 GOTO 1950
1910 IF S0>=12 THEN 1940
1920 I5=8
1930 GOTO 1950
1940 I5=9
1950 P0=P(I4,I5)
1960 REM CALCULATE RELATIVE HUMIDITY
1970 IF T0>0 THEN 2010
1980 A0=9.5
1990 B0=265.5
2000 GOTO 2030

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2010 A0=7.5
2020 B0=237.3
2030 IF T1>0 THEN 2070
2040 A1=9.5
2050 B1=265.5
2060 GOTO 2090
2070 A1=7.5
2080 B1=237.3
2090 E0=6.11*108*(A0*T0/(B0+T0))
2100 E1=6.11*108*(A1*T1/(B1+T1))
2110 R0=E1/E0*100
2120 PRINT " PASQUILL STABILITY CATEGORY = ";Q$(P0,P0)
2130 PRINT " RELATIVE HUMIDITY = ";R0
2140 PRINT
2150 PRINT
2160 REM KWIK: ATMOSPHERIC OPTICS AND SMOKE CONCENTRATION CALCULATIONS.
2170 FOR I=1 TO 4
2180 READ B(I),G(I),X(I)
2190 NEXT I
2200 V1=LOG(V0)
2210 V2=V1*V1
2220 V3=V2*V1
2230 H(1)=1.5551-.9811*V1-.0197*V2+.0041*V3
2240 H(1)=EXP(H(1))
2250 H(2)=1.50381511-.992319519*V1-.015972801*V2+.00368583*V3
2260 H(2)=EXP(H(2))
2270 H(3)=1.2394-1.0436*V1+.0099*V2-.0016*V3
2280 H(3)=EXP(H(3))
2290 H(4)=1.5176-1.7147*V1+.0001*V2+.0428*V3
2300 H(4)=EXP(H(4))
2310 R(1)=1.3306-.8825*V1-.0753*V2+.0129*V3
2320 R(1)=EXP(R(1))
2330 R(2)=1.481951707-.922595829*V1-.065509417*V2+.013680422*V3
2340 R(2)=EXP(R(2))
2350 R(3)=1.5556-.9013*V1-.0773*V2+.0173*V3
2360 R(3)=EXP(R(3))
2370 R(4)=1.5928-.9396*V1-.0627*V2+.0168*V3
2380 R(4)=EXP(R(4))
2390 H0=0
2400 IF S>=0 THEN 2420
2410 S=-S
2420 S=S*(PI/180)
2430 S=SIN(S)
2440 H4=0
2450 IF S=0 THEN 2480
2460 H4=1/S
2470 REM CALCULATE PRECIPITABLE WATER.
2480 W=.4477+.0328*T1+1.2E-3*T1*T1+1.84E-5*T1*T1*T1
2490 REM CALCULATE AMOUNT OF WATER IN PATH.
2500 DEF FNA(A)=EXP(-S*A/2)

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2510 L0=H3
2520 L1=H0
2530 L2=L0
2540 L3=.5*(L1+L2)
2550 L4=L2-L1
2560 L5=.2886751*L4
2570 W0=.5*L4*(FNA(L3+L5)+FNA(L3-L5))
2580 W1=W*W0
2590 REM CALCULATE TRANSMITTANCES FOR VISUAL, NEAR, MID AND FAR IR WAVELENGTH
2600 FOR I=1 TO 4
2610 REM CALCULATE TRANSMITTANCES OWING TO ABSORPTION BY WATER VAPOR.
2620 IF I<>4 THEN 2650
2630 T(I,1)=EXP(-.0681*W1)
2640 GOTO 2750
2650 DEF FNB(B)=EXP(-B^2)
2660 L0=B(I)*SQR(W1*PI)/2
2670 L1=H0
2680 L2=L0
2690 L3=.5*(L1+L2)
2700 L4=L2-L1
2710 L5=.2886751*L4
2720 M2=.5*L4*(FNB(L3+L5)+FNB(L3-L5))
2730 T(I,1)=2/SQR(PI)*M2
2740 T(I,1)=1-T(I,1)
2750 REM CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY HAZE AND FOG.
2760 IF P=0 THEN 2790
2770 T(I,2)=1
2780 GOTO 3070
2790 IF V0>=G(I) THEN 2990
2800 DEF FNC(C)=EXP(C*S*LOG(.1/H(I)))
2810 L0=H4
2820 L1=H0
2830 L2=L0
2840 L3=.5*(L1+L2)
2850 L4=L2-L1
2860 L5=.2886751*L4
2870 T3=.5*L4*(FNC(L3+L5)+FNC(L3-L5))
2880 T4=EXP(-H(I)*T3)
2890 DEF FND(D)=EXP(-D*S/4.1)
2900 L1=H4
2910 L2=H3
2920 L3=.5*(L1+L2)
2930 L4=L2-L1
2940 L5=.2886751*L4
2950 T5=.5*L4*(FND(L3+L5)+FND(L3-L5))
2960 T6=EXP(-.128*T5)
2970 T(I,2)=T4*T6
2980 GOTO 3070
2990 L0=H3
3000 L1=H0

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3010 L2=L0
3020 L3=.5*(L1+L2)
3030 L4=L2-L1
3040 L5=.2886741*L4
3050 T7=.5*L4*(FND(L3+L5)+FND(L3-L5))
3060 T(I,2)=EXP(-H(I)*T7)
3070 REM CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY PRECIPITATION.
3080 IF P=1 THEN 3110
3090 T(I,3)=1
3100 GOTO 3130
3110 IF V0>20 THEN 3090
3120 T(I,3)=EXP(-H3*R(I))
3130 REM CALCULATE TRANSMITTANCE OWING TO ATTENUATION BY SMOKE.
3140 T(I,4)=X(I)/(T(I,1)*T(I,2)*T(I,3))
3150 IF T(I,4)<=1 THEN 3170
3160 T(I,4)=1
3170 REM CALCULATE LINE OF SIGHT INTEGRATED CONCENTRATION.
3180 FOR K=1 TO 2
3190 READ D(K)
3200 NEXT K
3210 IF T(I,4)<>1 THEN 3260
3220 FOR J=1 TO 2
3230 C(I,J)=0
3240 NEXT J
3250 GOTO 3320
3260 FOR K=1 TO 2
3270 IF D(K)<>0 THEN 3300
3280 C(I,K)=0
3290 GOTO 3310
3300 C(I,K)=LOG(T(I,4))/-D(K)
3310 NEXT K
3320 NEXT I
3330 REM ATMOSPHERIC DIFFUSION CALCULATIONS.
3340 FOR L=1 TO 6
3350 READ A(L)
3360 NEXT L
3370 FOR I=1 TO 6
3380 FOR J=1 TO 3
3390 READ S(I,J)
3400 NEXT J
3410 NEXT I
3420 FOR I=1 TO 6
3430 FOR J=1 TO 3
3440 READ D5(I,J)
3450 NEXT J
3460 NEXT I
3470 READ H5(1,1),H5(1,2),H5(2,1),H5(2,2)
3480 READ U(1,1),U(2,1),U(1,2),U(2,2)
3490 A1=-1.24+1.19*LGT(Y)
3500 Z=10^A1

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3510 A2=ABS(A9-D0)*(PI/180)
3520 R2=SQR(13.69/(13.69*SIN(A2)*SIN(A2)+COS(A2)*COS(A2)))
3530 Y1=1.09521547+.02906894*R0-4.9575E-4*R0*R0+4.82E-6*R0*R0*R0
3540 Y2=3.364059144+.060502571*R0-1.15301E-3*R0*R0+1.33942E-5*R0*R0*R0
3550 C2=S(P0,1)+S(P0,2)*Z+S(P0,3)*Z^2
3560 D1=D5(P0,1)+D5(P0,2)*Z+D5(P0,3)*Z^2
3570 D2=1/D1
3580 IF S0<>0 THEN 3600
3590 S0=1
3600 S3=.515*S0
3610 FOR N=1 TO 6
3620 READ W(N)
3630 NEXT N
3640 FOR I=1 TO 4
3650 REM CALCULATE CROSSWIND INTEGRATED CONCENTRATION FOR WP SMOKE.
3660 FOR K=1 TO 2
3670 IF (I<3) AND (P0>4) THEN 3710
3680 S1=U(K,1)+.74*A(P0)*100^.9
3690 S2=U(K,2)+.667*C2*100^D1
3700 V(K)=W(P0)*Y2*H5(K,2)/(PI*S1*S2)
3710 REM MUNITION EXPENDITURES (HC SMOKE).
3720 Q(1)=Q(2)=.4 ! MUNITION EFFICIENCIES
3730 REM SUSTAINING SHELL SPACING FOR HC SMOKE.
3740 IF I>2 THEN 3810
3750 IF C(I,1)<>0 THEN 3780
3760 Y(I,K)=0
3770 GOTO 3810
3780 Y(I,K)=1/R2*(.731*Q(K)*Y1*H5(K,1)/(C2*S3*C(I,1)))^D2
3790 IF Y(I,K)<X0 THEN 3810
3800 Y(I,K)=X0
3810 NEXT K
3820 NEXT I
3830 FOR I=1 TO 4
3840 FOR K=1 TO 2
3850 IF I>2 THEN 4170
3860 REM CALCULATE INITIAL SHELL SPACING FOR HC SMOKE.
3870 I(I,K)=S3*45
3880 IF Y(I,K)<>0 THEN 3920
3890 E(I,K)=1
3900 F(I,K)=1
3910 GOTO 4070
3920 REM CALCULATE INITIAL VOLLEY FOR HC SMOKE.
3930 IF I(I,K)>Y(I,K) THEN 3950
3940 GOTO 3960
3950 I(I,K)=Y(I,K)
3960 E(I,K)=X0/I(I,K)
3970 Q5=INT(E(I,K))
3980 Q6=E(I,K)-Q5
3990 IF Q6=0 THEN 4010
4000 E(I,K)=Q5+1

