RECOMP II USER'S PROGRAM NO. 1104

PROGRAM TITLE: STANDARD ATMOSPHERE

PROGRAM CLASSIFICATION: General

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PURPOSE: Calculates pressure from altitude, or
                           vice-versa, assuming any model temperature-
                           altitude profile and the perfect gas law.

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STANDARD ATMOSPHERE

PURPOSE: Calculates pressure from altitude, or vice-versa, assuming any model temperature-altitude profile and the perfect gas law.

METHOD: Several variations of the fundamental differential equation,

$$\frac{dP}{P} = -Q \frac{dH}{T_m} \quad ,$$

are programmed.

A. To calculate altitude from pressure, either:

(1)
$$T_m = \frac{T_{mb}}{L_m} \left(\frac{P}{P_b} \right)^{-Q/L_m} \quad , \quad L_m \neq 0$$

and (2)
$$H = H_b + \frac{T_m - T_{mb}}{L_m} \quad .$$

or (3)
$$H = \frac{T_{mb}}{Q} \ln \left(\frac{P_b}{p} \right) + H_b \quad , \quad L_m = 0$$

and (4) $T_m = T_{mb}$

are used.

B. To calculate pressure from altitude, either:

(1) $P = P_b \text{ exponential} \left(\frac{-(H - H_b) Q}{T_{mb}} \right)$

and (2) $T_m = T_{mb}$ $\qquad , L_m = 0$

or (3)
$$P = P_b \left(\frac{T_{mb}}{T_m} \right)^{Q/L_m} \quad , L_m = 0$$

and (4) $T = T_{mb} + (H - H_b) \cdot L_m$

are used.

C. Base layer constants are obtained from a table stored at the end of this routine.

USE:

    A. Calling Sequence:

       1. To calculate pressure from altitude:

           TRA (Lo)

        Enter with altitude in the A & R registers

        Exit with pressure in the A & R registers

       2. To calculate altitude from pressure:

           TRA (Lo + 02)

        Enter with pressure in the A & R registers

        Exit with altitude in the A & R registers

       3. In both cases (1, 2 above), the following table is available in the locations shown:

(Lo + 100),	7760	H
(Lo + 102),	7762	P
(Lo + 104),	7764	T
(Lo + 106),	7766	T/288.16

    B. Time: approximately 1 second, either way

    C. Storage: 250 (octal) words, including all data for the 1959 ARDC Model Atmosphere. (Data occupy locations (Lo + 120) through (Lo + 247)).

      Both L and V loops are used.

      This routine is relocatable.

    D. Data:

       1. For each atmospheric layer, 4 data are required:

          H_b , height of base of layer

          P_b , pressure at base of layer

          T_{mb}, absolute temperature at base of layer

          L_m , temperature gradient throughout layer

      Sea level data goes in Lo + 120, 2, 4, 6. The next higher layer's data goes in the next eight words, and so on. The last valid data should be followed by H > larger than largest H to be encountered, and P = Zero.

2. Constant:

   Lo + 30:- Q = - 0.034 164 794 278 $^{\circ}$K/m'

3. Units:

   Any consistent set of units may be employed; the following are the present units:

   P : millimeters of mercury, mmHg

   H : geopotential meters, m'

   T_m : degrees Kelvin, $^{\circ}$K

   Q, L_m : Unit T per unit H, $^{\circ}$K/m'

4. Routines required (both are contained in Program Preparation Package #2):

   (a) Exponential (AN044) in 1050 (called from Lo + 43 and Lo + 73)

   (b) Logarithmic (AN037) in 0770 (called from Lo + 40 and Lo + 70)

UNITERMS: Altitude, static pressure, atmosphere, model atmosphere, standard atmosphere, pressure, temperature, lapse rate, geopotential.

