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TM-714/032/00

TECHNICAL MEMORANDUM

(TM Series)

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405 128

General Purpose	SYSTEM
Satellite Computer Program Descriptions	DEVELOPMENT
Milestone XI	CORPORATION
Correction Apparent Elevation for Refraction (RC)	2500 COLORADO AVE.
by DDC	SANTA MONICA
Nancy Speed	CALIFORNIA
9 November 1962	
Approved	
B. G. Ciaccia	

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SUBROUTINE IDENTIFICATION

- A. Title: Correct Apparent Elevation for Refraction (RC) -
Ident. F99, Mod. NS
- B. Programmed: J. C. Lenhoff, Lockheed Missile and Space Division
- C. Revised and Documented: 9 November 1962, Nancy Speer
System Development Corporation.

PURPOSE

RC corrects for refraction any number of apparent elevations which are within the range 0 to 2π .

USAGE

- A. Calling Sequence:

L	RTJ	RC
L+1	ZRO	EA
	ZRO	N

L+2 Normal Return

where: EA = the location of the first elevation to be corrected
N = the number of elevations to be corrected

- B. Inputs:

The input elevations must be expressed as floating-point radians within the range 0 to 2π .

- C. Results:

Each corrected elevation, as a radian value in floating-point format, is placed in the location of the input elevation. The correction factor is stored in the first cell of COMMON.

METHOD

RC picks up the first apparent elevation and, if it falls in the second quadrant, reduces it to its supplement. Angles in the third and fourth quadrants are taken as +0. The resulting reduced angle is used as the basis for determining the correction factor to be applied.

The correction factor is found, with the use of INDIV, by linear interpolation within the independent and dependent variable tables contained in RC. The independent variable table has 59 entries of

apparent elevations (E_A) from 0 to $\pi/2$; the dependent variable table has 59 values for refraction correction corresponding directly to the values in the first table. Each entry (d) in the dependent variable table was pre-computed as:

$$d = 2 / \left\{ (\tan E_A) + \left[2 (H/R - M_0) + \tan^2 E_A \right]^{1/2} \right\}$$

where: E_A = the apparent elevation

H = empirical constant scale height

R = radius of the earth

$H/R \approx .00303$

M_0 = index of refraction at the earth's surface -1, $M \approx .00033$

When INDIV yields the value of d, RC multiplies it by M_0 . The resulting correction factor is stored in COMMON.

Before the factor is applied, RC determines the quadrant in which the apparent elevation was originally. If it was in the first quadrant, the factor is subtracted from the original value; if in the second quadrant the factor is added. For angles in the third quadrant, the factor is added to π and for the fourth quadrant, the factor is subtracted from 0. The corrected elevation then is stored in the location of the original apparent elevation.

This procedure continues until all specified apparent elevations have been corrected.

RESTRICTIONS

A. Accuracy

The results of RC fall well within the requirement of accuracy to the fourth decimal place. A more definite statement of accuracy can not be made because accuracy varies greatly depending on the magnitude of the input and its proximity to any pair of entries in the two tables used for interpolation.

B. Input Limits

Inputs must be within the range 0 to 2π . Inputs outside these limits will not be reduced properly and will cause an error return from INDIV which, in turn, causes a jump to SUBERR and consequent halt.

C. Environment

RC uses the subroutines INDIV and SUBERR, and the Reference Pool. Index registers 1 and 2 are saved, used, and restored.

TIMING

Maximum $243.6xN + 101.4$ microseconds plus time for INDIV
 Minimum $198.0xN + 101.4$ microseconds plus time for INDIV
 where N = number of elevations

STORAGE REQUIREMENTS

A. Storage Allocation

Program 36_{10} cells
 Constants 122_{10} cells
 Temporary Storage $\frac{1}{159}$ cell
 159 cells

B. Constants

In addition to the tables used for interpolation, RC contains the following constants:

<u>TAG</u>	<u>DESCRIPTION</u>	<u>FORMAT</u>
SM	.00033 (refraction index-1)	floating
PTE	3.1415926535897	floating
LC1	1	fixed, scaled 2^0
COMP	-0	fixed

C. Temporary Storage

RC uses the following cell as well as the first cell in the COMMON table.

<u>TAG</u>	<u>DESCRIPTION</u>
SAVE	holds reduced angle

VALIDATION TESTS

A. Test Inputs

The test program contained a table of 21 radian values which were used as inputs to RC. Appendix A gives these inputs and the results from RC.