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4010 REM CALCULATE NUMBER OF GUNS FOR SUSTAINING VOLLEYS (HC SMOKE).
4020 F(I,K)=X0/Y(I,K)
4030 Q5=INT(F(I,K))
4040 Q6=F(I,K)-Q5
4050 IF Q6=0 THEN 4070
4060 F(I,K)=Q5+1
4070 R1=.5 ! RATE OF FIRE FOR HC SMOKE
4080 IF C(I,1)<>0 THEN 4100
4090 R1=0
4100 REM CALCULATE TOTAL NUMBER OF ROUNDS REQUIRED (HC SMOKE).
4110 ! J(I,K)=E(I,K)+1/2*F(I,K)*(T2-2) CHANGE COORDINATED WITH PENA ON 19MAY81
4120 J(I,K)=E(I,K)+(R1*T2-1)*F(I,K) ! THIS LINE REPLACES THE LINE ABOVE IT
4130 Q5=INT(J(I,K))
4140 Q6=J(I,K)-Q5
4150 IF Q6=0 THEN 4170
4160 J(I,K)=Q5+1
4170 IF (I<3) AND (P0>4) THEN 4700
4180 REM SHELL SPACING (L(I,K) & Z(I,K)) & VOLLEYS (G(I,K) & Q(I,K)) - WP SMOKE.
4190 IF C(I,2)<>0 THEN 4240
4200 Z(I,K)=0
4210 G5(I,K)=0
4220 Q9(I,K)=0
4230 GOTO 4390
4240 IF I>2 THEN 4310
4250 L(I,K)=V(K)/C(I,2)*100
4260 IF L(I,K)<X0 THEN 4280
4270 L(I,K)=X0
4280 Z(I,K)=L(I,K)
4290 G5(I,K)=X0/Z(I,K)
4300 GOTO 4320
4310 G5(I,K)=.6*C(I,2)/V(K)
4320 Q5=INT(G5(I,K))
4330 Q6=G5(I,K)-Q5
4340 IF Q6=0 THEN 4370
4350 G5(I,K)=Q5+1
4360 GOTO 4380
4370 G5(I,K)=Q5
4380 Q9(I,K)=G5(I,K)
4390 REM RATE OF FIRE FOR WP SMOKE.
4400 IF C(I,2)<>0 THEN 4430
4410 R5(I,K)=0
4420 GOTO 4570
4430 IF I>2 THEN 4460
4440 R5(I,K)=(Z(I,K)+60)/S3
4450 GOTO 4470
4460 R5(I,K)=120/S3
4470 R5(I,K)=R5(I,K)/20
4480 R5=INT(R5(I,K))
4490 R6=R5(I,K)-R5
4500 IF R6<.5 THEN 4520

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4510 R5=R5+1
4520 IF R5<>0 THEN 4540
4530 R5=1
4540 R5(I,K)=R5*20/60
4550 R5(I,K)=1/R5(I,K)
4560 IF R5(I,K)<1 THEN R5(I,K)=1
4570 REM CALCULATE TOTAL NUMBER OF ROUNDS REQUIRED (WP SMOKE)
4580 IF C(I,2)<>0 THEN 4610
4590 P5(I,K)=0
4600 GOTO 5010
4610 IF I>2 THEN 4640
4620 P5(I,K)=(T2*R5(I,K)-1)*Q9(I,K)+G5(I,K)
4630 GOTO 4650
4640 P5(I,K)=Q9(I,K)*(X0/60+1)*(T2*R5(I,K)-1)
4650 Q5=INT(P5(I,K))
4660 Q6=P5(I,K)-Q5
4670 IF Q6=0 THEN 4690
4680 P5(I,K)=Q5+1
4690 GOTO 5000
4700 REM CALCULATIONS FOR WP SMOKE E & F STABILITY CATEGORIES (STABLE FLOW)
4710 REM INITIAL SHELL SPACING
4720 IF (I=1) AND (K=1) THEN 4750
4730 IF (I<3) AND (K=2) THEN 4750
4740 IF (I=2) AND (K=1) THEN 4770
4750 L(I,K)=100
4760 GOTO 4780
4770 L(I,K)=50
4780 REM SUSTAINING SHELL SPACING
4790 IF (I=1) AND (K=1) THEN 4830
4800 IF (I=2) AND (K=2) THEN 4830
4810 IF (I=1) AND (K=2) THEN 4850
4820 IF (I=2) AND (K=1) THEN 4870
4830 Z(I,K)=100
4840 GOTO 4880
4850 Z(I,K)=200
4860 GOTO 4880
4870 Z(I,K)=50
4880 REM INITIAL VOLLEY - WP SMOKE.
4890 G5(I,K)=X0/L(I,K)+1
4900 REM SUSTAINING VOLLEY.
4910 Q9(I,K)=X0/Z(I,K)+1
4920 REM RATE OF FIRE - WP SMOKE.
4930 IF K=1 THEN 4950
4940 IF K=2 THEN 4970
4950 R5(I,K)=2
4960 GOTO 4980
4970 R5(I,K)=1
4980 REM TOTAL NUMBER OF WP ROUNDS REQUIRED.
4990 P5(I,K)=(T2*R5(I,K)-1)*Q9(I,K)+G5(I,K)
5000 NEXT K

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5010 NEXT I
5020 FOR I=1 TO 4
5030 PRINT LIN(7)
5040 READ A$
5050 PRINT "                                ";A$
5060 PRINT LIN(2)
5070 PRINT "                                METERS MINUTES"
5080 PRINT USING 5090;X0,T2
5090 IMAGE "                                SCREEN LENGTH/DURATION: ",DDDDD,,4X,DD.
5100 PRINT LIN(2)
5110 IF I>2 THEN 5530
5120 PRINT "                                HC SMOKE SCREEN"
5130 PRINT LIN(2)
5140 PRINT "                                105MM HOWITZER"
5150 PRINT LIN(1)
5160 PRINT "                                VOLLEY      GUNS RATE/ SPACING ROUNDS"
5170 PRINT "                                MIN      METERS"
5180 PRINT USING 5190;E(I,1),I(I,1)
5190 IMAGE "                                INITIAL:      ",DDD,11X,DDD
5200 PRINT USING 5210;F(I,1),R1,Y(I,1),J(I,1)
5210 IMAGE "                                SUSTAINING: ",2X,DD,2X,D.D,5X,DDDD,3X,DDDD
5220 PRINT LIN(3)
5230 PRINT "                                155MM HOWITZER"
5240 PRINT LIN(1)
5250 PRINT "                                VOLLEY      GUNS RATE/ SPACING ROUNDS"
5260 PRINT "                                MIN      METERS"
5270 PRINT USING 5190;E(I,2),I(I,2)
5280 IMAGE "                                INITIAL:      ",DDD,10X,DDDD
5290 PRINT USING 5210;F(I,2),R1,Y(I,2),J(I,2)
5300 IMAGE "                                SUSTAINING: ",2X,DD,2X,D.D,5X,DDDD,3X,DDDD
5310 PRINT LIN(3)
5320 PRINT "                                WP SMOKE SCREEN"
5330 PRINT LIN(2)
5340 PRINT "                                105MM HOWITZER"
5350 PRINT LIN(1)
5360 PRINT "                                VOLLEY      GUNS RATE/ SPACING ROUNDS"
5370 PRINT "                                MIN METERS"
5380 PRINT USING 5190;G5(I,1),L(I,1)
5390 IMAGE "                                INITIAL: ",DDD,10X,DDDD
5400 PRINT USING 5300;Q9(I,1),R5(I,1),Z(I,1),P5(I,1)
5410 IMAGE "                                SUSTAINING: ",2X,DD,2X,D.D,5X,DDDD,3X,DDDD
5420 PRINT LIN(3)
5430 PRINT "                                155MM HOWITZER"
5440 PRINT LIN(1)
5450 PRINT "                                VOLLEY      GUNS RATE/ SPACING ROUNDS"
5460 PRINT "                                MIN      METERS"
5470 PRINT USING 5190;G5(I,2),L(I,2)
5480 IMAGE "                                INITIAL: ",DDD,10X,DDDD
5490 PRINT USING 5300;Q9(I,2),R5(I,2),Z(I,2),P5(I,2)
5500 IMAGE "                                SUSTAINING: ",2X,DD,2X,D.D,5X,DDDD,3X,DDDD

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5510 PRINT LIN(2)
5520 IF I<3 THEN 5610
5530 PRINT "
5540 PRINT LIN(2)
5550 PRINT "
5560 PRINT "
5570 PRINT USING 5580;Q9(I,1),R5(I,1),P5(I,1)
5580 IMAGE "
5590 PRINT USING 5600;Q9(I,2),R5(I,2),P5(I,2)
5600 IMAGE "
5610 NEXT I
5620 PRINT LIN(6)
5630 PRINTER IS 16
5640 DISP "DONE"
5650 REM PASQUILL STABILITY CATEGORY DATA
5660 DATA 1,1,2,3,4,6,6
5670 DATA 1,2,2,3,4,6,6
5680 DATA 1,2,3,4,4,5,6
5690 DATA 2,2,3,4,4,5,6
5700 DATA 2,2,3,4,4,4,5
5710 DATA 2,3,3,4,4,4,5
5720 DATA 3,3,4,4,4,4,5
5730 DATA 3,3,4,4,4,4,4
5740 DATA 3,4,4,4,4,4,4
5750 DATA "ABCDEF"
5760 REM ABSORPTION COEFFICIENT, SCALE HEIGHT AND WAVELENGTH THRESHOLD.
5770 DATA 0.118,26.7,0.05
5780 DATA 0.18,7.5,0.05
5790 DATA 0.55,5.1,0.05
5800 DATA 0,5,0.05
5810 REM EXTINCTION COEFFICIENTS FOR HC AND WP.
5820 DATA 3.3,2.46
5830 DATA 1.5,2
5840 DATA 0,0.25
5850 DATA 0,0.32
5860 REM DATA USED TO CALCULATE SIGMA Y FOR CONTINUOUS SOURCE.
5870 DATA 0.4,0.32,0.22,0.144,0.102,0.076
5880 REM DATA USED TO CALCULATE SIGMA Z FOR CONTINUOUS SOURCE.
5890 DATA 0.139085297,0.015017284,-1.02581E-04
5900 DATA 0.122097643,0.01097037,-6.80135E-05
5910 DATA 0.110104377,0.010962963,-6.73401E-05
5920 DATA 0.097649832,0.010418519,-6.83502E-05
5930 DATA 0.070772166,7.27284E-03,-4.50056E-05
5940 DATA 0.055487093,6.55309E-03,-4.01796E-05
5950 DATA 0.944814815,-4.85185E-03,3.7037E-05
5960 DATA 0.894803591,-4.83951E-03,3.59147E-05
5970 DATA 0.854792368,-4.82716E-03,3.47924E-05
5980 DATA 0.816026936,-6.07407E-03,4.7138E-05
5990 DATA 0.786026936,-6.07407E-03,4.7138E-05
6000 DATA 0.726015713,-6.06173E-03,4.60157E-05

```

6010 REM UNIT (PER GUN) SOURCE STRENGTHS.
6020 DATA 18.7,1737.3,77.1,7076.2
6030 REM WP VOLUME SOURCE SIGMAS (U(2,2)).
6040 DATA 5.4,7.9,1.8,2.6
6050 REM STABILITY CONSTANTS FOR WP SMOKE.
6060 DATA 0.016, 0.016,0.016,0.016,0.016,0.016
6070 DATA "VISIBLE"
6080 DATA "NEAR IR"
6090 DATA "MID IR"
6100 DATA "FAR IR"
6110 END

APPENDIX L
APPLE II (BASIC) ALGORITHM

LIST 10,4200