SM/I, Research Division, Digital Computing Facility

Program No. 137 R Title   STANDARD ATMOSPHERE ROUTINE

Programmed by: W. Wellman   Date   April, 1961

Loc'n	Cm'd	Addr.	Contents	Accumulator	b	Remarks
.00	S.A.X	7.7.7.3.0			. .	enter here w/z
. . .	A.D.D	. .4.7.0			. .	
. . .1	C.T.L	. .1.0.0			. .	
. . .	T.R.A	7.7.6.1.0			. .	
. . .2	S.A.X	7.7.7.3.0			. .	
. . .	A.D.D	. .4.7.0			. .	
. . .3	C.T.L	. .2.0.0			. .	
. . .	T.R.A	7.7.6.0.1			. .	
. . .4	+.0.0	0.0.0.2.0	2@18		. .	
. . .	F.C.A	7.7.7.0.0			. .	← 27.1
. . .5	F.D.V	7.7.6.2.0			. .	
. . .	F.S.T	7.7.7.2.0			. .	
. . .6	F.C.A	7.7.7.0.0			. .	
. . .	F.S.T	7.7.6.2.0	P	P	. .	
. . .7	F.C.A	7.7.7.2.0		P/P_B	. .	
. . .	T.R.A	. .4.0.0			. .	
. .1.0	C.F.L	. .1.0.0.0	exit		. .	
. . .	T.R.A				. .	
. . .1	S.T.O	. .1.0.0			. .	set exit
. . .	C.L.A	7.7.7.3.0		z	. .	
. . .2	C.T.V	. .6.0.0			. .	
. . .	F.S.T	7.7.7.6.0			. .	
. . .3	C.L.A	7.7.6.5.0			. .	
. . .	S.T.A	7.7.6.7.0			. .	go to next higher
. . .4	A.D.D	7.7.7.0.0	8@18		. .	layer.
. . .	S.T.A	7.7.6.5.0			. .	
. . .5	F.C.S	. .1.1.0.0		$-z_b$	. .	
. . .	F.A.D	7.7.7.6.0	z	$z - z_b$	. .	
. . .6	T.P.L	7.7.6.3.0	≥0		. .	
. . .	F.C.A	7.7.7.6.0	z	z	. .	
. . .7	C.T.L	. .1.0.0.0			. .	
. . .	T.R.A	7.7.7.1.0			. .	→ 61.0
. .2.0	+.0.0	0.0.0.7.1			. .	
. . .	S.T.O	. .1.0.0	exit		. .	set exit
. . .1	C.L.A	7.7.7.3.0		P	. .	
. . .	C.T.V	. .0.0.0			. .	
. . .2	F.S.T	7.7.7.0.0	P		. .	
. . .	T.R.A	7.7.6.5.1			. .	
. . .3	C.L.A	7.7.6.6.0			. .	
. . .	A.D.D	7.7.6.0.0	8@18		. .	
. . .4	S.T.A	7.7.6.6.0			. .	
. . .	S.U.B	7.7.7.4.0			. .	
. . .5	S.T.A	7.7.6.7.0			. .	
. . .	F.C.S	7.7.7.0.0		$-P$	. .	
. . .6	F.A.D	. .1.1.2.0	P_b	$P_b - P$	. .	Choose largest P_b
. . .	T.P.L	7.7.6.3.0	≥0		. .	for which $P \geq P_b$
. . .7	C.T.L	. .1.1.0.0	base consts.	$P_j \leq P$	. .	
. . .	T.R.A	7.7.7.4.1			. .	→ 04.1