B. Procedure

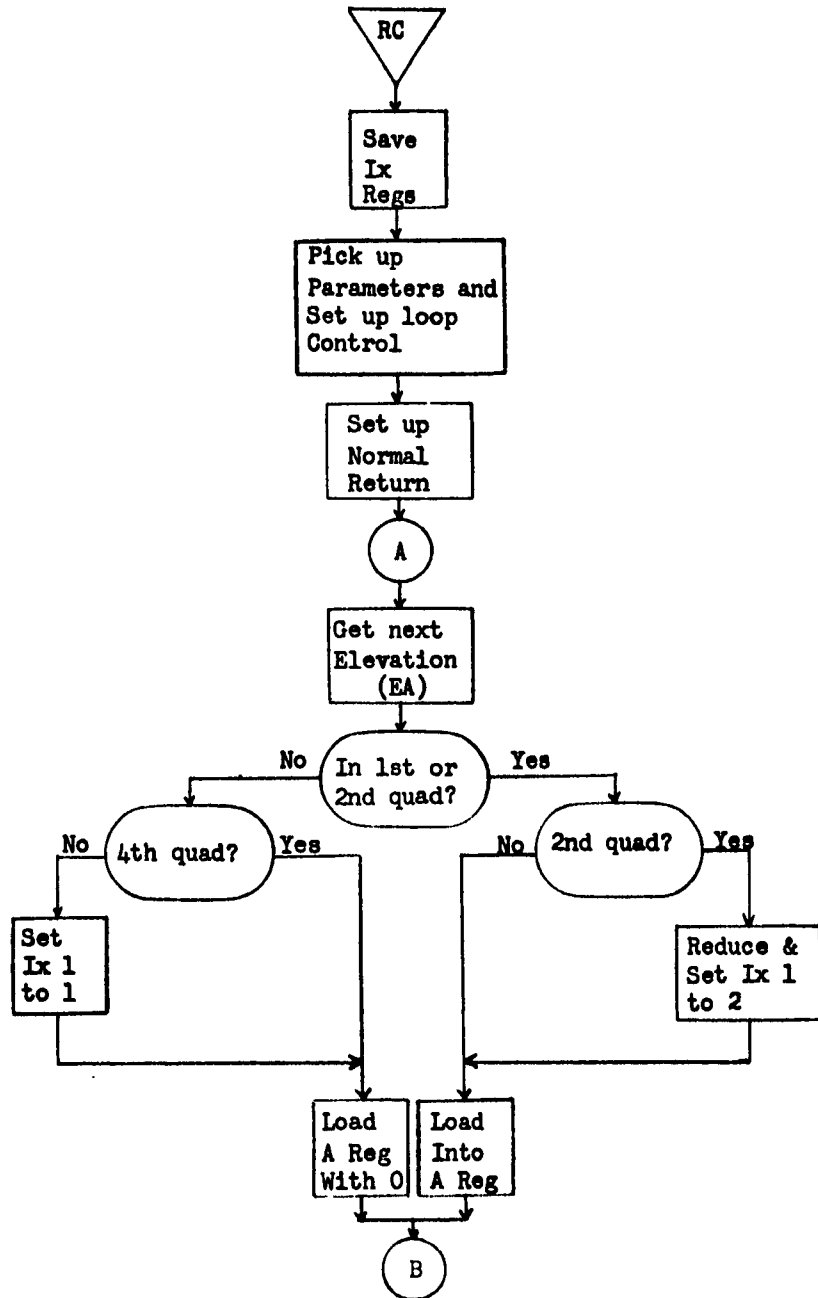
The test program was written as a callable function under MTCII control. The F99 mod. NS version of RC was incorporated as a re-defined function.