```
10  REM  KWIK SMOKE ALGORITHM FEB
    .,1982, PROGRAMMER SUE HANSE
    N
20  REM  KWIK METEOROLOGICAL INPUTS
    AND CALCULATIONS.
30  D$ = "": REM  CONTROL D
40  DIM C(4,2),T(4,4),V(2),W(6),Y
    (4,2),Z(4,2),S(6,3),A(6),Q(2
    ),H5(2,2),D5(6,3),U(2,2),R5(
    4,2),I(4,2),J(4,2),P5(4,2)
50  DIM E(4,2),F(4,2),G5(4,2),Q9(
    4,2),L(4,2),B(4),G(4),H(4),R
    (4),D(2),X(4),P(7,9)
60  PI = 3.1415927
63  DEF FN A(A) = EXP ( - S * A
    / 2)
64  DEF FN B(B) = EXP ( - (B *
    B))
65  DEF FN C(C) = EXP (C * S *
    LOG (.1 / H(I)))
66  DEF FN D(D) = EXP ( - D * S
    / 4.1)
70  PRINT D$:"PR# 4"
120  INPUT "MET SITE ID      ";I$
130  INPUT "LATITUDE OF MET SITE
    IN DEG      ";LO
140  INPUT "DIR. FROM EQUATOR (N=
    1&S=-1)     ";HS
150  LO = LO * HS
160  INPUT "LONGITUDE OF MET SITE
    IN DEG      ";L1
170  INPUT "DIRECTION FROM GREENW
    ICH (W=1&E=-1)  ";JS
180  L1 = L1 * JS
190  INPUT "ALTITUDE OF MET SITE
    - KILOMETERS   ";ZO
200  INPUT "JULIAN DATE OF MET OB
    SERVATION      ";JO
210  INPUT "ZULU TIME OF MET OBSE
    RVATION-HR      ";HO
220  INPUT "CEILING - FEET      ";
    CO
225  CO = CO * .3048
230  INPUT "CLOUD COVER-PERCENT
    ";C1
240  INPUT "VISIBILITY-MILES
    ";VO
245  VO = VO * 1.61
250  INPUT "PRECIPITATION(1=YES&0
    =NO)          ";P
260  INPUT "TEMPERATURE-DEG F
    ";T0
265  T0 = 5 / 9 * (T0 - 32)
270  INPUT "DEW POINT-DEG F      "
    ;T1
275  T1 = 5 / 9 * (T1 - 32)
280  INPUT "WIND DIRECTION-DEG
    ";D0
290  INPUT "WIND SPEED-KNOTS
    ";S0
```

```

300 INPUT "AVE ROUGHNESS ELEMENT
-CM      ";Y
310 INPUT "SLANT RANGE TO TARGET
-KM      ";H3
320 INPUT "ANGLE OF SIGHT TO TAR
GET-DEG   ";S
330 INPUT "DIRECTION OF LINE OF
SIGHT-DEG ";A9
340 INPUT "SCREEN LENGTH-METERS
";X0
350 INPUT "DURATION-MINUTES
";T2
355 TEXT
356 PRINT : PRINT TAB( 10)"MUNI
TION EXPENDITURES"
357 PRINT TAB( 11)"FOR HC AND W
P SMOKE": PRINT
360 PRINT "ID" SPC( 27)"= "I$
370 PRINT "LATITUDE" SPC( 9)"-DE
G" SPC( 8)"= "L0
380 PRINT "LONGITUDE" SPC( 8)"-D
EG" SPC( 8)"= "L1
390 PRINT "ALTITUDE" SPC( 9)"- K
M" SPC( 8)"= "Z0
400 PRINT "JULIAN DATE" SPC( 6)"
-DAY" SPC( 8)"= "J0
410 PRINT "ZULU TIME" SPC( 8)"-H
OURS" SPC( 6)"= "H0
420 PRINT "CEILING" SPC( 10)"-ME
TERS      = "C0
430 PRINT "CLOUD COVER" SPC( 6)"
-PERCENT   = "C1
438 XD = INT (V0 * 10 + .5) / 10
440 PRINT "VISIBILITY" SPC( 7)"-
KILOMETERS = "XD
450 PRINT "PRECIPITATION" SPC( 1
6)"= "P
458 XD = INT (T0 * 10 + .5) / 10
460 PRINT "TEMPERATURE" SPC( 6)"
-DEG C" SPC( 6)"= "XD
468 XD = INT (T1 * 10 + .5) / 10
470 PRINT "DEW POINT" SPC( 8)"-D
EG C" SPC( 6)"= "XD
480 PRINT "WIND DIRECTION" SPC(
3)"-DEG" SPC( 8)"= "D0
490 PRINT "WIND SPEED" SPC( 7)"-
KNOTS" SPC( 6)"= "S0
500 PRINT "AVE ROUGHNESS ELEMENT
-CM      = "Y
501 PRINT D$;"PR# 0"
502 INPUT "ARE ABOVE ENTRIES COR
RECT (1=YES&0=NO) ";XD
503 IF XD = 0 THEN 70
504 PRINT D$;"PR# 4"
510 FOR J = 1 TO 9
520 FOR I = 1 TO 7
530 READ P(I,J)
540 NEXT I
550 NEXT J
560 REM MET CALCULATIONS

```

```

570 IF C1 < > 100 THEN 600
580 IF C0 > 2133.6042 THEN 600
590 I1 = 0: I2 = 0: GOTO 1050
600 REM CALCULATE ANGULAR FRACI
    ON OF A YEAR FOR A GIVEN JUL
    IAN DATE (A0)
610 R9 = PI / 180: D9 = 180 / PI: L
    0 = L0 * R9
620 A0 = (J0 - 1) * 360 / 365.242

630 REM CALCULATE SOLAR DECLIN
    ATION ANGLE (A4)
640 A1 = A0 * R9: A2 = 279.9348 +
    A0
650 A2 = A2 + 1.914827 * SIN (A1
    ) - .079525 * COS (A1) + .0
    19938 * SIN (2 * A1) - .001
    62 * COS (2 * A1)
660 A2 = A2 * R9: A3 = 23.4438 * R
    9: A4 = SIN (A3) * SIN (A2)

670 A4 = ATN (A4 / SQR (1 - A4 *
    A4))
680 REM CALCULATE THE TIME OF M
    ERIDAN PASSAGE-TRUE SOLAR NO
    ON (A5)
690 A5 = 12 + .12357 * SIN (A1) -
    .004289 * COS (A1)
700 A5 = A5 + .153809 * SIN (2 *
    A1) + .060783 * COS (2 * A1
    )
710 REM CALCULATE SOLAR ANGLE (
    A6)
720 A6 = (15 * (H0 - A5) - L1) *
    R9
730 REM CALCULATE SOLAR ALTITUD
    E (A7)
740 A7 = SIN (L0) * SIN (A4) +
    COS (L0) * COS (A6) * COS
    (A4)
750 A7 = ( ATN (A7 / SQR (1 - A7
    * A7))) * D9
760 REM CALCULATE INSOLATION CL
    ASS NUMBER
770 I2 = 0
780 IF A7 < = 60 THEN 800
790 I2 = 4: GOTO 860
800 IF A7 < = 35 THEN 820
810 I2 = 3: GOTO 860
820 IF A7 < = 15 THEN 840
830 I2 = 2: GOTO 860
840 IF A7 < = 0 THEN 1010
850 I2 = 1
860 REM CALCULATE NET RADIATION
    INDEX FOR DAYTIME.
870 I3 = 0
880 IF C1 > 50 THEN 900
890 I3 = I2: GOTO 960
900 IF C0 > = 2133.6042 THEN 92
    0
910 I3 = I2 - 2: GOTO 960
920 IF C0 > = 4876.8096 THEN 94
    0

```

```

930 I3 = I2 - 1: GOTO 960
940 IF C1 < > 100 THEN 960
950 I3 = I2 - 1
960 IF I3 < > 0 THEN 980
970 I3 = I2
980 IF I3 > 1 THEN 1000
990 I3 = 1
1000 I1 = I3: GOTO 1050
1010 REM CALCULATE NET RADIATIO
      N INDEX FOR NIGHTTIME
1020 IF C1 > 40 THEN 1040
1030 I1 = - 2: GOTO 1050
1040 I1 = - 1
1050 REM CALCULATE PASQUILL STA
      BILITY CATEGORY
1060 I4 = 0: I5 = 0: IF I1 < > 4 THEN
      1080
1070 I4 = 1
1080 IF I1 < > 3 THEN 1100
1090 I4 = 2
1100 IF I1 < > 2 THEN 1120
1110 I4 = 3
1120 IF I1 < > 1 THEN 1140
1130 I4 = 4
1140 IF I1 < > 0 THEN 1160
1150 I4 = 5
1160 IF I1 < > - 1 THEN 1180
1170 I4 = 6
1180 IF I1 < > - 2 THEN 1200
1190 I4 = 7
1200 IF S0 > 2 THEN 1220
1210 I5 = 1: GOTO 1450
1220 IF S0 > = 4 THEN 1240
1230 I5 = 2: GOTO 1450
1240 IF S0 > = 6 THEN 1260
1250 I5 = 3: GOTO 1450
1260 IF S0 > = 7 THEN 1280
1270 I5 = 4: GOTO 1450
1280 IF S0 > = 8 THEN 1300
1290 I5 = 5: GOTO 1450
1300 IF S0 > = 10 THEN 1400
1310 I5 = 6: GOTO 1450
1400 IF S0 > = 11 THEN 1420
1410 I5 = 7: GOTO 1450
1420 IF S0 > = 12 THEN 1440
1430 I5 = 8: GOTO 1450
1440 I5 = 9
1450 P0 = P(I4, I5)
1460 REM CALCULATE RELATIVE HUM
      IDITY
1470 IF T0 > 0 THEN 1490
1480 A0 = 9.5: B0 = 265.5: GOTO 15
      00
1490 A0 = 7.5: B0 = 237.3
1500 IF T1 > 0 THEN 1610
1600 A1 = 9.5: B1 = 265.5: GOTO 16
      15
1610 A1 = 7.5: B1 = 237.3
1615 E0 = 6.11 * 10 ^ (A0 * T0 /
      (B0 + T0)): E1 = 6.11 * 10 ^
      (A1 * T1 / (B1 + T1)): R0 = E
      1 / E0 * 100
1620 PRINT "PASQUILL STABILITY C 129