Program No. 137-R Title _____

Programmed by: _____   Date April, 1961

Vr

Loc'n	Cm'd	Addr.	Contents	Accumulator	b	Remarks
.30	-.4.2	7.7.0.1.1	⎫		..	
...	-.1.0	4.1.4.3.0	$-Q$	.034,164,794,278	..	
...1	-.0.0	0.0.0.0.0	*(°K/M)		..	
...	-.0.0	0.0.0.2.0	⎭		..	
...2	F.S.T	7.7.7.0.0	T_m		..	
...	F.S.B	7.7.6.4.0	T_{mb}	$T_m - T_{mb}$	..	
...3	F.D.V	7.7.6.6.0	L_m	$z - z_b$	..	
...	F.A.D	7.7.6.0.0	z_b	z	..	
...4	F.S.T	7.7.6.0.0	z	z	..	
...	F.C.A	7.7.7.0.0	T_m	T_m	..	
...5	F.S.T	7.7.6.4.0	T_m		..	
...	C.T.V	..5.0.0		T_m	..	
...6	F.D.V	.1.1.4.0	$T_o = 288.16$	$T_m/288.16$	..	→56.0
...	F.S.T	7.7.6.6.0	T/T_o		..	
...7	F.C.A	7.7.6.2.0	?	P	..	
...	T.R.A	..1.0.0	→to exit		..	
.4.0	C.F.L	..1.0.0.0			..	
...	T.R.A	0.7.7.0.0	LOG		..	
...1	P.Z.E	7.7.7.4.0	ϵ		..	
...	H.T.R	..4.0.1		$L_n(P/P_b)$	..	
...2	C.T.V	..5.0.0			..	
...	T.R.A	7.7.7.0.0			..	
...3	F.M.P	7.7.6.0.0	$L_n(P/P_b)$	$(L_m/Q)L_n(P/P_b)$	..	
...	T.R.A	1.0.5.0.0	EXP		..	
...4	P.Z.E	7.7.7.4.0	ϵ		..	
...	H.T.R	..4.3.1			..	
...5	C.T.L	..1.0.0.0		$(P/P_b)^{-L_m/Q}$	..	
...	F.M.P	7.7.6.4.0	T_{mb}	T_m	..	
...6	C.T.V	..3.0.0			..	
...	T.R.A	7.7.7.2.0			..	
...7	C.F.L	..1.0.0.0			..	
...	T.R.A	0.0.0.0.1	"bump" for setting return location		..	
.5.0	F.S.T	7.7.6.0.0			..	
...	F.C.A	..1.0.6.0		L_m	..	
...1	T.Z.E	7.7.7.2.1			..	
...	F.D.V	..3.0.0	$-Q$	$-L_m/Q$	..	
...2	T.R.A	..4.3.0			..	
...	F.C.A	7.7.6.0.0	←$L_m = 0$		..	
...3	F.D.V	..3.0.0	$-Q$		..	
...	F.M.P	..1.0.4.0	T_{mb}	$z - z_b$	..	
...4	C.T.L	..1.0.0.0			..	
...	F.A.D	7.7.6.0.0	z_b	z	..	
...5	F.S.T	7.7.6.0.0	z	z	..	
...	F.C.A	7.7.6.4.0	T_m		..	
...6	F.D.V	..1.2.4.0	$T_o = 288.16$		..	
...	F.S.T	7.7.6.6.0			..	
...7	F.C.A	7.7.6.0.0	z	z	..	
...	T.R.A	..1.0.0	to exit	z	..	