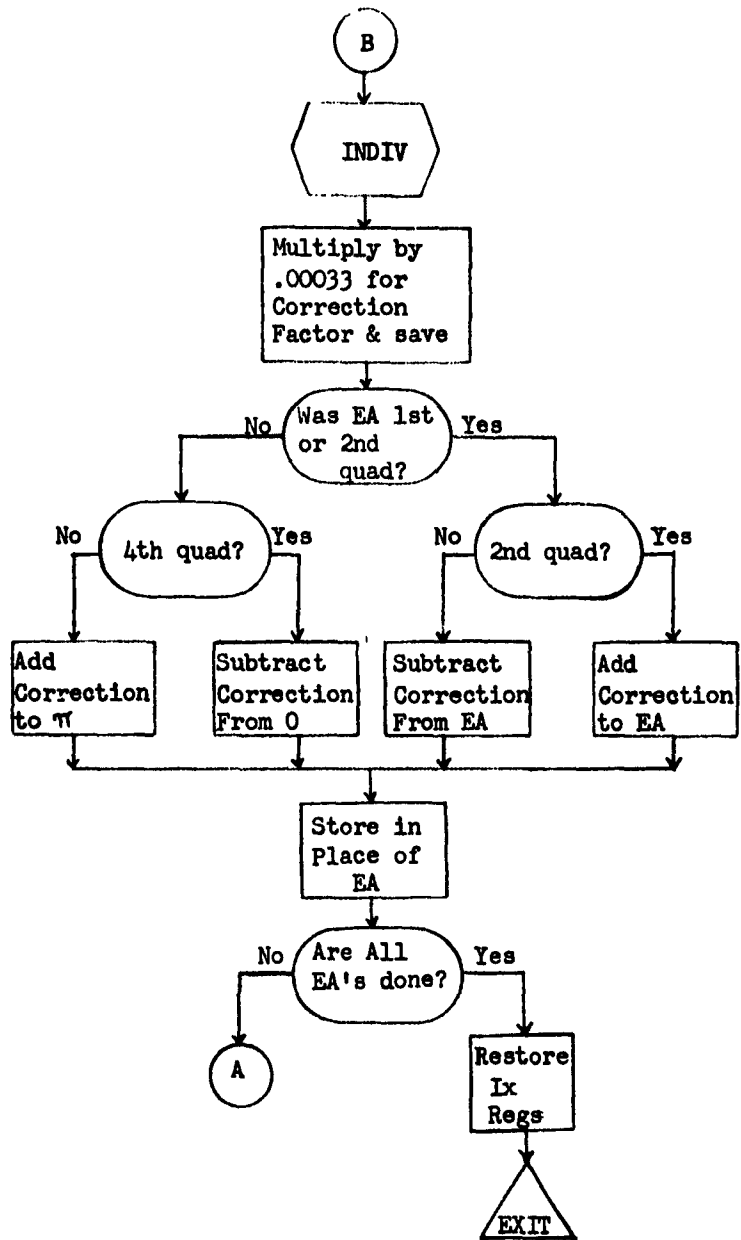
C. Results

RC gave the expected results in all cases.

REFERENCES

1. N-(L)-19126/000/00, Description of Revised RC
2. LMSC-447578, page 55.05.13, Systems Manual Subroutine Description of RC.
3. TM-(L)-715/025/00, Utility Program Descriptions, Milestone XI, Interpolate by Divided Differences (INDIV), (AFCPL #75024).
4. LMSD-447578, page 50.06.01, Systems Manual Subroutine Description of SUBERR.





APPENDIX A

The test results in decimal radians are shown in the following table.

<u>INPUT</u>	<u>RC RESULT</u>
.05236	.04773382079
.20944	.2079312841
.38397	.3831598609
.40143	.4006583167
.61087	.6104000062
.80285	.8025315364
1.0	.9997881829
1.23918	1.239066350
1.55334	1.553334237
1.58825	1.588255762
1.78024	1.780310141
2.75762	2.758430133
2.67035	2.670994323
2.09444	2.094630537
3.1415926535897	3.150574116
3.158	3.150574116
4.712	3.150574116
4.72	-.008981462391
6.27	-.008981462391
5.06145	-.008981462391
0	-.008981462391

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West, G. P.	24094A
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Wise, R. C.	24051
Wong, J. P.	Sunnyvale
Zubris, C. J.	22070
AFCPL (5)	14059

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System Development Corporation,
Santa Monica, California
GENERAL PURPOSE SATELLITE COMPUTER
PROGRAM DESCRIPTIONS MILESTONE XI
CORRECT APPARENT ELEVATION FOR
REFRACTION (RC).
Scientific rept., TM-714/032/00,
by N. Speer. 9 November 1962, 7p.,
4 refs.
(Contract AF 04(695)-40)

Unclassified report

DESCRIPTORS: Programming (Computers).
Satellite Networks.

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Reports that RC (Correct Apparent
Elevation for Refraction) corrects
for refraction any number of
elevations which are within the
range 0 to 2 ~~mi~~ *mi*.

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