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```

      ATEGORY = " MID$ ("ABCDEF",
      PO,1)
1628 XD = INT (RO * 10 + .5) / 1
      0
1630 PRINT "RELATIVE HUMIDITY" SPC(
      12)"= "XD
1640 PRINT : PRINT
1643 REM KWIK ATMOSPHEREC OPTIC
      S AND SMOKE CONCENTRATION CA
      LCULATIONS
1647 FOR I = 1 TO 4: READ B(1),G
      (I),X(I): NEXT
1650 V1 = LOG (V0):V2 = V1 * V1:
      V3 = V2 * V1
1660 H(1) = EXP (1.5551 - .9811 *
      V1 - .0197 * V2 + .0041 * V3
      ):H(2) = EXP (1.50381511 -
      .992319519 * V1 - .015972801
      * V2 + .00368583 * V3)
1670 H(3) = EXP (1.2394 - 1.0436
      * V1 + .0099 * V2 - .0016 *
      V3):H(4) = EXP (1.5176 - 1.
      7147 * V1 + .0001 * V2 + .04
      28 * V3)
1680 R(1) = EXP (1.3306 - .8825 *
      V1 - .0753 * V2 + .0129 * V3
      ):R(2) = EXP (1.48195171 -
      .92259583 * V1 - .06550942 *
      V2 + .01368042 * V3)
1690 R(3) = EXP (1.5556 - .9013 *
      V1 - .0773 * V2 + .0173 * V3
      ):R(4) = EXP (1.5928 - .939
      6 * V1 - .0627 * V2 + .0168 *
      V3)
1700 HO = 0: IF S > = 0 THEN 172
      0
1710 S = - S
1720 S = S * (PI / 180):S = SIN
      (S):H4 = 0
1730 IF S = 0 THEN 1750
1740 H4 = 1 / S
1750 REM CALCULATE PRECIPITABLE
      WATER
1760 W = .4477 + .0328 * T1 + .00
      02 * T1 * T1 + .0000184 * T1
      * T1 * T1
1770 REM CALCULATE AMOUNT OF WA
      TER IN PATH
1790 L0 = H3:L1 = H0:L2 = L0:L3 =
      .5 * (L1 + L2):L4 = L2 - L1:
      L5 = .2886751 * L4
1800 W0 = .5 * L4 * ( FN A(L3 + L
      5) + FN A(L3 - L5))
1805 W1 = W * W0
1810 REM CALCULATE TRANSMITTANC
      ES FOR VISUAL,NEAR,MID AND F
      AR IR WAVELENGTHS
1820 FOR I = 1 TO 4
1830 REM CALCULATE TRANSMITTANC
      ES OWING TO ABSORPTION BY WA
      TER VAPOR
1840 IF I < > 4 THEN 1870
1850 T(I,1) = EXP ( - .0681 * W1 130

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      ): GOTO 1890
1870 L0 = B(I) * SQRT (W1 * PI) /
      2:L1 = H0:L2 = L0:L3 = .5 *
      (L1 + L2):L4 = L2 - L1:L5 =
      .2886751 * L4
1880 M2 = .5 * L4 * ( FN B(L3 + L
      5) + FN B(L3 - L5)):T(I,1) =
      2 / SQRT (PI) * M2:T(I,1) =
      1 - T(I,1)
1890 REM CALCULATE TRANSMITTANC
      E OWING TO ATTENUATION BY HA
      ZE AND FOG
1900 IF P = 0 THEN 1920
1910 T(I,2) = 1: GOTO 2010
1920 IF V0 > = G(I) THEN 1990
1940 L0 = H4:L1 = H0:L2 = L0:L3 =
      .5 * (L1 + L2):L4 = L2 - L1:
      L5 = .288675 * L4
1950 T3 = .5 * L4 * ( FN C(L3
      + L5) + FN C(L3 - L5))
1955 T4 = EXP ( - H(I) * T3)
1970 L1 = H4:L2 = H3:L3 = .5 * (L
      1 + L2):L4 = L2 - L1:L5 = .2
      886751 * L4
1980 T5 = .5 * L4 * ( FN D(L3 + L
      5) + FN D(L3 - L5)):T6 = EXP
      ( - .128 * T5):T(I,2) = T4 *
      T6: GOTO 2010
1990 L0 = H3:L1 = H0:L2 = L0:L3 =
      .5 * (L1 + L2):L4 = L2 - L1:
      L5 = .2886741 * L4
2000 T7 = .5 * L4 * ( FN D(L3 + L
      5) + FN D(L3 - L5)):T(I,2) =
      EXP ( - H(I) * T7)
2010 REM CALCULATE TRANSMITTANC
      E OWING TO ATTENUATION BY PR
      ECIPITATION
2020 IF P = 1 THEN 2040
2030 T(I,3) = 1: GOTO 2060
2040 IF V0 > 20 THEN 2030
2050 T(I,3) = EXP ( - H3 * R(I))

2060 REM CALCULATE TRANSMITTANC
      E OWING TO ATTENUATION BY SM
      OKE
2070 T(I,4) = X(I) / (T(I,1) * T(
      I,2) * T(I,3))
2080 IF T(I,4) < = 1 THEN 2100
2090 T(I,4) = 1
2100 REM CALCULATE LINE OF SIGH
      T INTEGRATED CONCENTRATION
2110 FOR K = 1 TO 2: READ D(K): NEXT

2120 IF T(I,4) < > 1 THEN 2140
2130 FOR J = 1 TO 2:C(I,J) = 0: NEXT

2135 GOTO 2190
2140 FOR K = 1 TO 2
2150 IF D(K) < > 0 THEN 2170
2160 C(I,K) = 0: GOTO 2180
2170 C(I,K) = LOG (T(I,4)) / -
      D(K)
2180 NEXT K

```

```

2190 NEXT I
2200 REM ATMOSPHERIC DIFFUSION
CALCULATIONS.
2210 FOR L = 1 TO 6: READ A(L): NEXT

2220 FOR I = 1 TO 6
2230 FOR J = 1 TO 3: READ S(I,J)
: NEXT
2240 NEXT I
2250 FOR I = 1 TO 6
2260 FOR J = 1 TO 3: READ D5(I,J)
): NEXT
2270 NEXT I
2280 READ H5(1,1),H5(1,2),H5(2,1)
),H5(2,2)
2290 READ U(1,1),U(2,1),U(1,2),U
(2,2)
2300 A1 = - 1.24 + 1.19 * ( LOG
(Y) / LOG (10)):Z = 10 ^ A1
:A2 = ABS (A9 - D0) * (PI /
180):R2 = SQRT (13.69 / (13.
68 * SIN (A2) * SIN (A2) +
COS (A2) * COS (A2)))
2310 Y1 = 1.0952155 + .0290689 *
R0 - .00049575 * R0 * R0 + .
00000482 * R0 * R0 * R0:Y2 =
3.364059144 + .060502571 * R
0 - .00115301 * R0 * R0 + .0
000133942 * R0 * R0 * R0
2320 C2 = S(P0,1) + S(P0,2) * Z +
S(P0,3) * Z * Z:D1 = D5(P0,1
) + D5(P0,2) * Z + D5(P0,3) *
Z * Z:D2 = 1 / D1
2330 IF S0 < > 0 THEN 2350
2340 S0 = 1
2350 S3 = .515 * S0
2360 FOR N = 1 TO 6: READ W(N): NEXT

2370 FOR I = 1 TO 4
2380 FOR K = 1 TO 2: REM CALCUL
ATE CROSSWIND INTEGRATED CO
NCENTRATION FOR WP SMOKE
2390 IF (I < 3) AND (P0 > 4) THEN
2410
2400 S1 = U(K,1) + .74 * A(P0) *
100 ^ .9:S2 = U(K,2) + .667 *
C2 * 100 ^ D1:V(K) = W(P0) *
Y2 * H5(K,2) / (PI * S1 * S2
)
2410 REM MUNITION EXPENDITURES
(HC SMOKE)
2420 Q(1) = .4:Q(2) = .4: REM MU
NITION EFFICIENCIES
2430 REM SUSTAINING SHELL SPACI
NG FOR HC SMOKE
2440 IF I > 2 THEN 2500
2450 IF C(I,1) < > 0 THEN 2470
2460 Y(I,K) = 0: GOTO 2500
2470 Y(I,K) = 1 / R2 * (.731 * Q(
K) * Y1 * H5(K,1) / (C2 * S3
* C(I,1))) ^ D2
2480 IF Y(I,K) < X0 THEN 2500
2490 Y(I,K) = X0

```