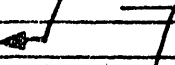LOG

EXP

Program No. 137-R Title _____

Programmed by: _____   Date April, 1961

Loc'n	Cm'd	Addr.	Contents	Accumulator	b	Remarks
60	+0.0	0.0.1.0.0	8 @ 18			
	-0.0	0.0.0.0.0				
.1	F.S.B	7.7.6.0.0		$z - zb$		← 17.1 z
	F.S.T	7.7.7.0.0	$z - zb$			
.2	F.C.A	7.7.7.6.0	z	z		
	F.S.T	7.7.6.0.0	z			
.3	F.C.A	7.7.6.6.0	Lm	Lm		
	C.F.L	.1.0.0.0				
.4	T.Z.E	..6.5.1				
	F.M.P	7.7.7.0.0		$(z - zb)Lm$		
.5	T.R.A	..6.7.0				
	F.C.A	7.7.7.0.0				
.6	F.D.V	7.7.6.4.0	Tb	$(z - zb) \div Tm$		
	T.R.A	..7.3.0				
.7	F.A.D	7.7.6.4.0	Tb	$Tb + Lm(z - zb)$		
	F.S.T	.1.0.4.0	Tm			
.7.0	F.D.V	7.7.6.4.0	Tmb	(Tm/Tmb)		LOG
	T.R.A	0.7.7.0.0	LOG			
.1	P.Z.E	7.7.7.4.0	ε			
	H.T.R	..7.0.1				
.2	F.D.V	.1.0.6.0	Lm	$(Tm/Tmb) \div Lm$		
	A.R.S	0.0.0.0.0				
.3	F.M.P	..3.0.0	P			
	T.R.A	1.0.5.0.0	EXP			EXP
.4	P.Z.E	7.7.7.4.0	ε			
	H.T.R	..7.3.1				
.5	C.T.L	.1.0.0.0		$P/Ph = (Tm/Tmb)^{Lmb/p}$		
	F.M.P	7.7.6.2.0	Pb	P		
.6	F.S.T	7.7.6.2.0	P	P		
	C.T.V	..3.0.0				
.7	F.C.A	7.7.6.4.0	Tm	Tm		
	T.R.A	7.7.7.6.0				
.1.0.0			} z			
.1						
.2			} P			
.3						
.4			} T			
.5						
.6			} T/T_0			
.7						

Program No. 137-R Title _____

Programmed by: _____ Date   April, 1961

Loc'n	Cm'd	Addr.	Contents		b	Remarks
1.10	. .	. . .	0	meters	. .	
. . .2	. .	. . .	760.	mm Hg	. .	
. . .4	. .	. . .	288.16	°K	. .	
. . .6	. .	. . .	−.0065	°K per M	. .	
1.20	. .	. . .	11.000.		. .	
. . .2	. .	. . .	169.752 74 5		. .	
. . .4	. .	. . .	216.66		. .	
. . .6	. .	. . .	0		. .	
1.30	. .	. . .	25,000		. .	
. . .2	. .	. . .	18.666 000 0		. .	
. . .4	. .	. . .	216.66		. .	
. . .6	. .	. . .	+.0030		. .	
1.4.0	. .	. . .	47,000		. .	
. . .2	. .	. . .	.903 380 0 48		. .	
. . .4	. .	. . .	282.66		. .	
. . .6	. .	. . .	0		. .	
1.5.0	. .	. . .	53,000.		. .	
. . .2	. .	. . .	.437 435 878		. .	
. . .4	. .	. . .	282.66		. .	
. . .6	. .	. . .	−.0045		. .	
1.60	. .	. . .	79,000.		. .	
. . .2	. .	. . .	.007 571 3 77 76		. .	
. . .4	. .	. . .	165.66		. .	
. . .6	. .	. . .	0		. .	
1.7.0	. .	. . .	90,000.		. .	
. . .2	. .	. . .	.000 783 328 147		. .	
. . .4	. .	. . .	165.66		. .	
. . .6	. .	. . .	+.0040		. .	
.200	. .	. . .	.105,000.		. .	
. . .2	. .	. . .	.000 055 898 413 9		. .	
. . .4	. .	. . .	225.66		. .	
. . .6	. .	. . .	+.0020		. .	
.21.0	. .	. . .	160,000.		. .	
. . .2	. .	. . .	.000 002 715 197 75		. .	
. . .4	. .	. . .	1325.66		. .	
. . .6	. .	. . .	+.0100		. .	
.22.0	. .	. . .	.170.000.		. .	
. . .2	. .	. . .	.000 002 117 854 01		. .	
. . .4	. .	. . .	1425.66		. .	
. . .6	. .	. . .	+.0050		. .	
.230	. .	. . .	200,000.		. .	
. . .2	. .	. . .	.000 001 069 122 73		. .	
. . .4	. .	. . .	1575.66		. .	
. . .6	. .	. . .	+.0035		. .	
.240	. .	. . .	100,000,000		. .	
. . .2	. .	. . .	zero		. .	
. . .4	. .	. . .	zero		. .	
. . .6	. .	. . .	zero		. .	