```

2500 NEXT K
2510 NEXT I
2520 FOR I = 1 TO 4
2530 FOR K = 1 TO 2
2540 IF I > 2 THEN 2740
2550 I(I,K) = S3 * 45: REM CALCU
    LATE INITIAL SHELL SPACING F
    OR HC SMOKE
2560 IF Y(I,K) < > 0 THEN 2580
2570 E(I,K) = 1: F(I,K) = 1: GOTO
    2670
2580 REM CALCULATE INITIAL VOLL
    EY FOR HC SMOKE
2590 IF I(I,K) > Y(I,K) THEN 261
    0
2600 GOTO 2615
2610 I(I,K) = Y(I,K)
2615 E(I,K) = X0 / I(I,K): Q5 = INT
    (E(I,K)): Q6 = E(I,K) - Q5
2620 IF Q6 < .5 THEN 2640
2630 E(I,K) = Q5 + 1
2640 F(I,K) = X0 / Y(I,K): Q5 = INT
    (F(I,K)): Q6 = F(I,K) - Q5: REM
    NUMBER OF GUNS FOR SUSTAINI
    NG VOLLEYS
2650 IF Q6 < .5 THEN 2670
2660 F(I,K) = Q5 + 1
2670 R1 = .5: REM RATE OF FIRE F
    OR HC SMOKE
2680 IF C(I,1) < > 0 THEN 2700
2690 R1 = 0
2700 REM CALCULATE TOTAL NUMBER
    OF ROUNDS REQUIRED (HC SMOK
    E)
2710 J(I,K) = E(I,K) + (R1 * T2 -
    1) * F(I,K): Q5 = INT (J(I,K
    )): Q6 = J(I,K) - Q5
2720 IF Q6 < .5 THEN 2740
2730 J(I,K) = Q5 + 1
2740 IF (I < 3) AND (P0 > 4) THEN
    3070
2750 REM SHELL SPACING <L() &Z(
    ) & VOLLEYS <G() &Q()>-WP SM
    OKE
2760 IF C(I,2) < > 0 THEN 2780
2770 Z(I,K) = 0: G5(I,K) = 0: Q9(I,
    K) = 0: GOTO 2860
2780 IF I > 2 THEN 2820
2790 L(I,K) = V(K) / C(I,2) * 100
    : IF L(I,K) < X0 THEN 2810
2800 L(I,K) = X0:
2810 Z(I,K) = L(I,K): G5(I,K) = X0
    / Z(I,K): GOTO 2825
2820 G5(I,K) = .6 * C(I,2) / V(K)

2825 Q5 = INT (G5(I,K)): Q6 = G5(
    I,K) - Q5
2826 IF Q6 < .5 THEN 2840
2830 G5(I,K) = Q5 + 1: GOTO 2850
2840 G5(I,K) = Q5
2850 Q9(I,K) = G5(I,K)
2860 REM RATE OF FIRE FOR WP SM
    OKE

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```

2870 IF C(I,2) < > 0 THEN 2890
2880 R5(I,K) = 0: GOTO 2980
2890 IF I > 2 THEN 2910
2900 R5(I,K) = (Z(I,K) + 60) / S3
      : GOTO 2915
2910 R5(I,K) = 120 / S3
2915 R5(I,K) = R5(I,K) / 20: R5 =
      INT (R5(I,K)): R6 = R5(I,K) -
      R5
2920 IF R6 < .5 THEN 2940
2930 R5 = R5 + 1
2940 IF R5 < > 0 THEN 2960
2950 R5 = 1
2960 R5(I,K) = R5 * 20 / 60: R5(I,
      K) = 1 / R5(I,K)
2970 IF R5(I,K) < 1 THEN R5(I,K)
      = 1
2980 REM CALCULATE TOTAL NUMBER
      OF ROUNDS REQUIRED (WP SMOK
      E)
2990 IF C(I,2) < > 0 THEN 3010
3000 P5(I,K) = 0: GOTO 3310
3010 IF I > 2 THEN 3030
3020 P5(I,K) = (T2 * R5(I,K) - 1)
      * Q9(I,K) + G5(I,K): GOTO 3
      040
3030 P5(I,K) = Q9(I,K) * (X0 / 60
      + 1) * (T2 * R5(I,K) - 1)
3040 Q5 = INT (P5(I,K)): Q6 = P5(
      I,K) - Q5
3050 IF Q6 < .5 THEN 3300
3060 P5(I,K) = Q5 + 1: GOTO 3300
3070 REM CALCULATIONS FOR WP SM
      OKE E&F STABILITY CATEGORIES
      (STABLE FLOW)
3080 REM INITIAL SHELL SPACING
3090 IF (I = 1) AND (K = 1) THEN
      3120
3100 IF (I < 3) AND (K = 2) THEN
      3120
3110 IF (I = 2) AND (K = 1) THEN
      3130
3120 L(I,K) = 100: GOTO 3140
3130 L(I,K) = 50
3140 REM SUSTAINING SHELL SPACI
      NG
3150 IF (I = 1) AND (K = 1) THEN
      3190
3160 IF (I = 2) AND (K = 2) THEN
      3190
3170 IF (I = 1) AND (K = 2) THEN
      3200
3180 IF (I = 2) AND (K = 1) THEN
      3210
3190 Z(I,K) = 100: GOTO 3220
3200 Z(I,K) = 200: GOTO 3220
3210 Z(I,K) = 50
3220 G5(I,K) = X0 / L(I,K) + 1: REM
      INITIAL VOLLEY
3230 Q9(I,K) = X0 / Z(I,K) + 1: REM
      SUSTAINING VOLLEY
3240 REM RATE OF FIRE
3250 IF K = 1 THEN 3270

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3260 IF K = 2 THEN 3280
3270 R5(I,K) = 2: GOTO 3290
3280 R5(I,K) = 1
3290 P5(I,K) = (T2 * R5(I,K) - 1)
      * Q9(I,K) + G5(I,K): REM T
      OTAL NO. OF ROUNDS REQUIRED
3300 NEXT K
3310 NEXT I
3320 FOR I = 1 TO 4
3324 PRINT D$:"PR# 0"
3325 INPUT "PRESS 1 AND RETURN W
      HEN READY FOR OUTPUT ":XD
3326 IF XD < > 1 THEN 3325
3327 PRINT D$:"PR# 4"
3330 PRINT : PRINT : PRINT : PRINT
      : PRINT : PRINT : PRINT
3340 READ A$
3345 PRINT TAB( 14)A$
3350 PRINT TAB( 25)"METERS MINU
      TES"
3355 X0 = INT (X0 + .5):T2 = INT
      (T2 + .5)
3360 PRINT "SCREEN LENGTH/DURATI
      ON: "X0" "T2
3370 IF I > 2 THEN 3600
3380 PRINT TAB( 11)"HC SMOKE SC
      REEN": PRINT TAB( 11)"105MM
      HOWITZER"
3390 PRINT "VOLLEY GUNS RATE
      / SPACING ROUNDS"
3400 E(I,1) = INT (E(I,1) + .5):
      I(I,1) = INT (I(I,1) + .5)
3410 PRINT "INITIAL" TAB( 13)E(I
      ,1) TAB( 25)I(I,1)
3420 F(I,1) = INT (F(I,1) + .5):
      R1 = INT (R1 * 10 + .5) / 1
      O:Y(I,1) = INT (Y(I,1) + .5
      ):J(I,1) = INT (J(I,1) + .5
      )
3430 PRINT "SUSTAINING" TAB( 13)
      F(I,1) TAB( 18)R1 TAB( 25)Y(
      I,1) TAB( 32)J(I,1)
3440 PRINT "VOLLEY GUNS RATE
      / SPACING ROUNDS": PRINT TAB(
      17)"MIN METERS"
3450 E(I,2) = INT (E(I,2) + .5):
      I(I,2) = INT (I(I,2) + .5)
3460 PRINT "INITIAL" TAB( 13)E(I
      ,2) TAB( 25)I(I,2)
3470 F(I,2) = INT (F(I,2) + .5):
      Y(I,2) = INT (Y(I,2) + .5):
      J(I,2) = INT (J(I,2) + .5)
3480 PRINT "SUSTAINING" TAB( 13)
      F(I,2) TAB( 18)R1 TAB( 25)Y(
      I,2) TAB( 32)J(I,2)
3490 PRINT TAB( 11)"WP SMOKE SC
      REEN": PRINT TAB( 11)"105MM
      HOWITZER": PRINT "VOLLEY
      GUNS RATE/ SPACING ROUNDS"
      : PRINT TAB( 17)"MIN METE
      RS"
3500 G5(I,1) = INT (G5(I,1) + .5
      ):L(I,1) = INT (L(I,1) + .5

```

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)
3510 PRINT "INITIAL" TAB( 13)G5(
      I,1) TAB( 25)L(I,1)
3520 Q9(I,1) = INT (Q9(I,1) + .5
      ):R5(I,1) = INT (R5(I,1) *
      10 + .5) / 10:Z(I,1) = INT
      (Z(I,1) + .5):PR(I,1) = INT
      (P5(I,1) + .5)
3530 PRINT "SUSTAINING" TAB( 13)
      Q9(I,1) TAB( 18)R5(I,1) TAB(
      25)Z(I,1) TAB( 32)P5(I,1)
3540 PRINT "VOLLEY      GUNS RATE
      / SPACING ROUNDS": PRINT TAB(
      17)"MIN METERS"
3550 G5(I,2) = INT (G5(I,2) + .5
      ):L(I,2) = INT (L(I,2) + .5
      )
3560 PRINT "INITIAL" TAB( 13)G5(
      I,2) TAB( 25)L(I,2)
3570 Q9(I,2) = INT (Q9(I,2) + .5
      ):R5(I,2) = INT (R5(I,2) *
      10 + .5) / 10:Z(I,2) = INT
      (Z(I,2) + .5):P5(I,2) = INT
      (P5(I,2) + .5)
3580 PRINT "SUSTAINING" TAB( 13)
      Q9(I,2) TAB( 18)R5(I,2) TAB(
      25)Z(I,2) TAB( 32)P5(I,2)
3590 IF I < 3 THEN 3650
3600 PRINT TAB( 11)"WP SMOKE SC
      REEN": PRINT TAB( 6)"ROUNDS
      /      RATE/      TOTAL": PRINT
      TAB( 5)"60 METERS  MINUTE
      ROUNDS"
3610 Q9(I,1) = INT (Q9(I,1) + .5
      ):R5(I,1) = INT (R5(I,1) *
      10 + .5) / 10:P5(I,1) = INT
      (P5(I,1) + .5)
3620 PRINT "105MM:" TAB( 10)Q9(I
      ,1) TAB( 18)R5(I,1) TAB( 27)
      P5(I,1)
3630 Q9(I,2) = INT (Q9(I,2) + .5
      ):R5(I,2) = INT (R5(I,2) *
      10 + .5) / 10:P5(I,2) = INT
      (P5(I,2) + .5)
3640 PRINT "155MM:" TAB( 10)Q9(I
      ,2) TAB( 18)R5(I,2) TAB( 27)
      P5(I,2)
3650 NEXT I
3660 PRINT : PRINT : PRINT : PRINT
      : PRINT : PRINT
3670 PRINT D$"PR# 0"
3680 PRINT "FINISHED"
3690 REM PASQUILL STABILITY CAT
      EGORY DATA
3700 DATA 1,1,2,3,4,6,6
3710 DATA 1,2,2,3,4,6,6
3720 DATA 1,2,3,4,4,5,6
3730 DATA 2,2,3,4,4,5,6
3740 DATA 2,2,3,4,4,4,5
3750 DATA 2,3,3,4,4,4,5
3760 DATA 3,3,4,4,4,4,5
3770 DATA 3,3,4,4,4,4,4
3780 DATA 3,4,4,4,4,4,4

```

3890 REM ABSORPTION COEFFICIENT
 ,SCALE HEIGHT,& WAVELENGTH T
 HRESHOLD
 3900 DATA 0.118,26.7,0.05
 3910 DATA 0.18,7.5,0.05
 3920 DATA 0.55,5.1,0.05
 3930 DATA 0.5,0.05
 3940 REM EXTINCTION COEFFICIENTS
 FOR HC AND WP
 3950 DATA 3.3,2.46
 3960 DATA 1.5,2
 3970 DATA 0.0,25
 3980 DATA 0.0,32
 3990 REM DATA USED TO CALCULATE
 SIGMA Y FOR CONTINUOUS SOUR
 CE
 4000 DATA 0.4,0.32,0.22,0.144,0
 .102,0.076
 4010 REM DATA USED TO CALCULATE
 SIGMA Z FOR CONTINUOUS SOUR
 CE
 4020 DATA .1390853,.01501728,-.
 00010258
 4030 DATA .12209764,.0109704,-.
 000068014
 4040 DATA .11010438,.01096296,-.
 .00006734
 4050 DATA .09764983,.01041852,-.
 .00006835
 4060 DATA .07077217,.00727284,-.
 .000045006
 4070 DATA .05548709,.0065531,-.
 00004018
 4080 DATA .94481482,-.0048519,.
 000037037
 4090 DATA .89480359,-.0048395,.
 000035915
 4100 DATA .85479237,-.0048272,.
 0000347924
 4110 DATA .81602694,-.0060741,.
 000047138
 4120 DATA .78602694,-.00607407,
 .000047138
 4130 DATA .72601571,-.0060617,.
 0000460157
 4140 REM UNIT (PER GUN) SOURCE
 STRENGTHS
 4150 DATA 18.7,1737.3,77.1,7076
 .2
 4153 REM WP VOL. SOURCE SIGMAS (U(2,2))
 4157 DATA 5.4,7.9,1.8,2.6
 4160 REM STABILITY CONSTANTS FO
 R WP SMOKE
 4170 DATA 0.016,0.016,0.016,0.0
 16,0.016,0.016
 4180 DATA "VISIBLE","NEAR IR","
 MID IR","FAR IR"
 4190 END

APPENDIX M

KWIK ALGORITHM FOR VOLUME OF FIRE TABLES GLOSSARY OF MNEMONICS (HPL/HP 9825A)

1. A	Index for relative humidity indicator
2. B	Index for 105- and 155-mm howitzer indicator
3. C	Visibility - miles
4. D	Index for stability/windspeed indicator
5. E	Dewpoint - degrees Fahrenheit
6. F	Wind direction - degrees
7. G;V(6)	Windspeed - meters per second
8. H	Index for stability/windspeed algorithms
9. I	Index for wavelength algorithms
10. J	Index for smoke algorithms
11. K	Index for gun (105- or 155-mm howitzer) algorithms
12. L	Index for smoke screen length algorithms
13. M	Index for smoke screen duration algorithms
14. N	Temperature - degrees Fahrenheit
15. P	Initial volley for HC smoke
16. Q	Relative humidity - percent
17. V	Direction of line of sight - degrees
18. Z	Roughness length - centimeters
19. r6	Angle of sight to target - degrees
20. r20	Slant range to target - kilometers
21. r21	Wavelength threshold level
22. A(7)	HC smoke screen length - meters,
23. B(2,4)	Table of transmittances resulting from water vapor, haze/fog, precipitation and smoke for visible, near, mid, and far infrared wavelengths
24. C(4,2)	Table of smoke concentration values for HC and WP smoke for visible, near, mid, and far infrared wavelengths
25. D(4)	Absorption coefficient error function
26. E(4)	Scale height for Mie scattering
27. F(4)	Haze and fog attenuation coefficients
28. G(4)	Precipitation attenuation coefficients
29. H(2,4)	Table of extinction coefficients for calculating HC and WP smoke concentrations visible, near, mid, and far infrared wavelengths
30. I(6)	Constant related to stability category for WP smoke
31. J(6)	Coefficients to compute sigma y
32. K(6,3),L(6,3)	Coefficients of roughness correction factor used in calculating sigma z for the various roughness lengths
33. M(2)	Yield factors for HC and WP

34. N(2)	Crosswind integrated concentration for WP smoke
35. O(5)	WP smoke screen length - meters
36. P(2,2,6,7,4)	Total number of rounds required to maintain HC and WP smoke screen
37. Q(6,4,2)	Number of guns (105- and 155-mm howitzer) for HC smoke for visible and infrared wavelengths and all stability categories
38. S(2,2)	Unit (per gun) source strength
39. T(2)	Munition efficiency for 105- and 155-mm howitzer, for HC smoke
40. U(2,2)	WP volume source sigmas for 105- and 155-mm howitzer
41. V(6);G	Windspeed - meters per second
42. W(7,4)	HC smoke screen duration - minutes
43. X(5,4)	WP smoke screen duration - minutes
44. Y(6,4,2)	Shell spacing for 105- and 155-mm howitzer for HC smoke
45. Z(6,4,2)	Shell spacing for 105- and 155-mm howitzer for WP smoke
46. AS(112)	Screen length identifier
47. BS(6)	105- and 155-mm howitzer indicator
48. CS(32)	Wavelength indicator 9. DS(3)
Precipitation indicator	
50. ES(4)	HC or WP smoke indicator
51. GS(54)	Stability/windspeed indicator
52. HS(81)	Relative humidity indicator
53. OS(80)	Smoke screen length indicator
54. WS(112)	HC smoke screen duration indicator
55. XS(80)	WP smoke screen duration indicator

APPENDIX N

VOLUME OF FIRE TABLES
(HPL/HP9825A) ALGORITHM

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0: "VOLUME OF FIRE TABLES (08/03/61)":
1: C11 A[7],D[4],L[4],H[2,4],J[6],K[6,3],L[6,3],S[2,2],V[6],CS[32]
2: C11 B[2,4],C[4,2],F[4],G[4],I[6],M[2],T[2]
3: C11 N[2],O[7],R[2,2,6,7,4],Z[6,4,2],OS[60]
4: C11 U[2,2],W[7,4],Y[6,4,2],Z[6,4,2],X[5,4]
5: C11 AS[112],BS[6],DS[3],LS[4],NS[81],WS[112],GS[54],AS[80]
6: "INITIALIZATION":
7: C11 7;C11 7
8: 101 1,D[*],L[*],H[*],J[*],K[*],L[*],S[*],V[*],CS
9: 200+A[1];400+A[2];600+A[3];800+A[4];1000+A[5];1500+A[6];2000+A[7]
10: 100+O[1];200+O[2];300+O[3];400+O[4];600+O[5]
11: .4+I[1]+I[2]
12: "          200          400          600"+AS[1,48]
13: "          800          1000          1500          2000"+AS[49,112]
14: "          100          200          300          "+OS[1,48]
15: "          400          600"+OS[49,80]
16: "      A/ 5      B/ 8      C/10      D/15      E/ 8      F/ 6      "+GS[1,54]
17: "10%< RELATIVE HUMIDITY <20%"+NS[1,27]
18: "21%< RELATIVE HUMIDITY <59%"+NS[28,54]
19: "RELATIVE HUMIDITY >60%      "+NS[55,81]
20: "      5  10  15  20  10  15  20  25"+WS[1,32]
21: "      10  15  20  25  15  20  25  30"+WS[33,64]
22: "      15  20  25  30  20  25  30  35  20  25  30  35"+WS[65,112]
23: "      5  10  15  20  5  10  15  20"+XS[1,32]
24: "      5  10  15  20  10  15  20  25  10  15  20  25"+AS[33,80]
25: "100"+DS[1,3];"155"+DS[4,6]
26: "100"+DS[1,2];"155"+DS[3,4]
27: 5+W[1,1];10+W[1,2]+W[2,1]+W[3,1]
28: 15+W[1,3]+W[2,2]+W[3,2]+W[4,1]+W[5,1]
29: 20+W[1,4]+W[2,3]+W[3,3]+W[4,2]+W[5,2]+W[6,1]+W[7,1]
30: 25+W[2,4]+W[3,4]+W[4,3]+W[5,3]+W[6,2]+W[7,2]
31: 30+W[4,4]+W[5,4]+W[6,3]+W[7,3]
32: 35+W[6,4]+W[7,4]
33: 5+A[1,1]+A[2,1]+A[3,1]
34: 10+A[1,2]+A[2,2]+A[3,2]+A[4,1]+A[5,1]
35: 15+A[1,3]+A[2,3]+A[3,3]+A[4,2]+A[5,2]
36: 20+A[1,4]+A[2,4]+A[3,4]+A[4,3]+A[5,3]
37: 25+A[4,4]+A[5,4]
38: 5.4+O[1,1];7.9+O[2,1];1.8+O[1,2];2.6+O[2,2]
39: .016+I[1]+I[2]+I[3]+I[4]+I[5]+I[6]
40: "INPUTS":
41: CRT " TEMPERATURE - DEG F",N
42: 5/9*(N-32)+N
43: 15+J
44: CRT "RELATIVE HUMIDITY (15,40 or 80) - PERCENT",Q
45: "VISIBILITY":
46: 25*1.61+C
47: "PRECIPITATION INDICATOR": "NO"+DS
48: "WIND DIRECTION - DEGREES":
49: 270+F
50: "ROUGHNESS LENGTH - CENTIMETERS":
*198

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51: 9.65+4
52: "SLANT RANGE TO TARGET - KM":
53: 2+r20
54: "ANGLE OF SIGHT TO TARGET - DEG":
55: 0+r6
56: "DIRECTION OF LINE OF SIGHT - DEGREES":
57: 225+v
58: "ATMOSPHERIC OPTICS CALCULATIONS":
59: 1n(C)+r0
60: r0*r0+r1
61: r1*r0+r2
62: 1.5551-.9811*r0-.0197*r1+.0041*r2+F[1]
63: exp(F[1])+F[1]
64: 1.50381511-.992319519*r0-.015972801*r1+.00368583*r2+F[2]
65: exp(F[2])+F[2]
66: 1.2394-1.0436*r0+.0099*r1-.0016*r2+F[3]
67: exp(F[3])+F[3]
68: 1.5176-1.7147*r0+.0001*r1+.0428*r2+F[4]
69: exp(F[4])+F[4]
70: 1.3306-.8825*r0-.0753*r1+.0129*r2+G[1]
71: exp(G[1])+G[1]
72: 1.481951707-.9225589*r0-.065509417*r1+.013680422*r2+G[2]
73: exp(G[2])+G[2]
74: 1.5556-.9013*r0-.0773*r1+.0173*r2+G[3]
75: exp(G[3])+G[3]
76: 1.5926-.9396*r0-.0627*r1+.0168*r2+G[4]
77: exp(G[4])+G[4]
78: "CALCULATE TRANSMITTANCE FOR VISIBLE - NEAR, MID AND FAR IR":
79: sin(r6)+r6
80: 0+r6
81: 11 r6#0;1/r6+r6
82: "CALCULATE DEW POINT":
83: 11 n>0;gtc "K1600"
84: 9.5+r0;265.5+r1
85: gtc "K1700"
86: "K1600":
87: 7.5+r0;237.3+r1
88: "K1700":
89: 6.11*10^(r0*N/(r1+N))+r4
90: 2*r4/100+r5
91: r1*(log(r5)-log(6.11))/(r0-log(r5)+log(6.11))+r
92: "CALCULATE PRECIPITABLE WATER":
93: .4477+.0328*E+1.2e-3*E^2+1.84e-5*E^3+r11
94: "CALCULATE AMOUNT OF WATER VAPOR IN PATH":
95: r20+r0;0+r1;r0+r2;.5*(r1+r2)+r3
96: r2-r1+r4;.2886751*r4+r5
97: .5*r4*(FNA(r3+r5)+FNA(r3-r5))+r9
98: r11*r9+r10
99: "TRANS. OWING TO ATTEN. BY WATER VAPOR.":
100: for i=1 to 2
101: 11 i=4;exp(-.0681*r10)+B[1,1];gtc "K2600"
    *14445

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102: D[1]*V(R10*PI)/2+R0;0+R1;R0+R2
103: .5*(R1+R2)+R3
104: R2-R1+R4
105: .2886751*R4+R5
106: .5*R4*(FNB(R3+R5)+FNB(R3-R5))+R12
107: 2/PI*R12+B[1,1]
108: 1-B[1,1]+B[1,1]
109: "TRANS. OWING TO ATTEM. BY HAZE AND FOG.":
110: "K2800":
111: IF DS="YES";1+B[1,2];GTO "K2900"
112: IF C>=E[1];GTO "K2800"
113: R8+R0;0+R1;R0+R2
114: .5*(R1+R2)+R3
115: R2-R1+R4
116: .2886751*R4+R5
117: .5*R4*(FNC(R3+R5)+FNC(R3-R5))+R13
118: EXP(-F[1]*R13)+R14
119: R20-R8+R0;R8+R1;R8+R0+R2
120: .5*(R1+R2)+R3
121: R2-R1+R4
122: .2886751*R4+R5
123: .5*R4*(FND(R3+R5)+FND(R3-R5))+R15
124: EXP(-.128*R15)+R16
125: R14*R16+B[1,2];GTO "K2900"
126: "K2800":
127: R20+R0;0+R1;R0+R2;.5*(R1+R2)+R3
128: R2-R1+R4;.2886751*R4+R5
129: .5*R1*(FND(R3+R5)+FND(R3-R5))+R17
130: EXP(-F[1]*R17)+B[1,2]
131: "TRANS. OWING TO ATTEM. BY PRECIP.":
132: "K2900":
133: IF DS="NO";1+B[1,3];GTO "K3100"
134: IF C>20;1+B[1,3];GTO "K3100"
135: EXP(-R20*C[1])+B[1,3]
136: "TRANS. OWING TO ATTEM. BY SMOKE.":
137: "K3100":
138: "WL THRES":
139: .05+R21
140: R21/(B[1,1]*B[1,2]*B[1,3])+B[1,4]
141: IF B[1,4]>1;1+B[1,4]
142: "LINE OF SIGHT INTERCR. CONCEN.":
143: IF B[1,4]=0;FOR J=1 TO 2;0+C[1,J];NEXT J;GTO "K3500"
144: FOR J=1 TO 2
145: IF H[J,1]=0;0+C[1,J];GTO "K3300"
146: LN(B[1,4])/H[J,1]+C[1,J]
147: "K3300":NEXT J
148: NEXT I
149: "ATMOS. DIFF. CAL.":
150: "K3500":
151: ACS(V-R)+R8
152: V(13.09/(13.09*SIN(R8)*SIN(R8)+COS(R8)*COS(R8)))+R18
*5540

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153: 1.09521547+.02906894*Q-4.9575e-4*Q*Q+4.82e-6*Q*Q*Q+M[1]
154: 3.364059144+.000502571*Q-1.15301e-3*Q*Q+1.33942e-5*Q*Q*Q+M[2]
155: for i=1 to 2
156: for n=1 to 6
157: K[n,1]+K[n,2]*Z+K[n,3]*Z^2+r9
158: L[n,1]+L[n,2]*Z+L[n,3]*Z^2+r17
159: 1/r17+r11
160: V[n]+G
161: "CROSSWIND INTEGR. CONC. FOR WP SMK.":
162: for k=1 to 2
163: if i<3; if n>4; gtc "K3600"
164: U[k,1]+.74*U[n]*100^.9+r4
165: U[k,2]+.667*r9*100^r17+r5
166: 1[n]*n[2]*S[k,2]/(pi*r4*r5)+N[k]
167: "K3600":
168: "MON. EXP. CALS.":
169: if i>2; gtc "K4010"
170: "INFL. SHELL SPAC. FOR HC SMK.":
171: G*45+r12
172: "SUST. SHELL SP. FOR HC SMK.":
173: if C[1,1]#0; gtc "K3700"
174: U+Y[n,1,K]; gtc "K3600"
175: "K3700":
176: for L=1 to 7
177: 1/r13*(.731*P[k]*M[1]*S[k,1]/(C[1,1]*G*r9))^r11+Y[H,1,K]
178: if Y[n,1,K]>A[L]; A[L]+Y[n,1,K]
179: "K3800":
180: if Y[n,1,K]=0; 1+P+Q[n,1,K]; gtc "K4000"
181: if r12>Y[n,1,K]; Y[n,1,K]+r12
182: "INFL. VOLY. FOR HC SMK.":
183: A[L]/r12+P
184: if irc(P)>0; inc(P)+1+P
185: "NUM. OF CONS FOR SUST. VOLYS. (HC)":
186: A[L]/Y[n,1,K]+Q[n,1,K]
187: if irc(Q[n,1,K])>0; int(Q[n,1,K])+1+Q[H,1,K]
188: "RATE OF FIRE FOR HC SMK.=0.5":
189: "K4000":
190: for n=1 to 4
191: "TOTAL NUM. OF RNDs. REQD. (HC)":
192: P+(.5*w[L,M]-1)*Q[n,1,K]+P[k,1,n,L,M]
193: if irc(P[k,1,n,L,M])>0; int(P[k,1,n,L,M])+1+P[k,1,n,L,M]
194: if k=1; if P[1,1,n,L,M]/(6*w[L,M])>3.1; 1000+P[1,1,n,L,M]
195: if k=2; if P[2,1,n,L,M]/(6*w[L,M])>1.1; 1000+P[2,1,n,L,M]
196: if L>5; gtc "K5050"
197: "K4010":
198: if i<3; if n>4; gtc "K4200"
199: "SHELL SPAC. (Z[ ]) & VOLYS (r13) - WP SMK.":
200: if C[1,2]#0; gtc "K4020"
201: U+Z[n,1,K]+r13; gtc "K4080"
202: "K4020":
203: if i>2; .6*C[1,2]/N[k]+r13; gtc "K4040"
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204: if C[1,2]=0; gtc "K4100"
205: A[K]/C[1,2]*100+Z[n,1,K]
206: if Z[n,1,K]>O[L]; O[L]+Z[n,1,K]
207: O[L]/Z[n,1,K]+r13
208: "K4040":
209: int(r13)+r1
210: if irc(r13)>0; r1+1+r13
211: "RATE OF FIRE FOR WP SMK.":
212: "K4080":
213: if 1>2; 120/V[n]+r19; gtc "K4090"
214: (Z[n,1,K]+60)/V[n]+r19
215: "K4090":
216: r19/20+r19
217: int(r19)+r1
218: if irc(r19)>=.5; r1+1+r1
219: if r1=0; 1+r1
220: r1*20/60+r19
221: 1/r19+r19
222: if r19<1; 1+r19
223: "K4100":
224: "TOTAL NUM. OF RNDs. REQD. (WP)":
225: if C[1,2]=0; 0+P[K,2,n,L,M]; gtc "K5050"
226: if 1<3; (X[L,M]*r19-1)*r13+r13+P[K,2,n,L,M]
227: if 1>2; r13*(O[L]/60+1)*(X[L,M]*r19-1)+P[K,2,n,L,M]
228: int(P[K,2,n,L,M])+r1
229: if irc(P[K,2,n,L,M])>0; r1+1+P[K,2,n,L,M]
230: gtc "K5000"
231: "K4200":
232: "CAL. FOR L & F STAB CAT":
233: "INITL SHELL SPAC. - WP SMK.":
234: if 1=1; if K=1; 100+r14
235: if 1=2; if K=1; 50+r14
236: if 1<3; if K=2; 100+r14
237: "INITL VOLY FOR WP SMK":
238: O[L]/r14+1+r15
239: "SUST SHL SPAC - WP SMK":
240: 0+r14
241: if 1=1; if K=1; 100+r14
242: if 1=1; if K=2; 200+r14
243: if 1=2; if K=1; 50+r14
244: if 1=2; if K=2; 100+r14
245: "SUST VOLY - WP SMK":
246: O[L]/r14+1+r16
247: "RATE OF FIRE FOR WP SMK":
248: if K=1; 2+r19
249: if K=2; 1+r19
250: "TOTAL NUM OF WP RNDs REQ":
251: r15+r16*(r19*X[L,M]-1)+P[K,2,n,L,M]
252: "K5000":
253: if K=1; if P[1,2,n,L,M]/(6*X[L,M])>3.1; 1000+P[1,2,n,L,M]
254: if K=2; if P[2,2,n,L,M]/(6*X[L,M])>1.1; 1000+P[2,2,n,L,M]
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255: "K5050":
256: next M
257: next L
258: next K
259: next H
260: fmt 3;/wrt 701
261: if Q=15;1+A
262: if Q=40;28+A
263: if Q=80;55+A
264: fmt 1,27x,"VOLUME OF FIRE TABLE - HC SMOKESCREEN;",1x,c27
265: wrt 701.1,n$(A,A+26)
266: 1+B
267: for K=1 to 2
268: fmt 1,"SCREEN(M)",c112,z;wrt 701.1,A$(1,112)
269: fmt 1,/, " MINUTES ",c112;wrt 701.1,W$(1,112)
270: fmt 1,"STABILITY",44x,c3,"mm HOWITZER ",z;wrt 701.1,B$(B,B+2)
271: 1+D
272: 4+B
273: for H=1 to 6
274: fmt 1,/,c9,z;wrt 701.1,G$(D,D+8)
275: for L=1 to 7
276: for M=1 to 4
277: fmt 1,z,1x,f3.0;wrt 701.1,P(K,1,H,L,M)
278: next M
279: next L
280: D+9+D
281: next H
282: fmt 1,2;/wrt 701.1
283: next K
284: gsc "NOTES HC"
285: fmt 2,21;/wrt 701.2
286: fmt 1,27x,"VOLUME OF FIRE TABLE - WP SMOKESCREEN;",1x,c27
287: wrt 701.1,n$(A,A+26)
288: 1+B
289: for K=1 to 2
290: fmt 1,16x,"SCREEN(M)",c80;wrt 701.1,O$(1,80)
291: fmt 1,16x," MINUTES ",c80;wrt 701.1,X$(1,80)
292: fmt 1,16x,"STABILITY",33x,c3,"mm HOWITZER",z;wrt 701.1,B$(B,B+2)
293: 1+D
294: 4+B
295: for H=1 to 6
296: fmt 1,/,16x,c9,z;wrt 701.1,G$(D,D+8)
297: for L=1 to 5
298: for M=1 to 4
299: fmt 1,z,1x,f3.0;wrt 701.1,P(K,2,H,L,M)
300: next M
301: next L
302: D+9+D
303: next H
304: fmt 1,2;/wrt 701.1
305: next K
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306: gsd "NOTES WP"
307: lmt 1,12/;wrt 701.1
308: "K5300":
309: next 1
310: gsf "DONE"
311: enc
312: "NOTES HC":
313: lmt 1,4/;wrt 701.1
314: if 1=1;gtc "K5400"
315: if 1=2;gtc "K5500"
316: "K5400":
317: lmt 1,35x,"1. CALCULATED FOR VISIBLE LIGHT WAVELENGTHS: 0.4 TO 0.7"
318: wrt 701.1;lmt 2,38x,"MICROMETERS.";wrt 701.2
319: lmt 1,/;wrt 701.1
320: gtc "K5600"
321: "K5600":
322: lmt 1,35x,"1. CALCULATED FOR NEAR IR WAVELENGTHS: .75 TO 2.5";wrt 701.1
323: lmt 1,38x,"MICROMETERS.";wrt 701.1
324: lmt 1,/;wrt 701.1
325: "K5800":
326: lmt 1,35x,"2. DATA COMPUTED IN NUMBER OF ROUNDS FOR QUARTERING WIND."
327: wrt 701.1
328: lmt 1,38x,"FOR CROSSWIND MULTIPLY THE EXTRACTED NUMBER OF ROUNDS"
329: wrt 701.1
330: lmt 1,38x,"BY 0.7.FOR HEADWIND OR TAIL WIND CONDITION, MULTIPLY"
331: wrt 701.1
332: lmt 1,38x,"EXTRACTED NUMBER OF ROUNDS BY 2.6";wrt 701.1
333: lmt 1,/;wrt 701.1
334: lmt 1,35x,"3. NUMBERS ASSOCIATED WITH PASQUILL STABILITY CATEGORY;"
335: wrt 701.1;lmt 1,38x,"WIND SPEED IN KNOTS.";wrt 701.1
336: lmt 1,/;wrt 701.1
337: lmt 1,35x,"4. ROUNDS IN SHADED (SHOWN AS $$$)AREA EXCLED RATE OF"
338: wrt 701.1
339: lmt 1,38x,"FIRE OF WEAPON/BATTERY.";wrt 701.1
340: lmt 1,/;wrt 701.1
341: lmt 1,35x,"5. MINUTES INDICATE DURATION OF EFFECTIVE SMOKE.";wrt 701.1
342: ret
343: "NOTES WP":
344: lmt 1,4/;wrt 701.1
345: if 1=1;gtc "K6400"
346: if 1=2;gtc "K6500"
347: "K6400":
348: lmt 1,35x,"1. CALCULATED FOR VISIBLE LIGHT WAVELENGTHS: 0.4 TO 0.7"
349: wrt 701.1;lmt 1,38x,"MICROMETERS.";wrt 701.1
350: lmt 1,/;wrt 701.1
351: gtc "K6800"
352: "K6800":
353: lmt 2,35x,"1. CALCULATED FOR NEAR IR WAVELENGTHS: .75 TO 2.5";wrt 701.2
354: lmt 1,38x,"MICROMETERS.";wrt 701.1
355: lmt 1,/;wrt 701.1
356: "K6800":

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357: fmt 1,35x,"2. DATA COMPUTED IN NUMBER OF ROUNDS FOR QUARTERING WIND."
358: wrt 701.1
359: fmt 1,38x,"FOR OTHER WIND DIRECTIONS THERE IS NO SIGNIFICANT"
360: wrt 701.1
361: fmt 1,38x,"DIFFERENCE IN NUMBER OF ROUNDS REQUIRED.";wrt 701.1
362: fmt 1,/;wrt 701.1
363: fmt 1,35x,"3. NUMBERS ASSOCIATED WITH PASQUILL STABILITY CATEGORY;"
364: wrt 701.1;fmt 1,38x,"WIND SPEED IN KNOTS.";wrt 701.1
365: fmt 1,/;wrt 701.1
366: fmt 1,35x,"4. ROUNDS IN SHADED (SHOWN AS $$$) AREA EXCEED RATE OF"
367: wrt 701.1
368: fmt 1,38x,"FIRE OF WEAPON/BATTERY.";wrt 701.1
369: fmt 1,/;wrt 701.1
370: fmt 1,35x,"5. MINUTES INDICATE DURATION OF EFFECTIVE SMOKE.";wrt 701.1
371: ret
372: "END":ret exp(-r6*p1/2)
373: "END":ret exp(-p1^2)
374: "END":ret exp(p1*r6*ln(.1/F[1]))
375: "END":ret exp(-p1*r6/4.1)
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ATMOSPHERIC SCIENCES RESEARCH REPORTS

1. Blackman George R., Cloud Geometry Analysis of the Smoke Week III Obscuration Trials, ASL-TR-0103, January 1982.
2. Sutherland, R. A., and D. W. Hoock, An Improved Smoke Obscuration Model ACT II: Part 1 Theory, ASL-TR-0104, January 1982.
3. Lentz, W. J., The Visioceilometer: A Portable Visibility and Cloud Ceiling Height Lidar, ASL-TR-0105, January 1982.
4. Kennedy, Bruce W., An Analysis of Craters Produced by Artillery Munitions During Dusty Infrared Test Series, ASL-TR-0106, January 1982.
5. Steinhoff, R. G., Program Listings for EOSAEL 80-B and Ancillary Codes AGAUS and FLASH, ASL-TR-0107, February 1982.
6. Lindberg, James D., Compiler, Early Wintertime European Fog and Haze Report on Project Meppen 80, ASL-TR-0108, April 1982.
7. Miller, Walter B., User's Guide for the OL-274 Passive Target Acquisition Program, ASL-TR-0109, May 1982.
8. Rubio, Roberto, C. L. Tate, M. L. Hill, H. N. Ballard, M. Izquierdo, C. McDonald, The Maneuverable Atmospheric Probe (MAP), a Remotely Piloted Vehicle, ASL-TR-0110, May 1981.
9. Heaps, Melvin G., A Vertical Structure Algorithm for Low Visibility/Low Stratus Conditions, ASL-TR-0111, June 1982.
10. Vechione, William J., The Automatic Meteorological Station System AN/TMQ-30 (), ASL-TR-0112, August 1982.
11. Copp, J. D., Impact of Spatial and Temporal Frequency of Meteorological Data on Field Artillery Accuracy, ASL-TR-0113, August 1982.
12. Barber, T. L., and E. B. Stenmark, Large Print System on a Graphic Computer Terminal for Visually Handicapped Programmers, ASL-TR-0114 August 1982.
13. Kays, Marvin D., Weather Effects During the Battle of the Bulge and the Normandy Invasion, ASL-TR-0115, August 1982.
14. Richardson, M. B., A General Algorithm for the Calculation of Laser Beam Spreading, ASL-TR-0116, August 1982.
15. Barber, T. L., Water Vapor as a Tracer in Remote Wind Sensing: A Feasibility Study, ASL-TR-0117, August 1982.
16. Lentz, W. J., A Simplification of Lentz's Algorithm, ASL-TR-0118, August 1982.

17. Seagraves, Mary Ann and J. F. Ebersole, Visible and Infrared Transmission Through Snow, ASL-TR-0119, August 1982.
18. Pena, Ricardo, KWIK Smoke Obscuration Model: User's Guide, ASL-TR-0120, September 1982.

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